number per brood is noticed (table 1). The thin egg membrane and rather loose binding substance between the eggs in the brood could account for egg loss during incubation. Linear regressions between egg number or juvenile number on carapace width of *O. senex senex* are not strong, but larger females accommodate more eggs of juveniles in the brood and there is a strongly correlated linear relationship between the brood pouch volume and carapace width (figure 3A and B).

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1. Katre Shakuntala, *J. Anim. Morphol. Physiol.*, 1977, **24**, 13.
2. Ponnuchamy, R., *Studies on the bioenergetics of feeding and behaviour of a few freshwater prawns*, Ph.D. Thesis, Bangalore University, 1981, p. 164.
3. Ponnuchamy, R., Ayyappan, S., Ravichandra Reddy, S. and Katre Shakuntala, *Proc. Indian Acad. Sci.*, 1979, **B88**, 353.
4. Rao, Ch. N., Ponnuchamy, R., Katre Shakuntala and Ravichandra Reddy, S., *Inter. J. Invertebr. Reprod.*, 1981, **3**, 75.

THE SPINNING OF PUPARIUM BY LARVAE OF EUMENID AND SPHECID WASPS REARED IN GLASS TUBES

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NESTING activities and intelligence of Eumenid and Sphecid wasps have drawn the attention of a number of workers[1-10]. Surprisingly, little attention has been paid to their metamorphosis. This is probably because, the metamorphosis takes place in closed mud cells. Unless, the cells are opened and developing stages are reared in suitable containers, it becomes impossible to observe and record the progress of stages. Success of rearing them in glass tubes made it possible to follow metamorphic changes in these wasps[7]. Over a period of four years, metamorphosis of *Eumenes conica* Farb. (Emenidae), *Sceliphron coromondelicum* Lapel (Sphecidae) and *Sceliphron violeceum* Fabr. (Sphecidae) from the egg stage to adult stage is being studied in this department.

Mud cells of *E. conica* (figure 1 MC) and *S. coromondelicum* (figure 2, MC) were collected from time to time from the environs of the Zoology Department. Eggs and larvae of *S. violaceum* were collected from electrical installations. After opening these mud cells and pin-hole nests, the developing stages were recorded and placed in glass tubes (50 mm height and 10 mm diameter) (figure 3, I, II, III). The tubes were closed with cotton plugs (figure 4, CT) and kept in horizontal position in a card board box. During the studies, spinning of puparium by full grown larvae of these wasps was found to be strikingly different from those spun by larvae of the same wasps in mud cells and pin hole nests.

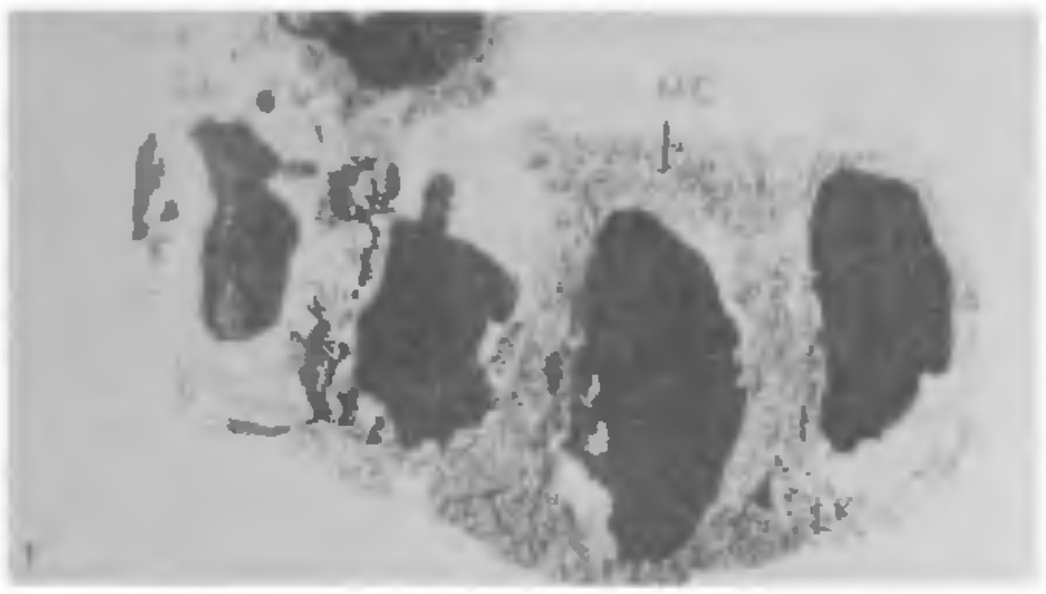
A. *Spinning of puparium by larvae of E. conica:*

