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COMPARISON OF SAMPLING TECHNIQUES FOR VINEYARD FOLIAGE SPIDERS (ARANEAE)

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Abstract

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In order to estimate the composition of the foliage spider fauna in a vineyard four concurrent sampling methods (pitfall, yellow sticky trap, drop-cloth technique and standardised visual search) were compared for their suitability. The relative frequency of spider families was different for all the methods used. The chosen methods were compared with regard to spider diversity and to that of the groups targetted by each method. The advantages and disadvantages (including cost effectiveness and animal welfare) of each method were evaluated.

Introduction

Spiders exist in almost all environments including agricultural ecosystems. Their importance has already been noticed and their role as predators of potential pests has been recognised. Some work has been performed in various agricultural ecosystems to learn more about the interactions between spiders and their potential prey, and the application of this knowledge for the improvement of pest control (e.g. Agnew, Smith, 1989; Heidger, Nentwig, 1989; Nyffeler, Benz, 1987; Riechert, 1990; Riechert, Bishop, 1990; Riechert, Lockley, 1984).

In vineyards, some studies have already been conducted to evaluate the ecological role of spiders (e.g. Costello, Daane, 1995; Mayse et al., 1995; Roltsch et al., 1998). In southern Portuguese vineyards, monitoring the spider fauna of grape foliage has recently been initiated as part of an IPM programme (Meierrose, Colaço, 1996). The primary aim is to monitor fluctuations in spider population density. Identification of the main species is needed. Appropriate field methodology must be chosen to implement such a programme.

The present study established a comparison between four sampling techniques: pitfall, yellow sticky traps (YST), standardised visual search and drop-cloth (also known as "beating" cf. SOUTHWOOD, 1978 or "shake-cloth" cf. ROLTSCH, 1998). The chosen methods were compared with regard to the spider diversity and to the target groups for each method. The advantages and disadvantages (including cost effectiveness and animal welfare) of each method were evaluated.

Material and methods

Field work was performed in Reguengos de Monsaraz (Alentejo, Portugal) in a homogenous plot of Trincadeira variety vines within a large vineyard (90 ha). Weekly samples were collected during July and August 1998.

1. Twelve pitfall traps were placed in the centre of the plot in 4 lines along the rows (3 traps per row, 2 m apart). An open tile-covered box protected each trap (10 cm deep, 6 cm diameter). The liquid level was monitored and corrected whenever needed in order to restore the level after evaporation.
2. Two YST (12 cm x 18 cm – Plexiglas Ref. 566) were placed diagonally in the centre of the plot, 100 m apart.
3. The drop-cloth technique was performed by continuously shaking the branches and leaves of the vines for about 10 seconds. The spiders fell onto a 1 m^2 cloth stretched over a wooden frame and were then collected with a "pooter". This technique was carried out in two plant rows (randomly selected), with ten replicates per row.
4. The standardised visual search concerned the plants and the structures that supported them. A search for spiders covering 100 plants lasted about 120 minutes. This method was applied to 20 random plants in 5 consecutive rows.

A cluster analysis (UPGMA) was carried out where the spider samples were sorted out into their taxonomic families as variables. The linkage distance, taken to be the Euclidean distance, and its correlation coefficient were determined. A Spearman correlation (a=0.05) was also used to test for a functional relationship between the total number of spiders and the families obtained by all sampling techniques. Depending on the morphotypes/species identified, the Simpson, Shannon-Wiener and Brillouin indices of diversity and evenness were calculated.

Results

From the 17 families sampled, only the Araneidae, Linyphiidae, Salticidae and Theridiidae were collected simultaneously by all the techniques employed (Table 1). Drop-cloth and standardised visual search produced fairly similar results. The percentage of adults captured by each method is given: pitfall traps – 70%; standardised visual search – 64%; drop-cloth – 49% and YST – 45%.

The cluster analysis (Fig. 1) formed groups according to the field methods, with a correlation coefficient of 97% (which reveals a good translation of the original data). There was no significant Spearman correlation between the spider totals captured weekly by each method (Fig. 2). The same analysis made with families simultaneously collected by all the techniques also resulted in the absence of a significant correlation.

