BOLL. ACC. GIOENIA SCI. NAT.	Vol. 26	n. 345	pp. 263-271	Catania 1993

Preliminary experimental study of the homing phenomenon in *Clubiona corticalis* (Walckenaer, 1802) (Araneidae, Clubionidae)

MARC P.

Université de Rennes 1, Laboratoire de Zoologie Générale et d'Ecophysiologie, L.A. INRA, URA 696 - Campus de Beaulieu, 35042 Rennes Cédex

RIASSUNTO

E' stato dimostrato che *Clubiona corticalis* utilizza dei ripari per costruirci il proprio nido di riposo. L'esistenza di un ritorno al nido quando gli individui sono messi in condizioni normali di alimentazione è stata provata. L'assenza prolungata di cibo conduce però all' abbandono del nido e alla costruzione di un nuovo nido in un altro riparo. Quando persiste quest'assenza di prede, non viene più costruito alcun nido, l'attività va avanti durante la giornata e, infine, dopo qualche giorno, porta alla morte dei ragni. Per altro i ragni non si sistemano a caso nei diversi ripari proposti; le ipotesi che permettono di spiegare questo fenomeno di "homing", e i parametri che possono influenzare la scelta dei diversi ripari vengono discussi.

Parole chiave: Araneidae, Alimentazione, Predazione, Nidi di riposo, Riparo, Homing, Laboratorio.

SUMMARY

It was shown that *Clubiona corticalis* built his resting-nest inside a shelter. When the spiders were provided with prey they went back to their nest every day. Nevertheless, a lack of food induces the spiders to neglect their resting-nest and to build a new one in another shelter. If the starvation continues, no more nests was used, the spider's activity extended during the day, and after a few days it ended with the death of the Araneids. There was not a random distribution of the spiders in the differents shelters. Some hypothesis explaining the homing as well as the choice of the shelter are discussed.

Key words: Araneidae, Foraging tactic, Predation, Resting-nest, Shelter, Homing, Laboratory.

1 - *Introduction*

The study of the daily activity rhythm of *Clubiona corticalis* (MARC, 1990) has shown that this species is able to cover long distances (10 meters minimum to more than 180 meters) each night searching preys or a sexual partner. In spite of this shiftings, it seems to return to her resting-nest. The homing phenomena which consist in a periodic return to a same resting shelter, are well known in Vertebrates and some Invertebrates, but rare are the studies in Araneids. Most of them have been done on the funnel web spider *Agelena labyrinthica* (Araneae, Agelenidae) (GORNER & CLAAS, 1985) or on diurnal wandering species (e.g. Salticidae, Lycosidae) (HILL, 1979; PAPI & SYRJAMÄKI, 1963). In the case of a utilization of *Clubiona corticalis* in biological control, it is important to examine its abilities to be fixed in the agrosystem. The aim of this experiment is first to control the systematic utilization of shelters by this species to build its resting-nest and to see if there are preferences in the choice of the shelter, and secondly to study the homing phenomenon in relation with the availability of preys.

The marking of this spider in the field is problematic. The trees' bark must be removed and that leads to a more or less important, destruction of the spiders' shelter and resting-nest. Indeed, the silk of the resting-nest is fixed on one side to the trunk of the tree and on the other side on the inside part of the bark. In addition, the stress of the capture, anaesthesia and marking may induced a flight of the spiders. For these reasons we have decided to approach this through laboratory experiments.

2 - *Material and method*

The spiders used in this experiment (5 males and 5 females) have been collected in a forest under the bark of *Pinus sylvestris* and reared individually in the laboratory until maturity. The experiment took place over 3 weeks. Each spider is placed in an individual transparent plastic box, inclined at 60' with respect to the horizontal plan. The experiments were carried out at a temperature of 22 $\pm$ 2°C and under natural photoperiod.

