ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/317597506

List of leaf beetles (Coleoptera: Chrysomelidae) from Lagodekhi reserve with new records for Transcaucasia...

Article *in* Zootaxa · June 2017

DOI: 10.11646/zootaxa.4277.1.6

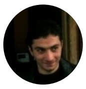
CITATION
1

READS
114

3 authors:

Ebru Gül Çilbiroğlu Aslan
Süleyman Demirel University, Isparta, Turkey
40 PUBLICATIONS **169** CITATIONS

SEE PROFILE



Levan Mumladze
Ilia State University
46 PUBLICATIONS **219** CITATIONS

SEE PROFILE

George Japoshvili
Agricultural University of Georgia
153 PUBLICATIONS **536** CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:

Project

Scale insects of apple orchards and their enemies in Eastern Georgia. View project

Project

The invertebrate animals of Colchis National Park (coastal part), their biodiversity and population of the main habitats and ecosystems. GNSF View project

All content following this page was uploaded by Ebru Gül Çilbiroğlu Aslan on 15 June 2017.

The user has requested enhancement of the downloaded file.

Zootaxa 4277 (1): 086–098
http://www.mapress.com/j/zt/
Copyright © 2017 Magnolia Press

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.4277.1.6
http://zoobank.org/urn:lsid:zoobank.org:pub:BFC106DD-B9B5-46A1-9216-96CC255595AB

List of leaf beetles (Coleoptera: Chrysomelidae) from Lagodekhi reserve with new records for Transcaucasia and Georgia

EBRU GÜL ASLAN[1], LEVAN MUMLADZE[2,3] & GEORGE JAPOSHVILI[2,4]

[1]*Department of Biology, Faculty of Arts and Science, Süleyman Demirel University, Isparta, Turkey. E-mail: ebruaslan@sdu.edu.tr*
[2]*Invertebrate Research Center, Agladze #26, Tbilisi-0119, Georgia. E-mail: giorgij70@yahoo.com*
[3]*Biodiversity Research Center, Institute of Ecology and Institute of Zoology, Ilia State University, 3/5 Cholokashvili Ave., Tbilisi, 0162, Georgia*
[4]*Institute of Entomology, Agricultural University of Georgia, Agmashenebeli Alley #240, Tbilisi, Georgia.*
E-mail: g.japoshvili@agruni.edu.ge

Abstract

Leaf beetles of Lagodekhi National Park have been studied for the first time. Thirty two species were recorded from the area of which 14 are new for Georgia, 1 genus and 8 species are new to Transcaucasus. Together with the additional 16 species that were already known from literature, a total of 48 chrysomelid species for Lagodekhi reserve is listed here with notes on the specimens examined and general distributions. Some insights into the elevational pattern of leaf beetle diversity in Lagodekhi National Park are also provided.

Key words: Chrysomelidae, Georgia, Caucasus, new records, elevational diversity gradient

Introduction

Leaf beetles (Coleoptera: Chrysomelidae) is one of the largest groups of insects with up to 40.000 species described (Jolivet *et al.*, 2009; Biondi and D'Alessandro, 2012). They display a close ecological relationship with plants (Jolivet and Verma, 2002) and therefore have an important role in ecosystems. Many of them are significant crop pests, they can live in any habitat that has vegetation and thus making the group of special interest. Leaf beetles are comparatively well studied in a world-wide context from different perspectives (Flowers and Hanson, 2003; Baselga and Novoa, 2006; Borowiec *et al.*, 2011; Ekiz *et al.*, 2012; Biondi *et al.*, 2013; Linzmeier and Riberio-Costa, 2013; Sassi, 2014; Bezdek and Regalin, 2015; Zurita *et al.*, 2016), however, data on Chrysomelidae diversity (and invertebrate animals in general) is very scarce for some regions. E.g. only a few old studies are available for Georgia (country) which is one of the world's biodiversity hotspots harboring a diverse fauna and flora (Zazanashvili *et al.*, 2004). First notes on the fauna of leaf beetles of Georgia were published in 1878 (Schneider & Leder, 1878). Later Zaitsev (1929-1953) provided some new data and Shengelia (1951) published the first list of Chrysomelidae of Georgia including 22 species. Kobakhidze (1956) indicated 10 species of chrysomelids for the Lagodekhi region. Since then, several authors contributed to the study of Chrysomelidae diversity of Georgia (Seperteladze, 1960, 1966, 1973, 1983; Kanchaveli and Supatashvili, 1968; Lopatin, 1988) resulting in a total of 293 species recorded from Georgia. After 1988, no new data were added to the leaf beetle fauna of Georgia except for a few records provided in Orlova-Bienkovskaja (2014). Obviously, a comprehensive synthesis revising and summarizing the species diversity and distribution data of Georgian chrysomelids does not exist.

After a long break we provide new data on the species diversity of Chysomelidae in Lagodekhi National Park (LNP) of Georgia. The results presented here is a part of an on-going project which aims to investigate the species diversity, spatial and temporal distribution patterns of major insect groups in LNP. In particular our aim here is to provide a species account of Chrysomelidae occurring in LNP and to explore spatial and temporal distributions of their diversity along with an elevational diversity gradient.

 Accepted by M. Schoeller: 27 Mar. 2017; published: 15 Jun. 2017

Material and methods

Study area and data collection. LNP is located in the south-eastern slopes of Greater Caucasus with an area of 19.8 km^2 extending from 570 to 3500 m a.s.l. The park is the oldest nature reserve in the Caucasus (established in 1912) and is represented with well-preserved primary mountain forests and other landscapes (APA 2016). During 2014 we established seven Malaise traps in LNP at different altitudes (Table 1). In LNP the forest habitats are completely dominating below 2100 m. In the forested landscapes we set up traps in small naturally open patches with dense herbaceous vegetation. We used a single Malaise trap per elevation as our sampling protocol was adjusted to extensive data collection during the whole vegetation period. The traps were established before the start, and lasted until the end of vegetation season, length of which was different for each elevation (Table 1). Trap contents were collected in every 10 (±1) days and placed in 96% ethanol. The chrysomelid specimens were sorted, labeled, dissected, and identified to species by the first author under an Olympus SZ61 stereomicroscope using the taxonomic keys and figures given by Konstantinov (1998), Döberl (2000), Čížek & Doguet (2008), and Warchalowski (2010).

Malaise traps were obtained from BandN Entomological services (http://www.entomology.org.uk/). All voucher specimens are deposited in the entomological collection of Agricultural University of Georgia, Tbilisi, Georgia.

