# REPRODUCTIVE BIOLOGY AND LIFE HISTORY STAGES OF *HAPLACARUS DAVISI* A. XAVIER *ET AL*., 2005 (ACARI: ORIBATEI)

**Alphonsa Xavier [1] and M.A. Haq [2]**

[1] Selection Grade Lecturer, Department of Zoology, Government Arts and College, Calicut, Kerala 673018, India
[2] SMIS Dale, Kohinoor, Thenhipalam, Kerala, India
Email: puthusery@sify.com

**ABSTRACT**

*Breeding behaviour and post embryonic development of the lohmanniid mite* Haplacarus davisi *A. Xavier et al., 2005 were studied in detail by rearing them in specially constructed culture vials, offering their preferred food, under laboratory conditions. Oviposition, hatching, the various developmental stages and total duration in days from egg to adult are described in the present paper. Sketches showing the various life history stages are also given.*

**KEYWORDS**

*Deutonymph, hatching, incubation, larva, moulting, Oviposition, protonymph, tritonymph.*

**ABBREVIATIONS**

ro - Rostal seta; *exa* - anterior exobothridial seta; exp - posterior exobothridial seta; *le* - lamellar seta; in - interlamellar seta; bo - bothridium; ss - sensillus.

Very little work has been done on the breeding biology of lohmanniid mites. These constitute a significant component of soil mesofanua which are actively involved in the humification process. They feed voraciously on decaying plant litter and release into the soil nutrient rich faecal pellets (Fujikawa, 1972; Dinsdale, 1974; Haq, 1996; Jain *et al*., 1999). Larval and nymphal stages are even more active feeders when compared to adults and they feed continuously (Wallwork, 1967; Woodring, 1963). A deeper insight into the biology and life history stages of these cryptic organisms will help to develop strategies to exploit their potential in biodegradation of organic litter and nutrient cycling.

*Haplacarus davisi* A. Xavier *et al*., 2005 is a lohmanniid mite, seen in association with decaying leaf litter of *Xylea xylocarpa*.

## MATERIALS AND METHODS

### Collection and extraction of mites

Decaying leaf litter of *X. xylocarpa* inhabited by *H. davisi* was collected from Kakkanchery in Malappuram district of Kerala. It was extracted in a modified Berlese-Tullgren funnel apparatus for 48 hours to separate the mites. The emerging mites were collected in collecting vials containing moistened and powdered leaf litter of *X. xylocarpa*. The collected mites were then transferred to culture vials for rearing and observation.

### Preparation of culture vials

In the laboratory, mites were cultured in specially designed culture vials made up of plastic. The culture medium was prepared by mixing plaster of paris and charcoal in the ratio 4:1. This mixture was made into a smooth paste with distilled water. A few drops of 1% thymol solution were also added into the mixture as a fungicide. This mixture was carefully poured into plastic containers having 3-5cm diameter and 4cm height. Care was taken to prevent trapping of air bubbles while pouring the medium. The surface of the medium was made smooth and even and the vials were allowed to set and dry for two days. The medium was then kept moist by adding a few drops of distilled water. Minute pin holes were made in the lids of these culture vials to maintain air circulation.

### Rearing of mites

About 2-30 mites comprising adult males and females were introduced into a series of culture vials. Moistened and powdered leaf litter of *X. xylocarpa* was placed in the centre of each culture vial as food item. Culture vials were closed with lids containing minute holes for exchange of gases and kept in desiccators to maintain a relative humidity of 80-90% and temperature 30 ± $1^0$C.

### Study of life stages

Culture vials were routinely examined to study the biology of each species. Surface of culture medium and food materials were checked regularly to see whether the females had oviposited. Ovipositional behaviour of females in each case was noted. When eggs were detected, they were transferred into separate culture vials with maximum care. A minimum of 10 eggs were introduced into each culture vial. Further development of the eggs were followed closely. A detailed study of the egg, incubation, hatching, larval and nymphal stages, intervening quiescent and moulting phases was carried out. Permanent slides of the various life stages of each species were prepared. Mounted slides were then examined under a Leitz Aristoplan microscope to study the morphological details. Drawings were made using the camera lucida attached with the microscope. Measurements were taken using an ocular micrometer. Details regarding the duration of development from egg to adult including the duration of each individual stage were worked out.

