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NATURAL HISTORY OF THE *CRAMBE FEEDER*, *LIXUS CIRCUMCINCTUS* (COLEOPTERA: CURCULIONIDAE)

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ABSTRACT

Field investigations showed that *Lixus circumcinctus* Boheman 1835 (Coleoptera: Curculionidae) is a major herbivore species living on *Crambe orientalis* in northeastern Anatolia and on *Crambe tataria* in central Anatolia. Adults hibernate in the root crown of host plants. They associate with their hosts in the spring, feed on leaves, young stems and buds, and lay solitary eggs in the stem and lower leaves of petiole. Larvae open galleries oriented downward toward the root crown. Mature larva make a pupal case using plant fibers at the end of gallery, and pass the pupal stage in the late summer. Second generation adults appear in early autumn, overwinter in the same niche, and complete one generation a year. *Crambe orientalis* harbors 7 species of weevils in eastern Turkey, and *Crambe tataria* harbors 8 weevil species in central Anatolia.

Key Words: *Crambe*, *Lixus circumcinctus*, biology, host plants, weevil complex

RESUMEN

Investigaciones en el campo demostraron que *Lixus circumcinctus* Boheman 1835 (Coleoptera: Curculionidae) es una especie herbívora de gran importancia que vive en *Crambe orientalis* en el nororiente de Anatolia, y en *Crambe tataria* en el centro de Anatolia. Los adultos hibernan en la corona de la raíz de sus plantas hospederas. Estos se asocian con su hospedero en la primavera, cuando se alimentan de hojas, tallos jóvenes y brotes, y depositan huevos solitarios en tallos y en peciolos de las hojas bajeras. Las larvas construyen galerías orientadas hacia abajo, en dirección a la corona de la raíz. Al final de la galería las larvas maduras construyen una cámara pupal utilizando fibras de plantas y permanecen en estado pupal durante el verano. Una segunda generación de adultos aparece al principio del otoño, permanece en el mismo nicho durante el invierno, y completa una generación por año. *Crambe orientalis* es hospedera de 7 especies de picudos en el oriente de Turquía, y *Crambe tataria*, de 8 especies de picudos en el centro de Anatolia.

The genus *Crambe L.* (Brassicaceae) consists of about 40 species in the world (Francisco-Ortega et al. 2002); 16 species of *Crambe* are distributed from East and North Europe to Central Asia (Prina 2009), and 3 species in Turkey (Davis 1982). *Crambe* species, especially *C. abyssinica* Hoschst. Ex. R. E. Fries, are prospective industrial and food crops expected to serve as a new source of vegetable oil for food and industrial uses (Gastaldi et al. 1998), as well as an important source of non-woody fibers (Tutus et al. 2010) and as a source of pulp fiber in place of increasingly scarce pulp wood (Jimenez et al. 2005). *Crambe* spp. May also be exploited as medicinal plants (Şener et al. 1998), wild food plants for humans (Aksakal & Kaya 2008; Dreon & Paoletti 2009), and landscape plants (Karahan & Yılmaz 2001), but they can also be weeds in agricultural fields (Kantar et al. 1999; Çam & Atay 2004; Tursun et al. 2006).

Curculionoidae is a highly diverse superfamily with about 62,000 described species (Oberprieler et al. 2007). Curculionoidae is the largest group of highly specialized phytophagous insects (Korotyaev 2000). Premier Brassicaceae feeder groups include members of Ceutorhynchinae, Baridinae, Lixinae; and mainly the genera *Ceutorhynchus* Germar 1824, *Melanobaris* Alonso-Zarazaga & Lyal 1999, *Aulacobaris* Desbrochers 1892, *Lixus* Fabricius 1801 (Scherf 1964; Ter-Minassian 1967; Korotyaev & Gültekin 1999; Colonnelli 2004; Gültekin 2007).

