Mother-young Interactions During the Brood-care Period in 
Anelosimus crassipes (Araneae: Theridiidae)

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Abstract The theridiid spider Anelosimus crassipes (Araneae, Theridiidae) is a maternal species. The offspring were provided the prey by mother during the gregarious period. However, the mode of feeding changed as the young grew up, i.e., at the beginning of the gregarious period, the offspring were offered the prey immobilizing by the mother, in the end of the gregarious period, the prey capture was performed by the mother and her young. Analysis of the sequence of prey-supply activity showed prey-recognition of spiderlings were released by mother’s behavior unit “WLK.” Spiderlings never ran towards the prey without the unit “WLK” of mother. The tolerance of mother to young was investigated experimentally by exchanging the mother. The result showed the mother distinguished her own young from other’s. The present study showed that in A. crassipes maternal behavior depends on the communication mechanism consists of stimuli emanating from the mother to young.

Introduction

Most spiders live solitarily almost all their lives except short-period after emerging. However, some species of spiders has extended gregarious phase of life, such as communal one (Brach 1975, 1977; Christenson 1984; Vollrath 1986; Vollrath et al., 1983), or mother-spiderling bonding one (Kullmann, 1972; Ito, 1985; Gundermann et al., 1988; Bessekon et al., 1992). Both are based on maternal behavior.

In general, “maternal behavior” means egg-sac care (guarding, cocoon opening), food-supply activity (regurgitation feeding, offering the prey, sharing the prey) and guarding the young. These behavior consists of complex factors of mother and her young. Especially, the food-supply activity needs accurate mutual recognition and tolerance between mother and her young (Ito, 1985). The regulation of maternal

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food-supply behavior has been studied by Gundermann et al. (1988, 1992). They showed that in the funnel-web spider Coelotes terrestris the maternal food-supply behavior requires mother's particular internal state which seems to develop at the time of the offspring's emergence and is also influenced by stimuli emitted by the young.

In the present paper, the maternal behavior of a theridiid spider Anelosimus crassipes (Bösenberg et Strand, 1906) was observed under natural and laboratory conditions. Furthermore, the mother-offspring interaction during the maternal food-supply period was studied experimentally.

Methods

The theridiid spider Anelosimus crassipes is common in Japan, especially abundant at the seaside bush. This spider lives in an irregular-web woven under the leaves, mainly broad-leaved trees (Fig. 1).

In order to know the life history of A. crassipes and to investigate the maternal behavior, the field observations were made at Ninomiya (Kanagawa Pref., Japan) in the seashore of the Pacific coast, from May 10 to Aug. 31, 1989.

Based on the field data, observations on food-supply sequences during the brood-care period were made using 8 mm video tape recorder (Canon, Hi 8) under laboratory conditions. Eighteen females with young (12) and without young (6) which were collected at the study site, and were retained for the behavioral analysis. Observations were made every other day during the gregarious phase by offering the prey, e.g., fruits fly, and moth.

Eighteen females were used for the experiment on the tolerance of mother to her young. In order to clarify the influence of internal condition of the female, the

![Fig. 1. Schematic presentation of the web of Anelosimus crassipes in the field.](image)
experiment was performed on the two different characteristic groups, i.e., Group (A): Exchanging the mother of same phase (Phase II), Group (B): Exchanging the mother of different phase (Phase II and with egg-sac). The experiments on these two groups were performed in the field (for the meaning of "Phase" see Results).

Results

Life history of A. crassipes
The male (3.5 mm in the body length) and females (4.5 mm) of A. crassipes matured in the end of May. However, the male matured about one week earlier than the female. The copulation occurred as soon as each female matured, and then the male disappeared. One egg-sac containing about 40 eggs (28–51, N=6) was constructed and the mothers were carrying their cocoon with their chelicerae. After 2-week incubation period, some 30 (20–44, N=19) young (0.85 mm in the body length) hatched, then the egg-sac was opened by the mother. The spiderlings stayed with their mother for about 2 weeks, then dispersed gradually and lived a solitary life. In most cases, the mother disappeared before dispersing of the young. The molting of the spiderlings was observed about 1 week after emergence (Fig. 2).

Observations of maternal food-supply behavior
Maternal food-supply behavior was observed during the gregarious period. However, the mode of feeding changed as shown in Table 1, i.e., the first 2 days after

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Fig. 2. Life history of Anelosimus crassipes.

Table 1. Shifting of the mode of maternal food-supply behavior.

