

RESEARCH ARTICLE

Distribution of *Onthophagus vacca* and *O. medius* (Coleoptera: Scarabaeidae, Scarabaeinae) in Romania

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Abstract

Morphological and molecular data indicate that two valid species exist in Europe within the two species complex, *Onthophagus vacca* and *O. medius*. The aim of our study is to check specimens from major museum collections and some personal collections from the country and to assign them to *O. medius* or *O. vacca*. We have examined 417 specimens belonging to the following collections: "Grigore Antipa" National Museum of Natural History Bucharest, Brukenthal National Museum-Natural History Museum, Department from Sibiu and the authors' personal collections. We extracted elevation data for each specimen and we created distribution maps. The biogeographic distribution for Romania shows the ranges of *O. vacca* and *O. medius* overlap and they are found in all the country's bioregions. Our study shows a high ecological plasticity in both species. Our data apparently indicate a preference for altitudes below 500 meters, possibly influenced by non-random sampling.

Keywords

Altitude preference, distribution, *Onthophagus vacca*, *O. medius*, Romania.

Introduction

The genus *Onthophagus* is the biggest genus of the subfamily Scarabaeinae and tribe Onthophagini and has a worldwide distribution (Smith 2006). Scarabaeinae currently include around 5700 valid species which belong to 227 genera and 12 tribes (Davis et al. 2008). With about 2300 valid species, *Onthophagus* is a hyperdiverse genus within the subfamily Scarabaeinae (Rossini et al. 2016). Erichson (1848) distinguished two taxa, *Onthophagus vacca* (Linnaeus, 1767) and *O. medius* (Kugelann, 1792) (from Prussia), based on a comparison of the two species that revealed clear differences between them. However, the wide variation of external morphology and colour determined that *O. medius* to be treated as a junior synonym of *O. vacca* by subsequent authors (e.g. Horion 1958, Balthasar 1963, Baraud 1985, 1992, Martin-Piera and López-Colón 2000, Kabakov 2006). The morphological and molecular data examined indicate the existence of two distinct species (Roy et al. 2015) in Europe within the *O. vacca* complex that are widely sympatric: *O. vacca* and *O. medius*. Rössner et al. (2010) mention the species *O. medius* for Romania for the first time: “Desert. Deliblát, Banat, Holtz” (actually Deliblát is on the territory of Serbia, being at least 5 kilometers - as the crow flies - from Romania) (4♀, ZMHB); “Rumänien, Donaudelta, Unirea [bei Brăila]”, 11.VI.1988, leg. Hornburg (1♂, 3♀, COH); “Comana Vlașca”, A. L. Montandon (1♂, DEI); “Dobroudja Mangalia” leg. A. L. Montandon (1♂, DEI); “Jassy [= Iași]” (3♂, ZSM); Bucharest (1♂, ZSM).

For Romania, Panin (1957) recorded *O. vacca*, spread throughout the country, and its aberration *medius* – credited to Panzer (1796). A vertical distribution up to 800–1300 meters a.s.l. in the mountains is mentioned for the two species.

The aim of our study is to check major museum collections and private collections, to clarify the distribution of the two species, to add new records for Romanian territory and to evaluate the geographic and vertical distribution of the two species in Romania.

Material and methods

For our research we have examined 417 specimens, 330 specimens being identified as *O. vacca* and 87 specimens as *O. medius*. Most specimens examined (382) had complete collecting data and could be used for the distribution map. The material was obtained from 93 locations from all over the country. The material examined comes largely from the MGAB entomological collections (the *Palearctic Coleoptera* collection; the study collection) and BNM collections (*Eckbert Schneider* collection, *Eugen Worell* collection, *Hannenheim* collection, *Karl Petri* collection, *Transylvanian Society of Natural Science* collection and *Rolf Weyrauch* collection), as well as from the authors’ private collections: C. Mancî, C. Chimișliu and A. Ruicănescu.