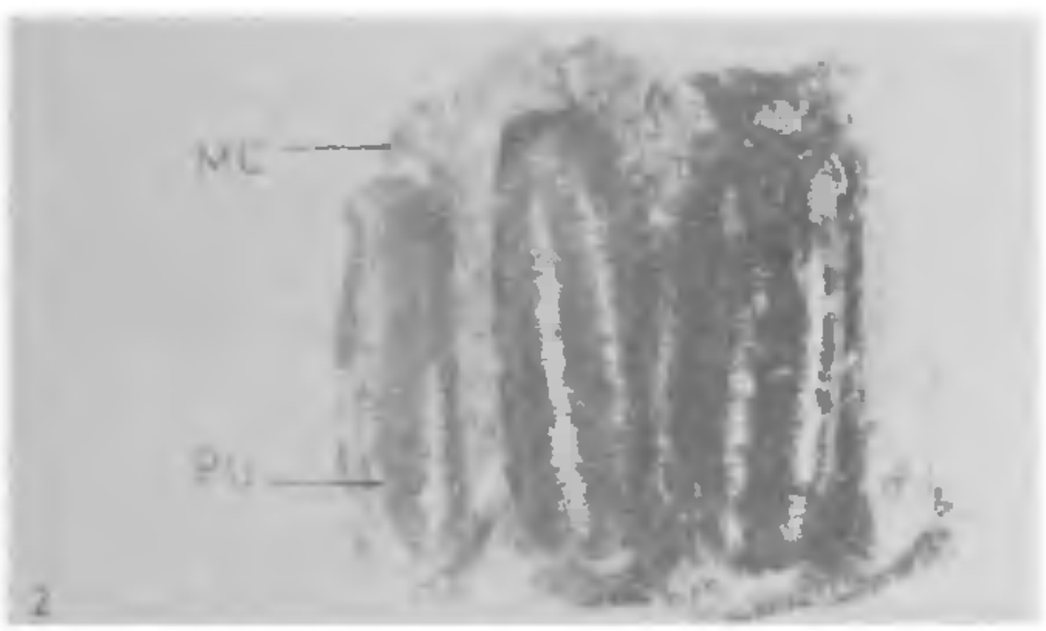
The full grown larvae secreted silk and applied it to inner surface of glass tubes by moving to and fro in a random fashion along the length of the tubes. Some of the larvae however reached the cotton plug where application of silk secretion assumed a definite order so that the entire inner surface of the plug was covered in the form of double sheath (figure 3, I, SH), supported around nearby tube walls. In majority of the cases, the curvature of the two sheaths was parallel to each other (figure 4, A, arrow). However, in some of the remaining cases the curvature of one sheath was exactly opposite to the other (figure 4, B, arrow) giving the appearence of a bi-concave structure. In a few cases, meconium (figure 4, C, ME) of the larva was found to be partitioned from pupal chamber by the double membranous sheath (figure 4, C, SH) at the end of the tube. In none of the above described cases, was the sheath in continuation with the secretion that was applied to inner surface of the glass tube. Thus, the glass tube reared larvae of *E. conica* do not spin puparium in true sense of the term and do not enclose the developing stage completely.

