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The European species of the *microphthalmum*-group in the genus *Porrhomma* (Araneae: Linyphiidae)

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ABSTRACT Contrib. Nat. Hist. 12: 1081–1094.

The *microphthalmum*-group of the genus *Porrhomma* is newly characterised, and the European species are revised. The following names are synonymised: *Porrhomma lativelum* Tretzel, 1956 with *Porrhomma microps* (Roewer, 1931); and *Porrhomma spipolae* Caporiacco in Bianchi & al., 1949 with *Porrhomma microps* (Roewer, 1931). A key is provided to the males of the *microphthalmum*-group.

Introduction

The genus *Porrhomma* consists of about 30 species, occurring in the temperate zone of the Northern Hemisphere. About 25 species occur in the Palaearctic region, and about 9 species occur in the Nearctic region (Platnick 2006). Presently, the centre of species diversity for this genus lies directly in the centre of Europe; 15 of the species (i.e. half of the total number) occur within the territory of the Czech Republic (Buchar & Růžička 2002). Six species of the genus are only known from female examples; some species are only known according to one unique record. All species display an overall resemblance, and European authors have therefore repeatedly tried to revise their knowledge of them for their period (Cambridge 1894, Jackson 1913, Miller & Kratochvíl 1940, Thaler 1968). However, Asian and North American species were never included into these complex studies, and their affinities to the European species remain unknown. Almost one third of the species were not described until the second half of the 20th century. Much of the data is uncertain and the whole genus deserves a thorough revision.

The tendency for colonization of shallow and deep subterranean spaces is characteristic of numerous species (Růžička 1999); about one third of them exhibit morphological adaptations to a subterranean mode of life. A large intraspecific variability of some conspicuous characters (size and spacing of eyes, presence of femoral spines, pigmentation) is connected with the transition to the subterranean mode of life. These characters were often used as diacritic characters; a fact that further complicates the species' identification (Fage 1931, Helsdingen 1986).

Fage (1931) classified the species into three species groups; the classification being strictly based upon the structure of the copulatory organs. Miller & Kratochvíl (1940) designated the second of Fage's groups as the *microphthalmum*-group, according to the widely distributed species *P. microphthalmum*. In his crucial treatise, Thaler (1968) includes into this group the species *P. microphthalmum* (O. P.-Cambridge, 1871), *P. lativelum* Tretzel, 1956, *P. microps* (Roewer, 1931), *P. profundum* M. Dahl, 1939 and *P. rosenhaueri* (L. Koch, 1872). Helsdingen (1986) additionally incorporated into this group the species *P. spipolae* Caporiacco, 1949.

The chaetotaxy of the femora, and the sizes and spacing of the eyes, were often used for distinguishing the species; yet these characters are of no importance (Helsdingen 1986). The only morphological characters then remaining are the large differences in size, and the differences in the structure of genitalia. None of the authors mentioned in the paragraph above had available the actual specimens of all of the named species. They only used the published illustrations for comparisons with their own material. The structures of the male palp used for identification, the embolus and anterior radical process, have the form of flat bands. The best possibility to observe such a structure is to view it perpendicularly to the plane of that band. The problem, however, is that both of these structures are curved (Fig. 6), making the comparison of species based upon illustrations more difficult, because the pictures of these parts very much depend upon the angle of view (Thaler & Plachter 1983). Also, the vulvae are more similar in comparison with the male palps. All of these facts attest to the exceptionally great need for the physical comparisons of the material of all species to be "under one microscope".

The aim of this paper is to characterise the *microphthalmum*-group in detail and to evaluate the status of the European species incorporated into this group, based on the structure of the male palp.