The specimens were collected between 1858 (*Transylvanian Society* collection) and 2018 (MGAB - study collection). The identification was made on the basis of

both inner morphological structures (Figs 1A; 2B) and outer morphological features (Figs 1A, 1B; 2B, 2C); the identification followed the key of Rössner et al. (2010). Information recorded for each specimen are as follows: number of individuals, sex, the collection site and date, alphabetically grouped by counties, the collector's name. For individuals where precise locality data were available (382 specimens, < 1 km) we georeferenced the location using Google Earth Pro v7.3. Subsequently, we extracted elevation information for each specimen using a 30 meters digital elevation model (freely available for download from www.eea.europa.eu) and ArcGIS 10.4 (ESRI 2013) which were used to test the existence of any vertical bias.

A distribution map of the two *Onthophagus* species was also generated using ArcGIS 10.4.

Vertical distribution for each species was investigated by means of bar charts created in Microsoft Excel 2016.

The photos were taken using the digital camera Canon EOS 5D mark IV; for photo stacking technique and for photo processing Adobe Photoshop v.20 was used.

Abbreviations:

AR - Collection of Adrian Ruicănescu, Cluj, Romania;

BNM - NHMD - Brukenthal National Museum – Natural History Museum Department;

CC - Collection of Cornelia Chimişliu, Craiova, Romania;

CM - Collection of Cosmin Mancu, Iaşi, Romania;

COH - Collection of Oliver Hillert, Berlin, Germany;

DEI - Deutsches Entomologisches Institut, Müncheberg (L. Behne, L. Zerche), Germany;

MGAB - “Grigore Antipa” National Museum of Natural History;

ZMHB - Zoologisches Museum der Humboldt-Universität zu Berlin (J. Frisch), Germany;

ZSM - Zoologische Staatssammlung München (M. Baehr), Germany

Mt./Mts. - Mountain/s; spec. (s) - specimen/s; coll. - collection;

Abbreviations for the county names in Romania: AB - Alba; AR - Arad; AG - Argeş; B - Bucureşti; BC – Bacău; BR - Brăila; BV - Braşov; BZ - Buzău; CJ - Cluj; CL - Călăraşi; CS - Caraş-Severin; CT - Constanţa; DJ - Dolj; GL - Galaţi; GR - Giurgiu; GJ - Gorj; HR - Harghita; HD - Hunedoara; IF - Ilfov; IL - Ialomiţa; IS - Iaşi; MH - Mehedinţi; MM - Maramureş; MS - Mureş; NT - Neamţ; OT - Olt; PH - Prahova; SB - Sibiu; SJ - Sălaj; SM - Satu Mare; SV - Suceava; TL - Tulcea; TR - Teleorman; TM - Timiş; VL - Vâlcea; VN - Vrancea; VS - Vaslui.

Results and discussions

In the examined material we have identified 330 specimens of *Onthophagus vacca* and 87 specimens of *O. medius*. Taking into account

the examined material, we presume that *O. medius* occurs more rarely than *O. vacca*. We present the analyzed material according to the taxonomic system.

Genus *Onthophagus* Latreille, 1802

Subgenus *Palaeonthophagus* Zunino, 1979

***Onthophagus (Palaeonthophagus) vacca* (Linnaeus, 1767)**

Examined material: 330 specimens

“Grigore Antipa” National Museum of Natural History collections (MGAB) - 228 spec.

Paleartic Coleoptera Collection - 23 specimens: Bucharest, coll. R. Canisius (1♀); MH, Turnu Severin, 08.02.1964, (leg.?) (1♂); PH, Azuga (7♀); PH, Buștenari, coll. R. Canisius (1♀); PH, Sinaia, 06.23.1965, leg. A. Roșca (1♀); TR, Nanov forest, 05.13.1980, leg. I. Matache (1♀); without collecting data (3♂, 8♀).

