Natural History Observations on a Population of *Vesperus luridus* (Coleoptera: Cerambycidae) in Central Italy

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Abstract: Natural history observations were made, during August–September 2021, on a population of the ecologically poorly known *Vesperus luridus* (Cerambycidae) at a hilly locality of Latium, Central Italy. These beetles were searched for by night along a 170 m long transect, with the help of hand torches. During the field surveys, we recorded a total of 130 individuals, of which 128 were males and 2 females. All individuals were observed between 21 h 45 and 01 h 15, with above-ground activity peaking from 22 h 45 to 23 h 45. The minimum observed density per day showed a rapid increase to a peak at the end of August, followed by a slower decrease in the following two weeks. Mean male density was 0.32 individuals per transect m², whereas only two females were observed (mean density 0.006 individuals per transect m²). Most individuals were found on trees, and they appeared to be highly attracted to artificial lights. One female, situated on a tree at a height of 170 cm, was surrounded by five courting males.

Keywords: coleoptera; *Vesperus*; ecology; density; Italy

1. Introduction

*Vesperus* (Dejean, 1821) is the only genus of the tribe Vesperini (Mulsant, 1839), which is in turn one of the two tribes of the Vesperinae subfamily [1,2]. *Vesperus* has a circum-Mediterranean distribution and has been carefully studied from a taxonomic point of view [3], whereas ecological data remains scarce for all species in the genus [4,5]. However, ecologically speaking, these species are very interesting, with pronounced sexual size dimorphism and especially with remarkable intersexual ecological divergence; in all species apart from *Vesperus macropterus*, the females are brachypterous and are unable to fly. They spend most of their adult life underground, whereas the smaller males fly well and tend to climb trees and actively disperse. Summarized notes on their biology are presented in [3].

*Vesperus luridus* (Rossi, 1794) is found in southern France (including Corsica), Italy (including Sardinia and northern Sicily) and the Dalmatian region; males of this species are 12–18 mm length and females are 16–22 mm [3,6]. Its natural history has not been studied carefully so far, but this species has been listed in several local studies and species checklists [7–11]. This species has also been reported to cause damage to grape cultures in some parts of its range [12,13]. *Vesperus luridus* apparently has a scattered distribution in Italy, but is known to be locally common in some regions (for instance, in coastal Tuscany), and has been recorded as a prey item of the scops owl *Otus scops* [14]. In the present paper, we report preliminary field observations on the natural history of a single population of *Vesperus luridus* from a hilly area of central Italy, focusing on adult sex ratio, density, body size and activity patterns.
2. Materials and Methods

The field study was carried out during August and September 2021, at a hilly locality of central Italy (Oriolo Romano, province of Viterbo), Latium, about 450 m.a.s.l. The site consisted of a 170m-long transect along an unpaved street, surrounded by two files of planted trees (Celtis australis) on each side of the street, positioned at an average distance of 3–10 m from each other (Figure 1). The study area is moderately well-lit at night by street lamps with a height of about 3m, spaced about 30 m from each other.

Figure 1. The study site in Oriolo Romano, central Italy. Photo by Luca Luiselli.

Field surveys were carried out from 20:00 h to 02:00 h, using handheld torches (10-W, 390-lumen CFG Patriot), by 2–4 surveyors per night (Visual Encounter Surveys methodology). Overall, approximately 144 man-hours were spent in the field (man-hours being defined as the cumulative number of hours spent in the field by the research team, considering each of the observers independently). Each surveyor searched for beetles by carefully scrutinizing the ground and the whole trunk of the various trees up to about 4.5 m high, and recorded each individual observed. In order to avoid pseudoreplication, we counted individuals encountered along only one direction of the transect in each survey day. All the observed individuals were sexed, and their height from the soil was also recorded. In addition, a sample of 67 males and 2 females were measured for body length using an electronic calliper (Mitutoyo Digital Calliper, Edmund Optics; precision ± 0.1 mm). On occasion, particular behaviours (for instance, male courting) were recorded. Observed individuals’ species was identified by using the determination key provided by Vives [3]. Sexes were distinguished on the basis of their external features.

