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Life Cycle, Survivorship and Life Expectancy of Ground Spider *Hippasa partita* (Cambridge) Under Laboratory Conditions

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Abstract.- The post embryonic development of *Hippasa partita* (Cambridge) (Araneae: Lycosidae) was studied under laboratory conditions. Three gravid, 11 adult females and 3 males were released separately into each cage and development was followed up to the last moulting and till death of individual. Four females spinned cocoon in the laboratory. The incubation period ranged from 8–17 days. No hatching occurred in cocoons without female. Maximum number of viable eggs was 55 as compared to 67 non-viables, and the hatchability was 79%. All the spiderling comprised 8 developmental stages. First two moultings could not be recorded which occurred inside the cocoons. At third moulding, spiderlings emerged from the cocoons and spent on an average three days on mother's back. After leaving mother, the spiderling, formed gossomere and lived there for two to three days, before leading an independent life. Early spiderling stages were of shorter duration, with a high mortality rate as compared to the later developmental stages in which mortality approached zero and the intermoult period extended greatly. The spiderlings, which became adult in the laboratory survived longer due to the favourable conditions.

Key words: Arthropoda, Arachnida, Araneae, Lycosidae, *Hippasa partita*, Survivorship, life Expectancy, ground spider.

INTRODUCTION

Pakistan is among the top ten citrus producing countries (Khan, 1992). Phytophagus insects cause serious damage to the citrus crop. Eleven insect species are recorded as citrus pests. Of these, citrus white fly (*Dialeurodea citri*), citrus psylla (*Diaphorina citri*), lemon butterfly (*Papilio demoleus*), and citrus leaf miner (*Phyllocnistis citrella*) stand out as major citrus pests.

Araneae constitute a large part of predatory fauna of orchards, plantations and are less sensitive to pesticides and insecticides than other predators (Laster and Brazzel, 1968). Spiders have been reported feeding on a wide range of different animal groups, in general they concentrate on insect preys and to lesser extent on spiders (Wise, 1993), have complex and well-regulated pattern of maturation (Levy, 1970). Crome (1956a) studied the egg sac construction in an orb weaver *Araneus quadratus* and reported the process of cocoon formation.

According to Bristowe (1939), Peterson (1950) and Kaston (1970) clutch size is directly related to the size of females and their hunting manner. Feeding conditions also effect the clutch size and repeated production of the clutches gradually decreases and larger individual produces more eggs. Anderson (1990), Marshal and Gittleman (1994) reported that successivous clutches were significantly smaller than the first clutch. Higgins and Rankin (1996), Higgins (2000) reported that large early maturing females have greater reproductive success as compared to late maturing females. Several functions have been attributed to maternal care as reported by (Randell, 1977; Buskirk, 1981). Evans (1998) reported that maternal care is also provided to unrelated juvenile individuals.

Eckart (1967) reported that the intermoult intervals are mostly dependent on nutritional conditions and the number of moults on the relative body size. Variation in growth rate reflects the availability of food (Stearn and Koella, 1986). Males are dwarf and hence need fewer moults to reach maturity as compared to females (Head, 1995). Low rate of increasing mass in development increases the duration of each stage, high rate of growth usually increase fitness along with ecological and physiological cost. Arendt (1997) and Higgins (2000) stated that strong fitness cost is associated with slow growth rate in females. The

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present paper describes the life cycle of ground spider, *Hippasa partita*.

MATERIALS AND METHODS

Three gravid, 11 adult females and 3 males of *Hippasa pertita* were released separately into each cage. Each specimen was observed daily for the record of females with or without cocoon, cocoon formation, number of cocoon made/female, incubation period, hatching, maternal care and total viable and non-viable eggs/cocoon. Each spiderlings was reared individually at room temperature in a cage with a small petridish containing water, a cotton plug was placed inside for an easy access to water, to some extent it also helped to control the humidity. Top cover of the cage was fixed with mess gauze for aeration. Spiderlings were fed on alternative days with aphids, jassids and mosquito larvae. Statistical analysis was based on Minervino (1993), who calculated life cycle and number of reminder days of each individual.

Survivorship (l_x) was calculated as

$$Ix = \frac{Nx}{No}$$

Where N_X = number of individuals which were alive in each stage; and No = total number of eggs which were hatched.

Life expectancy (ex) was calculated as

$$ex = \frac{Tx}{Ix}$$

Where T_x = total number of remainder days in the life of an individual that had reached at age "x".

$$Tx = \sum_{m}^{x} \underline{Ix}$$

"m" is the maximum age, which was recorded.

