

New Species of Marine Littoral Mites (Acari: Oribatida) from Taiwan and India, with a Key to the World's Species of *Fortuynia* and Notes on Their Distributions

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Badamdorj Bayartogtokh, Tapas Chatterjee, Benny K.K. Chan, and Baban Ingle (2009) New species of marine littoral mites (Acari: Oribatida) from Taiwan and India, with a key to the world's species of *Fortuynia* and notes on their distributions. *Zoological Studies* 48(2): 243-261. Species of the small oribatid mite genus *Fortuynia* (Ameronothroidea: Fortuyniidae) mostly inhabit marine littoral zones in the tropics and subtropics. In the present paper, we describe 2 new species, *Fortuynia taiwanica* sp. nov. and *Fortuynia arabica* sp. nov., collected from the marine coastal areas of Taiwan and India, respectively; the descriptions are based on adult and juvenile specimens. A diagnostic key to the adults of known species of *Fortuynia* in the world is given along with a summary of their geographical distributions. <http://zoolstud.sinica.edu.tw/Journals/48.2/243.pdf>

Key words: Fortuyniidae, New species, Taiwan, India.

Although the majority of oribatid mites inhabit soils and litter of terrestrial ecosystems, some groups have also colonized marine littoral habitats, and those mites, which are restricted to this type of environment, are likely physiologically, ecologically, and morphologically adapted. They subsist on algal sporelings, marine fungi, or detritus, and some may be carnivorous in the intertidal habitats of rocky shores, mangroves, etc. (Luxton 1992). Moreover, some species dwell in crevices of rocks or barnacles and oyster shells, or are associated with green and red algae.

Fortuynia is a small genus of oribatid mites, which was proposed by van der Hammen (1960) with *F. marina* van der Hammen, 1960 as the type species. The following combination of characters can be considered diagnostic characters for

adults of *Fortuynia*: a complex system of tubes or channels present between the bothridia and coxae; vestigial interlamellar and exobothridial setae; notogaster with 14 pairs of setae; 5 pairs of genital setae, 1 pair of aggenital setae, 3 pairs of anal and adanal setae; and monodactylous legs.

All known species of *Fortuynia* have been described or recorded from tropical and subtropical marine littoral zones of the world. Representatives of this genus are widespread throughout the Indo-Pacific region, and currently the genus comprises 7 known species and 2 subspecies, all relatively abundant in marine coastal areas (Marshall and Pugh 2002).

In the present work, we describe 2 new species, collected from the marine littoral of Taiwan and India, based on both adult and immature stage

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materials. Following the description, we discuss aspects of the systematics, distribution, and ecology of the genus, and present a diagnostic key to adults of known species of the world.

MATERIALS AND METHODS

Materials examined in the present study were collected from marine coastal areas of Taiwan and India, among intertidal algae. Specimens were cleared in lactic acid, mounted on temporary slides, and preserved in alcohol. Line drawings were made using a camera lucida attached to a compound microscope (PZO SK 14, in the Department of Zoology, National University of Mongolia). The holotypes of both new species are deposited in the collection of the Division of Insects, Field Museum, Chicago, IL, USA. Paratypes are deposited in the collection of the Department of Zoology, National University of Mongolia, Ulaanbaatar, Mongolia.

Morphological terminology used in this work is based mostly on that developed over many years by Grandjean (e.g., 1955). Unless otherwise noted, measurements are given as a range, with the mean in parentheses, and the measurements are based on the available materials. Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the ventral plate, to avoid discrepancies caused by different degrees of notogastral distension. Notogastral length was also measured in the lateral aspect, from the anterior to the posterior edge; notogastral width refers to the maximum width in the dorsal aspect. Setal formulas of legs are given as numbers per segment for appendages (from trochanter to tarsus), and as the number per podosomal segment (I-IV) for epimeres.

The following abbreviations are used in the text and figure legends: *ro*, rostral seta; *le*, lamellar seta; *in*, interlamellar seta; *ex*, exobothridial seta; *ss*, sensillus; *bo*, bothridium; *ci* and *ce*, internal and external prodorsal ridges, respectively; *c*₁, *da*, *dm*, *dp*, *la*, *lm*, *lp*, *h*₁, *h*₂, *h*₃, *p*₁, *p*₂, and *p*₃, notogastral setae; *ia*, *ih*, *im*, *ip*, and *ips*, notogastral lyrifissures; *gla*, opisthosomal gland opening; *h*, *a*, and *m*, hypostomal setae; *cha* and *chb*, cheliceral setae; *1a*, *1b*, *1c*, *2a*, *3a*, *3b*, *3c*, *4a*, *4b*, and *4c*, epimeral setae; *g*₁, *g*₂, *g*₃, *g*₄, and *g*₅, genital setae; *ag*, aggenital seta; *an*₁ and *an*₂, anal setae; *ad*₁, *ad*₂, and *ad*₃, adanal setae; *iad*, adanal lyrifissure; *v*, *bv*, *d*, *l*, *pl*, *pv*, *s*, *a*, *u*, *p*, *it*, *tc*, and *ft*, leg setae; *φ*, solenidion of leg tibia; *σ*, solenidion of leg genu; *ε*,

famulus of leg I tarsus.

DESCRIPTIONS OF SPECIES

Family Fortuyniidae van der Hammen, 1963

Genus *Fortuynia* van der Hammen, 1960

Fortuynia taiwanica Bayartogtokh, Chatterjee et Chan, sp. nov.

Adult (Figs. 1-3)

Diagnosis: Medium-sized species with general characters of *Fortuynia*. Rostrum very slightly projecting anteroventrally in lateral view, but rounded in dorsal view; prodorsal ridges *ce* and *ci* absent; interlamellar and exobothridial setae vestigial, represented by their alveoli; sensillus with smooth clavate head and long, narrow stalk; notogastral setae *c*₁, *c*₂, and *la* finely barbed, other setae smooth; posterior setae *h*₂ and *p*₁ much longer than other notogastral setae; setae *h*₁, *h*₃, *p*₂, and *p*₃ shortest; genital setae *g*₄ and *g*₅ represented only by their alveoli.

Measurements: Body length of male 427 μm, female 488 μm; length of notogaster of male 378 μm, of female 395 μm; width of notogaster of male 284 μm, of female 311 μm.

Integument: Dark brown. Surface of body and leg segments with thick cerotegument being very finely punctate on dorsal and ventral plates and having rather large granules on venter of pedotectum I, lateral part of prodorsum, and around leg acetabula.

Prodorsum (Figs. 1A, C, 2A): Shape of prodorsum nearly triangular; rostrum rounded in dorsal view, but very slightly projecting anteroventrally in lateral view, its tip not sharp, but blunt. Rostral seta (*ro*) 44-52 μm long, thin, smooth, inserted on anterolateral side of rostrum. Lamellar seta (*le*) nearly as long as *ro*, inserted on dorsolateral side of prodorsum, close to former setae. Interlamellar (*in*) and exobothridial (*ex*) setae vestigial, only their alveoli visible. Sensillus (*ss*) with smooth clavate head and relatively long, narrow, curved stalk, its exposed portion 52-67 μm long. Bothridium (*bo*) irregular funnel-shaped, its posterior part concealed under anterior margin of notogaster. Prodorsal ridges *ce* and *ci* absent.

Notogaster (Figs. 1A-C): Oval in dorsal



Fig. 1. *Fortyunia taiwanica* Bayartogtokh, Chatterjee et Chan, sp. nov. (adult, male). (A) Dorsal view; (B) ventral view; (C) lateral view.

aspect, about 1.3 times as long as wide; lenticulus-like light spot present on anterocentral part of notogaster. Dorsosejugal suture complete, conspicuously arched anteriorly. Fourteen pairs of notogastral setae thin, pointed distally; setae c_1 , c_2 , and la finely barbed, other setae smooth. Setae c_1 , da , dm , la , lm , and lp similar in length, i.e., 72-80 μm long; setae c_2 about 48 μm long, setae dp , h_1 , h_3 , p_2 , and p_3 much shorter than other setae, length of which varies 36-45 μm . Posterior notogastral setae p_1 and h_2 longest, distinctly longer than other setae, length of which varies 122-131 μm . Setae p_2 and p_3 situated on lateroventral side of notogaster, other setae inserted dorsally. Lyrifissures ia , ih , im , ip , and ips well-developed, but small in size as shown in figure 1C. Opisthosomal gland opening (gla) situated between setae lm and lp (close to latter setae), i.e., posterolateral to lyrifissure im , close to lp .

Gnathosoma (Fig. 1B): Subcapitular mentum slightly wider than long, with a few weakly developed microtubercles. Hypostomal seta h about 58 μm long, setae a and m about 29 μm long, all of them thin, smooth. Chelicerae chelate, moderately strong, with a few small blunt teeth; setae cha and chb thin, smooth; Trägårdh's organ inconspicuous. All setae of palp thin, smooth; anteroculminal eupathidium acm not fused to tarsal solenidium ω , but separate; formula of palpal setation: 0-2-1-3-9 including solenidium ω .

Epimeral region (Figs. 1B, C): Surface of epimeral region nearly smooth; epimeral borders well-developed. Epimeral setae medium long, thin; seta $1b$ about 54 μm long, other setae 18-22 μm long; epimeral setal formula: 3-1-3-3. Discidium well-developed, on which epimeral seta $4c$ is inserted. Pedotectum I with large granular tubercles ventrally; pedotectum II small.

Anogenital region (Figs. 1B, C): Genital aperture distinctly larger than anal one; both anal and genital plates smooth. Five pairs of genital and 1 pair of aggenital setae thin, smooth, 17-20 μm long; g_4 and g_5 represented by their alveoli. Two pairs of anal and 3 pairs of adanal setae thin, smooth; ad_1 74-78 μm , other anal and adanal setae 33-36 μm long. Adanal lyrifissure iad situated in paranal position, at level a little anterior to setae an_1 .

Legs (Figs. 2B, C, 3): Claws of all legs rather thick, dorsal edge sclerotized and brown. Femora I-IV and trochanters III and IV with narrowly elongated porose areas. Trochanter IV with distinct dorsodistal projection in front of setal alveolus d . Most of leg setae conspicuously

barbed, except a few setae of trochanters and femora. Setae l' of genu, v' of tibia and pv' of tarsus of leg IV strongly thickened, with dense barbs; other setae thin, pointed distally. Formulae of leg setation (including famulus): I (1-4-2-3-18); II (1-4-2-3-15); III (2-3-1-3-15); IV (2-2-2-3-12); formulae of solenidia: I (1-2-2); II (1-1-2); III (1-1-0); IV (0-1-0).

Materials examined: Holotype (δ) and 1 paratype (φ): He-Ping Island, coast of the Pacific Ocean, northeast of Taiwan, 25°09'45"N, 121°45'46"E, from intertidal coralline algae on exposed rocky shores, 6 Mar. 2007, Col. B. K.K. Chan.

Protonymph (Figs. 4, 5)

Measurements: Body length 277 μm ; length of notogaster 195 μm ; width of notogaster 192 μm .

Integument: Yellowish-brown. Body and leg segments covered with thin, smooth cerotegument, and small granules present on lateral part of prodorsum and around leg acetabula.

Prodorsum (Figs. 4A, C): Shape of prodorsum nearly triangular; rostrum rounded in dorsal view, but distinctly projecting anteroventrally in lateral view. Rostral seta thin, smooth, inserted on dorsal side of rostrum close to each other. Lamellar seta short, less than 1/2 length of ro , inserted dorsally on prodorsum. Interlamellar and exobothridial setae vestigial, only their alveoli present. Sensillus with smooth clavate head and short, curved stalk. Bothridium small, irregular funnel-shaped.

Notogaster (Figs. 4A-C): Nearly as long as wide; dorsosejugal suture complete, triangularly arched anteriorly. Fifteen pairs of notogastral setae thin, pointed distally; setae c_1 , da , la , lm , and h_2 very finely barbed unilaterally, other setae smooth. Setae c_1 , da , dm , la , lm , and h_2 moderately long, similar in length; setae c_2 , c_3 , dp , lp , h_1 , and h_3 short, much shorter than other setae; setae p_2 and p_3 moderately long, situated on ventral side of notogaster. Lyrifissures and opisthosomal gland opening absent.

Gnathosoma (Figs. 4B, D, 5E): Subcapitular mentum much wider than long, without microtubercles. Hypostomal setae h , a , and m short, thin, smooth. Chelicerae chelate, with a few small blunt teeth; setae cha and chb moderately long, thin, smooth; Trägårdh's organ inconspicuous (Fig. 5E). Palpal setae thin, smooth; anteroculminal eupathidium acm not fused to tarsal solenidium ω ; formula of palpal setation: 0-2-1-3-9 including solenidium ω (Fig. 4D).

conspicuously barbed. Formulae of leg setation (including famulus): I (0-2-2-3-15); II (0-2-1-3-13); III (0-2-1-1-13); IV (0-0-0-0-7); formulae of solenidia: I (1-1-2); II (1-1-2); III (1-1-0); IV (0-0-0).

Material examined: One specimen: same data as for adults.

Deutonymph (Figs. 6, 7)

Measurements: Body length 366 μm ; length of notogaster 308 μm ; width of notogaster 229 μm .

Integument: Yellowish-brown, body and leg segments covered with thin, smooth cerotegument,

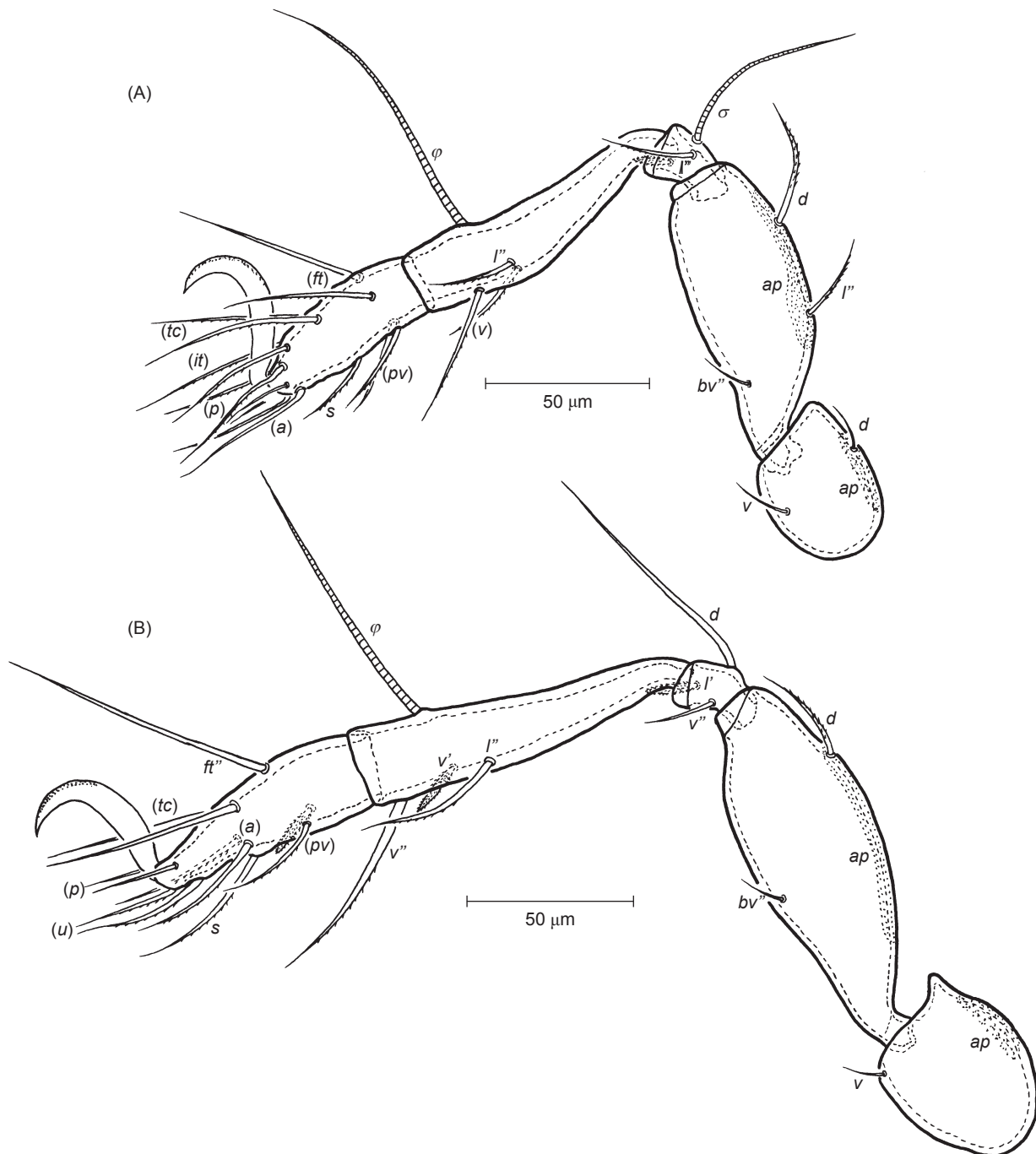


Fig. 3. *Fortuynia taiwanica* Bayartogtokh, Chatterjee et Chan, sp. nov. (adult, male). (A) Leg III (right, antiaxial view); (B) leg IV (right, antiaxial view).

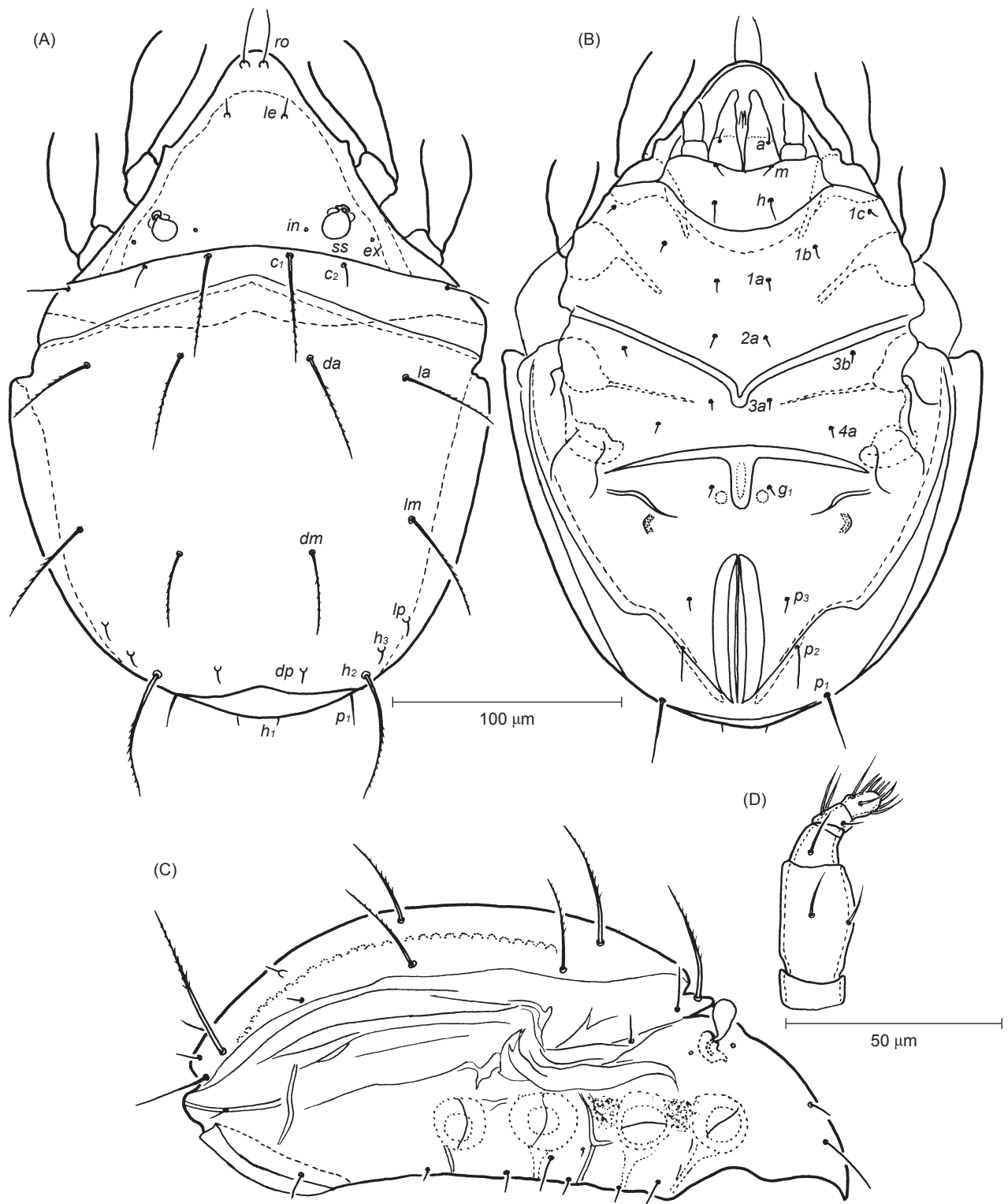


Fig. 4. *Fortuynia taiwanica* Bayartogtokh, Chatterjee et Chan, sp. nov. (protonymph). (A) Dorsal view; (B) ventral view; (C) lateral view; (D) palp (right, antiaxial view).

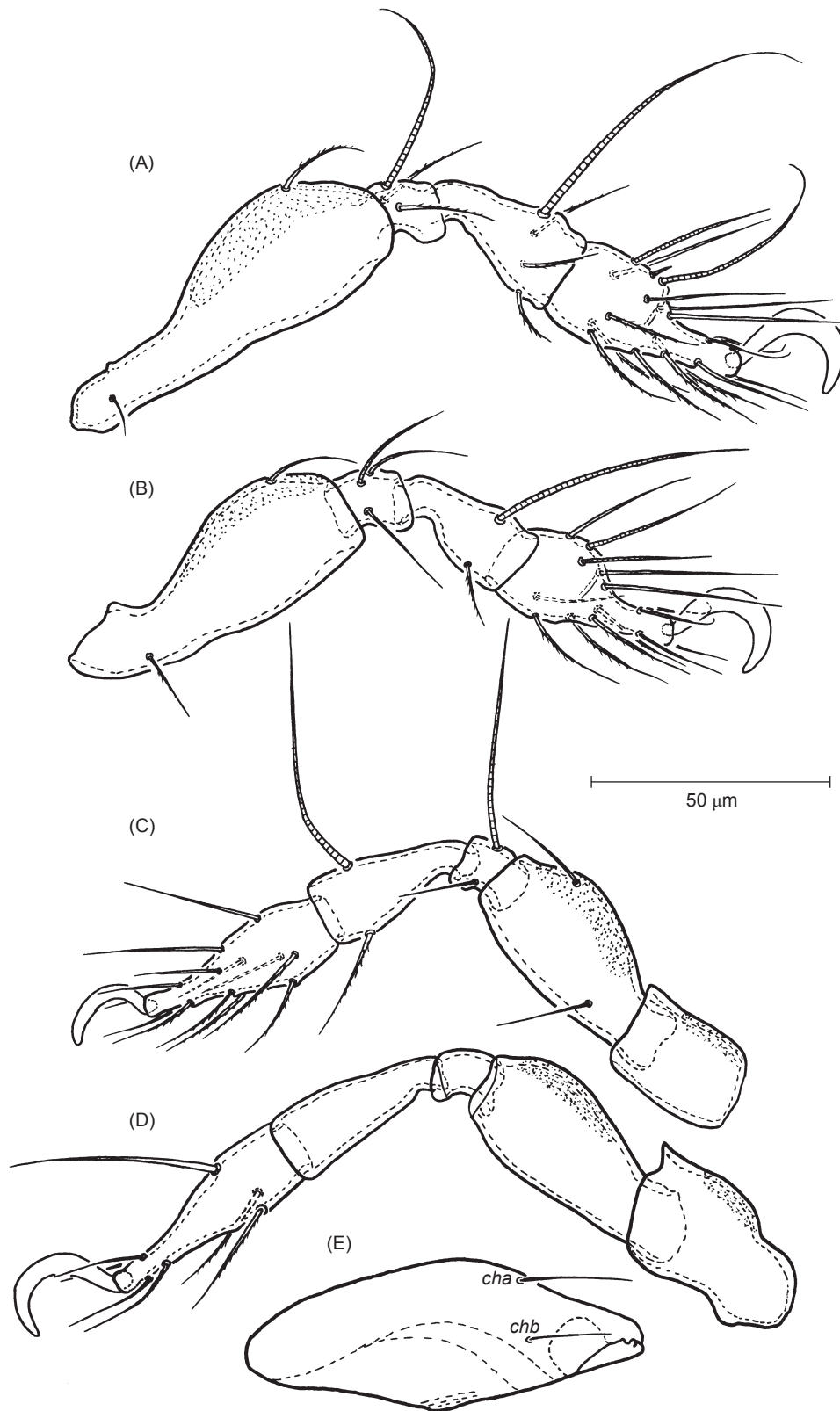


Fig. 5. *Fortuynia taiwanica* Bayartogtokh, Chatterjee et Chan, sp. nov. (protonymph). (A) Leg I (right, antiaxial view, trochanter omitted); (B) leg II (right, antiaxial view, trochanter omitted); (C) leg III (right, antiaxial view); (D) leg IV (right, antiaxial view); (E) chelicera (right, antiaxial view).



Fig. 6. *Fortuynia taiwanica* Bayartogtokh, Chatterjee et Chan, sp. nov. (deutonymph). (A) Dorsal view; (B) ventral view; (C) lateral view.

and small granules present on lateral part of prodorsum.

Prodorsum (Figs. 6A, C): Rostral and lamellar setae similar to those of protonymph; interlamellar and exobothridial setae vestigial. Sensillus relatively small, with smooth clavate head.

Notogaster (Figs. 6A-C): As long as wide; dorsosejugal suture complete, triangularly arched anteriorly; anterolateral ends of notogaster projecting laterally. Fourteen pairs of notogastral setae similar in size to those of protonymph, but seta p_3 absent, seta dm relatively short.

Gnathosoma (Fig. 6B): Hypostomal setae, chelicera, and palp same as those of protonymph.

Epimeral region (Fig. 6B, C): Sejugal and 4th epimeral borders strongly developed, 2nd and 3rd apodemes stronger than in protonymph. Epimeral setal formula: 3-1-2-2.

Anogenital region (Figs. 6B, C): Genital plates incompletely developed. Anterior genital papilla small, posterior papilla large; 2 pairs of short genital setae present. Anal plates well developed; anal setae absent, 3 pair of adanal setae short, thin.

Legs (Fig. 7): Trochanters III and IV with distinct dorsodistal projections. All leg setae thin, pointed distally, and most of ventral setae conspicuously barbed. Formulae of leg setation (including famulus): I (0-1-2-3-15); II (0-1-2-3-13); III (1-2-1-1-13); IV (0-2-2-1-10); formulae of solenidia: I (1-1-2); II (1-1-1); III (1-1-0); IV (0-1-0).

Material examined: One specimen: same data as for adults.

Remarks: Adults of *Fortuynia taiwanica* sp. nov. can be easily distinguished from those of most other species of *Fortuynia* by the absence of the prodorsal ridges ce and ci , and the relatively short notogastral setae c_1 , c_2 , and dp . According to their original descriptions, the majority of known species, such as *F. maculata* Luxton, 1986, *F. marina* van der Hammen, 1960, *F. inhambanensis* Marshall & Pugh, 2000, *F. rotunda* Marshall & Pugh, 2000, and *F. yunkerii* van der Hammen, 1963 bear either both of these ridges or at least one of them.

Only 3 known taxa, namely *F. elamellata* Luxton, 1967, *F. elamellata shibai* Aoki, 1974, and *F. sinensis* Luxton, 1992, have no prodorsal ridges as does the new species described here. However, the 1st species, *F. elamellata* described by Luxton (1967) from New Zealand, differs from *F. taiwanica* sp. nov. in the very long notogastral setae c_1 and da as opposed to moderately long setae in the new species, the presence of well-

developed genital setae g_4 and g_5 in contrast to vestigial setae in the new species, and a different situation of the aggenital and adanal setae ad_2 , and the notogastral setae da and la (in *F. elamellata* aggenital seta is inserted at the level posterior to genital seta g_4 , but in the new species seta ag is anterior to g_4 ; adanal seta ad_2 is situated at the same level as the adanal lyrifissure, but in the case of *F. taiwanica* sp. nov. seta ad_2 is situated far anterior to iad ; and notogastral seta da is situated at the level anterior to la , but this seta is controversially situated in the new species).

The Japanese subspecies, *F. elamellata shibai* described by Aoki (1974) can be distinguished from *F. taiwanica* sp. nov. by the much longer notogastral setae c_1 , dp , and h_1 as opposed to shorter setae in the new species; longer epimeral and genital setae as opposed to shorter setae in new species; and a different arrangement of adanal seta ad_2 .

Fortuynia sinensis, described by Luxton (1992) from the Hong Kong shore, differs from this new species in the conspicuously prominent rostrum as opposed to the rounded rostrum in the new species; long setae dp and h_1 of the notogaster rather than very short setae in new species; and relatively short notogastral setae p_1 and h_2 in contrast to the very long setae p_1 and h_2 in the new species.

Etymology: The specific name "*taiwanica*" refers to the name of the country, Taiwan, which encompassing the type locality of this species.

***Fortuynia arabica* Bayartogtokh, Chatterjee et Ingole, sp. nov.**

Adult (Figs. 8, 9)

Diagnosis: Medium-sized species with general characters of *Fortuynia*. Rostrum distinctly projecting anteroventrally in lateral view, but rounded in dorsal view; prodorsal ridges ce and ci absent; interlamellar and exobothridial setae vestigial; sensilli with densely barbed clavate head and moderately long, narrow stalk; notogastral setae thin, smooth; setae h_1 , p_2 , and p_3 much shorter than other notogastral setae; setae h_2 longest.

Measurements: Body length 409-451 (425) μm ; length of notogaster 323-348 (338) μm ; width of notogaster 253-281 (263) μm . Only male specimens available.

