

INVERTEBRATES OF CONSERVATIVE INTEREST FROM PLATFORMA COTMEANA, A ROMANIAN NATURAL PROTECTED AREA

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Abstract

Current work was carried out in a Natura 2000 site of community importance, ROSCI 0354, Platforma Cotmeana, with a surface of 12.529 ha, located in the Central Southern part of Romania in a hilly area. The site is mainly dominated by broadleaf forest, from which 30% consists of beech species, an important habitat component for the studied species. Focal species of this research were: *Lucanus cervus* (Linnaeus, 1758), *Cerambyx cerdo* Linnaeus, 1758, and *Morimus asper funereus* Mulsant, 1862, as listed in the annex of EU Habitat Directive. For each species, numerical abundance, sex ratio, and other aspects of their biology were estimated. Habitat preference and the occurrence of individuals were recorded in order to evaluate their distribution in the site. Future perspectives on the status of the conservation of species in site were assessed by evaluation of human impact activities affecting the quality of their habitat. It was noted that most dominant species is *L. cervus* with an occurrence of 314 individuals, followed by *M. asper funereus* with 92 individuals, and *C. cerdo* with 41 individuals. An exoskeleton of *Rosalia alpina* (Linnaeus, 1758) was found, fact explained by the limit of species distribution area in the site.

Keywords: biology, Natura 2000, saproxylic beetles, species distribution

1. INTRODUCTION

The Habitats Directive or the Council Directive 92/43 / EEC on the conservation of natural habitats and of the wild fauna and flora was adopted in 1992, and its main objective is the conservation of wild fauna and flora species as well as natural habitats in the territory of the states of the European Union. Thus, it was decided to establish a network of special avifauna protection areas (SPAs), and sites of community importance (SCI) aimed at the conservation of natural habitats and wild species of community interest with the exception of birds: Natura 2000 (Iorgu, 2015), with a 18% land share in the European Union area (Brînzan, 2013). Natura 2000 sites in Romania currently cover 22.68% of the country's land area, representing 383 SCIs and 148 SPAs (with a 16.76% share of land area and 14.91% respectively) being the Member State of the EU with the greatest biogeographical diversity, on its territory being found five of the nine bioregions, namely: Alpine, Continental, Pontic, Pannonian and Steppe, the last being found only in our country (Brînzan, 2013). A large part of Natura 2000 sites overlaps with the 963 protected natural areas of national interest (national parks, natural parks and reservations) spread over 7% of the Romanian area (Brînzan, 2012). As a signatory of the Convention on Biological Diversity (CBD), Romania has the obligation to apply the provisions of art. 6 stipulating that the parties shall "develop national strategies, plans and programs for the conservation of biological diversity and the sustainable use

of its components, or adapt existing strategies, plans or programs to that end", including the monitorisation of the conservation status of invertebrate species, as listed in the Annexes of the Habitats Directive which can be found in the Annexes of the GEO no. 57/2007 approved by Law no. 49/2011 and in the reference list in Annex IV of O.M. no. 2387/2011, which amends O.M. no. 1964/2007. There are currently 73 invertebrate species of community interest, of which: one species of leech (Annelida), seven species of snails (Gastropoda), one species of shell (Bivalvia), two species of crayfish (Crustacea), five species of dragonflies (Odonata), eight species of grasshoppers and grasshoppers (Orthoptera), 21 species of beetles (Coleoptera) and 28 species of butterflies (Lepidoptera) (Iorgu, 2015). Saproxylic insects along with fungi play an important role in wood degradation in most forest ecosystems (Ulyshen, 2016). It is estimated that 20-30% of all forest insects are saproxylic, and the presence of dead and decaying wood habitats is a necessity for this category of insects (Davies et al., 2009; Komonen and Müller, 2018). At European level, populations of saproxylic beetle species are declining as a result of habitat destruction or fragmentation. According to Geiser (1998), about 50% of German saproxylic beetle species are threatened. This situation led to increase in studies dedicated to these species in recent years, aiming to understand their biology and ecology, assess the size of populations, identify threats and dangers in order to maintain populations at a level that eliminates the danger of extinction.

