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Further studies on Nearctic *Chymomyza amoena* (LOEW) (Diptera: Drosophilidae) in Switzerland

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Nearctic *Chymomyza amoena* can now be found among the nondomestic forest drosophilids in Switzerland. Hypotheses concerning its entry into this drosophilid community are evaluated. Since discovery in the Maggia Valley, Canton Ticino in 1990 and 1991 that *C. amoena* could be reared from parasitized acorns, chestnuts and wild cherries collected in the forests, from domestic apples collected in several locations, and captured over bait in forest places where fruits and nuts had been collected, it has continued to expand its range there. In July 1997 *C. amoena* was reared from damaged hazelnuts and wild apples as well as domestic apples collected on the Valley floor. It was also reared from wild cherries collected in the mountains above Cevio and was present among drosophilids captured over bait on the lower slopes. It was reared from parasitized acorns collected in the Bolle di Magadino, also in July 1997. In all substrates except domestic apples, it was the only drosophilid present. *Penicillium* spp. (a yellow strain) was present in 5 acorns analyzed, *Candida* in only one. Ecologically, *C. amoena* continues to be a fruit-and-nut breeder as in the United States. Nearctic *C. amoena* has been among the mostly nondomestic drosophilids captured by baiting in Hönggerberg and Dietikon, Canton Zürich, since 1989 and 1990 respectively, yet remains rare. Where it is breeding in these two areas remains unknown. The greater variety of nuts and fruits available in the Maggia Valley may account for its stronger presence there.

Keywords: *Chymomyza amoena*, Switzerland, forest drosophilids, breeding sites, open ecological niche, wild apples, wild cherries, acorns, chestnuts, hazelnuts, *Penicillium*.

INTRODUCTION

Nearctic *Chymomyza amoena* (LOEW), an introduced species in Europe, has spread widely since its first capture in the former Czechoslovakia in 1975 (MÁCA & BÄCHLI, 1994). In Switzerland it seems to have entered the forest drosophilid community. Since its discovery in 3 places in Canton Ticino in 1988, it has become well established among forest drosophilids in the Maggia Valley. Eighty-nine *C. amoena* were reared from parasitized chestnuts *Castanea sativa*, acorns *Quercus robur*, and wild cherries *Prunus avium* collected in the forests in 1990 and 1991, 140 were reared from domestic apples *Malus domesticus*. In September 1991, 117 *C. amoena* were netted over bait among 7677 mostly non-domestic drosophilids in these same forest places where substrates yielding *C. amoena* had been collected (BURLA & BÄCHLI, 1992).

In the Bolle di Magadino, a protected forest preserve above Gordola on Lake Maggiore, 597 *C. amoena* were netted over bait among 4261 mostly non-domestic drosophilids in late June, 1995 (BÄCHLI, unpublished). This is the largest number of *C. amoena* coming to bait in a single area, far surpassing numbers collected by baiting in the United States (see BAND, 1996). Most drosophilids were in the *obscura* or mycophagous groups. Only 27 *Drosophila* (26 *D. immigrans*; 1 *D. melanogaster*) were cosmopolitan.

In Canton Zürich *Chymomyza amoena* continues to be present in low numbers among drosophilids captured in two forest places, Hönggerberg and Dietikon. One hundred seventy-seven *C. amoena* have been captured at 3 sites in a wooded area at Hönggerberg since 1989 among 78541 non-domestic drosophilids; 14 *C. amoena* have been captured at Dietikon also in a wooded area among 37639 non-domestic drosophilids since 1990.

Its success in Europe and entry into the forests in Switzerland has given rise to sometimes conflicting, sometimes complimentary hypotheses. Originally a forest species in North America, *C. amoena* has long been recognized as a nut breeder (STURTEVANT, 1921; WINSTON, 1956; DORSEY *et al.*, 1962; WILLIAMS, 1989; BAND, 1991, 1996). It has also been captured in forests from New York to Minnesota (LEVITAN, 1954; SPIETH, 1957; DORSEY & CARSON, 1958). Its attraction to fruits and ability to breed and overwinter in fruits and nuts in the urban and suburban environment enabled it to become a domestic species (BAND, 1988a–d, 1995a, 1996; BAND & BAND, 1984, 1987). It is thought to have entered Europe on imported fruits.