Seven shelters were stuck inside each box in a similar disposition (Fig. 1). Each shelter was of 4 centimeters long (except the shelter number 5 which is only 3 centimeters). All the shelters have two ope-

nings (except the shelter number 7 which has only one opening) and are in plastic except the shelter number 3 which is in cardboard.

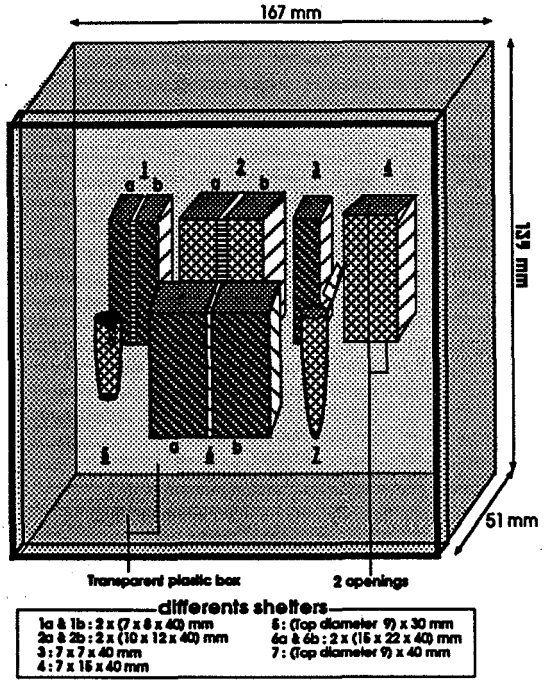

Fig. 1 - Disposition of the differents shelters in the experimental boxes.

Two batches were used, one of seven individuals (4 males and 3 females) and the other of three individuals (2 females and 1 male). The first day of experiment, the spiders were placed in the boxes around 7 p.m. Each individual was given 15 wingless *Drosophila.* At 7 p.m. during the rest of the experiment only the boxes numbers 8, 9 and 10 were provided every two days with 2 caterpillars of *Cydia pomonella* L. (Lepidoptera, Tortricidae) weighing from 1 to 1,5 mg. The site of the spiders in the boxes and in the shelters were noted every morning from 9 a.m. to 11 a.m. as well as the existence of a resting-nest.

The analysis of the homing phenomenon was done putting down the number 1 to an individual returning the day following to its resting-nest and 0 to a spider moving to another one. The days spended outside a re-

sting-nest were not considered in the analysis if the individual did not build any other resting-nest before death. Finally, if a day spended outside a resting-nest was followed by a day in a resting-nest it was referred to the day preceeding the day outside nest for the attribution of the number 1 or 0 (Table I).

	Days / Boxes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Spiders without prey	n°1 m	3	3	3	3	hl	hl	hl	†												
	n°2 m	1a	1a	1a	1a	1a	1a	1a	1a	hl	1a	hl	hl	†							
	n°3 m	1b	1a	1a	1a	1a	1a	1a	1a	1a	1a	hl	hl	†							
	n°4 m	1b	1b	1b	1b	1b	hl	hl	†												
	n°5 F	3	3	1b	4	1b	1a	1a	1b	1a	4	1b	1b	6b*	hl	hl	hl	hl	hl	†	
	n°6 F	1a	1a	1a	1a	hl	1a	1a	hl	2a	4	2a	1a	1b	1b	hl	hl	hl	†		
	n°7 F	3	4	4	1b	3	3	1a	3	4	6b*	hl	4	1a	hl	hl	hl	†			
Spiders with preys	n°8 F	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b
	n°9 F	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b	1b
	n°10 m	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a	1a

Table I - Numbers of the shelters used by *Clubiona corticalis* during the twenty days (^{m}: male; ^{F}: female; hl: out of nest; †: death; * no silken nest).

3 - *Results*

In the batch where the individuals were not provided with prey, all the spiders were dead after 20 days (Table I). The death occured on and after the 8th day and the last individual was founded dead the 19th day. On the other hand, in the batch provided with prey no mortality was registred.