Information about synonymy, and geographical distribution is given as in Löbl and Smetana (2010), therefore we did not repeat the same in this contribution, unless not necessary.

High diversity of vegetation is supposed to support a high diversity of phytophagous insects (Andrew and Hughes, 2004; Lassau *et al.* 2005; Ødegaard 2006; Baselga and Jimenes-Valvarde, 2007; Aslan and Ayvaz, 2009; Aslan, 2010). To test the effect of plant diversity on leaf beetle communities, in each sampling location, we also made a complete inventory of vascular plants in four 10 m X 10 m square random plots around each Malaise trap, respectively. Plant inventory was performed three times a year (May, June and September) to account the species with small seasonal vegetation periods. Here we only use a plant species richness data for each studied elevation while the more details of plant distribution patterns will be presented elsewere.

Data analyses. Obtained species abundance data was checked for sampling accuracy using an asympototic estimator to obtain expected species richness (Chao *et al.*, 2016a; Chao and Chiu, 2016). This was done for whole data pooled together to obtain a general overview on the total species diversity, and also for each elevations separately to estimate and compare the elevation related species diversity (Chao *et al.*, 2016b). The relationship between explanatory (elevation and plant species richness) and response variables (raw and estimated species richness of leaf beetles and total density per plot) was then visulized using scatterplots and tested for significance using generalized linear modelling (GLM) using R software (R Core Team, 2015). Since species richness is a count data we used GLM with Poisson error structure and log-link function (Quinn and Keough, 2002). In the list below we included also species recorded from LNP before our study, however this data was not included in statistical analyses as far as there is no exact distribution data (altitude or geographic coordinates) provided in the references.

Results and discussion

Species check-list

In total 374 individuals representing 32 species were recorded in LNP during our field survey, among which one genus *Macrocoma* Chapuis, 1874 is new to Caucasus, 14 species are new to Georgia and 8 species are new to Transcaucasus. Additionally 16 species were already known from literature sources; therefore the total number of chrysomelid species recorded in Lagodekhi Natural Park sums up to 48 species. The species check-list with records in LNP and general distributions according to Gruev & Döberl (1997), Gruev (2003) and Warchalowski (2010) is following below. Species new to Georgia are marked with a single asterisk (*) and those new for South Caucasus are marked with double asterisks (**).

Genus *Agelastica* Dejean, 1836

1. *Agelastica alni* (Linnaeus)
   Distribution. Known from Georgia (Kobakhidze, 1956). Palaearctic.

Genus *Altica* Müller, 1764

2. *Altica carinthiaca* Weise*
   Specimen examined. 1 male, H3, 15-25.05.2014.
   Distribution. W-Palaearctic.
3. *A. hampei* (Allard) *
   Specimen examined. 1 female, H7, 15-25.VII.2014.
   Distribution. Armenia, Daghestan, Turkey and Ukraine (Crimea).
4. *A. oleracea* (Linnaeus)
   Specimen examined. 1 male, H1, 25.07-05.08.2014.
   Distribution. Known from Georgia (Gruev, 2003). Palaearctic.
5. *A. palustris* (Weise)
   Specimens examined. 1 male, H1, 15-25.06.2014; 1 male, 25.05-04.06.2014; 1 female, H4, 15-25.05.2014.
   Distribution. Known from Georgia (Gruev, 2003). W-Palaearctic.
6. *A. quercetorum* Foudras
   Specimen examined. 1 female, H5, 25.05-04.06.2014.
   Distribution. Known from Georgia (Kobakhidze, 1956).
   Europe, Turkey and Caucasus.

Genus *Aphthona* Chevrolat, 1842

7. *Aphthona euphorbiae* (Schrank)
   Specimens examined. 1 female, H2, 12-23.04.2014; 1 female, H4, 4-14.09.2014; 1 female, H4 27.09-06.10.2014; 1 male, H4, 25.07-05.08. 2014; 1 male, H3, 27.09-06.10.2014; 1 male, H1, 15-25.08.2014; 1 male, H1, 15-25.05.2014.
   Distribution. Known from Georgia (Gruev, 2003). Palaearctic.
8. *A. reitteri* Allard
   Specimens examined. 1 male, H5, 25.08-04.09.2014; 1 male, H5, 27.09-06.10.2014; 2 females**,** H5, 4-14.09.2014.
   Distribution. Known from Georgia (Lopatin and Seperteladze, 1979; Gruev, 2003).
   Caucasus.
9. *A. testaceicornis* Weise
   Specimens examined. 2 males, H1, 5-15.05.2014.
   Distribution. Known from Georgia (Gruev, 2003). Caucasus.

Genus *Batophila* Foudras, 1860

10. *Batophila olexai* Král
    Specimens examined. 1 male, H5, 25.08-04.09.2014; 6 males, 5 females, H1 25.05-04.06.2014; 2 females, H3, 5-15.05.2014; 1 female, H2 25.06-05.07.2014; 2 males, H4 25.05-04.06.2014; 3 males H2, 5-14.09.2014; 2 males, 2 females H2, 27.09-06.10.2014; 2 males H3, 27.09-06.10.2014; 5 males, 10 females, H1, 04-14.06.2014; 1 male, 3 females H1, 15-25.08.2014; 3 males, 5 females, H2, 25.08-04.09.2014; 2 males, 1 female, H4, 15-25.05.2014; 3 males, 5 females, H3, 25.05-04.06.2014; 13 males, 12 females, H1, 15-25.05.2014; 4 females, H3, 04-14.06.2014; 1 male, 3 females, H3, 25.08-04.09.2014; 1 male, 1 female, H5, 4-14.09.2014; 14 males, 9 females, H2, 15-25.05.2014; 5 males, 6 females, H2, 25.05-04.06.2014; 1 male, H1,

25.06-05.07.2014; 2 females, H3, 03.05.2014; 1 male, 1 female, H4, 03.05.2014; 4 males, 6 females, H1, 2-12.IV. 2014; 3 males, 3 females, H1, 5-15.05.2014; 1 male, H1, 23.04-03.05.2014; 2 males, 5 females, H2, 04.05.2014; 2 males, 1 female, H2, 5-15.05.2014; 1 male, 1 female, H1, 12-23.04.2014; 2 males**,** H2**,** 12-23.04.2014.

Distribution. Known from Georgia (Gruev, 2003; Orlova-Bienkowskaja, 2014).
Bulgaria, Greece and Turkey.

