

Research articleSubmitted: July 18th, 2015 - Accepted: November 16th, 2015 - Published: December 31st, 2015**Updated distribution of *Osmoderma eremita* in Abruzzo (Italy) and agro-pastoral practices affecting its conservation (Coleoptera: Scarabaeidae)**Patrizia GIANGREGORIO¹, Paolo AUDISIO², Giuseppe Maria CARPANETO³,
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Abstract

New records of *Osmoderma eremita* (Scopoli, 1763) (Coleoptera: Scarabaeidae: Cetoniinae) are reported for Abruzzo (Italy), together with a review of its distribution in this region. *O. eremita* is a saproxylic beetle dependent on the presence of hollow deciduous trees with abundant wood mould in their cavities. The major threats for the species are habitat loss and fragmentation. EU Habitats Directive requests to the member States its protection and the monitoring of its conservation status. Detection of its occurrence is the first step to protect the species. The surveys have been carried out in ten sites of Abruzzo by using black cross-windows traps baited with specific pheromone. The species has been recorded for the first time in the Sant'Antonio forest and its presence is confirmed in the Peligna Valley, after a decade. The populations seem to be confined to small patches of suitable habitats. At local level, the abandonment of the pollarding practice (willow and beech forests) and the use of pollarded trees as biomass for fuel are the major threats for this species. Indeed some key actions, such as the protection of old hollow trees and the continuation of pollarding practice in rural landscape, could be key factors for the conservation strategies of the species in the study area.

Key words: saproxylic beetles, dead wood, Habitats Directive, semi-natural habitats, hollow trees, Abruzzo, biomass exploitation.**Introduction**

Osmoderma eremita (Scopoli, 1763) is an obligate saproxylic beetle (Coleoptera: Scarabaeidae: Cetoniinae), listed on Appendix II of the Bern Convention, included as Near Threatened (NT) in the European IUCN Red List (Nieto et al. 2010) and as Vulnerable (VU) in The Italian Red List (Audisio et al. 2014). Its protection is considered a priority under the EU Habitats Directive (Council Directive 92/43/EEC-Annex II and IV) and the monitoring of the conservation status of the species is requested to the member states of the European Union (Council Directive 92/43/EEC-Articles 11 and 17).

O. eremita has a patchy distribution throughout Western Europe, from southern Sweden to northern Spain and

Italy, excluding the British Isles. In Italy there are three different taxa of the genus *Osmoderma* (Audisio et al. 2007, 2009): a) *O. eremita* in northern and central Italy; b) *O. cristinae* Sparacio, 1994, in northern Sicily; c) '*O. italicum*' Sparacio, 2000 (a still debated taxon, by some specialists ranked as a subspecies of *O. eremita*) in southern peninsular Italy. Up to now, Lazio and Abruzzo Regions seem to be the southernmost areas inhabited by typical populations of *O. eremita* but further research is needed to assess the distribution and taxonomic identity of '*O. italicum*' populations.

The NT/VU status of *O. eremita* is due to loss and fragmentation of habitats in which this species occurs, characterized by live old-growth broadleaf trees with hollow trunks and large amounts of wood mould within the cavi-

ties (Ranius et al. 2005). Forests with hollow trees have become very rare, highly fragmented and subject to continuing significant decline (Hannah et al. 1995; Nieto et al. 2010; Knorn et al. 2012), due to intensive forestry and agricultural exploitation practices. It has been calculated that in Europe only 0.2% of old-growth forests survived, mainly in remote, mountainous areas or within some well managed nature reserves (Frank et al. 2009; Schulze et al. 2009).

