INTRODUCTION

Scattered in the Arachnological literature are some reports on the breeding of spiders such as eggs per clutch, time between clutches and fertility (Turnbull, 1973). The ecological variables such as photoperiod (Miyashita, 1987), foraging success (Riechert and Tracy, 1975, Wise, 1979 and Morse and Fritz, 1987) and individual variables such as female size (Fritz and Morse, 1985 and Killebrew and Ford, 1985) continue to play a role in spider breeding.

The primary determinants of fecundity are female longevity and foraging success. The age at first reproduction, the life time fecundity and the survivorship of offsprings can seldom be measured in spiders (Vehrencamp and Bradbury, 1984 and Horn and Ruben Stein, 1984).

The variety of responses to the same environmental variables suggest that it may be unwise to generalise breeding (Eberhard, 1979). Ambient temperature appears not to influence fecundity in Theridiid *Achaearanea tepidariorum* (Miyashita, 1987) but has a strong influence on *Theridion rufipes*.
Similarly, food deprivation does not affect the number of eggs produced either by Linyphiid *Linyphia triangularis* (Turnbull, 1962) or Lycosid genus *Paradosa* (Kessler, 1971) but it does affect the number of eggs produced by *Paradosa* species (Kessler, 1971) and by a Thomisid *Misumena vatia* (Fritz and Morse, 1985).

Mass also contribute directly in fecundity per clutch as it does in many other invertebrates (Suter, 1990). With respect to number of eggs per clutch, earlier clutches contained more eggs than did later clutches and this relationship was earlier reported by Austard (1982 & 1989).

The mother spider prepares a silken sheet in which the eggs are laid. After laying the mass of eggs, the females cover them with a silken sheet and moulds the mass into an egg sac characteristic of her species. The egg sac is not merely a covering made in a haphazard way but in a more or less elaborate structure made in a definite manner. It is frequently easy to recognise the spider species from its egg sac than from a spider itself. Most spiders deposit all their eggs at one laying and enclose them in a single egg sac. But in certain species the egg laying is extended over a
considerable period of time and a series of egg sacs are formed (Tikadar, 1980).

Nutrients are required to produce yolk which is the primary constituent of spider eggs and so a positive relationship between feeding rate and fecundity was expected. This relationship reflected reality under field conditions. Clutch size and foraging success to life time fecundity was observed by Austard (1989).

During pregnancy the female appears quite different from its normal condition. Naturally the abdomen is elongated with a wide dorsal depression in the middle. But in pregnant condition all the shades and depressions disappear and the abdomen becomes broader and more striking. The shape of the abdomen becomes somewhat triangular and truncated (Morse, 1989).

Parental care is found to a certain extent in spiders. Maternal care is very common in the vagabond families like Thomisidae, Salticidae, Gnaphosidae and Clubionidae. The female guards the egg sacs until they hatch. Pisauridae carry their egg sacs wherever they wonder. Lycosid egg sacs are attached to the spinnerets. The egg sacs of web building spiders receive scant
attention from their mother with notable exceptions of Theridiids Pholcids, Agelenids and Eresids (Turnbull, 1973).

**Plexippus paykullii** is a cosmotropical Salticid spider that produces silk mainly to construct egg sacs to avoid dessication of the eggs and attack by enemies (Vijayalekshmi and Sivaraman, 1988).

Female *Cyrtophora cicatrosa* lays chains of beaded egg sacs which hang at the central part of the upper web (Palanichamy, 1980).

The fertilised female *Stegodyphus sarasinorum* lays its eggs in a cocoon located at the tunnel of its web (Jambunathan, 1905 and Bradoo, 1973). The cocoons are zealously guarded by the owner female (Stern and Kullmann, 1975).

Spiders are available in plenty in this district but informations available on their breeding biology are meagre (Sathiamma, et al., 1986). Although some investigations have been undertaken on the breeding biology of spiders only a few datas are available on egg production alone (Palanichamy, 1984). Turnbull (1962 &
1965) studied the egg production of *Linyphia triangularis* and *Agelenopis potteri* and Edger (1971) on *Paradosa lugubris*. Kessler (1971) evaluated egg production in a few *Paradosa* species.

