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A new species of Cyphophthalmi (Arachnida, Opiliones, Sironidae) from Eastern Slovenia

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Abstract

A new species of Cyphophthalmi belonging to the Laurasian family Sironidae is described and illustrated on the basis of external anatomy and genitalia. *Siro crassus* **sp. n.**, known from leaf litter from two beech forest localities in Eastern Slovenia, is a relatively large (2.2–2.6 mm in length), long-legged epigean species, in which the patella of leg IV surpasses the end of the body. The new species resembles the European *Siro rubens* Latreille, 1804 and *S. valleorum* Chemini, 1990 in the projecting female rear end, but differs from these species, among other features, in having ornamented metatarsi on all four pairs of walking legs.

Key words: Taxonomy, *Siro*, Alps, Europe

Introduction

The family Sironidae includes small (1.0–2.6 mm in length) harvestmen which superficially resemble mites and live cryptically in leaf litter, and in endogean and hypogean habitats across Laurasia (Shear 1980; Juberthie 1988; Giribet 2000). From the 32 species and subspecies described to date (according to the online catalogue by Giribet, consulted on 21 August 2006: http://collections.oeb.harvard.edu/Invertebrate/Cyphophthalmi/species.cfm), those of the Balkan and neighboring areas have recently been placed in the resurrected genus *Cyphophthalmus* Joseph, 1868 (Boyer *et al.* 2005). The Balkan Peninsula is one of the biodiversity centers for sironids, hosting more than a dozen described species (Kratochvíl 1937, 1940, 1958; Rafalski 1958; HadS̄i 1973a,b; Staręga 1976; Juberthie 1991; Mitov 1994; Giribet 2000; Boyer *et al.* 2005). In addition, a considerable number of undescribed species occur in the area (Karaman *et al.* 1994; Boyer

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et al. 2005; Karaman 2005a, b).

In the neighboring Alpine region, two sironid species have been recognized, *Cyphophthalmus duricorius* Joseph, 1868, and *Siro valleorum* Chemini, 1990. Until recently, *C. duricorius* constituted the only species recorded for both Austria and Slovenia (Joseph 1868; HadŠi 1973a, b; Martens 1978; Novak & Gruber 2000; Blick & Komposch 2004; Komposch & Gruber 2004; all under *Siro*). Joseph (1882) noted that in one of his previous papers (Joseph 1868: fig. 3, table I) he did not refer to *C. duricorius*, but to another species, *C. cyphopselaphus* Joseph, 1881 (synonymyzed by Novak & Gruber 2000), which he described from a cave in southern Slovenia (Joseph 1881) on the basis of a juvenile specimen, probably of *C. duricorius* (see Novak & Gruber 2000). This species was also cited from another cave in central Slovenia. Since Slovenia shares both Alpine and Balkan habitats, the presence of southern sironid species has long been expected, but only *C. duricorius* had been found there so far. During the course of a recent exploration of the hilly region of Slovenske gorice in northeastern Slovenia, a new species of Cyphophthalmi was discovered. The new sironid species, which we assign to the genus *Siro*, is described and illustrated below.

Methods

External morphology and genitalia were studied and drawn using an Olympus CH30 microscope with a drawing tube. The spermatopositor was photographed under a Nikon Eclipse E800 compound microscope using GIF (green) and ND2 filters with a mounted digital Net camera DN100, and processed with Eclipse Net software. One male and one female paratypes were photographed under a Leica MZ 12.5 dissecting microscope using a mounted JVC KY-F70B digital camera. Digital images captured at different focal planes were assembled using the application Auto-Montage Pro Version 5.00.0271 by Syncroscopy. The same specimens were subsequently used for SEM examination and one or two legs were employed for DNA extraction, following the protocols described by Boyer *et al.* (2005). The remaining legs of both individuals were kept in 98% ethanol at -80 ºC for future molecular analysis.

Spermatophores have been reported in species belonging to the genera *Cyphophthalmus* (see Karaman 2005a; Novak 2005) and *Stylocelus* (P. Schwendinger observation, in Schwendinger & Giribet 2005), and they probably also occur in members of the genus *Siro*, hence the term spermatopositor, introduced by van der Hammen (1985), is used here instead of penis.

The spermatopositor of the holotype and the ovipositor of a female paratype were studied from temporary mounts, the ovipositor after placement for about 1 min. in hot lactic acid, and embedding in glycerol.

Measurements were taken from images drawn with a drawing tube mounted on the microscope. All appendages were placed in a lateral position; their lengths were measured

on their dorsal sides and the width at the widest parts. Tarsal claws were excluded from the measurements. The position of the adenostyle on tarsus IV was measured from the distal end of the tarsus. Measurements separated by a slash refer to length/width.

***Siro crassus* sp. n.**
Figs 1–32

Holotype: ♂ from Velika Slavšina (46.533263°N, 15.960520°E; 290 m altitude), Slovenia, UTM code WM75 (Fig. 1), 09.VI.1984, wet deep beech litter sieving, L. Slana, M. Ferenc & T. Novak leg. (TN 310/2002). Paratypes: ibid., 2 ♂, 1 ♀ (TN 310/2002); ibid., 13.X.2005, deep solid humic soil near beech roots, L. Slana Novak & T. Novak leg.: 2 ♀ (TN 139/2005); ibid., 15.X.2005: 1 ♂, 1 ♀ (TN 140/2005); Šega near Makole (46.300144°N, 15.659478°E; 350 m altitude), UTM: WM53, 09.IV.1983, forest floor, L. Slana, M. Štangelj & T. Novak leg.: 1 ♂ (LS 362/1985, rev. TN 2006). Holotype, 2 ♂ paratypes and 2 ♀ paratypes deposited in the Prirodoslovni muzej Slovenije, Ljubljana, Slovenia; ex collection T. Novak & L. Slana Novak (TN 310/2002; TN 139/2005). 1 ♂ (MCZ 68552, ex TN 140/2005) and 1 ♀ (MCZ 68553, ex TN 140/2005) paratypes mounted for SEM and used for DNA analysis (MCZ DNA101802, ex TN 140/2005) deposited in the Museum of Comparative Zoology, Harvard University (Cambridge, Massachusetts, USA); 1 ♂ (LS 362/1985) and 1 ♀ (TN 139/2005) in the Naturhistorisches Museum Wien (Austria).

