Tylenchids (Nematoda) extracted from soil

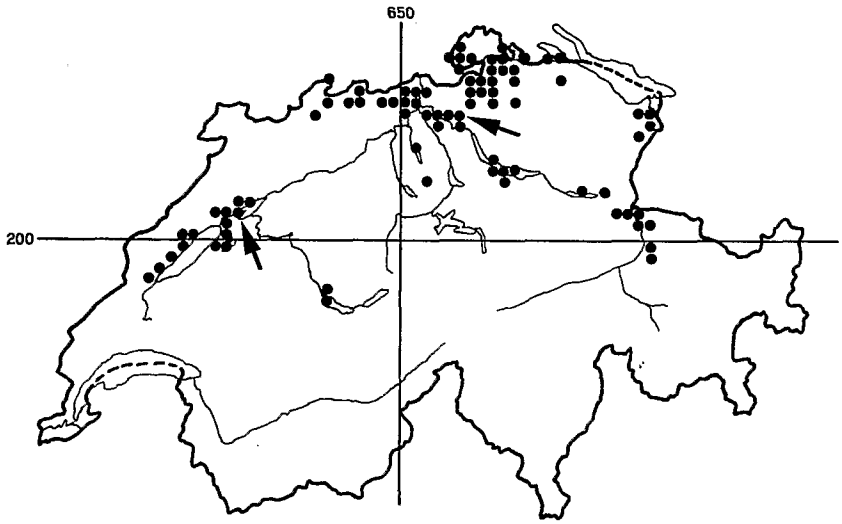

Fig. 1. Distribution of the investigated 82 vineyards. *Criconemella xenoplax* was found everywhere except for two places marked by an arrow.

suspended subsequently following a method by Bieri and Delucchi (1980). From the suspension, an equivalent of 200 cm^3 of soil was processed using the centrifugal method. For further concentration, the suspen-

numbers of females and of collected species were used. The diversity index was calculated after Shannon-Wiener, from which the relative index of diversity was derived.

Results and discussion

Frequency and abundance of the species

Thirty-one species of nematodes belonging to 15 genera were recorded in 82 vineyards. Eleven species occured in at least 10 vineyards; the frequency distribution of their abundance is shown in Figure 2. Species recorded in less than ten vineyards are listed in Table 1.

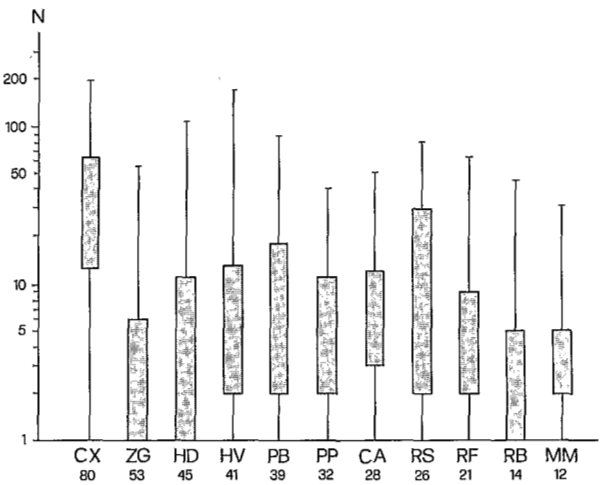

Fig. 2. Frequency distribution of the abundance of the most common species. Thick bars indicate the abundance of 50 % of the vineyards where the species were found (CX = *Criconemalla xenoplax;* ZG = *Zygotylenchus guevarai;* HG = *Helicotylenchus digonicus;* HV = *H. vulgaris;* PB = *Paratylenchus baldacii;* PP = *P. peraticus;* CA = *Criconemella antipolitana;* RS = *Rotylenchulus borealis;* RF = *Rotylenchus fallorobustus;* RB = *R. buxophilus;* MM = *Merlinius microdorus;* N = number of adults per 100 mm³ soil; figures on abscissa = frequency).