Hence the present study was undertaken to know about the egg cocoon, egg deposition, egg cocoon construction, diameter of the egg and also the parental care of three species of spiders *P. paykullii*, *C. cicatrosa* and *S. sarasinorum*. 
MATERIALS AND METHODS

Gravid females of *Plexippus paykullii* were collected from walls of buildings and tree trunks and *Cyrtophora cicatrosa* were collected from their webs in the fields and brought to the laboratory in polytene bags. Gravid females could be identified by their enlarged and truncated abdomen. These spider species were fully fed with *Musca domestica*. The webs of *Stegodyphus sarasinorum* were removed along with branches of trees, kept in polytene bags and brought to the laboratory for further studies.

*P. paykullii* were transferred to plastic containers 6"x6"x6" and when they started to build felts they were changed to polytene bags 6"x6"x6". The mouth of the polytene bags were tied tightly with threads and the bags were perforated here and there with the help of a sharp needle for the passage of air. When oviposition was over the cocoons constructed on the walls of the polytene bags were cut off from the bags and placed in polytene containers for future studies.

The length and breadth of egg cocoons, the number of eggs oviposited, cocoons spinning, the time
taken for the construction of egg cocoons, diameter of the eggs, incubation period and parental care were studied.

Gravid female *Cyrtophora cicatrosa* were transferred to 24"x24"x24" cages and allowed to construct their webs. They were iteroparous, oviposting successive batches of eggs in different egg cocoons. The number of egg cocoons constructed were studied both in the laboratory and in the field. The time interval between the construction of successive egg cocoons was noted. The length and breadth of egg cocoons, the number of eggs oviposited and the diameter of the eggs were observed. Egg cocoon construction was not studied in *C. cicatrosa* because its cocoon construction was nocturnal.

*Stegodyphus sarasinorum* webs were dissected out in the laboratory to study the number of egg cocoons present in each web. The length and breadth of egg cocoons, the number of eggs oviposited and the diameter of the eggs were studied.

The observed datas were statistically analysed and the results were compared with one another.
RESULTS

The results of this studies are summerised in tables 40 to 44 and figures 60 to 63.

PLEXIPPLUS PAYKULLII

The egg cocoons of this spiders were spun against the corners of polytene bags. The egg sacs were white roughly circular and flattened. It consisted of a densely woven sheet in which the eggs were placed. The second densely woven sheet covered the eggs. It had a tough paper like texture. The length $3.34 \pm 0.64$ cm; breadth $1.91 \pm 0.06$ cm (Table 40).

To make an egg cocoon, a small sheet of silk was first spun which formed the basal disc. *P. paykullii* oviposited its eggs ($15.6 \pm 0.471$) in one group and arranged them side by side in a single layer. Eggs were semitransparent yellow and spherical with a diameter of $0.807 \pm 0.005$ mm (Table 41). Over this a fine silken sheet was made which completely enclosed the eggs and its edges were firmly attached to the surface. The time took for the construction of egg cocoon was $3.31 \pm 0.519$ hours (Table 44).
PLATE 17: Egg cocoon of *Plexippus paykullii* with eggs

PLATE 18: Egg cocoon of *Cyrtophora cicatrosa*
The female usually stood above the eggs between the middle and outer layer of silk. The female left the nest by one of the two small oval holes present near the edges of the nest. Inside this retreat, she remained till the eggs are hatched and the spiderlings ready to leave the cocoon. Mother guard the nests usually for a considerable but variable period of time 16 ± 0.15 days (Plate 17).

**CYRTOPHORA CICATROSA**

The egg cocoons of *C. cicatrosa* were oval, pear shaped, green in colour and arranged one above the other. The cocoons were spun very tightly and the eggs were completely sealed off from outside. At the top was a small opening and it was plugged with white woolly silk. The length 0.65 ± 0.05 cm; breadth 0.4 ± 0.001 cm (Plate 18).

The number of egg cocoons produced was highly variable. The female *C. cicatrosa* were iteroparous ovipositing 6.9 ± 0.328 cocoons in the field and 3.22 ± 1.20 in the laboratory. The number of eggs laid were 40.5 ± 1.005 in the field and 37.6 ± 0.66 in the laboratory (Table 43). The eggs were white, semi
PLATE 19: Egg cocoon of *Stegodyphus sarasinorum*

PLATE 20: 1 instar stage of *Cyrtophora cicatrosa*
transparent and spherical. The diameter was 0.608 ± 0.006 (Table 42).

