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A New Genus and Three New Species of the Mite Family Arctacaridae (Parasitiformes, Mesostigmata) from North America

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Abstract—A new genus *Proarctacarus* and three new species, *P. canadensis* (Rocky Mountains, Alberta, Canada), and *P. johnstoni* (Rocky Mountains, Idaho, Utah, USA), and *P. oregonensis* (Coast Ranges, Oregon, USA), are described and the diagnosis of the family Arctacaridae is refined. The majority of records of species of the genus *Proarctacarus* is associated with mountain coniferous forests. The regular arrangement of setae (transverse rows) and sigillae on the large soft opisthosoma suggests the presence of 10 abdominal segments (besides telson), including pregenital segment VII. The setae of this segment (2–3 pairs) are situated dorsolaterally at the border between podosoma and opisthosoma and are distinctly marked by the last row of podosomal setae (segment VI) and first complete row of opisthosomal setae associated with sigillae *sg* (genital segment VIII). The setae on pregenital segment VII are described in Mesostigmata for the first time. The taxonomic value of the character "presence/absence of ambulacrum I" and the taxonomic position of the cohort Arctacarina are discussed.

Until recently, the family Arctacaridae has been represented by a single genus *Arctacarus* Evans including three species: *A. rostratus* Evans, 1955, *A. beringianus* Bregetova, 1977, and *A. dzungaricus* Bregetova, 1977. Few findings of these species were limited to tundra and mountain regions of Middle, Central, and northeastern Asia, Russian Far East (Bregetova, 1977a; McLean *et al.*, 1978; Volonikhina, 1994), and also northern and western parts of North America (Evans, 1955; Behan, 1978; Danks, 1981; Thomas and McLean, 1988; Krantz, 1978; Johnston, 1982). A study of these rare mites is of interest in many aspects. The significant morphological originality and archaism of representatives of Arctacaridae, and their mosaic similarity to Zerconina, on the one hand, and to Parasitina and Dermanyssina, on the other, puts this family in the exclusive position in all the discussions concerning the phylogeny of the suborder Mesostigmata. This phenomenon is reflected in that the family Arctacaridae is placed in different superfamilies of various cohorts (Table 1), or ranked as a separate cohort (or suborder) pari passu Zerconina, Parasitina, and Dermanyssina (Johnston, 1982; Woolley, 1988; Evans, 1992; Norton *et al.*, 1993).

A new genus[1] and 5 new species were revealed in the collection of Arctacaridae collected by acarologists of different countries. An analysis of the type series of *A. beringianus* and *A. dzungaricus* and topotypes of *A. rostratus*, also of a new material made it possible to refine the diagnoses of the family Arctacaridae and the genus *Arctacarus* and to establish the synonymy of *A. beringianus* Bregetova, 1977 and *A. rostratus* Evans, 1955.[2]

The type species (and the only species known before 1977) of the family *A. rostratus* was described in 1955 from Arctic tundras of Alaska and after that was not mentioned for more than 20 years. Subsequent recordings from the northern parts of Asia and North America were also associated with tundra and forest-tundra habitats of plain and mountain regions (Bregetova, 1977a; Behan, 1978; McLean *et al.*, 1978; Thomas and McLean, 1988; Volonikhina, 1994; new data), whereas the distribution ranges of the rest six species of the genus, including undescribed ones, are, apparently, very limited and associated mainly with mountain coniferous forests.

In the present communication, a new genus and three new species from Canada and USA are described.

The nomenclature of the podosomal setae (Fig. 1, *1*) is given according to Lindquist and Evans (1965) with

[1] The existence of this genus was first mentioned by Johnston (1982).

[2] Publication with a rationale of the synonymy is in preparation.

Table 1. Taxonomic position of the family Arctacaridae among Mesostigmata (= Gamasida), according to different authors

Taxon	Evans, 1955	Evans and Till, 1979	Krantz, 1970, 1978; Krantz and Ainscough, 1990	Bregetova, 1977a	Bregetova, 1977b	Johnston, 1982; Woolley, 1988; Evans, 1992; Norton *et al.*, 1993
Cohort (suborder)	Epicriina	Gamasina	Gamasina	Gamasina	Gamasina	Arctacarina
Division (group)		Epicriides			Laelapina	
Superfamily	Zerconoidea		Parasitoidea		Arctacaroidea	
Family	Arctacaridae					

a single correction.[3] The poroidotaxy and adenotaxy are given according to Johnston and Moraza (1991), with a correction for *gds*4 (Moraza and Lindquist, 1998), the terminology is given according to Athias-Henriot (1969a, 1969b). Only opisthonotal glands are designated according to Sellnick (1958), without association with any setae, because of the significant differences in the chaetom between *Arctacarus* and *Proarctacarus*.[4] Cuticular glands with orifices situated laterally to the anterior angles of the sternal shield[5] *gvb* (from "brachium", Latin for shoulder), and also poroids *it* (from "temporalis", Latin for temporal), situated on the dorsal margin of the peritremal shield at the level of coxae II, are designated and described in Mesostigmata for the first time. Poroids of the anal valves are designated as *ian*. The sigillotaxy (Fig. 1) follows Athias-Henriot (1975).

The length of all the shields is measured along the median line, and the width, in the widest part. The length of the legs and tarsi are given without length of the ambulacrum. Measurements were made for all the available specimens and the results are given in the text in micrometers.

Family **ARCTACARIDAE** Evans, 1955

Type genus *Arctacarus* Evans, 1955.

Diagnosis. Dorsal surface of female with large (usually podonotal)[6] shield, leaving posterior part of body exposed; 1–5 pairs of mesonotal shields; pair of sclerites with 1–3 openings of glands *Po*3; and composite pygidial sclerite. The known males possessing one or two shields covering entire body. Sternal shield in both sexes free, with 2 or 3 pairs of setae. In male, genital orifice situated in posterior part of shield, covered with valve of complicated shape with pair of eugenital setae. In female, setae *St*1 attached on anterior margin of sternal shield or before it; in the known males, these setae attached on granulated cuticle before sternal shield or on large presternal shield. In female, metasternal and genital setae situated on membrane, genital shield jar-shaped, vaginal sclerites present, and anal shield free, bearing only anal setae. In male, the degree of fusion of metasternal, genital, endocoxal, and ventro-anal shields varying from separate shields to common shield. Peritrema long or shortened; peritremal shield of female free or fused with dorsal shield at anterior margin of body; in male, these shields fused along entire length. Opisthosomal chaetom varied; number of opisthonotal setae varied from 13 to 36 pairs, and number of opistogastral setae, from 8 to 17. Adenotaxy of dorsal surface of body the following: *gdj*2, *gdj*4, *gdz*5, *gdz*4, *Po*1, *Po*2,[7] Po3; ventral surface usually with cuticular glands *gv*1 and *gv*2;[8] glands *gvb* (laterally to anterior angles of sternal shield), *gv*3 (on anal shield), and *gp* (on peritremal shield) well developed. Glands *Po*3 and *gv*2 multiplied; *Po*3 usually opening with 2 or 3 pores situated on common sclerites, or several (2–4) follicles connected with single pore of gland; *gv*2 porous field with 2–15 pores. Poroidotaxy of podosoma: *idj*1 (fissure), *idj*3, *idj*6, *idz*3, *ids*4, sternal *iv*1–3, and peritremal *it*, *ip*1, and *ip*2; on opisthosoma, number of poroids varied: in females, only *jdz*6, *iv*5, and *ian* always present; in male, set of these pores more complete. Tectum varying in structure and differing in conspecific females and males; salivary styli attached under tectum

[3] If the first transverse row of the podosomal setae includes 3 pairs, then *r*1, rather than *s*1, is the lateral seta [the fact established in a study of *A. dzungaricus*, in which 4 pairs of setae are found in this row); see also Lindquist and Moraza (1998)].

[4] Glands *Po*1, *Po*2, and *Po*3 of Sellnick (1958) probably correspond to *gdz*6, *gdZ*1, and *gdZ*3 of Johnston and Moraza (1991).

[5] These glands are also present in representatives of other cohorts of Mesostigmata (Zerconina, Parasitina, and Dermanyssina).

[6] Only in *A. rostratus*, the podonotum is "augmented" with a fragment of the opisthonotum with a single transverse row of setae.

[7] Well developed in *Proarctacarus* gen. n., rudimentary or absent in *Arctacarus*.

[8] Absent in *A. dzungaricus*.

