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Lucanus cervus (Coleoptera: Lucanidae) sampling during its flight period in Northern Italy: data from an ongoing survey in an oak forest

Davide SCACCINI[1] & Matteo ANACLERIO[2]

[1] Via A. Moro 25, Zelo Buon Persico, Lodi, Italy (e-mail: davide.scaccini@alice.it)
[2] Institute of Agricultural and Environmental Chemistry, Università Cattolica del Sacro Cuore, Piacenza, Italy

Abstract

In a forest in Northern Italy, adults of *Lucanus cervus* were periodically monitored in 2014 and 2015 from June to August. Sightings of walking and flying individuals were recorded, and captured individuals were sexed, measured, marked and then released.
Data about first and last appearances and their trend in the season were recorded for each sex and for flying specimens, with morphometric data of captured individuals. Some differences in their presence were noticed between the two investigated summers.
Finally, we speculated that the main predators of the adults in the area could be the raptor *Falco tinnunculus* and the corvid *Corvus cornix*, due to their massive presence and the examined stag beetle remains.
Differences on both presence and trend of *L. cervus* adults could be ascribed to weather conditions, since in 2014 summer was more cold and rainy than in 2015. The study is still in progress and aims to a multi-annual assessment of the biology of this protected saproxylic beetle.

Keywords: Monitoring, behavior, stag beetle, climate change, saproxylic.

Introduction

The European stag beetle, *Lucanus cervus* (Linnaeus, 1758) (Coleoptera: Lucanidae), is a protected species listed in Annex II of the Habitats Directive. In the IUCN (International Union for the Conservation of Nature) list, the species is considered Near Threatened (NT) in Europe (NIETO & ALEXANDER, 2010), while in Italy it is listed as Least Concern (LC) (AUDISIO *et al*., 2014). In Flanders (Northern Belgium), *L. cervus* is Endangered (EN) (THOMAES *et al*., 2015).
Generally, the species is distributed in Northern and central Italy, while the congenus *L. tetraodon* Thunberg, 1806 occurs in the center and South (BARTOLOZZI & MAGGINI, 2005; 2007).
Their larvae are dependent on deadwood in which they live several years, while adults have a short flight period, presenting crepuscular and nocturnal activity (cf. FRANCISCOLO, 1997; SMITH, 2003).
To achieve a better knowledge on the biology of *L. cervus*, a two-year study was conducted on a Northern Italian population during its flight period, recording data on adults presence, morphometry and other features.

Material and methods

In 2014 and 2015, adults of *L. cervus* were monitored in Croara (Piacenza province, Northern Italy), where the population is abundant and stable (pers. obs.). The survey started from the beginning of June to the beginning of August, with weekly observations. Surveys were programmed and adapted also considering the weather condition, avoiding rainy and windy days. Monitoring was carried out from 6:45 pm to 9:45 pm (UTC + 1), collecting data on walking and flying individuals found along a 500-m long and 10-m wide transect (coordinates: 44°55'20" N, 9°34'30" E, elevation: abt. 240 m a.s.l.). The same arrangement of the transect is reported in the European monitoring protocol for the stag beetle (CAMPANARO *et al*., 2016). During the three hours, the transect was walked up and down

three times, walking with a constant speed (30 minutes for 500 m). All captured adults were sexed, measured (with a caliper), marked (with non-toxic acrylic paints) and released. Data about the presence of flying individuals were also collected.

Results

First activity above the ground for each sex, flight activity, and cumulative percentage in presence are reported in Figs 1 and 2. In the two years, a total of 78 males, 26 females, and 63 flying individuals were observed. In 2014, the first activity above the ground was similar to that in 2015 (end of June to the beginning of July). Males were observed for the first time on June 30th 2014, and on July 1st 2015. The first female activity above ground documented during 2014 was on July 22nd, while in 2015 on July 9th. Consequently, the recorded gap male-female on first activity was about 22 days in 2014, and 8 days in 2015. The peak of flight was on the week of July 15th in 2014, and in the first decade of July in 2015; in both cases, flight started mainly after 8:30 pm, with a peak after 9:10 pm (up to 9:40 pm approx.). For sexed flying specimens, only in one case (on July 22nd 2014) a flying female was recorded, out of more than 65 flying specimens in total (less than 1.6 %). Only one marked male was recaptured after a week, on July 15th 2014.

