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*Chymomyza amoena* (Diptera: Drosophilidae) reared from chestnuts, acorns and fruits collected in the Canton Ticino, Switzerland.

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A total of 54 *C. amoena* were reared from chestnuts and acorns, of which 52 were collected in forests and their edges, in the Maggia Valley of the Canton Ticino. Another 127 specimens were reared from apples and 6 from wild cherries, gathered from the floor at domestic places and in forests, respectively. A total of 117 *C. amoena* were netted over banana bait in the same forests. Rearing data suggest aggregated oviposition. In Europe the species was first recorded in 1975. It seems to be a fairly recent import from North America, reaching Europe on a domestic route.

Keywords: breeding substrates, aggregated reproduction, immigration, Drosophilidae, *Chymomyza amoena*.

INTRODUCTION

In Europe the drosophilid species *Chymomyza amoena* LOEW, 1862 was first recorded in 1975 from Czechoslovakia (MÁČA & LAŠTOVKA, 1985), later Hungary (PAPP & PECSENYE, 1987), Yugoslavia (KEKIĆ & BÄCHLI, 1983), Romania (CEIANU, 1989), Germany (in Berlin, SCHUMANN, 1987; in Tübingen and Schöngesing, unpublished) and Austria (in Wien, unpublished). In Switzerland, the species was recorded from three places in the Ticino (unpublished), from the alpine place Savognin, the prealpine Klöntal and from places in and near Zurich (BURLA & BÄCHLI, 1991). Since its description in 1862 it was reported in North America from Minnesota to Ontario, south to Nebraska, Texas and Florida, also Arizona, Utah, Mexico (WHEELER, 1965). More recently, a wealth of information about its American natural history was provided (BAND, 1988a; 1988b; 1988c; 1988d; 1989; 1991). What concerns us most at the moment is the following: In the U.S.A., *C. amoena* is originally a forest dweller breeding in native fruits and nuts. In connection with the spread of colonists and their agriculture, *C. amoena* invaded domestic habitats by breeding in apples, pears and plums. Hence, in domestic environments it is considered a domestic species (BAND, 1988c). It is able to survive winter in preadult stages, involving coldhardiness (BAND, 1988d).

Since most records from Europe are from domestic habitats as well, the immediate opinion was that this species is a fairly recent immigrant from North America, probably brought to Europe in connection with agricultural plants (SCHUMANN, 1987). It was a surprise when it emerged from chestnuts that had been collected in a forest of the Maggia Valley, south of the Alps (BURLA & BÄCHLI, 1991). Later we netted it over bait in the same habitat. This made us reconsider its classification as an immigrant.

The present report will be mainly on breeding and netting *C. amoena* in the Maggia Valley of the Canton Ticino of Switzerland. The emphasis will be on breed-

ing from chestnut. Later we included acorn and, occasionally, wild cherry, crab-apple, domestic apple and plum. Finally, the immigration hypothesis will be discussed. When BAND (1991) briefly announced our first rearing yields from chestnuts, she confronted the immigration hypothesis with the possibility of an originally Holarctic range of the species.