The adults of *O. eremita* have a life span of approximately one-two months and can be found from around late May to early September but mainly in June-July. The females lay their eggs in the wood mould where the larvae develop over the next 3-4 years depending on climatic conditions (Ranius et al. 2005). Although *O. eremita* can develop on various broadleaf trees, in Italy the preferred host species seem to be oaks (*Quercus* spp.), willows (*Salix* spp.), beech (*Fagus sylvatica*), chestnut tree (*Castanea sativa*), lime trees (*Tilia* spp.), ashes (*Fraxinus* spp.), elms (*Ulmus* spp.), and maples (*Acer* spp.) (Ranius et al. 2005; Macagno et al. 2012; Audisio & Carpaneto unpublished data). Microclimate conditions do not appear to influence the presence of this species in Mediterranean woodlands but the frequency of occurrence is higher in cavities with low soil contamination and abounding in dry or half-moist wood mould (> 4 L) (Chiari et al. 2012). However, many Italian forests are too young to include hollow trees of considerable size and with the features described above (Baratelli 2004). Nevertheless, in many European cultivated lands, some broadleaf fast-growing trees, as willows (*Salix* spp.) and mulberries (*Morus* spp.) are often pollarded in order to make durable baskets with their young branches. This old agricultural practice can compensate the lack of suitable forests in croplands because the hollows generated in the tree top represent an artificial habitat which can become optimal for *O. eremita* within a few decades (Schaffrath 2003; Audisio et al. 2003; Baratelli 2004; A. Campanaro unpublished data). In some areas of Italy, as the Po Valley, the rows of pollarded willows along waterways seem to have become the most important habitat for *O. eremita* in areas where old-growth forests are absent or very scarce (Audisio et al. 2003; Baratelli 2004; Ranius et al. 2005). Based on these considerations, we infer that the abandonment of pollarding seems to be another major factor threatening this species in Italy.

The status of *O. eremita* in Abruzzo is still scarcely known, because most of records dates back between the 1970's and 1990's.

The aims of this study are:

- a) to review the distribution data of *O. eremita* in the Abruzzo Region;
- b) to detect the occurrence of this species in selected Sites of Community Importance (SCI) and protected areas of Abruzzo;
- c) to identify the major threats and suggest the suitable management strategies to conserve the habitat type of the species.

Material and methods

Data sources

A screening of the scientific literature on scarab beetles was performed in order to find both historical and recent data from Abruzzo. Few data were found in literature sources (Marotta et al. 1997; Sparacio 2000; Carpaneto et al. 2005; Ranius et al. 2005; Di Santo & Biscaccianti 2014) and other data were obtained by the private "Database of Italian Scarab Beetles" of G.M. Carpaneto and E. Piattella, including all the specimens personally checked by the two specialists in many public or private collections. The data are listed in Table 1. In the present work we have also included unpublished data obtained under the monitoring activities of the Project LIFE11 NAT/IT/000252 MIPP "Monitoring of Insects with Public Participation" (Mason et al. 2015).

Study area

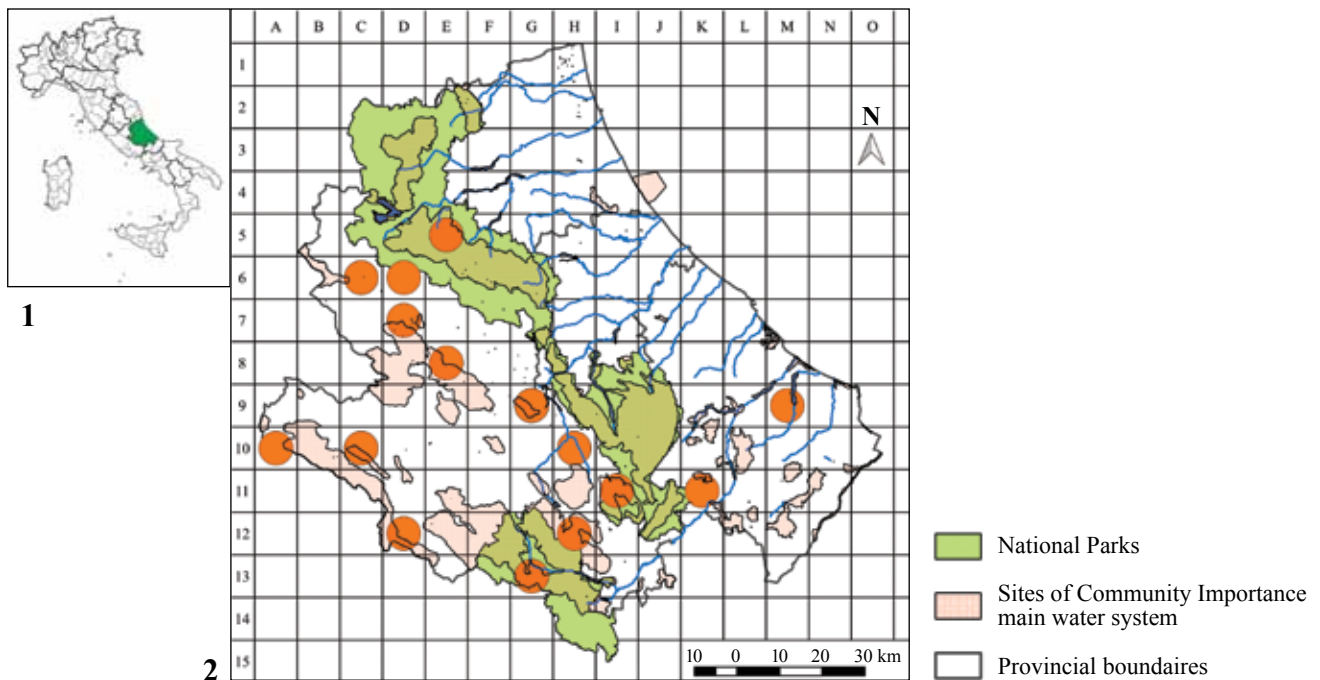
The fieldwork was carried out in two protected areas, the Majella National Park (MNP) and the Sorgenti del Pescara Nature Reserve (SPNR), located in Central Apennines, within the Abruzzi Region (Figs 1-2). This mountain region includes three limestone ranges running from NW to SE with elevations higher than 2,500 m. Climate regime in the study area can be described as Mediterranean montane with cold snowy winters and precipitation minima during summer.