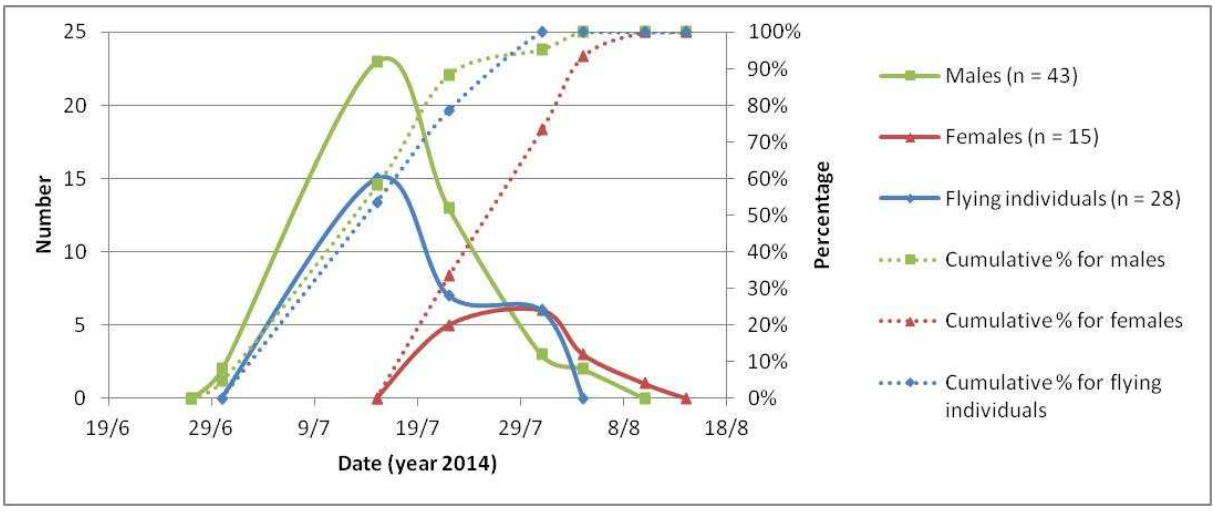

Fig. 1. Presence and cumulative percentage of males, females and flying individuals in 2014. Solid lines are referred to the left ordinate, and the dotted ones to the right.