During the first 4 days of the experiment all the spiders used a shelter to built their resting-nest. After that, some individuals which were not provided with prey stay in a shelter during the day, others not. All the spiders provided with preys used a shelter during all the experiment. All the individuals stayed out of resting-nests and shelters before death (batch 1) during the day between 2 and 5 days (with an average of 3 days).

The 4 males of the first batch and the individuals of the one provided with prey returned every day to the resting-nest built the first day of

experiment if the days spent out of the resting-nest just before death are not counted.

	Spiders without prey							Spiders with preys		
	Males				Females			Females		Male
Boxes	**n°1**	**n°2**	**n°3**	**n°4**	**n°5**	**n°6**	**n°7**	**n°8**	**n°9**	**n°10**
Ratio of homing	3/3	8/9	8/9	4/4	3/12	6/13	2/12	19/19	19/19	19/19
Ratio of homing in each of the two batches	54,8% (34/62)							100% (57/57)		
Ratio of homing in males and females	92% (23/25)				29% (11/37)			100% (38/38)		100% (19/19)

Table II - Ratio of homing of *Clubiona corticalis* in each box.

The comparison of the percentages (Table II) show some very significant differences ($p<0,001$) between the two batches and between the males and females when provided with prey with respect to the homing. On the other hand, the comparison of the percentages of homing between the males not provided with prey and the individuals provided with preys did not show any significant differences ($p>0,05$).
In other respects, the spiders were not randomly distributed in the differents shelters (Table III).

Number of the shelter	**1a**	**1b**	**2a**	**2b**	**3**	**4**	**5**	**6a**	**6b**	**7**
Nb. of days of utilization	50	54	2	0	10	7	0	0	2	0

Table III - Utilization of the differents shelters by *Clubiona corticalis* during the twenty days of experiment.

Shelters 5 and 7 have not been used by the spiders and the number 6 have been used two times over 125 possibilities (addition of the whole days of utilization of a shelter by the spiders). No resting-nest was builded in this last shelter. In the others shelters resting- nest were settled. The shelter 2 was occupied only twice, and the 4th and 3td 7 and 10 respectively. It was the shelter 1 which was used preferentially 104/125.

4- *Discussion*

Clubiona corticalis had high alimentary needed and the starvation prolonged after one week began to induce death, first in males and after in female. Adult males which spend less time searching for preys than the females do, show a high locomotory activty in relation with the search of a sexual partner (MARC, 1990). It could explain a higher mortality.These behaviour differences could involve the males to constitute less reserves than females. Indeed, males consume less than females (MARC, 1990), and even with plenty of preys males seems to consume only the preys necessary for their maintenance energy, so they are vulnerable when the disponibility of preys is low.

During the 4 first days of experiment, all the spiders used a shelter to built their resting-nest. Their behaviours do not seems to be perturbated yet by starvation, indicating that when it is possible they fixed their resting-nest in a shelter. Indeed in the field all these spiders are founded protected in a shelter, often under a tree bark.

In the batch provided with preys (n° 8 to 10), the spiders return to their resting-nest each day all along the experiment and the preys have been consumed involving a hunting activity and then a locomotory activity. There are significant differences between the batch provided with preys and the other one, showing a change in the behaviour of the Clubionids.

When the spiders are not provided with preys (n° 1 to 7) only the males return to their resting-nest, except for the days preceeding death, where no more resting-nests are used. Indeed at that point spiders showed a residual day-time activity because of starvation. There are significant differences in the behaviour of males and females, in these conditions the females used several shelters and build several resting-nests during the experiment. On the other hand, there are no significant differences in the males' behaviour, both seeming to come back to their resting-nests. It is therefore highly likely that starvation forced the females to move to another shelter in order to find prey (Fig. 2).