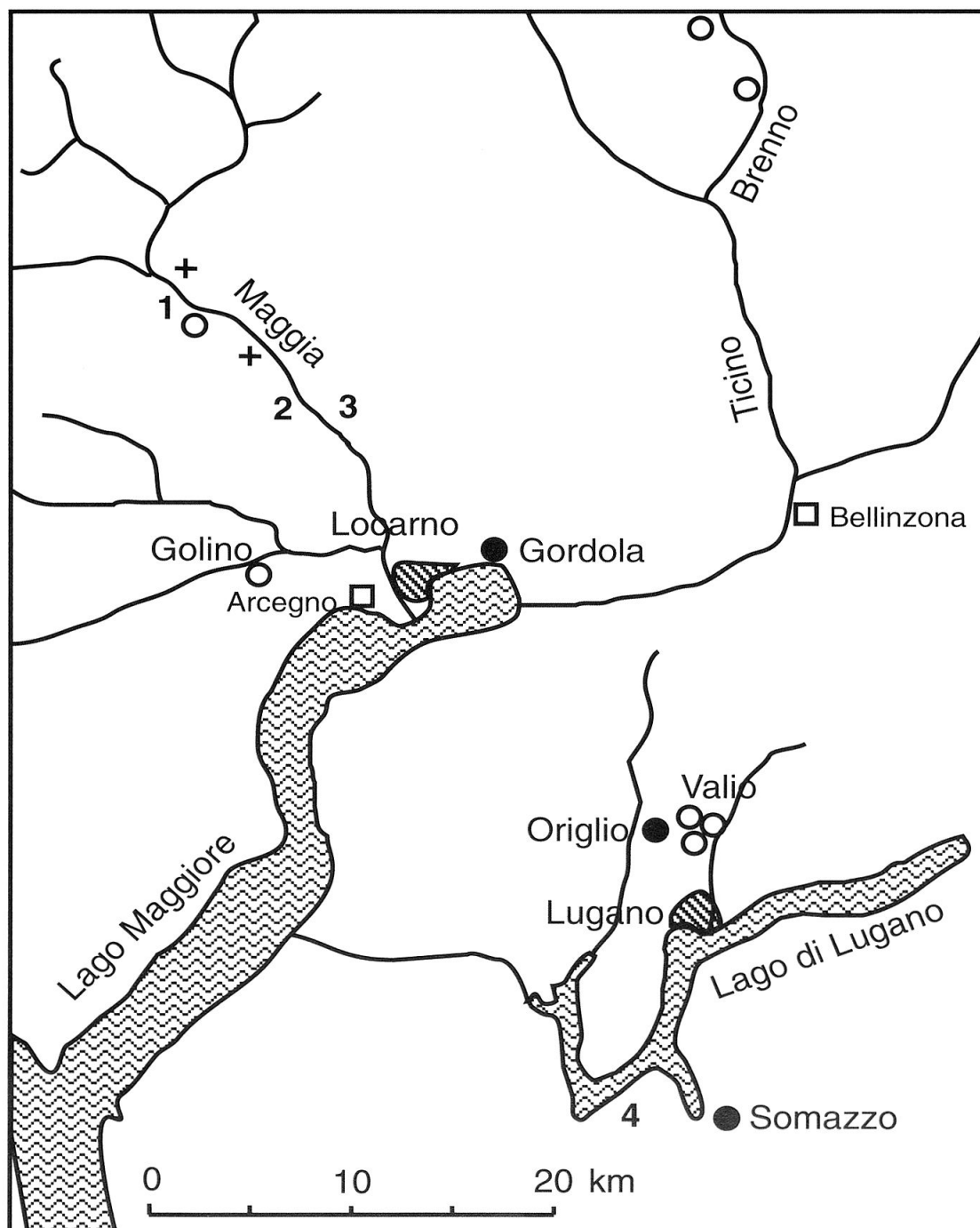


Fig. 1. Map of the southern part of the Canton Ticino. The cities Bellinzona, Locarno and Lugano are mentioned for easy orientation. Lines stand for rivers, Ticino, Maggia, Brenno. Numbers 1 to 4, towns mentioned in Tab. 1; solid circles, places where *C. amoena* was recorded before this study; open circles, places where nut samples failed to yield *C. amoena*; crosses, 2 places from where apples collected in August 1990 yielded 13 *C. amoena* (BURLA & BÄCHLI, 1991). Squares, places where previous large collections of drosophilids failed to include *C. amoena*.