Material and Method

Material

To delimit the *microphthalmum*-group, the material of all *Porrhomma*-species occurring within the territory of the Czech Republic was used (Buchar & Růžička 2002): *Porrhomma cambridgei* MERRETT, 1994, *Porrhomma campbelli* F. O. P.-CAMBRIDGE, 1894, *Porrhomma convexum* (WESTRING, 1851), *Porrhomma egeria* SIMON, 1884, *Porrhomma errans* (BLACKWALL, 1841), *Porrhomma lativelum* TRETZEL, 1956, *Porrhomma microcavense* WUNDERLICH, 1990, *Porrhomma microphthalmum* (O. P.-CAMBRIDGE, 1871), *Porrhomma montanum* JACKSON, 1913, *Porrhomma myops* SIMON, 1884, *Porrhomma oblitum* (O. P.-CAMBRIDGE, 1871), *Porrhomma omissum* MILLER, 1971, *Porrhomma pallidum* JACKSON, 1913, *Porrhomma pygmaeum* (BLACKWALL, 1834), and *Porrhomma rosenhaueri* (L. KOCH, 1872).

For further material on the species of the *microphthalmum*-group, see below.

Structure of the male palp

The bulbus of the linyphiid male palpus can be divided into five main regions: subtegulum, tegulum, suprategulum, column, and the embolic division (Saaristo 1971). The system of Coddington (1990) and Hormiga (2000) was followed in the designation of palpal sclerites (Figs. 1, 2).

The subtegulum (ST) attaches the bulbus to the cymbium.

The tegulum (T) is the next large palpal structure.

A term "protegulum" (PT) was introduced by Holm (1979), to designate a protruding membraneous part of the tegulum. The protegulum of *Porrhomma*-species is formed by the outer process (PT-OP) and the white inner membrane (PT-IM).

The whole suprategulum (SPT) is visible only after dissection of the palp into its individual parts. The distal suprategular apophysis (DSA) is visible on the unexpanded palp, behind the embolus.

At present, the identification of males is mainly based on the form of embolic division (Thaler 1991), which consists of the radix (R) and three sclerites attached: anterior radical process (ARP), embolus (E), and embolic membrane (EM). The radix is a flat sclerite of triangular form. The apex directed to the base of the palp is designated as the radical tailpiece (TP), the second apex is transformed into the anterior radical process (ARP), and the third one represents the posterior radical apex (PRA).

The velum (V) is the membranous structure on the ventral side of the embolus (Fig. 3). Tretzel (1956) described a complicated structure of the velum, and explained that there are, in fact, two overlapping vela; an outer velum and an inner velum. Nobody has used this velum description, because of the poor visualization of the transparent structures. In this paper, the velum is considered to be the transparent structure on the ventral side of the embolus (sensu Thaler 1968, Helsdingen 1986); the outline of which is quite well visualized in the microscope.

The embolic membrane (EM) is the transparent structure adjacent to the embolus (Fig. 1).

The embolus, embolic membrane, anterior radical process, posterior radical apex, distal suprategular apophysis, and the protegulum point toward the distal end of the palp, and play the main role during copulation.

Abbreviations used:

ARP	anterior radical process
DSA	distal suprategular apophysis
E	embolus
EM	embolic membrane
PRA	posterior radical apex
PT-OP	protegulum-outer process
PT-IM	protegulum-inner membrane
R	radix
ST	subtegulum
SPT	suprategulum
T	tegulum
TP	radical tailpiece
V	velum

Specimen preparation and study

The individual parts of the male palp of all species were dissected, mounted, photographed (often from various different angles of view), and compared. The method introduced by Holm (1979), of mounting male palps and their dissected parts into a jelly, was used. The structures were examined using an Olympus SZX-12 stereomicroscope and a BX-40 compound microscope. The photographs were taken using an Olympus Camedia C-5060 digital camera.

The dissected parts were stored in capillary tubes. Scanning electron micrographs were made with a JSM 6 300 scanning electron microscope. The left palp was used.

Results

Porrhomma microphthalmum-species group

No interspecific differences were found in the structure of the subtegulum, suprategulum, distal suprategular apophysis, radical tailpiece, or embolic membrane.

In most of the species, the upper radix margin leads from the PRA up to the ARP in a continuous arc, not in the form of a wave (Fig. 1). In the species *P. microphthalmum*, *P. profundum*, and *P. microps* the upper radix margin forms a distinct wave at the transition from the PRA up to the ARP (Figs. 3, 5).

