Notes on
the Biology of *Filistata insidiatrix* (Forsk.)

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During the month of July 1949 I made some investigations on spiders at San Cataldo, a former monastery near Amalfi by the Gulf of Salerno, Italy. The main purpuse of my observations was to study the microclimate in the habitats of different spiders and its bearing, if any, on the behaviour of these spiders, with the object of collecting material for a comparison with similar work in Denmark (Thamdrup 1948, Nørgaard 1948). During my investigations I found that the biology of *Filistata insidiatrix* suggested a close relationship between behaviour and microclimate, and consequently I spent a good deal of my time looking more closely at this spider.

My stay in the south of Italy was made possible by a scholarship from the San Cataldo Institution, and the Natural History Museum in Aarhus defrayed the expenses of the journey and supplied the necessary instruments. I am much indebted to both institutions. I am also indebted to Mr. Eric Duffey, Oxford, for his helpful linguistic corrections of the M. S.

Construction of the Web.

Filistata insidiatrix (Forsk.) is a cribelate spider. It is very common throughout the Mediterranean area, the Azores, Madeira, and the Canary Islands (Simon 1914). Its biology has been studied by L. Berland (1914 & 1922). Consequently the present article is to be considered as supplementary to his findings, particularly with a view to calling attention to some ecological facts, and thereby bring to light certain details of the animal's biology.

F. insidiatrix constructs its web on vertical or slightly sloping walls of rock, and on the walls of vine-terraces. The web consists of a snare and a retreat-tube leading into a crack in the rock (fig. 1) or an aperture between the stones of a wall. In a few cases the retreat-tubes were placed in empty burrows dug out by bees or wasps. The length of the tube varies very much depending upon

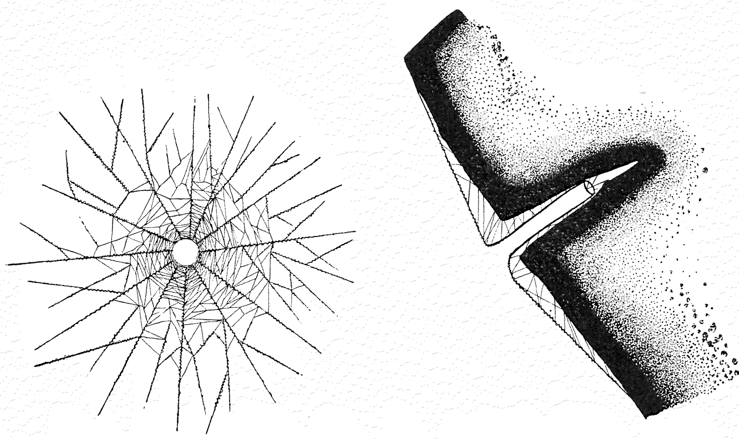

Fig. 1. *Filistata* snare (left), and schematic section of tube, suspended in a crevice (right). P. Gross del.

the depth of the natural hollow. I have no evidence that the spider is itself able to dig a cavity, and its long legs and frail structure suggest that it is unable to do so. Most of the tubes are 5—10 cm. long, and in a single case a tube-length of 20 cm. was found.

The diameter of the tube of the adult spider is 5—8 mm. and 2—3 mm. with the young ones. It is a striking fact that the tube is always narrower than the hollow in which it is placed. Obviusly it is not made simply by lining the hollow with silk, but hung up in it by means of threads, which also serve to suspend it. The importance of this feature of the construction will be dealt with later.

The tube is open at both ends, and the outer opening is surrounded by a suspended snare, made of radiating threads, irregularly crossed by a multitude of other threads (fig. 2). The radiating as well as the crossing threads are in parts covered with calamistrated silk. The size of the snare varies according to the age of the animal, and so does the diameter of the tube. The small-

