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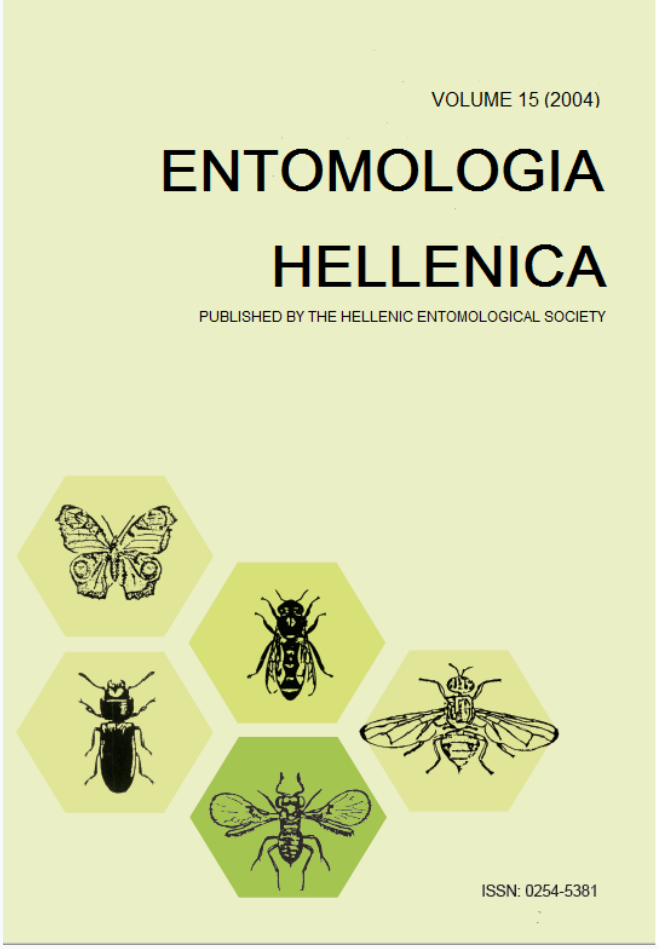

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Ecological data of *Lepidosaphes gloverii* (Hemiptera: Diaspididae) in Greece

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ABSTRACT

In June 2001 the scale *Lepidosaphes gloverii* (Packard) (Hemiptera: Diaspididae) was found on orange trees in Peloponnesus, Gastouni area, (Southwestern Greece). From the day it was first recorded until August 2003 observations on orange trees were held both in field and laboratory, concerning the biology and ecology of this scale. *L. gloverii* infests mainly the upper surface of the leaves and the fruits and less the shoots of the tree. During the period April to August 2002 the scale completed 3 overlapping generations. Female fecundity ranged between 32 and 57 eggs. *Chilocorus bipustulatus* (L.) (Coleoptera: Coccinellidae) and *Rhyzobius lophanthae* Blaisdell (Coleoptera: Coccinellidae) predators were found to feed upon this scale. In July 2002 a mass release of those predators took place on infested orange trees. To assess the action of these predators, observations were conducted in both field (by shaking the branches of the trees and counting the number of the predators) and laboratory (by counting the predated scales found on leaves). The release of predators contributed to the decrease of infestation density of trees. *C. bipustulatus* developed significantly higher populations than *R. lophanthae.*

Introduction

The most important scales of Diaspididae family (Hemiptera) that infest citrus trees in Greece are *Aonidiella aurantii* (Maskell), *Aspidiotus nerii* Bouché, *Chrysomphalus dictyospermi* (Morgan), *Lepidosaphes beckii* (Newman) and *Parlatoria pergandii* Comstock (Koroneos 1934, Argyriou 1979a, 1979b, Argyriou et al. 1981, Katsoyannos 1996).

Lepidosaphes gloverii (Packard) (Hemiptera: Diaspididae) is recorded in many areas, like Central and Northern America, Asia and Europe. It has also been recorded in the majority of Mediterranean countries (Hall 1924, Lepiney and Mimeur 1931, Gomez-Menor Ortega 1937, Longo et al. 1995). It is considered to cause serious damage to citrus and ornamental plants (Talhouk 1975, Rosen 1990).