The Simpson, Shannon-Wiener and Brillouin indices showed a higher diversity of the spider fauna captured by pitfall traps (Table 2). The four combined methods produced the highest rates of diversity.

T a b l e 1. Spider families captured using various methods, showing the total number and percentages of spiders captured, and the time needed to perform the methods and to identify the spiders to family level.

Families		**Visual Search**	**Drop-cloth**	**Pitfall Traps (12 traps)**	**Yellow Sticky Traps (2 traps)**
Araneidae		4 %	7 %	5 %	11 %
Clubionidae		1 %	1 %	9 %	
Linyphiidae		6 %	7 %	12 %	28 %
Salticidae		9 %	5 %	5 %	33 %
Theridiidae		15 %	2 %	18 %	11 %
Thomisidae		15 %	37 %	1 %	
Oxyopidae		28 %	30 %		11 %
Philodromidae			4 %		6 %
Pisauridae		2 %	1 %		
Uloboridae		1 %	1 %		
Agelenidae		18 %		10 %	
Gnaphosidae			4 %	8 %	
Amaurobiidae				10 %	
Dysderidae				2 %	
Lycosidae				6 %	
Oonopidae				1 %	
Zodariidae				5 %	
Total		214	213	93	18
Handling time	**Field**	120 min.	45 min.	40 min.	20 min.
	Lab.	–	30 min.	60 min.	60 min.
Exposure time		–	–	7 days	7 days

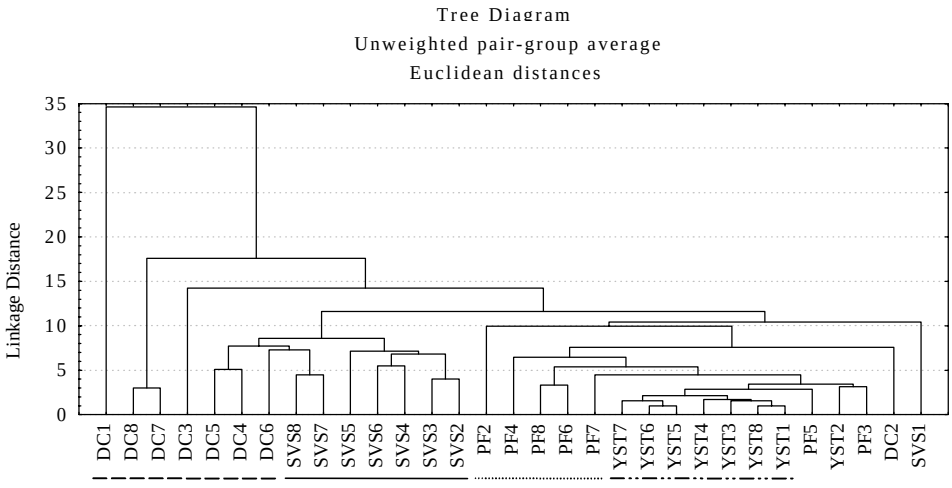

Fig. 1. Tree diagram of the various methods in relation to the totals captured per family. (DC: drop-cloth; SVS: standardised visual search; PF: pitfall; YST: yellow sticky traps; the numbers represent different samplings; dots indicates groups).

T a b l e 2. Values of the Simpson, Shannon-Wiener and Brillouin indices applied to the morphotypes encountered in each method.

