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DISTRIBUTION OF TRICHODORIDS IN THE VINEYARDS OF THE PROVINCE OF TRENTO (NORTHEASTERN ITALY)

by

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Summary. This survey describes the distribution of Trichodorid nematodes in the grapevine plantations of the Province of Trento. Four species were recorded, including the first Italian record of *Trichodorus primitivus* de Man. In the survey 300 vineyards were sampled in the main vine growing areas. Sixty-nine positive sites containing 79 trichodorid populations were located. The maps showed the geographical distribution of each species. *T. viruliferus* Hooper was the most commonly found species and had a uniform distribution in the vineyards with sandy soils, in the plains, hills and mountains of six valleys. *Paratrichodorus teres* Hooper was the next most prevalent species and was found in samples from the Adige and the Cembra valleys, always in old vineyards growing in sandy soils on the plains. Populations of the other two species *T. sparsus* Szczygiel and *T. primitivus* were restricted in both number and distribution. *Trichodorus sparsus* was found in the Sarca valley in both old and young vineyards in sandy soils on the plains. *Trichodorus primitivus* was found, in very low numbers, in the Adige and the Lagarina valleys, restricted to young vineyards with sandy loam, loamy sand and clay soils on the plains and the hills.

Trichodorid nematodes are known to cause damage to many crops of economic importance both by direct feeding on the root system of plants and by vectoring viruses. In Italy there have been several surveys of the distribution of these nematodes and the damage they cause. However, these surveys have often been very general (Roca and Lamberti, 1985) or specifically related to areas of poor growth or outbreaks of disease in the crops. In 1966 Van Hoof *et al.* reported the occurrence of *Trichodorus viruliferus*, *Paratrichodorus teres* (syn. *T. teres*) and *P. nanus* (syn. *T. nanus*) in a survey of the spread of Tobacco rattle virus (TRV) in the northern regions of Italy. *Trichodorus viruliferus* was also found in Piedmont (Roca *et al.*, 1977; Mancini *et al.*, 1979) and Umbria (Roca and Rana, 1981). Mancini *et al.* (1979) also reported *T. aequalis* from Piedmont but after more detailed study it was described by De Waele *et al.* (1982) as a new species, *T. taylori*. De Waele *et al.* (1982) also mapped the distribution of *T. sparsus* in northern and central Italy. Roca and Lamberti (1984), in a survey of Trichodoridae in soils under cultivation and from undisturbed vegetation in the Italian regions, found a total of eight species: *P. minor*, *P. tansaniensis*, *P. tunisiensis*, *T. similis*, *T. sparsus*, *T. taylori*, *T. variopapillatus* and *T. viruliferus*. In this paper a survey restricted to vineyards of the Province of Trento is described.

In the 1960s at the Experimental Station of Agriculture of San Michele all'Adige, a research project was initiated to determine the viticultural practice in the Province of

Trento. The project resulted in the production of the «Viticultural map» of the Province of Trento. In 1977 it was decided to supplement the map with a «Nematode map» of the Trentino vineyards (with particular respect to the virus vector nematodes — *Xiphinema*, *Longidorus* and *Trichodorus*). The main object was to provide research workers and technicians with a data base for viticultural improvements in the Province. This would help the viticulturists and wine producers to become more effective as part of the European Economic system, utilising to best advantage those soils particularly suited to vine-growing.

Viticulture in the Trento region has been practiced in soils used specifically for the cultivation of grapes for many years. Due to the limited availability of ground, crop rotation has not been possible. Vines that die or are non-productive are removed and immediately replaced.

At the present time viticulture is practiced in the plains, the hills and the mountains using modern methods. However, in the past the vines were planted in row with mulberry or other fruitiferous trees and between the rows were planted potatoes, beet-roots, legumes, cereals or fodder plants. This paper describes a study of the distribution of the virus vector nematodes of the genera *Trichodorus* and *Paratrichodorus* in the vineyards of Trentino.