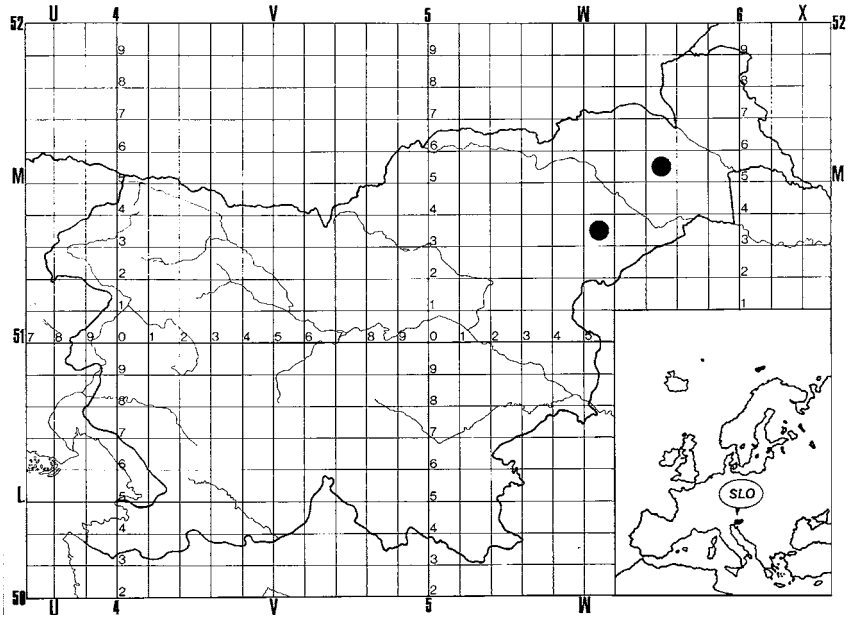


FIGURE 1. Localities of *Siro crassus* **sp. n.** (dots) in Slovenia.

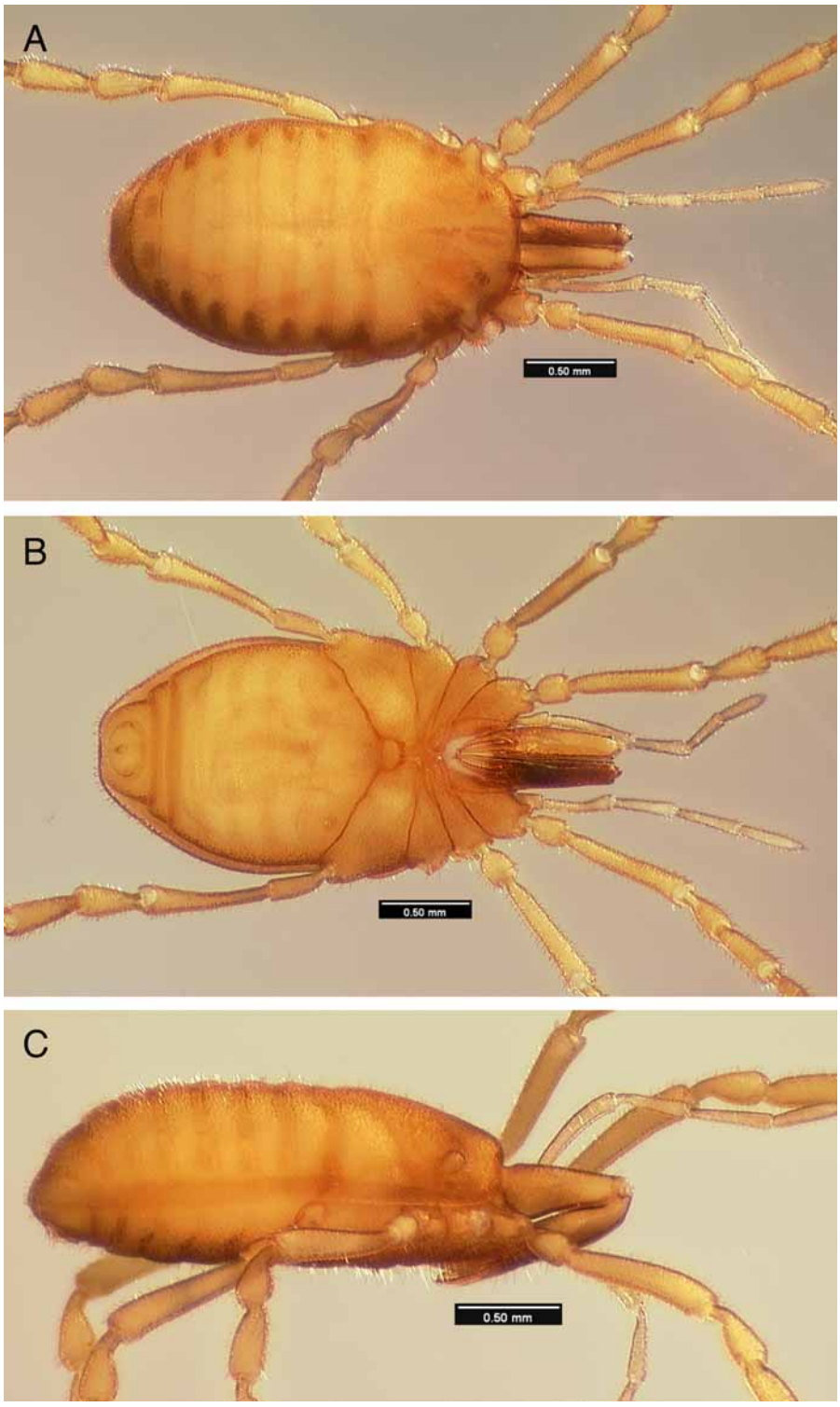


FIGURE 2. *Siro crassus* **sp. n.**, male paratype MCZ 68552 and MCZ DNA101802: A, dorsal view; B, ventral view; C, lateral view.

