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**The Camel Tick, *Hyalomma (Hyalomma) dromedarii* Koch, 1844
(Ixodoidea: Ixodidae): Description of the Egg and Redescription of
the Larva by Scanning Electron Microscopy**

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Abstract: The present study describes the egg of *Hyalomma (H.) dromedarii* for the first time and adds more features to the larva using Scanning Electron Microscopy (SEM) in order to extend our knowledge on these acarine stages to be useful for further taxonomical or control studies. With the purpose of presenting exact description of acarine eggs, it is preferable to examine them both with and without SEM processing. SEM processing caused partial removal of the chorion which makes the egg shell clear and easily observed. The study revealed rough surface of egg shell which was surrounded by the chorion. The egg shell was perforated particularly at poles. The chorion appeared as a finely perforated cloth. Different forms of bumps were noticed between egg shell and chorion. Length, width, l/w ratio and pore diameter of the egg were measured. SEM investigation of the larva revealed smooth scutum with slight irregular ornamentation and horizontally folded extensible cuticle with vertical ridges. At least 2 types of cuticular openings were noticed on the extensible cuticle of the idiosoma. The first type was represented by 1 pair on dorsal side and 2 pairs on ventral one. It was surrounded with thick integumental ring and guarded with 2 internal lips. The second type was numerous, slit-like and without rings or lips. Dorsolateral plate of the hypostome carried numerous oval, tile-like and elevated denticles while ventral one carried 4 rows of posteriorly directed retrograde conical denticles. Mouth enclosed 2 cheliceral digits, each terminated with 3 lobes. Each lobe is supported with 2 or 3 conical denticles which were externally directed to the posterior. Haller's organ on the tarsus of the first pair of legs consisted of anterior pit and posterior capsule. The pit contained 6 conical sensillae while the capsule opening had extensively branched margin. Measurements of the whole body, idiosoma, scutum, eye, capitulum, hypostome, palp, cuticular pores, legs and Haller's organ sensillae of the larva are also presented.

Key words: Eggshell, immature stages, SEM, ticks

Introduction

Hyalomma (Hyalomma) dromedarii, the camel tick, is distributed in deserts, semideserts and steppes from northwestern India and southern USSR to Arabia and Africa north of the equator wherever camels occur (Hoogstraal *et al.*, 1981). Adult *H. dromedarii* infest chiefly camels. Cattle are also common hosts. Less common hosts of adults are sheep, buffaloes, horses, donkeys and mules. Few records were noticed from goats, dogs and wild mammals (hyena). Immatures may feed on camels

but commonly infest a wide variety of wild rodents and also lizards, birds, hedgehogs and hares (Hoogstraal, 1956).

H. dromedarii, participates in the epidemiology of Crimean-Congo hemorrhagic fever virus (Hoogstraal, 1979; Rodriguez *et al.*, 1997), Dera Ghazi Khan virus, Dhori virus (Hoogstraal *et al.*, 1981), Quarantilla virus (Converse and Moussa, 1982), Kadam virus (Wood *et al.*, 1982), theileriosis of camels (*Theileria camelensis*) and cattle (*T. annulata*) (Hoogstraal *et al.*, 1981), Q fever (*Coxiella burnetii*) (Bazlikova *et al.*, 1984) and spotted fever rickettsia (*Rickettsia rickettsii*) (Lange *et al.*, 1992).

Former descriptions of eggs in acarines were mainly concerned with histological sections accompanied with few SEM pictures of the developing oocytes in their ovaries (ElShoura *et al.*, 1989; Slusser and Sonenshine, 1992; Denardi *et al.*, 2004). On the contrary, considerable literatures were encountered in describing insect eggs using SEM (Burkhart *et al.*, 2000; Castro *et al.*, 2002; Dominguez and Cuezco, 2002; Nickles *et al.*, 2002; Fenoglio and Rosciszewska, 2003; Alencar *et al.*, 2003, 2005; Wolf *et al.*, 2003; Junkum *et al.*, 2004; Sukontason *et al.*, 2004, 2005). Rare studies were concerned with the morphology of acarine eggs particularly those using SEM technique.

Controversially to acarine eggs, SEM was noticeably used in description of their larvae. Application of that tool in acarine larval morphology includes those carried out in *Ixodes bakeri* (Clifford *et al.*, 1976), *Rhipicephalus kochi* (Clifford *et al.*, 1983), *Ornithodoros yunker* (Keirans *et al.*, 1984), *O. puertoricensis* (Endris *et al.*, 1989), *Amblyomma rotundatum* (Keirans and Oliver, 1993), *I. venezuelensis* (Durdin and Keirans, 1994), *Hyalomma marginatum* (Buczek *et al.*, 2000), *I. neuquenensis* (Guglielmone *et al.*, 2004), *I. loricatus* (Marques *et al.*, 2004), *I. parvicornis* (Venzal *et al.*, 2005) and *Amb. parvitarsum* (Estrada-Peña *et al.*, 2005). Although the above numerous studies on the description of tick larvae, the majority of them presented few pictures for certain parts and without a detailed description. Also in his thorough description of *H. asiaticum* using SEM, Balashov (1983) restricted his study to nymph and adults. Accordingly, there is much need for a detailed study showing almost the entire features of egg and larva of a representative model of ixodid ticks. *H. dromedarii* is a cosmopolitan tick species and one of the medically and economically important ticks in the Middle and Far East area. Light Microscope (LM) characters of *H. dromedarii* larva were previously mentioned in studies of El-Kammah *et al.* (1995) and Apanaskevich (2002). In the present article, the author describes the egg of *H. dromedarii* for the first time and adds more information on its larval features in order to extend our knowledge on these acarine stages. The study will also be useful for further taxonomical, based on eggs or immature stages and/or control studies.