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<th>Phase</th>
<th>the days after emergence</th>
<th>the mode of food-supply behavior</th>
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<td>II</td>
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<td>offering the prey</td>
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<td>III</td>
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<td>catching the prey together</td>
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emergence, the spiderlings were motionlessly in group and ate nothing (Phase I). The mother offered the prey to her young from the third day and last it about 4 days (Phase II), and then the spiderlings caught the prey with their mother before dispersing (Phase III). However, the spiderlings began the catch the prey by themselves, in case of disappearance of the mother during the gregarious phase.

**Sequences of maternal food-supply behavior**

In order to clarify the behavioral acts of the mother and the spiderlings in the sequences of food-supply behavior, the behavioral units were defined as GUENDERMANN's units (GUENDERMANN et al., 1988) which is partly reformed.

**Behavioral units 1 (for the mother and her young)**
- WPT—Wait position: Standing motionlessly at the retreat.
- PUR—Pursuit: Running towards the prey.
- CAP—Capture: Catching and biting the prey (after short palpations by the first pair of legs).
- CAR—Carrying into the retreat: Carrying the prey held between the chelicerae.
- DIS—Discarding prey: Leaving the prey, and moving to the retreat.
- WRP—Wrapping: Wrapping the prey with silk.
- DRU—Drumming: Drumming on the web using the pedipalps.
- GRO—Grooming: Cleaning legs and pedipalps using the chelicera.
- IMO—Immobilizing: Immobilizing the prey by fixing to the web.
- WLK—Walking: Walking around the web with spinning the thread.
- EAT—Eating: Eating the prey.

**Behavioral units 2 (for the spiderlings)**
- CTP—Contact with the prey.
- KEP—Keeping with prey: Remaining in contact with the prey, whatever their mother’s behavior.
- PUM—Pursuing the prey-carrying mother.
- RUM—Running away from the mother.
- CTM—Contact with the mother: At least 3 young coming into contact with their mother.

**The analysis of the mother's behavior**

The females were divided five characteristic groups as followed, and the sequences of feeding behavior is shown in Fig. 3.

1) The females without young and eggs (N=7).
2) The females with eggs, but without young (N=8).
3) The females with young (Phase I) (N=5).
4) The females with young (Phase II) (N=11).
5) The females with young (Phase III) (N=7).

The feeding sequences occurred in the same way in its initiation in all groups. As soon as the prey dropping onto the web, the mother ran towards (PUR), and caught it (CAP). Then the prey was carried to the retreat (CAR). The mother wrapped the prey there (WRP), and fixed it to the web by the silk (IMO). After CAR or WRP, sometimes the mother left her prey and backed to retreat (DIS).
The sequences after that was alternative. In case of the group 1) and 2) (without young), the prey was eaten (EAT) immediately after IMO. On the other hand, in case of the group 3), 4) and 5) (with young), the mother left the prey and walked around the web (WLK). No contact with her young was observed in the course of this behavior.

There was no significant difference in the feeding sequences between two groups 1) and 2) which are without young. Also no significant difference was there, in the three groups with young 3), 4) and 5). However, these two categories, with young and without young, can be divided clearly by difference of the behavioral acts following the unit IMO. That is, the unit WLK followed IMO in the group with young in most cases, while the unit EAT followed IMO in the group without young in most cases ($\chi^2$-test, $p < .05$).

The analysis of the young's behavior

When the prey was dropped onto the web, no reaction was observed from the spiderlings in Phase I and II. Only the spiderlings Phase III showed the reaction

![Diagram of sequences of the feeding behavior during gregarious period.](image)
They ran towards the prey following their mother in a group (PUM) (Fig. 4). After immobilizing the prey (IMO), the mother left and walked around (WLK). Then the young remained in contact with the prey and ate it.

In case of the spiderlings in Phase II, the feeding behavior seems to be led by the mother's behavior, especially unit WLK. In the course of this study, all of the young's behavior unit PUR (running towards the prey) occurred after mother's unit WLK.

In case of the spiderlings in Phase I, they reacted neither to the prey nor to their mother's behavior at all.

**Experiment on the tolerance of mother to young**

In cases of the experiment A), that is, exchanging the mothers in phase II each other, the mother never settled down and ran away from other's web (N=4).

In cases of the experiment B), that is, exchanging the mothers of different phases, 1) in case of the mother with egg-sac, she scattered other's young and then disappeared, or 2) in case of others, she bit the egg-sac and ran away from other's web (N=5).