Materials and methods

The Province was divided into viticultural regions or

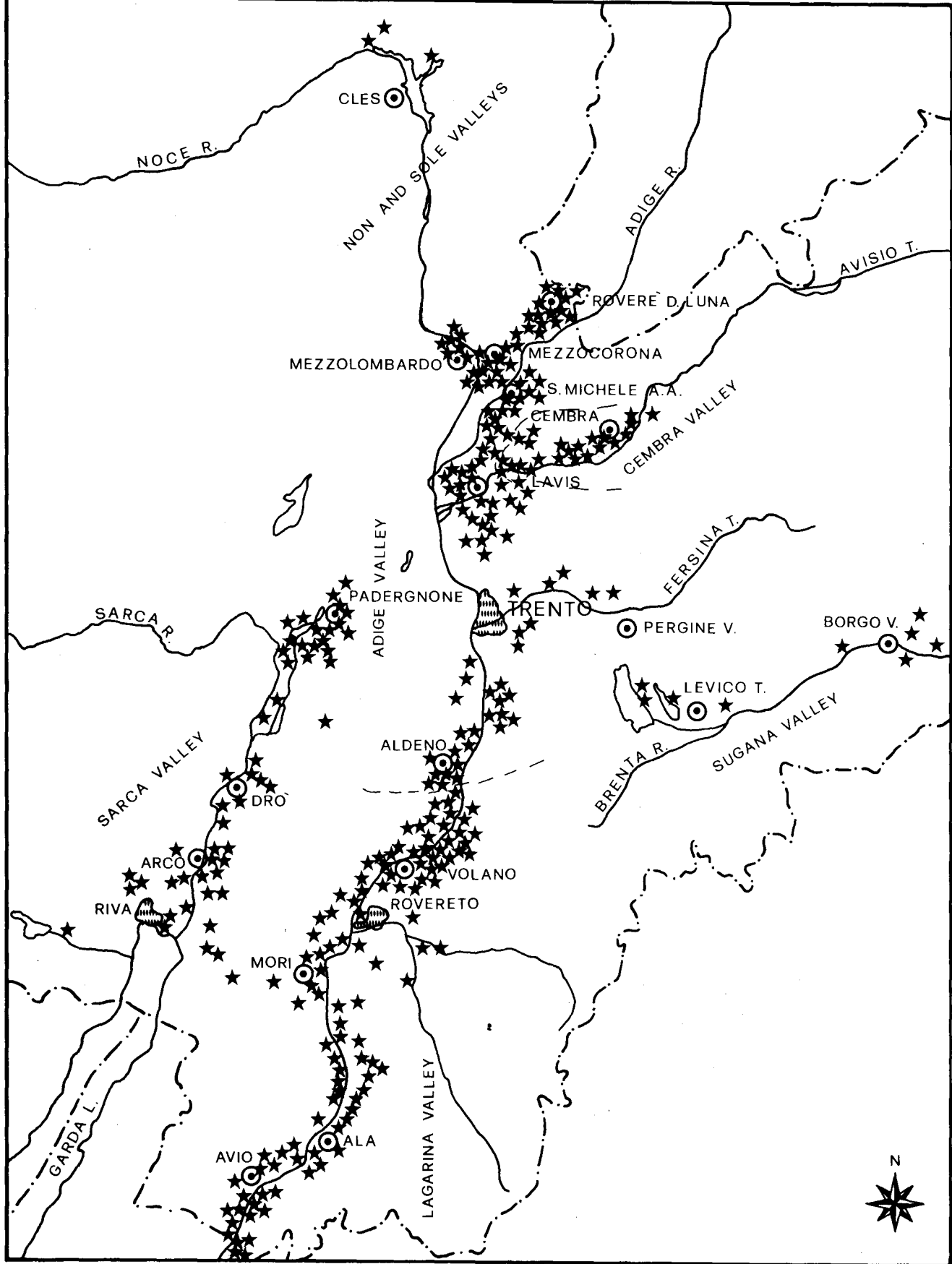


Fig. 1 - Total sites sampled in the Province of Trento.

valleys, not geographically but on the basis of the Viticultural map of Trentino. An area of 10962 ha was covered in the survey and 300 representative samples (1/36 ha) were taken in the valleys, Lagarina, of Adige, of Sarca and Ledro, Sugana, of Cembra and of Sole and Non. The survey was more intense in the largest viticultural valleys, where viticulture is of particular economic importance. A descriptive survey card was completed for each selected vineyard to locate the vineyard and to describe the environmental conditions. Each sample, representative of a vineyard, was obtained by mixing 4-5 kg of soil, collected from the roots of plants showing symptoms of virus disease. Samples were collected from the top 30-40 cm using a trowel or spade and were transported to the laboratory in polythene bags. All samples were processed as soon as possible, usually within 72 hrs. Nematodes were extracted from 500 ml sub-samples by the Cobb's sieving technique. The extracted nematodes were killed in hot 4% formalin. Each sample was examined for specimens of *Longidorus*, *Xiphinema*, *Trichodorus* and *Paratrichodorus*. For the purpose of this paper numbers of Trichodorids present were counted. Specimens were mounted in anhydrous glycerol by a slow method and the species identified.

