

Demodex castoris sp. nov. (Acari: Demodecidae) parasitizing *Castor fiber* (Rodentia), and other parasitic arthropods associated with *Castor* spp.

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ABSTRACT: A new species of demodecid mite, *Demodex castoris* sp. nov. (Acari: Prostigmata: Demodecidae), is described based on adult stages from the skin of the nasal region of the Eurasian beaver *Castor fiber* Linnaeus, 1758, collected in Poland. This is the first detection of a representative demodecid mite in rodents of the suborder Castorimorpha and also represents the first detection of a skin mite in Eurasian beavers. The new species is a small skin mite (average 173 µm in length) characterized by sexual dimorphism related to body proportions. *D. castoris* sp. nov. was observed in 4 out of 6 beavers examined (66.6%), with a mean intensity of 10.8 and an intensity range of 2–23 ind. host⁻¹. This paper also contains a checklist of parasitic arthropods known from *Castor* spp.

KEY WORDS: *Demodex castoris* sp. nov. · Demodecid mite · Parasites · Eurasian beaver · *Castor fiber* · Semiaquatic mammal

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INTRODUCTION

Mites of the family Demodecidae (Acari: Prostigmata) are skin parasites observed in mammals belonging to most orders. Among the over 120 species described so far, nearly 40% are species specific to various rodents (Izdebska et al. 2014, Izdebska & Rolbiecki 2015a) and have been described from hosts of the most numerous suborder, Myomorpha, as well as in Sciuomorpha and Hystricomorpha. However, to date, no information has been available concerning the occurrence of Demodecidae in rodents of the suborder Castorimorpha, including Heteromyidae, Geomyidae, and Castoridae. While Geomyidae and Heteromyidae include American rodents, Castoridae currently includes only 1 semiaquatic genus, viz. *Castor*, which is widely distributed throughout the Holarctic region. Two castorid species are currently recognized: the North American beaver *C. canadensis* Kuhl, 1820 and the Eurasian beaver *C. fiber* Linnaeus, 1758 (Lavrov & Orlov 1973, Rosell & Sun 1999, Kuehn et al. 2000, Durka et al. 2005).

C. fiber, the largest rodent in Eurasia, has become extinct in many regions or has been threatened with extinction, although as a result of reintroduction programs and consistent protection, this species recently demonstrated an increase in population numbers and an increase in available habitat (Batbold et al. 2008, Janiszewski et al. 2009, Halley et al. 2012). However, legal restrictions on obtaining their species may be one of the causes of incomplete knowledge of its parasitofauna. Some ectoparasites of *C. fiber*, including ticks and unique/specific hair acarofauna, have been described (e.g. Haitlinger 1991, Kadulski 1998, Bochkov & Saveljev 2012), but no information has thus far been available about the occurrence of skin mites from the family Demodecidae in beavers. Demodecid mites are common in terrestrial mammals from different groups, although their occurrence in predatory mammals associated with aquatic environments, including seals and sea lions, has also been reported (Dailey & Nutting 1980, Desch et al. 2003). A representative of the family Demodecidae was also recently found in European otter *Lutra lutra*

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(Linnaeus, 1758) (Izdebska & Rolbiecki 2014a). *Demodex castoris* sp. nov. described herein is the first observation of Demodecidae in rodents of the suborder Castorimorpha and is the first representative environmental group of so-called skin mites in the Eurasian beaver.

MATERIALS AND METHODS

In April 2011, 6 specimens (2 males, 4 females) of the Eurasian beaver from northern Poland (Warmian-Masurian Voivodeship, 53° 58' N, 22° 41' E and Podlaskie Voivodeship 54° 19' N, 22° 49' E) were examined for demodecid mites. The host skin fragment digestion method was used to recover skin mites (Izdebska 2004). Skin fragments of 1 cm² were collected from several body regions, including the head (eyes, ears, sensory hair of the nose, lips, and chin region), neck, abdomen, back, limbs, and genital–anal area. Skin samples were preserved in 70% ethanol and digested in 10% KOH; samples obtained were decanted and analyzed using phase-contrast microscopy. Specimens found were mounted in polyvinyl lactophenol solution and measured (all measurements are given in micrometers). Measurements were taken as follows: gnathosomal width = width at base; podosomal and opisthosomal width = maximum width. Specimen depositories and reference numbers are cited using the following abbreviations: MIZ, Museum and Institute of Zoology, Polish Academy of Sciences, Warszawa, Poland; UG DIZP, University of Gdańsk, Department of Invertebrate Zoology and Parasitology, Gdańsk, Poland. The description of the species adopted the nomenclature commonly used for the family Demodecidae (Nutting 1976) and was completed with the nomenclature proposed by Bochkov (2008) for the superfamily Cheyletoidea (Acari: Prostigmata). Mammal nomenclature used in this paper follows Wilson & Reeder (2005).