Study Collection - 205 specimens: AR, Gurahonț, 19.06.1961, leg. N. Săvulescu (1♂); AG, Pitești, 09.05.1961, leg. N. Săvulescu (1♀); BV, Predeal, 04.07.1992, leg. H. Tănase (1♂); B, Herăstrău [Regele Mihai I], 03.05.1991, leg. H. Tănase (1♂); BZ, Balaurl Hill, 16.04.2005, leg. V. Ungureanu (2♂, 2♀); BZ, Balaurl Hill, 12.05.2004, leg. V. Ungureanu (1♀); BZ, Frasinu forest, 12.05.1987, leg. N. Găldean (2♂); BZ, Izvorul Dulce, Slănic river valley, 03.05.2005, leg. V. Ungureanu (5♂, 4♀); CS, Băile Herculane, 04.05.1986, leg. V. Brădescu (1♂); GL, Hanul Conachi, 07.1950 (1♀); CJ, Valea Fânătelor, N 46.819195, E 23.601314, 22.04.2018, leg. A. Drăghici (2♂, 3♀); CT, Agigea, 07.08.1964 (1♂); CT, Băneasa - Canaraua Fetei, 24.07.1955, leg. N. Săvulescu (2♂, 2♀); CT, Băneasa - Canaraua Fetei, 15.05.1963, leg. N. Săvulescu (1♂, 2♀); CT, Băneasa - Canaraua Fetei, 10.04.1999, leg. N. Săvulescu (1♀); CT, Esecchioi, 10.06.1961, leg. N. Săvulescu (1♂, 1♀); CT, Esecchioi, 12.05.1963, leg. N. Săvulescu (1♀); CT, Esecchioi, 13.05.1963, leg. N. Săvulescu (1♂, 2♀); GR, Comana forest, 10.05.1962, leg. I. Drăghia (1♀); GR, Comana forest, 15.05.2005, leg. V. Ungureanu (1♀); HR, Búdösfürdő, [Sântimbru, Băile Pucioasa], 1952, coll. E. Varadi (1♂); IS, Podu Roș, 02.05.1976, (leg.?) (4♂, 2♀); IS, Poieni, 17.04.1953, (leg.?) (1♂, 1♀); IS, Oțeleni, 09.06.1974, (leg.?) (1♂, 2♀); IS, Oțeleni, 16.06.1974, (leg.?) (1♀); IF, Chitila, 27.04.1954, leg. X. Scobiola (1♀); IF, Pasărea forest, 21.05.1954, leg. N. Săvulescu (1♀); MM, Nagvnyires [Mireșul Mare], 1916, coll. E. Varadi (2♀); MM, Repedea, 24.05.1997, leg. R. Serafim (1♂); MH, Breșnița Ocol, 20.05.1964, leg. N. Săvulescu (56♂, 68♀); MH, Gura Văii, 15.05.1970, leg. N. Săvulescu (1♂, 2♀); MH, Strehaia, 22.06.1963, leg. R. Serafim (1♂); MH, Strehaia, 24.06.1983, leg. R. Serafim (1♂, 1♀); NT, Gadinți, 05.05.1978 (1♀); NT, Ion Creangă, 17.04.1975, (leg.?) (1♀); NT, Ion Creangă, 02.06.1978, leg. R. I. Calinescu (1♂); NT, Roman, 14.05.1964, (leg.?) (1♀); NT, Horia, Roman, 15.04.1966, (leg.?) (1♀); NT, Horia,