Results

In the survey 300 vineyards were sampled and 69 positive sites were recorded. The location of the sampled vineyards is shown in Fig. 1. From 69 positive sites 79 trichodorid populations were identified to species level. A total of four species were found: *Paratrichodorus teres* Hooper, 1962; *Trichodorus primitivus* de Man, 1880; *T. sparsus* Szczygiel, 1968; *T. viruliferus* Hooper, 1963. The geographical distributions of the species are shown in Figs. 2 and 3.

PARATRICHODORUS TERES Hooper 1962 (Fig. 4)

Paratrichodorus teres was reported, but not described, by Van Hoof *et al.* (1966). The biometric characteristics of a population of this species found at Giovo-Ceola in the Cembra valley are reported here:

6 ♀ ♀: L = 0.65 (0.62-0.71) mm; a = 17.5 (15.1-19.8); b = 4.9 (4.6-5.5); c = subterminal; V = 55.7 (55.3-56.7); onchiostyle = 45.7 (43.5-50.0) µm.

Body cylindrical, straight when killed by heat and tapering rapidly to the lip region. Tail tip rounded. Pronounced ventral overlap of oesophagus. Gonads paired, opposed, ovaries reflexed with oocytes present. Vulva appears as a short longitudinal slit; small oval refractive thickenings at junction of vulva and vagina with a characteristic shape in lateral view (Fig. 4). Anus subterminal, paired caudal pores almost terminal. Lateral body pores are visible. Males were not found. The specimens are in poor

condition and the length of the specimens differs from the original description (L = 0.65 mm viz. 0.86 mm). There appears to have been considerable shrinkage in the bodies and their lengths are now closer to that of *P. tansaniensis*. Lateral body pores are visible on many of the females; such pores have not been reported for *P. tansaniensis*.

P. teres was the second most commonly found species. The distribution of the species was restricted and mostly found in samples from the Adige and Cembra valleys (Table I) always in old vineyards in sandy soils generally in the plains.

TABLE I - Localities of the province of Trento and grapevine rootstocks where *Paratrichodorus teres* specimens were collected.

Districts	Localities	Rootstocks
Giovo	Mosana-Piaggi	Kober 5BB (<i>V. berl.</i> x <i>V. rip.</i>)
»	Ceola	» » » »
Lavis	Carmine	» » » »
Mezzocorona	Zablan	101/14 (<i>V. rip.</i> x <i>V. rup.</i>)
»	Ischia	3309 (<i>V. rip.</i> x <i>V. rup.</i>)
»	»	101/14
»	Camorzi	»
Mezzolombardo	Vignoli	T8B (<i>V. berl.</i> x <i>V. rip.</i>)
»	Vicino al Noce	Kober 5BB
Vezzano	Norighe	» »

TRICHODORUS PRIMITIVUS De Man 1880 (Fig. 4)

The biometric characteristics of a population of *T. primitivus* found at Mezzocorona in the Adige valley are:

4 ♂ ♂: L = 0.74 (0.65-0.82) mm; a = 24.9 (22.9-26.4); b = 5.9 (4.8-6.8); onchiostyle = 45.8 (43.5-47.1) µm; spicules = 34.6 (32.4-35.3) µm; gubernaculum 16.3 (14.7-17.6) µm.

2 ♀ ♀ (same population): L = 0.7-0.7 mm; a = 21.5-22.3; b = 5.1-5.4; c = subterminal; c' = 0.4-0.4; V = 55-57; onchiostyle = 46-46 µm.

Females have a straight cylindrical body when killed by heat, tapering to the lip region. Tail tip rounded with subterminal anus. Excretory pore level with the anterior end of the expanded portion of the oesophagus. Three ventromedian papillae located anterior to the excretory pore. Oesophageal glands do not overlap the intestine. Gonads paired and opposed; ovaries reflexed with oocytes. Spermatheca present. Vulva with wide opening and large re-

fractive thickenings at the junction of the vulva and vagina (Fig. 4). Males: anterior three-fourths of body slightly curved ventrally, posterior fourth curved about 90°. Excretory pore and papillae as in the females. Three ventro-median supplementary papillae: the first near the proximal end of the spicules; the second, three-quarter body-width anterior to the first; and the third, two body-widths anterior to the second. Spicules variable in shape, manubrium *c.* 3 µm wide at the proximal end, narrowing to *c.* 1 µm in the middle of the spicule. The gubernaculum is convex anteriorly for most of its length — only the proximal end is flat.