Materials and Methods

H. dromedarii were collected from camel farms, Al-Ain City, United Arab Emirates during February 2005. Ticks were identified according to Hoogstraal *et al.* (1981). Engorged female ticks were separately placed in small glass vials in an incubator adjusted at 28±1 °C and 75% relative humidity. Vials were securely covered and containing small parts of filter papers to collect their wastes. They were daily observed until egg deposition and hatch. Eggs or emerged larvae were immediately collected and placed in clean vials containing saline solution (0.7% NaCl).

Eggs and larvae were washed several times using saline solution to remove debris. Specimens were fixed in 2.5% glutaraldehyde mixed in phosphate buffer solution (PBS) at a pH of 7.4 at 4 °C for 24 h. They were then rinsed twice with PBS at 10 min intervals. Specimens were next treated with 1% osmium tetroxide at room temperature for 1 day for post-fixation. This was followed by rinsing twice

with PBS and dehydrating with alcohol. To replace water in the eggs with alcohol, they were subjected to increasing concentrations of ethanol as follows 30, 50, 70, 80, 90 and 95% for 15 min each. They were then placed in absolute alcohol for 10 min for 2 changes. Finally, they were subjected to critical point drying in order to complete the dehydration process (Junkum *et al.*, 2004). In order to view specimens, they were first attached with double-sided carbon tape to aluminum stubs so that they could be coated with gold in a sputter-coating apparatus (JEOL JFC-1200). The surface topography of eggs and larvae was viewed at 25 kV in a JEOL-JSM5600 scanning electron microscope (Japan) at Central Laboratories Unit, United Arab Emirates University, United Arab Emirates.

Some eggs and larvae were examined without fixation or dehydration. They were mounted on stubs with carbon tape, sputter-coated with gold and examined with the above instruments (Nickles *et al.*, 2002). These specimens are referred to herein after as (unprocessed). Measurements (in micrometers) of different parts were given as a mean \pm SD (min-max) of at least 10 specimens.

Results

The scanning electron micrographs revealed oval eggs of 469 ± 35.25 (400-505) length and 381 ± 35.10 (304-414) width, with an egg index (l/w ratio) of 1.23 (Fig. 1, 3 and 5). One polar region was slightly broader than the other. Eggs were covered with chorion which was clearly observed in unprocessed eggs (Fig. 1 and 2). Chorion appeared as irregular plates containing narrow slits between them (Fig. 2). Fixation and dehydration processes caused wrinkling in the chorion plates and disappearance of these slits (Fig. 3 and 4) or slight removal of the chorion itself (Fig. 5). Chorionic sculpture of the egg appeared as an irregular pattern with smooth swelling boundaries (Fig. 4). Egg surface following chorion removal was not smooth (Fig. 6).

Both polar and lateral zones of the egg surface contained numerous openings (Fig. 7 and 8). Aggregates of granular patches were irregularly scattered between openings (Fig. 9). Outline of these openings was circular, oval or irregular with a diameter of 0.57 ± 0.29 (0.2-1.1) (Fig. 8 and 10). Small bumps were noticed on the egg shell (Fig. 11 and 12). These bumps appeared as conical (Fig. 11), with lateral expansions (Fig. 12) or with irregular shapes (Fig. 13 and 14). Egg shell was not rigid and might crumple particularly at polar zones (Fig. 13).

Unfed larvae had a dorsoventrally flattened body (Fig. 15). Total length, from apex of hypostome to posterior body margin, was 709.5 ± 28.73 (661.5-742.5). Body consisted of 2 major parts; the capitulum or gnathosoma and the unsegmented body or idiosoma. Capitulum articulated with the idiosoma with a fold of extensible cuticle.

Dorsal surface of idiosoma was oval with broader posterior margin (Fig. 15). Idiosoma had 2 anterolateral scapulae guarding the fold between capitulum and idiosoma (Fig. 16). Length from the apex of scapulae to posterior margin of idiosoma was 606 ± 17.14 (580.5-634.5), while idiosomal width was 474.19 ± 15.2 (445.5-486). Scutum had broadly rounded posterior margin and carried 2 pairs of medial and 1 pair of marginal small and pointed setae (Fig. 16). Scutum length from scapulae to posterior margin along median line was 258.19 ± 15.2 (229.5-283.5) and its width was 405 ± 17.68 (364.5-418.5). Eyes positioned at point of maximum width of the scutum (Fig. 16). They were oval and measured 50 ± 2.28 (48.4-51.6) length and 34.68 ± 3.42 (32.26-37.1) width. Tegument of the scutum was smooth with slight irregular ornamentation while that of the posterior area to the scutum, or the extensible cuticle, was softer and extensively folded (Fig. 17-20). Foldings were mostly horizontal with vertical ridges (Fig. 18-20). Tegument of posterior margin was subdivided into 9 festoons (Fig. 17). Width of each festoon was greater than its length except the middle one which was as long as wide

(Fig. 17 and 19). Two large vertical openings were positioned anterolateral to festoons, each was observed in front of the second festoon (Fig. 17). The opening was oval with 7.43 ± 0.4 (7.14-7.71) length and 4 ± 0.61 (3.57-4.43) width (Fig. 18). It was externally surrounded with a thick ring of the integument and internally contained 2 lips. Numerous small slit-like openings [4.08 ± 0.12 (4-4.17) in length] were scattered on the dorsal extensible cuticle (Fig. 17 and 19). Small openings devoided integumental rings or internal lips (Fig. 20). Extensible part of the idiosoma carried 2 pairs of medial setae and 8 pairs of marginal setae. These setae were simple, short and pointed (Fig. 17 and 19).