In this context, the study presented in this paper contributes to the monitoring of the conservation status of community invertebrate species in general and of saproxylic coleoptera in the ROSCI0354 Platforma Cotmeana in particular.

In Romania, the size of protected saproxylic insect populations is currently being assessed.

2. MATERIALS AND METHODS

The natural area of Community importance ROSCI0354 Platforma Cotmeana, designated by the European Directive 92/43, has an area of 12,529 ha and belongs to the continental bioregion. The site is located in the northern third of the Cotmenei Piedmont, with the coordinates N 44.974167 lat. and E 24.431389 long., having a strongly fragmented relief of the hydrographic network with frequent processes of slope degradation (Fig. 1). The altitude varies between 198 m in the south and 549 m in the north. The climate is temperate continental, with average annual temperatures above 10° C, average annual rainfall between 580 and 600 mm, and a maximum monthly rainfall in June (Standard Form). The year 2014 was characterized by below normal thermal values in April-May and a high rainfall regime throughout the year. The forest ecosystem occupies 90% of the area and consists of planted deciduous forests, heterogeneous in age, with a high degree of fragmentation due to the predominant arrangement on the slopes.

The following forest habitats are found in the area: 91M0 (Pannonian-Balkan turkey oak-sessile oak forests) - 16%, 91Y0 (Dacian oak and hornbeam forests) - 28%, 9130 (Asperulo-Fagetum beech forests) - 30%, and 91E0 (Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*) - 4% (Doniță et al., 2005). In some areas of the site, the presence of clearings in the forest consist by veteran *Quercus* species is noticeable.

Research focused on protected saproxylic beetle species, *Lucanus cervus* (Linnaeus, 1758), *Cerambyx cerdo* Linnaeus, 1758, and *Morimus asper funereus* Mulsant, 1862, and was conducted between April and October 2014 in above-mentioned habitats. It were investigated old trees of *Quercus* spp., *Fagus sylvatica*, *Carpinus betulus*, etc., rots with rotten wood residues, old trunks, veteran trees with cracks, fallen trees, etc., stacks of wood, litter, paths, forest roads. In order to estimate the populations of protected species and the preference for a certain type of habitat, three

transects were delimited in each habitat, the surface of a transect being 2000 sqm (100 m long and 20 m wide).

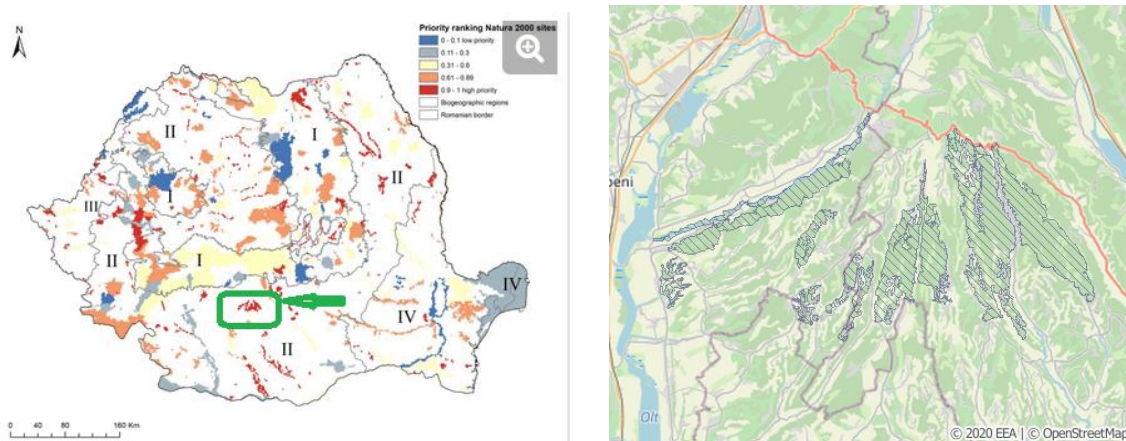


Figure 1. Geographical position of the Platforma Cotmeana site

www.biorxiv.org; <https://eunis.eea.europa.eu/sites/ROSCI0354>

The individuals observed on the trunks and on the litter were recorded, and after the end of the flight period exoskeletons of *L. cervus* and *C. cerdo* were taken into account (Campanaro et al. 2011). In the case of *M. asper funereus*, exoskeletons were rarely present, in our study only one being recorded.

