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Occurrence on elm and phenology of Auchenorrhyncha potential vectors of the phytoplasma associated with elm yellows disease

Abstract - The phenology of Auchenorrhyncha of elm was studied in northeastern Italy; in particular potential vectors of the phytoplasma associated with elm yellows disease (EY) were considered. The adults of Auchenorrhyncha were monitored on elm (*Ulmus minor* Miller) using yellow sticky traps. Out of 38 species identified, seven are known to be vectors of phytoplasmas and three others belong to genera including vectors. Two species, *Philaenus spumarius* (Linnaeus) and *Allygidius atomarius* (Fabricius), are known vectors of the phytoplasma associated with EY. On the basis of adult phenology some suggestions on biological cycle of some leafhoppers are given.

Riassunto - *Presenza su olmo e fenologia di Auchenorrinchi potenziali vettori di fitoplasmi associati al giallume dell'olmo.*

Nell'Italia nord-orientale è stata studiata la fenologia di auchenorrinchi dell'olmo (*Ulmus minor* Miller); in particolare sono stati considerati i potenziali vettori di fitoplasmi associati al giallume dell'olmo (elm yellows, EY). Gli adulti degli auchenorrinchi sono stati campionati su olmo con trappole cromotropiche gialle invischiate. Sono state identificate 38 specie, sette delle quali sono vettori di fitoplasmi e tre appartengono a generi con vettori noti. *Philaenus spumarius* (Linnaeus) e *Allygidius atomarius* (Fabricius), sono note quali vettori dell'agente causale di EY. Sulla base della fenologia degli adulti sono state formulate nuove ipotesi sul ciclo biologico di alcune cicaline.

Key words: elm, Auchenorrhyncha, adult phenology, vector, phytoplasma.

INTRODUCTION

The European field elm *Ulmus minor* Miller is one of the most frequent and widespread tree species in Europe. In Italy the survival of this plant has been threatened by Dutch elm disease (caused by the fungus *Ophiostoma novo-ulmi* Brasier) and elm yellows disease (EY), a phytoplasmosis introduced from North America (Pisi *et al.*, 1981; Conti *et al.*, 1987; Mittempergher, 1997). The latter disease was observed on *U. minor* and other species of genus *Ulmus* and is widespread in Italy (Mittempergher

et al., 1999). The whitebanded elm leafhopper *Scaphoideus luteolus* Van Duzee, the main vector of the phytoplasma associated with EY (Baker, 1948), is not present in Europe (Nast, 1972; della Giustina, 1989; D'Urso, 1995). The leafhopper *Allygidius atomarius* (Fabricius) and the spittlebug *Philaenus spumarius* (Linnaeus), that are minor vectors of the EY agent (Matteoni & Sinclair, 1988), are both widespread in Europe.

Recently stolbur type phytoplasmas have been detected in France in elms on which a general decline and yellowing of leaves were noticed (Sforza *et al.*, 1998).

The aim of this research was to study the phenology of Auchenorrhyncha fauna of elm with respect to the potential vectors of the phytoplasma associated with EY in Italy.

MATERIALS AND METHODS

The Auchenorrhyncha fauna of *U. minor* was monitored during 1994, 1996 and 1997 in a locality of northeastern Italy (locality Pasiano di Pordenone, 12° 39' longitude E, 45° 50' latitude N, 12 m altitude). In the investigated area a few elms were present along a hedgerow surrounding one hectare vineyard where no insecticides were used. During 1997 one elm died and during 1999 a general decline (yellowing foliage and precocious exfoliation) in a second plant was observed. The symptoms were not characteristic of Dutch elm disease.

The adults of Auchenorrhyncha were monitored using yellow sticky traps. The sampling periods were April 24 - December 11 in 1994, May 15 - November 5 in 1996 and March 12 - November 2 in 1997. Two traps were hung on a branch (about 2 m from the ground and 1 m from the trunk) of two different elms. The traps (21x11 cm) were smeared with glue (TEMOOCID, Kollant, Padova, Italy) and replaced every week.

In the laboratory adults were identified under a dissecting microscope using different dicotomic keys (mostly those of Ribaut, 1936, 1952). The nomenclature used is as reviewed by della Giustina (1989). All the specimens were counted and their sex noted. To establish if the sex ratio was significantly different from 1:1 the binomial probability distribution was used.