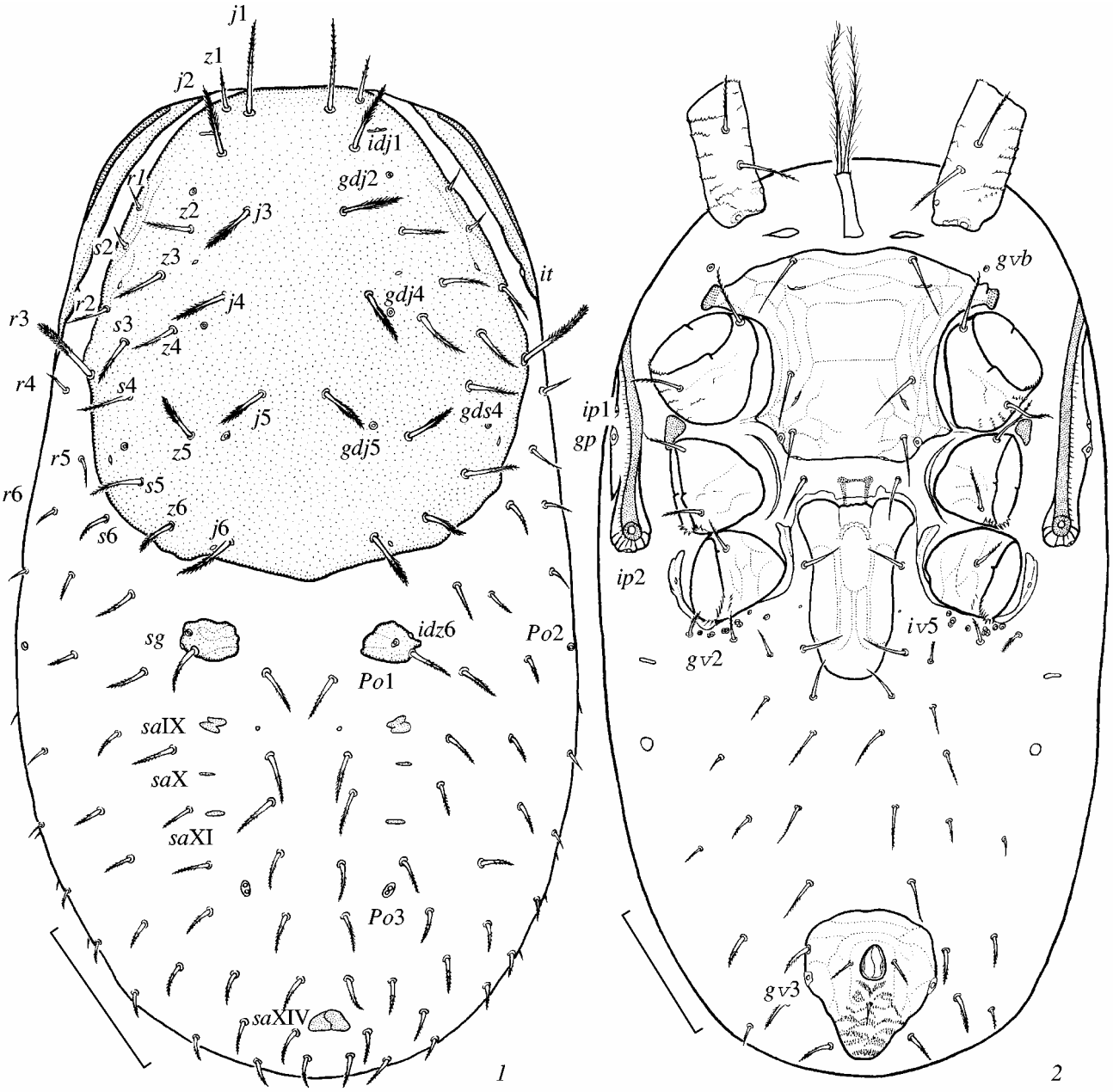

Fig. 1. Female of *Proarctacarus canadensis*, gen. et sp. n.: (*1*) dorsal surface; (*2*) ventral surface. Scale 200 μm.

and not connected with corniculi. Corniculi horn-shaped, small pointed denticle usually present medially to base of each corniculus.[9] Deuterosternal suture without longitudinal striation, with 10–12 rows of denticles, with 1–30 denticles in each row. Cheliceral claws large, with node in fascia of retractor of mobile digit. Sexual dimorphism present in structure of chela: in female, both digits bearing numerous denticles, pilus dentilis looking like thin-walled elevation with two apical papillae; in male, claw robust, with 1 or 2 large teeth on digits, and pilus dentilis needle-shaped. Apotele on palpal tarsus 3-armed, its median pointed arm widened apically; membrane connecting palpal femur and genu forming thin-walled outgrowth, in which duct of dermal gland opening. Chaetotaxy of legs I–IV: coxae (2)(2)(2)(1), trochanteres (6)(5)(5)(5), femora (2–5/4–2)[10] (2–5/3–1)(1–4/1–0)(1–3/1–1), genua (2–3/2,3/1–2)(2–3/1,2/1,2)(2–2/1,2/1–2)(2–2/1,3/1–1), tibiae (2–3/2,3/2–2)(2–2/1,2/1–2)(2–1/1,2/1–2)

[9] Rudimentary in *A. rostratus*.

[10] *A. dzungaricus* with a single seta *pl* on the femur I is the only exception.

(2–1/1,3/1–2); tarsi II–IV with 18 setae (*av*2 and *pv*2 present). Claws on tarsus I normally developed or reduced to varied extent. In male, femora II and IV with apophysae (modified setae).

The family includes two genera: *Arctacarus* Evans, 1955 and *Proarctacarus* gen. n. (known only as females).

The distribution range of the family is mostly limited to Megaberingia (in the interpretation by Yur'ev, 1976). Most records were made in mountain coniferous forests. Only *A. rostratus* widely populates the forest-tundra and tundra of northeastern Asia (to the east of the Indigirka River), and also northwestern and northern North America (to the west of the Hudson Bay).

A Key to Species of Arctacaridae (*Females*)

1(2). Opisthosoma small, with 3–4 setae in central row between rather large dorsal shield (its length exceeds half length of body) and pygidial sclerite. Cuticular glands *Po*2 rudimentary or absent, *Po*3 situated laterally, with 2 or 3 pores each. Anterior angles of sternal shield widened, inserted as rectangular lobes into space between coxae I and II. Presternal area with distinct granulation, occasionally combined with pair of small transverse shields, reticular ornament, or rows of small sclerites. Deuterosternal suture very narrow in anterior part (rows usually containing 1–5 denticles). Pores of gland *gv*2 (2–8) open on common sclerites behind coxa IV and accompanied only with 1 setae, or gland undeveloped. Tien Shan, eastern Yakutia, Chukotka, Magadan Province, Kamchatka, Sakhalin, Alaska, Oregon (USA), North West Territories of Canada to the west of Hudson Bay .... *Arctacarus* Evans, 1955.

2(1). Opisthosoma large, with 6 setae in central row between rather small dorsal shield and pygidial sclerite (Fig. 1, *1*). Cuticular glands *Po*2 present, Po3 situated dorsally, with 1 or 2 pores each. Anterior angles of sternal shield narrow, enveloping coxae II at the front (Fig. 1, *2*). Presternal area without granulation, with pair of small shields. Deuterosternal suture of uniform width, all its rows with numerous (4–30) denticles (Fig. 2, *2*). Pores of gland *gv*2 (3–15) dispersed behind coxae IV; caudally, this pore field is bordered by 3 setae. Western North America (Coastal Ridges and Rocky Mountains) .... *Proarctacarus* gen. n.

Genus ***Proarctacarus*** Makarova, gen. n.

Type species *Proarctacarus canadensis* sp. n.

Diagnosis. Females. Body large (length of idiosoma 1 mm or more). Dorsal surface with rounded podonotal shield, 2–5 pairs of mesonotal shields (4 pairs correspond to sigillae *sg*, *sa* IX, *sa* X, and *sa* XI), and pygidial sclerite (*sa* XIV). Numerous opisthonotal setae (29–36 pairs) arranged in more or less transverse rows, including 6 rows situated between podonotum and pygidial sclerite. Laciniae of tritosternum with long pubescence. Presternal area with pair of small shields and without granulation. Anterior angles of sternal shield pointed, enveloping coxae II at the front; shield with 3 pairs of setae. Metasternal shields absent. Genital shield jar-shaped, with more or less three-lobed anterior margin and without setae; vaginal sclerite present. There exist 11–17 pairs of opisthogastral setae, central row before anal shield containing 4 or 5 setae. Metapodal shields (1 or 2 pairs) small. Anal shield rounded-triangular, with 3 anal setae; cribrum extended. Peritrema long, projecting beyond level of anterior margin of sternal shield. Pores of gland *gv*2 (3–15 on each side) dispersed behind coxae IV; pored area bordered by 3 setae at posterior margin. Glands *Po*2 well developed. Glands *Po*3 with 1 or 2 large pores each, situated posteriorly to 4th pair of opisthosomal setae of inner row. Poroidotaxy of podosoma typical of the family; opisthosoma only with *jdz*6, *iv*5, and *ian*. Tectum in general triangular, with denticles of different size. Deutosternal suture of uniform width, all its rows with numerous (4–30) denticles. Legs of moderate length or long (leg IV frequently longer than body); claws in tarsus I normally developed or reduced, pulvillus absent.

Male unknown.

Differential diagnosis is given in the key to the genera above.

The genus includes three new species: *P. canadensis*, *P. johnstoni*, and *P. oregonensis*.

Distribution. Species of the genus populate mountain regions in the western part of North America (Coastal Ranges and Rocky Mountains); associated mainly with coniferous forests.

Etymology. The Latin prefix "pro-" points to the plesiomorphic character of the genus in comparison with the genus *Arctacarus*, and means "afore," proto.

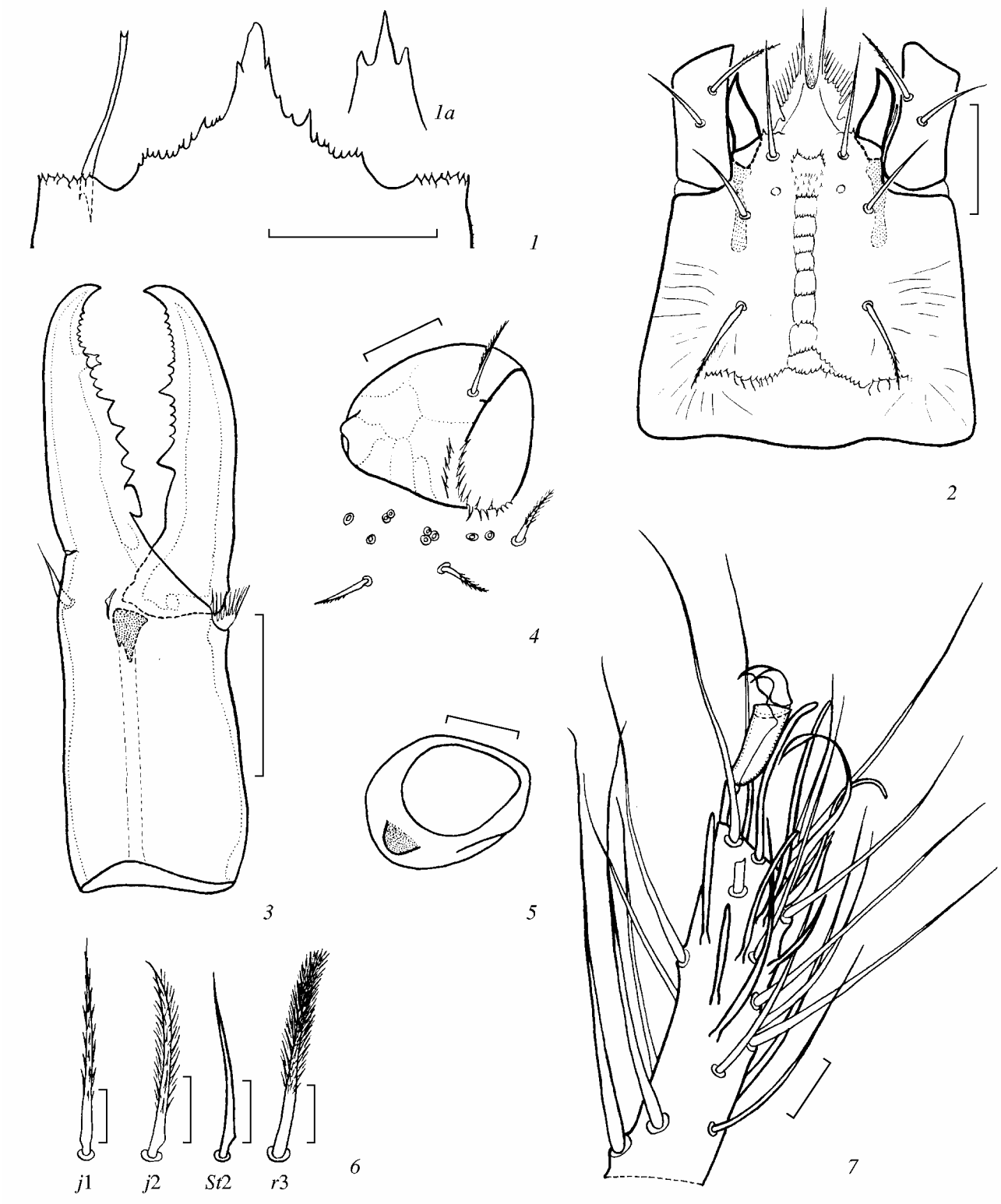

Fig. 2. Female of *Proarctacarus canadensis* gen. et sp. n.: (*1*) tectum; (*1a*) variant of shape of apex; (*2*) base of gnathosoma; (*3*) chelicerae; (*4*) coxa, ventral view; (*5*) coxa, lateral view; (*6*) some body setae; (*7*) apex of tarsus I. Scale (μm): (*1–3*) 100; (*4,5*) 50; (*6, 7*) 25.

Proarctacarus canadensis Makarova, sp. n.
(Figs. 1, 2)

Material. Holotype ♀, Canada, Rocky Mountains, Alberta, near Seebe Vil. (51°06′ N, 115°04′ W), in humus under *Pinus contorta*, 18.IV.1969 (L.S. Skaley); paratype 1 ♀, same locality and date; deposited at the Research Center, Agriculture and Agri-Food Canada, Ottawa, Canada.

Description. Female. Body large (1220–1260 × 660), moderately sclerotized, oblong-oval. Cuticle of shields and leg segments yellowish fuscous, finely granulate. Thecae of most setae of body, some setae of legs, and pores of cuticular glands, all banded; many setae with small obtuse-angled proximal denticle (Fig. 2, *6*).

Dorsal surface (Fig. 1, *1*) with large egg-shaped podonotal shield (610–620 × 560–580), 5 pairs of mesonotal shields behind podonotal shield, and combined pygidial shield. Anterior mesonotal shields (*sg*) larger than others (48–56 × 68–80), with one seta each. Podonotum with indistinct ornament, with 19 pairs of setae: *j*1–6, *z*1–6, *s*2–5, and *r*1–3; setae *s*1 absent, *s*6 and *r* 4–6 situated on membrane. Smallest setae of podonotal shield *r*1 and *s*2 (30–34) nearly smooth, other setae densely pubescent; length of most of them 60–84; length of *j*1 107, of *r*3 90. Opisthonotal setae (34–36 pairs) arranged in rather regular transverse rows. 6 complete rows with 4–5 pairs of setae in each row[11] situated between podosoma and pygidial shield. Five or six pairs of setae situated behind pygidial shield. In addition, 3 pairs of setae form incomplete transverse row, interrupted in middle, at border between podosoma and opisthosoma.[12] Most of opisthonotal setae pubescent to various degrees, only lateral setae smooth; length of setae i transverse rows gradually decreasing from longitudinal axis (48–62) to lateral margins (25–33). Dorsal poroidotaxy and adenotaxy typical of genus; gland *Po*3 with 1 or 2 pores; 2 follicles opening in pores of glands *gdj*2, *gdj*4, *gds*4, *Po*1, and *Po*3; 1 follicle, in pores of all other glands.

Tritosternum with narrow base (72–82 × 27–30) and long laciniae (200–208), pubescence formed by large ciliae. Small (9–11 × 42–44) triangular presternal shields situated laterally to tritosternum (Fig. 1, *2*). Length of sternal shield 240–245, width 376–404; its anterior margin slightly concave, posterior margin straight; anterior angles of shield narrow, extending backwards to coxae II, terminate there in granular area; shield with 3 pairs of smooth setae (*St*1 92–96, *St*2 74–80; *St*3 66–70), 3 pairs of poroids (*iv* 1–3), and pores of glands *gv*1, situated on posterior margin of shield laterally to setae *St*3; reticular ornament developed in anterior and lateral parts of shield. Metasternal setae (62–65) situated on membrane, smooth. Genital shield narrow (240–268 × 152–160), flask-shaped; anterior margin of shield three-lobed; vaginal sclerite looking like angular arch, indistinct. Genital setae *St*5 (50–52) outside shield, attached at level of its median narrowing, smooth. Endocoxal shields, adjacent to coxae III, sickle-shaped, distinct. Exocoxal shields between coxae II and III triangular. Pericoxal shields, enveloping coxae IV, ribbon-shaped, of irregular thickness and sclerotization. 7–9 pores of multiplied gland *gv*2 situated behind coxae IV; part of these pores untied in groups of 2 or 3 pores in each group; at posterior margin, each pore field is bordered by row of 3 opisthogastral setae of various degree of pubescence (Fig. 2, *4*). Total number of opisthogastral setae 16–17 pairs; one pair situated laterally to cribrum, other setae forming 6 more or less transverse rows (2–4 pairs of setae in each row). Setae of central row *JV*1–5 longest (52–60), other setae shorter (28–42); *JV*1,2 and small lateral setae smooth, other more or less pubescent. Two pairs of metapodial shields present (anterior shields stick-shaped, posterior shields rounded). Anal shield rounded (200 × 176), with extended posterior margin; cribrum consisting of fields of very small denticles; weakly pubescent adanal setae (37–41) longer than smooth postanal seta (30). Peritremal shield normally developed, with 3 poroids (*it*, *ip*1, *ip*2) and large theca of gland *gp*; its posterior part rugose, narrower than anterior part. Peritrema narrow (12), long (460–488), anteriorly reaching to fissure *idj*1.

Tectum in general triangular; its margin with numerous denticles of different sizes (Fig. 2, *1*); salivary styli narrow and long. Corniculi horn-shaped, of medium proportions (80 × 30); small pointed denticle present medially to base of each corniculus (Fig. 2, *2*). Lobes of

[11] Description and drawings were made during a study of deformed specimens; therefore, some inaccuracies in the topography of the caudal chaetom are possible.

[12] Homologization of the opisthosomal chaetom according to the terminology of Lindquist and Evans (1965) for "holotrichous Gamasina" is impossible, although longitudinal series of setae are distinct.

hypostome fringed, with median outgrowths; apex of labrum visible between these outgrowths. Deuterosternal suture with 10 or 11 rows of small denticles (4–11 denticles in each row), suture width 16–20; basal row continues beyond limits of suture. Setae *C*1, *C*2, and *C*4 of same length (82–92), *C*3 lacking in specimens studied, *C*1 and *C*2 smooth, *C*4 scarcely pubescent. Chelicerae large, che length 216–220 (Fig. 2, *3*); dorsal setae slightly widened basally; rounded incisive plate developed on *d.f.* proximally; 3–7 rather large denticles situated distally to this plate; 8–11 small denticles situated closer to apex. At base of *d.m.*, incisive plate looking like low sharp costa; before this costa, 2 large denticles alternate with 2 groups of 4–10 small denticles. Specialized setae *al*1 (34–38) and *al*2 (53–60) of palp genu spatula-shaped in distal half, pubescent laterally; *al* on femur (34–40) and *v*2 on trochanter (62–68) strong, with coarse pubescence. In addition to palpal setae mentioned, only *d*3 on femur pubescent.

Legs long, fore and hind legs longer than body. Ambulacrum I on pedicellate base, pulvillus absent (Fig. 2, *7*); chela normally developed, but smaller (16) than in legs II–IV (22–24). On legs II–IV, pulvillus, lateral outgrowths of pretarsal sheath (24–30), and apical setae of tarsus *ad*1 and *pd*1 (24–38) small. Leg chaetotaxy typical of family; setae of various length, most of them more or less pubescent. In apical fourth of tarsus I (Fig. 2, *7*), sensillum with lanceolate apex and 8 rod-shaped solenidia of various length (32–72) visible among needle-shaped setae. Distal margin and posterior surface of all coxae with rows of small denticles. Small hemispherical apophysis developed on coxa IV dorsally (Fig. 2, *5*). Leg length: I 1240–1280; II 890–944; III 824–836; IV 1220–1280; tarsi: I 324–340; IV 384–416.

Differential diagnosis. The new species is most closely related to *Proarctacarus johnstoni*, sp. n., differing in the presence of setae on anterior mesonotal shields, the number of pores of the gland *gv*2 (7–9, and not 3–5), etc.

Etymology. The species name indicated the locality of the first record.

Proarctacarus johnstoni Makarova, sp. n. (Fig. 3)

Material. Holotype ♀, USA, Rocky Mountains, Idaho, Campground Willow Flat, in humus of *Pseudotsuga taxifolia*, 12.VI.1973 (G.F. Knowlton) (slide OSAL 000452). Paratypes: 7 ♀, same locality and date (slides OSAL 000450, 000451, 000453–000457); 2 ♀, USA, Rocky Mountains, Utah, 5.IV.1972 (G.F. Knowlton) (slides OSAL 000448, 000449). Holotype and most of paratypes deposited at the Laboratory of Acarology, Ohio State University, Columbus, USA; 2 paratypes (slides OSAL 000450, 000451), at the Zoological Institute, Russian Academy of Sciences, St. Petersburg.

Description. Female. Body large (1140–1340 × 760–840), oblong-oval. Cuticle of sclerites pale brown, finely granulate. Fine folds of interscutal membrane with rounded tubercles (Fig. 3, *1*), only caudally to coxa IV with pointed denticles. Most of setae pubescent. Large setae of body with small obtuse-angled denticle at base. Thecae of most setae and pores of cuticular glands banded.

Podonotum (528–624 × 516–592) rugose, with sharply bent lateral margins and rounded posterior margin (Fig. 3, *1*). Podonotum with 19 pairs of pubescent setae (*j*1–6, *z*1–6, *s*2–5, and *r*1–3); setae *r*3 largest (80–100) and strongly pubescent; *r*1 and *s*2 smallest (20–38) and weakly pubescent; length of other setae 44–80. Setae *r*4–6 and *s*6 attached laterally to shield, *s*1 absent. Opisthonotal area with small (36–52 × 40–84) mesonotal shields (sigillae *sg*) with pores of glands *Po*1 and poroids *idz*6, four pairs of small sclerites, and compound pygidial sclerite. Opisthonotal setae (32–33 pairs) strong, strongly pubescent, their length 21–62 (lateral setae the shortest), arranged in more or less regular transverse rows. 6 rows with 3–5 pairs of setae in each row situated between anterior mesonotal shields and pygidial sclerite. 6–7 pairs of setae situated caudally to pygidial sclerite. Three setae, forming short transverse rows, situated laterally to anterior mesonotal shields. Dorsal poroidotaxy and adenotaxy typical of genus; gland *Po*3 more frequently with 2 pores, less frequently with 1 pore; 2 follicles, as a rule, opening in pores of glands *gdj*2, *gdj*4, *gds*4, *Po*1, and *Po*3; 1 follicle, in pores of all other glands.

Tritosternum with narrow base (68–79 × 27–32); lacinia long (160–188), uniformly pubescent by scarce long ciliae (Fig. 3, *2*). Presternal shields small (8–12 × 32–52), narrow. Sternal shield (188–236 × 360–388) reticulate; its anterior margin nearly straight, posterior margin slightly concave; shield with 3 pairs of setae (*St*1–3), 3 pairs of lyrifissures (*iv* 1–3), and glands *gv*1. Anterior angles of sternal shield enveloping coxae II at the front, their distal parts distinctly sepa-

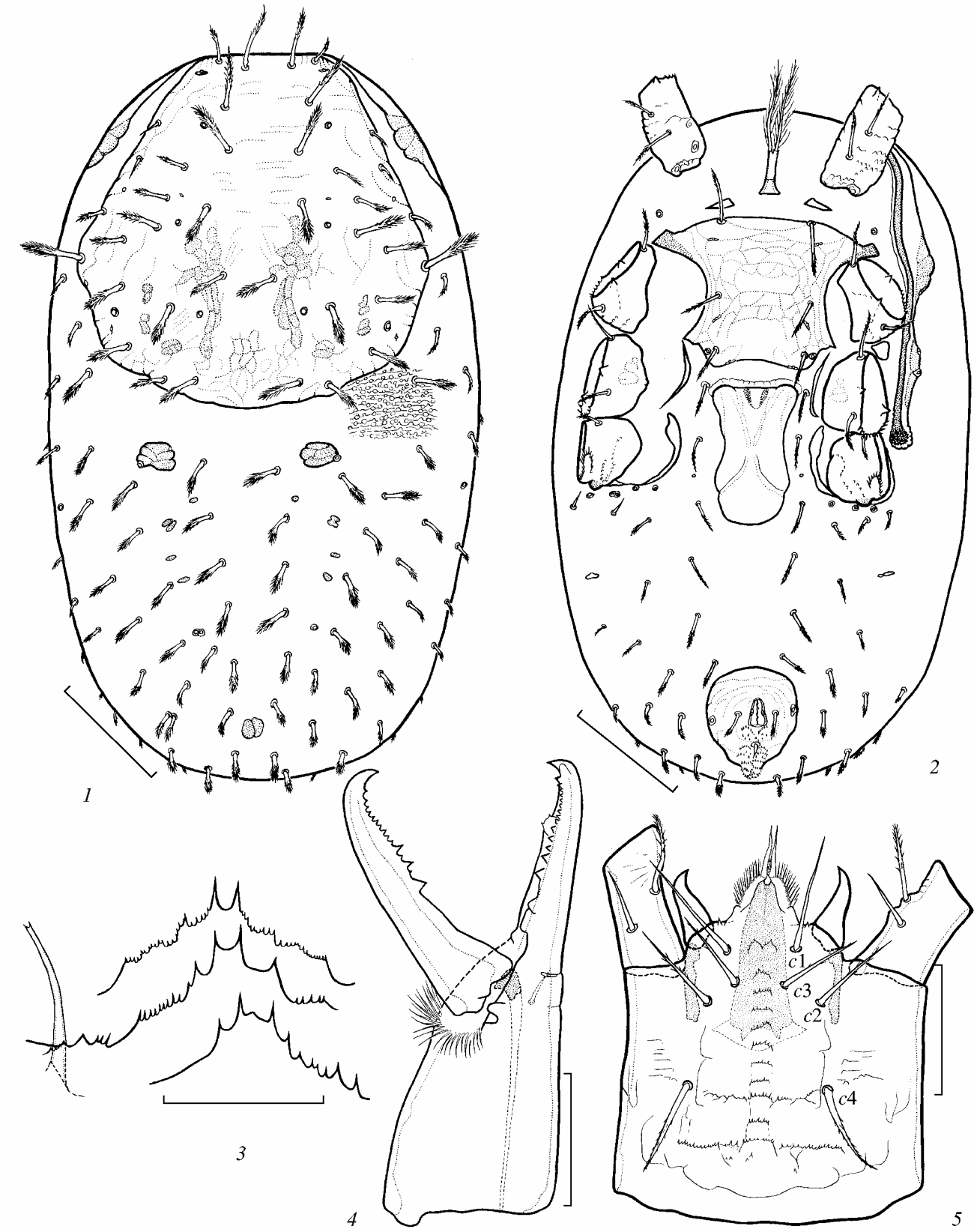

Fig. 3. Female of *Proarctacarus johnstoni* sp. n.: (*1*) dorsal surface; (*2*) ventral surface; (*3*) variants of shape of tectum; (*4*) chelicerae; (*5*) base of gnathosoma. Scale (μm): (*1*, *2*) 200; (*3*–*5*) 100.

rated. Genital shield (241–280 × 121–156) flask-shaped, without setae; anterior margin of shield membranous; vaginal sclerite present. Length of setae *St*1–5 decreasing backwards (from 76–86 to 49–56) and their pubescence increases (*St*1 frequently smooth). Endocoxal shields of coxae III narrow, arcuate; exocoxal shields between coxae II and III triangular. Endo- and exocoxal sclerites around coxae IV ribbon-shaped, with indistinct borders. Gland *gv*2 with 3–5 pores. Opistogastral setae (13–14 pairs) arranged in 5 transverse rows; setae strong, densely pubescent in distal half, their length varying from 26 (some lateral setae) to 62 (setae of median row). Metapodal shields small, of varying shape. Anal shield (172–212 × 140–176) rounded, reticulate, with tong-shaped, extended cribrum; weakly pubescent adanal setae (33–43) longer than smooth postanal seta (20–31). Peritremal shield with distinct sigillae, its anterior part wider than posterior part; peritreme long (436–536), reaching level of fissure *idj*1, its width 12–14.