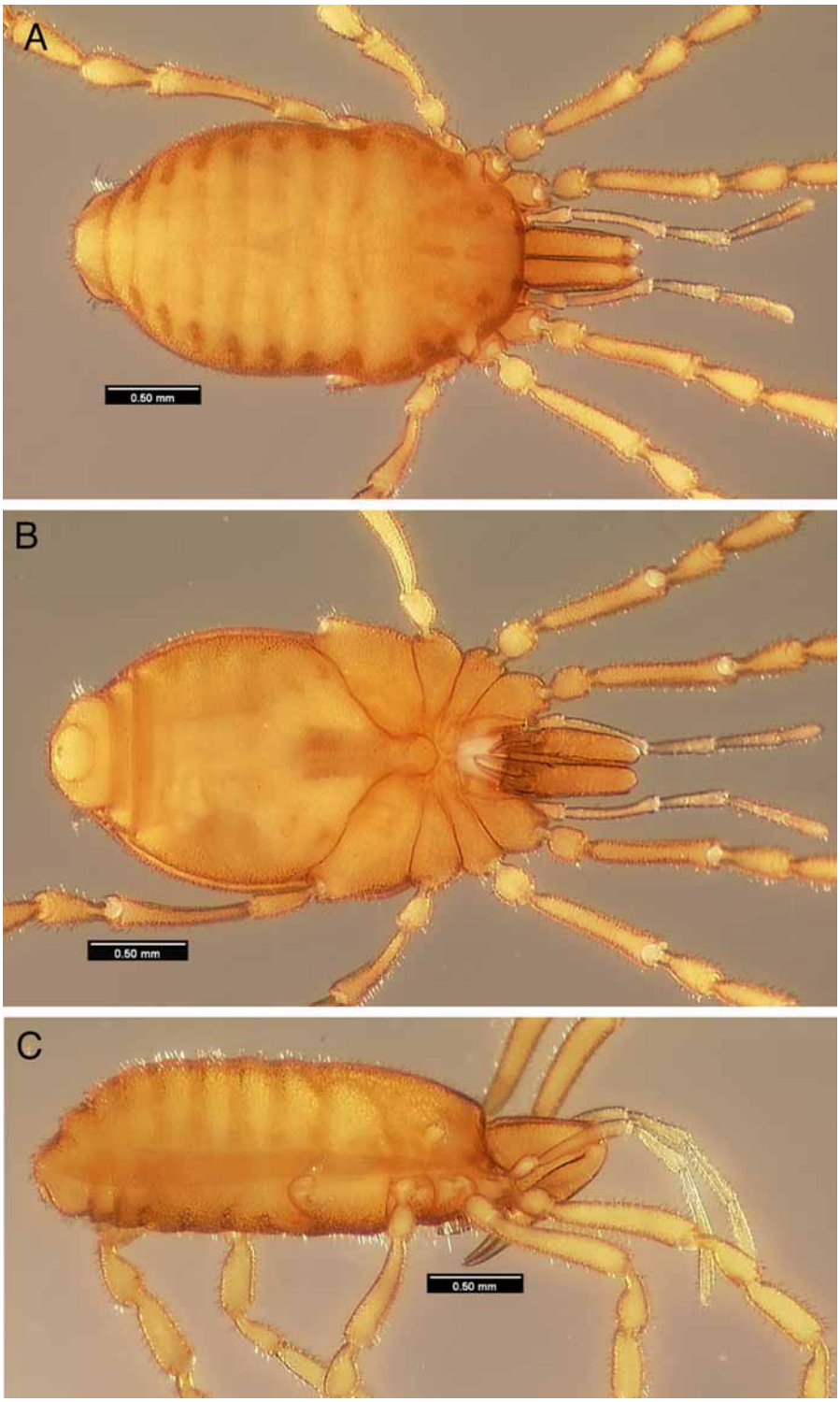


FIGURE 3. *Siro crassus* **sp. n.**, female paratype MCZ 68553 and MCZ DNA101802: A, dorsal view; B, ventral view; C, lateral view.

Etymology: From Latin adjective *crassus*, meaning solid or thick. The species epithet refers to the body shape of the new species, which is relatively large and robust for a member of the genus *Siro*.