Capitulum contained a basal sclerotized plate, the basis capituli, anterior to which the elongated mouth cone or hypostome attached (Fig. 21-28). The 4 segmented palpi extended anterolaterally from the basis capituli. Capitulum length, from tip of the hypostome to posterodorsal margin, was 135.9 ± 2.8 (133.3-138.9) and width, between lateral ends of basis capituli, was 179.28 ± 17.48 (157.5-220.5). Basis capituli was a subtriangular with lateral pointed expansions. Its posterior margin was straight from dorsal side (Fig. 21) and curved from ventral one (Fig. 22). Two openings were noticed on the dorsal side of basis capituli (Fig. 21), each appears as a deep rectangular pit without special external or internal structures (Fig. 24).

The hypostome extended anterior to the basis capituli. On the ventral side of the hypostome base, there were 2 median small openings and 2 small external pointed setae (Fig. 23). Hypostome length, from apex to the level of these 2 setae, was 79.2 ± 1.2 (78.3-80) and its width was 24.6 ± 1.9 (Fig. 23-26). Hypostome appeared as a tube made up of 2 hardly sclerotized plates, one dorsolateral and the other ventral, connected together by a thin extensible cuticle on lateral sides (Fig. 22 and 27). The dorsolateral plate contained median dorsal narrow groove which widen posteriorly and numerous denticles (Fig. 25). Denticles are oval, tilelike and enlarged posteriorly (Fig. 25 and 26). Anteriorly, they markedly elevated and separated (Fig. 26). The ventral plate of the hypostomal tube carried 4 rows of posteriorly directed retrograde conical denticles (Fig. 27). Terminally the dorsolateral and ventral plates enclosed the mouth opening in which 2 cheliceral digits were arisen from lateral sides (Fig. 28). Each cheliceral digit terminated with 3 lobes, each lobe was supported with 2 or 3 conical denticles which were externally directed to the posterior (Fig. 28).

Lateral to the hypostome, two palps were attached to the basis capituli (Fig. 29-32). Palp length was 120.3 ± 1.94 (118.9-121.7) while its width was 42.2 ± 3.5 (38.3-45). Each palp consisted of 4 segments. Segment 1 was difficult to notice from dorsal view (Fig. 29) and devoided any kind of setae (Fig. 30). Segments 2 and 3 appeared as a fused segment where the suture between them was inconspicuous dorsally (Fig. 29) and undetectable ventrally (Fig. 30). Combined segments 2+3 became larger and broader terminally (Fig. 30). Segments 2+3 collectively carried 9-10 setae. These setae had spirally located minor denticles (Fig. 32). Segment 4 was cylindrical and located in a cup-like indentation on the ventral surface of segments 2+3 (Fig. 30 and 31). Segment 4 carried 12 setae (7 lateral and 5 terminal). These setae were thick hair-like and terminated with rounded tips (Fig. 31).

Larva carried 3 pairs of legs attached to the ventral side of the body (Fig. 33-37). Each leg was divided into 7 primary segments (Fig. 34). Beginning with the most proximal, they were the coxa, trochanter, femur, patella, tibia, tarsus and pretarsus. Trochanter and tarsus were further subdivided into trochanter 1, 2 and tarsus 1, 2, respectively. The spur of coxa I was large and appeared as isosceles triangle (Fig. 34). Patella length was 131.3 ± 8.8 (125-137.5). Leg segments were built of heavily sclerotized cuticle and joined to each other by highly movable articulation of flexible cuticle. Pretarsus joined to a basal sclerite which terminated with a median empodium (Fig. 35). The latter was wrinkled into folds of extensible cuticle and carried 1 pair of curved true claws. Length of each claw was ≈ 46 . Leg setae were almost simple, unbranched and pointed (Fig. 33). Setae on coxae were the