In order to define the level of host infestation, the main parasitological parameters were measured as the prevalence (percentage of host infested), mean intensity (average number of parasites in infested hosts), and the intensity range (minimum and maximum number of parasite individuals per host) (Margolis et al. 1982).

All applicable institutional, national, and international guidelines for the care and use of animals were followed. Ethical permission for the research was granted by the 3rd Local Ethical Committee on Animal Testing in Warsaw, Poland (Resolution No.

11/2010, 28 January 2010), and by the Regional Directors for Environmental Protection in Olsztyn, Poland (Resolution No. RDOŚ-28-OOP-6631-0007-638/09/10/pj, 25 January 2010).

RESULTS

Demodex castoris sp. nov. (Acari: Demodecidae)

Description. Holotype (with paratype variation in parentheses).

Male. Slender, body length 143 (134–168) µm, width 28 (21–33) µm (Table 1). Podosoma and opisthosoma of a similar width. Gnathosoma trapezoidal, elongated (Fig. 1B). Pair of conical supracoxal spines (setae elc.p) (2 µm long) on dorsal side of gnathosoma, at anterior end of the coxal (basal) segment of palp

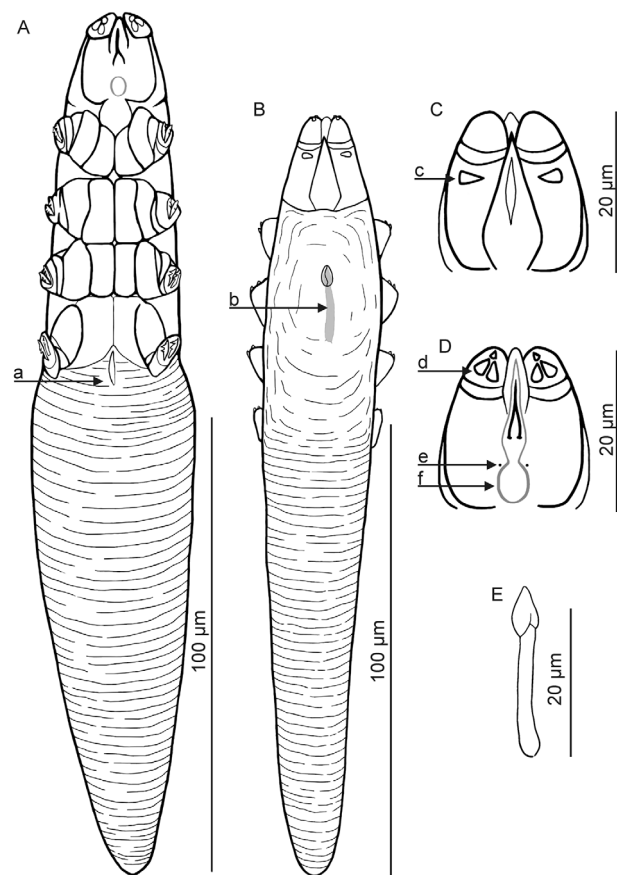


Fig. 1. *Demodex castoris* sp. nov. (A) Female, ventral view, showing vulva (arrow a). (B) Male, dorsal view, with aedeagus (arrow b). (C) Gnathosoma of male, dorsal view; arrow c points to supracoxal spine. (D) Gnathosoma of male, ventral view: terminal segment of palp (d), subgnathosomal seta (e), pharyngeal bulb (f). (E) Aedeagus

Table 1. Morphological measurements (means \pm SD, ranges in parentheses, in μm) of adult *Demodex castoris* sp. nov. TBL: total body length

Morphologic feature	Male (n = 16)	Female (n = 27)
Gnathosoma		
Length	18 \pm 2 (15–23)	19 \pm 2 (16–22)
Base width	18 \pm 2 (14–24)	18 \pm 2 (14–22)
Podosoma		
Length	49 \pm 4 (45–63)	60 \pm 4 (50–68)
Width	28 \pm 3 (21–33)	27 \pm 3 (22–35)
Opisthosoma		
Length	85 \pm 8 (70–100)	106 \pm 9 (90–127)
Width	26 \pm 3 (22–33)	32 \pm 3 (24–38)
Aedeagus	21 \pm 2 (20–26)	–
Vulva	–	11 \pm 2 (9–16)
TBL	152 \pm 10 (134–168)	185 \pm 11 (164–209)

