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Forest-ecological aspects of the genus *Allardius* Ragusa, 1898 (Coleoptera Tenebrionidae) in Sicily and Sardinia

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ABSTRACT The genus *Allardius* Ragusa, 1898 (Coleoptera Tenebrionidae) includes only two species: *Allardius oculatus* (Baudi di Selve, 1876) endemic to Sicily and *A. sardiniensis* (Allard, 1877) endemic to Sardinia. They are infrequent species in nature with few reports in entomological bibliography. The authors describe and illustrate the larvae and the biological aspects of *Allardius*. In particular, it is highlighted the strong saproxylophagous activity of these beetles and the importance of their role in the ecology of a forest in relation to the presence of "dead wood".

KEY WORDS Tenebrionidae; *Allardius*; larvae description; Deadwood; saproxylic diversity.

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INTRODUCTION

The genus *Allardius* Ragusa, 1898 (Coleoptera Tenebrionidae, subfamily Tenebrioninae, tribe Helopini, subtribe Helopina) includes only two species medium-sized, winged, with nocturnal habits and summer phenology, sylvicolous and corticicolous (i.e. living under the bark); they show an obvious sexual dimorphism with males that appear smaller, opaque on the dorsal surface, with median tibiae strongly curved; the females, larger and more robust, with dorsal surface shiny and median tibiae slightly curved. The geographical distribution is limited to Sicily for *A. oculatus* (Baudi di Selve, 1876) (Fig. 1) and to Sardinia for *A. sardininensis* (Allard, 1877) (Fig. 2) (Luigioni, 1929; Porta, 1934; Gardini, 1995; Aliquò et al., 2007; Löbl et al., 2008; Aliquò & Soldati, 2010).

A. oculatus was described for Sicily by Baudi di Selve (1876) on a single female specimen caught in the Madonie (see also Ragusa, 1898) sent to him by the Sicilian entomologist E. Ragusa. Allard (1877) believed that these two species, because of the particular shape of the pronotum and the length of the metasternum, should belong to a new genus which was later described by Ragusa (1898) as a subgenus of *Helops* Fabricius, 1775 and dedicated to Allard. *A. oculatus* is considered a rare species with very few specimens reported so far, recently signalized in mixed forests and cork at medium altitudes in two Sicilian localities (Caronia, Messina province and Palermo, Addaura), illustrated and described by Aliquò et al. (2007) and Aliquò & Soldati (2010).

A. sardiniensis seems limited to Southern Sardinia, particularly in the area of Monte Sette Fratelli, Cagliari (Aliquò et al., 2007). It is reported in various web pages for Monte Sette Fratelli, Cagliari (http://www.naturamediterraneo.com/forum/topic.asp?TOPIC_ID=60136; http://www.entomologiitaliani.net/public/forum/phpBB3/viewtopic.php?f=178&t=3105) and Monte Serpeddì, Musui, 800 m asl,Cagliari, Burcei (http://www.naturalphotodesign.it/taxonomy/gruppi-sistematici-trattati/Regno-Animalia/Phylum-Arthropoda/Classe-Insecta/Ordine-Coleoptera/Fam.-Tenebrionidae/Allardius-sardiniensis-Allard-1877-Sardegna.html).

On the whole, the research carried out in recent years on the island faunas has allowed us to discover several numerous populations of the two species of *Allardius* and make interesting, preliminary observations on their biology and ecology.

MATERIALS AND METHODS

Two Sicilian populations of *A. oculatus* (Palermo, Addaura, 100 m above sea level; Trapani, Castellammare del Golfo, Monte Inici, 400 m asl) (Figs. 3-6) and one population of *A. sardiniensis* (Cagliari, Monte Sette Fratelli, Campu Omu, 455 m asl) (Fig. 7) have been investigated. The environments of collection were similar to each other, being very dense wooded areas with a predominance of oak (*Quercus ilex* L.) in the dead wood of which the larvae of *Allardius* were developing. Observations were conducted in the field, in the places of discovery and, later, in laboratory where the dead wood attacked by the larvae of *Allardius* was transferred by special boxes. It was thus possible to observe and record periodically the various stages of larval development (Figs. 8, 9) and, in the summer period, to study the behavior of the adults. All sites of collection, along with the wood attacked by the larvae and all stages of the life cycle were photographed with a Canon EOS 400D. The study, which began in February 2010, for the Sicilian populations, and in April 2011 for the one of Sardinia is still ongoing. The studied material is preserved in the collections of the authors.

