

IMPORTANCE OF FIRST PREY TO SPIDERLING SURVIVAL IN *LYCOSA* SP. (ARANEAE: LYCOSIDAE)¹

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Maternal care in *Lycosa* sp. was found to slightly affect survival rate of spiderlings; those separated earlier had less chances of survival than those separated later. A satisfactory survival rate for spiderlings was obtained only when given a first meal of the collembolan, *Cyphoderus javanus* Boerner. With increased quantity of prey maintained daily, a corresponding increase in survival as well as weight was observed. Delaying the availability of the first meal beyond two days after separation from the mother increased mortality significantly. A taxonomic description of this undetermined spider species is provided.

Spiders are obligate carnivores which prey principally on insects. But being general predators, their potential as biological control agents of insect pests has not been as well recognized as the more host- or prey-specific entomophagous insects and pathogens. Recent local observations suggest, however, that predation by certain spiders contributes to population control of major insect pest species such as the corn borer, *Ostrinia furnacalis* (Guenee) (IRRI Annual Report, 1974) and the brown planthopper, *Nilaparvata lugens* (Stal), on rice (Gavarra and Raros 1975).

During a preliminary survey of spiders in corn fields around Laguna and Batangas in 1973, an undetermined species of hunting spider, *Lycosa* sp.³ showed great promise as predator. This spider was the most frequently encountered of the predatory invertebrates in upland farms. It was often observed stalking prey in the whorl cup of corn and on the ground among crop stubbles and other plant debris. Initial attempts to rear the spider in the laboratory were generally unsatisfactory; spiderling survival was abnormally low compared with the relatively successful mass-rearing of *Lycosa pseudoannulata* Boes. et Str. in this laboratory by Gavarra and Raros (1975).

Lycosid spiders exhibit parental care of the young. The eggs are incubated in an egg sac which is attached to the spinnerets and carried by the gravid fe-

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³ Species determination awaits completion of a study on "Systematics of Philippine *Lycosidae*" in this laboratory. For the purposes of the present work, however, a taxonomic description of the species is provided.

male until the spiderlings emerge to mount their mother's abdomen. The female carries the spiderlings for a period ranging from 10 to 14 days in the temperate zone (Turnbull 1973). A much shorter period is expected in the tropics, e.g., an average period of 3.5 days for *L. pseudoannulata* (Gavarra and Raros 1975). During this period, it is assumed that the spiderlings utilize food reserves derived from the egg yolk, and upon exhaustion of this reserve the spiderlings disperse to become independent from the mother and soon must feed.

In *L. pseudoannulata*, the timing, quality, and quantity of the first prey obtained after dispersal have profound influence on spiderling survival (Gavarra and Raros 1975). Although spiders are known to be resistant to starvation (Turnbull 1962, Miyashita 1968), failure to obtain first prey soon after dispersal may account for a bulk of juvenile mortality. The role of debris-associated microarthropods, especially the acarines and collembolans, as initial prey is apparently significant in this regard. However, reviews of spider biology (Turnbull 1973), collembolan and general soil arthropod research (Christiansen 1964, 1970) surprisingly reveal little information on spider-soil microarthropod relationships.

Research on the potential of spiders as biological control agents has been inconclusive (Turnbull 1973). Evidently more experimental results are needed especially from studies which evaluate the impact of the spider predation by experimental field releases of potential species. So far, however, these types of studies have not been done for lack of adequate mass-rearing techniques for spiders.

This study was undertaken to provide information on the feeding requirements for the spiderlings of *Lycosa* sp. and thereby facilitate the development of procedures for mass-rearing spiders in the laboratory. Specifically, the effects of the following factors on spiderling survival were evaluated: (1) duration of maternal care, (2) the type of first prey, as well as timing and quantity of the first meal, and (3) the use of *Drosophila* adults as prey. The investigations were conducted from September, 1973 to November, 1974 in the Arachnology Laboratory of the Department of Entomology, University of the Philippines at Los Baños.

MATERIALS AND METHODS

General handling and maintenance of spiders. Sexually mature adults of *Lycosa* sp., collected from the experimental plots of the Multiple Cropping Project, The International Rice Research Institute, served as source of the spiderlings used in this study. Since the spiders are cannibalistic, these were confined individually in 5.2 x 2.7-cm plastic vials. The holding vials contained moist soil up to one-fourth of capacity. They were thus maintained using *Drosophila* adults as prey. Because *Drosophila* can be mass-reared easily, it was possible to supply the spiders with abundant prey throughout the study.