(Fig. 1C). On the terminal segments of palpi, 3 conical spines (1 smaller and 2 larger), located close to each other forming a triangle. On the ventral part of gnathosoma, oval pharyngeal bulb, with minute subgnathosomal setae (setae n) on both sides anteriorly (Fig. 1D). Four pairs of short, overlapping 6-segmented (5 free and 1 integrated segment with venter of podosoma) legs on the podosoma; 2 forked claws on each tarsus. Epimeral plates (coxal fields) with distinct sclerotized edges, narrow, Pair I trapezoidal, Pairs II–IV rectangular. Opisthosoma constitutes 54% (49–60%) of body length; elongated, narrowed and sharp at the end, densely striated (Fig. 1B). Opisthosomal organ absent. Aedeagus 20 (20–26) μm long, at dorsal side of podosoma at level of Pairs II and III of epimeral plates. Genital opening at level of anterior end of Pair I of epimeral plates (Figs. 1B, 1E).

Female. Body shape similar to male; however, anterior end of opisthosoma wider (sometimes even twice) than podosoma (Figs. 1A & 2A). Body length 185 (164–209) μm , width 32 (24–38) μm (Table 1). Gnathosoma trapezoidal, elongated, longer than base width. Supracoxal spines (2 μm long) and other gnathosoma morphological details similar to those in males. Four pairs of short, overlapping 6-segmented (5 free and 1 integrated segment with venter of podosoma) legs on podosoma, tarsi with 2 forked claws. Epimeral plates narrow, Pair I trapezoidal, Pairs II–III rectangular, with distinct sclerotized edges; posterior edges of Pair IV weakly sclerotized, form triangular incision with vulva inside (Fig. 1A). Vulva 11 (9–16) μm long. Opisthosoma constitutes 57% (52–61%) of body length; elongated, wider at base, narrow toward end, sharp at end, with dense striation. Opisthosomal organ absent.

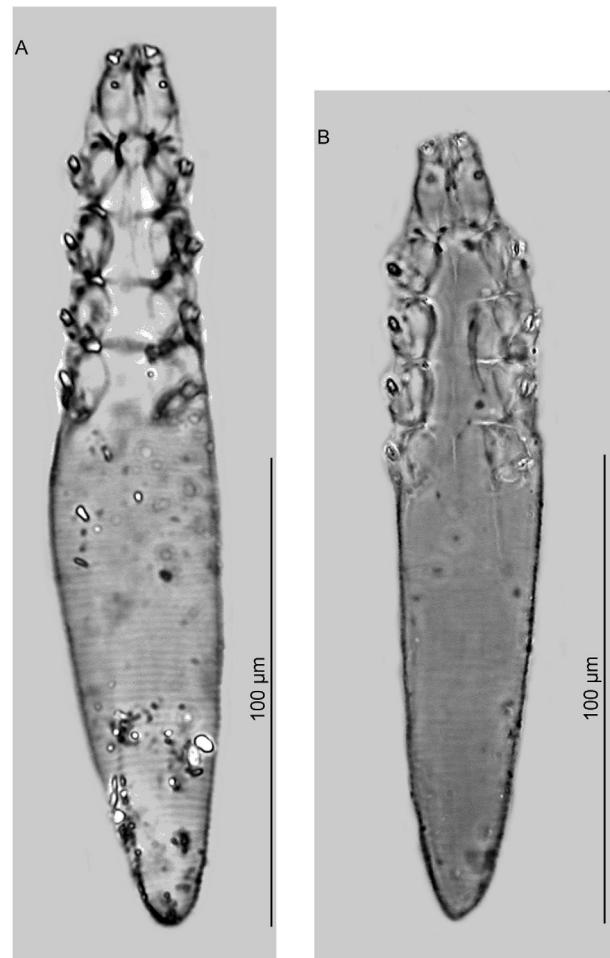


Fig. 2. *Demodex castoris* sp. nov.: (A) female, (B) male

Type host and locality. *Castor fiber* Linnaeus, 1758 (Eurasian beaver). Northern Poland. It is probable that the distribution of *D. castoris* corresponds directly to that of its host, *C. fiber*.

Infestation and location in the host. *D. castoris* sp. nov. was noted in 66.6% of the 6 examined Eurasian beavers, with a mean intensity 10.8 and an intensity range of 2–23 ind. per host; 43 individuals were found in total (16 males, 27 females). Mites were found exclusively in the skin of the nose.