RESULTS

Allardius oculatus. The study began with the identification and gathering of branches of *Quercus ilex* attacked by the larvae of *Allardius*. The wood was collected directly on the ground, in the thick of the forest, between the wet foliage litter and debris at the foot of oak trees. The branches, whose diameter ranged from 10 to 105 mm, often displayed on the bark traces more or less extensive of fungal attacks or holes out of *Allardius* emerged in previous years. Even the consistency of the branches was variable in relation to the larval attacks suffered; indeed, the larvae occur in the same wood with different generations and in different years, digging numerous tunnels into the wood until its complete degradation (Fig. 10). In our study it was possible to observe simultaneously larvae in varying degrees of development, at the moment up to three years. The tunnels are normally more or less straight and parallel to the length of the branch attacked but often, in more advanced stages of wood degradation, tend to collide with one another and to have irregular course. The larvae are very active, move quickly and use the urogomphi (i.e. paired horns) to defend themselves; they develop into the wood with very large populations and in almost absolute monopoly; in our study we found larvae of *Stictoleptura cordigera* (Fussli, 1775) (Coleoptera Cerambycidae) and *Anthaxia* (*Cratomerus*) *hungarica* (Scopoli, 1772) (Buprestidae). Despite this crowding condition, larvae did not show any form of aggression or cannibalism behavior. Pupae (Fig. 11) occur at the end of May-June and last about twenty days. Adult flickering starts in mid-June and continues in July. The flicker holes are circular and show a diameter of 5-8 mm. Adults observed in the laboratory are quite active and move quickly on the surface of dead branches; they stop very quickly and tie up at the point where they are at the slightest glimmer of artificial light; in the rest position they often adhere to the wood with the head flexed forward and antennae straight forward slightly broaden and bent at the apex. Male is smaller than female and during mating (Fig. 12) is located on her back holding her with the front and medium legs placed at the sides of the abdomen and with the antennae on the sides of the pronotum. On some occasions we also observed 2-3 males on the back of a female (Fig. 13). The female is under the male with the antennae straight and lean forward, parallel to the substrate.

DESCRIPTION OF THE LARVA. The description is based on a larva 28 mm long, 3.1 mm wide, head capsule 2.4 mm broad (Figs. 14-16). The body is brownish-yellow with blackish mandibles; cuticle sclerotized, with shiny and very rugose surface of tergites and sternites. Head prognathous, oval, slightly tilted downward; vertex with 2 long setae before the posterior margin, 3 long setae on each lateral margin and 4 long setae behind the anterior margin. Clypeus little convex in lateral view, transverse, rounded at the anterior margin and particularly at the sides, with two long setae before the posterior margin, 3 long setae on each side and 3-4 little setae on the anterior margin. Labrum tran-

