Available online at www.sciencedirect.com
SCIENCE DIRECT

European Journal of Soil Biology 42 (2006) 82–88

EUROPEAN JOURNAL OF SOIL BIOLOGY

http://france.elsevier.com/direct/ejsobi

Original article

Habitat use and activity patterns of larval and adult *Cantharis* beetles in arable land

Michael Traugott *

Center for Mountain Agriculture and Institute of Zoology and Limnology, University of Innsbruck, Technikerstraße 25, 6020 Innsbruck, Austria

Received 3 May 2005; accepted 11 October 2005
Available online 15 November 2005

Abstract

Generalist predators play a key role in agriculturally and environmentally sustainable systems of pest control. A detailed knowledge on their ecology, however, is needed to improve management practices to maximize their service of pest control. The present study examines the habitat use and activity patterns of larval and adult *Cantharis* beetles that are abundant predators in arable land. Laboratory experiments revealed that sixth instar larvae of *Cantharis fusca* and *Cantharis livida* significantly preferred high relative humidity levels of 85–90% to lower ones. This can explain their preference for meadows over fields due to the more favorable microclimatic conditions in the former habitats. Surface activity of sixth instar *Cantharis* larvae during autumn, winter and early spring occurred at soil temperatures above 0 °C. However, no correlation between surface activity and soil temperature, air temperature or relative humidity was found above 0 °C. Catches of sixth instar *Cantharis* larvae within fenced pitfall traps were higher in a meadow (Mean ± S.D.; 13.8 ± 7.63 individuals m^{-2}) than in a field (4.60 ± 2.89 individuals m^{-2}). Mark-recapture density estimations for sixth instar larvae indicated mean densities of 25.9 ± 5.63 (field) and 42.8 ± 16.0 individuals m^{-2} (meadow). The same pattern was found for adult emergence rates in the field (0.17 ± 0.39 adults m^{-2}) and meadow (1.83 ± 1.17 adults m^{-2}) as well as for adult densities in the vegetation (field 4.89 ± 3.62 adults 60 m^{-2}; meadow 12.5 ± 11.2 adults 60 m^{-2}). It is concluded that especially in winter elements that provide plant cover should be incorporated in arable fields to enhance larval cantharid population densities and to attract them from their prime grassland habitats into arable sites.

Keywords: Generalist predators; Pest control; Habitat choice; Winter activity; Habitat manipulation

1. Introduction

Generalist predators are an essential part within natural enemy communities found in agroecosystems [21], and as shown by manipulative field studies they can reduce pest numbers significantly [22]. To maximize the benefits arising from the exploitation of natural regulatory mechanisms, however, an understanding of natural insect enemy ecology is vital. For example, habitat manipulation measures that aim to enhance predator populations should be based on the knowledge of habitat selection and activity patterns shown by certain predator groups.

Soldier beetles within the genus *Cantharis* (Coleoptera: Cantharidae) often constitute an important component of arthropod communities found in arable land, both in terms of biomass and individual numbers [23, 3,16,9]. *Cantharis* larvae and adults are, at least partly, carnivorous and prey on a variety of invertebrates [8,30,

* Present address: Cardiff School of Biosciences, Cardiff University, Main Building, Park Place, P.O. Box 915, Cardiff CF10 3TL, UK. Tel.: +43 512 507 5693; fax: +43 512 507 2930.
E-mail address: Michael.Traugott@uibk.ac.at (M. Traugott).

1164-5563/$ - see front matter © 2006 Elsevier SAS. All rights reserved.
doi:10.1016/j.ejsobi.2005.10.001

31,17,11,14,29]. They therefore contribute to natural pest control in agricultural and forest systems.

Although this beetle family occurs frequently and abundantly, only few studies have focused on their ecology compared with the wealth of information available on other arthropod groups like spiders or carabid beetles. The present study addresses this lack of knowledge as it investigates, for the first time, the habitat use and activity patterns of both larval and adult *Cantharis* beetles to better understand their response to management practices and habitat manipulation. The aims of this study were threefold: (i) to investigate the response of sixth instar *Cantharis fusca* and *Cantharis livida* larvae to different humidity levels in laboratory experiments, (ii) to study the relationship between temperature and humidity on epigaeic activity of sixth instar *Cantharis* larvae, and (iii) to investigate the spatial distribution and abundance of larval and adult *Cantharis* species in a temperate field and meadow system.

