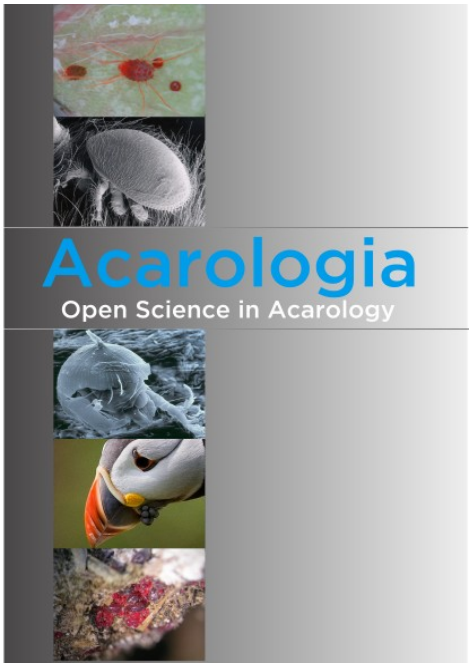

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A new species *Zachvatkinibates svanhovdi* sp. nov. (Acari: Oribatida: Punctoribatidae) from Norway with comments on Punctoribatidae in Fennoscandia

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Original research

ABSTRACT

The adults of the new species *Zachvatkinibates svanhovdi* A. Seniczak & S. Seniczak **sp. nov.** are described and illustrated from Norway, and this is the first finding of *Zachvatkinibates* Shaldybina, 1973 in Fennoscandia. This species is the most similar to *Z. quadrivertex* (Halbert, 1920), but differs from it mainly by the shape of notogastral setae, posterior tectum of notogaster and lack of postanal porose area *Ap*, which in *Z. quadrivertex* is present. In *Z. svanhovdi*, the prodorsal seta *in* is long, translamella is narrow, notogastral setae are short and distally pliable, notogastral porose areas are usually oval and of medium size, but *Aa* can be larger, especially in males. Dorsal crest on tarsus I is present. The cytochrome oxidase I (COI) barcodes (length: 658 bp) of five specimens of the new species are provided; the maximum variation within the species was 2.41% (p-dist). The morphology and ecology of the new species is compared with other *Zachvatkinibates* species. The knowledge on family Punctoribatidae in Fennoscandia is updated, and *Mycobates carli* (Schweizer, 1922) is first reported from Norway.

Keywords oribatid mites; sexual dimorphism; leg setation; dorsal crest; sex structure; DNA barcoding
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Introduction

Zachvatkinibates Shaldybina, 1973 *sensu stricto*, with the type species *Z. nemoralis* Shaldybina, 1973, is a medium sized genus that comprises 18 species, according to Subías (2004, 2022). However, this author included *Minunthozetes selgae* Pérez-Íñigo, 1976 in this genus, which is not consistent with diagnosis of Behan-Pelletier & Eamer (2008). In the later species, the posterior notogastral tectum is complete, whereas in *Zachvatkinibates* it is medially broken.

The diagnosis of the adult of *Zachvatkinibates* was proposed by Shaldybina (1973), but Behan-Pelletier (1988) and Behan-Pelletier & Eamer (2005) consecutively modified it, and in the latter paper it was as follows: notogaster with rounded, convex medial process on anterior tectum and pair of thickened bands bordering medial process, posterior notogastral tectum incomplete medially, indicated by wide margination or narrow slit bordered by overlapping tectal lobes; lenticulus absent, octotaxic system expressing sexually dimorphism in some

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species, postanal porose area and axillary saccule of subcapitulum present, and mental tectum of subcapitulum absent.

The main aim of this paper is to describe and illustrate the morphology and ecology of *Z. svanhovdi*, and to compare it with congeners. Another aim is to update information on Punctoribatidae in Fennoscandia, and add *Z. svanhovdi* and *Mycobates carli* (Schweizer, 1922) to the list of species in this region.

Material and methods

Study site

The sample was collected at the river outlet (Figure 1) of the Jacob's River in north-eastern Finnmark, Sør-Varanger municipality, Norway. The region is characterized by an oceanic-continental climate with a mean annual temperature of 0.1 °C and a mean annual precipitation of approximately 620 mm (Bjørklund *et al.* 2015). The Jacob's River (Grense Jakobselv; area 237 km^2) is a river that runs along the Norwegian-Russian border and discharges into the Varanger Fjord, a bay located in the Barents Sea. The river is part of the Norwegian Protection Plan II3 and hence cannot be used for hydropower purposes. Generally, the vegetation can be characterized as northern boreal in a transition zone between oceanic and continental vegetation sections (Moen 1998, Bjørklund *et al.* 2015) in north-eastern Finnmark. The landscape along the river consists of hills with sparse heath vegetation near the coast, hilly landscapes and plateaus further inland. Along the river, the vegetation is commonly characterized by different vegetation types: closest to the river is often a well-developed sandy beach with key plants like the oyster plant (*Mertensia maritima* L.), followed by a transition zone with oyster plant and sea pea (*Lathyrus japonicus* Willd.), white sandy dunes with sand ryegrass [*Leymus arenarius* (L.) Hochst.] and sea pea, grey sandy dunes with sand ryegrass and red fescue (*Festuca rubra* L.), and dry, species-poor dune grass heath with strong hints of fringed pink (*Dianthus superbus* L.; https://elvedelta.miljodirektoratet.no/delta-322.htm, https://www.biodiversity.no/NiN2.0/T21-C-2). At the river outlet, where the sample was taken, there is also a semi-limestone beach meadow (Elven & Johansen 1983), which is characterized by freshwater-affected salt weed (*Salicornia* sp.) communities (P.E. Aspholm, NIBIO, Svanhovd; pers. comm.). The sampling location was in an area that is considered brackish water area (https://elvedelta.miljodirektoratet.no/delta-322.htm).

Sampling and studying of mites

The adults of *Z. svanhovdi* A. Seniczak *et* S. Seniczak **sp. nov.** used in this study were collected by A. Fjellberg on 26.08.2021 from Troms and Finnmark county, Northern Norway, Sør-Varanger community and Gr. Jakobselv locality, at river outlet (69.71258° N, 30.87123° E, 0.5 m a. s. l.). One collective sample was taken on the shore of Jacob's River, in the transect from the river edge to more distant part from it (about 10 m long, Figure 1). This sample was extracted in Berlese funnel for one week. We investigated the density, sex ratio, number of gravid females and carried eggs, and body length and width, based on 30 randomly selected specimens. We measured a total body length (tip of rostrum to posterior edge of notogaster) in lateral aspect and body width (widest part of notogaster) in dorsal aspect, and size of anal and genital openings and setae perpendicularly to their length in µm.

The illustrations are limited to the dorsal, lateral and ventral aspect and some leg segments of adult, and palp and chelicera. Illustrations were prepared from individuals mounted temporarily in lactic acid. In the text and figures we used the following abbreviations: rostral (*ro*), lamellar (*le*), interlamellar (*in*) and exobothridial (*ex*) setae, lamella (*La*), translamella (*Tr*), bothridium (*bo*), bothridial seta (*bs*), tutorium (*Tut*), pteromorph (*Ptm*), notogastral setae (c_2, *l*-, *h*-, *p*-series), porose areas (*Aa*, *A1*, *A2*, *A3*), lyrifissures (*ia*, *im*, *ih*, *ip*, *ips*, *iad*), circumpedal carina (*cp*), opisthonotal gland opening (*gla*), subcapitular setae (*a*, *m*, *h*), pedotectum (*Pd*), custodium

Figure 1 General view of the river shore, where *Zachvatkinibates svanhovdi* A. Seniczak *et* S. Seniczak **sp. nov**. was collected (photo: Arne Fjellberg).

(*cus*), discidium (*Dis*), genal tooth (*gt*), cheliceral setae (*cha*, *chb*), Trägårdh organ (*Tg*), palp setae (*sup*, *inf*, *l*, *d*, *cm*, *acm*, *lt*, *vt*, *ul*, *su*) and solenidion ω, epimeral setae (*1a–c*, *2a*, *3a–c*, *4a–c*), genital (*g*) and aggenital (*ag*) setae, adanal and anal setae (*ad*-, *an*-series), leg solenidia (σ, φ, ω), famulus (ε) and setae (*bv*, *ev, d*, *l*, *ft*, *tc*, *it*, *p*, *u*, *a*, *s*, *pv*, *pl*, *v*). Terminology used follows that of Grandjean (1949, 1953) and Norton and Behan-Pelletier (2009). The species nomenclature follows Subías (2004).

For scanning electron microscopy (SEM), four mites were air-dried and coated with Au/Pd in a Polaron SC502 sputter coater and placed on Al-stubs with double-sided sticky carbontape. Observations and micrographs were made with a ZEISS Supra 55VP scanning electron microscope.