T. primitivus occurred infrequently and in very low numbers in the Adige (2 sites) and Lagarina (3 sites) valleys (Table II), always occurring in young vineyards in sandy

loam, loamy sand and clay soils, in the plains or on the hills. This is the first record of *T. primitivus* in Italy.

TRICHODORUS SPARSUS Szczygiel, 1968

This species occurred in samples collected in vineyards of the Sarca valley in the western part of the province (Fig. 3; Table III). The populations are morphologically and biometrically within the range of the European populations of this species (Loof, 1973) and a detailed description of the species and its biometrics are provided by Roca and Lamberti (1984). *T. sparsus* was found in both old and young vineyards in sandy soils in the plains.

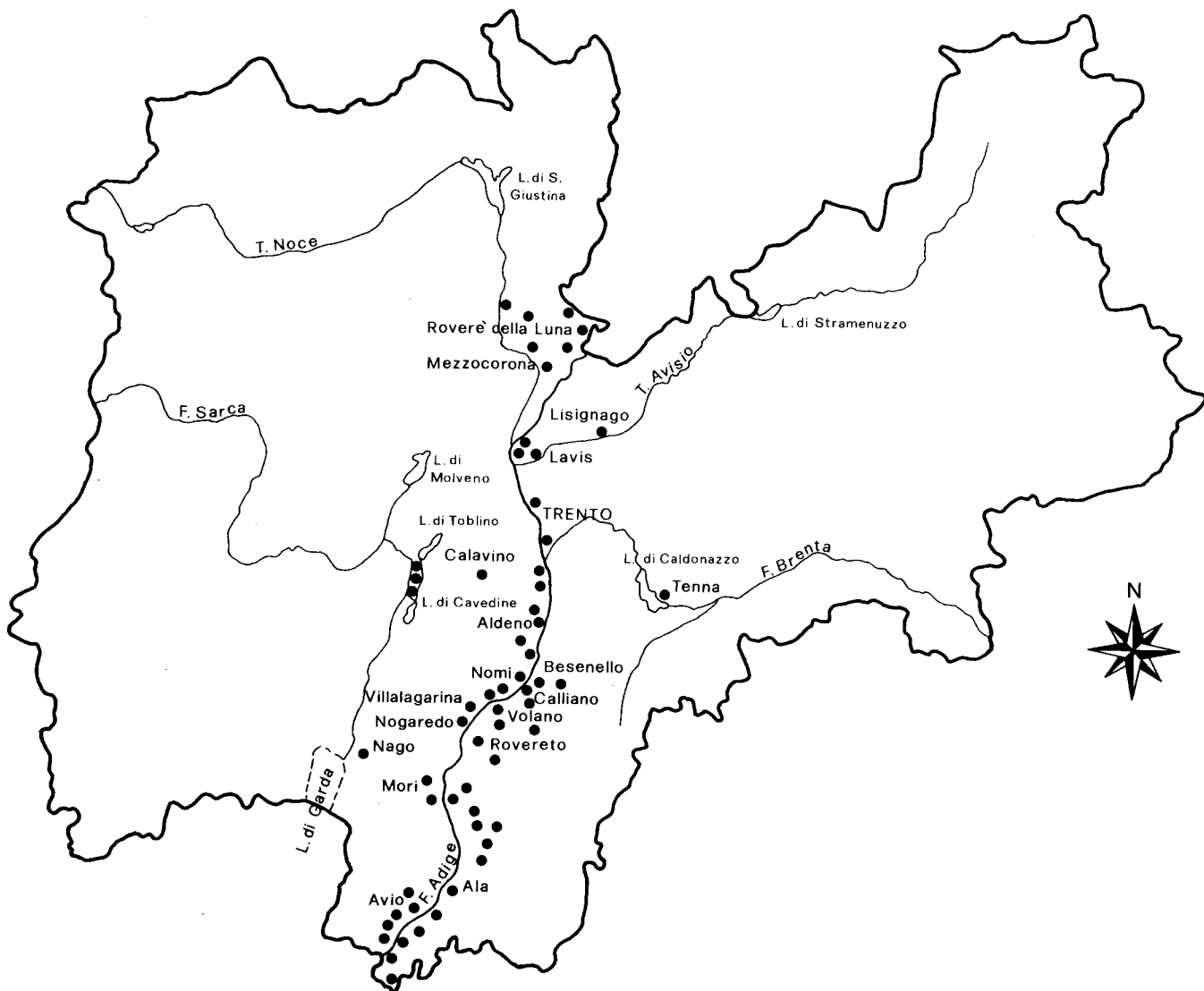


Fig. 2 - Distribution of *Trichodorus viruliferus* in the Province of Trento.