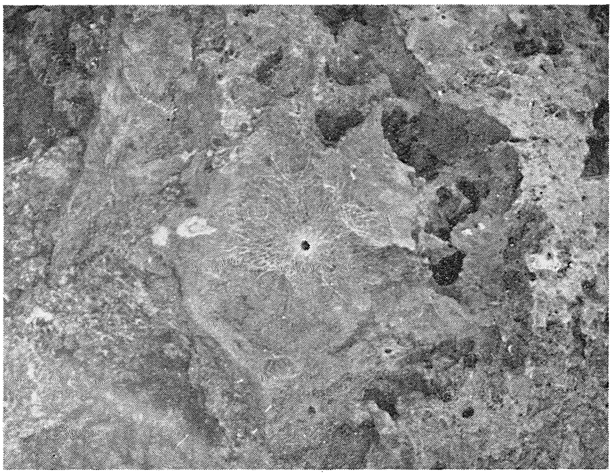

Fig. 2. Part of a rock with several *Filistata* webs. One is particularly distinct. E. Nørgaard phot.

est snares are not more than one or two centimetres in diameter, the largest are 5—10 cm., and a single one had a diameter of 16 cm.

The complete structure with its distinct radial threads issuing from the edge of the retreat-tube, resembles a *Segestria*-web, and the cover of calamistrated silk gives it some similarity to an *Amaurobius*-web. In structure as well as in function it bears a certain resemblance to the orb-web of the *Araneidae*; as pointed out by Wiehle (1929). It is, however, extremely doubtful whether the spinning behaviour of *Filistatata* is one of the earlier stages of that of the *Araneidae,* as interpreted by Wiehle. The phenomenon is rather a case of convergence. The problem of building a circular snare (round the centre platform with the orb-weavers, or round the mouth of the tube with *Filistata*) is solved in almost the same way by two otherwise distantly related families of spiders.

Occasionally there were two snares to the same re-

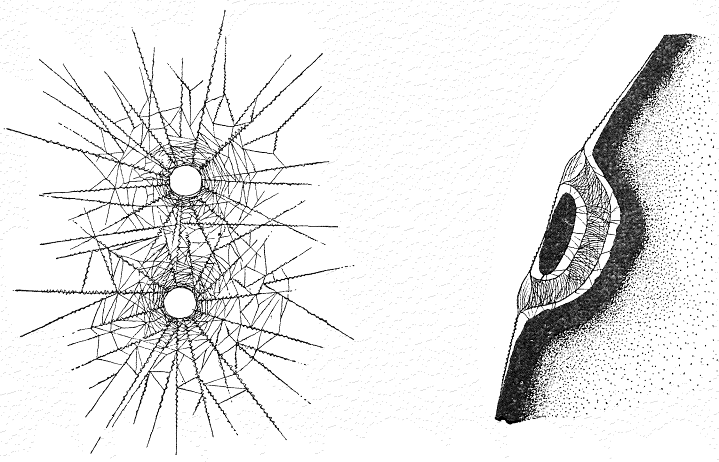

Fig. 3. Retreat tube with two snares. The shape of the crack induces to build a bent tube with two outer openings, around either of which the spider has spun a snare. P. Gross del.

treat-tube (fig. 3). This variety occurs, when the tube is constructed in a cavity with two openings on to the surface of the rock. The retreat will then appear as a bent tube with two outer openings, around each of which a snare is built. In Bornholm (1950) I also found a single case of this peculiar development of two snares to the same tube in the spider *Segestria senoculata.* I should not omit pointing out that these examples — probably contrary to expectations — illustrate the rigidity and consistency of the building instinct. In *Filistata* as well as in *Segestria* the stimulus "outer opening" calls forth the response "snare-building". When in the above cases the spider, having built its snare, runs to the other end of the retreat, it once more faces the stimulus "outer opening", upon which the instinctive reaction "snare-building" is bound to follow.

Prey and Method of Catching it.

While Berland (1922) in the south of France observed how *Filistata* removed all the remnants of the prey from the snare, my observations prove the contrary. Sucked parts of chitin were often left in the snares, and in all the tubes I examined, I found remains of meals in greatly varying quantities. For the purpose of later analysis of the distribution of the snares, it is important here to examine the type of prey (table 1). The number of sucked insects amounted to 42.6 $^0/_0$ of the total number of prey, while the number of wood-lice was 55.6 $^0/_0$. As the size of the individual wood-louse is considerably above the average size of the caught insects, it may be rightly concluded that in the San Cataldo area wood-lice constitute an essential part of *Filistata*'s food,

Table 1. Showing kind and number of prey from 6 tubes of *Filistata insidiatrix*.

