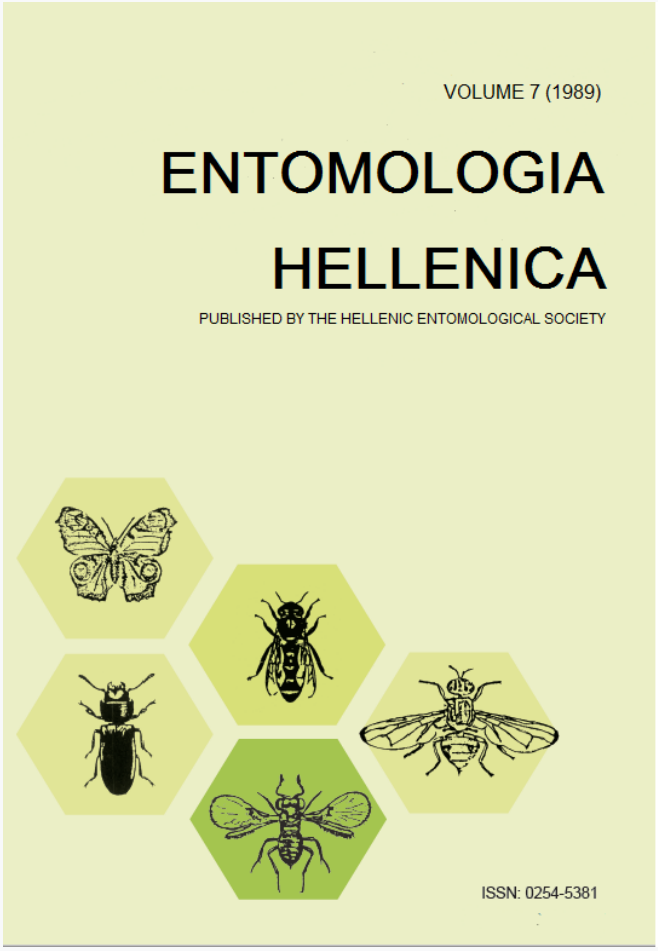
ENTOMOLOGIA HELLENICA

Vol 7 (1989)



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doi: 10.12681/eh.13965

To cite this article:

Sobhian, R., Katsouannos B. I., & Kashefi, J. (1989). Host specificity of Aceria centaureae (Nalepa), a candidate for biological control of Centaurea díffusa De Lamarck. *ENTOMOLOGIA HELLENICA*, *7*, 27–30. https://doi.org/10.12681/eh.13965

Host Specificity of *Aceria centaureae* (Nalepa), a Candidate for Biological Control of *Centaurea diffusa* De Lamarck[1]

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ABSTRACT

Filed collected rosettes or twigs of *Centaurea diffusa* De Lamarck, infested by the gall mite *Aceria centaureae*, were fixed onto appropriately grown and planted test plants of ten different species in the area of Thessaloniki, Greece, in 1985 and 1986. The test plants were inspected for presence of galls and mites a few to several days after their contact with the infested twigs. Gall formation occurred on all of the *Centaurea diffusa* test plants, either of Greek or U.S. origin, and on some of the *Centaurea solstitialis*, L. test plants. No galls or other mite damage could be found on the other test plants, which were *Carthamus tinctorius* L. (safflower), *Cirsium creticum* (De Lamarck) D'Urville, of local origin and six *Cirsium* species of U.S. origin, i.e. *cymosum* (Greene) J. T. Howell, *occidentale* (Nutt) Jeps., *pastoris* Howell, *andersonii* (Gray) Petrak, *brevistylum* Crong; and *undulatum* (Nutt.) Spreng. These results suggest that *A. centaureae* most probably has a very restricted host plant range, feeding only on weedy *Centaurea* spp. Thus the mite should be considered as a possible candidate for biological control of diffuse knapweed in the U.S.A. and Canada.

