

Interspecific and intraspecific interactions between spider species from apple orchards

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Summary: The intraspecific and interspecific predation between some spider species listed in apple orchards *Anyphaena accentuata*, *Diaea dorsata*, *Philodromus cespitum* has been studied. It has been shown that even in extreme conditions this predation is low. An analysis with a video recording system completes the study concerning *Anyphaena accentuata*. It is demonstrated that there are interactions limiting cannibalism during encounters and also some avoidance phenomena of individuals that suggest, in this wandering nocturnal spider, a distance recognition.

1. INTRODUCTION

It is generally admitted that there is high intraspecific and interspecific predation between spider species (BRISTOWE 1958; GREENSTONE 1978). However, there are only few studies on the subject, in addition most of them concern web-spider species (RIECHERT 1984; RYPSTRA 1986; SPILLER 1986) or diurnal species of the Lycosidae and Salticidae families (EDGAR 1969; NOSSEK & ROVNER 1984; JACKSON 1982). EDGAR (1969) finds 24,4% of cannibalism in the lycosid spider *Pardosa lugubris* and HALLANDER (1970) confirms in other *Pardosa* species that this kind of predation occurs frequently. Nevertheless, KRAFFT (1975) indicates that in *Pardosa* and *Lycosa rabida* there are interactions limiting the cannibalism like "legs raising" and NOSSEK and ROVNER (1984) demonstrated that cannibalism was uncommon (<1%) between conspecific groups as well as heterospecific groups of the spider species *Lycosa punctulata*, *L. rabida* and *L. huella*.

In the case of a biological control with Araneids in orchards, the resort to releases of

spiders (MARC 1989), will strongly increase their density. A high cannibalism will then reduce their efficiency, that is why emphasis has been laid on this aspect of predation. The study has been carried out on three species listed from apple orchards (MARC unpubl. data): *Anyphaena accentuata*, *Diaea dorsata* and *Philodromus cespitum*.

2. MATERIAL AND METHODS

For the general analysis, about eight hundred spiders of these three species were collected on deciduous trees by beating the low branches. Spiders were placed individually in micro-tubes (Ependorff). In the laboratory, after corroboration of the identification of the smaller individuals, the Araneids were left in natural photoperiod, in ambient temperature and without any food for five days. The fifth day, all individuals were weighed. The spiders that were harmed during the collection were kept out of the experiment because they were vulnerable. The others were laid two by two in Petri boxes (9 cm diameter and 1,5 cm high) between 18 and 19.30hrs. A high moisture was maintained in each enclosure with a damp wad of cotton disposed so that no shelter was available. The enclosures were controlled twice a day during a week and cannibalism cases noted. All the spiders captured were used for only one experiment.

For a more precise analysis of the agonistic interactions, a study was carried out with video equipment comprising :

- a black and white camera with a "Newicon" tube (HV 735) sensitive to weak red light with a wavelength between 6300 and 7500 A, and a 12,5 mm/ 1,3 lens, with a minimum foca/distance of 0,3 m ;
- a black and white monitor (VM 906) ;
- a Panasonic AG 6015 video recorder equipped with several recording speeds (from 25 to 1 shots per sec), corresponding recording periods (3 to 72 h), and a timer.

Each spider was placed in a plastic box (10 x 8 x 1 cm), the outer sides of which were covered with yellow paper, to obtain better contrast and to prevent individual spiders from seeing each other. The paper was squared in centimeters. A high moisture was maintained in each box with a damp wad of cotton. A plexiglass lid was used to shut each enclosure. Three boxes were placed in the camera field and isolated from their stand, and the apparatus placed in a room apart from that in which the video recordings were analysed, in order to avoid vibrations. The experiments were carried out under natural photoperiod conditions, although a constant red light was necessary for night filming. Temperature and brightness were recorded throughout the experiments. The video recorder was programmed to take six pictures per second. Because the present work was carried out on animals with rapid movements the time needed to analyse the recording was quite lengthy, limiting the number of circadian periods which could be studied. In the analysis of each circadian period, the beginning and the end of locomotory activity, the time when encounters and avoidances occurred was noted, as

well as the distances covered by the spiders. The activity was compared to the photoperiod (Greenwich Mean Time was used in the results). Four females and two juveniles of *Anyphaena accentuata* were studied in these experiments, during 96 hours. These individuals were in the same conditions as those of the previous experiments. The weight ratio was 1.