Many species of parasitoids, predators and fungi have been reported as natural enemies of *L. gloverii*. The hymenopterous parasitoids that attack *L. gloverii* belongs to the following species: *Signiphora fax* (Signiphoridae) (Teran et al. 1985), *Adelencyrtus inglisiae* (Encyrtidae) (Konar 2001), *Encarsia herndoni* (Aphelinidae) (Viggiani and Liotta 1989) and the aphelinids *Aphytis ling-*

nanensis (Woolley et al. 1994), *Encarsia elongata* (Benassy and Brun 1989), *Aphytis lepidosaphes*, *Aspidiotiphagus citrinus* (Bruwer and Schoeman 1990) and *Aspidiotiphagus lounsburyi* (Ceballos et al. 1988). Its predators are the coccinellids *Zagloba beaumonti*, *Pentilia discors* (Arias-Reveron 1990) and *Chilocorus nigrita* (Bruwer and Schoeman 1990). Pathogenic fungi of *L. gloverii* are *Podonectria coccicola* and *Verticillium* sp. (Gao and Ouyang 1981).

The serious infestation of *L. gloverii* on citrus observed in Greece, the importance of this enemy that causes serious damage in citrus orchards, as well as the lack of information about its ecology in Greece, were the motives that lead to the present study. In this study data concerning the phenology, population dynamics and the action of natural enemies of *L. gloverii*, are presented.

Materials and Methods

L. gloverii was found to infest *Citrus sinensis* var. *navelina* in Southeastern Greece, (Peloponnesus, area of Gastouni). The scale was identified by the author at the Laboratory of Biological Control of Benaki Phytopathological Institute and was confirmed by the Researcher Entomologist Dr Ferenc Kozár (Plant Protection Institute, Hungarian Academy of Sciences). A specimen was sent to the collection of the Natural History Museum of France (Museum National d' Histoire Naturelle). The study was conducted from June 2001 to August 2003 in an orange orchard of 37 acres. The age of the trees was 25 years. The distance between the trees was 6m on the same row and the distance of one row to another was 7m.

To study the phenology of L. *gloverii,* 20 samples consisted of branches (25cm length) were randomly selected and transported to the laboratory into nylon bags. The samples were examined under binocular stereoscope and the number and instars of the scales, as well as the predated and dead individuals on the upper leaf surface were recorded and expressed as number of scales/cm^2.

The monitoring of population dynamics of the predators was performed by shaking branches of trees over a 1mx1m cloth, at 12 randomly collected points in the orchard. The species, the number and the developmental stage of the predators falling from the branches on the cloth, were recorded. These actions were conducted once every 15 days from April to September and once a month, for the rest of the year. On 22/7/2002, 1.500 adults of *Chilocorus bipustulatus* (L.) and 1.500 adults of *Rhyzobius lophanthae* Blaisdell were released, coming from mass rearing in insectaries, feeding on *Aspidiotus nerii* Bouché and *Chrysomphalus aonidum* (L.), under controlled conditions (temperature 25±2 °C, RH 65±2% and photoperiod 16h/day). The mean numbers of the predators (*C. bipustulatus* and *R. lophanthae*) counted using the above procedure were compared using Student's t-test (Landi 1977).

During the study, the trees were sprayed 3 times with mineral oil 1,5%, at the following dates: 5/9/2001, 24/5/2002 and 25/9/2002. No other applications with plant protection products were applied in the orchard during the study.

For the study of the fecundity of the scale, 50 ovipositing females were examined in June 2001. These individuals were settled on the upper surface of the leaves. Temperature in the field was recorded using a thermograph.

Results

The scale mainly settles on the upper surface of the leaves, fruits and to a lesser degree on the branches. In Fig. 1 is shown the frequency of instars of *L. gloverii* on leaves and the mean maximum and minimum monthly temperatures during the study period. Crawlers had three distinct peaks per year: in June, August and October, respectively. The rest of the instars did not appear to have relevant peaks.