Excessive precipitation during the activity period of *L. cervus* did not allow the use of the twilight transect method, considered the most efficient by Harvey et al. (2011a) and Vrezec et al. (2012).

The behavior of the species and the characteristics of the habitat were followed, the sex ratio, the abundance and the dominance of the species were taken into account (Simionescu, 1984). At the same time with the inventory of the species, the coordinates of the signalling areas were recorded with a Garmin GPSmap 60 CSx.

3. RESULTS AND DISCUSSIONS

In the Platforma Cotmeana site, three species of protected saproxylic beetles have been identified: *L. cervus*, *C. cerdo*, and *M. asper funereus*.

A fragmented exoskeleton of *Rosalia alpina* (Linnaeus, 1758) male was recorded in a secular beech forest (9130 habitat) located at the western limit of the area, at an altitude of 422 m (44° 57' 27.7" / 24° 24' 15.0"). The species is probably at the edge of its range.

a. Period of activity of saproxylic beetle species

The activity of the adults of these species begins at different times in the spring depending on the climatic needs. In the conditions of the year 2014, a mating couple of *M. asper funereus* was observed on April 21 on a beech trunk in the area. In warmer springs this species may emerge from hibernation in the first half of April. Adults were observed until the first part of August, but a male was recorded on September 18 (Fig. 2). Vrezec et al. (2010) and Dojnov et al. (2012) mention the activity of adults in Eastern and South-eastern Europe between April and September.

In the case of *L. cervus*, the first adults observed on April 25 were males, and after about a week females were recorded, the European stag beetle being a proterandric species. Harvey et al. (2011b)

reports the occurrence of adults in April in southern Europe. The last active males were observed on July 9, while the females in oviposition were present until August 26, these having a much longer longevity.

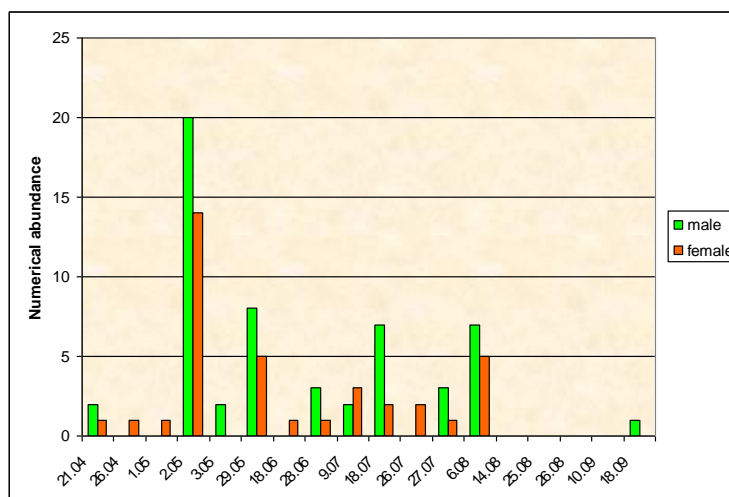


Figure 2. Numerical abundance of *M. asper funereus* adults, *Platforma Cotmeana*

The small number of *C. cerdo* individuals observed in the field, and the abundant rainfall in May did not allow for the specification of their period of activity. The first adult was recorded in early June, and on August 25 a couple was spotted on a veteran oak trunk in the twilight. The species may still be active in early September.

b. Sex ratio

According to the data recorded on the site, the dominance of males was found in all three species, the sex ratio having close values in the case of *L. cervus* and *M. asper funereus* (Fig. 3).