Tectum in general triangular, with 3–5 large apical teeth; lateral margins of tectum stepped, with numerous small denticles; salivary styli narrow and long, projecting beyond apex of tectum (Fig. 3, *3*). Corniculi horn-shaped (60–64 × 24–31); pointed denticle present medially to base of each corniculus. Inner lobes of hypostome fringed, with narrow distal outgrowths. Deuterosternal suture with 10–12 rows of small denticles (4–20 denticles in each row), of uniform width (19–22); 1st and 3rd rows from base continue beyond limits of suture. Setae on base of gnathosoma needle-shaped, *C*2–*C*4 pubescent to various extent (Fig. 3, *5*); *C*1 (88–96) longer than *C*2, *C*4 (72–78) and *C*3 (68–72). Chelicerae large, chela length 176–196; dorsal seta (34–40) needle-shaped (Fig. 3, *4*). Short incisive plate situated at base of *d. f.*; 5–7 large and 7–10 small denticles situated anteriad this plate (total number of denticles 13–15), pilus dentilis of shape typical of the genus. *D. m.* with 12–15 denticles, some of them (more frequently, 1st, 2nd, and 5th from base) larger than others. Specialized setae on medial surface of palpal segments (*v*2 on trochanter, *al* on femur, spatula-shaped *al*1, and *al*2 on genu) with scarce pubescence in distal part; most of other setae smooth; length of setae: *v*1 on trochanter 50–59, *v*2 on trochanter 54–62, *al* on femur 26–46, *al*1 on genu 34–36, and *al*2 on genu 46–52. Trochanter of palps with small median tubercle.

Legs of moderate length, fore legs (1032–1136) always and hind legs (1104–1200) frequently longer than body. Ambulacrum I on pedicellate base, pulvillus absent, claws normally developed, but smaller (12) than in legs II–IV (19–21). Leg chaetotaxy typical of the genus. In apical third of tarsus I, together with sensillum with lanceolate apex, 8 rod-shaped, apically rounded solenidia of various length (27–68). On legs II–IV, outgrowths of pretarsal sheath (14–22) and tarsal setae *ad*1 and *pd*1 (26–38) small. Most of setae on legs more or less pubescent. Small tubercle-like apophysis present on coxa IV dorsally. Length of tarsus I 264–294; of tarsus IV, 364–400.

Variability. The pubescence of sternal setae and setae *C*2–4 at the base of the gnathosoma can vary or, occasionally, be absent. The lateral margins of the tectum are occasionally smooth, without denticles. The second pair of the mesonotal sclerites is undeveloped in 7 out of 10 females. The number of pores of glands *gv*2 (3–5) and *Po*3 (1–2) can vary and is frequently asymmetrical in separate individuals. The number of rows of the deuterosternal suture is inconstant (10–12). In a single female, the left poroid *iv*5 was replaced by a seta, and in another female, the right anterior mesonotal shield possessed a seta (as in *P. canadensis*, sp. n.)

Differential diagnosis. The new species is most closely related to A. *canadensis* sp. n., differing in the absence of setae on the anterior mesonotal shields, number of pores of gland *gv*2 (3–5, rather than 7–9), etc.

Etymology. The species was named for the notorious American acarologist Donald Johnston, who was the first to record the new genus of the family Arctacaridae from Rocky Mountains (Johnston, 1982).

Proarctacarus oregonensis Makarova, sp. n.
(Fig. 4)

Material. Holotype ♀, USA, Coastal Ranges, Oregon, Benton Co., 20 mi SW Philomath, nr. Marys Peak (44°30'N, 123°33'W), in a hollow of spruce, 9.V.1958 (G.W. Krantz); paratypes: 1 ♀, same locality and date; 1 ♀, Oregon, Benton Co., Mac Donald Forest, moss on oak roots, 12.XI.1980 (J.D. McIver). Together with the type series, 2 deutonymphs exist,[13] Oregon, Benton Co., Marys Peak, 1300 m , in rot of decaying stump of Tsuga, 9.VII.2000 (G.W. Krantz). All the material is deposited at the Chair of Entomology, Oregon State University, Corvallis, USA.

[13] Description of immature phases is beyond the scope of the present communication.

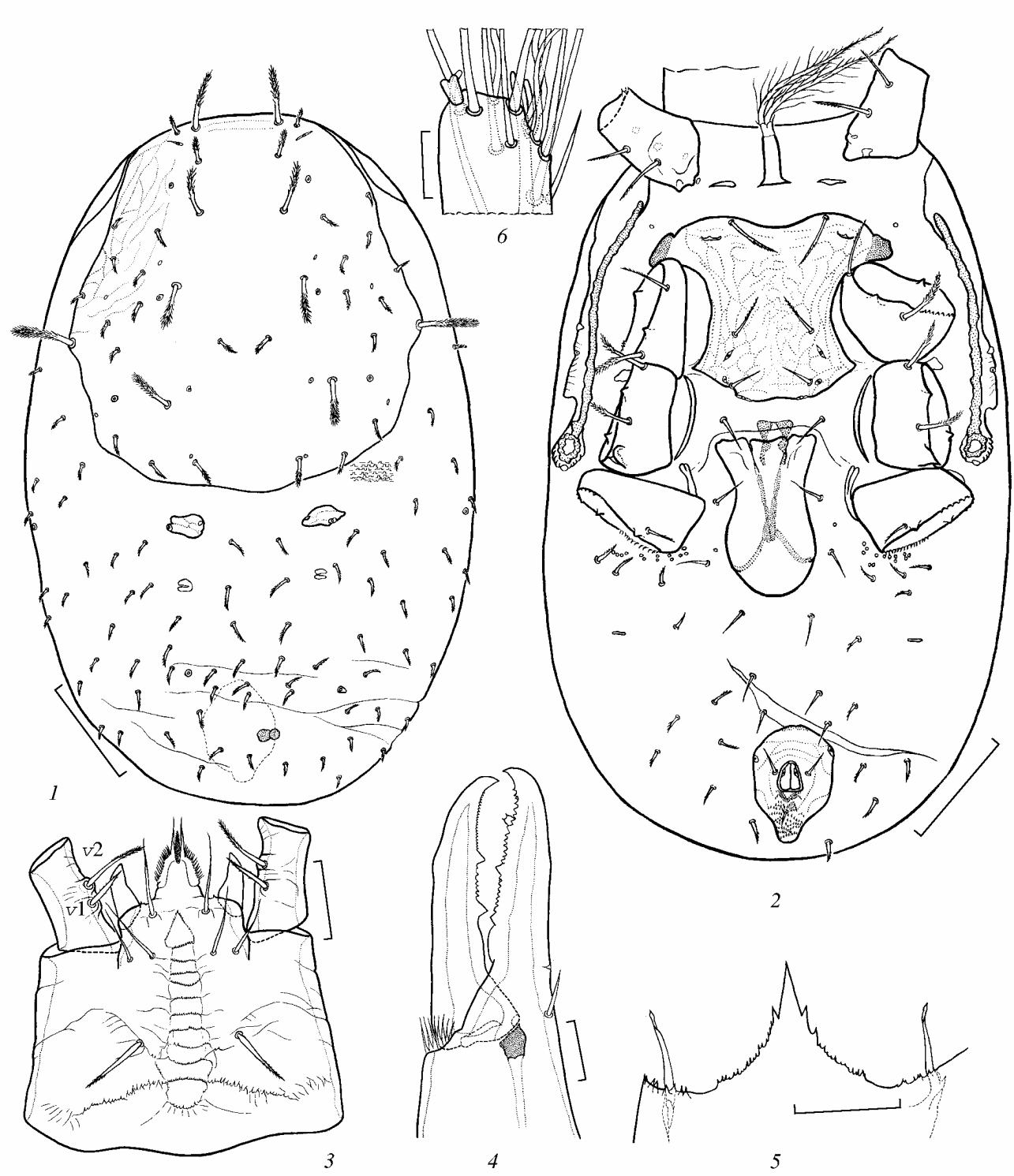

Fig. 4. Female of *Proarctacarus oregonensis* sp. n.: (*1*) dorsal surface; (*2*) ventral surface; (*3*) base of gnathosoma; (*4*) chelicerae; (*5*) tectum; (*6*) apex of tarsus I (only specialized setae are shown). Scale (μm): (*1*, *2*) 200; (*3*, *5*) 100; (*4*) 50; (*6*) 25.