Genus *Cassida* Linnaeus, 1758

11. *Cassida denticollis* Suffrian
Distribution. Known from Georgia (Zaitsev, 1938).
W-Palaearctic.
12. *C. inquinata* Brulle
Distribution. Known from Georgia (Seperteladze, 1973).
Mediterranean Region, Caucasus and Turkmenistan.
13. *C. margaritacea* Schaller
Distribution. Known from Georgia (Zaitsev, 1937).
Europe and Caucasus.
14. *C. nebulosa* Linnaeus
Distribution. Known from Georgia (Zaitsev, 1937). Palaearctic.
15. *C. palaestina* Reiche
Distribution. Known from Georgia (Zaitsev, 1937).
Armenia,SW-Asia and Kazakhstan.
16. *C. subreticulata* Suffrian
Distribution. Known from Georgia (Zaitsev, 1937).
Palaearctic.
17. *C. viridis* Linnaeus
Distribution. Known from Georgia (Zaitstsev, 1937; Kobakhidze, 1956).
Palaearctic.

Genus *Chaetocnema* Stephens, 1831

18. *Chaetocnema concinna* (Marsham)
Distribution. Known from Georgia (Kobakhidze, 1956; Gruev, 2003).
Palaearctic.

Genus *Chrysolina* Motschulsky, 1860

19 *Chrysolina caspica* (Weise)
Distribution. Known from Georgia (Orlova-Bienkowskaja, 2014).
Caucasus.
20. *Ch. limbata* (Fabricius)
Distribution. Known from Georgia (Orlova-Bienkowskaja, 2014).
Palaearctic.
21. *Chrysolina* sp.
Specimen examined. 1 female H7, 05-15.08.2014.

Genus *Cryptocephalus* Müller, 1764

22. *Cryptocephalus bicolor* Eschscholtz
    Distribution. Known from Georgia (Seperteladze, 1973, *as concinnus* Suffrian)
    Europe, Crimea, Caucasus, Turkey and Iran.
23. *Cryptocephalus* sp.
    Specimens examined. 2 females, H5, 25.07-05.08. 2014.

Genus *Donacia* Fabricius, 1775

24. *Donacia cinerea* Herbst
    Distribution. Known from Georgia (Zaitsev, 1953; Kobakhidze, 1956).
    W-Palaearctic.

Genus *Epitrix* Foudras 1860

25. *Epitrix atropae* Foudras*
    Specimens examined. 1 female, H2, 12-23.04.2014; 1 female, H3, 03.05.2014.
    Distribution. Europe, Caucasus, Turkey and Algeria.
26. *E. hirtipennis* (Melsheimer)**
    Specimens examined. 1 male, H7, 25.08-04.09.2014; 2 males, 2 females, H7, 25.06-05.07.2014; 3 males, H7, 05-15.08.2014; 1 male, H4, 03.05.2014; 1 male, H1, 2-12.04. 2014; 1 male, H1, 15-25.06.2014; 1 female, H1, 25.05-04.06.2014; 1 female, H2, 5-15.08.2014; 1 male, H5, 5-15.08.2014.
    Distribution. N-America (introduced), Italy, Greece and Turkey.
27. *E. intermedia* Foudras**
    Specimens examined. 1 female H4, 05-15.08.2014; 1 female H1, 25.05-04.06.2014
    Distribution. S-Europe, Balkans and Turkey.
28. *E. setosella* (Fairmaire)**
    Specimens examined. H1, 23.04-03.05.2014; 1 female, H2, 04.05.2014; 1 male, H1, 15-25.06.2014; 1 male, H1, 04-14.06.2014; 1 female, H1, 15-25.05.2014.
    Distribution. China and Siberia.

Genus *Galeruca* Geoffroy, 1762

29. *Galeruca tanaceti* (Linnaeus)
    Specimen examined. 1 male H3, 25.05-04.06.2014.
    Distribution. Known from Georgia (Seperteladze, 1966). Palaearctic.

Genus *Gastrophysa* Chevrolat, 1837

30. *Gastrophysa polygoni* (Linnaeus)
    Distribution. Known from Georgia (Kobakhidze, 1956 as genus *Gastroidea*).
    Europe, Caucasus, Turkey, C-Asia and N-America (introduced).

Genus *Longitarsus* Berthold, 1827

31. *Longitarsus aeneicollis* (Faldermann)

Specimen examined. 1 female, H5, 27.09-06.10.2014.
Distribution. Known from Georgia (Gruev, 2003). Europe, Mediterranean area, Caucasus and C-Asia.

32. *L. lycopi* (Foudras)
Specimens examined. 1 female, H1, 25.06-05.07.2014; 1 female, H1, 5-15.05.2014; 1 male, H1, 15-25.06.2014; 2 males, H1, 04-14.06.2014; 2 females, H1, 15-25.05.2014.
Distribution. Known from Georgia (Gruev, 2003). W-Palaearctic.

33. *L. nanus* (Foudras)**
Specimens examined. 1 female H5, 15-25.08.2014.
Distribution. Europe, Turkey, Algeria, Daghestan and Azerbaijan.

34. *L. pellucidus* (Foudras)*
Specimens examined. 2 males, 3 females, H5, 25.08-04.09.2014; 1 male, 1 female, H5, 25.07-05.08. 2014; 1 male, H4, 15.09-27.09.2014; 2 males, H4, 25.06-05.07.2014; 1 female, H4, 15-25.07.2014; 2 males, 1 female, H3, 25.08-04.09.2014; 1 male, H5, 4-14.09.2014; 4 males, 7 females**,** H3**,** 4-14.09.2014.
Distribution. Palaearctic.

35. *L. pulmonariae* Weise
Specimens examined. 4 males, 3 females, H5, 25.08-04.09.2014; 6 males, 8 females, H5, 25.07-05.08. 2014; 2 males, H2, 5-15.08.2014; 3 males, 4 females, H3, 15-27.09.2014; 2 males, 4 females, H3, 5-15.08.2014; 4 males, 1 female, H3, 15-25.08.2014; 3 males, H5, 5-15.08.2014; 2 males, H3, 25.08-04.09.2014; 2 males, 3 females, H5, 4-14.09.2014; 9 males, 27 females H6, 5-15.05.2014.
Distribution. Known from Georgia (Gruev, 2003). Europe, Balkans, Turkey and Caucasus.

