The taxonomical status and diversity of Balkan sironids (Opiliones, Cyphophthalmi) with descriptions of twelve new species

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The resurrected genus *Cyphophthalmus* is defined morphoanatomically and its relationship with the genus *Siro*, from which it has been separated, is discussed. The genus *Tranteeva* is synonymized with *Cyphophthalmus*. Twelve new species are here described: *Cyphophthalmus paragamiani*, *Cyphophthalmus thracicus*, *Cyphophthalmus gordani*, *Cyphophthalmus neretvanus*, *Cyphophthalmus kratochvili*, *Cyphophthalmus conocephalus*, *Cyphophthalmus trebinjanus*, *Cyphophthalmus ognjenovici*, *Cyphophthalmus martensi*, *Cyphophthalmus rumijae*, *Cyphophthalmus zetae*, *Cyphophthalmus trebinjanus*, for *C. corfuanus*, *Cyphophthalmus bithynicus*, and *Cyphophthalmus yalovensis* a new status is given. Relevant taxonomic characters are reviewed to illustrate the diversity of Balkan sironids. Phylectic relationships amongst species are reviewed and discussed. The results provide the basis for discussion on the relevance of minute morphological differences in the taxonomy of Cyphophthalmi. © 2009 The Linnean Society of London, Zoological Journal of the Linnean Society, 2009, 156, 260–318.


INTRODUCTION

Cyphophthalmi, with almost 150 known species, is by far the smallest of the four opilionid suborders. However, current knowledge of the group does not adequately reflect its real diversity. The reason for this lies primarily in the cryptic lifestyle and extremely localized distribution of these animals, making them difficult to find and study. High levels of endemism of known Cyphophthalmi suggest the hypothesis that there are still many species awaiting discovery in poorly sampled or unsystematically studied areas. In addition, there are reasons to believe that there is hidden diversity amongst the known Cyphophthalmi. I have had an opportunity to see that the North American fauna of this group is much more diverse than suggested by Shear (1980).

To a lesser degree this is also the case with the known Balkan Cyphophthalmi. On the one hand, the existence of hidden diversity is partly because of the extreme conservativeness of morphological characteristics of this group, the life in microcavities of the substratum having caused an almost uniform acariform appearance of the species with little variations, making differences inconspicuous. On the other hand, the hidden diversity is a result of an inadequate approach in determining taxonomically distinctive characters and criteria for their importance, which cannot be identical to the criteria applied to other opilionids. An important characteristic which emphasizes their specificity is insemination through spermatophores (Karaman, 2005a) in at least some genera (families?). The character of the copulatory organ, often essential in reconstructing phylectic relationships in the order Opiliones (Martens, 1976), has thus lost much of its taxonomic significance. Another
important characteristic that makes the study of the order difficult is the small size of these animals (mostly 1.5–2.5 mm), requiring use of special techniques.

Arguments for the above claims are based on the results of my long-standing work on collecting and studying Balkan Cyphophthalmi. Here, in a wider area rich in this fauna, distribution areas of (sometimes closely related) species and groups of species cross and overlap, and even closely related species occur sympatrically. The complex composition and distribution of the Cyphophthalmi fauna in the Balkan Peninsula (Karaman, 2005b) originate primarily from dynamic geotectonic and climatic changes that took place in this geographical area over the whole Tertiary, followed by the processes of speciation of geographically isolated populations as well as migrations of some populations. Study of the complex issue of Balkan Cyphophthalmi has made necessary the introduction of adequate taxonomic characters and criteria for distinguishing individual taxa. The results emphasize the relevance of minute morphological differences in the whole Cyphophthalmi taxonomy. The same criteria and some of the characters can be universally applicable to all other Cyphophthalmi. They certainly challenge the current compositions of some genera (e.g. *Siro*, *Paragovia*).

Confirmation of validity of the taxonomic criteria applied to Balkan Cyphophthalmi can be found in the results of a study based on DNA data analysis by Boyer, Karaman & Giribet (2005) that included some of the species described in the present paper.

The European Cyphophthalmi fauna is made up exclusively of members of the family Sironidae. A total of 28 species from six genera is known to date. In European regions outside the Balkan Peninsula, there are only ten known species belonging to five genera (not including the Balkan genus *Cyphophthalmus* with the species *Cyphophthalmus duricorius* Joseph, 1868, which spreads with a part of its distribution area over the borders of the Balkan Peninsula north-west to the south-eastern Alps). Almost all these species are endemic to the Mediterranean part of south-western Europe, with the exception of a species known from localities in the Italian Alps (Chemini, 1989), another one from eastern Slovenia (Novak & Giribet, 2006), and a species from a smaller area in the Northern Carpathians (Mašan, 1998). The monotypic genera *Odontosiro* Juberthie, 1961 and *Paramiopsalis* Juberthie, 1962 are distributed in the north-west of the Iberian Peninsula (Rambla & Fontarnau, 1984). Three species of the genus *Parasiro* Hansen & Sørensen, 1904 are distributed in north-eastern Spain and the southernmost parts of France, Corsica, and Sardinia, and a locality in the Apennine Peninsula (Tuscany) (de Bivort & Giribet, 2004). One species of the genus *Iberosiro* is known from a cave in Portugal (de Bivort & Giribet, 2004). However, the genus *Siro*, which is present in the European fauna with four recent species, has a disjunctive distribution area in Europe and North America. The species from the Balkan Peninsula and Asia Minor have been separated from this genus into the resurrected genus *Cyphophthalmus* (Boyer et al., 2005; Karaman, 2005a, b), endemic in these regions.