However, the European Continent has become difficult to invade and European forests largely closed to the introduction of new species (DI CASTRI, 1989, 1990), especially insects (NIEMALÄ & MATTSON, 1996). *Chymomyza amoena* retains an attraction to newly damaged trees and cut wood, characteristic of the genus (BAND, 1996; BÄCHLI & BURLA, 1985; BURLA, 1995); BURLA & BÄCHLI (1992) suggested that it might also retain an arboreal mating habit. MÁCA & BÄCHLI (1994) argued its success on the European Continent might be due either to finding an open ecological niche or to superior competitive ability. BURLA & BÄCHLI (1992) found that chestnuts and acorns gathered in the Maggia Valley yielded many other types of insects, indicating that opportunities for *C. amoena* breeding were limited, as earlier observed by WINSTON (1956). Hazelnuts *Corylus avellana* were not investigated. Also, BURLA & BÄCHLI (1992) sampled only ripe apples from the Maggia Valley. They sampled wild apples in September 1990, but *C. amoena* was not present.

BAND (1988a, 1988b) reported the capture of pairs in the urban environment on fallen small unripe apples; the pairs produced fertile eggs in the laboratory, consistent with the ability of a species to reproduce in the domestic environment. She also reported that *C. amoena* had a lengthy developmental time. BAND (1996) suggested a possible factor aiding the spread of *C. amoena* in Europe was its ability to capture the parasitized unripe/ripe fruit breeding niche which it inhabited in the United States largely unnoticed. BURLA & BÄCHLI (1992) had shown that aggregated oviposition existed in parasitized chestnuts and acorns, and in apples. BAND (1996) also suggested two additional factors aided *C. amoena*'s establishment in Europe: its ecological versatility already evident from breeding results in the Maggia Valley (BURLA & BÄCHLI, 1991, 1992), and its coldhardiness. Emergence of 14 *C. amoena* from chestnuts and acorns collected in March 1991 in the Maggia Valley (BURLA & BÄCHLI, 1992) is consistent with its overwintering in a preadult stage (BAND & BAND, 1984, 1987).

To compare the status of *C. amoena* populations in the Zürich area and in Ticino after nearly a decade, an investigation was conducted in July 1997. Unripe fallen domestic apples were collected in the Zürich area, where available. In the Maggia Valley, chestnuts, acorns, hazelnuts, domestic and wild apples and wild cherries were gathered from the Valley floor. Drosophilids were also netted over the domestic apples. To determine if *C. amoena* could be found along the slopes above the Maggia Valley, floor wild cherries were collected at the Valle di Bosco above

Cevio and netted over bait from Cevio to Cerentino. Acorns were gathered in the Bolle di Magadino.

Chymomyza amoena has entered the temperate woodland drosophilid community in Switzerland, and is continuing to expand its range and the substrates in which it can breed in Canton Ticino despite a slower rate of development compared to cosmopolitans *D. immigrans*, *D. simulans*, and ecologically versatile *D. subobscura*. There is at present no evidence that it breeds in parasitized unripe fruits as in the United States. Where it is breeding in the Dietikon and Hönggerberg areas remains unknown.

MATERIALS AND METHODS

Canton Zürich

Over 125 fallen domestic apples, *Malus domestica* (DOSSLER & HEITMANN, 1994), were collected at several sites in Zürich (11.7.97), at Hönggerberg (7.7.97), at Gockhausen (8.7.97), in a meadow at Geeren (8.7.97), and near the road at Kyburg (10.7.97). None showed evidence of having been parasitized by codling moth *Cydia pomonella* although a few had been punctured by apple weevils, *Rhynchites* sp. (KOTTE, 1958).

Canton Ticino

In the Maggia Valley, substrates yielding *C. amoena* in July 1997 were collected in or near forests or the Maggia River. They include:

Ripening fallen, damaged domestic apples, *Malus domestica*, along a trail near Lodano (15.7.97). The apples were already beginning to attract *Drosophila*. Thirty-one apples were collected. Eleven of the apples had 18 *C. amoena* eggs; some of these also had *Drosophila* eggs. None of the 31 apples, upon dissection, had codling moth tunnels or pest larvae in them. Twenty-seven were retained for transport back to Zürich.