## MATERIAL AND METHODS

With the exception of one chestnut from south of the Lago di Lugano, all items from which we reared *C. amoena* were collected in the Maggia Valley of the Canton Ticino (Fig 1). Places from which *C. amoena* was obtained (Tabs 1 and 2) were the following:

Tab. 1. Yield of rearing drosophilid flies. Column headings: ref, reference number used in Fig. 1; town, the closest one to the collecting place; N\_c, number of nuts or fruits collected; N\_y, number of nuts and fruits which yielded drosophilid flies; C.am, *C. amoena*; D.mel, *D. melanogaster*.

ref.	town	date	habitat	fruit	N_c	N_y	C. am	D. mel
1	Biètt	Nov. 90	forest edge	chestnut	144	1	3	
1	Biètt	Sep. 91	yard	apple	13	8	120	
2	Lodano	Mar. 91	oak forest	acorn	120	12	21	
2	Lodano	Sep. 91	oak forest	acorn	21	2	10	
2	Lodano	Sep. 91	meadow	apple	26	2	7	
2	Lodano	June 91	forest	wild cherry	≈100		6	
3	Maggia	Mar. 91	forest	chestnut	102	2	15	
3	Maggia	Jul. 91	forest edge	chestnut	128	1	3	
3	Maggia	Jul. 91	forest edge	wild cherry	≈100			58
4	Serpiano	Nov. 90	forest edge	chestnut	19	1	2	
<b>Total</b>					≈770	29	187	58

Biètt - A group of about 12 small rural stone houses, a little more than 1 km north of Cevio. The first place is at the lower periphery of the settlement, close to the traffic road. The second place is within the adjoining forest, 50 m from its edge, at an elevation 40 m higher than the road. It is the same place which yielded 24 *C. amoena* in August 1990. Apples mentioned in Tab. 1 are from a yard in the uppermost part of Biètt.

Cevio - A forest edge 1 km north of Cevio, shortly before a hospital.

Lodano - About 400 m north of Lodano a strip of oak wood runs perpendicular to the Valley axis, bordering a country road. The wood measures about 300 m in length and 40 in width, and is cut by 2 roads into 3 sections. It contains more oaks than chestnut trees. Acorns were collected in the 2 uppermost sections where also wild cherries were picked from the floor.

Maggia - A trail leads uphill through the forest from its edge east of the town of Maggia to the Capella della Pioda at an elevation 60 m higher than the forest edge. Chestnuts were collected over the whole distance.

Serpiano - At the edge of a chestnut wood, on the road from Meride to Serpiano in the Mendrisiotto.

In all, we collected in this study 1974 chestnuts in 29 samples and 411 acorns in 5 samples. We also gathered 39 apples, 118 crabapples, about 200 wild cherries, 31 plums and 15 figs. With the exception of 6 chestnut samples, all nuts and fruits were gathered in the Maggia Valley. In Tab. 1 only those samples are mentioned which yielded *C. amoena*.

Chestnuts and acorns were gathered from the forest floor and at its edge. Only those nuts were kept which had at least one hole from a burrowing weevil larva. Upon returning to Zurich, each nut was placed singly in a numbered glass vial on

Tab. 2. Faunistical record from netting drosophilid flies over banana bait, September 1991. At the same places and at the same time, chestnuts or acorns were collected for rearing *C. amoena*. Species of *Drosophila* grouped by ecological characteristics. Numbers are column percentages. Bottom line, total frequency per sample; rightmost column, total frequency per species.

	<b>Biètt</b>	<b>Cevio</b>	<b>Lodano</b>	<b>Maggia</b>	<b>Total</b>
<b>Chymomyza</b>					
amoena	0.51	0.17	5.94	0.87	117
<b>Drosophila</b>					
melanogaster	0.34	0.34	2.97	3.05	154
simulans	0.08	0.11	1.14	0.58	38
funebis		0.11	0.08	0.17	9
immigrans	0.85	1.72	0.46	0.20	53
repleta			0.08		1
subobscura	4.16	6.26	22.22	18.29	1080
obscura	3.31	3.10	3.27	4.18	280
tristis	0.59	0.52	0.30	0.61	41
ambigua		0.06		0.09	4
helvetica	45.55	43.85	37.67	62.28	3940
phalerata	18.66	24.71	13.70	4.94	1000
kuntzei	21.03	12.64	8.98	3.83	718
transversa	0.17	0.34	0.30	0.09	15
testacea	4.58	5.92	2.82	0.55	213
histrio	0.08	0.11		0.06	5
deflexa				0.15	5
rufifrons				0.03	1
<b>Leucophenga</b>					
maculata			0.08		1
<b>Scaptomyza</b>					
pallida	0.08			0.03	2
<b>Total</b>	<b>1179</b>	<b>1740</b>	<b>1314</b>	<b>3444</b>	<b>7677</b>

a piece of wetted blotting paper. Most of the vials were then kept in a culture room, the others in a garage.

