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DIVERSITY AND ABUNDANCE OF PHYTOSEIID MITES (ACARI: PHYTOSEIIDAE) IN VINEYARDS AND THE SURROUNDING VEGETATION IN NORTHEASTERN ITALY

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RÉSUMÉ: Des échantillonnages sur les acariens ont été réalisés dans des milieux non cultivés autour de six vignobles, et dans ces vignobles, dans différents environnements viticoles de l'Italie du nord pendant trois ans. Les acariens phytophages (en particulier Tetranychoida et Eriophyoidea) ont été observés rarement tandis que les tydéides (Tydeoidea) étaient abondants soit dans les vignobles soit dans les milieux non cultivés. D'autres acariens (Winterschmidtiiidae) ont été rencontrés seulement sur les plantes spontanées. Les phytoséiides (Phytoseiidae) ont été rencontrées fréquemment dans les vignobles et dans les milieux non cultivés. Six espèces de phytoséiides ont été recensées dans les vignobles et 18 espèces dans la végétation spontanée. Les caractéristiques foliaires semblent avoir une influence importante sur la colonisation des phytoséiides. Dans certains environnements des espèces comme *Amblyseius andersoni* et *Typhlodromus pyri* étaient abondantes soit dans les vignobles soit dans les milieux non cultivés. Certaines plantes spontanées présentaient des densités relativement élevées de phytoséiides ou étaient colonisées par plusieurs espèces. Elles peuvent être considérées dans les projets concernant l'aménagement dirigé des bordures des vignobles en particulier des haies.

ACARI
PHYTOSEIIDAE
BIODIVERSITY
GRAPEVINE
NATURAL VEGETATION
BIOLOGICAL CONTROL

SUMMARY: Surveys of mites occurring in six vineyards and in the surrounding vegetation (hedgerows and stand margins) were carried out in different areas of the Veneto Region (north-eastern Italy). Phytophagous mites (e.g. Tetranychoida and Eriophyoidea) were rarely abundant in vineyards and the surrounding vegetation. Tydeoidea were widespread in vineyards and on wild plants, Winterschmidtiiidae common on some wild plants but not in vineyards. Phytoseiidae were a major part of the mite communities in vineyards and on natural vegetation. A total of 18 phytoseiid species were found on the natural vegetation, 6 species occurring on grapevines. Leaf morphology appeared to be more important than prey availability with regard to phytoseiid colonization.

Some predatory species dominated in both the vineyard and the natural vegetation, in particular *Amblyseius andersoni* and *Typhlodromus pyri*. The mechanisms affecting abundance and persistence of phytoseiids on wild plants should be studied to optimise strategies for successful population management in vineyards. Plant species with rich phytoseiid diversity or supporting high densities of important species could be considered for planting and/or conserve hedgerows.

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Predatory mites of the family Phytoseiidae play a fundamental role in controlling phytophagous mites in several crops (HELLE and SABELIS, 1985; LINDQUIST *et al.*, 1996). Their occurrence on natural vegetation has been considered in relation with orchards since the 1950s (e.g. COLLYER, 1956; CHANT, 1959) and the potential of natural vegetation as a reservoir of predatory mites stimulated a number of studies (e.g. FAUVEL & COTTON, 1981; SOLOMON, 1981; BOLLER *et al.*, 1988; GROUT & RICHARDS, 1990; LOZZIA & RIGAMONTI, 1990; TUOVINEN & ROKX, 1991; COLI *et al.*, 1994; TIXIER *et al.*, 1998, 2000). Mite communities in vineyards and on the surrounding vegetation were monitored in Northeastern Italy, the population dynamics of the most important families (i.e. Tetranychidae, Tydeidae and Phytoseiidae) being studied for a three-year period (DUSO *et al.*, 1993). A complex of five phytoseiid species commonly occurred in the vineyard where tetranychid mites were controlled. The phytoseiids and the tydeids were the mostly abundant mites on natural vegetation, whereas phytophagous mites reached very low levels. The phytoseiids *Amblyseius andersoni* (Chant) and *Euseius finlandicus* (Oudemans) were dominant on the natural vegetation, however *Typhlodromus pyri* Scheuten dominated in the vineyard. More recently, similar investigations were extended to six vineyards and on the vegetation surrounding them. Preliminary reports originating from these surveys have been discussed by DUSO & FONTANA (1996). The main objective of this research was to identify plant species likely to improve biological control of grapevine pests, by providing refuge, overwintering and alternative food sources for antagonists.

MATERIALS AND METHODS

Experimental sites and sampling methods

The study was carried out in six sites of the Veneto region (Northeastern Italy). Two sites were located in a plain: Lancenigo (Piave valley) and Teolo (near Colli Euganei). The other ones being in hilly areas: Zovon (Colli Euganei), Santo Stefano and San Pietro di Barbozza (Valdobbiadene) and Negrar (Valpolicella). In each site a vineyard contiguous to hedge-

rows or broadleaf stands was selected. Sampling was performed mostly during 1988 and 1989. In these seasons, vineyards were not treated with insecticides or acaricides, except in one case (Lancenigo) where methyl-parathion was erroneously applied in 1989. Downy mildew and powdery mildew were controlled with various fungicides (mostly copper oxychloride, mancozeb, cymoxanil, phosethyl-Al, folpet, and wettable sulphur). Most of them are known to be selective towards phytoseiids (GIROLAMI *et al.*, 1989). A total of 18 plant species were considered (6-10 plants per site). Attention focused especially on elder (*Sambucus nigra* L.), hazel (*Corylus avellana* L.), field maple (*Acer campestre* L.), hop hornbeam (*Ostrya carpinifolia* Scopoli), red dogwood (*Cornus sanguinea* L.), blackberry (*Rubus ulmifolius* Schott) and nettle (*Urtica dioica* L.). The remaining sampled plants were *Acer pseudoplatanus* L., *Alnus glutinosa* Gärtner, *Castanea sativa* Miller, *Ficus carica* L., *Humulus lupulus* L., *Juglans regia* L., *Lamium purpureum* L., *Prunus avium* L., *Quercus pubescens* Willd., *Robinia pseudacacia* L., *Ulmus campestris* Auct.. Some leaf morphology features (density of trichomes on the leaf blade and along the main veins, occurrence and type of domatia, etc.) of these plant species were examined under dissecting microscope. Observations were performed on 20 leaves per plant species; trichome densities were expressed according to frequency classes (i.e. < 50 per cm²; 50-100 per cm², 100-150 per cm², etc.).