In 50 % of the vineyards the numbers of adults per 100 cm³ of soil ranged between 37 and 117, and the numbers of species between 4 and 7. The relative abundance of a particular species was generally low. Only in one third of the vineyards the relative abundance was above 7 % for the following species : *Zygotylenchus guevarai, Helicotylenchus vulgaris, Rotylenchulus borealis, Paratylenchus peraticus, Criconemella antipolitana* and *C. xenoplax.*

The geographical distribution of the species did not reveal any particular tendency. Some species were extremely rare or absent from the Canton Graubünden and the adjacent area of the Walensee (eastern part of Switzerland) : *H. vulgaris, R. borealis, Z. guevarai* and *P. peraticus* (Fig. 3). All these species exhibit some relationships to measured ecological factors (see below). *Rotylenchus buxophilus* was rarely observed in the Jura region were many samples were taken (Fig. 3, E). In Figure 4 the frequency distributions of the vineyards characteristics are summarized. The frequency distributions of the relative abundance of the most common species, *Criconemella xenoplax,* shows two distinct peaks (Fig. 5). This indicates the existence of two groups of vineyards with different characteristics. The vineyards where the relative abundance of the species is below 55 % are characterized by higher numbers of species as well as higher values of absolute and relative indices of diversity ($P \leqslant 0.001$). Moreover, in this group of vineyards the absolute and relative abundances of *C. antipolitana* and of *Helicotylenchus vulgaris* were found to be higher ($P \leqslant 0.001$) than in the other group. To a lesser degree the same holds true for *P. peraticus, Merlinius microdorus, H. digonicus* and *Z. guevarai* (all : $P \leqslant 0.05$). In some regions of the sampled area, the indices of diversity show that the vineyards of each of the above mentioned two groups are geographically connected. No significant coincidence of their distribution with measured ecological factors was observed.

Table 1

List of species, found in the soil of less than ten vineyards examined. The numbers on the right hand side indicate the frequency of the findings.

Tylenchorhynchus dubius (Bütschli, 1873) Filipjev, 1936	6
Nagelus " leptus " (Allen, 1955) Siddiqi, 1979	1
Amplimerlinius macrurus (Goodey, 1932) Siddiqi, 1976	5
Trophurus sculptus Loof, 1956	2
Macrotrophurus arbusticola Loof, 1958	5
Helicotylenchus pseudorobustus (Steiner, 1914) Golden, 1956	2
Rotylenchus pumilus (Perry, 1959) Sher, 1961	1
Rotylenchus sp.	4
Pratylenchus crenatus Loof, 1960	2
P. neglectus (Rensch, 1924) Filipjev & Sch. Stekh., 1941	2
P. pseudopratensis Seinhorst, 1968	1
P. thornei Sher & Allen, 1953	3
Paratylenchus projectus Jenkins, 1956	5
P. italiensis Raski, 1975	3
P. goodeyi Oostenbrink, 1953	1
P. macrodorus Brzeski, 1963	9
Criconemella rustica (Micoletzky, 1915) Luc & Raski, 1981	1
C. vadensis (Loof, 1964) De Grisse & Loof, 1965	5
C. informis (Micoletzky, 1922) Luc & Raski, 1981	6
Hemicycliophora thienemanni (Schneider, 1925) Loos, 1948	1

Relationships between pairs of species

No interdependence of the abundances of any two species could be found. However, *Merlinius microdorus* was observed more frequently than expected in association with *Rotylenchus fallorobustus* as well as with *Cri-*