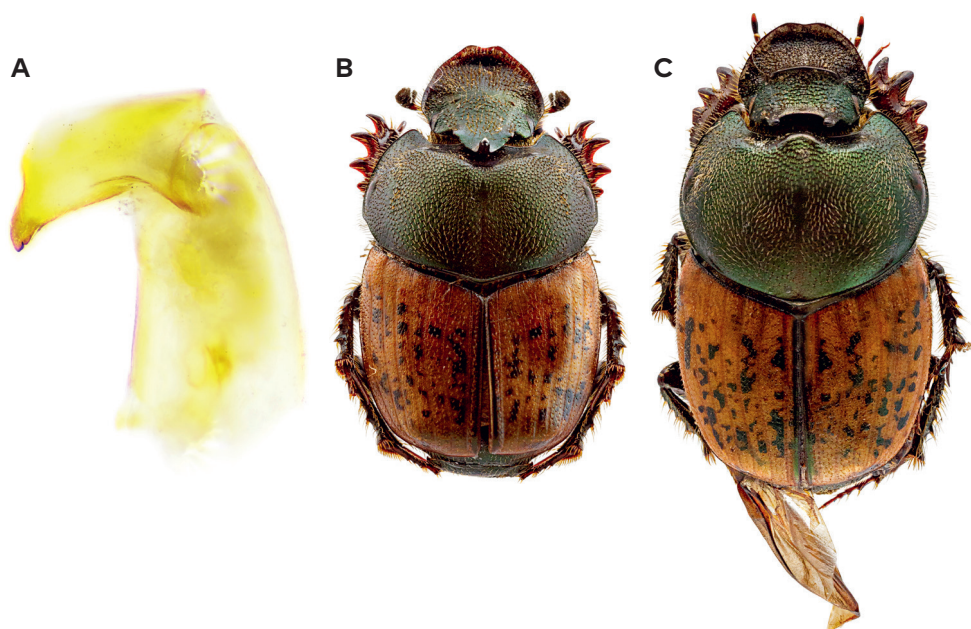


Figure 1. The species *O. vacca* (Linnaeus, 1767): A - aedeagus; B - male specimen; C - female specimen. Photographed by I. Ș. Iorgu

Roman, 18.04.1967, (leg.?) (1♀); NT, Piatra Neamț, 11.07.1962, (leg.?) (1♂, 1♀); NT, Vulpășești, 24.04.1978, (leg.?) (1♀); SM, Tarna Mare, 20.05.1987, leg. R. Serafim (1♂, 1♀); TL, Enisala, 27.06.1991, leg. N. Găldean (1♀); TL, Corugea, 07.05.2018, leg. C. Stanciu (1♂).

Brukenenthal National Museum, Natural History Museum Department (BNM - NHMD) - 33 spec.

Eckbert Schneider Collection: SB, Sibiu, 13.04.1952, (leg.?) (1♂); SB, Sibiu, 17.04.1952 (1♂); SB, Cibin Mountains, 15.05.1955, (1♂) (leg. E. Schneider).

Eugen Worell Collection: SB, Hermannstadt [Sibiu], 09.1923, leg. E. Worell (2♂); without collecting data (1♂, 2♀).

Hannenheim Collection: without collecting data (1♀).

Karl Petri Collection: CJ, Klausbg [Cluj - Napoca] 1891, (leg.?) (1♂); CJ, Klausbg [Cluj - Napoca], (leg.?) (1♀); SB, Sibenburgen, Hermannstadt [Transilvania, Sibiu], leg. Rudolf Albrecht (1♀); SB, Rother Thurm [Turnul Roșu], 1892, (leg.?) (1♀); Transilvania SB [Sibenburgen], 1891, (leg.?) (1♀).

Collection of the *Transylvanian Society of Natural Sciences*: SM, Hadad [Satu Mare], leg. Kiss (1♂, 1♀); SB, Hermannstadt, Sibenburgen [Sibiu, Transilvania], leg. Rudolf Albrecht (1♂); SB, Hermannstadt [Sibiu], 1883, leg. Kimakovicz (1♂); Tr [Transilvania], 1858, leg. Bielz (1♂, 1♀); Tr [Transilvania], 1895 (1♂, 1♀); SJ, Zilah, [Zalău], leg. Kiss (1♀) without collecting data (1♂, 1♀).

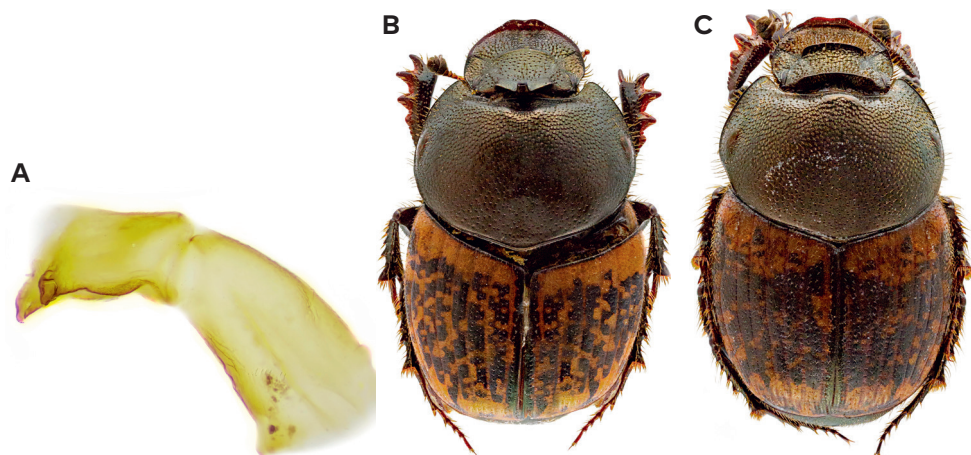


Figure 2. The species *Onthophagus medius* (Kugelann, 1792): A - aedeagus; B - male specimen; C - female specimen. Photographed by I. Ș. Iorgu

