

Seasonal food of *Ceratomegilla notata* (Coleoptera: Coccinellidae) in mountain environments of Northern Italian Alps

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Abstract. The aim of this study was to clarify the diet of *Ceratomegilla notata* (Laicharting), a common species in different mountain habitats of the Palearctic region. In Italy it is found only in alpine ecosystems between 800–1700 m. In these areas, up to 1200 m, various crops (e.g., maize, potatoes) are present. The high meadows are cut for hay. From 2002 to 2003 investigations on the foraging behaviour of this ladybird were carried out in mountain habitats (six near Villabassa, in Bolzano province, and six near Soraga, in Trento province) and in the “Paradisìa” Botanic Garden (Gran Paradiso National Park). *C. notata* adults and larvae were found on the flowering plants, especially those infested by aphids. The study of their diet was done taking random D-Vac samples of 20 adults and 20 larvae/habitat every 15 days, between July and September. The influence of the haymaking on *C. notata* populations was also evaluated.

In agricultural fields the ladybirds prey on *Rhopalosiphum maidis* (Fitch), *R. padi* (L.) on maize and on *Acyrtosiphon pisum* (Harris) and *Therioaphis luteola* (Born.) on *Trifolium pratense* L. In the natural pastures, adults and larvae feed on *Cavariella theobaldi* G. & B. found on *Heracleum sphondylium* (Umbelliferae), *Sitobion avenae* L. on *Avena sativa* L., *Megoura viciae* (B.) and *A. pisum* on *Vicia cracca* L., *Uroleucon jaceae* (L.) on *Cirsium arvense* Scop., *U. cichorii* (Koch) on *Hypochaeris radicata* L. and *Macrosiphum weberi* Born. on *Scabiosa* sp. A study of the gut contents revealed the presence of aphids, Umbelliferae pollens and spores of fungi (e.g., *Alternaria* spp., *Helminthosporium* spp., *Puccinia* spp.). Statistically significant associations between different food sources were more frequent for adults than for larvae in both 2002 and 2003. Thrips are an important prey of this ladybird in the absence of aphids. *C. notata* is an important aphidophagous species in Alpine habitats.

INTRODUCTION

Ceratomegilla notata (Laich.), a rare species found in some sub-mountain and mountain areas of the Palearctic region, has recently become a component of lowland areas of Bohemia and adapts easily to man-changed environments such as agricultural landscapes (Horion, 1961; Savoiskaya, 1983; Hodek & Honěk, 1996). The ladybird is present also in Poland at low levels (P. Ceryngier, pers. comm.). In Italy it is present in some areas of alpine ecosystems. Few data are available about the diet of this species. Savoiskaya (1983) reported *C. notata* as a predator of aphids of *Urtica* sp.

The aim of this study was to study and report the occurrence, diet and foraging behaviour of this ladybird in Alpine ecosystems. In fact the feeding habits of *C. notata* have rarely been studied.

MATERIAL AND METHODS

The investigations were carried out in 2002 and 2003, in natural pastures and in agroecosystems of the eastern and western Italian Alps. The eastern sites studied were natural pastures near La Thuile (1400 m) (Aosta) and the Alpine Garden “Paradisìa” (1700 m) in the Gran Paradiso National Park (1254 m) (Cogne, Aosta). The western sites investigated were natural meadows around Soraga (1242 m) (Trento), Brunico (838 m), Villabassa (1158 m) and Tesido (1219 m) (Bolzano), as well as natural pastures of the Armentara area (1580 m) (Bolzano), and natural meadows around Cortina D’Ampezzo (1211 m) (Belluno).

In the Alpine habitats, the distribution of *C. notata* was observed from low to high altitudes. In the morning between 10.00 a.m.–12.00 noon, visual observations on flowering plants were carried out to record the presence of this coccinellid and its foraging behaviour. Also the flowering plants and the aphid infestations were recorded. Plant and aphid species were identified. Moreover, phenological phases of plants and agricultural practices were recorded. The influence of harvesting on *C. notata* foraging behaviour was considered.

The study of *C. notata* diet was done taking random D-Vac samples of 20 adults and 20 larvae in meadows near Villabassa every 15 days between July and September. In the laboratory, the adults and larvae were dissected at stereomicroscope; the gut content was observed at the light microscope, aphids and other preys’ remains were recorded (presence or absence); pollens and fungi spores were counted.

We tested for positive and negative associations between the presence of different food sources in the digestive tracts of individual *C. notata* adults and larvae. For this purpose, we derived for each sample the number of coccinellid individuals with remains of a particular food in the gut. In other words, correlation coefficients were computed on the basis of whether individual ladybirds do or do not have a particular food item in their gut. We also tested correlation coefficients for statistical significance.