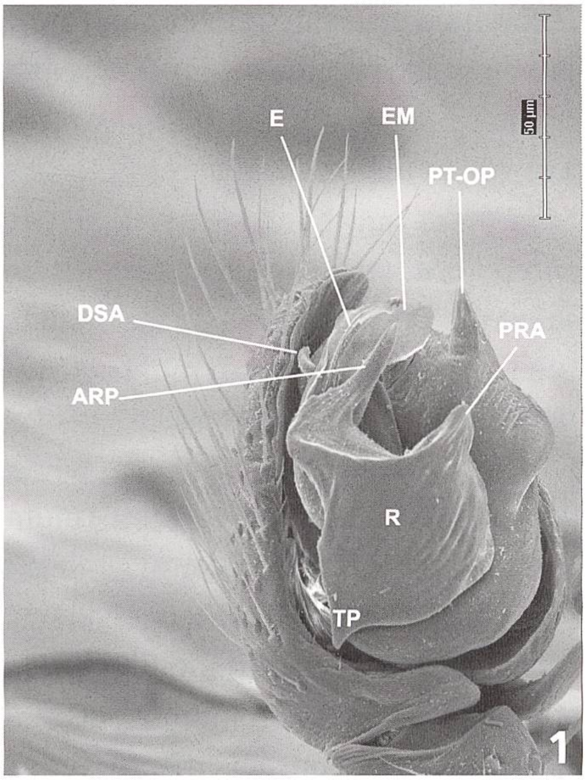
In the retrolateral view, in most *Porrhomma*-species studied, the tegulum is broader than long; the PT-OP and PT-IM are situated at the top centre. The PT-IM is longer than wide; symmetrically trapezoidal or triangular, sometimes even slightly asymmetric (Fig. 2). In the species *P. microphthalmum*, *P. profundum*, and *P. microps* the tegulum is as broad as long; the PT-OP is situated high. The PT-IM is broader than long, ending obliquely (Fig. 4).

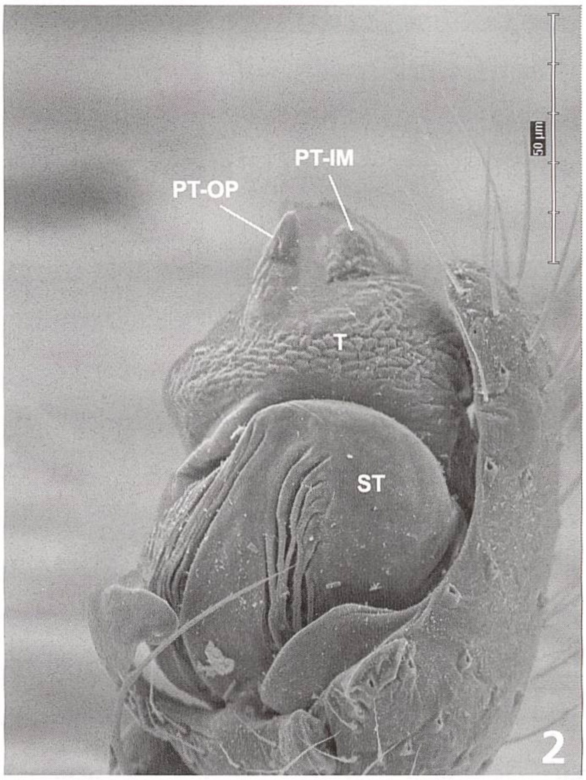
The embolus of *Porrhomma*-species takes various forms. A few of the species have a short embolus with a broad velum (*P. egeria*, *P. campbelli*, *P. montanum*). However, most of the species have a long, curved embolus with a narrow velum. In the species *P. microphthalmum*, *P. profundum*, and *P. microps* the embolus is long, sickle-shaped, and at the end curved almost to a right angle, with a distinct and broad velum containing a dark pigmented spot (Figs. 7–9).

The ARP also assumes various forms. *P. microcavense* has an extraordinarily thick ARP; *P. egeria* has a membranous, transparent ARP; and the ARP of *P. campbelli* and *P. montanum* is short and curved upwards to the embolus. The ARP of other species is of medium length, in *P. microps* the ARP is longest.

