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RESEARCH NOTE

SURVIVAL OF THE HUNTING SPIDER, *HIBANA VELOX* (ARANEAE, ANYPHAENIDAE), RAISED ON DIFFERENT ARTIFICIAL DIETS[1]

Spiders occupy an important part of the overall predatory arthropod fauna in different terrestrial ecosystems (Riechert 1974; Riechert & Lockley 1984). They are also known to play an important role in the regulation of pest species in agriculture (Whitcomb et al. 1963; Dondale et al. 1979; Dean et al. 1982; Mansour et al. 1982; Culin & Yeargan 1983; Mansour et al. 1983; Oraze & Grigarick 1989; Riechert & Bishop 1990; Barrion & Litsinger 1995). Baseline information on life history and biology is fundamental for ecological work and is also important to further investigate the potential of spiders as biological control agents. However, life history studies have been done on very few species of spiders. One reason is the lack of reliable rearing methods to determine life histories and other biological data directly from laboratory cultures. Another reason is the lack of appropriate artificial diets. Since spiders are primarily carnivorous, they require behavioral cues from the prey to initiate attack and feeding (Riechert & Luczak 1982). This makes the rearing and maintenance of spiders in the laboratory a very laborious task. Moreover, it appears that most spiders must feed on a variety of insect prey species to obtain the optimum nutrition for survival and reproduction (Greenstone 1979; Uetz et al. 1992). The need to rear different insect prey species makes it especially difficult to culture spiders in the laboratory. Formulation of artificial diets would greatly facilitate laboratory rearing of spiders; however, knowledge of the complete nutritional requirements for spider is necessary. Recently, it was reported that some species of wandering spiders are facultative nectar feeders (Taylor & Foster 1996). This could explain the success of some previous works (Peck & Whitcomb 1968; Whitcomb 1967) on rearing spiders in the insectary using artificial diets. This finding of nectivorous feeding behavior inspired us to compare the survival of spiders under different artificial diets. For this study the hunting spider *Hibana* (= *Aysha*) *velox* (Becker 1879) (Anyphaenidae) was selected because it was found to be the dominant species in lime (*Citrus aurantifolia* [Christm.] Swingle 1914) orchards in south Dade County, Florida. Also, its spiderlings were observed to feed on the larvae of citrus leafminer, *Phyllocnistis citrella* Stainton 1856. Voucher specimens of *H. velox* and *P. citrella* are deposited at the Division of Plant Industry (DPI), Gainesville, Florida.

To test the effects of the different artificial diets on the survival of *H. velox*, egg sacs were collected in the field and brought into the laboratory and kept until the eggs hatched. The resulting offspring were used for the experiment. Each spiderling was maintained in a separate container as described by Peck & Whitcomb (1968) with some modifications to prevent cannibalism. Instead of glass tubing with both ends open, common laboratory glass vials (15 mm diameter × 60 mm long) were utilized. The open end was plugged with cotton through which a stemmed cotton swab had been inserted. The cotton swab inside the glass vial was saturated with the artificial diet by dipping. Three different artificial diets were included in the experiment: 30% sucrose solution (cane sugar, Publix Supermarket Inc., Lakeland, Florida); milk + yolk mixture (1 cup homogenized milk + 1 fresh chicken egg yolk), and soybean (non-dairy beverage). Water served as the control. Nutritional composition of the milk + yolk and soybean diets

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Table 1.—Nutritional composition of milk + yolk and soybean diets based on the manufacturer's nutritional analysis and given as amount per 100 ml of media.

Nutrient composition (per 100 ml of media)	Milk + yolk	Soybean
Total fat	3.0 g	1.3 g
Saturated fat	1.3 g	0.0 g
Cholesterol	98.0 mg	0.0 mg
Sodium	83.0 mg	39.0 mg
Total carbohydrates	6.1 g	11.0 g
Sugars	5.2 g	6.5 g
Protein	6.1 g	2.6 g
Potassium	0.0	126.0 mg
Vitamin A	350 IU	0.0 IU
Thiamin (B1)	0.0	0.05 mg
Riboflavin	0.0	0.03 mg
Niacin	0.0	0.52 mg
Pantothenic acid	0.0	0.35 mg
Pyridoxine hydrochloride	0.0	0.05 mg
Folate	0.0	0.02 mg
Vitamin C	0.52 mg	0.0
Vitamin D	44 IU	0.0
Biotin	0.0	2.6 μg
Calcium	139.0 mg	26.0 mg
Iron	0.31 mg	0.31 mg
Phosphorus	0.11 g	0.04 g
Magnesium	0.0	17.4 mg
Zinc	0.0	0.26 mg

are provided (Table 1). Twenty spiderlings were included for each artificial diet. Two replications in time were prepared and kept at 27 °C in different rearing chambers, one at 45% relative humidity (RH) and the other at 80% RH. The two RH conditions were chosen based on work by Peck & Whitcomb (1968) and Taylor & Foster (1996).