DNA barcoding

Five specimens of *Z. svanhovdi* were used for DNA barcoding. Each specimen was photographed, and the photos are available at Barcode of Life Data System (BOLD, http://boldsystems.org). The specimens were subsequently placed in a well containing 50 ml of 90% ethanol in a 96-well microplate and send to the Canadian Centre for DNA Barcoding (CCDB 2021). Mites were sequenced for the barcode region of the COI gene according to standard protocols at CCDB (http://www.ccdb.ca), using either LepF1/LepR1 (Hebert *et al.* 2003) or LCO1490/HCO2198 (Folmer *et al.* 1994) primer pairs. The DNA extracts were placed in archival storage at -80 °C at the Canadian Centre for DNA Barcoding. The sequences are available in GenBank (accession numbers in the section on the Type material). The voucher specimens are stored in the Entomological Collections at the Department of Natural History, University Museum of Bergen, University of Bergen, Bergen, Norway (ZMBN).

Obtained COI sequences were blasted against GenBank to detect and exclude possible contaminations and ensure high quality. Sequence variation within *Z. svanhovdi* specimens was calculated in BOLD using Kimura 2 Parameter distance model, pairwise deletion, and BOLD Aligner (Amino Acid based HMM).

Results

Zachvatkinibates svanhovdi A. Seniczak *et* S. Seniczak sp. nov.

Zoobank: A6272084-12BA-4FAC-BA43-7582C1D30CEB

(Figures 2–11)

Diagnosis

Adult of medium size (449–507), with generic characters of *Zachvatkinibates* given by Behan-Pelletier & Eamer (2005). Prodorsal seta *in* long, translamella narrow, notogastral setae short and distally pliable, notogastral porose areas usually oval and of medium size, but *Aa* can be larger, especially in males. Postanal porose area *Ap* absent, dorsal crest on tarsus I present.

Description of adults

Measurements — Holotype (female) length 494, and width 299. Mean length (and range) of females 490.3±7.1 (481–507, n = 15) and males 468.9±12.2 (449–481, n = 15), mean maximum width (and range) of females 299.0±6.2 (293–319) and males 276.7±8.3 (254–293).

Integument — Brown and microporose.

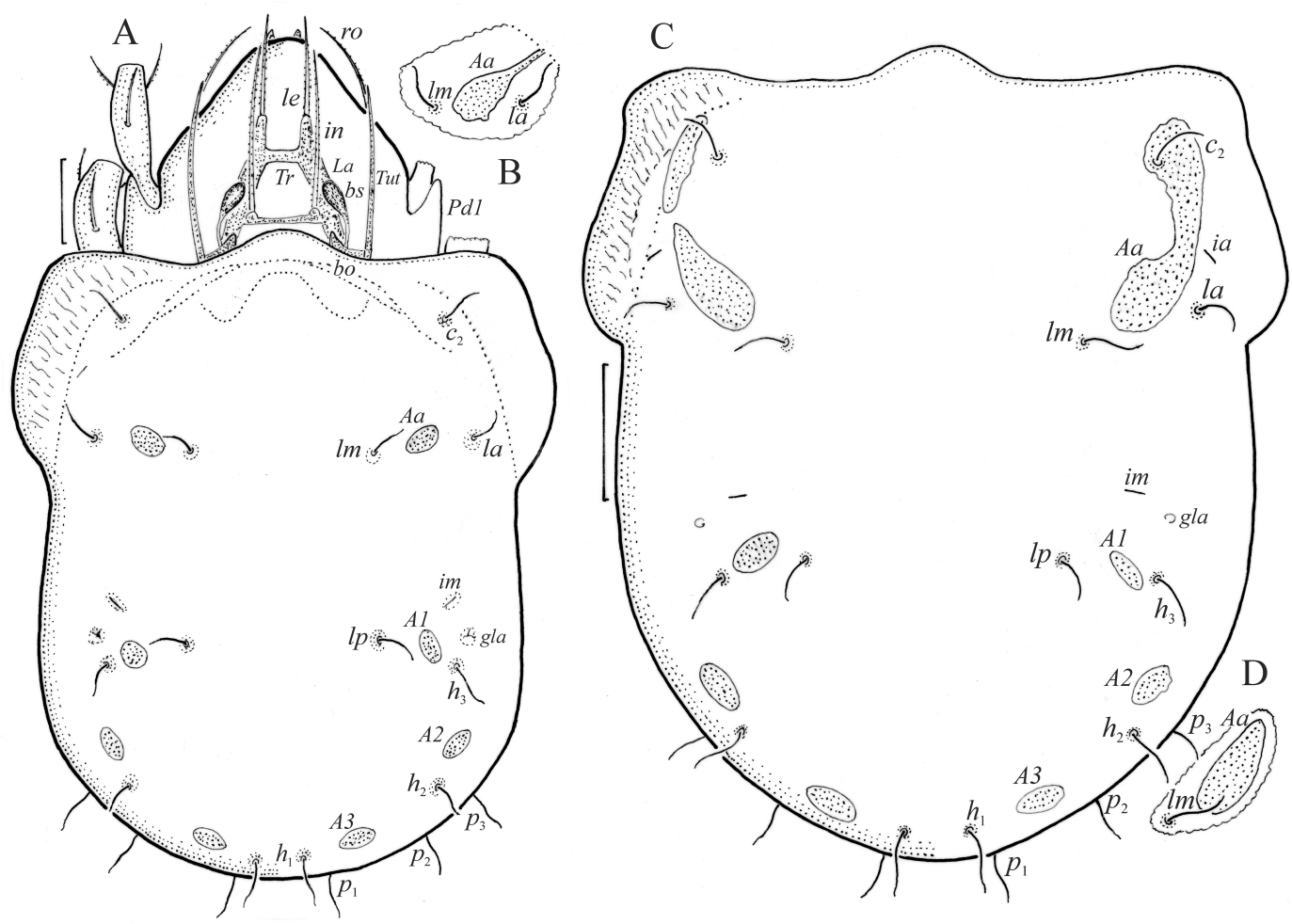

Figure 2 *Zachvatkinibates svanhovdi* A. Seniczak *et* S. Seniczak **sp. nov.**, scale bars 50 µm. A – female, dorsal aspect, legs partially drawn; B – porose area *Aa* of another female (enlarged); C – notogaster of male; D – shape of porose area *Aa* of another male.

