

# NAIAZETES REEVESI N. G., N. SP. (ACARI: ORIBATIDA: ZETOMIMIDAE) FROM SEMI-AQUATIC HABITATS OF EASTERN NORTH AMERICA

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ZETOMIMIDAE  
TAXONOMY  
SEXUAL DIMORPHISM

**ABSTRACT:** *Naiazetes reevesi*, a new genus and species of oribatid mite, is based on adult specimens from semi-aquatic habitats in eastern Quebec and Alabama. This genus is tentatively placed in the Zetomimidae based on the shared presence of an unusually large male genital sclerite in *Naiazetes*, *Heterozetes* and *Zetomimus*. *Naiazetes* shows unique sexual dimorphism, with differences in shape of the rostrum, and shape and position of genital papilla *Va* between male and female specimens.

ZETOMIMIDAE  
TAXONOMIE  
DIMORPHISME SEXUEL

**RÉSUMÉ:** Un genre et une espèce nouveaux, *Naiazetes reevesi*, n. g., n. sp., sont établis pour des adultes provenant d'habitats semiaquatiques de l'Est du Québec et de l'Alabama. Nous tentons de placer ce genre parmi les Zetomimidae en raison de la présence d'un sclérite génital mâle inhabituellement grand chez *Naiazetes*, *Heterozetes* et *Zetomimus*. *Naiazetes* montre un dimorphisme sexuel unique, avec des différences de la forme du rostre, et de la forme et position de la papille génitale *Va* entre mâles et femelles.

The oribatid fauna of aquatic and semi-aquatic habitats of eastern North America is considered to be comparatively well known at least at the generic level. Included in this fauna are species in the crotonioid genera *Platynothrus* (Camisiidae), *Mucronothrus* and *Trhypochthoniellus* (Trhypochthoniidae), *Malaconothrus* and *Trimalaconothrus* (Malaconothridae), the tectocephoid genus *Tegeocranellus* (Tectocephidae), the hydrozetoid genera *Hydrozetes* (Hydrozetidae) and *Limnozetes* (Limnozetidae), and the ceratozetoid genera *Zetomimus* and *Heterozetes* (Zetomimidae), and *Punctoribates* (Mycobatidae) (MARSHALL *et al.*, 1987). Recently, however, I collected a new ceratozetoid species, representing a new genus, displaying unique sexual dimorphism, from biologically similar but latitudinally well separated, semi-aquatic habitats in eastern North America.

The purpose of this study is to describe adults of

this new species. I propose a new genus for this species and discuss relationships with the Zetomimidae. The distinct sexual dimorphism shown by adults of this species suggests the existence of some kind of associative mating behaviour.

Morphological terminology used in this study follows that developed by F. GRANDJEAN (see TRAVÉ and VACHON, 1975 for references). The following conventions of measurement and description are used: *prodorsal structures*, *setae*: measured on dissected, slide mounted specimens; *total length*: measured from tip of rostrum to posterior edge of notogaster, on specimens in cavity slides; *notogastrol length to width ratio*: measured when viewed perpendicular to circumgastric scissure, on specimens in cavity slides; *leg setal formula*: famulus is included in tarsal setal count on leg I and solenidial counts are in parentheses.

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*NAIAZETES* n. gen.

*Type species:* *Naiazetes reevesi* n. sp.; monotypic.

*Diagnosis:* Adults have the following unique combination of character states: rostrum of male with long dens, that of female with short or no dens; rostral setae positioned close to anterior of rostrum and dorsal to tutorial cusp; tutorial cusp brush-like; genital papilla Va of male narrower than Vm and Vp, cone-shaped distally and less sclerotized than Vm and Vp; male genital sclerite large, its length subequal to that of genital plate; dorsal extensions of anterior edge of genital plate large, subtriangular; postanal porose organ expressed as saccule; humeral saccule present; tarsi heterotridactylous.

*Description:* *Adult.* Poronotic, brachypyline oribatid mites tentatively placed in the Zetomimidae (SHALDYBINA, 1966, 1974). Rostral setae positioned close to anterior of rostrum, anterior to lamellar cusps, genal incision, and dorsal to tutorial cusp (Figs. 3, 6, 7). Rostrum of male with long dens (Figs. 1, 7), that of female with short or no dens (Figs. 3, 4, 6). Lamellae narrow, slightly converging; lamellar cusps of medium length, tapered, bearing lamellar setae (Fig. 1). Bothridium with small dorsal scale, with ventral scale well developed medially and laterally (Fig. 1). Genal tooth short, broad, triangular (Figs. 3, 10). Tutorium narrow, with brush-like cusp (Figs. 3, 6, 8, 9). Pedotectum I large, convex dorsally, covering acetabulum I (Fig. 3). Custodium pointed distally (Figs. 2, 12). Circumpedial carina present (Fig. 3). Dorsosejugal porose area present, humeral saccule present, porose area Al not evident. Epimeral setal formula 3-1-2-3. Notogaster slightly longer than wide, with 10 pairs of setae and 4 pairs of porose areas (Fig. 1), anterior tectum strongly convex in interlamellar region. Posterior notogastral tectum absent (Fig. 13). Pteromorphs curved ventrally, immovable, without line of desclerotization (hinge). Genital papilla Va of male positioned dorsal to and laterally to Vm, Vp (Figs. 16, 17). Genital papillae Va of male cone-shaped distally, less sclerotized distally, and slightly narrower than Vm and Vp (Figs.