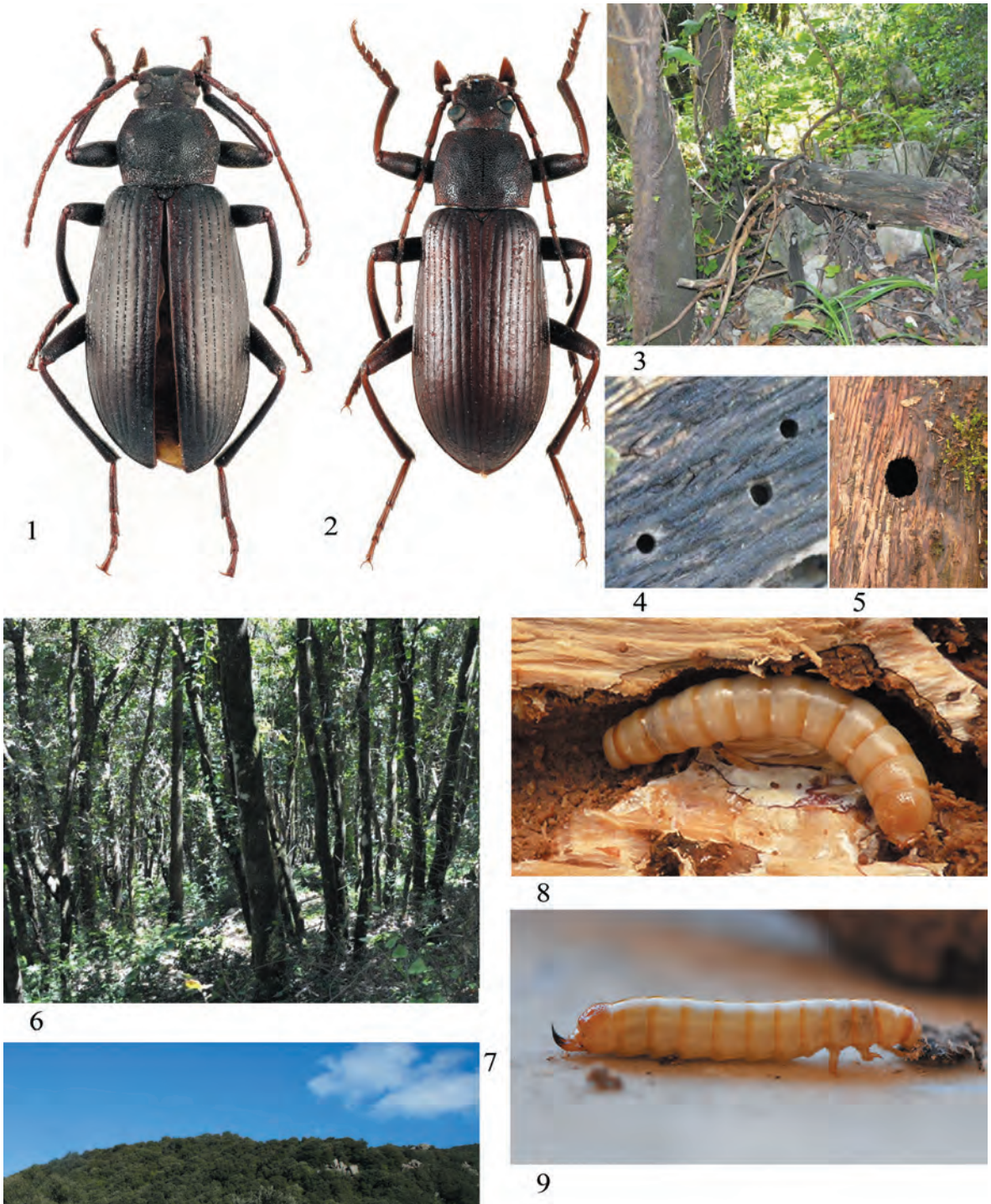

Figure 1. *Allardius oculatus* from Sicily, Palermo, Addaura. Figure 2. *A. sardininensis* from Sardinia, Monte Sette Fratelli, Cagliari. Figures 3-6. Monte Inici, Sicily: habitat of *A. oculatus* with holes of *A. oculatus* in branches of oak (4-5). Figure 7. Monte Sette Fratelli, Sardinia: habitat of *A. sardiniensis*. Figure 8. Larva of *A. oculatus* (Monte Inici). Figure 9. Larva of *A. sardiniensis* (Monte Sette Fratelli). Figures 1, 2, photos by M. Romano.

