

Habitat of *Carduus nutans* L. in Italy and Two Phytophagous Insects.

by
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ABSTRACT

Carduus nutans L. (Compositae) is usually found in loamy-sand soil of marginal productivity which has been disturbed by man or animals. Common associated plants are species of grasses, legumes and composites. The biology of two phytophagous insects, *Cheilosia grossa* (Fallen) (Diptera: Syrphidae) and *Ceutorhynchus trimaculatus* F. (Coleoptera: Curculionidae) that are being considered as biological control agents against *C. nutans* is presented. Preliminary host specificity tests indicate that both species of insects may be safe for release in the U. S.—

Musk thistle, *Carduus nutans* L., is a noxious weed introduced into North America from Europe in the early 1900's. It is now of economic importance in 27 states (Dunn 1976). This plant reduces yields from pasture and hay fields by removing moisture and plant food. Also, livestock refuse to enter heavily infested areas and will not graze close to the spiny plants.

In pasture and rangeland, *C. nutans* can be controlled by applying herbicides and by following up with recommended management practices (Furrer and McCarty 1976). However, these methods are less than satisfactory because the treatment must be repeated for several years until the reservoir of seed in the ground is exhausted. Therefore, biological control of this weed has been investigated, and two insects, *Rhinocyllus conicus* (Froelich)² and *Ceuthorrhynchidius horridus* Panzer² have been studied and released (Surles *et al.* 1974, Kok *et al.*, 1975). Although *R. conicus* is damaging *C. nutans* at some sites, (Hodgson and Rees 1976) it is becoming apparent that no single organism will be able to control *C. nutans* throughout its range. Perhaps the combined impact of several insects feeding at different times on different parts of the plant will be more successful. The Biological Control of Weeds Laboratory-Europe, ARS, U.S.D.A.,

Rome, Italy, is therefore investigating musk thistle in its native area and is studying *Cheilosia grossa* (Fallen)³ and *Ceutorhynchus trimaculatus* F.² two additional phytophagous insects that may aid in providing control. These insects cause considerable damage to *C. nutans* in the field and were felt to have high control possibilities. Some current results concerning the habitat of *C. nutans* and the biology of these two insects are reported here.

Habitat of *C. nutans*.—Large infestations of *C. nutans* occur frequently in Italy and southern France, areas characterized by fall and winter rains and by hot dry summers (Walter and Lieth, 1960). Surveys were therefore conducted in Italy from 1974 to 1976 to locate where the weed was growing. Then associated plants at sites that contained a high density of *C. nutans* were sampled during the flowering period, May to June. The 9 sample areas were each ca 50 m² were located in the Piedmont, Lazio, Tuscany, Abruzzi and Calabria regions of Italy, and were generally typical of other infested areas in each region.

Carduus nutans is found in Italy in open sunny areas. Heavy infestations are usually found in well drained soil that is loamy sand in texture and low in nutrients, especially nitrogen. Only occasionally is it found in loam or clay-loam soil. Infestations tend to develop on land of marginal productivity that has been disturbed by animals or people, but once the weed is established, reinfestations may continue for years, even if the site is undisturbed. Large infestations were found primarily along roadsides, in fallow fields, and in overgrazed pastures but at such sites, there was a positive correlation between amount of bare ground and plant density (Table 1.). Plants were taller and had more flowers per plant in overgrazed pastures and were shortest and had fewest flowers along roadsides. *Carduus nutans* was also found in winter seeded wheat, at rubbish dumps and in animal campsites. Of the many plant groups found as-

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² Coleoptera: Curculionidae.

³ Diptera: Syrphidae.

Table 1. Relationship between groundcover and density of *Carduus nutans* in three habitats in Italy 1974-75.

| Habitats 1) | % Bare ground | % <i>C. nutans</i> cover | no. <i>C. nutans</i> /m ² |
|---------------------|---------------|--------------------------|--------------------------------------|
| Roadsides | 5 | 5 | 0.7 |
| Fallow fields | 10 | 12 | 1.6 |
| Overgrazed pastures | 20 | 14 | 2.9 |

1) Mean of three sites per habitat.

sociated with *C. nutans* at all sites, the most common were grasses (*Bromus sterilis* L., *Lolium perenne* L., *Avena* sp.) legumes (*Trifolium* sp., *Vicia* sp.), and composites (*Onopordum illyricum* L., *Silybum marianum* (L.) Gaertn.).