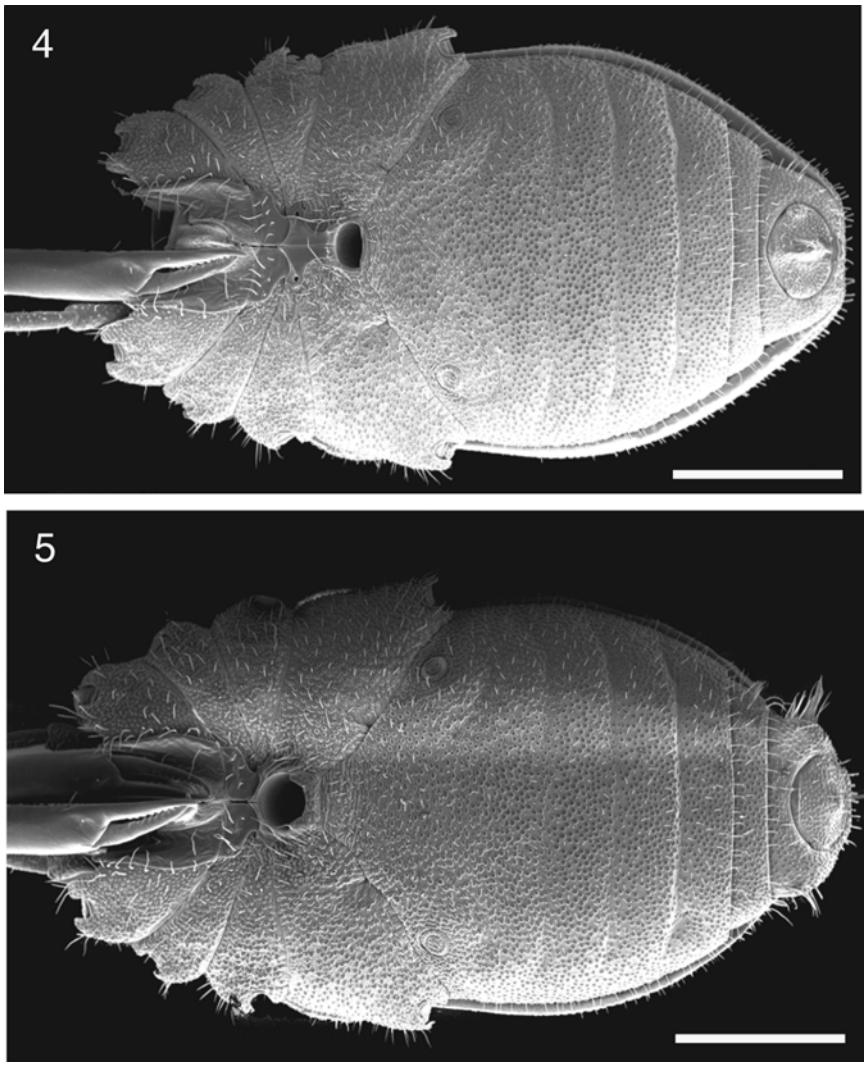
Diagnosis: Relatively large, 2.2–2.6 mm in length (Figs 2–5), long-legged and robust *Siro* species with elongated leg IV so that patella IV surpasses the posterior end of the opisthosoma (Figs 2, 3). Corona analis of male broad (Figs 2b, 4, 8); corona analis of female protruding, with a concentration of lateral setae on the sides (Figs 3b, 5, 9, 11). Anal plate of male and female with a longitudinal median keel (Figs 8–9); tergite VIII of male with three anal gland pores (Fig. 10). Metatarsi of legs I–IV completely ornamented with a tuberculate surface (*sensu* Murphree 1988) (Figs 18, 20, 22, 24, 27).

Description: Total length of male holotype (in mm) (female paratype TN 310/2002 in parentheses) 2.29 (2.48); largest body width in prosoma behind ozophores: 1.32 (1.39); width across ozophores 1.05 (1.15); body length/width ratio 1.73 (1.78). Body orange-brown (dark to strong brown according to the Munsell's Color Charts (2000): 7.5YR 3/3–7.5YR 4/6) in life and in ethanol (Figs 2, 3). Anterior margin of dorsal scutum slightly concave; prosomal region almost semicircular. Eyes absent. Ozophores conical, of type II (*sensu* Juberthie 1970), with subterminal ozopore[1] and with spiral ornamentation of ozophore (sensu de Bivort & Giribet 2004). Transverse prosomal sulcus V-like; transverse opisthosomal sulci inconspicuous (Figs 2a, 3a). Dorsal scutum convex; maximum width in prosomal area behind ozophores. Opisthosomal part of dorsal shield slightly wider than ventral side.