**STEGODYPHUS SARASINORUM**

The egg cocoons of *S. sarasinorum* were round white and button shaped (Plate 19). They were placed in the tunnels of the web. The length and breadth are 1.71 ± 0.22; 1.125 ± 0.008 cm (Table 29). The females were iteroparous and constructed 4.275 ± 0.36 egg cocoons. The number of eggs laid were 67.5 ± 8.6. The eggs were yellowish white, transparent and spherical. The diameter was 0.724 ± 0.084 mm (Table 41).
<table>
<thead>
<tr>
<th>S.NO.</th>
<th>SPECIES</th>
<th>PARAMETERS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>LENGTH</td>
<td>BREADTH</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>P. PAVKULLII</td>
<td>3.34 ± 0.64</td>
<td>1.91 ± 0.06</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>C. CICATROSA</td>
<td>0.65 ± 0.05</td>
<td>0.4 ± 0.001</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>S. SARASINORUM</td>
<td>1.71 ± 0.22</td>
<td>1.125 ± 0.008</td>
<td></td>
</tr>
</tbody>
</table>

**TABLE - 40**

LENGTH AND BREADTH OF THE COCOONS OF CHOSEN SPECIES OF SPIDERS (CM)

EACH VALUE \( \bar{x} \pm S.D. \) IS THE MEAN OF TEN OBSERVATIONS
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Species</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>P. PAYKULLII</em></td>
<td>0.807 ± 0.005</td>
</tr>
<tr>
<td>2.</td>
<td><em>C. CICATROSA</em></td>
<td>0.608 ± 0.006</td>
</tr>
<tr>
<td>3.</td>
<td><em>S. SARASINORUM</em></td>
<td>0.724 ± 0.084</td>
</tr>
</tbody>
</table>

**TABLE 41**

**DIAMETER (MM) OF EGGS OF CHOSEN SPECIES OF SPIDERS.** EACH VALUE \( \bar{x} \pm S.D. \) IS THE MEAN OF TEN OBSERVATIONS
### TABLE 42

NUMBER OF EGG COCOONS OVIPOSITED BY CHOSEN SPECIES OF SPIDERS.

EACH VALUE $\bar{x} \pm S.D.$ IS THE MEAN OF TEN OBSERVATIONS

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Species</th>
<th>Egg Cocoon</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>C. CICATROSA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Field</td>
<td>$6.9 \pm 0.328$</td>
</tr>
<tr>
<td></td>
<td>Laboratory</td>
<td>$3.22 \pm 1.20$</td>
</tr>
<tr>
<td>2.</td>
<td>S. SARASINORUM</td>
<td>$4.275 \pm 0.36$</td>
</tr>
</tbody>
</table>
TABLE - 43

NUMBER OF EGGS OVIPOSITED BY CHOSEN SPECIES OF SPIDERS. EACH VALUE $\bar{x} \pm S.D.$ IS THE MEAN OF TEN OBSERVATIONS

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>SPECIES</th>
<th>EGGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>P. PAYKULLII</td>
<td>15.6 $\pm$ 0.471</td>
</tr>
<tr>
<td>2.</td>
<td>C. CICATROSA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FIELD</td>
<td>40.5 $\pm$ 1.005</td>
</tr>
<tr>
<td></td>
<td>LABORATORY</td>
<td>37.6 $\pm$ 0.66</td>
</tr>
<tr>
<td>3.</td>
<td>S. SARASINORUM</td>
<td>67.5 $\pm$ 8.6</td>
</tr>
<tr>
<td>S.No.</td>
<td>Parameter</td>
<td>P. Paykullii</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>1.</td>
<td>Construction Time</td>
<td>3.31 ± 0.519 HRS</td>
</tr>
<tr>
<td>2.</td>
<td>Incubation Period</td>
<td>16 ± 0.15 DAYS</td>
</tr>
</tbody>
</table>

**Table 44**

Time for the construction of the egg cocoon and the incubation period of P. Paykullii. Each value $\bar{x} \pm$ S.D. is the mean of ten observations.
Fig. 60. Relationship between the length and breadth of the egg cocoon of *Plexippus paykullii*
Fig. 61. Relationship between the length and breadth of the egg cocoon of *Cyrtophora cicatrosa*
Fig. 62. Eggs laid by *Plexippus paykullii* and *Cyrtophora cicatrosa*
Fig. 63. Diameter of the eggs of *Plexippus paykullii* and *Cyrtophora cicatrosa*
DISCUSSION

One of the most interesting details in the life of spiders is the provision made by the female for the care of the young. Eggs are never laid singly but they are laid in one or more masses and each mass is protected by a covering of silk the egg sac or egg cocoon (Tikadar 1980). Hite et al., (1966) gave a detailed description of egg sac construction and oviposition of brown spider.