Introduction

Diffuse knapweed, *Centaurea diffusa* De Lamarck is rapidly becoming one of the most economically important rangeland weeds in the United States and Canada. Diffuse knapweed is estimated to infest 756,000 acres in Washington, 750,000 acres in Oregon, and 73,000 acres in Idaho (Maddox 1979). There is a strong suspicion that the weed was introduced into North America in alfalfa (*Medicago sativa* L.) seeds, either from Asia Minor (Turkmenistan) or with hybrid alfalfa seeds from Germany (Maddox 1982). The main economic loss from diffuse knapweed is reduction in high quality forage (for economic loss in infested areas, see Maddox 1979). Since knapweed infestations occur extensively on land of low economic value, the high costs of chemical control are not feasible. Therefore, biological control of diffuse knapweed has been investigated as a possibility for management of the weed in the United States and Canada. To date, four species of insects have been released and are established on this weed in North America. These are: *Urophora affinis* Frauenfeld, *Sphenoptera jugoslavica* Obenberger, *Metzneria paucipunctella* Zeller, and *Pterolonche inspersa* Staudinger (Maddox 1982, and P. Dunn personal communication).

In an attempt to find additional biological control agents, two candidates, a seed feeder, *Bangasternus fausti* (Reitter), (Coleoptera:

[1] Received for publication December 15, 1989.

Curculionidae) and a gall mite, *Aceria centaureae* (Nalepa) (Acarina: Eriophyidae), which is the subject of this paper, were found by the senior author in northern Greece.

Aceria centaureae is a central European mite which causes serious leaf galling and sometimes death of *C. diffusa* rosettes. It was also reported by Buhr (1964) on some other *Centaurea* spp., but has never been reported from any economically important plant.

The aim of this study was to determine the host specificity of *A. centaureae* as part of a project to introduce and evaluate the mite in the U.S. for biological control of diffuse knapweed. The study showed that *A. centaureae* has a narrow host range and a sample of *C. diffusa* leaves, infested with the gall mite was sent to the ARS biological control laboratory in Bozeman, Montana, for further host specificity tests, in 1987. However the study was halted because another *Aceria* mite which attacks the meristemic tissue of *C. diffusa* without producing any galls was discovered in the same area. A sample of this mite was sent for identification but it was not clear to the taxonomist whether this was another *Aceria* species or a different stage of the life cycle of *A. centaureae*. The taxonomy and biology of the two mites has been under study in 1988 and 1989 in Florence, Italy, and in Thessaloniki, Greece, and it has been determined that these are two different species of mites (M. Castagnoli and R. Sobhian unpublished data). Thus the study of the host specificity of the gall mite, *A. centaureae*, will continue in the USA, under quarantine conditions, in 1990.

Materials and Methods

Two experiments were conducted, one in 1985 and the other in 1986. The aim of the 1985 experiment was to determine if *Aceria centaureae* could be transferred from field infested *Centaurea diffusa* plants and re-colonized, either on other native or U.S. biotypes of *C. diffusa* plants. The objective of the 1986 experiment was to study the host specificity of the mite, with emphasis on native U.S. *Cirsium* species.

1985 experiment

Two samples of diffuse knapweed seeds collected in Spokane, Washington and Gilliam County, Oregon were provided by the USDA-ARS Biological Control Laboratory in Albany, California. The seeds were sown separately in two pots on October 15, 1984, and the pots were kept under natural conditions. In February 1985, small *C. diffusa* rosettes were collected in Thermi, near Thessaloniki, northern Greece and transplanted to a pot to be used as the control. For all plants, 22 cm diam. plastic pots were used. On March 6, 1985, *C. diffusa* rosettes bearing old galls from the previous year were collected in Geroplatanos, near Arnea, and placed directly onto the potted test plants. No infestation could be observed on the test plants until March 15, which suggests that the mites did not move from the infested plants to the test plants. In order to facilitate movement of the mites, the infested rosettes were removed, broken into small pieces, and put back on the test plants. The test plants were inspected regularly, until September, for presence of galls and some of the galls found were examined under a stereomicroscope for the presence of mites.

1986 experiment

A field experiment consisting of a randomized complete block design of ten treatments (plant species), replicated ten times, was established at the University Farm of Thessaloniki University. Each block (1.5×1.5 m), contained one plant in a 22 cm diam. pot buried in the soil at the center of each block on March 26. The blocks, which were adjacent to each other were weeded sufficiently to allow the test plants to grow, and watered as needed.

The test plant species were selected on the basis of botanical relationships, economic importance, and considerations of North American native flora. They are listed in Table 1.