## OBSERVATION AND RESULTS

### Oviposition

Gravid female deposited solitary eggs among the food materials provided. Body cavity of the female carried 2-3 eggs at a time. Usually a female deposited single egg a day but rarely two. The number of eggs laid by a female during her life time though not studied precisely, a female under laboratory condition laid eight eggs within a period of six days. Further observation helped to record the death of the same female within a few days.


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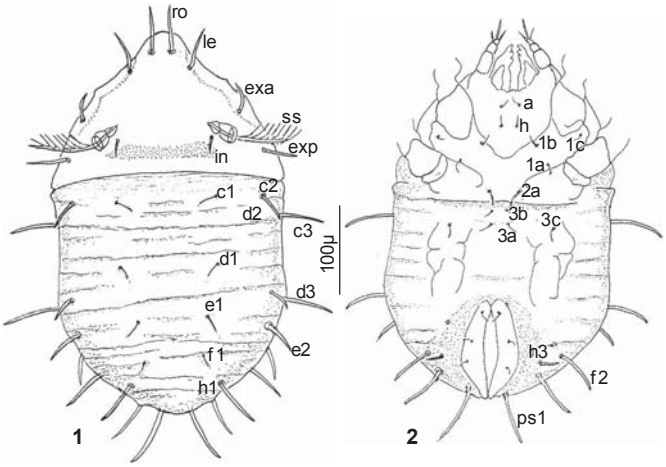
**Incubation and hatching**
The egg during initial stage of development appeared swollen and milky-white in appearance. After an incubation period of two weeks, it became creamy. Towards the time of hatching on the third week, the creamy-white egg became light brown in colour. Before the emergence of the larva, at about 24-36 hours, a small slit appeared towards the anterior end along the longitudinal axis of the egg. This slit enlarged posteriorly and the hexapod larva emerged out by protruding its first pair of legs.

**Duration of life stages**
Larva after emergence remained inactive for about half an hour near the empty egg case. It became slowly active, stretched out its legs and started wandering about. When it recognised a preferred food, feeding activity started which extended for a period of 15-16 days. Feeding became vigorous during the successive days. Quite often aggregates of larvae were found feeding on the leaf lamina. After the active period of feeding, the larva became quiescent for 8-9 days. During this period, the body appeared slightly swollen. Towards the end of the quiescent phase the body became transparent with the appearance of weakened areas along the postero-lateral region of the notogaster. Slits developed at the weakened areas got extended towards the anterior and posterior sides. The last pair of legs got extruded through the posterior slit. The pressure exerted by the moulting larva further extended the slit on both directions. The individual slowly emerged out by the gradual backward movements of the body. The process of moulting took 2-3 hours. The process of moulting was similar in all the subsequent nymphal stages. After the emergence, the nymphs remained motionless for about 10-15 minutes which represented a hardening period and then started moving and feeding. The protonymph emerged after the moulting led an active period of 18-21 days. Then it became quiescent for 8-9 days as in the first quiescent phase. Moulting released the deutonymph. It entered the third quiescent phase after an active period of 21-23 days. The third quiescent phase appeared slightly longer than the second quiescent phase and it ranged from 9-12 days. The third moult produced the tritonymph. The tritonymph remained active for a period of 20-22 days. It entered the fourth quiescent phase which lasted for about 8-9 days after which moulting occurred, releasing the adult. Thus *H. davisi* completed the development from egg to adult in 130-144 days.

**MORPHOLOGICAL DESCRIPTION OF LIFE STAGES OF *H. DAVISI***
(All measurements given in mm)

**Egg**
Length: 230 (Range 230-240); Width: 152 (Range 151-160). Freshly laid eggs appeared white in colour, oval in shape and smooth in appearance. But microscopic scrutiny revealed fine reticulations over the egg. At the time of hatching, the colour of the egg gradually changed to light brown.

