

A review of the Genus *Papillacarus* (Acari: Lohmanniidae) in Vietnam with Remarks on the Taxonomic Status of *P. arboriseta*

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Abstract: A review of the oribatid mites of the genus *Papillacarus* Kunst, 1959 (Oribatida: Lohmanniidae) in Vietnam, with remarks on the taxonomic status of *P. arboriseta*, is presented. The article provides also a key to nine species recorded in Vietnam, namely *P. arboriseta* Jeleva et Vu, 1987, *P. benenensis* Vu, Ermilov et Dao, 2010, *P. cornutus* (Sarkar et Subias, 1984), *P. hirsutus* (Aoki, 1961), *P. indistinctus* Ermilov, Anichkin et Wu, 2012, *P. polygonatus* Ermilov et Anichkin, 2011, *P. polysetosus* Ermilov, Anichkin et Wu, 2012, *P. ramosus* Balogh, 1961, and *P. undirostratus* Aoki, 1965. For each species, a list of synonyms, information on types and type localities, a brief new description, an illustration, taxonomic problems, as well as remarks on the ecology and distribution are included. These species are known from the Oriental Region and Southeast Asia, and five of them are recorded only from Vietnam.

Keywords: Oribatida, Lohmanniidae, *Papillacarus arboriseta*, Vietnam

Introduction

Oribatid mites (Acari: Oribatida) play an important role in soil ecosystems, particularly for decomposition of plant litter, nutrient cycling, soil formation, and for distribution of a number of parasites and diseases (BALOGH, BALOGH 2002, BERON 2011). The oribatids are one of the major acarine groups, which occur mainly in the soil environment, and are still little known in Asian tropical ecosystems (VU 1990, VU, NGUYEN 2000, YIN WENYING *et al.* 2000, CORPUZ-RAROS 2005, HASEGAWA, KITAYAMA 2006). In Vietnam, after the first work of BALOGH, MAHUNKA (1967), some studies on oribatids started in the 1980s. Recently the oribatid fauna of Vietnam was studied by VU (2007, 2012), DAO *et al.* (2010), ERMILOV, VU (2012), and NGUYEN, VU (2012).

Lohmanniidae is a moderately diverse oribatid family, which comprises more than 20 genera and is distributed mainly in the tropical and subtropical

regions. The genus *Papillacarus*, one of the most diverse genera in the family Lohmanniidae, was described in 1959 by Kunst with the type species *Lohmannia murcioides aciculata* Berlese, 1904. The genus *Papillacarus* Kunst, 1959 is known with more than 30 species, and most of them have a restricted pantropical and subtropical distribution (GRANDJEAN 1950, BALOGH 1961, BALOGH, BALOGH 2002, NORTON 2009, SUBIAS 2013).

The knowledge of the oribatid genus *Papillacarus* Kunst, 1959 in Vietnam is insufficient (JELEVA, VU 1987, VU 2009, VU *et al.* 2010, ERMILOV *et al.* 2011, 2012). The aim of this study is to provide a review of the genus, as well as remarks on the taxonomic status of *P. arboriseta* Jeleva et Vu, 1987, and, based on the specimens obtained throughout Vietnam, to give a key to nine species recorded in the country.

Material and Methods

The samples were obtained from six habitat types as follows: forest, disturbed forest, scrub, grassland, poly-annual cultivated and annual cultivated habitat. The mites were taken from the following four different vertical layers: decaying wood debris and moss lying on 0 – 100 cm above surface forest litter, forest litter lying on the soil surface, soil top layer of 0-10 cm below surface, and soil deep layer of 11-20 cm below surface. The studied soils were grouped into four main types after the classification introduced by the Vietnamese National Institute for Soils and Fertilizers (2002), namely: neutral alluvial soil, ferralitic reddish brown soil, ferralitic brownish soil derived from limestone, and dark loamy soil. All study sites were distributed within six geographic regions: northwest upland, northeast upland, Red River Delta, north central Vietnam, central north Vietnam, and southern Vietnam (Vietnam Ministry of Agriculture and Rural Development 2006).

The oribatid mites were extracted using a Berlese funnel apparatus and preserved in 70% ethanol, then mounted in lactic acid on temporary cavity slides for measurement and illustration. The body length was measured in dorsal view, from the tip of the rostrum to the posterior edge of the ventral plate. The notogastral width refers to the maximum width in dorsal aspect. Some specimens were dissected for detailed study. The terminology used in the text is follows BALOGH, MAHUNKA (1983).

Results and Discussion

Genus *Papillacarus* Kunst, 1959

Papillacarus Kunst, 1959. Acta Univ. Carol., Biol: 52.

Synonym: *Lohmannia* Grandjean, 1950. Arch. Zool. Exp. Gén., 87: 159.

Type species: *Lohmannia murcioides* Berlese, 1896 var. *aciculata* Berlese, 1904. Redia, II: 24, Tav. 2, fig. 39.

At present, nine *Papillacarus* species are known in Vietnam, namely: *P. arboriseta* Jeleva et Vu, 1987, *P. benenensis* Vu, Ermilov et Dao, 2010, *P. cornutus* (Sarkar et Subias, 1984), *P. hirsutus* (Aoki, 1961), *P. indistinctus* Ermilov, Anichkin et Wu, 2012, *P. polygonatus* Ermilov et Anichkin, 2011, *P. polysetosus* Ermilov, Anichkin et Wu, 2012, *P. ramosus* Balogh, 1961, and *P. undirostratus* Aoki, 1965. These species are known from the Oriental Region and Southeast Asia, and five of them are recorded only from Vietnam.

1. *Papillacarus arboriseta* Jeleva et Vu, 1987 (Fig. 1: a, b, c)

Papillacarus arboriseta Jeleva et Vu, 1987:

Act. Zool. Bulg., 33: 10-11. figs. 1-1, 1-2.