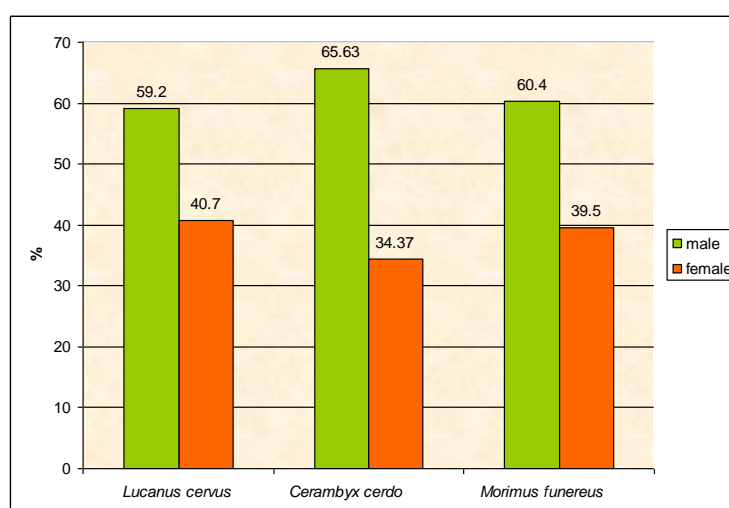


Figure 3. Sex-ratio in saproxylic Coleoptera

For *L. cervus*, 45 ♂♂ and 31 ♀♀ were recorded as active adults, and for *M. asper funereus*, 55 ♂♂ and 36 ♀♀. Couples of *L. cervus* are observed in the last decade of May and during the month of

June, while for *M. asper funereus* the mating is highlighted throughout the activity period, with a peaking in the first half of May, according to the observations to Vrezec et al. (2010) (Fig. 4 a-b). The dominance of *M. asper funereus* males is observed at each movement in the site, including the one in August (Fig. 2), unlike *L. cervus*, in which towards the end of the activity period the females dominate. Similarly on May 2, a fight between individuals was caught, when a mating couple was disturbed by an angry male (Fig. 5).

In the case of *C. cerdo*, the sex-ratio values may deviate from the normal ones as they were based on a small number of active individuals, 21 ♂♂ and 11 ♀♀, due to the small populations of this species. One of the males showed an anomaly in the right antenna, the terminal articles forming a right angle with the rest of the antenna. It was observed on 26 June 2014, in the western extremity of the site (91Y0 habitat) (Fig. 6).



Figure 4. The mating: a. *L. cervus*, 28 May 2014, Drăganu Forest (91Y0 habitat);
b. *M. asper funereus*, 29 May 2014, Lintești Forest (9130 habitat)



Figure 5. *M. asper funereus* fighting males



Figure 6. Antennal anomaly of *C. cerdo* male

c. Polyphagous behavior

The remarkable polyphagia of the stag beetle larvae is revealed by the large number of woody species mentioned in literature (Harvey et al., 2011b). In the site, females were frequently observed during oviposition at the base of the trunks of *Quercus* spp., *F. sylvatica*, *C. betulus*. On May 2, a female was recorded emerging from a *Crataegus monogyna* hollow (Fig. 7a-b). Many adults were observed during feeding (Fig. 7c). Eight last instar larvae were also observed in a trunk of *Q. petraea*, which shows that females can lay consistent eggs in the same place (Fig. 7d).



Figure 7. Some aspects of *L. cervus* biology: a. female in the *Crataegus monogyna* hollow; b. female near the hollow -2 May, 2014; c. female feeding with sap on *Quercus* spp.; d. 8 last instar larvae in a rotten trunk of *Q. petraea*

In the case of *M. asper funereus*, males and females were observed on freshly cut trunks, dry or old stems belonging to different woody species: *F. sylvatica*, *Quercus* spp. (sessile oak, Hungarian oak, Turkey oak and pedunculate oak), *C. betulus*, *Robinia pseudoacacia*, *Salix* spp.

Taking into account that there are mixed forests in the site, the statistical calculation based on the woody substrate of the adults revealed the preference of *M. asper funereus* for *F. sylvatica* in a proportion of 69.8%, followed by *Q. cerris* with 9.58% (Fig. 8). The attachment of *M. asper*

funereus to *Quercus* wood has been found in areas with dominant oak forests (Bărbuceanu et al., 2015), which demonstrates the advantages of polyphagous behaviour in the spread of the species.

