

A new species and first record of the genus *Tuberaleyrodes* Takahashi (Hemiptera Aleyrodidae) from India

Anil Kumar DUBEY

Zoological Survey of India, Andaman and Nicobar Regional Centre, Andaman and Nicobar Islands, Port Blair, India

Abstract

The whitefly genus *Tuberaleyrodes* Takahashi is reported for the first time from India with description of a new species, *Tuberaleyrodes monpa* sp. nov. The new species was found infesting leaves of *Macaranga peltata* (Roxburgh) Muller (Euphorbiaceae) in the State of Arunachal Pradesh in North-East India. Euphorbiaceae is a new host family record for *Tuberaleyrodes* species. The new species differs from its Malaysian congener *Tuberaleyrodes aequalis* Dubey et Martin in having fewer submarginal setae, prominent thoracic tracheal pores, large median tubercles on abdominal segments I-VII and in the shape of vasiform orifice.

Key words: Arunachal Pradesh, *Macaranga*, monpa, new record, whitefly.

Introduction

Whiteflies are exclusively phloem sap-sucking hemipteran insects and some of them are pests of agricultural crops. The taxonomy of this group is based on morphology of the fourth larval stage pupal case (puparium). Currently, the family Aleyrodidae includes 1705 species belonging to 192 genera and placed in four subfamilies including one fossil subfamily Bernaeinae Shcherbakov (Shcherbakov, 2000; Evans *et al.*, in press). The whitefly genus *Tuberaleyrodes* Takahashi was established for a single species, *Tuberaleyrodes machili* Takahashi from the Oriental region (Takahashi, 1932). *Tuberaleyrodes* was established based on the presence of dorsal setae on elevated cuticle or elongate tubercles. So far, the genus was comprised of 13 species worldwide with distribution in Brunei (Borneo), China, Hong Kong, Japan, Malaysia, Sulawesi and Taiwan (Dubey and Martin, 2018); it is reported here for the first time from India with description of a new species, *Tuberaleyrodes monpa* sp. nov. bringing the total number of species to 14, worldwide. The new species was found infesting leaves of *Macaranga peltata* (Roxburgh) Muller (Euphorbiaceae) in Arunachal Pradesh, India. The type locality is the largest state in North East India and shares its borders with adjoining countries Bhutan, China and Myanmar. Previous and present records of the genus indicate that it is distributed in Indo-China, Indo-Myanmar to South East Asia. *Tuberaleyrodes* shares characteristics of the dorsal tuberculate setae with *Acanthaleyrodes* Takahashi which is distributed in China, Hong Kong, India and Taiwan, but the latter differs in having posteriorly elevated vasiform orifice (Takahashi, 1931). *Tuberaleyrodes* species prefer to feed on lauraceous hosts (Lauraceae), but other host plant families such as Annonaceae, Anacardiaceae, Myristicaceae, Symplocaceae are also recorded (Dubey and Martin, 2018). The discovery of *T. monpa* on *M. peltata* adds Euphorbiaceae as a new host plant family for the genus *Tuberaleyrodes*. Line drawings, images of holotype and SEM microphotographs on leaf surfaces are provided with description. An identification key to puparia of all the *Tuberaleyrodes* species included here is updated from Dubey and Martin (2018).

Materials and methods

The pupal cases of the new species, *T. monpa* were collected on the leaves of *M. peltata* from Sago forests in Arunachal Pradesh, northeastern India. Puparia were mounted on slides following Dubey and David (2012). A DM500 Leica compound microscope with DFC500 digital camera configuration was used for identification and imaging of the holotype. SEM images were taken with an EVO MA 10 microscope (Carl Zeiss, Jena, Germany; 20 kV/ EHT, 20 Pa, 130× to 101,000× magnifications) (24 nm Au-Pa alloy coat) following Dubey and Ramamurthy (2013). SEM imaging was done at Division of Entomology, Indian Agricultural Research Institute, New Delhi. Standard terminologies are used for puparial morphology, following Bink-Moenen (1983), Martin (1985) and Gill (1990). The holotype and 2 paratypes are deposited in the Zoological Survey of India, Kolkata and one paratype in the National Forest Insect Collection, Forest Research Institute, Dehradun, India.