Plexippus paykullii, Cyrtophora cicatrosa and Stegodyphus sarasinorum make special cocoons on which they lay their eggs and the P. paykullii mothers remain guarding them long after the eggs are hatched. It is evident from the earlier studies of Mathew (1931) that the females of other Salticids and Pholcids also guard their eggs.

There is a great variation in the form of egg cocoons. (Rose, et al., 1982). The egg sac is more tightly webbed and sealed off from outside (Sathiamma, et al., 1985). The egg cocoon of P. paykullii is large white and pappery and that of C. cicatrosa is small, pear shaped and green and S. sarasinorum is white, round and button shaped.
**P. paykullii** constructs a single cocoon and oviposited all its eggs in a single batch. **C. cicatrosa** constructed many cocoons after a single mating. Construction of more than one egg sac after a single mating has been observed in *Metaphiddipus galathe* (Horn and Starks, 1972).

The average number of egg sacs produced by *Achaeranea tepidariorum* is fourteen, however a female can produce a maximum of twenty egg sacs. Eberhard (1973) and Valerio (1976) observed that Bolar spider *Mastophora dizzdenci* produced up to eleven sacs. On the contrary wolf spiders like *Paradosa lugubris* produced only two egg sacs (Edger, 1971 and Kessler, 1973). It is common that the tropical Araneid spiders produced many egg sacs (Eberhard, 1973).

**C. cicatrosa** produced many egg sacs. It was suggested by Horn and Starks (1972) and Robinson (1975) that the spiders receive a large number of sperms in one single mating and store them in the spermatheca for future construction of successive egg cocoons.

**C. cicatrosa** and **S. sarasinorum** are iteroparous. Bowl and Doily spiders were also considered iteroparous
(Austard, 1982 & 1989). Bradoo (1972 & 1975) reported that each female *S. sarasinorum* makes two to four cocoons in her lifetime. Jacson and Joseph (1973) suggested that only one cocoon is normally made by each female.

The number of eggs present inside a cocoon varies in *P. paykullii*, *C. cicatrosa* and *S. sarasinorum* and there is a great variation among these three species of spiders. Similar observations were recorded by Kullmann and Zimmermann (1975) and Stern and Kullmann (1975) and they attributed that the cause depends on the geographical location where the observation was made. The diameter of the egg also varies and this may probably due to the amount of yolk deposited in the eggs.

*Lyssomanes jemineus* (Eberhard, 1974) and *Asemonea murphys* (Watner, 1980) do not spin elaborate egg cocoon structures. The egg cocoon of *P. paykullii* is elaborate. The egg sacs are made by placing eggs on a basal layer of silk, covering them with a second layer of silk that is continuous with the enclosing silk of tubular nest. It is flat, densely woven with a paper like covering. A similar type of egg cocoon was found in other Salticid also (Forster and Blest, 1970 and Platnick, 1971). It also resembles the egg sac of Gnaphosidae (Jackson, 1973). The egg sacs of
**Holcolaetis** and **Thania** more or less resembled the egg sac of Gnaphosidae but lack a papery texture (Jackson, 1985).

Parental care has recently attracted considerable interest (Trivers, 1972) and it ranges from guarding eggs to carrying them and the resulting offsprings until they approach reproductive maturity (Trivers, 1974). The parent-young conflict was studied by Trivers (1984) and their life histories by Stern (1976 and 1977).

**P. paykullii** oviposited the eggs on silk and cavities were made on both the sides for the movement of the female spiders. They stood on the eggs between the middle and outer layers of silk. **P. paykullii** takes great care to reduce mortality and propagate the species and hence parental care is of great significance in this species. **Heteropoda venatoria** are reported to carry their brood sacs fairly against their sternae with the help of pedipalp till they release their young ones (Bhattacharya, 1941 and Ross, et al., 1982). These spiders guard the eggs until the young ones are emerged (Morse, 1987).
Guarding behaviour enhances survival and they seldom wander far from the cocoon during guarding phase (Morse, 1987 & 1989). Similar behaviour was noticed in *P. paykullii*. They did not even predate and the amount of feeding deviated much during such periods as noticed in *Heteropoda venatoria* (Ross, et al., 1982).