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A collection of spiders and harvestmen from two caves in Ontario and Newfoundland, Canada (Araneae, Opiliones)

Wilfried Breuss

ABSTRACT Contrib. Nat. Hist. 12: 297–313.

In the years 1995 and 2006 the author visited the Bonnechere Caves (Ontario) and the Corner Brook Caves (Newfoundland) and thereby conducted zoological collections. Five species of spiders could be ascertained: *Oreophantes recurvatus*, *Porrhomma convexum* (Linyphiidae), *Meta ovalis* (Tetragnathidae), *Rugathodes sexpunctatus* (Theridiidae) and *Eidmannella pallida* (Nesticidae). All of them are widely distributed and concerning their connection to caves they have to be classified as troglophiles or trogloxenes. As expected, no troglobionts were found. *P. convexum* seems to be especially noteworthy. There are only a few nearctic records of this species, all from the northwestern region (Alaska, Washington, Alberta and British Columbia). The present findings from the (most) eastern provinces of Canada emphasize the wide distribution of *P. convexum*. Harvestmen are represented by only one species, *Leiobunum elegans*. This phalangiid is widespread and common in the northeast of North America.

Keywords: biospeleology, caves, Canada, *Porrhomma convexum*, spiders, harvestmen, Newfoundland, Ontario

Introduction

The inception of biospeleological research in North America is the description of a cave fish from the Mammoth Cave in Kentucky by DeKay in 1842 (Hobbs 2005). The interest in biospeleological questions has so far concentrated on the southern regions of the continent (USA, Mexico), whereas Canadian caves have only been given little attention. Summarising papers concerning the fauna of Canadian caves are from Peck & Fenton (1977), Peck (1988, 1994, 1998), Shaw & Davis (2000) and Moseley (2007).

Generally, caves in northern regions are only rarely populated by animals. Troglobites are rare, whereas troglophilic and trogloxenic species predominate. Caves in temperate climate zones show a definitely higher number of obligatory inhabitants. Thus, the roughly 350 known invertebrate taxa from Canadian caves contain only about 5 troglobites and stygobites (Peck 1994), whereas 673 terrestrial and 300 aquatic troglobites are known from caves in the USA and Mexico (Culver & al. 2000). In this respect the diversity of the fauna of Canadian caves is comparable with that of caves in western Austria, where the author could detect also only about 5 troglobitic species, mainly from the aquatic fauna (Breuss 1993, 1995, 2001, 2002, 2004).

This reduction of species in northern caves is due to the influence of the last ice age – Holdhaus (1954) and Janetschek (1956) describe a "faunistic devastation" of formerly glaciated regions of the Alps. For North America, Peck (1994) ascertained that "The southern limit of Pleistocene glaciation is generally the northern distributional limit of troglobites". In Austria only the record of *Eukoenenia spelaea strouhali* Condé (Palpigradi) in the year 1948 in a tunnel near Innsbruck (N-Tyrol) led Janetscheck (1956) to the conclusion that even in regions with former glacial coverage, a survival of cold periods in the crevices of the mountains was generally possible. The discovery of a blind cave beetle of the genus *Arctaphaenops* and of the pseudoscorpion *Neobisium (Blothrus) aueri* Beier in the North Eastern Alps corroborate this conclusion (Breuss 2004, Christian 1999, 2004). However, for the wide majority of subterranean communities in northern regions, an only post-glacial age has to be assumed. They may have reached the caves in the course of a reinvasion during the Holocene starting from southern "massifs de refuge" (Janetschek 1956). The possibility for remigration covering a great distance is presumed especially for stygobionts like the Western European *Proasellus cavaticus* (Leydig, 1871) (Asellidae). For this aquatic isopod such an expansion is assumed along the interstitial of the big rivers, starting from a southwestern refuge (Pust 1990, Breuss 1995).

To my tutor and mentor Dr. Konrad Thaler (19. 12. 1940–11. 7. 2005)

Materials, Collecting sites

The recent collections from the Bonnechere Caves and the Corner Brook Caves contain altogether 36 spiders from 5 species in 4 families, as well as 3 harvestmen from only one species. Taxonomic references are not completely listed. For further information see Platnick (2009). Voucher specimens are deposit-