Investigations were carried out in 1988 (Lancenigo, Negrar, San Pietro di Barbozza, Teolo) and 1989 (all the sites) every 15-20 days, from mid-April to mid-September; 50 leaves per plant species were chosen from the middle area of the shoot according to observations on mite distribution (GIROLAMI, 1981; DUSO, unpublished data). Leaves were examined in the laboratory under a dissecting microscope to assess mite density. Mites were preserved in Oudemans' fluid and later mounted on slides, usually in Hoyer's medium, to be identified using a phase contrast microscope. Concerning eriophyoids, dried specimens were prepared using the methods described by JEPSON *et al.* (1975) and NUZZACI & VOVLAS (1976). Predatory insects were also monitored. Phytoseiid genera are reported according to MORAES *et al.* (1986) and CHANT & MCMURTRY (1994).

Additional samples were taken in all the sites during 2002. It was not possible to take samples from the vineyard located at Negrar. In the 1990s the use of insecticides (mainly organophosphates and chitin-inhibitors) increased in most vineyards to control *Scaphoideus titanus* (Ball.), vector of the *Flavescence dorée* disease. In the vineyard located at Lancenigo pyrethrins were employed instead of organic insecticides. During 2002, samples were taken in mid-July, late August and early September using the above-mentioned procedures.

Differences between phytoseiid densities recorded on wild plants, within each site, were analysed by using the REPEATED option of Proc GLM of SAS (SAS Institute, 1989), and considering the date as a repeated measure (Repeated Measures ANOVA). The means were separated using REGWQ Test, and the significance used in this study was set at a P level of 0.05. For a synthetic presentation of the results, the discussion was focused on analysis of contrasts. Before carrying out an ANOVA logarithmic transformation, i.e. $\log(y + 1)$, was applied to the data. Phytoseiid densities were expressed as the number of motile forms per 17.8 cm² of leaf surface, the average surface of the smallest leaves (*A. campestre*). Data used for these analyses were taken from 1988 and 1989 samples.

The diversity in the Phytoseiidae

Phytoseiid diversity (D) was calculated on different wild plants, within each experimental site, using the Margalef index ($D = S - 1/\log N$; where S is the number of species and N is the number of individuals). Phytoseiid communities occurring in vineyards and on wild plants surrounding them where compared using the Coefficient of Similarity proposed by SØRENSEN (SOUTHWOOD, 1978); in particular, $C_s = 2j/(a + b)$, where j is the number of species common to the two samples, a and b are the total number of species in each sample. A modified SØRENSEN Coefficient was also considered (SOUTHWOOD, 1978); in particular, $C_N = 2jN/(aN + bN)$, where aN is the total number of individuals sampled in habitat a , bN is the total number of individuals sampled in habitat b , and jN is the sum of the lesser values for the species common to both habitats.

RESULTS

Leaf morphology

Some leaf morphology features of the sampled plants are reported in TABLE 1. The leaf blade of most plants is glabrous or slightly pubescent. *Cornus sanguinea* and *Q. pubescens* are characterised by a moderate leaf pubescence, but in the first case trichomes are very short. In a number of plants leaves show hairy veins and/or tuft domatia. These features, more developed on *A. pseudoplatanus* and *Q. pubescens* than on other species, are positively associated to phytoseiid mite abundance (e.g. WALTER, 1996). The presence of a furrow along the main vein is also commonly associated to the occurrence of phytoseiids.

Mites occurring on natural vegetation

Phytoseiidae and Tydeidae were the main mites collected on natural vegetation. A number of families (Diptilomiopidae, Eriophyidae, Tenuipalpidae, Tetranychidae, Winterschmidtidae) were recorded at moderate densities. Finally, mites belonging to other families (e.g. Acaridae, Iolinidae, Phytoptidae, Stigmaeidae, Tarsonemidae, Trombidiidae, etc.) were collected less frequently.

Phytoseiidae were collected on all the plants considered. A total of 18 phytoseiid species were found: *Amblyseius andersoni* (Chant), *A. rademacheri* Dosse, *Euseius finlandicus* (Oudemans), *Galendromus* nr. *longipilus* (Nesbitt), *Kampimodromus aberrans* (Oudemans), *K. ericinus* Ragusa & Tsolakis, *K. langei* Wainstein & Arutunjan, *Neoseiulella aceri* (Collyer), *N. tiliarum* (Oudemans), *Neoseiulus reductus* (Wainstein), *Paraseiulus soleiger* (Ribaga), *P. talbii* (Athias-Henriot), *P. triporus* (Chant & Yoshida Shaul), *Phytoseius horridus* Ribaga, *P. plumifer* (Canestrini & Fanzago), *Typhlodromus bakeri* Garman, *T. pyri* Scheuten, *Typhloseiulus simplex* (Chant).

The Tydeoidea were widespread on several plants. In most cases they were abundant in mid- and late season than in early season. The Tydeidae, mainly *Tydeus caudatus* (Dugès) and *T. californicus* (Banks) were commonly recorded. *Lorrya* nr. *teresae* (Carmona) was locally occurring, *Homeopronematus* sp.

Plant species	Leaf blade		Vein features		type	Domatia hair density within domatia
	glabrous (Y/N)	hair density (No/cm ²)	furrow (Y/N)	hair density (No/cm ²)		
<i>Acer campestre</i>	Y		Y	< 50	tuft	> 300
<i>Acer pseudoplatanus</i>	N	50-100	Y	> 300	tuft	150-200
<i>Alnus cordata</i>	Y		Y		tuft	200-250
<i>Castanea sativa</i>	Y		N	< 50		
<i>Cornus sanguinea</i>	N	> 300	Y	100-150	pit	< 50
<i>Corylus avellana</i>	N	< 50	Y	100-150	tuft	< 50
<i>Ficus carica</i>	N	< 50	N	100-150	tuft	< 50
<i>Humulus lupulus</i>	Y		Y		pocket	< 50
<i>Juglans regia</i>	Y		Y		pit	< 50
<i>Lamium purpureum</i>	Y		Y	< 50		
<i>Ostrya carpinifolia</i>	Y		Y	50-100	tuft	<50
<i>Prunus avium</i>	Y		Y	< 50	tuft	< 50
<i>Quercus pubescens</i>	N	> 300	Y	200-250	tuft	50-100
<i>Robinia pseudacacia</i>	Y		N	< 50		
<i>Rubus ulmifolius</i>	Y	< 50	Y	50-100		
<i>Sambucus nigra</i>	Y		Y	< 50		
<i>Ulmus campestre</i>	Y		Y		tuft	100-150
<i>Urtica dioica</i>	N	100-150	Y	150-200	pocket	< 50

TABLE 1: Leaf features examined on 18 plant species sampled near vineyards in northern Italy.

and *Lorryia* sp., were less frequent, *Triophyteus lebruni* (André) was also found.

