

***Granuliphorura pomorskii* sp. n. (Onychiuridae: *Tullbergiinae*)  
and *Friesea oregonensis* sp. n. (Neanuridae: *Frieseinae*),  
two new species of psammobiotic Collembola from North America**

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Abstract. Two new species of genera *Granuliphorura* RUSEK, 1976 and *Friesea* DALLA TORRE, 1895 are illustrated and described from the Oregon Dunes on the Pacific Coast of North America. Taxonomic remarks are provided.

Key words: Springtails, taxonomy, *Granuliphorura*, *Friesea*, sand, United States

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## I. INTRODUCTION

Many species of springtails inhabit sandy areas such as coastal beaches and dunes, riverbanks, continental dune fields and deserts. Many of them are strictly restricted to these habitats and classified as psammobiotic or psammophilic (e.g. THIBAUD & CHRISTIAN 1997; THIBAUD & WEINER 1997; THIBAUD & PALACIOS-VARGAS 2001; FJELLBERG 2009). Because of living between fine-grained loose sediments and sand grains, these forms are characterized by set of features: minute body size, slim and slender body shape, relatively short antennae and legs, usually absence of body pigment, strong reduction or absence of eyes and furca. Despite of nearly 300 arenicolous species being formally recorded and described from sandy biotopes of the world (THIBAUD 2007), our knowledge of the distribution, habitat requirements, biology, taxonomy and diversity of this Collembola group is still insufficient and far from satisfactory.

The Oregon Dunes are one of the largest coastal sand dunes on Earth and the Northern Hemisphere. Surprisingly, the springtail fauna of the mentioned area is completely unknown. During a visit of the author to United States, a few sand samples from the area were collected. An examination of the material indicated that two species belonging to subfamilies *Tullbergiinae* and *Frieseinae*, respectively, are new to science. Their description, taxonomic affinities and bionomic notes are presented below.

## II. MATERIALS AND METHODS

Specimens were extracted from sand samples using a Tullgren apparatus. The specimens thus extracted were cleared in potassium hydroxide and chloral phenol, then mounted on slides in Swan's medium. Observation was done using a Nikon Eclipse 80i phase contrast microscope. All drawings were prepared using the camera lucida. Type material is preserved in the Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Kraków, Poland (ISEA), and in the entomological collection of Zoological Institute, Wrocław University, Poland (ZIWU). Terminology for the description follows that given in CASSAGNAU (1958), YOSII (1962), MASSOUD (1967), GROW and CHRISTIANSEN (1974), LAWRENCE (1977) and FJELLBERG (1998).

Abbreviations used in text and figures are: ant. I-IV = antennal segments I-IV, AOIII = antennal III organ, PAO = postantennal organ, th. I-III = thoracic terga I-III, abd. I-VI = abdominal terga I-VI.

## III. TAXONOMY

### *Granuliphorura pomorskii* sp. n.

Figs 1-10

**Type material.** Holotype (female in ISEA) and paratypes (5 females and 2 males in ISEA and ZIWU).

**Type locality.** USA: Oregon, Oregon Dunes, Siuslaw National Forest, 10 km North of Florence town, Baker Beach, sand, roots of *Ammophila arenaria*, coastal dune, 23. IX. 2007, leg. A. SMOLIS.