The test plants were collected and cultured as follows: the seeds of six U.S. *Cirsium* species, provided by the USDA-ARS laboratory in Rome, were sown in November and a second series was sown in December 1985. These were *Cirsium cymosum* (Greene) J. T. Howell, *C. occidentale* (Nutt.) Jeps., *C. pastoris* J. T. Howell, *C. andersonii* (Gray) Petrak, *C. brevistillum* Crong., and *C. undulatum* (Nutt.) Spreng. At the same time, *Centaurea solstitialis* L., and *C. diffusa* seeds, collected in northern Greece were sown. The seeds were grown in small Jeffy sets in the greenhouse and transplanted to plastic pots in January 1986. Seeds of safflower, *Carthamus tinctorius* L. (var. Hartman) provided by the USDA-ARS laboratory, in Albany, California, were sown in Jeffy sets in February 1986 and transplanted to plastic pots in March 1986. *Cirsium creticum* (De Lamarck) D'Urville, were field collected as daughter plants at Agios Prodromos, near Thessaloniki, and transplanted to pots in February 1989.

Efforts were made, starting in early April, to lo-

TABLE 1. Number of galls and percentage of plants infested by *Aceria centaureae* 15, 24, and 32 days after inoculation.

	27.V. 1986		5.VI.1986		13.VI.1986	
Test plant Species*	No. galls X±SD	% infested plants	No. galls X±SD	% infested plants	No. galls X±SD	% infested plants
Cirsium cymosum	0	0	0	0	0	0
C. occidentale	0	0	0	0	0	0
C. pastoris	0	0	0	0	0	0
C. andersonii	0	0	0	0	0	0
C. brevistylum	0	0	0	0	0	0
C. undulatum	0	0	0	0	0	0
C. creticum	0	0	0	0	0	0
Centaurea diffusa	44.8±34.6	100	14.1±11.0	100	35.0±35.1	100
C. solstitialis	11.3±21.8	60	3.3± 6.2	60	3.3± 5.3	40
Carthamus tinctorius	0	0	0	0	0	0

* Ten replicates per plant species at the beginning of the experiment.

cate galled *C. diffusa* rosettes for inoculating the test plants. Finally, on May 10, sufficient numbers of infested plants were found near Geroplatanos, along the road to Arnea. Twigs of the infested plants were divided into 100 portions with about the same number (30-40) of galls per portion.

One portion of such infested twigs was attached by string on each test plant near the growing point, allowing the mites to leave the galls and infest the test plants. At that time the experimental plants were in good condition. The American *Cirsium* plants were in rosette stages with 8-10 well developed leaves, while the other test plants were in bolting stages. The test plants were inspected on May 17, May 27, and June 5 and 13, i.e. 6, 15, 24, and 32 days after inoculation, for the presence of galls, and the number of galls found on each plant was recorded. In addition, a few leaves with galls were removed and examined under a stereomicroscope for the presence of mites. After termination of the experiment all of the U.S. *Cirsium* plants were destroyed.

Results and Discussion

1985 experiment

Until March 15 no galls could be found on the *C. diffusa* test plants inoculated with intact, gall-bearing, field-collected *C. diffusa* rosettes. However, when the infested rosettes were broken into pieces and were put back on the test plants, eight days later (March 23), galls were found on the *C. diffusa* plants of U.S. origin as well as on the local *C. diffusa* control plants. Gall formation on U.S. plants was heavier than on local plants but this was probably due to the fact that the U.S. plants were in a better growing condition. Very small rosettes of the 5-leaf stage also were infested. The galls were light green, about 1-2 mm in diam., and in some cases were fused together, forming larger spots on the leaves. Up to 5 mites were found among the spongy tissue of each gall, below the epidermis of the leaves. Galls were present on the plants and mites were found in them throughout the season, until the end of September, when the observations were terminated. As plant growth declined the number of galls as well as the number of mites per gall declined. During June and July, some of the plants were still developing and some galls were found also on the developing stems. No mites could be found in old galls, which by that time have become pink.

1986 experiment

On March 17, only six days after the transfer of the infested *C. diffusa* twigs to the test plants, galls were found on all *C. diffusa* and on some of the *C. solstitialis* plants. The maximum number of galls on *C. diffusa* plants per leaf at that time was 7 and the maximum number of galls per plant was over 100. The results of the subsequent observations on May 27 and June 5 and 13 are given in Table 1. Galls were found on all of the *C. diffusa* and 6 of the 10 *C. solstitialis* plants. However, mites were found only in the galls of *C. diffusa* plants. The galls on *C. solstitialis* plants were found mainly on stems, while on *C. diffusa* they were found exclusively on leaves, particularly on young leaves. None of the other test plants had galls or other evidence of mite damage.