The Tetranychidae were found at low levels. *Tetranychus urticae* Koch was observed especially on *U. dioica* and *R. ulmifolius* and in late season. *Eotetranychus carpini* (Oudemans) was present in very low numbers on *O. carpinifolia* and likewise *Tetranychopsis horrida* (Canestrini & Fanzago) on *C. avellana*. Among the Tenuipalpidae, *Cenopalpus pulcher* (Canestrini & Fanzago) and *Brevipalpus garmani* Baker, were recorded on *P. avium* and *S. nigra* respectively.

Concerning the Eriophyoidea, the Eriophyidae were frequent on *A. campestre* [*Cecidophyes campestris* de Lillo & Fontana and *C. gymnaspis* (Nalepa)], *Acalitus brevitarsus* (Fockeu) was seldom found on *A. glutinosa*. The Diptilomiopidae were commonly collected on *C. sanguinea* (*Diptacus corni* de Lillo & Fontana, *Diptacus sanguineus* de Lillo) and *U. dioica* [*Quadracus urticarius* (Canestrini & Massalongo)].

Among the Winterschmidtidae, the fungivore *Czenspinksia transversostriata* (Oudemans) was found to be abundant on *C. avellana* but also common on other plants (e.g. *A. campestre*, *R. ulmifolius*, *C. sanguinea*).

Phytoseiid abundance and diversity in different sites

SAN PIETRO DI BARBOZZA : During 1988, predatory mite densities were relatively higher in the vineyard at the sprouting and in early August (1.8 and 1.9 motile forms per leaf, respectively). One year later, the phytoseiid population trend was similar (2.7 and 3.2 motile forms per leaf in late April and early August, respectively). In 2002, *T. pyri* was also abundant in late summer (1.36 motile forms per leaf in August). The spider mite *Panonychus ulmi* (Koch) was relatively important only in late 1988. Tydeids were more common in the spring and in late summer. Phytoseiids were widely distributed on wild plants. The effect of plant species on phytoseiid abundance was significant during 1988 ($F = 91.57$; d.f. = 7, 388; $p < 0.0001$) and 1989 ($F = 85.36$; d.f. = 7, 388; $p < 0.0001$). The highest phytoseiid levels were found on *C. avellana* (average 0.81 motile forms per 17.8 cm² of leaf surface) in 1988, on *S. nigra* (average 0.4 motile forms per 17.8 cm² of leaf surface) and *U. dioica* (average 0.38 motile forms per 17.8 cm² of leaf surface) in 1989. Tydeids reached relatively high densities on *A. pseudoplatanus* and *C. sativa* (maximum 0.9 and 0.74 motile forms per 17.8 cm² of leaf surface, respectively).

SAN PIETRO DI BARBOZZA

Phytoseiid species

Host plants		<i>A. rademacheri</i>	<i>E. finlandicus</i>	<i>K. aberrans</i>	<i>K. ericinus</i>	<i>K. langei</i>	<i>N. aceri</i>	<i>N. tiliarum</i>	<i>P. talbii</i>	<i>P. plumifer</i>	<i>T. pyri</i>	No. of individuals
<i>Vitis vinifera</i>	1988		1.3						12		86.7	75
	1989		1.7						4.7		92.2	64
	2002		1.9						1.9		96.2	104
<i>Acer campestre</i>	1988				5.3		94.7					19
	1989		81.8		4.5		9				4.5	22
<i>Acer pseudoplatanus</i>	1988		90.9				9.1					66
	1989		68.2		4.5						27.3	22
	2002		64.5	31.8							3.7	214
<i>Castanea sativa</i>	1988		100									41
	1989		100									14
	2002		100									26
<i>Corylus avellana</i>	1988		1.2		2.3			96.5				86
	1989				22.2			77.8				18
	2002		2.1		97.9							142
<i>Ostrya carpinifolia</i>	1988		69.3			30.6						62
	1989		87.5			12.5						16
	2002		34.2			63.1					2.6	38
<i>Rubus ulmifolius</i>	1988		4							92	4	25
	1989		40							40	20	5
	2002									75	25	8
<i>Sambucus nigra</i>	1988		100									23
	1989		95.6							4.3		23
	2002		94.7								5.3	113
<i>Urtica dioica</i>	1988	34.7	10.2		2				2	46.9	4.1	49
	1989									100		28
	2002									100		8

TABLE 2: Phytoseiids (percentage and total number of individuals) collected at San Pietro di Barbozza (1988, 1989 and 2002) on the grapevine and the surrounding vegetation.

Three phytoseiid species were collected in the vineyard, being *T. pyri* the most abundant (TABLE 2). Nine phytoseiid species were found on wild plants surrounding the vineyard during 1988, seven species were recorded in 1989 and six species in 2002 (TABLE 2). *Euseius finlandicus* was widespread in all seasons.

LANCENIGO : During 1988, phytoseiids occurring in the vineyard reached maximum levels in early May (1.7 motile forms per leaf). In the subsequent season, phytoseiids were seldom recorded on the grapevine probably due to the application of methyl-parathion. Their densities increased again during 2002 (average 0.64 motile forms per leaf). Among tetranychids, *P. ulmi* and *E. carpini* populations fluctuated at moderate densities (1-3 motile forms per leaf). Tydeids were commonly found in spring. Phytoseiid densities were significant different among wild plants ($F = 97.38$; d.f. = 6, 343; $p < 0.0001$; and $F = 120.51$; d.f. = 5, 294;

$p < 0.0001$, for 1988 and 1989 respectively) and they were higher on *C. avellana* during 1988 (average 1.39 motile forms per 17.8 cm² of leaf surface) and on *A. campestre* during 1989 (average 1.51 motile forms per 17.8 cm² of leaf surface) than on the remaining plants. Phytoseiid seasonal abundance did not appear to be related to the availability of tetranychids and eriophyoids.

Four phytoseiid species were found in the vineyard (TABLE 3). *Kampimodromus aberrans* was found more continuously than other species. *Typhlodromus pyri* probably originated from a nearby vineyard receiving a release in the late 1980s. Nine phytoseiid species were found on wild plants during 1988, six during 1989, and eight during 2002 (TABLE 3). *Euseius finlandicus* and *A. andersoni* were the most frequent species.