**Larva** (Figures 1 & 2)
Measurements: Length: 380 (370-388); width: 228 (222-232). The newly emerged larva could be distinguished by its small




***Figures 1-2.* Haplacarus davisi *- Larva***
***1 - dorsal view; 2 - ventral view***

wrinkled body and creamy-white colour. Body soft and without any sclerotisation. Towards the end of the larval life, developed a pale brown colour. The larva possessed three pairs of legs.

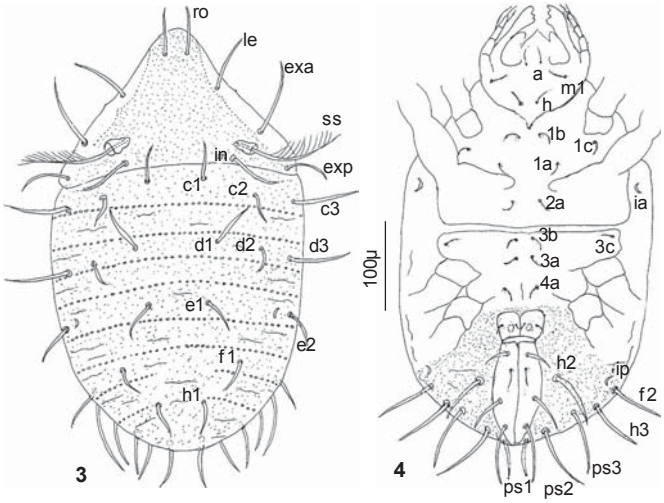
Prodorsum: Anterior end of the prodorsum roughly triangular with broad base and conical apex. Lateral margin smooth but with a slight projection above the level of seta *exa*. Lamellae represented by weak ridge. All prodorsal setae smooth with pointed tip. Seta *ro* inserted below the rostral apex and measures 43. Seta *le* measures 37, inserted below the level of seta *ro*. Seta *in*, the smallest among all prodorsal setae, measures 17, inserted below the bothridium. Setae *exa* and *exp* arise from postero-lateral border of the prodorsum and measures 27 and 34, respectively. A band of closely set punctations present below and between the level of *bo*, extending a little beyond the insertional points of seta in laterally. Sensillus (*ss*) well developed with eight branches. Bothridia (*bo*) directed laterally downwards.

Notogaster: Notogaster somewhat elongated in shape. Lateral and posterior margins wavy. Dorsosejugal region demarcated by a slightly convex line. Fourteen pairs of notogastral setae present. All setae smooth. Marginal setae longer. Integument of notogaster without any ornamentation but with wrinkles.

Ventral Region: Oral appendages visible from the ventral side. Pedipalp three segmented. Rutellum with three blunt teeth. Chelicera poorly developed. Infracapitulum with two pairs of simple, smooth setae, *a* and *h*. Epimeral setal formula 3-1-3-0. Genital area not developed. Anoadanal plates fused with three pairs of setae. All setae small and smooth.

Legs: Three pairs. All legs monodactylous.

**Protonymph** (Figures 3 & 4)
Measurements: Length: 457 (450-465); width: 265 (260-268). Protonymph could be easily distinguished from the larva by its larger body size and four pairs of legs. Body light brown in colour and carried a few wrinkles. Integument ornamented with




***Figures 3-4.*** **Haplacarus davisi** **-** ***Protonymph***
***3 - dorsal view; 4 - ventral view***

fine punctations.

Prodorsum: Prodorsum terminate anteriorly as a blunt, rounded rostrum and gradually becomes broader posteriorly. Lamellae more prominent than that of larva. All prodorsal setae well developed and exhibit increase in size than that of larva. All setae smooth. Seta *ro* 46 long, inserted far below the rostral apex. Seta *le* springs from the lateral border of prodorsum and measures 51. Setae *exa* and *exp* placed laterally measuring 60 and 45 respectively. Seta in inserted below the level of bothridial cup (*bo*) and measures 51. Bothridium with wide, laterally directed opening. *ss* with 10-12 branches. Prodorsum punctated.