Among European species of the genus *Porrhomma*, the species *P. microphthalmum*, *P. profundum*, and *P. microps* have several common characteristics, by which they can be characterised as the *microphthalmum*-group:

The upper radix margin forms a distinct wave at the transition from the PRA up to the ARP (Figs. 3, 5).





Figs. 1–2. Male palp, *P. pygmaeum*. – 1: prolateral view; – 2: retrolateral view. Scale line: 50 µm.

In retrolateral view, the tegulum is as broad as long, and the PT-AP is situated high. The PT-IM is broader than it is long and ends obliquely (Fig. 4).

The embolus is long, sickle-shaped; at the end curved almost to a right angle, with a distinct, broad velum containing a dark pigmented spot (Figs. 7–9).

Porrhomma microphthalmum (O. P.-Cambridge, 1871)

Linyphia microphthalma; O. P.-Cambridge (1871): p. 434, Pl. 56, no. 25 (descr. ♂♂); transferred by Simon (1884: 372, erroneously "pl. LXI").

P. microphthalmum – F. O. P.-Cambridge (1894): p. 106, Pl. II, fig. 7a (♂); synonymy.

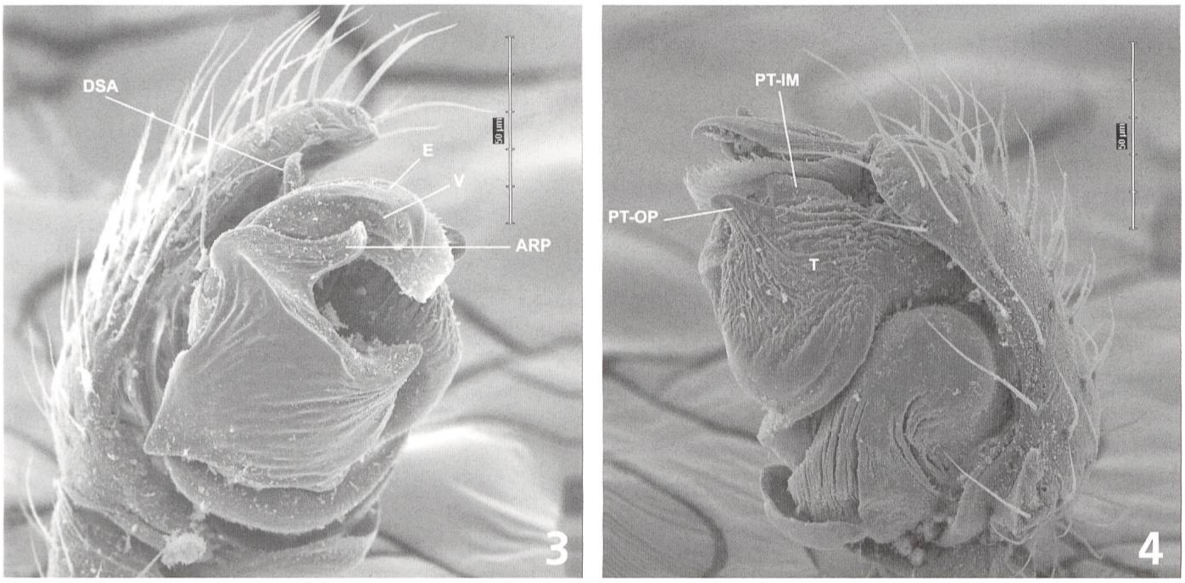
P. microphthalmum – Jackson (1913): p. 41, Pl. II, figs. 16, 26 (♂ ♀); synonymy.

P. microphthalmum – Miller & Kratochvíl (1940): p. 169, Abb. 3, 4.1–2 (♂ ♀).

P. microphthalmum – Locket & Millidge (1953): p. 333, Text-figs. 199G, 200F, 202G (♂ ♀).

P. m. microphthalmum – Miller & Obrtel (1975): p. 8, Pl. I, Figs. 8-9, Pl. II, Fig. 5 (♂ ♀).

Material used: A mixed sample of material from the whole of the Czech Republic.



Figs. 3–4. Male palp, *P. microphthalmum*. – 3: prolateral view; – 4: retrolateral view. Scale line: 50 µm.