TEOLO: Phytoseiid densities peaked in this vineyard in mid-July (1.18 motile forms per leaf) of 1988 but

LANCENIGO

Phytoseiid species

Host plants		<i>A. andersoni</i>	<i>A. rademacheri</i>	<i>E. finlandicus</i>	<i>K. aberrans</i>	<i>K. ericinus</i>	<i>K. langei</i>	<i>N. acerri</i>	<i>N. tiliarum</i>	<i>P. soleiger</i>	<i>Parasetius talbii</i>	<i>Phytoseius planifer</i>	<i>P. horridus</i>	<i>T. bakeri</i>	<i>T. pyri</i>	No. of individuals
<i>Vitis vinifera</i>	1988	28.8			71.2											118
	1989	25			50							25				8
	2002	3.1			44.4									52.4		63
<i>Acer campestre</i>	1989	47.2		52.8												36
	2002	0.9		40		7.7	45.8					1.8	5.7			105
<i>Alnus glutinosa</i>	1988	12.7	9.3	76.4												55
	1989			94.7					10.2							19
	2002			92.4		1							0.5	6.1		195
<i>Corylus avellana</i>	1988	7		2.4	4	75.8			10.7			0.8				128
	1989	4.3		2.1	8.6	27.8			55.9			2.1				47
	2002					90.2	6.1		3.7							164
<i>Lamium purpureum</i>	1988	76.7		10		3.3						10				30
	2002	15		1								1				17
<i>Rubus ulmifolius</i>	1988	60.8		14.3	14.3							10.7				28
	1989	47.6		47.6								4.8				21
	2002	43.7		21.9		12.5						21.9				32
<i>Sambucus nigra</i>	1988	14.3		81.4		2.9					1.4					70
	1989	22.7		77.3												22
	2002			100												174
<i>Urtica dioica</i>	1988	3.6			1.8					3.6		90.9				55
	1989				3.7							96.3				27
	2002											100				12

TABLE 3: Phytoseiids (percentage and total number of individuals) collected at Lancenigo (1988, 1989 and 2002) on the grapevine and the surrounding vegetation.

TEOLO

Phytoseiid species

Host plants		<i>A. andersoni</i>	<i>A. rademacheri</i>	<i>E. finlandicus</i>	<i>K. aberrans</i>	<i>K. ericinus</i>	<i>N. reductus</i>	<i>P. talbii</i>	<i>P. triporus</i>	<i>P. plumifer</i>	<i>T. pyri</i>	No. of individuals
<i>Vitis vinifera</i>	1988	59.5		38.1				2.4				42
	1989	50		4.1							45.8	24
	2002	65.2		13							21.7	23
<i>Castanea sativa</i>	1988	4.1		91.7							4.1	24
	1989			92				8				25
	2002		21.4	64.3				7.1			7.1	14
<i>Cornus sanguinea</i>	1988	10.3		89.7								39
	1989			100								12
	2002			37.5				12.5			50	8
<i>Ficus carica</i>	1989										100	2
	2002		3.7		55.6	3.7				14.8	22.2	27
<i>Prunus avium</i>	1988	4.8		94				1.2				83
	1989	13		78.3			4.3				4.3	23
	2002	47.6		42.8				9.5				21
<i>Quercus pubescens</i>	1989			100								9
	2002			66.7					33.3			3
<i>Robinia pseudacacia</i>	1988			100								1
<i>Rubus ulmifolius</i>	1988	7.3	24.4	2.4		2.4				53.7	9.8	41
	1989	11.8	47.1					2.9		38.2		34
	2002	13.6	2.3	9.1						27.2	47.7	44
<i>Sambucus nigra</i>	1988	19.5		53.7							26.8	41
	1989	27.2		54.5			9.1				9.1	11
	2002	11.1		88.9								9
<i>Urtica dioica</i>	1988		5.3							94.7		38
	1989		50							50		10
	2002									100		29

TABLE 4: Phytoseiids (percentage and total number of individuals) collected at Teolo (1988, 1989 and 2002) on the grapevine and the surrounding vegetation.

reached low densities (less than 1 motile form per leaf) in 1989 and 2002. *Panonychus ulmi* populations reached moderate levels only in early September 1988. Tydeids were relatively abundant in spring and/or late season. Differences in phytoseiid densities on wild plants were significant ($F = 174.91$; d.f. = 8, 441; $p < 0.0001$; and $F = 71.61$; d.f. = 6, 343; $p < 0.0001$; for 1988 and 1989 respectively). *Prunus avium* showed the highest values in 1988 (average 0.99 motile forms per 17.8 cm² of leaf surface), *R. ulmifolius* in 1989 (average 0.42 motile forms per 17.8 cm² of leaf surface). Tetranychids were rare while eriophyoids were recorded especially on *U. dioica* and *C. sanguinea*. High tydeid populations were recorded on *S. nigra* and *C. sativa*, but especially on *F. carica* (maximum 59.8 motile forms per 17.8 cm² of leaf surface).

Four phytoseiid species were recorded on the grapevine being *A. andersoni* the most frequent (TABLE

4). Seven phytoseiid species were collected on natural vegetation during 1988 and 1989 and nine species during 2002 (TABLE 4). *Euseius finlandicus* and *A. andersoni* were the most abundant predatory mites. In some cases, the seasonal abundance of phytoseiids was apparently related to that of tydeids (e.g. on *S. nigra* and *C. sanguinea*).

NEGRAR : Predatory mite densities fluctuated at high levels in the vineyard peaking in late summer (18.64 motile forms per leaf in August 1988 and 17.22 motile forms per leaf in October 1989). Tetranychids were never found and tydeids reached low levels (less than 2 motile forms per leaf in some samplings). Differences in phytoseiid densities among wild plants were significant in 1988 ($F = 113.70$; d.f. = 9, 486; $p < 0.0001$) and 1989 ($F = 120.15$; d.f. = 8, 437; $p < 0.0001$). *Cornus sanguinea* was characterised by the highest population levels in 1988 (average 1.22

NEGRAR

Phytoseiid species

Host plants		<i>A. andersoni</i>	<i>A. rademacheri</i>	<i>E. finlandicus</i>	<i>K. aberrans</i>	<i>K. ericinus</i>	<i>K. langei</i>	<i>N. aceri</i>	<i>N. tiliarum</i>	<i>P. talpii</i>	<i>P. plumifer</i>	<i>T. bakeri</i>	<i>T. pyri</i>	<i>No. of individuals</i>
<i>Vitis vinifera</i>	1988	1			99									202
	1989				88.2					11.8				76
<i>Acer campestre</i>	1988			53.1		34.7		6.1		6.1				49
	1989			50		50								4
<i>Cornus sanguinea</i>	2002	5.7						11.4					82.9	70
	1988	8.2		36.1	42.6					1.6	9.8		1.6	61
	1989			73.7	10.5			2.6		7.9	2.6		2.6	38
<i>Corylus avellana</i>	2002			55.1									44.9	49
	1988			8.7		80.4			10.9					46
	1989			20		50			25			5		20
<i>Humulus lupulus</i>	2002			3.6		10.7	3.6		82.1					28
	1988	17.8		81.2	1									107
	1989			92	4						4			25
<i>Ostrya carpinifolia</i>	2002			72									28	25
	1988	3		33.3			45.5		3				15.1	33
	1989			16.7			75		8.3					12
<i>Prunus avium</i>	2002			22.7			50		27.3					22
	1988	4.5		88.3									7.2	111
	1989			97.8						2.2				45
<i>Robinia pseudoacacia</i>	2002			76.9	7.7				3.8	11.6				26
	1988	10		90										10
<i>Rubus ulmifolius</i>	2002			100										2
	1988	6		2	12				2				8	50
	1989	3.1		3.1							93.8			32
<i>Sambucus nigra</i>	2002	3	15.2	27.4						3	9		42.4	33
	1988	17		71.7	5.7	1.9				1.9	1.9			53
	1989			100										33
<i>Urtica dioica</i>	2002	6.7		33.3									60	15
	1988	1	4.1		10.2						74.5			98
	1989										100			30
	2002	50									50			4

TABLE 5: Phytoseiids (percentage and total number of individuals) collected at Negrar (1988, 1989 and 2002) on the grapevine and the surrounding vegetation.