sverse, slightly convex in lateral view, with 2 long discal setae and 2 long setae on each lateral margin. Epipharynx with long, marginal and discal setae. Mandible asymmetrical, strongly sclerotized with apices distinctly bidentate and with robust teeth at the base, more developed in the left part. Maxilla with primary cardo, stipes, maxillary palpus and lacinia; maxillary palpus three-segmented, with the last segment pointed and with one long seta on the outer edge of the second segment. Labium with distinct prementum, mentum and submentum. Antennae trimerous; antennomere I very short, wider than long; antennomere II 4-4.5 times longer than the first one; antennomere III similar to the second but more slender and rounded at apex with 1-3 very short setae. Prothorax wider than long with 4-5 setae situated to lateral margin and 2-3 on the dorsal surface and with little and sparse punctures. Forelegs somewhat longer and stouter than mid- and hindlegs; trochanters short, covered by numerous long setae; femurs elongated, covered by numerous long setae; tibiotarsi covered by numerous short and strong spines. Claws brown, pointed at apex, shorter than tibiotarsi. Abdominal tergites 1-7 with setae dorso-laterally; dorsal cuticle very bright, wrinkled transversally and with the little punctures concentrated mainly in the anterior half of each segment; spiracles small and circular. Abdominal tergites 7 and 8 with large, deep, rounded holes. Abdominal tergite 8 with two little elevated protuberances, two small dimples and two long setae in the middle of the dorsal surface. Abdominal tergite 9 transverse in dorsal view, irregularly rounded at apex and with 10 little setae, with two prominent, projecting urogomphi strongly and almost completely sclerotized, with 3 long setae situated laterally of each urogomphus, 2 in the center posteriorly, and 3 on each situated, respectively, one to the base, one just above and another at about mid-length, laterally. Lateral parts of abdominal tergite 9 also with one small and rounded prominence and a larger one, protruding and hunched.

Pupa white with darker urogomphi and brown claws, mandible apices and eyes. It is characterized by well developed lateral process and by abdominal tergite 9 with a pair of urogomphi. These structures have an antipredator devices (Steiner, 1995; Bouchard & Steiner, 2004).

Allardius sardininensis. The observations carried out on the Sardinian population of *A. sardiniensis* are similar to those performed on *A. oculatus* from Sicily and even the main biological characteristics of both larvae and adults are similar. The branches of oak attacked, at least the ones we observed, had a smaller diameter (max 6 cm) and the larvae show some morphological differences (Figs. 17-18). In particular, the body appears more distended posteriorly, the dorsal cuticle is less wrinkled and more dotted, mainly on the abdominal tergite 7, the antennomere III is more elongated and more rounded at the apex, the clypeus is less rounded at the sides; the abdominal tergite 9 has holes larger, deep and rounded; the dimples in the middle of the dorsal surface are larger and deeper.

CONCLUSIONS

Although the present work on the populations of *A. oculatus* and *A. sardiniensis* is still in progress, nevertheless, it has already allowed us to make important observations, most of which are original and unpublished, including the descriptions of the larvae of the two species, and of the main biological and ecological characteristics of both larvae and adults. In addition, it was better and more accurately defined the distribution range of *A. oculatus* in Sicily in the light of new locations surveyed. The larvae description showed the absence at the base of abdominal segment 9 of small cylinder-shaped or cone-shaped protuberances confirming that *Allardius* belong to the subtribe Helopina (see Purchart & Nabozhenko, 2005).

Notably, we showed a very clear distinct saproxylic activities of *Allardius* and their important role in the forest ecology. In fact, in recent years, the Deadwood is one of the indicators chosen to assess the state of forests and the sustainability of their management (MCPFE, 2003; EEA, 2007); moreover, its role in the forest ecosystem and biodiversity conservation emerged in an increasingly evident manner supported by numerous scientific studies (Wermelinger & Duelli, 2002; Mason et al., 2003; Hahn & Christensen, 2004; Humphrey et al., 2004; Travaglini et al., 2007; Pignatti et al., 2009). Hence, the peculiar biology of *Allardius*, especially when it is supported by numerous and stable populations, allows us to consider these species as the top detritivores of dead wood of the forests they inhabit, thus stressing the importance of

