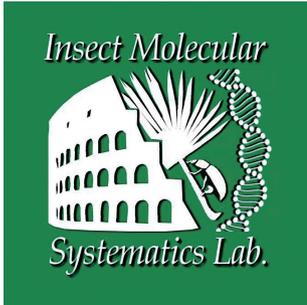




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A revision of distribution, ecology and conservation issues of the threatened comb-claw beetle *Gerandryus aetnensis* (Coleoptera: Tenebrionidae, Alleculinae)Irene PICCINI^{1,*}, Luca CRISTIANO², Viviana DI PIETRO³, Simona BONELLI¹, Alessandro B. BISCACCIANTI⁴¹ Department of Life Sciences and Systems Biology, University of Turin, Via Accademia Albertina 13, 10123 Turin, Italy - irene.piccini@unito.it; simona.bonelli@unito.it² Museum of Natural History, Via S. Francesco di Sales 188, 10022 Carmagnola (Turin), Italy - luca.museo@gmail.com³ Laboratory of Socioecology and Social Evolution, KU Leuven, Naamsestraat 59, 3000 Leuven, Belgium - viviana.dipietro@kuleuven.be⁴ Laboratorio di Entomologia ed Ecologia Applicata, Department PAU, Mediterranean University of Reggio Calabria, Salita Melissari, Reggio Calabria, Italy - alessandro.biscaccianti@unirc.it

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Abstract

Gerandryus aetnensis (Rottenberg, 1871) is a rare and localized beetle, previously known only for Maritime Alps and Sicily. In this paper we provide a revision of geonemy, ecology and status of conservation, including a proposal for a new assessment of its extinction risk in the framework of the European saproxylic beetles, based upon several new records from western Alps, northern, central, southern Apennine, and Sicily. Thus, the species is a W-Alpino-Apenninic subendemic saproxylic species, associated to tree hollows in both coniferous and deciduous forests. We also propose to assess *G. aetnensis* as Vulnerable at global and Italian level.

Key words: saproxylic beetles, Alleculinae, IUCN threatened species, geonemy, endemic/subendemic species, Italy.**Introduction**

The monotypic genus *Gerandryus* Rottenberg, 1873 occupies a rather isolated position inside the tribe Alleculini, easily recognizable by the combination of the following characters: simple tarsomeres of all tarsi, without a distinct lobe on the underside, antennae long and slender, reaching up the middle of elytra in both sexes, the whole body and the appendages only with short, recumbent pubescence, strongly emphasized sexual dimorphism, besides the unusual, strongly mimetic colour pattern of the type species. Porta (1934) wrongly states that the genus is characterized by having simple mandibles, not divided at apex: instead, the mandibles are shortly but distinctly bilobed at apex, as those of *Allecula* Fabricius, 1801 and other genera.

Gerandryus aetnensis (Rottenberg, 1871) is currently assessed as Endangered in the Red List of Italian saproxylic beetles (Audisio et al. 2014; Carpaneto et al. 2015), and as Near Threatened in the latest updated version of the European Red List of saproxylic beetles (Calix et al. 2018). In our opinion, both the assessments are inadequate and should be revised.

In this paper, we present a revision of distribution, ecology and conservation issues of this rare and poorly known species, based upon several new data collected during different research projects, communicated by colleagues or preserved in public collections.

Material and Methods

Materials reported in this study were obtained mainly through the following programs: Life project “*Gestione della rete dei SIC e delle ZPS nel Parco Nazionale del Cilento e Vallo di Diano*” (LIFE06NAT/IT/0005), for the data of Cilento, Campania region, carried out in 2008-2010, research projects “*Studi su presenza, distribuzione e ruolo nella conservazione degli ecosistemi forestali dei Coleotteri in Direttiva Habitat e saproxilici del Parco Nazionale dell’Aspromonte*” and “*Servizi per l’analisi dello stato attuale e per la stesura delle relative misure specifiche di conservazione dei siti della rete Natura 2000 ricompresi interamente o parzialmente nel Parco Nazionale dell’Aspromonte*”, for the data of Aspromonte, Calabria region, carried out in 2015-2017, research project “*Analisi della fase*

iniziale di ricolonizzazione faunistica dopo l'incendio del Morrone dell'estate 2017 attraverso lo studio quali-quantitativo delle comunità di Coleotteri", for the data of Majella, Abruzzo region, carried out in 2018-2019, research project "Zerynthia polyxena in Val Clarea", carried out during 2019 in the framework of the environmental studies promoted by TELT - Tunnel Euralpin Lyon Turin, for the data of Val Clarea, Piedmont region.