16, 17). Subtriangular, sclerotized, dorsal extensions of anterior edge of the genital plates (*nRa*) (GRANDJEAN, 1968, 1969) well developed (Fig. 17). Genital papillae Vm, Vp of male subequal in size and shape to papillae Va, Vm and Vp of female, and positioned closely dorsad of genital plate. Ovipositor normal for Brachypyliina, similar to that described for *Eremaeus hepaticus* by GRANDJEAN (1956a). Genital sclerite of male large, subequal in length to genital plate. Six pairs of genital, 1 pair of aggenital, 3 pairs of adanal, and 2 pairs of anal setae. Postanal porose organ expressed as small saccule. Mentum with lateral ridges, in longitudinal line with and opposing ridge on each gena (Figs. 11, 14). Axillary saccule of subcapitulum<sup>1</sup> absent (Fig. 14). Genua I and II without ventral cusps; seta *l''* of these segments setiform. Tarsi heterotridactylous.

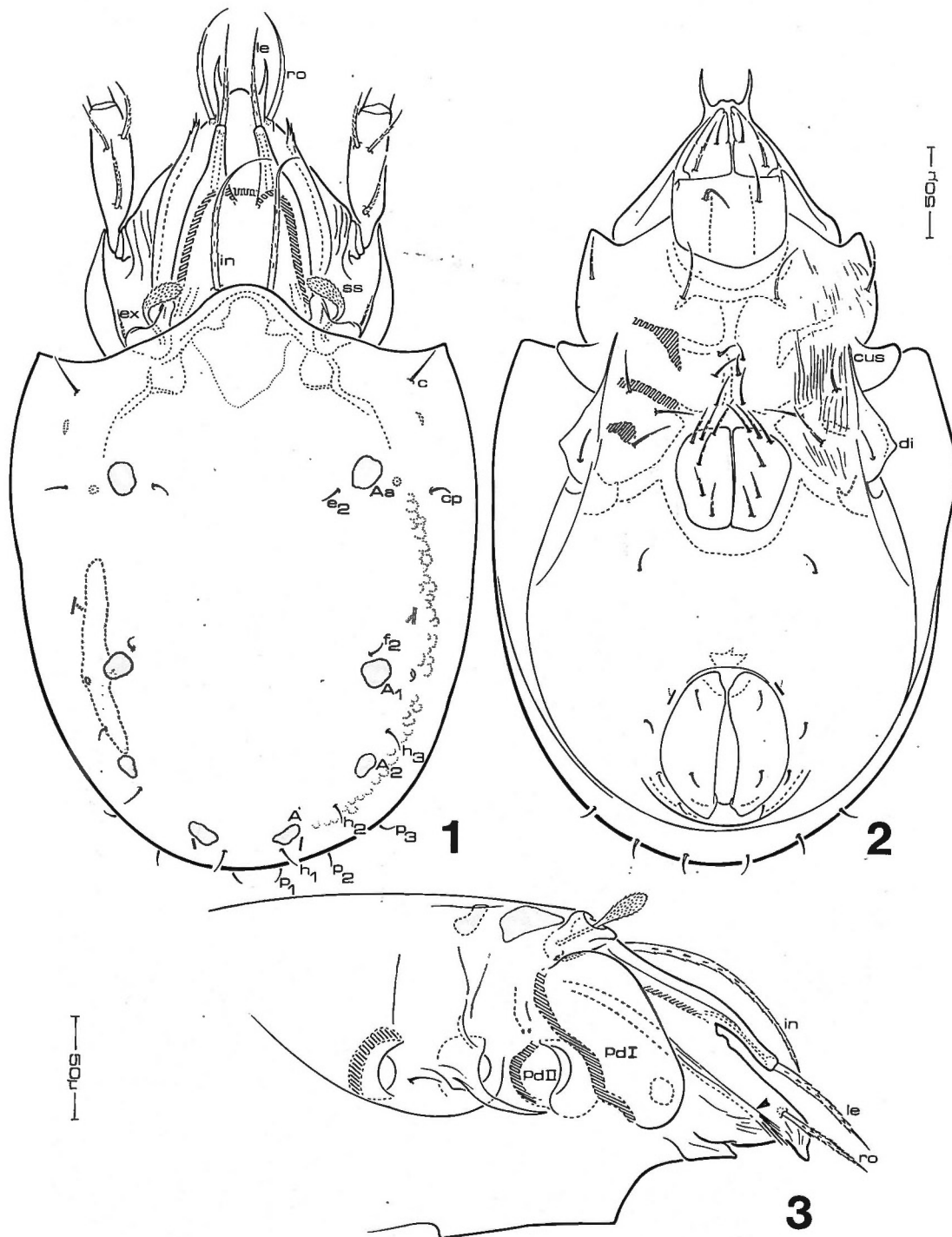
*Etymology.* The Latin generic prefix is from 'naias' or water-nymph, referring to the semi-aquatic habitat of the type species; *-zetes* is a common generic suffix in the Ceratozetoidea. The specific epithet of the type species is in honour of the American acarologist Marcel REEVES, a colleague and friend, and collector of many interesting oribatid mites for the Canadian National Collection of Insects and Arachnids.

## RELATIONSHIPS AND CLASSIFICATION

*Naiazetes* has a series of character states which are autapomorphic within the Brachypyliina: (1) sexually dimorphic genital papillae Va; (2) sexually dimorphic rostrum; (3) postanal porose organ expressed as saccule; and (4) highly modified tutorial cusp. It is placed in the Ceratozetoidea based on the presence in the adult of the following combination of structures: (a) tutorium, (b) genal tooth, (c) well-developed, long custodium, (d) pteromorphs. However, this placement is problematic, but should be clarified when immatures are collected and examined.

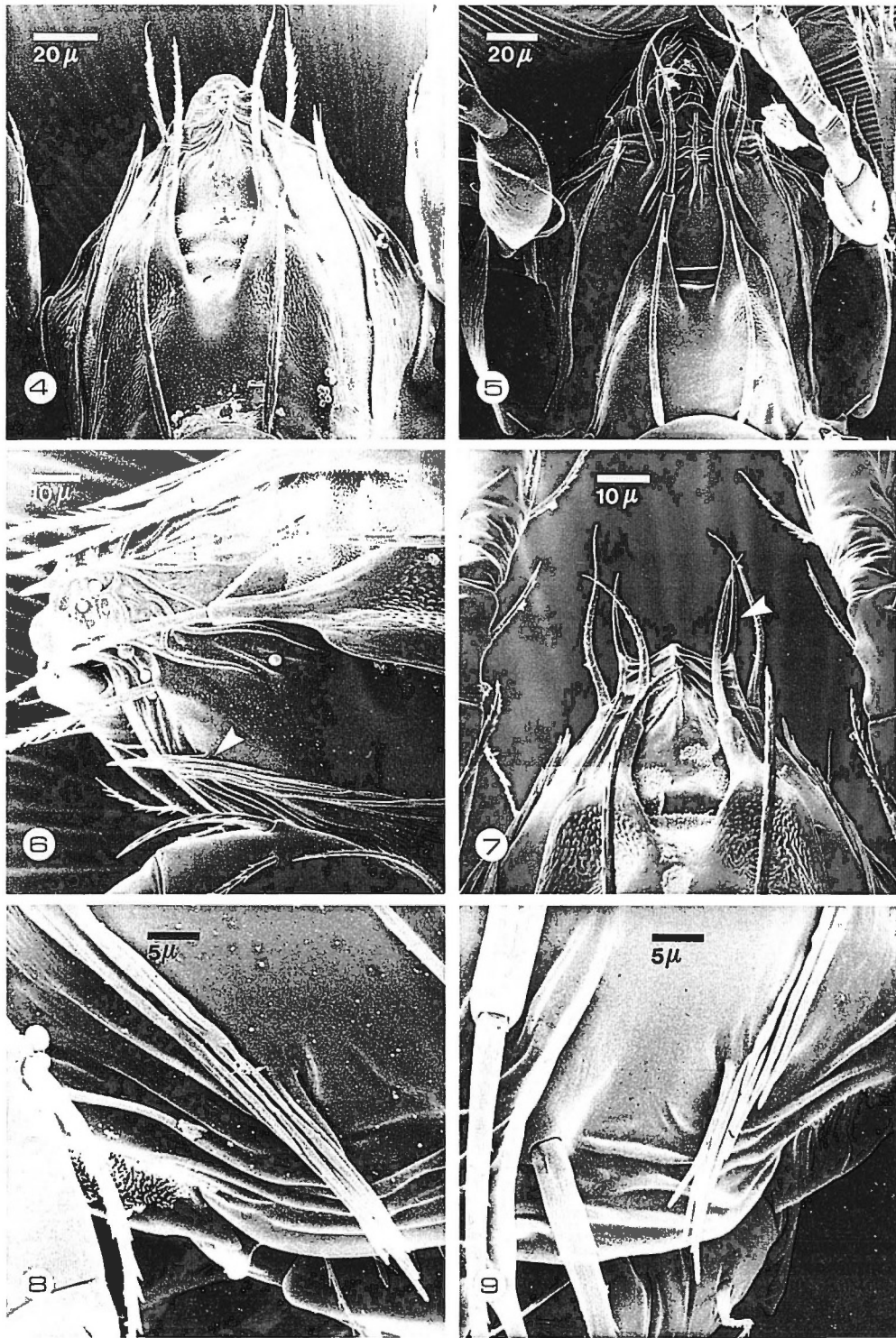
The absence of the axillary saccule of the subcapitulum is considered a secondary loss. The axillary saccule of the subcapitulum has been found in all

1. This terminology is proposed by NORTON *et al.* (in press).



FIGS. 1-3: *Naiazetes reevesi* sp. nov.

1. — Adult ♂, dorsal aspect. 2. — Adult ♂, ventral aspect. 3. — Adult ♀, lateral aspect of podosoma after removal of legs, subcapitulum and notogaster (tutorium indicated by arrow).



FIGS. 4-9: *Naiazetes reevesi* sp. nov.

4. — Prodorsum of adult ♀. 5. — Prodorsum of adult ♂. 6. — Lateral aspect of prodorsum of adult ♀ (tutorial cusp indicated by arrow).  
7. — Rostrum of adult ♂ in dorsal aspect (rostral dens indicated by arrow). 8-9. — Variation in structure of tutorial cusp.

ceratozetoid species examined, including species of *Heterozetes* and *Zetomimus* (NORTON & BEHAN-PELLETIER, 1986), other than *Guatemalozetes* (BEHAN-PELLETIER & RYABININ, 1991) and an undescribed species of *Heterozetes* in the Canadian National Collection of Insects and Arachnids.

The morphology of the tutorial cusp in *Naiazetes* is unique among those Brachypylina in which a tutorialium is developed. The tutorial cusp of species in ceratozetoid genera such as *Heterozetes* and *Zetomimus* can be heavily ridged, though it never forms a "brush-like" structure. However, this heavy ridging may be a synapomorphy of Zetomimidae, with the brush-like condition a more derived state.

*Naiazetes* shares a unique apomorphy with species of the zetomimid genera *Heterozetes* and *Zetomimus*: the male genital sclerite is large, subequal in length to that of the genital plate. The male genital sclerite in species of *Heterozetes* and *Zetomimus* that I have examined is large, and more noticeably sclerotized than in representatives of the Ceratozetidae or Mycobatidae. The ratio of length of genital sclerite to length of genital plate in *Naiazetes* ( $n = 6$ ) is 0.9: 1.0 (range 0.77 to 0.96: 1.0). That of other representatives of the Ceratozetidae is as follows ( $n$  is the number of slide-mounted male specimens examined): Chamobatidae (*Chamobates* sp. ( $n = 1$ ) 0.67: 1.0), Zetomimidae (*Heterozetes* spp. ( $n = 5$ ) 1.0: 1.0 (range 0.85 to 1.13: 1.0); *Zetomimus* sp. ( $n = 1$ ) 1.24: 1.0), Euzeidae (*Euzetes* sp. ( $n = 1$ ) 0.38: 1.0), Ceratozetidae (*Ceratozetes gracilis* (Michael) ( $n = 7$ ) 0.58: 1.0 (range 0.52 to 0.68: 1.0)), and Mycobatidae (*Mycobates* spp. ( $n = 7$ ) 0.57: 1 (range 0.48 to 0.64: 1)).

SHALDYBINA (1966) established the family Zetomimidae based on the absence of macrosclerites on the hysterosoma of immatures, and the absence of a setal pair of the  $h$  series in the larva (11 pairs of hysterosomal setae). Later (SHALDYBINA, 1974) she recognized the absence of macrosclerites as representing a secondary loss, and presented a more complete diagnosis of the family. Characters of the adults included: (a) different number of claws on tarsi I and tarsi IV; (b) arrangement of genital setae in an almost regular longitudinal row; (c) displacement of the genital opening anteriorly, so that epimeral setae  $2a$  and  $3a$  are in transverse align-

ment; (d) seta  $l''$  on genua I and II short and spiniform; and (e) genua I and II with ventral cusps. Other than the different number of claws on tarsi I and IV, all of these character states are subject to homoplasy within the Ceratozetoidea. None of these character states is found in *Naiazetes*. However, both *Heterozetes* and *Zetomimus* need revision to establish how diagnostic these character states are for the family. For example, an undetermined species of *Heterozetes* from western Canada has all tarsi heterotridactylous, and genital setae  $g_2$  and  $g_1$  are positioned on the anterior margin of the genital plate.

Within the Ceratozetoidea, *Naiazetes* and species of *Heterozetes* also uniquely share a lateral ridge on the mentum of the subcapitulum, opposing a corresponding ridge on the gena. Another character state shared by adult *Naiazetes*, *Heterozetes* and *Zetomimus* is the short, triangular genal tooth, but the polarity of this character is unclear. In Ceratozetidae this structure is long, subtriangular, and comparatively narrow. Species of Mycobatidae have a genal tooth that is shorter, though less broad than in Zetomimidae (BEHAN-PELLETIER, 1994).

