The life history of Pardosa amentata (Cl.) (Araneae, Lycosidae)

by

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The ecology of lycosid spiders was rather neglected until recently, although they are important carnivores in terrestrial habitats. During the last few years, however, increasing attention has been paid to this group of spiders. WIEBES (1960) published data about the occurrence of lycosid spiders in a Dutch dune area, and also (WIEBES 1959, 1962) collected data about the systematics and occurrence of Dutch lycosid spiders. NØRGAARD (1952) dealt with the ecology of some Danish lycosids. SCHMIDT (1957) published observations on the reproductive behaviour of *Pardosa amentata* (Cl.). Spider populations of different habitats were described by TRETZEL (1952, 1954), KNÜLLE (1953) and HEYDEMANN (1960). KUENZLER (1958) reported about the niche relations of some lycosid spiders in the United States.

For some years we have made observations on the ecology of some Dutch lycosids, especially of *Pardosa amentata* (Cl.). Also we studied some aspects of the behaviour of this spider and some allied species, so we can give some additional data about the life history. We mention the collaboration of Messrs. J. J. LAMMENS and J. C. VAN VEEN, who made some of observations.

We are indebted to Mr. H. COOK, who revised the English text.

Pardosa amentata (Cl.) is a very common lycosid spider in the Netherlands. It can be found not only on the banks of streams, as SCHMIDT (1957) mentions, but is also common in rather humid open habitats. We noted very dense populations at the sides of ditches with a rather scanty vegetation. Most observations were made of populations near Amsterdam, on sites where sand was pumped upon in preparation for construction. Here, but in the drier habitats, which have a very poor vegetation, *Pardosa monticola* (Cl.) also occurs, which, however, forms less dense populations. This species is common in dune areas (cf. WIEBES, 1959).

Most species of the genus *Pardosa*, including *Pardosa amentata*, winter as subadults in the penultimate stage. Small immature specimens occur also, but their number is quite small. In the sub-adults males and females can easily be distinguished, as the palps of the males are already enlarged. The number of males and females is about equal, as can be seen in table 1.

The animals were collected around the roots of grass, and under dead leaves and other loose material.

Table 1. The number of males and females of subadult *Pardosa amentata*, captured in autumn.

	Males	Females
Oct. 27th 1958	76	94
Oct. 28th 1958	59	49
Nov. 4th 1958	162	165
Nov. 18th 1958	63	75
Dec. 12th 1958	76	87
Total	436	470
Percentage	48.1	51.9

In normal circumstances, moulting occurs in the last decades of March or the first decades of April. In a population, observed March 28th, 1959, about fifty percent of the males were mature, whereas none of the females were observed to have moulted. This shows that males moult earlier than females, which was also observed by SCHMIDT (1957). In the laboratory males appear to moult about 3 days in advance of females, although a considerable overlap occurs. At the same time differences in weight between males and females can be noted. The weights of males, when moulting, were found to be between 23 and 25 mgs, whereas those of females were between 28 and 33 mgs. This difference in weight is probably related to the difference in moulting time. When mature, males weigh about 25 mgs, whereas females increase in weight as cited below.

Climatic conditions during early spring are important in determining the time of moulting. The animals are very photopositive and prefer temperatures of about 32° C, as was concluded from experiments in the laboratory. When mean daily temperatures in spring are low, moulting is retarded. Moulting is also determined by the exposure of the site where the population lives. Populations living at the side of ditches, exposed to the south, sometimes moult a fortnight earlier compared with populations which are less favourably situated. Even parts of the same population can show rather striking differences in advancement of development, depending on exposure.