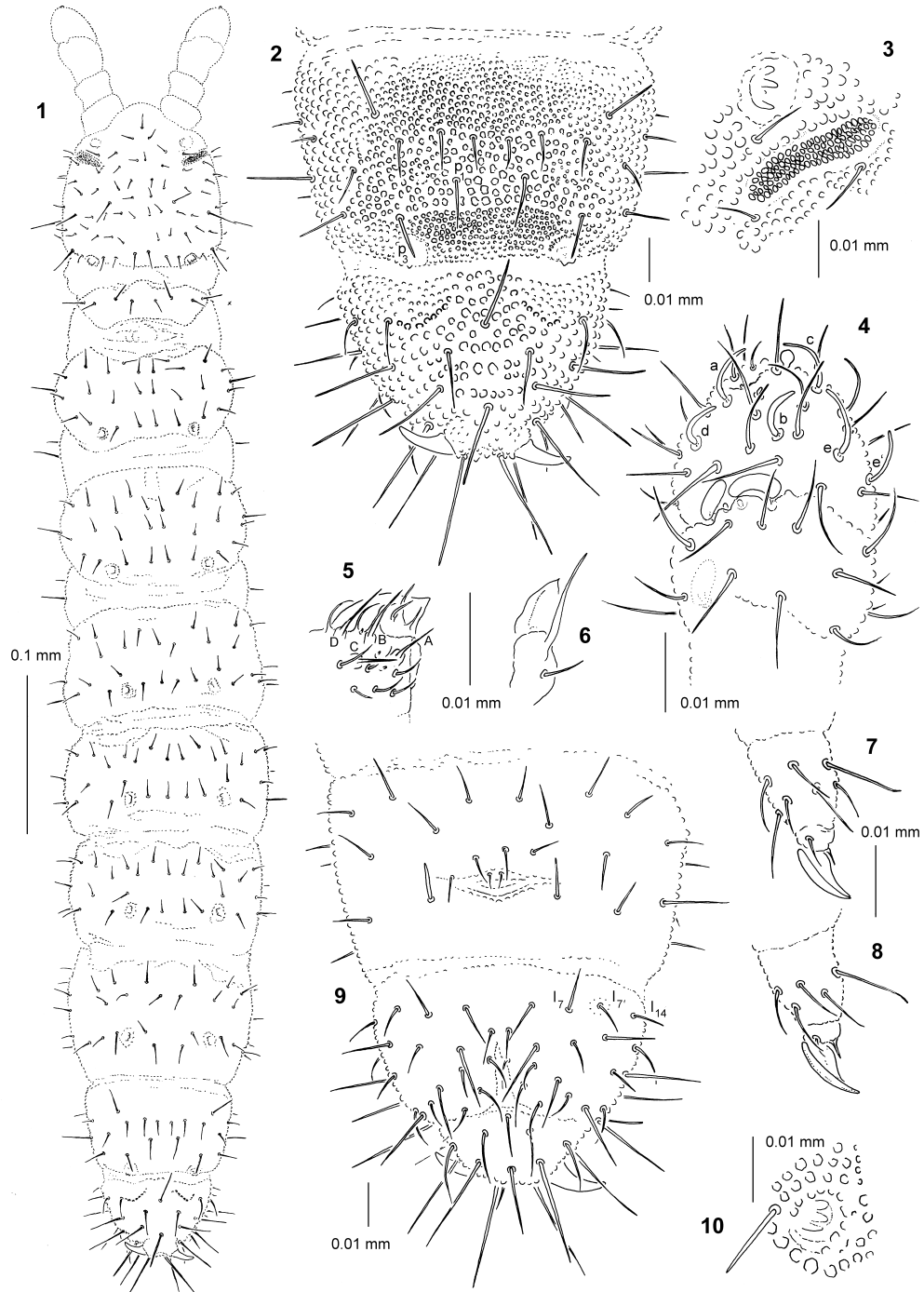
**Diagnosis.** The new species is characterized by: body length of 0.67-0.77 mm, dorsal granulation with fields of coarser granules, abd. V-VI with the largest granules of similar size, PAO consisting of 60-90 simple vesicles in four rows, AOIII with two large sensilla, ant. IV with six sensilla a-e', labium with 4 four papillae A-D, th. II-III and abd. I-V with 1+1 pseudocelli, abd. VI with two crescentic ridges, abd. V with chaetae  $p_1$  situated in front of sensilla  $p_3$ , subcoxa III with four chaetae, tibiotarsi I-III with relatively long and slightly clavate chaetae, claw with very short empodial appendage, and presence of males.

**Description.** Habitus as in Fig. 1. Body length (without antennae) 0.67-0.77 mm (holotype: 0.74 mm). Body white. Granulation of dorsal side of body distinct and heterogeneous, with fields of coarser granulation (Fig. 2). Differentiation of dorsal chaetae into macro- and microchaetae marked on head and last abdominal segment, on other segments mostly meso- and short macrochaetae present (Figs 1-2).