Integument: Dark brown. Surface of body

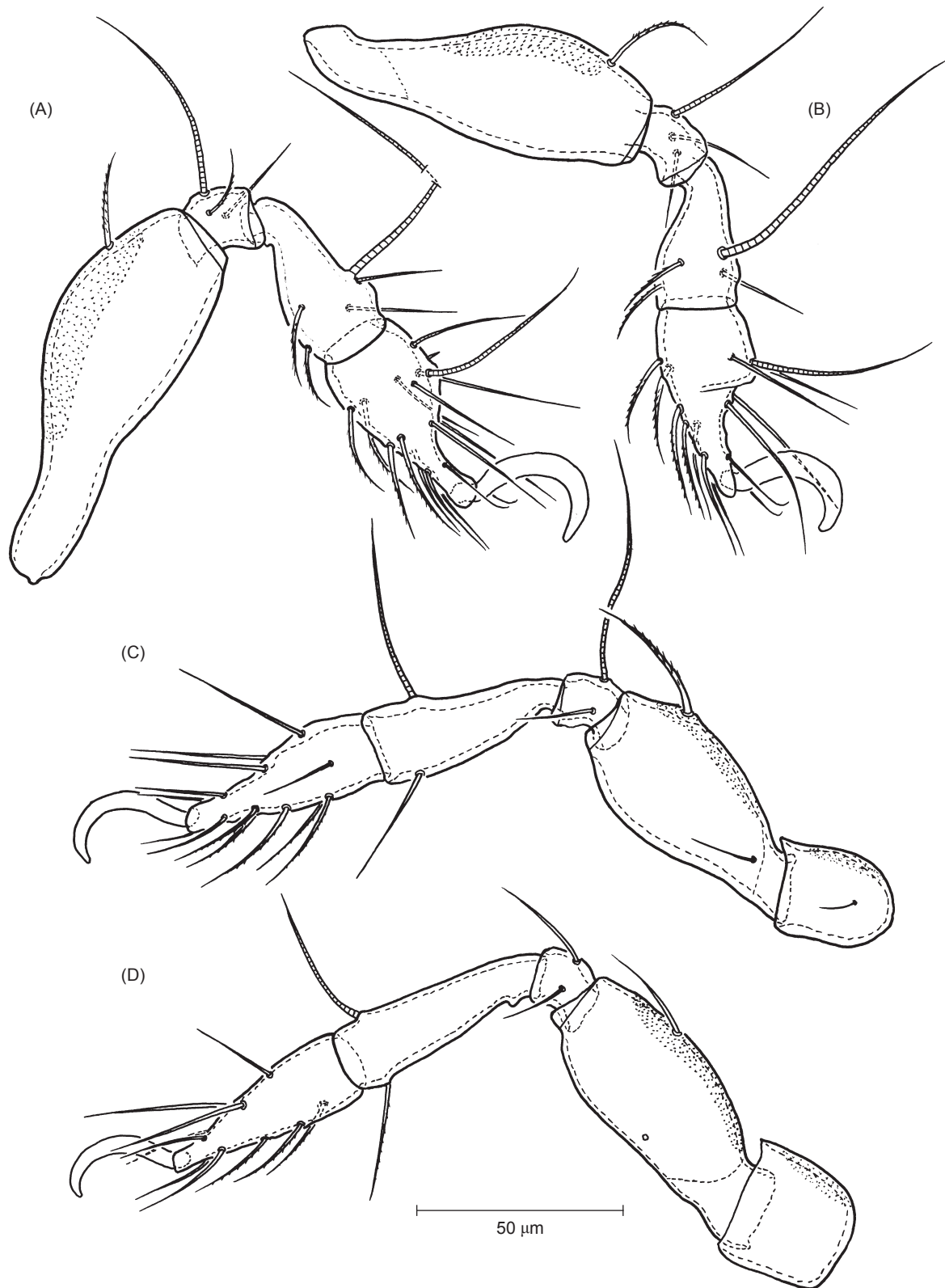


Fig. 7. *Fortuynia taiwanica* Bayartogtokh, Chatterjee et Chan, sp. nov. (deutonymph). (A) Leg I (right, antiaxial view, trochanter omitted); (B) leg II (right, antiaxial view, trochanter omitted); (C) leg III (right, antiaxial view); (D) leg IV (right, antiaxial view). One of the setae of femur IV was broken, hence only its alveolus is illustrated.

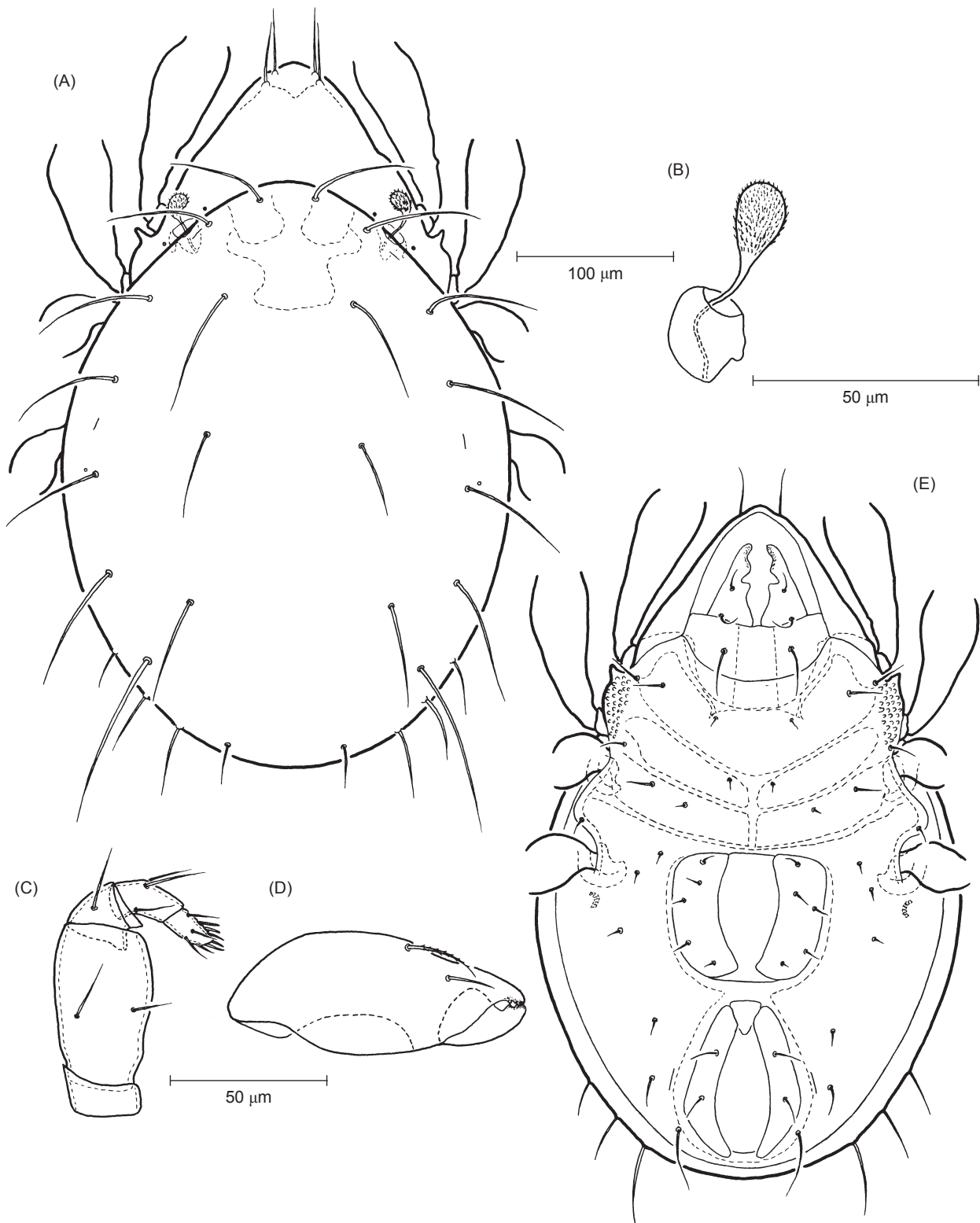


Fig. 8. *Fortuynia arabica* Bayartogtokh, Chatterjee et Ingole, sp. nov. (adult, male). (A) Dorsal view; (B) sensillus and bothridium; (C) palp (right, antiaxial view); (D) chelicera (right, antiaxial view); (E) ventral view.

and leg segments with thick cerotegument being very finely punctate on dorsal and ventral plates and having rather large granules on venter of pedotectum I, on lateral part of prodorsum, and around leg acetabula.

Prodorsum (Figs. 8A, B, 9A): Rostrum rounded in dorsal view, but conspicuously projecting anteroventrally in lateral view. Rostral seta 52–58 μm long, thin, smooth, inserted on anterolateral side of rostrum. Lamellar seta 49–55 μm long, inserted on dorsolateral side of prodorsum. Interlamellar and exobothridial setae vestigial, only their alveoli visible. Sensillus with densely barbed clavate head and moderately long stalk; its exposed portion 35–42 μm long. Bothridium irregular funnel-shaped, its posterior part concealed under anterior margin of notogaster. Prodorsal ridges *ce* and *ci* absent.

Notogaster (Figs. 8A, 9A): Oval in dorsal aspect, about 1.3 times as long as wide; lenticulus-like light spot weakly developed on the anteroventral part of notogaster. Dorsosejugal suture complete, conspicuously arched anteriorly. Fourteen pairs of notogastral setae thin, smooth; setae *h*₁, *p*₂, and *p*₃ much shorter than other setae, *h*₂ longest, about mm 118 long; other setae similar in length, i.e., 78–93 μm long. Lyrifissures *ia*, *ih*, *im*, *ip*, and *ips* well developed, but small. Opisthosomal gland opening (*gla*) situated anterolateral to setae *ip*.