Some days after moulting the male spider prepares a spermweb. The central portion of this small structure measures about 1 to 3 mm. The spider deposits a small drop of spermfluid, which is sucked up by the palpal organs. In this process, which is known as sperm-induction, the palps are directed to the rear and the sperm is taken up by both palps alternatively, through the meshes of the web. The palps are used as copulatory organs. After the sperm-induction the male spider is ready to mate and courtship behaviour can be seen. SCHMIDT (1957) remarks that a male spider, after each copulation, prepares once more a sperm-web. We observed several times, however, that males, which had just completed mating, may court other females immediately afterwards, without preparation of a sperm-web. Occasionally mating occurred. SCHMIDT (1957) also mentions that subadult males show some aspects of courtship behaviour. We have indeed seen some courtship behaviour in subadult males, but this occurred quite rarely.

Of 20 males observed in the laboratory 1 mated three times, 5 mated twice, 7 mated once and 7 did not mate at all. Therefore probably the level of sexual activity in different males is not equal.

In the courtship behaviour different phases occur. When a male is in search for a female, he shows a remarkable mode of locomotion, which can be named "Puppet-walking" (SCHMIDT 1957: Stelzgang). The animal stands high on its legs and walks with jerky movements. The moment of movement appears to be shorter in comparison with the normal movement. When a male detects a female display is started. The palps are raised sideways, alternatively one palp higher than the other. Next moment, both are lowered, violently vibrating, and withdrawn. After a step forward the process is repeated. Though normally both palps are raised alternatively, in some spiders one of the palps is raised higher than the other every time. As far as we observed this does not interfere with mating. The signals,

used in allied species of lycosid spiders are different, which probably means an ethological barrier between the species (BRISTOWE & LOCKET, 1926; BRISTOWE, 1960).

HOMANN (1928—1934) demonstrated that the change from searching behaviour to display was caused by optimal stimuli. He mentions that lycosid spiders only perceive the overall form of objects. SCHMIDT (1957) noted that male spiders display to other males, which observation we can corroborate. We noted also display of males to females which were anaesthetized by ether vapor. In this case the display, which sometimes can go on for hours (see also GERHARDT, 1923) is very short of duration. The males try to mate rather quickly.

We, however, observed also display to females which could not be detected by sight, as the females were hidden in crevices of the soil. Therefore also olfactorial stimuli must be important (BRISTOWE & LOCKET, 1926).

Several authors (GERHARDT, 1923; SCHMIDT, 1957; BRISTOWE, 1958) have mentioned that the male mounts the female from the front side. This, indeed, commonly occurs, but we observed rather frequently males mounting females from the lateral sides, and even sometimes from the rear. Next, the male takes the mating position. Now the front of the male is directed to the rear of the female. Alternatively the palps are inserted into the epigyne of the female reproductive organs. With the help of the pressure of the body fluid, the sperm mass is injected into the epigyne (see also GERHARDT, 1923).

Mating is accepted by the female beginning about one week after the moult. In this stage, before and after mating, females are seen actively hunting for prey. The animals are very mobile now, which phenomenon will be commented on elsewhere. As is said before, females after moulting normally weigh between 28 and 33 mgs. The weight increases to about 50—55 mgs. This weight is reached under normal weather conditions about a fortnight to three weeks after the moult. In the laboratory we noted that the time required for mating in full grown females was very short as compared to females with intermediate weights. Indeed, it may also be suggested that full grown females can postpone egg-laying when they have not yet mated. In this case egg-laying occurs very quickly after mating, occasionally after some hours. In these cases the eggs were fertilized and developed normally. If mating fails to occur, which was arranged in the laboratory by keeping females in isolation, unfertilized eggs are laid. An egg-sac is formed, which, however, in due time is sucked out or left.