In order to assess whether the observed sex ratio was unequal, we performed an observed-versus-expected contingency χ² test by using PAST 4.0 statistical software. The minimum observed density per survey night was calculated as the number of recorded individuals divided by the transect length in each night of survey. The mean observed density per survey night was the average between the various minimum densities calculated daily. In the text, means are presented ±1 Standard Deviation. Alpha was set at 5%.
3. Results

The earliest individuals were observed on 24 August. During the whole survey period, we observed respectively 2 individuals (one male and one female) on 24 August, 2 (males) on 26 August, 54 (all males) on 27 August, 27 (26 males, 1 female) on 3 September, 23 (males) on 7 September, 19 (males) on 9 September, 3 on 10 September, 1 on 11 September, and 0 on both 12 and 13 September. Overall, during the field surveys, we recorded a total of 130 individuals, 128 males and 2 females (adult sex-ratio significantly unequal: $\chi^2 = 122.2$, $df = 1$, $p < 0.0001$). All specimens were observed between 21 h 45 and 01 h 15. Above-ground activity appeared at its peak from 22 h 45 to 23 h 45 (about 70% of individuals observed in that time interval).

The minimum observed density per survey night varied remarkably, showing a rapid increase to a peak at the end of August followed by a slower decrease in the following two weeks. The mean observed density for males was 0.32 individuals per transect m$^2$, whereas that of females was 0.006 individuals per transect m$^2$ (Figure 2).

Figure 2. Minimum observed density per survey night of Vesperus luridus at the study area in Oriolo Romano, central Italy.

Seven male individuals were observed on the ground, nearby a lit street lamp (coordinates: 42.157107, 12.134430). All other individuals, including the two females, were found on trees at a height of 10–200 cm, between 42.157119, 12.134371 and 42.156007, 12.132924 geographic coordinates. One female was found on a street lamp at a height of 10 cm, and the other female was found on a tree at a height of 170 cm. This latter female was surrounded by five males that were trying to court her, on 3 September. Male courting behaviour consisted of a series of concentric circles made with the body that lasted for a few seconds. This courting behaviour was made in the presence of the female by the five co-courting males, but was also observed in other males that were apparently not in the vicinity of any female. Several male individuals had severely cut antennas and even missing legs, suggesting that male-male combat for access to females may be a rule in this species.

Males (mean = 11.2 ± 2.6 mm, maximum length = 15 mm, $n = 64$) were remarkably smaller than females (mean = 17.4 ± 3.5 mm, maximum length = 20 mm), but since only two females were observed, no statistical test can be conducted.

4. Discussion

Our data suggest that the activity period of adult Vesperus luridus extends for about three weeks from the second half of August to the first half of September, which is a similar-length period of activity to that observed in Sardinian Vesperus macropterus [4]. However, the peak of activity is certainly shorter: we observed 41.5% of the total sample in just one night, and 94.6% of the total sample within a period of exactly fourteen nights.
Consequently, the observed minimum density per night also had a short peak at the end of August. Oriolo Romano has a relatively continental climate, with cold and rainy autumns. Therefore, the observed pattern is typical of *Vesperus* populations inhabiting hilly and mountainous sites; conversely, *Vesperus* populations from dry/hot Mediterranean sites tend to have their reproductive phase and above-ground activity peaks by December [4]. The observed sample size suggests that the local *Vesperus luridus* population should be large and abundant. This is surprising if one considers that no single individual was observed at the study area and in the surroundings (i) by the authors during about 20 years of opportunistic research and (ii) by a dedicated team of entomologists that, using traps and Visual Encounter Surveys, recorded several other species of Cerambycidae at the study area [15]. Thus, we are led to think that *Vesperus luridus* should have an extremely scattered distribution overall in the Oriolo Romano area.