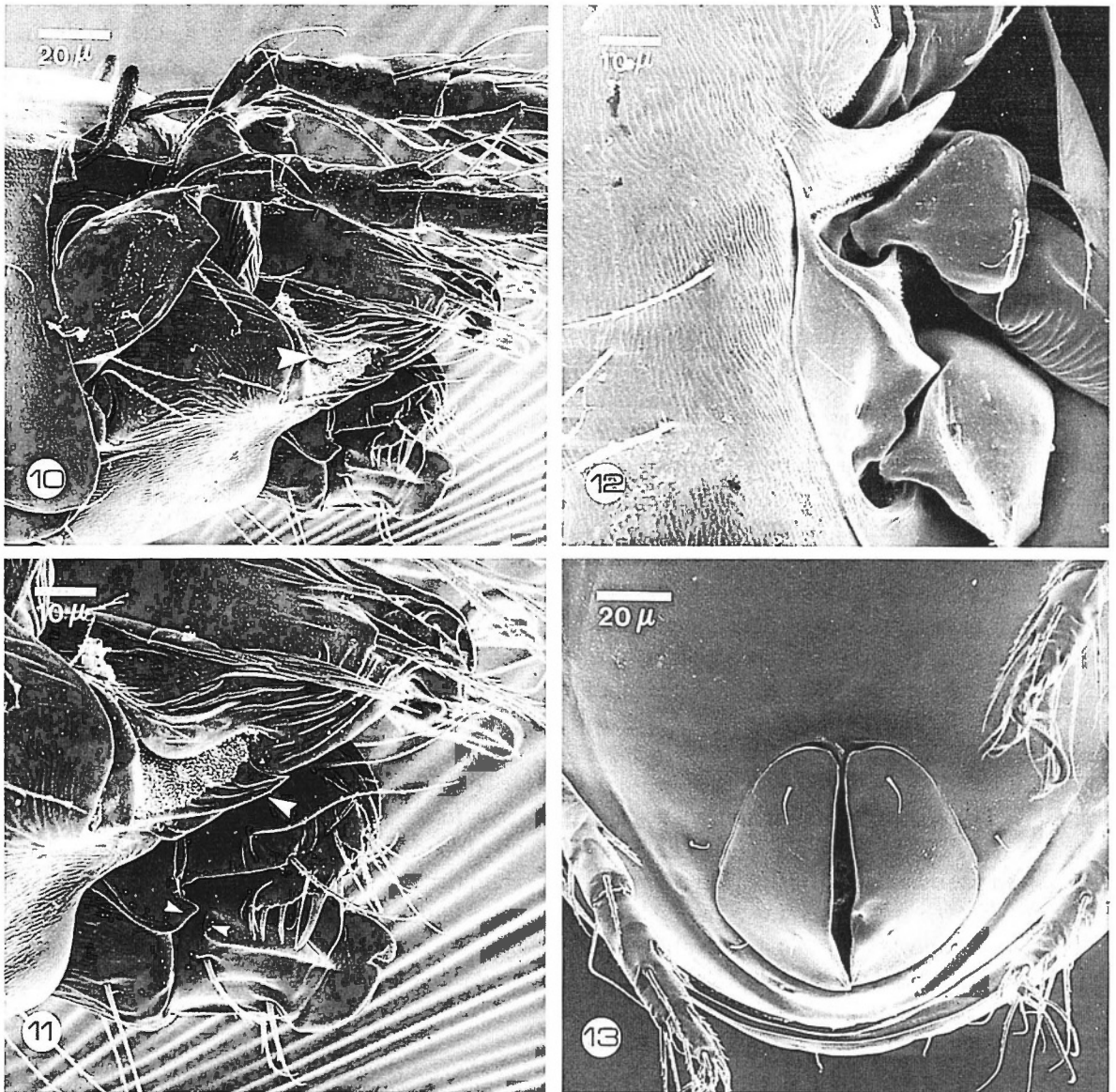
The position of the rostral setae in *Naiazetes*, close to the anterior of the rostrum, is an apomorphy found in the ceratozetid genera *Parafurcobates* Hammer and *Lophozetes* Balogh. It is a character state found also in the Oripodoidea, and possibly has evolved independently many times in the Brachypylina.

#### *Naiazetes reevesi* n. sp.

**Adult Measurements.** Mean total length: female ( $n = 10$ ) 418  $\mu\text{m}$  (range 405–437  $\mu\text{m}$ ); male ( $n = 10$ ) 399  $\mu\text{m}$  (range 373–413  $\mu\text{m}$ ). Mean notogastral width: female 267  $\mu\text{m}$  (range 259–284); male 254  $\mu\text{m}$  (range 243–267  $\mu\text{m}$ ).

**Integument.** Integument microtuberculate over whole body and leg segments. Distinct longitudinal striae in lateral regions of epimera (Figs. 2, 12), on pedotectum I (Fig. 10), and abaxial surfaces of femora I to IV and trochanters III and IV. Granular cerotegument restricted to region between pteromorph, pedotectum I, tutorialium, and lateral





FIGS. 10-13: *Naiazetes reevesi* sp. nov., adult ♀.

10. — Lateral aspect of podosoma (carina on lateral of rostrum indicated by arrow). 11. — Lateral aspect of rostrum and subcapitulum (genal tooth indicated by large arrow; opposing ridges on mentum and gena indicated by small arrows). 12. — Epimeral region showing custodium, discidium and pattern on integument. 13. — Ventral aspect of posterior region of the hysterosoma.

body wall, extending medially on prodorsum to interlamellar region (Fig. 4) and mediad lamellar cusps (Fig. 7).

*Prodorsum.* Rostrum rounded, with lateral dens; dens sexually dimorphic, such that female dens absent or present to 6 μm in length (Figs. 3, 4, 6),

and male dens present, 20–24 μm in length (Figs. 1, 5, 7). Ridges extending from dens posteriorly to midway between insertion of rostral setae and base of lamellar cusps. Area medial to these ridges sculptured (Figs. 4, 5, 7); area lateral to these ridges with 3 to 5 curving ridges following margin of

rostrum and extending dorsad acetabulum I (Figs. 10, 11). Small ridge laterally on rostrum, dorsad genal tooth (Fig. 11). Rostral setae (*ro*) directed anteriorly, weakly barbed, 62–74  $\mu\text{m}$ , mutual distance at their base 28–36  $\mu\text{m}$  (Figs. 1, 5, 6, 7). Lamellae narrow, converging, 116–124  $\mu\text{m}$  long, without translamella. Base of lamellar cusps broad; cusps long, 30–40  $\mu\text{m}$ , narrowing distally to width of lamellar setae. Transverse ridges on prodorsum in area of lamellar cusps (Figs. 4, 5), these giving appearance of translamella in some slide-mounted specimens. Sensillus short, 50–56  $\mu\text{m}$  long, with half of length composed of barbed, clavate head; head directed medially (Fig. 1). Exobothridial seta (*ex*) 20–24  $\mu\text{m}$ , borne on tubercle. Bothridium with small dens medially.