Seasonal dynamics of food in relation to habitats are not reported in the present paper and will be published separately.

RESULTS

The adult captures of *C. notata* in the Italian Alps revealed that the species is distributed between 800–1700 m on high meadows and on field crops (e.g., maize at

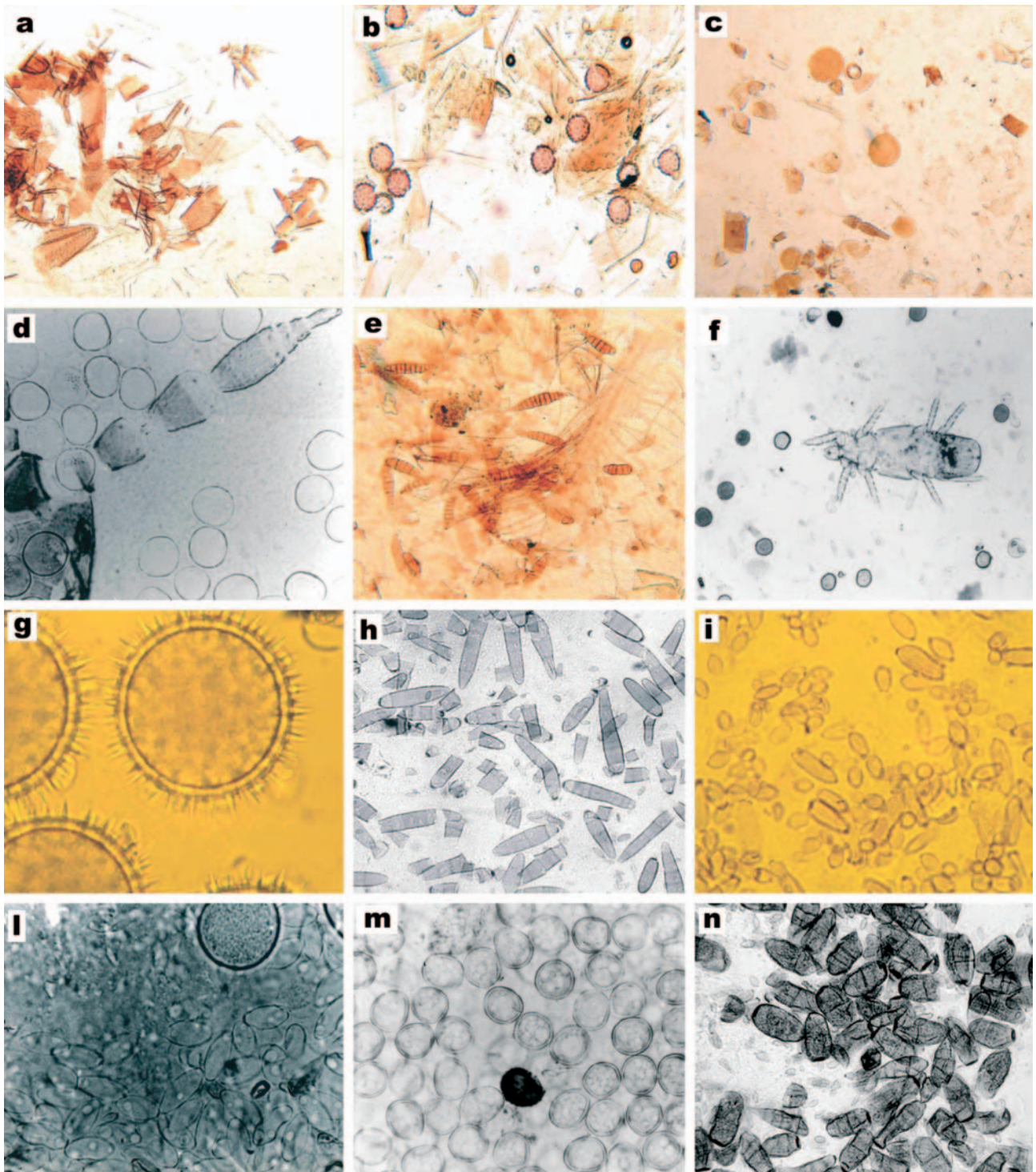


Fig. 1. Examples of gut content observed in *Ceratomegilla notata*: (a) aphid remains; (b) aphid remains and *Carduus* spp. pollens; (c) aphid remains and maize pollen; (d) thripid remains among Gramineae pollens; (e) thripid wings among *Alternaria* spp. spores; (f) mite among *Puccinia* spp. spores; (g) Compositae pollens; (h) *Helminthosporium* spp. conidia; (i) *Cladosporium* spp. conidia; (l) *Oidium* spp. conidia among pollens; (m) *Puccinia* spp. spores; (n) *Stemphylium* spp. conidia.