Description. Female. Body large (1000–1224 × 700–740), oval, moderately sclerotized, with strong chelicerae and legs. Body sclerites and appendages yellowish brown. Cuticle of sclerites finely granulate; fine folds of interscutal membrane on dorsal and lateral surfaces of body looking like rows of small brackets. Thecae of most setae and pores of cuticular glands banded.

Podonotum (644–680 × 624–656) ovoid, its anterolateral margins with reticulate ornament (Fig. 4, *1*). Opisthonotal area with two pairs of shields, large (36–40 × 67–84), corresponding to sigillae *sg*, and small (sigillae *sa* IX), and also compound pygidial sclerite. All setae on dorsal surface more or less pubescent. Podonotal shield with 19 pairs of setae (*j*1–6, *z*1–6, *s*2–5, and *r*1–3); setae *s*1 absent, *s*6 and *r*4–6 situated on membrane. Setae *j*1 (94–108), *r*3 (116–119), *j*3,4, and *z*5 (76–92) largest and most pubescent, indistinct tubercle present at base of each seta; length of setae *j*2,6 44–61, of setae *s*2 and *r*1,2 19–26, length of other setae on shield 28–40. Opisthonotal area with 29–33 pairs of setae (length varying from 24 to 50), setae of inner row longest. Opisthonotal chaetom occasionally asymmetrical, and damaged state of specimens (fractures and folds) giving no way of describing the setal topography accurately, however, posteriad 1st pair of mesonotal shields, 7 irregular transverse rows of setae (3–5 pairs in row) distinguishable; 2 setae present laterad each of these shields. Dorsal poroidotaxy and adenotaxy typical of genus; gland *Po*3 with single large pore (associated with 4 follicles), opening behind 4th pair of opisthonotal setae of inner row; glands *dgs*4 and *Po*1 with two follicles, other glands with one.

Tritosternum with long base (90–102 × 36–44); laciniae (180–196) pubescent, length of ciliae strongly increasing toward base (Fig. 4, *2*). Presternal shields small (16 x 40). Sternal shield (288–304 × 412–428) with extended anterior angles, enveloping coxae II and terminating in granulate area; anterior margin of shield weakly concave, posterior one straight; reticulate ornament covers entire shield, but especially distinct on lateral areas. Shield with 3 pairs of setae, 3 pairs of lyrifissures (*iv* 1–3), and glands *gv*1. Setae *St*1 (80–92) and St2 (70–75) pubescent, *St*3 (40–60) smooth; setae *St*4 (60) and *St*5 (49–55) situated on membrane, smooth. Genital shield (280–288 × 164–180) flask-shaped, anterior margin of shield trilobed. Vaginal sclerite elongate, granulate. Endocoxal shields adjacent to coxae III and IV narrow, ribbon-shaped, similarly to exocoxal shields of coxae IV; exocoxal shields between coxae II and III small, triangular. Glands *gv*2 with 13–15 pores; row of 3 pubescent setae situated caudally to each pore field. Most of opisthogastral setae (total number 11–14 pairs) short (25–35), pubescent, only setae of inner row longer (40–51) and smooth. Metapodal shields very small, rod-shaped. Anal shield (194 × 139–179) rounded or oval, reticulate, with extended cribrum; pores *gv*3 large; postanal seta (20) shorter than adanal setae (38–40), all setae smooth. Peritrematic shield of varying width (widest in anterior part). Peritreme anteriorly terminated at level of setae *j*2, its length 440–484, width 13–15.

Tectum in general triangular; its lateral margins with 1–2 large denticles in median part and numerous small denticles at base; salivary styli relatively short, not projecting beyond apex of tectum (Fig. 4, *5*). Corniculi horn-shaped (Fig. 4, *3*), of normal proportions (74–80 × 32); pointed denticle present medially to base of each corniculus. Lobes of hypostome fringed, medially protruded into narrow outgrowths; apex of labrum visible between outgrowths. Deutosternal suture widest (to 56) in median part, with 10–12 rows of small denticles (10–30 denticles in each row); second from base row of denticles projecting far beyond suture. Setae *C*1 (92–96), *C*2 (67–69), and *C*3 (78) smooth, needle-shaped, *C*4 (86–90) stronger, weakly pubescent. Chela large (231–240); *d. f.* proximally with rounded incisive plate; both digits with 2 large denticles; rows of numerous (5–17) small blunt denticles between large denticles and apices of digits (Fig. 4, *4*); dorsal seta needle-shaped (36–40). Specialized setae on palp genu *al*1 (40–46) and *al*2 (56–59) spatula-shaped at apex, serrate; *al* on palp femur (36–39) strong, pubescent (in addition, all dorsal femoral setae also pubescent); setae of palp trochanter strong, *v*2 (70–76) distinctly pubescent, *v*1 (56–58) weakly serrate.

Legs massive, fore legs slightly shorter or longer than body, hind legs longer than body; femur IV less than thrice longer than wide. Leg chaetom typical of the family. Many leg setae more or less pubescent. Ambulacrum I reduced to short (8–13), indistinct transparent outgrowth, bifurcate apically (Fig. 4, *6*). Among specialized setae developed in upper fourth of tarsus I, seta with lanceolate apex clearly visible, together with 8 rod-shaped solenidia of various shape (18–80). Length of claws (29–36), outgrowths of pretarsal sheath (34–46), and apical setae of tarsi *ad*1 and *pd*1 (42–70) increasing from leg II to leg IV. Distal margins of coxae and some other leg segments, with small denticles. Many segments with ornament of small tubercles. Posterior surface of coxa III with small rounded apophysis with pointed outgrowth (Fig. 4, *2*). Leg length: I 1168–1192, II 952–1024, III 944–1024, III 944–976, IV 1368–1400; length of tarsi: I 252–268, IV 464–472.

Differential diagnosis. The species is most closely related to *Proarctacarus johnstoni* sp. n., differing in the reduced ambulacrum on tarsus I (bifurcate papilla),

number of mesonotal shields (2 pairs instead of 5), number of pores of gland *gv*2 (13–15 instead of 3–5), heterogeneous chaetom of the podonotum, etc.

Etymology. The species name reflects the locality of the first record.

A Key To Species of Proarctacarus, gen. n. (females)

1(2). Ambulacrum I reduced to indistinct thin-walled outgrowth with bifurcate apex (Fig. 4, *6*). Two pairs of mesonotal shields situated between podonotum and pygidial sclerite (Fig. 4, *1*). Pore field of gland *gv*2 with 13–15 pores (Fig. 4, *2*). Setae of podonotum heterogeneous (e.g., *j*3,4 twice as long as *j*5). Laciniae of tritosternum with short distal pubescence and long proximal pubescence. Legs thicker (femur IV less than thrice longer than wide). Coastal Ranges: Oregon, USA ..... *P. oregonensis*, sp. n.

2(1). Ambulacrum I well developed, although claws smaller than in legs II–IV and pulvillus absent (Fig. 2, *7*). Five pairs of mesonotal shields of various sizes situated between podonotum and pygidial sclerite. Pore field of gland *gv*2 with 3–9 pores. Most of podonotal setae of similar size. Laciniae of tritosternum with uniform long pubescence. Legs finer (femur IV more than thrice longer than wide).

3(4). Anterior mesonotal shields bearing single seta each (Fig. 1, *1*). Pore field of gland *gv*2 with 7–9 pores (Fig. 1, *2*). Rocky Mountains: Alberta (Canada) ..... *P. canadensis*, sp. n.

4(3). Anterior mesonotal shields without setae (Fig. 3, *1*). Pore field of gland *gv*2 with 3–5 pores (Fig. 3, *2*). Rocky Mountains: Idaho, Utah (USA) ..... *P. johnstoni*, sp. n.

DISCUSSION

The originality of the morphology of mites of the family Arctacaridae and, in particular, the variable organization of the ambulacrum I and opisthosomal chaetom, invites a discussion of some general problems of the morphology and taxonomy of Mesostigmata.

Structure of ambulacrum I. The presence or absence of claws on the fore legs is traditionally treated as a character of a high taxonomic rank (*Opredelitel'*…, 1977; Karg, 1965; 1993; Krantz, 1978; Evans and Till, 1979; Johnston, 1982; Krantz and Ainscough, 1990; Evans, 1992; etc.), characterizing the whole families, with only few exceptions (genera *Neopodocinum*, *Ameroseiella*, *Pergamasellus*, and *Rhodacarus*). In mites of Arctacarina, pulvillus I is absent, and the following degrees of further reduction of the ambulacrum are observed:

(1) Pretarsus situated at pedicellate base (behind distal part of tarsus), claws normally developed, but smaller than those in legs II–IV—*Proarctacarus canadensis* sp. n. (Fig. 2, *7*), *P. johnstoni* sp. n.

(2) Claws sessile, very small (indistinct)—*Arctacarus rostratus*.

(3) Ambulacrum rudimentary, looking like vesicular papilla with bifurcate (*P. oregonensis* sp. n., Fig. 4, *6*) or rounded (two new species of *Arctacarus*) apex.

(4) Ambulacrum absent (*Arctacarus dzungaricus*).

Such a spectrum of intermediate states of the character contradicts the concept of its stability and restricts its applicability as a diagnostic character to the species level. The same situation occurs in the genus *Antennoseius* (Ascidae). However, some acarologists, who study this genus, accept the existence of two subgenera (*Antennoseius* s. str. and *Vitzthumia* Thor, 1930), based only on the presence or absence of pretarsus I (Chelebiev, 1984; Lindquist and Walter, 1989; Eidelberg, 2000; etc.). Such a formal approach results in that apparently closely related species were placed in different subgenera (e.g., Chelebiev, 1984).

