PREY HANDLING AND FOOD EXTRACTION BY THE TRIANGLE-WEB SPIDER *HYPTIOTES CAVATUS* (ULOBORIDAE)

Triangle-web spiders, *Hyptiotes cavatus* (Hentz), emerge from egg sacs as second instars, begin constructing prey-capture webs when they enter the third stadium, and mature as sixth instars (Opell 1982). During an earlier laboratory rearing study of developmental rates and web production (Opell 1982), I also collected prey remains and recorded prey handling times. Here, I describe the prey necessary for the maturation of *H. cavatus*, trace developmental changes in its prey handling times and prey extraction rates, and evaluate the feeding efficiencies of each of its instars.

Table 1.—Prey consumption and prey extraction during *Hyptiotes cavatus* development.

	PREY CONSUMPTION			PREY EXTRACTION (mg dry weight)		
INSTAR	No. Spiders	Mean No. Prey/Spider	SD	No. Prey	Mean Extraction Per Fly	Stadium Total
3rd	21	3.9	1.8	72	0.08	0.32
4th	21	2.8	0.7	59	0.16	0.43
5th	21	4.7	1.3	97	0.15	0.64
6th	—	—	—	86	0.16	—
Total	14	11.0	2.6			

All spiders used in this laboratory study were reared from egg sacs and were individually housed in plastic containers that measured 30 × 16 × 8.5 cm. Wooden dowel rods cemented into each container provided web attachment sites. Spiders were kept at 23-25°C and 85-95% relative humidity and maintained on a 10:14 hour light:dark cycle. I checked these spiders daily and blew one wild type *Drosophila melanogaster* (both males and females were used) into each web they produced. I recorded the duration of a complete prey wrapping sequence and from this subtracted periods of inactivity and prey transport to obtain actual prey wrapping time, I began timing feeding when a prey's thick silk swathing became transparent as it absorbed digestive enzymes, checked specimens every 10-15 minutes thereafter, and noted when the spider had discarded its prey.

These extracted prey were collected, placed in a vacuum desiccator with desiccant, and stored until the study was completed four and one-half months later, at which time they were pooled by instar and weighed on a Metler® H-31 AR balance. At 6-8 week intervals during this study, three samples of 100 fruit flies each were taken from the stock cultures used to feed the spiders, placed in a clean vial, heat-killed by holding the vial over a steam jet for 5 seconds, spread on filter paper, and placed in a vacuum desiccator. From the mean dry weight of these flies (0.19 mg, range 0.17-0.23 mg), I subtracted the mean dry weight of the prey discarded by spiders of each stadium to obtain prey extraction values.

Table 1 summarizes the number of prey consumed during each stadium and the amount of material extracted from each prey. The numbers of prey eaten by males and females are combined because t-tests reveal no significant difference ($p > 0.05$) between them. Only the mean numbers of flies eaten by fourth and fifth instars differ significantly ($p < 0.05$) when compared with t-tests.

The amount of material spiders extract from flies doubles after the third instar, but shows no increase thereafter (Table 1). The small size of third instars may limit the volume of digestive enzymes they can produce and make available to them only half the potential food of a fruit fly. Although the number of prey consumed by third and fourth instars does not differ significantly, this increased extraction by fourth instars is responsible for their having a 34% greater total prey extraction (mean number of prey consumes × mean extraction) than third instars. The greater number of flies eaten during the fifth stadium results in a further 49% increase in food intake.

Table 2 documents a 77% decrease in wrapping time and an 84% decrease in feeding time from third to sixth stadia. The percentage of prey handling time devoted to wrapping drops by half after the third stadium, but remains constant thereafter. Extraction efficiency increases during development, with fourth instars

Table 2.—Developmental changes in *Hyptiotes cavatus* prey handling. All times are in hours. Extraction values are in mg dry weight.

	WRAPPING TIME			FEEDING TIME			TOTAL TIME PER FLY				mg EXTRACTED PER HOUR FEEDING
INSTAR	No.	Mean	SD	No.	Mean	SD	No.	Mean	SD	% Wrapping	
3rd	31	0.44	0.22	21	6.55	4.31	11	6.25	4.54	7	0.012
4th	35	0.34	0.12	10	10.31	4.18	10	10.67	4.25	3	0.016
5th	42	0.22	0.06	20	5.21	1.42	20	5.41	1.42	4	0.029
6th	20	0.13	0.05	12	3.06	0.70	12	3.18	0.73	4	0.052

acquiring 1.3 times more food per hour of feeding than third instars and fifth and sixth instars each removing 1.8 times more food per hour than subsequent instars (Table 2).

The laborious prey wrapping characteristic of uloborids (see Lubin 1986 for a review) may compensate for their lack of poison glands and their inability to inject prey. Lubin (1986) found that prey type and mass influence the thoroughness of uloborid wrapping. All spiders of this study were fed the same type of prey and, judging by the opacity and smoothness of the wrapped flies, wrapping thoroughness remains relatively unchanged during development. Therefore, the shorter wrapping times characteristic of later instars probably reflect increases in the aciniform silk glands and spigots used in prey wrapping (Foelix 1982) and reductions in the time required for spiders to circumscribe a prey during early wrapping stages and to manipulate a partially swathed fly during latter wrapping stages.

Together with the previous developmental study of *H. cavatus* (Opell 1982), these results emphasize the small cost of web production. Accidental web damage caused spiders to receive an average of only 0.84 flies per web constructed. Despite this, their development times did not differ markedly from those of natural populations.

Although wrapping and feeding times differ among instars, the proportion of each stadium's "web construction" phase (Opell 1982) devoted to prey handling remains surprisingly small and constant. Third instars devote 4.8% of this time to prey handling, fourth instars 7.3%, and fifth instars 5.5%.

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