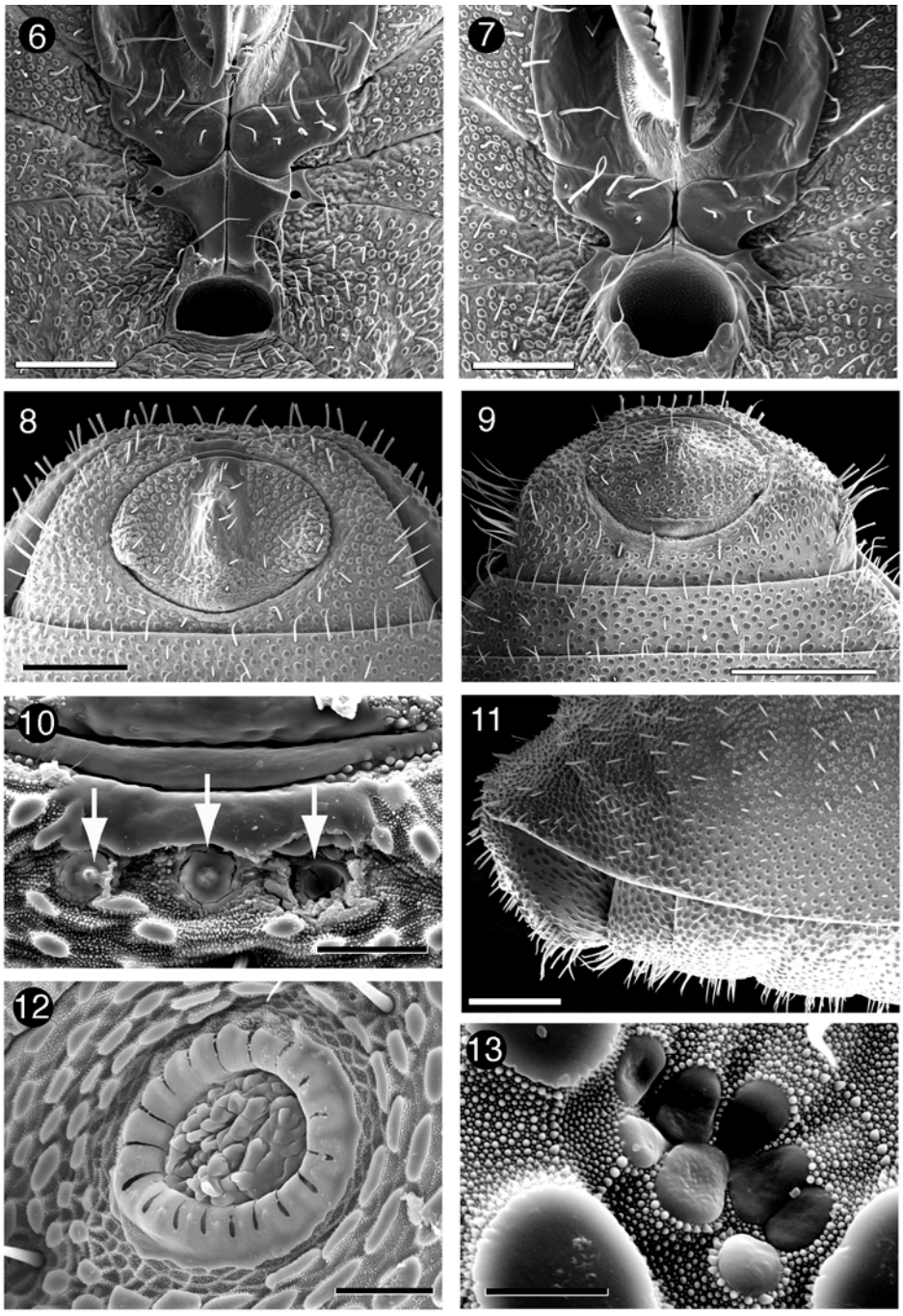
Ventral prosomal complex of males (Figs 2b, 4, 6) with coxae I, II and IV meeting in the midline, the later for a distance longer than the gonostome length; coxae II and IV with broad endites; coxae III not meeting in the midline; coxal pores clearly visible between coxae III and IV. Projections of coxae IV endite present in the anterior portion of the gonostome wall. Coxae II free, not fused to coxae III–IV. Ventral prosomal complex of female (Figs 3b, 5, 7) only with coxae I and II meeting along the midline; coxae II with large endites; coxal pores not observed. Male gonostome sub-semicircular, with slightly concave posterior margin, wider than long (0.152 x 0.109 mm), and delimited laterally and antero-laterally by the elevated endites of coxae IV (Fig. 6). Female gonostome semicircular anteriorly, wider than long (0.183 x 0.116 mm) (Fig. 7). Gonostome of female forming a tube angled at about 45° from the body surface, as in *Stylocellus globosus* Schwendinger & Giribet, 2004 (see Schwendinger *et al.* 2004). Spiracles (Fig. 12) of circular type (*sensu* Giribet & Boyer 2002), circular to oval in shape in male, oval in female, with a maximum diameter of 0.048 and 0.069 mm, respectively.

1. de Bivort & Giribet (2004) described the different type of ozophores in Cyphophthalmi and used the term "plugged" for those ozopores partially capped by a smooth surface (their figures 10a–h, 11a–e). It seems that the "cap" of the ozophores is the polymerized substance exuding from the ozopore. This type of ozophore should be referred to as having a subterminal ozopore.

Ventral opisthosomal region of male without conspicuous modifications or gland openings. Opisthosomal tergite IX and sternites 8 and 9 fused into a broad, low corona analis in males (Figs 8), and into a protruding corona analis with a concentration of long lateral setae in females (Figs 9, 11). Anal plate oval, 0.299 mm (in males) and 0.309 (in females) mm wide; in males with a high, thin medial ridge, in female individuals with a less conspicuous one; ridge with setae (Figs 8, 9). Three anal gland pores on tergite VIII of males (Fig. 10). Cuticle with tuberculate-microgranular surface (*sensu* Murphree 1988; this is referred to as "ornamented" hereafter), nearly uniform in dorsal areas and in ventral areas including coxae; tuberculate elements typically elongated behind gonostome and around spiracles. An additional microtuberculate pattern present in the ventral opisthosomal region where different segments merge (Fig. 13), possibly indicating the location of arthrodial membranes during postembryonic development.



FIGURES 4–5. *Siro crassus* **sp. n.**, ventral view of paratypes MCZ 68552–68553 and MCZ DNA101802. 5, male; 6, female. Scale bars 600 µm.



FIGURES 6–13. *Siro crassus* **sp. n.**, paratypes MCZ 68552–68553 and MCZ DNA101802. 6, ventral prosomal complex of male (scale bar 150 µm); 7, ventral prosomal complex of female (scale bar 150 µm); 8, ventral anal region of male (scale bar 150 µm); 9, ventral anal region of female (scale bar 250 µm); 10, anal gland openings (see arrows) (scale bar 30 µm); 11, anal region of female, lateral view (scale bar 200 µm); 12, left spiracle of male (scale bar 25 µm); 13 detail of the cuticular granulation of the ventral opisthosomal region (scale bar 10 µm).

Chelicerae (Fig. 14) relatively short and robust; basal article in males 1.13 mm long, 0.28 mm wide, with a ventral process, but without a conspicuous dorsal crest; second article 1.04 mm long, 0.19 mm wide; movable finger 0.38 mm long; all articles with few setae, the proximal one almost entirely granulated; 9 uniform denticles on the cutting edge of each cheliceral finger (Fig. 15). Second cheliceral segment not ornamented.

Palp (Fig. 16) 1.93 mm long, smooth, slightly ornamented on coxa and trochanter. Measurements of palpal articles in male holotype, length/width (L/W ratio) in mm: Trochanter 0.249/0.108 (2.31), femur 0.521/0.106 (4.92), patella 0.355/0.093 (3.82), tibia 0.403/0.087 (4.63), tarsus 0.347/0.089 (3.90); claw 0.05 mm long (Fig. 17).