Further personal investigations of one of us (ABB) in Sicily were also undertaken during 2020. Other unpublished data were obtained from museums (as listed below) and colleagues.

Data of specimens examined are listed from North to South and from East to West, botanical nomenclature follows Bartolucci et al. (2018), uncertain dates (years) in Table 1 are given in square brackets. The new assessment here proposed for *G. aetnensis* follows criteria and guidelines of IUCN (2012, 2019), its extent of occurrence (EOO) and area of occupancy (AOO) are calculated using QGIS® version 3.10 software.

Acronyms of repository collections:

- ABB** A. B. Biscaccianti's personal collection, Rome, Italy;
LCR L. Cristiano's personal collection, Carmagnola (TO), Italy;
MZSF Zoological Museum, La Specola University, Florence, Italy;
MZUR Zoological Museum, Sapienza Rome University, Rome, Italy.

Abbreviations of Italian provinces:

- AQ** L'Aquila;
CT Catania;
FR Frosinone;
LU Lucca;
ME Messina;
RC Reggio Calabria;
SA Salerno;
TE Teramo;
TO Turin.

Results

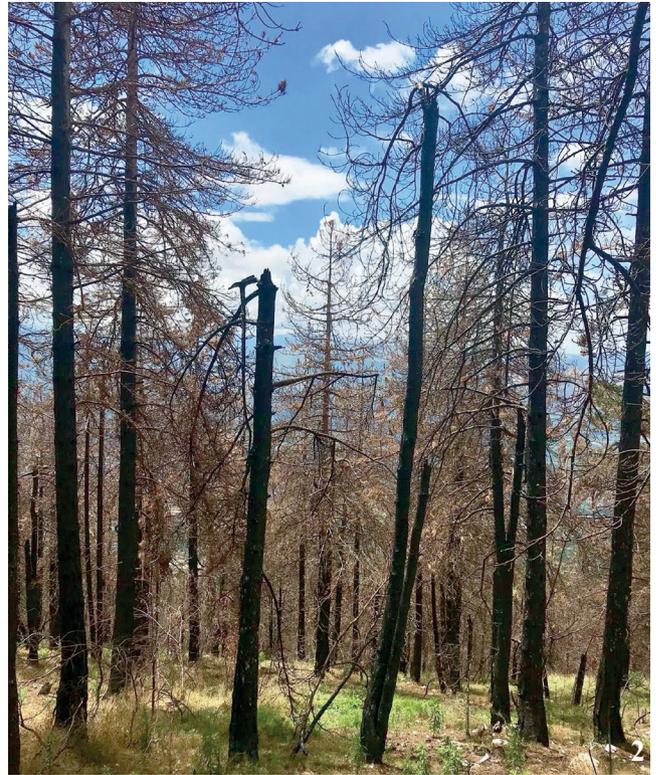
Gerandryus aetnensis (Rottenberg, 1871)

Parablops aetnensis Rottenberg, 1871: 256.

Material examined. Italy, Piedmont: Cottian Alps, Val Clarea, Chiomonte (TO), Mt. Cappella Bianca S, loc. La Ramats, 1100 m, 25.X.2019, window-flight trap on *Castanea sativa* Mill., I. Piccini and V. Di Pietro lgt, 1♂ (LCR); Cottian Alps, Val Chisone, Fenestrelle (TO), 1200 m, 30.V.2000, F. Angelini lgt, 1♀ (MZSF); **Tuscany:** Vagli di Sopra (LU), 900 m, 21.V.1998, chestnut woods, F. Angelini lgt, 1♂, (MZSF); **Latium:** Simbruini Regional Park,