**Discussion**

1. **Maternal behavior of Anelosimus crassipes**

   The female of *A. crassipes* is always carrying the egg-sac with her chelicerae during the incubation period in the field. The prey dropped onto the catching area of the web was often ignored by the mother with the egg-sac during this period. The female seems to stick to the egg-sac too much from this fact. In *A. crassipes* the opening of the cocoon was performed by the mother. As she needs to know the right time to open, some signals should be emitted from the cocoon.

   The mode of prey-supply activity seems to be different between *A. crassipes* and other maternal species as follows; KULLMANN et al. (1971, 1972) reported that the mother spider fed her offspring by regurgitation in *Theridion impressum*, *T. sisyphium*, *Stegodyphus pacificus*, *S. sarasinorum* and *S. mimosarum*. In *Achaearanea japonica*

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**Fig. 4. Correlation between mother's behavior unit “WLK” and offspring’s behavior.**

For mother: WLK; Walking. For spiderlings: PUM; Pursuing the prey-carrying mother. PUR; Pursuit. Running towards the prey. EAT; Eating.
(= *Theridion japonicum*), after the mother catching and biting the prey, the spiderlings come near to it and eat it with their mother. Such way of feeding behavior lasts for about 2–3 weeks and then the spiderlings begin to catch the prey by themselves from about the end of the gregarious period. The mother is sucked out by her offsprings after her death (Iro, 1985). Following species also shows similar behavior: *Theridion impressum*, *T. sisyphium*, *Stegodyphus pacificus* and *S. lineatus* (Kullmann, 1972), etc.

But in *A. crassipes* the spiderlings rarely ate the prey with their mother. As shown in results, the mother left the prey after catching and handling it during the gregarious period (Phase II and III), then the leaving prey was eaten by the spiderlings. The mother seems to emit the signal to her young by her behavioral act of "WLK" from the observations, however the detail of the mechanism is unknown. The mother was never eaten by the spiderlings in this species.

2. **Recognition between mother and offspring**

"Maternal behavior" requires the recognition between mother and offspring. However the degree of recognition of the mother seems to be different from that of offspring.

Recognition of a mother to her offspring: The mother performed positive prey-supply behavior during gregarious period to her young as shown above. The mother never eat her young and sequences of the feeding behavior of the mother is released only by the prey item. From these facts, spiderlings are clearly discriminated from the prey, and are accepted as the existence requiring her care. On the other hand, the experiment on the tolerance to young shows that the mother distinguishes her own offspring from other's. In this experiment, whatever the Phase of offspring, they were never accepted by other's mother. These facts suggest that recognition of mother to her young depends on a mechanism which is accurate and quickly. It is discussed about this mechanism afterwards.

Recognition of spiderlings to their mother: In the course of the observations of maternal behavior, it was hardly occurred that spiderlings seemed to emanate some stimuli to the mother. In this species, the spiderlings seem to just receive and react to the stimuli emitted from their mother.

Recognition among spiderlings of each other: As cannibalism are common in spiderlings of many species having extended gregarious period, just like *A. crassipes*. In the spiderlings of *A. crassipes*, no mutual attack was observed. As they were keeping contact with each other by touching with their pedipalps, it may be this pedipalpal behavior playing a role to ease the tense among spiderlings.

3. **Mechanism of communication in maternal behavior**

Discussed as above, the interaction between mother and spiderlings is very important for establishment of the maternal activity. In particular, communication is indispensable to this activity. In all characteristic periods during parental cycle, communication plays a great part for it.

In *A. crassipes* the mode of communication seems to be one sided, from mother to spiderlings, judging from the observation of their behavioral acts.

The results of the observations show that spiderlings of Phase I and II seems to be unable to recognize the prey by themselves. In the course of the feeding se-
quences, behavior unit “WLK” of the mother seems to enable perceiving the prey for her young. Unit of “WLK” also gives the information of the position of the prey to them. While, it does not seem that the behavior of the mother is influenced by the offspring’s.

What kind of stimuli the unit “WLK” contains? There are two possibilities: One is the vibration which is mediated by the thread of the web during the walking of the mother. Another is the contact with the spiderlings. However, further experiments are needed to clarify these possibilities.

In other maternal species of spiders, various ways of maternal food-supply activity was observed. In Coelotes terrestris, different from A. crassipes, maternal prey-supply activity seems to depend of a mechanism regulated by the young which requires high flexibility in the mother’s behavior (GUNDERMANN et al., 1988). Also it is observed that several vibrating signals produced by the mother. These facts suggest the existence of exchange the information between mother and spiderlings in this case. However, in order to investigate the detail of the mechanism of communication between mother and offspring, further technical skill is needed.

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References


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