For each protected area a brief description is reported below: MNP has a total area of 74,082 ha, with an altitude between 200 and 2,793 m a.s.l. (1,300 m on average). The park extends into the southern part of Abruzzo, at a distance of 40 km from the Adriatic Sea. The alternating episodes of human intervention and land abandonment modeled a landscape where agricultural areas are returning to oak (*Quercus pubescens*) woodlands at lower altitudes (400-600 m) and beech (*Fagus sylvatica*) forest at higher altitudes (1200-1800 m). Interspersed with these two types of wood formations there is a landscape mosaic composed of shrublands, patches of grass/herb vegetation, and bare rock outcrops. Even though the MNP forests are generally exploited for timber, some areas with old-growth trees are still present, such as the forest of Sant'Antonio, the Sant'Angelo Valley and the Foro Valley. The Sant'Antonio forest cannot be considered as a "wild" biotope, because it was heavily managed through the centuries and trees have been pollarded in order to get fresh forage for livestock. This practice has ended over half century ago, and since then the local vegetation remained almost undisturbed acquiring an aspect of old growth forest. The SCI sites investigated were: IT7110204, south western Majella; IT7140043, Monti Pizzi - Monte Secine; IT7130031, Fonte di Papa; IT7140203, Majella.

SPNR has a surface of 822 ha with an altitude between 240 and 350 m a.s.l. (250 m on average). The SCI IT-7110097 Fiumi Giardino, Sagittario, Aterno, Sorgenti del

Table 1 – Literature and unpublished records of *Osmoderma eremita* in Abruzzo. Localities, years and dates of sampling (when known) are given for each record. The column “Prov.” stands for “Province”. The column “Quadrant” indicates the localization of the record on Fig. 2. PNALM = Abruzzo, Lazio and Molise National Park; MNP = Majella National Park; GSMLNP = Gran Sasso and Monti della Laga National Park; SVRP = Sirente-Velino Regional Park; SPNR = Sorgenti del Pescara Nature Reserve; FGSASP = SCI Fiumi Giardino - Sagittario - Aterno Sorgenti del Pescara; GC-EP DB = G.M. Carpaneto and E. Piattella, Database of Italian Scarab Beetles (unpublished). MIPP DB = Data base of the Project LIFE11 NAT/IT/000252 MIPP “Monitoring of Insects with Public Participation” (<http://lifemipp.eu/>).