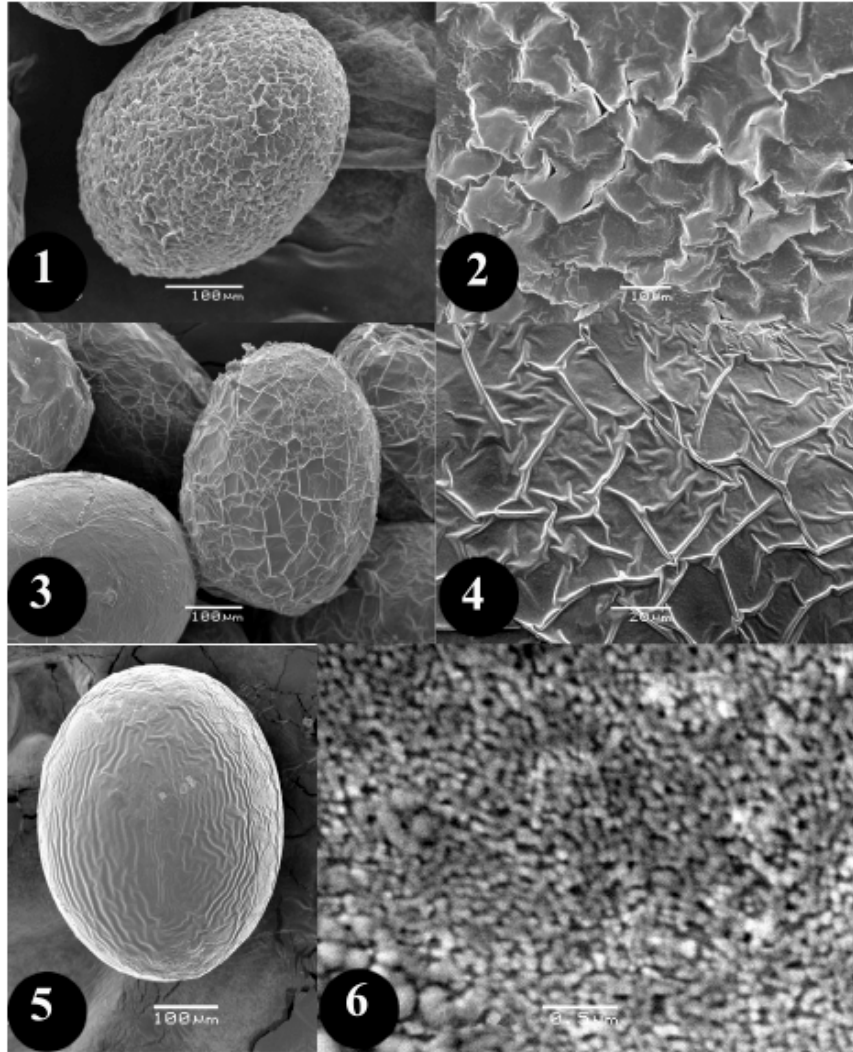


Fig. 1-6: Scanning electron micrographs of the egg of *H. dromedarii*. 1. Unprocessed egg with chorion covering it. 2. As in Fig. 1 showing irregular plates and slits of the chorion. 3. Processed eggs with wrinkled chorion. 4. As in Fig. 3 showing irregular chorionic sculpture with smooth swelling boundaries. 5. Processed egg without chorion. 6. As in Fig. 5 showing rough egg surface following chorion removal

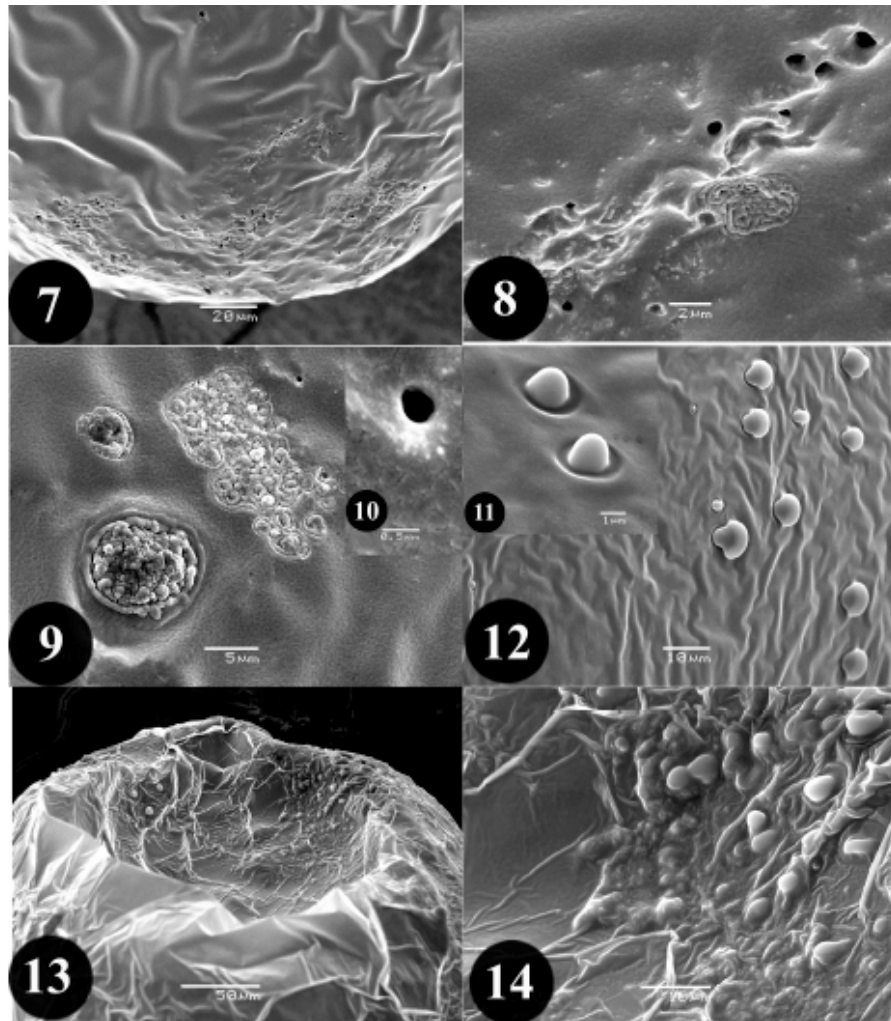


Fig. 7-14: Scanning electron micrographs of the egg of *H. dromedarii*. 7. Polar region of a processed egg showing restriction of numerous pores in that region rather than the remaining. 8. As in Fig. 7 showing different forms of openings. 9. As in Fig. 7 showing irregular aggregates of granular patches. 10. As in Fig. 8 showing higher magnification of one opening. 11. Processed egg with scattered small conical bumps. 12. As in Fig. 11 showing conical bumps with lateral expansions. 13. Processed egg with crumpled polar region. 14. As in Fig. 13 showing irregularly shaped bumps