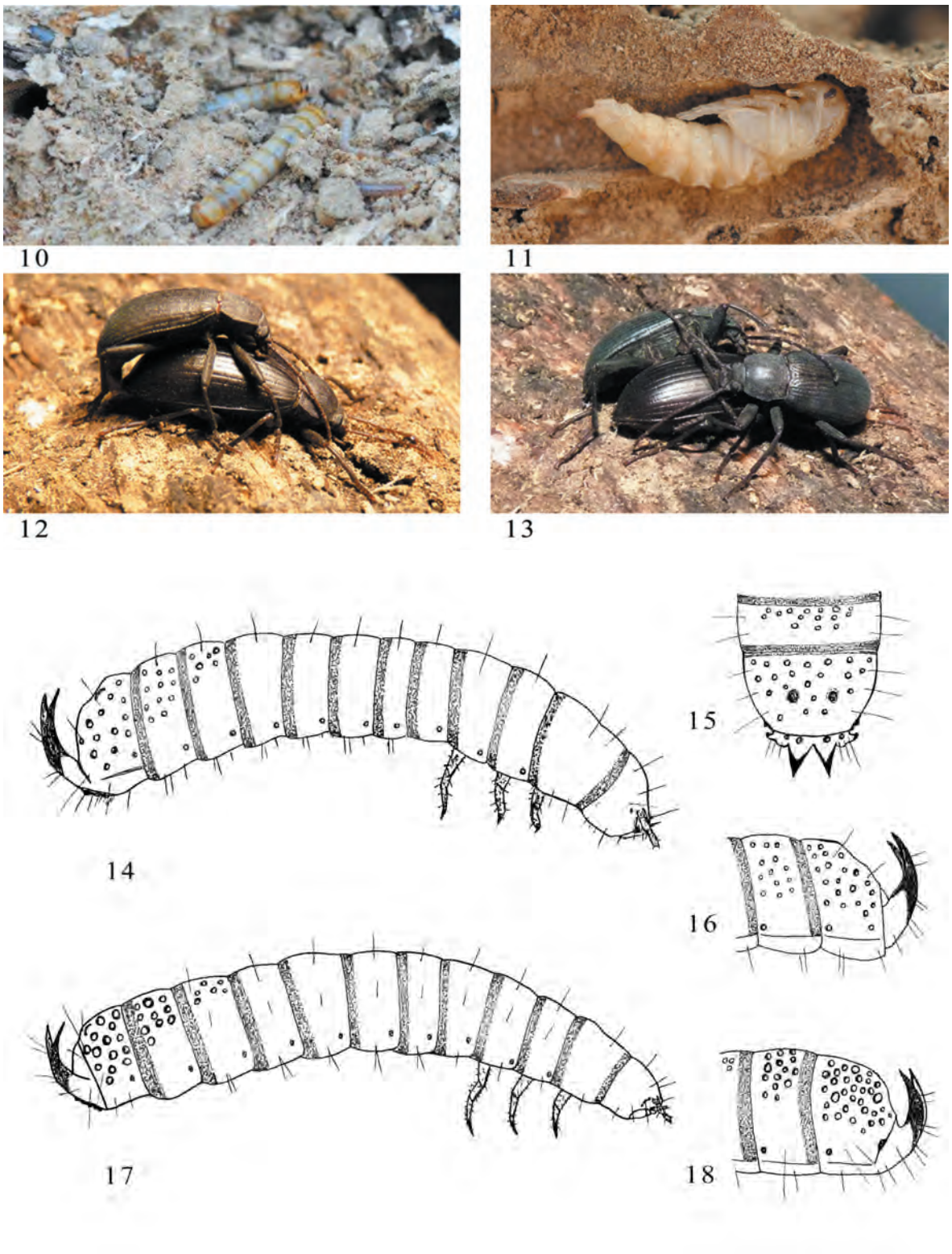

Figure 10. Larvae of *Allardius oculatus* (Palermo, Addaura): several generations in the wood completely degraded. Figure 11. Pupa of *A. oculatus* (Monte Inici). Figures 12, 13. *A. oculatus* (Monte Inici) during mating. Figures 14-16. Larva of *A. oculatus* (Monte Inici), in particular (Figs. 15, 16), abdominal tergite 8-9 in dorsal view (15) and in lateral view (16). Figures 17, 18. Larva of *A. sardiniensis* (Monte Sette Fratelli), in particular (Fig. 18), abdominal tergite 8-9 in lateral view.

their role in the forest ecology in relation to the presence of "dead wood".

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