



**Description of life cycle stages of the broad mite  
*Polyphagotarsonemus latus* (Banks, 1904) (Acari: Tarsonemidae)  
based on light and scanning electron microscopy**

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**ABSTRACT**

The broad mite, *Polyphagotarsonemus latus* egg, larva, nymph, male and female are described using light and scanning electron microscopy. SEM of egg revealed that its surface is sculptured by the presence of transparent sacs with irregularly shaped peripheral tubercle-like structures located at their bases. The structure of these sacs as seen from SEM examination suggests their role in fixation of the egg on plant leaves and/or respiration of the embryo. It also suggested that the tubercles may act as a basal support for the sacs. SEM of larva revealed the presence of whitish transverse groups of lines and hundreds of minute tubercles lying between them. The study demonstrated that the nymph remains enclosed within the skin of larva until the adult is formed. Quiescent nymphs are observed to attract males. The male is observed to carry a nymph at a right angle by its genital capsule and when female emerges mating occurs. The 4<sup>th</sup> pair of legs in the male is modified into a claspers-like organ. SEM description of female *P. latus* showed that it has a relatively soft oval body with the gnathosoma observed broad at its base and narrow terminally like a rostrum. It also revealed downward direction of the gnathosoma and its articulation with the idiosoma. The body of the male is divided by distinct pleats between gnathosoma, prosoma, metasoma, opisthosoma and genital capsule. Detailed description and measurements of the egg as well as different body regions of larva, nymph and adults are recorded. The present study also described the fine structure of the dorsal cuticle of the larva and changes occurring during development into a quiescent nymph.

**1. INTRODUCTION**

The broad mite, *Polyphagotarsonemus latus* is a minute herbivorous mite with a variety of host range and is widely distributed in tropical and subtropical areas around the world. It was first described by Banks (1904) as *Tarsonemus latus* from the terminal buds of Mango in green house in Washington DC, USA (Denmark, 1980). It attacks numerous economic crops and ornamental plants belonging to more than 60 families like Solanaceae, Cucurbitaceae and Malvaceae causing severe symptoms (Zhang, 2003).

Primary hosts of *P. latus* comprise cotton, pepper, tomato, cucumber, citrus, legumes, tea, coffee, mango, gerbera, begonia, dahlia and jasmine (Pérez-Otero *et al.*, 2007). It feeds on the newest growths, causing malformation of the terminal leaves. They become severely stunted, hardened and curl down at the edges with brownish or reddish lower surfaces, depending on host species (Labanowski and Soika, 2006).

Numerous studies are accessible on *P. latus* but most of them are concerned with the ecology, biology and control of the mite. A few dealt with the morphology of the life cycle stages (Cho *et al.*, 1993; Nucifora and Vacante, 2004; Pérez-Otero *et al.*, 2007). Zhang (2003) reported a key to family Tarsonemidae beside notes on common names and distribution of its species including *P. latus*. However, the above studies offered incomplete data with a few micrographs. Martin (1991) presented brief notes on the morphology of different stages of *P. latus* using scanning electron microscopy (SEM).

The present work offers fine and detailed description for all life cycle stages that may be useful for further taxonomical, comparative and control studies.

## 2. MATERIALS AND METHODS

### 2.1. Collection of specimens:

The broad mite *P. latus* was collected from unsprayed sweet pepper plants grown in a plastic house in a protected cultivation farm belonging to the Agriculture Research Center, Giza governorate, Egypt. Mite colonies were maintained on potted pepper plants under laboratory conditions for two weeks before the start of experiments. Mites were collected from laboratory culture using a fine paint brush under stereo-binocular microscope.

### 2.2. Light microscopy:

Mounted slides were made for different mite stages at Plant Protection Research Institute, Dokki area, Giza governorate, Egypt. Specimens were cleared in lactic acid for one day. For permanent preparation of

mite stages, each specimen was placed in a drop of Hoyer's medium (50 ml distilled water, 30 g gum Arabic, 200 g chloral hydrate and 20 ml glycerin) and covered with a cover slip. The slide then placed in an oven adjusted at 42°C for another one day to remove air bubbles near the cover edge. Slides were examined by light microscope and illustrated by line drawings using camera-lucida. Illustrations and measurements were made for each stage. Body length was measured from the point at which the gnathosoma meets the idiosoma to the posterior edge of the body. Body width was measured across the widest part of the body. Changes in shape caused by preparation techniques, such as deformations caused by application of the cover slip or mounting medium, were considered to be negligible.

### 2.3. Scanning electron microscopy (SEM):

Using a fine paint brush, mites were collected from the laboratory culture from leaf pieces under stereo-binocular microscope. Leaf pieces, 5×10 mm, containing eggs or live stages of *P. latus*, were mounted on stubs with carbon tape, and examined under low vacuum scanning electron microscope (JEOL/EO-JSM-5500) (Nickles *et al.*, 2002) at Al-Azhar University, Cairo, Egypt.

## 3. RESULTS

The morphological features of each stage (egg-adult) of the life cycle of *P. latus* are described in this study. The use of both light and scanning electron microscopy were essential in order to fully describe this pest.

### 3.1. Egg stage:

The egg is elongate, oval and slightly elevated. The egg is  $\simeq 107 \mu\text{m}$  in length and  $\simeq 64 \mu\text{m}$  in width. The exposed surface of the egg carries around 29-37 sacs more or less evenly distributed (Fig. 1a). The sacs exhibit high refractive index as they appear whitish compared to the darker background of the egg body. Each sac is  $\simeq 10 \mu\text{m}$  long and  $\simeq 8.5 \mu\text{m}$  wide. SEM processing of the egg causes the membranes of these sacs to deflate and appear as a wrinkled cloth. The translucent surface of the sacs reveal

irregularly shaped tubercles arranged surround a central darker area (Fig.1b). peripherally at the bases of these sacs The latter appears finely perforated.