Weyrauch Collection: CT, Dobruja [Agigea], 14.05.1975 (2♂, 4♀); SB, Altenbg [Viile Sibiului], 05.05.1954, (2♀) (leg. R. Weyrauch).

Collection of Cosmin Mancî, Iași, Romania (most specimens were collected by C. Mancî) - 58 spec.

BC, Comănești, N 46.4281, E 26.4408, leg. A. Pintilioaie, 29.05.2010, (1♀); CT, Băltăgești, N 44.495982, E 28.186284, 07.04.2012, (1♂, 1♀); CT, Crucea, N 44.513576, E 28.204993, 05.04.2012, (3♂, 3♀); CT, Grădina, N 44.546471, E 28.460854, 21.04.2014, (1♂, 1♀); CT, Gura Dobrogei, N 44.489498, E 28.562142, 12–20.04.2013, (1♂, 1♀); CT, Limanu, N 43.8101, E 28.5164, 11.04.2012, (1♂); CT, Vadu, N 44.446068, E 28.741494, 08.04.2012, (2♀); HD, Hațeg, N 45.61, E 22.95, 1938, leg. E. Teleki, (1♂); IS, Valea Lupului: Valea lui David, N 47.196567, E 27.466245, 18.04.2010, (11 spec. - sex not determinated); IS, Valea Lupului: Valea lui David N 47.1965, E 27.4662, 23.04.2010, (3♂, 1♀); IS, Valea Lupului: Valea lui David, N 47.1965, E 27.4662, 01.05.2010, (4♂); IS, Valea Lupului: Valea lui David, N 47.1965, E 27.4662, 05.05.2010, (3♂, 2♀); IS, Valea Lupului: Valea lui David, N 47.1939, E 27.4675, 26.03.2011, (6♂, 4♀); IS, Valea Lupului: Valea lui David, N 47.196207, E 27.468615, 25.04.2011, (1♂, 1♀); TL, Maliuc, N 45.1799, E 29.1042, 27.04.2010, (1♀); TL, Partizani, N 45.1937, E 28.9718, 19.05.2001, (4♂).

Collection of Cornelia Chimișliu (CC) - 9 spec.

DJ, Preajba, 15.05.2001, (1♀); DJ, Rodovan, 03.05.2001, (2♀); GJ, Cheile Galbenului, 14.08.2005, (2♂, 3♀); OT, Colonești, 22.04.2004, (1♀) (leg. C. Chimișliu).

Collection of Adrian Ruicănescu, Cluj, Romania - 2 spec.

MH, Orșova, Valea Vodiței, N 44.720312, E 22.482442, 22.06.1981, (1♀); MH, Orșova, Valea Vodiței, N 44.720312, E 22.482442, 22.06.1986, (1♂) (leg. A. Ruicănescu).

Onthophagus (Palaeonthophagus) medius (Kugelann, 1792)

Material examined: 87 specimens

“Grigore Antipa” National Museum of Natural History collections (MGAB) - 27 spec.

Study Collection: CJ, Valea Fânațelor, 22.04.2018, leg. A. C. Drăghici (2♀); CT, Băneasa-Canaraua Fetei, 15.05.1963, leg. N. Săvulescu (1♀); CT, Esecchioi, 13.05.1963, leg. N. Săvulescu (1♂); CT, Oltina, 12.05.1958, leg. N. Săvulescu (1♀); GR, Comana Forest, 15.05.2005, leg. V. Ungureanu (1♀); IS, Podu Roș, 02.05.1976, (leg.?) (1♂, 1♀); IS, Poieni, 17.04.1953, (leg.?) (1♂, 2♀); MH, Breșnița Ocol, 20.05.1964, (leg.?) (4♂, 10♀); SV, Câmpulung Moldovenesc, 07.05.1952, (leg.?) (1♂); TL, Corugea, 07.05.2018, leg. C. Stanciu (1♀).