The oak/chestnut (*Quercus robur*/*Castanea sativa*) forest north of Lodano where acorns yielding *C. amoena* were collected in 1991 also contains hazelnut trees, *Corylus avellana*. Six hazelnuts on the forest floor were gathered (15.7.97). Acorns and chestnuts at this site were mostly shells. Many contained ants or ant colonies, indicating that they had progressed to stage IV of the acorn decay process and contain insects from the forest floor (WINSTON, 1956). Ten semi-intact acorns were found not to contain any *C. amoena* larvae.

Wild apples *Malus sylvestris* (DOSSLER & HEITMANN, 1994) on the ground and pulled from the tree were gathered at Someo at a site across the suspension bridge over the Maggia River (15.7.97)

At Biett, chestnuts *Castanea sativa* collected in the chestnut forest adjoining the settlement were mostly shells and also contained ants or ant colonies; 45 were still intact and had an exit hole from a weevil larva. Upon dissection, they were found to be relatively dry. In 1997, precipitation at Maggia had been the lowest in February (2,7 mm) and March (0,7 mm) of any two consecutive months of the 1990s; a similar situation existed at Cevio. At Maggia, 114,8 mm rain fell during the first two weeks of July; only 89,5 mm at Cevio. No *C. amoena* eggs or larvae were in the 45 parasitized acorns.

Wild (sweet) cherries, *Prunus avium*, were collected in the Valle di Bosco above Cevio (14.7.97).

Drosophilids were netted over the fallen apples at Lodano (14–16.7.97) Bait was also placed at intervals along the road from Cevio to Cerentino, and flies netted both morning and evening for two days (15,16.7.97)

At the Bolle di Magadino, acorns having a weevil larval exit hole (i.e. parasitized acorns) were gathered (17.7.97). Of the 63 acorns collected, 9 contained a total of 7 *C. amoena* larvae, 3 eggs, 1 pupa and 5 empty pupal cases. *Chymomyza* preadult stages are distinguishable from *Drosophila* preadult stages, and one of us (H. T. BAND) employs the dissection method to determine oviposition on/in parasitized or damaged substrates (apples, acorns) (BAND, 1996). Many acorns, with or without larvae, had a moist, pulpy interior, somewhat granular in appearance.

Twenty-seven of the fallen domestic apples, the wild apples, and hazelnuts from the Maggia Valley, 20 of the wild cherries from the Valle di Bosco and 9 acorns from the Bolle di Magadino were transferred to small aluminum containers for return to Zürich.

Microbial samples were also plated from 5 parasitized acorns from the Bolle di Magadino. Culture medium for the isolation of fungi was as follows: malt extract (Difco), 3% (v/v) with agar, 1,5% (v/v) is the basal medium. The initial enrichment medium contained 35 mg/l Rose Bengal (Sigma) and 10 ml/l of medium Penicillin G/Streptomycin sulfate (stock solution: 10000 U/ml Pen; 10mg/ml Strep). Both Rose Bengal and the antibiotics were added sterile to the medium at the time Petri dishes were poured. The medium was tested in advance at Michigan State University for its ability to grow both yeast and *Penicillium* fungi.

RESULTS AND DISCUSSION

Canton Zürich

Collections in July and August in a wooded area at 3 sites at Hönggerberg and in a wooded area at Dietikon in July or August have provided consistent evidence of the presence of *C. amoena* for nearly a decade. Neither site is adjacent to orchards. Oaks are present at Dietikon and at Hönggerberg. There are farms somewhat removed from the collecting site at Hönggerberg, one of which has an old orchard. Fruits obtained there or gathered elsewhere provide no evidence that *C. amoena* is using unripe fallen parasitized apples or other fruits as a breeding resource in early/mid-July in northern Switzerland. There was no evidence *C. amoena* females were attracted to *Rhynchites* weevil punctures for oviposition and no evidence on apple dissection that pest larvae were present in the interior of the apple. Weevil larvae lack legs, codling moth larvae have legs; neither were present in the fallen unripe apples collected.