36. *L. succineus* (Foudras)*
Specimens examined. 1 male, H4, 25.06-05.07.2014; 3 males, H3, 05.07-05.08.2014; 2 females, H3, 27.09-06.10.2014; 9 males, 11 females, H3, 25.05-04.06.2014; 5 males, 4 females, H3, 04-14.06.2014; 2 males, 4 females, H3, 25.08-04.09.2014; 6 males, H3, 5-15.08.2014; 2 males, H2, 15-25.05.2014; 1 male, 2 females, H3, 15-25.05.2014; 1 male, 4 females**,** H5**,** 15-25.07.2014.
Distribution. Palaearctic.

Genus *Mniophila* Stephens, 1831

37. *Mniophila muscorum* (Koch)
Specimens examined. 1 female, H4, 15-25.05.2014; 1 male, H4, 04-14.06.2014.
Distribution. Known from Georgia (Gruev, 2003; Orlova-Bienkowskaja, 2014).
Europe, Turkey and Caucasus.

Genus *Macrocoma* Chapuis, 1874**

38. *Macrocoma rubripes* (Schaufuss)**
Specimen examined. 1 female, H1, 23.04-03.05.2014.
Distribution. Balkans, Turkey and Turkmenia.

Genus *Phaedon* Dajl, 1823

39. *Phaedon cochleariae* (Fabricius)
Specimens examined.1 male, H1, 5-15.05.2014; 1 male, H1, 23.04-03.05.2014.
Distribution. Known from Georgia (Kobakhidze, 1956) misspelled as *cochlearidae*.
Europe, Turkey, Caucasus and C-Asia.

Genus *Phyllotreta* Chevrolat, 1837

40. *Phyllotreta astrachanica* Lopatin
    Specimen examined. 1 female, H3, 15-25.06.2014.
    Distribution. Known from Georgia (Gruev, 2003). Europe, Turkey, Caucasus and Kazakhstan.
41. *Ph. erysimi* Weise**
    Specimens examined. 1 male, H5, 25.08-04.09.2014; 1 male, H5, 15-25.08.2014.
    Distribution. Mediterranean area, Russia and C-Asia.
42. *Ph. nemorum* (Linnaeus)
    Distribution. Known from Georgia (Kobakhidze, 1956; Gruev, 2003).
    Palaearctic.
43. *Ph. nigripes* (Fabricius)**
    Specimens examined. 1 female, H6, 04-14.06.2014; 1 male, 1 female, H6, 25.06-05.07.2014; 1 female, H7, 05-15.07.2014; 1 female, H1, 27.09-6.10.2014; 1 female H2, 5-14.09.2014.
    Distribution. W-Palaearctic.
44. *Ph. ochripes* (Curtis)
    Specimens examined. 1 male, H2, 5-15.05.2014; 1 male, H2, 27.09-06.10.2014.
    Distribution. Known from Georgia (Kobakhidze, 1956).
    Palaearctic.
45. *Ph. striolata* (Fabricius)
    Distribution. Known from Georgia (Kobakhidze, 1956, as *vittata*).
    Palaearctic.
46. *Ph. vittula* (Redtenbacher)*
    Specimen examined. 1 female, H7, 05-15.07.2014.
    Distribution. Palaearctic.

Genus *Psylliodes* Berthold, 1827

47. *Psylliodes cuprea* (Koch)
    Specimens examined. 1 male, H3, 06.10-16.10.2014; 1 female, H1, 15-25.05.2014; 1 female, H3, 04-14.06.2014.
    Distribution. Known from Georgia (Gruev, 2003). Palaearctic.
48. *Ps. isatidis* Heikertinger**
    Specimens examined. 1 male, H2, 15-25.05.2014; 3 males, 1 female, H3, 15-25.05.2014.
    Distribution. Sibero-European.

Species inventory. The number of leaf-beetle species known from Lagodekhi protected areas arrived at 48 species, with 14 new records due to our study. In spite of the relatively low number of captured species (32 in total), they constitute ca. 11% of all Chrysomelidae known from Georgia (Zaitsev, 1929-1953; Shengelia 1951; Kobakhidze, 1956; Seperteladze, 1960-1983; Orlova-Bienkowskaja, 2014). Most of the species (53%) collected during this study were represented by singletons (11species) and in pairs (6 species), indicating the spatial rarity of leaf beetles in LNP. The correlation between the number of individuals and the species richness was very strong (r=0.9, p=0.032) meaning that the actual species number would increase significantly in case of increasing sampling effort. In contrast, asymptotic species richness estimation (calculated for each sampling plot) predicted in average additional 4 (±1sd) species at each elevation and 9 additional species when all the data were pooled together which could be interpreted as a fairly complete inventory (Table 1). The estimated low species richness could be ascribed to a relatively low number of species for each elevation while species turnover rate is high (34% in average) considering the short distance between plots (in average 1.2 km). Although not similar studies are available for neighbour areas, the sampling of Chrysomelidae is usually based on sweep nets rather than Malaise traps (Bouzan *et al.*, 2015; Sánchez-Reyes *et al.*, 2014, 2016). Indeed, the actual species richness could significantly increase in case of sweep netting and beating as the sampling with Malaise traps may not be able to effectively collect beetle species associated with herbaceous and arboreal vegetation (Aslan *et al.*, 2012).

TABLE 1. A summary table describing the sampling localities, habitat description, total abundances for each locality, total and estimated species richness of chrysomelids and plants. The last column indicates the length of the vegetation gradient expressed as counts of 10-day sampling events.

Sampling localities	Elevation	Longitude	Latitude	Habitat
H1	665	41.85248	46.28776	Low-land forest
H2	845	41.85585	46.29273	Mountain forest
H3	1345	41.87146	46.31153	Mountain forest
H4	1850	41.88273	46.32185	Mountain forest
H5	1900	41.88557	46.32413	Subalpine forest
H6	2230	41.89805	46.33387	Subalpine meadow
H7	2559	41.90616	46.33340	Alpine meadow

continued.