Notogaster: Notogaster oval in shape with rounded posterior border. Sixteen pairs of notogastral setae present. $ps_2$ and $ps_3$ newly added. Setae exhibit moderate increase in length than in the larva. All setae smooth and simple. Eight notogastral bands seen, formed of chains of closely set area porosae, $s_7$ and $s_8$ incomplete medially. Lyrifissure *im* visible close to seta $e_2$ as a small slit. Integument of notogaster ornamented with fine scattered punctations.

Ventral Region: Gnathal appendages well developed. Pedipalp five segmented. Chelicera sclerotised. Rutellum fully developed with three blunt notches towards its tip. Infracapitulum well developed with three pairs of simple smooth setae. Seta $m_1$ newly added. Epimeral region more pronounced than the larva. Epimeral setal formula 3-1-3-1. All setae smooth. Genital plates wider than longer, carrying a pair of genital suckers and two pairs of smooth setae. Preanal plate narrow. Anoadanal plates fused, longer, widest medially and carry three pairs of adanal and a single pair of anal setae. Adanal setae $ad_3$ newly added. Lyrifissures *ia* and *ip* visible on ventral aspect. Area surrounding anoadanal and genital plates with punctations.

Legs: Four pairs. All legs monodactylous.

**Deutonymph** (Figs. 5 & 6)

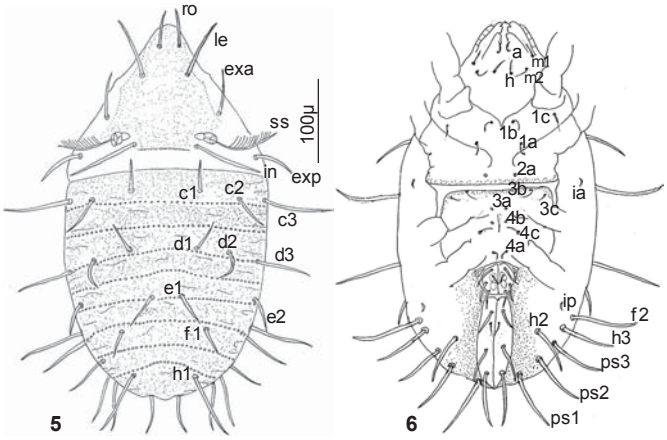
Measurements: Length: 480 (470-492); width: 267 (260- 272). Deutonymph could be distinguished by its slightly bigger size and pale brown colour. A few wrinkles present in the previous stage retained. Integument with fine punctations.

Prodorsum: Prodorsum flat and triangular, broader than longer. Rostral apex smooth and rounded. Lamellar ridge prominent. All prodorsal setae resemble those of the previous stage, but slightly longer. Seta *ro* measures 51. Seta *le* 74. Seta in longest measuring 81. Setae *exa* and *exp* almost of the same length, 62. All setae smooth with pointed tips. Bothridium and *ss* similar to that of protonymph. The prodorsum carries a transverse ridge between the points of insertion of *in* and formed of transverse striations.

Notogaster: Notgaster elongated, oval with round posterior end. Sixteen pairs of notogastral setae. Marginal setae ranging in size from 74-83 central setae measure 47-52. All setae smooth and simple. Eight notogastral bands present formed of chains of closely set oval or round area porosae. All bands complete, the last one slightly arched in the middle. Integument of notogster bears fine punctations as in the protonymph.

Ventral Region: Pedipalp well developed with five segments. Chelicera sclerotised. Rutellum with three blunt notches as in the protonymph. Infracapitulum with four pairs of smooth setae. Seta $m_2$ newly added. Epimeral setal formula 3-1-3-3. Setae 4*b* and 4*c* newly added. All setae smooth in appearance. Genital plates with two pairs genital suckers and four pairs of smooth setae. Three setae arranged along the outer border of the genital plate and the fourth pair along the inner border. Outer setae longer compared to the inner. A triangular aggenital plate present along the anterolateral border of genital plates. Preanal plate narrow. Anal and adnanal plates fused, three pairs of adanal and a single pair of anal seta present. All setae smooth. Fissures *ia* and *ip* visible. Integument surrounding anoadanal and genital plates bears fine punctations.