Filettino (FR), 1980-2000, F. Angelini lgt (specimens no longer available, F. Angelini pers. com.); **Abruzzo:** Gran Sasso National Park, Pietracamela (TE), Prati di Tivo, 1980-2000, beech forest, F. Angelini lgt (specimens no longer available, F. Angelini pers. com.); Majella National Park, Pratola Peligna (AQ), Colle delle Vacche, 1099 m, 12.X.2018, pitfall trap in burned pine woods, A.B. Biscaccianti lgt, 1♀ (ABB); **Campania:** Cilento National Park, Camerota (SA), between Punta del Cavaliere and Vallone Sant'Iconio, 150 m, IX.2008, pine woods, A.B. Biscaccianti lgt, 1♀ (ABB); **Calabria:** Aspromonte National Park, San Luca (RC), Pietra Mazzulisa, Bosco Afreni, 1419 m, 3.X.2016, A.B. Biscaccianti, F. Manti and E. Castiglione lgt, 1♂ (ABB); **Sicily:** Mt. Etna, Montelaguardia (CT), 720 m, 3.XI.1948, F. Hartig lgt, 1♀ (MZUR); Peloritani Mts., Montalbano Elicona (ME), Bosco di Malabotta, loc. Portella di Croce Mancina, 1237 m, 23.X.2020, remains in a cavity on *Quercus cerris* L., A.B. Biscaccianti and E. Giuliano Grimaldi lgt, 1♀ (ABB).

The specimen from Piedmont was sampled in a thermophile area in the Val Clarea (Fig. 1) using windows-flight traps baited with ethanol 90°, placed on hollow-trees and active from July to October, recharging intervals of one month. The site is an abandoned chestnut orchard with *Quercus* L. and *Prunus* L., clearings and open areas interspersed, southern exposure. An adult was caught during the last sampling session (end September – end October). In the Majella National Park (Abruzzo) the sampling site was located in a core area of forest fire that affected the south-western side of the Morrone mountain chain. Two sampling plots were selected in the area, one in a burned beech forest and the other in a burned reforestation of black pine (*Pinus nigra* J.F. Arnold subsp. *nigra*) (Fig. 2). The study area was investigated for two years after fire (2018 and 2019) using both aerial traps on the canopy, baited with a mixture of red wine, beer and ripe fruit, and pitfall traps baited with vinegar, active from June to October, recharging intervals of one month. *Gerandryus aetnensis* was caught only the first year, during the last sampling session (mid September – mid October), with a pitfall trap in the pine woods. The specimen from Cilento National Park (Campania) was collected by beating dead branches of *Pinus halepensis* Mill. subsp. *halepensis* in a xeric Mediterranean environment, unusual for *G. aetnensis*. The site, in fact, is an apparently autochthonous coastal Aleppo pine woods, where the discovery of this species was rather unexpected. Unfortunately, the area where the species was detected has been largely deforested in 2017. The sampling site in the Aspromonte National Park (Calabria) was located in a well preserved old-growth forest of Calabrian pine (*Pinus nigra* J.F. Arnold subsp. *laricio* Palib. ex Maire) (Fig. 3), characterized by the presence of several veteran trees of *Quercus petraea* (Matt.) Liebl. subsp. *austrotyrrhenica* Brullo, Guarino & Siracusa and a large amount of deadwood. In this place, *G. aetnensis* was caught with a pitfall trap baited with vinegar and positioned inside a hollow-oak.



Figs 1-3 – Collecting sites of *Gerandryus aetnensis* (Rottenberg, 1871). 1, Val Clarea, Piedmont (photo D. Bellone); 2, burned pine woods of Colle delle Vacche, Majella, Abruzzo (photo A. B. Biscaccianti); 3, Bosco Afreni, Aspromonte, Calabria (photo A. B. Biscaccianti).

In order to better understand the biology and ecology of *G. aetnensis*, not yet well known, one of us (ABB) visited a site in northern Sicily where the species was recently discovered: Bosco di Malabotta (Baviera 2011 and pers. comm.). The site investigated is a well preserved ancient Turkey-oak mountain forest, with an abundance of old, senescent and dead trees of Turkey-oak, beech, maple, chestnut and other species. Remains of *G. aetnensis* were found inside a hollow-oak, as expected.

We calculated the extent of occurrence (EOO) and the area of occupancy (AOO) for the species at global level and Italian level, in order to evaluate the most appropriate risk category for the IUCN Red List assessment, and the relevant criteria to apply. EOO, measured by a minimum convex polygon (excluding sea and islands), resulted of 70,318 km² at global level. The estimate of AOO is scaled using 2 x 2 km grid cells for all records collected after 1999, and 10 x 10 km grid cells for older records (ante 2000), since a certain degree of uncertainty exists regarding the exact location and extension of the latter, which however we retain not to exclude, all but one (Gravina di Catania, see below). The result is a total and Italian AOO of 752 km² (Table 1; Fig. 4) and 732 km² respectively.