Striking geographical variation in substrate utilization is known for some *Drosophila*, England versus Switzerland (SCHATZMANN, 1977; SHORROCKS, 1982; BURLA *et al.* 1987, 1991). However, MANI *et al.* (1997) showed that late August or September is the time codling moth larvae exit apples in eastern Switzerland. With only one generation a year for codling moth in northern and eastern Switzerland, life-cycles for *C. amoena* and codling moth may be out of phase.

However, to determine that females retained a capacity to oviposit in parasitized unripe fallen apples, replicate cultures of a Zürich *C. amoena* stock maintained at Michigan State University since August 1997 were presented with parasitized unripe green fallen apples for oviposition over a 72 hour period. Apples were

inspected under a dissecting microscope to determine that they did not contain eggs laid by a local Michigan *C. amoena* natural population. The first replicate Zürich culture was provided with a parasitized green apple 2 cm in diameter over each of 3 consecutive days beginning on 5 July 1998. The second Zürich replicate culture was presented with a 2,5 cm diameter parasitized green apple for 72 hours. In the first replicate females laid a total of 40 eggs on the three apples; in the second replicate females laid a total of 146 eggs on the one apple in the 72-hour period. These results indicate that Swiss *C. amoena* females still retain the capacity to utilize parasitized unripe fallen apples as a breeding resource although the stock tested had been maintained in the laboratory on medium for 10 months.

Canton Ticino

Chymomyza amoena was again found to be breeding in multiple substrates, both fruits and nuts, in mid-July. One of them, damaged hazelnuts, is a new breeding substrate for this species. It is also a first report of a drosophilid, *C. amoena*, breeding in wild apples. Both would qualify as open ecological niches (MÁCA & BÄCHLI, 1994). *Chymomyza amoena* can now be found in the mountains above Cevio.

Tab. 1. Emergence of drosophilids from fruits collected in Canton Ticino in July, 1997. Abbreviations: gr = wild apples collected on the ground; tr = wild apples collected on the tree.

Place	Altitude	Fruit		*Drosophila*							
				immigrans		*simulans*		*subobscura*		*Chymomyza amoena*	
			No.	♀	♂	♀	♂	♀	♂	♀	♂
Lodano	340 m	domestic apples	27	30	44	11	7	22	27	26	28
Someo	360 m	wild apples, gr	11							5	4
		wild apples, tr	2							5	2
Valle di Bosco	1060 m	wild cherries*	20								1
Total by species				74		18		49		71	

* 1 weevil *Furcipus rectirostris*, Kirschkernstecher, also emerged

Fruit breeding, July 1997

As seen in Tab. 1, two cosmopolitan *Drosophila*, *D. immigrans* and *D. simulans*, and ecologically versatile *D. subobscura* were also breeding in ripe damaged domestic apples in addition to *C. amoena*. *Drosophila immigrans* had been collected in the Maggia Valley (BURLA & BÄCHLI, 1992) but was not among *Drosophila* emerging from September-gathered apples (BURLA & BÄCHLI, 1991, 1992). BAND (1988a, 1988b, 1995b) consistently bred *D. immigrans* and *C. amoena* from July-gathered apples in Virginia from both farm and forest locations. *Chymomyza amoena* flies have also been observed on fallen unripe and ripe apples in July in both Michigan and Virginia (BAND, 1988a–d). As shown in Tab. 4, more drosophilid species were netted over the apples at Lodano than were breeding in them. As in 1991 (BURLA & BÄCHLI, 1992) *D. subobscura* and *D. helvetica* comprise at least 60 % of the collection.

Chymomyza amoena was the only species to emerge from the wild apples. This has been the only or the predominant species to breed in native crabapples in the United States. Emergence from wild apples gathered from the tree is also consis-

tent with findings in the United States; apples have usually shown evidence of parasitism (BAND, 1988a, 1988b, 1988d). It was also the only species emerging from the wild cherries gathered in the Valle di Bosco, although 281 drosophilids representing 12 species were netted at the higher elevation. The fact that *C. amoena* breeds in wild cherries agrees with past findings (BURLA & BÄCHLI, 1992).