Diagnosis: *P. microphthalmum* is an epigaeic species, pigmented, with normally developed eyes. Width of the cephalothorax: 0.59–0.69 mm (our own measurements, N=40); 0.60–0.70 mm (Thaler 1983, 1991, Helsdingen 1986). The free end of the embolus is approximately as long as the velum is wide. The ARP is relatively short, approximately twice as long as broad; maximally, it reaches up to the end of the velum (Fig. 7).

Comments: The figures in the descriptions of O. P.-Cambridge (1871) are insufficient, but two revising authors, F. O. P.-Cambridge (1894) and Jackson (1913), studied the type material and presented characteristic pictures of the genitalia. Today, *P. microphthalmum* is clearly defined, well characterised, and a widely distributed European species.

Porrhomma profundum M. Dahl, 1939

P. rosenhaueri (L. Koch, 1872) – Kratochvíl (1934): p. 186, Figs. 4a–b (♂ ♀); misidentified, see Dahl (1938) and Miller & Kratochvíl (1940).

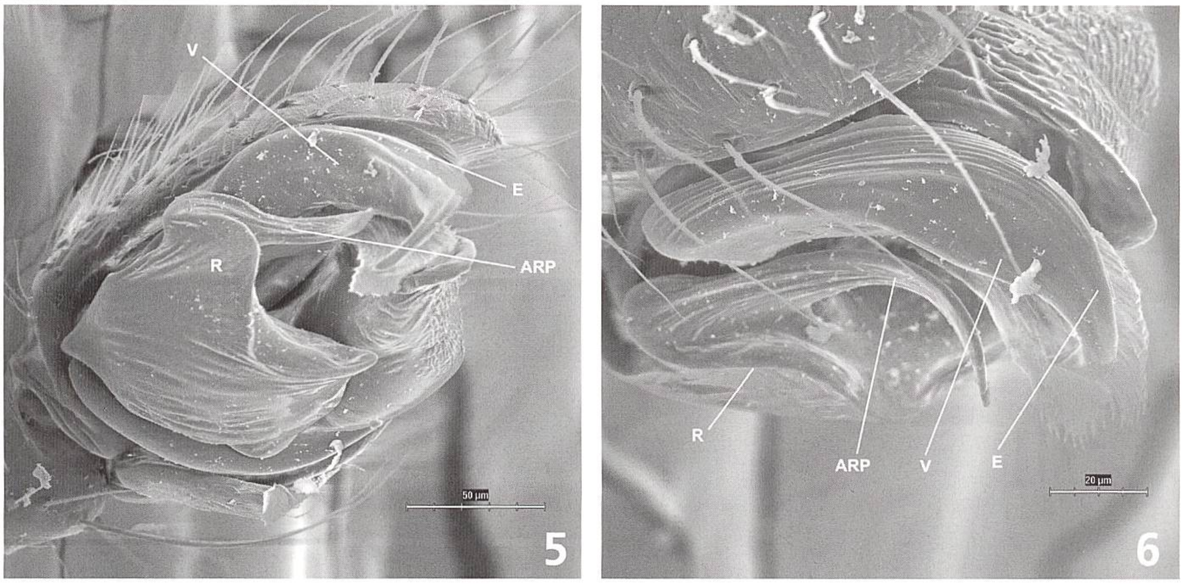
P. cavernicola M. Dahl, 1938; Dahl (1938): p. 127, Figs. 4d, 6a–b, 7, 9d (descr. ♂ ♀); preoccupied by Keyserling (1886: 123).

P. profunda M. Dahl, 1939; Dahl (1939): p. 48; replacement name, replaced the preoccupied name *cavernicola* Dahl, 1938.

P. profundum – Miller & Kratochvíl (1940): p. 176, Abb. 6 (♂ ♀).

P. microphthalmum profundum – Tretzel (1956): p. 54; downgraded to subspecies.

P. rosenhaueri hungaricum Loksa, 1970; Loksa (1970): p. 269, Abb. 1–6 (descr. ♂ ♀); synonymised by Thaler & Plachter (1983: 260).