SANTO STEFANO

Phytoseiid species

Host plants		<i>A. andersoni</i>	<i>E. finlandicus</i>	<i>K. ericinus</i>	<i>K. langei</i>	<i>N. tiliarum</i>	<i>P. talbii</i>	<i>P. plumifer</i>	<i>T. pyri</i>	<i>T. simplex</i>	No. of individuals
<i>Vitis vinifera</i>	1989								100		22
	2002		19.7				4.9		75.4		61
<i>Cornus sanguinea</i>	1989			3.3			3.3		93.3		30
	2002		20.3				1.7		78		59
<i>Corylus avellana</i>	1989	5.1	23.1	53.8				17.9			39
	2002		3.5	61.8	14.1	20.6					170
<i>Juglans regia</i>	1989		96.7			3.3					30
	2002		100								33
<i>Ostrya carpinifolia</i>	1989				75		25				4
	2002		69.4		4.6				21.3	4.6	108
<i>Rubus ulmifolius</i>	1989							90.9	9.1		11
	2002		6.7						93.3		15
<i>Sambucus nigra</i>	1989		50						50		2
	2002		80.2				1		18.8		101

TABLE 6: Phytoseiids (percentage and total number of individuals) collected at Santo Stefano (1988, 1989 and 2002) on the grapevine and the surrounding vegetation.

motile forms per 17.8 cm² of leaf surface), *S. nigra* and *U. dioica* during 1989 (average 0.58 motile forms per 17.8 cm² of leaf surface for both plants). Tetranychids were recorded on hop only. Tydeids were common on *S. nigra*, and *A. campestre* (maximum 1.9 and 1.84 motile forms per 17.8 cm² of leaf surface, respectively). On the latter the dynamics of phytoseiids appeared to be related to that of tydeids.

Three phytoseiid species were found in the vineyard and *K. aberrans* was clearly dominant (TABLE 5). Eleven phytoseiid species were collected on the natural vegetation in 1988 and 1989, ten species in 2002 (TABLE 5). *Euseius finlandicus* was the most abundant species. During 2002, the occurrence of *T. pyri* on natural vegetation was wider than in previous years.

SANTO STEFANO: During 1989, phytoseiids reached low population levels in the vineyard (maximum 0.60-0.64 motile forms per leaf in July and September) while their densities appeared to be higher in 2002. In 1989, *P. ulmi* populations increased in late summer but at non-damaging levels (1.98 motile forms per leaf). Tydeids were not common. On natural vegetation, phytoseiid abundance was affected by plant species ($F = 103.32$; d.f. = 5, 294; $p < 0.0001$) and the highest densities were found on *C. sanguinea*

(average 0.62 motile forms per 17.8 cm² of leaf surface).

In the vineyard *T. pyri* only was recorded during 1989 while *E. finlandicus* and *P. talbii* were also detected in 2002 (TABLE 6). Eight phytoseiid species were found on wild plants during 1989 when *E. finlandicus*, *K. ericinus* and *T. pyri* were relatively common (TABLE 6). In 2002, phytoseiid complex was somewhat similar to that observed in 1989 (TABLE 6). The most relevant difference concerned the wide distribution of *T. pyri*. Phytophagous mites and tydeids were not common.

ZOVON: During 1989, phytoseiid densities reached low levels (maximum density 0.54 motile forms per leaf in early May) in the vineyard. Population levels appeared to be higher in 2002 (average 1.42 motile forms per leaf). Phytoseiid densities were significantly different among wild plants in 1989 ($F = 83.36$; d.f. = 5, 294; $p < 0.0001$); *C. avellana* and *U. dioica* were characterised by the highest population levels (average 0.33 and 0.37 motile forms per 17.8 cm² of leaf surface, respectively). Tetranychids and tydeids were seldom collected.

Four phytoseiid species were recorded in the vineyard. *Typhlodromus pyri* was the most frequent during 1989, *A. andersoni* during 2002 (TABLE 7). Four phytoseiid species were found on the natural

Phytoseiid species

Host plants		<i>A. andersoni</i>	<i>E. finlandicus</i>	<i>G. longipilus</i>	<i>K. aberrans</i>	<i>K. ericinus</i>	<i>N. tiliarum</i>	<i>P. talbii</i>	<i>P. plumifer</i>	<i>T. pyri</i>	No. of individuals
<i>Vitis vinifera</i>	1989	10								90	10
	2002	63.4	9.8					7.3		19.5	41
<i>Corylus avellana</i>	1989				100						33
	2002	3.8	3.8	11.5		7.7	11.5	3.8		57.7	26
<i>Humulus lupulus</i>	1989		92.6						7.4		27
	2002	11.1	22.2					22.2		44.4	9
<i>Prunus avium</i>	1989		72.7						9.1	18.2	11
	2002	14.3						28.6		57.1	7
<i>Rubus ulmifolius</i>	1989				9.1				81.8	9.1	11
	2002	4.5							77.3	18.2	22
<i>Ulmus minor</i>	1989		100								11
	2002		20							80	10
<i>Urtica dioica</i>	1989		8.7						87	4.3	23
	2002								100		1

TABLE 7: Phytoseiids (percentage and total number of individuals) collected at Zovon (1988, 1989 and 2002) on the grapevine and the surrounding vegetation.

vegetation during 1989, eight species during 2002. In this year *T. pyri* was collected on most plants (TABLE 7).