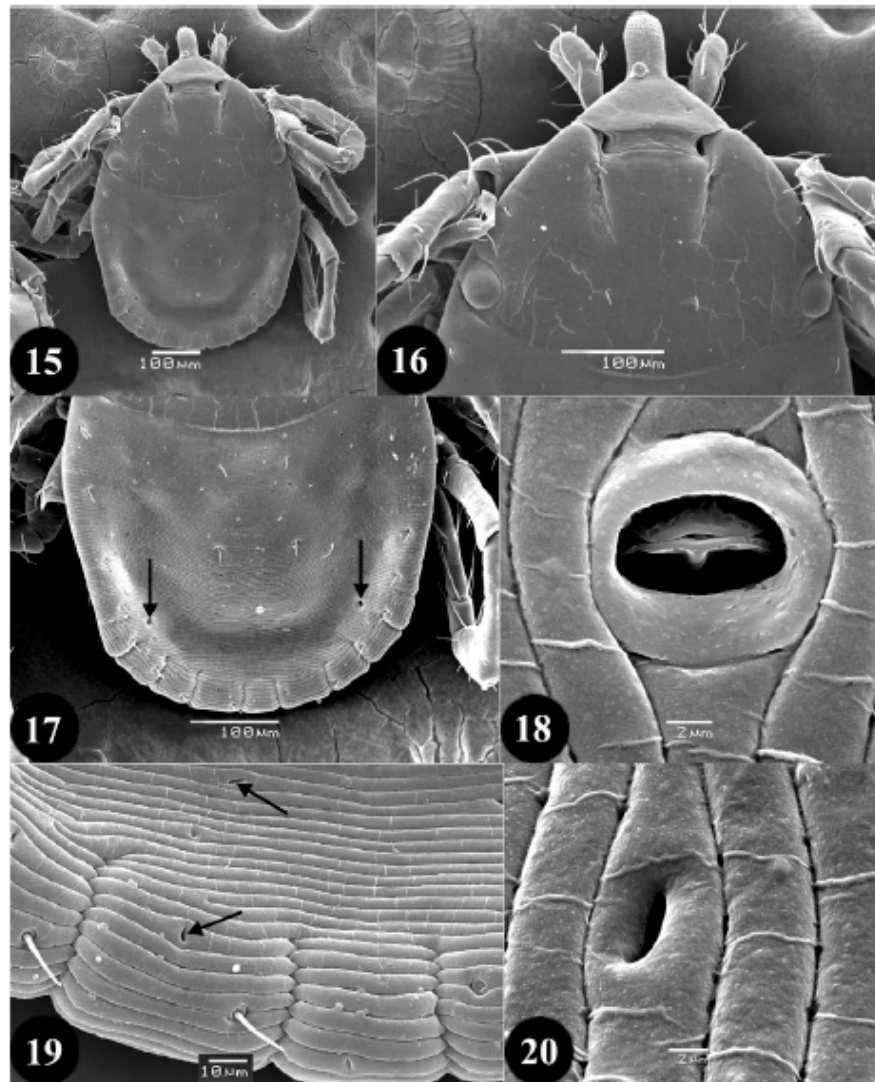


Fig. 15-20: Scanning electron micrographs of the larva of *H. dromedarii*. 15. Dorsal surface with capitulum and idiosoma. 16. Capitulum and scutum with eyes and setae. 17. Extensible part of the idiosoma showing horizontal foldings, festoons and setae. Arrows points to large openings. 18. Large opening with thick integumental rings and 2 internal lips. 19. As in Fig. 17 showing scattered small openings (arrows). 20. Higher magnification of small openings showing their lack to outer rings or internal lips