	Tube No.							
	1	*2*	*3*	*4*	*5*	*6*	total	
Flies	1	1			1	2	5	9 (16.7 $^0/_0$) flying to the snare.
Wasps						3	3	
Cicada				1			1	
Ants			1	1	3	1	6	45 (83.3 $^0/_0$) creeping to the snare.
Beetles	1		1	1	2	1	6	
Caterpillars		1				1	2	
Wood-lice	10	9	2	2	3	4	30	
Centipedes				1			1	
Total	12	11	4	6	9	12	54	

which is in direct contrast to Berland's observations that *Filistata* refuses to eat those animals. The data in table 1 also show that only 16.7 % of the animals caught can have flown into the snare, the remaining 83.3 % walked (ran or jumped) on to the snare from the surrounding rock.

As an illustration of the method of catching the prey an observation taken directly from my note-book reads:

"A wood-louse is placed on a snare. It endeavours to escape. The spider sitting in the tube receives a jerk. It takes one step towards the wood-louse, stands still for a moment, then takes another step. The wood-louse sits almost motionless. Nearly a minute elapses before the spider reaches the wood-louse and touches it with its forelegs. The wood-louse is now quite still. The spider seizes it with its forelegs. The wood-louse moves, and quick as lightning it is dragged towards the spider and bitten in one of its many legs with the chelicerae. The movements of the wood-louse soon get feebler, and ultimately they cease."

The same procedure takes place every time, only the speed of the spider's reaction varies. If, as in the above case, the prey is quiet, the spider proceeds slowly, but if the wood-louse struggles violently to get away, the spider moves rapidly to it and overpowers it.

The sucking is done through the hole in the leg in which the poison has been injected. In this way no damage is done to the chitinous skeleton, and for some time afterwards it is possible to identify the remains of the prey (Bonnet 1939).

The spider usually sits in its tube with its forelegs stretched out on the snare and is thus able to detect the slightest vibrations of the web. Several webs were touched with a vibrating pair of tweezers, and the response of the spider followed immediately. Some of them only stretch their forelegs a little further forward, others come right up to the tweezers and touch them, but then they would rush back to the tube again.

A more detailed examination of the effect of the web-vibrations on the reactions of *Filistata* was made with an electric vibrator (Nørgaard 1943). On the 23. 7. 1949 at 5 p. m. ten different webs were touched with it. In seven of the cases the spider came out instantly. Small individuals hurried back into the tube at once, while the bigger ones bit the vibrator-needle. They hung on to it firmly, and some even continued to hang on, when I pulled back the needle, so that they followed it some way, before they let go.

Table 2 shows the results of another series of experiments, in which the interval between the vibrator-needle touching the net and the spider reaching the needle was timed by a stop watch. The needle was in contact with the web for 5 seconds, and only two of the spiders did not respond, before the needle was taken away.

Finally table 3 shows the results of another experiment, in which the same web was touched several times, with intervals of half a minute between each stimulus. The spider came forward every time, but by the 9th experiment 8 seconds elapsed, before the response appeared.

Table 2. Showing results of vibrator experiments on 10 different webs.

Web No.	Result	Time of reaction in seconds
1	+	1.2
2	—	
3	+	1.4
4	—	
5	+	1.0
6	+	1.7
7	+	0.9
8	+	1.2
9	+	3.1
10	+	1.7

Table 3. Showing a spider's response to repeated toguchin of its web. (Interval between stimuli ½ minute).