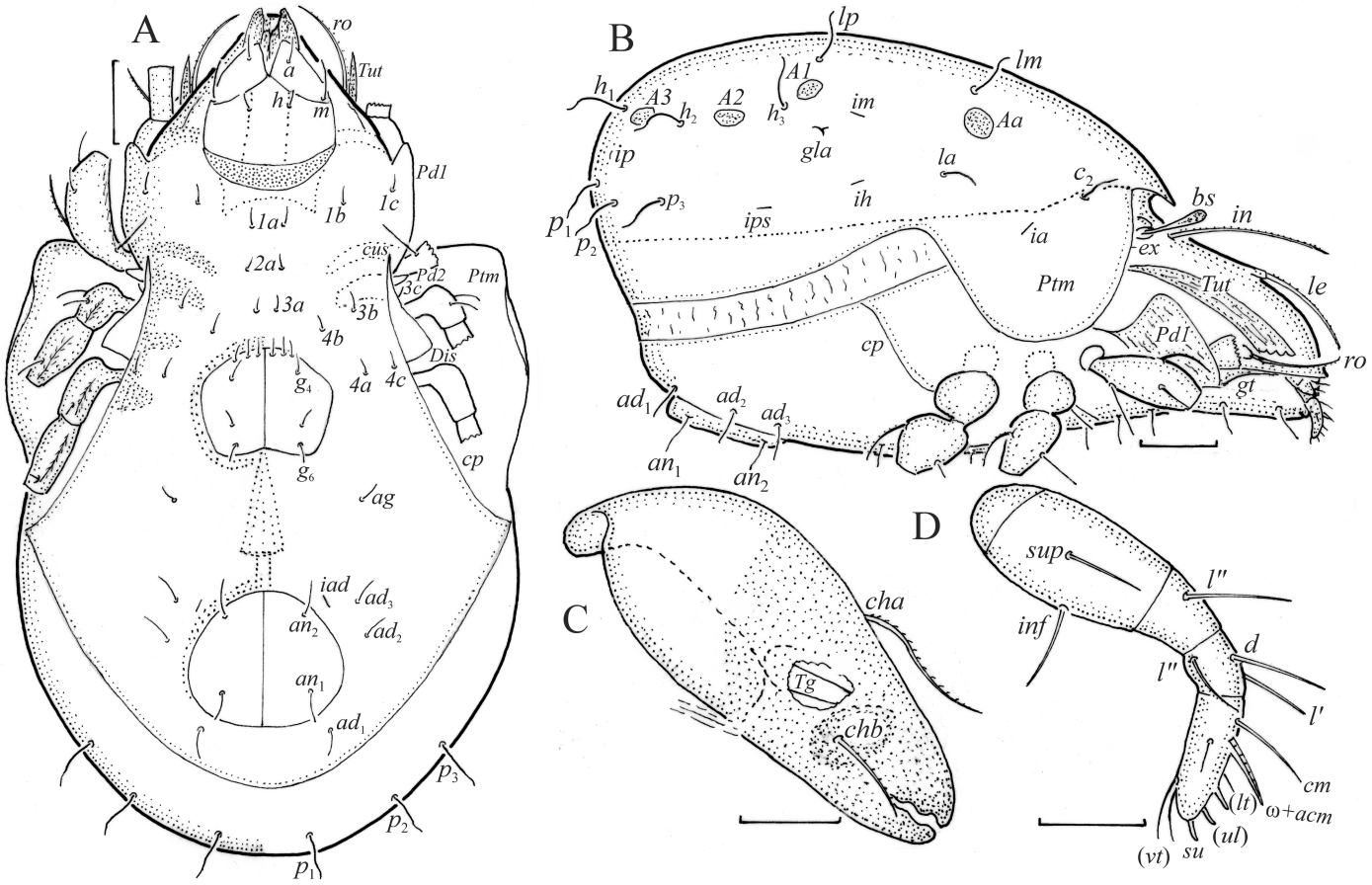

Figure 3 *Zachvatkinibates svanhovdi* A. Seniczak *et* S. Seniczak **sp. nov.**, female. A – ventral aspect, legs partially drawn, scale bar 50 µm; B – lateral aspect, legs partially drawn, scale bar 50 µm, mouthparts, right side, scale bars 20 µm; C – chelicera (Trägårdh organ in transparent area); D – palp.

Prodorsum — Sub-triangular, rostrum rounded. Seta *ro* relatively long (47–52), laterally barbed and in lateral position (Figures 2A, 3A, 3B, 5A, 5D, 6A–C, 8C, 8D, 9A, 10A), seta *le* longer (62–66), and seta *in* longest (77–80), both finely barbed; all acuminate; seta *ex* short (17) and smooth. Lamella long (77–110), narrow at base and wider in place of connection with translamella, translamella of medium size (29–31), narrow, lamellar cusp (length 15) rounded. Bothridium with well-developed medial scale, bothridial seta of medium size (43–46), clavate with smooth stalk and barbed head (Figures 2A, 3B, 5A, 5B, 5D, 6A, 6B, 6D, 7B, 7C, 9C).

Notogaster — Longer (females 380–398, males 357–378) than wide (females 293–319, males 254–293) with well-developed movable pteromorphs. Notogastral setae (10 pairs, including c_2) short (15–26), and smooth (Figures. 2–3B, 4, 5, 6A, 6D, 7A–C, 8A, 9C, 9D). Lyrifissure *ia* posterolateral to seta c_2, *im* anterior to seta h_3, *ip* anterolateral to seta p_1, *ips* anterior to seta p_3, *ih* posterior to seta *la*, and opisthonotal gland opening *gla* anterolateral to seta h_3 (Figures 2A, 8D). Shape of porose areas (4 pairs) differs between females and males. In females, porose areas oval, *Aa* slightly larger than other porose areas (Figures 2, 3B), in some individuals *Aa* can be elongated. In 15 males investigated, porose areas clearly larger (Figure 2C, 2D) than in females, and in some individuals *Aa* can be elongated, and of crescent shape or divided in two parts. Generally, in both sexual forms shape of other porose areas slightly varies within individuals, and postanal porose area is absent. Posterior tectum of notogaster is broken in middle and rounded ends overlap (Figure 4).

Gnathosoma — Subcapitular setae *h*, *m* and *a* short (18–24) and smooth (Figures 3A, 3B,

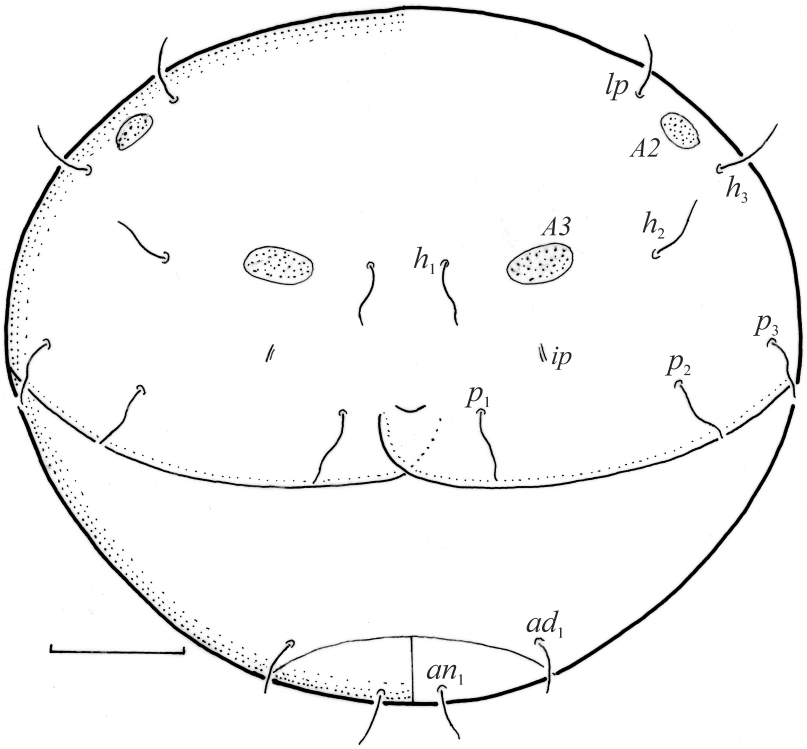

Figure 4 *Zachvatkinibates svanhovdi* A. Seniczak *et* S. Seniczak **sp. nov.**, female, posterior aspect, scale bar 50 µm.

5C, 7B–D, 8C, 8D). Palp short (75), setae relatively short and smooth (Figures 3D, 5D, 9A, 10A), formula of palp setae [trochanter to tarsus (+ solenidion ω)]: 0-2-1-3-9(1). Chelicera longer (96), seta *cha* longer than *chb*, both barbed (Figures 3C, 9A, 10A). Axillary saccule short (12).

Ventral and lateral regions — Most epimeral setae short and smooth (10–13, Figures 3A, 5C, 8B, 8C). Genital setae (six pairs) as short as epimeral setae, $g_{1\text{-}3}$ in anterior position. Aggenital setae (one pair) also short, adanal setae longer (three pairs, 22–29) and anal setae longest (two pairs, 29–32), all smooth (Figures 3A, 3B, 4, 5B, 5C, 8A, 8B). Lyrifissure *iad* short, located lateral to anterior part of anal plates. Discidium large, triangular; custodium long (40–42), narrow and pointed; tutorium long (122–126), narrow at base and distally wider and pointed (Figures 3B, 7B–D, 9A, 9B, 10, 11). Pedotectum I large (73 x 30), narrow at base and concave dorsally (Figure 3B), and with longitudinal striae, genal tooth of medium size (30–22). Circumpedal carina well formed. Humerosejugal porose areas *Am* and *Ah* oval.

Legs — Trochanters III and IV and all femora flattened with ventral carina. Porose areas on paraxial side of trochanters III and IV and femora I–IV. Femur I with longitudinal striae, most leg setae barbed (Figures 5, 6, 7, 8B–D, 9A–C). Seta *ft″* on tarsus I relatively long, solenidia ω_1 and ω_2 of similar length, famulus short; solenidia ω_1 and ω_2 and famulus ε located on small dorsal crest. Solenidia ω_1 and ω_2 on tarsus II relatively long and of similar size. Formulae of leg setae [trochanter to tarsus (+ solenidia)]: I – 1-4-3(1)-4(2)-20(2); II – 1-4-3(1)-4(1)-15(2); III – 2-3-1(1)-3(1)-15; IV – 1-2-2-3(1)-12. Tarsi heterotridactylous. Homology of leg setae and solenidia given in Table 1.