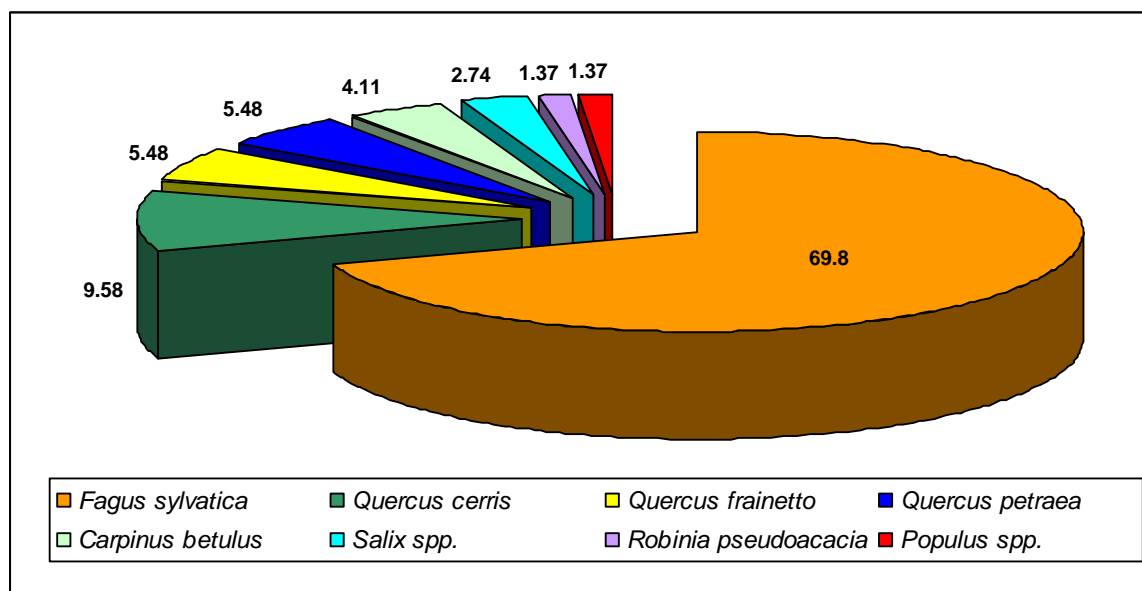


Figure 8. Location of *M. asper funereus* on woody species (%), Platform Cotmeana, 2014

C. cerdo was found only in sessile oak, Hungarian oak, Turkey oak and pedunculate oak wood (Fig. 9 a-b), although it is also known in other woody species (Buse et al., 2007).



Figure 9. *Cerambyx cerdo* in veteran *Q. petraea*: a. male hidden in a gallery, 28 June; b. 160 years old *Q. petraea* - 16 holes/sqm.

On the trunk of a 160-year-old sessile oak tree with a southern exposure, at a height of about 1 m above the ground, there were 16 holes/sqm (Fig. 9b). Literature mention the preference of this species for veteran trees of *Quercus* spp. isolated, with sun exposure, inhabited especially in the lower part. The diameter of the trunk is recognized as a determining factor in the diversity of saproxylic insects, too (Buse et al., 2007; Albert et al., 2012; Drag and Cizek, 2015).

Although it is known that the species prefers 120-140-year old trees, larval development can also occur in younger, partially dry trees. Thus, in a 74-year-old sessile oak tree, an emergency hole was observed at 86 cm above the ground, and at its base the exoskeleton of a female was identified, a situation highlighted in another area protected by Bărbuceanu et al. (2015).

d. Saproxylic Coleoptera distribution in site

L. cervus is common in the site, the 314 specimens (active or exoskeleton) being recorded in the habitats 91M0 (175 specimens), 91Y0 (128 specimens) and 9130 (10 specimens) with trees older than 45 years; a female was also observed in habitat 91E0. The optimal habitat is represented by the *Quercus* forests (91M0 and 91Y0), these representing 44% of the forest habitat of the area (Fig. 10 a-d), in which stag beetle dominates with 90.2%, and respectively 70.3% the other two species (Fig. 11). The presence of slopes at the level of the area in a proportion of about 80% influences the density and size of the populations.