Despite a very small sample size (*n* = 2), it seems that females climb to reach elevated perches where they can attract males more easily. Indeed, the single female that had climbed over 150 cm from the ground had five males simultaneously courting her. In the closely related *Vesperus macropterus*, females also climb onto dry plants to reach elevated positions where they can attract males. Oviposition of *Vesperus luridus* is likely to occur on the ground, whereas *Vesperus macropterus* oviposits on the inflorescences of some plants (*Thymus, Hyparrhenia, Carlina*; see [4]) and *Vesperus xatarti* Mulsant, 1839 in the cracks in the bark of pines [3]. Larvae of this species are known to be polyphagous, but mainly feed on grapevines (*Vitis vinifera*) and Common Olive (*Olea europaea*), and dig tunnels in the roots (see https://www.biolib.cz/en/taxon/id168194/; accessed on 19 September 2021).

Our study revealed an extremely male-biased adult sex ratio. Although this pattern might have been influenced by higher elusiveness of the non-flying females or a lower attraction of this sex to artificial night lights, the statistical significance indicates that males are effectively much more abundant in the field. We suggest that the extremely biased sex ratio may be due to females sitting hidden in leaf litter or debris, so they could not be observed easily by the surveyors. They could use pheromones from these places in order to attract the males while minimizing predation risk. Our data mirror those of Vives [3], who also suggested that males are more numerous than females in *Vesperus* populations in general. However, since Vives [3] did not provide any quantitative data to support his statement, we cannot elaborate more on this apart from stating that our study is the first statistically documenting a biased sex-ratio in this Cerambycidae genus. In addition, species-specific variability in adult sex ratios can be expected in *Vesperus* populations, and it cannot be excluded that other *Vesperus luridus* populations may have even more biased adult sex ratios. For instance, females were relatively abundant in *Vesperus macropterus* from Sardinia [4]. However, in this latter species the females are fully winged and potentially able to fly normally, so much so that it is likely that the operational sex ratio is less skewed than it is in *Vesperus luridus*. From a sexual selection point of view, the extreme abundance of males against a small number of females may enhance the male-male sexual competition. Interestingly, we observed that even five males were concurrently courting a single female at less than 3 cm distance from her. Potentially strong male-male sexual competition may explain why several males were observed with damaged legs and antennae at the sighting time (some samples are currently deposited in the private entomological collection “Luiselli”, Rome, Italy). Apparently, one of the two observed females was clearly attracted to artificial light (as she was climbing on a street lamp), thus suggesting that a greater attraction to street lamps for males cannot be the sole reason justifying the male-biased sex ratio. Vives [3] reported that both sexes are clearly attracted by artificial lights in *Vesperus* species, but Sechi [4] suggested that this behaviour occurs only in males in *Vesperus macropterus*. Anyway, in beetles, when the females are not winged/flying, the sex ratio tends to be clearly biased towards males, for instance in *Pachypus* (Dejean, 1821) species with females lacking elytra and hindwings and having an almost entirely hypogean (fossorial) lifestyle [16,17]. Thus, the pattern we observed in *Vesperus luridus* cannot be considered surprising. In these cases, the gene flow is reduced in the least dispersing sex due to the
sex-biased dispersal (males being much more actively dispersing than females) [18]. This common phenomenon can influence the potential for introgression of maternally versus paternally transmitted genes [18].

In terms of body size, our study confirmed that males were much smaller than females, this pattern being general in Vesperus species [3]. Considering that, as in another species with larger-female sexual size dimorphism (Vesperus macropterus) adult males have a very short lifespan (they normally die 1–2 days after being observed in activity) whereas females may live for a few more days till oviposition occurs [4], it is likely that the same longevity pattern should occur in Vesperus luridus as well. Adult longevity may also be heavily affected by predation rates; at the study area, we observed a high density of two Carabidae (an undetermined species of the genus Pterostichus (Bonelli, 1810) and Carabus granulatus interstitialis (Duftschmid, 1812)), one Staphylinidae (Ocypus alens (Muller, 1764)), one Lycosidae spider, and the common toad (Bufo bufo (Linnaeus, 1758)). All these species are insectivorous and have been observed multiple times at the basis of the trees where Vesperus individuals were seen and in the same activity hours, thus almost certainly representing a high potential hazard for Vesperus luridus and especially for the ground-dwelling females.

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