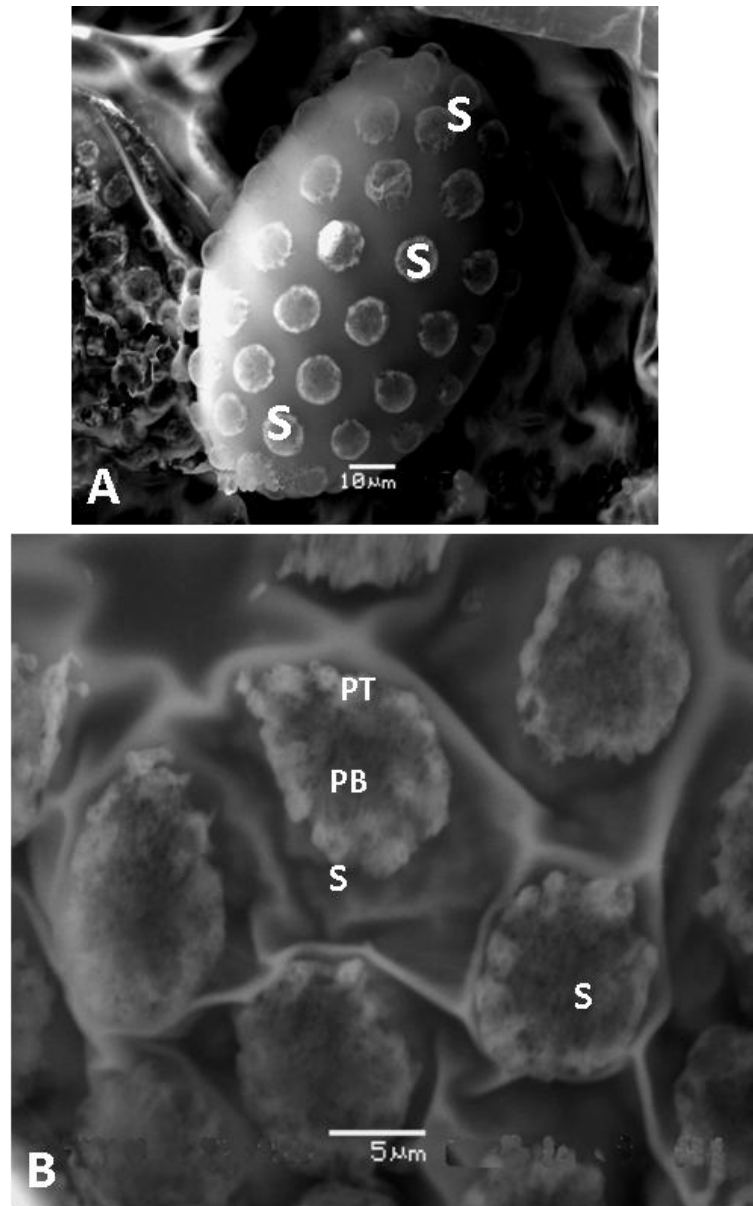


Fig. 1: Scanning electron micrographs of the egg of *Polyphagotarsonemus latus*. (A): Oval egg carrying rows of sacs (S). (B): Enlarged portion of the egg surface showing peripheral tubercles (PT) around roughly perforated area (PB) in each sac (S).

### 3.2. Larval stage:

Eggs hatch into three-legged larvae (Fig. 2). There was no apparent sexual dimorphism in the larval stage. The larva is very small ( $\simeq 142 \mu\text{m}$  in length and  $\simeq 72 \mu\text{m}$  in width). It is pear shape and more or less whitish (Fig. 2). On the dorsal surface of the larva, there are 8 pairs of setae; two pairs on

the propodosoma, two pairs on the metapodosoma and four pairs on the opisthosoma (two lateral and two median) (Fig. 2a). Propodosoma is  $\simeq 42 \mu\text{m}$ , metapodosoma is  $\simeq 58 \mu\text{m}$  and opisthosoma is  $42 \mu\text{m}$  in length. The ventral side of the larva carries seven pairs of setae; two pairs of propodosomal setae, one pair of

metapodosomal setae situated near side of the coxa of leg III and four pairs of opisthosomal setae (Fig. 2b) Propodosomal setae were longer ( $\approx 14 \mu\text{m}$ ) than metapodosomal ones ( $\approx 10 \mu\text{m}$ ). The larva possesses three pairs of legs; two pairs situated more or less anterior and one posterior. Leg I carries a terminal claw, leg II and III terminated with ambulatory sucker-

like pulvilli. Legs I, II and III measured  $\approx 34$ , 36 and  $\approx 40 \mu\text{m}$  in length, respectively.

SEM examination revealed that the cuticle of the dorsal surface is divided by three bands of marked whitish transverse lines. The areas between these lines are sculptured by groups of minute elevations of whitish tubercle-like structures that are surrounded by darker bands (Fig. 2c, d).