In March 1991, 4 samples of wild cherries were gathered from the forest floor at 3 places. The cherries were ripe and soft and some were damaged. The 4 samples were of about equal size. Each sample was kept in the culture room in a plastic box (BURLA & BÄCHLI, 1991). All other fruits were collected in September 1990. A

sample of ripe domestic apples, some with spots of rot, was gathered from a yard in Biètt. Another sample of apples were from underneath a solitary apple tree in a meadow behind the wooded river bank of the Maggia, 300 m from Lodano; these apples were ripe, partly eaten and dry from a long drought. A sample of crabapples (*Malus sylvestris*) was picked from the twigs or gathered from the floor along the trail to the Capella della Pioda above Maggia, another one in an abandoned agricultural farm near the town of Someo, on the other side of the Maggia river (place mentioned by BURLA & BÄCHLI, 1991). Each fruit was kept separately in a vial or box of adequate size in the garage.

While collecting nuts and fruits in September 1991, flies were netted on 2 days, after exposing banana bait in the early afternoon of the first day.

Large sections of the narrow Maggia Valley bottom are wooded. The core of the cities, which are small, is surrounded by residential areas. There, yards contain fruit trees, mostly apple, cherry, plum and pear. At the periphery are vineyards of various sizes, some reaching the forest. The slopes of the Valley are steep and carry dense forests over an altitudinal range which at some places measures 1400 meters. Open pastures including a few human settlements extend above the forest up to the rocks of the mountains. On the slopes, lower parts of the forest are secondary. Native trees are common beech (*Fagus sylvatica*), common hazel (*Corylus avellana*), English oak (*Quercus robur*), European larch (*Larix europea*), holly (*Ilex aquifolium*), hornbeam (*Carpinus betulus*), lime (*Tilia*), locust tree (*Robinia pseudacacia*), maple (*Acer* sp.), rowan ash (*Sorbus aucuparia*), Scotch pine (*Pinus sylvestris*), silver birch (*Betula pendula*), whitebeam (*Sorbus aria*) and wild cherry (*Prunus avium*). Where the forest meets the Valley bottom, barberry (*Berberis vulgaris*) is often frequent, less so cornel (*Cornus mas*) and crabapple (*Malus sylvestris*).

In the woods, chestnut trees (*Castanea sativa*) are present in various proportions, often dominating along the forest edge. They were introduced into the Ticino some 2000 years ago under the cultural influence of the Romans. Today, these trees grow up to an altitude of 1000 m. While chestnuts formerly were basic food for men and cattle, their use was largely abandoned during the last century, and the trees were less cared for. It is likely that crabapple and wild cherry were originally cultivated as well. In the Maggia Valley, remains of terraces separated by stone walls are signs of previous agriculture. These remains are common from the lower edge of the slope deep into the forest, as well as in the neighborhood of settlements on the slopes.

## RESULTS AND DISCUSSION

### *Rearing Chymomyza amoena*

A first breeding record of 24 *C. amoena* was from 100 chestnuts, collected on 31. August 1990 in the forest site above Biètt (BURLA & BÄCHLI, 1991). The chestnuts were kept together in a plastic box. Hence we were unable to assay from how many of the nuts the flies had emerged.