*Lateral Aspect of Podosoma.* Genal tooth short, broad, subtriangular, with surface ridges (Fig. 3, 11). Tutorium 124–128  $\mu\text{m}$  long, narrow, with dorsal ridges. Cusp of tutorium brush-like, formed of dorsal ridges of fused part of tutorium and additional ridges (Figs. 3, 6, 8, 9); ridges free or partially fused distally (Figs. 8, 9). Dorsal margin of pedotectum I ventral to insertion of seta *ex*. Custodium long, narrow, curved, 28–34  $\mu\text{m}$ , reaching anteriorly to pedotectum II (Figs. 3, 12). Discidium triangular between acetabula III and IV (Fig. 12). Dorsosejugal porose area well developed; porose area A1 not evident (Fig. 3).

*Notogaster* (Fig. 1). Longer than wide, ratio of 1.2:1.0. Notogastral setae all 9–14  $\mu\text{m}$ . Porose areas circular to oval in shape, length 20–25  $\mu\text{m}$ , subequal in size; Aa generally more circular than A1 to A3, A1 and/or A2 often smaller than Aa or A3. Small lenticulus present.

*Ventral Region* (Figs. 2, 12, 13). Epimeral setae weakly barbed, *1b* longest seta, about 42  $\mu\text{m}$ , *1a*, *1c*, *2a*, *3a*, *4a* 18–22  $\mu\text{m}$  long, *4b* about 26  $\mu\text{m}$ , *4c* about 12  $\mu\text{m}$ . Genital setae barbed, anterior three pairs positioned along anterior margin of genital plate. Anal and adanal setae about 18  $\mu\text{m}$  long, smooth. Anterior edge of genital plate (*nRa*) in both sexes with ridges as in *Pilogalumna ornatula* Grandjean (GRANDJEAN, 1969: Fig. 7B); with dorsally directed, sclerotized, subtriangular extensions well developed (Fig. 17). Ratio of length of genital sclerite to length of genital plate ( $n = 6$ ) 0.9: 1.0

(range 0.77 to 0.96: 1.0). Genital sclerite noticeably sclerotized throughout, more heavily sclerotized than has been described for other Brachypylina (GRANDJEAN, 1955, 1956b). Genital sclerite with 6 rather than 7 pairs of eupathidia; possibly pair *kx* lost, as hypothesized by GRANDJEAN (1955, 1956b) for *Podacarus auberti* Grandjean; all eupathidia acuminate,  $\tau_2$  longer than other  $\tau$  eupathidia. Postanal saccule about half size of humeral saccule.