At 45% RH, all the spiders on all of the diets died in less than 30 days from the start of the experiment. In contrast, Peck & Whitcomb (1968) reported best survival [42 days for *Chiracanthium inclusum* (Hentz 1847) and 90 days for *Gladicosa* (reported as *Lycosa gulosa* (Walckenaer 1837)] when the spiders were kept at 45% RH. There was no significant difference for the age at death of *H. velox* on different diets. The mean age at death of the spiders kept at 45% RH was 13 days (range, 7–18) on soybean diet; 10 days (range, 8–11) on milk + yolk diet; 12 days (range, 7–16) on 30% sucrose solution; and 11 days (range, 7–14) on water. Spiders kept at 80% RH survived longer, especially spiders on soybean and milk + yolk diets. In 30 days, the percent survival of spiders on soybean diet (82.5%) was significantly higher ($P \leq 0.05$) than on milk + yolk diet (46%). Spiders raised on 30% sucrose solution and water did not survive for the duration of the experiment. The mean age at death of spiders on sucrose solution was 14 days (range, 5–21); whereas for spiders on water, it was 11 days (range, 8–12). On both soybean and milk + yolk diets, the first mortality occurred at 6 days after the start of the experiment. A drastic increase in mortality was observed on milk + yolk diet from day 6 to day 16 after the start of the experiment; the survival endpoint was reached at day 17 (Fig. 1). Mortality was less on soybean diet; the survival endpoint was at day 12 (Fig. 2). The single mortality at day 21 was due to fungal contamination.

Although the percent survival on soybean diet was significantly higher ($P \leq 0.05$) than on milk + yolk diet, development of the spiders seemed to be delayed. This observation was based on percent molting, time of molting, and carapace width of the spiders. Spiders raised on milk + yolk diet underwent two molts 30 days after the start of the experiment (Fig. 1). The earliest molt was 6 days after the

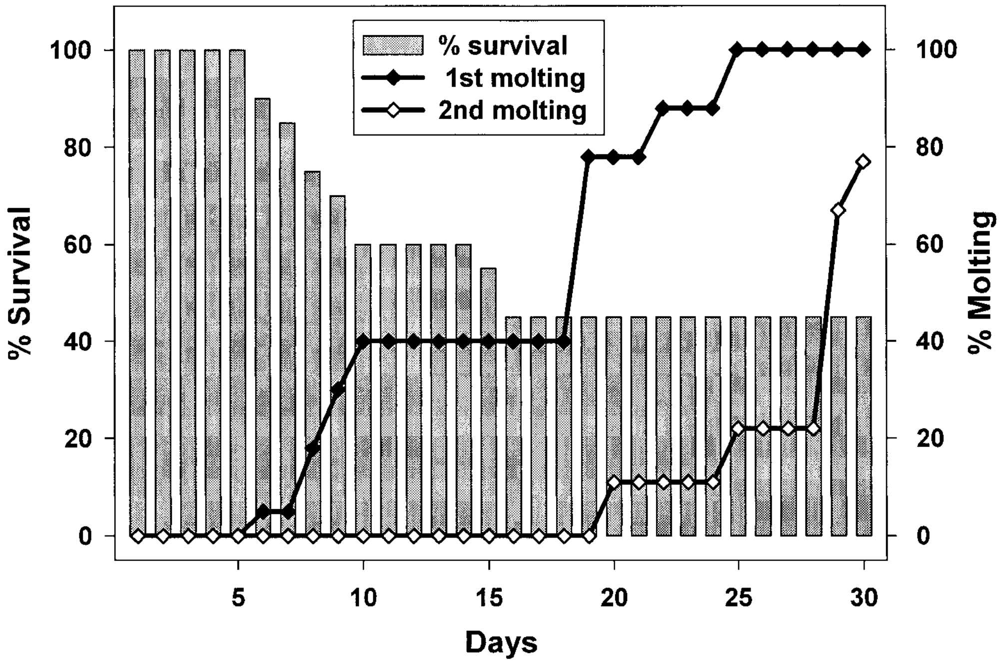

Figure 1.—Percent survival and molting of *Hibana velox* using milk + yolk diet as artificial diet.