Postantennal organ 2.5-3 times longer than diameter of the nearest pseudocellus, narrow elliptical, in shallow depression (Figs 1, 3). PAO consists of 60-90 simple vesicles lying in four parallel rows. Labial palp with 4 papillae A-D (papilla E absent), 6 proximal chaetae, 3 accessory papillae (papilla d' absent), 4 guard chaetae and 3 hypostomal chaetae (Fig. 5). Basal parts of labium with 4+4 and 5+5 chaetae. Maxillary palp simple, with 1 sublobal hair (Fig. 6). Chaetotaxy of labrum: 4/3, 4, 2. Mandible strong, maxilla with strong apical teeth and short lamellae.

Dorsal chaetotaxy of head as in Fig. 1. Uneven chaeta  $v_0$  on head present. 3+3 chaetae along ventral line of head. Antennae slightly shorter than head (Fig. 1). Chaetotaxy of antennal segments III and IV as in Fig. 5. Ant. I with 7 chaetae, ant. II with 11 chaetae. AOIII with two small internal sensory rods and two very large, thick and slightly curved sensilla. Ventral side of ant. III with large and thick sensillum. Ant. IV with small globular apical vesicle, small subapical organite, microsensillum and 6 relatively long and slim, slightly curved sensilla a-e' (Fig. 4).

Pseudocellar formula: 11/011/11111. Arrangement of pseudocelli as in Fig. 1. Pseudocelli circular, crescentic (Figs 3, 10; type III, WEINER & NAJT 1991).



Figs 1-10. *Granuliphorurapomorskii* sp. n. 1 – habitus and dorsal chaetotaxy (holotype); 2 – abdomen V-VI, dorsal view; 3 – postantennal organ and the nearest pseudocellus; 4 – antennal segments III-IV, dorsal view; 5 – labial palp; 6 – maxillary palp; 7 – tibiotsarsus and claw of the third pair of legs, ventrolateral view; 8 – tibiotsarsus and claw of the third pair of legs, dorsolateral view; 9 – abdomen VI, ventral view; 10 – pseudocellus and sensillum p 3 of Abd. IV.

Dorsal chaetotaxy as in Figs 1-2. Sensilla on th. and abd. simple and not thickened, similar in shape to ordinary chaetae. Thoracic pleurites I, II, III with 2, 3, 3 chaetae respectively. Chaetae  $p_1$  on abd. V situated in front of sensilla  $p_3$  (Fig. 2). Granulation and arrangement of dorsal chaetae of abd. V-VI as in Figs 1-2. The largest granules of dorsal part of abd. I-V, especially along medial line of terga, similar in size or the same size as coarsest granules of abd. VI (Fig. 2). Abdominal tergum VI with two crescentic ridges in anterior part and two large spines on distinct papillae. Thoracic sternum II and III with 1+1 chaetae, ventral tube with 6+6 chaetae (2+2 chaetae in basal part). Abdominal sternum V with 1+1 slightly thickened sensilla behind genital plate. Bisexual species. Genital plate of adult male consists of 16-18 chaetae (6+10-12). Chaetotaxy of anal lobes as in Fig. 9. Anal lobes with additional chaeta  $l_7$  between chaetae  $l_7$  and  $l_{14}$ .

Tibiotarsi I, II, III with 12, 12, 11 chaetae respectively (chaeta M absent) (Figs 7-8). Inner tibiotarsal chaetae relatively long and slightly clavate. Femora with 10 chaetae each. Trochanters with 5 chaetae each. Coxae I, II, III with 3, 8, 7-8 chaetae respectively. Subcoxae I, II, III with 0, 4, 4 chaetae respectively. Claws without inner tooth. Empodial appendage very short, without lamella (Figs 7-8).

**R e m a r k s.** *Granuliphorura pomorskii* sp. n. is closely related to *G. obtusochaeta* RUSEK, 1976 (described from the southern part of Vancouver Island, Canada), the type and the only species of the genus *Granuliphorura* RUSEK, 1976. The new species differs clearly from its congener in having narrow elliptical PAO with 60-90 vesicles (in *G. obtusochaeta* broad elliptical PAO with 48-50 vesicles), th. and abd. with meso- and short macrochaetae mainly (in *G. obtusochaeta* micro- and long macrochaetae), additional chaeta  $l_7$  between chaetae  $l_7$  and  $l_{14}$  on anal lobes (in *G. obtusochaeta* absent) and 4 subcoxal chaetae on hind leg (in *G. obtusochaeta* 3 chaetae). Moreover, in *G. pomorskii* chaetae  $p_1$  are placed in front of sensilla  $p_3$  on abd. V (in *G. obtusochaeta* chaetae and sensilla situated in one row) and granules between chaetae  $p_1$  on abd. V are the same size as the largest granules of abd. VI (in *G. obtusochaeta* granules of abd. VI distinctly larger than ones of preceding segment). In addition, both species differ in habitat requirements and ecological preferences, *G. pomorskii* live in sand of coastal dunes, whereas *G. obtusochaeta* was collected in deep soil layer of dry Douglas-fir forest (Rusek 1976).

CHRISTIANSEN and BELLINGER (1980) synonymised the genus *Granuliphorura* RUSEK, 1976 with the genus *Tullbergia* LUBBOCK, 1876, however, this taxonomic act was not accepted by most taxonomists (e.g. FJELLBERG 1998; ZIMDARS & DUNGER 1994). CHRISTIANSEN and BELLINGER, in the same paper, described a several new species in the mentioned genus. Amongst them, *Tullbergia nulla* CHRISTIANSEN & BELLINGER, 1980 (described from Indiana state) seems to be similar to the new species, while both forms are characterized in having narrow elliptical PAO, first thoracic segment without pseudocelli, abdomen V with displacement of chaetae  $p_1$  forward into  $m_1$  position and presence of 1+1 pseudocelli on th. II-III and abd. I-V. However, in *T. nulla* differentiation of chaetae into macrochaetae and microchaetae is very well developed on fourth abdominal segment (in *G. pomorskii* very poorly marked), granules of abd. VI are distinctly larger than ones of preceding segments (in *G. pomorskii* some granules on abd. I-V are the same size as largest granules of last abdomen), tibiotarsal chaetae are short and pointed (in *G. pomorskii* inner chaetae are relatively long and slightly clavate) and body length maximum 1.5 mm (in *G. pomorskii* body length of only 0.67-0.77 mm). Nevertheless, the more substantial comparison between these species and analysis of their affinities are actually impossible, since the original description of *T. nulla* lack the detail expected of modern accounts. Undoubtedly, as it was earlier suggested by FJELLBERG (1998), the taxonomic status of most *Tullbergia* species described from the northern hemisphere needed further comprehensive studies. These additional data are also required to resolve the relationships between known forms of "large" *Tullbergiinae*.

**E t y m o l o g y.** The new species is dedicated to Professor Romuald Jacek POMORSKI, the eminent taxonomist in Collembola, and my teacher and colleague.

*Friesea oregonensis* sp. n.

Figs 11-19, Tab. 1

**T y p e m a t e r i a l.** Holotype (male in ZIWU) and paratypes (2 females and 4 males in ISEA and ZIWU).

**T y p e l o c a l i t y.** USA: Oregon, Oregon Dunes, Siuslaw National Forest, 10 km North of Florence town, Baker Beach, sand, dune-forest with sitka spruce *Picea sitchensis*, 23. IX. 2007, leg. A. SMOLIS.

**D i a g n o s i s.** This species is characterized by: white body, head with 2+2 small and unpigmented eyes, body without clavate chaetae, abd. VI with three spines in position  $a_1$  and  $p_0$ ; reduced furca with 3+3 chaetae and without mucro; retinaculum with 1-2+1-2 teeth; tibiotarsi I, II, III with 17, 17, 16 chaetae respectively; tibiotarsi with pointed chaetae.

**D e s c r i p t i o n.** Body length (without antennae) 0.42-0.69 mm (holotype: 0.52 mm). Color of the body in alive and alcohol white. Habitus typical of the genus (Fig. 11). Granulation homogeneous, rather fine (Fig. 18).

Area ocellaris with 2+2 unpigmented and relatively small eyes (Figs 11-12). Labium with 14-15 chaetae, chaeta L papillated. Chaetotaxy of labrum: 4/5,3,4. Mandible typical of *Friesea* DALLA TORRE, 1895, with 8 teeth. Maxilla sickle-shaped with two small dentate lamellae.

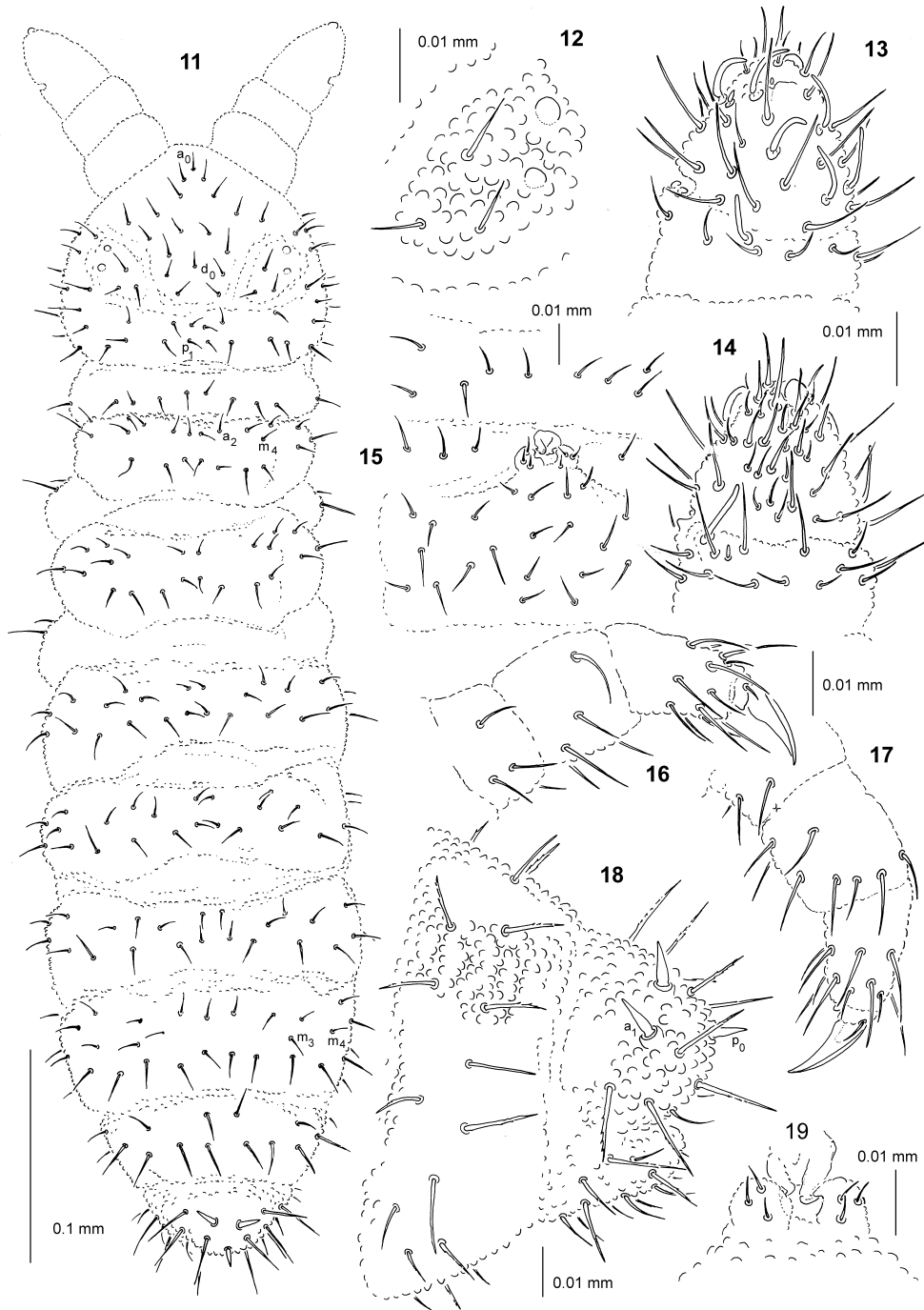
Dorsal chaetotaxy of head as in Figs 11-12. Uneven chaetae  $a_0$  and  $d_0$  on head present or absent. Head with chaetae  $p_1$  and 3 chaetae oc. 2+2 chaetae along ventral line of head. Antennae slightly shorter than head (Fig. 11). Chaetotaxy of antennae as in Figs 13-14. Ant. I with 7 chaetae, ant. II with 11-13 chaetae. Ant. III and IV fused dorsally. AOIII with two small internal sensilla and two slightly curved, cylindrical guard sensilla. Ventral microsensillum on ant. III present. Ant. IV with distinct and simple apical vesicle, chaeta i, small subapical organite, microsensillum and 6 short, relatively slim, curved sensilla.