Touch No.	1	2	3	4	5	6	7	8	9	10
Time of reaction in seconds	1.2	0.8	1.0	1.3	1.1	1.0	3.9	1.5	8.2	2.0

In addition, another individual experiment of the 25. 7. 1949 (taken directly from my note-book):

"9^{20} a. m.: In a large web the spider is overpowering a wood-louse. It is sitting in the opening of the tube holding the prey with its two anterior pairs of legs and the palpi. The wood-louse has ceased struggling, and the spider drags it a little way into the tube, so that most of it is protuding. A faint rhytmic movement of the prey indicates that suction takes place.
At 10^{50} a. m. the spider is still sitting in the mouth of the tube with its prey. The vibrator-needle is put on the snare some centimetres away. Immediately the spider releases its prey and retires to the tube. A few seconds later it turns round and runs past the wood-louse to the vibrator-needle and holds on to it. I free the needle. The spider again runs past the wood-louse into the tube, sitting there quite motionless, without paying any attention to its prey.
Two minutes later: As the spider has not yet returned to feed on the wood-louse, I touch the latter with the vibrator, upon which the spider immediately runs forward and resumes its feeding."

This experiment proves that the actions of the spider are to such a degree dependent on vibrations that a new stimulus is necessary, before the sucking will be resumed, and in the case mentioned, the spider had been away for only a very short time.

In conclusion it may be stated that *Filistata insidiatrix* like other web-spinning spiders orientates itself in the web by means of a sense of touch. In any case when catching prey, web-vibrations have a spectacular effect on the spider's reactions.

Distribution of Webs in Relation to Environmental Factors.

In the area of my investigations the webs were found in the greatest number on a cliff just below the town of Scala, where the majority of the observations were made. This locality is situated abt. 300 metres above

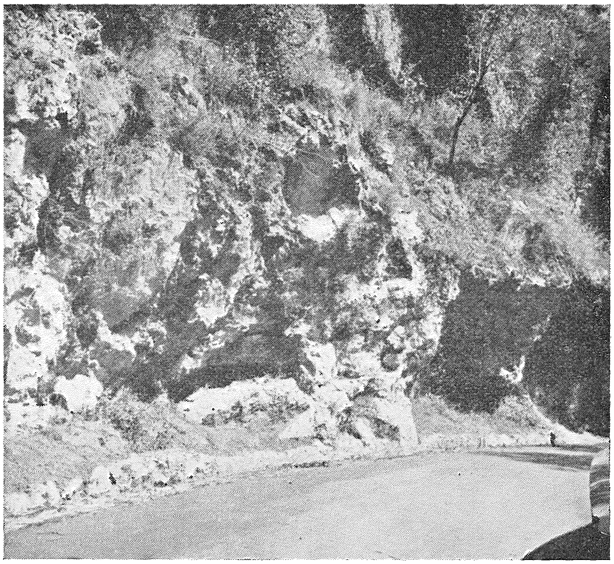

Fig. 4. Rocks along the road from Amalfi to Scala. Here *F. insidiatrix* was found in abundance. In addition were webs of *Segestria* sp., *Meta* sp., and *Pholcus phalangoides*.
E. Nørgaard phot.

sea level. This wall of rock (fig. 4) was created by blasting, which was carried out for the construction of the Amalfi-Scala road. It consists of a calcareous sandstone of very irregular shape. Throughout most of its course the precipice faces south and is almost vertical.

The *Filistata* webs are built close to each other and extend from the surface of the road to the top of the rock, several metres higher up. On one square metre at a height of two metres above the ground I counted 75 webs, a medley of large and small ones. The greater part of the webs are placed on the lower side of small projections, and near their edge. Such a projection is shown in fig. 5. The upper part is almost vertical and the lower 20 cm. slightly overhanging. The asterisks in-

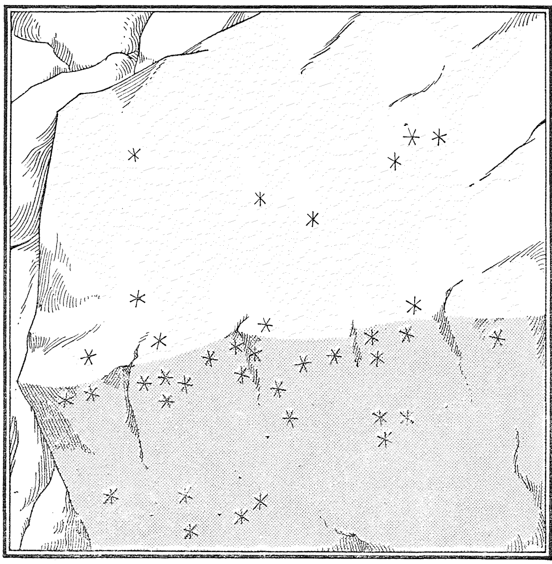

Fig. 5. A sector of 1 square metre of the rock from fig. 4. The asterisks indicate *Filistata* webs. These are mainly concentrated by the edge of the lower surface of the projection.
P. Gross del.