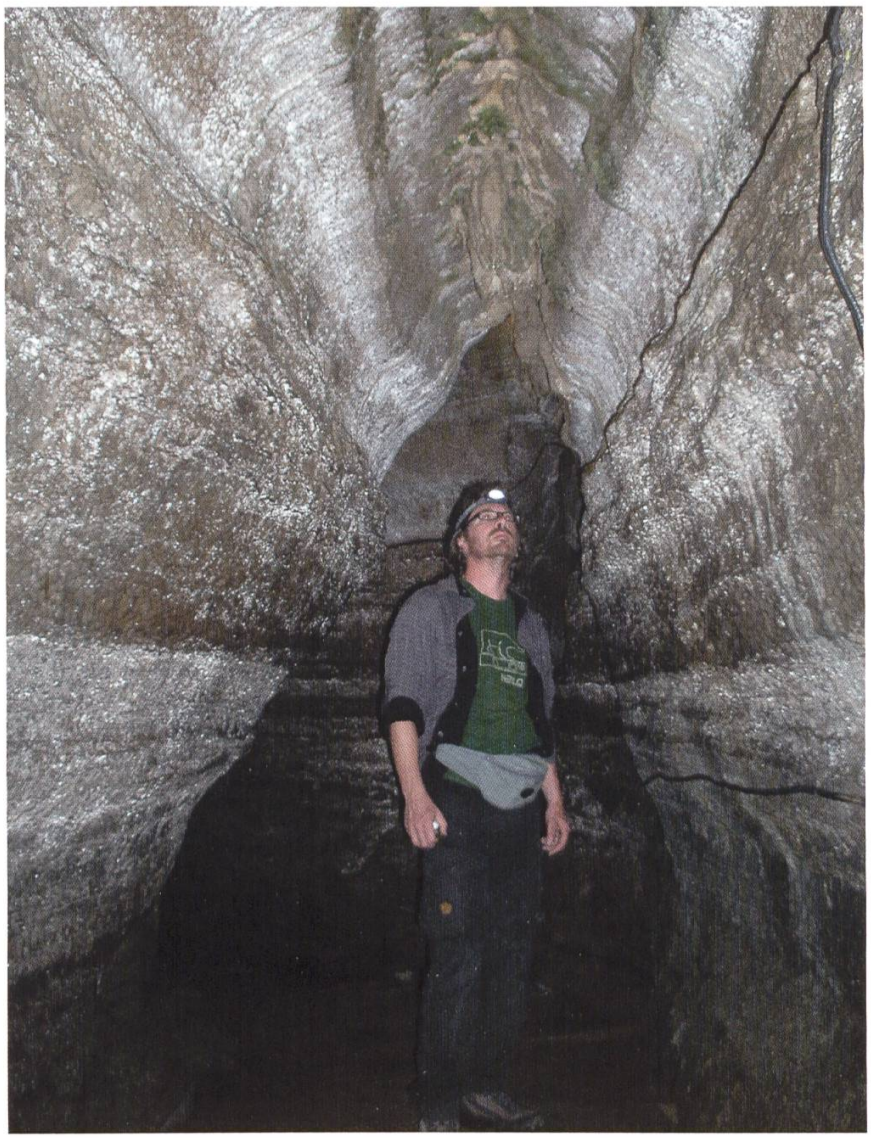


Fig. 1. Bonnechere Caves, Ontario: "Looking for *Porrhomma*" (Photo: O. Erdogan).

ed in the Canadian National Collection of Insects, Arachnids and Nematodes (CNC), the Collection W. Breuss (CWB) and the Natural History Museum Bern (NMBE).

Bonnechere Caves, Eganville, ON (N 45° 30', W 77° 00'): Fig. 1.

The Bonnechere Caves are located in the Bonnechere River Park 8 km from Eganville south of Pembroke (Renfrew County). The caves were discovered in 1855 by the geologist Alexander Murray but first exploration did not begin before 1955. Today, about 150 m of passages are known. The caves developed in the mid-Ordovician limestones of the Ottawa Formation. After deglaciation the Bonnechere Caves were submerged by the Champlain Sea and subsequently by the Bonnechere River. From May to October water is pumped out of the caves for tourist purposes. During the winter season parts of the caves are flooded.

Corner Brook Caves, Corner Brook, NF (N 48° 55', W 57° 54'): Fig. 2.

The Corner Brook Caves are situated in the Ordovician limestones, about 2 km south of the city of Corner Brook, western Newfoundland. These lime-

Fig. 2. Corner Brook Caves, Newfoundland: Entrance near Hoover Dam (Photo: H. Wäger).

stones are partially metamorphosed to marbles. The caves were carved out by the water of the Corner Brook Stream. Because a part of the stream still flows through the cave, especially in wet seasons the water level has to be checked before entering Corner Brook Caves. Research on the geology and genesis of the Corner Brook Caves was done by Chislett (1996). So far about 450 m of passages have been explored and three entrances are known. The majority of the collected specimens are from the entrance area near Hoover Dam.

Collecting sites of *Porrhomma*-specimens in Vorarlberg, Austria:

Barbarastollen (N 47° 06' 00", E 09° 55' 06"): historic mine near Schruns, Bartholomäberg; total length 78 m, 1352 m a.s.l.

Kobelach (N 47° 23' 18", E 09° 46' 04"): gorge of the Kobelach river, Dornbirn; 560 m a.s.l.

Baschg-Cave (N 47° 15' 00", E 09° 40' 00"): karstcave near Feldkirch, length 310 m, 780 m a.s.l.

Abbreviations:

ad	adult
sad	subadult
juv	juvenile

Araneae

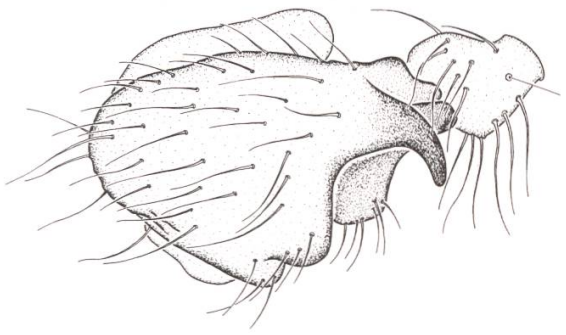
Linyphiidae

***Oreophantes recurvatus* (EMERTON, 1913)** (Figs. 3–6)

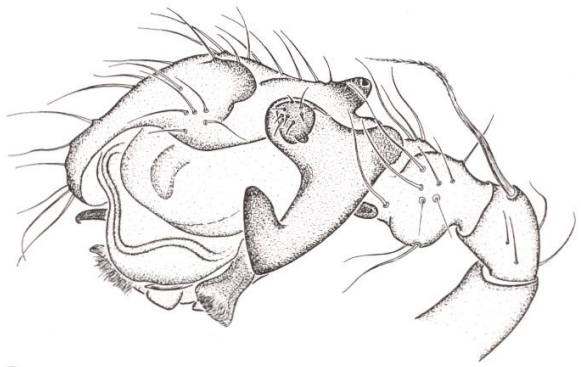
Taxonomy: Paquin & Dupérré (2003), Helsdingen (1973, sub *Oreonetides recurvatus*).