Cheilosia grossa.—One promising candidate for biological control of *C. nutans* found in the survey in Italy is *Cheilosia grossa*. The taxonomy of the genus *Cheilosia* is confused and many type specimens have been lost since the last major revision by Becker (1894). The biology of *C. grossa* has never been studied. However, the larvae do extensive damage to the early flower buds, stems, and roots of *Carduus nutans* and were collected from both *C. nutans* and *Carduus pycnocephalus* L., between May and August 1975 at 14 locations throughout Italy and 2 locations in France. At some sites up to 90% of the plants were infested.

In Italy, adult *C. grossa* emerged from pupae in March and April, when some buds of *C. nutans* have formed, but bolting has not yet occurred. In the field, oviposition was observed once on the upper surface of the leaf, but mating and oviposition have not occurred in the laboratory. In April and May, hatched larvae enter the stem, just below the flower bud and feed in the stem cortex. Thus the young leaves surrounding the terminal bud may be damaged by the entry of the larvae, but the bud is killed because the larvae feeds immediately below it. This feeding does not impare the overall vigor of the plant which produces secondary stems with smaller flowers. However as the larvae continue downward toward the crown and root, they do have a significant impact. Feeding continues through May. In June the plant begins to bloom, and the larvae decrease slightly in size and produce coarse, undigested particles of plant material which may prevent dessication during the summer.

Mature larvae estivate in the dying plant from June to September. When the location of estivating larvae in 25 plants from Calabria dissected in 1975 was recorded, 38% of 130 larvae (range from 0 to 13 per plant) were found in the stems, 2.7±2.9 cm above the crown, 18% were in the crown,

and 44% were in the root 2.4±1.1 cm below the crown.

In France, the damage done by *Cheilosia grossa* to *Carduus nutans* was more severe. Here, larvae were found 25 cm or more in the root. Perhaps dry soil conditions caused the larvae to feed downward to find moisture.

The larvae of many species of *Cheilosia* bore into the stems of plants or fungi. *Cheilosia grossa* has been recorded only from the tribe Cynareae (Compositae) (Séguy 1961). Preliminary host specificity test have now been made with young larvae by placing each in a glass tube (2 mm diam x 15 mm long) and inserting the end of the tube into the stem or bract of a test plant (6-8 replications of each species of plant tested). Plants were dissected after 11 days, and the larval mortality was recorded. Test plants not sustaining young larvae of *Cheilosia grossa* in the greenhouse were: *Brassica oleraceae* L. var. *capitata*, *Lupinus albus* L., *Lycopersicon esculentum* Mill., *Nicotiana tabacum* L., *Aster* sp., *Carthamus tinctorius* L., *Antirrhinum majus* L., *Linaria vulgaris* Mill., *Petunia hybrida* Vilm., *Geranium pelargonium* L., Test plants sustaining young larvae of *Cheilosia grossa* were: *Carduus nutans* L. (Italy), *Carduus nutans* L., (Canada), *Carduus pycnocephalus* L., *Carduus crispus* L., *Cirsium lanceolatum* (L.) Hill, *Silybum marianum* (L.) Gaertn., *Onopordum illyricum* L., *Cynara scolymus* L., *Galactites tomentosa* (L.) Moench., *Centaurea nicaeensis* All., *Cichorium intybus* L., *Helianthus annuus* L., and *Primula obconica* Hance.

In this test, root damage was done to one plant of *Chicorium* but the larva was not found. Little damage was done to the stems of *Helianthus*, *Centaurea* and *Primula*; larvae had not grown. Survival of *Cheilosia grossa* in test plants may have been aided by the hollow stems of these plants.

Larvae were able to survive in *Cynara* when placed directly in cut sections of stem, but were not able to survive when placed on the surface of either stems or bracts, apparently because they could not penetrate the epidermis successfully.