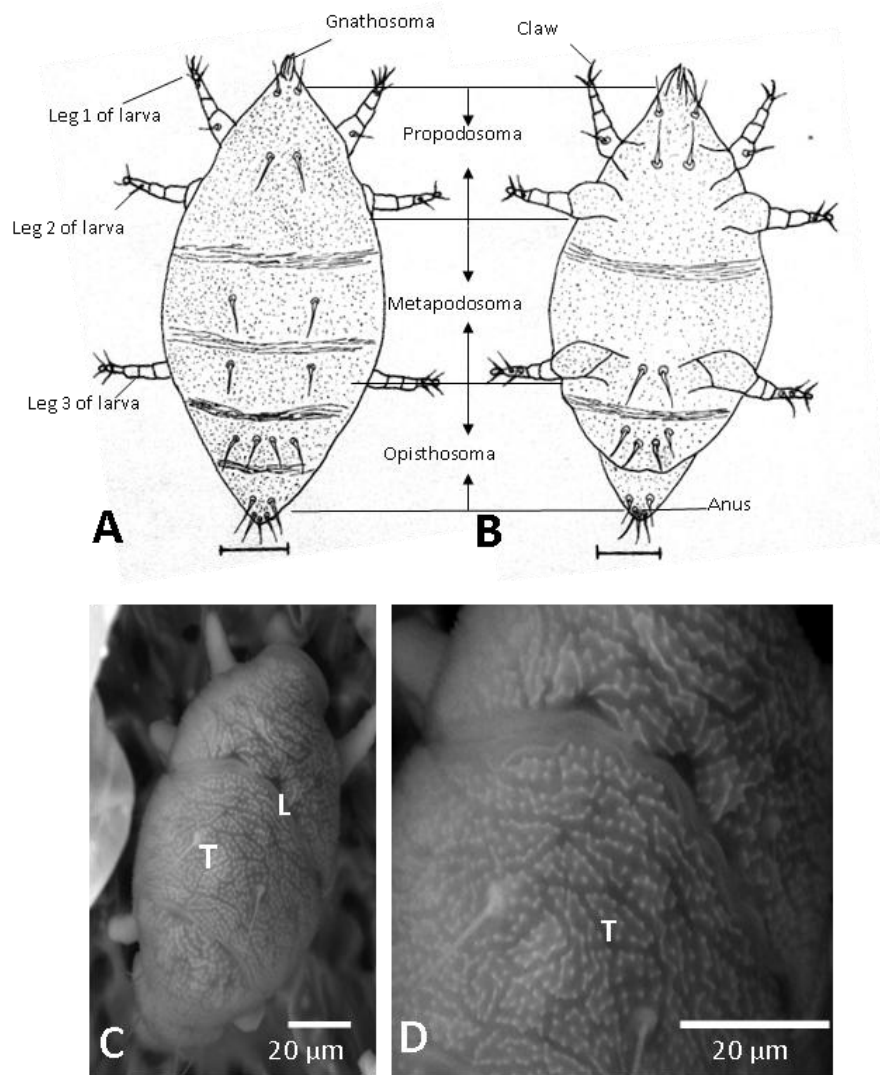


Fig. 2: Camera lucida drawings (A, B) and Scanning electron micrographs (C, D) of *Polyphagotarsonemus latus* larva. (A) and (B): Dorsal and ventral views, respectively showing body regions and three pairs of legs. Scale= 20  $\mu\text{m}$ . (C): Dorsal view showing minute tubercles (T) and transverse groups of lines (L). (D) Enlarged portion of larval dorsal surface showing arrangement of tubercles (T) in polygonal shapes.

### 3.3. Nymphal stage (quiescent):

The nymph is elliptical in shape, the longest axis is  $\approx 120.5 \mu\text{m}$  and the widest is  $\approx 75 \mu\text{m}$ . The body of the nymph is divided into three well-defined portions namely propodosoma ( $\approx 27.3 \mu\text{m}$  long), metapodosoma ( $\approx 56.8 \mu\text{m}$  long) and opisthosoma ( $\approx 36.4 \mu\text{m}$  long). The gnathosoma lies between the 1<sup>st</sup> pair of legs. There is no apparent sexual dimorphism in the nymphal stage. The nymph possesses 5 pairs of setae on the ventral surface (Fig. 3a); one pair of propodosomal setae, three pairs of metapodosomal setae and one pair of opisthosomal setae. It carries four pairs of legs that adhere tightly to the nymphal body as long as it remains enclosed within the skin

of the larva until the adult stage is formed (Fig. 3). The nymph is more or less sharply pointed at both ends. Two gnathosoma are distinct; one more posterior for the nymph and another more anterior for the larva (Fig. 3).

SEM examination of the quiescent nymph revealed a noted difference between its dorsal cuticle which is in fact the cuticle of the metamorphosing larva and that of the preceding larval stage. Beginning of the molting causes the dorsal cuticle to stretch resulting in disappearance of the darker bands surrounding each group of tubercle-like structures which in turn become evenly distributed on the body. The three bands dividing the body expand also revealing their true thickness and structure (Fig. 3c, d).

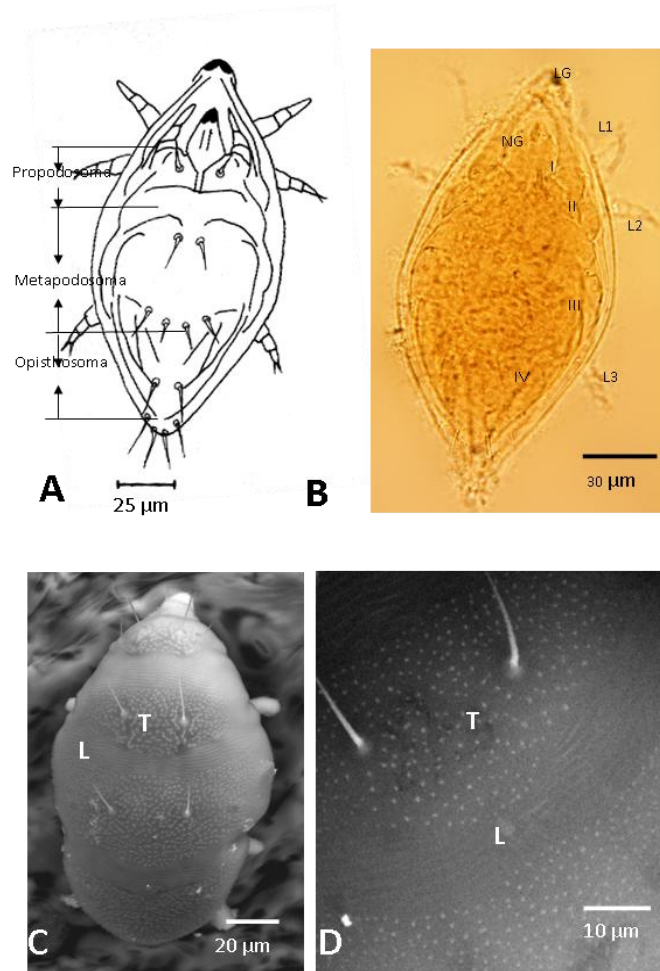


Fig. 3: Camera lucida drawing (A), light micrograph (B) and SEM photomicrographs (C, D) of *Polyphagotarsonemus latus* nymph with its four legs (I-IV) enclosed inside the larval moult with its three legs (L 1-3). LG= gnathosoma of larva, NG= gnathosoma of nymph. SEM shows stretching of the outer larval integument, scattering of tubercles (T) and increase in number of lines (L) in transverse groups.

### 3.4. Male stage:

Sexual dimorphism is characteristically pronounced in adult *P. latus*. The male measured  $138.9 \pm 7.8 \mu\text{m}$  in length and  $74.9 \pm 1.9 \mu\text{m}$  in width (Fig. 4). It is marked by a narrow posterior end and much broader in its middle region (metapodosoma) (Fig. 4). The male body is divided into three distinct portions namely propodosoma ( $48.2 \pm 1.9 \mu\text{m}$  long), metapodosoma ( $64.3 \pm 1.4 \mu\text{m}$  long) and opisthosoma ( $26.3 \pm 4.7 \mu\text{m}$  long). The male's dorsal surface carries three pairs

of propodosomal setae, three pairs of metapodosomal setae, two pairs of opisthosomal setae and a rounded posterior genital plate, bearing two pairs of shorter setae. Ventrally, there are six pairs of setae; two pair of propodosomal setae, three pairs of metapodosomal setae and one pair of opisthosomal setae (Fig. 4b). The gnathosoma lying at the anterior proximity of the body measures ( $\simeq 34.2 \mu\text{m}$  in length and  $\simeq 31.1 \mu\text{m}$  in width).