RESULTS

AUCHENORRHYNCHA SPECIES

In table I the Auchenorrhyncha captured on *U. minor* during the three years are reported. Mesophyll feeders Typhlocybinae belonging to the same genus were aggregated since they are not important as phytoplasma vectors. Literature data on biology (excluding Typhlocybinae) and ability to transmit phytoplasmas of each species are also reported. Central-northern European literature was considered only when information from northern Italy or surrounding areas was not available.

Table 1 - Number of adults of Auchenorrhyncha species captured on Ulmus minor *using yellow sticky traps in a locality of northeastern Italy during three years. Data on biology and ability to transmit phytoplasmas associated with plant diseases are also reported.*

families, subfamilies and species	1994 tot	1996 ♀	1996 ♂	1996 tot	1997 ♀	1997 ♂	1997 tot	phyto-plasmosis (*)	biological data (°)	biological data (#)
CIXIIDAE										
Hyalesthes obsoletus Sign.	106	4	27	31	12	56	68	STOL, BN, VK	herb, e, 1	1,2
others	14	0	0	0	–	–	4			
DICTYOPHARIDAE										
Dictyophara europaea (L.)	1	0	2	2	0	1	1		herb, (e, 1)	3
FLATIDAE										
Metcalfa pruinosa (Say)	2	0	2	2	1	0	1		herb, arb (elm), e, 1	4
CERCOPIDAE										
Cercopis vulnerata Rossi	2	0	0	0	0	1	1		herb, n, 1	5
Philaenus spumarius (L.)	10	0	3	3	1	16	17	EY, STOL	herb, e, 1	6
CICADELLIDAE										
Megophthalminae										
Megophthalmus scanicus (Fall.)	9	0	0	0	0	1	1		herb, (e-a), 1	7,8,9
Macropsinae										
Macropsis fuscula (Zett.)	0	0	0	0	0	3	3	RuS	*Rubus* spp., e, 1	10
M. mendax (Fieber)	72	16	36	52	18	46	64		*Ulmus* spp., e, 1	11
Idiocerinae										
Idiocerus herrichii Kirschb.	1	2	10	12	3	17	20		*Salix* spp., a	11
Iassinae										
Iassus scutellaris (Fieb.)	17	3	10	13	0	11	11		*Ulmus* spp., e, 1	11
Aphrodinae										
Aphrodes makarovi Zachv.	2	2	1	3	0	1	1	AY, CPh, EAY	herb, e, 1	10
Cicadellinae										
Cicadella viridis (L.)	0	1	0	1	0	0	0		herb, e, 2-3	12,13
Deltocephalinae										
Allygidius sp.	110									
A. atomarius (F.)	–	10	91	111	45	114	159	EY	herb, arb, (n), 1	11,14
A. furcatus (Ferr.)	–	8	3	11	5	1	6		e or n, 1	
Fieberiella florii (Stål)	6	2	0	2	12	0	12	AP	arb, e-n-a, 1	15
Japananus hyalinus (Osborn)	0	0	2	2	2	3	5		*Acer* spp., e, 1-2	16
Platymetopius major (Kirschb.)	17	0	4	4	3	8	11		arb, e, 1	3
Scaphoideus titanus Ball	5	1	15	16	3	9	12	FD	*Vitis* spp., e, 1	17
Selenocephalus obsoletus (Germ.)	0	0	0	0	0	1	1		herb, arb	11

(continuation of table 1)

families, subfamilies and species	1994	1996			1997			phyto-plasmosis (*)	biological data (°) (#)
	tot	♀	♂	tot	♀	♂	tot		
Typhlocybinae									
Alebra wahlbergi (Boh.)	1234	156	598	854	273	1222	1495		
Arboridia parvula (Boh.)	0	0	0	0	0	1	1		
Edwardsiana spp.	–	–	–	510	94	374	468		
Empoasca vitis (Göthe)	–	472	1400	1872	–	–	–		
Eurhadina concinna (Germ.)	1	0	0	0	13	10	23		
Fagocyba douglasi (Edw.)	–	48	96	144	282	287	569		
Frutioidia bisignata (M. & R.)	9	1	5	6	41	190	231		
Kybos smaragdulus (Fall.)	0	0	0	0	0	2	2		
Ribautiana spp.	650	48	198	246	89	436	525		
Zygina spp.	–	–	–	–	33	139	172		
Zyginella pulchra Löw	0	0	0	0	1	1	2		