The diversity in phytoseiid communities

The diversity in phytoseiid communities occurring on different plants was measured by the MARGALEF index. Relatively high values of the parameter *D* were observed at Negrar (1988 and 1989) and Teolo (2002) (TABLE 8). *D* values calculated for 1988 and 1989, within each site, were comparable for a number of plant species. In other cases fluctuations were frequently observed (e.g. San Pietro di Barbozza and Teolo). Contrasting data was also observed for a single plant species across the sites (e.g. *C. sativa* at San Pietro di Barbozza and Teolo). In a number of sites, relatively high *D* values were found for *C. avellana* and *R. ulmifolius*. An additional analysis was performed by aggregating the data of 2 (Santo Stefano and Zovon) or 3 years (the remaining sites). The highest *D* values were found for *C. avellana* (1.72 and 0.94 at Zovon and Santo Stefano respectively), *R. ulmifolius* (1.26 at Teolo), *S. nigra* (1.30 at Negrar), *A. glutinosa* (1.26 at Lancenigo), and *U. dioica* (1.26 at San Pietro di Barbozza).

The analysis of the similarity between phytoseiid communities occurring on the grapevine and on wild plants showed relatively high values (0.8-1) of C_s for

C. sanguinea, *H. lupulus*, *P. avium*, *R. ulmifolius*, *S. nigra*, and *U. dioica* (TABLE 9). However, the relatively low number of species per plant and of individuals per species suggested the use of a modified SØRENSEN Coefficient (C_N). C_N values were usually lower than C_S values (TABLE 10). Relatively high C_N values (> 0.5) were recorded for *C. sanguinea*, *C. sativa* and *P. avium* in some sites or years.

DISCUSSION

Phytoseiid mites dominant on wild plants and their economic importance

In the hedgerows or in margins of stands, *E. finlandicus* dominated among phytoseiids in all sites confirming the results of other surveys carried out in this region (RAGUSA & PAOLETTI, 1985; PAOLETTI & LORENZONI, 1989; PAOLETTI *et al.*, 1989; DUSO *et al.*, 1993). The dominance of *E. finlandicus* over other phytoseiid species may depend on a number of ecological factors, e.g. development and reproduction on a wide range of foods, interspecific and intraspecific competition, and dispersal ability (SCHAUSBERGER, 1997). The occurrence of *E. finlandicus* at moderate densities at Teolo (1988) and Santo Stefano (late summer of 2002) seems to reflect its abundance on the contiguous plants as observed by DUSO *et al.* (1993). In the remaining cases, the low numbers of this pre-

Sites	Year	<i>Acer campestre</i>	<i>Acer pseudoplatanus</i>	<i>Alnus glutinosa</i>	<i>Castanea sativa</i>	<i>Cornus sanguinea</i>	<i>Corylus avellana</i>	<i>Ficus carica</i>	<i>Humulus lupulus</i>	<i>Juglans regia</i>	<i>Lamium purpurea</i>	<i>Ostrya carpinifolia</i>	<i>Prunus avium</i>	<i>Quercus pubescens</i>	<i>Robinia pseudacacia</i>	<i>Rubus ulmifolius</i>	<i>Sambucus nigra</i>	<i>Ulmus campestris</i>	<i>Urtica dioica</i>
San Pietro di Barbozza	1988	0.34	0.24	-	0	-	0.45	-	-	-	-	0.24	-	-	-	0.62	0	-	1.28
	1989	0.97	0.65	-	0	-	0.35	-	-	-	-	0.36	-	-	-	1.24	0.32	-	0
	2002	*	0.37	-	0	-	0.2	-	-	-	-	0.28	-	-	-	0.48	0.21	-	0
Lancenigo	1988	*	-	0.74	-	-	1.03	-	-	-	0.88	-	-	-	-	0.91	0.71	-	0.75
	1989	0.27	-	0.33	-	-	1.29	-	-	-	*	-	-	-	-	0.66	0.32	-	0.31
	2002	0.85	-	0.56	-	-	0.39	-	-	-	0.71	-	-	-	-	0.87	0	-	0
Teolo	1988	-	-	-	0.63	0.27	-	*	-	-	-	-	0.45	*	0	1.35	0.54	-	0.27
	1989	-	-	-	0.31	0	-	0	-	-	-	-	0.96	0	*	0.85	1.25	-	0.43
	2002	-	-	-	1.14	0.96	-	1.21	-	-	-	-	0.66	0.91	*	1.13	0.46	-	0
Negrar	1988	0.77	-	-	-	1.21	0.52	-	0.42	-	-	1.14	0.42	-	0.43	1.27	1.25	-	0.67
	1989	0.72	-	-	-	1.37	1.01	-	0.62	-	-	0.81	0.26	-	*	0.58	0	-	0
	2002	0.47	-	-	-	0.25	0.91	-	0.31	-	-	0.64	0.92	-	0	1.42	0.73	-	0.72
Santo																			
Stefano	1989	-	-	-	-	0.59	0.82	-	-	0.29	-	0.72	-	-	-	0.42	0.43	-	-
	2002	-	-	-	-	0.49	0.82	-	-	0	-	0.64	-	-	-	0.37	0.43	-	-
Zovon	1989	-	-	-	-	-	0	-	0.3	-	-	-	0.83	-	-	0.83	-	0	0.64
	2002	-	-	-	-	-	1.97	-	1.37	-	-	-	1.03	-	-	0.65	-	0.43	0

* not sampled

TABLE 8: Phytoseid diversity calculated for different wild plants, within each experimental site, using the Margalef index (D).

Sites	Year	<i>Acer campestre</i>	<i>Acer pseudoplatanus</i>	<i>Castanea sativa</i>	<i>Cornus sanguinea</i>	<i>Corylus avellana</i>	<i>Humulus lupulus</i>	<i>Ostrya carpinifolia</i>	<i>Prunus avium</i>	<i>Rubus ulmifolius</i>	<i>Sambucus nigra</i>	<i>Ulmus campestre</i>	<i>Urtica dioica</i>
San Pietro di Barboza	1988	*	*		-	-	-	-	-	0.67	*	-	0.67
	1989	0.57	0.67	*	-	-	-	-	-	0.67	*	-	*
	2002	-	0.67	*	-	-	-	-	-	*	0.8	-	*
Lancenigo	1988	-	-	-	-	0.5	-	-	-	0.67	*	-	0.67
	1989	*	-	-	-	0.67	-	-	-	0.67	*	-	0.8
Teolo	1988	-	-	0.67	0.8	-	-	-	1	*	0.67	-	*
	1989	-	-	*	*	-	-	-	0.57	*	0.86	-	*
	2002	-	-	0.57	0.67	-	-	-	0.67	0.75	0.8	-	*
Negrar	1988	*	-	-	0.5	*	0.88	*	*	0.5	0.5	-	0.67
	1989	*	-	-	0.5	*	*	*	*	*	*	-	*
Santo Stefano	1989	-	-	-	0.5	*	-	*	-	0.67	0.67	-	-
	2002	-	-	-	1	*	-	0.57	-	0.8	1	-	-
	1989	-	-	-	-	*	*	-	*	*	-	*	*
Zovon	2002	-	-	-	-	0.73	1	-	0.86	0.57	-	0.67	*

* = Coefficient < 0.5

TABLE 9: A comparison of phytoseid communities occurring in vineyards and on wild plants surrounding them using the Sørensen Coefficient (C_S).