When spiderlings were necessary for the various experiments, sexually mature adults were paired in empty ice cream boxes where mating readily occurred. In approximately 14 days, egg sacs were formed and the spiderlings emerged usually 6 days later. All experimental spiderlings were also confined individually in medicine glass vials that were slightly smaller than those used for the adults. Similarly, these holding vials for spiderlings were filled to one-fourth capacity with moist soil. Every aspect of testing and observation was performed in an air-conditioned room in which the temperature ranged from 25 to 26°C and treatment effects were observed on 15 spiderling cultures, replicated 4 times in complete random design.

Effects of maternal care. Like a typical lycosid, the spiderlings of *Lycosa* sp. mount their mother's abdomen immediately after emergence. Here, they remain attached for as long as 4 days. During this stage, some spiderlings may be dislodged accidentally from the abdomen as their mother moves about debris and plant foliage in search of prey. The fate of such prematurely detached spiderlings is not known. Thus, spiderlings of varying ages from emergence were experimentally dislodged from their mother's abdomen and reared with the collembolan, *Cyphoderus javanus* Boerner, as prey. Their survival rates were observed and compared.

Effects of first prey. As indicated earlier, *Lycosa* sp. associated with decomposing crop stubbles. Closer field observations revealed that the spiderlings fed on soil- and litter-associated collembolans. Other "decomposer" microarthropods such as acarines and drosophilid or stratiomyid flies may also serve as prey. However, the collembolans, represented mainly by *Cyphoderus javanus* in the experimental lots, apparently constitute the critical first prey of the spiderlings. To evaluate the relative importance of these arthropods, newly separated spiderlings were reared separately on *Cyphoderus javanus*, oribatid mites and *Drosophila* adults. Spiderling survival and growth were compared. Likewise, the effects on these parameters of delayed availability and quantity of the first prey were evaluated.

Use of Drosophila in spider mass rearing. The mass rearing of spiders requires also mass rearing of their prey. A wild population of *Drosophila* has been conveniently mass-reared in the laboratory on boiled, mashed and moistened sweet potato tubers. All stages of a related *L. pseudoannulata* species are being concurrently maintained satisfactorily on adult *Drosophila*. Very young spiderlings of our present species, however, cannot subdue the much bigger *Drosophila* adults. To successfully capitalize on *Drosophila* as a convenient prey species, the proper spiderling age when prey switch to *Drosophila* could be made without affecting survival rates was determined. For this purpose, newly dispersed spiderlings were offered initially with the suitable first prey. At varying intervals, the first prey were withdrawn and replaced immediately with *Drosophila* adults.

RESULTS AND DISCUSSION

Effects of maternal care of young on spiderling survival. The results presented in Table 1 show that separating spiderlings prematurely from their mother during the first 4 days after emergence slightly affected their survival. The effect varied with age. Those separated on the first or second day after emergence had significantly lower survival than those separated on the third day.

In this test, the prematurely separated spiderlings were provided non-limiting quantities of a suitable prey, the collembolan *C. javanus*. That majority of the test spiderlings survived (about 80-95% survival) suggests that perhaps the survival value of maternal care (i.e., the female carrying its young) is due largely to protection of the young from physical factors of mortality. It may be significant to note at this point that among arthropods, the life stage most vulnerable to adverse environmental factors, especially physical, is usually the stage immediately after hatch.

Effects of first prey on spiderling survival. After 4 days of maternal care and protection, the spiderlings separate from their mother to independently seek shelter and food. They soon become intimately associated with decaying

TABLE 1. Effect of forced separation on survival of spiderlings up to 7 days of age.

| No. of days on mother's abdomen | Mean per cent survival ¹ |
|---------------------------------|-------------------------------------|
| 1 | 79.82 b |
| 2 | 84.50 b |
| 3 | 94.75 a |

¹ Means not followed by the same letter are not significantly different at 5% level; Duncan's New Multiple Range Test.

plant debris in the field. On decaying crop stubbles of corn, peanut, and mungo the spiderlings were commonly observed feeding on collembola which, together with mites and stratiomyid flies, numerically dominated the decomposer arthropod fauna of crop stubbles.

A laboratory test, conducted to evaluate the relative importance of the above decomposer arthropods as prey species, confirms the field observation that collembolans constitute the critical first prey species of spiderlings (Table 2). The collembolan *C. javanus*, an unidentified oribatid mite *Schelorbitates* sp., and *D. melanogaster* adults (substituted for stratiomyid flies) were liberally supplied as prey species to newly separated spiderlings. After 7 days of daily feeding, spiderling survival was excellent on the collembolan while survival on the oribatid mite or on *Drosophila* was low.