2. Material and methods

2.1. Cantharis species

The present study deals with the three cantharid species *C. fusca*, *C. livida*, and *C. rustica* which show an univoltine life cycle: in central Europe adults appear from May to July, the larvae (six stages) are active from summer to early spring, and pupation takes place in March and April [7,26,34]. The adults are mainly found in the vegetation where they feed on nectar, pollen, and honeydew and occasionally prey on invertebrates [20, 29]. Eggs are deposited into the upper soil layer; early larval instars are mainly endogaeic whereas the fifth and sixth instars are predominately active on the soil surface. Sixth instar larvae feed besides soft-tissued insects mainly on Lumbricidae [29]. In the sixth instar larvae of *C. fusca* and *C. livida* show a mean body length/biomass of 25.2 mm/202.9 mg and 18.6 mm/72.1 mg, respectively. *C. rustica's* body size and biomass is very similar to those of *C. fusca*. More details on *Cantharis* biology can be found in Janssen [7] and Traugott [25].

2.2. Laboratory experiments

A humidity-gradient apparatus was used to test the response of sixth instar larvae of *C. fusca* and *C. livida* to different humidity levels. No experiments could be conducted with *C. rustica* larvae because this species was not reared in the laboratory. Furthermore, larvae of this species were not available in sufficient numbers from the field. The apparatus consisted of seven conical perspex chambers (80 mm diameter, 110 mm height), each with a conical reservoir (75 mm diameter, 25 mm height) that was tightly fit at the base and covered by a fine plastic net (0.2 mm mesh size). The chambers were arranged in a row and connected by perspex tubes (15 mm diameter, 50 mm length) at the level of the nets so that the larvae could easily move among the chambers. The reservoirs in the chambers were filled with different solutions (see below) to create a humidity gradient ranging from 90% relative humidity (RH) to 30% RH [32]. The reservoirs were filled with the following solutions: chambers 1 and 2 with distilled water, chamber 3 with saturated NaCl solution, chamber 5 with saturated $MgCl_2 \times 6H_2O$ solution, and chambers 6 and 7 with P_2O_5 granulate. The reservoir of chamber 4 remained unfilled. The top of chambers 2, 4 and 6 was tightly sealed with Perspex caps, whereas chambers 1, 5 and 7 were capped by HOBO H8 Pro dataloggers that continuously recorded air temperature and RH during the experiments. Because *Cantharis* larvae are mainly night-active during their sixth instar [25], the experiments were carried out in a climate chamber at 10 °C and darkness to simulate the natural conditions.

Laboratory-reared, sixth instar *C. fusca* and *C. livida* larvae [25] were used in this experiment. To stabilize the humidity gradient within the apparatus the chambers were filled with the above-described solutions 24 h prior to the start of the experiments. Each experiment was started by releasing a group of 10 larvae in chamber 4. The experiment was run for 15 h and every 2–3 h the number of larvae in each chamber was recorded (4–6 recordings per experiment) by using a torch. After running two groups the gradient was reversed by exchanging the reservoirs between chambers 1/7, 2/6, and 3/5 and another 24 h stabilization time. Altogether, in both *C. fusca* and *C. livida* two groups each were run in the initial and reversed gradient, resulting in 40 individuals tested per species.

The total number of larvae per species found within each chamber was compared among chambers by the Kruskal–Wallis test. In case of a significant test result, pairwise Mann–Whitney *U*-tests were carried out to further investigate which groups were significantly different from each other [4]. Larval numbers recorded in chambers 1/2 and 6/7 were summarized as one treatment each because of similar RH conditions in these chambers.

2.3. Field studies

Two fields (field #1: 17 × 180 m, field #2: 18 × 140 m) and two meadows (meadow #1: