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SEM observations on the external features of pink citrus rust mite, *Aculops pelekassi* (Keifer) (Acari: Eriophyidae)

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Abstract: The external features of pink citrus rust mite, *Aculops pelekassi* (Keifer) were observed under scanning electron microscope. The body of this mite was spindle-shaped with a length of 100-150 μm. The propodosoma lines were irregularly arranged and the hysterosoma possessed 30-40 rings. The legs originated from the ventral portion of gnathosoma and extended forward. The first, second and third coxa possessed seta on their surface. Genital organ and a pair of setae were observed bellow the coxal base. The cover flap of the genital organ had 12 muscles on its surface. The tubercle of the flagellate ventral seta was cone-shaped and had a length of 15 μm. The first and second legs were six segmented where the tarsus had a single claw and a branched feathered claw. The gnathosoma was appended under the propodosoma and was extended forwardly. The palpi were segmented and smoothly surfaced. The rostrum was fixed between the palpi and the needle-like stylets were projected from its cavity.
Key words: Gnathosoma, hysterosoma, genitalia, rostrum, stylets

Introduction

The majority of the members in family Eriophyidae are of considerable economic importance. They are commonly known as gall, rust, bud and blister mites. Eriophyids are almost invisible to the unaided eye and are exclusively plant feeders. The various symptoms caused by these mites appear on the buds, shoots, stems and twigs. Bud blisters, bud stunting, bud discoloring, bud enlarging and its premature drop as well as shoot and twig clustering are often caused by the rust mites. Flowers are subjected to abnormal shaping, discoloring, failure to opening and finally premature drop occurs. Fruit become irregular shaped and leads to the damaged seeds. Leaves turn to abnormal, stunning, withering, bronzing and withertip (Keifer *et al*., 1982; Yang *et al*., 1995; Hall *et al*., 1997).

Because of the diminutive size, eriophyids pose problems. Hot often encountered in working with other arthropod texa that transmit plant viruses. In most texa individuals transferred and subsequently recorded from test plants after a prescribed transmission period (Oldfield, 1970).

Citrus fruit russeting in Japan has become a serious production problem for satsuma mandarin. The causal agent of the problem was misidentified as the citrus rust mite, *Phyllocoptruta oleivor* (Ashmead). All the rust mite collected from various citrus orchards in Japan were not *P. oleivor* but instead the pink citrus rust mite, *Aculops pelekassi* (Keifer) (Tetsuzo *et al.*, 1978; Yang *et al*., 1995).

Transpiration rates of citrus fruits damaged by citrus rust mite was found to be higher. Fruit drop rate was also increased in Valencia and Pineapple orange (Allen, 1978).

The mouthparts of the eriophyids are specifically adopted for the piercing of plant cells. The length of the chelicerae indicates that they are able to pierce only a very few cell layers of tissues. The citrus rust mite penetrates only the epidermal cell layers of orange rinds (Oldfield, 1970).

The adults of *A. pelekassi* start to crawl out in late April from the overwintering sites of satsuma mandarin in Japan. The eggs are deposited on the buds and newly developed leaves. The population density rapidly increases in early summer, which reaches maximum in late July. Summer generations of this mite moved from the leaves to immature fruits. They feed on the fruit and results in russeting. In early October the adult mites begin to crawl from the leaves and fruits to the bud (Morin and Martinez, 1981; Seki, 1982).

The study of the morphology of *A. pelekassi* therefore becomes important to understand the function of the organs used for infestation on citrus plants and fruits.

The eriophyid body has three acarine sections like gnathosoma, propodosoma and hysterosoma. The rostrum has been greatly modified but still has most of the original parts (Hislop and Jeppson, 1976). There are several reports regarding damage, ecology and symptoms of rust mite and some descriptions of the functional organs were available only in reports of Krantz (1973) and Jeppson *et al*. (1975).

The present study was conducted to observe the morphology of *A. pelekassi* to elaborate the functional organs taking part in infestation of citrus plants under scanning electron microscope.

Materials and Methods

The experiment was conducted in the Citriculture Laboratory, Faculty of Agriculture, Ehime University, Japan. The mites were collected from the infested leaves of citrus plants in the campus vicinity. The leaves were flicked in a beaker with water to separate the mites without causing damage to their body. The water containing mites was filtered in lens cleaning paper and was wrapped for further procedures.

Samples were pre-fixed in 4% glutaraldehyde in 0.1 M phosphate buffer, pH 7.2, followed by rinsing in the same buffer and were post-fixed in 1% osmium tetroxide. Dehydration was carried out with a graded ethanol series and samples were dried in a Vacuum Device Inc., VDF-20 freeze dryer. Dried samples were mounted on the specimen stubs, coated with gold using Eiko Engineering Co., LTD., 1B-2 ion sputter and finally were viewed under a Hitachi S-2250N Scanning Electron Microscope at 20 kV and photographed. The numerical data pertinent to the study were collected measuring the desired structures from the prints.

Results

The body of the *A. pelekassi* was spindle-shaped and consisted of gnathosoma (Gn), propodosoma (Pr) and hysterosoma (Hy) having the length of 100-150 μm when observed under scanning electron microscope (Fig. 1). The front leg (FL) and the second leg (Sle) originated from the ventral sides of gnathosoma (Fig. 1). Propodosomal lines were irregularly arranged and hysterosoma had 30-40 rings (Fig. 1). The gnathosoma (Gn) occupied the middle portion of the legs on the ventral side of the body while the genital organ (Gen) exposed lip-shaped structure at the lower part of the coxae of legs (Fig. 2). The linings near propodosoma were comparatively deep and variable. The submidian line (SL)

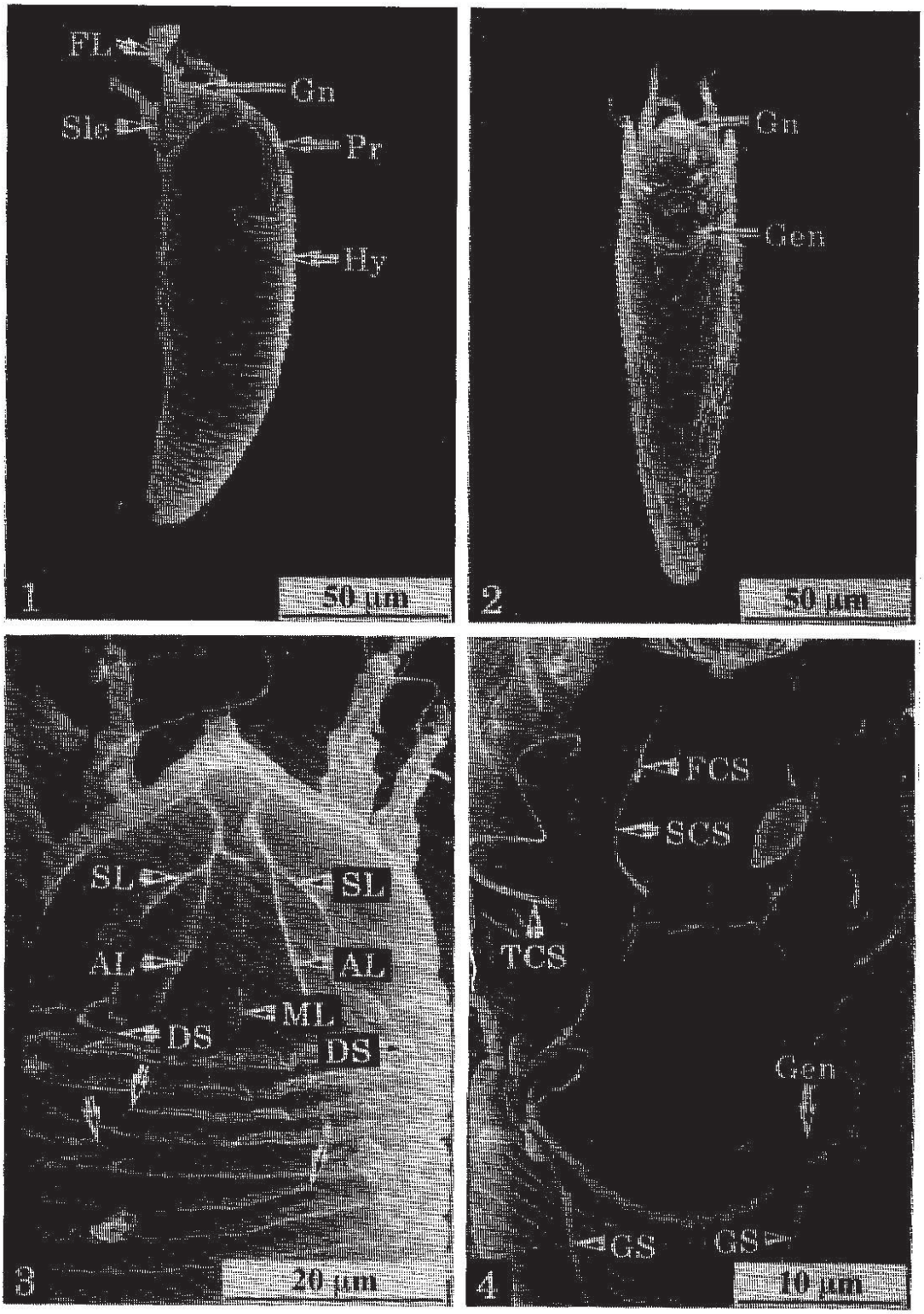

Fig. 1-4: SEM micrographs showing external features of pink citrus rust mite, *Aculops pelekassi* (keifer). 1: Lateral view of the spindle-shaped body showing gnathosoma (Gn), propodoaoma (Pr), hysterosoma (Hy), front leg (FL) and send leg (Sle). 2: Position of gnathosoma (Gn and lip-shaped gential organ (Gen). 3: Submidian line (SL), admidian line (AL), median line (ML) arranged on the propodosoma near the dorsal setae (DS) and the disconnected rings (arrow) on the hysterosoma. 4: First coxal seta (FCS) appeared close to the second coxal seta (SCS) where the third coxal seta (TCS) originated form the base of the coxsa and the genital organ (Gen) having a pair of genital setae (GS) at the lower part

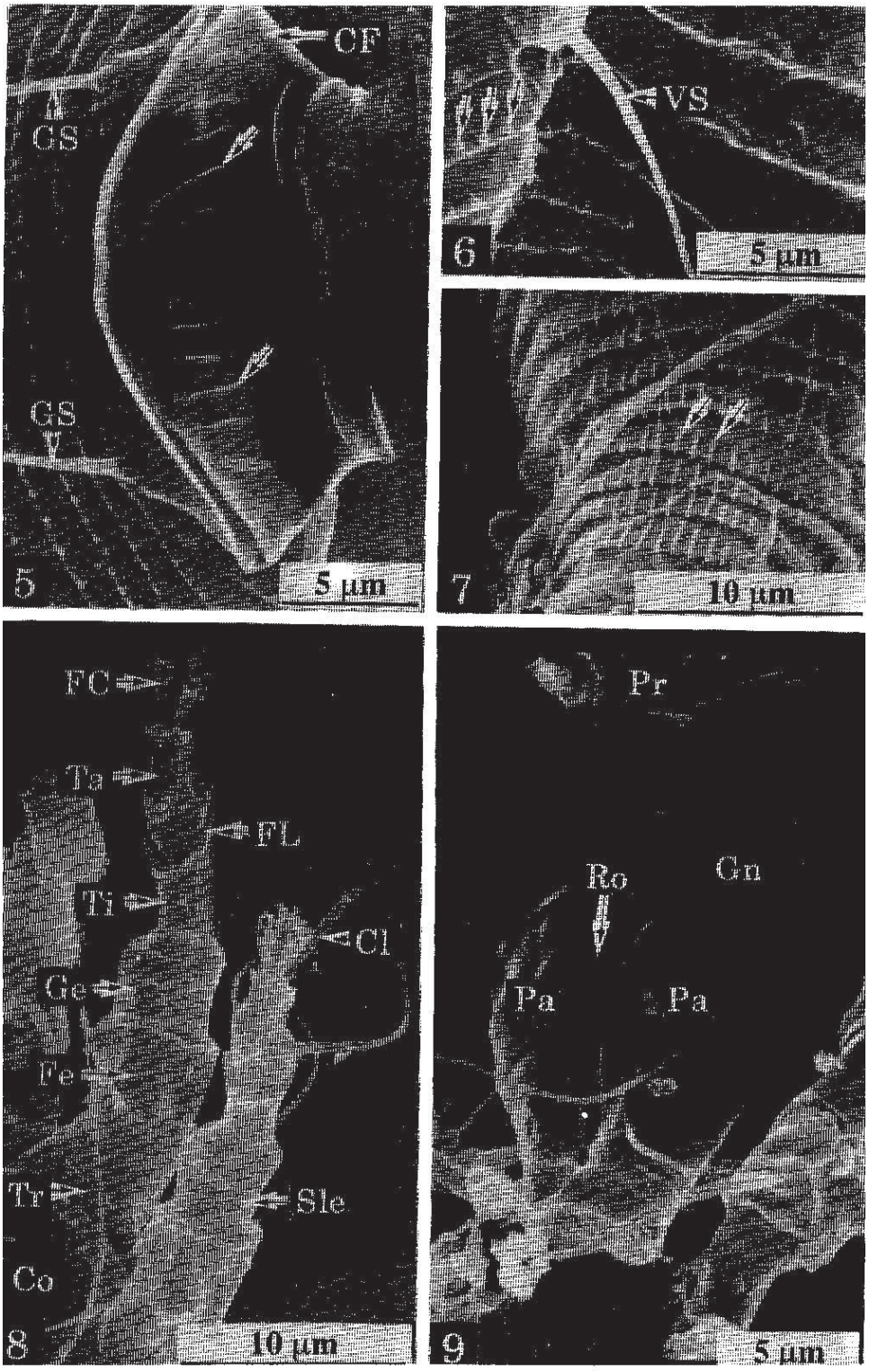

Fig. 5-9: SEM micrographs showing the caracteristics of different organs in *Aculops pelekassi* (keifer). 5: The cover flap (CF) of the genital organ possessing muscles and a pair of genital setae (GS) on lower flap. 6: Ventral seata (VS) projected from the cone-shaped tubercle and the microtubercles (arrow) on the cuticle. 7: Posterior rings showing longitudinal ridges (arrow) having similar spaces between them. 8: Front leg (FL) and second leg (Sle) showing fleshy coxa (Co), narrow trochanter (Tr), long femur (Fe), short genu (Ge), thinner tibia (Ti), longer tarsus (Ta) which pasessed branches feathered claw (FC) and a tomb-shaped claw (Cl) at the apex. 9: Gnathosoma (Gn) appended under the propodosoma (Pr) and the rostrum (Ro) between the palpi (Pa)

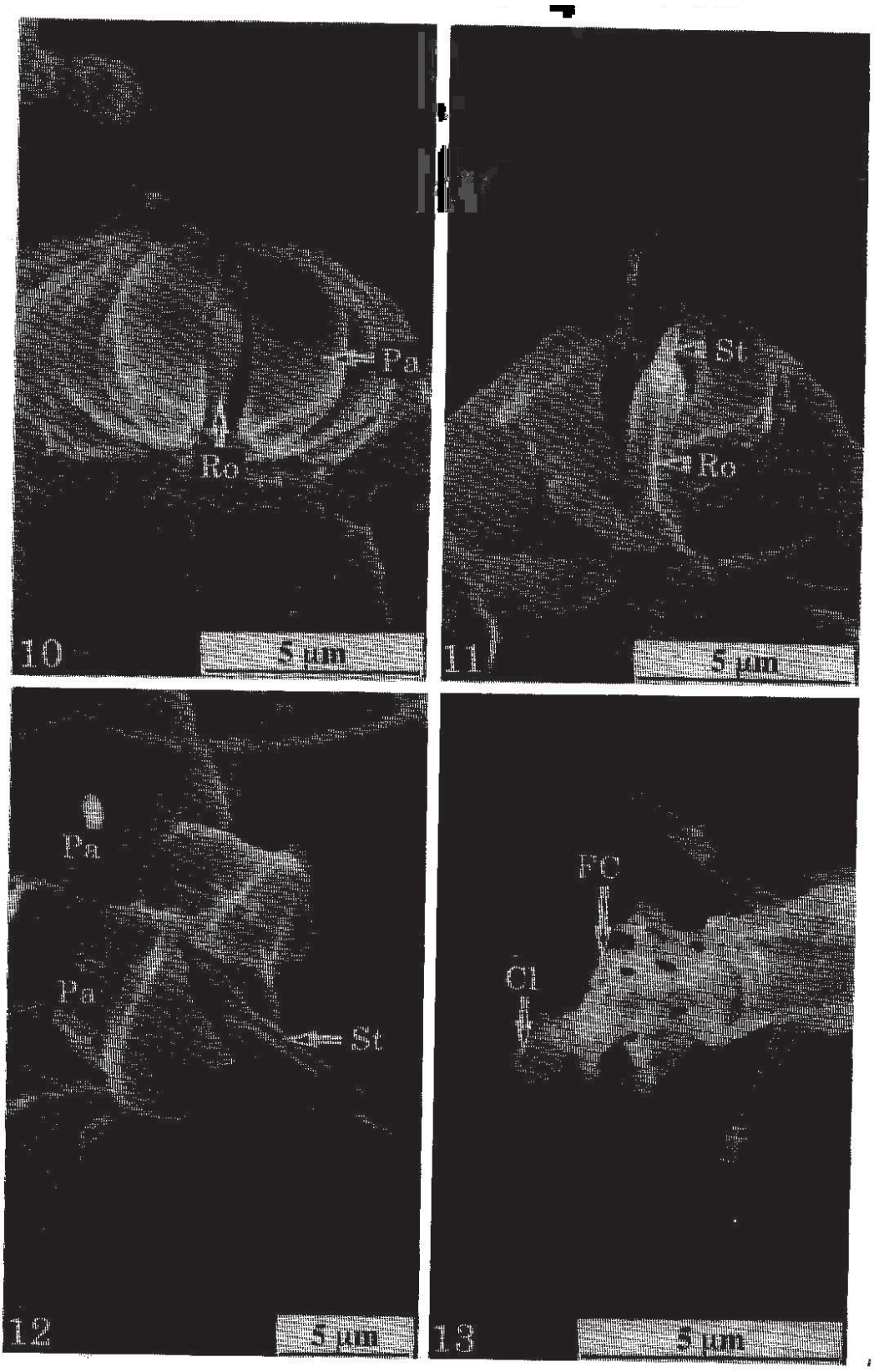

Fig. 10-13: SEM micrographs of the mouthparts and tarsus of *Aculops pelekassi* (Keifer). 10: Closed oral cavity of the rostrum (Ro). 12: The club-shaped stylets (St) projected between the palpi (Pa). 13: Tarsus having feathered claw (FC) and a tob-shaped claw (Cl) at the apex

was shorter than the admidian line (AL) (Fig. 3). The admidian line starts from the base of the hysterosoma and was extended up to the apex of the propodosoma. Median line (ML) existed between the admidian lines. The dorsal setae (DS) positioned very close to the base of admidean line (Fig. 3). The rings of the hysterosoma were irregularly disconnected (arrows) (Fig. 3). The first coxal seta (FCS) projected in parallel position to the second coxal seta (SCS) (Fig. 4). The third coxal seta (TCS) appeared at the middle of the second leg coxa (Fig. 4). A pair of genital setae (GS) were originated from lower lip of genital organ (Gen) which was 6 μm below the base (Fig. 4).

The cover flap (CF) of the genital organ comprised of 12 muscles on its sides by keeping a gape at the middle region (Fig. 5). Genital setae (GS) were smoothly surfaced and directed ventrally (Fig. 5). The tubercle of the ventral seta (VS) was cone-shaped and had a length of 15 μm (Fig. 6). The ventral rings possessed lobs (arrow) keeping the similar distance between them (Fig. 6). While the posterior rings composed of longitudinal ridges (arrow), which were extended horizontal to the body and kept the equal gap in them (Fig. 7). The front leg (FL) and second leg (SLe) were six segmented (Fig. 8). The basal segment was fleshy coxa (Co), second short trochanter (Tr), third long femur (Fe), forth genu (Ge) smaller than femur, fifth tibia (Ti) thinner and longer and the last one was tarsus (Ta), which was irregularly longer. The tarsal segment had a branched feather claw (FC) and a claw (Cl), which was tomb-shaped at the apex. The second leg claw was bigger than that of the first leg (Fig. 8). The gnathosoma (Gn) was appended under the propodosoma (Pr) extending forwardly. The palpi (Pa) were segmented and smoothly surfaced. The rostrum (Ro) was fixed between the palpi and was extended up to the apex (Fig. 9).

Rostrum (Ro) appeared between the pads of the palpi (Pa) at the same level of pads (Fig. 10). The needle-like stylets (St) projected from the tip of the rostrum (Ro) (Fig. 11). The extruded stylets (St) were club-shaped and extended 10 μm away from the palpi (Pa) which had slim median and glabrous apical region (Fig. 12). The tarsus of the legs possessed branched feathered-claw (FC) and another claw (Cl) exposed as tomb-shaped structure at the apex projected behind the feather claw (Fig. 13).

Discussion

The body of the *A. pelekassi* has a length of 170 μm having 52-58 rings (Ehara and Shinkaji, 1975) while Kadono and Ashihara (1995) had reported 36-46 rings. The *Aculus comatus* (Nelepa) had a length from 187-290 μm (Krantz, 1973). Hong and Zhang (1997) reported the robust fusiform of body in Diptilomiopinae Keifer. We found the body as spindle-shaped having a length ranging from 100-150 μm and the rings were 30-40 which showed the smaller body length and less number of rings. The ventral part of rings possessed lobs while the posterior portion had longitudinal ridges.

Propodosoma of this mite composed of submedian line, admedian line and median line (Krantz, 1973; Ehara and Shinkaji, 1975; Ehara and Ashihara, 1995). Similar propodosomal lines were observed in our study but their structure was more clear and prominent. The original sketch of the lines which starts from the base of the hysterosoma and extended up to the apex of the propodosoma was clearly understood.

The gnathosoma in eriophyid mites composed of palpi and rostrum. The rostrum enclosed each side by the padipalps. Their action was telescoped (Jeppson *et al.*, 1975; Hislop and Jeppson, 1976). In our study, the rostrum was sandwiched between the palpi and was extended up to the apex. The palpi were segmented but the structure revealed that the telescopic action was not possible because of the wider base and narrow apex.

The front and second legs of all eriophyoid species have the same segmentation. Normal leg segments are the coxa, trochanter, femur, genu, tibia and tarsus (Jeppson *et al.*, 1975). The legs composed of six segments. The feathered claw was used for the species identification (Ehara and Shinkaji, 1975). In this study, we observed legs, which had six segments but were different in shape and length for every segment. Feathered claw composed of several branches and the claw in the second leg was longer than that of the first leg.

Genital organ consisted of cover flap which hinged anteriorely and was obscurely patterned with longitudinal ribs with genital setae (Krantz, 1973; Ehara and Shinkaji, 1975). We found that the genital organ was lip-shaped and possessed cover flap having 12 muscles but these were divided into two sections of six left and six on the right side.

Rostrum was strongly down curved and oral stylets medially curved with chelicerae and auxiliary stylets (Whitmoyer *et al.*, 1972; Krantz, 1973). There are more than two sets of stylet projects from the gnathosoma of eriophyid mites (Jeppson *et al.*, 1975; Roberts *et al.*, 1994). While in tetranychid mites the stylets projects from the rostral cavity as an interlocked organ (Andre and Remacle, 1984). In Diptilomiopinae the stylets were elongated and projected from the oral cavity (Hong and Zhang, 1997). The results of this study exposed the similar kind of gnathosoma but had a pair of segmented palpi with pad-like tips. The rostrum was fixed between the palpi and was extended up to the apex. The tip of the rostrum remained closed during resting stage and open to protract needle-like stylets during active feeding stage. Their club shape disclosed a reservoir type of organ near the tip of the stylets and may accumulate enzymes and virus for injection into the citrus plants. The stylets could have the ability to penetrate in the leaves up to 10 μm. We could not observed any auxiliary stylets other than oral stylets in *A. pelekassi*.

In conclusion, the pink citrus rust mite and the plant interactions were not published extensively. We could not find the broad discussions about the fixation of palpi on plant surface and the projection of needle-like stylets. The penetration mechanism of stylets has also not described well. Ehara and Shinkaji (1975) have referred the residual rust symptoms on plant leaves. We find the mechanism of stylets protection from the rostrum. They project from the rostral cavity only and could extend up to 10 μm.

References

Allen, J.C., 1978. The effect of citrus rust mite damage on citrus fruit drop. J. Econ. Entomol., 71: 746-750.