Figure 10. *L. cervus* and *C. cerdo* habitat a. Secular forest of *Quercus frainetto* and *Q. cerris*, August 25, Cotmenitei Valey; b. Cotmenitei Valey location on site map; c. Feeding place for *L. cervus*, Cotmenitei Valey, 25 August; d. Secular forest of *Q. petraea*, *Q. frainetto* and *Q. cerris*, Plopului Valey

In sunny *Quercus* habitats arranged on a plateau with few trees, the species reaches an average density of 2-4 i./2000 sqm. Exceptionally, in forest clearings with veteran trees or at the edges, *L. cervus* reached numerical densities of 22 i./2000 sqm (44. 93674/24. 58404) (Fig. 10 a-c).

The stag beetle has also been observed on the edges of young *Quercus* forest (around 20 years old), in which the presence of secular trunks provides optimal conditions for oviposition of females, which are more pedestrian, thus favoring the spread of the species.

41 individuals of *C. cerdo* were recorded in habitats 91M0 (16 specimens) and 91Y0 (25 specimens). Partially dry trees over 70 years may ensure the development of larvae, despite the old *Quercus* forests, veteran trees from forest edges and clearings known as the preferred habitat of the species (Buse et al., 2007; Redolfi De Zan et al., 2017). The secular Hungarian oak and Turkey oak plateaus on the Cotmeniței Valley and the Plopului Valley (in the south-eastern extremity of the area) offer the best conditions for the survival of the species (Fig. 10 a, d). In favorable habitats, *C. cerdo* recorded a relative abundance of 13.7% and 8.2%, respectively (Fig. 11).

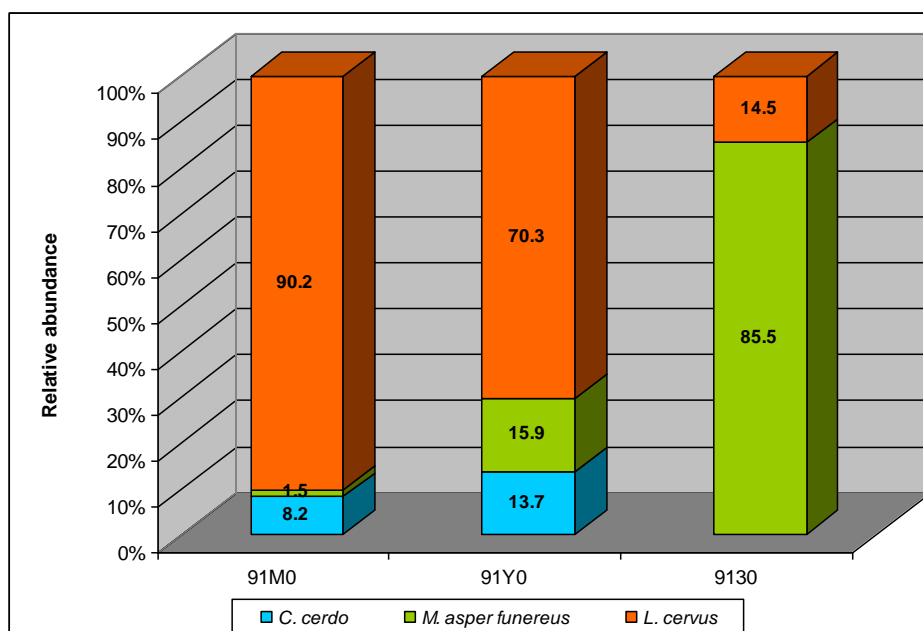


Figure 11. Relative abundance of saproxylic beetle species in the habitats of the Platforma Cotmeana

M. asper funereus is common in the site, 91 active adults and one exoskeleton being recorded between April to September. The abundance of the species is higher in the habitat 9130 (59 specimens), but it is also favorable the habitat 91Y0 (29 specimens), in which along with the *Quercus* species there is *F. sylvatica* preferred by the species. 3 specimens were observed in habitat 91M0 and one specimen in habitat 91E0. Adults were often found on freshly cut trunks.