Discussion

Distribution

Over the last century, *Gerandryus aetnensis* was alternatively considered endemic to Sicily (Borchmann 1910; Mader 1928; Sparacio 1999; Baviera 2011), presumed so (Gardini 1995; Fattorini 2013), or present in Sicily and Maritime Alps (Bertolini 1904; Luigioni 1929; Porta 1934), the latter distributional pattern later confirmed by the discovery of the species in south-eastern France (Bouyon & Casset 2005; Bouyon et al. 2015), and definitely also in Piedmont (Poggi 2016). This unusual, apparently disjunct geonomic pattern has been questioned by Bouyon & Casset (2005).

The new records published in the present paper show that *G. aetnensis* actually occurs from western Alps, throughout the whole Apennine chain, up to northern Sicily (Fig. 4). Thus, the species should be regarded as a W-Alpino-Apenninic subendemic element (sensu Vigna Taglianti et al. 1999). The erroneous quotation for Greece reported by Novak & Petterson (2008) has been recently deleted by Novak (2020), who, however, wrongly corrected also the distribution of *G. aetnensis* in Italy, limiting it to Sicily only.

Table 1 – Known localities of *Gerandryus aetnensis* and criteria used to calculate area of occupancy (AOO).

Locality	Accuracy	Grid	Km ²	Last record	Source
France, Modane	high	2x2 km	4	2016	Dodelin 2016
France, Fontan, Vallée de la Ceva	high	2x2 km	4	2006	Bouyon et al. 2015
France, Saint-Delmas-le-Selvage, Vallon de Saint-Dalmas	high	2x2 km	4	2009	Bouyon et al. 2015
France, La Brigue, Vallon de Groa	high	2x2 km	4	2010	Bouyon et al. 2015
France, Tende, Vallon de la Minière	high	2x2 km	4	2010	Bouyon et al. 2015
Italy, Chiomonte, Val Clarea	high	2x2 km	4	2019	Present paper
Italy, Fenestrelle, Val Chisone	high	2x2 km	4	2000	Present paper
Italy, Val Pesio	low	10x10 km	100	1912	Gestro 1914; Poggi 2016
Italy, Terme di Valdieri, Gias delle Mosche	high	2x2 km	4	2008	Poggi 2016
Italy, Vagli di Sopra	low	10x10 km	100	1998	Present paper
Italy, Pietracamela, Prati di Tivo	low	10x10 km	100	[1980-2000]	Present paper
Italy, Pratola Peligna, Colle delle Vacche	high	2x2 km	4	2018	Present paper
Italy, Filettino	low	10x10 km	100	[1980-2000]	Present paper
Italy, Camerota, Vallone Sant'Iconio	high	2x2 km	4	2008	Present paper
Italy, San Luca, Bosco Afreni	high	2x2 km	4	2016	Present paper
Italy, Montalbano Elicona, Bosco Malabotta	high	2x2 km	4	2020	Present paper
Italy, Castelbuono	low	10x10 km	100	[1898]	Ragusa 1898
Italy, Petralia Sottana	high	2x2 km	4	2014	Poggi 2016
Italy, Montelaguardia, Mt. Etna	low	10x10 km	100	1948	Present paper
Italy, Nicolosi	low	10x10 km	100	1868-[1906]	Rottenberg 1871; Poggi 2016
Italy, Gravina di Catania	extinct	-	-	1953	Sapuppo 2002
GLOBAL AREA OF OCCUPANCY (AOO)			752		