dicate the distribution of the nets, and it can be seen that they are concentrated on the extreme part of the lower side of the projection. Three factors apparently determine this characteristic distribution of the webs. In first place, it is likely that retreat-tubes and snares are more easily constructed. Secondly there are better chances of catching food. Thirdly, there will be a reasonable chance of avoiding unfavourable micro-climatic conditions.

To illustrate further these suggestions it may be mentioned that in many cases the sloping area is very uneven and abounds in cracks, which makes it easier to find suitable space for suspension of the retreat-tube, and the roughness of the surface offers an abundance

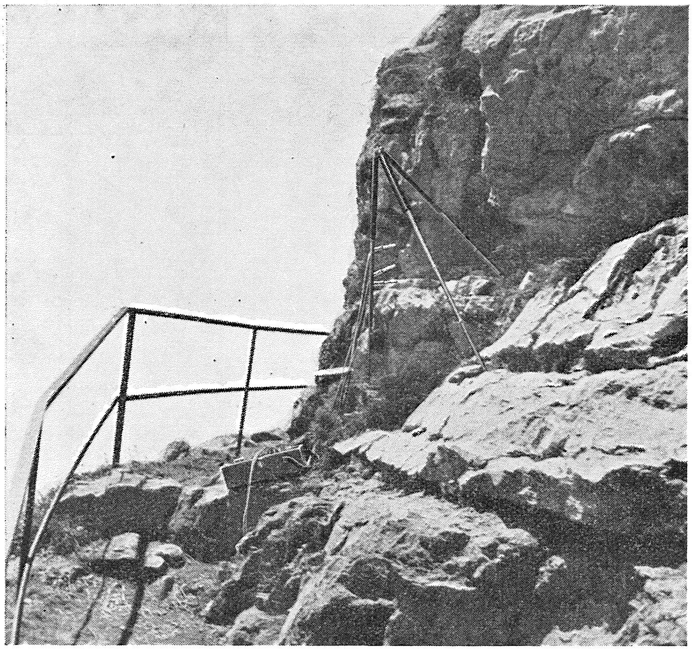

Fig. 6. Recording of temperature on a rock abt. 500 m. above sea level. The thermistors are placed on a tripod.
E. Nørgaard phot.

of convenient points, to which the snare may be attached. With reference to food, it is described (table 1) how *Filistata* mainly feeds on animals crawling on the rocks. When such animals approach the edge of the projection, they may very easily lose their footing and tumble down into a spider's snare. These two circumstances are evidently contributory causes to the characteristic placing of the nets, but these may not be the only causes; if anything, the micro-climate of the rock is a dominant factor.

With a resistance thermometer of the "thermistor"-type (Macfadyen 1949) a series of temperature recordings was made in the San Cataldo district (fig. 6). Mention must here be made of a series of recordings from the lower and upper part of a projection. The measurements were made adjacent to the upper and lower surfaces of the projection, with the thermistors placed as close to the rock as possible, without directly touching it. Two other thermistors were placed 5 cm. above and 5 cm. below the rock, respectively. The distance between the thermistors and the edge of the rock was constant. A fifth thermistor was placed in a *Filistata* retreat near the others.