The genus *Lixus*, a member of Lixini tribe, has a nearly worldwide distribution with over 150 species in the Palearctic Region (Csiki 1934; Ter-Minassian 1967). The immature stages of *Lixus* species are endophagous; they are usually stem, root crown and petiole inhabitants (Scherf 1964; Nikulina 1989; Gültekin 2007; Volovnik

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2007), and exceptionally *L. obesus* Petri 1904 is a seed feeder (Gültekin 2005). The host range includes several families of higher plants such as Chenopodiaceae, Apiaceae and Brassicaceae. The majority of known *Lixus* species develop on the Brassicaceae; and most of these belong to the subgenus *Compsolixus* Reitter 1916. Previously *Lixus circumcinctus* Boheman 1835 was a member of subgenus *Lixoglyptus* Reitter 1916 (Csiki 1934; Ter-Minassian 1967), however, *Lixoglyptus* was elevated to genus level and transferred to the tribe Cleonini, but *Lixus circumcinctus* was left in *Lixus* 'incertae sedis' by Alonso-Zarazaga (2008).

As a *Crambe* feeder, *L. circumcinctus* is distributed in the Azerbaijan, Armenia, Iran and Turkey; where the host plants are *C. armena* N. Busch in Armenia (Ter-Minassian 1967), and *C. orientalis* and *C. tataria* in Turkey (Korotyaev & Gültekin 2003; Gültekin 2007). Another *Crambe* inhabiting *Lixus* species is *L. canescens* Steven 1829, which is associated with *Crambe pontica* Stev., *C. tataria* Sebeok, *C. steveniana* Rupr., *C. mitridatis* Juz., and *C. maritima* L. (Ter-Minassian 1967; Volovnik 2007).

In this paper, the ecology of *L. circumcinctus* and the weevil complex on *Crambe* is briefly presented.

Material and Methods

Field surveys were conducted in eastern Turkey. Biological observations on *Lixus circumcinctus* were conducted at Atatürk University Campus [N 39° 54'.266", E 41° 12'.962"] (Erzurum Province) at an elevation of 1850 m absl mainly on *Crambe orientalis* (Figs. 1 and 2). In addition, some observations were conducted during field researches in the Cappadocia territory, Central Anatolia on *Crambe tataria* (Figs. 3 and 4). To determine the duration of different biological stages, eggs and pupae were collected together with plant parts and held in cages in the laboratory. Photographs of eggs and first instar larvae were taken with a digital camera mounted on an Olympus SZX-7 stereomicroscope.

Results

Adults of *Lixus circumcinctus* started to leave their overwintering places in the third wk of May. The adults emerged and fed on host plant leaves from the outside to inside, the stems (Fig. 7), lateral branches (Fig. 5) and young flower buds. They damaged the main vein of the leaves to facilitate oviposition and feeding. The adult stage persisted to mid Jun. Most plants each had 2 adults, but sometimes as many as 6. In observing mating pairs, the male proceeded to copulate with the female, while the latter was chewing out an oviposition hole in the stem (Fig. 6).

Beginning in the last wk of May, the *L. circumcinctus* female laid each egg into a 1-2 mm deep cavity in the stem or at the main vein of the leaf, hole made with her chewing mouthparts at the distal end of her elongated rostrum. The opening of oviposition cavity and the space around the egg was sealed with a sealant containing macerated plant fibers, which the female had prepared from saliva and the tissue that was chewed in the course of excavating the oviposition cavity (Figs. 8 and 9). These sealed oviposition sites turn black in the course of time (Fig. 8). Some plants hosted more than 20 eggs depending on the size of the plant and the number of adults. Egg hatch and emergence of first stage larvae continued for about 2 wk. Eggs could be found in the field until the end of Jun.