TABLE 2. Per cent survival of spiderlings after 7 days of rearing on different prey species

| Prey Species | Per cent mean survival ¹ |
|--------------------------------|-------------------------------------|
| <i>Cyphoderus javanus</i> | 95.00 a |
| <i>Drosophila melanogaster</i> | 38.33 b |
| <i>Scheloribates</i> sp. | 10.00 c |

¹ Means not followed by the same letter are not significantly different at 5% level; Duncan's New Multiple Range test.

Table 3 shows the performance of spiderlings reared on varying daily supply of *C. javanus* individuals. The data show that at least 2 collembolans per spiderling per day are required to obtain satisfactory survival although heavier spiderlings were obtained on a daily supply of 3-4 collembolans. Moreover, table 4 shows that the spiderlings must obtain their first prey within 2 days after separating from the mother. Further delay in obtaining the first meal progressively increased spiderling mortality.

The importance of Collembola to the survival and maintenance of *Lycosa* sp. populations in cultivated farms is clearly apparent from these results. In constituting the critical first prey of spiderlings, Collembola are key prey species to high spiderling survival. But with prevailing crop management procedures, and as cropping intensity and management levels increase, crop stubble management with the view to recycle organic matter continues to receive little attention. In general, organic litter turnover rate decreases and this affects not only the natural buffering capacities of soils but also beneficial biotic relationships. For instance, decreased litter turnover results in decreased Collembola abundance and, accordingly, also spiderling survival.

TABLE 3. Per cent survival and weight of spiderlings after 14 days of rearing at different quantities of its prey, *C. javanus*.

| No. of <i>C. javanus</i> supplied daily | Mean ¹ | |
|--|-------------------|----------|
| | Survival | Weight |
| 1 | 33.25 d | 0.597 d |
| 2 | 83.33 bc | 1.102 c |
| 3 | 86.67 abc | 1.447 bc |
| 4 | 93.33 ab | 2.230 ab |
| 5 | 96.67 a | 2.890 a |

¹ Within column, means not followed by the same letter are not significantly different at 5% level; Duncan's Multiple Range test.

TABLE 4. Effect of delayed first meal (*C. javanus*) on spiderling survival.

| No. of days delayed | Mean per cent survival ¹ |
|---------------------|-------------------------------------|
| 0 | 98.33 a |
| 1 | 100.00 a |
| 2 | 98.33 a |
| 3 | 66.67 b |
| 4 | 60.00 b |
| 5 | 31.67 c |
| 6 | 28.00 c |
| 7 | 10.00 c |

¹ Means not followed by the same letter are not significantly different at 5% level; Duncan's Multiple Range Test.

Use of Drosophila in mass rearing of Lycosa sp. Since large numbers of *D. melanogaster* are easily mass-reared on readily available media, e.g., ripe bananas or boiled sweet potato, and adult flies are convenient to handle, *Drosophila* are presently the most suitable laboratory insects to use in the mass rearing of spiders. Indeed, the spider species *Lycosa pseudoannulata* has been successfully reared in this laboratory on *D. melanogaster* as the only prey. However, when *D. melanogaster* was used in the rearing of *Lycosa* sp., spiderling survival was unsatisfactory (Table 1). Compared with spiderlings of *L. pseudoannulata*, young spiderlings of *Lycosa* sp. are more fragile and less capable of capturing and handling *Drosophila* adults. To obtain satisfactory survival on *D. melanogaster*, the spiderlings of *Lycosa* sp. apparently require 3 to 4 days of prior feeding on a more suitable prey, e.g., Collembola, as shown in Table 5. The results in Table 5 also suggest that the spiderlings may begin to prey on species as large as *Drosophila* 4 days after separating from their mother.

TABLE 5. Effect of prey shifting from *C. javanus* to *D. melanogaster* on spiderling survival up to 27 days of age.

| No. of days of initial feeding on <i>C. javanus</i> | Mean per cent survival ¹ |
|---|-------------------------------------|
| 0 | 6.67 c |
| 1 | 65.00 b |
| 2 | 73.33 b |
| 4 | 95.00 a |
| 8 | 100.00 a |

¹ Means not followed by the same letter are not significantly different at 5% level; Duncan's New Multiple Range Test.

Taxonomic description of *Lycosa* sp.