Papillacarus arboriseta Jeleva et Vu, 1987; Vu 2009: Vietnam Journal of Biology TCSH, 31(1): 17-18, figs. 2a, 2b.

Papillacarus arboriseta Jeleva et Vu, 1987; ERMILOV *et al.* 2011: Acarologia 51(2), 161.

Papillacarus arboriseta Jeleva et Vu, 1987; NGUYEN, VU 2012: Journal of Sciences. Vietnam National University, Hanoi. 28(1): 128-134.

Specimens Examined and Ecological Notes. 1) Dinh Hoa (Thai Nguyen province), 21°40'N-105°46'E, 25.1.1988, Natural forest, Ferralitic brownish soil derived from limestone, Northeast uplands, 600-900 m a.s.l., 0-10 cm (n=3), 2) Tam Dao National Park (Vinh Phuc province), 21°27'N-105°38'E, 27.5.1995, Grassland, Ferralitic reddish brown soil, Northeast uplands, 900 m a.s.l., 0-10 cm (n=5), 3) Xuan Nha Nature Reserve (Son La province), 20°38'N-104°41'E, 19.11.1991, Forest, Ferralitic brownish soil derived from limestone, Northwest uplands, 1450 m a.s.l., 0-10 cm (n=5), 4) Phu Tho town (Phu Tho province), 21°25'N-105°14'E, 23.12.1983, Annual cultivated land, Neutral alluvial soil, Northwest uplands, 200-400 m a.s.l., 0-10 cm, a.s.l. (n=2), 5) Xuan Son National Park (Phu Tho province), 21°07'-104°56'E, 26.4.2005 & 15.10.2009, Forest, Disturbed forest, Scrub, Poly-annual cultivated habitat, Ferralitic brownish soil derived from limestone, Northwest uplands, 400-900 m a.s.l., 0-10 cm (n=3+7), 6) Ba Vi National Park (Hanoi), 21°03'N-105°22'E, 10.12.2003 & 25.8.2004, Forest, Ferralitic brownish soil derived from limestone, Red River delta, Forest litter & 0-100 cm above Forest litter, 400-900 m a.s.l., 0-20 cm (n=3+4), 7) Phong Nha – Ke Bang National Park (Quang Binh province), 17°22'N-105°45'E, 14.3.2010 & 25.8.2004, Forest, Ferralitic brownish

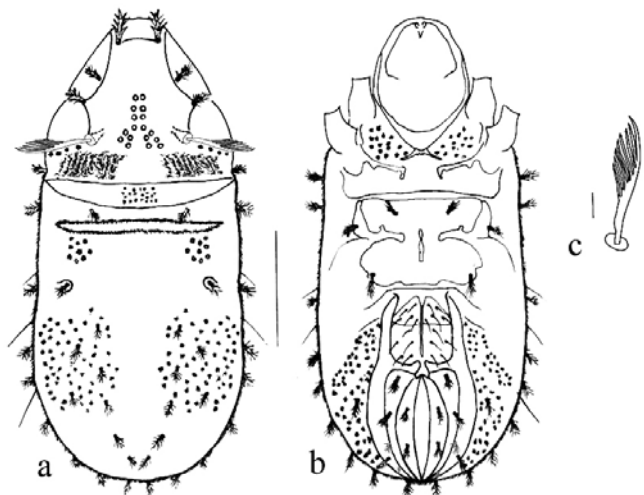


Fig. 1. *P. arboriseta*: a. Dorsal side, b. Ventral side, c. Sensillus. Scale bar 100 µm (a, b) and 10 µm (c)

soil derived from limestone, Central North Vietnam, 800-900 m a.s.l., 0-10 cm (n=3).

Measurements (Body length X Notogastral width). 378-412 X 157-168 µm.

Description. Rostrum truncate. Sensillus pectinate with 7-8 setae. All prodorsal setae bilaterally strongly barbed, tree-shaped. Rostral setae basis lying on clear transversal line, exclinate. Chitinous thickness can be seen posteriorly, reaching to front exobothrydium setae basis and posteriorly to bothrydium. Chitinous sculpture with rough spots. Posteriorly to the prosoma there is a transversal zone covered with fine spots, forming cross lines. Body surface covered with densely situated chitinous cylindrical papillae, considerably rising over the surface. There are slightly manifested fossulae vitiforms. All dorsal setae considerably rising over the surface. All dorsal setae tree-shaped as prosomal. Among them, there are some separate filiform setae considerably longer than the others. No pygidial neothrychi can be seen.

Genital plates with transversal suture. Ventral setae structure similar to dorsal one, except the genital setae, which always are common, setiform. Chitinous sculpture resembling that of the notogaster dorsal side.

General distribution. At present, the species is recorded only from Vietnam.

ERMILOV *et al.* (2011), based on the specimens obtained only from central and southern Vietnam, considered *P. arboriseta* Jeleva et Vu, 1987, as a synonym of *P. hirsutus* (Aoki, 1961). On the basis of numerous specimens obtained throughout the country, particularly from northern, central and southern Vietnam, *P. arboriseta* clearly differs from *P. hirsutus* by the morphological features presented in Table 1.

2. *Papillacarus benenensis* Vu, Ermilov et Dao, 2010 (Fig. 2: a, b, c)

Papillacarus benenensis Vu, Ermilov et Dao, 2010, Vietnam Journal of Biology TCSH, 32(3): 16-17, figs. 2: A, B, C.

Holotype is deposited in the collection of the Zoological Institute of Russian Academy of

Sciences, St. Petersburg, Russia. Paratype is deposited in the collection of the Center for Biodiversity Resources Education and Development (CEBRED), Hanoi National University of Education, Vietnam, 136 Xuan Thuy Rd., Cau Giay, Vietnam, and in the collection of the Zoological Institute of Russian Academy of Sciences, St. Petersburg, Russia (n=2).