Legs (Figs 18–27; Table 1) relatively long and robust. Leg I of holotype longer than leg II; leg I of female paratype TN 310/2002 slightly shorter than leg II. Except for the tarsi, all articles ornamented on legs I–IV. Tarsus IV of male entire, with a broad adenostyle (Figs 24, 26) (0.067/0.050 mm), subcylindrical at the base, with lateral pore; distal margin at 41% of tarsal length. Claws hooked, smooth, without dentition or lateral pegs (Figs 19, 21, 23, 25).

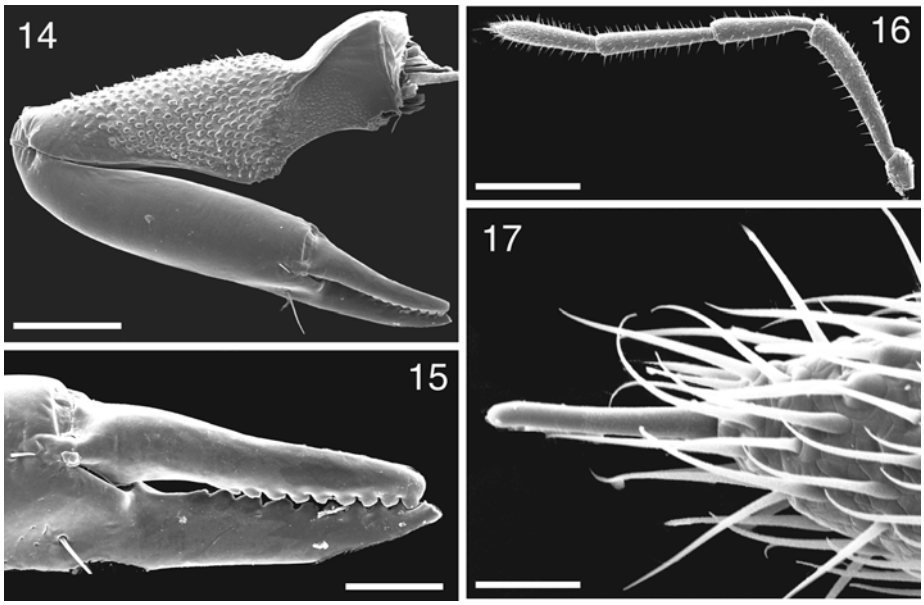
TABLE 1. Leg measurements (in mm) in *Siro crassus* **sp. n.** Measurements refer to male holotype (female paratype in parentheses).

Leg	Trochanter	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	0.27 (0.20)	0.76 (0.70)	0.38 (0.38)	0.46 (0.46)	0.34 (0.28)	0.66 (0.52)	2.87 (2.54)
II	0.23 (0.25)	0.71 (0.66)	0.36 (0.35)	0.42 (0.45)	0.34 (0.30)	0.61 (0.61)	2.67 (2.62)
III	0.30 (0.24)	0.54 (0.55)	0.32 (0.30)	0.38 (0.39)	0.30 (0.26)	0.58 (0.53)	2.42 (2.27)
IV	0.37 (0.33)	0.68 (0.71)	0.39 (0.39)	0.42 (0.43)	0.32 (0.46)	0.63 (0.64)	2.81 (2.96)

Spermatopositor (Figs 28–30) short, typical of sironids, smooth, measuring 0.272/ 0.144 mm; movable fingers 0.015 mm long, slightly curved outwards, ending as hooks (Fig. 28, see arrow; nearly straight and one behind the other), shorter than the membranous median lobe; microtrichial formula: 3, 14, 6+6 (n = 1). Gonopore complex not observed.

Ovipositor (Figs 31–32) 1.37 mm long, typical of *Siro* (see Juberthie 1967a), composed of two apical lobes and 31 circular articles (n = 1), each with 8 short setae equal in length; these setae slightly longer on the 2nd and 3rd subterminal articles, and about three times longer on the terminal circular article; most-basal article without setae. Apical lobes each with a long terminal seta and 12–13 setae slightly increasing in length towards the tip; sensitive processes with 2–3 branches carrying 5–6 simple and 2–3 bifurcate setae. Receptaculum seminis in proximal half of apical lobe, elongated, consisting of two sacs. The largest of several eggs: 0.58 mm long, 0.45 mm wide.

Variation: Range of body length: Males (n = 5), and females (n = 4) in parentheses: 2.20–2.29 (2.40–2.61).