TABLE II - Localities of the province of Trento and grapevine rootstocks where *Trichodorus primitivus* specimens were collected.

Districts	Localities	Rootstocks
Mezzocorona	Fratte	101/14
Volano	Le Ville-Ponta	Kober 5BB
»	Praolini	» »
»	»	» »
Lavis	Carminè	» »

TABLE III - Localities of the province of Trento and grapevine rootstocks where *Trichodorus sparsus* specimens were collected.

Districts	Localities	Rootstocks
Mezzocorona	Zablan	101 14
»	Ischia	101/14/3309
Nago-Torbole	Linfano	Kober 5BB
Calavino	Ponte Olivetti	» »
Dro	Gere	» »

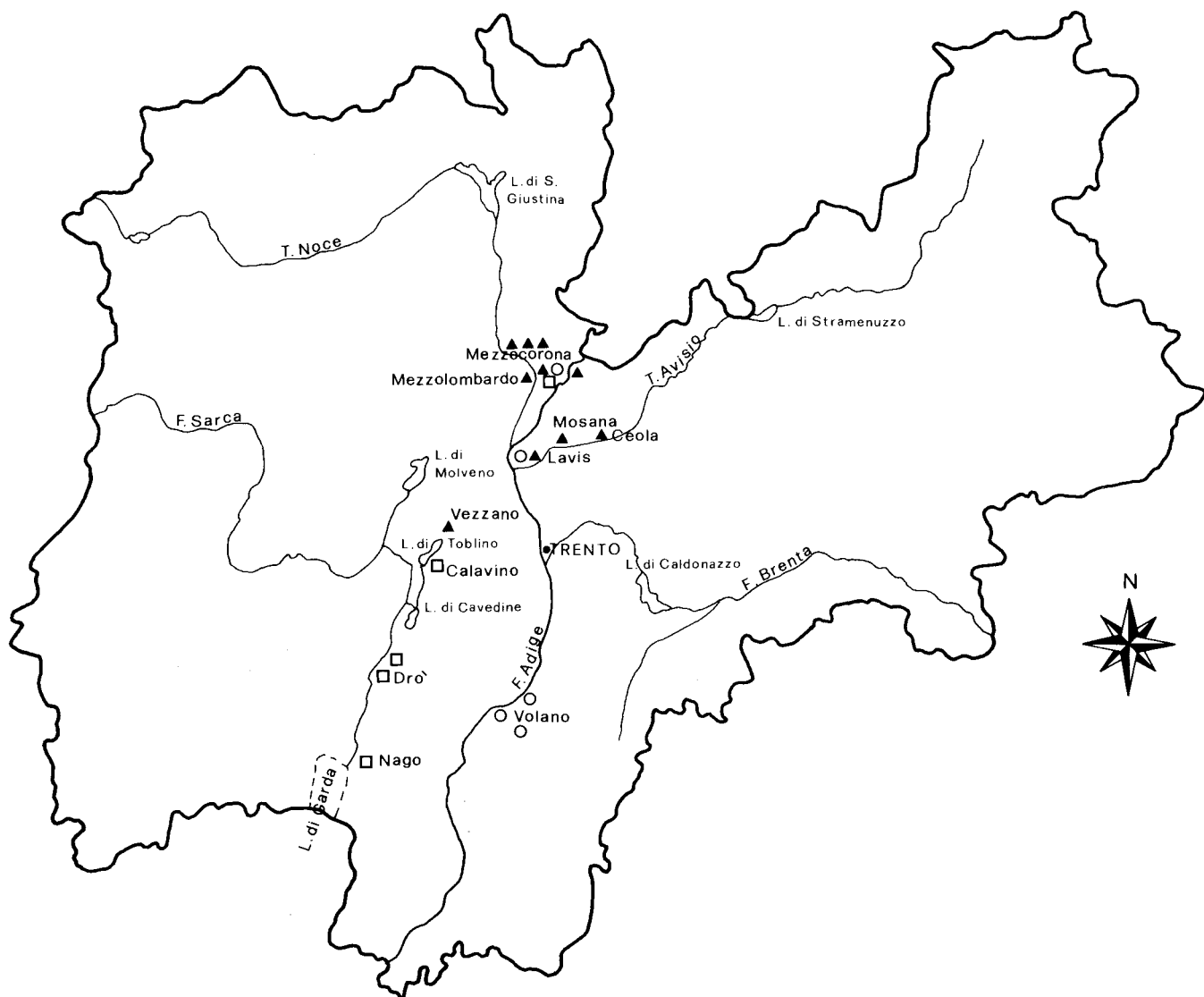


Fig. 3 - Distribution of *Trichodorus primitivus* ○, *T. sparsus* □, and *Paratrichodorus teres* ▲ in the vineyards of the Province of Trento.

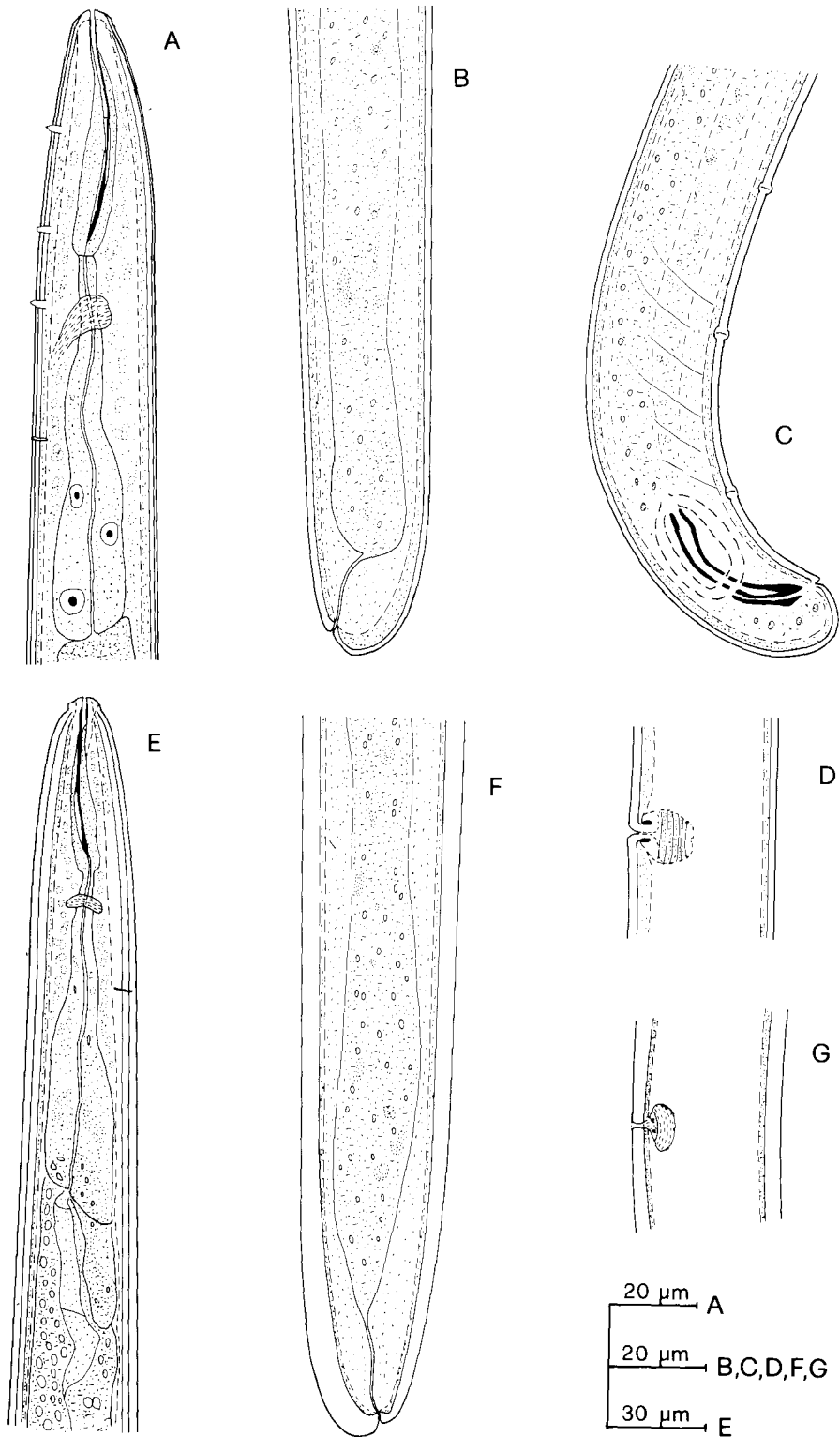


Fig. 4 - *Trichodorus primitivus*: A and B, female anterior and posterior region; C, male posterior region; D, vulval region; *Paratrichodorus teres*: E and F, female anterior and posterior region; G, vulval region.