Tab. 1 contains a list of those 6 out of 28 nut samples which yielded drosophilid flies (the first record of August 1990, mentioned above, is omitted). Comparing the data given in Tab. 1, it is not obvious under which conditions of place, habitat and season the species thrives. At least a few comments can be made. *C. amoena* can be bred from substrates collected in the breeding and in the overwintering season, as known before from the U.S.A. (BAND, 1988d). There is a higher rate of inva-



sion for acorns than for chestnuts. Yet, the local environment may have a stronger effect than the species of the nut. Whereas in August 1990 the first sample of 100 chestnuts from the forest above Biètt yielded 24 *C. amoena* (BURLA & BÄCHLI, 1991), 380 chestnuts collected at the same spot during 3 subsequent trips yielded none. Thus, the dispersion of *C. amoena* seems to be patchy, and the patches seem to change place and density in time. Whereas the yield from domestic apples was larger than from nuts, crabapples seemed not to be very attractive. Crabapples which are a breeding resource of *C. amoena* in the U.S.A. (BAND, 1988d) probably are a different species. Although agriculture is not stressed in the Maggia Valley, there are enough fallen domestic fruits to nourish a large population of flies. Chestnuts and acorns seem to account for only a small section of the local fly population. These nuts represent a huge breeding resource which apparently is little exploited by *C. amoena*. Hence, *C. amoena* is partly, or predominantly, domestic as in the USA. That it is present in the forest at all may be because it also retains an arboreal mating habit (BAND, submitted).

While some 50 wild cherries from the oak wood near Lodano yielded 6 *C. amoena*, from another cherry sample of equal size, collected during the same days along the forest trail to the Capella della Pioda, 58 *Drosophila melanogaster* emerged. The two yields demonstrate spatial separation between the two species, while both habitats were forests and the breeding resource was the same.

#### *Aggregated reproduction*

Only few of the nuts yielded *C. amoena*, but the few that did demonstrate aggregated reproduction: 12 nuts yielded 1 fly, 2 nuts 2 flies, other 2 nuts 3 flies, 2 nuts yielded 9 flies and 1 nut 14 flies. Aggregated oviposition was reported by (BAND, 1989) and traced to three causes including laying eggs in clusters. Repeated egg laying in one and the same nut may involve staying nearby for hours, and possibly defending the item against other females. Defending of breeding items containing a freshly laid egg was observed to occur in *D. subobscura* (BURLA *et al.*, 1987).

#### *Netting C. amoena*

The flies netted over bait are listed in Tab. 2. The result shows that *C. amoena* resides in the forests. A difference in proportions between places may be caused either by the notorious patchyness of the species, or by a dissimilarity between forests. The four places differ by composition, exposition, and inclination of the floor. The respective netted samples also differ somewhat by the assemblage of drosophilid species. In the places Biètt and Cevio, the fungus breeders *D. phalerata*, *D. kuntzei* and *D. testacea* have higher proportions than in Maggia, whereas in Maggia and Lodano, the domestic species *D. melanogaster* and the semi-domestic *D. subobscura* have higher proportions than in Biètt and Cevio. The proportion of *C. amoena* was highest in the oak wood near Lodano.

When in 1970, drosophilids were netted in forests near Arcegno, about 10 km south of Maggia, *C. amoena* was not seen among 32,812 flies (BÄCHLI, 1972). Also, in another netting record from 1981 at 10 places of the Leventina, between Bellinzona and All'Acqua, *C. amoena* was not found among 22,385 flies. It must be fairly recently that the species either reached the Ticino, or increased its population to a density that allowed detection.

*Is C. amoena an immigrant?*

Had *C. amoena* been native in Europe, it is unlikely that it could have kept unnoticed. This is the main argument against the hypothesis of a Holarctic distribution of the species. As we furthermore observe ecological habits of the species in our study area, they appear to be identical to characteristics mentioned by BAND (1988d) for American representatives. In both continents, *C. amoena* breeds in roughly the same fruits and nuts. Other similarities are aggregated reproduction, larvae present in overwintered substrates, and a patchy as well as unstable dispersion. There is but a historical difference: while in North America the species was originally dwelling in woods from which it invaded domestic habitats, with us it was originally an imported pest of domestic fruits, whereupon it invaded surrounding forests. The invasion of forests is probably due to the retention of an arboreal mating behavior, which is common to several *Chymomyza* species. Hence, the presence of *C. amoena* in forests of the Maggia Valley is not a proof of Holarctic origin.