Specimens Examined and Ecological Notes. 1) Xuan Son National Park (Phu Tho province), 21°07'N-104°56'E, 22.4.2005, Forest, Ferralitic reddish brown soil, Northwest uplands, 300-400 m a.s.l., 0-10 cm (n=2), 2) Ben En National Park (Thanh Hoa province), 19°31'N-19°40'N & 105°23'E -105°35'E, 15.7.2008 & 10.1.2009, Forest, Ferralitic reddish brown soil, North Central, 200-300 m a.s.l., 0-10 cm (n=5).

Measurements. 620-680 X 320-350 µm.

Description. The body colour is yellow. Surface of all body with reticulate sculpturing, though only weakly visible on prodorsum. Roughly triangular form, occupying about 1/3 of total body length. Anterior margin of rostrum undulate. All setae weakly

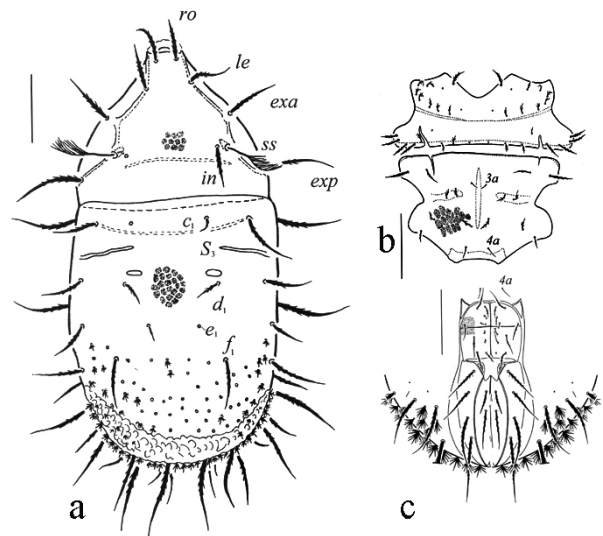


Fig. 2. *P. benenensis* (After Vu *et al.* 2010): a. Dorsal side, b. Epimeral area, c. Anogenital area. Scale bar 100 µm (a, b, c)

Table 1. Differences in morphological features between *P. arboriseta* Jeleva et Vu, 1987 and *P. hirsutus* (Aoki, 1961)

Character	Data on the specimens of <i>P. arboriseta</i> obtained from Vietnam.	Data on the specimens of <i>P. hirsutus</i> obtained from Vietnam.
Rostral setae	Rostral setae basis lying on clear transversal line.	Rostral setae basis not lying on a transversal line.
Sensillus	Sensillus pectinate with 7-8 long cilia.	Sensillus pectinate with 13-14 short cilia.
Prodorsum sculpture	With rough spots.	With fine spots.
Notogaster setae	Tree-shaped and always there are a few separate filiform setae considerably longer than the others.	Tree-shaped and there are not separate filiform setae considerably longer than the others.
Genital setae	Setiform.	Tree-shaped form or setiform.
Distribution	Northern and central Vietnam.	Central and southern Vietnam.

thickened proximally, conspicuously ciliate on both sides. Sensilli pectinate branches. Bothridia funnel-shaped. Notogaster about 1.25 times as long as wide. One pair of incomplete transversal bands (S_3) observable between rows of setae *c* and *d*. Posterior margin rounded. Setation both heteromorphic and strong neotrichous. With 18 pairs of long setae, weakly thickened proximally and conspicuously ciliate.

Epimeral region is similar to that in other species of the genus. Epimeres neotrichous, especially I and II, and setal formula: 10-9-5-4. Most setae thin, with long, thin ciliate. Six pairs of setae longer, thicker. Anogenital region is similar to that of other species of the genus, but the length of setae differs. Anal (two pairs) and adanal (four pairs) setae long. Genital setae heterogeneous: four lateral pairs long, six medial pairs shorter; divided between two pairs of plates as typical for the genus.

General distribution. At present, the species is recorded only from Vietnam.

3. *Papillacarus cornutus* (Sarkar et Subias, 1984) (Fig. 3: a, b)

Vepracarus cornutus Sarkar et Subias, 1984: Oriental Insects, Vol. 18: 26, figs. 1-2.

Papillacarus cornutus (Sarkar et Subias, 1984); ERMILOV *et al.* 2011: Acarina 20(1): 21.

Specimens Examined and Ecological Notes. Cat Tien National Park (Dong Nai province), 11°25'N-107°25'E, 2-3.2009, Forest, Dark loamy soil, Southern Vietnam, 149 m a.s.l. (n=?).

Measurements. 342-349 X 134-141 μ m.

Description. The body colour is yellow to brownish. Body surface covered with polygonal network sculpture, turbeculate-reticulate in large cornutus. Rostrum is rounded; ro. setae inserted far below rostral tip and bilaterally branched; le, in., anterior exostigmatic and posterior exostigmatic setae similar to rostral but shorter; horn-like projection present just in front of exa setae; in. setae very close to bothridium which being cup-shaped, and se. bilaterally barbed with thick stem, distal barbs longer than basal ones (Sarkar, Subias 1984). Notogaster with 16 pairs of normal setae, similar to prodorsal and with bilateral branching which being decreasing in long towards the tip; in the pygidial region neotrichous setae small and star-shaped, approximately 18 pairs.

Genital setae 10 pairs, 5 pairs on anterior genital plates and rest 5 on posterior one, all setae very short and bilaterally barbed; anal setae – 2 pairs, adanal setae – 4 pairs, very similar to normal notogastral setae.

General distribution. An Oriental species, known from India and Vietnam.

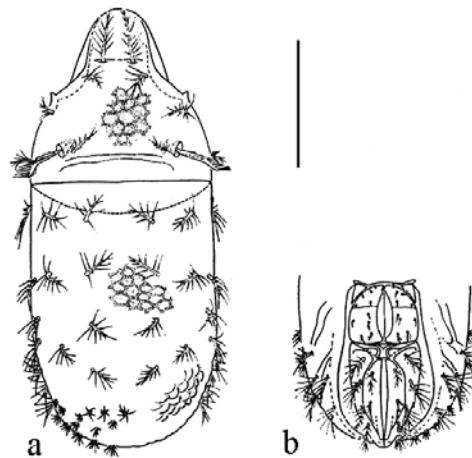


Fig. 3. *P. cornutus* (After SARKAR, SUBIAS 1984): a. Dorsal side, b. Anogenital area. Scale bar 100 μ m

4. *Papillacarus hirsutus* (Aoki, 1961) (Fig. 4: a, b, c)

Cryptacarus hirsutus Aoki, 1961. Jap. J. Appl. Ent. Zool., 5(1) 64-66, Abb. 2: A, B, C, D.

Papillacarus hirsutus (Aoki, 1961); HAMMER 1972: figs. 11, 11a.

Papillacarus hirsutus (Aoki, 1961); CORPUZ-RAROS 1979. Philip. J. Biol. 8(3): p. 330-332, fig. 21, 24.

Papillacarus hirsutus (Aoki, 1961); ERMILOV *et al.* 2011. Acarology 51(2)158-161, figs. 1: A, B, C, D, E.

Papillacarus hirsutus (Aoki, 1961); NGUYEN, VU 2012. Journal of Sciences. Vietnam National University, Hanoi. 28(1): 128-134

Specimens Examined and Ecological Notes. 1) Phong Nha – Ke Bang National Park (Quang Binh province), 14.3.2010: 17°22'N-105°45'E, 800-900 m a.s.l., and 17°50'N-106°24'E, Central North Vietnam, 500-600 m a.s.l., Forest litter and top soil layer of 0-10 cm (n=5); 2) Cat Tien National Park (Dong Nai province), 11°25'N-107°25'E, 2-3.2009, Forest, Dark loamy soil, Southern Vietnam, 149 m a.s.l. (n=20); 3) Yokohama city (Kanagawa prefecture, Japan), 33°28'N-139°35'E, 8.8.2011, Forest, Dark loamy soil, Forest litter, 42 m a.s.l. (n=4).

Measurements. 336-360 X 143-155 μ m; and 384-422 X 141-169 μ m (Japanese specimens: Aoki 1961), and 363-394 X 173-185 μ m (Philippine specimens: Corpuz-Raros 1979).

Description. The body colour is yellowish to light brown. Surface of body and legs with dense papillae. Dorsal papillae rounded, lateral papillae conical. Rostrum slightly rounded or truncate in dorsal view, colourless. ro, le, in and both pairs of exo-bothridial (exa, exp) setae branched; sensilli pectinate, with 13 or 14 branches in one side. Two pairs of transverse bands (S_3 and S_4) well developed, and both interrupted medially. Notogastral setae multiply branched. Roughly triangular in dorsal view, occupy-

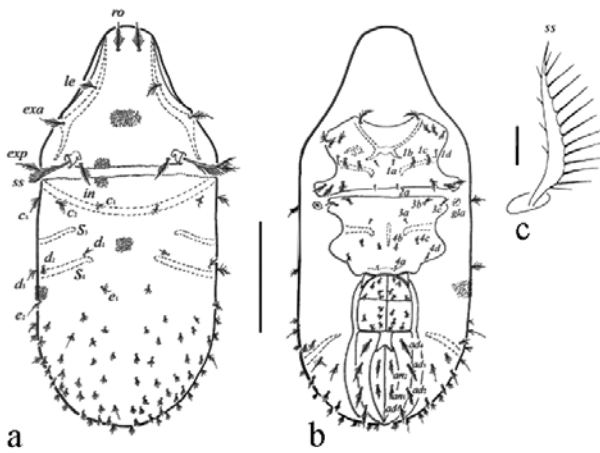


Fig. 4. *P. hirsutus* (After ERMILOV *et al.* 2011): a. Dorsal side, b. Ventral side, c. Sensillus. Scale bar 100 μ m (a, b) and 10 μ m (c)

ing about 1/3 of total body length. Only eight pairs of notogastral setae (c1, c2, c3, d1, d2, d3, e1, e2) well visible, other notogastral setae are difficult for differentiating between numerous neotrichous setae.

Epimeres I and II neotrichous, setal formula: 8 (seldom 9)-4-3-4. Medial setae 1a, 2a, 3a, 4a and often setae 1d setiform, smooth, other setae branched or setiform, ciliate. Two pairs of anal (an1, an2) and four pairs of adanal (ad1 – ad4) setae setiform, with long cilia; genital plates with tree-shaped setae. Two pairs of anal and four pairs of adanal setae setiform, with long cilia.

General distribution. An Oriental species, ranged in Japan, Tahiti, Tongatapu Island, India, Philippines, and Vietnam.

P. hirsutus (Aoki, 1961) is easily distinguishable from *P. arboriseta* Jeleva et Vu, 1987 by the morphological features presented in Table 1.

5. *Papillacarus indistinctus* Ermilov, Anichkin et Wu, 2012 (Fig. 5: a, b)

Papillacarus indistinctus Ermilov, Anichkin et Wu, 2012: Zootaxa 3593: 79-83, figs. 1-22

Specimens Examined and Ecological Notes. Cave in the Cat Tien National Park (Dong Nai Province) (= Dong Nai Biosphere Reserve), 08.2012, 11°27'N-107°22'E, Southern Vietnam, Ground substratum, 185 m a.s.l. (n=4).

Measurements. 763-813 X 365-398 μ m.

Description. Rostrum slightly concave. Body surface covered with foveolate sculpture. Observed is clearly one transverse band (S) developed on notogaster. Prodorsal, notogastral, anal and adanal setae relatively long, setiform and ciliate.

The new described species *Papillacarus indistinctus* is very similar to *P. polygonatus* Ermilov et Anichkin, 2011. It clearly differs from the above-

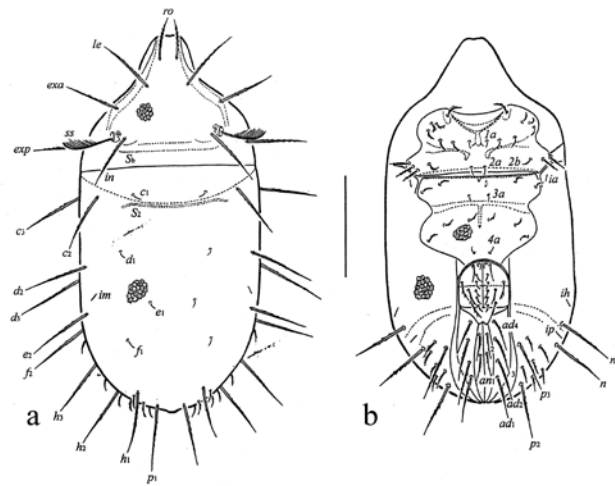


Fig. 5. *Papillacarus indistinctus* (After ERMILOV *et al.* 2012): a. Dorsal side, b. Ventral side. Scale bar 200 μ m

mentioned species by the types of neotrichal setae: versus two types in *P. indistinctus*, and versus three types in *P. polygonatus*. Long notogastral setae c2 can be seen, which are slightly shorter than c3 in *P. polygonatus* and are considerably shorter than c3 in *P. indistinctus* (Ermilov *et al.* 2012).

General distribution. At present, the species is recorded only from Vietnam.

6. *Papillacarus polygonatus* Ermilov et Anichkin, 2011 (Fig. 6: a, b, c)

Papillacarus polygonatus Ermilov et Anichkin, 2011. Acarina 19(2): 236-241, figs. 25-47.

Papillacarus polygonatus Ermilov et Anichkin, 2011; ERMILOV *et al.* 2012: Acarina 20(1): 21.

Specimens Examined and Ecological Notes. Cat Tien National Park (Dong Nai province), 11°25'N-107°25'E, 2-3.2009, Forest, Dark loamy soil, Southern Vietnam, 149 m a.s.l. (n=14).

Measurements. 680-747 X 332-365 μ m.

Papillacarus polygonatus Ermilov et Anichkin, 2011, differs from all the known *Papillacarus* species by three types of neotrichous setae, which are only one or two types in other species. Three pairs genital setae considerably long.

The body colour is yellow-brownish. Sculpture covered body foveolate of polygonal and large, forming polygonal network on prodorsum, notogaster, and lateral part of body and anogenital region. Prodorsum roughly triangular in dorsal view, occupying about 1/3 of total body length. Ro., le., in. and both pairs of exobothridial setae long, setiform, thickened, with cilia. Sensilli pectinate. Bothridia funnel-shaped. Only two pairs of transversal bands well developed: S2 complete, S3 medially incomplete. Neotrichous setae of three types: dorsal setae minute, marginal and anoanal setae short, setiform, with long cilia,

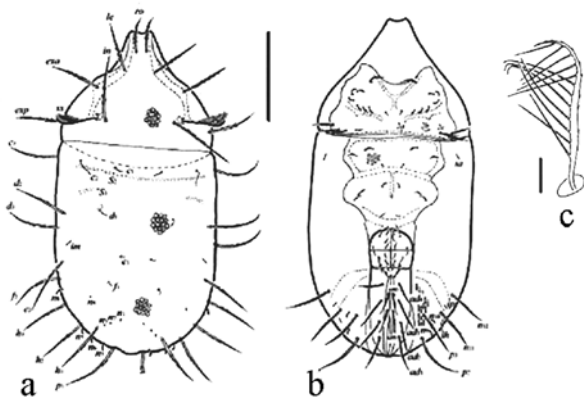


Fig. 6. *Papillacarus polygonatus* (After ERMILOV, ANICHKIN 2011): a. Dorsal side, b. Ventral side, c. Sensillus. Scale bar 200 μm (a, b) and 10 μm (c)

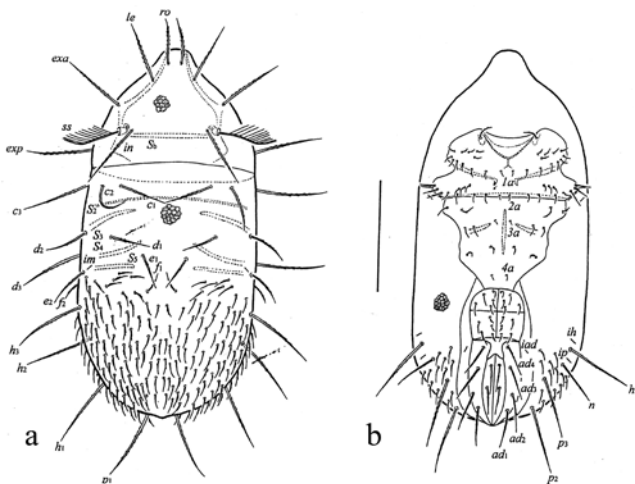


Fig. 7. *Papillacarus polysetosus* (After ERMILOV *et al.* 2012): a. Dorsal side, b. Ventral side. Scale bar 200 μm

and latero-ventral setae long, setiform, thickened, with cilia (ERMILOV, ANICHKIN 2011).

Genital setae heterogeneous. Two pairs of anal and four pairs of adanal setae. Adanal setae longer than anal setae.

General distribution. At present, the species is recorded only from Vietnam.

7. *Papillacarus polysetosus* Ermilov, Anichkin et Wu, 2012 (Fig. 7: a, b)

Papillacarus polysetosus Ermilov, Anichkin et Wu, 2012: Zootaxa 3593: 83-86, figs. 23-35.

Specimens Examined and Ecological Notes. Cave in the Cat Tien National Park (Dong Nai Province) (=Dong Nai Biosphere Reserve), 08.2012, 11°27'N-107°22'E, Southern Vietnam, Ground substratum and semidecayed leaves, 165 m a.s.l. (n=4).

Measurements. 664-680 X 298-315 μm .

Description. Rostrum relatively rounded. Surface of body foveolate.

Notogastral setae short, setiform and ciliate, and more than 80 pairs. Setae c1 and c2, d1 and d2, e1 and e2, f1 and f2 are shorter than others. Prodorsal, anal and adanal setae setiform and ciliate. *Papillacarus polysetosus* is very similar to two Chinese species *P. jinggangshanensis* Chen, Yang et Liang, 2011, and *P. konglinensis* Chen et Yang, 2011. However, *P. polygonatus* clearly differs from both mentioned species by the larger body size, the presence of polygonal ornamentation on prodorsum and notogaster, and longer notogastral setae (ERMILOV *et al.* 2012).

General distribution. At present, the species is recorded only from Vietnam.

8. *Papillacarus ramosus* Balogh, 1961 (Fig. 8: a, b)

Papillacarus ramosus Balogh, 1961; Act. Zool. Hung., VII (1-2) p. 26, figs. 11-12.

Papillacarus ramosus Balogh, 1961; Corpuz-Raros 1979: Philippine Journal Biol. 8(3): 331-332, figs. 23, 26.

Papillacarus ramosus Balogh, 1961; ERMILOV *et al.* 2012: Acarina 20(1): 21.

Specimens Examined and Ecological Notes. Cat Tien National Park (Dong Nai province), 11°26'N-107°26'E, 2-3.2009, Forest, Dark loamy soil, Southern Vietnam, 137 m a.s.l. (n=?).

Measurements. 545-627 X 264X294 μm (Philippine specimens: Corpuz-Raros 1979), and 487 X 226 μm (Indonesian specimens: Balogh 1961).

Description. Notogaster surface covered with extensively neutrichous setae, has long and slender arboriform hairs as well as thick bushy ones. This species differs from all the other species of *Papillacarus* by the interlamellar and lamellar setae being differently shaped. Setae in has three cilia, le setae – four, and ro has a single main stern with many short cilia on both sides. Notogastral setae c1, d1 and e1 are also large and bear several long cilia on each side. The submarginals and marginal are longer, branched, but armed with a few fine barbs basally. The arboriform hairs on neutrichous part are commonly larger and sparser (CORPUZ-RAROS 1979).

General distribution. A Southeast Asian species, ranged in Indonesia, Philippines and Vietnam.

9. *Papillacarus undirostratus* Aoki, 1965 (Fig. 9: a, b, c)

Papillacarus undirostratus Aoki, 1965: Oribatiden (Acarina) Thailand. I, Nat. and Lif. in Southeast Asia, 4: 140-142, Abb.19-20.

Papillacarus undirostratus Aoki, 1965; VU, NGUYEN 2000: Journal of Biosciences 25(4): 382.

Papillacarus undirostratus Aoki, 1965; VU 2009: Vietnam Journal of Biology – TCSH, 31(1): 18-19, figs. 3a, b, c.

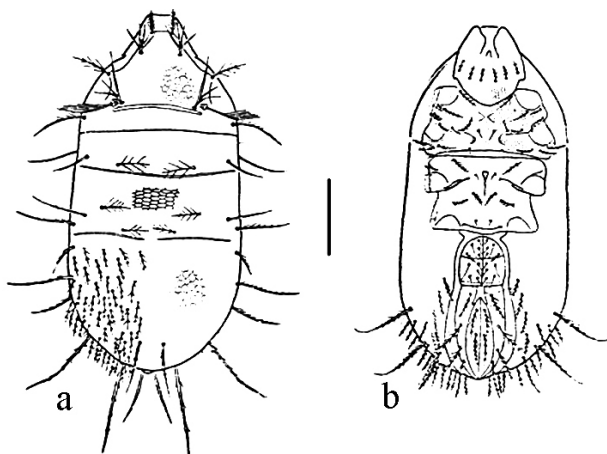


Fig. 8. *Papillacarus ramosus* (After BALOGH 1961): a. Dorsal side, b. Ventral side. Scale bar 120 μ m

Specimens Examined and Ecological Notes.

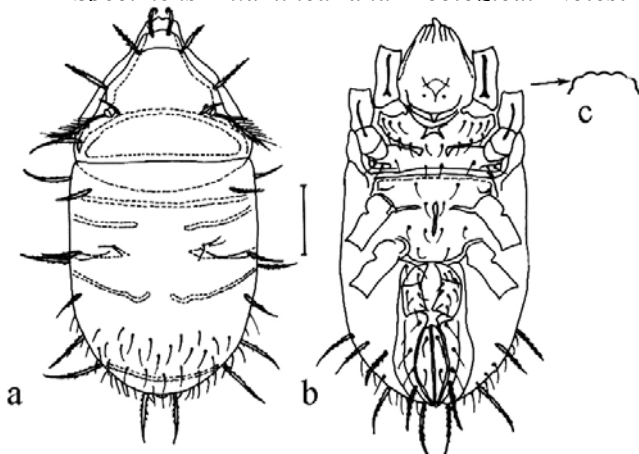


Fig. 9. *Papillacarus undirostratus* (After AOKI 1965): a. Dorsal side, b. Ventral side, c. Rostrum edge. Scale bar 120 μ m

Tam Dao National Park (Vinh Phuc province), 21°27'N-105°38'E, 27.5.1995, Poly-annual cultivated habitat, Ferralitic reddish brown soil, Northeast uplands, 900 m a.s.l., 0-10 cm (n=7).