800–1100 m). In the eastern Alps the ladybird is common on Compositae (e.g., *Carduus* spp.) and Umbelliferae (e.g., *Heracleum sphondylium* L.) found in the “Paradisia” Botanic Garden. In this habitat, *C. notata* adults and larvae feed on pollens and aphids, in particular *Cavariella theobaldi* G. & B. infesting *H. sphondylium*. This ladybird also preys on the same aphid on the

same plants in natural pastures. In the agricultural fields of western Alps, this species feeds on *Rhopalosiphum maidis* (Fitch) and *R. padi* (L.) on maize, *Therioaphis luteola* (Born.) and *Acyrtosiphon pisum* (Harris) on *Trifolium pratense* L., *Sitobion avenae* (F.) on *Avena sativa* L. It also feeds on pollens of these plant species. In natural meadows the ladybird preys on *Megoura viciae*

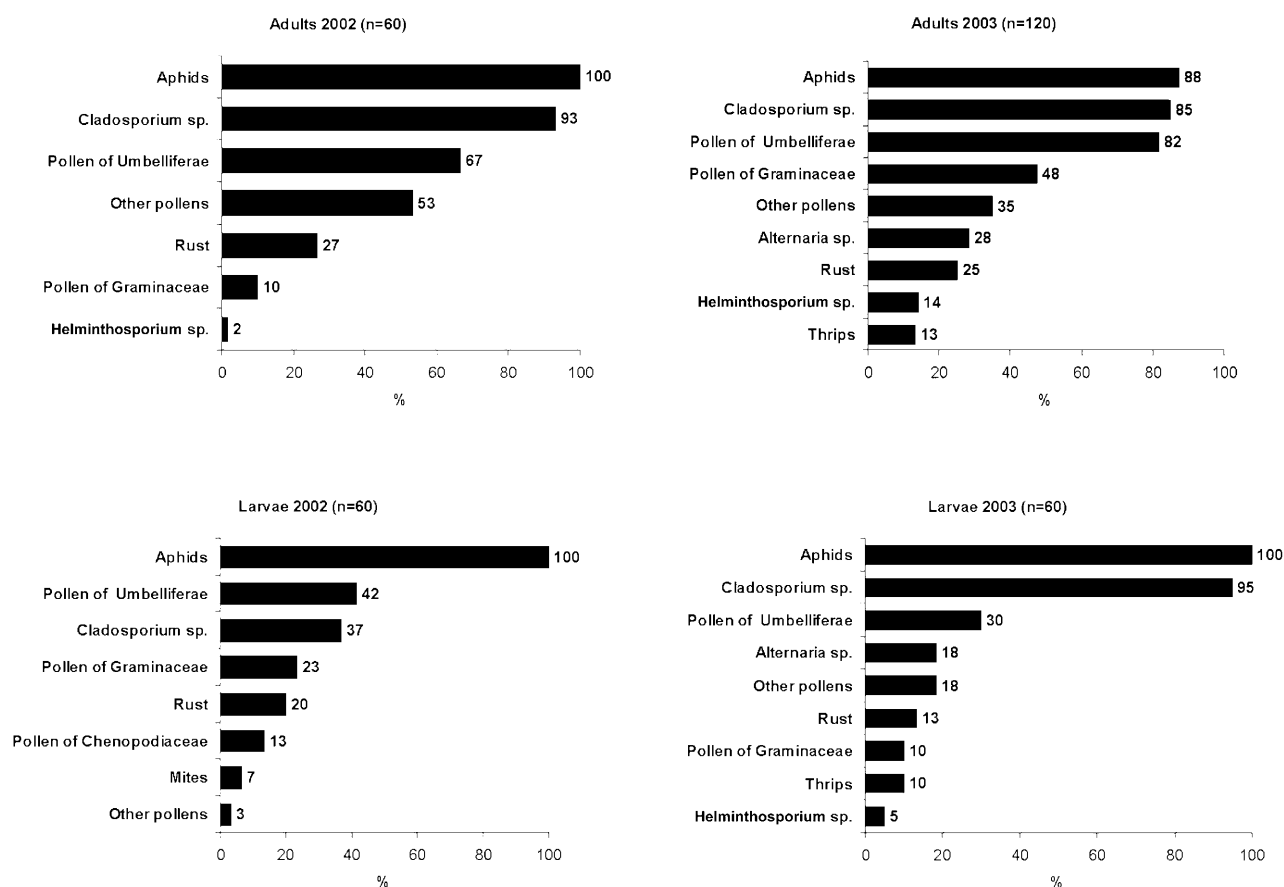


Fig. 2. Percentage of *Ceratomegilla notata* larvae and adults showing different food remains for 2002 and 2003.