In the survey *T. viruliferus* was the most commonly found species with a wide distribution in the six valleys (Table IV). It also occurs throughout Italy in association with various herbaceous and woody plants. Populations of this species were found in 20% of the samples analysed. It was recorded from young and old vineyards in sandy soils in the plains, hills and mountains. Population size ranged from more than 200 specimens/500 ml of soil to less than 10 specimens/500 ml of soil. The populations fit the original description of the species. A detailed description of the *T. viruliferus* and its biometrics are provided by Roca and Lamberti (1984).

TABLE IV - Localities of the province of Trento and grapevine rootstocks where *Trichodorus viruliferus* specimens were collected.

Districts	Localities	Rootstocks
Roveré della Luna	Vinchieri	T8B
» »	Pipelare	101/14
Mezzocorona	Zablan	»
»	Fratte	»
»	Ischia	101/3309
»	Catanei	101/14
»	S. Antonio	»
Aldeno	Spinelli	Kober 5BB
»	Pradazzi	» »
»	Socco	» »
Trento	Ravina	» »
»	Gardolo-Maso Garbini	» »
»	Lamar	» »
»	Romagnano	» »
Besenello	Rimoni	» »
Calliano	Maso Part	» »
»	Ischietta	» »
»	Campagnole	» »
Volano	Le Ville Ponta	» »
»	» » »	» »
»	Ponta	» »
»	Praolini	» »
»	Loffi	» »
Villalagarina	Piazze	» »
»	Cesura	» »
Nogaredo	Nogaredo	» »
Ala	Baitoni	» »
»	Serravalle/Ischia	» »
»	Marani-Soini	» »

Districts	Localities	Rootstocks
Ala	Villetta	Kober 5BB
»	Serravalle/Ischia	» »
»	Serravalle/Moiere	» »
»	S. Margherita	» »
»	S. Margherita/Sgardaiolo	» »
»	Marani Pozze	» »
Avio	Mama Prai	» »
»	Masi Igon	» »
»	Masi Prati	» »
»	Sabbionara	» »
»	Sabbionara/Campeì	» »
»	VO Destro/Cimitero	» »
»	Borghetto	» »
»	Dazio vecchio	» »
»	Ischia	» »
»	Caprolongo Chizzola	» »
Tenna	Tenna Paese	» »
Nago-Torbole	Nago	» »
Calavino	Sarche	» »
»	Ponte Olivetti	» »
»	Palazzina	» »
Cavedine	Brusino	» »
Rovereto	Lizzana	Rupestris
»	Novicello	Kober 5BB
Nomi	Bastie	» »
Mori	Casotte	» »
Lavis	Carmine	101/14
»	Torbisi	Kober 5BB
»	Sort	» »
Lisignago	Lingoy	» »

Discussion

Although more extensive sampling would be necessary to provide a detailed distribution map, sufficient survey data have been collected to produce a meaningful picture of the distribution and the species composition of trichodorids in the grapevine plantations of the Province of Trento. In the survey 23% of the soil samples were positive for trichodorid nematodes. This may be an underestimate of the abundance of trichodorids as low density populations could have been lost in the transit of soil samples to the laboratory or during nematode extraction. The soil samples were processed by a method to obtain all vector genera and therefore yielded low trichodorid numbers. Van Hoof *et al.* (1966) detected trichodorids in 50% of the

120 samples collected in cultivated soils in northern Italy during a study of the relationship between TRV and its vectors. Roca and Lamberti (1984) found trichodorids in 380 of 4,000 (9.5%) samples collected in the Italian regions in soils under cultivation and from undisturbed vegetation. In their survey, extending over 1,500 km from north to south, only 8 species were found: three *Paratrichodoros* and five *Trichodoros*.