First stage larvae (Fig. 10) started to emerge from second wk of Jun. These larvae opened galleries within the stems (Figs. 11 and 12), and tunneled downward to the base of the stem (Fig. 13). The frass, produced by the larvae by consuming the tissue ingested while extending the gallery, was moist and putrified over time. Larvae became mature by the time they had tunneled to the base of the stem, and usually 1 to 5 mature larvae occupied the base of the stem. At this site each mature larva prepared a pupal case by using thin plant fibers (Fig. 14). Mature larvae were present throughout Aug. Pupation in the pupal cases occurred during the last 2 wk of Aug (Fig. 14), and the duration of pupal period was about 2 wk.

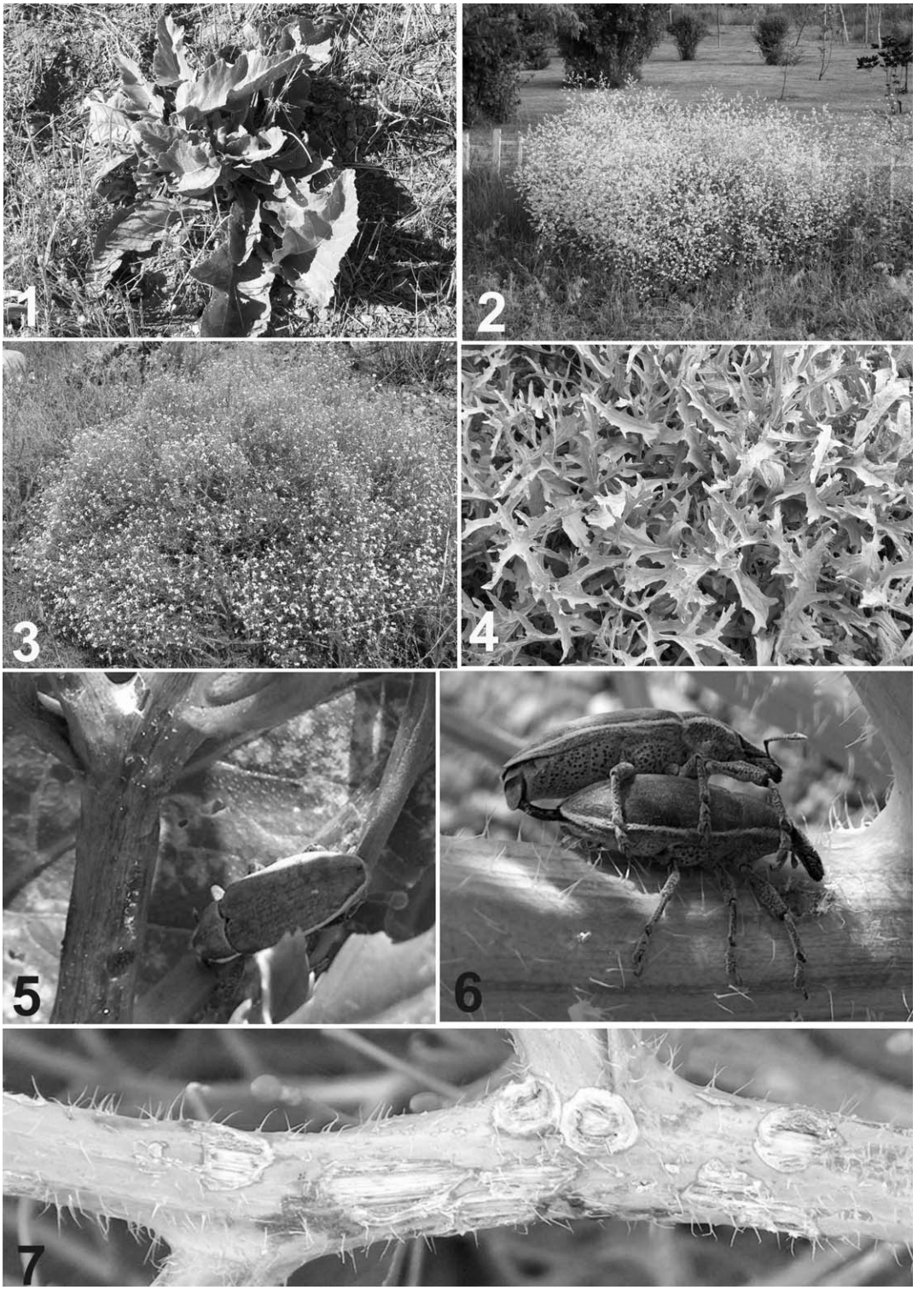
Transformation of pupae into adults occurs in the pupal case (Fig. 15) beginning in the latter part of Aug and ending early in Sep. The adults overwintered in the same place. Thus, *L. circumcinctus* has only one generation a year.