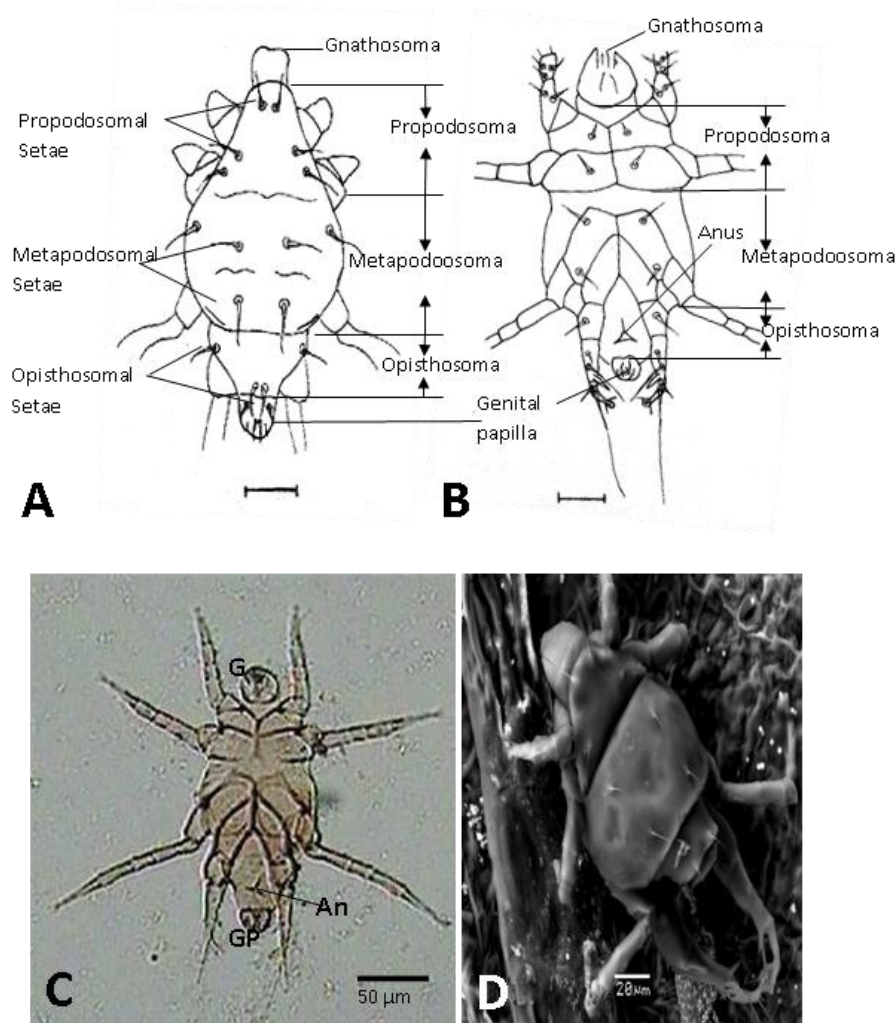


Fig. 4: Camera lucida drawings of dorsal (A) and ventral (B) views of *Polyphagotarsonemus latus* male showing different body regions. Scale= 25  $\mu\text{m}$ . (C): As in (B) but with light microscope showing elongated legs than in female. An= Anus, G= Gnathosoma, GP= Genital papilla. (D): Dorsal view with scanning electron microscopy showing distinct sutures between body regions.

The genital capsule ( $\simeq 12.5 \mu\text{m}$  in length and  $\simeq 15.6 \mu\text{m}$  in width) is semi-

circular, located ventrally posterior to the opisthosoma and consists of 2-3 triangular

genital papillae (Fig. 5f). The anal plate surrounding the anus is large, well defined and located in front of the genital capsule on

the ventral side of the opisthosoma and marked by three peripheral indentations (Fig. 5f).

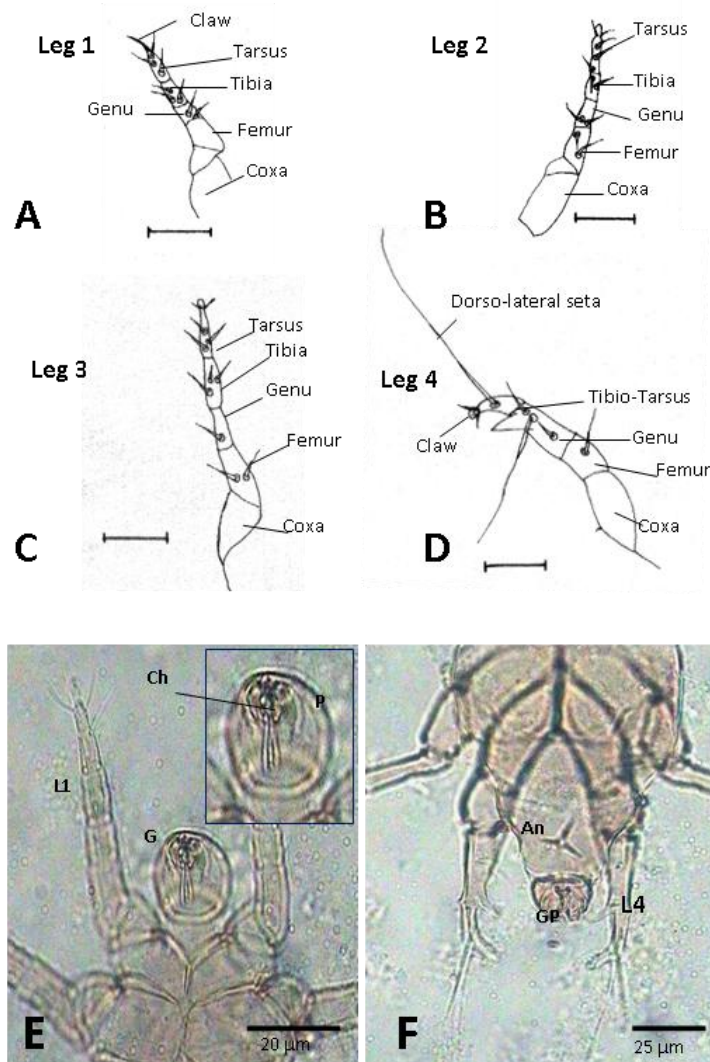


Fig. 5: Camera lucida drawings of four legs (A-D) of *Polyphagotarsonemus latus* male showing different segments in each leg. Scale= 25  $\mu$ m. (E) and (F): Light micrographs of anterior and posterior regions, respectively of male showing higher magnification of gnathosoma (G), genital papilla (GP) and legs (L1-4). Inset of (E) shows gnathosoma consisting of two serrated cheliceral digits (Ch) surrounded with two non segmented triangular pedipalps (P). An= anus, GP= Genital papilla.