Results

Genus *Tuberaleyrodes* Takahashi 1932

Type species: *Tuberaleyrodes machili* Takahashi 1932: 29.

Diagnosis: Puparium elliptical or oval, with distinct tubercles on the dorsum, often some or all of them elevated, with some dorsal and other setae fixed in a socket located on elevated tubercles, referred to as tuberculate setae. Longitudinal moulting suture reaching anterior margin and transverse moulting suture reaching submedian area. Thoracic tracheal pores and clefts usually indicated. Cephalic, first, eighth abdominal and caudal setae present. Vasiform orifice rounded or elongate. Operculum filling most of the orifice. Lingula tip slightly exposed. Ventrally, paired ventral abdominal setae and a submarginal ventral fold may be present (see more details in Dubey and Martin, 2018).

Distribution. Taiwan (Takahashi, 1934; 1935); Japan (Takahashi, 1958); Hong Kong (Martin and Lau, 2011); Malaysia, Brunei (Borneo), Sulawesi (Dubey and Martin, 2018); China (Wang *et al.*, 2013); India (new record).

Remarks. The genus is reported for the first time from

India. Puparia of the two whitefly genera, *Acanthaleyrodes* and *Tuberaleyrodes* only are known to have the elevated dorsal tubercles bearing setae (tuberculate setae). *Acanthaleyrodes* differs from *Tuberaleyrodes* in having the vasiform orifice placed on a prominent protu-

berance. Sometimes this elevation is longer than the distance between the base of orifice and the puparial caudal margin, and the caudal furrow does not connect the posterior end of the orifice and the puparial caudal margin. (Dubey *et al.*, 2014).

Key to the puparia of *Tuberaleyrodes* species described worldwide

(Updated from Dubey and Martin, 2018)