During the winter period, preovipositing and ovipositing females were more abundant than individuals of the immature instars. Male nymphs were recorded throughout the year. The number of alive, dead and predated individuals of *L. gloverii* on leaf surface, is shown in Fig. 2A. Alive scales decreased, while predated scales increased. Higher was the increase of the number of dead scales. After spraying, an increase in the number of dead individuals was observed, whereas after the mass release of the predators an increase in the number of predated individuals was recorded.

Population dynamics of larvae and adults of *C. bipustulatus* and *R. lophanthae* is shown in Fig. 2B. *Chilocorus bipustulatus* was observed in higher populations than *R. lophanthae* ($t=6.1$, $P<0.05$).

Fertility fluctuated between 32 and 57 with an average of 37.7 ± 8.03 (mean ± SD) eggs per female.

Discussion

From the continuous presence of all stages of the scale throughout the year, it is gathered that *L. gloverii* completes overlapping generations during the year (Fig. 1). The three peaks of crawlers observed in June, August and October, respectively, indicate that the scale must complete 3 generations per year. The rest instars did not appear to have relevant peaks during the year as crawlers did. This may be attributed to the higher mortality of the crawlers compared with the other instars as well as the applications of sprays. Smith et al. (1997) report that *L. gloverii* completes 5-6 generations per year in Queensland and 2-4 generations in New South Wales. The difference in the number of generations appeared in the above study and the results of the present study (3 generations per year), could be attributed to the differences in climatic conditions and host plant, where the scale develops.

The increase of dead individuals per scale after the sprayings and after the release of the predators, and the increase in the number of predators collected could gather to conclude that the release of predators and spraying contribute to the decrease of infestation.

The population of *C. bipustulatus* was significantly higher than that of *R. lophanthae* almost throughout the period of the study. This is probably related to the inability of *R. lophanthae* to develop high populations on every diaspidid scale. In other studies concerning diaspidid predators in Greece it has been reported that *R. lophanthae* develops high populations even in winter (Stathas 2000a, 2001a). The development of *R. lopphanthae* depends on the species of the scale on which it feeds. It has been reported that the development of *R. lophanthae* on scales with harder scale cover [like *Aonidiella aurantii* (Maskell) and *Chrysomphalus aonidum* (Linnaeus)] is more difficult than on scales with softer scale cover (like *Aspidiotus nerii* Bouchè) (Stathas 2000b, 2001b, Stathas et al. 2002). Honda and Luck (1995) attribute the incapability of rearing *R. lophanthe* on diaspidids with hard scale cover to the morphological characteristics of its mouthparts.

Bruwer and Schoeman (1988) reared *L. gloverii* in laboratory on several preys and temperatures, and found that the mean optimum fecundity was 44.2 crawlers/female, in sour orange trees at 30°C. The difference with the number of 37.7 found in the present study may be attributed to the differences of the developmental conditions and to the host plant.