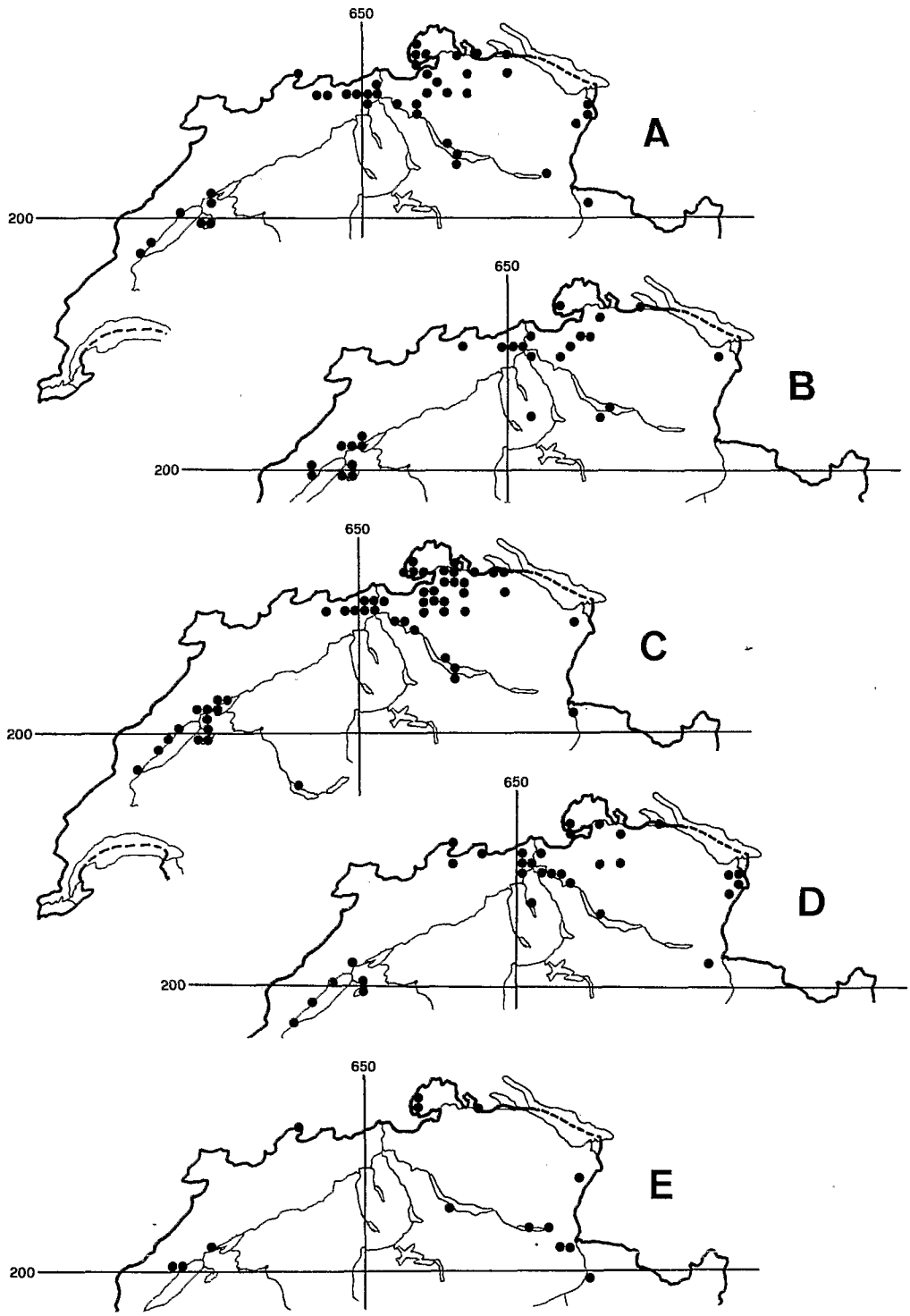

Fig. 3. Records of *Helicotylenchus vulgaris* (A), *Rotylenchulus borealis* (B), *Zygotylenchus guevarai* (C), *Paratylenchus peraticus* (D), and *Rotylenchus buxophilus* (E).

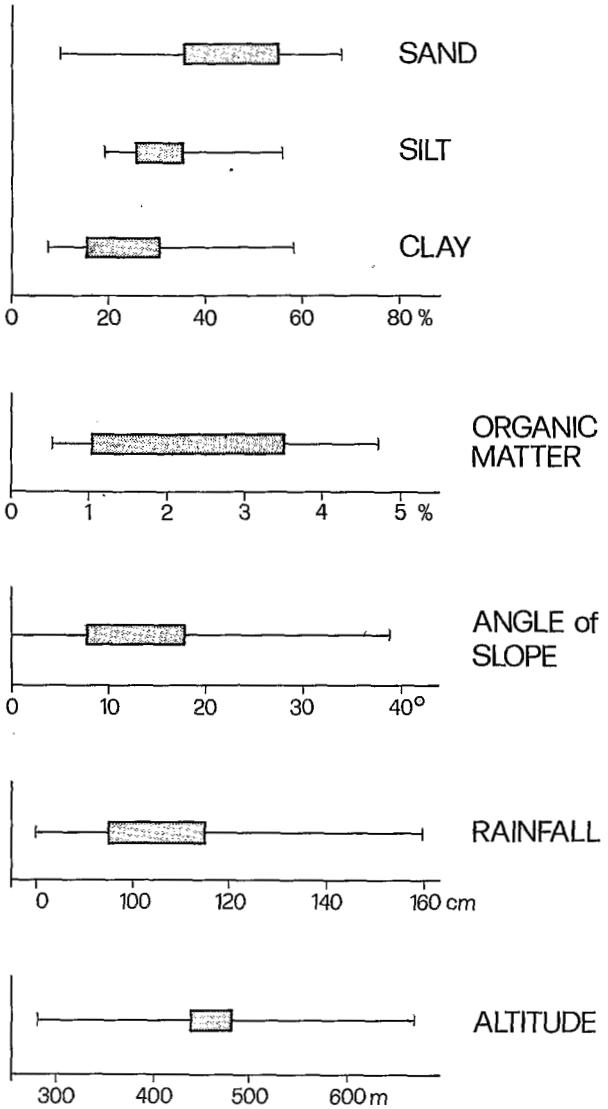

Fig. 4. Frequency distribution of the measured ecological factors. The thick bars indicate the values corresponding to 50 % of the vineyards around the mean.