Gnathosoma (Figs. 8C–E): Infracapitular mentum wider than long, without microtubercles. Hypostomal seta *h* about 40 μm long, seta *a* 37 μm , and seta *m* 29 μm long, all of them thin, smooth. Chelicerae chelate, moderately strong, with a few small blunt teeth; setae *cha* moderately

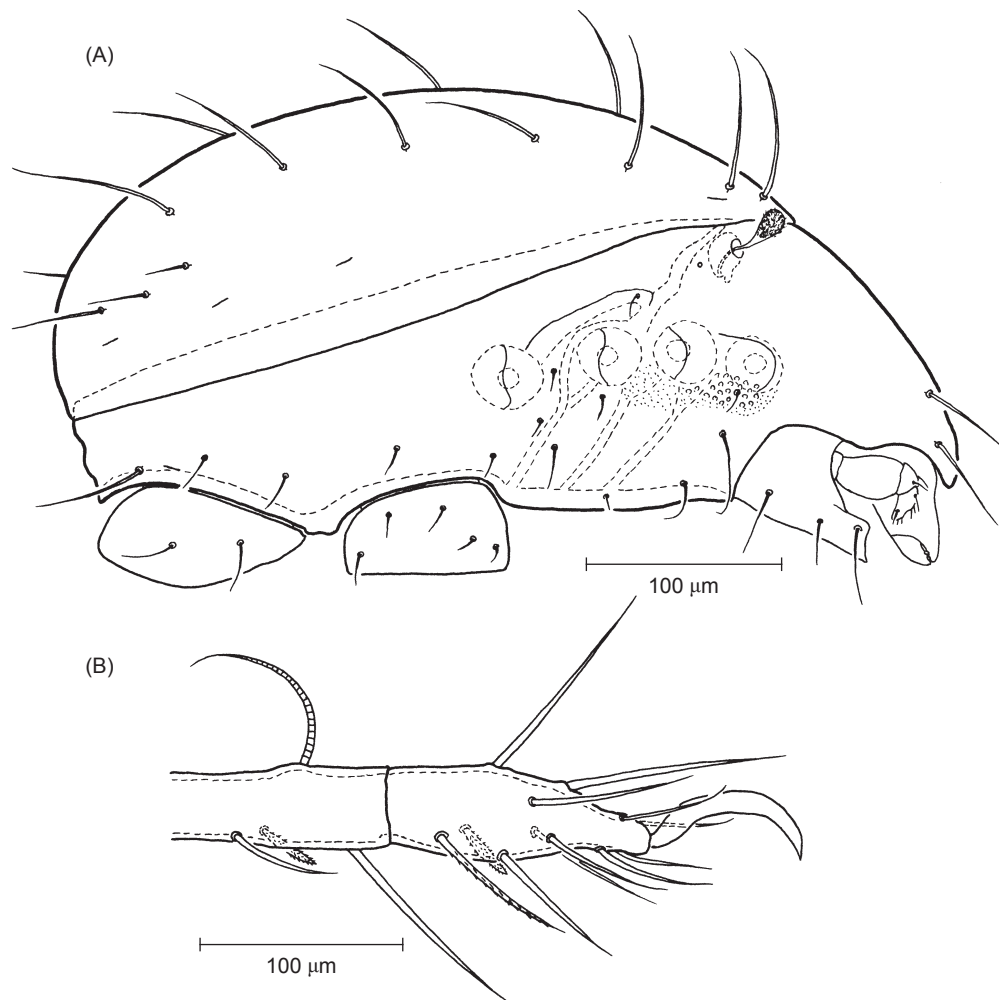


Fig. 9. *Fortuynia arabica* Bayartogtokh, Chatterjee et Ingole, sp. nov. (adult, male). (A) Lateral view; (B) tarsus and distal part of tibia leg IV (right, antiaxial view).

long, finely barbed; *chb* short, smooth; Trägårdh's organ inconspicuous (Fig. 8D). All setae of palp thin, smooth; anteroculminal euphathidium *acm* not fused to tarsal solenidion ω ; formula of palpal setation: 0-2-1-3-9 including solenidion ω (Fig. 8C).

Epimeral region (Fig. 8E): Surface of epimeral region smooth; epimeral borders well developed. Epimeral setae moderately long, thin; seta *1b* about 54 μm long, other setae 18-22 μm long; epimeral setal formula: 3-1-3-3. Discidium well developed. Pedotectum I with large granular tubercles ventrally; pedotectum II small.

Anogenital region (Fig. 8E): Genital aperture distinctly wider, but shorter than anal aperture; both anal and genital plates smooth. Five pairs of genital and 1 pair of aggenital setae short, thin, smooth. Anal setae 25-28 μm long, adanal setae *ad*₂ and *ad*₃ 22-25 μm ; *ad*₁ 46-52 μm long. Adanal lyrifissure *iad* situated in paranal position, at same level as adanal seta *ad*₂.

Legs: Claws of all legs rather thick. Femora I-IV and trochanters III and IV with narrowly elongated porose areas. Trochanter IV with distinct dorsodistal projection. Setation of legs similar to that of former species. Most of leg setae conspicuously barbed, except a few setae of trochanters and femora. Setae *l'* of genu, *v'* of tibia, and *pv'* of tarsus of leg IV strongly thickened, with dense barbs; other setae thin, pointed distally (Fig. 9B). Formula of leg setation (including famulus): I (1-4-2-3-18); II (1-4-2-3-15); III (2-3-1-3-15); IV (1-2-3-3-12); formula of solenidia: I (1-2-2); II (1-1-2); III (1-1-0); IV (0-1-0).

Materials examined: Holotype (δ) and 3 paratypes (δ): Anjuna Beach, Goa, West coast of India, Arabian Sea, 15°34'05"N, 78°44'28"E, from intertidal algae on exposed rocky shores, 3 June 2007, Coll. T. Chatterjee and B. Ingole.

Deutonymph (Fig. 10)

Measurements: Body length 381 μm ; length of notogaster 320 μm ; width of notogaster 232 μm .

Integument: Dark brown, body and leg segments covered with thick, smooth cerotegument; small granules present on lateral part of prodorsum.

Prodorsum (Fig. 10A): Rostral setae 32 μm long, thin, smooth, inserted in distinct tubercles. Lamellar seta as long as *ro*, inserted dorsally on prodorsum. Interlamellar and exobothridial setae vestigial. Sensillus with smooth clavate head and short stalk; bothridium small.

Notogaster (Figs. 10A, B): Oval in dorsal aspect, about 1.3 times as long as wide; dorsosejugal suture complete, broadly rounded anteriorly. Only 10 pairs of notogastral setae (some of which were broken); setae *c*₁, *c*₂, *da*, and *dp* absent; setae *c*₃ and *dm* about twice as long as posterior notogastral setae; alveolus of seta *p*₂ situated on ventral side of notogaster. Lyrifissures and opisthosomal gland opening absent.

Gnathosoma (Fig. 10B): Hypostomal setae *h* and *a* moderately long, smooth; seta *m* vestigial. Structures of chelicera and palp similar to those of the deutonymph of former species; formula of palpal setation: 0-2-1-3-9 including solenidion ω .

Epimeral region (Fig. 10B): Sejugal and 4th epimeral borders strongly developed; other epimeral borders incomplete. Epimeral setae short, thin; epimeral setal formula: 3-1-2-2.

Anogenital region (Fig. 10B): Anal aperture larger than genital one; genital plates incompletely developed. In single examined specimen, 3 pairs of genital setae irregularly situated. Anal plates well developed; 2 pairs of anal and 3 pairs of adanal setae, some setae vestigial. Adanal lyrifissure *iad* situated at level anterior to anal aperture.

Legs (Figs. 10C-F): Distal segments of most legs broken in single specimen studied here, also some setae of available segments broken. Therefore, we could not examine the details of all leg setation. Claws of leg II rather thick, blunt at tip. Structure and setation of leg II and some proximal segments of other legs are illustrated.

Material examined: One specimen: same data as for adults.

Tritonymph (Figs. 11, 12)

Measurements: Body length 432 μm ; length of notogaster 346 μm ; width of notogaster 347 μm .

Integument: Yellowish-brown, body and leg segments covered with thin, smooth cerotegument, and small granules present on lateral part of prodorsum.

Prodorsum (Figs. 11A, C): Rostral seta 42 μm long; lamellar seta 38 μm long, both inserted dorsally on small tubercles. Interlamellar and exobothridial setae not vestigial, but minute. Sensillus with smooth capitate head and short stalk; bothridium small.