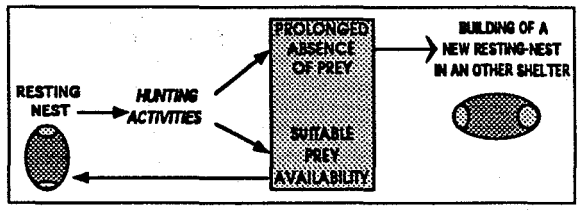

Figure 2: Schematic representation of *Clubiona corticalis* shiftings related to prey availability.

These shifts caused by a low availability of prey in the occupied sites have also been observed by TURNBULL (1964) with a frame-web spider, *Achaearanea tepidariorum* Koch. He showed that individuals placed in a room built their web at random in respect to the availability of prey at the beginning. If there are not enough prey in the occupied sites, the location is rapidly deserted. On the other hand, when there are sufficient prey in a site, the spider enlarges its web and stays there. The windcurrents which bring the prey seem to be significant as well. Other studies have confirmed this behaviour in other species. DABROWSKA-PROT *et al.* (1973) argued that the high densities of two web-spiders, *Linyphia triangularis* Clerk et *Enoplognatha ovata* Clerk, found in an ecotone in Poland where the thermic and structural conditions were not particulary favorable, high densities were linked to the abundance of prey in this environment. KRONK et RIECHERT (1979) observed seasonal shifts in a Lycosid, (*Lycosa santrita*) which goes toward sites where the availability of prey is high. This type of behaviour causes the spiders to form aggregations which are useful in the control of pests.

The homing phenomenon has thus been demonstrated by this experiment. It is probably also present in nature, but this behaviour needs to be investigated in the field. It is known that in other forms of communication, during intraspecific and interspecific interactions, spiders used numerous signals: visual (FORSTER, 1982), acoustic (UETZ et STRATTON, 1982), vibratory (transmitted by silk or substratum) (BARTH, 1982), tactile (KRAFFT, 1982), chemical (airborne and contact pheromones) (TIETJEN *et* ROVNER, 1982). Some of these signals are also used in the orientation necessary to the homing, but so far only hypotheses can be proposed to explain this phenomenon. It is likely that the explanation will take into account several hypothesis, more especially as the species show a contagious distribution in the field.

1 - Spiders could follow their silken thread, impregnated or not with pheromone.
2 - Their resting-nest could be impregnated with a volatil pheromone.
3 - There could exist a memorisation of the topography.
4 - There could exist a memorisation of the situation of the resting-nest owing to the detection of parameters like: the wind, humidity, lunar light, gravity, ...

Otherwise, the shelter number 1 was by far the most used, probably because of its dimensions. Indeed, the shelters 1, 2, 4 and 6 are of the same shape, the same color (Ivory), the same length, 2 openings (top and bottom), and all are in plastic. On the other hand, the inner dimensions are different. The shelter number 1 is the smallest, it could explain *Clubiona corticalis* preferences. However, the amount of light in the shelter during the day is also dependent on its dimensions and may be an important parameter. In the future, it will be important to study more completely the qualities of a good shelter for this species in order to succed in fixing the spiders in apple orchards.

5 - *Conclusion*

It was demonstrated under experimental conditions that the nocturnal wandering spider *Clubiona corticalis*, return to its resting-nest when there is a good availability of prey. However, in case of prolonged lack of preys, the females moved to another shelter to build a new resting-nest. In the field, this could correspond to a shifting toward other hunting zone. Rare are the studies on homing in Araneids and these data raise many interesting questions and bring a new "model" to the area of research concerning the foraging tactics of predators.

It was also shown that *Clubiona corticalis* used a shelter to build its resting-nest inside when there was a good availability of prey. The shelter has to be sufficiently dark and may be of dimensions smaller than 1 centimeter. However, other studies are needed to define the qualities of a good shelter for this species.

Acknowledgment

The author wlshes to thanks Stacy Payne and Caroline Allais for their help in translating this manuscript.

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