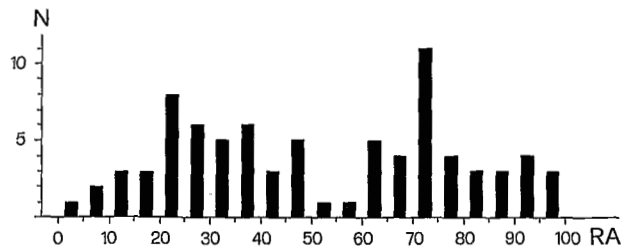

Fig. 5. Frequency distribution of the relative abundance (RA) of *Criconemella xenoplax* (N = number of findings).

conemella antipolitana ($P \leq 0.001$). These results do not indicate the nature of the association, which was tested by forming three classes of vineyards, i.e. two classes having one of the associated species alone and a third class of vineyards having two species present. The ANOVA did not reveal the existence of a measured ecological factor favoring the species. It is concluded that the association of the species might indicate differences in the preference for microhabitats and in feeding behaviour, thereby reducing competition for food supply. In fact, the morphology of the associated species is very different.

RELATIONSHIPS BETWEEN SPECIES AND MEASURED ECOLOGICAL FACTORS

Assuming normal distribution, the following relationships are all significant at the 5 % level or below. However, the correlation coefficients are not indicated because of the considerable variance in the data.

Helicotylenchus vulgaris : By considering the vineyards with no other species of the same genus, the numbers of the larvae could also be included in a multiple regression analysis. The results obtained indicate that highest numbers of adults and larvae are to be expected in vineyards with highest rainfall, highest organic matter content, highest altitude, and lowest inclination (in decreasing order of importance). Thus, 65 % of the total variance could be explained. All of the mentioned characteristics are somehow related to soil moisture : the higher the moisture content, the more abundant the species. This finding agrees well with the observation that *H. vulgaris* was mainly found in soils with higher contents of clay, i.e. in soils with a high capacity for water retention ($P \leq 0.05$).

Zygotylenchus guevarai : The number of adults and larvae, and the percentage of silt in the soil were positively correlated (Fig. 6). As the species is small, this correlation might also prove the existence of a relationship between available pore space and reproduction rate.

Paratylenchus peraticus and *Criconemella antipolitana* : The absolute and relative abundance of *P. peraticus* in vineyards free of weeds (class 1) was higher than in vineyards with some weeds (class 2) (Fig. 7 A for relative abundance). *C. antipolitana* was found to behave in the opposite way whereby only the relative abundance was concerned (Fig. 7 B).

Criconemella xenoplax : The total number of females and larvae decreased with increasing amount of clay (Fig. 8) in vineyards where no other congeneric species were present. In clay soils, where pores are small, this species seems to be hindered in its movements. This result is in agreement with Seshadri (1964) who found

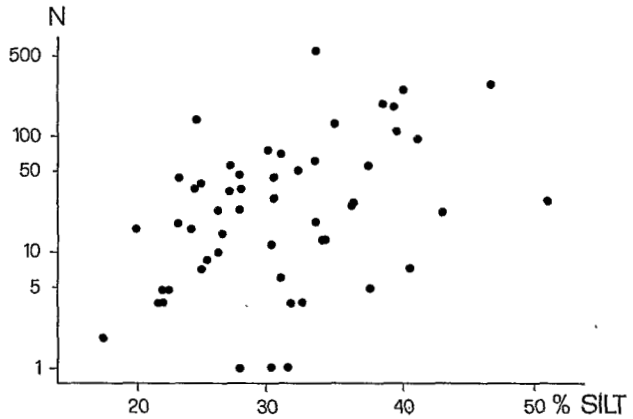

Fig. 6. Relationship between abundance of *Zygotylenchus guevarai* (N = adults + larvae, per 100 cm³ of soil) and

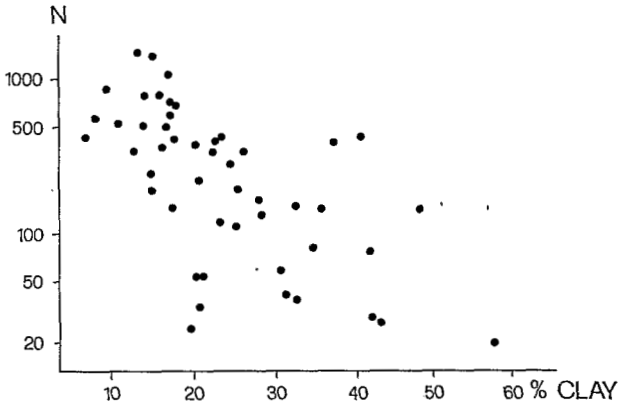

Fig. 8. Relationship between abundance of *Criconemella xenoplax* (N = adults + larvae, per 100 cm³ of soil) and amount