Besides *L. circumcinctus*, weevils associated with *Crambe orientalis* L. in eastern Turkey are *Aulacobaris coerulescens* (Scopoli 1763), *Melanobaris crambephaga* (Korotyaev & Gültekin 1999), *Ceutorhynchus pallidactylus* (Marsham 1802), *Ceutorhynchus erivanus* Schultze 1898, *Ceutorhynchus fabrilis* Faust 1887, *Ceutorhynchus sophiae* Gyllenhal 1837, whereas those associated with *Crambe tataria* Sebeok in central Anatolia are *Bruchela suturalis* (Fabricius 1792), *Aulacobaris janthina* (Boheman 1836), *Melanobaris* sp. nr. *semistriata* (Boheman 1836), *Ceutorhynchus chalybaeus* Germar 1824, *Ceutorhynchus picitarsis* Gyllenhal 1837, *Ceutorhynchus sulcicollis* (Paykull 1800).

Discussion

Lixus circumcinctus is one of the larger *Lixus* in the Palaearctic with conspicuous white stripes, complete on 10th interval, and limited to apical half of 9th interval in the form of very narrow line on each ventral margin, whereas white stripes are vague on the 11th intervals. These features

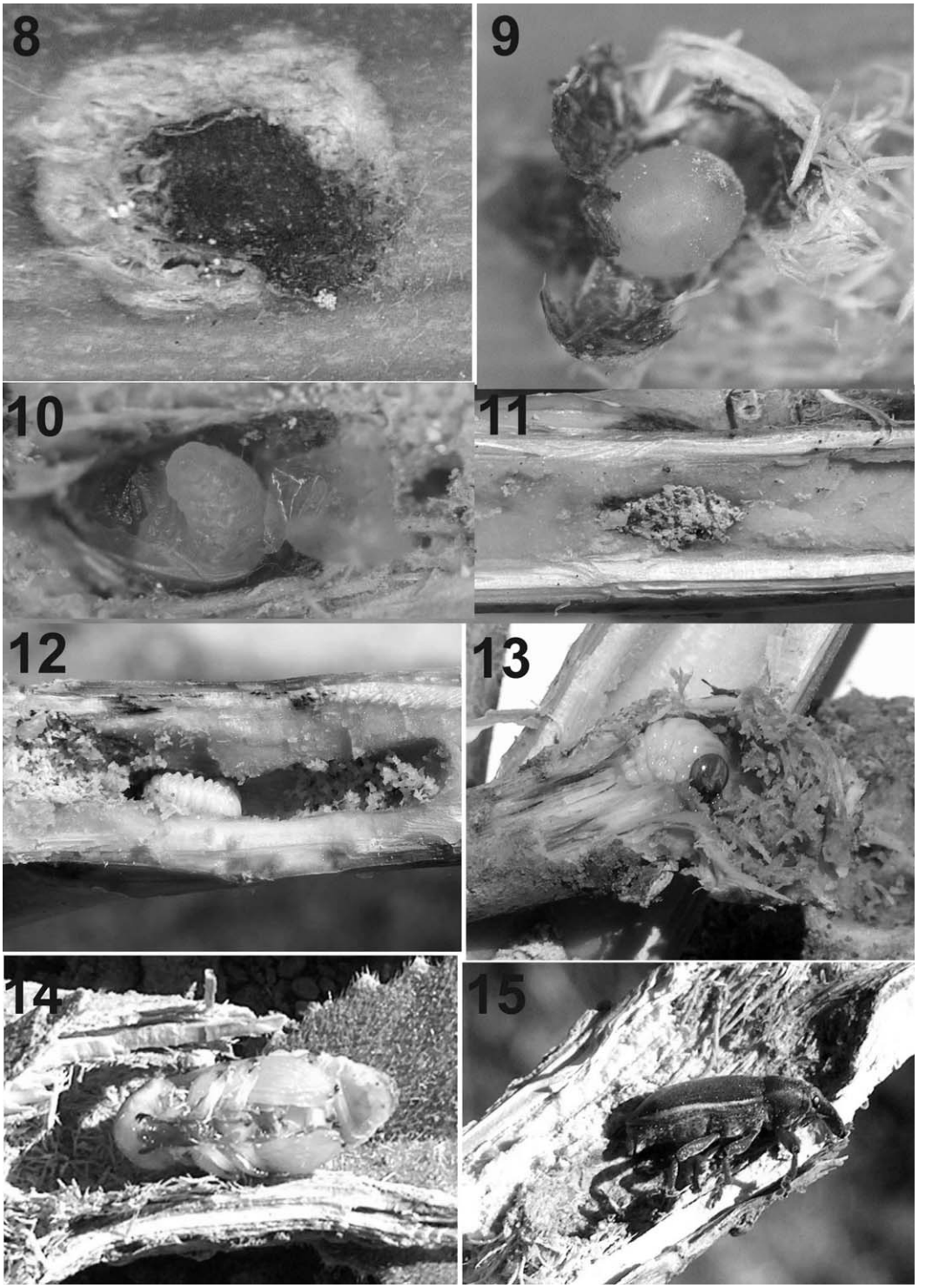
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Figs. 1-7. Host plants, *Lixus circumcinctus* Boheman adults and their feeding damage. (1-2) *Crambe orientalis*; (3-4) *Crambe tataria*; (5) adult feeding on lateral branch of *C. orientalis*; (6) a mating pair; (7) feeding damage of adults on a stem of *C. tataria*.

See above figures in color at Supplementary material online at http://www.fcla.edu/FlaEnt/fe944.htm#infoLink1.