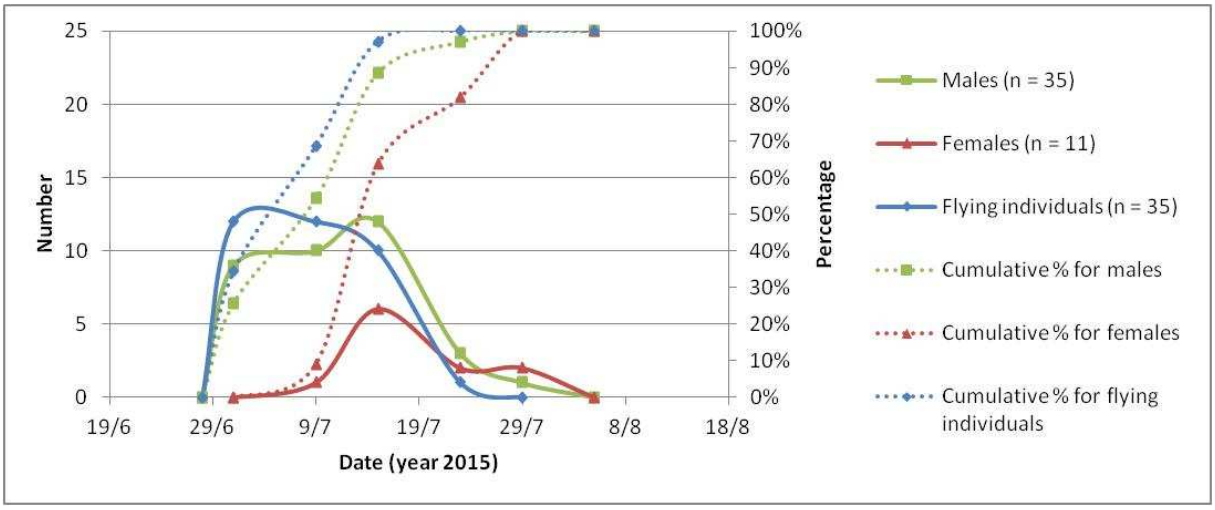

Fig. 2. Presence and cumulative percentage of males, females and flying individuals in 2015. Solid lines are referred to the left ordinate, and the dotted ones to the right.

Total length (from the tip of mandible to the tip of elytra) of measured individuals and the sex ratio (partial and total) are summarized in Table 1, separated for sampling event. The biggest male observed was 65.50 mm long and the smallest 36.20 mm; the biggest female was 40.90 mm long, while the smallest 30.05 mm (Table 1). Further morphometric data of the studied population are reported by SCACCINI *et al.* (2016).
Finally, some remains were found in the forest, and allocated to common predators of the stag beetle such as raptors and corvids (see the discussion).

Table 1. Summary table on total length and sex ratio.

(Measures in mm)	MALES – length				FEMALES – length				Female-to-male ratio
	Mean (± st. dev.)	Minimum	Maximum	*n*	Mean (± st. dev.)	Minimum	Maximum	*n*	
2014 sampling									
i	45.95 (± 4.31)	42.90	49.00	2	-	-	-	-	-
ii	47.27 (± 5.64)	37.30	59.70	23	-	-	-	-	-
iii	45.71 (± 5.59)	36.20	52.00	13	36.76 (± 0.70)	36.00	37.60	5	1 : 2.60
iv	52.43 (± 8.16)	43.30	59.00	3	39.07 (± 1.93)	35.70	40.90	6	1 : 0.50
v	48.90 (± 6.22)	44.50	53.30	2	37.57 (± 1.63)	36.30	39.40	3	1 : 0.67
vi	-	-	-	-	38.00	38.00	38.00	1	-
TOT 2014	47.17 (± 5.74)	36.20	59.70	43	37.93 (± 1.71)	35.70	40.90	15	1 : 2.87
2015 sampling									
i	49.26 (± 6.27)	39.90	61.90	9	-	-	-	-	-
ii	49.86 (± 6.72)	42.40	65.50	10	38.60	38.60	38.60	1	1 : 10.00
iii	49.58 (± 3.89)	44.00	54.60	12	34.86 (± 2.69)	30.05	38.00	6	1 : 2.00
iv	55.67 (± 2.75)	53.00	58.50	3	38.35 (± 0.49)	38.00	38.70	2	1 : 1.50
v	47.45	47.45	47.45	1	36.73 (± 3.22)	34.45	39.00	2	1 : 0.50
TOT 2015	50.04 (± 5.46)	39.90	65.50	35	36.17 (± 2.70)	30.05	39.00	11	1 : 3.18
TOT 2014-2015	**48.46 (± 5.76)**	**36.20**	**65.50**	**78**	**37.18 (± 2.31)**	**30.05**	**40.90**	**26**	**1 : 3.00**