Male. Cephalothorax $2.5 \pm .025$ mm long and $1.51 \pm .026$ mm wide. Carapace dark brown at edges, becoming lighter toward middle; median area divided by a distinct line, the latter extending to both anterior and posterior margins; lighter

lines similarly present, radiating from middle portion of carapace toward sides. Eye region dark brown to black, with long hairs; median row of eyes larger than posterior eyes, anterior eyes slightly procurved and are smallest. Abdomen ovate, smaller than cephalothorax; dorsum brown, with short hairs and yellow transverse irregular markings; venter light brown without distinct markings. Legs hairy, generally brown with yellowish annulations. Pedipalps yellow but with an enlarged black terminal segment. Total length $4.38 \pm .044$ mm (based on 50 specimens).

Female. Cephalothorax $2.74 \pm .34$ mm long and $1.99 \pm .026$ mm wide. Carapace, eyes, and legs same as in male. Abdomen brown, with short hairs; with small irregular yellow markings throughout dorsal region; ventrally with small indistinct black spots on dark yellow background; epigynum bud-like, with black marking at base. Total length $5.32 \pm .044$ mm (based on 50 specimens).

SUMMARY AND CONCLUSION

The duration of maternal care by *Lycosa* sp. of its young spiderlings was found to affect survival slightly. Prematurely separated spiderlings had lower survival than those separated later.

The effect of the kind and number of first prey on spiderling survival was determined. Spiderlings survived excellently on the collembolan *Cyphoderus javanus* as initial prey. Poor survival was observed from those reared on *D. melanogaster* and the oribatid mite *Scheloriabates*. At least 2 individual collembolans were required for satisfactory spiderling survival; more than 2 individuals gave better survival and heavier spiderlings. Also, spiderlings fed within the first two days after separation from the mother prevented high mortality.

Drosophila melanogaster can be used for mass rearing of *Lycosa* sp. spiderlings provided they are first fed with *C. javanus* during their first four days.

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LITERATURE CITED

- CHRISTIANSEN, K. 1964. Bionomics of Collembola. *Ann. Rev. Ent.* 9:147-178
 ————. 1970. The scope and direction of contemporary soil arthropod research. *International Symposium on Pesticides in the Soil*: 8-14.
 GAVARRA, M. R. and R. S. RAROS (1973) 1975. Studies on the biology of the predatory wolf spider, *Lycosa pseudoannulata* Boes. et Str. (Araneae: Lycosidae). *Philipp. Ent.* 2(6):427-444, figs., tables.

- INTERNATIONAL RICE RESEARCH INSTITUTE. 1974. Annual report for 1973. Section on multiple cropping. Los Baños, Philippines.
- MIYASHITA, K. 1968. Quantitative feeding biology of *Lycosa T-insignita* Boes. et Str. (Araneae: Linyphiidae). Bull. Nat. Inst. Agr. Sci. Jap. C 22: 329-334.
- TURNBULL, A. L. 1962. Quantitative studies of the food of *Linyphia triangularis* Clerk (Araneae: Linyphiidae). Canad. Ent. 94:1233-1249.
- TURNBULL, A. L. 1973. Ecology of the true spiders (Araneomorphae). Ann. Rev. Ent. 18:305-348.

The life cycle of *Eotetranychus cordatus* Rimando was studied using *Citrus mitis* (L.) and *Californica loma* (C. medica L.) as hosts. It includes four developmental stages, namely, an egg, larva, protonymph, and deutonymph. Comparative data on the rate of development, fecundity, fecundity, fertility and survival to maturity of the species are given for the two host plants.

The results of a year-long survey of the population trends of *Eotetranychus cordatus* on citrus are presented. Similar field data on plant-inhabiting predators and other arthropods are also given.

Mites play an important role regarding citrus production. Mites (1969) reported that many species of citrus mites cause direct injury by feeding on plant sap. Feeding may result also in the discoloration, desiccation, or abscission of the leaves or in the discoloration or stunting of the fruits (Lohr 1970). Affected fruits may drop prematurely, or mature with blemishes that reduce their quality and market value. *Tetranychus citricus* Banks, the mite responsible for leprosis in Florida, also limits the production of citrus in other parts of the world (Khor et al. 1968). In Argentina, Paraguay and Uruguay, thousands of acres of orange trees have been abandoned because of this mite-induced trouble (Demark and Minns 1967). Severely attacked plants and trees may become completely debilitated and defoliated.

In most citrus groves the control of citrus mites is an important problem. Spector and Olson (1947) and DeBach and Baker (1951) reported that application of DDT, insectary pyrophosphate, or other zinc sulfate and para-then not only did not control red mites completely but also were followed by increased infestation. Chemical treatment of citrus trees against specific pests

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