Unlike the other two species, this pedestrian wingless beetle can inhabit areas with a higher density of trees and shrubs, and with dry wood. The optimal habitat is represented by forests over 45 years old, where dry trees necessary for development may be present. However, the low dispersal capacity of individuals causes fragmentation of the area, so that during the period of activity of adults, in habitats that seemed favorable, the species was not found, which affects the size of the population.

C. cerdo has often been mentioned in association with *L. cervus* (Panin and Săvulescu, 1961), a situation noted in the forest clearings or at the edges with secular trees in Cotmenița Valey and Plopului Valey, where the stag beetle dominates in proportion of 90 - 97.7%. The association *L.*

cervus - *M. asper funereus* is also present, but depending on the habitat one of these species dominates (Fig. 11).

e. Saproxylic beetles threats

Observations on the site showed that in some localities (May 3, Uda commune, northeast of the area) a traditional practice is maintained which consists of using the mandibles of *L. cervus* male as an aphrodisiac, a practice also mentioned by Sprecher-Uebersax (2008) in Bavaria. Thus, a local woman refers to her 20-year-old nephew from Bucharest, who uses a powder prepared from *L. cervus* mandibles. In the same locality, according to the reports, the habit of children to make necklaces from mandibles is still present sporadically. Although the stag beetle is common in the area, responsible management is required so that the existence of this species is not affected over time. It should be noted that Lucanidae species are among the most susceptible to forest disturbances (Lachat et al., 2012).

The main threat to *M. asper funereus* is the temporary storage of timber resulting from logging. Thus, 33 individuals, of which 14 females and 19 males, were observed on May 2, 2014 in the stacks temporarily stored on the forest road in Dealu Boului Forest (Cocu commune, southeast of the area) (Fig. 12 a,b).



Figure 12. Legal and illegal deforestation in the site: a, b. Beech stacks, Dealu Boului Forest, May 2 and 29, 2014; c-d. Veteran pedunculate oak cut with *C. cerdo* galleries, Cotmeniței Valey, 25 August.

It is possible that the number of adults was higher, but the way the wood was stored did not allow for detailed observations. Oviposition occurs in stacked wood, affecting irreparably the future generations. In the temporarily stored wooden stacks, the presence of the species was found each time, some of the adults in mating, a situation mentioned by other authors (Manu et al., 2017). Despite the forest regulations regarding the shortest storage period, they are not always followed. For this reason it is recommended to avoid deforesting during periods when the species are most active. Starting from the low mobility of individuals corroborated with loss of resources, Dojnov et al. (2012) are concerned about the perspectives of the species at a European level.

In the case of *C. cerdo* species, cutting and extracting secular trees is a major threat, a situation highlighted in the area (Fig. 12 c-d). The protection of veteran trees is a major condition in ensuring adequate microhabitats for this saproxylic species (Davies et al., 2009). The expansion of the area occupied by *C. betulus* and *R. pseudoacacia* in the site represents another threat to the saproxylic insects.

In the last decades, with all the effort of local authorities with attributions in the management of forest resources, there is a drastic reduction of the forest habitat in Romania, as a result of illegal logging, which has become more and more widespread; some forestry staff paid dearly in their efforts to protect the forests. As a result, the populations of these saproxylic beetles can be expected to decrease in the future in our country.

4. CONCLUSIONS

Observations carried in a Natura 2000 site, Platforma Cotmeana, highlight three species of protected saproxylic beetles: *Lucanus cervus*, *Cerambyx cerdo*, and *Morimus asper funereus*.

The good conservation status of the forest habitats in the area leads to the presence of these species in most of the investigated areas. The predominant arrangement of forests on the slopes at the level of the area influences the density and size of the populations of these species.

At the edges with secular trees it is found the association *L. cervus* – *C. cerdo* where the European stag beetle dominates in proportion of 90 - 97.7%. Other association, *L. cervus* – *M. asper funereus*, is also present, but in a more balanced relationship. Our observations have revealed the preference of *M. asper funereus* adults for *Fagus sylvatica* in a percentage of 69.8% compared to other forest species, given that beech forests have a share of 30% of the forested area.

Although there is a good management of the forest ecosystem by the forestry administration, the abusive deforestation at national level registered in the last years constitutes a serious threat for the conservation of the habitat of these species, even in the area that was the object of this study.

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