Sampling localities	Total abundance	Species richness	Expected richness	Unique species	Plant richness
H1	100	13	15	5	51
H2	74	10	16	1	50
H3	111	11	23	3	39
H4	24	9	15	1	34
H5	49	8	12	3	90
H6	5	3	4	2	139
H7	11	4	7	2	119

Patterns of diversity distribution. Leaf beetles, while being a very diverse family, is rather poorly studied from an elevational diversity gradient perspective. Only a few studies are available, mainly from Mexico (Furth, 2009; Sánchez-Reyes *et al.*, 2016, 2014) and Brazil (Bouzan *et al.*, 2015). All these studies are reporting a hump shaped diversity patterns along with elevational gradient except Sánchez-Reyes *et al.* (2016). In this case, the highest diversity was found at the highest elevation which was at 1080m a.s.l.. This on the other hand indicates that the actual pattern of species diversity may be hump-shaped rather than positive linear if the data from elevations above 1080 m would have been gathered. In contrast to species richness distribution in the above mentioned studies, there is no consistent pattern in the distribution of total abundances with elevations. In our case, both measures of species richness (observed and estimated) as well as individual density are decreasing with increasing elevations in a linear manner (Table 2; Fig. 1). GLM with Poisson errors proved to fit data well with elevation explaining a significant amount of variation in diversity distribution of leaf beetles (Table 2). In contrast to elevation the beetle diversity and abundance were inversely related to plant species richness (Spairman's r=-0.6, p>0.05 and r=-0.7, p>0.05) (Fig. 2). Such kind of inconsistency between the diversities of plants and terrestrial snails were also observed in LNP where plant species richness (also increased with elevation) was not related to snail species richness at all (showing unimodal pattern) (Mumladze *et al.*, 2017). However, the distribution of snails as well as plants is rather well explained by a climatic variability hypothesis while there is no obvious sampling bias introduced. Unexpected (although insignificant) relationship between plant and leaf beetle species richness in our case is supposed to be a sampling artifact rather than an anomalous phenomena. Indeed, the increase of plant species richness with increasing elevations is completely due to herbaceous vegetations, beetle diversity of which may not be correctly accounted for Malaise traps. On the other hand, the observed elevational diversity

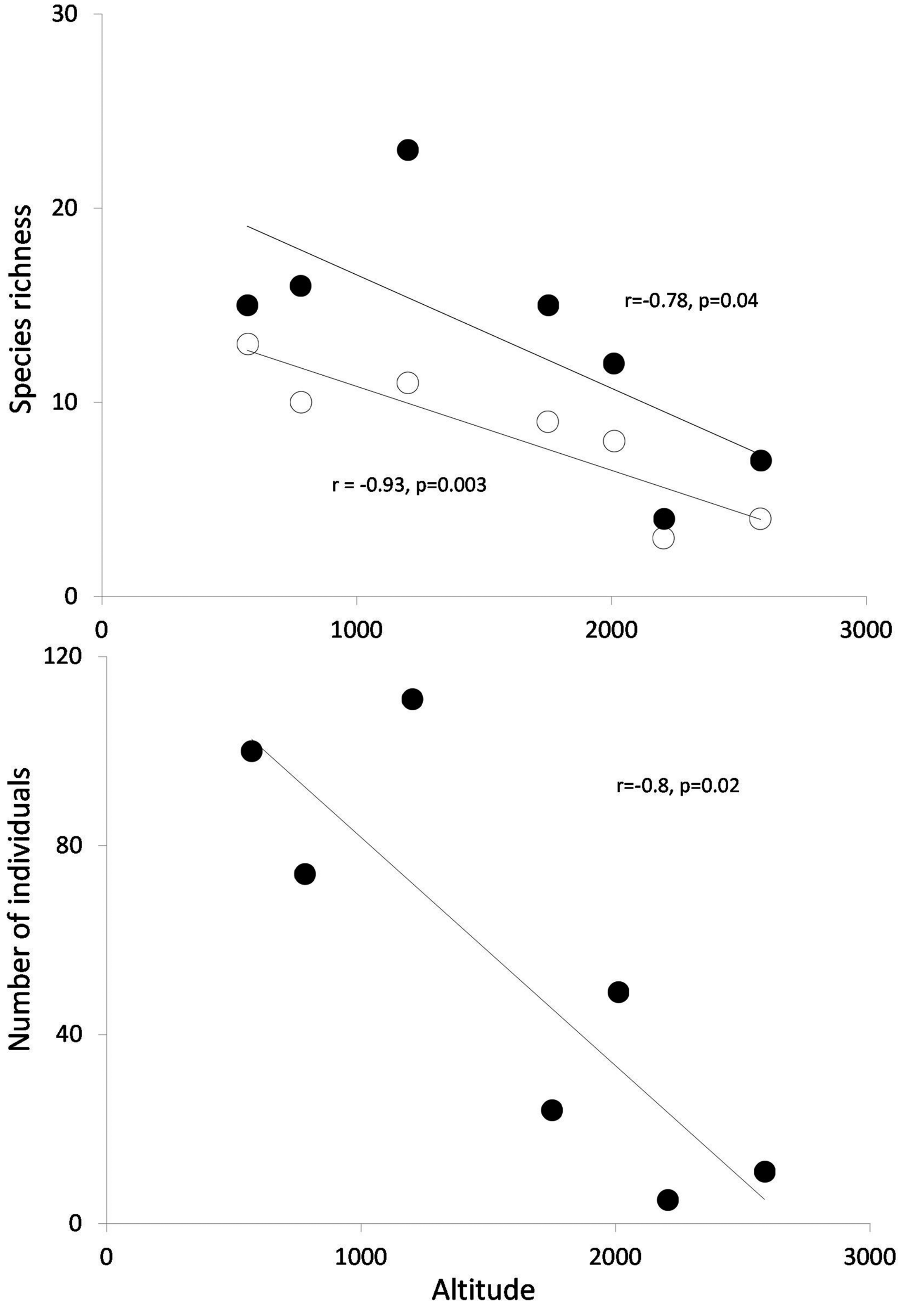


FIGURE 1. Species richness (upper panel) and abundance (lower panel) distribution along with elevational gradient. On upper panel, open and filled circles indicate raw and estimated species richness respectively.