Type specimens. Holotype: male, (Reg. No. CCfDc18), Poland, Podlaskie Voivodeship, Okliny (54° 19' N, 22° 49' E), host *C. fiber* (Reg. No. 5), host collector S. Fryderyk, IV/2011, deposited in the UG DIZP. Paratypes: 14 males (Reg. Nos CCfDDc01m, CCfDDc10m, CCfDDc12m–13m, CCfDDc15m–16m, CCfDDc18m, CCfDDc23m, CCfDDc26m–27m, CCfDDc33m–34m, CCfDDc37m, CCfDDc39m, CCfDDc40m, CCfDDc43m), 23 females (Reg. Nos CCfDDc02f–04f, CCfDDc07f–09f, CCfDDc11f, CCfDDc17f,

Table 2. Morphological differences between *Demodex castoris* sp. nov. and *D. ratticola*. TBL: total body length; PW: podosomal width; OW/OL: opisthosomal width/length; EPP: epimeral plate pair; GO: genital opening

Morphologic feature	<i>Demodex castoris</i> sp. nov.		<i>Demodex ratticola</i>	
	Males (n = 16)	Females (n = 27)	Males (n = 20)	Females (n = 20)
TBL (µm)	152	185	195 ^a	186 ^a
PW (µm)	28	27	35 ^a	36 ^a
OW (µm)	26	32	27 ^a	31 ^a
TBL:max. width	5.5	5.8	5.6 ^b	5.2 ^b
OL:TBL (%)	56	57	60 ^b	55 ^b
Supracoxal spine				
Length (µm)	2	2	3.5–4	3.5–4
Shape	Conical	Conical	Peglike	Peglike
Location	Anterior end of coxal palp segment	Anterior end of coxal palp segment	Midline of coxal palp segment	Midline of coxal palp segment
Palp structure	Conical spines (1 small, 2 larger), forming triangle	Conical spines (1 small, 2 larger), forming triangle	Usually 2 denticuli on anterior edge, and 1 simple and two 2-tined spines ventrally	Usually 2 denticuli on anterior edge, and 1 simple and two 2-tined spines ventrally
Subgnathosomal setae location	Both sides, anterior to pharyngeal bulb	Both sides, anterior to pharyngeal bulb	Both sides, medial to pharyngeal bulb	Both sides, medial to pharyngeal bulb
Opisthosomal organ	Absent	Absent	Spindle-shaped	Finger-like
Opisthosoma shape at end	Sharpened	Sharpened	Rounded	Rounded
EPP IV posterior edge in females	–	Triangular	–	Arched
Aedeagus				
Length (µm)	21	–	30	–
Location	Level with EPP II & III, GO level with EPP I & II border	–	Level with EPP II & III, GO below anterior end of EPP II	–
Host				
Species	<i>Castor fiber</i>	<i>Castor fiber</i>	<i>Rattus norvegicus</i>	<i>Rattus norvegicus</i>
Location	Skin of nasal region	Skin of nasal region	Skin of head (nose, lips, chin)	Skin of head (nose, lips, chin)
Reference	Present study	Present study	Bukva (1995) ^c	Bukva (1995) ^c

^aRounded to the first decimal place; ^bcalculated from the measurements of Bukva (1995); ^cmorphological features of *D. ratticola* not provided by Bukva (1995) completed by Izdebska & Rolbiecki (2014b)

CCfDDc19f–22f, CCfDDc24f–25f, CCfDDc28f–32f, CCfDDc35f–36f, CCfDDc38f, CCfDDc41f–42f), Poland, Podlaskie Voivodeship, Okliny (54° 19' N, 22° 49' E) and Warmian-Masurian Voivodeship (Cimochy, 53° 58' N, 22° 41' E), host *C. fiber* (Reg. Nos. 1–6), other data the same as holotype. One male paratype (Reg. No. 13/2013/4) and 4 female paratypes (Reg. Nos 13/2013/1–13/2013/3, 13/2013/5), same localities and host collector, host *C. fiber* (Reg. Nos. 1, 6), deposited in the MIZ.

Etymology. The specific epithet *castoris* refers to the name of the host species.

Differential diagnosis. See Table 2. In terms of morphological features and type of microhabitat, *D. castoris* sp. nov. is the most similar to *D. ratticola*

Bukva, 1995 observed in the nasal region of the brown rat *Rattus norvegicus* (Berkenhout, 1769) (Muridae).

DISCUSSION

Beavers are semi-aquatic, and it would thus be reasonable to assume that this would be the factor limiting the occurrence of parasitic arthropods on these mammals. However, mammals that are secondarily adapted to an aqueous lifestyle usually retain, at least partially, a set of parasitic arthropods typical for related terrestrial mammals. This is probably conditioned by long-term evolution of the para-

site–host system, where the relationship of parasite and mammal is so strong that the parasite stays with the host regardless of its habitat, gradually yielding new adaptations (Izdebska et al. 2015). In fact, the typical parasitofauna of the Eurasian beaver includes fur mites of the genus *Schizocarpus*, of which 45 species have been described in the Eurasian beaver and 24 in the North American beaver (including animals from farms in Europe). Moreover, parasitic beetles from the family Leiodidae, typical in beavers, have also been demonstrated in both species (Appendix 1). The greatest potential to survive is noted here for parasites such as skin mites that live in stable conditions provided by the skin or internal organs of the hosts. Representatives of this group, viz. demodecid mites, which are common in terrestrial mammals, have also been reported in different mammals associated with aquatic environments, including otters, seals, and sea lions (Dailey & Nutting 1980, Desch et al. 2003, Izdebska & Rolbiecki 2014a). It seems that skin or subcutaneous mites should also be associated with beavers, due to the stable life environment of skin tissues. However, the only representative of this ecological group that has been noted in North American beavers is the itch mite *Psorobia castoris* Kok, Lukoschus and Clulow, 1970 (Kok et al. 1970, Giesen 1990). No representatives of Demodecidae, which are common in other groups of rodents, have been noted (Izdebska 2012, Izdebska & Rolbiecki 2013a).

Demodecidae are parasites characterized both by host and topical specificity. They are linked to hair follicles, various kinds of glands, and epidermis, and are sometimes noted in the oral cavity, tissue of the anterior part of the esophagus, or the ear canal (Izdebska & Rolbiecki 2015a,b). They usually exhibit topographical preferences (Izdebska & Rolbiecki 2013b). *Demodex castoris* sp. nov. described here in Eurasian beavers were found exclusively on head skin in the nasal region. Species of this group demonstrating analogous localization are known in rodents; for example, *D. ratticola* in the brown rat is observed in the area of the nose, lips, or chin (Izdebska & Rolbiecki 2012a,b, 2014b). *D. longior* Hirst, 1918 from the wood mouse *Apodemus sylvaticus* Linnaeus, 1758 (Muridae) and *D. gracilentus* Izdebska and Rolbiecki, 2013 from the striped field mouse *A. agrarius* (Pallas, 1771) (Muridae) have only been found in the area near the vibrissae (Izdebska & Rolbiecki 2013b). *D. castoris* sp. nov. is presumably a Eurasian beaver-specific parasite, and it is possible that representatives of this group of species parasitize North American beavers as well.

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Appendix 1. Parasitic arthropods associated with beavers *Castor* spp.

Group	Species	Host(s)	Occurrence	Reference(s)
Insecta Phthiraptera Trichodectidae	<i>Trichodectes castoris</i> Osborn, 1896 (synonymized with <i>Neotrichodectes mephitidis</i> (Packard, 1873) from <i>Mephitis</i> spp., Hopkins & Clay 1952)	<i>C. canadensis</i> (probably wrongly identified host, Hopkins & Clay 1952)	North America: USA	Osborn (1896)
Coleoptera Leiodidae	<i>Leptinillus validus</i> (Horn, 1872)	<i>C. canadensis</i>	North America: Canada, USA	Lawrence et al. (1965), Peck (2007), Majka & Langor (2008)
	<i>Platypyllus castoris</i> Ritsema, 1869	<i>C. canadensis</i> , <i>C. fiber</i>	North America: Canada, USA	e.g. Lawrence et al. (1965), Belfiore (2006), Peck (2006), Majka & Langor (2008), Moskowicz (2011)
			Asia: Russia	Arzanov et al. (2013)
			Europe: Belarus, Belgium, Czech Republic, France, Germany, Latvia, Netherlands, Norway, Poland, Russia, Slovakia, Sweden, Switzerland, Ukraine	e.g. Kadulski (1998), Peck (2006), Buchholz et al. (2008), Moskowicz (2011), Arzanov et al. (2013), Pushkin (2014)
Siphonaptera Ctenophthalmidae	<i>Corrodopsylla curvata</i> (Rothschild, 1915)	<i>C. canadensis</i>	North America: USA	Lawrence et al. (1965)
Ceratophyllidae	<i>Megabothris quirini</i> (Rothschild, 1905)	<i>C. canadensis</i>	North America: USA	Lawrence et al. (1965)
	<i>Monopsyllus vison</i> (Baker, 1904)	<i>C. canadensis</i>	North America: USA	Lawrence et al. (1965)
Acari Ixodida	<i>Dermacentor albipictus</i> (Packard, 1869)	<i>C. canadensis</i>	North America: USA	Stiles (1910)
Ixodidae	<i>Ixodes apronophorus</i> (Schulze, 1924)	<i>C. fiber</i>	Europe: Poland	Kadulski (1998)
	<i>Ixodes banksi</i> Bishopp, 1911	<i>C. canadensis</i>	North America: Canada, USA	Gregson (1956), Lawrence et al. (1965)
	<i>Ixodes hexagonus</i> Leach, 1815	<i>C. fiber</i>	Europe: Poland	Kadulski (1998), Haitlinger (1991)
Mesostigmata Laelapidae	<i>Androlaelaps fahrenheitzi</i> (Berlese, 1911) (= <i>Haemolaelaps glasgowi</i> (Ewing, 1925))	<i>C. canadensis</i>	North America: USA	Lawrence et al. (1965), Nelder & Reeves (2005)
	<i>Ondatraelaps</i> (= <i>Laelaps</i>) <i>multispinosus</i> (Banks, 1910)	<i>C. canadensis</i>	North America: USA	Lawrence et al. (1965)
Prostigmata Demodecidae	<i>Demodex castoris</i> sp. nov.	<i>C. fiber</i>	Poland	Present study
Psorergatidae	<i>Psorobia castoris</i> Kok, Lukoschus and Clulow, 1970	<i>C. canadensis</i>	North America: Canada	Kok et al. (1970)
Trombiculidae	<i>Neotrombicula whartoni</i> (Ewing, 1929)	<i>C. canadensis</i>	North America: USA	Nelder & Reeves (2005)