Measurements. 535-620 X 273-309 μ m, and 533-611 X 270-305 μ m (Thailand specimens: Aoki 1965).

Description. The body is coloured light brown, and in oval form. Body surface not covered with dense papillae. Polygonal network sculpture is unclear. There are four distinct and rounded protrusions in the front edge of the rostrum. Surface of prodorsum with a small, rounded outgrowth. Rostral setae curved. Le. and in. setae are unbranched or with fine branches. Setae c1, d1, e1 tiny and simple. Notogaster has 16 pairs of normal setae.

General distribution. A Southeast Asian species, known from Thailand and Vietnam.

Key to nine *Papillacarus* species known in Vietnam

1. Body length > 500 μ m 2
- Body length < 500 μ m 6
2. Anterior margin of rostrum with four distinct and rounded protrusions. Rostral setae curved. Polygonal network sculpture on the body surface unclear. *undirostratus* Aoki, 1965.
- Anterior margin of rostrum without four distinct and rounded protrusions. Rostral setae not curved. Polygonal network sculpture on the body surface clear 3
3. Anterior margin of rostrum concave..... 4
- Anterior margin of rostrum strongly concave. Neotrichous setae of three types: dorsal setae minute, marginal and ano-adanal setae short, setiform, with long cilia, and latero-ventral setae long, setiform, thickened, with cilia. Notogastral setae c3 considerably longer than setae c2. *polygonatus* Ermilov et Anichkin, 2011.
- Anterior margin of rostrum slightly concave. Neotrichous setae of two types. Notogastral setae c3 is slightly longer than c2. *indistinctus* Ermilov, Anichkin et Wu, 2012.
- 4 Anterior margin of rostrum rounded 5
- Anterior margin of rostrum strongly rounded. In, le and ro setae with single main stem bearing fine cilia on both sides. Notogastral setae short, setiform and ciliate *polysetosus* Ermilov, Anichkin et Wu, 2012.
- Anterior margin of rostrum slightly rounded to straight. In setae with three, le setae with four long main branches, and ro setae have a single main tree-shaped stem. Notogastral setae long and arboriform. *ramosus* Balogh, 1961.
5. Anterior margin of rostrum undulated. In, le and ro setae with single main stem bearing fine cilia on both sides. Surface of body with reticulate sculpturing. *benenensis* Vu, Ermilov et Dao, 2010.
- 6 Body surface covered with polygonal network sculpture, turbeculate-reticulate in large cornutus *cornutus* (Sarkar et Subias, 1984).
- Body surface not covered with polygonal network sculpture, but with dense papillae..... 7
7. Prodorsal surface covered with rough spots. Rostral setae basis lying on transversal line. Sensillus with 7-8 long cilia. Genital setae setiform...*arboriseta* Jeleva et Vu, 1987.
- Prodorsal surface not covered with rough spots, but with fine spots. Rostral setae basis not lying on transversal line. Sensillus with 13-14 short cilia. Genital setae tree-shaped or setiform *hirsutus* (Aoki, 1961).

Conclusions

The distribution of the oribatid mites, the genus *Papillacarus* Kunst, 1959, is restricted mainly to the tropical and subtropical regions. This genus is known with more than 30 species, among them nine species have been recorded from Vietnam. These

nine species all are from the Oriental Region and Southeast Asia, and five of them are recorded only from Vietnam, namely: *P. arboriseta* Jeleva et Vu, 1987, *P. benenensis* Vu, Ermilov et Dao, 2010, *P. indistinctus* Ermilov, Anichkin et Wu, 2012, *P. polygonatus* Ermilov et Anichkin, 2011, and *P. polysetosus* Ermilov, Anichkin et Wu, 2012.