Andre, H.M. and C. Remacle, 1984. Comparative and functional morphology of the gnathosoma of *Tetranychus urticae* (Acari: Tetranychidae). Acarologia, 25: 179-190.

Ehara, S. and N. Shinkaji, 1975. *Aculops pelekassi* (Keifer). In: An Introduction to Agricultural Acarology, Ehara, S. and N. Shinkaji (Eds.). Zenkoku Nouson Kyouiku Kyoukai, Tokyo, pp: 103-104, (In Japanese).

Ehara, S. and W. Ashihara, 1995. *Aculops pelekassi* (Keifer). In: Plant Mites of Japan in Colors, Ehara, S. (Ed.). Zenkoku Nouson Kyouiku Kyoukai, Tokyo, pp: 150-151, (In Japanese).

Hall, D.G., C.C. Childers, J.E. Eger and J.C. Allen, 1997. Citrus rust mite (Acari: Eriophyidae) counts on fruit and the negative binomial distribution. Florida Entomol., 80: 1-10.

Hislop, R.G. and L.R. Jeppson, 1976. Morphology of the mouthparts of several species of phytophagous mites. Ann. Entomol. Soc. Am., 69: 1125-1135.

Hong, X. and Z.Q. Zhang, 1997. Systematics and generic relationships of the mites in the subfamily Diptilomiopinae (Acari: Eriophyoidea: Diptilomiopidae). System. Entomol., 22: 313-331.

Jeppson, L.R., H.H. Keifer and E.W. Baker, 1975. Eriophyoidae Nelepa. In: Mites Injurious to Economic Plants, Jeppson, L.R., H.H. Keifer and E.W. Baker (Eds.). University of California Press, Berkeley, pp: 327-396.

Kadono, E. and W. Ashihara, 1995. *Aculops pelekassi* (Kiefer). In: Plant Mites of Japan in Colors, Ehara, S. (Ed.). Zenkoku Nouson Kyouiku Kyoukai, Tokyo, pp: 217-226, (In Japanese).

Keifer, H.H., W.B. Edward, K. Tokuwo, D. Mercedes and E.S. William, 1982. An Illustrated Guide to Plant Abnormalities Caused by Eriophyoid Mites in North America. USDA., California, USA., pp: 178.

Krantz, G.W., 1973. Observations on the morphology and behavior of the filbert rust mite, *Aculus comatus* (Prostigmata: Eriophyoidea) in oregon. Ann. Entomol. Soc. Am., 66: 709-717.

Morin, J.M. and H. Martinez, 1981. Populations dynamics of the citrus rust mite (*Phyllocoptruta oleivora* Ashmead) and its relation to the phenology of orange trees (*Citrus sinensis* Osbeck cv. Valencia late) in Cuba. Proc. Int. Soc. Citricult., 2: 658-660.

Oldfield, G.N., 1970. Mite transmission of plant viruses. Ann. Rev. Entomol., 15: 343-380.

Roberts, I.M., A.T. Jones and J.W. Amrine, Jr., 1994. Ultrastructure of the black currant gall mite, *Cecidophyopsis ribis* (Acari: Eriophyidae), the vector of the agent of reversion disease. Ann. Applied Biol., 125: 447-455.

Seki, M., 1982. Life Cycle of the Pink Citrus Rust Mite, *Aculops pelekassi* (Keifer), in Japan. In: Proceedings of the International Society of Citriculture, International Citrus Congress, November 9-12, 1981, Tokyo, Japan, (Matsumoto, K. (Ed.). International Society of Citriculture, Shimizu, Japan, pp: 1982-1983.

Tetsuzo, T., E. Shuji and Y. Seiji, 1978. Effect of infestation by citrus rust mite, *Aculops pelekassi* (Keifer), on development of satsuma mandarin fruit and availability for juice processing from damaged fruit: Agricultural report No. 44. Saga University, Japan, pp: 57-66.

Whitmoyer, R.E., L.R. Nault and O.E. Bradfute, 1972. Fine structure of *Aceria tubpee* (Acarina: Eriophyidae). Ann. Entomol. Soc. Am., 65: 201-215.

Yang, Y., J.C. Allen, J.L. Knapp and P.A. Stansly, 1995. Frequency distribution of citrus rust mite (Acari: Eriophyidae) damage on fruit in 'Hamlin' orange trees. Environ. Entomol., 24: 1018-1023