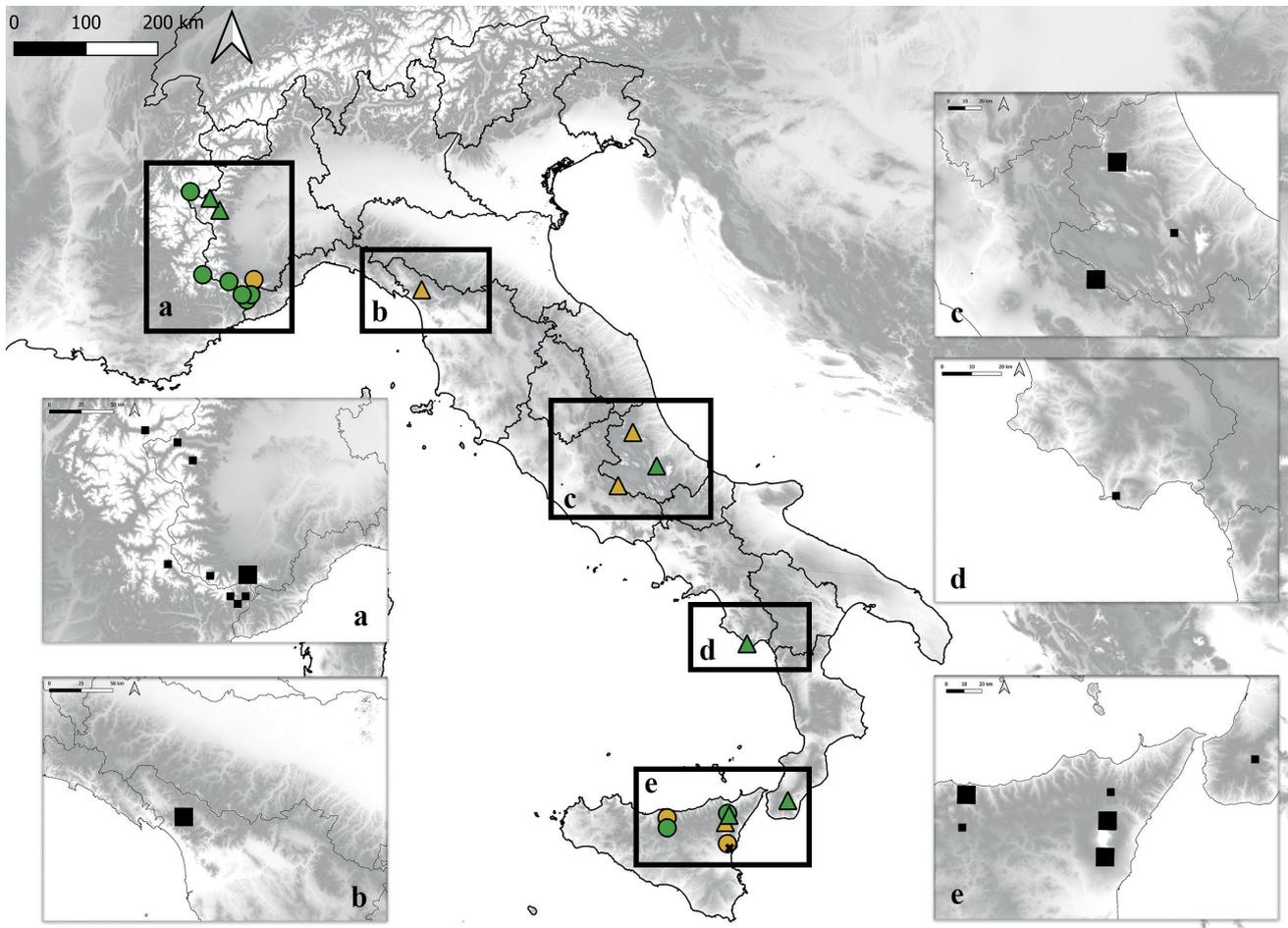


Fig. 4 – Geonemy and area of occupancy (AOO) of *Gerandryus aetnensis* (Rottenberg, 1871). Main figure, species geonemy; boxes, AOO calculation. Symbols: triangles, new records; circles, literature records; black cross, extinct in the site; yellow, records ante 2000; green, records post 1999 (main figure); large squares, 10 x 10 km grid cells; small squares, 2 x 2 km grid cells (boxes).

In addition to the data summarized by Poggi (2016), this species has been collected also at Gravina di Catania (Sicily) in 1953 (Sapuppo 2002), a lowland place nowadays destroyed by the urbanization of the city of Catania, thus the species is deemed to be extinct in the site.