The most frequently recorded species in this survey was *T. viruliferus* (59 records). It is also the species most widespread throughout Italy. In contrast, only a few records of the three other species were obtained. The small number of records for these species is indicative of their restricted distributions in the vineyards. *T. primitivus* was found only at five sites, all in the Adige and the Lagarina valleys. On each occasion it was found in very low numbers and in young vineyards. Although *T. primitivus* has been found previously throughout Europe, this paper presents the first record of it in Italy. The species possibly has been introduced with imported plants or soil and has been able to adapt to the new conditions. It is generally accepted that the more primitive, less specialised species can adapt more readily (Alphey and Boag, 1976).

Paratrichodoros teres was the second most commonly found species (10 records). The species was recorded first by Van Hoof *et al.* (1966), who observed that *T. teres* (syn.

TABLE V - *The occurrence of single and mixed species populations of Trichodoridae in the infested grapevine plantations (results from 1977-1980).*

	Number of fields infested with*	%
Trichodoridae	300	100
<i>T. v.</i>	59	19,7
<i>T. s.</i>	5	1,7
<i>T. p.</i>	5	1,7
<i>P. t.</i>	10	3,3
<i>T. v.</i> alone	52	17,3
<i>T. s.</i> alone	2	0,7
<i>T. p.</i> alone	1	0,3
<i>P. t.</i> alone	7	2,3
<i>T. v.</i> + <i>T. s.</i>	2	0,7
<i>T. v.</i> + <i>T. p.</i>	3	1,0
<i>T. v.</i> + <i>P. t.</i>	1	0,3
<i>T. v.</i> + <i>T. p.</i> + <i>P. t.</i>	1	0,3
<i>T. v.</i> + <i>T. s.</i> + <i>P. t.</i>	1	0,3

* *T. v.* = *T. viruliferus*; *T. s.* = *T. sparsus*; *T. p.* = *T. primitivus*; *P. t.* = *P. teres*.

P. teres) which in the Netherlands had been found only in marine soils, was present far inland in Italy. It was reported from along the course of the Adige as far as Brunico (Province of Bolzano, northern Trento), as well as Sondrio and north of Mantova in the middle of the Po basin. In this survey, it was similarly found along the course of Adige in the northern part of its valley and in two samples in the Cembra valley along the Avisio. This species occurred only in old vineyards in the plains and in sandy soils. This species with a restricted distribution is probably a residue of the original fauna.

Trichodoros sparsus is a common species in northern Italy being recorded mainly under trees such as poplar, alder and chestnut. In this survey it was found in the western part of the province in vineyards of various ages, along the Sarca river. The species may have occurred more commonly, but failed to survive with only vines present as hosts.

Except *T. sparsus* for which the ability to transmit virus has not yet been demonstrated, the other three trichodorid species are all known as vectors of TRV.

The majority of the infested vineyards had trichodorid populations of 20-50 specimens/500 ml of soil. Table V indicates that 19.7% of the infested fields contained *T. viruliferus* and that this species was the only species in 17.3% of the infested fields. It appears that *T. viruliferus* is more tolerant of different environmental conditions than the other species. In contrast *T. primitivus* and *T. sparsus* only occur alone on one and two occasions respectively, but in combination with *T. viruliferus* on three and two occasions and on one occasion with *P. teres* (Tables V and VI). *P. teres* was found in single species populations in seven vineyards and once with *T. viruliferus*, once with *T. primitivus* and once with *T. sparsus*.

A study of the natural habitats can help to identify the dominant factors influencing distribution of these nematodes. The ecology of trichodorid nematodes is complex. In many investigations single environmental factors have been studied but rarely has an attempt been made to define the ecosystem. The factors which influence the populations and determine the distribution patterns are still not

TABLE VI - *The occurrence of single populations of Trichodoridae and of their association with each other (in populations with two species).*

	<i>T. viruliferus</i>	<i>T. sparsus</i>	<i>T. primitivus</i>	<i>P. teres</i>
<i>T. viruliferus</i>	52	2	3	1
<i>T. sparsus</i>		2	1	0
<i>T. primitivus</i>			1	0
<i>P. teres</i>				7

fully understood. From this survey the optimum soil types for locating trichodorids were sandy loams and loamy sands. Similar findings have been recorded by many workers. An explanation of this distribution was suggested by Jones *et al.* (1969), who postulated that soil pore spaces were very important for activity and survival. It was suggested that due to their size trichodorids were unable to penetrate the densely packed soils containing much clay or silt. An exception to this appears to be *T. primitivus* which was also found in clay soil.

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