At each spot 10 recordings were made from 10^{40} to 11^{55} a. m. on the 24th of July, 1949. Table 4 shows that the max. temperature on the upper surface of the projection was 39.0° C. There is nothing surprising in this temperature, as it is to be expected that the lethal tem-

Table 4. Temperature recordings from the lower and upper part of a projection and from a *Filistata* tube on the 24th of July from 10^{40} to 11^{55}.

	average of 10 readings °C.	minimum °C.	maximum °C.
Upper surface of projection	38.1	37.0	39.0
5 cm. above do. ..	30.0	28.0	31.0
Lower surface of projection	35.0	32.0	36.0
5 cm. below do. ..	29.3	27.0	31.0
In *Filistata* tube .	24.8	24.5	25.0

perature for *Filistata* as in other species from decidedly hot localities will be considerably higher, presumably in the region of 50° C. (Nørgaard 1948). But during the hottest hours of the day in unusually warm periods, the temperature will probably be considerably higher than in the period of this experiment. As an example it may be mentioned that the temperature of the air near San Cataldo on several occasions exceeded 35° C. in the shade, while it was only 27° C. in the above period. A rise in temperature of the air is generally followed by a still greater rise in temperature of the air close to the earth, which in such cases may reach or even exceed the lethal temperature of even very thermophilic species. Here it may be of major importance that the temperature on the lower surface of the projection, as shown in table 4, is on an average 3.1° C. lower than the temperature on the upper surface. This microclimatic factor, in conjunction with what has been said about the occurrence of points, to which the network can be attached, and the chances of catching prey, probably provides sufficient evidence to prove why most of the webs are to be found on the lower surface of the projections.

In addition table 4 shows that the temperature in the retreat-tube is far from reaching that of the surrounding rock. That is in all probability due to the insulating layer of air between the rock and the retreat-tube (fig. 1), and some ventilation of the tube which, as will be remembered, is in open connection with more or less deep and numerous cracks in the rock. A minor feature of the animal's behaviour must be considered in relation to this point. In the morning and late in the afternoon most *Filistata* individuals were sitting in the mouth of their tubes with their forelegs extended over the snare, ready to respond to the slightest touch of the net. But for some hours in the middle of the day no spiders were to be seen in the webs, and it was very difficult (in cases impossible) with the vibrator to induce them to come out. This period of staying in the heat-insulated tube in the hottest hours of the day can be interpreted as an avoiding reaction against the too high outside temperatures.

A comparison between a variety of rocky parts of the San Cataldo district showed that the webs were far more frequent on the rock near Scala than on other walls examined. The reason for this may be found in the greater moisture content of the rock, which was indicated by dark damp spots and fresh green pads of moss in the hollows beneath the protruding rock. The dampness has not, however, any direct influence on the distribution of *F. insidiatrix,* this spider being able to live in air with a low humidity and without drinking water, for long periods. On the other hand moisture is of considerable importance to the main prey-animal, the wood-louse. This animal requires ample humidity and as it is a herbivore, the abundance of its food will depend on the moisture of the soil. Summarising it may be stated that a suitably high relative humidity with a rich growth of plants results in a large number of wood-lice, on which many spiders, in this case *Filistata insidiatrix,* may exist.

Competitors were few at the time of the year, when the investigations were made. On the face of the rock there were webs of *Segestria* sp., but never in any great number, only 1 or 2 $^0/_0$ of that of *Filistata.* Although *Segestria* catches the same prey, there is, generally speaking, little competition. On the plants were snares of *Uloborus* sp., and in the deep hollows in the rock, webs of *Pholcus phalangoides* and *Meta* sp., but the snares of all these spiders are mainly traps for flying prey, consequently they even less than *Segestria* competed with *Filistata.*

Concluding Remarks.

An attempt has been made above to discuss certain aspects of the biology of *F. insidiatrix*. It is shown how environmental factors, temperature in particular, are related to the spider's behaviour. The maximum temperature on the wall of the rock is responsible to a certain degree for the distribution of the webs, and the spider's daily period of rest. It is described how *F. insidiatrix* has different food-preferences and food-behaviour in the San Cataldo district to that of *F. insidiatrix* in Banyuls-sur-Mer, where Berland made his investigations (Berland 1922). There was no opportunity to go into other details of the spider's biology. Yet a mention should be made of the fact that after transfer to Denmark three females with cocoons moulted, after the young ones had emerged. This confirms Berland's discovery that the female *Filistata* moults after one breeding period and breeds again next year, a peculiarity probably unknown in any other spider.

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