Discussion

In the studied area, *L. cervus* appeared above the ground from the end of June to the beginning of July, with a peak of presence on the first 10-15 days of July for both investigated years (Figs 1-2). Differences are shown from studies in central and Northern Europe (*e.g.* SMITH, 1998; 2003; 2011; FREMLIN, 2009; FREMLIN & FREMLIN, 2010; HARVEY *et al.*, 2011; RINK & SINSCH, 2011), and the first appearance was similar to other Italian visual encounter surveys as described by CHIARI *et al.* (2014). In both years in Croara, males appeared first, as reported in other studies (*e.g.* FREMLIN, 2009; THOMAES *et al.*, 2010; SMITH, 2003; 2011; HARVEY *et al.*, 2011; RINK & SINSCH, 2011). Only one marked male out of the 78 was recaptured (1.28 % of males, and 0.96 % of total marked specimens), showing that monitoring methods of mark-release-recapture may need more frequent surveys (*e.g.* CAMPANARO *et al.*, 2011a).
Adults of *L. cervus* are considered weather-dependent (*e.g.* RINK & SINSCH, 2007; 2011; FREMLIN & FREMLIN, 2010). In particular, they are influenced by air temperature (RINK & SINSCH, 2011), wind (for flying individuals), relative humidity (RINK & SINSCH, 2007; FREMLIN & FREMLIN, 2010) and

maybe by atmospheric pressure (FREMLIN & FREMLIN, 2010). Actually, the current climate change (IPCC, 2013) can increase the vulnerability of local populations, reducing activity period and increasing metabolic cost for thermoregulation (RINK & SINSCH, 2011). As well as the growth of anthropogenic disturbance, the climate change can also cause the loss of a suitable habitat, as reported for the endemic stag beetle of Taiwan, *L. miwai* Kurosawa, 1966 (HUANG, 2014). In the present study, differences in occurrence and trend of *L. cervus* adults between two years could be ascribed to different weather conditions. A notable difference in first appearance was reported for females, about two weeks later in the colder and rainy 2014 than in 2015. When higher temperature occurs, the stag beetles seem to emerge later than when it is lower (MORETTI & SPRECHER-UEBERSAX, 2004a; b). Further studies and more data are needed to achieve a better knowledge on the biology of the population, in particular related to their climate responses.

The female-to-male ratio (Table 1) fit with some previous studies (*e.g.* FREMLIN, 2008; 2009; FREMLIN & FREMLIN, 2010), even though the sex ratio is reported to change with different sampling methods (HARVEY *et al.*, 2011; CHIARI *et al.*, 2014).

Furthermore, morphometric data of the captured specimens fit with *L. cervus* features (cf. FRANCISCOLO, 1997); males were not very large and females were in their typical range of size (Table 1). The morphometric analysis of males in the studied population reported the presence of the two different forms, *minor* and *major* (SCACCINI *et al.*, 2016).

Finally, we speculated that the main predators of the adults in the area could be the kestrel *Falco tinnunculus* Linnaeus, 1758 and the hooded crow *Corvus cornix* (Linnaeus, 1758), because they were present in large numbers near the forest during stag beetles' peak of flight and the presence of predated stag beetle remains. In particular, at the evening of July 15th 2015, 9 individuals of the kestrel were observed roosting on two pylon cables, close together. Remains typically consisted of male heads, pronota and elytra, while the abdomen is taken out by the predator. These kind of remains are typical for corvids (CAMPANARO *et al.*, 2011b; SMITH, 2011; FREMLIN *et al.*, 2012). Large numbers of the hooded crows were seen in the forest during several surveys. Both the kestrel and the hooded crow are known predators of *L. cervus* (*e.g.* HALL, 1969; LACROIX, 1969; FRANCISCOLO, 1997; CAMPANARO *et al.*, 2011b). Despite the presence of the fox, *Vulpes vulpes* (Linnaeus, 1758), no remains of *L. cervus* were found in its examined faeces.

Conclusion

Monitoring of *L. cervus* populations can be useful for its preservation and to improve the knowledge on this threatened species, also in relation to the current climate change. The study is still in progress and aims to a multi-annual assessment of the *L. cervus* biology.

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