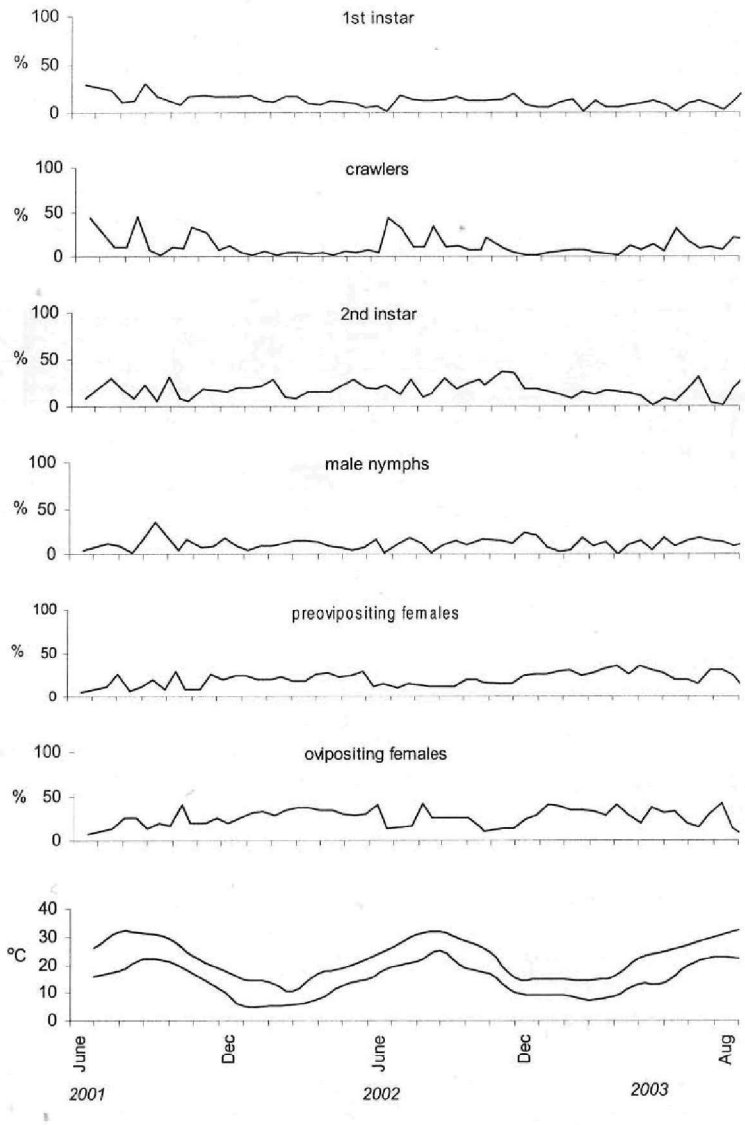

FIG. 1. Developmental stages (percentage composition) of *Lepidosaphes gloverii* on citrus and monthly average temperatures from June 2001 to August 2003, in southern Greece.