	Prov.	Municipality	Locality	Data sources	Year	Date of record	Quadrant
1	AQ	Bisegna	PNALM, San Sebastiano	GC-EP DB	1999	19/07/1999	G13
2	AQ	Cappadocia/Pereto	Simbruini Mountains, between Pereto and Cappadocia	GC-EP DB; Ranius et al. 2005	1965	-	C10
3	AQ	Cappadocia, Camporotondo	Val Dogana (near Camporotondo di Cappadocia)	GC-EP DB; Ranius et al. 2005	1996	-	C10
4	AQ	L’Aquila	Costa Masciarelli	Sparacio 2000	1991	23/07/1991	D7
5	AQ	L’Aquila	Pile	Sparacio 2000	1972	16/07/1962	D6
6	AQ	L’Aquila	Preturo	Sparacio 2000	unknown	-	C6
7	AQ	Morino	Zompo Lo Schioppo Regional Reserve (above Morino)	GC-EP DB; Ranius et al. 2005	1997	08/1997	D12
8	AQ	Opi/Civitella Alfedena	PNALM, between Opi and La Camosciara	GC-EP DB; Ranius et al. 2005	1974	-	G13
9	AQ	Civitella Alfedena	Riserva Naturale Orientata Feudo Intramonti e Colle di Licco	MIPP DB	2014	26/07/2014	G13
10	AQ	Opi	PNALM, Val Fondillo	GC-EP DB; MIPP DB	2014	6/8/2014	G13
11	AQ	Pereto	Simbruini Mountains, Pereto	GC-EP DB; Ranius et al. 2005	1996	-	A10
12	AQ	Pescasseroli	PNALM, Pescasseroli (town)	Sparacio 2000	1971	11/8/1971	G13
13	AQ	Pescasseroli	PNALM, La Difesa di Pescasseroli	GC-EP DB; MIPP DB	2014	26/8/2014	G13
14	AQ	Pescocostanzo	MNP, Sant’Antonio forest	Original data	2013	From 24/7/2013 to 23/8/2013	I11
15	AQ	Pizzoli	Pizzoli (near to MNP)	GC-EP DB; Ranius et al. 2005	1980	03/06/1980	C6
16	AQ	Rocca di Mezzo	SVRP, Fontavignone	GC-EP DB; Ranius et al. 2005	1971	10/07/1971	E8
17	AQ	Scanno	PNALM, Val di Corte	GC-EP DB	1972	07/1972	H12
18	AQ	Sulmona	Peligna valley	Marotta et al. 1997	unknown	-	H10
19	AQ	Tagliacozzo	Montelli	Sparacio 2000	1954	00/08/1954	C10
20	CH	Montenerodomo	MNP, Monti Pizi, Serra Montitto	GC-EP DB; Biscaccianti in litteris; Ranius et al. 2005	2003	02/08/2003	K11
21	CH	Scerni		GC-EP DB; Ranius et al. 2005	1964	23/06/1964	M9
22	PE	Popoli	Peligna valley	GC-EP DB; Sparacio 2000; Ranius et al. 2005	1990	10/07/1990	G9
23	PE	Popoli	SPNR, FGSASP	Original data	2013	06/07/2013	G9
24	PE	Popoli	Orti di Popoli	Original data; MIPP DB	2013	From 06/07/2013 to 16/12/2013	G9
25	PE	Popoli	SPNR, springs of Pescara River	Original data	2013	06/7/2013	G9
26	TE	Pietracamela, Intermesoli	GSMLNP, Vallone Venacquaro	GC-EP DB; Ranius et al. 2005	1991	19/08/1991	E5
27	TE	Pietracamela, Intermesoli	GSMLNP, Monte Corvo, Valle Venacquaro, Fonte Novello	Di Santo & Biscaccianti 2014	2011	06/9/2011	E5



Figs 1-2 – 1. Map of Italy and location (in green) of Abruzzo Region; 2. Map (10x10 km grid) showing the distribution of *Osmoderma eremita* in Abruzzo, updated to August 2013 (historical and new data). Records of *O. eremita* are represented as orange circles. National Parks, provincial boundaries and main water system are also shown.

Pescara (FGSASP) is crossed by four rivers, which gives the name to the SCI, is located in the Peligna valley and managed by the SPNR. The locality “ORTI” was included in this study for its proximity to the SCI and because of previous records of *O. eremita* in the literature.

Surveys methods

Based on the occurrence of suitable habitats for the species (old-growth forests, monumental trees, willow and poplar rows) and by using the Geographic Information System (GIS) software, 22 sites have been selected for a preliminary survey. During spring-summer 2013, 60 suitable trees for *O. eremita* (i.e. hollow trees with wood mould or old trees without cavities but with big fractures in the trunk) were searched within the sites; for a total of 1,053 ha of area investigated. Each suitable tree was marked, georeferenced by using Garmin GPS (MAP 60 CSX), and recorded the descriptive parameters, e.g. tree species; decay stage; number, position, size and height of the cavities; trunk diameter at breast height (DBH) (Chiari et al. 2012, 2013a, 2013b, 2014). The wood mould sampling (WMS) was carried out on the trees in order to find the preimaginal stages of the species (larvae and cocoons), larval frass and body remains of adults (Chiari et al. 2012, 2014).

After preliminary survey, a subsample of 10 sites (Table 2) with suitable hollow trees was selected to set the traps in order to collect the adults of the hermit beetle. During the summer 2013, the black cross windows traps (BCWT) (Fig. 3), baited with the racemic mixture of the

O. eremita pheromone (R) - (+) - γ - decalactone (Svensson & Larsson 2008), were set in accord with the protocol proposed by Campanaro *et al.* (2011) and Trizzino *et al.* (2013). The BCWT were placed on the trunk, suspended from tree branches, at the height of the hollow, and checked every 1 or 2 days in order to avoid insect death caused by dehydration, sunstroke or drowning. Sex was determined by examining pronotum (the male has two distinct ridges while the female has only a slight mark of them: Fig. 4; Schaffrath, 2003). After, the beetles were released on the same hollow tree of capture.

Results

In Table 1 we summarized historical data on presence and distribution of *Osmoderma eremita* in Abruzzo, together with new data obtained with our surveys, up to August 2013. The map (Fig. 2) shows that some records are outside of the border of SCIs and protected areas.

No signs of *O. eremita* were found during the preliminary surveys with WMS. Adults have been found only by the use of BCWTs, in four of the 10 sites selected in the study area (Area codes: ANTO, PESC, PARC, ORTI) between July and August 2013 (Table 2). Inside MNP, in ANTO (Fig. 5), seven specimens of *O. eremita* were sampled in three trees inside the forest. Eight individuals were sampled inside the SCI Fiumi Giardino - Sagittario - Aterno Sorgenti del Pescara (FGSASP) in three different sam-

Table 2 – List of the 10 sites, where BCWTs have been placed to capture adult specimens of *O. eremita*. Each study area is identified by an unique code (Code area). “Prov.” stands for “Province”; N shows the number of adults captured and the number of traps used (between brackets). Natura 2000 codes of the protected area in which the area is located and the extension of territory investigated for searching suitable host trees are shown in column “SCI/protected areas” and “Area extension (ha)” respectively; MNP: Majella National Park; SPNR: Sorgenti del Pescara Nature Reserve (SPNR).

Code area	Prov.	Municipality	Locality	N	Trap sampling period	SCI/protected area	Area extension (ha)
ALBE	AQ	Pacentro	Sant’Alberto	0 (3)	18/7/13-20/7/13	MNP	35,22
ANTO	AQ	Pescocostanzo	Sant’Antonio Forest	7 (5)	23/7/13-26/7/13 21/8/13-23/8/13	IT7110204 - MNP	65,31
TORN	CH	Palombaro	Tornelli	0 (3)	31/7/13-2/8/13	MNP	35,03
PIAN	PE	Bolognano	Piano d’Orta	0 (3)	28/8/13-30/8/13	IT7140203 - MNP	13,16
CAPI	PE	Caramanico Terme	Case Capirossi	0 (4)	9/7/13-11/7/13	MNP	20,24
LUCH	PE	Caramanico Terme	S. Tommaso - I Luchi	0 (4)	24/8/13-27/8/13	IT7140203 - MNP	266,79
ORTI	PE	Popoli	Orti di Popoli	4 (4)	3/7/13-6/7/13	Close to IT7110097	0,80
PARC	PE	Popoli	Parco fluviale Giardino	1 (1)	3/7/13-6/7/13	IT7110097	1,42
PESC	PE	Popoli	Sorgenti del Pescara	3 (1)	3/7/13-6/7/13	IT7110097 - SPNR	0,76
ROCC	PE	S. Eufemia a Majella	Orta, above Roccamanico	0 (4)	9/7/13-11/7/13	IT7140203 - MNP	143,34



Fig. 3 – A black cross window trap (BCWT) set on a pollarded willow at the study area “ORTI”, in the Peligna Valley.

pling stations (PESC, PARC, ORTI) (Figs 3-4), at six different willow trees.

Discussion

Considering the total number of records of *O. eremita* in Abruzzo (Table 1-2; Fig. 2), the species appears to be patchily distributed in this region but widespread within its borders. The occurrence of the species even outside protected areas highlights the need of extending conservation measures.

With this study, the occurrence of *O. eremita* has been recorded in the Sant’Antonio forest (MNP) for the first time and confirmed in the Peligna Valley (FGSASP) after a decade (Table 2). The Sant’Antonio forest covers approximately 500 ha between 1,290 and 1,420 m a.s.l., and is characterized by the presence of huge old-growth beech trees, some of which are >30 m tall, with a circumference which often exceeds 400 cm at base. The main feature of this area is that it has been managed in past centuries as wooded pasture. Therefore, beech trees were pollarded for production of a large amount, easily removable and renewable, of frond. Trees were cut at the top to make them produce numerous small branches with a dense foliage, which were removed every year in order to ensure a constant forage for cattle in the area. The practice of pollarding led to the formation of a big woody callus on top of the trunks, which rapidly accelerated the hollow formation, thus providing an optimal habitat for *O. eremita*. This process often brings about the formation of so-called “candelabra-shaped” beeches. Unfortunately, in the last 50 years the Sant’Antonio beech trees have not been pollarded (Her-



Fig. 4 – *Osmoderma eremita*, adults sampled at the study area “PESC”, in the SCI “Fiumi Giardino - Sagittario - Aterno Sorgenti del Pescara”.

manin 2012), thus preventing the formation of newly suitable hollows. A monitoring project in Sant’Antonio forest should be useful to assess the status of the population and apply the correct conservation actions.