3. RESULTS

3.1 General analysis

The three species have been studied by pairs. Only the figures relating to the species *Anyphaena accentuata* are presented here. Concerning the intraspecific predation, the cannibalism cases occur when the weight ratio of the individuals is above 4 (figure 1). Then it occurs rapidly, in the first fifteen hours after the beginning of the experiment. The same type of results is obtained with both other studied species.

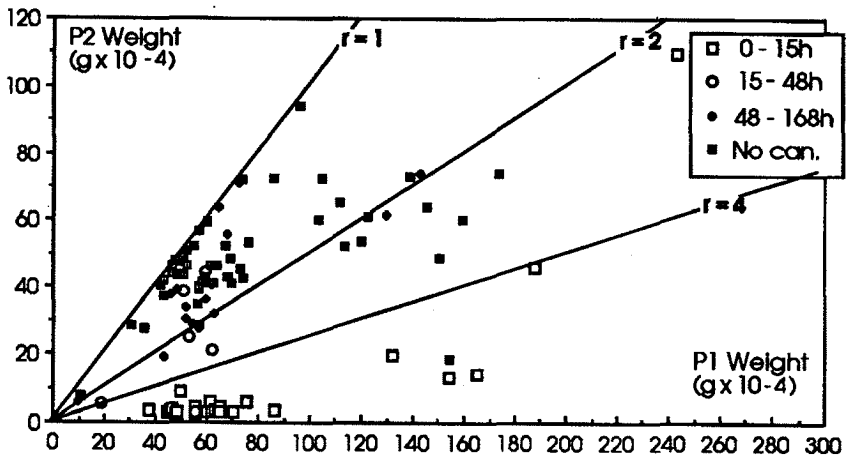


Fig. 1 - Time and weight related intraspecific predation in *Anyphaena accentuata*. The different symbols indicate the time when cannibalism occurs. The black squares showing the absence of cannibalism after a week. Three ratios of weight between individuals (1, 2 and 4) are materialized by continuous lines.

The results of the study of the interspecific predation do not show more cannibalism cases in these species (figures 2a-b). Only scarce cases are to be noted when the weight ratio is below 4. The experiments in *Philodromus cespitum* and *Diaea dorsata* produce the same results.

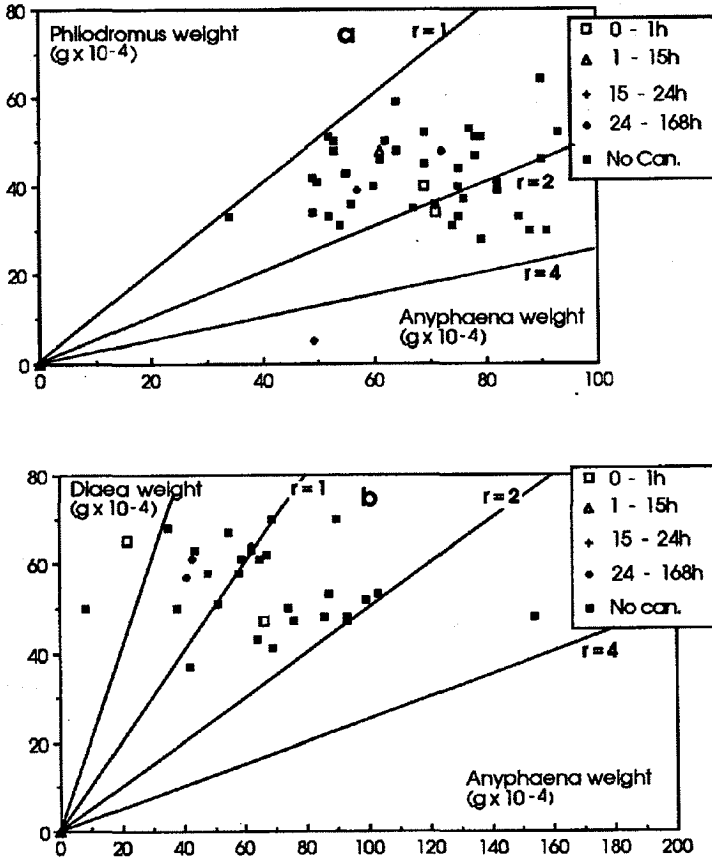


Fig. 2 a-b : Time and weight related interspecific predation between *Anyphaena accentuata* - *Philodromus cespitum* (a) and *Anyphaena accentuata* - *Diaea dorsata* (b).