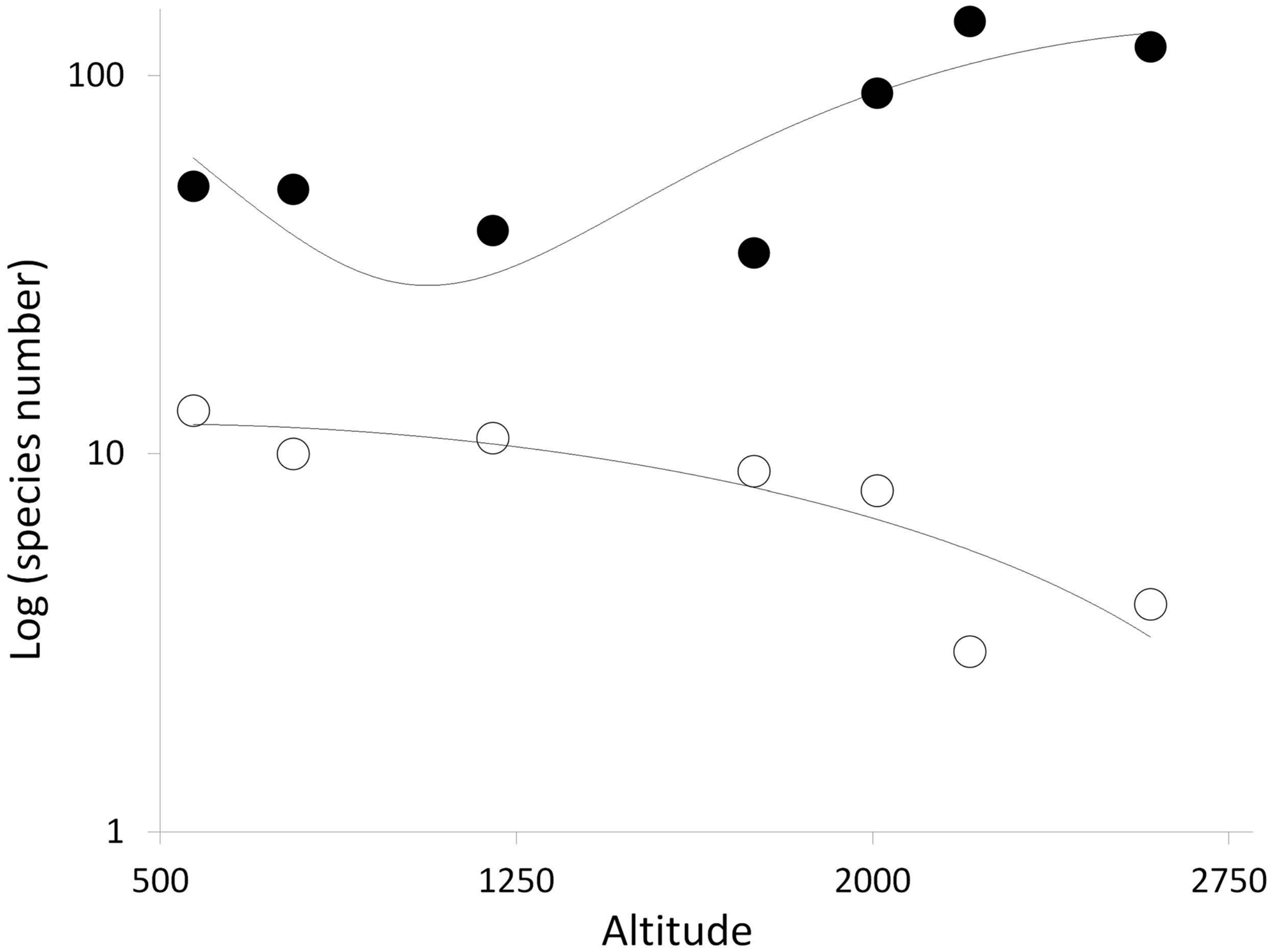


FIGURE 2. Contrasting distribution of plant (black circles) and chrysomelid (open circles) species richness along with elevational gradient. Note that richness is presented in log scale.

pattern of leaf beetles could also be a biased by the same reason. E.g. the number of plant species does not uniformly increases along with elevation. In the forest area (H1-H4) plant species richness is generally decreasing which is in concordance with beetle diversity (Table 1; Fig. 2). In the higher elevations (H5-H7) number of plant species is increasing quickly (from 34 at H4 to 90 at H5) which is due to herbaceous vegetation, and the beetle species richness does not reflect this change. The last two highest elevational plots which represent completely treeless subalpine meadows exposed highest plant species richness and lowest beetle species diversity. These clearly show that the Malaise trap is able to capture leaf beetle communities more or less effectively only in forest habitats. Nevertheless, the beetle species richness in forests is decreasing with elevation, and the estimate of beetle species richness is presumably affected by a strong sampling bias in subalpine to alpine areas. If this assumption will hold then meadows above tree line harbouring a large plant species diversity would also result in a much diverse beetle community. To test these hypotheses, additional data collection is necessary in subalpine to alpine areas of LNP.

TABLE 2. Summary statistics of GLM regressions assuming poisson errors. p_1, p_2, p_3 represents the significance level of chi-square tests for residual deviance, variable importance (after analyses of variance) and dispersion testing. Values larger than 0.05 for p_1 and p_3 indicating good model fitting to data and absence of overdispersion, respectively.

	Null Dev.(df)	Res. Dev.(df)	p_1	p_2	p_3
Raw richness vs elevation	10.7(6)	3.0 (5)	0.6	0.005	0.59
Estimated richness vs elevation	13.5(6)	7.2(5)	0.2	0.010	0.48
Density vs elevation	10.7(6)	3.2(5)	0.7	0.006	0.53
Beetle richness vs plant richness	10.7(6)	2.3(5)	1.0	0.003	0.70

Acknowledgments

We would like to thank to Dr. Andrzej Bienkowski, Institute of Animal Ecology and Evolution, Russian Academy of Sciences, for his valuable comments and help during preparing the list of chrysomelids.We also thank to Mr. Giorgi Sulamanidze director of Lagodekhi protected areas for his support during this study. We are greatful to Rustaveli National Science Foundation for financial support through the project ref. FR/221/7-110/13.

References

Andrew, N.R. & Hughes, L. (2004) Species diversity and structure of phytophagous beetle assemblages along a latitudinal gradient: predicting the potential impacts of climate change. *Ecological Entomology*, 29, 527–542. https://doi.org/10.1111/j.0307-6946.2004.00639.x

APA (2016) Lagodekhi protected areas. Available from: http://apa.gov.ge/en/ (accessed 8 January 2016)

Aslan, E.G. & Ayvaz, Y. (2009) Diversity of Alticinae (Coleoptera: Chrysomelidae) in Kasnak Oak Forest Nature Reserve, Isparta, Turkey. *Turkish Journal of Zoology*, 33, 251–262.