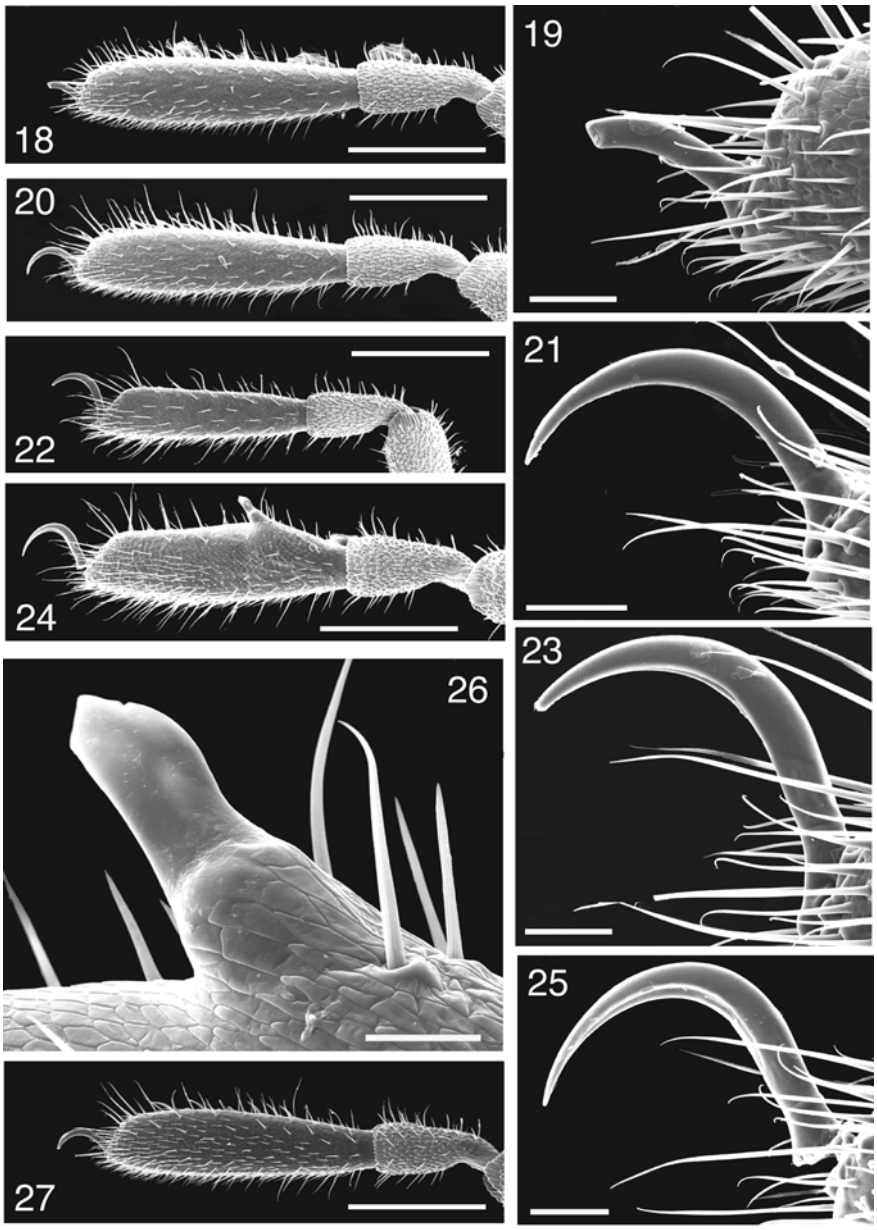
FIGURES 14–17. *Siro crassus* **sp. n.**, male paratype MCZ 68552 and MCZ DNA101802. 14, left chelicera, retrolateral view (scale bar 250 µm); 15, detail of cheliceral fingers (scale bar 100 µm) [note that lower angled edge corresponds to the glue on the carbon tape]; 16, left palp, retrolateral view (scale bar 400 µm); 17, detail of palpal claw (scale bar 25 µm).

Distribution and ecology: So far this species has been found in two localities in northeastern Slovenia (Fig. 1). In 1984, four *S. crassus* **sp. n.** and four *C. duricorius* (TN 311/2002) specimens were collected, found syntopically within 20–30 cm deep, wet, undecomposed leaf litter of European beech (*Fagus sylvatica* Linnaeus, 1753) covering a shallow natural ditch with trickling water. In 2005, a dozen of microhabitat types were systematically investigated at the type locality, and four further specimens of *S. crassus* **sp. n.** were found, but only in deep solid humic soil (color according to Munsell's Color Charts (2000): 10YR 1/1) near beech roots.

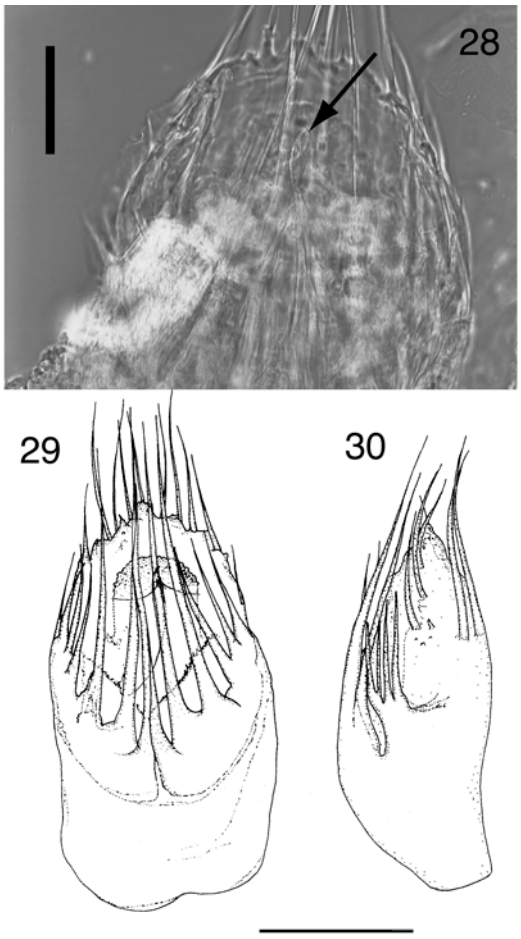
Sex ratio: So far 5 males and 4 females were found, nearing a 1:1 sex ratio.