Segment composition of opisthosoma. Species of the North American *Proarctacarus* gen. n. are distinguished among other Arctacaridae by the big size (more than 1 mm), relatively large opisthosoma, and great number of the opisthosomal setae. The regular, possibly segment-to-segment, arrangement of the setae and muscular sigillae, closely resembling the opisthonotal organotaxy of Opilioacarinae (Van der Hammen, 1970), does not allow to suppose the presence of neotrichy. In these archaic mites, the arrangement of cuticular structures of the opisthosoma corresponds to a plastically expressed metamery.[14] The body of Opilioacarinae comprises 19 segments and the telson, including 13 opisthosomal segments (Van der Hammen, 1970). There is no common opinion concerning the segmentary structure of Parasitiformes. The body segmentation is manifested only in the arrangement of setae, small cuticular glands, and poroids, and, thus,

[14] This has also been demonstrated for ixodid ticks (see discussion about festoons in Klompen *et al.*, 1996).

all discussions of this matter are speculative (Evans, 1992). The caudal bending, which results in most mites in the ventral position of the initially terminal anal orifice (Zakhvatkin, 1952; Sitnikova, 1978), also masks the real number of segments of the opisthosoma.

Various authors assumed the presence of 5 to 10 segments (besides telson) in the opisthosoma of Parasitiformes (Zakhvatkin, 1952; Dubinin, 1959; Lange, 1969; Athias-Henriot, 1971; Sitnikova, 1978; Evans and Till, 1979; Van der Hammen, 1979a; Shcherbak, 1982; Lindquist, 1984; etc.). The smallest number of segments in the definitive abdomen (5 + telson) was found in holotrichous Gamasina (Dermanyssina), besides the pregenital segment (Evans and Till, 1979; Lindquist, 1994), and corresponds to the number of metameres in the abdomen of the ixodid tick embryo (Anderson, 1973). Zakhvatkin (1952) and Lange (1969) found 9 segments (besides telson) in the opisthosoma of Parasitiformes; however, they assumed that pregenital segment VII partly (Lange, 1969) or entirely (Zakhvatkin, 1952) belongs to the podosoma, and three last segments are underdeveloped and fused, forming the anal macrosomite. The largest number of opisthosomal segments (10) was mentioned by Van der Hammen (1979a).

The preginital segment VII, considered to be strongly reduced in all the Parasitiformes, is, as a rule, free of cuticular structures and serves for articulation of the podosoma and opisthosoma (Zakhvatkin, 1952; Sitnikova, 1978; Klompen *et al.*, 1996), forming a distinct constriction between these tagmae only in Rhodacaridae (Lange, 1969).[15] And only recently, setae were found in dorsolateral areas of the body at the border between podosoma and opisthosoma in a nymph of one of 53 studied ticks of the family Ixodidae (Metastigmata) - *Ixodes ricinus* (Linnaeus, 1758), and poroids and setae in a larva of another species - *Ixodes tasmani* Neumann, 1899 which are excessive for the generalized set of these structures in Ixodidae (Klompen *et al.*, 1996). Our data on the chaetotaxy of adult mites of another suborder (Mesostigmata), namely, species of the genus *Proarctacarus* (at least, *P. canadensis* sp. n. and, to a lesser extent, other species), point to the presence of 2 or 3 pairs of setae in the same areas (Fig. 1, *1*). These "additional" setae, situated between transverse rows of posterior podonotal setae *j*6, *z*6, *s*6, *r*6, and "anterior" opisthonotal setae "*J*1", "*Z*1", "*S*1", and "*R*1" (this row is well marked by sigillae of the genital segment *sg*, glands *gdz*6 = *Po*1, and poroids *idz*6), apparently, belong to segment VII of the idiosoma. Apparently, this is the first mention of the presence of a distinct chaetom on segment VII in Mesostigmata.

The subsequent 6 complete rows of setae, situated in *Proarctacarus* before the pygidial sclerite (*sa*XIV), consist of 3–5 pairs of setae each. The arrangement of 5–7 pairs of setae caudally to *sa*XIV is unstable, frequently asymmetrical; however, 3 short transverse rows are traced in *P. canadensis* sp. n. and *P. johnstoni* sp. n.; the last of these rows (1 or 2 setae only) is, as a rule, turned to the ventral side, enveloping anal aperture caudally. Thus, the topography of setae and sigillae on the dorsal surface of *Proarctacarus* indirectly points to the presence of 10 intact opisthosomal segments (besides telson), and the total revealed number of segments in the body of *Proarctacarus* must evidently be 16 (plus telson). This state is probably similar to the initial state, characteristic of the order.

However, only 5 or 6 transverse rows of setae are found on the opisthosoma of representatives of another genus of the family Arctacaridae (*Arctacarus*), including 4 rows between the podosoma and *sa*XIV. Similar differences in the opisthosomal chaetom are also found in other cohorts of Mesostigmata, namely, Parasitina (Parasitidae) and Dermanyssina (Veigaiidae and Rhodacaridae); in orthotrichic species of these cohorts, the number of transverse rows of the opisthonotal setae, situated before sigillae *sa*XIV, varies from 6 (in forms with a large opisthosoma) to 4. A more abundant chaetom, typical of many representatives of these families, although not associated with an extensive neotrichy, cannot be described in terms of the widely used scheme suggested for the holotrichous Dermanyssina (Lindquist and Evans, 1965; Lindquist, 1994), where the opisthonotal setae are treated as belonging to 5 transverse rows. For example, many species of *Phorytocarpais*, *Rhabdocarpais*, and *Parasitus* (Parasitidae), and some *Veigaia* and *Gamasolaelaps* (Veigaiidae), similarly to *P. canadensis*, possess 8(9) pairs of setae in the inner rows of the opisthosomal area, with 6 pairs of setae situated between the podosoma and *sa*XIV. It is also important to note that the anal aperture frequently occupies a position close to the terminal one in males of Parasitidae, and last pairs of dorsal and ventral setae are arranged along an arc that envelops it posteriorly. Probably, this is the archaic state.

[15] In Shcherbak's (1982) opinion, there are no facts indicating the absence of segment VII in Rhodacaridae.

Previously it has been accepted that in general the decrease in size of mites was accompanied by shortening of the opisthosoma, which took place mainly in its caudal part, due to the caudal bending (Dubinin, 1959; Sitnikova, 1978; Lindquist, 1984). The "pygidization" of the opisthosoma on the background of the general tendency toward minimization of Parasitiformes has even been mentioned (Lange, 1970). An opinion has also been expressed that the reduction of the idiosoma could occur in the central part; in this case, segments VII–XII were included in the podosoma (Van der Hammen, 1979b). However, we, as well as some other acarologists (Lindquist, 1984; Evans, 1992), regard such reduction as poorly believable. For example, distinct differences in size and chaetotaxy of the opisthosoma between representatives of *Proarctacarus* and *Arctacarus* (similarly to many other taxa within Parasitina, Veigaiidae, and Rhodacaridae) are in no way associated with the structural features of the podosoma. At the same time, some of the abovementioned considerations indicate that the abdomen in *Arctacarus* is reduced in an area between segment VIII and originally segment XIV. The fact that the most reduced dorsal chaetom, found in species of the family Arctacaridae (in *A. rostratus* and two undescribed species of *Arctacarus*), can be homologized with the use of nomenclature suggested by Lindquist and Evans (1965), points to the regular character of the reduction resulting in the common (?optimal) set of setae in different cohorts of Mesostigmata, e.g., Dermanyssina (Evans and Till, 1979), Zerconina (Lindquist and Moraza, 1998), Parasitina (e.g., in *Porrhostapsis*), and Arctacarina.

Thus, one can assume that the shortening of the opisthosoma (or, at least, of its cuticular formations) in Mesostigmata occurred not only (or not so much) in the caudal part and was accompanied by caudal bending, but also between segments VIII and (initially) XIV, and also at the expense of to the pregenital segment. An indirect evidence in favor of this assumption can also be found in the regressive state of the tergosternal musculature of the opisthosoma in mesostigmatic mites (Athias-Henriot, 1971). In addition, the complete large opisthosoma of some representatives of Arctacaridae, Parasitidae, Rhodacaridae, and Veigaiidae can be treated as one more symplesiomorphy of these families, together with the peculiarities of the leg chaetotaxy (Table 2).

Taxonomic position in the Mesostigmata. In the original description, the monotypic genus *Arctacarus* was immediately placed in the separate family Arctacaridae within the cohort Epicriina (Evans, 1955), because the type species *A. rostratus*, although closely resembling gamasid mites (Parasitina, Dermanyssina) in appearance, possessed such specific morphological features as the mediosternal position of the genital orifice and the presence of distinct sternal shield in the male (similar to that in the female). In addition, a species was characterized by a strong sexual dimorphism. Subsequently, the rank of the family Arctacaridae and its taxonomic position within Mesostigmata were repeatedly revised (Table 1). However, the concept that Arctacaridae belongs to the separate cohort Arctacarina, is nowadays most common.