Notogaster (Figs. 11A-C): Nearly as long as wide; dorsosejugal suture complete, almost straight and very slightly arched anteriorly; anterolateral

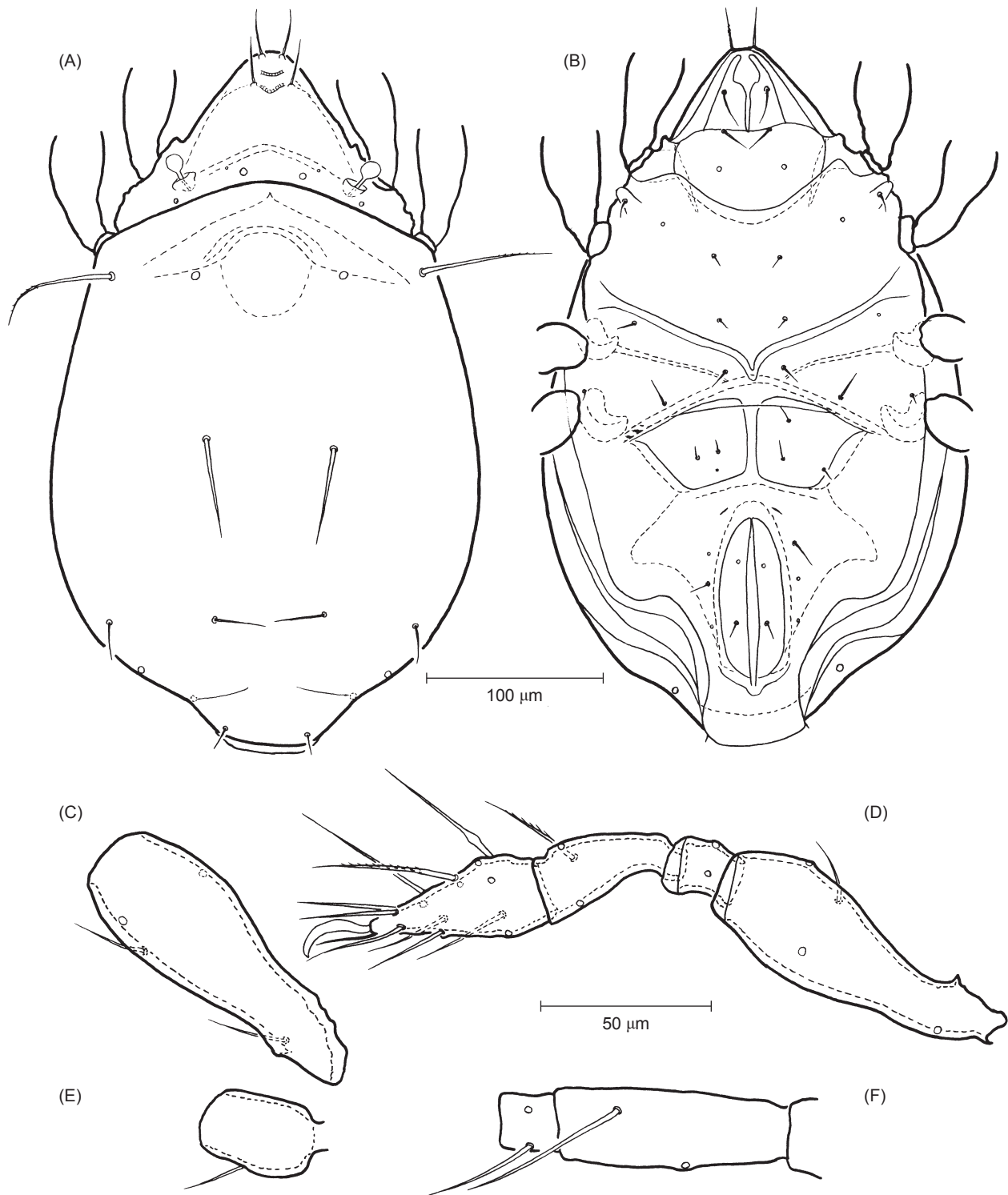


Fig. 10. *Fortuynia arabica* Bayartogtokh, Chatterjee et Ingole, sp. nov. (deutonymph). (A) Dorsal view; (B) ventral view; (C) femur of leg I (right, antiaxial view); (D) leg II (right, antiaxial view, trochanter omitted); (E) femur of leg III (right, antiaxial view); (F) femur and genu of leg IV (right, antiaxial view). Some of the leg setae were broken, so only their alveoli are illustrated.



Fig. 11. *Fortuynia arabica* Bayartogtokh, Chatterjee et Ingole, sp. nov. (tritonymph). (A) Dorsal view; (B) ventral view; (C) lateral view.

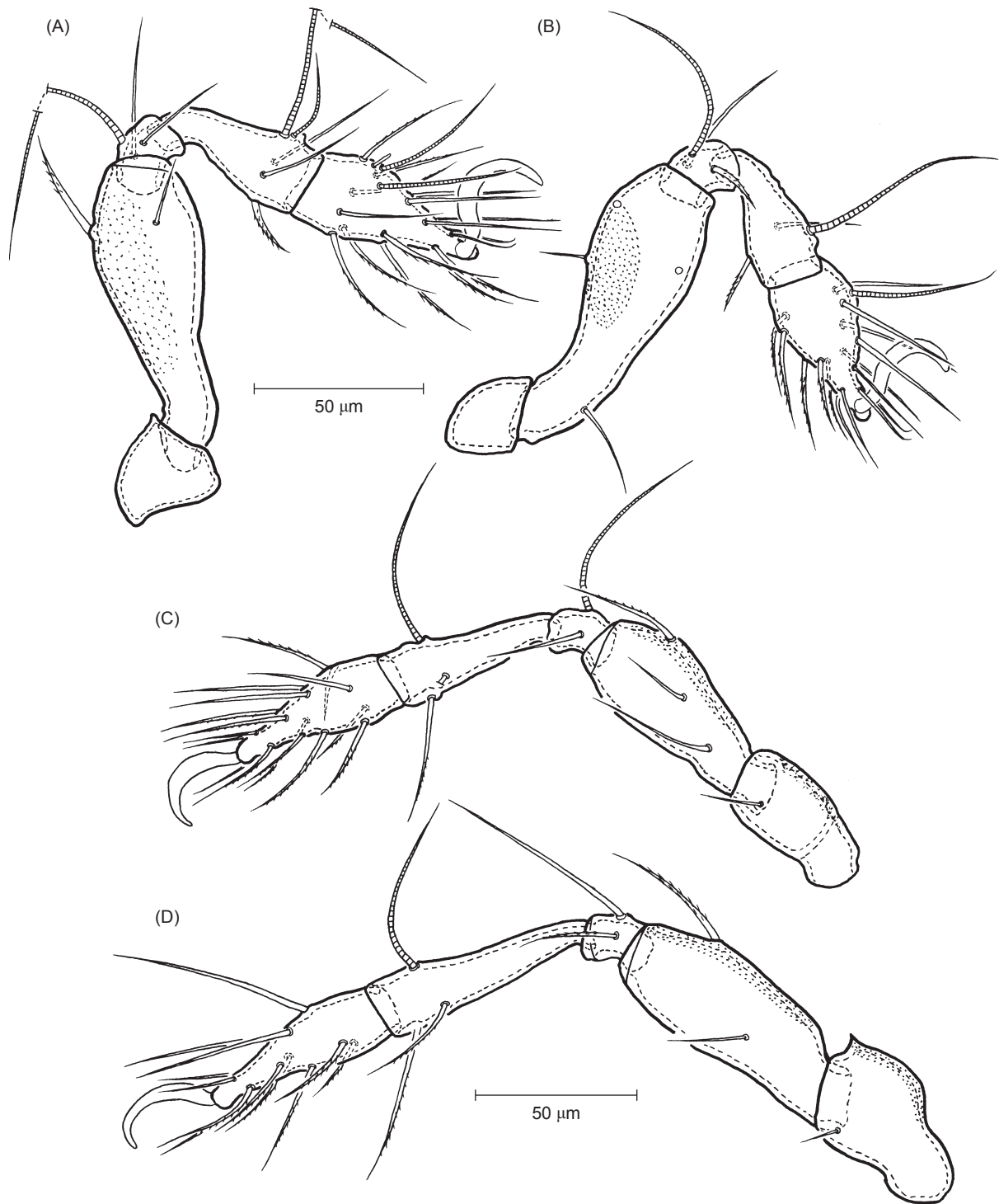


Fig. 12. *Fortuynia arabica* Bayartogtokh, Chatterjee et Ingole, sp. nov. (tritonymph). (A) Leg I (right, antiaxial view); (B) leg II (right, antiaxial view); (C) leg III (right, antiaxial view); (D) leg IV (right, antiaxial view). Some of the setae of femur II were broken, so only their alveoli are illustrated.

ends of notogaster with small projections laterally. Fifteen pairs of notogastral setae thin, smooth; setae lp and h_2 longest, 78-102 μm long; setae h_1 , p_1 , and p_2 relatively short (13-28 μm); other setae similar in length (51-70 μm). Lyrifissures and opisthosomal gland opening absent.