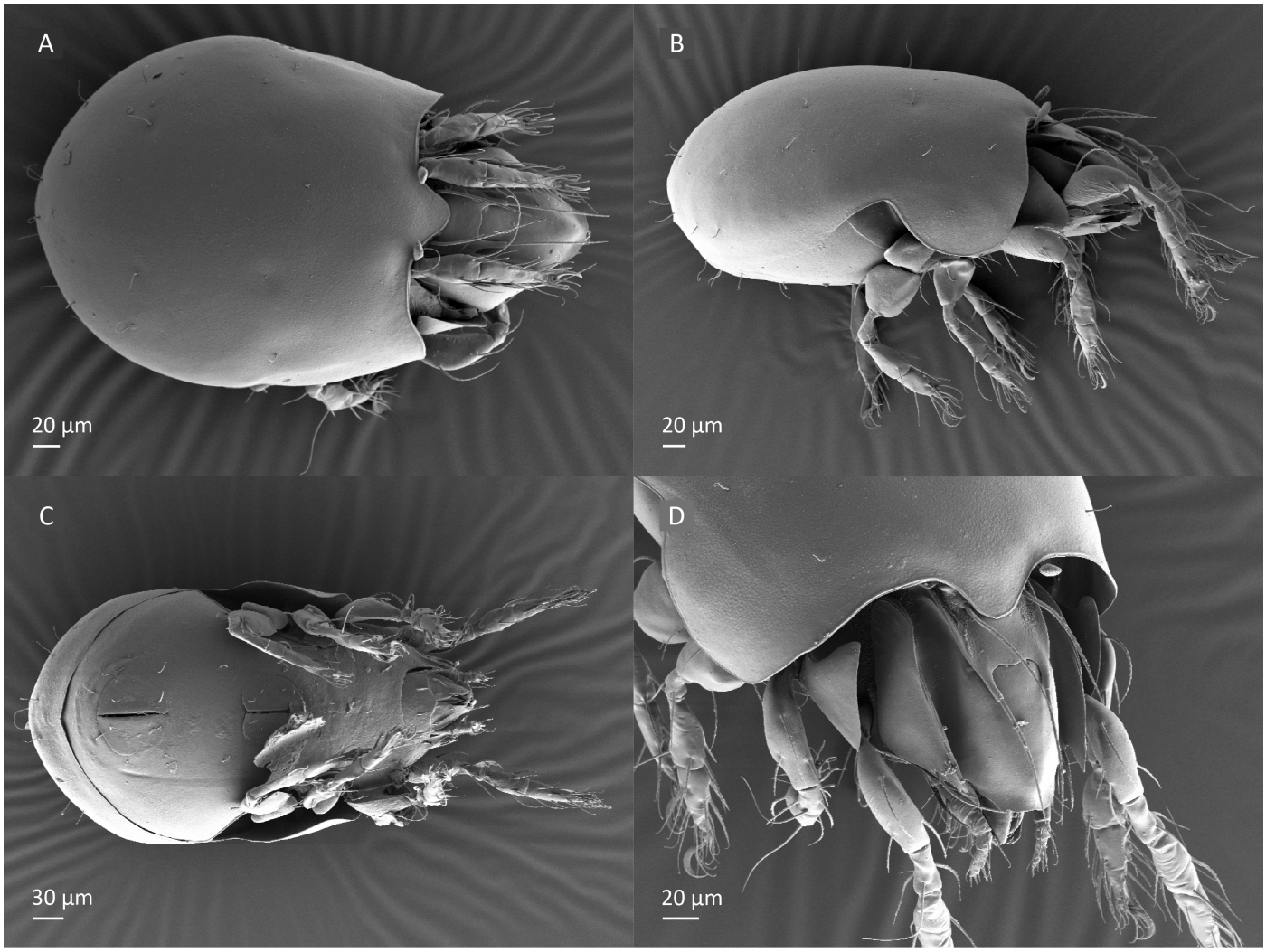

Figure 5 *Zachvatkinibates svanhovdi* A. Seniczak *et* S. Seniczak **sp. nov.** adult, SEM micrographs. A – dorsal view; B – lateral view; C – ventral view; D – frontolateral view.

Results of DNA barcoding

The barcode based on the cytochrome oxidase I (COI) mitochondrial DNA region (length: 658 bp) of five specimens of the new species is provided under GeneBank accession numbers: OP824977 (SUB2896631 SOITS201-22), OP824978 (SUB2896631 SOITS202-22), OP824979 (SUB2896631 SOITS203-22), OP824980 (SUB2896631 SOITS205-22), OP824981

Table 1 Leg setae (Roman letters) and solenidia (Greek letters) in *Zachvatkinibates svanhovdi* A. Seniczak *et* S. Seniczak **sp. nov.**

Legs	Trochanter	Femur	Genu	Tibia	Tarsus
I	*v'*	*d*, *bv''*, (*l*)	(*l*), σ, *v'*	(*l*), (*v*), φ_1, φ_2	*l''*, (*ft*), (*tc*), (*it*), (*pl*), (*p*), *v'*, (*pv*), (*a*), *s*, (*u*), ε, ω_1, ω_2
II	*v'*	*d*, *bv''*, (*l*)	(*l*), σ, *v'*	(*l*), (*v*), φ	(*ft*), (*tc*), (*it*), (*p*), (*pv*), *s*, (*a*), (*u*), ω_1, ω_2
III	*v'*, *l'*	*d*, *ev'*, *l'*	*l'*, σ	(*v*), *l'*, φ	(*ft*), (*tc*), (*it*), (*p*), (*pv*), *s*, (*a*), (*u*)
IV	*v'*	*d*, *ev'*	*d*, *l'*	(*v*), *l'*, φ	*ft''*, (*tc*), (*u*), (*pv*), *s*, (*a*), (*p*)

Note: pairs of setae in parentheses.

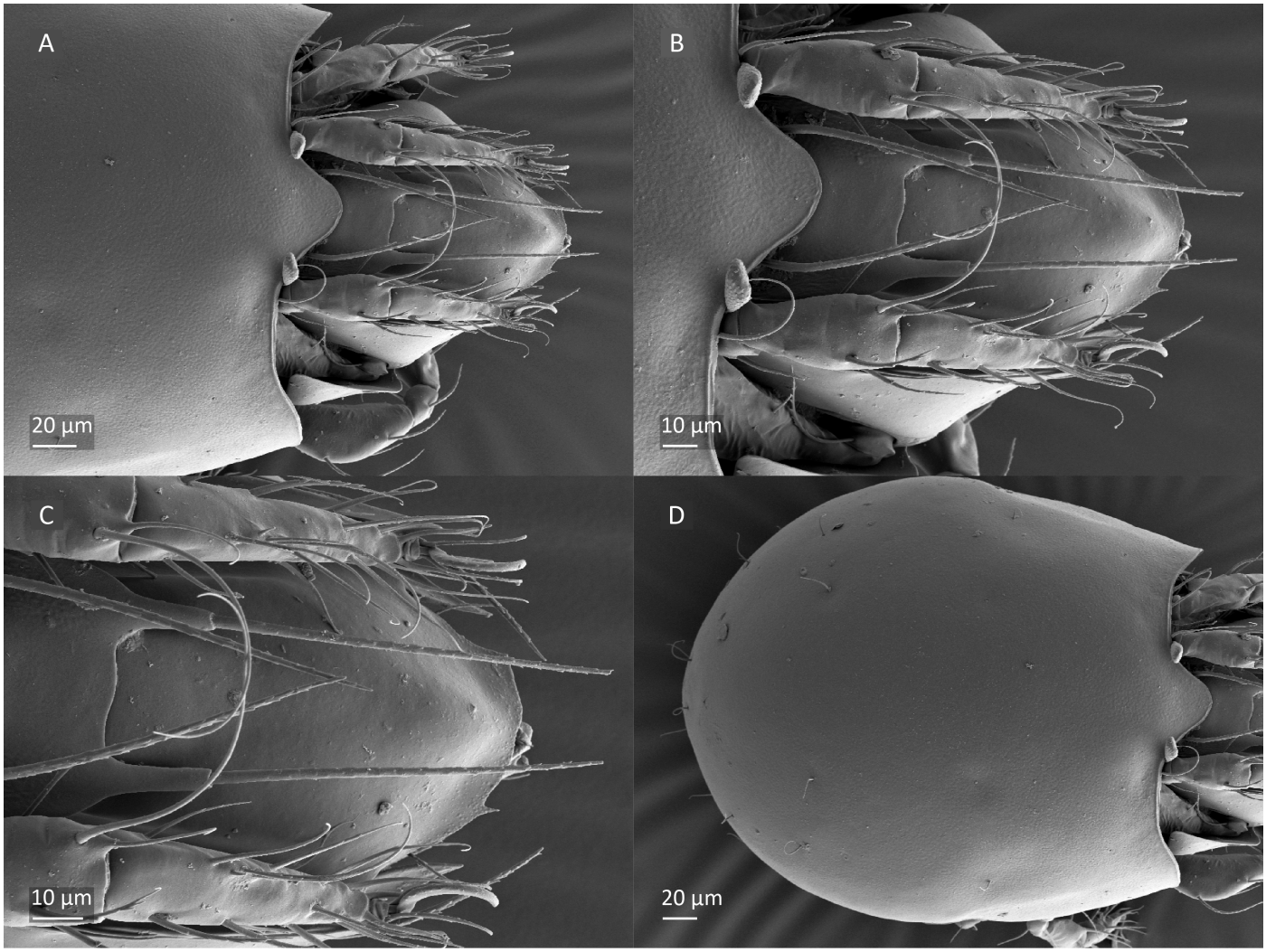

Figure 6 *Zachvatkinibates svanhovdi* A. Seniczak *et* S. Seniczak **sp. nov.** adult, SEM micrographs. Dorsal view. A – anterior and medial part; B, C – anterior part; D – medial and posterior part.