–: specimens not counted.
(*): AP (apple proliferation); AY (ash yellows); BN (bois noir); CPh (clover phyllody); EAY (European aster yellows); EY (elm yellows); FD (flavescence dorée); RuS (rubus stunt); STOL (stolbur), VK (Vergilbungskrankheit); data from Brcak (1979), Arzone & Alma (1999) and other papers cited in the text.
(°): reported in the order: host plant (herb = herbaceous, arb = arboreous), overwintering stage (e = egg, n = nymph, a = adult) and number of generations a year; data on biological cycle referred to central-northern Europe are between brakets; data on biological cycle suggested by this research are underlined.
(#): Alma et al., 1988[1]; Sforza & Boudon-Padieu, 1998[2]; Schiemenz, 1969[3]; Duso, 1984[4]; Mauri, 1982[5]; Vidano et al., 1989[6]; Remane, 1958[7]; Günthart & Thaler, 1981[8]; Villiers, 1977[9]; Vidano, 1988[10]; Ribaut, 1952[11]; Frediani, 1955[12]; Arzone, 1972[13]; Müller, 1957[14]; Arzone & Alma, 1999[15]; Arnò et al., 1988[16]; Vidano, 1964[17]

38 species belonging to five families were identified. Seven species (*Hyalesthes obsoletus* Signoret, *Philaenus spumarius* (Linnaeus), *Macropsis fuscula* (Zetterstedt), *Aphrodes makarovi* Zachvatkin, *Allygidius atomarius* (Fabricius), *Fieberiella florii* (Stål), *Scaphoideus titanus* Ball) are reported in literature as vectors of phytoplasmas, but none of them has a complete life cycle on *Ulmus* spp.

Metcalfa pruinosa (Say), *Macropsis mendax* (Fieber) and *Iassus scutellaris* (Fieber) are the only species (excluding Typhlocybinae) that can have a complete life cycle on *Ulmus* spp.; therefore elm is an occasional host for most of the captured species.

Four species belonging to the genus *Edwardsiana* (*E. frustrator* (Edwards), *E. hippocastani* (Edwards), *E. plebeja* (Edwards), *E. rosae* (Linnaeus)), three species belonging to the genus *Ribautiana* (*R. cruciata* (Ribaut), *R. tenerrima* (Herrich-Schäffer), *R. ulmi* (Linnaeus)) and four species belonging to the genus *Zygina* (*Z. flammigera* (Fourcroy), *Z. nivea* (Mulsant & Rey), *Z. rhamni* (Ferrari), *Z. thitide* Ferrari) were identified.

Only a few specimens of *M. fuscula*, *Cicadella viridis* (Linnaeus) and *Arboridia parvula* (Boheman) were captured in one year only.

The sex ratio was almost always significantly biased to males. In two cases,

Eurhadina concinna (Germar) and *Fagocyba douglasi* (Edwards) (only 1997), it was not significantly different from 1:1 and in two other cases, *Allygidius furcatus* (Ferrari) and *Fieberiella florii* (Stål), it was significantly biased to females.

POPULATION DYNAMICS AND PHENOLOGY OF SOME SPECIES

Figures 1 and 2 show the dynamics of adult captures of nine species, including four vectors of phytoplasmas and three species belonging to subfamilies of Cicadellidae which include vectors (see table 1).

In figure 1 the three species, which were more abundant, are considered. *H. obsoletus* was captured from late June to early September and showed a peak of presence in late July. *M. mendax*, that completes its biological cycle only on *Ulmus* spp., was observed from June to August with a peak in late June. *A. atomarius* adults were detected from mid May to early September with a peak in early June.

In figure 2 the dynamics of the other six species are reported. *Ph. spumarius* was captured during June and July without any evident peak. The adults of *Megophthalmus scanicus* (Fallén), the only year when the captures were abundant, were observed during June with a peak at the beginning of the month. *I. scutellaris*, monophagous on elm, was detected from early June to late July with a peak in late June. *A. furcatus* adults were found from late June to early September with a peak in July. *F. florii* was captured from late June to autumn without any evident peak. *S. titanus* adults were observed from mid July to late August and were more abundant in August.