The male has four pairs of long and spindle shaped legs. The 1<sup>st</sup> and 2<sup>nd</sup> pairs of legs adhere closely to each other occupying the anterior  $\frac{1}{3}$  of the body and are maintained in a fronto-lateral position. The last two pairs of legs though are similarly close to each other. The 3<sup>rd</sup> leg lies in a

postero-lateral position and the 4<sup>th</sup> pair is totally directed backwards (Fig. 4). Leg I, II, III and IV measure  $70 \pm 2.4$ ,  $85 \pm 1.4$ ,  $107.5 \pm 4.6$  and  $94.6 \pm 4.4$   $\mu$ m in length, respectively. Each of first three legs consists of five segments namely coxa, femur, genu, tibia and tarsus. Coxae III and IV of the male

are sharply and distinctively contiguous. Leg I terminates in a single claw, while legs II and III terminate in a pair of claws and a membranous empodium. Leg IV is four-segmented namely coxa ( $\simeq 34.9 \mu\text{m}$  in length), femur ( $\simeq 17.4 \mu\text{m}$  in length), genu ( $\simeq 24.9 \mu\text{m}$  in length) and fused tibia + tarsus (tibio-tarsus) ( $\simeq 17.4 \mu\text{m}$  in length). The tibiotarsal segment terminates by a button like claw and bends into a claspers-like organ (Figs. 4, 5). The fourth leg possesses two long setae, a dorso-lateral seta  $\simeq 87.2 \mu\text{m}$  long and a ventro-lateral one  $\simeq 57.3 \mu\text{m}$  long (Fig. 5).

SEM examination of the male's dorsal surface reveals distinct pleating of the metapodosoma so as to overlap the anterior propodosoma and the posterior opisthosoma.

The latter in turn overlaps the genital plate. SEM examination of males holding the females in a copulation position revealed that the male picks up the female nymph at a right angle to the male's body (Figs. 4, 5 and 7f). The female nymph seems to be carried on a terminal pad of the male's genital capsule (Fig. 7f).

### 3.5. Female stage:

The female body ( $138.9 \pm 5.5 \mu\text{m}$  long and  $97.3 \pm 5.6 \mu\text{m}$  wide) appears oval and more or less elevated along its dorsal axis (Fig. 6, 7). The body of female is divided into three well-defined portions namely propodosoma ( $38.9 \pm 3.3 \mu\text{m}$  long), metapodosoma ( $69.4 \pm 1.6 \mu\text{m}$  long) and opisthosoma ( $33.3 \pm 2.3 \mu\text{m}$  long) (Fig. 6).

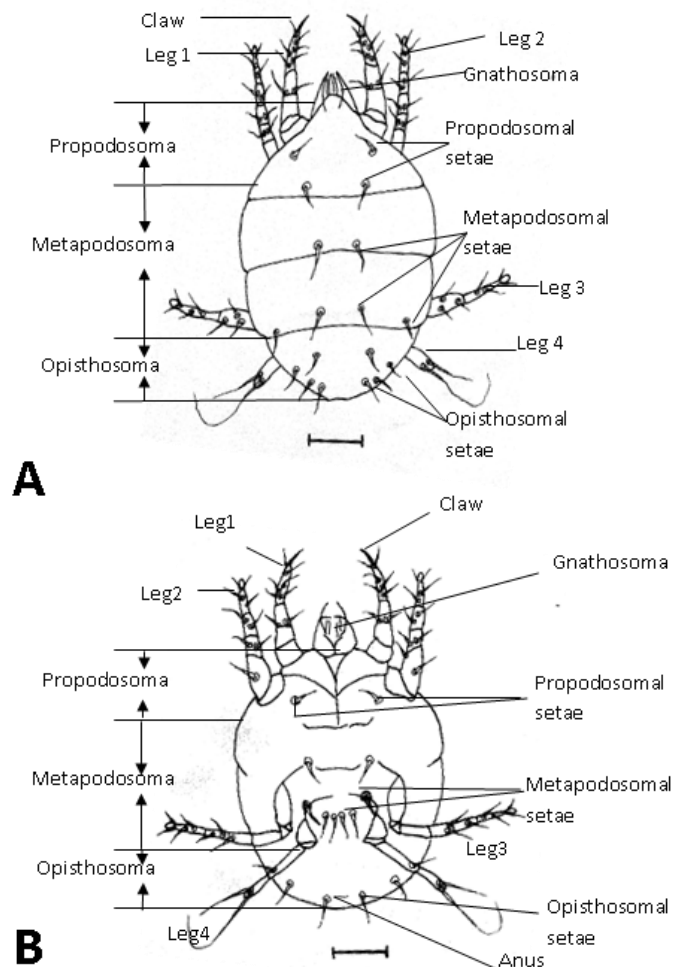


Fig. 6: Camera lucida drawings of dorsal (A) and ventral (B) views of *Polyphagotarsonemus latus* female showing three body regions, gnathosoma and four pairs of legs. Scale=  $25 \mu\text{m}$ .

The female has nine pairs of setae on its dorsal surface; two pairs of propodosomal setae, three pairs of metapodosomal setae and four pairs of opisthosomal setae (Fig. 6a). The ventral view reveals seven pairs of setae; one pair of propodosomal setae, four pairs of metapodosomal setae and two pairs of opisthosomal setae (Fig. 6b).

Legs (I- IV) measured  $\simeq 54.6$ ,  $54.3$ ,  $72.4$  and  $54.3 \mu\text{m}$  in length. The anterior two pairs of legs are widely separated from the posterior ones (Fig. 7 a, d, e). The legs II, III and IV of female do not carry any claws (Fig. 6).