Tab. 2. Number of *Chymomyza amoena* emerging from hazelnuts and acorns collected in Canton Ticino.

Place	Altitude	Nut	No.	♀	♂	Total
Lodano	340 m	hazelnut, 1		1	1	2
		hazelnut, 2		3	1	4
		hazelnut, 3		6	6	12
		hazelnut, 4		6	3	9
		hazelnut, 5		2	1	3
		Total	6*	18	12	30
Bolle di Magadino	200 m	acorns	9	3	2	5

* One of the hazelnuts collected did not yield flies

Nut breeding

As shown in Tab. 2, a total of 30 *C. amoena* emerged from 5 of the hazelnuts gathered in the forest at Lodano. WILLIAMS (1989) lists *C. amoena* breeding in acorns *Quercus* sp, butternut hulls *Juglans regia*, and black walnut hulls *J. nigra* in the United States but not hazelnuts. American hazelnuts *Corylus americana* and *Corylus cornuta* are smaller than European hazelnuts *Corylus avellana* (WYMAN, 1971). Hazelnuts may be a new niche for this species in Europe. Nuts did not appear parasitized; however, the shells had a cleft permitting entrance to the interior. The damaged nuts, when opened, still had an intact kernel, but a grainy black humid substance between the kernel and the shell, possibly corresponding to the decaying hull. This appeared to be where the larvae were feeding.

Acorns gathered at the Bolle di Magadino had exit holes made by weevil larvae. Only *C. amoena* appeared to breed in the parasitized acorns. *Penicillium* (a yellow strain) was cultured from 5 of the acorns, the yeast *Candida* from only one of the 5. *Penicillium* in acorns was in agreement with findings in the United States that *C. amoena* larvae are not primarily yeast feeders (WINSTON, 1956; BAND & BAND, 1984; BAND, 1995b).

DORSEY *et al.* (1962) called *C. amoena* a secondary invader of acorns since females gain access to the interior for oviposition by means of openings made by other agents, usually exiting pest larvae. BAND (1988b, 1988d, 1995b) termed *C. amoena*'s reliance on a prior pest to invade firm substrates an example of "interspecies dependency." KOTTE (1958) lists only two insects as pests of acorns and chestnuts in Europe, *Cydia* (*Carpocapsa*) *splendana*, a relative of codling moth, and the weevil *Balaninus elephas*. He lists one as a pest in hazelnuts, the weevil *Balaninus nucum*. WINSTON (1956) reported that *C. amoena* could be found in acorns in stage II and especially stage III of the decay process. However, other insects including other dipterans also breed the fallen acorns (WINSTON, 1956; BURLA & BÄCHLI, 1992). DORSEY *et al.* (1962) only found *C. amoena* among acorns in 13 collections of 283 acorn collections in West Virginia.

Nevertheless, *C. amoena* was the only nut-breeding drosophilid listed by WILLIAMS (1989) in the United States. BAND (1988a, 1995b, 1996) and BAND & BAND (1984, 1987) recorded 488 *C. amoena* larvae taken from or adults emerging from nuts in Michigan and Virginia (182 larvae, 306 adults). Other *Drosophila* have been infrequent (CARSON, 1965; SPIETH, 1987; BAND, 1995b). *Chymomyza amoena* has likewise been the predominant drosophilid reared from nuts in the Maggia Valley and the Bolle di Magadino, 113 *C. amoena* compared to 4 *D. kuntzei* and 1 *D. subobscura* (BURLA & BÄCHLI, 1991, 1992, and here). Elsewhere 1 *D. subobscura* has been reared from acorns collected at Gockhausen (BURLA & BÄCHLI, 1991)

Tab. 3. Emergence records of drosophilids from fruit and nut substrates collected in Canton Ticino in July 1997 by day of emergence. Emergence is dated in relation to the day the first *Drosophila* began to emerge.