Gnathosoma (Fig. 11B): Hypostomal setae h , a , and m moderately long, smooth. Chelicerae chelate, with a few blunt teeth; setae cha and chb thin, smooth; Trägårdh's organ inconspicuous. Palpal setae thin, smooth; anteroculminar eupathidium acm not fused to tarsal solenidium ω ; formula of palpal setation: 0-2-1-3-9 including solenidium ω .

Epimeral region (Fig. 11B): Sejugal and 4th epimeral borders strongly developed; other epimeral borders incomplete. Epimeral setal formula: 3-1-3-3.

Anogenital region (Fig. 11B): Anal aperture much larger than genital one; genital plates incompletely developed. Oblique-transversal border framing the genital region posteriorly. Anterior 2 genital papillae rounded, posterior papilla oval; 4 pairs of genital setae and 1 pair of aggenital setae short, smooth. Anal plates well developed; 2 pairs of anal and 3 pairs of adanal setae 19-25 μm long except for longest setae ad_1 , at 48 μm long. Adanal lyrifissure not evident.

Legs (Fig. 12): Claws of all legs thick, blunt at tip. Femora I-IV and trochanters III and IV with large porose areas. Trochanter IV with distinct dorsodistal projection. All leg setae thin, pointed distally and most of ventral setae conspicuously barbed; some setae vestigial. Formulae of leg setation (including famulus): I (0-2-2-3-17); II (0-4-2-2-15); III (1-3-1-2-15); IV (2-2-2-2-12); formulae of solenidia: I (1-2-2); II (1-1-1); III (1-1-0); IV (0-1-0).

Material examined: One specimen: same data as for adults.

Remarks: The adult of *Fortuynia arabica* sp. nov. is easily distinguished from those of all other species of *Fortuynia* by the densely barbed sensilli as opposed to the smooth sensilli in all known species, and the absence of prodorsal ridges ce and ci .

The present new species can also be distinguished from another new species described here, *F. taiwanica* by the much longer notogastral setae c_2 , dp , and h_1 as opposed to the very short setae in the compared species; a much shorter notogastral seta p_1 rather than a long p_1 in *F. taiwanica*, and more posterior situation of adanal seta ad_2 in contrast to the anterior situation of that

seta in the *F. taiwanica*.

Etymology: The specific name "*arabica*" refers to the Arabian Sea, on which the type locality borders.

DISCUSSION

Grandjean (1955) established the family Podacridae within the superfamily Ameronothroidea, to accommodate his newly established genus, *Podacarus*. In his initial description of the genus *Fortuynia*, van der Hammen (1960) noted certain differences between his newly proposed genus and the 2 other existing families, the Podacaridae and Ameronothridae, and he concluded that the differences, though important, did not justify the creation of a new family. Thus, he included *Fortuynia* in the family Podacaridae.

However, van der Hammen (1963) later described a 2nd species of this genus, *F. yunkerii*, based on adult and immature stages. In the light of new information on developmental stages of *Fortuynia*, van der Hammen (1963) reviewed his earlier decision comparing it again to the Podacaridae and Ameronothridae, and established the new family, Fortuyniidae.

Wallwork (1963) recognized the placement of *Fortuynia* in the Fortuyniidae, but subsequently he did not follow this concept in his redefinition of the Podacaridae (Wallwork 1964). Balogh (1965) assigned *Fortuynia* to the Podacaridae, apparently regarding its differences as being of generic significance only. Luxton (1967) analyzed the main characters of *Fortuynia*, comparing them to those of the families Podacaridae and Ameronothridae, and he justified the validity of the family Fortuyniidae. With such different assignments in classifying this group, further detailed studies on the structure and development of various species of the group are important in order to arrive at a satisfactory classification.

Concerning the distribution of members of *Fortuynia*, the geographical ranges of most species are mainly coastal areas of the Indo-Pacific Oceans. Thus, *F. sinensis* and *F. elamellata shibai*, *F. taiwanica* sp. nov., and *F. arabica* sp. nov. are found in the Indo-Malaysian Region. Two species, *F. marina* and *F. elamellata*, are recorded in the Oceania Region, while *F. yunkerii* is known only in the Nearctic Region. Four other taxa, *F. maculata*, *F. inhambanensis*, *F. rotunda*, and *F. elamellata micromorpha* are distributed in the Afrotropical Region (van der Hammen 1960 1963, Luxton

1967 1986 1990 1992, Aoki 1974, Marshall and Pugh 2002). In addition, *F. rotunda* was recently reported from southern Japan (Karasawa and Aoki 2005).

In conclusion, the following key can be used to identify adults of all known species of this genus.

Key to adults of the world's species and subspecies of the genus *Fortuynia*

1. Either external or internal ridges (*ce* and *ci*) of prodorsum present 2
 - Both external and internal ridges of prodorsum absent .. 7
2. External ridge (*ce*) present on prodorsum; sensillus straight or gently curved 3
 - External ridge absent from prodorsum; sensillus sharply incurved 6
3. Both external and internal ridges present; posterior notogastral setae extremely short. 4
 - Only external ridge (*ce*) present; all notogastral setae long 5
4. Internal ridge (*ci*) reaching alveolus of interlamellar seta; all ventral setae short; vestigial *c*₃ present; notogastral seta *la* situated anterior to seta *da*
 - *F. marina* van der Hammen, 1960
 - Internal ridge (*ci*) not reaching interlamellar vestige; ventral setae long; *c*₃ vestige absent; notogastral seta *la* situated at same level or posterior to seta *da*
 - *F. rotunda* Marshall & Pugh, 2002
5. Setae *c*₁ as long as distance between their alveoli; epimeral, genital and aggenital setae short, anal and adanal setae slightly longer; vestige of *c*₃ absent; notogastral seta *la* situated posterior to seta *da*; adanal seta *ad*₂ situated anterior to lyrifissure *iad*
 - *F. yunker* van der Hammen, 1963
 - Setae *c*₁ nearly twice as long as distance between their alveoli; all ventral setae long; vestigial *c*₃ present; notogastral seta *la* situated at same level or anterior to seta *da*; adanal seta *ad*₂ situated at same level as lyrifissure *iad* *F. maculata* Luxton, 1986
6. Distance between alveoli of setae *c*₁ and *c*₁ more than double that between those of setae *c*₁ and *c*₂; aggenital seta absent; lamellar ridge present; adanal seta *ad*₂ situated anterior to lyrifissure *iad*
 - *F. inhambanensis* Marshall & Pugh, 2002
 - Distance between alveoli of setae *c*₁ and *c*₁ nearly double or less than that between alveoli of setae *c*₁ and *c*₂; aggenital seta present; lamellar ridge absent; adanal seta *ad*₂ situated at same level or posterior to lyrifissure *iad* ...
 - *F. sinensis* Luxton, 1992
7. Setae *da* nearly equal or shorter than their mutual distance, approximately same length as seta *la*, inserted posterior to *la* 8
 - Setae *da* longer than their mutual distance, nearly twice as long as *la*, inserted anterior to seta *la*
 - *F. elamellata elamellata* Luxton, 1967
8. Sensillus smooth; notogastral seta *c*₂ very short, 1/2 as long as *c*₁ 9
 - Sensilli densely barbed; notogastral seta *c*₂ long, as long as *c*₁ *F. arabica* sp. nov.
9. Notogastral seta *dp* long, nearly as long as *lp*; adanal setae *ad*₂ situated at same level as lyrifissure *iad* 10

- Notogastral setae *dp* very short, much shorter than *lp*; adanal seta *ad*₂ situated at level far anterior to lyrifissure *iad* *F. taiwanica* sp. nov.
- 10. Anal setae nearly as long as their mutual distance; plastron extending medially along epimeral border III towards genital plates *F. elamellata shibai* Aoki, 1974
- Anal setae twice as long as their mutual distance; no medial extension of plastron
 - *F. elamellata micromorpha* Marshall & Pugh, 1992

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