Sites	Year	<i>Acer campestre</i>	<i>Acer pseudoplatanus</i>	<i>Castanea sativa</i>	<i>Cornus sanguinea</i>	<i>Corylus avellana</i>	<i>Humulus lupulus</i>	<i>Ostrya carpinifolia</i>	<i>Prunus avium</i>	<i>Rubus ulmifolius</i>	<i>Sambucus nigra</i>	<i>Ulmus campestre</i>	<i>Urtica dioica</i>
San Pietro di Barboza	1988	-	-	-	-	-	-	-	-	0.04	-	-	0.06
	1989	0.07	0.19	-	-	-	-	-	-	0.09	-	-	-
	2002	-	0.06	-	-	-	-	-	-	-	0.07	-	-
Teolo	1988	-	-	0.51	0.49	-	-	-	0.34	-	0.10	-	-
	1989	-	-	-	-	-	-	-	0.21	-	0.14	-	-
	2002	-	-	0.22	0.45	-	-	-	0.59	0.42	0.25	-	-
Lancenigo	1988	-	-	-	-	0.11	-	-	-	0.29	-	-	0.04
	1989	-	-	-	-	0.25	-	-	-	0.21	-	-	0.09
Negrar	1988	-	-	-	0.22	-	0.02	-	-	0.06	0.04	-	0.07
	1989	-	-	-	0.13	-	-	-	-	-	-	-	-
Santo Stefano	1989	-	-	-	0.85	-	-	-	-	0.03	0.04	-	-
	2002	-	-	-	0.98	-	-	0.41	-	0.39	0.40	-	-
	2002	-	-	-	-	0.33	0.36	-	0.15	0.08	-	0.20	-

TABLE 10: A comparison of phytoseid communities occurring in vineyards and on wild plants surrounding them using a modified Sørensen Coefficient (C_N).

dator in vineyards is likely due to its pesticide susceptibility. Other species frequently found on the natural vegetation but rarely found or not recorded in these vineyards were *K. ericinus*, *K. langei*, *N. tiliarum* and *P. plumifer*. In northeastern Italy these species are rarely found in vineyards even if untreated, with the exception of *P. plumifer* on *V. labrusca* varieties (V. GIROLAMI, pers. comm.). *Kampimodromus aberrans* was relatively abundant in two vineyards but not common on natural vegetation. In other investigations carried out in Italy and France, *K. aberrans* was seen to be widespread on natural vegetation close to vineyards (COIUTTI, 1993; CIOFFI, 2000; TIXIER *et al.*, 1998). In France, migration towards vineyards was observed but settlement was not clearly assured (TIXIER, 2000; TIXIER *et al.*, 2000). In two sites *A. andersoni* was distributed on several plants and in the respective vineyards but this situation was observed during one year only. The case of *T. pyri* appeared to be the most interesting. During the first two experimental years its population densities on the wild vegetation were often low but this species was dominant in 3 vineyards. The abundance of *T. pyri* on plants surrounding vineyards increased in 2002 especially at Negrar, Santo Stefano and Zovon. During this season, the role of natural vegetation as a reservoir of phytoseiids of economic importance involved more *T. pyri* than other species. This data is consistent with the results reported by BOLLER *et al.* (1988) in Switzerland. It is difficult to ascertain if the larger distribution of *T. pyri* on plants surrounding vineyards observed in 2002 was favoured by the use of insecticides during the 1990s. Ad hoc studies on phytoseiid interchanges between vineyards and natural vegetation are required (TIXIER *et al.*, 1998, 2000).

Factors affecting phytoseiid dominance

Some phytoseiid species were clearly associated to specific hosts, i.e. *N. aceri* with *Acer* spp., *N. tiliarum* and *Kampimodromus* spp. with *C. avellana*, *P. plumifer* with *U. dioica*. These findings are partially consistent with those of surveys conducted in Italy (CARGNUS, 1995; MAZZON *et al.*, 2001; NICOTINA & CIOFFI, 1998; CIOFFI, 2000; TSOLAKIS *et al.*, 2000). In several cases, the colonization of certain hosts by phytoseiids was clearly associated to leaf morpho-

logy. The three *Kampimodromus* species were more common on plants characterized by hairy leaf veins (e.g. *C. avellana*) or showing domatia at the conjunction of the principal vein axils (e.g. *O. carpinifolia*). On the other hand, *E. finlandicus* was often dominant on plants having a glabrous leaf blade (e.g. *C. sativa*, *P. avium*, *S. nigra*) independently of domatia occurrence. Some relations between body size and leaf colonization patterns have been found: phytoseiids occurring on pubescent leaves or frequently found in domatia have usually small size. Some of them belong to the genera *Kampimodromus* and *Phytoseius* (BARRET & KREITER, 1992; WALTER, 1992; DUSO & VETTORAZZO, 1999). Their living in these leaf structures is associated with ideal climatic conditions for hatching and moulting, lower rates of competition, higher pollen retention (BARRET & KREITER, 1992; DUSO, 1992; KREITER *et al.*, 2002). Phytophagous mites are rarely occurring in domatia in contrast with predators and fungivores and thus mutualistic relationships between plants and predatory mites are strongly suggested (WALTER, 1996). Large predators such as *E. finlandicus* seem to find optimal conditions on glabrous leaves. Leaves of several plant species present glabrous undersurfaces but also tuft domatia (e.g. *A. campestre*). The presence of two different microhabitats on the same leaf allows for the coexistence of two or more species having different colonization preferences. On maples, *N. aceri* was observed typically in leaf domatia, while *E. finlandicus* preferred to run on blade surfaces. A similar example is reported by BARRET & KREITER (1992) concerning the colonization of *Tilia cordata* L. by *N. tiliarum* and *E. finlandicus*. Domatia are reduced or lacking in other plant species (e.g. *R. pseudacacia*), which are poorly colonized by phytoseiids.

Similar observations can be extended to vineyards. *Kampimodromus aberrans* and *T. pyri* populations reach higher densities on varieties having pubescent leaves than on those characterized by glabrous leaves (DUSO, 1992). The latter are colonized more frequently by *A. andersoni* (CAMPORESE & DUSO 1996). Data originating from the present study confirm this trend: vineyards of varieties with pubescent leaf undersurfaces were colonized mostly by *K. aberrans* (Lancenigo, Negrar) and *T. pyri* (San Pietro di Barbozza, Santo Stefano, Zovon in 1989). In the remain-

ning vineyard (Teolo), with a variety having glabrous leaf undersurfaces, *A. andersoni* and *E. finlandicus* were found more frequently.