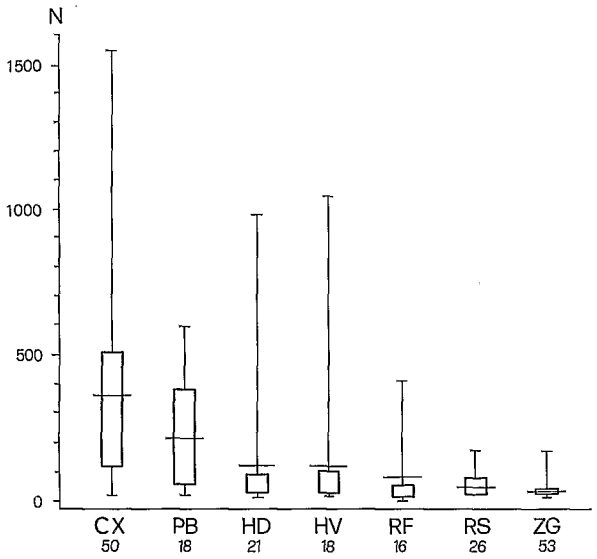

Fig. 9. Frequency distribution of the abundance of adults and larvae of seven species. Within the range of the thick bars half of the sites are located, and mean values are indicated by a crossline (CX = *Criconemella xenoplax;* PB = *Paratylenchus baldacii;* HD = *Helicotylenchus digonicus;* RF = *Rotylenchus fallorobustus;* RS = *Rotylenchulus borealis;* ZG = *Zygotylen-*

BIERI, M. & DELUCCHI, V. (1980). Eine neu konzipierte Auswaschanlage zur Gewinnung von Bodenarthropoden. *Mitt. Schweiz. Ent. Ges.*, 53 : 327-339.

DE GRISSE, A. T. (1969). Redescription ou modification de quelques techniques utilisées dans l'étude des nématodes phytoparasitaires. *Meded. Rijksfak. Landbouw-Wetensch. Gent*, 34 : 351-369.

DONCASTER, C. C. (1962). A counting dish for nematodes. *Nematologica*, 7 : 334-336.

GOODEY, J. B., FRANKLIN, M. T. & HOOPER, D. J. (1965). *T. Goodey's the nematode parasites of plants catalogued under their hosts.* Farnham Royal, Bucks., England, Commonw. Agric. Bur., 214 p.

GÜNTZEL, O. (1981). A rapid and efficient method for concentrating nematodes from a suspension. *Nematologica*, 27 : 246-248.

KATALAN-GATEVA, SH. (1980). Ectoparasitic nematodes of the family Hoplolaimidae Filipjev, 1934 found in the rhizosphere of the vine (*Vitis vinifera* L.). *Acta zool. bulgarica*, 14 : 59-63.

KLINGLER, J. (1975). Beobachtungen über die parasitische Aktivität des Nematoden *Macroposthonia xenoplax* an Rebenwurzeln. *PflanzenKr.*, 11 : 722-728.

KLINGER, J. & GERBER, B. (1972). Wachstumsdepressionen an [illegible]

PALMISANO, A. M. (1970). I Nematodi associati alla vite e loro importanza fitopatologica. In : *Quaderni Viticoltura - Difesa Fitosanitaria, Pisa, 18-19 Feb. 1970 :* 155-195.

RASKI, D. J. (1952). On the morphology of *Criconemoides* Taylor, 1936, with descriptions of six new species. *Proc. helminth. Soc. Wash.,* 19 : 85-99.

RASKI, D. J. (1975). Revision of the genus *Paratylenchus* Micol., 1922 and a description of new species. Part II of three parts. *J. Nematology,* 7 : 274-295.

Accepté pour publication le 26 février 1987.

SEINHORST, J. W. (1959). A rapid method for the transfer of nematodes from fixative to anhydrous glycerin. *Nematologica,* 4 : 67-69.

SESHADRI, A. R. (1964). Investigations on the biology and life cycle of *Macroposthonia xenoplax* Raski, 1952 (Nematoda : Criconematidae). *Nematologica,* 10 : 540-562.

WEISCHER, B. (1961). Nematoden im Weinbau. *Weinberg und Keller,* 8 : 33-49.

ZAR, H. J. (1974). *Biostatistical Analysis.* London, Prentice Hall, Intern. Inc., 620 p.