The preparation of the egg-sac is described elsewhere (VLIJM, 1962). The egg-sac is continually carried by the spinnerets. Newly formed egg-sacs have a blue-green colour. In *Pardosa nigriceps* (Thor.) this colour remains for the whole period, but in *Pardosa amentata* (Cl.) after about three days it changes into a yellowish-brown colour. When carrying their egg-sacs females of *Pardosa amentata* sometimes show some kind of site-attachment, which phenomenon will be reviewed more extensively elsewhere. The egg-sacs are carried for about 3—4 weeks, depending on the weather in this period. The development of the young spiders, like that of the adults, appears to be primarily dependent on temperature. NØRGAARD (1952) mentions that females of *Pardosa pullata* (Cl.), carrying egg-sacs, prefer higher temperatures in comparison with females without egg-

sacs. In preliminary experiments in the laboratory we were not able to corroborate these results in *Pardosa amentata.* The preferred temperature could be determined once more to be about 32° C. However, in this connection, we made some field observations which may be of interest:

"Amsterdam, Buitenveldert, observation May 8th 1959, 2.45 p.m. to 4.30 p.m. Sun shines bright, after 3.45 p.m. occasionally some high clouds, moderate wind from eastern directions.

At 2.45 p.m. very few females with cocoons could be observed. After some time they could be detected, sitting in crevices in the soil. Their detection was facilitated by the display of some males. The females exposed their egg-sac to the sun, but withdrew their body in the shadow of the crevices. They left their shelters only to chase displaying males. From 3.45 p.m. and onward occasionally some high clouds (cirrus) passed along the sun. The sun then shone diffusely; lowering of the temperature was perceptible. Just some seconds after this occurrence, a number of females left their hiding places at once and exposed themselves to the sun. The reaction was reversible. It was observed three times in sequence."

From this observation it is suggested that the temperature which the females prefer apparently is suboptimal for the development of the young spiders in the egg-sac. Possibly the observed behaviour in *Pardosa amentata* may be compared with the preference of higher temperatures in females of *Pardosa pullata* as observed by NØRGAARD (1952).

Towards the end of the period in which the egg-sac is carried, some days before the young spiders will hatch, cocoons are carried more often with the aid of the cheliceres. Gradually the seam of the cocoon appears all round as a white ring. At the same time the cocoon becomes more rounded, presumably by the increasing activity of the spiderlings it contains. They can get more room, because of the biting of the female, the texture of the seam is made thinner. In the laboratory we were able to h e a r the gnawing of the female at the cocoon. Eventually a hole is bitten in the seam. The young spiders successively leave the cocoon through this opening. They mount the female by way of her legs, and arrange themselves upon the abdomen, first upon the dorsal side but if necessary also at the lateral and ventral sides and sometimes even at the rear of the cephalothorax. Most often the number of the spiderlings is between 30 and 50. During the process of hatching the female sits almost motionless.

The spiderlings remain on the abdomen for about two to four days. Their colour changes from yellowish (caused by the remaining yolk in their abdomens) to greyish-brown when the yolk is consumed. They leave the female both actively and passively. Their movements gradually increase, but also the movements of the female increase strongly. Occasionally the female brushes the abdomen with her legs, which causes some young spiders to be wiped off. Now the female is very mobile and no site-attachment is observed.

LAMBS-TYCHE (1939) and WIEBES (1960) discussed the origin of small-egg-sacs which are carried occasionally in autumn. LAMBS-TYCHE has suggested four possibilities:

1. Animals which carry egg-sacs in autumn belong to a second generation.
2. For some reason the last moult of these animals was retarded.

3. The animals lost their original egg-sac and again formed a cocoon.
4. The small number of eggs which are contained in the autumnal egg-sacs is possibly caused by peculiar local circumstances. WIEBES is of the opinion that sometimes a female will prepare a second egg-sac.

As regards this phenomenon, we observed, both in the field (by marking-techniques) and in the laboratory, the formation of a second egg-sac in *Pardosa amentata* (Cl.), *P. monticola* (Cl.), *P. nigriceps* (Thor.) and *P. lugubris* (Walck). The phenomenon is thus widespread. This occurs both after hatching of the young spiders from the first egg-sac, as well as after accidents with the first cocoons. Once we observed in the laboratory a female *P. monticola* which completed a fourth cocoon, whereas in 6 females of this species a third cocoon was observed. As a rule, in the laboratory, about one week after hatching of the young, a new cocoon is formed. From all the cocoons mentioned young spiderlings hatched. The third and fourth cocoons, however, were notably smaller in comparison with the first and second cocoons.