Brukenthal National Museum, Natural History Museum Department (BNM - NHMD) - 37 spec.

Eckbert Schneider Collection: SB, Sibiu, 17.04.1952, (1♂); SB, Sibiu Reussbach [Valea Rusciorului], (1♀); SB, Hammersdorfer Berg [Dealul Gușteriței], 19.04.1966, (1♀); SB, Slimnic Zakelsberg [Dealul Zackel], 29.04.1955, (1♀) (leg. E. Schneider).

Eugen Worell Collection: 05.1931, leg. Ackerman (3♂); 06.1931, leg. Ackerman (2♀); without collecting data (1♂, 1♀).

Hannenheim Collection: SB, Hammersdorfer Berg [Dealul Gușterița], 05.06.1955, (1♂, 1♀); SB, Klein Scheuern [Șura Mică], 20.05.1956, (1♀) (leg. H. Hannenheim).

Karl Petri Collection: CJ, Klausburg [Cluj - Napoca], 1891, (leg.?) (1♂, 2♀); TM, M. Ujvar [Uivar], 1891 (1♂).

Collection of the *Transylvanian Society of Natural Sciences*: Banat, 12.04.1885, leg. Birthler 1895 (1♂); Banat, 04.06.1885, leg. Birthler, 1895 (1♀); Banat, 1895, leg. Birthler (1♀); SB, Hammersdorfer Berg [Dealul Gușterița], 02.06.1888, leg. Km [Kimakovicz] (1♀); SB, Sibenburgen Hermannsstadt [Sibiu, Transilvania], leg. R. Albrecht (2♂, 2♀); SB, Hermannstadt [Sibiu], leg. Km [Kimakovicz] (1♂); Transilvania, 1858, leg. Bielz (2♂, 1♀).

Weyrauch Collection: CT, Agigea, 14.05.1975, (1♂, 1♀); CT, Canaraua Fetei, 19.06.1971, (1♀); CT, Hagieni forest, 18.06.1974, (1♂); CT, V. Jartmac [Iortmac valley], 23.06.1965, (1♂); SB, Zibinsgebirge [Dealul Zakel], 05.05.1954, (1♂); SB, Altenbg [Viile Sibiului], 05.05.1954, (1♂) (leg. R. Weyrauch).

Collection of Cosmin Mancî, Iași, Romania (CM) - 16 spec.

CT, Băneasa - Canaraua Fetei, N 44.0678, E 27.6446, 04.04.2014, (4♂, 4♀); CT, Crucea, N 44.513576, E 28.204993, 05.04.2012, (1♀); CT, Gura Dobrogei, N 44.489498, E 28.562142, 20.04.2012, (1♂); IS, Valea Lupului: Valea lui David, N 47.1965, E 27.4662, 23.04.2010, (3♀); TM, Ghirada Nouă, N 45.7621, E 21.3079, 28.04.1998, (1♀); TM, Green Forest, N 47.7834, E 21.2721, 29.04.1997, (1♀); TL, Măcin Mountain, N 45.244169, E 28.186793, 12.04.2004, (1♂) (leg. C. Mancî).

Collection of Adrian Ruicănescu (AR) - 7 spec.

CJ, Făget, N 46.725969, E 23.579002 02.05.1984, (2♀); MH, Breșnița Ocol, Vărănic Mountain, N 44.676153, E 22.587972, (2♂); MH, Drobeta-Turnu Severin, N 44.624645, E 22.671915, 06.1977, (2♂, 1♀) (leg. A. Ruicănescu).

Of the 67 European species of the genus *Onthophagus* and the 25 species in Romania (Ziani and Bezdek 2016), the similarity between species *O. vacca* and *O. medius* caught our attention because they are often confused with each other. A few important morphological characters which help us to differentiate between these two species are: the colours of elytra, head and pronotum, the shape of anterior edge of clypeus at males and the shape of parameres.