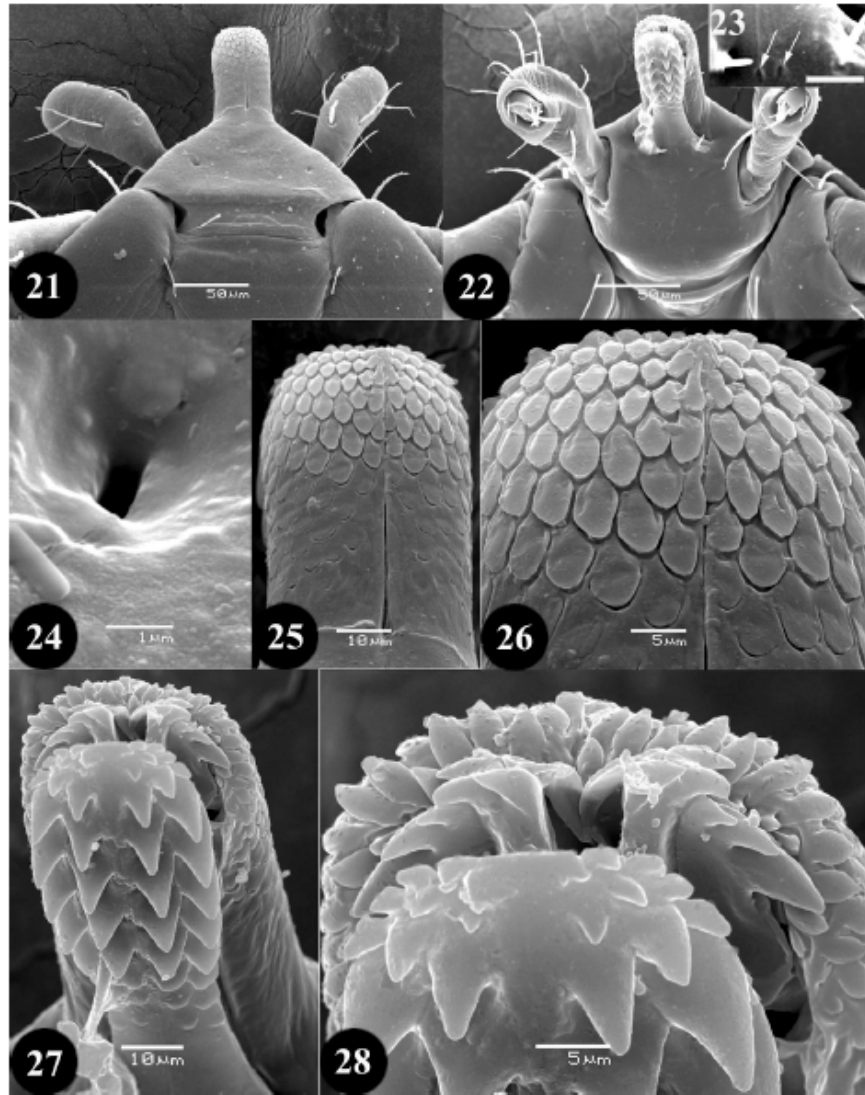


Fig. 21-28: Scanning electron micrographs of the larva of *H. dromedarii*. 21. Dorsal view of the capitulum. 22. Ventral view of the capitulum. 23. As in Fig. 22 showing the 2 pores (arrows) at the hypostome base. Bar = 10 μm. 24. As in Fig. 21 showing deep rectangular pit on lateral sides of the basis capituli. 25. Dorsal view of the hypostome showing the median groove that became wide posteriorly. 26. As in Fig. 25 showing denticles which became elevated and separated in the anterior and enlarged in the posterior. 27. Venter of the hypostome showing 4 rows of retrograde conical denticles. 28. As in Fig. 27 showing cheliceral digits terminated with 3 lobes, each supported with 2-3 conical denticles

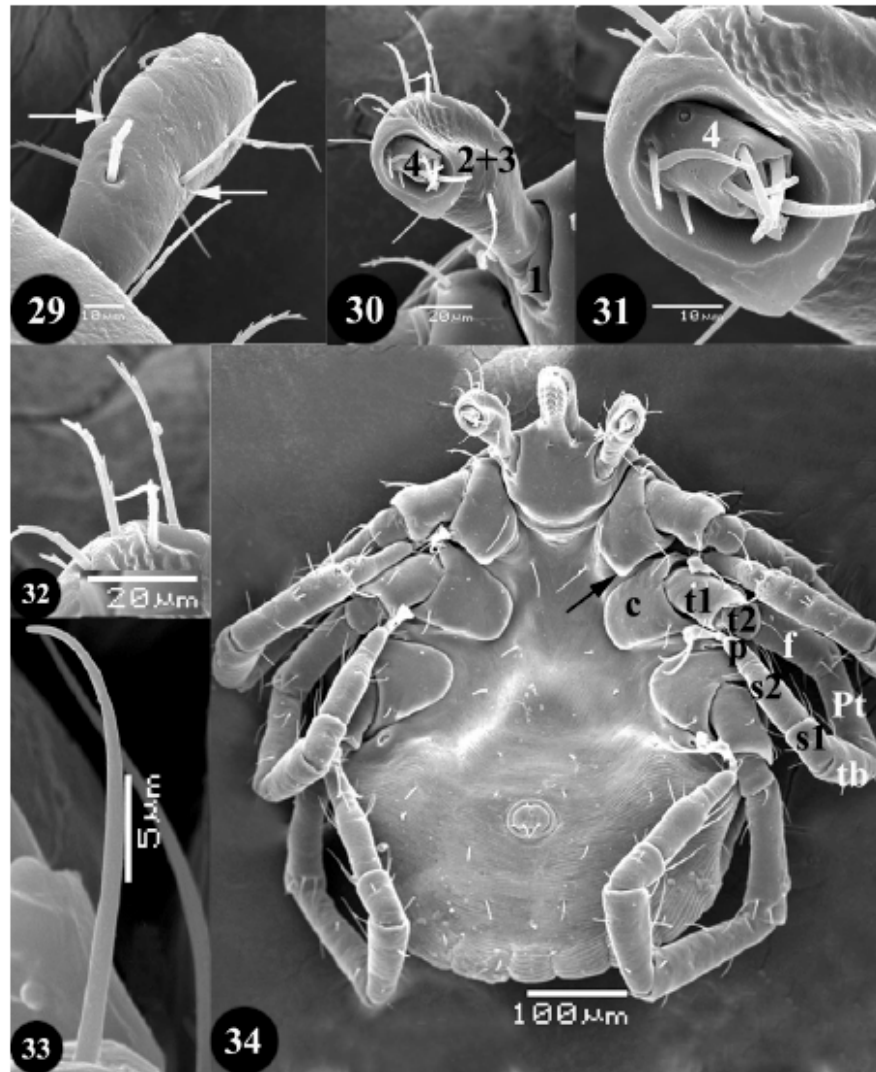


Fig. 29-34: Scanning electron micrographs of the larva of *H. dromedarii*. 29. Dorsal view of the palp. Arrows pointed to the inconspicuous suture between segments 2 and 3. 30. Ventral view of the palp. 31. As in Fig. 30 showing segment 4 of the palp. 32. As in Fig. 30 showing minor denticles spirally located on the setae of segments 2+3 of the palp. 33. Unbranched and pointed leg seta. 34. Ventral view of the larva showing segments of the leg; c, coxa; t1, trochanter 1; t2, trochanter 2; f, femur; Pt, patella; tb, tibia; s1, tarsus 1; s2, tarsus 2; p, pretarsus; arrow pointed to the spur of coxa I