Figs. 5–6. Male palp, *P. microps*. – 5: prolateral view; – 6: apico-lateral view. Scale lines: Fig. 5: 50 µm; Fig. 6: 20 µm.

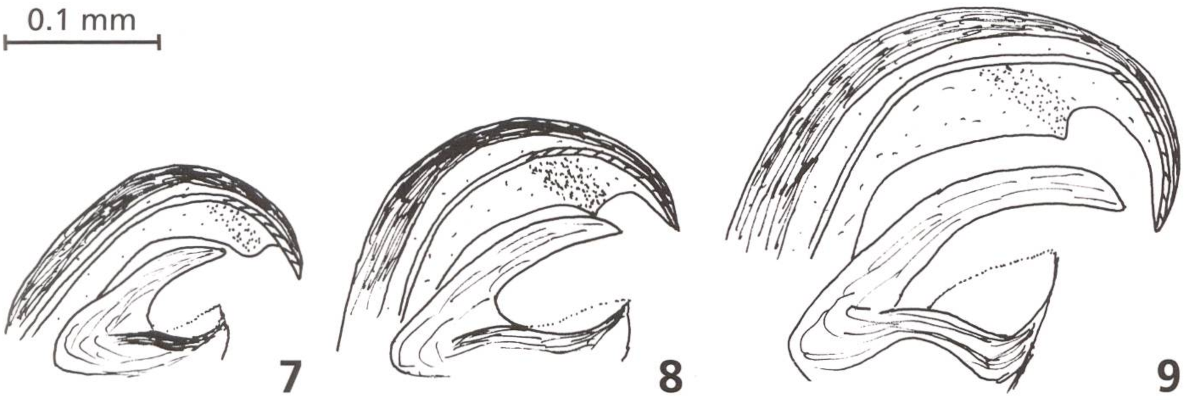
P. profundum – Miller (1971): p. 238, pl. XLVII, figs. 17–18 (♂ ♀).
P. microphthalmum profundum – Miller & Obrtel (1975): p. 8, Pl. I, Figs. 10–11, Pl. II, Fig. 7 (♂ ♀).
P. microphthalmum profundum – Thaler & Plachter (1983): p. 260; synonymy.
P. profundum – Thaler (1983): p. 146, Abb. 104 (♂).

Material used: 1 ♂ 1 ♀ 2 juv., "*Porrhomma profunda* M. Dahl (*cavernicola* M. Dahl), Slowakei: Aggtelek-Grotte, det. M. Dahl (Typen): 4 ex." Naturhistorisches Museum Wien, Inv. No. 4824.

P. profundum: 1 ♂ 4 ♀, "Slovakia, Slovak Karst, Domica cave, 11 May–1 July 1999, leg. L'. Kováč".

Diagnosis: *P. profundum* is an exclusive cave inhabitant, depigmented, and with reduced eyes. Width of the cephalothorax: 0.73–0.79 mm (Domica cave), 0.75 mm (Aggtelek cave). The free end of the embolus is approximately as long as the velum is wide. The ARP is relatively short, approximately twice as long as broad; it reaches only slightly behind the velum (Fig. 8).

Comments: Kratochvíl (1934), in his list of the cavernicolous spiders in Yugoslavia, presented pictures of the genitalia of a species from the genus *Porrhomma* and designated it as *P. rosenhaueri*. Dahl (1938) found the pictures different from *P. rosenhaueri*, but identical with material from the cave near Aggtelek in northern Hungary. Based on this material, she described a new species *P. cavernicola*; later renamed *P. profunda*. However, the pictures presented were insufficient for the identification of the species, so the first real description of this species was presented by Miller & Kratochvíl (1940). These authors advised that the pictures presented by Kratochvíl (1934) were



Figs. 7–9. The embolus and the ARP. – 7: *P. microphthalmum*; – 8: *P. profundum*; – 9: *P. microps*. Scale line 0.1 mm.

based upon material from the Bükk Mts. in Hungary and concluded: "*P. profundum* occurs exclusively in caves in northern Hungary, Slovakia and Transylvania. Its occurrence is known from the Domica cave in Slovakia and Baradla cave in Hungary (these caves represent parts of one cave system) and in Stephan's cave in the Bükk Mts."