- 1 - Puparium subcircular; eighth abdominal setae nearly twice the length of vasiform orifice or longer; caudal furrow ridges/margins made up of prominent tubercles and overlapping with caudal fold; a prominent submarginal ventral fold demarcating ventral submarginal area with two parallel lines or a groove; caudal fold margins merging with submarginal ventral fold; Malaysia *T. ordo* Dubey et Martin 2018
- - Puparium elliptical or oval; eighth abdominal setae equal to or less than the length of vasiform orifice; caudal furrow ridges/margins simple, not located on prominent tubercles; submarginal ventral fold absent, if present, caudal fold margins not merging with it (as in *Tuberaleyrodes neolitsae* Young 1944) 2
- 2 - Submargin with 12 or 14 pairs of tuberculate setae (including caudal pair); apex of all of these setae reaching beyond margin, submedian and/or subdorsal setae absent 3
- - Submargin with less than 10 pairs of tuberculate setae, apex of these setae may reach beyond margin, submedian and/or subdorsal setae present 4
- 3 - Submargin with a row of 14 pairs of tuberculate setae, bases of these setae connected by a dorsal crease; large median tubercles absent on abdominal segments, minute median tubercles present on cephalothorax and abdominal segments in groups and also on submedian area in longitudinal row; Malaysia *T. aequalis* Dubey et Martin 2018
- - Submargin with less than 12 pairs of tuberculate setae, bases of these setae not connected by a crease; large median tubercles present on abdominal segments, not in groups; longitudinal row of submedian tubercles present; India *T. monpa* sp. nov.
- 4 - Cephalic and the first abdominal setae only in the form of tuberculate setae; median tubercles on abdominal segment I–VII usually present as tubercle clusters or entirely absent or variably present; Malaysia *T. glutae* (Corbett 1935)
- - Cephalic, first abdominal as well as submedian/subdorsal setae also in the form of tuberculate setae, but not the caudal setae; median tubercles large otherwise either in group of minute tubercles or present along the segment sutures 5
- 5 - Median length of abdominal segment VII shorter than VI, almost half the length of segment VI 6
- - Median length of abdominal segment VII not shorter than VI, almost equal to the length of segment VI 7
- 6 - Six pairs of long subdorsal tuberculate setae present; eight pairs of simple submarginal setae present along the bases of tuberculate setae; mesothoracic setae absent; China *T. lauri* Dubey et Wang 2013
- - Nine pairs of long submarginal tuberculate setae present; simple submarginal setae absent; mesothoracic setae present; Malaysia *T. rambutana* Takahashi 1955
- 7 - Tuberculate setae absent on submedian area near termination of abdominal segment sutures II/III–VI/VII 8
- - Tuberculate setae present on submedian area near termination of abdominal segment sutures II/III–VI/VII 9
- 8 - Thoracic tracheal pore area not invaginated deeply and not marked with C-shaped internal rim, shallow indent likely but without internal chitinised rim; both meso- and metathoracic or at least mesothoracic setae present; Malaysia *T. variabilis* Dubey et Martin 2018
- - Thoracic tracheal pore area deeply invaginated and marked with C-shaped internal rim with chitinised teeth; meso- and metathoracic setae absent; median tubercles large, somewhat rigid; Malaysia *T. spiniferosa* (Corbett 1933)
- 9 - Four pairs of tuberculate setae present near termination of abdominal segment sutures II/III to posterior to segment VIII and one pair of simple setae present near caudal furrow; median tubercles and minute tubercles absent on cephalothoracic and abdominal segments; apex of antennae reaching beyond the base of prothoracic legs; Borneo *T. bruneiensis* Dubey et Martin 2018
- - Two pairs of tuberculate setae may be present near termination of segment sutures II/III to posterior to segment VIII and one pair of simple setae may be present; median tubercles and/or minute tubercles may be present along the abdominal segment sutures; apex of antennae not reaching beyond the base of prothoracic legs 10
- 10 - Puparia elliptical; all or at least most of the submarginal setae reaching beyond the puparial margin 11
- - Puparia oval; none of the submarginal setae reaching beyond the puparial margin 12
- 11 - Submarginal setae not placed on tuberculate base; vasiform orifice elongate cordate, longer than wide; Hong Kong *T. crypta* Dubey et Martin 2018
- - Submarginal setae placed on tuberculate base; vasiform orifice cordate, as long as wide; Japan, Taiwan *T. actinodaphnis* Takahashi 1935
- 12 - Thoracic tracheal area with clear cleft; meso- and metathoracic setae absent; submedian area of cephalothorax and abdomen with a longitudinal row of tubercles; Taiwan *T. bobuae* Takahashi 1934
- - Thoracic tracheal area with slight indentation, cleft absent; meso- and metathoracic setae present; submedian area of cephalothorax and abdomen without longitudinal row of tubercles 13
- 13 - Puparia greyish black in life; ventral submarginal area with a fold along puparial margin; submedian area of metathorax without a pair of tubercle clusters, not pigmented; median tubercles present on abdominal segments; China *T. neolitsae* Young 1944
- - Puparium pale; ventral submarginal area without a fold along puparial margin; submedian area of metathorax with a pair of tubercle clusters, usually pigmented; median tubercles absent on abdominal segments, but minute tubercles along the segment sutures present; Japan, Taiwan *T. machili* Takahashi 1932

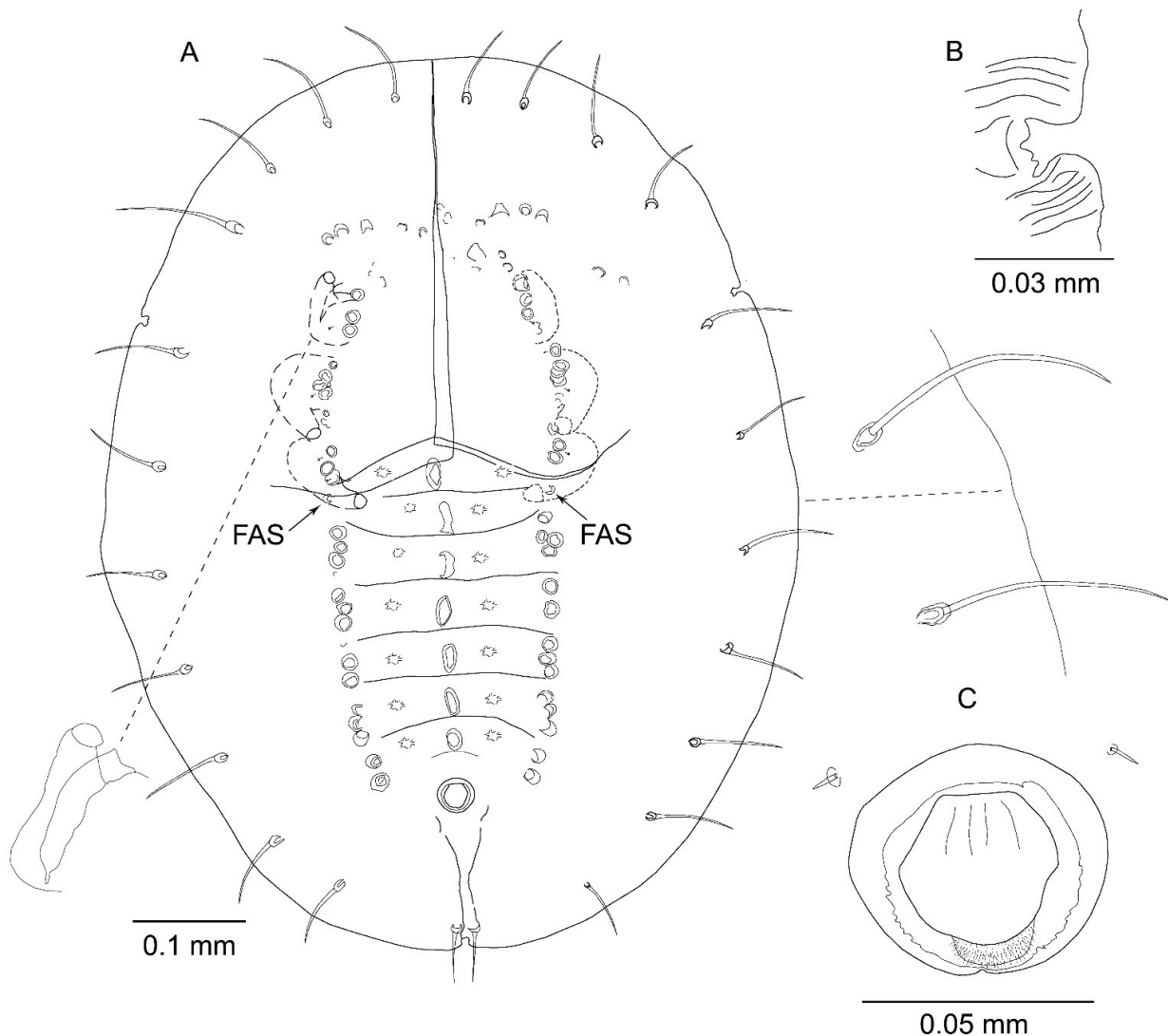


Figure 1. *Tuberaleyrodes monpa* sp. nov., line drawings, holotype puparium: **1A)** Puparium; **1B)** Thoracic tracheal pore; **1C)** Vasiform orifice. FAS- First abdominal setae.

Taxonomic description

Tuberaleyrodes monpa sp. nov. (figures 1-3)

Puparium: White, with secretion of little wax deposits; oblong (figure 1A, 3A); widest from metathorax to abdominal segment II region; 1700-1750 μm long, 1300-1400 μm wide; found singly on the underside of leaves, one puparium per leaf.

Margin - smooth or faintly irregularly crenulate; 23 crenulations in 0.1 mm. Caudal and thoracic tracheal pores (figure 1B, 2C, 3B) indicated with C-shaped invaginations. Anterior and posterior marginal setae 15-25 and 28 μm long, respectively.

Dorsum - submargin not demarcated from the dorsal disc with a faint crease. Submargin with transverse ridges, reaching subdorsal area. Submarginal setae reaching beyond margin (figure 2D, 3C). Longitudinal moulting suture reaching margin and transverse moulting sutures reaching submedian area, curving anteriorly and terminating on metathorax. Submedian tubercles present in longitudinal rows on cephalothorax and abdomen (figure 2A, 2B). Median tubercles present on abdominal segments I-VII (figure 2B). Pro-meso-, meso-metathoracic and

abdominal intersegmental sutures prominent. Submedian depressions present. Cephalothorax (725-755 μm) was smaller than the abdomen (969-1020 μm), medially. Median length of mesothorax (80-88 μm) slightly longer than metathorax (67-85 μm). Median length of abdominal segment VI subequal to the segment VII. Median length of abdominal segments I-VIII (A1-A8) measured as: A1 100-102, A2 75-85, A3 77-88, A4 90-95, A5 87-95, A6 70-82, A7 70-82, A8 42-48 μm . Geminate pores present, pore/porette spacing approximately 5 μm . Five pairs of geminate pores between the first abdominal setae. Thoracic furrows absent. Caudal tracheal furrow narrow, 225-240 μm long, 7-13 μm wide; caudal ridges present, apically bearing a pair of caudal setae. Pockets continuous.

Vasiform orifice - circular in mounted puparia (figure 1C, 2F), subcircular in SEM images (figure 3D), not elevated posteriorly, inner margin smooth, 67-75 μm long, 70-73 μm wide; operculum subcordate, almost filling the orifice in length, upper surface with 3-4 fine grooves, inner apical margin with microtrichia, 50-58 μm long, 42-50 μm wide, broadest at middle, apical end 25 μm wide; apex of lingula visible.