Material examined: Bonnechere Caves: 1 ♂ 2 ♀, 23. 8. 1995 (CWB); 1 ♀ 1 sad ♀, 7. 8. 2006 (NMBE); Corner Brook Caves: 1 sad ♀, 26. 7. 2006.

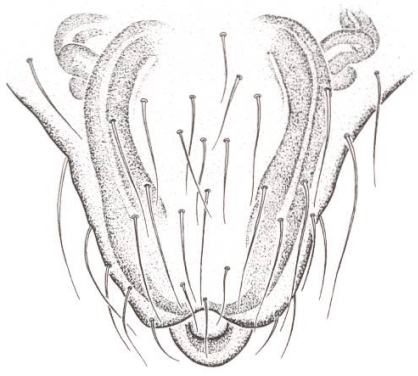
O. recurvatus is the only species known within the genus. In Newfoundland *O. recurvatus* is recorded from mixed coniferous woods (Pickavance & Dondale 2005). Koponen (1987) mentions this species from a Balsam fir forest in 860 m a.s.l. at Mont du Lac des Cygnes, Quebec. In the Corner Brook



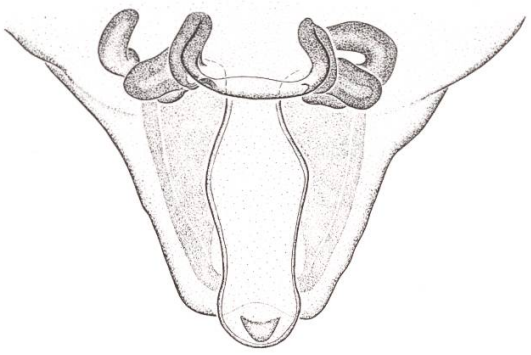
3 0.2 mm



4 0.2 mm



5 0.2 mm



6 0.2 mm

Figs. 3–6. *Oreophantes recurvatus* (EMERTON, 1913). Bonnechere Caves. Left male palp in dorsal (3) and retrolateral view (4); female epigynum in ventral (5) and dorsal view (6).

	Bonnechere Caves n = 5 (5)		Corner Brook Caves n = 0 (1)		Baschg-Cave n = 8 (19)	
	♂	♀	♂	♀	♂	♀
TL	2.27	2.29	-	2.32	2.27	2.48
	2.05–2.41	2.00–2.51	-	-	2.06–2.40	2.34–2.54
PL	1.19	1.11	-	1.18	1.16	1.18
	1.10–1.29	1.04–1.27	-	-	-	-
PW	0.87	0.79	-	0.90	0.84	0.81
	0.82–0.90	0.73–0.90	-	-	-	-
LF1	1.11	1.03	-	1.12	1.03	1.06
	1.04–1.20	0.94–1.16	-	-	-	-
DF1	0.20	0.19	-	0.24	0.19	0.20
	0.20–0.22	0.18–0.22	-	-	-	-
DF1/LF1	0.18	0.19	-	0.21	0.19	0.19
	0.17–0.19	0.18–0.19	-	-	-	-
Tm1	0.40	0.42	-	0.47	0.45	0.46
	0.37–0.42	0.37–0.44	-	-	-	-

Tab. 1: *Porrhomma convexum*, m (f): Average and variation of total length (TL), length of prosoma (PL), width of prosoma (PW), length femur 1 (LF1), diameter femur 1 (DF1) and position of trichobothrium on metatarsus 1 (Tm1). Measurements of specimens from Baschg-Cave are taken from Breuss (1995).

Caves the author collected *O. recurvatus* only in the entrance area, whereas in Bonnechere Caves specimens were found throughout the cave. Further records from caves in Ontario are from Hope Bay Cave, Horse Collar Cave and Mount Nemo Cave (Peck 1988; sub *Oreonetides recurvatus* EMERTON).