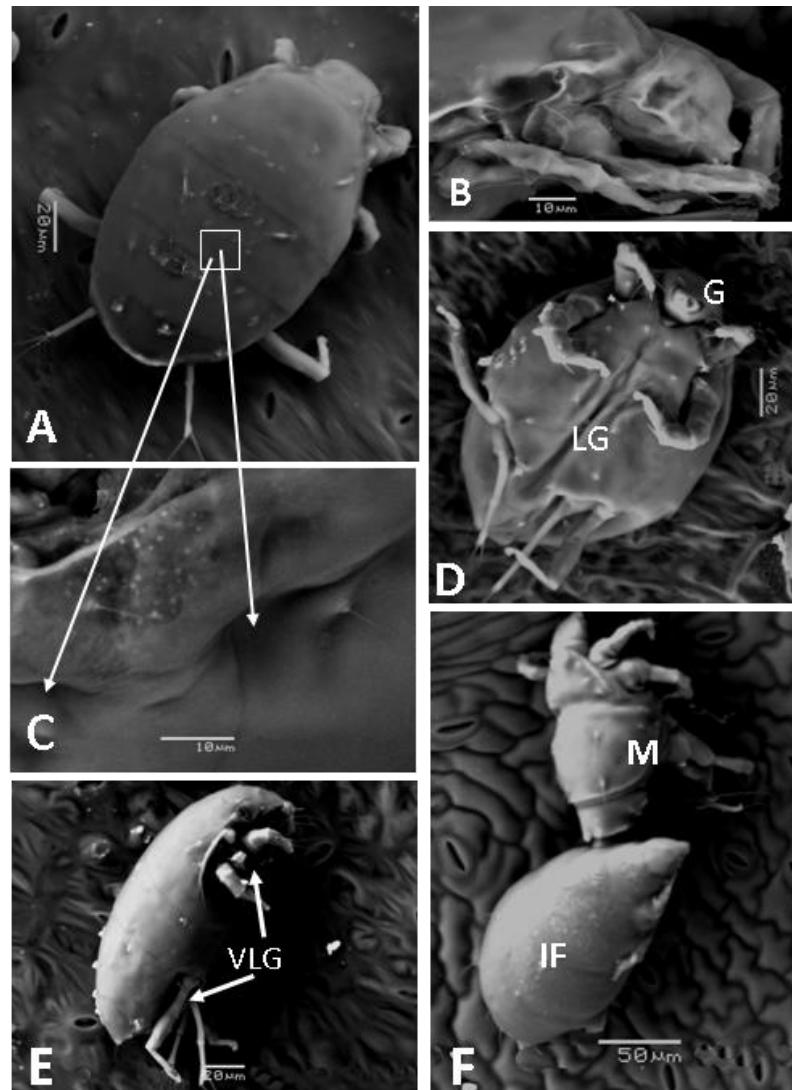


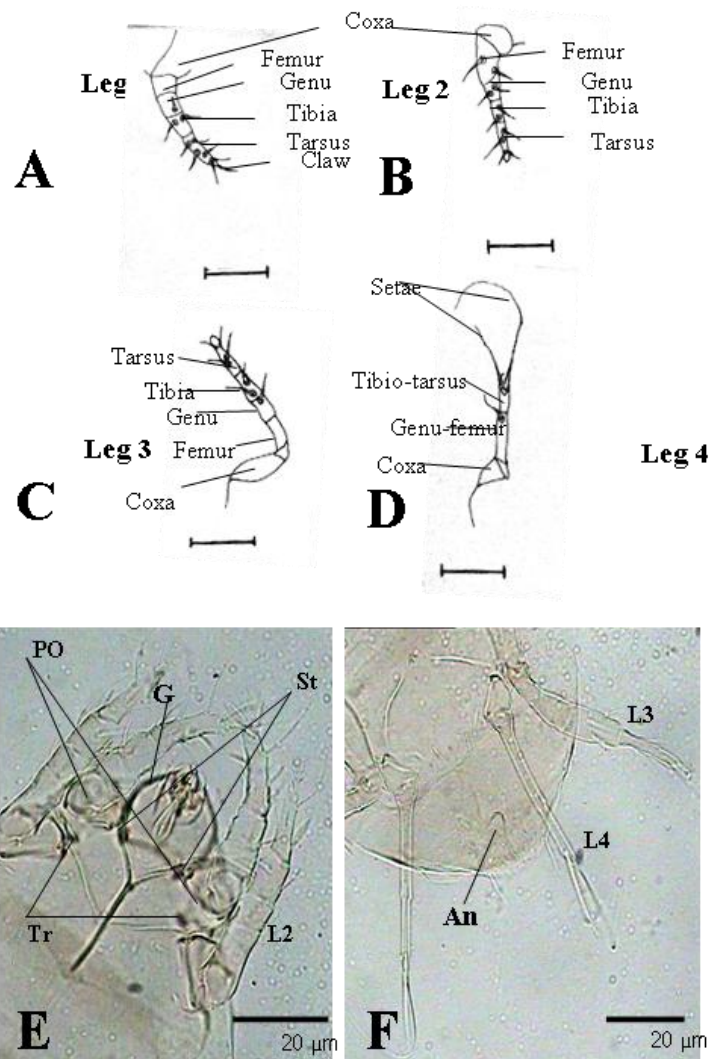
Fig. 7: Scanning electron micrographs of female *Polyphagotarsonemus latus* (A-E). (A): Dorsal view showing downward direction of gnathosoma (G). (B): Fronto-lateral view showing gnathosoma with its narrow proboscis. (C): As in (A) showing higher magnification of dorsal surface (small square) containing skin depressions. (D): Ventral view showing median longitudinal groove (LG). (E): Lateral view showing insertion of 1<sup>st</sup> and 2<sup>nd</sup> legs in anterior ventro-lateral groove (VLG) and 3<sup>rd</sup> and 4<sup>th</sup> legs in another posterior one. (F): Male (M) with its genital papillae carries immature female (IF).

Each of the first three legs consists of five segments namely coxa, femur, genu,

tibia and tarsus (Fig. 8 a-c). The leg IV has three segments namely coxa ( $\simeq 11.3 \mu\text{m}$

long), genu + femur ( $\approx 22.6 \mu\text{m}$  long) and tibia + tarsus ( $\approx 11.3 \mu\text{m}$  long). The fourth leg has two long setae on the tibiotarsal segment; the dorso-lateral seta is  $\approx 70.2 \mu\text{m}$  long and the ventro-lateral one is  $\approx 24.9 \mu\text{m}$  long. The posterior legs are covered with less setae than the anterior ones (Fig. 8). A pair of clavate pseudostigmatic organs is located dorsolaterally and distally between coxae I and II near the anterior margin of the

propodosoma (Fig. 8e). A pair of sensilla (trichobothria) is observed at the bases of these organs. The female gnathosoma ( $\approx 26.7 \mu\text{m}$  long and  $22.7 \mu\text{m}$  wide) is largely rounded (Figs. 7, 8). The gnathosoma is observed to contain two slender stylettiform chelicerae between the non segmented triangular palps (Fig. 8e). Two stigmata are dorso-laterally located at the gnathosomal base (Fig. 8e).



**Fig. 8:** Camera lucida drawings of four legs (A-D) of *Polyphagotarsonemus latus* female showing different segments in each leg. Scale=  $25 \mu\text{m}$ . (E) and (F): Light micrographs for anterior and posterior regions, respectively of female showing higher magnification of gnathosoma (G), stigmata (St) pseudostigmatic organs (PO), trichobothria (Tr), anus (An) and legs (L1-4).