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References

- AOKI J. 1961. Beschreibungen von neuen Oribatiden Japans. – *Japanese Journal of Applied Entomology and Zoology*, **5** (1): 64-69.
- AOKI J. 1965. Oribatiden (Acarina) Thailand. I. – *Nature and Life in Southeast Asia*, 4.
- BALOGH J. 1961. An outline of the family Lohmanniidae Berlese, 1916 (Acari: Oribatei). – *Acta Zoologica Hungarica*, **VII** (1-2): 19-44.
- BALOGH J., P. BALOGH 2002. Identification Keys to the Oribatid Mites of the Extra-Holarctic Regions. 1, Well-Press Publishing Limited. Budapest, 451 p. and 504 p.
- BALOGH J., S. MAHUNKA 1967. New oribatids (Acari, Oribatei) from Vietnam. – *Acta Zoologica Hungarica*, **13** (1-2): 39-74.
- BALOGH J., S. MAHUNKA 1983. The soil mites of the World. 1. Primitive oribatids of the Palaearctic region. Elsevier, Amsterdam, 372 p.
- BERON PETAR 2011. Checklist and Bibliography of the Fauna of Acari (Arachnida) in Bulgaria. Prof. Marin Drinov Academic Publishing House. Bulgaria, 129 p.
- CORPUS-RAROS L.A. 1979. Philippine Oribatei (Acarina). II. Family Lohmanniidae. – *Kalikasan, Philippine Journal Biology*, **8** (3): 315-334.
- CORPUZ-RAROS L. A. 2005. Checklist and bibliography of Philippine Acari (Arachnida), 1844-2005. – *Philippine Entomology*, **19** (2): 99-167.
- DAO DUY TRINH, TRINH THI THU AND VU QUANG MANH 2010. Data of species composition, distribution and zoogeography of oribatid mites (Acari: Oribatida) in the Xuan Son National Park, Phu Tho province. – *Journal of Science*. Vietnam National University, Hanoi, **26** (1): 49-56. (In Vietnamese, English Summary).
- ERMILOV S. G., A. E. ANICHKIN 2011. The oribatid mite families Nanhermanniidae and Lohmanniidae of Cat Tien National Park (Vietnam). – *Acarina*, **19** (2): 231-241.
- ERMILOV S. G., M. Q. VU 2012. Two new species of oribatid mite (Acari: Oribatida) from Phong Nha – Ke Bang National Park of Central Vietnam. – *International Journal of Acarology*, **38** (2): 160-167.
- ERMILOV S.G., A.E. ANICHKIN, D. WU 2012. Two new species of the genus *Papillacarus* (Acari: Oribatida: Lohmanniidae) from caves of Southern Vietnam. – *Zootaxa*, **3593**: 75-88.
- ERMILOV S. G., W. NIEDBALA, A. E. ANICHKIN 2012. Oribatid mites of Dong Nai biosphere reserve (= Cat Tien National Park) of southern Vietnam, with description of a new species of *Pergalunna* (Acari, Oribatida, Galumnidae). – *Acarina*, **20** (1): 20-28.
- ERMILOV S. G., S. SHIMANO, M. Q. VU 2011. Redescription of *Papillacarus hirsutus* with remarks on taxonomical status of *Papillacarus arboriseta* (Acari: Oribatida: Lohmanniidae). – *Acarology*, **51** (2): 155-163.
- GRANDJEAN F. 1950. Etude sur les Lohmanniidae (Oribates, Acariens). – *Archives de Zoologie Experimentale et Generale*, **87** (2): 95-161.
- HAMMER M. 1972. Investigation on the oribatid fauna of Tahiti, and on some oribatids found on the Atoll Rangiroa. – *Det Kongelige Danske Videnskabernes Selskab*, **19** (3): 1-65.
- HASEGAWA M., M. TO, K. KITAYAMA 2006. Community structure of oribatid mites in relation to elevation and geology on the slope of Mount Kinabalu, Sabah, Malaysia. – *European Journal of Soil Biology*, **42** (Suppl. 1): 191-196.
- JELEVA M., M. Q. VU 1987. New Oribatids (Oribatei, Acari) from the Northern part of Vietnam. – *Acta Zoologica Bulgarica*, **33**: 10-18.
- KUNST M. 1959. Bulgarische Oribatiden (Acarina) III. – *Acta Universitatis Carolinae Biologica*, **6** (1): 51-74.
- National Institute for Soils and fertilizers 2002. The basic information of main soil units of Vietnam. Thegioi Publishers. Hanoi, 158 p.
- NGUYEN HAI TIEN, VU QUANG MANH 2012. Species diversity of the oribatid mites community in the Phong Nha – Ke Bang National Park, Quang Binh province. – *Journal of Science*, Vietnam National University, Hanoi, **28** (1): 128-134 (In Vietnamese, English Summary).
- NORTON A. R. 2009. Systematic relationships of Lohmanniidae (Acari: Oribatida). – In: Sabelis M. W., J. Bruin (Eds.): Trends in Acarology. Springer, Netherlands, 9-16.
- SARKAR S., L. S. SUBIAS 1984. New lohmanids (Acarida: Oribatida) from India. *Oriental Insects*, **18**: 25-30.
- SCHATZ, H., R. SCHUSTER 2012. First records of Lohmanniidae (Acari: Oribatida) from the Bermuda Islands. – *Acarologia*, **52** (3): 247-257.
- SUBIAS L. S. 2013. Listado sistemático, sinonímico y biogeográfico de los ácaros oribátidos (Acariformes: Oribatida) del mundo (excepto fósiles) Graellsia 60 (número extraordinario): Online version accessed in May 2013. 570 p; (<http://www.ucm.es/info/zoo/Artropodos/Catalogo.pdf>).
- Vietnam Ministry of Agriculture and Rural Development 2006. Forest area and forest land not used for forestry planning. Agricultural Publishing House, Hanoi, 152 p. (In Vietnamese).
- VU Q. M. 2012. Oribatid soil mite (Acari: Oribatida) of northern Vietnam: Species distribution and densities according to soil and habitat type. – *The Pan-Pacific Entomologist*, **87** (4): 209-222.
- VU Q. M., T. T. NGUYEN 2000. Microarthropod community structures (Oribatei and Collembola) in Tam Dao National Park. – *Journal of Biosciences C* **25** (4): 379-386.
- VU Q. M., S. G. ERMILOV AND T. D. DAO 2010. Two new species of Oribatid Mites (Acari: Oribatida) from Vietnam. – *Vietnam Journal of Biology*, TCSH, **32** (3): 12-19.
- VU QUANG MANH 1990. Microarthropods (Microarthropoda: Oribatei and Collembola) in soil animal community structures of Vietnam. – *Vietnam Journal of Biology*, TCSH, **12** (1): 3-10 (IN VIETNAMESE, ENGLISH SUMMARY).
- VU QUANG MANH 2007. Fauna of Vietnam. Vol. 21: Oribatid Mites (Acari: Oribatida). Hanoi, Vietnamese Academy of Sciences and Science Techniques Publishing House, 355 p. Hanoi (In Vietnamese).
- VU QUANG MANH 2009. Oribatid mite of the Genus *Papillacarus* Kunst 1959 (Acari: Oribatida) in Vietnam. – *Vietnam Journal of Biology*. TCSH 31(1):14-20 (In Vietnamese, English Summary).
- Yin Wenyong et al. (Eds.) 2000. Pictorial Keys to Soil Animals of China. Science Press. Beijing and New York. 727 p.

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