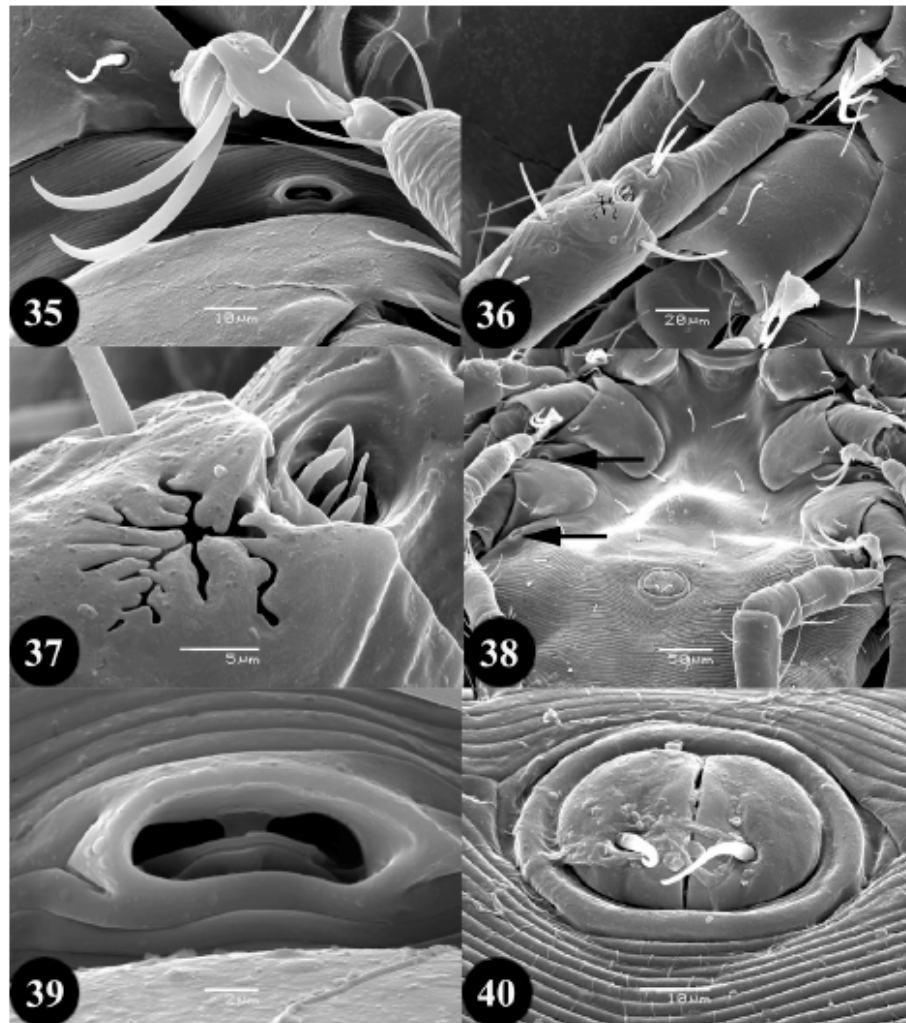


Fig. 35-40: Scanning electron micrographs of the larva of *H. dromedarii*. 35. The pretarsus carrying the empodium and 2 claws. 36. Haller's organ on the pretarsus of the 1st leg. 37. As in Fig. 36 showing the anterior pit and posterior capsule. 38. Higher magnification of the ventral view showing an opening behind the coxae of the 2nd and 3rd legs (arrows). 39. As in Fig. 38 showing internal lips of these openings. 40. Anal opening guarded with 2 leaves, each carried small pointed seta

smallest as they ranged between 10.4-13, while setae on the remaining segments were longer and ranged between 10.5-36.8. Haller's organ was noticed on the tarsus of the first pair of legs only (Fig. 36 and 37). It consisted of anterior pit and posterior capsule (Fig. 37). Anterior pit contained 6 conical sensillae, their length ranged between 2.37- 5.25 (Fig. 37). Three sensillae, the smallest and the largest 2, were much wider than others. Opening of posterior capsule had extensively branched margin which prevented examining the internal of the capsule (Fig. 37).

Two pairs of oval openings were noticed on the ventral side of the idiosoma, the first was located between coxae of second and third pairs of legs, while the second was located just behind coxae of the third pair of legs (Fig. 38 and 39). Length of each opening was 8.39 ± 0.32 (8.16-8.62) and its width was 3.53 ± 0.09 (3.47-3.59). It contained 2 internal lips and externally surrounded with a cuticular thickening (Fig. 39).

Anal opening was located at the beginning of the posterior one-third of the idiosomal ventral surface (Fig. 34). It appeared as a vertical slit guarded with two leaves (Fig. 40). Each leaf was made of hard cuticle and carried 1 unbranched short pointed seta. Anal opening was surrounded with a wide oval perianal cuticular fold (Fig. 40).

Discussion

Biometry and scanning electron microscopic studies of acarine eggs and larvae not only provide descriptions of far greater accuracy and fidelity than achieved by traditional light microscope, but they can also be used to aid in the differentiation of the species and subspecies of a particular genus based on these stages. The present study provided SEM examination of *H. dromedarii* egg and larva and compared the results with those mentioned in other acarines or insects. In order to accurately examine *H. dromedarii* egg, it is better to use both techniques, i.e., with and without SEM processes (fixation and dehydration). SEM processing caused partial removal of the chorion which made the egg shell clear and easily observed. Each technique showed some characters. Examining them without processing was greatly matched with studies of Nickles *et al.* (2002). Using SEM processing was applied by many workers (Burkhart *et al.*, 2000; Dominguez and Cuezco, 2002; Sukontason *et al.*, 2004).

The chorion covering the egg of *H. dromedarii* appeared as a finely perforated cloth. Egg shell was also perforated particularly at poles. Pores of the chorion and the egg shell most likely facilitate the gas exchange of the developing embryo. Presence of the chorion around the egg shell probably represents an extra barrier for the embryo against external pollutants. Coating of the egg with the chorion was previously noticed in insects (Dominguez and Cuezco, 2002; Nickles *et al.*, 2002; Wolf *et al.*, 2003; Junkum *et al.*, 2004; Sukontason *et al.*, 2004). In these studies, chorion of a certain species, subspecies or even particular variety had its own topographical features. Similarly, SEM of the acarine eggs may also share in the differentiation of their taxa.