Aslan, E.G. (2010) Comparative diversity of Alticinae (Coleoptera: Chrysomelidae) between Çığlıkara and Dibek Nature Reserves in Antalya, Turkey. *Biologia*, 65 (2), 316–324. https://doi.org/10.2478/s11756-010-0025-7

Aslan, E.G., Japoshvili, G., Aslan, B. & Karaca, I. (2012) Flea beetles (Coleoptera: Chrysomelidae: Alticinae) collected by Malaise trap method in Gölcük Natural Park (Isparta, Turkey) with a new record for the Turkish fauna. *Archives of Biological Sciences*, Belgrade, 64 (1), 365–370. https://doi.org/10.2298/ABS1201365A

Baselga, A. & Novoa, F. (2006) Diversity of Chrysomelidae (Coleoptera) in Galicia, Northwest Spain: estimating the completeness of the regional inventory. *Biodiversity and Conservation*, 15, 205–230. https://doi.org/10.1007/s10531-004-6904-x

Baselga A. & Jiménez-Valverde, A. (2007) Environmental and geographical determinants of beta diversity of leaf beetles (Coleoptera: Chrysomelidae) in the Iberian Peninsula. *Ecological Entomology*, 32, 312–318. https://doi.org/10.1111/j.1365-2311.2007.00880.x

Bezděk, J. & Regalin, R. (2015) Identity of species-group taxa of the Western Palaearctic Clytrini (Coleoptera: Chrysomelidae: Cryptocephalinae) described by Maurice Pic and Louis Kocher. *Acta Entomologica Musei Nationalis Pragae*, 55 (Supplement), 1–113.

Biondi, M. & D'Alessandro, P. (2012) Afrotropical flea beetle genera: a key to their identification,updated catalogue and biogeographical analysis (Coleoptera, Chrysomelidae, Galerucinae, Alticini). *Zookeys*, 253, 1–158. https://doi.org/10.3897/zookeys.253.3414

Biondi, M., Urbani, F. & D'Alessandro, P. (2013) Endemism patterns in the Italian leaf beetle fauna (Coleoptera: Chrysomelidae). *ZooKeys*, 332, 177–205. https://doi.org/10.3897/zookeys.332.5339

Borowiec, L., Ścibior, R. & Kubisz, D. (2011) Critical check-list of the Polish Chrysomeloidea, excluding Cerambycidae (Coleoptera: Phytophaga). *Genus*, 22 (4), 579–608.

Bouzan, A.M., Flinte, V., Macedo, M.V. & Monteiro, R.F. (2015) Elevation and temporal distributions of Chrysomelidae in southeast Brazil with emphasis on the Galerucinae. *Zookeys*, 547, 103–117. https://doi.org/10.3897/zookeys.547.9723

Chao, A. & Chiu, C.H. (2016) *Nonparametric estimation and comparison of species richness*. *In*: *Encyclopedia of Life Sciecnes*. John Wiley & Sons, Ltd, Chichester, pp. 1–11. https://doi.org/10.1002/9780470015902.a0026329

Chao, A., Chiu, C.H. & Jost, L. (2016a) Statistical challenges of evaluating diversity patterns across environmental gradients in mega-diverse communities. *Journal of Vegetation science*, 27, 437–438. https://doi.org/10.1111/jvs.12420

Chao, A., Ma, K.H. & Hsieh, T.C. (2016b) iNEXT (iNterpolation and EXTrapolation) Online: Software for Interpolation and Extrapolation of Species Diversity [WWW Document]. Aailable from: http://chao.stat.nthu.edu.tw/wordpress/software_download/ (accessed 24 April 2017)

Čížek, P. & Doguet, S. (2008) *Klic k urcovani drepciku (Coleoptera: Chrysomelidae: Alticinae) Ceska a Slovenska*. Mestske Muzeum, Nove Mesto nad Metuji, Bratislava, 232 pp. [in Slovak]

Döberl, M. (2000) Beitrag zur Kenntnis der Gattung *Epitrix* Foudras, 1860 in der Paläarktis (Coleoptera: Chrysomelidae: Alticinae). *Mitteilungen des Internationalen Entomologischen Vereins e. V. Frankfurt am Main*, 25, 1–23.

Ekiz, A.N., Şen, İ., Aslan, E.G. & Gök, A. (2013) Checklist of leaf beetles (Coleoptera: Chrysomelidae) of Turkey, excluding Bruchinae. *Journal of Natural History*, 47 (33–34), 2213–2287. https://doi.org/10.1080/00222933.2012.763069

Flowers, R.W. & Hanson, P.E. (2003) Leaf beetle (Coleoptera: Chrysomelidae) diversity in eight Costa Rican habitats. *In*:

Furth, D.G. (Ed.), *Special topics in leaf beetle biology, Proceedings of the Fifth International Symposium on the Chrysomelidae*. Pensoft Publishers, Moscow, pp. 25-51.

Furth, D.G. (2009) Flea beetle diversity of the Sierra Tarahumara, Copper Canyon, Mexico (Chrysomelidae: Alticinae). *In*: Jolivet, P., Schmitt, M. & Santiago-Blay, J. (Eds.), *Research on Chrysomelidae*. Koninklijke Brill, Leiden, pp. 131–151. https://doi.org/10.1163/ej.9789004169470.1-299.45

Gruev, B.A. (2003) A comparative study on the fauna of Alticinae (Coleoptera, Chrysomelidae) in the Asian part of Turkey and the adjacent countries Georgia, Armenia, Iran, Iraq and Syria. *Travaux scientifiques de l'Université de Plovdiv*, Animalia, 39 (6), 19–40.

Gruev, B. & Döberl, M. (1997) General distribution of the flea beetles in the Palaearctic Subregion (Coleoptera, Chrysomelidae: Alticinae). *Scopolia*, 37, 1–496.

Gómez-Zurita, J., Cardoso, A., Coronado, I., De la Cadena, G., Jurado-Rivera, J.A., Maes, J-M., Montelongo, T., Nguyen, D.T. & Papadopoulou, A. (2016) High-throughput biodiversity analysis: Rapid assessment of species richness and ecological interactions of Chrysomelidae (Coleoptera) in the tropics. *In*: Jolivet, P., Santiago-Blay, J. & Schmitt, M. (Eds.), Research on Chrysomelidae 6. *ZooKeys*, 597, pp. 3–26.
https://doi.org/10.3897/zookeys.597.7065

Jolivet, P., Santiago-Blay, J.A. & Schmitt, M. (2009) *Research on Chrysomelidae. Vol. 2*. Brill, Leiden, 300 pp.

Jolivet, P. & Verma, K.K. (2002) *Biology of leaf beetles*. Intercept Publishers, Andover, Hampshire, 332 pp.

Kanchaveli G., Supatashvili S. (1968) *Forest Entomology*, Ganatleba, Tbilisi. 373 pp.

Kobakhidze, D. (1956) Materials to study entomofauna of Lagodekhi state reserve. *Proceedings of Institute of Zoology*, 14, 189–214.