A study of the type material of the known species, the description of a new genus (with three new species), and acquaintance with the morphology of two new species of the genus *Arctacarus* from Yakutia (sp. 1) and Oregon (sp. 2), made it possible to refine significantly the previously assumed diagnosis of the family (Evans, 1955, 1992; Johnston, 1982). A morphological analysis of representatives of Arctacaridae, including their chaetotaxy, gave no reason to relate them to any cohort of Monogynapsina, because members of Arctacarina demonstrate a mosaic similarity with the closest of these, including the key diagnostic characters (Tables 2, 3), and most of common characters are symplesiomorphic.

For example, the mediodternal position of the genital aperture, presence of the eugenital setae, absence of the structures serving for transfer of a spermathodose on the male's chela, and also absence of the membranous genital valve on the genital shield of the female, unite Arctacarina and the complex [Epicriina + Zerconina] (Evans, 1955); however, these characters are plesiomorphic (Moraza and Lindquist, 1998). The relationship between these taxa is confirmed by secondary and, probably, associated characters, such as the loss of the solid opisthonotal sclerotization in females (retained in males and deutonymphs) and hypertrophy of dermal glands *gdZ*3 (=*Po*3), which is characteristic of all 7 species of Arctacaridae and was also noticed in mites of the monotypic family Coprozerconidae (Zerconoidea) (Moraza and Lindquist, 1998). However, the absence of these morphological structures in any other representative of the vast cohort Zerconina suggests their parallel development. Mites of the complex [Epicriina + Zerconina] possess the plesiomorphic structure of spermatozoids ("vacuolated type"), basic for Anactinotrichida sensu Lindquist, 1984, and are character-

Table 2. Occurrence of chaetom types of separate leg joints in Arctacarina and closely related cohorts of Monogynaspina (according to Evans, 1963, with addition from Moraza and Lindquist, 1998, and new data)

Joint—number of setae	Epicriina	Zerconina	Arctacarina	Parasitina	Dermanyssina		
					Veigaiidae	Rhodacaridae	Others
Femur I—13	+	+	+	+	+	+	+, –
Genu I—13	+	+	+	+	+	+	+, –
Femur II—11	+	+	+	+	+	+	+, –
Genu II—11	+	+	+	+	+	+	+, –
Tibia II—10	+	+	+	+	+	+	+, –
Tibia IV—10	+	+, –	+	+	+	+	+, –
Tibia I—14*	+	+	+	+	+	+	–
Genu IV—10*	+	+	+	+	+	+	–
Genu III—10*	+	+	+	–	–	–	–, (+)
Tibia III—9*	+	+	+	–	–	–	–, (+)

(+) very rarely.

* The type of chaetotaxy is found in the lower Uropodinae (Athias-Binche and Evans, 1981; Athias-Binche, 1982).

ized by the tocospermy (fertilization through the genital aperture, Athias-Henriot, 1968), and also by the presence of paired oviducts and non-differentiated ovary, which are typical not only of several cohorts of Mesostigmata, but also of other groups of Anactinotrichida (Ixodida, Opilioacarida, and Holothyrida) (Alberti, 2000a, 2002c). Being the initial for the superorder, this system of reproduction was called the "architocospermy" (Alberti, 2002a, 2002b). Relating Arctacaridae to [Epicriina + Zerconina] is impossible because of the absence of synapomorphies, as pointed out earlier (Moraza and Lindquist, 1998).

The character of sexual dimorphism in Arctacarina attracts special attention. No males are known in mites of the genus *Proarctacarus*. Strong sexual dimorphism in males of *Arctacarus* is expressed in the following external characters: different proportions of the body; significantly stronger sclerotization; hypognathous gnathosoma; very large chelicerae with solitary denticles on massive digits and not bifurcate (as in females) pilus dentilis; hood-shaped and strongly sclerotized tectum; shortened hypostome; and armament of the legs with apophysae.[16] Similar differences in the structure of males and females are characteristic of mites of the cohorts Parasitina and Dermanyssina and are associated with the process of copulation, which occurs through a primary genital opening (tocospermy) in Parasitina, and through the gonopores, usually associated with the bases of the legs (podospermy, Athias-Henriot, 1968), in Dermanyssina. Data on the copulative behavior and the mode of fertilization in Arctacarina are absent. Spermathecae, associated with legs, were not found in females of the genus *Arctacarus*, for which males are known (*A. rostratus*, *Arctacarus* sp. 1, *Arctacarus* sp. 2). In contrast to Arctacarina, the male genital aperture in Parasitina and Dermanyssina is shifted to the anterior margin of the sternal shield, and the mobile digit of the chelicerae possesses a device for the transfer of a sperm dose. In addition, spermatozoids of these mites belong to the advanced "ribbon-type" (Witaliński, 1975; Alberti, 1988; Witaliński and Dallai, 1991). This fact was treated as a synapomorphy of these cohorts and, together with the peculiarities of the structure of the female genital system (presence of an unpaired oviduct and subdivision of the ovary into trophic and generative parts) served as a basis for characterization of the breeding system of Parasitina and Dermanyssina as the "neospermy," or, more precisely, "neotocospermy" and "neopodospermy," respectively (Alberti, 2002a, 2002b).

The overwhelming majority of basic characters of Arctacarina, common with another cohorts (Tables 2, 3), are plesiomorphic or secondary, of independent origin (reduction of ambulacrum I, reduction of the opisthonotum in females, and hypertrophy of

[16] Among the characters mentioned, probably, only the structure of the chelicerae in males of *Arctacarus* has no analogues within mesostigmatic mites (Mesostigmata): they are evidently modified, but, at the same time, lack appendages (sperm dactyls) on cheliceral digits (as in Dermanyssina, Heterozerconina, and some Antennophorina) and spermatothreme (as in Parasitina).

Table 3. Occurrence of some morphological characters in Arctacarina and closely related cohorts of Monogynaspina

Character	Epicriina	Zerconina	Arctacarina	Parasitina	Dermanyssina		
					Veigaiidae	Rhodacaridae	Others
Ambulacrum I absent*	+		+	+		+	+
Euanal setae present*		+		+		+	+
Pygidial shield in protonymph absent*			+		+		
Cuticular glands *gv*2 multiplied*	+	+	+	+	+	+	?
Male genital aperture mediosternal*	+	+	+				
Eugenital setae in male present		+	+				
In female, opistonotum not developed, but it is present in male and deutonymphs		+	+				
Large salivary styli attached above chelicerae			+	+			
Articulation membrane between genu and femur of palp with outgrowth*				+	+	+	
Male chelicerae and legs significantly modified*			+	+	+	+	+
6 setae present in inner row between podosoma and pygidial sclerite (sigillae *sa* XIV)			+	+	+	+	
Male chelicerae with spermatodactyl; females with spemathecae**					+	+	+
Lateral glands, opening at bases of coxae I, present			+	+	+		
Ovary differentiated			+	+	+		
Node in chela developed*			+				
Rudimentary rutelli present***			+				
Male sternal shield separated*			+				
Cuticular glands "*gdZ*3" = *Po*3 multiplied			+				
Pilus dentilis looking like excrescence with two papillae			+				
Spermatozoids of another type, than "vacuolated" and "ribbon"**			+				

Some data are given after Evans (1992), Moraza and Lindquist (1998), Alberti and Krantz (2002), Alberti *et al.* (2002).

* Found in other cohorts of Mesostigmata.

** Found in Heterozerconidae.

*** Among Anactinotrichida, rutelli (in addition to corniculi) were found in Opilioacarina; probably some structures in *Choriarchus* Kinn, 1966, *Trichodiplogynium* Trägårdh, 1950, Antennophorina, *Nenteria* Oudemans, 1915, Uropodina, *Pyrosejus* Lindquist et Moraza, 1993, Cercomegistina are homologues of these structures (see Kinn, 1966; Hirschmann and Wisniewski, 1993; Wisniewski and Hirschmann, 1993; Lindquist and Moraza. 1993).

glands *gdZ*3 = *Po*3). Among the specific characters of Arctacarina, only three (last rows in Table 3) are, probably, autapomorphic. No synapomorphic characters in the external morphology of Arctacarina and other cohorts of Monogynapsina were revealed.[17] In other words, morphological data give us no basis for establishing relationships of Arctacarina, that invites spermatological and molecular studies (Moraza and Lindquist, 1998; Alberti, 2002a), used at present for solving "basic" taxonomic problems (Klompen, 2000; Alberti, 2002a, 2002b; Alberti *et al.*, 2002; Alberti and Klompen, 2002). However, the first results of a study of spermatozoids of *Arctacarus* sp. 2 from Oregon gave no way of relating Arctacarina with any group of mesostigmatic mites, because the structure of these cells is so unusual and advanced (Alberti and Krantz,

[17] Probably, the presence of lateral glands, opening at bases of coxae I, and of a differentiated ovary, which have been found in Arctacarina only recently, will be the only synapomorphic morphological characters of Arctacarina, Parasitina, and Dermanyssina (Alberti and Krantz, 2002).

2002). Only recently, a study of the ribosomal genes of *Proarctacarus* made it possible to relate them to the complex [Parasitina + Dermanyssina] (H. Klompen, personal communication). This is the first reliable confirmation of the previous assumptions concerning a sister group of Arctacarina, which included either Parasitina (Krantz, 1978; Moraza and Lindquist, 1998), or the complex [Parasitina + Dermanyssina] (Norton *et al.*, 1993).

The unusual range of the family, small number of species and scarcity of records, together with the presence of distinctly archaic morphological characters, point to its relic character.

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