Ceutorhynchus trimaculatus.—Another promising candidate for biological control of *Carduus nutans* is *Ceutorhynchus trimaculatus*. Larvae of this insect damage the growing tips of rosettes and buds of the developing plants. *Ceutorhynchus trimaculatus* is univoltine. Adults emerge from pupae in the soil at the end of April and feed on leaves of new rosettes and mature plants for 3 to 4 weeks. This feeding consists of biting small circular areas out of the surface of the leaves. Then, at the end of

May they return to the soil to estivate. Adults gradually become active again after the fall rains, about the first of November, but density and percentage males decrease from a maximum of 92 insects per 100 plants and 50% males at the beginning of November to 1.5 per 100 plants and 10% males in March. Oviposition, first observed the middle of November, continues through March or until the females die. The females oviposit from 1 to 4 eggs in small grooves that they make along the leaf midrib, but occasionally they place loose eggs on the under surface of the leaf. The larvae feed gregariously, bore into the leaf buds or growing tips and feed down into the crown itself. They injure the growing tips, new growth is often stimulated and this new leaf and flower tissue, in turn, is used for oviposition in January and February. Newly emerging larvae feed in these buds, usually destroying them. The mature larvae exit into the soil and pupate.

Although *C. trimaculatus* has never recorded from *Cynara* sp., tests were conducted for 2 years in Rome to determine whether it could survive on artichoke, *Cynara scolymus*, in the field since such survival would be a major threat to the artichoke industry of California and would prevent release. During the first year, 5 ovipositing females were placed in cages containing plants of either *Cynara scolymus* or *Carduus nutans*. The plants were dissected periodically to determine oviposition and larval development. The second year the experiment was repeated with 30 females per cage, a density at least 12 times the highest which is found in the field. In both years, oviposition occurred on both *Carduus nutans* and *Cynara scolymus*. However, larvae fed to maturity and pupated in the soil only on *C. nutans*. Only first-instar larvae were found on *C. scolymus* and examination of the soil did not reveal any pupae. Also newly hatched first-instar larvae were placed on stem pieces of *Cynara scolymus* and *Carduus nutans* (changed weekly) in plastic vials. The larvae fed, pupated, and emerged as normal appearing adults from both plants, but those reared on *C. scolymus* died after 2 months without laying eggs.

DICUSSION

The potential of *Cheilosia grossa* and *Ceutorhynchus trimaculatus* is in their ability to maintain a continuous feeding stress against *Carduus nutans*. Thus the attack of *R. conicus* on the receptacle and seeds of the developing head and that of *Ceuthorrhynchidius horridus* on the growing tips in crown of the rosette would be complemented by the feeding of *C. trimaculatus* on the growing tips and leaf buds and the feeding of *C. grossa* on the terminal head and in the root. The combined attack could reduce the vigor of the plant, and, as a result, the production of viable seed.

Although *C. nutans* is abundant throughout Italy, the two insects are not evenly distributed throughout the host range of the plant. In the selection of initial release sites in North America, *C. grossa* is found in the greatest numbers in the cooler mountain climate of Calabria and should be considered for the northern part of the U.S. and for Canada. Neither insect has been recorded from artichoke in Italy and tests presented here indicate that both species of larvae cannot survive to the second instar stage on the intact plant.

REFERENCES

- Becker, T. 1894. Revision der Gattung *Cheilosia* Meigen. Nova Acta Acad. Caes. Leop. Carol. 62: 194-512.
- Dunn, P. H. 1976. Distribution of the weedy thistles, *Carduus nutans*, *Carduus acanthoides*, *Carduus pycnocephalus* and *Carduus crispis*, in the United States. J. Range Manag. (In Press).
- Hodgson, J. M., and N. E. Rees. 1976. Dispersal of *Rhinocyllus conicus* for biocontrol of Musk thistle. Weed Sci. 24: 59-62.
- Kok, L. T., R. H. Ward, and C. Grills. 1975. Biological studies of *Ceuthorrhynchidius horridus* (Panzer), in introduced weevil for thistle control. Ann. Entomol. Soc. Am. 63: 503-505.
- Furrer, J. D., and M. K. McCarty. 1976. Musk Thistle. Its appearance, spread and control. Univ. Neb. E.C. 76-160 6 p.
- Séguy, E. 1961. Dipteres Surphides de l'Europe occidentale Mem. Mus. Natn. Hist. (A, Zoo) 23: 1-248.
- Surles, W. W., L. T. Kok, and R. L. Pienkowski 1974. *Rhinocyllus conicus* establishment for biocontrol of thistles in Virginia. Weed Sci. 22: 1-3.
- Walter H., and H. Lieth. 1960. Klimadiagramm Welt-atlas. VEB Gustav Fischer Verlag, Jena.