(SUB2896631 SOITS204-22). The maximum variation within the species was 2.41% (p-dist) that is expected intraspecific variation of COI in oribatids. (e.g., Pfingstl *et al.* 2019, Seniczak *et al.* 2019). These are the first public COI sequences to be reported for the genus *Zachvatkinibates* and therefore, genetic distances to other species could not be calculated.

Distribution, ecology and biology

Zachvatkinibates svanhovdi was found in Troms and Finnmark county, Northern Norway, in a collective sample, taken in the transect on the shore of the river, so it is not possible to give precisely the species microhabitat. Among the 30 individuals investigated, collected at the end of August, the sex ratio (females to males) was 1:1, and no females were gravid and carried eggs.

Type material

The holotype (female) and four paratypes (2 females and 2 males) are deposited in the University Museum of Bergen, University of Bergen, Bergen, Norway (ZMBN).

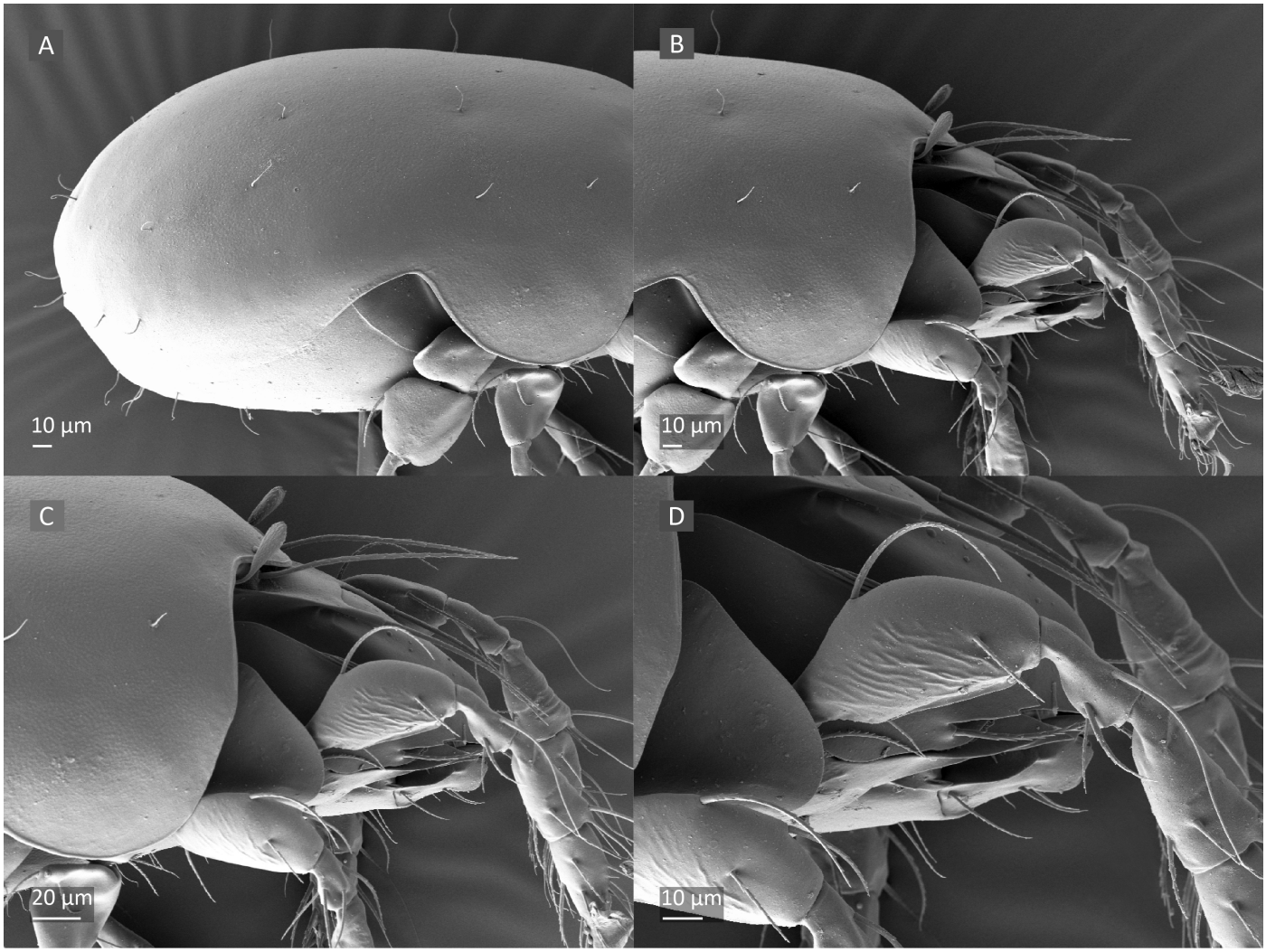

Figure 7 *Zachvatkinibates svanhovdi* A. Seniczak *et* S. Seniczak **sp. nov.** adult, SEM micrographs. Lateral view. A – posterior and medial part; B – anterior and medial part; C, D – anterior part.

Etymology

The species is named in honour of the biological station NIBIO Svanhovd, which is located in eastern Finnmark in the Pasvik valley, where the project leading to the collection and description of this new species was carried out.

Comparison of morphology of *Zachvatkinibates svanhovdi* with congeners and remarks

Seniczak *et al.* (2020d) compared selected morphological characters of adults of 15 *Zachvatkinibates* species and stated that the largest among them is *Z. nortoni* Behan-Pelletier *et* Eamer, 2005, and smallest is *Z. anoporosus* (Mahunka, 2006), and the body length of several species overlaps. These authors also compared the length of prodorsal seta *in* and notogastral setae, shape of translamella and some porose areas. To this list *Z. erimo* Shimano *et* Aoki, 2019 should be added. Based on this list of species, *Z. svanhovdi* A. Seniczak *et* S. Seniczak **sp. nov.** is the most similar to *Z. quadrivertex* (Halbert, 1920), but differs from it mainly by the shape of notogastral setae, posterior tectum of notogaster and lack of postanal porose area *Ap*, which in *Z. quadrivertex* is present. In *Z. svanhovdi*, most notogastral setae are distally pliable,