As is mentioned above, in normal years a second generation occurs in *P. amentata* as rarely as in other species of the genus. This is also suggested by the absence of males in autumn, although females regularly are to be found. HEYDEMANN (1960), however, observed adult females (carrying egg-sacs) and males of *P. purbeckensis* (Cambr.) in September and October 1959. He supposes that the animals had matured unusually early on account of the warm summer of that year. Every year young spiders in various stages of development can be found during the reproductive season. Therefore, the observed males and females may possibly have originated from these late-comers. Possibly these animals also are of importance for the survival of the species, when bad weather occurs during the reproductive period.

The small size of the cocoons formed in autumn also points to the supposition of second cocoons. Even in the laboratory, under favourable climatological and food conditions, second cocoons are smaller than first cocoons. Indeed, these cocoons are formed without a second copulation. In the field mature males, as in the case mentioned by HEYDEMANN (1960), are very rarely found. As the cocoons, as WIEBES (1960) mentions, contain normal developing spiderlings, this is also an argument for the hypothesis that cocoons observed in autumn are second cocoons. Furthermore, as we observed in the laboratory, the behaviour of females in regard to cocoons which contain unfertilized eggs, is always abnormal. In those cases, shortly after forming, the cocoon is either sucked out or left.

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Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin. (N.F.), Band 2, Heft 3, 15.XI.1962. Walter de Gruyter & Co., Berlin, Prijs D.M. 30.—.

Wij ontvingen deze aflevering, p. 109—168 van deel 2, ter aankondiging voor de Bibliotheek. Zij bevat 4 artikelen met de volgende onderwerpen: de tanden van de potvis, het natuurreservaat Teufelsbruch in Berlijn-Spandau, de functie van de kaken der vissen en de morfologie en histologie van het oog van de giraffe. Geen entomologische bijdragen dus, zodat we het bij deze korte aankondiging van de overigens weer voortreffelijk geïllustreerde aflevering moeten laten. — LPK.

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Bovenstaande publicatie, waarvan de Bibliotheek een exemplaar ter aankondiging ontving, behoort tot de serie „Mitteilungen aus dem Archiv für Geschichte der Naturforschung und Medizin der Deutschen Akademie der Naturforscher Leopoldina". Zij bevat een foto van VERHOEFF, een inleiding van Rudolph ZAUNICK, een levensbeschrijving door Dr. VERHOEFF zelf en een lijst van zijn publicaties, die in totaal 670 titels bevat. Een groot aantal daarvan is nog door ruil te krijgen van de Zoologische Staatssammlung te München. VERHOEFF was vooral bekend als specialist in de Duizendpoten en Pissebedden. — LPK.

Vangsten op stroop in 1961. De heer VAN AARTSEN schrijft in *Ent. Ber.* 22: 231 (dec. 1962), dat de specifieke najaarsvlinders in 1961 vrijwel niet op gesmeerde bomen verschenen. Met uitzondering van *Agrochola macilenta* en *Eupsilia transversa* kan ik het hiermee niet eens zijn. Ik smeerde op 6 en 10 oktober 1961 te Heemskerk op slechts 11 bomen met de volgende resultaten:

Allophyes oxyacanthae: 48 en 63 exemplaren,
Conistra vaccinii: 38 en 54 exemplaren,
Agrochola lota: 32 en 46 exemplaren,
Agrochola helvola: 4 en 58 exemplaren,
Agrochola circellaris: 42 en 12 exemplaren.

J. HUISENGA, Leliestraat 17, Wormerveer.

[Dit bewijst weer eens te meer, hoe sterk de ervaringen plaatselijk kunnen verschillen en hoe voorzichtig men moet zijn met het uitspreken van een oordeel over een bepaald seizoen. — LPK.]