Porrhomma microps (Roewer, 1931)

Troglohyphantes microps Roewer, 1931; Roewer (1931): p. 72, Abb. 7a–b (descr. ♀); transferred by Thaler (1967: 171).
Porrhomma kolosvaryi Kratochvíl, 1934; Kratochvíl (1934): p. 186, Figs. 5a–b (descr. ♂ ♀); synonymised by Thaler (1967: p. 171).
P. kolosvaryi – Miller & Kratochvíl (1940): p. 173, Abb. 5 (♂ ♀).
Porrhomma spipolae Caporiacco, 1949; Caporiacco, in Bianchi & al. (1949): p. 500, figs. 2a–b (descr. ♂ ♀); **new synonymy**.
Porrhomma microphthalmum lativela Tretzel, 1956; Tretzel (1956): p. 45, Abb. 1–4 (descr. ♂); **new synonymy**.
P. microphthalmum kolosvaryi – Tretzel (1956): p. 54; downgraded to subspecies.
Porrhomma microps – Thaler (1967): p. 171, Abb. 5 (♀); transferred from *Troglohyphantes*.
P. microps – Holm (1968): p. 190, Fig. 12 (♀).
P. spipolae – Thaler (1968): p. 384; nomen dubium.
P. kolosvaryi – Dobat (1969): p. 195, Abb. 1–4 (♂).
P. microphthalmum microps – Miller & Obrtel (1975): p. 8, Pl. II, Fig. 6 (♂).
P. microphthalmum lativela – Miller & Obrtel (1975): p. 9, Pl. I, Figs. 1–7, Pl. II, Figs. 8–10 (♂, descr. ♀).

P. spipolae = *P. convexum* (Westring, 1851) – synonymised by Brignoli (1979: 26); rejected.

P. microphthalmum lativela – Thaler & Plachter (1983): p. 257, Abb. 20–22 (♂ ♀).

Porrhomma lativela – Thaler (1983): p. 146, Fig. 2–3, Abb. 102–103 (♂ ♀); elevated to species.

P. lativela – Helsdingen (1986): p. 13, Figs. 1–5 (♂ ♀).

P. spipolae – Helsdingen (1986): p. 15, Figs. 6–8 (♂ ♀); removed from synonymy of *P. convexum*, considered a valid species.

P. lativela – Thaler (1991): p. 236, Abb. 636.2 and 636.4 (♂ ♀).

P. microps – Gasparo & Thaler (2000): p. 18, 37 (data on the *locus typicus*).

P. microps – Deltshev, Lazarov & Petrov (2003): p. 19, Figs. 2–5 (♂ ♀).

Material used: *P. microps*: 1 ♂ 1 ♀, "Topotyp.!, leg F. Gasparo, det. K. Th., Grotta di Trebiciano, VG 17, m 341, com. Trieste. F. Gasparo l. 17. 7. 1999". Note: "Lindnerhöhle = Grotta di Trebiciano, VG 17" (Gasparo & Thaler 2000).

P. lativelum: 1 ♂ 9 ♀, "South Moravia, Lanžhot, National Nature Reserve Ranšpurk, lowland forest, 1996–1999, leg. V. Bryja".

Porrhomma spipolae: 2 ♂ 1 ♀, "syntypes, EMILIA-ROM: Grotta della Spipola (BO), 3/V/1949 A. Vaile! Museo Zoologico de 'La Specola', Firenze".

Diagnosis: *P. microps* is a depigmented species, with eyes reduced in various stages. It inhabits leaf litter and caves. Width of the cephalothorax: 0.73–0.91 mm (*lativelum*, Lanžhot, N=10); 0.75 –0.95 mm (Thaler 1983, 1991, Helsdingen 1986, sub *lativelum*); 0.82–0.92 (*spipolae*, Grotta della Spipola), 0.76–0.81 mm (*microps*, Grotta di Trebiciano). The free end of the embolus is approximately 2–3x as long as the velum is wide. The ARP is relatively long, approximately three times longer than it is broad, and reaches almost to the end of the embolus (Fig. 9).