Konstantinov, A.S. (1998) *Revision of the Palearctic species of* Aphthona *Chevrolat and cladistic classification of the Aphthonini (Coleoptera: Chrysomelidae: Alticinae)*. Associated Publishers, Gainesville, Florida, 429 pp.

Lassau, S.A., Hochuli, D.F., Cassis, G. & Reid, C.A.M. (2005) Effects of habitat complexity on forest beetle diversity: do functional groups respond consistently? *Diversity and Distributions*, 11, 73–82.
https://doi.org/10.1111/j.1366-9516.2005.00124.x

Linzmeier, A.M. & Ribeiro-Costa, C.S. (2013) Seasonal pattern of Chrysomelidae (Coleoptera) in the state of Paraná, southern Brazil. *Biota Neotropica*, 13 (1), 153–162.
https://doi.org/10.1590/S1676-06032013000100018

Lopatin, I. & Seperteladze, M. (1979) New and little-known leaf-eating Beetles (Coleiptera, Chrysopelidae) in Georgia's fauna. *Bulletin og Georgian Academy of Sciences*, 94 (2), 461–463.

Löbl, I. & Smetana, A. (2010) *Catalogue of Palaearctic Coleoptera: Chrysomeloidea. Vol. 6.* Apollo Books, Stenstrup, 924 pp.

Mumladze, L., Asanidze, Z., Walther, F. & Hausdorf, B. (2017) Beyond elevation: Testing the climatic variability hypothesis vs Rapoport's rule in vascular plant and snail species in the Caucasus. *Biological Journal of the Linean Society*. [published online]
https://doi.org/10.1093/biolinnean/blx027

Nakhutsrishvili, G. (2013) *The vegetation of Georgia (South Caucasus). 2nd Edition*. Springer, Berlin, 235 pp.
https://doi.org/10.1007/978-3-642-29915-5

Orlova-Bienkowskaja, M. (2014) Catalogue of locations of leaf-beetles (Chrysomelidae) of Russia. Online publication. Available from: https://www.researchgate.net/publication/261705007_Catalogue_of_locations_of_leaf-beetles_Chrysomelidae_of_Russia_Katalog_mestonahozdenij_listoedov_Coleoptera_Chrysomelidae_Rossii (accessed 24 April 2017)

Ødegaard, F. (2006) Host specificity, alpha- and beta-diversity of phytophagous beetles in two tropical forests in Panama. *Biodiversity and Conservation*, 15, 83–105.
https://doi.org/10.1007/s10531-004-3106-5

Quinn, G.P. & Keough, M.J. (2002) *Experimental design and data analysis for biologists*. Cambridge University Press, Cambridge, 553 pp.
https://doi.org/10.1017/CBO9780511806384

R Core Team (2016) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available from: https://www.R-project.org/ (accessed 24 April 2017)

Sánchez-Reyes, U.J., Niño-Maldonado, S., Barrientos-Lozano, L., Clark, S.M. & Jones, R.W. (2016) Faunistic patterns of leaf beetles (Coleoptera, Chrysomelidae) within elevational and temporal gradients in Sierra de San Carlos, Mexico. *Zookeys*, 611, 11–56.
https://doi.org/10.3897/zookeys.611.9608

Sánchez-Reyes, U.J., Niño-Maldonado, S. & Jones, R.W. (2014) Diversity and altitudinal distribution of Chrysomelidae (Coleoptera) in Peregrina Canyon, Tamaulipas, Mexico. *Zookeys*, 417, 103–132.
https://doi.org/10.3897/zookeys.417.7551

Sassi, D. (2014) Taxonomic remarks, phylogeny and evolutionary notes on the leaf beetle species belonging to the *Cryptocephalus sericeus* complex (Coleoptera: Chrysomelidae: Cryptocephalinae). *Zootaxa*, 3857 (3), 333–378.
https://doi.org/10.11646/zootaxa.3857.3.2

Schneider, O. & Leder, H. (1878) Beiträge zur Kenntniss der kaukasischen Käferfauna. *Verhandlungen des Naturforschenden Vereins in Brünn*, 17, 3–104.

Seperteladze, M. (1960) To the fauna of leaf-eater beetles from (Coleoptera: Chrysomelidae) Georgia SSR. *Bulletin of acadey of Science of Georgia*, 25 (1), 61–64.
Seperteladze, M. (1966) To study fauna of leaf-eater beetles (Coleoptera: Chrysomelidae), from Tbilisi and it's neighbourhood. *Materials to fauna of Georgia*, 1966 (Metsniareba), 36–45. [in Russian].
Seperteladze, M. (1973) The new data on leaf beetles of Georgian fauna. *Materials of Georgian fauna*, 3, 113–132.
Seperteladze, M. (1983) Landscape distribution of leaf-eater beetles (Coleoptera: Chrysomelidae) in the teritory of Samtskhe-Trialeti and Javakheti. *Fauna and Ecology of Invertebrate animals in Georgia*, 1983, 167–177. [in Russian]
Soberón, J. & Peterson, T. (2004) Biodiversity informatics: managing and applying primary biodiversity data. *Philosophical Transactions of the Royal Society B*, Biological Sciences, 359, 689–698.
https://doi.org/10.1098/rstb.2003.1439
Warchalowski, A. (2010) *The Palearctic Chrysomelidae: Identification Keys. Vols. 1 & 2*. Natura Optima Dux Foundation, Warszawa, 1212 pp.
Zaitsev, P. (1929) Distribution of subfamilies of Hispini and Cassidini (Coleoptera: Chrisomelidae) in Caucasus. *Proceedings of Zoological Sector*, 2, 1–16. [in Georgian]
Zaitsev, F. (1937) Distribution of subfamilies Hispini and Cassidini (Coleoptera, Chrisomelidae) members in Caucasus. *Proceedings of Zoological Sector*, 2, 1–16. [in Russian]
Zaitsev, F. (1953) Water beetles of Georgian fauna. *Proceedings of Institute of Zoology*, 11, 87–126.
Zazanashvili, N., Sanadiradze, G., Bukhnikashvili, A., Kandaurov, A., Tarkhnishvili, D. (2004) *Caucasus*. *In*: Mittermaier, R., Gil, P., Hoffmann, M., Pilgrim, J., Brooks, T., Mittermaier, C., Lamoreux, L. & da Fonseca, G. (Eds.), *Hotspots Revisited: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions*. CEMEX/Agrupacion Sierra Madre, Mexico city, pp. 148–153.

View publication stats