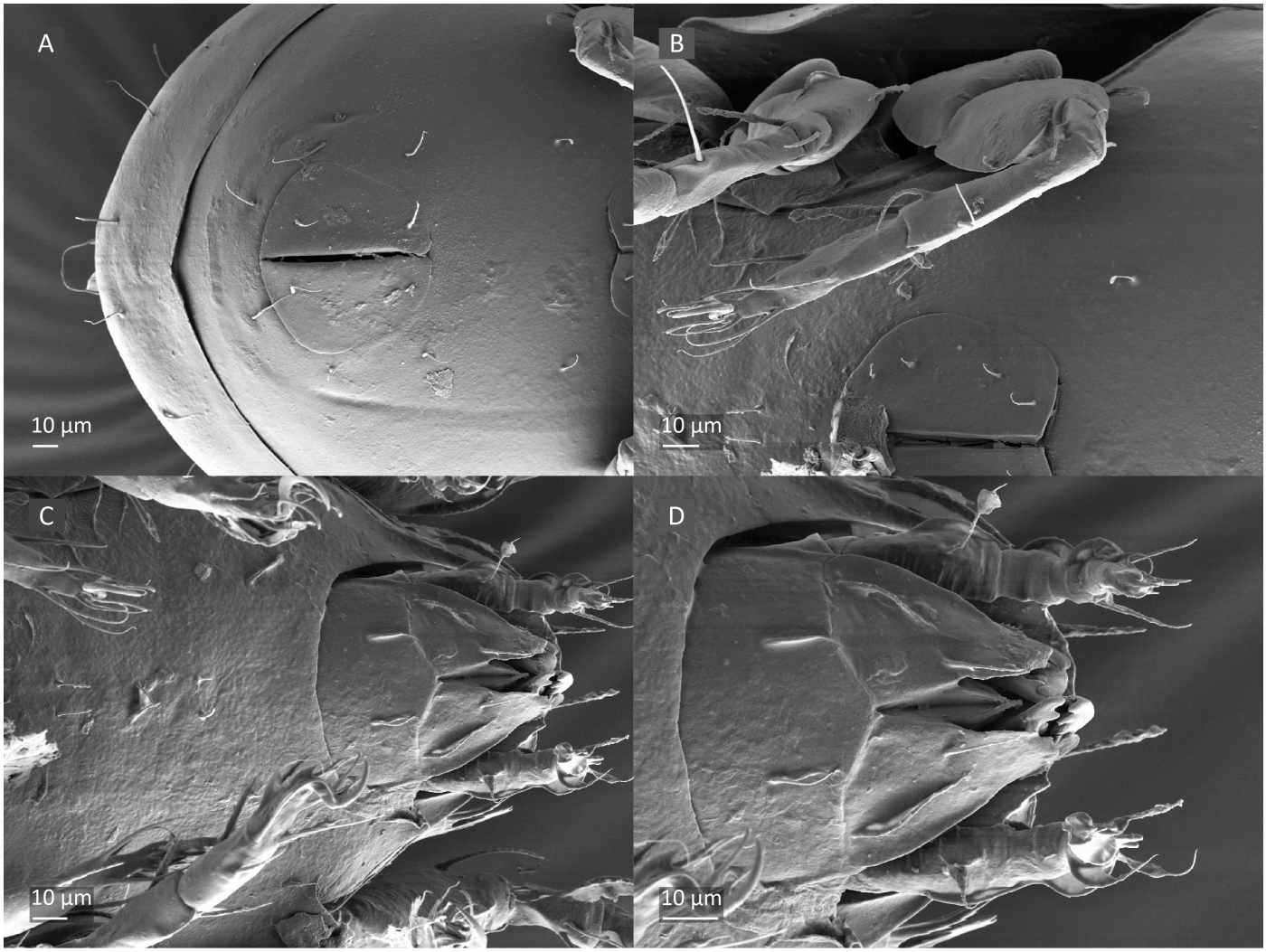

Figure 8 *Zachvatkinibates svanhovdi* A. Seniczak *et* S. Seniczak **sp. nov.** adult, SEM micrographs. Ventral view. A – posterior part; B – medial part; C, D – anterior part.

whereas in *Z. quadrivertex* they are not. In both species, the posterior tectum of notogaster is broken in the middle, the ends are rounded, but in *Z. svanhovdi* they overlap, whereas in *Z. quadrivertex* they are separated by a certain distance. In *Z. svanhovdi*, lyrifissures *ips* and *ih* are placed at larger distances from seta *p* than in *Z. quadrivertex*. Moreover, in female of *Z. svanhovdi* porose area *Aa* is located between setae *la* and *lm* (*vs*. anteromedial to seta *la* in *Z. quadrivertex*), and porose areas *A2* and *A3* are as large as *A1*, whereas in *Z. quadrivertex* they are smaller than *A1*. In some males of *Z. svanhovdi*, the porose areas *Aa* are larger than in *Z. quadrivertex*. In the diagnosis for *Zachvatkinibates* by Behan-Pelletier & Eamer (2005), postanal porose area *Ap* is present, but *Z. svanhovdi* has no porose area, so the diagnosis for this genus should be changed to "postanal porose area *Ap* present or absent".

In *Z. svanhovdi*, sexual dimorphism is observed in the body size and octotaxic system (Table 2). Males are slightly smaller than females, have larger porose areas, and *Aa* can be divided in two parts (*vs.* in females it is uniform). In six other species of *Zachvatkinibates*, sexual dimorphism is more distinct than in *Z. svanhovdi* (Table 2). Interestingly, the species listed in Table 2 seem to be correlated with littoral habitats of cold climate zones (Behan-Pelletier & Eamer 2010, Behan-Pelletier 2015).

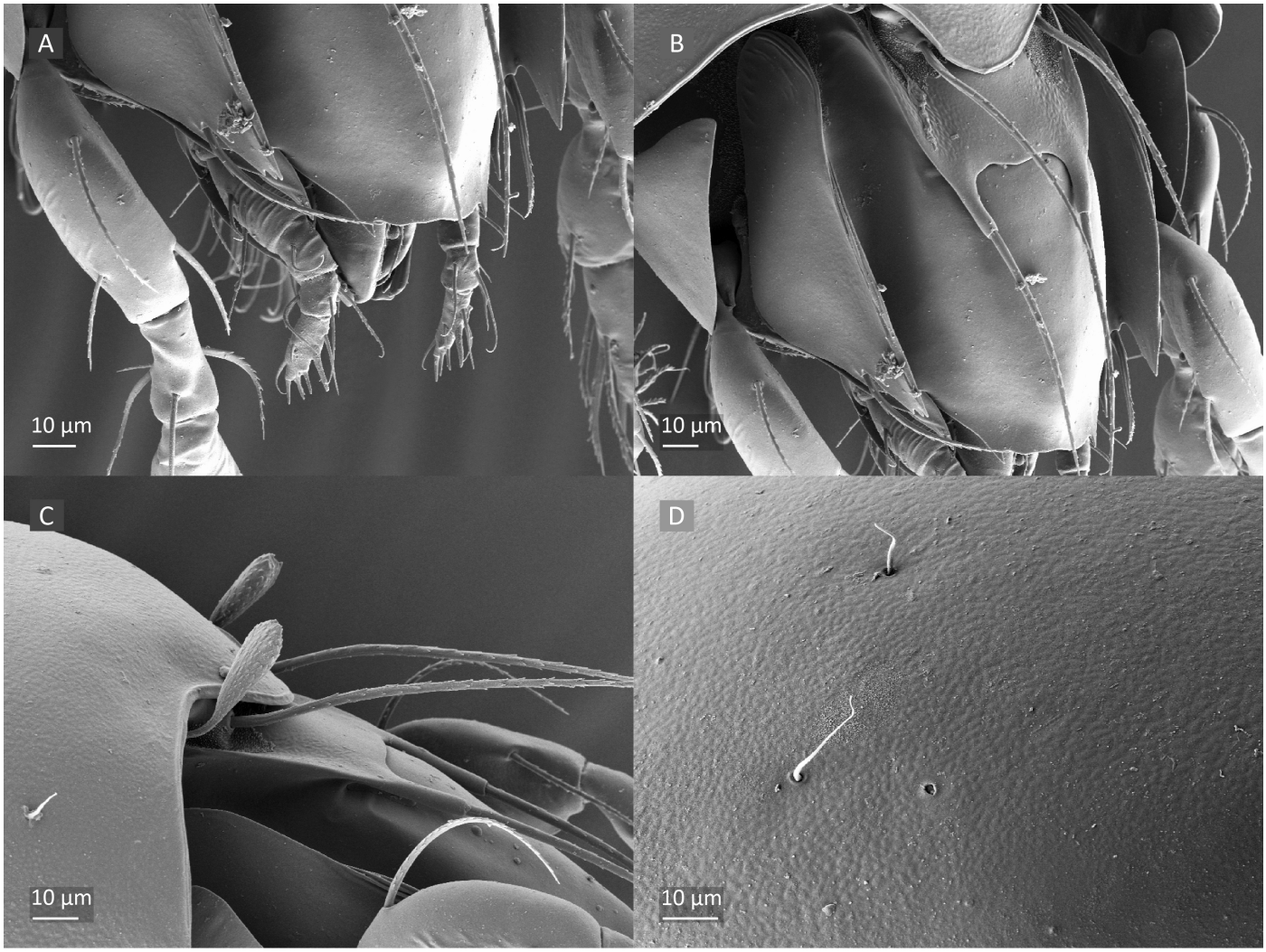

Figure 9 *Zachvatkinibates svanhovdi* A. Seniczak *et* S. Seniczak **sp. nov.** adult, SEM micrographs. A, B – anterior part; frontolateral view; C – bothridial setae; D – gla opening.

The adult of *Z. svanhovdi* has the dorsal crest on tarsus I, as other species of *Zachvatkinibates* (Shaldybina & Grishina 1987, Behan-Pelletier 1988, Bayartogtokh & Aoki 1998, Behan-Pelletier & Eamer 2005, Seniczak *et al.* 2020d). In *Minunthozetes* Hull, 1916, the leg crests are better developed than in *Zachvatkinibates* and occur on part of tibiae and tarsi I, II and IV (Seniczak & Seniczak 2018, Seniczak *et al.* 2018) and may suggest close relationship of *Zachvatkinibates* with *Minunthozetes*. In other genera of Punctoribatidae such as *Mycobates* Hull, 1916 and *Punctoribates* Berlese, 1908, the leg crests on tibiae and tarsi are absent (Seniczak & Seniczak 2008, Seniczak *et al.* 2015, 2020c). The latter two genera have dorsal projection on tibia II, which in *Zachvatkinibates* and *Minunthozetes* is absent.

Based on the checklists of Oribatida of Norway (Mehl 1979), Sweden (Lundqvist 1987), and Finland (Niemi *et al.* 1997), and other publications listed in Seniczak and Seniczak (2020) and Seniczak *et al.* (2020a,b, 2021), *Z. svanhovdi* represents the first finding of *Zachvatkinibates* in Norway and Fennoscandia. Species of *Zachvatkinibates* are known from Central and Eastern Asia, Northern America, and only few from Europe (Table 4). Their ecology varies a lot. For example, six species inhabit littoral zone and beach debris, other were found in bogs, forests, including forest canopy, and even in the debris in the alpine zone (Table 4).