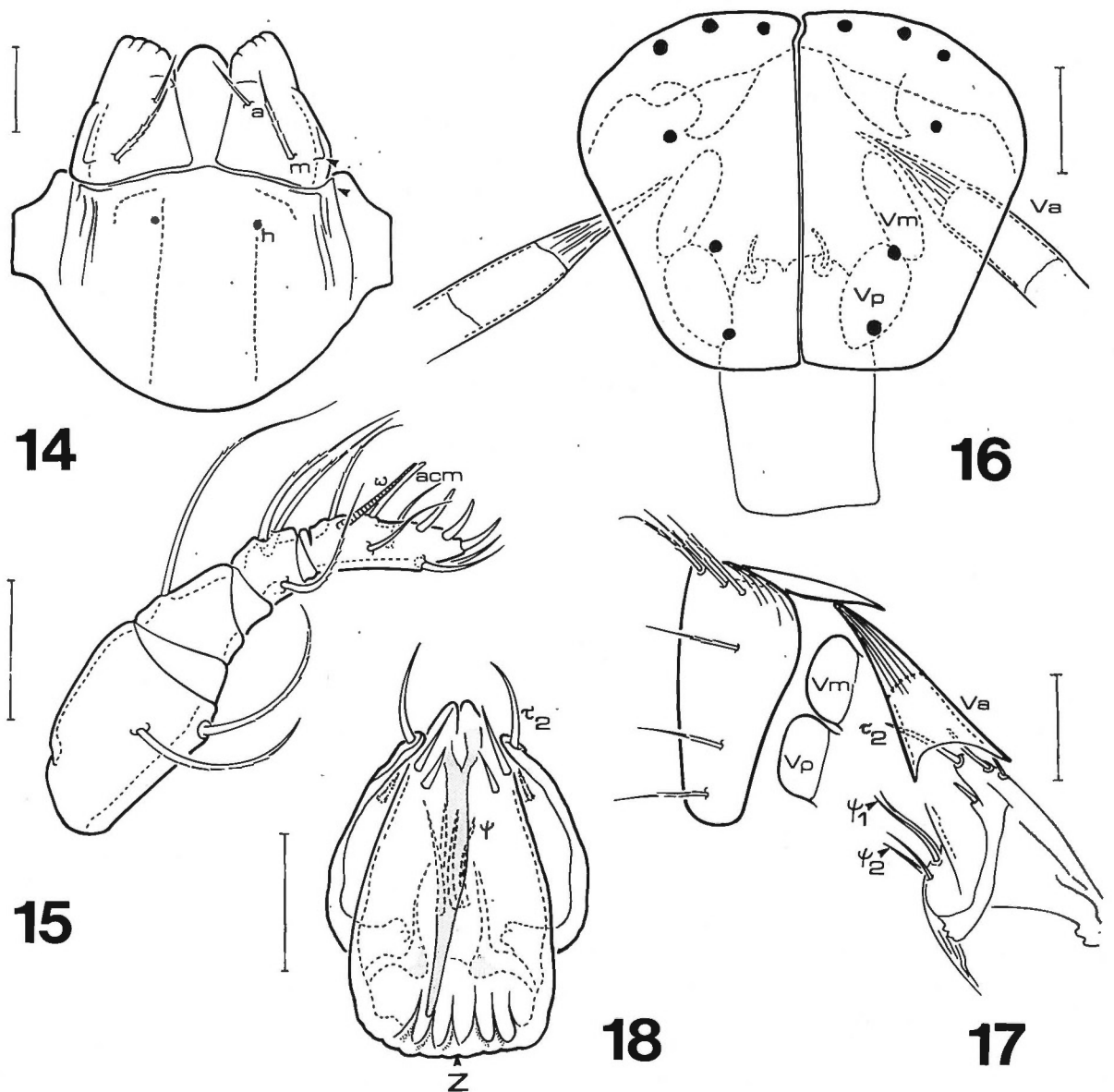
*Legs* (Figs. 19–22). Setation (I to IV): trochanters 1-1-2-1; femora 5-5-3-2; genua 3(1)-3(1)-1(1)-2; tibiae 4(2)-4(1)-3(1)-3(1); tarsi 19(2)-15(2)-15-12. Tarsi heterotridactylous, without tarsal pulvillus. Lateral tarsal claws with minute dorsal dens. Tibia I with anterodorsal apophysis (Fig. 19). Seta *s* of tarsus I eupathidic (unilaterally setiform on one specimen).

*Material examined.* *Holotype:* adult male. USA: ALABAMA, Conecuh Co., Conecuh National Forest, Open Pond Recreational Area, 31°05.41'N; 86°32.7'W, Conecuh Trail, 10 March 1994 (V. BEHAN-PELLETIER) from decaying sedges and grasses at edge of small pond; deposited in the Canadian National Collection of Insects and Arachnids (CNC), Agriculture Canada, Ottawa, type number 22099. *Paratypes:* 50 adults with same data as holotype; CANADA: QUEBEC: Parc Frontenac, Secteur Sud, 20 August 1985 (V. BEHAN-PELLETIER) 5 from grasses at edge of Lac St. François. Paratypes deposited in the Field Museum of Natural History, Chicago, the collection of R. A. NORTON, the Muséum national d'Histoire naturelle, Paris and the CNC.

*Habitat:* This species was collected in large numbers from decaying sedges and grasses at the edge of a small pond in Conecuh National Forest, Alabama, whereas a sample collected about 2 m away from detritus at the edge of the same pond yielded no specimens.

*Distribution:* This species has an Appalachian distribution, based on specimens known so far. Fossil specimens have been collected from the Hiscock site, a late Quaternary locality in western New York State, from a fibrous, gravelly layer, older than 8500 years (JENNINGS, 1993; ERICKSON, pers. comm.).