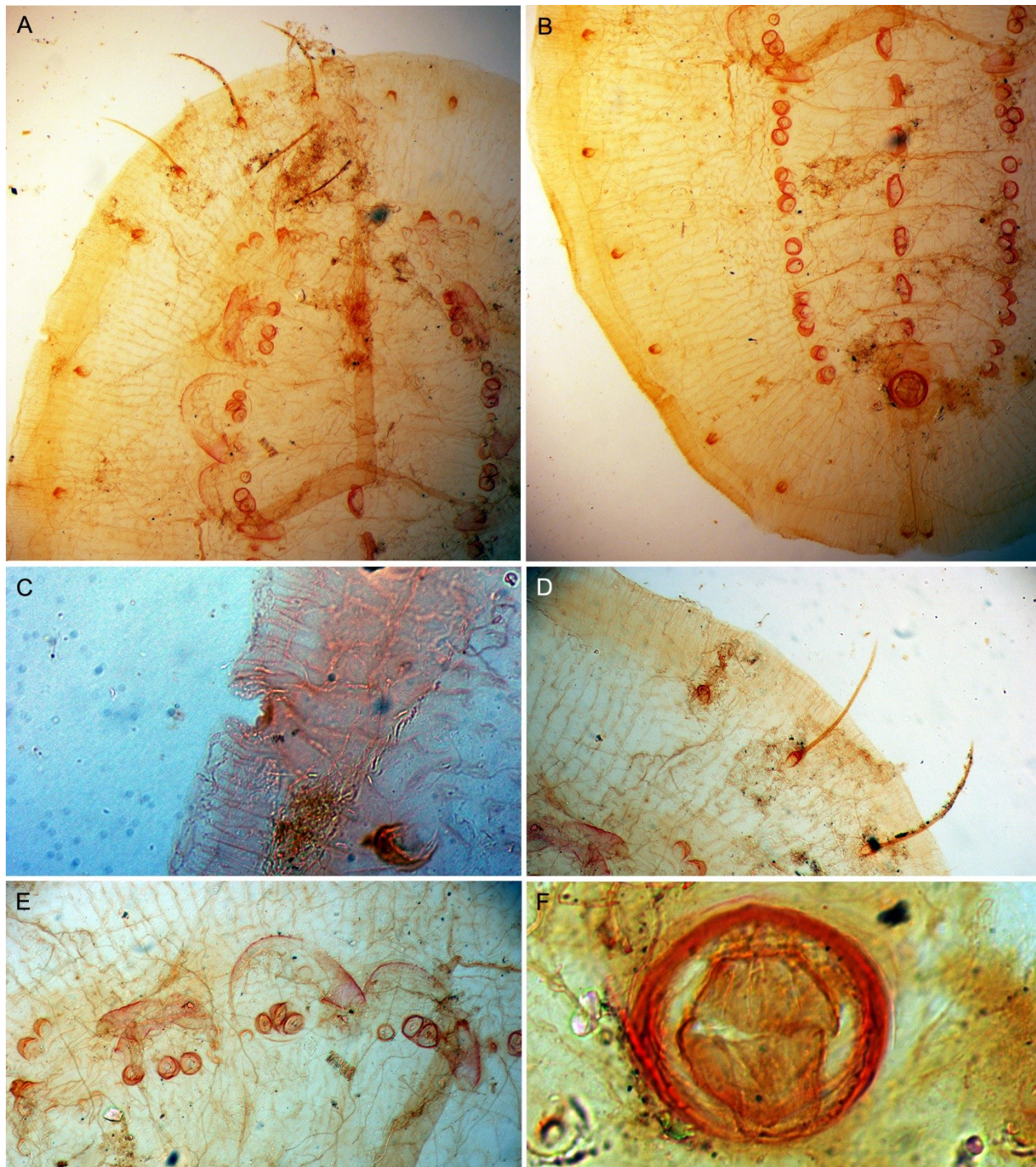


Figure 2. *Tuberaleyrodes monpa* sp. nov., holotype puparium: **2A)** Cephalothorax; **2B)** Abdomen; **2C)** Thoracic tracheal pore; **2D)** Submarginal setae; **2E)** Submedian tubercles, legs; **2F)** Vasiform orifice.

Venter - paired ventral eighth abdominal setae 37–40 μm long, 57–70 μm apart. Thoracic and caudal tracheal folds absent. Antennae reaching the base of the prothoracic legs (figure 2E), 122–137 μm long (including keel, 12 μm long). Microsetae at base of prothoracic legs 3–7 μm long, meso-, and metathoracic legs 7–10 μm ; microsetae also present near apical pads. Spiracles and adhesive sacs present.

Chaetotaxy - cephalic, first, eighth abdominal and caudal setae, 95–33, 57–60, 7–13 and 165 μm long respectively. Caudal setae in row of submarginal setae. Submarginal tuberculate setae 12 pairs, 155–185 μm long.

Host plant: Euphorbiaceae: *Macaranga peltata* (Roxburgh) Muller.

Type material

Holotype: one puparium on a slide. INDIA: Arunachal Pradesh, Basar, Sago forests, 5 km from Basar, one puparium on slide, on *Macaranga peltata*; 24.v.2013; 27°96.14'N, 94°78.70'E, A. K. Dubey (Deposited in the ZSI, Head Quarter, Kolkata, India).

Paratypes: 3 puparia on 3 slides, collection data same as for the holotype (ZSI 2, NFIC-FRI 1).

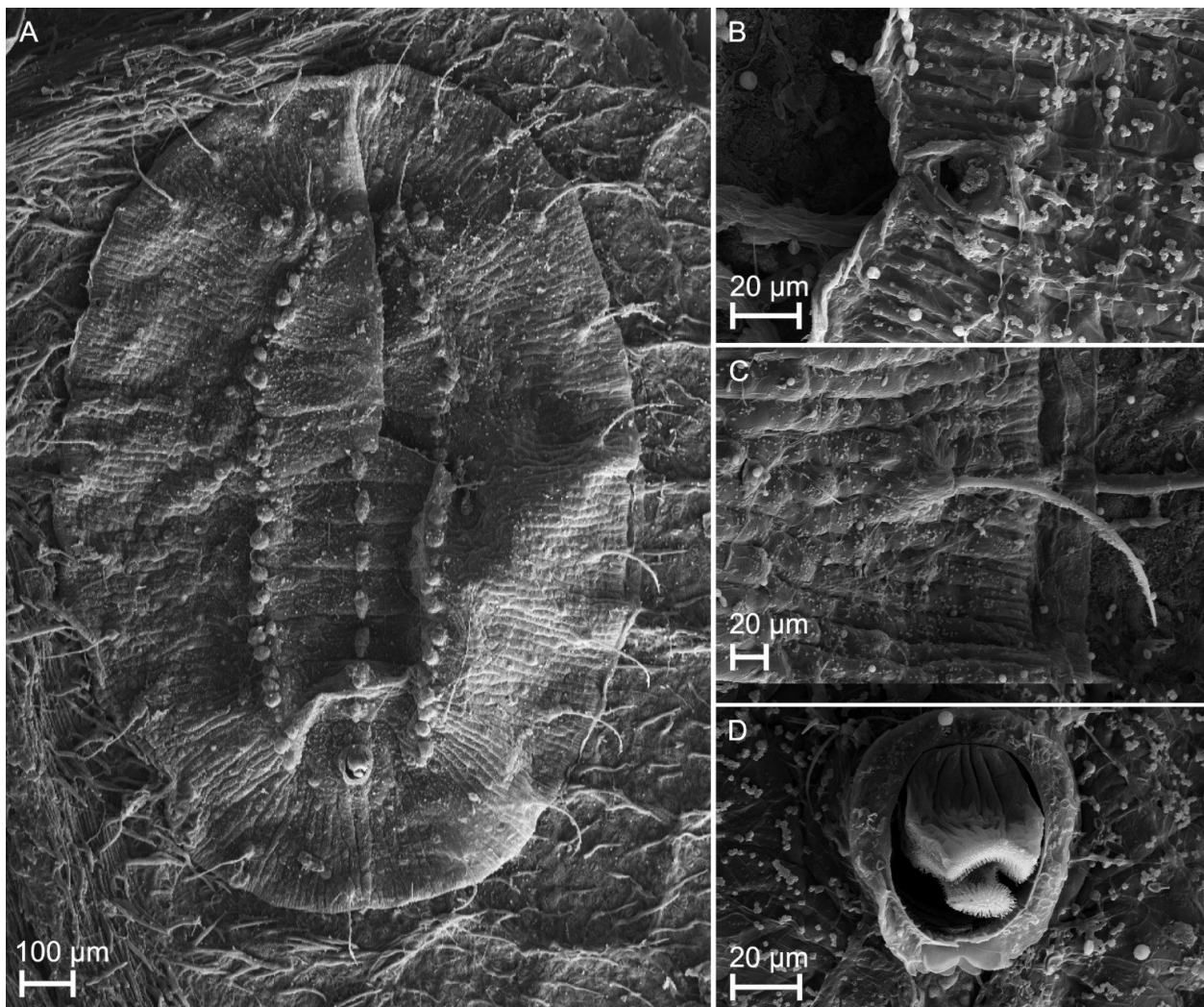


Figure 3. *Tuberaleyrodes monpa* sp. nov., SEM microphotographs: **3A)** Puparium, dorsal view; **3B)** Thoracic tracheal pore; **3C)** Submarginal setae; **3D)** Vasiform orifice.

Etymology

The species is named in honour of the 'Monpa' tribes of Arunachal Pradesh, the only tribes in the state known for nomadic life.

Distribution

India: Arunachal Pradesh.

Comments

Puparia of the new species are similar to those of *T. aequalis* Dubey et Martin but differ in the shape of the vasiform orifice and in having 12 pairs of submarginal tuberculate setae (including caudal setae), prominent thoracic tracheal pores and large median tubercles on abdominal segments I-VII. The record of *Tuberaleyrodes* from India confirms its natural distribution range in the Indo-Pacific region.

Acknowledgements

I am thankful to the Director, ZSI, Kolkata for the facilities. This research was supported by a grant under Network Project on Insect Biosystematics (21-17) from the Indian Council of Agricultural Research, New Delhi, India.

References

- BINK-MOENEN R. M., 1983.- Revision of the African whiteflies (Aleyrodidae), mainly based on a collection from Tchad.- *Monografieën Nederlandse Entomologische Vereniging*, 10: 1-210.
- CORBETT G. H., 1933.- Aleurodidae of Malaya.- *Stylops*, 2: 121-129.
- CORBETT G. H., 1935.- Malayan Aleurodidae.- *Journal of the Federated Malay States Museum*, 17: 722-852.
- DUBEY A. K., DAVID B. V., 2012.- Collection, preservation and preparation of specimens for taxonomic study of whiteflies (Hemiptera: Aleyrodidae), pp 1-19. In: *The whiteflies or mealywing bugs: biology, host specificity and management* (DAVID B. V., Ed.).- Lambert Academic Publishing, Saarbrücken, Germany.