Legs: Four pairs. All legs monodactylous.



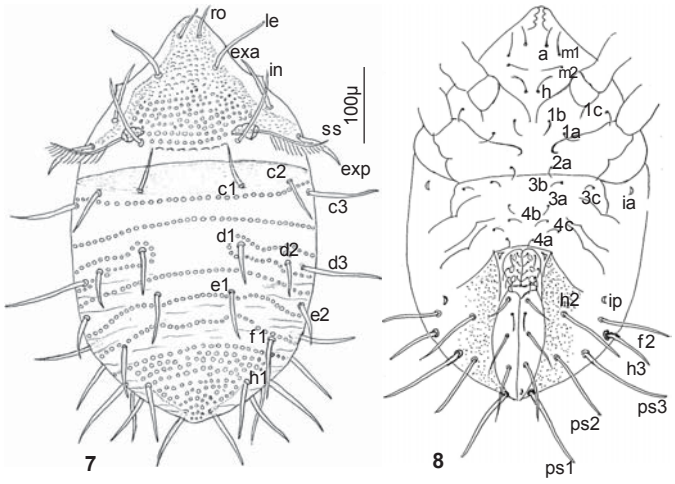

***Figures 5-6.*** **Haplacarus davisi** **-** ***Deutonymph***
***5 - dorsal view; 6 - ventral view***

**Tritonymph** (Figs. 7 & 8)
Measurements: Length: 500 (490-510); width: 293 (280-300). Tritonymph could be easily distinguished from other stages by its large body, brown colour and three pairs of genital suckers.

Prodorsum: Prodorsum broader than longer, flat, broad based with conical tip and a small lateral projection. Rostral apex smooth. Lamellae well demarcated. All prodorsal setae resemble those of the deutonymph but disposition vary considerably. Seta *ro* smallest, measures 54 inserted a little below the rostral apex. Seta *le* curves outwards measuring 78. Seta in inserted very close to *bo*, longest among all prodorsal setae, measuring 82. Setae *exa* and *exp* springs from the lateral margin of the prodorsum, measures 72 and 68 respectively. All setae smooth with pointed tips. *ss* with 12-14 branches. A transverse ridge formed of 6-8 crescentic elevations present between insertion points of seta *in*. Integument of prodorsum provided with rounded fovelolae which gradually change into crescentic elevations towards the rostral tip.

Notogaster: Shape of notogaster similar to that of deutonymph. Dorsosejugal line distinctly marked. Sixteen pairs of smooth notogastral setae. Marginal setae longer, range in size from 73-81 while central setae measure 54-64. Eight notogastral bands formed of closely arranged circular area porosae present. Notogastral bands $s_3$ and $s_4$ incomplete and become fused together towards the mid line. Integument of the notogaster bear rounded foveolae towards the posterior end.

Ventral region: Pedipalp, chelicera and rutellum as in the deutonymph. Infracapitulum with four pairs of smooth setae resembling those of the previous stage. Epimeral setal formula 3-1-3-3. All setae smooth. Genital plates with three pairs of genital suckers and eight pairs of smooth setae. Four setae arranged along the outer border of the genital plate and four along the inner border, outer setae longer compared to the inner. Aggential plate triangular, situated along the anterolateral border of genital plate. Preanal plate narrow. Anal and adanal plates fused. Three pairs of adanal and a single pair of anal seta present. All setae smooth. Adanal setae decreasing in length from $ad_1$ to $ad_3$. Fissure ia visible outside the sejugal apodeme. Fissure *ip* located close to the postero-lateral margin of the body. Integument surrounding anoadanal and genital plates bears fine punctations.