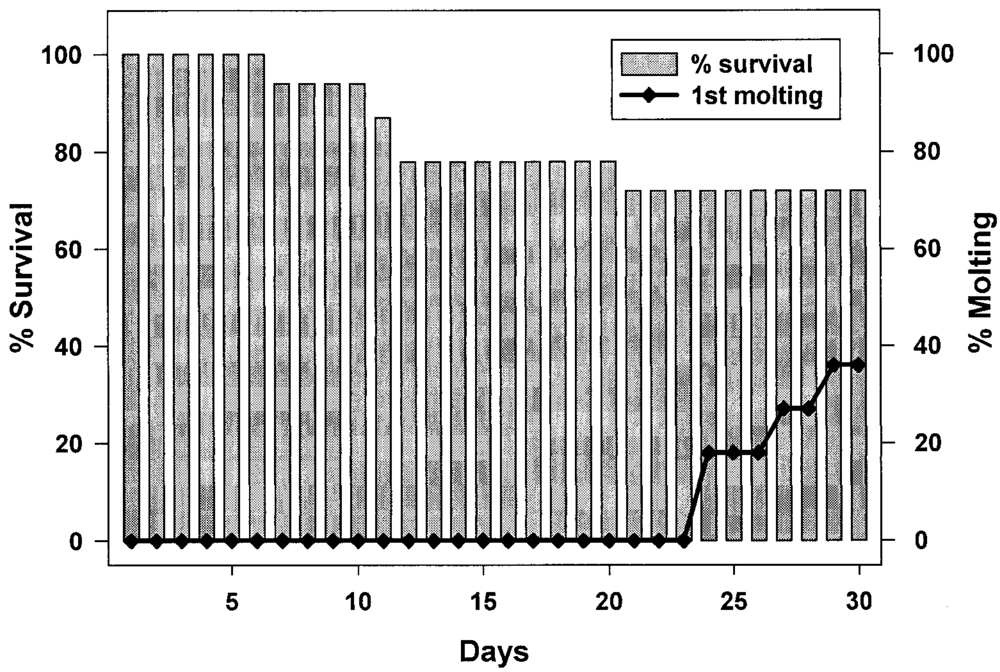

Figure 2.—Percent survival and molting of *Hibana velox* using soybean as artificial diet.

start of the experiment; the mean age at first molt was 17 days (range, 6–30). The mean age at second molt was 25 days (range, 20–30). On soybean diet, the molting of the spiders was late compared to the spiders on milk + yolk diet. The first molt was at 24 days and only 40% of the surviving spiders molted 30 days from the start of the experiment (Fig. 1). The average carapace width of spiders raised on milk + yolk diet was 0.70 mm (range, 0.50–0.85), whereas spiders on soybean diet had an average carapace width of 0.50 mm (range, 0.35–0.58). In general, the carapace width of spiders on milk + yolk diet was more than 25% greater than that of spiders on soybean diet. These findings suggest the importance of supplying more complete nutritional requirements when rearing spiders using artificial diets. The soybean diet is devoid of cholesterol (Table 1) which is the common source of sterol. It was reported that cholesterol is a precursor of ecdysone, the molting hormone (Foelix 1982). This may explain the delayed development of spiders on soybean diet. The milk + yolk diet has a high level of cholesterol, probably contributing to the normal progress of spider development. Nevertheless, the high level of carbohydrates in the soybean diet (Table 1) suggests that carbohydrate could be an important component of the artificial diet for spiders. Carbohydrates are the major energy source important for survival or longevity of any arthropod species (Singh 1984).

In this experiment, we observed that the percent survival of spiders on soybean diet was almost twice that on milk + yolk diet. Furthermore, the drastic increase in mortality of spiders on milk + yolk diet in the first two weeks of rearing the spiders may be avoided if enough carbohydrate is available at that stage of development. From the result of this experiment, we can hypothesize that a combination of soybean and milk + yolk diets could provide more balanced nutritional requirements for wandering spiders. Thus, an experiment to assess the performance of combining soybean and milk + yolk diet on spider survival and development is underway.

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