Discussion

Siro crassus **sp. n.** is probably an oligothermophile, moderately hygrophile, and endemic to the marginal Eastern Alps. So far, its preferred microhabitats appear to be deep humic soils in Europeran beech forests. Its large body and long legs, resembling those of mesostigmatic Acari, enable relatively rapid movements. This species is most likely adapted to deep, moderately wet, humic soil microhabitats with interspaces, like fissures between tree roots and soil, and small mammal burrows. In 2002–2005, the new species could not be found in any of more than 50 intensively investigated other localities in the



FIGURES 18–27. *Siro crassus* **sp. n.**, left legs of paratypes MCZ 68552–68553 and MCZ DNA101802. 18, tarsus and metatarsus of leg I of male, retrolateral view (scale bar 400 µm); 19, detail of claw I (scale bar 50 µm); 20, tarsus and metatarsus of leg II of male, retrolateral view (scale bar 400 µm); 21, detail of claw II (scale bar 50 µm); 22, tarsus and metatarsus of leg III of male, retrolateral view (scale bar 400 µm); 23, detail of claw III (scale bar 50 µm); 24, tarsus and metatarsus of leg IV of male, retrolateral view (scale bar 400 µm); 25, detail of claw IV (scale bar 50 µm); 26, detail of adenostyle (scale bar 30 µm); 27, tarsus and metatarsus of leg IV of female, retrolateral view (scale bar 400 µm).

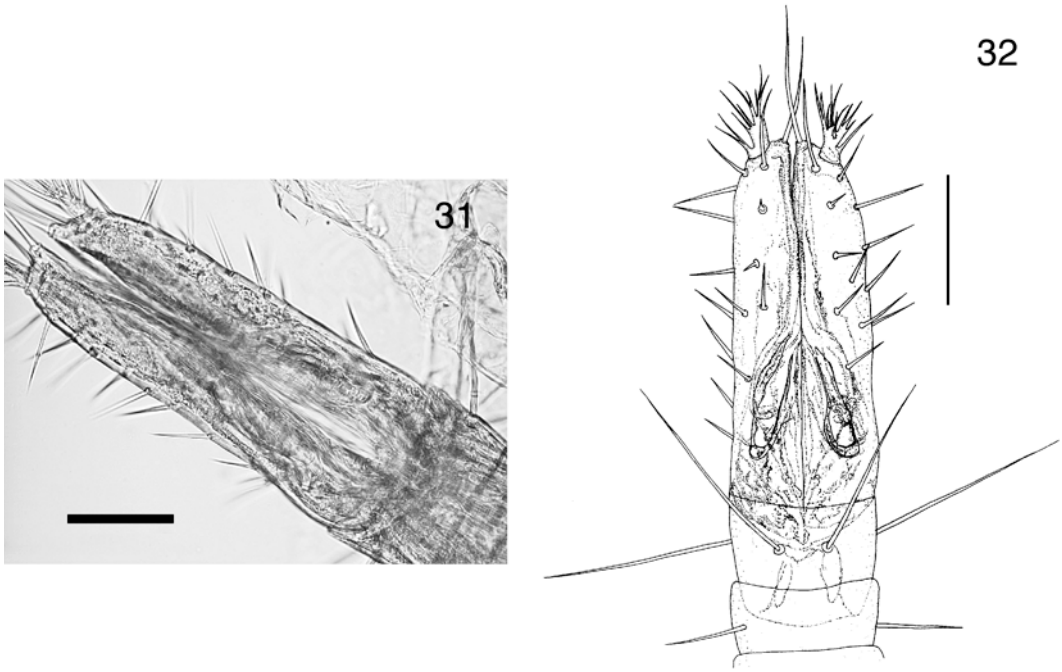


FIGURES 28–30. *Siro crassus* **sp. n.**, spermatopositor of male paratype LS 362/1985 and of holotype TN 310/2002. 28, male paratype, dorsal view, inverted light micrograph showing the slightly outward curved movable finger tips (see arrow) (scale bar 50 µm); 29, holotype, line drawing, dorsal view; 30, same, lateral view (scale bar 100 µm).

vicinity, although more than 200 *C. duricorius* were recorded there. In total, about 4 m^3 of material was sieved. None of those localities had deep solid humic soil near beech roots. When this soil type was sampled at the type locality, four specimens of *S. crassus* **sp. n.** were collected in about 0.2 m^3 of soil. Nevertheless, the apparent rarity of the species is undoubtedly the consequence of our scarce knowledge about its preferred microhabitat.

In its habitus, *Siro crassus* **sp. n.** is closest to *S. valleorum* and *S. rubens* (see Juberthie 1967a; Chemini 1990; de Bivort & Giribet 2004), which resemble each other in the ventral prosomal complex of males and females, as well as in the protruding anal region with long lateral setae in females. These three species undoubtedly form a clade of Western

European sironids, among which *S. crassus* **sp. n.** is the largest species, although its anal crest is much less conspicuous than that of its Western European congeners. As typical for other members of the genus from Europe and North America, *Siro crassus* **sp. n.** has three anal gland pores in tergite VIII (see Juberthie, 1967b; de Bivort & Giribet 2004). Other European genera have fewer or no anal gland pores. Members of the genus *Cyphophthalmus* studied at the SEM have two anal gland pores in tergite VIII (see de Bivort & Giribet 2004: figures 38g, h), *Paramiopsalis* also has two gland pores, and *Iberosiro*, *Odontosiro* and *Parasiro* lack anal glands. A major difference between the new species and all other sironids is the presence of a relatively smooth tarsus and of a completely ornamented metatarsus on all legs (Figs 18, 20, 22, 24, 27), a character found in members of the families Neogoveidae (including *Metasiro americanus* (Davis 1933), formerly in Sironidae), Pettalidae and Troglosironidae.



FIGURES 31–32. *Siro crassus* **sp. n.**, distal portion of ovipositor of female paratype TN 310/2002. 31, light micrograph, slightly deformed after treatment with lactic acid (scale bar 50 µm); 32, line drawing (scale bar 100 µm).

In the description of another putative species of the genus *Siro*, *S. carpaticus* Rafalski, 1956 (see Rafalski 1956, 1958), there is no mention about the shape of the posterior portion of the opisthosoma in females despite discussing other sexually dimorphic characters. Likewise, no mention of the presence or absence of anal glands is provided. However, *S. carpaticus* clearly differs from *S. crassus* **sp. n.** in the metatarsal ornamentation.

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