Comments: For more than 30 years, the species was known under the name *P. kolosvaryi*. Miller & Kratochvíl (1940) recorded it from both caves and open terrain, and warned of the great variability in both eye size and vulva structure among specimens from Slovakia, Styria (Austria) and from Southern Europe.

Caporiacco (in Bianchi & al. 1949) described *P. spipolae* from caves in Italy. Based on insufficient illustrations, Thaler (1968) designated *P. spipolae* as a *species inquirenda*, and Brignoli (1979) synonymised it with *P. convexum*. Helsdingen (1986) evaluated the type material, presented new illustrations, and rejecting previous conclusions included *P. spipolae* in the *microphthalmum*-group.

Tretzel (1956) described a subspecies *P. microphthalmum lativela* from leaf litter in Germany and found numerous fine differences, when comparing it with *P. kolosvaryi* and *P. profundum* (however, he knew of these species only from illustrations!). He concluded that *P. lativelum* could not be assigned to one of these species, based particularly on the size and spacing of eyes.

Thaler (1967) found *P. kolosvaryi* to be a younger synonym of *P. microps*, a cave spider described from Italy.

Holm (1968) designated his specimen from open country in Sweden as *P. microps*.

Miller & Obrtel (1975) compared *microphthalmum*, *microps*, *profundum* and *lativela* and concluded: "It is rather difficult to estimate the taxonomic value of small but constant differences in the structure of their copulatory organs."

Thaler & Plachter (1983) compared their own material from caves in Germany with illustrations of *microps*, and designated this material as *lativela* for "geographical reasons".

Thaler (1983) demonstrated clear differences, on the species level, between *microphthalmum* and *lativela* in their body dimensions; and between *profundum* and *microps* in the form of the end part of the embolus.

Helsdingen (1986) summarized the records of specimens designated as *kolosvaryi*, *microps* and/or *lativela*, in both open habitats and caves, throughout the whole of Europe.

All indices and study of the material leads to the conclusion: *kolosvaryi* = *spipolae* = *lativelum* = *microps*.

Key to males of *Porrhomma microphthalmum*-species group

1 Eyes normally developed, the body pigmented, cephalothorax width <0.70 mm. The free end of the embolus is approximately as long as the velum is wide. The ARP is relatively short, approximately twice as long as it is wide; maximally reaching up to the end of the velum (Fig. 7)..... ***microphthalmum***

– Eyes reduced, the body depigmented, cephalothorax width >0.73 mm..... **2**

2 The free end of the embolus is approximately as long as the velum is wide. The ARP is relatively short, approximately twice as long as wide; it reaches to slightly behind the velum (Fig. 8) .... ***profundum***

– The free end of the embolus is approximately 2–3x longer than the velum is wide. The ARP is relatively long, approximately three times longer than wide; it reaches almost to the end of the embolus (Fig. 9) .... ***microps***

Discussion

The subsurface spaces (in the upper soil layers), as well as shallow spaces (in stony accumulations and in the void systems within rocks), offer a microclimatic gradient between the soil surface and deep subterranean spaces. These subsurface and shallow spaces represent the transition zone, in which the gradual adaptation to the stable environment of deep subterranean spaces takes place. Microphthalmy represents the most common adaptation to subterranean life (Růžička 1999). A wide range in the reduction of the eyes is documented in several species. The specimens of *P. egeria* Simon, 1884 living in the surroundings of mountain snow fields exhibit fully pigmented eyes; the specimens living within stony accumulations exhibit reduced eyes, and the specimens living in deep caves often exhibit full anophthalmy (Miller & Kratochvíl 1940, Sanocka 1982). The specimens of *Troglohyphantes kordunlikanus* Deeleman-Reinhold, 1978 living in caves have smaller and less pigmented eyes then the specimens living in leaf litter (Deeleman-Reinhold 1978). Such a great variability in eye size (and therefore also their spacing) represents a usual phenomenon within the complex of adaptive changes, connected with the transitions to life in subterranean spaces. The repeatedly described *Porrhomma microps* represents another similar case.

Acknowledgements

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