	Drosophila			*Chymomyza*				
	immigrans	*simulans*	*subobscura*	*amoena*				
Day	domestic apples	domestic apples	domestic apples	domestic apples	wild apples twig	wild apples ground	acorns	cherries
1		11						
2		5					1	
3	10	1						
4	5	1						
5	18		4					
6	14		10					
7	11		13					
8	3		8					
9			13					
10			1	1			1	
11							2	1
12				3				
13				3		1		
14				7				
15				4				
16				11				
17				6		1		
18				4				
19				1				
20				7				
21				3		1		
22				2				
23						1		
24					1	4		
25					3			
26	5						1	
27	4			2	1			
28	3							
29								
30	1							
31						1		
32								
33								
34					1			
35					1			
Totals	74	18	49	54	7	9	5	1

while SCHATZMANN (1977) reared 3 *D. subobscura*, 1 *Scaptomyza pallida*, and 1214 *D. busckii* from English walnut hulls, *Juglans regia*. *Scaptomyza pallida* has not been recorded from nuts in the Maggia Valley although it is present (BURLA & BÄCHLI, 1992, and Tab. 4).

Developmental times compared

As shown in Tab. 3, the developmental time for *C. amoena* is considerably longer than for other *Drosophila*. The one relatively rapid *C. amoena* emergence from acorns is consistent with finding a pupa in the acorns. BAND (1988a) also noted that *Drosophila* species typically emerge before *C. amoena* when present, and that initial emergence dates for *C. amoena* from wild crabapples *Malus coronaria* in May, domestic fruits (plums, apples) in summer and fruits and nuts in autumn in the United States tended to be similar, requiring at least 3 weeks at room temperature (22 °C) before adults began to emerge. BURLA (1997) reported that in stock culture *C. caudatula* required 30 days to develop from egg to adult; ENOMOTO (1981) stated that *C. costata* required about 40 days to develop from egg to adult. MÁCA & BÄCHLI (1994) suggested that superior competitive ability might have aided *C. amoena*'s establishment in Europe. Its lengthy developmental time in comparison to the typical fruit-breeding *Drosophila* makes it more likely that differences in substrate utilization have contributed to *C. amoena*'s success.

Drosophilids above the Valley floor

Drosophilids netted over bait at different elevations between Cevio and Cerentino verify that *C. amoena* is now above the Valley floor, as demonstrated by its emergence from wild cherries gathered at the Valle di Bosco. Above the Valley floor

Tab. 4. Drosophilids collected over apples at Lodano, July 14–16, and over bait at various altitudes above Cevio-Cerentino, July 15–16, 1997.

Species	Lodano	Cevio-Cerentino						
	340 m	1080 m	1020 m	820 m	680 m	540 m	420 m	Total
D. bifasciata	3	1				1		5
D. deflexa	1							1
D. fenestrarum		1						1
D. funebris			2			1		3
D. helvetica	29	2	14	1	233	226	22	527
D. histrio		3		3	15	2	1	24
D. hydei	6							6
D. immigrans	6		3	7		2	14	32
D. kuntzei		21	11	58	399	931	65	1485
D. obscura	4	94	59	33	149	46	28	413
D. phalerata		15	23	27	73	98	24	260
D. simulans	1							1
D. subobscura	21	100	371	63	535	413	443	1946
D. testacea	8	31	25	30	152	282	29	557
D. tristis	3	1	3		2	9	8	26
C. amoena	3					3		6
S. graminum		2						2
S. pallida	3	10		9			1	23
Totals	88	281	511	231	1558	2014	635	5318

only two cosmopolitan *Drosophila* species, 3 *D. funebris* and 32 *D. immigrans*, were among the 5230 mostly non-domestic drosophilids netted over bait. Again, *obscura* group (*D. helvetica*, *D. obscura*, *D. subobscura*) and mycophagous Drosophila (*D. kuntzei*, *D. testaca*) dominate the collection (Tab. 4).

At 1060 m where *C. amoena* was found in wild cherries, the climate at the Valle di Bosco may be less moderate that in the Valley floor. Elsewhere, in Switzerland genotypic changes have been found to occur in *D. subobscura* with altitude (BURLA *et al.*, 1986). *Drosophila kuntzei* and *D. subobscura*, which emerged from an August 1990 chestnut collection in the Maggia Valley (BURLA & BÄCHLI, 1991, 1992) are the two most frequent species above Cevio.