- DUBEY A. K., MARTIN J. H., 2018.- A review of the genus *Tuberaleyrodes* Takahashi (Hemiptera: Aleyrodidae) with description of five new species from Brunei, Hong Kong and Malaysia.- *Zootaxa*, 4402 (2): 251-282.
- DUBEY A. K., RAMAMURTHY V. V., 2013.- *Dialeurolonga* redefined (Hemiptera: Aleyrodidae): with a new genus and species from India, two new genera from Australia, and discussion of host-correlated puparial variation.- *Zootaxa*, 3616: 548-562.
- DUBEY A. K., SINGH S., MARTIN J. H., 2014.- *Acanthaleyrodes elevatus* sp. n. (Hemiptera: Aleyrodidae) from India, with key to species and discussion of tuberculate setae.- *Zootaxa*, 3881 (1): 33-48.
- EVANS G. A., MARTIN J. H., DROHOJOWSKA J., STOCKS I. C., DOOLEY J., DUBEY A. K., SZWEDO J., 2021.- Whiteflies of the World (Hemiptera: Sternorrhyncha, Aleyrodidae) - a catalogue of the taxonomy, distribution, hosts and natural enemies of whiteflies. Part 1 - Subfamilies Aleurodicinae, Udamoselinae, Bernacinae and other fossil whiteflies.- *Zootaxa*, in press.
- GILL R. J., 1990.- The morphology of whiteflies, pp. 13-46. In: *Whiteflies: their bionomics, pest status and management* (Gerling D., Ed.).- Intercept, Andover, UK.
- MARTIN J. H., 1985.- The whitefly of New Guinea (Homoptera: Aleyrodidae).- *Bulletin of the British Museum (Natural History) (Entomology)*, 50: 303-351.
- MARTIN J. H., LAU C. S. K., 2011.- The Hemiptera-Sternorrhyncha (Insecta) of Hong Kong, China - an annotated inventory citing voucher specimens and published records.- *Zootaxa*, 2847: 1-122.
- SHCHERBAKOV D. E., 2000.- The most primitive whiteflies (Hemiptera; Aleyrodidae; Bernacinae subfam. nov.) from the Mesozoic of Asia and Burmese amber, with an overview of Burmese amber hemipterans.- *Bulletin of the Natural History Museum London (Geology)*, 56: 29-37.
- TAKAHASHI R., 1931.- Some Formosan whiteflies.- *Journal of the Society of Tropical Agriculture. Taiwan*, 3: 218-224.
- TAKAHASHI R., 1932.- Aleyrodidae of Formosa, Part I.- *Report, Department of Agriculture, Government Research Institute Formosa*, 59: 1-57.
- TAKAHASHI R., 1934.- Aleyrodidae of Formosa, Part III.- *Report, Department of Agriculture, Government Research Institute. Formosa*, 63: 39-71.
- TAKAHASHI R., 1935.- Aleyrodidae of Formosa, Part IV.- *Report, Department of Agriculture, Government Research Institute Formosa*, 66: 39-65.
- TAKAHASHI R., 1955.- Descriptions of some new and little known species of Aleyrodidae from China and Malaya (Homoptera).- *Acta Entomologica Sinica*, 5: 221-235.
- TAKAHASHI R., 1958.- *Aleyrodes*, *Tuberaleyrodes* and *Dialeurolodes* from Japan.- *Mushi*, 31: 63-68.
- WANG J.-R., DUBEY A. K., DU Y.-Z., 2013.- Description of a new species of *Tuberaleyrodes* (Hemiptera: Aleyrodidae) from China.- *Florida Entomologist*, 96 (2): 619-623.
- YOUNG B., 1944.- Aleyrodidae from Szechwan, I.- *Sinensia. Shanghai*, 15: 129-139.

Author's address: Anil Kumar DUBEY (corresponding author: anil.2kd@gmail.com), Zoological Survey of India, Andaman and Nicobar Regional Centre, Andaman and Nicobar Islands, Port Blair, India 744102.

Received June 8, 2021. Accepted August 6, 2021.