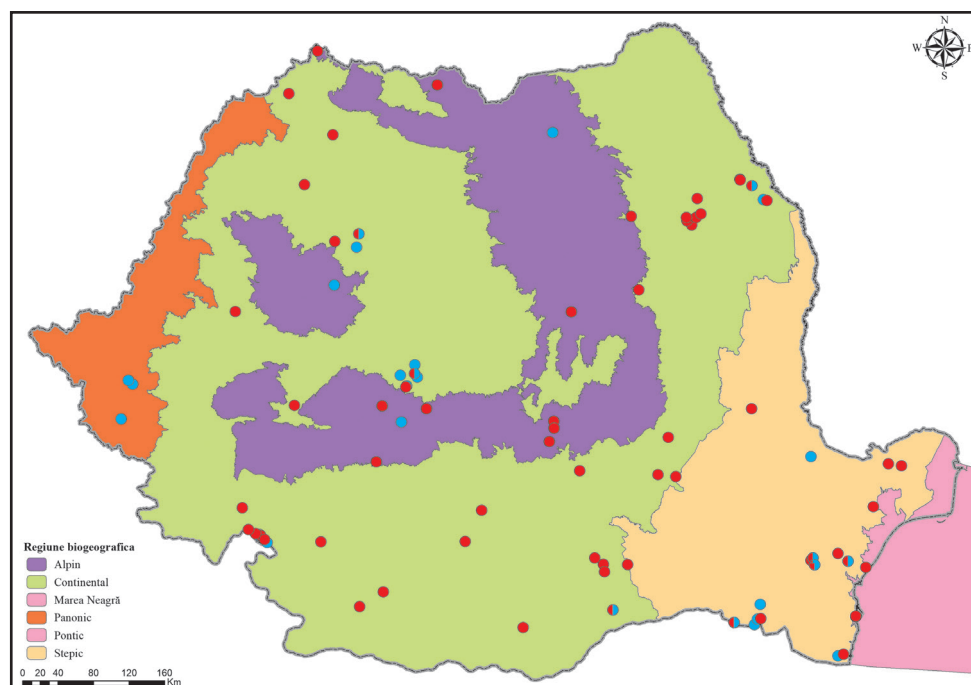


Figure 3. The geographic distribution for Romania: *Onthophagus vacca* (red dots) and *O. medius* (blue dots), based on examined material.

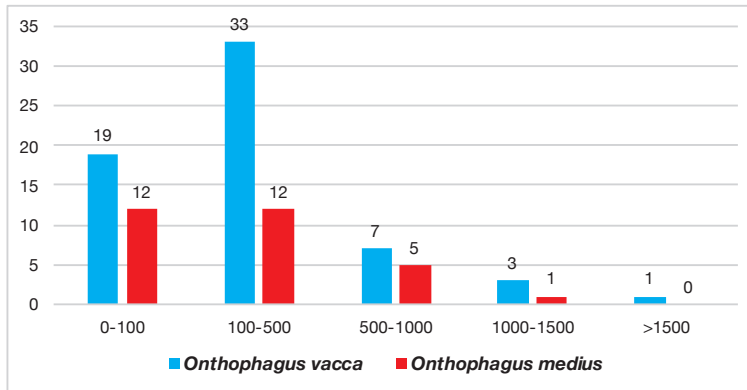


Figure 4. Vertical distribution for *Onthophagus vacca* and *O. medius* (according our data).

We consider that it is necessary to clarify the fact that both can be found in the same locations, through behavioral and ecological differences in view.

The geographic distribution shows that the two species are sympatric in Romania, and they are found almost in all bioregions (Fig. 3) being collected together also in the same place and at the same time. The species seem to be rarer from the Pannonic and Pontic bioregion and this can be viewed as an artefact of biased collecting. Our study reveals a high ecological plasticity for both species. From our data we can see an altitude preference for habitats below 500 meters for *O. vacca* and *O. medius* (62 sites of 93 sites have an altitude of up to 500 meters) (Fig. 4), more homogenous sampling is needed to confirm if this really is the case.

It is hoped that the present study encourages additional field work. A higher sampling effort would surely allow a better view on of the two species.

Systematic studies are required for a better knowledge of the distribution and preferences of the two species in Romania.

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