Regarding to areas included in FGSASP: PESC is a riparian forest patch dominated by white willow; PARC is an urban park with monumental deciduous trees, and ORTI is a row of pollarded willows within an agricultural context. In the countryside area of Peligna valley, where *O. eremita* has been reported over the past decades, the practice of pollarding was maintained over centuries.

Even though the occurrence of the hermit beetle has been confirmed only in four sites (18% of the total sites selected), this apparent absence might be due to difficulty in detecting the species in areas where its populations have a low density (Chiari et al. 2012, 20013a, 20013b, 2014). Nowadays, the current populations of *O. eremita* are supported by a low number and a patchy distribution of suitable trees. The long distance among these trees may be a factor that prevents the population stability (Chiari et al. 2012). In fact, the adults of this species have low dispersal rate and range, and therefore require a network of closer trees in order to maintain population viability (Ranius & Hedin 2001). The longest dispersal range ever recorded for an adult in the Mediterranean region was 1.5 km, but the majority of individuals do not move more than a few hundred meters of their emergence tree (Chiari et al. 2013a). As a result, the species is now often confined to small patches of trees, increasing the predation risk and reducing the reproductive success of the individuals, becoming local sinks for the population.

Despite the environmental heterogeneity, all the sam-

pling stations that have been somehow subjected to human activities, especially pollarding, seem to have been beneficial for the conservation of *O. eremita*. Moreover, the presence of *O. eremita* in the study area PARC confirms that this species can occur in habitats with high human recreational activity. Occurrence of the species in urban parks has already been recorded in the last decades in many countries including Italy (e.g Florence, Rome, L’Aquila) (Sparacio 2000; Ranius et al. 2005; Carpaneto et al. 2010). Urban parks often host old hollow trees which are kept alive because of their aesthetical and recreational value, thus providing important reservoirs for the species (Carpaneto et al. 2010). The presence of endangered saproxylic beetles should be taken into account when trees are cut in urban parks for human safety, by avoiding the removal of trees hosting *O. eremita*. The use of old hollow trees as biomass for fuel is a new threat, recently appeared in Abruzzo: on December 2013, during a survey at Orti di Popoli (a location of *O. eremita*), some local men were observed while were loading some freshly uprooted, old pollarded willows on a lorry, and they referred that those logs were destined to become biomass for fuel production; an entire row of willow trees, along more than one hundred meters was so destroyed in that period (G. Carpaneto, E. Maurizi and F. Mosconi, pers. observ.).

Conclusions

The major threat for the survival of *Osmoderma* populations, in Abruzzo as in other parts of Italy, is the loss and fragmentation of suitable habitats, as the presence of old

Fig. 5 – Old hollow beech trees at the study area “ANTO”, in the Majella National Park.



growth trees with cavities and a large amount of wood mould is under significant decline. This is caused by modern forestry and agricultural management based on frequent tree cutting, removal of dead wood and abandonment of pollarding. For this reason, the Abruzzo Region has dedicated a specific section regarding the definition, designation and protection of old-growth forests (in Italian: “*boschi vetusti*”) within the recently enacted Regional Law on Forests and Pastures (L. R. 01/04/2014 n. 3).

Many tree species require centuries before naturally reaching the conditions suitable to host *O. eremita*, thus semi-natural biotopes, like urban parks, wooded pastures, pollarded beech woodlands and pollarded willow rows, are of crucial importance for the surviving of this beetle. Nowadays, populations of this species appears to be extremely rare and localized in Abruzzo; thus conservation policies have to be carried out locally, by mapping and preserving all trees potentially suitable for the life cycle of this species. In order to preserve and create new decaying trees with cavities, forestry and cultural practices such as pollarding should be promoted, while the removal of old trees should be avoided locally, where *O. eremita* is present and in suitable surrounding areas. Moreover, further investigations are needed to deepen the knowledge of the occurrence and distribution of *O. eremita* within this region.

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