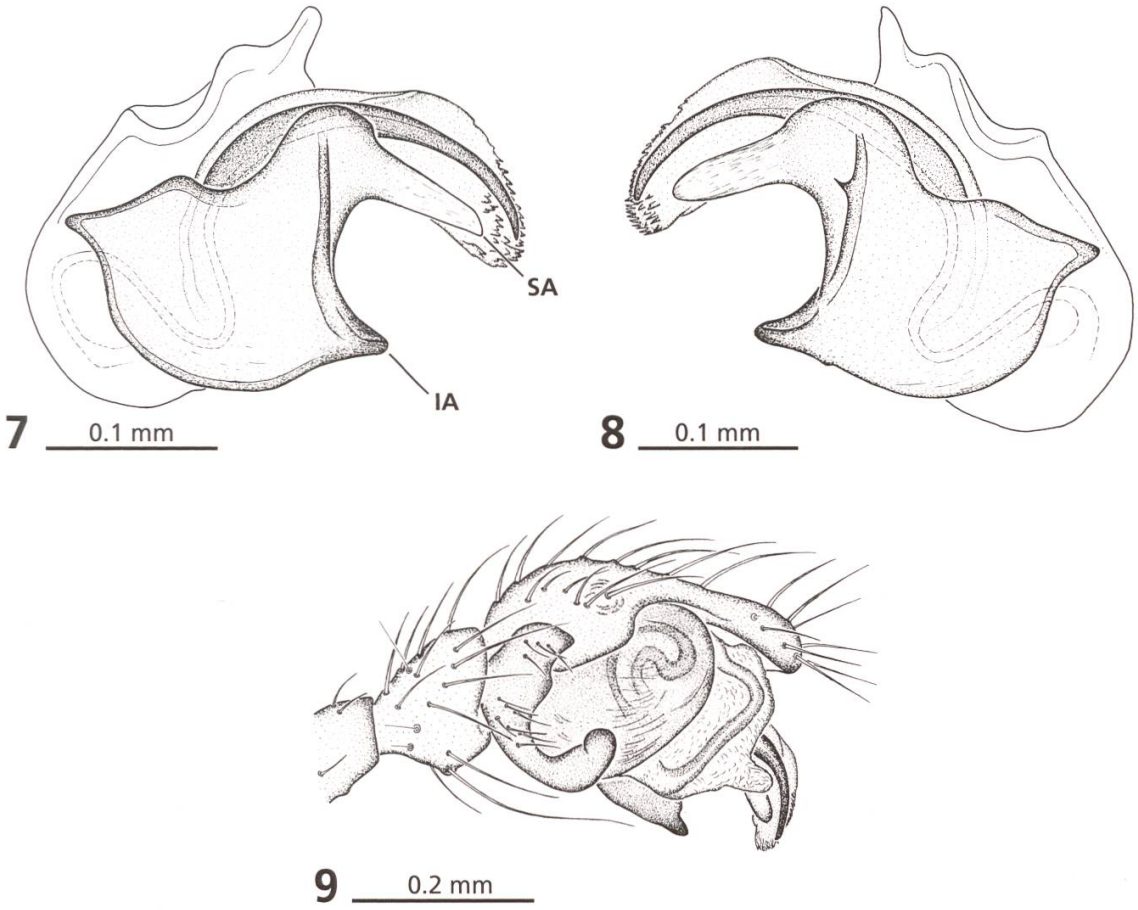
Distribution: Nearctic, northern N-America (Ubick & al. 2005).

***Porrhomma convexum* (WESTRING, 1851)** (Figs. 7–15, Tab. 1)

Taxonomy: Thaler (1968), Bourne (1977, 1977/78), Breuss (1995).

Material examined: Bonnechere Caves: 6 ♂ 5 ♀, 23. 8. 1995 (1 ♂ 1 ♀, CNC; 1 ♂ 1 ♀, NMBE; CWB); 1 sad ♂, 1 juv, 7. 8. 2006; Corner Brook Caves: 1 ♀, 26. 7. 2006; Barbarastollen: 1 ♂, 8. 9. 1997; Kobelach: 1 ♀, 24. 7. 1999 (CWB).

Diagnosis: Basically the classification of *Porrhomma*-species is difficult, and even Thaler emphasizes: "...jede Beschäftigung mit diesen Tieren erfordert [demnach] viel Geduld" (Thaler 1968: 363). For example the colouration but also the size and the relative position of the eyes show considerable intraspecific variation. Additionally to the interpretation of the sexual organs, a biometric classification according to Bourne (1977, 1977/78) and Breuss (1995) might be helpful (Tab. 1). For taxonomic confirmation, the Canadian specimens were compared with *P. convexum* from Austria.



Figs. 7–9. *Porrhomma convexum* (WESTRING, 1851). Barbarastollen (7), Bonnechere Caves (8, 9). Embolic division (7, 8); right palp in retrolateral view (9). IA: inferior apophysis; SA: superior apophysis.

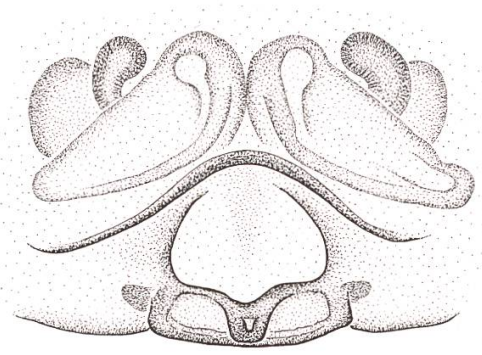
Distribution of leg spines (♂, ♀; n=10): Femora I–IV: dorsal 1-1-0-0, prolateral 1-0-0-0; Patellae I–IV: 1-1-1-1; Tibiae I–IV: dorsal 2-2-2-2, prolateral 1-0-0-0, retrolateral 1-1-0-0.

The distribution of leg spines is identical in both sexes. Only two specimens show a slight deviation (two dorsal spines on femur I and two retrolateral spines on tibia I respectively).