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Figs. 8-15. Niches of immature stages of the *Lixus circumcinctus* Boheman. (8) oviposition mark; (9) egg; (10) first stage larva emerging from egg; (11) frass from a larva feeding remnant in a gallery; (12) young larva tunneling in stem; (13) mature larva tunneled to the rootcrown; (14) pupa in the rootcrown; (15) new generation teneral adult in rootcrown.

See above figures in color at Supplementary material online at http://www.fcla.edu/FlaEnt/fe944.htm#infoLink1.

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are shared with species of the subgenus *Compsolixus*, namely intervals 9th-11th with white stripes, and perhaps its inclusion into this subgenus would be appropriate. However, although the majority of *Compsolixus* are associated with Brassicaceae, the type species of this subgenus *Lixus juncii* Boheman 1835 is a pest of *Beta vulgaris* L. which is a Chenopodiaceae. Determining the right position of *Lixus circumcinctus*, and placing it in a subgenus already described, or erecting a new subgenus should be done after a supraspecific level phylogenetic analysis of the Lixini, which is beyond the scope of this paper.

This is the first biological study of *L. circumcinctus* which is one of the large herbivores on *Crambe* plants. As mentioned above, the importance of this plant group is increasing its suitability for a broad spectrum of uses. In addition, *Crambe* plants play an important role with respect to biodiversity by serving food, ecological niches and harborage for many insect species such as pollinators, natural enemies and herbivores.

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