3.2 Videographic analysis

To know if the low occurrence of intraspecific and interspecific predation obtained in the previous experiment is not due to an artificial lack of locomotory activity in the enclosures, the analysis of video recorded documents has been carried out and the results concerning *Anyphaena accentuata* are given.

The locomotory activity of this species and the photoperiod synchronize. The beginning of this activity coincides with the minimal light intensity recorded and lasts all night until the increase of light intensity in the morning (figures 3a and 3c). There is a peak of locomotory activity during the first third hours of the night.

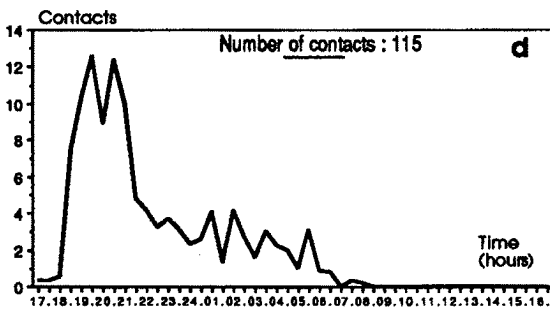
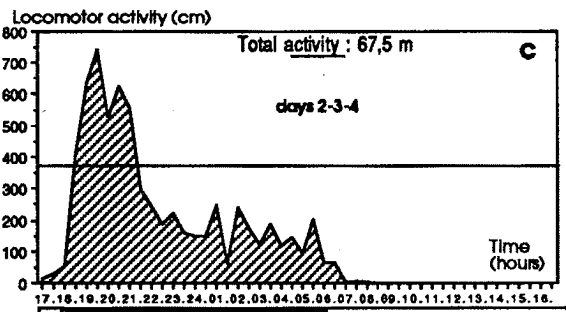
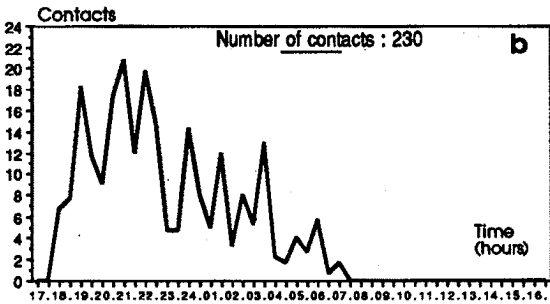
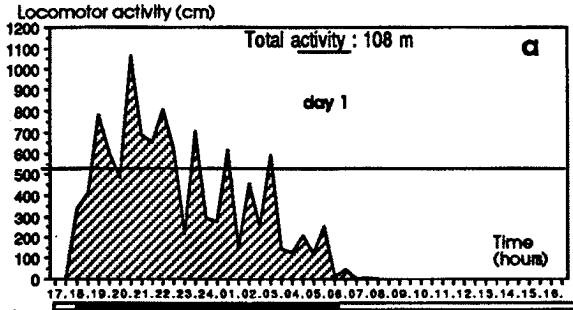


Fig. 3 a-d - Daily locomotory activity and agonistic behaviour in *Anypaena accentuata*. a and b during the first circadian period (n=3), c and d during the last three circadian periods (n=3). The average total distance covered during a circadian period corresponds to a pair of individuals in the same enclosure.

The spiders covered an average of 108 meters during the first circadian period, the locomotory activity decreased to 67,5 meters during the last three days of the experiment (figures 3a, 3c and 4a). The graph of the number of contacts for the different circadian periods show the same aspect as the locomotory activity graph (figures 3b, 3d and 4a). The number of contacts during the first day of the experiment is on an average of 230, it decreased afterwards to 115.