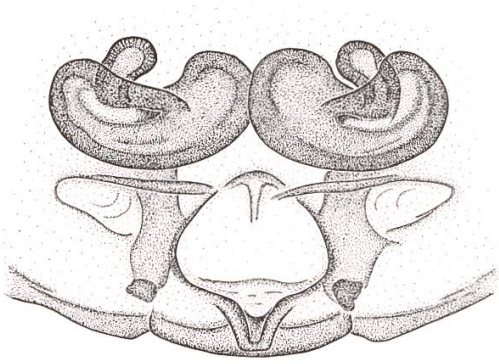
Specimens from Canada and Austria show high correspondence in all features considered (Figs. 7–15, Tab. 1). Only in some of the Canadian males, a minute tooth was present on the groin of the embolic division, between the inferior (IA) and the superior apophysis (SA, Fig. 8).

Habitat: In Canada as in Europe, *P. convexum* colonises habitats with constantly high humidity and low temperature, such as entrances of caves and mines, river banks and rock slopes. The highest records of *P. convexum* in Europe are from 2200 m a.s.l.

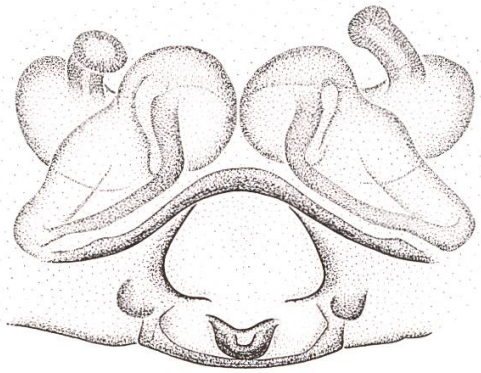
Distribution: Holarctic; in the Nearctic from Alaska to Greenland and south to Washington (Bennett & al. 2006).



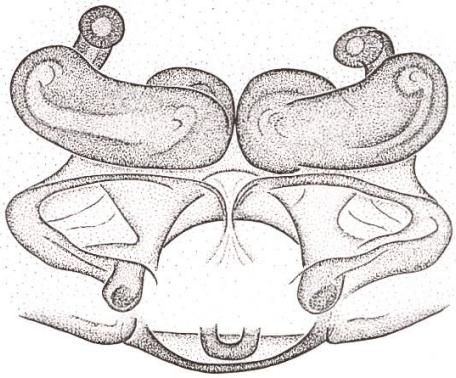
10 0.1 mm



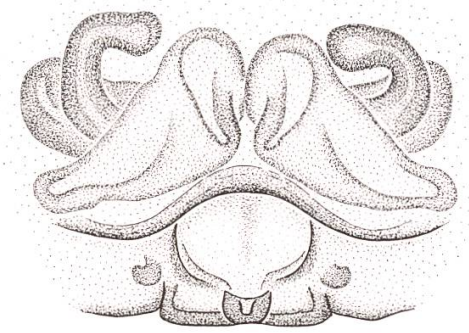
11 0.1 mm



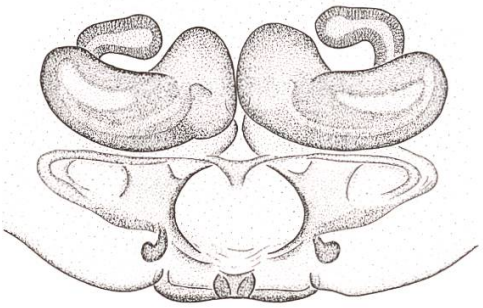
12 0.1 mm



13 0.1 mm



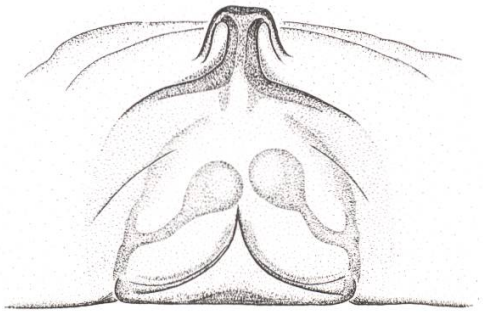
14 0.1 mm



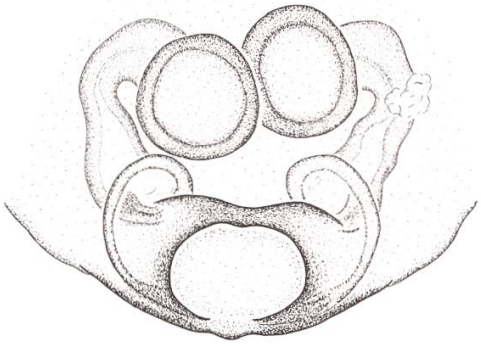
15 0.1 mm

Figs. 10–15. *Porrhomma convexum* (Westring, 1851). Bonnechere Caves (10, 11), Corner Brook Caves (12, 13), Kobelach (14, 15). Female epigynum in ventral (10, 12, 14) and dorsal view (11, 13, 15).