From the results of the present study and from the literature, it follows that most proba-

bly *Aceria centaureae* is a rather stenophagous species restricted to the genus *Centaurea* and therefore poses no danger to safflower or other cultivated or ornamental plants, nor to native North American *Cirsium* spp. Thus we suggest that the mite should be considered as a possible candidate for biological control of diffuse knapweed in North America. However, further host specificity tests and information on its biology are needed before a final decision can be made for its introduction to North America.

Acknowledgment

We would like to extend our thanks to several persons and institutions whose efforts have been instrumental in making these studies possible: M. Castagnoli (Instituto Sperimentale per la Zoologia Agraria, Firenze, Italy) for identifying the mite; P. H. Dunn and S. Clement (USDA-ARS, Biological Control of Weeds Laboratory-Europe, Rome, Italy) for providing U.S. *Cirsium* seeds and for their support; D. M. Maddox and S. Rosenthal (USDA-ARS Laboratory, Albany, California)for providing safflower and *Cirsium* seeds; the Greek Ministry of Agriculture, Plant Protection Service for the permission (No. 191098.6.12.85) to grow U.S. *Cirsium* plants for the test; Prof. M. E. Tzanakakis, M. Castagnoli, G. Campobasso and L. E. Wendel, for critically reading the manuscript. The work was supported by a grant (No. 59-32U4-6-66) from USDA/ARS.

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KEY WORDS: Gall mite, Diffuse knapweed, Weeds

Πειράματα Εξειδίκευσης ως προς τα Φυτά-Ξενιστές του Ακάρεως *Aceria centaureae* Nalepa (Acarina: Eriophyidae), Υποψήφιου για τη Βιολογική Καταπολέμηση του Ζιζανίου *Centaurea diffusa* De Lamarck (Compositae)

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ΠΕΡΙΛΗΨΗ

Κατά τη διάρκεια των ετών 1985 και 1986 έγιναν πειράματα υπαίθρου με το άκαρι *Acerea centaureae* το οποίο προκαλεί κηκίδες (στα φύλλα κυρίως) του φυτού *Centaurea diffusa*. Προσβεβλημένα από το άκαρι τμήματα του φυτού *C. diffusa* τέθηκαν σε επαφή με πειραματικά φυτά ορισμένων ειδών που βρίσκονταν σε κατάλληλο στάδιο ανάπτυξης. Ακολούθησαν περιοδικοί έλεγχοι για τη διαπίστωση ύπαρξης προσβολής από το άκαρι στα πειραματικά φυτά. Παρατηρήθηκε δημιουργία κηκίδων σε όλα τα πειραματικά φυτά *C. diffusa* είτε αυτά ήταν ελληνικής είτε βορειοαμερικανικής προέλευσης, καθώς και σε μερικά από τα πειραματικά φυτά του είδους *Centaurea solstitialis* L. Καμία κηκίδα ή άλλο σύμπτωμα προσβολής από το άκαρι δεν παρατηρήθηκε στα άλλα πειραματικά είδη φυτών τα οποία ήταν τα ακόλουθα: *Carthamus tinctorius* L., *Circium creticum* (De Lamarck) D'Urville ελληνικής προέλευσης και έξι (6) είδη του γένους *Cirsium* βορειοαμερικανικής προέλευσης (Η.Π.Α.), τα: *cymosum* (Greene) Howell, *occidentale* (Nutt) Jeps, *pasteris* Howell, *andersonii* (Gray) Petrak, *brevistylum* Crong, και *undulatum* (Nutt.) Spreng.

Τα αποτελέσματα αυτά υποδηλώνουν ότι πιθανότατα το άκαρι *Aceria centaureae* είναι μάλλον ολιγοφάγο είδος το οποίο προσβάλλει μόνον ορισμένα ζιζάνια του είδους *Centaurea* και επομένως μπορεί να θεωρηθεί ως υποψήφιο είδος για τη βιολογική καταπολέμηση του *C. diffusa* στις Η.Π.Α. και στον Καναδά.