Sampling technique	Simpson			Shannon-Wiener			Brillouin		
	1-D	1-Dmax	E	H'	H'max	E	H	Hmáx	E
Visual Search	0.85	0.95	0.89	3.19	4.17	0.77	2.92	3.84	0.77
Drop-cloth	0.88	0.95	0.92	3.38	4.17	0.81	3.04	3.76	0.81
Pifall	0.92	0.96	0.95	3.83	4.32	0.89	3.28	3.70	0.89
Sticky Traps	0.92	0.96	0.95	3.28	3.46	0.94	2.44	2.52	0.96
Combined techniques	0.92	0.98	0.94	4.20	5.21	0.81	3.94	4.88	0.81

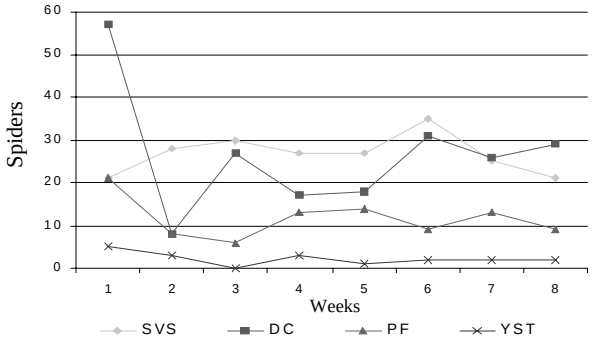

Fig. 2. Total spiders sampled with each technique; SVS – standardised visual search; DC – Drop-cloth; PF – pitfall; YST – yellow sticky trap.

Discussion

Our aim was to compare some techniques in order to choose the most suitable one for a monitoring programme for the foliage spider fauna in a vineyard. Accordingly, the pitfall trap does not seem a suitable technique. It is directed to ground-living spiders, such as Lycosidae, Gnaphosidae or Amaurobiidae, although a large number of Linyphiidae and Theridiidae were also caught. THORNHILL (1983) suggested that some Linyphiidae species depend less on webs to capture their prey and show similar behaviour to the Lycosidae when capturing prey by active search. This behaviour may be the reason for the numerous Linyphiidae captured in the pitfall traps. Although the percentage of adults captured in pitfalls was high, it was lower than that recorded by TOPPING, SUNDERLAND (1992) who claimed that this method fails to capture immature spiders even if they are present in the environment. For instance, the majority of the Theridiidae collected in the pitfalls were immature, probably actively dispersing when captured. The highest spider diversity was registered for pitfall sampling, which was not the most labour-intensive technique. In spite

of this, pitfall sampling is not completely appropriate here, because it does not sample the foliage spiders in representative numbers.

The YST collected mainly Linyphiidae and Salticidae in high numbers. The Linyphiidae are considered to be one of the groups that mainly use ballooning as a form of dispersal. Salticidae were seen moving along leaves and wires. So there is a higher probability for them to be intercepted by the YST. Although it is a technique directed to the vegetation, and is also the least time-consuming method, it is, nevertheless, not the ideal method here because the catches are not sufficiently representative of the spider fauna. It is also a rather destructive technique not only killing the spiders but also leaving them in a very poor condition for subsequent identification.

Thus we are left with drop-cloth and standardised visual search. These techniques produced fairly similar results, although the drop-cloth captured mainly non-web-building species in the vegetation, while standardised visual search targetted primarily web-building spiders of the vegetation layer. An unexpected result of visual search was the relatively low number of Araneidae observed. As the individuals sampled were almost all dispersing immatures they had less probability to be sampled. As adults, the Araneidae are prominent enough (by their webs, sizes and forms) to be observed (Costello, Daane, 1997). In order to obtain a representative sample of this family, the technique should be performed during the period in which the webs occur, as they are rebuilt every day.

As the results obtained by the last two methods are very similar the choice between them should be determined by cost-effectiveness. The cost analysis is defined in terms of time consumption. Thus the most time-consuming is the standardised visual search technique. Nevertheless, this technique also yields some ecological information, such as the preferred microhabitat of the spiders, or, in the case of web spiders, the type of prey.

Both techniques necessitate killing a considerable number of spiders for precise identification. However, once the most abundant species are identified it is possible to perform the other identifications in the field using a ”spy-pot” and a magnifying glass (Roberts, 1995).

Conclusions

Pitfall and YST did not work out as suitable techniques for the aims of this study. Drop-cloth and standardised visual search remain as candidate techniques. The choice between them depends on cost-effectiveness, as the results obtained were fairly similar. Both techniques seem suitable for a monitoring programme of the vineyard foliage spider fauna for integrated production.

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