The genus *Porrhomma* contains 33 species plus one subspecies (Platnick 2009). Currently, 9 species are known from the nearctic region (Buckle & al. 2001, Ubick & al. 2005). These species are: *Porrhomma boreale* (Banks, 1899) from Alaska; *P. cavernicola* (Keyserling, 1886) from the USA; *P. convexum* (Westring, 1851) from Canada and the USA; *P. egeria* Simon, 1884 from Ontario; *P. gertschi* Hackman, 1954 from Newfoundland; *P. macrochelis* (Emerton, 1917) from Canada and Alaska; *P. ocella* Chamberlin & Ivie, 1943



16 0.2 mm



17 0.1 mm

Figs. 16–17. ***Eidmannella pallida*** **(EMERTON, 1875) (16),** ***Rugathodes sexpunctatus*** **(EMERTON, 1882) (17). Corner Brook Caves (16), Bonnechere Caves (17). Female epigynum in ventral view.**

from the USA and Alberta; *P. sodonta* (CHAMBERLIN, 1948) from the USA and *P. terrestre* (EMERTON, 1882) from the USA, Alberta, Newfoundland and Quebec.

The first nearctic record of *P. convexum* comes from the Aleutians (Holm 1960). Since then, *P. convexum* has been mentioned only from a few localities in northwestern North America: Alberta (Waterton Lakes NP, Bear Hump; Castle Crown Wildness, Castle River; Shorthouse 2006), British Columbia (Carmanah Valley, North Vancouver; Bennett & al. 2006) and Washington (without exact locality; Crawford 1988). For Ontario and Newfoundland *P. convexum* is recorded for the first time. Two females of *Porrhomma* from Newfoundland ("Glide Lake" and "Corner Brook", Pickavance & Dondale, 2005) should be examined for an eventual affiliation to *P. convexum*.

Regarding caves as habitats, only *P. cavernicola*, which is widespread in the Appalachian Mountains, is considered as troglobiont (Miller 2005). *P. convexum* and *P. egeria* can be classified as troglophilic. According to Peck (1988), *P. egeria* is known from only three caves in Ontario (Hope Bay Cave, Horse Collar Cave, Rockwood Caves).

Nesticidae

***Eidmannella pallida* (EMERTON, 1875)** (Fig. 16)

Taxonomy: Paquin & Dupérré (2003).

Material examined: Corner Brook Caves: 1 ♀, 1 juv, 26. 07. 2006 (CWB).

Diagnosis: Total length 2.2–3,5 mm (♂), 3.5–4 mm (♀); male palp and epigynum characteristic. "The degree of troglomorphy and the coloration pattern of *Eidmannella pallida* is variable" (Ubick & al. 2005).

The genus *Eidmannella* is represented in North America with 7 species. Six of these are regarded as locally endemic in caves in Texas (Ubick & al. 2005). Only *E. pallida* shows a wide distribution with records from the USA, Mexico, Central America and the West Indies. The northern border of distribution is reached in southern Ontario, Quebec and Newfoundland. Peck (1988) reports this "widespread troglophilic species" from Moira Cave and Museum Cave No. 1 in Ontario (sub *Nesticus pallidus*). In Newfoundland *E. pallida* is regarded as having been introduced. Habitats are mixed coniferous woods, caves and human habitations (Pickavance & Dondale 2005).

In caves in western Austria the author himself regularly found the closely related, holarctic and troglophilic *Nesticus cellulanus* (Clerck, 1757) (Breuss 1995). This species is introduced on the northeast coast with records from New York, Massachusetts, Maine, Nova Scotia and Quebec (Ubick & al. 2005). Moseley (2007) mentions *N. cellulanus* from the parietal fauna of Frenchman's Cave in Nova Scotia, replacing *E. pallida*. These are the first cave records of *N. cellulanus* in North America.

Distribution: cosmopolitan (Platnick 2009), almost cosmopolitan (Wunderlich 1992).

Tetragnathidae

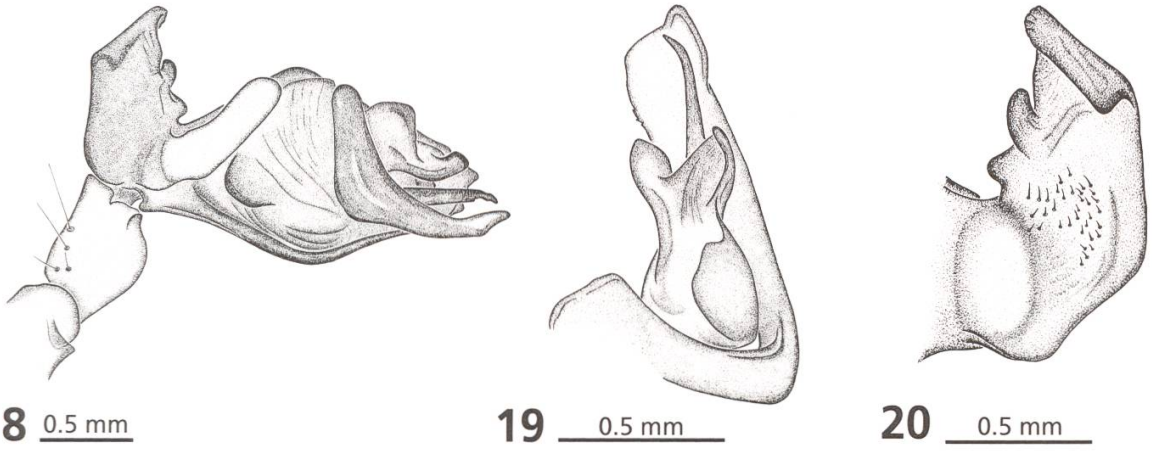
***Meta ovalis* (Gertsch, 1933)** (Figs. 18–20)

Taxonomy: Marusik & Koponen (1992) sub *Meta americana*, Paquin & Dupérré (2003).