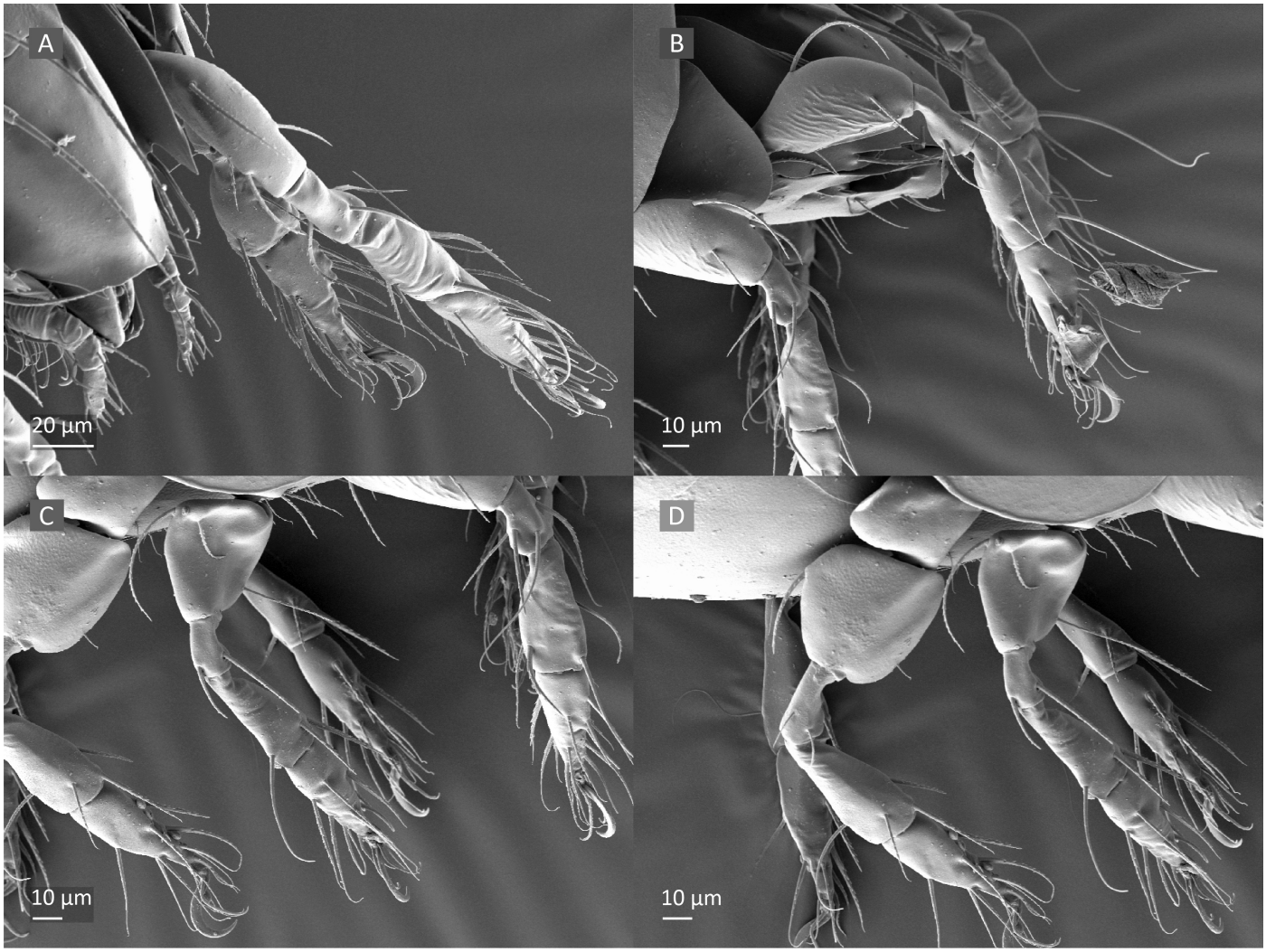

Figure 10 *Zachvatkinibates svanhovdi* A. Seniczak *et* S. Seniczak **sp. nov.** adult, SEM micrographs. Leg I. A – frontolateral view; B – lateral view; lateral view; C – legs I–III; D – leg III and VI.

Comments on Punctoribatidae in Fennoscandia and new record of *Mycobates carli*

The family Punctoribatidae to which *Zachvatkinibates* belongs to is represented in Fennoscandia by four genera and ten nominative species, including *Mycobates carli* (Schweizer, 1922) which is reported here as new to Norway and Scandinavian part of Fennoscandia (Table 3). It was found in alpine tundra in Finse (Vestland, Western Norway, 60°35′14.0″N 7°30′50.2″E, 1228 m a. s. l., 06.08.2022, leg. Anna Seniczak), on forest floor with mosses and lichens. The description of climatic conditions in Finse was given earlier (Seniczak & Seniczak 2021). This species was represented in the sample only by few adults, (density 10 individuals per 500 cm^3), and co-occurred with more abundant *M. sarekensis* (Trägårdh, 1910).

Mycobates carli has been mostly considered a southern European (Subías 2004, 2022), European (Weigmann 2006) or Eurosiberian species (Honciuc 1993), known especially from the Central, Southern, Eastern, and South-Eastern parts of Europe. It has been reported from numerous localities in the Alps (Fischer & Schatz 2020, Schatz & Bruckner 2021), the Giant Mountains (Materna 2000, Starý 2006, Miko 2013), Carpathian Mts. (Nae & Băncilă 2017, Skubała & Maslak 2009), and is also known from Caucasus Mts. (Schatz & Bruckner 2021).

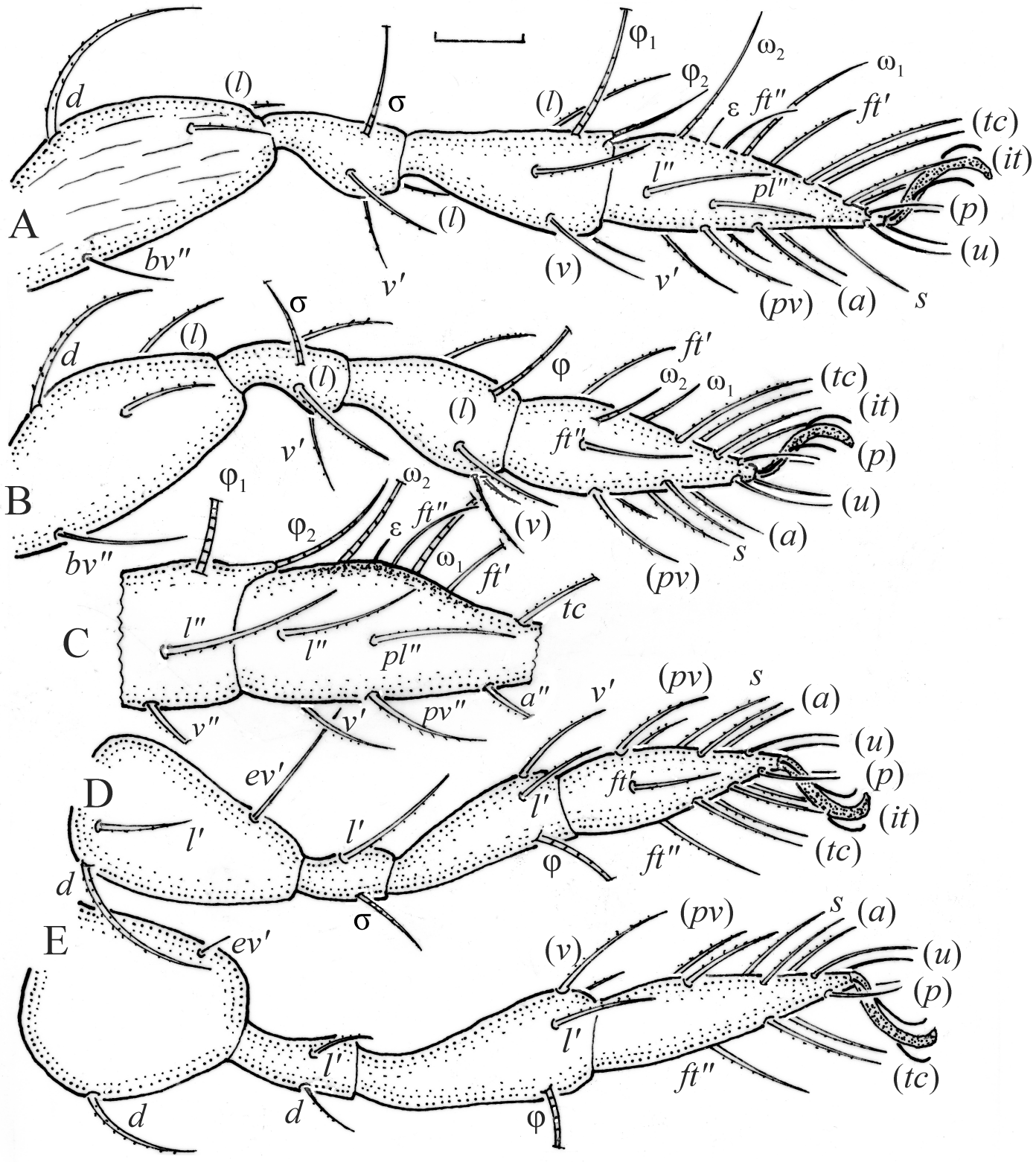

Figure 11 *Zachvatkinibates svanhovdi* A. Seniczak *et* S. Seniczak **sp. nov.**, leg segments of adult (part of femur to tarsus), right side, antiaxial aspect, setae on the opposite side not illustrated are indicated in the legend, scale bar 20 μm. A – leg I, tarsus (*pl'*); B – leg II; C – part of tibia and tarsus I; D – leg III, tibia (*v''*); E – leg IV.