Among the species not reported in the figures, large numbers of *Idiocerus herrichii* Kirschbaum and *Platymetopius major* (Kirschbaum) were captured. The adults of *I. herrichii* were observed in early March and in early-mid November, those of *P. major* from late June to early September.

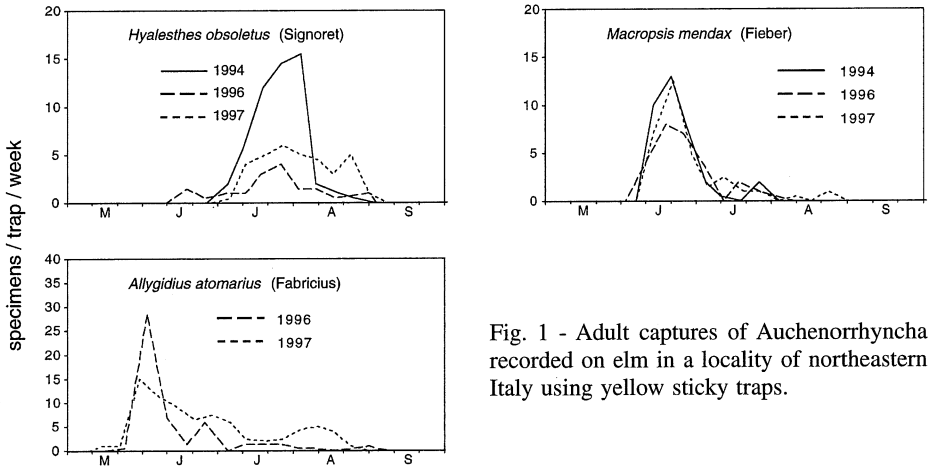

Fig. 1 - Adult captures of Auchenorrhyncha recorded on elm in a locality of northeastern Italy using yellow sticky traps.

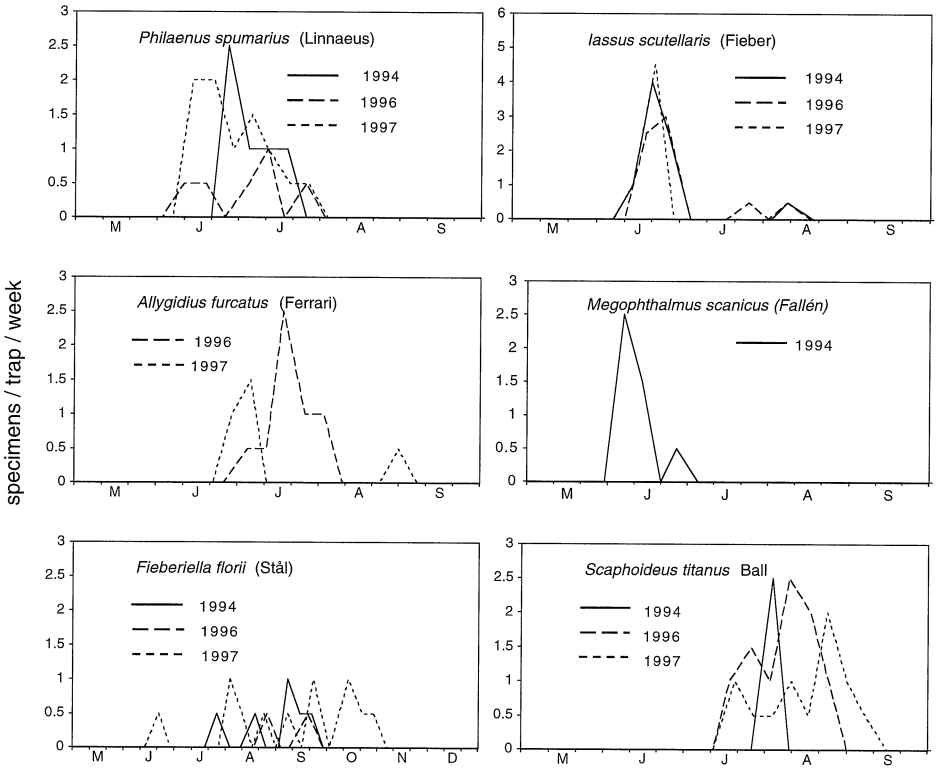

Fig. 2 - Adult captures of Auchenorrhyncha recorded on elm in a locality of northeastern Italy using yellow sticky traps.