As native European *Drosophila*, overwintering at some stage can be expected. *Drosophila* typically overwinter as adults, *Chymomyza* as coldhardy larvae. *Chymomyza amoena* emerging from nuts collected in the Maggia Valley in March 1991 (BURLA & BÄCHLI, 1992) experienced the coldest winter [average temperature of 2,8 °C] of the period from 1981 to 1997, according to weather data from Locarno-Monti. Any *Drosophila* larvae present would not have been expected to survive subzero temperatures occurring during this cold winter. However, *D. kuntzei* is among the mycophagous *Drosophila*; *D. subobscura* seems to prefer berries or other fruits in Switzerland (SCHATZMANN, 1977; SHORROCKS, 1982; BURLA & BÄCHLI, 1991, 1993) and to overwinter in compost piles, where internal temperatures may remain above freezing, or as adults (WALTER, 1990).

A composite picture of C. amoena fruit-and-nut breeding in the Maggia Valley

Whereas 13 *C. amoena* among 305 other *Drosophila* emerged from domestic apples collected in the Maggia Valley in September 1990 (BURLA & BÄCHLI, 1991), it did not emerge from ripe and rotting fruits (apples, pears) collected at Lodano in October 1997; these yielded 275 *Drosophila*. In general, in Michigan and Virginia when fruits become attractive to *Drosophila*, *C. amoena* has been observed to move to less ripe fruits. Given *C. amoena*'s longer developmental time, and the low fertility of the average female (<50 progeny: BAND, 1988a–c) more rapidly developing *Drosophila* which also have a greater reproductive capacity also have greater success breeding in fermented fruit substrates than *C. amoena*.

Since the new season's nut crop becomes available in autumn, parasitized or damaged nuts in general may provide more consistently available breeding sites for *C. amoena* over a longer duration in the Maggia Valley and possibly elsewhere. The fact that hazelnuts, chestnuts and acorns are available in the woods near Lodano in addition to apples in summer may also account for the fact that *C. amoena* continues to be present in greater numbers in this region of the Maggia Valley as observed previously by BURLA & BÄCHLI (1992).

Chymomyza amoena and forest habitats

The finding of BURLA & BÄCHLI (1992) that *C. amoena* has entered the forest habitat in the Maggia Valley and is collected among non-domestic drosophilids there and in Canton Zürich is not surprising. In the Maggia Valley, the valley floor is partly wooded and forests cover the lower slopes of the mountains. Chestnut, oak, hazel are common; wild cherry and wild apple also occur. Forests in the Höngger-berg and Dietikon areas do not contain as many types of fruit and nut-bearing trees but oaks are present as are hazelnuts. Consequently, although European forest ecosystems now seem resistant to invasion by plants (DI CASTRI, 1989, 1990) and

insects (NIEMALÄ & MATTSON, 1996), the ability of *Chymomza amoena* to exploit parasitized/damaged nuts and wild fruits as breeding resources enabled it to join the woodland drosophilid array in Switzerland which consists of numerous individuals in the mycophagous and *obscura* group of *Drosophila*. Parasitized or damaged nuts provide the open ecological niche for *C. amoena* (MÁCA & BÄCHLI, 1994) since no European drosophilid has been characterized as a nut breeder.

Perhaps the most striking difference between *C. amoena* as a forest species in North America and in Switzerland is the readiness with which it comes to bait in Canton Ticino. Considering only the Valley floor and collections in Biasca and the Bolle di Magadino in June 1995, to date 721 *C. amoena* have been captured among 14128 drosophilids. *Chymomyza amoena* accounts for 5.1 % of the total number captured. LEVITAN (1954) commented that it was more common in spring (March–May) in New York and New Jersey; none at all came to bait after late August. SPIETH (1957) captured 8 by baiting over 3 summers at Itasca Park in Minnesota, and DORSEY & CARSON (1956) captured 77 by baiting over three summers and two winters in a densely forested area in West Virginia. BURLA & BÄCHLI (1992) captured 117 by baiting in September 1991 in the Maggia Valley. Thus, we may ask, are genetic changes in progress in *C. amoena* in the Maggia Valley, or does the increase in numbers reflect an increase in breeding sites available to this species, as evident from its emergence from domestic and wild apples, wild cherries, hazelnuts, chestnuts and acorns?

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