Group	Species	Host(s)	Occurrence	Reference(s)
Astigmata Chirodiscidae	<i>Schizocarpus alaskensis</i> Fain and Whitaker, 1988	<i>C. canadensis</i>	North America: USA	Fain & Whitaker (1988), Whitaker et al. (1989), (2009)
	<i>Schizocarpus anomalis</i> Bochkov, 1993	<i>C. canadensis</i> ^a	Europe: Russia	Dubinina et al. (1993)
	<i>Schizocarpus azasicus</i> Bochkov and Saveljev, 2012	<i>C. fiber</i>	Asia: Russia	Bochkov & Saveljev (2012)
	<i>Schizocarpus brachyurus</i> (Dubinina, 1964) (= <i>S. parabrachyurus</i> Fain and Lukoschus, 1985) (= <i>S. intercalatus</i> Fain and Lukoschus, 1985)	<i>C. fiber</i>	Asia: Russia	Bochkov & Saveljev (2012)
			Europe: Germany, Poland, Russia	Dubinina (1964), Fain & Lukoschus (1985), Haitlinger (1991) ^b , Kadulski (1998) ^b , Bochkov et al. (2012)
			Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus brevicaudata</i> (Dubinina, 1964)	<i>C. fiber</i>	Europe: Germany, Poland, Russia	Dubinina (1964), Fain & Lukoschus (1985), Kadulski (1998) ^b
	<i>Schizocarpus brevis</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus capitis</i> (Dubinina, 1964)	<i>C. fiber</i>	Europe: Germany, Poland, Russia	Dubinina (1964), Fain & Lukoschus (1985), Kadulski (1998) ^b , Bochkov et al. (2012)
			Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus centralis</i> Fain and Whitaker, 1988	<i>C. canadensis</i> , <i>C. canadensis</i> ^a	North America: USA	Fain & Whitaker (1988)
			Europe: Russia	Dubinina et al. (1993)
	<i>Schizocarpus contrarius</i> Fain and Whitaker, 1988	<i>C. canadensis</i>	North America: USA	Fain & Whitaker (1988)
	<i>Schizocarpus curtus</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Europe: Poland	Bochkov et al. (2012)
			Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus daberti</i> Bochkov and Saveljev, 2012	<i>C. fiber</i>	Asia: Russia	Bochkov & Saveljev (2012)
	<i>Schizocarpus diebzigensis</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Europe: Germany	Fain & Lukoschus (1985)
	<i>Schizocarpus distinctus</i> Fain and Whitaker, 1988	<i>C. canadensis</i>	North America: USA	Fain & Whitaker (1988), Whitaker et al. (1989)
	<i>Schizocarpus exiguus</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus faini</i> Bochkov, Labrzycka, Skoracki and Saveljev, 2012	<i>C. fiber</i>	Europe: Poland	Bochkov et al. (2012)
	<i>Schizocarpus fedjushini</i> (Dubinina, 1964)	<i>C. fiber</i>	Asia: Russia	Bochkov & Saveljev (2012)
			Europe: Belarus, Poland, Russia	Dubinina (1964), Haitlinger (1991) ^b , Kadulski (1998) ^b , Bochkov & Saveljev (2012), Bochkov et al. (2012)
			Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus furcatus</i> Fain, Whitaker and Smith, 1984	<i>C. canadensis</i>	North America: USA	Fain et al. (1984), Fain & Whitaker (1988)
	<i>Schizocarpus gozdziowskii</i> Bochkov, Labrzycka, Skoracki and Saveljev, 2012	<i>C. fiber</i>	Asia: Russia	Bochkov & Saveljev (2012)
			Europe: Poland, Russia	Bochkov & Dubinina (2011), Bochkov et al. (2012)
	<i>Schizocarpus grandis</i> (Dubinina, 1964)(= <i>S. dubinia</i> Fain and Lukoschus, 1985)	<i>C. canadensis</i> ^a , <i>C. fiber</i>	Asia: Russia	Bochkov & Saveljev (2012)
			Europe: Russia	Dubinina (1964)
			Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus heatherae</i> Bochkov, Labrzycka, Skoracki and Saveljev, 2012	<i>C. fiber</i>	Europe: Poland, Russia	Bochkov (2012), Bochkov et al. (2012)

Group	Species	Host(s)	Occurrence	Reference(s)
Astigmata Chirodiscidae (continued)	<i>Schizocarpus heideckeii</i> Bochkov and Saveljev, 2012	<i>C. fiber</i>	Asia: Russia	Bochkov & Saveljev (2012)
	<i>Schizocarpus hexapilis</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Europe: Germany	Fain & Lukoschus (1985)
	<i>Schizocarpus humilis</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Europe: Germany	Fain & Lukoschus (1985)
	<i>Schizocarpus indianensis</i> Fain, Whitaker and Smith, 1984	<i>C. canadensis</i>	North America: USA	Fain et al. (1984), Fain & Whitaker (1988), Whitaker et al. (1989), Nelder & Reeves (2005)
	<i>Schizocarpus insignis</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Asia: Mongolia, Russia	Fain & Lukoschus (1985), Bochkov & Saveljev (2012)
			Europe: Germany, Poland	Fain & Lukoschus (1985), Bochkov et al. (2012)
			Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus inversus</i> Fain, Whitaker and Smith, 1984	<i>C. canadensis</i>	North America: USA	Fain et al. (1984), Fain & Whitaker (1988), Whitaker et al. (1989), (2009)
	<i>Schizocarpus klompeni</i> Bochkov, Labrzycka, Skoracki and Saveljev, 2012	<i>C. fiber</i>	Europe: Poland	Bochkov et al. (2012)
	<i>Schizocarpus latus</i> (Dubinina, 1964) (= <i>S. ventricosus</i> Fain and Lukoschus, 1985)	<i>C. canadensis</i> ^a , <i>C. fiber</i>	Europe: Poland, Russia	Dubinina (1964), Kadulski (1998) ^b
			Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus lavrovi</i> Bochkov and Saveljev, 2012	<i>C. fiber</i>	Asia: Russia	Bochkov & Saveljev (2012)
	<i>Schizocarpus mingaudi</i> (Trouessart, 1896) (= <i>Prolabidocarpus canadensis</i> Lawrence, 1948)	<i>C. canadensis</i> , <i>C. fiber</i>	North America: USA	Fain et al. (1984), Fain & Whitaker (1988), Whitaker et al. (1989, 2009)
			Europe: Belarus, Poland, Russia	Dubinina (1964) ^c , Kadulski (1998) ^b , Bochkov et al. (2012) ^c
	<i>Schizocarpus minor</i> (Dubinina, 1964)	<i>C. canadensis</i> ^a , <i>C. fiber</i>	Europe: Poland, Russia	Dubinina (1964), Kadulski (1998) ^b
	<i>Schizocarpus modestus</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Asia: Russia	Bochkov & Saveljev (2012)
			Europe: Germany	Fain & Lukoschus (1985)
	<i>Schizocarpus numerosus</i> (Dubinina, 1964)	<i>C. fiber</i>	Europe: Germany, Poland, Russia	Dubinina (1964), Fain & Lukoschus (1985), Haitlinger (1991) ^b , Kadulski (1998) ^b , Bochkov et al. (2012)
	<i>Schizocarpus ornatus</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus parahexapilis</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus parahumilis</i> Bochkov, Labrzycka, Skoracki and Saveljev, 2012	<i>C. fiber</i>	Europe: Poland	Bochkov et al. (2012)
	<i>Schizocarpus paramingaudi</i> Fain and Whitaker, 1988	<i>C. canadensis</i> , <i>C. canadensis</i> ^a	North America: USA	Fain & Whitaker (1988), Whitaker et al. (1989), (2009)
			Europe: Russia	Dubinina et al. (1993)
	<i>Schizocarpus parvus</i> (Dubinina, 1964)	<i>C. canadensis</i> ^a , <i>C. fiber</i>	Europe: Poland, Russia	Dubinina (1964), Kadulski (1998) ^b , Bochkov et al. (2012)
	<i>Schizocarpus postannulatus</i> Fain and Whitaker, 1988	<i>C. canadensis</i>	North America: USA	Fain & Whitaker (1988), Whitaker et al. (1989)
	<i>Schizocarpus posticus</i> Fain and Whitaker, 1988	<i>C. canadensis</i>	North America: USA	Fain & Whitaker (1988), Whitaker et al. (2009)
	<i>Schizocarpus protinus</i> Fain and Whitaker, 1988	<i>C. canadensis</i>	North America: USA	Fain & Whitaker (1988), Whitaker et al. (1989)
	<i>Schizocarpus pseudonumerosus</i> Bochkov, Labrzycka, Skoracki and Saveljev, 2012	<i>C. fiber</i>	Europe: Poland	Bochkov et al. (2012)