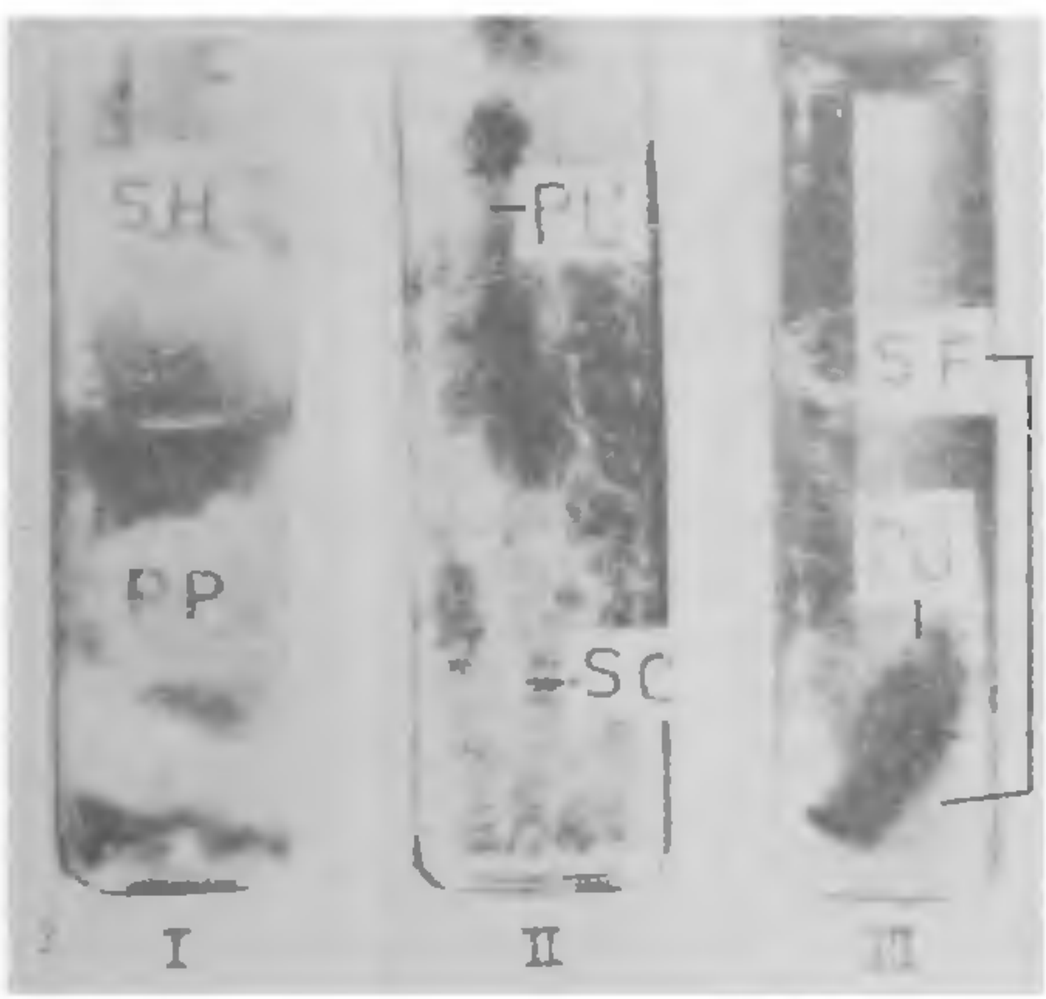
In nature, when the larvae line their mud cells with silk secretion in such a way that a continuous sheath of double membrane is formed (figure 1, SH, seen partially). The colour of the sheath, irrespective of its place of application remained white, even after it aged.

B. *Spinning of puparium by larvae of S. coromondelicum:*

The full grown larvae secreted silk and applied it to the inner surface of glass tubes in such manner as to form a centrally placed column of silk fibres (figure 3, II, SC) along the axis of the tubes and then spun the main tubular puparium (figure 3, II, PU). The column and the puparium were anchored to the inner surface of the glass tubes by a number of silk fibres (figure 3, II,







SF). The height of fifteen puparia was found to vary between 20 and 25 mm while, the diameter at the centre of these puparia was between 3 and 4 mm.

In nature, the larvae do not apply the secretion to the inner surface of cells but, spin a very few supporting silk fibres and utilise almost all the secretion to spin the tubular puparium (figure 2, PU). An average height of fifteen puparia spun in mud cells was between 18 and 20 mm while, their diameter at the center was between 4 and 5 mm. Irrespective of the place, either in mud cells or in the glass tubes, the tubular puparium turns brown as it ages while the supporting silk column and fibres remain absolutely white.

C. *Spinning of puparium by larvae of S. violaceum*:

The full grown larvae secreted the silk which was used for spinning the main tubular puparium (figure 3, III, PU) and the supporting fibres. The central column was not constructed. The height of fifteen puparia spun in glass tubes was between 15 and 16 mm, while their diameter at center was about 3 to 4 mm.

In nature, when larvae spin silk secretion in their pin-hole nests they probably do not apply it to the inner surface of the metal of nest, as no trace of secretion was found when the surfaces were carefully scraped. The larvae do not spin a large amount of supporting fibres as in each nest, hardly a few fibres were observed and collected. The height of fifteen puparia collected from pin hole nests was between 13 and 14 mm, while their diameter at the centre was between 5 and 6 mm. Irrespective of the location of puparium, it turns brown as it ages while, the supporting fibres remain absolutely white.