SEM showed that the gnathosoma is held in a downward position where it is difficult to observe from the dorsal side

(Fig 7 a, b). The gnathosoma appears broad at its base and rostrum-like terminally (Fig. 7b). The smooth dorsal surface of

female appears to be divided more or less by 3 superficial lines (Fig. 7a). Ventrally a longitudinal median groove is seen formed by two lateral cuticular flaps. This groove extends from the vicinity of the 1<sup>st</sup> two pairs of legs to end between the two last pairs by a funnel-like structure (Fig. 7d).

#### 4. DISCUSSION

The present study extends our previous preliminary knowledge of the morphological details of the egg, larva, quiescent nymph, and adults (male and female) of the mite *P. latus*. The morphological details dealt with are the shape, measurements, and surface sculpturing of all different body regions in every developmental stage using light and surface scanning electron microscopy.

SEM description of *P. latus* egg showed that it is elongate, oval, slightly elevated and externally sculptured. Its exposed surface carries 29-37 knob-like sacs arranged in evenly distributed rows. The sacs were previously described as tubercles (Martin, 1991; Zhang, 2003) or as tufts (Peréz-Otero *et al.*, 2007). The egg length measures  $\simeq 107 \mu\text{m}$  in the present study which is more or less similar to that previously mentioned by Martin (1991) who recorded  $\simeq 100 \mu\text{m}$ . SEM processing in the present study caused deflating of these sacs so as to appear as a crumpled tissue. Consequently, the translucent surface of these sacs helped to elucidate irregularly shaped peripheral tubercles at their bases. These tubercles may probably act as basal support for the sacs holding them in an upright position. SEM also revealed minute perforations in the egg surface between the tubercles of each sac.

In *P. latus*, the egg shell is notably sculptured by sacs or knob-like structures. Witaliński (1993) reported that egg chorion in Acaridid mites of the genera *Tyrophagus* (*T. longior* and *T. perniciosus*) and *Aleuroglyphus* is additionally coated in the distal portion of the oviduct by an exochorion material that forms the microsculpture. He further mentioned that eggs with microsculpture either have an

adhesive or non-adhesive exochorion. In *P. latus*, the external sculpture of the egg together with its deposition on the lower part of the leaves suggests the presence of an adhesive layer that fixes the egg to the substratum similar to that reported by Alberti and Coons (1999). Other interpretations of the function of sculptured egg shells in *P. latus* as in various mites might be having a respiratory function (Callaini and Mazzini, 1984) or serve to reduce water loss (Witaliński, 1993). Egg shell structure and function in *P. latus* needs further histological studies to be evaluated.

Detailed description and measurements of different body regions of *P. latus* larva in the present study was not documented in previous studies. The larval length in the present study is  $\simeq 142 \mu\text{m}$  versus  $\simeq 117.5 \mu\text{m}$  in description of Martin (1991). The presence of three whitish transverse bands of lines and minute tubercles scattered between them was also observed by Martin (1991). Using SEM at higher magnification in the present study revealed triangular or polygonal arrangement of these tubercles on larval surface.

*P. latus* nymph possesses four pairs of legs and remains enclosed within the skin of larva until the adult is formed. The quiescent nymph is observed to attract males, carried by its genital capsule to terminal new leaves and when female emerges from nymphal molt, male immediately commences mating. Such contribution to mite dispersal was previously mentioned by Jeppson *et al.* (1975), Martin (1991) and Peréz-Otero *et al.* (2007). Martin (1991) suggested that the male's genital capsule might function as a suction pad and the fourth leg of male might be used for initial manipulation of the female. SEM of the larval skin surrounding the nymph in the present study revealed stretching of the integument, scattering of the tubercles and widening of lines in the transverse bands.

The subdivision of *P. latus* body into three portions namely propodosoma, metapodosoma and opisthosoma mentioned

in the present study was also reported in the general body form of family Tarsonemidae (Jeppson *et al.*, 1975). The *P. latus* adults are dimorphic where males are markedly different from females in their morphological features. Males are seen markedly broader at its middle region and tapers posterior similar to previous findings (Zhang, 2003; Labanowski and Soika, 2006). The three pairs of setae on the dorsal surface of the propodosoma or on the ventral surface of metapodosoma were previously mentioned by Jeppson *et al.* (1975), Zhang (2003) and Labanowski and Soika (2006). The present SEM description of the male showed distinct demarcation between gnathosoma, different body regions and genital plate which was not mentioned in previous light (Jeppson *et al.*, 1975; Zhang, 2003) or SEM studies (Martin, 1991). Definite pleating was observed in the skin of metapodosoma so as to overlap the posterior part of the propodosoma and the anterior part of the opisthosoma. This pleating causing a kind of articulation between body regions probably facilitates the process of holding the female and/or mating.

The male carries four pairs of long and spindle shaped legs. The 1<sup>st</sup> and 2<sup>nd</sup> pairs extend forward, while the 3<sup>rd</sup> and 4<sup>th</sup> ones extend more posterior (Denmark, 1980). The fourth pair of legs in male tarsonemids was regarded as an accessory copulatory appendage (Jeppson *et al.*, 1975) since it clasps the female during copulation (McDaniel, 1979). This appendage represents an adaptation developed for better performance of copulatory functions but passively in locomotion (Jeppson *et al.*, 1975). The fourth pair of legs of the male in the present study was markedly enlarged, had four segments; the last one carries two long setae and terminates with a button like strong claw. Similar observations were previously reported by Zhang (2003). The body length of the male measured 138.9 µm in the present study whereas Denmark (1980) and Peréz-Otero *et al.* (2007) reported it to be 168 µm and 110 µm, respectively. Other measurements of width, body regions, legs, setae, leg segments, gnathosoma and

genital capsule as well as SEM description of male were not presented in previous studies.

The body of female *P. latus* in the present study appeared soft, oval and swollen with unornamented dorsal surface as previously mentioned by Zhang (2003) and Peréz-Otero *et al.* (2007). Jeppson *et al.* (1975) reported that body of female *P. latus* was covered by a carapace like dorsal idiosoma and McDaniel (1979) reported that adults of superfamily Tarsonemoidea have idiosoma covered by a number of overlapping horny plates. The current SEM study revealed the presence of skin depressions on female dorsal surface which is divided by definite suture lines. A longitudinal groove appears on the female ventral side formed by two cuticular flaps and ending in a funnel like structure. This indicates that the integument of *P. latus* is somewhat softer than previously mentioned in the SEM study of Martin (1991) or other light microscopic descriptions of the above authors. The funnel like structure observed in the female may be related to the process of receiving or transporting of sperms during insemination.