Biology, ecology

Gerandryus aetnensis (Fig. 5) is usually considered a saproxylic species (Audisio et al. 2014; Bouyon et al. 2015; Carpaneto et al. 2015), because it has always been collected in forest environments, but its biology is unknown. The finding of a female remains inside a hollow-oak at Bosco di Malabotta, and the specimens collected with traps placed inside or adjacent to tree hollows (see above), as well as data reported by Dodelin (2016), confirm that *G. aetnensis* is a saproxylophagous element linked to tree hollows. Moreover, in the two sites of Calabria and Sicily above mentioned, the species was associated to *Osmoderma italicum* Sparacio, 2001 [alternatively considered a moderately diversified group of populations of *O. eremita* (Scopoli, 1763) or a puta-

tive subspecies of the latter: Zauli et al. 2016; Maurizi et al. 2017] and *O. cristinae* Sparacio, 1994, respectively (Biscaccianti and Giuliano Grimaldi pers. obs.), two stenotope and strongly localized saproxylic species, living inside tree hollows and with a low dispersal ability (Biscaccianti et al., unpublished results).

Gerandryus aetnensis lives in both coniferous and deciduous forests, apparently without preference, and is not associated to particular species of trees. Adults of the species have been collected on *Abies* Lam., *Castanea* Mill., *Corylus* L., *Larix* Mill., *Pinus* L., *Prunus* L. and *Quercus* L., but only the presence of tree hollows or deep crevices on decaying parts of trees seems to be relevant for larval development. Furthermore, the species is not exclusive to high elevations (above 1000 m according to Poggi 2016), and its late phenology is only apparent. As assumed by Bouyon et al. (2015) and confirmed by the data here reported, together with others provided by C. Baviera (in literis, 2020), it is evident that adults of *G. aetnensis* emerge in late summer and, after a period of activity, overwinter only to reappear in the following spring.



Fig. 5 – Habitus of female of *Gerandryus aetnensis* (Rottenberg, 1871) from Vallée de la Ceva, France (photo H. Bouyon).

Conservation issues

Although we have shown that *Gerandryus aetnensis* is distributed more continuously than previously known, it occurs marginally in south-eastern France, along the Italian borders (Bouyon et al. 2015; Poggi 2016), and fragmentarily in Italy, from western Alps to Sicily. Hence, both the assessments as Endangered (EN) in Italy (Audisio et al. 2014; Carpaneto et al. 2015) and Near Threatened (NT) in Europe (Calix et al. 2018) are inadequate since they are based upon incomplete data.

Overall, the main threats for *G. aetnensis* are not yet well known, but at least loss of habitat, often due to unsuitable forestry management involving structural simplification of forest ecosystems, is an important key factor whose effects are often irreversible or, at least, require long-time restoration (Grove 2002; Belcik et al. 2019). In Italy, Europe, but also all over the world, habitat represented by veteran decayed- and hollow-trees is continuously declining over time, due to several interconnected anthropogenic causes, making populations of specialized saproxylic beetles increasingly isolated and threatened (Persiani et al. 2010; Lindenmayer et al. 2012; Carpaneto et al. 2015; Della Rocca et al. 2019; Belcik et al. 2019).

Gerandryus aetnensis seems to have a low dispersal ability, as most beetles inhabiting hollow-trees (Ranias 2002; Schauer et al. 2018; Feldhaar & Schauer 2018), confirmed by our data: in Val Clarea (Piedmont) the species has been detected in only one sampling plot out of 14, in the whole Aspromonte (Calabria) has been detected in only

one hollow-tree out of more than 150 investigated, while at Bosco di Malabotta (Sicily) more than 30 hollow-trees has been accurately investigated, but only one hosted *G. aetnensis*; moreover, in the latter place only three specimens were previously collected between 2005 and 2006 (C. Baviera in litteris, 2020).

Our results strongly support the proposed uplisting of *G. aetnensis* to Vulnerable (VU) risk category, thus shifting it from the lower Near Threatened (NT) category previously recognized (Calix et al. 2018). Conditions of criterion B2 a, b (iii) (IUCN 2012, 2019) are fully met: the species shows an area of occupancy (AOO) of 752 km² (Table 1), its genomic pattern is severely fragmented, making more than 50% of known populations widely isolated (Fig. 4), its low dispersal ability, as well as the continuously declining of its habitat, are strongly supported by our results and by relevant literature on saproxylic beetles conservation as well. Conversely, at Italian level *G. aetnensis* should be moved to a rank lower than currently assessed (EN: Carpaneto et al. 2015), because of the new localities here reported, which make Italian AOO (732 km²) wider than that set for Endangered species.

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