Material examined: Bonnechere Caves: 1 sad ♂, 1 sad ♀, 23. 8. 1995; 1 ♂, 1 sad ♂, 1 juv, 7. 8. 2006; Corner Brook Caves: 2 sad ♀, 26. 7. 2006 (CWB).

Two species of the genus *Meta* are known from North America: *M. dolloff* Levi, 1980 from California and *M. ovalis* Gertsch, 1933 from the Northeast (Ubick & al. 2005). Originally, North American specimens of *Meta* were assigned to the European *Meta menardi* Latreille, 1804. Marusik & Koponen (1992) split *M. menardi* into three closely related, allopatric species: *M. menardi* in Europe, *M. manchurica* in the Russian Far East und *M. americana* in eastern North America. Finally, Dondale (1995) synonymised *M. americana* Marusik & Koponen, 1992 with *M. ovalis* (Gertsch, 1933).

The troglophilic orb-weaving spider *Meta ovalis* is, like *M. menardi* in Europe, a common species of cave entrances. In Newfoundland *M. ovalis* also settles in houses and outbuildings, basements and rootcellars (Pickavance & Dondale 2005). *M. ovalis* is already known from both investigated caves.



Figs. 18–20. ***Meta ovalis*** **(Gertsch, 1933): Bonnechere Caves. Right male palp in retrolateral view (18), embolic apophysis (19) and paracymbium (20).**

Additional subterranean records from Ontario are listed in Peck (1988). *M. ovalis* is also common in caves and mines in Nova Scotia and southern New Brunswick (Moseley 2007).

Distribution: Eastern North America with northernmost records from Newfoundland, Nova Scotia, southern Quebec and the northern shore of Lake Superior. The southernmost record is from Louisiana (Marusik & Koponen 1992).

Theridiidae

Rugathodes sexpunctatus (Emerton, 1882) (Fig. 17)

Taxonomy: Paquin & Dupérré (2003).

Material examined: Bonnechere Caves: 2 ♀, 2 juv, 23. 8. 1995; 1 juv, 7. 8. 2006 (CWB).

Already Peck (1988) mentions *R. sexpunctatus* from the Bonnechere Caves. The present specimens were found in the entrance area of this cave. The author has not been able to prove the existence of this species in the Corner Brook Caves. In Newfoundland *R. sexpunctatus* populates mixed coniferous woods, shrubs and herbs, gardens (Pickavance & Dondale 2005). Further records of *R. sexpunctatus* from caves and mines in Ontario are from Alona Bay Mine, Hope Bay Cave, Mount Nemo Cave, Renfrew Mine, Rockwood Caves, Stonehouse Cave and Wawa Mine (Peck 1988, sub *Theridion sexpunctatum*).

Distribution: USA, Canada, Alaska, Russia (Platnick 2009).

Sclerosomatidae

***Leiobunum elegans* Weed, 1889** (Figs. 21–23)

Leiobunum bicolor (Wood, 1868)

Taxonomy: Edgar (1990).

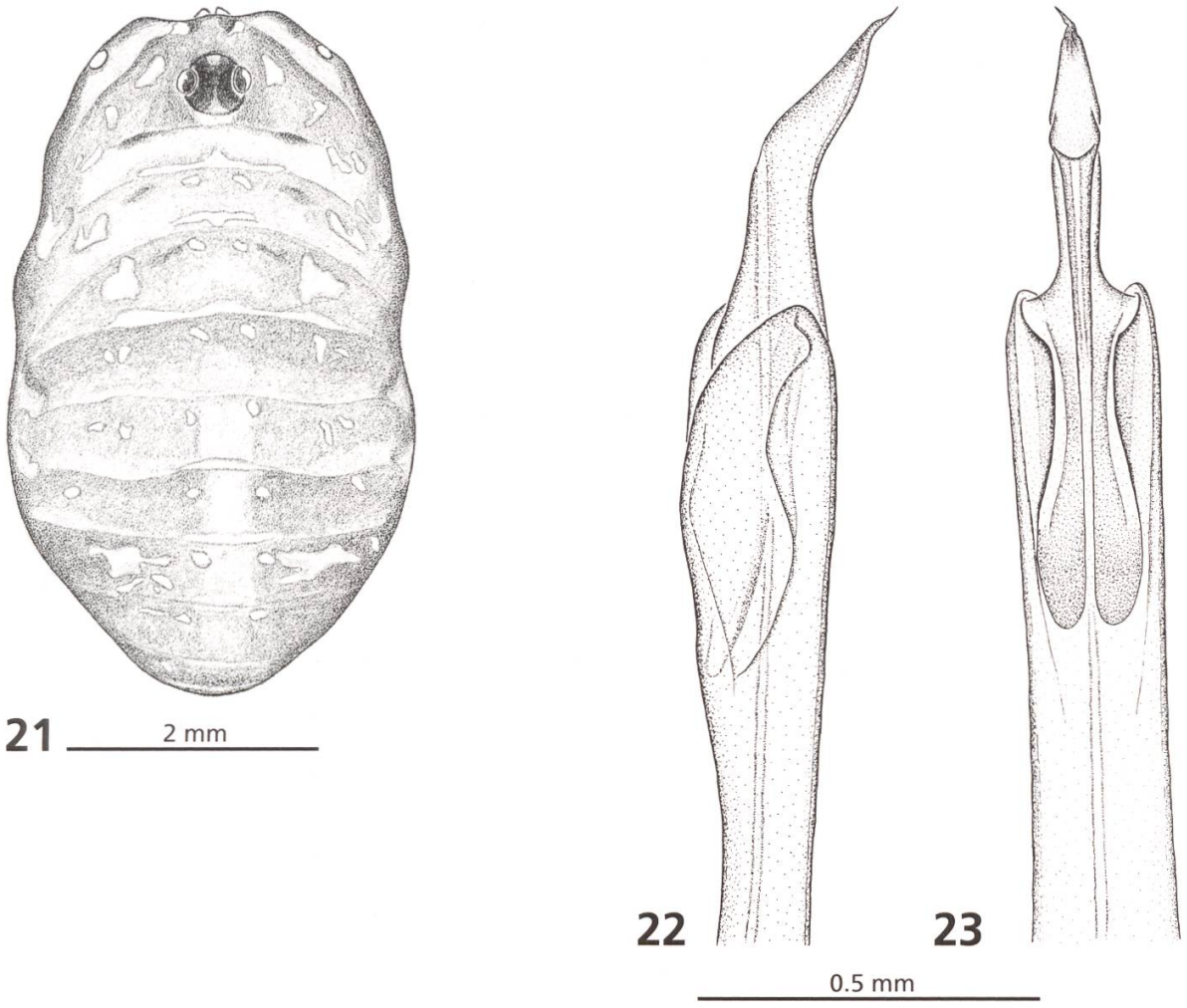
Material examined: Bonnechere Caves: 1 ♂, 23. 8. 1995, 1 sad ♂, 7. 8. 2006; Corner Brook Caves: 1 sad ♀, 26. 7. 2006 (CWB).