Regarding the egg shell, the rough surface of the shell in the present study possibly due to the coalescing of the egg shell forming secretory vesicles released from the oocyte cell membrane. Merging of these vesicles, originated from Golgi complex and rough endoplasmic reticulum of the developing oocyte, was formerly observed in *Amb. hebraeum* (Diehl *et al.*, 1982), *H. asiaticum* (Balashov, 1983) and *Argas persicus* (Swelim *et al.*, 2003). Irregular aggregates of granular patches noticed at shell poles of *H. dromedarii* egg might represent incomplete coalescing of the egg shell vesicles. This was previously noticed in *Ornithodoros moubata* (Diehl *et al.*, 1982). Simple conical, conical with lateral expansions or irregularly shaped bumps which looked like to be externally coated with the chorion and observed between the egg shell and the chorion probably represented some sort of excreta of the

developing embryo passed from the egg shell or debris passed from the outside through the chorion slits. Nature of these bumps needs further biochemical or TEM studies of eggs.

Discriminating measurements of *H. dromedarii* larva carried out by El-Kammah *et al.* (1995) and Apanaskevich (2002) were greatly supported by those measured in the present study. The present study also presented more measurements similar or greater than those carried out by many authors in other tick species in order to be useful for instructing keys based on larvae for classifying *Hyalomma* species. Concerning morphological characters of the larva in the present study, 1) the basis capituli posterior margin was straight from dorsal side and curved from ventral side. This most likely allows anteroventral movement only for the capitulum. This contradicts the opinion of Balashov (1983) who stated that the capitulum of *H. asiaticum* nymph may move dorsoventrally. 2) The structure of the hypostome with dorsal denticles and ventral backward retrograde denticles almost certainly supports the insertion of the hypostome into the skin of the host. Also, the terminal conical denticles of cheliceral digits probably permit the digits to move mediolaterally to cut the host skin. This greatly supports the opinion of Balashov (1983) in female *H. asiaticum*. 3) The structure of the palp in the present study was in great agreement with that described in larvae of *H. dromedarii* by Apanaskevich (2002) and in *I. parvicornis* by Venzal *et al.* (2005) who reported the fusion of segments 2 and 3 in one large segment. Number and shape of setae on this fused segment greatly matched with the sum of setae of segments 2 and 3 described in larva of *H. asiaticum* (Balashov, 1983). 4) Minute conical setae located at the hypostome base on the ventral side and simple, elongated and pointed setae observed on the idiosoma in larva of *H. dromedarii* were previously noticed in nymph and adults of *H. asiaticum* (Balashov, 1983). Balashov suggested conical and pointed setae as chemoreceptors and mechanoreceptors, respectively. Third type of setae carrying minute denticles and located on the palps of *H. dromedarii* larva in the present study was previously noticed in *H. asiaticum* larva (Balashov, 1983). Function of different types of setae in larvae needs further physiological studies.

Regarding the openings noticed in *H. dromedarii* larva; 1) The 2 minute openings noticed at the hypostomal base in the present study were observed in *H. asiaticum* female (Balashov, 1983). Presence of these openings from larva up to female possibly indicated an important function of the glands below them. This needs further studies to define their structure and the nature of their secretion. 2) Rectangular pits located on the dorsal side of the basis capituli of the present larva shares the location of the pores in the same area of the nymph and the porose area of the female *H. asiaticum* noticed by Balashov (1983). Accordingly, these pits almost certainly represented the rudiments of the porose area which secrete a sticky material from the Genes' organ below them in order to stick and waterproof the laid eggs. 3) The 2 types of openings observed on the extensible cuticle of the dorsal surface in the present study. The first type only represented by 2 openings, each was located anterolateral to festoons. It was externally surrounded with thick ring of the integument and internally guarded with 2 lips. The second type was numerous, slit-like and devoided integumental rings or internal lips. Such openings were not previously observed in SEM studies carried out on larvae of *O. puertoricensis* (Endris *et al.*, 1989), *Amb. rotundatum* (Keirans and Oliver, 1993), *I. neuquenensis* (Guglielmone *et al.*, 2004), *I. parvicornis* (Venzal *et al.*, 2005) and *Amb. parvitarsum* (Estrada-Peña *et al.*, 2005). Such openings were noticed in female *H. asiaticum* (Balashov, 1983). 4) Lateroventral and posterior to coxae II and III, 2 pairs of openings with thick integumental rings and internal lips were noticed in the present study. Balashov (1983) noticed only one pair of spiracular plates behind coxae IV in nymph and adults of *H. asiaticum*. High CO₂ concentration in the ambient air of female *H. dromedarii* caused drastic water loss through the spiracular plates (Hefnawy, 1970). Since the larvae had no tracheal system (Knülle and Rudolph, 1982), this type of openings on the

ventral side and those of the 1st type of the previous group on the dorsal side of *H. dromedarii* larva perhaps share in its respiratory process. The second type of dorsal pores may be connected to integumental glands below the cuticle. Integumental glands underlying the cuticle were previously observed in hard (Walker *et al.*, 1996) and soft ticks (Montasser and Amin, 2005).

Haller's organ on 1st tarsus of *H. dromedarii* larva in the present study was a common feature in all stages of ticks (Waladde and Rice, 1982). Rechav *et al.* (1977) demonstrated olfactory receptor cells in its sensillae. Olfactory reception was mainly ascribed to the posterior sensillae in the capsule while the anterior sensillae were attributed for heat and humidity reception (Ivanov and Leonovich, 1983). The present study coincided with that of Buczek *et al.* (1998) who reported 6 sensillae in the anterior pit of *H. marginatum* larva. Some workers (Klompén and Oliver, 1993; Buczek *et al.*, 1998) divided these sensillae into porose, grooved or serrate. This classification was not clear in larva of the present study where these surface characters might still not formed in *H. dromedarii* larva or larvae of the above studies which were mainly concerned with nymphal and adult stages.

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