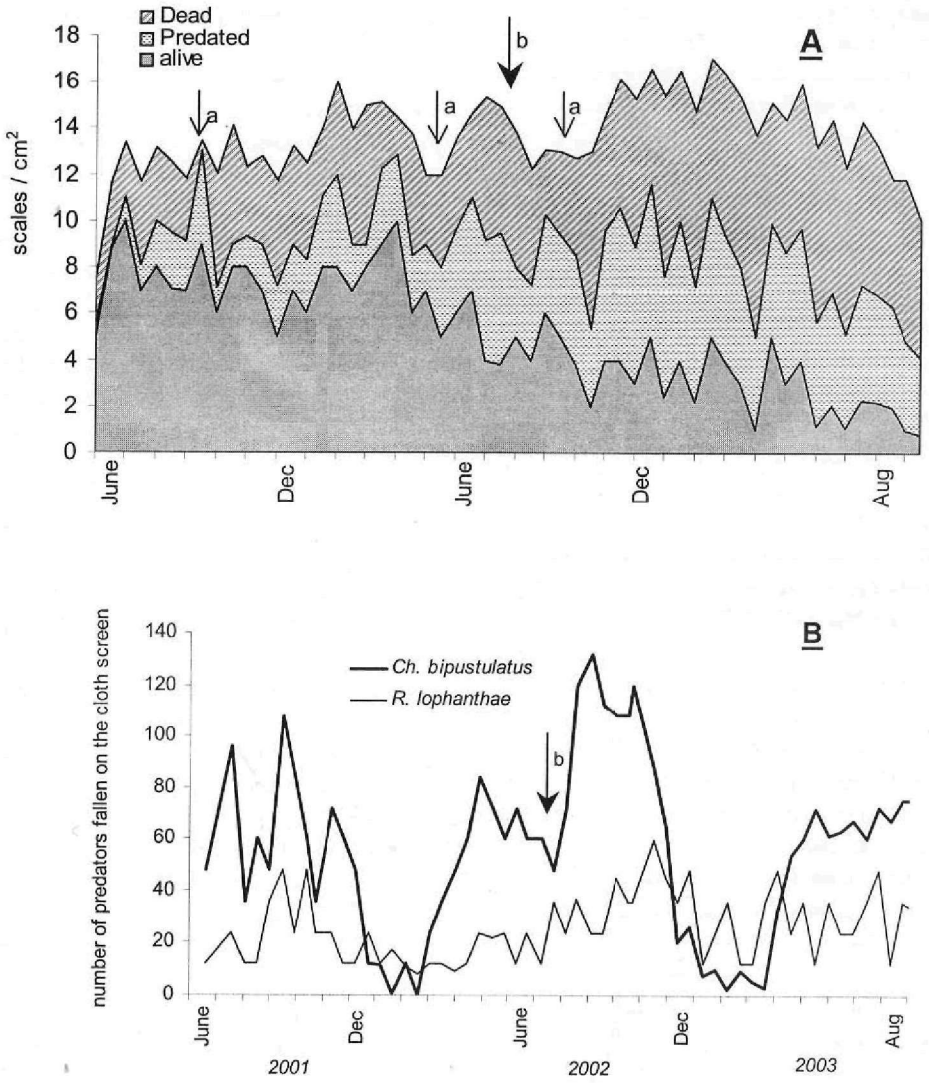

FIG. 2.
(A): Alive, dead and predated individuals of *Lepidosaphes gloverii* found on orange tree leaves in southern Greece, from June 2001 to August 2003.
(B): Number of predators (larvae and adults) recorded by 12 beatings of tree branches on the cloth screen.
- a: Spray applications with mineral oil
- b: Releasing of *Chilocorus bipustulatus* and *Rhyzobius lophanthae*.

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KEYWORDS: *Chilocorus bipustulatus*, fecundity, Greece, *Lepidosaphes gloverii*, orange trees, phenology, *Rhyzobius lophanthae*.

Οικολογικές παρατηρήσεις του *Lepidosaphes gloverii* (Hemitera: Diaspididae) στην Ελλάδα

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ΠΕΡΙΛΗΨΗ

Τον Ιούνιο του έτους 2001 βρέθηκε το κοκκοειδές *Lepidosaphes gloverii* (Hemiptera: Diaspididae) σε πορτοκαλιές στην περιοχή Γαστούνη Ηλείας. Από την ημέρα της καταγραφής του και μέχρι τον Αύγουστο του 2003 έγιναν παρατηρήσεις σε πορτοκαλιές της περιοχής αυτής ανά τακτά χρονικά διαστήματα και παρατηρήσεις στο εργαστήριο, που αφορούσαν στη μελέτη της βιολογίας και οικολογίας του εντόμου. Το κοκκοειδές προσβάλλει κυρίως την άνω επιφάνεια των φύλλων, τους καρπούς και λιγότερο τους βλαστούς. Κατά το χρονικό διάστημα Απριλίου – Οκτωβρίου 2002 συμπλήρωσε 3 επικαλυπτόμενες γενεές. Η γονιμότητα των θηλέων κυμάνθηκε μεταξύ 32 και 57 ωών. Εναντίον του κοκκοειδούς βρέθηκαν να δρουν τα αρπακτικά έντομα *Chilocorus bipustulatus* (L.) και *Rhyzobius lophanthae* Blaisdell (Coleoptera: Coccinellidae). Τον Ιούλιο του έτους 2002 έγινε σε προσβεβλημένο πορτοκαλεώνα μαζική εξαπόλυση των πιο πάνω αρπακτικών ειδών. Για την εκτίμηση της δράσης των αρπακτικών έγιναν παρατηρήσεις στον αγρό (τινάγματα της κόμης των δένδρων και καταμέτρηση των αρπακτικών) και εξετάσεις στο εργαστήριο (καταμέτρηση στα φύλλα των προσβεβλημένων κοκκοειδών από αρπακτικά). Από τις παρατηρήσεις αυτές φάνηκε αφενός πως τα αρπακτικά που εξαπολύθηκαν συνέβαλαν στη μείωση της προσβολής και αφετέρου πως το *Ch. bipustulatus* αναπτύχθηκε σε σημαντικά υψηλότερους πληθυσμούς από το *R. lophanthae*.