(B.) infesting *Vicia cracca* L., *Uroleucon jaceae* (L.) on *Cirsium arvense* Scop., *U. cichorii* (Koch) on *Hypochaeris radicata* L., *Macrosiphum weberi* (Born.) on *Scabiosa* sp., and *C. theobaldi* G. & B. on *H. sphondylium* L. This last host plant belongs to Umbelliferae and is a dominant plant in natural pastures and wild areas, flowering all summer long. When the high meadow hay is cut (twice: beginning July and end August), the ladybird adults fly to wild areas where they forage on aphids and pollen of *H. sphondylium*. The larvae remain in the field and collect saprophytic fungi (e.g., *Cladosporium* spp.) commonly found on straw moistened by frequent rain.

The study of gut content of both adults and larvae revealed the presence of aphids, thrips, mites, pollens of various plants (e.g., Graminaceae, Compositae and Umbelliferae) and spores of fungi (e.g., *Alternaria* spp., *Puccinia* spp., *Cladosporium* spp., *Helminthosporium* spp., and other unidentified species) (Fig. 1). The percentage (%) of *C. notata* larvae and adults showing different food remains in their gut is reported in Fig. 2.

In 2002, correlation coefficients related to the larvae of *C. notata* were not statistically significant, while in 2003 there was a positive correlation between the presence of Graminaceae and Umbelliferae pollens and between *Puccinia* spp. spores and other pollens ($P \leq 0.05$) (Table 1). All larvae dissected contained aphid remains. A significant ($P \leq 0.05$) negative correlation coefficient between presence of Umbelliferae pollens and other pollens was

found for *C. notata* adults in 2002; a negative association ($P \leq 0.01$) between the presence of thrips and aphids was evident from the observations carried out on the adults of *C. notata* in 2003 (Table 2). These results may indicate that thrips are an important prey of *C. notata* in absence of aphids. Statistically significant positive associations between different food sources [Graminaceae pollens and aphids; *Helminthosporium* spp. and Umbelliferae pollens ($P \leq 0.05$); other pollens and Umbelliferae pollens; *Cladosporium* spp. spores and Umbelliferae pollens; *Helminthosporium* spp. spores and *Cladosporium* spp. spores ($P \leq 0.01$)] were more frequent for adults than for larvae in both 2002 and 2003. When the ladybirds feed on maize aphids, they also collect the pollen; and those on Umbelliferae seem to collect both the pollen and *Helminthosporium* spp. spores infesting the plant. The other pollens are collected together with Umbelliferae pollens since they all are flowering at the same time. The different fungal

TABLE 1. Significant correlation coefficients computed on the basis of number of *Ceratomegilla notata* larvae per sample having a particular food item in gut in 2002 and 2003 (* $P \leq 0.05$).

Food item	Year	
	2002	2003
Graminaceae pollen/Umbelliferae pollen	—	0.278*
<i>Puccinia</i> spp./Other pollens	—	0.265*

TABLE 2. Significant correlation coefficients computed on the basis of number of *Ceratomegilla notata* adults per sample having a particular food item in gut in 2002 and 2003 (* P ≤ 0.05; ** P ≤ 0.01).

Food item	Year	
	2002	2003
Thrips/Aphids	—	-0.371**
Graminaceae pollens/Aphids	—	0.191*
Other pollens/Umbelliferae pollens	-0.306*	0.293**
<i>Cladosporium</i> spp./ Umbelliferae pollens	—	0.241**
<i>Helminthosporium</i> spp./ Umbelliferae pollens	—	0.208*
<i>Helminthosporium</i> spp./ <i>Cladosporium</i> spp. spores	—	0.571**

spores are correlated since they are present in the straw and are also infecting these plants.

DISCUSSION AND CONCLUSIONS

C. notata is a common ladybird in Italian alpine mountains from 800 to 1700 m. Its diet consists of various aphid species, thrips, mites, Graminaceae, Compositae and Umbelliferae pollens, spores of fungi (mainly *Alternaria* spp. and *Cladosporium* spp.).

This ladybird plays an important role in controlling harmful aphids (e.g., *R. maidis* and *R. padi* on maize) in crops from 800 to 1100 m. In natural pastures both adults

and larvae of *C. notata* prefer *C. theobaldi* G. & B., an aphid infesting *H. sphondylium*.

Our results also show that thrips are an important prey of *C. notata* in absence of aphids; the food specificity is more pronounced in adults than in larvae. However, *C. notata*'s diet varies depending on the food sources available at different times and in the different habitats.

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