Habitus as well as penis structure of the collected specimens allow a classification as the woodland harvester *Leiobunum elegans* (Figs. 21–23). However, the lack of coxal teeth, which are characteristic for the genus *Leiobunum*, is remarkable. According to Martens (1978) this negative feature points to the genus *Nelima*. A generic transfer of *L. elegans* to *Nelima* is intended for the next edition of the "Catalogue of the Opiliones of North America" (Cokendolpher pers. comm., 24. 10. 2006). Moseley (2007) already follows this suggestion and reports *L. elegans* (sub *Nelima elegans*) from several caves and mines from southern New Brunswick and Nova Scotia, where this species commonly hibernates. Peck (1988) also gives one record from Ontario's "Museum Cave No. 1" (sub *L. bicolor*).

Distribution: From eastern North America to the Midwest, with the northern border of distribution in Ontario and Newfoundland (Cokendolpher & Lee 1993).

Discussion

Different biospeleological studies come to the conclusion, that the fauna of caves in northern regions are strongly influenced by the glacial history of the specific area (e.g. Holdhaus 1954, Janetschek 1956, Peck 1988, Breuss 1995, Moseley 2007). One of the consequences is a decreasing number of troglobionts particularly in the terrestrial fauna of caves with increasing latitude. For this reason, in North America biological research in subterranean habitats was done primarily in the United States and in Mexico. With the increasing number of ecological studies, the non-obligate fauna of Canadian caves only recently became of notable interest (Moseley 2007). Including the present study, from the investigated caves currently 5 (Bonnechere Caves) and 4 (Corner Brook Caves) species of spiders respectively, and one harvestman are known (Tab. 2).



Figs. 21–23. *Leiobunum elegans* Weed, 1889: Corner Brook Caves (21), Bonnechere Caves (22, 23). Habitus subadult male (21); penis in lateral (22) and ventral view (23).

The present collection from the Bonnechere Caves and the Corner Brook Caves contains 34 spiders and 3 harvestmen. Spiders are represented by 5 species in 4 families, harvestmen by only one species. As expected, all ascertained species are widely distributed and have to be classified as troglophilic or trogloxenic. Especially noticeable is *Porrhomma convexum* (Linyphiidae) which is well known from Europe. This species has just recently been recorded from western North America. The present findings from the far east of Canada signify a considerable expansion of the known area of distribution. Moseley (2007) mentions that 17% of the cavernicolous terrestrial invertebrates of Nova Scotia and southern New Brunswick are probably European in origin. Given examples are the nesticid spider *Nesticus cellulanus* and the springtail *Folsomia fimitaria* (L.). Presently it appears uncertain whether *P. convexum* is autochthonous in the eastern provinces of Canada or has been introduced from the palaearctic region.

Species	Bonnechere Caves	Corner Brook Caves
Oreophantes recurvatus	Br	Br
Porrhomma convexum	Br	Br
Eidmannella pallida	-	PD, Br
Meta ovalis	Pe, Br	Br
Tetragnatha elongata	Pe	-
Rugathodes sexpunctatus	Pe, Br	-
Leiobunum elegans	Br	Br

Tab. 2. Spiders and harvestmen from Bonnechere Caves, Ontario and Corner Brook Caves, Newfoundland: Br = Breuss (present study), PD = Pickavance & Dondale (2005), Pe = Peck (1988).

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