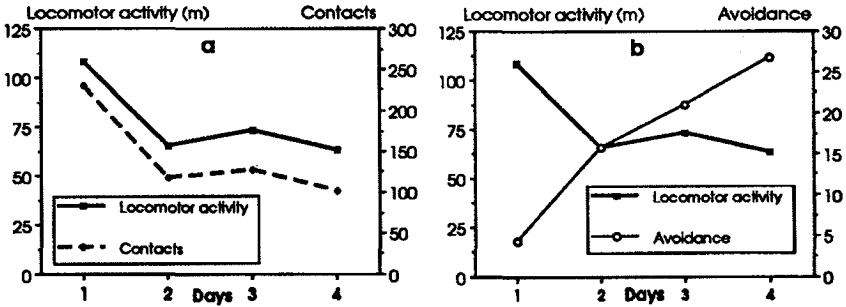


Fig 4 a-b - Time related locomotory activity and agonistic behaviour of contact (a) and of avoidance (b) in *Anyphaena accentuata*.

The number of avoidances increased as the experiment progressed (figure 4b).

The ratio of the number of contacts and the distances covered by a pair of spiders decreases during the four days of the experiment (figure 5). However, the ratio of the number of contacts added to the avoidances number and the distances covered by a pair of spiders decreases only between the first day and the second day of the experiment and becomes stable afterwards (figure 5).

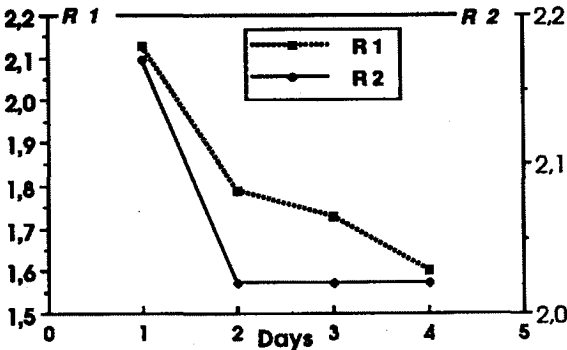


Fig. 5 - Time related agonistic behaviour in *Anyphaena accentuata*. R1, ratio of the number of contacts and locomotory activity (in meters); R2, ratio of the number of contacts added to the number of avoidances and the locomotory activity.

4. DISCUSSION - CONCLUSIONS

An easy method of investigating intraspecific and interspecific predation in non web-spiders was set up to point out the species with high rate of cannibalism. As these species can not be used in biological control. In addition, it is important to know if, among the species that are most numerous in the agrosystem, such a species is present.

Concerning apple orchards, in general, the results seem to be encouraging because the intraspecific predation cases are scarce as well as the interspecific ones in the three main non web-spiders species listed from the apple trees : *Anyphaena accentuata*, *Philodromus cespitum* and *Diaea dorsata*. Nevertheless, in these experiments if the weight ratio of a pair of spiders is high, above 4, there are frequent cases of predation and then it occurs rapidly. The study conditions were deliberately made extreme. There was no shelter nor any possibility of escape for the Araneids. The volume of the enclosures was very small and the spiders were hungry. Therefore, the cannibalism that occurred in these conditions could be considered as a maximum rate for these three species. In natural circumstances, these conditions do not exist and it is likely that the smaller spiders are able to find shelter in vegetation to escape the predation of a bigger conspecific.

The videographic analysis confirms that the scarce cases of predation between these spiders are not the consequences of any lack of movement in the enclosures, but that there are, indeed, interactions limiting this predation. In spite of very numerous encounters (up to 379 during a circadian period) there is no predation. Furthermore, there are some avoidances phenomena in *Anyphaena accentuata* that minimize the risks of intraspecific predation. It is shown that during the experiments an increase number of theoretic contacts are replaced by avoidances (figure 6). These results are supported by NOSSEK & ROVNER (1984), they showed in Lycosidae species that food deprivation did not increase conspecific cannibalism and even that hunger lowers their fighting potential and thereby increases their avoidance tendency. The study of the mechanisms of recognition and the description of the agonistic behaviour still remains to be carried out. Nevertheless the observation of the behaviour of *A. accentuata* seems to point to strong similarities with the behaviour of the lycosid spiders studied by NOSSEK & ROVNER (1984). Moreover, this study also pointed out that *A. accentuata* is a nocturnal wandering spider. The avoidance phenomena suggest, in this species supposedly with poor vision, a distance recognition probably due to mechanoreceptors. There is a peak of activity at the beginning of the night probably connected with a hunting period as it was shown in a close-related family species *Clubiona corticalis* (MARC, 1990). SCHMITT & al. (1990) show a similar peak in three species of *Cupiennius*. The locomotory activity and the photoperiod synchronize and this is confirmed by a previous study on this species (unpub. data).

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