Table 2 Selected morphological characters of *Zachvatkinibates* species with distinct dimorphism of notogastral porose areas; ♀ – females, ♂ – males.

Species	Body length (µm)	Seta *in* reaching rostrum	Shape of *Aa*	Size of porose areas			Setae *ad*-, *an*-series
				A1	*A2*	*A3*	
Z. erimo Shimano *et* Aoki 2019	♀440–449 ♂450	yes	rounded, as large as in male	as large as *Aa*	as large as *A1* *A2* and *A3* fused	smaller than *A2*	as long as *ag*
Z. nortoni Behan-Pelletier *et* Eamer, 2005	♀525–594 ♂ 525–574	yes	rounded, as large as in male	smaller than *Aa*	as large as *A1* *A1*, *A2* and *A3* fused	as large as *A2*	as long as *ag*
Z. quadrivertex (Halbert, 1920)	♀450–500 ♂415–480	yes	oval, smaller than in male elongated	as large as *Aa* smaller than *Aa*	smaller than *A1* as large as *A1*	larger than *A2* as large as *A2*	?
Z. shaldybinae Behan-Pelletier *et* Eamer, 2005	♀499–528 ♂470–508	no	rounded, smaller than in male elongated or divided	smaller than *Aa* smaller than *Aa*	as large as *A1* smaller than *A1*	as large as *A2* larger than *A2*	?
Z. schatzi Behan-Pelletier *et* Eamer, 2005	♀528–554 ♂505–544	no	elongated, smaller than in male	smaller than *Aa*	smaller than *A1* *A1*, *A2* and *A3* fused	larger than *A2*	?
Z. maritimus Shaldybina, 1973	♀473 ♂?	yes	irregular, smaller than in male elongated	smaller than *Aa* smaller than *Aa*	smaller than *A1* as large as *A1*	larger than *A2* as large as *A2*	as long as *ag*
Z. svanhovdi A. *et* S. Seniczak **sp. nov.**	♀481–507 ♂449–481	yes	oval, smaller than in male elongated or divided	smaller than *Aa* smaller than *Aa*	as large as *A1* as large as *A1*	as large as *A2* as large as *A2*	longer than *ag*

In the north of Europe it has only been reported from plain tundra of the Kola Peninsula (Leonov & Rakhleeva 2015). It is considered subalpine and alpine (Weigmann 2006, Fischer & Schatz 2007), predominantly lichenocolous (Materna 2000), and muscicolous (Schatz & Bruckner 2021). It has been found in a peatland, 870 m a. s. l. (Starý 2006), at dry limestone plateau, 550 m a. s. l. (Lazarus & Krisper 2014), and in soils polluted with heavy metals in Romania, where it was associated with Cu, As and Mn (Manu *et al.* 2019). Most often it has been collected from soil or ground vegetation, but has been also reported from the unique microhabitat of the intermediate layer between the base of the soil and the bedrock, called "mesovoid shallow substratum" (Nae & Băncilă 2017) and from decaying wood (Skubała & Maslak 2009).

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Table 3 Occurrence of Punctoribatidae in Fennoscandia, N – Norway, S – Sweden, F – Finland; * – new to Norway and Fennoscandia.

Genus	Species	Country
Minunthozetes Hull, 1916	*M. pseudofusiger* (Schweizer, 1922)	F, N
	M. semirufus (C.L. Koch, 1841)	F, S, N
Mycobates Hull, 1916	*M. carli* (Schweizer, 1922)*	N
	M. parmeliae (Michael, 1884)	F, S, N
	M. sarekensis (Trägårdh, 1910)	F, S, N
	M. tridactylus Willmann, 1929	N
Punctoribates Berlese, 1908	*P. hexagonus* Berlese, 1908	F
	P. punctum (C.L. Koch, 1839)	F, S, N
	P. sellnicki Willmann, 1928	F, S, N
Zachvatkinibates Shaldybina, 1973	*Z. svanhovdi* A. *et* S. Seniczak **sp. nov.***	N

Table 4 Distribution and ecology of *Zachvatkinibates* species.

Species	Distribution	Habitat	Sexual dimorphism	Reference
Z. anoporosus (Mahunka, 2006)	Romania (Poiana Brazilor, Ocna Șugatag, Muntii Piatra, 900 m a. s. l.)	Bog, decaying wood, some *Sphagnum*	Unknown	Mahunka (2006)
Z. conjunctus Shaldybina, 1987	Russia (Stolby Nature Reserve, Krasnoyarsky Krai)	Moss cushion at the base of a pine tree	Unknown	Shaldybina & Grishina (1987)
Z. eoeryi (Mahunka, 1972)	South Europe: Croacia (near Split), Portugal (Lagoon of Faro)	Predominantly marine littoral debris, e.g., algae, detritus	Unknown	Mahunka (1972), Weigmann (2009)
Z. epiphytos Behan-Pelletier, Eamer *et* Clayton, 2001	Canada (Montane Alternative Silvicultural Systems, Vancouver Island), USA (Willamette National Forest, Oregon)	Epiphytes (mainly lichens) in coniferous forest canopy	No	Behan-Pelletier *et al* . (2001), Winchester *et al* . (2008)
Z. erimo Shimano *et* Aoki, 2019	Japan (Hyakuninhama, Shono, Erimo City, Horoizumi)	Roots of Poaceae, dead parts of plants, soil on a sandy beach	Yes	Shimano & Aoki (2019)
Z. latilamellatus Bayartogtokh *et* Aoki, 1998	Mongolia	Siberian larch (*Larix sibirica* Ledeb.) forest	Unknown	Bayartogtokh & Aoki (1998), Seniczak *et al* . (2020b)
Z. lobatus (Hammer, 1977)	Pakistan (Lowari Pass, 3400 m a. s. l.)	Thin moss on the soil, grass, *Potentilla*, *Epilobium* , *Fragaria* , *Geranium* , pine cones	Unknown	Hammer (1977)
Z. maritimus Shaldybina, 1973	Russia (Primorsky krai), USA (Alaska), Canada (Yukon, Vancouver Island, British Columbia)	Coastal debris, supratidal meadows, coastal and lentic littoral habitats	Yes	Shaldybina (1973, 1987), Behan-Pelletier (1988), Ryabinin (2015)
Z. mongolicus Bayartogtokh, 2003	Mongolia (Gobi Gurvan Saykhan Nature Reserve, southern Mongolia)	Semidesert, soil under *Artemisia santolinifolia* (Pamp.) Turcz. ex Krasch and organic debris accumulated	No	Bayartogtokh (2003)
Z. nemoralis Shaldybina, 1973	Kyrgyzstan and Mongolia	Litter between roots, the alpine region	Unknown	Shaldybina (1973, 1987)
Z. nortoni Behan-Pelletier *et* Eamer, 2005	Canada (British Columbia)	Beach debris	Yes	Behan-Pelletier & Eamer (2005)
Z. quadrivertex (Halbert, 1920)	Atlantic coastal regions of Europe, from Denmark to South Portugal, Russia (Islands of White Sea, Far East: Kunashir Island in Kuril Islands)	Lower tidal level of marine saltmarshes, fir forest	Yes	Shaldybina (1987), Weigmann (2009), Ryabinin (2015)
Z. schatzi Behan-Pelletier *et* Eamer, 2005	Canada (British Columbia)	Beach debris	Yes	Behan-Pelletier & Eamer (2005)
Z. shaldybinae Behan-Pelletier *et* Eamer, 2005	Canada (eastern and northeastern), Greenland	Littoral	Yes	Behan-Pelletier & Eamer (2005), Makarova & Behan-Pelletier (2015)
Z. tetrasklerosis Behan-Pelletier, 1988	USA (California)	Litter of different species of conifers	No	Behan-Pelletier (1988)
Z. volgini Shaldybina, 1973	Russia (Far East: Shikotan and Yuri islands in Kuril Islands, Sakhalin)	Gull's nest on the coast, quackgrass [*Elymus repens* (L.) Gould] and brier meadow	Unknown	Shaldybina (1973, 1987), Ryabinin (2015)

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