Nevertheless, our observations are too scanty to refute this hypothesis convincingly. As we failed to net flies in domestic habitats, we ignore whether *C. amoena* flies are there equally, or more, frequent. Another point to mention is that the sampled forest places were at most 100 meters away from the forest edge. Should the study be continued, one ought to penetrate much deeper into the forest.

*The community of nut-dwellers*

From many acorns and chestnuts, animals other than *C. amoena* emerged. In decreasing order of frequency these were beetles, ants, various dipterans (mostly Sciaridae, rarely Cecidomyiidae, Lauxaniidae, Chloropidae, Heleomyzidae), parasitic Hymenoptera, caterpillars, Forficulidae and spiders. Several chestnuts which were opened after *C. amoena* emerged from them, contained mites.

Among beetles, weevil larvae were numerous in November 1990, when 13 larvae emerged from 640 nuts and others kept feeding, recognizable by the large amount of feces they expelled from the nut. In the other 3 samples, larvae were present but rare. In September 1991, 148 adult Ptinidae beetles emerged from 340 nuts, in numbers varying from 1 to 8 per nut.

Colonies of the ant *Leptothorax nylanderii* were found in all 4 seasons from November 1990 to September 1991. The number of colonies was 8 (in parenthesis the number of nuts collected in the respective season, here 640), 26 (845), 42 (604) and 5 (323). Beside of the colonies, many singly foraging ants were noticed. With only a few exceptions, all belonged to *L. nylanderii*.

Thus, if larvae of *C. amoena* develop in the confinement of a nut shell, they are dangerously exposed to competitors and predators. Several observations suggest seasonal changes in the composition of the community, which may help to explain our unsteady yields of *C. amoena*. This also applies to other drosophilid species. Whereas in August 1990, 1 *Drosophila subobscura* and 4 *D. kuntzei* hatched from a batch of chestnuts (BURLA & BÄCHLI, 1991), no drosophilid fly other than *C. amoena* emerged later from many more nuts.

## ZUSAMMENFASSUNG

*Chymomyza amoena* entwickelte sich aus Edelkastanien, Eicheln, Wildkirschen, Äpfeln und Zwetschgen, die (mit Ausnahme einer Kastanie) im Maggital gesammelt wurden. Die Häufigkeitsverteilung der Anzahl gezüchteter Fliegen pro Kastanie oder Eichel deutet auf eine aggregierte Eiablage. Da in den Nüssen präimaginale Stadien enthalten sein mussten, ist erwiesen, dass diese den Winter



bei gehemmtem Wachstum zu überdauern vermögen. An den gleichen Orten konnten mit Netz über Köder Imagines gefangen werden. In den U.S.A. gilt *C. amoena* als ursprüngliches Faunenelement des Waldes. Die Art wurde erst zum Kulturgänger, als sie das von Kolonisatoren angepflanzte Obst als Entwicklungssubstrat annahm. Da *C. amoena* erstmals im Jahr 1975 in Europa nachgewiesen wurde, in der Schweiz erst in den Achtzigerjahren, dürfte dieses Vorkommen auf eine aus den USA erfolgte Einschleppung mittels angestecktem Obst handeln. Alle von uns beobachteten ökologischen Eigenschaften bestätigen diese Vermutung, da sie mit den in den USA erforschten Eigenschaften übereinstimmen. Die Alternative, dass *C. amoena* ursprünglich holarktisch verbreitet war und damit auch in Europa vorkam, kann nicht gestützt werden.

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Thomas BURLA collected in the Maggia Valley the batch of 100 chestnuts from which *C. amoena* emerged for the first time. Mrs. Anita BURLA was most efficient at collecting many subsequent nut samples. Dr. D. AGOSTI determined the ant species *Leptothorax nylanderi*. Dr. H.T. BAND made helpful suggestions and helped with the English.

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