Group	Species	Host(s)	Occurrence	Reference(s)
Astigmata Chirodiscidae (continued)	<i>Schizocarpus pusillus</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Asia: Russia	Bochkov & Saveljev (2012)
			Europe: Germany	Fain & Lukoschus (1985)
	<i>Schizocarpus pygidialis</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Europe: Poland, Russia	Bochkov & Dubinina (2011), Bochkov et al. (2012)
			Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus radiatus</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Asia: Russia	Bochkov & Saveljev (2012)
			Europe: Poland, Russia	Bochkov & Dubinina (2011), Bochkov et al. (2012)
			Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus reductus</i> Fain and Whitaker, 1988	<i>C. canadensis</i>	North America: USA	Fain & Whitaker (1988), Whitaker et al. (1989, 2009)
	<i>Schizocarpus saveljevi</i> Bochkov, 2012	<i>C. fiber</i>	Europe: Russia	Bochkov (2012)
	<i>Schizocarpus similis</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Europe: Germany, Russia	Fain & Lukoschus (1985), Bochkov & Dubinina (2011)
	<i>Schizocarpus spinifer</i> Fain, Whitaker and Smith, 1984	<i>C. canadensis</i>	North America: USA	Fain et al. (1984), Fain & Whitaker (1988), Whitaker et al. (1989, 2009)
	<i>Schizocarpus subdiebzigensis</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus subhexapilis</i> Fain and Lukoschus, 1985	<i>C. canadensis</i> ^a , <i>C. fiber</i>	Europe: Poland, Russia	Bochkov & Dubinina (2011), Bochkov et al. (2012)
			Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus subminor</i> (Dubinina, 1964)	<i>C. fiber</i>	Europe: Russia	Dubinina (1964)
	<i>Schizocarpus subornatus</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Asia: Russia	Bochkov & Saveljev (2012)
			Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus subparvus</i> (Dubinina, 1964)	<i>C. canadensis</i> ^a , <i>C. fiber</i>	Europe: Poland, Russia	Dubinina (1964), Kadulski (1998) ^b , Bochkov et al. (2012)
	<i>Schizocarpus subvirgulatus</i> Fain, Whitaker and Smith, 1984	<i>C. canadensis</i>	North America: USA	Fain et al. (1984), Fain & Whitaker (1988), Whitaker et al. (1989)
	<i>Schizocarpus testiculatus</i> Bochkov, Labrzycka, Skoracki and Saveljev, 2012	<i>C. fiber</i>	Europe: Poland	Bochkov et al. (2012)
	<i>Schizocarpus tetrapilis</i> Fain, Whitaker and Smith, 1984	<i>C. canadensis</i>	North America: USA	Fain et al. (1984), Fain & Whitaker (1988), Whitaker et al. (1989)
	<i>Schizocarpus tuvnicus</i> Bochkov and Saveljev, 2012	<i>C. fiber</i>	Asia: Russia	Bochkov & Saveljev (2012)
	<i>Schizocarpus unzhakovi</i> Bochkov and Saveljev, 2012	<i>C. fiber</i>	Asia: Russia	Bochkov & Saveljev (2012)
	<i>Schizocarpus ventricosus</i> Fain and Lukoschus, 1985	<i>C. fiber</i>	Europe: Location not determined	Fain & Lukoschus (1985)
	<i>Schizocarpus virgulatus</i> Fain, Whitaker and Smith, 1984	<i>C. canadensis</i>	North America: USA	Fain et al. (1984), Whitaker et al. (1989)
	<i>Schizocarpus zurowskii</i> Bochkov, Labrzycka, Skoracki and Saveljev, 2012	<i>C. fiber</i>	Asia: Russia	Bochkov & Saveljev (2012)
Europe: Poland			Bochkov et al. (2012)	

^aAccording to Bochkov & Dubinina (2011), some *Schizocarpus* spp. can colonize North American beavers held at the same farms as Eurasian beavers (e.g. in Russia)

^bAccording to Bochkov et al. (2012), determination of *Schizocarpus* spp. requires re-examination

^cAccording to Bochkov et al. (2012), records of *S. mingaudi* on *C. fiber* are the result of incorrect determination or transfer of this parasite to *C. fiber* from *C. canadensis* that co-occurred with them in captivity