***Figures 7-8.*** **Haplacarus davisi -** ***Tritonymph***
***7 - dorsal view; 8 - ventral view***

**Diagnostic features of life stages** (Table 1)
Larva minute and creamy white in colour. Body soft with fine wrinkles and integument without sclerotisation. Larva sluggish with three pairs of monodactylous legs. Sensillus well developed with eight branches. Notogaster bears 14 pairs of setae. Epimeral setal formula 3-1-3-0. Genital area not developed. Anoadanal plates fused with a single pair of anal and two pairs of adanal setae. All setae smooth. Protonymph developed the fourth pair of legs and eight notogastral bands, $s_7$ and $s_8$-incomplete medially. Sensillus with 10-12 branches. Epimeral setal formula 3-1-3-1. Genital plates developed with two pairs of setae and a single pair of genital suckers. The fused anoadanal plate with three pairs of adanal and a single pair of anal setae. Deutonymph characterised by the presence of a prodorsal ridge formed of transverse striations between the points of insertion of setae in. Eight complete notogastral bands. Epimeral setal formula 3-1-3-3. Genital plates with four pairs of setae and two pairs of genital suckers. Aggenital plates triangular. Tritonymph largest of all nymphal stages and the body more sclerotised and brown in colour. Sensillus with 13-14 branches. Prodorsal ridge formed of 6-8 crescentic elevations stretched between insertional points of seta in. Notogastral bands $s_3$ and $s_4$ incomplete and fused together towards the midline. Genital plates with eight pairs of setae and three pairs of genital suckers. Integument with foveolae and punctations.

## Conclusion

When soil and litter samples were collected during the monsoon season, a large number of adults and immature stages were obtained. But when soil was dry, the collection consisted only of adults and that too very few in number. This shows that in natural habitat *H. davisi* reproduce only during the monsoon season. Earlier studies have shown that oribatid mites, especially larvae and nymphs are unable to consume dry litter (Hartenstein, 1962; Harding & Stuttard, 1974). Availability of moisture triggers microbial action on organic litter and such microbially conditioned litter is selected by these mites for feeding (Ramani & Haq, 2001). But while conducting breeding experiments in laboratory conditions, the mites were provided with powdered and moistened leaf litter which made consumption of the same by the mites easy. *H. davisi* thus completed its development from egg to adult in 130-144 days at a humidity of 80-90% and temperature of 30±1$^0$C under laboratory conditions.

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***Table 1. Diagnostic features of various life stages of* Haplacarus davisi**

| Nature of Sensillus | Larva | Protonymph | Deutonymph | Tritonymph | Adult |
|---|---|---|---|---|---|
| | Well developed with 8 branches | 10-12 branches | 10-12 branches | 13-14 branches | 13-14 branches |
| Prodorsal ridge | - | - | Between insertional points of setae *in* formed of transverse striations | Formed of 6-8 crescentic area porosae | Formed of 6-8 interrupted crescentic area porosae |
| Notogastral setae | 14 pairs, smooth | 16 pairs, smooth | 16 pairs, smooth | 16 pairs, smooth | 16 pairs, smooth as in |
| Notogastral bands | not developed | 8 bands, $s_7$ and $s_8$ incomplete medially | 8, complete bands | 8, $s_3$ and $s_4$ incomplete and fused together | tritonymph |
| Epimeral setal formula | 3-1-3-0 | 3-1-3-1 | 3-1-3-3 | 3-1-3-3 | 3-1-3-3 |
| Number of genital setae | 0 | 2 pairs | 4 pairs | 8 pairs | 10 pairs |
| Number of genital suckers | 0 | 1 pair | 2 pairs | 3 pairs | 3 Pairs |
| Aggenital plate | - | - | triangular | triangular | triangular |
| Number of adanal seta | 2 pairs | 3 pairs | 3 pairs | 3 pairs | 4 pairs |
| Number of anal seta | 1 pair | 1 pair | 1 pair | 1 pair | 1 pair |
| Legs | 3 pairs, monodactylous | 4 pairs, monodactylous | 4 pairs, monodactylous | 4 pairs, monodactylous | 4 pairs, monodactylous |
| Length | 380 (370-388) | 457 (450-465) | 480 (470-492) | 500 (490-510) | 549 (540-558) |
| Width | 228 (222-232) | 265 (260-268) | 267 (260-272) | 293 (280-300) | 316 (310-322) |

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