These observations suggest that the rearing of the wasp larvae in glass tubes certainly affect their normal behaviour of spinning the puparia. It changes as

Figures 1–4. 1. A view of opened mud cells of *E. conica.* × 2. **2.** A view of opened mud cells of *S. coromondclicum* having puparia. × 2. **3.** Glass tubes showing puparium of I – *E. conica.* II – *S. coromondelicum.* III – *S. violaccum* × 2. **4.** Free hand sketch of glass tubes showing various modes of sheath spun by larvae of *E. conica.* A – Curvature of two sheaths, parallel. B – Curvature of two sheaths opposing each other. C – Meconium partitioned from pupal chamber by double sheath. CT – Cotton plug; MC – Meconium of larva; PP – Pupa of *E. conica*; PU – Puparium; SC – Silk column; SF – Supporting silk fibres; SH – Double sheath at cotton plug; SH' – Double sheath at meconium.

situation demands. The larvae of *E. conica* do not follow a specific pattern of construction and fail to enclose themselves in puparial sheath completely. They spin the double sheath, at least in two different patterns the reasons for which, at present are obscure. As far as the behaviour of the larvae of *S. coromondelicum* and that of *S. violaceum* is concerned, the change is restricted to the amount of secreted silk and its utilization in construction of supporting structures like central column and fibres as per demands of 'unnatural' situation. This clearly shows that the larvae of sphecid wasps have the potential to secrete much higher amount of silk, if necessary and that, they are able to discriminate the habitat and decide whether or not there is a need to errect supporting structures.

There is very little difference between the dimensions of the puparia spun in mud cells and those constructed in glass tubes by the larvae of *S. coromondelicum* and *S. violaceum*. Thus the artificially induced changes in the habitat do not affect the size and shape of the puparium. As the silk secreted by larvae of *E. conica* ages, its colour remains unchanged. But, the ageing of the silk produced by the larvae of the sphecid wasps shows definite change; supporting fibres and central column remaining white, while the tubular puparium turns brown. This suggests that the silk secreted by the larvae of *E. conica* is probably composed of only one type of scleroprotein while the silk secreted by the larvae of *S. coromondelicum* and that of *S. violaceum* is composed of at least two different types of scleroproteins. Florkin and Bricteux[11] reported that fibroin made by *Psenulus concolor* (sphecidae) contain high proportion of glycine, alanine, serine and glutamic acid. A comparative biochemical study on composition of silk secreted by the larvae reported in this paper is in progress.

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1. Hingston, R. W. C., *J. Bombay Nat. Hist. Soc.*, 1926, **31,** 241.
2. Hingston, R. W. C., *J. Bombay Nat. Hist. Soc.*, 1927, **31,** 890.
3. Jaykar, S. D. and Mangipudi, R. Shastri, *J. Bombay Nat. Hist. Soc.*, 1964, **61,** 708.
4. Jaykar, S. D. and Spurway, H., *J. Bombay Nat. Hist. Soc.*, 1965, **62,** 193.
5. Jaykar, S. D. and Spurway, H., *J. Bombay Nat. Hist. Soc.*, 1967, **64,** 307.
6. Jaykar, S. D. and Spurway, H., *J. Bombay Nat. Hist. Soc.*, 1968, **65,** 148.
7. Joshi, P. V., *Biovigyanam*, 1981, **7,** 149.
8. Soans, A. B. and Soans, J. S., *J. Bombay Nat. Hist. Soc.*, 1969, **66,** 221.
9. Spurway, H., Dronamraju, K. R. and Jaykar, S. D., *J. Bombay Nat. Hist. Soc.*, 1964, **61,** 1.
10. Ruben, D. E., *J. Bombay Nat. Hist. Soc.*, 1963, **60,** 283.
11. Florkin, M. and Bricteux, G. S., *Arch. Int. Physiol. Biochem. Liege*, 1961, **65,** 148.

CHROMOSOME STUDIES IN INDIAN DIPLOPODA (MYRIAPODA) I: A NOTE ON THE OCCURRENCE OF POLYPLOIDY IN *POLYDESMUS GRACILIS*

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THE application of techniques such as air drying[1], acetic-saline-Giemsa (ASG)[2] and Giemsa C-banding[3] has renewed our interest in the chromosome cytology of Diplopoda which has been reviewed recently[4]. The present paper deals with the cytology of male meiosis of a south Indian millipede, *Polydesmus gracilis* (sp. nov.) using air drying technique.

Males of *Polydesmus gracilis* (family Polydesmidae) were collected from American College Campus, Madurai, during the monsoon season. Adult males were injected with 0.2 ml of 0.05% colchicine and after 5 hr, testes were dissected in normal saline. Testes follicles were treated separately with one of the hypotonic solutions[5], like 0.125 M potassium chloride and 0.016 M sodium citrate for 1 hr at room temperature. The use of 0.016 M sodium citrate gave the best results in the preparation of both mitotic and meiotic metaphase chromosomes. Air-drying methods[6] were employed as in previous studies[1].

The diploid chromosome number ($2n$) as revealed by both somatic and spermatogonial metaphases is 12 (figures 2 and 4). The male is heterogametic with an XY type of sex-mechanism.

The onset of meiotic prophase is characterized by the appearance of slender chromatin strands, each terminating with a heterochromatic knob (figure 5). Thus there are 12 knobs, which correspond to the