DISCUSSION

POTENTIAL VECTORS

The most interesting species with respect to the transmission of the phytoplasma associated with elm yellows disease are *H. obsoletus*, *Ph. spumarius*, *M. mendax*, *A. atomarius* and *S. titanus*.

H. obsoletus is a vector of the 16SrXII group phytoplasmas (Sukhov & Vovk, 1947; Maixner, 1994; Sforza *et al.*, 1998; Bertaccini, 1999) and could be of practical importance only if the association between stolbur phytoplasma and elm decline observed in France was demonstrated. The first annual captures of *H. obsoletus* adults in northeastern Italy occurred at the same time as eastern Europe (see Brcak, 1979 for a review) and northern Italy (Alma *et al.*, 1988), but almost a month later than it is reported for the warmer areas of France (Sforza & Boudon-Padieu, 1998). On the basis of capture level, elm appears to be a good host for adults considering that the

nymphs develop on herbaceous plants (see Brcak, 1979 for a review) and that in 1997 during the same monitoring period only one adult was captured in the vineyard where two traps had been placed about five meters from the sampled elms.

The spittlebug *Ph. spumarius* is a minor vector of the phytoplama associated with EY in North America (Matteoni & Sinclair, 1988) and recently it was reported to be a vector of stolbur phytoplamas in Russia (Vlasov *et al.*, 1992). The number of captures of the spittlebug suggests that this cercopid could be a vector of EY agent also in Europe.

The role of the monophagous leafhopper *M. mendax* as a possible vector should be considered since the phytoplasma associated with rubus stunt (16SrV-C) is phylogenetically closely related to that associated with EY disease (16SrV-A) (Lee *et al.*, 1995; Bertaccini, 1999) and is transmitted by *M. fuscula* (De Fluiter & van der Meer, 1953), a monophagous leafhopper belonging to the same genus.

Also the role of *A. atomarius*, a minor vector of the phytoplasma associated with EY (Matteoni & Sinclair, 1988), should be considered since the captures were abundant.

S. titanus is the specific vector of the phytoplasma associated with flavescence dorée (FD) (Schvester *et al.*, 1961; Carraro *et al.*, 1994) belonging to 16SrV group as the EY agent (Marcone *et al.*, 1997; Bertaccini, 1999). Even if the high number of captures on elm are probably due to proximity to the vineyard, its role as vector should not be ignored since it belongs to the same genus of *S. luteulus* the most important vector of EY agent in North America (Baker, 1948). Considering the distribution of *S. titanus* in Italy, the leafhopper cannot be a vector of EY agent in central and southern Italy.

NEW SUGGESTIONS ON THE BIOLOGICAL CYCLE OF SOME SPECIES

In table 1 some suggestions based on the above mentioned results regarding the biological cycle of some species are reported.

M. scanicus – The dynamics of the captures is in accordance with the biological cycle in nearby Switzerland (Günthart & Thaler, 1981). Overwintering in the egg stage and the development of one generation a year seem very probable in northern Italy.

M. mendax – The dynamics of the captures suggests that this species has one generation a year on elm. Overwintering in the egg stage is most probable as the elm is a deciduous plant and *M. fuscula*, belonging to the same genus, overwinters in this stage (Vidano, 1988).

I. herrichii – The detection of adults in late autumn and in late winter suggests that the leafhopper overwinters as an adult.

I. scutellaris – The dynamics of the captures suggests that this species has one generation a year on elm. Overwintering in the egg stage is very probable since elm is a deciduous tree and *I. lanio* (Linnaeus), belonging to the same genus, overwinters in this stage (Müller, 1957).

A. atomarius – Capture of the first adults in mid May is in accordance with the overwintering in the nymphal stage, recorded by Müller (1957) for northern Europe,

while the dynamics of captures indicate the development of one generation a year. Adults are reported both on herbaceous and arboreous plants (e. i. elm) (Ribaut, 1952), but probably the nymphs develop on herbaceous plants because overwintering in the nymphal stage is unlikely on a deciduous tree.

A. furcatus – The dynamics of the captures suggests that this species has one generation a year and overwinters in the egg or nymphal stage.

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