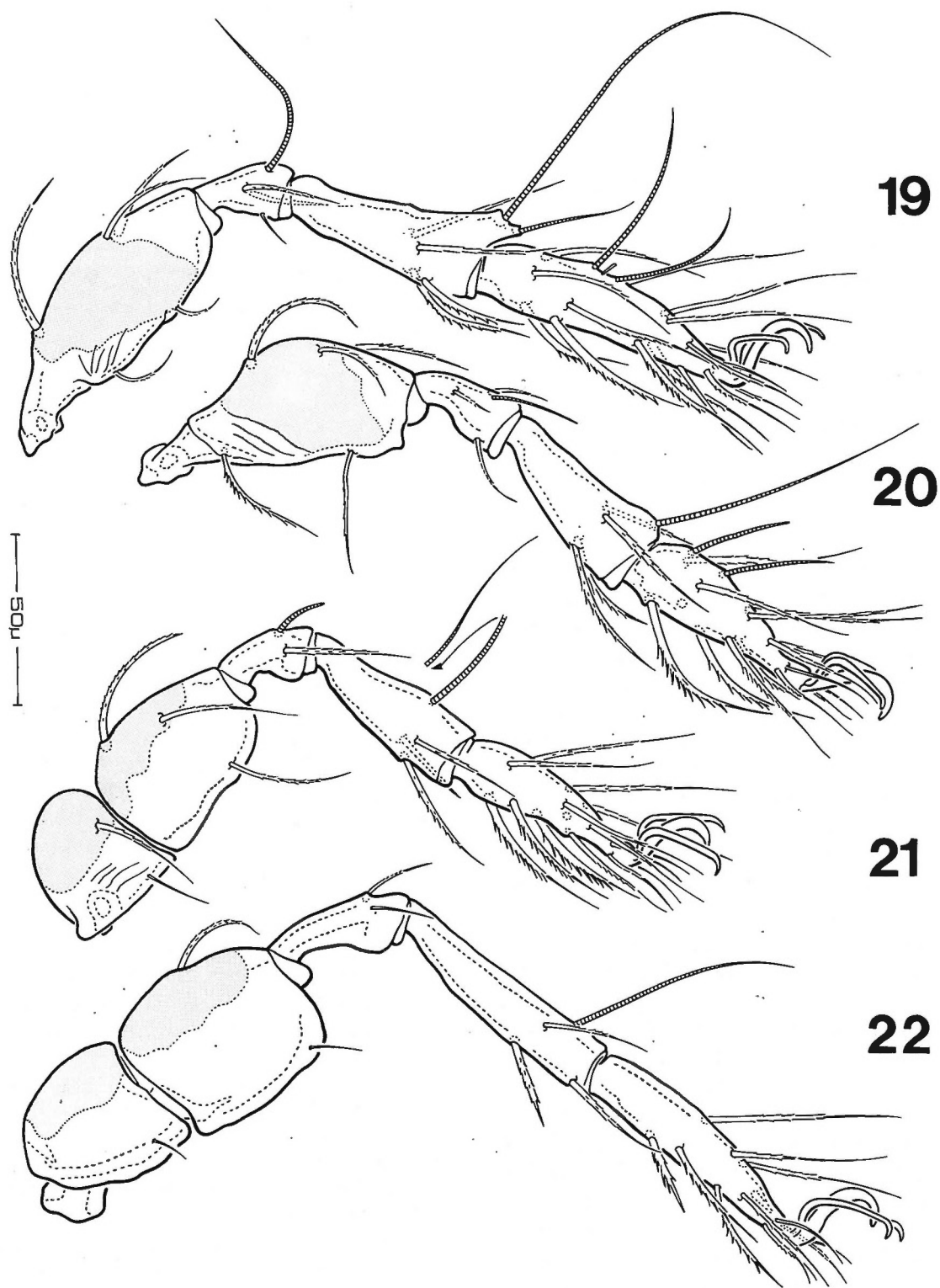
*Food:* Parts of pine pollen occurred in guts of 4



FIGS. 14–18: *Naiazetes reevesi* sp. nov.

14. — Subcapitulum (opposing ridges on mentum and gena indicated by arrows). 15. — palp. 16. — Genital region of ♂ showing position of genital papillae Va, Vm, and Vp relative to each other and genital plates, (position of genital sclerite indicated diagrammatically). 17. — Lateral aspect of ♂ genital region (ventral plate removed), showing position of genital plate, genital papillae and genital sclerite relative to each other. 18. — Genital sclerite of ♂, dorsal aspect. Bar measures 20 μm.





FIGS. 19–22: *Naiazetes reevesi* sp. nov., adult ♂.

19. — Leg I, trochanter removed. 20. — Leg II, trochanter removed. 21. — Leg III. 22. — Leg IV. All legs in abaxial view.

specimens; fungal hyphae were found in the guts of 10 other specimens.

#### REMARKS ON SEXUAL DIMORPHISM

TRAVÉ (1959) reviewed sexual dimorphism in Oribatida, and among Brachypylna noted its occurrence in the Hydrozetoidea, Ameronothroidea, Oripodoidea and Galumnoidea. Sexual dimorphism is rare in Ceratozetoidea, except that females of a species are generally larger and have relatively larger genital plates than males (SOLHØY, in press). Sexually dimorphic notogastral porose areas are found in the mycobatid *Zachvatkinibates maritimus* Shaldybina (BEHAN-PELLETIER, 1988). PAVLITSHENKO (1991) on the basis of 2 male specimens described *Chamobates callipygis*, subsequently placed in the genus *Xiphobates* (PAVLITSHENKO, 1993). This species has the unusual apomorphies of porose areas A3 being positioned contiguously on a tubercle on the posterior of the notogaster, and porose areas A1 and A2 in transverse alignment. The positioning of porose areas A3 in this species is possibly sexually dimorphic, analogous to the dimorphic porose areas in *Mochloribatula* (NORTON, 1983). *Naiazetes reevesi* shows sexual dimorphisms which are unique in the Oribatida: the modification of genital papillae Va found only in the male, and the modified rostrum.

Modified genital papillae are present in early derivative groups (GRANDJEAN, 1932, 1954; NORTON & LIONS, 1992), and the pycnonotic Brachypylna (GRANDJEAN, 1960, 1963; BEHAN-PELLETIER, 1991), but in all cases are similarly modified in conspecific males and females. Modified genital papillae have hitherto not been noted in the poronotic Brachypylna (BEHAN-PELLETIER, 1991). GRANDJEAN (1969) described in detail structures in the genital area, using *Pilogalumna ornatula* Grandjean as an example. He illustrated (1969: Fig. 7A) the genital papillae of the male as positioned dorsal to the genital plates, with the three genital papillae in longitudinal and dorsoventral alignment. In contrast, in male *Naiazetes* genital papilla Va is removed from alignment with Vm and Vp dorsally and laterally, and Va has a cone-shaped structure.

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