RESULTS AND DISCUSSION

The cocoons are pale to yellowish white, oval in shape, made up of fine silk threads. Females with or without cocoon were recorded from April through September. Out of 14 females only 4 females built cocoons in the laboratory. If accidentally a cocoon is detached or lost and found, it was readily reattached. Female carries cocoon throughout the incubation period (from egg laying to hatching of spiderlings). First two hatchings took place inside the cocoon and the female still carried the cocoon with itself. Maximum incubation period was recorded as 17 days in contrast to minimum of 8 days with an average of 13 days. Crome (1956a) studied the egg sac construction, and described the stages involved during the course of cocoon formation. Sadana (1972) reported that in Lycosids a female makes a maximum of 4 cocoons having 4–130 eggs during her life time. During present study one female formed 5 cocoons in the laboratory with the range of 23-67 eggs/cocoon. A total of 357 eggs were recorded from all cocoons of which 283 were viable eggs. Maximum and minimum hatching was recorded as 85% and 72% respectively. Overall hatching remained 79%. Kessler (1971) reported that number of eggs decreased with increased brood care. Enders (1996) studied that lycosid spiders have higher egg production. On hatching all the spiderlings get settled on their mother's back in several layers. The number of eggs/cocoon decreased with time. Being 67 in the first and only 30 eggs in 5th cocoon. The number of egg/cocoon varied from 39–67 eggs and a mean of 51 eggs/cocoon (Table I). On the whole 79% eggs were fertile. No hatching took place in the cocoons without female. The unhatched cocoons were opened at different duration. The number of eggs ranged from 23-55 with an average of 39 eggs/cocoon. Third spiderling stage took place outside the cocoon.

Foelix and Chu-Wang (1973) reported that the mother access her offspring during hatching and spiderlings climb on her back. The present study reports that during brood care average time spent on mother's back was 3 days which ranged from 3–4 days in all cases. At this stage if female was disturbed it showed aggressive behaviour.

Table I:- Record of hatching %age of 7 cocoons of *H. partita*

No. of Cocoon	1	2	3	4	5	6	7	Total	Mean±SD
Total eggs	52	39	67	50	40	57	52	357	51±8.94
Fertile eggs	43	33	52	40	29	45	39	283	40.42±7.09
Hatching %	82.69	84.61	77.61	80.00	72.5	78.94	75.00	79.27	79.25

Spiderlings and mother usually did not feed during this period. After leaving the mother, spiderlings form a gossomere. There they stay for 2–3 days. Then abandoned it to live on their own, at this stage they start dispersing.

All spiderlings passed 6 developmental stages before becoming adult. Third moulting took place with a range of 9–23 days. Now each spiderling was separately kept into a cage. After this stage an increase in average duration of all developmental stages was recorded as spiders progressed in their development. The mean duration of all stages of *H. partita* was 106 days for males and 132 days for females (Table II), it was also recorded that *H. partita* spends winter season without further breeding (Table III). On an average, five spiderlings became adult from each batch. A total of 35 spiderlings became adult from all eggs with a mean of 27±3.43 and a range of 18–21 days and the average survival was recorded as 71%. Overall, 14 males and 21 females became adult in the laboratory. The field collected males and females were also kept under observation to record their longevity along with these individuals. The mean individual life span (from eclosion to death) was 165 days for females and 148 days for males; mean duration of adult life was 30 days for females and 35 days for males. Males attained maturity after 7^{th} moulting and females after 8^{th} moulting. The females are always larger than males and consequently needs one or two more moultings to reach maturity.

In males maturity period ranged from 96–125 days with an average individual life of 145 days. Individual life (total life) ranged from 126–165 days. In the case of females the maturity period ranged from 123–147 days with an average duration of 135 days and individual life duration of 162 days (total life) which ranged from 150–177 days. The longevity of males and females was recorded as survival period, as 200 days for males and 184 days

Table II.- Duration (Days) mean, range and standard deviation of life cycle of *H. partite.*

Life cycles phases	Mean±SD	Range
Eclosion-last moult for females	135±5.91	126 – 150
Eclosion-last moult for males	109±7.31	99 – 128
Dispersion-last moult for females	132±5.70	123 – 147
Dispersion-last moult for males	106±7.16	96 – 125
Eclosion-death for female	162±7.40	150 – 177
Eclosion-death for male	145±9.69	126 – 165
Last moult-death for female	30±7.26	20 – 40
Last moult-death for male	35±6.41	30 - 46

Table III.- Average duration (days) (Mean ± SD) and range of each instar in the life cycle of *H. partite.*

Developmental Stage	n	Mean ± S.D	Range (days)
3^{rd} spiderling	24	16 ± 2.66	12 – 20
4^{th} spiderling	17	17 ± 4.74	11 – 26
5^{th} spiderling	11	29 ± 4.61	23 – 36
6^{th} spiderling	8	25 ± 3.36	20 – 29
7^{th} spiderling	6	28 ± 4.98	21 – 34
8^{th} spiderling	5	28 ± 3.72	23 – 30
♂ adult (L_1)	14	106 ± 7.16	06 – 125
♂ adult (F_1)	3	200 ± 30.02	169 – 229
♀ adult (L_2)	21	135 ± 5.91	123 – 147
♀ adult (F_2)	14	184 ± 116.8	50 – 351

Abbreviations used: L_1, males from egg sacs reared in the laboratory; F_1, male collected from the field and recorded longevity; L_2, female from egg sacs reared in the laboratory; F_2, females collected from the field and record longevity.

Table IV.- Survivorship and life expectancy of all *H. partita* developmental stages.