Dorsal chaetotaxy of thorax as in Fig. 11. Chaetae  $a_2$  and  $m_4$  on th. II present. Chaetae  $a_3$  and  $a_4$  on th. II-III present. Sensillar formula of th. 022. Sensilla relatively thin, as long as nearest ordinary chaetae. Thoracic sterna without chaetae. Tibiotarsi I, II, III with 17, 17, 16 chaetae respectively (chaeta M absent) (Figs 16-17). Tibiotarsi without visible clavate chaetae. Femora I, II, III with 12, 11, 10 chaetae respectively. Trochanters with 5 chaetae each. Coxae I, II, III with 3, 7-8, 7-8 chaetae

Table 1

Morphological differences between *Friesea oregonensis* sp. n., *F. stachi*, *F. geminioculata*, *F. microphthalmia*, *F. nauimetzli* and *F. danica*

Characters	<i>oregonensis</i>	<i>stachi</i>	<i>geminioculata</i>	<i>microphthalmia</i>	<i>nauimetzli</i>	<i>danica</i>
Pigmentation of eyes	–	+	–	+	+	+
Number of chaetae on ventral tube	4+4	?	3+3	4+4	4+4	4+4
Number of chaetae on dens	3+3	2+2	1+1	3+3	2+2	3+3
mucro	–	–	–	+	–	+
Abd. VI with clavate chaetae	–	?	–	–	+	–
Number of chaetae on tibiotarsi I-III	17,17,16	?	?	18,18,17	17,17,16	18,18,17
tibiotarsi I-III with clavate chaetae	–	–	+	–	–	–
Tooth on claw	–	–	–	+	–	–



Figs 11-19. *Friesea oregonensis* sp. n. 11 – habitus and dorsal chaetotaxy (holotype); 12 – area ocularis; 13 – antennal segments III-IV, dorsal view; 14 – antennal segments III-IV, ventral view; 15 – chaetotaxy of abdominal segments II-IV, ventral view; 16 – trochanter, femur, tibiotalarsus and claw of third pair of legs, ventrolateral view; 17 – trochanter, femur, tibiotalarsus and claw of third pair of legs, ventrolateral view; 18 – abdomen V-VI, dorsolateral view; 19 – dens and retinaculum



Fig 20. The Oregon Dunes, Baker Beach, type locality of *Granuliphorura pomorskii* sp. n. and *Friesea oregonensis* sp. n.

respectively. Subcoxae I, II, III with 0, 2, 2 chaetae respectively. Claws without inner tooth (Figs 16-17). Empodial appendage absent.

Dorsal chaetotaxy of abdomen as in Figs 11, 18. Sensillar formula of abd. 11111. Abd. VI with three, relatively short and straight anal spines; two spines in position  $a_1$  and one spine in position  $p_0$  (Fig. 18). Chaetae  $m_3$  and  $m_4$  on abd. IV present or sporadically absent (Fig. 11). Ordinary chaetae on abdominal segments slightly serrated. Ventral chaetotaxy of abd. as in Figs 15, 19. Ventral tube with 4+4 chaetae. Retinaculum with 1-2+1-2 teeth. Furca reduced, in state 3 (CASSAGNAU 1958), with 3+3 microchaetae and without mucro (Fig. 19). Chaetotaxy of manubrium as in Fig. 15. Unpaired anal lobe with 3 chaetae. Even anal lobes with 15-16+15-16 chaetae and 3+3 microchaetae.

**R e m a r k s.** Because of the presence of 2+2 eyes, furca and three anal spines, *Friesea oregonensis* sp. n. is similar to the following species: *F. stachi* KSENEMAN, 1936, *F. geminioculata* LOKSA, 1964 (both from the Carpathians, Europe; KSENEMAN 1936; LOKSA 1964), *F. microphthalma* DEHARVENG & BEDOS, 1991 (from Thailand) *F. nauimetzli* PALACIOS-VARGAS & ACOSTA, 1994 (from Mexico) and *F. danica* FJELLBERG, 1998 (described from Denmark). They differ in many morphological characters summarised and given in the Table 1.

**E t y m o l o g y.** The new species is named after the state Oregon.

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