The anterior and posterior two pairs of legs in female *P. latus* were widely separated similar to that mentioned by Jeppson *et al.* (1975). The present SEM study revealed the insertion of both the anterior and posterior two legs in ventrolateral grooves which were not mentioned in previous studies. The anterior two pairs of legs are more densely studded with setae than the posterior ones similar to that reported by Jeppson *et al.* (1975) and Zhang (2003). The three segments forming the fourth leg of female *P. latus* with the two terminal long setae on the tibiotarsus, fusion between genu and femur and absence of claws or empodia in that leg as well as the four segments forming the fourth leg of the male and its termination with a single claw and the claspers like structure were applied as a taxonomic features for family Tarsonemidae (Krantz, 1978). Female *P. latus* length in the present study measured 138.9 µm whereas previously it was reported as 160 µm by

Pérez-Otero *et al.* (2007). The present study added measurements of width, different body regions, legs, gnathosoma and genital capsule as well as SEM description of the female which were rarely presented in previous light or SEM studies.

The situation of clavate pseudostigmatic organs, stigmatal openings and trichobothrial sensilla in the anterolateral margin of female *P. latus* was previously mentioned by Zhang (2003) and represent distinctive features for family Tarsonemidae (Krantz, 1978). Function of pseudostigmatic organs was uncertain (Jeppson *et al.*, 1975). Jeppson and his colleagues suggested that these organs act as highly modified sensilla or specialized sense organs since they seem to have no relationship to the tracheal system. Presence of stigmatal openings in female *P. latus* and their absence in case of male was also noticed by Jeppson *et al.* (1975) and Zhang (2003). Jeppson *et al.* (1975) and Krantz (1978) mentioned that the stigmatal openings were internally connected to a tracheal system in female tarsonemid mites beginning from the external orifices, converge in the region of leg II and disappear inconspicuously in the opithosomal region.

Light microscope examination of male or female gnathosoma showed that it was oval, capsulate and carried two median slender stylettiform chelicerae between non segmented triangular palps. These observations were previously reported by Krantz (1978) and Zhang (2003). The present SEM study showed that the gnathosoma was distinct from the idiosoma, completely directed downwards where it was difficult to observe from the dorsal view and appeared broad at its base and narrow terminally like a rostrum. The latter observations greatly support the proper function of the chelicerae which include piercing of plant cells and sucking the plant sap. Furthermore, the articulation between gnathosoma and idiosoma helps in forward or downward motion of the former to undergo the above functions. Krantz (1978) mentioned that *P. latus* may produce

teratosities in plant tissues on which they feed, presumably through injection of salivary toxins. This assumption needs further histological studies to verify.

The semi-circular shape of the male genital capsule and its subterminal location on ventral side of opisthosoma is similar to that described by Denmark (1980). The present study added that it consisted of 2-3 triangular genital papillae and carried two pairs of short dorsal setae. The anal plate surrounding the anus is large, well defined and located in front of the genital capsule on the ventral side of opisthosoma and marked by 3 indentations similar to Denmark (1980) findings.

The present fine morphological study provides the essential bases for identification of the undetectable *P. latus* regarded undoubtedly as the most important mite of many crops in green houses. Such needed information will help in developing an integrated control system that will overcome their reproduction capacity and modes of dispersal and which complies with the environmental requirements established by many countries.

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## 6. REFERENCES

- Alberti, G. and Coons, L. B. (1999). Acari: Mites. In: Harrison, F. W. and Foelix, R. F. (eds). Microscopic anatomy of invertebrates, vol 8C. Chelicerate Arthropoda. Wiley-Liss Inc, New York, pp 515–1215.
- Banks, N. (1904). Class 111, Arachnida, Order 1, Acarina, four new species of injurious mites. Journal of the New York Entomological Society, 12:53-56.
- Callaini, G. and Mazzini, M. (1984). Fine structure of the egg shell of *Tyrophagus*

- putrescentiae* (Schränk) (Acarina: Acaridae). *Acarologia*, 25: 359-364.
- Cho, M. R.; Chung, S. K. and Lee, W. K. (1993). Taxonomic study on cyclamen mite (*Phytonemus pallidus*) and broad mite (*Polyphagotarsonemus latus*). *Korean Journal of Applied Entomology*, 32(4): 433-439.
- Denmark, H. A. (1980). Broad mite, *Polyphagotarsonemus latus* (Banks). FDACS-DPI Bureau of Entomology Circular No. 213.
- Jeppson, L.R.; Baker, E.W. and Keifer, H.H. (1975). *Mites Injurious to Economic Plants*. University of California Press, Berkeley, California, 614 pp.
- Krantz, G. W. (1978). *A manual of Acarology*. 2<sup>nd</sup> ed. Oregon State University Book Stores, Corvallis, Oregon, USA, pp. 509.
- Labanowski, G. and Soika, G. (2006). Tarsonmid mites on ornamental plants in Poland: new data and an overview. *Biological Letter*, 43(2): 341-346.
- McDaniel, B. (1979). *How to know the mites and ticks*. Wm. C. Brown Company Publishers. Dubuque, Iowa.
- Martin, N. A. (1991). Scanning electron micrographs and notes on broad mite *Polyphagotarsonemus latus* (Banks), (Acari: Heterostigmata: Tarsonemidae). *New Zealand Journal of Zoology*, 18(3): 353-356.
- Nickles, E.P.; Ghiradella, H.; Bakhru, H. and Haber, A. (2002). Egg of the Karner Blue Butterfly (*Lycaeides Melissa samuelis*): Morphology and elemental analysis. *J. Morphol.*, 251: 140-148.
- Nucifora, A. and Vacante, V. (2004). Citrus mites in Italy. VII. The family Tarsonemidae. Species collected and notes on ecology. *Acarologia*, 44(1/2): 49-67.
- Peréz-Otero, R.; Mansilla-Vazquez, J. P. and Salinero-Corral, M. C. (2007). First report of the broad mite *Polyphagotarsonemus latus* (Banks) on *Camellia japonica* in Spain. *American Camellia Yearbook*, pp. 52-56.
- Witaliński, W. (1993). Egg shells in mites: Vitelline envelope and chorion in Acaridida (Acari). *Exp. Appl. Acarol.*, 17: 321-344.
- Zhang, Z. Q. (2003). *Tarsonemid mites. Mites of greenhouses: Identification, biology and control*. CABI Publishing Co., UK, pp. 99-126.