Spiderling stage	l_x	T_x	e_x
3^{rd}	58.58	36.97	0.628
4^{th}	65.6	84.57	1.28
5^{th}	84.7	133.75	2.06
6^{th}	81.2	176.96	2.17
7^{th}	60.7	213.26	3.5
8^{th}	60.0	249.25	4.15

for females with a range of 169–229 and 59–359 days, respectively. Highest mortality was recorded during 3rd and 4th spiderling stage i.e. 31 and 38% respectively which decreased gradually and approached zero at 8th spiderling stage and the overall mortality remained 29%. Survivorship started stabilizing from the 5th spiderling stage when the males started to become adult increases onward and stabilizes after 6th developmental stage. Calder (1984) reported that large body size decrease mortality which is attained by extending growth period. During present study at 5th developmental stage mortality was greatly reduced and in the 7th and 8th developmental stage the mortality was zero. Life expectancy peaked at 6th developmental stage and then gradually stabilized. Adult phase occupies 1/3rd of entire life duration and presents the higher values to spiderling stage duration, size, feeding rate and the lower values of mortality. The results of mortality rate at 3rd and 4th stage spiderling were in agreement with Minervino (1993).

REFERENCES

ANDERSON, J.F., 1990. The size of spider eggs and their energy contents. *J. Arachnol*., **18**: 73-78.

ARENDT, J.D., 1997. Adaptive intrinsic growth rates: An integration across taxa. *Rev. Biol*., **72**:

BRISTOWE, W. S., 1939. *The comity of spiders*. Royal Society, London.

BUSKIRK, R.E., 1981. Sociality in the Arachnida. In: *Social spiders*, vol. 2, pp. 282-367. Harvard University Press, Cambridge.

CALDER, W.A., 1984. *Size, function and life history*. Harvard University Press, Cambridge., USA.

CROME, W., 1956a. Kokonbau und Eiablage eingerkeruzspinnenarten des Genus *Araneus* (Araneae: Araneidae). *Dtsch. Ent. Z. (N.F.),* **3**: 28.

ECKERT, M., 1967. Experimentelle Untersuchungen zur Hautungsphysiologie bei Spinnen. *Zool. Jb. Physiol*., **73**: 49.

ENDERS, F., 1996. Clutch-size related to hunting manners of spider species. *Ann. Ent. Soc. Am*., **69**: 991-998.

EVANS, T.A., 1998. Offspring recognition by mother crab spider with extreme maternal care. *Proc. R. Soc. Lond*., **265**: 129-134.

FOELIX, R.F. AND CHU-WANG, I.W., 1973. The morphology of spider sensilla chemoreceptor. *Tiss. Cells*, **5**: 44.

HEAD, G., 1995. Selection on fecundity and variation in the degree of sexual size dimorphism among spider species (Araneae). *Evolution*, **46**: 775-781.

HIGGINS, L., 2000. The Interaction of season length and development time alters size at maturity. *Oecologia*, **122**: 51-59.

HIGGINS, L. AND RANKIN, M. A., 1996. Different pathways in arthropod postembryonic development. *Evolution*, **50**: 573-582.

KASTON, B. J., 1970. Comparitve biology of American black widow spider. *Trans. San Diego Soc. Nat. Hist*., **16**: 33.

KESSLER, A., 1971. Relation between egg production and food consumption in species of genus *Pardosa* (Araneae: Lycosidae) under experimental conditions of food abundance and food shortage. *Oecologia*, **8**: 93-109.

KHAN, I.A., 1992. Prospect of citrus industry in Pakistan. *Proceeding of First International Seminar on Citri-culture in Pakistan*, pp. 3-10.

LASTER, M.L. AND BRAZZEL, J.R., 1968. A comparison of predator populations in cotton under different control programs in Mississippi. *J. econ. Ent*., **61**: 714-718.

LEVY, G., 1970. The life cycle of *Thomisus omustus* (Thomisidae: Araneae) and out lines for the classification of the life histories of spiders. *J. Zool. London*, **60**: 523-536.

MARSHALL, S.D. AND GITTLEMAN, J.L., 1994. Clutch size in spiders: Is more better? *Funct. Ecol*., **8**: 118-124.

MINERVINO, E., 1993. Life cycle of *Misumenops pallida* (Araneae: Thomisidae). *Mem. Inst. Oswaldo. Cruz, Rio. de Janeiro*., **88**: 49-52.

PETRESON. B., 1950. The relation between size of mother and number of eggs and youngs in some spiders and its significance for the evolution of size. *Experientia*, **6**: 96.

RANDELL, J. B., 1977. New observations of maternal care exhibited by the green-lynx spider, *Peucetia viridans* Hentz (Araneae: Oxyopidae). *Psyche*, **83**: 286-289.

SADANA, G. L., 1972. Studies on the postembryonic development of epigynum of *Lycosa chaperi* Simon (Lycosidae: Araneidae). *Res. Bull. Punjab Agric. Univ., India*, **23**: 243-247.

STEARNS, S.C. AND KOELLA, J.C., 1986. The evolution of phenotypic plasticity in life history traits. Predation of reaction norms for age and size at maturity. *Evolution*, **40**: 893-913.

WISE, D. H., 1993. *Spiders in ecological webs*. Cambridge University Press, Cambridge, UK.

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