Phytoseiid-host plant associations appeared to be poorly related to the occurrence of their typical prey, i.e. tetranychids and eriophyoids. In contrast, tydeids were constantly recorded on some plants. Tydeids are potential prey for some phytoseiid species (MCMURTRY *et al.*, 1970; OVERMEER, 1985), and optimal prey for others, such as *P. soleiger* and *P. talbii* (DOSSE, 1956; CAMPORESE & DUSO, 1995). The latter were scarcely represented on natural vegetation while the seasonal abundance of some common predatory mites sometimes appeared to be related to that of tydeids (e.g. *E. finlandicus* on *Acer* spp., *C. sativa* and *S. nigra*). Among the remaining mite groups encountered in this survey, we could mention tenuipalpids and winterschmidtids. The former are an important source of foods for some phytoseiids (MCMURTRY *et al.*, 1970; KOSTIAINEN & HOY, 1996), while the role of winterschmidtids is scarcely documented (DOSSE, 1956; KNISLEY & SWIFT, 1971). Feeding on small insects, honeydew and mould can improve phytoseiid survival but the effects of these food sources are known in a limited number of cases, including *E. finlandicus* (KROPCZYNSKA-LINKIEWICZ, 1971; TANIGOSHI, 1982; SCHAUSBERGER, 1997). A number of species found in this survey can develop and reproduce on pollen (MCMURTRY & CROFT, 1997) and it is reasonable that phytoseiid persistence on natural vegetation is strongly affected by pollen availability. A significant effect of certain fungi on phytoseiid biology has been reported for some of species reported in the present study (CHANT, 1959; KROPCZYNSKA-LINKIEWICZ, 1971; DAFTARI, 1979; BAKKER, 1993; ZEMEK & PRENEROVA, 1997; DUSO *et al.*, 2003). The preference for a host plant by a phytoseiid species could be also related to the capacity of piercing leaf cells. This event, reported by CHANT (1959) and KREITER *et al.* (2002) for *K. aberrans*, may have great implications for phytoseiid persistence.

During 1988 and 1989 the phytoseiid species found to be more abundant in vineyards were *T. pyri*, *A. andersoni* and *K. aberrans*. In 2002 these species were confirmed as dominant even if *K. aberrans* and *A. andersoni* were not abundant. Unfortunately, we have no data for Negrar where *K. aberrans* was widespread

in the past. Apparently, the increased use of organic insecticides in the 1990s did not affect phytoseiid communities in these vineyards, in particular those colonized by *T. pyri* and *A. andersoni*. Both species are known to be resistant to a number of insecticides (DUSO *et al.*, 1992). The strain of *K. aberrans* occurring at Lancenigo was seen to be susceptible to OPs (DUSO, unpublished data). Its persistence is most likely due to the use of pyrethrins instead of organic insecticides.

Plant species with a potential role in promoting phytoseiid diversity and abundance

Eighteen phytoseiid species were recorded on the vegetation surrounding the vineyards under examination. The number of phytoseiid species found in each site ranged from 9 to 14. These values are close to those found in previous studies carried out in the same area (11 species in a single agro-ecosystem, DUSO *et al.*, 1993) and higher than those found in other studies carried out in northern Italy (5 species in various agro-ecosystems, LOZZIA and RIGAMONTI, 1990) and Switzerland (7 species in various agro-ecosystems, BOLLER *et al.*, 1988). More diversified phytoseiid complexes have been found in southern Italy (16 species in a single agro-ecosystem, CIOFFI, 2000) and southern France (14 species in a single agro-ecosystem, TIXIER, 2000).

Plant species composition and structure, their proximity to vineyards, and the management of the latter (especially pesticide use) are obvious factors affecting the diversity of phytoseiid species occurring on wild plants. It was not possible to compare phytoseiid diversity across the sites because of their marked differences (plant species number, vegetation structure, climate, etc.). An analysis of communities recorded on different plants (within each site) showed that phytoseiid diversity was often higher on *C. avellana* and *R. ulmifolius* than on other plants. At the same time, phytoseiid communities occurring on *C. sanguinea*, *C. sativa* and *P. avium* were more similar than others to those of the grapevine, at least in some sites or years. This data suggests a role of these plants as a reservoir of phytoseiids for vineyards even if additional information is needed.

Planning a new hedgerow plantation clearly depends on the type of farm (organic or conventio-

nal, etc.) or the farming goals, i.e. protection from wind, increase of wood production, reduction of nutrient releases, promotion of apiculture, etc. Biological control is considered with attention in organic farms only. The role of plants as reservoirs for phytoseiids is only a part of the total expected biological control functions, since grape moths and leafhoppers (assumedly unaffected by phytoseiids) cause the most frequent problems to European vineyards. Most of the plants encountered in this study showed positive features for this purpose. *Corylus avellana* provides large amounts of pollen early in the season, potentially used by overwintering phytoseiids and other beneficials, including honeybees. This plant is colonized by specific eriophyoids and tetranychids, winterschmidtids and aphids (honeydew) for long periods, and it is frequently infected by powdery mildew. *Corylus avellana* is frequently colonized by the same phytoseiid species occurring in vineyards, i.e. *K. aberrans* (COIUTTI, 1993; CIOFFI, 2000) and, to a lesser extent, *T. pyri* (BOLLER *et al.*, 1988). Other plants provide large amounts of pollen (e.g. *C. sanguinea*, *O. carpinifolia* and *S. nigra*) or support a wide range of non-damaging mite species (e.g. *Acer* spp.). The positive role of *R. ulmifolius* and *U. dioica* in providing habitats for parasitoids and predators is also well known (ARZONE *et al.*, 1988; CERUTTI *et al.*, 1989; SOMMAGGIO *et al.*, 1995). However, the management of these two plants is difficult. Some plant species (e.g. *C. avellana*, *C. sanguinea*, and *S. nigra*) were often characterised by high densities of phytoseiids. During 1988 and 1989 the predatory mites dominant on these plants were seldom those considered important for vineyards. However, the results obtained during 2002 suggest a major role of some wild plant species (e.g. *C. sanguinea* and *S. nigra*) in the conservation of *T. pyri* populations.

Implications of these findings require additional studies. The settlement of predatory mites occurring on natural vegetation into vineyards seems to be hardly menaced because of their susceptibility to conventional pesticides. It is likely that predatory mites living on wild plants close to vineyards may have some contacts with chemicals because of the spray drifting. This is assumed to be especially true of hedgerows and stand margins. The effects of pesticides on predatory mites should involve also strains

originating from natural vegetation. Furthermore, population genetics will give a fundamental contribution in assessing the real potential of natural vegetation for biological control (TIXIER *et al.*, 2002).

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