In contrast to the Cyphophthalmi fauna of other parts of Europe, in the Balkan Peninsula Cyphophthalmi is less heterogeneous, but considerably more richer in species and more widely distributed (Fig. 35A). There are 18 species known to date; however, on the basis of my unpublished data and those of P. Mitov from Sofia, it can be assumed that this genus actually includes more than 50 species.

**MATERIAL AND METHODS**

Most of the endogean Cyphophthalmi specimens were collected in mesovoid shallow substratum (MSS), by sifting soil and detritus through a sieve onto white fabric. A number of specimens was captured by hand, beneath rocks and stones in characteristic spots, mostly screees overgrown with woods, at the depth of 0.5 to 1 m. The troglobitic Cyphophthalmi were collected by hand, searching thoroughly over the walls and floors of limestone caves and pits.

Specimens were preserved in the field in 70% ethanol and dissected in diluted glycerine by an original technique. Dissections were effected with microneedles under a stereoscope microscope, separating the dorsum, appendages, spermatopositor, and ovipositor. Except the dorsum, all separated parts and the remainder were put in distilled water and then mounted on slides in Faure’s mounting medium (40 g chloral hydrate, 10 g gum Arabic; 5 g glycerine, 5 g glacial acetic acid, 5 g glucose, and distilled water).

Drawings were made using a camera lucida on an Olympus BX51 microscope.

The separated dorsum, and in some cases the whole specimen, was prepared by dehydration through graded alcohol and acetone and cleaned in a sonicator. Dried samples mounted on stubs were prepared in a Baltec SCD005 Sputter Coater. Scanning electron microscopy (SEM) photographs were taken with a JEOL-JSM-64601v SEM microscope in high vacuum.

Body length was measured from the midpoint of the anterior margin to the posterior margin of the dorsum. Legs were measured without coxae and claws, pedipalps without coxae and apotele. For cheliceral articles, maximal lengths are given.

Species are arranged in phyletic groups, named species first, then new species.
TAXONOMY

The SIRO PUZZLE

Since the first description of the species *Siro rubens* Latreille, 1804 (first described cyphophthalmid) until today, 24 recent species and subspecies have been described in the genus *Siro*. A somewhat greater number of Cyphophthalmi species is known in the genus *Rakaia* from New Zealand and Australia – 29 taxa (Giribet, 2000), and the genus *Stylocellus* from South-East Asia – 24 species (Giribet, 2002). In contrast to these two genera (and all Cyphophthalmi genera known to date), the genus *Siro* has far surpassed the distribution areas of other genera. This genus as circumscribed ‘traditionally’ is distributed across wider areas of two continents – America: the west coast of North America, the Appalachian Mountains in eastern North America (Shear, 1980) and Europe: Western Europe – an area in south-eastern France, the southern and south-eastern Alps, the Balkan Peninsula to its southernmost points and south-east to western parts of Asia Minor (Gruber, 1969), and north-east to the current and best reflect the differences between the genera *Siro* and *Cyphophthalmus*. The *Siro* division based on Rafalski’s criteria was rejected by Juberthie (1991) and *geosiro*, was farther subdivided into the then single genus *Siro*. He nominated *Siro duricorius* (now C. *duricorius*) as type species for the subgenus *Siro s.s*. This naming of the division, however, could not be justified because of the fact that *S. rubens* is the type species of the genus *Siro*. Nevertheless, the criteria used in this division are still current and best reflect the differences between the genera *Siro* and *Cyphophthalmus*. The *Siro* division based on Rafalski’s criteria was rejected by Juberthie (1967b, 1968). However, in an analysis of the affinity of the species *T. paradoxa* [now Cyphophthalmus paradoxxus (Kratochvil, 1958)], Juberthie (1991) included the species *S. duricorius* (now C. *duricorius*) in the subgenus *Cyphophthalmus* without explanation, simply putting in parentheses beside the species name – ‘s/s *Cyphophthalmus*’. Although aware of the obvious affinity of the species *T. paradoxa* with Balkan sironids, which he recognized as distinct within the genus *Siro*, he surprisingly did not synonymize the genera *Tranteeva* and *Siro*, which would have been logical at that time. In this way the status quo position of the genus *Tranteeva* unnecessarily continued to obscure the position of the species.

Table 1. Key characteristics differentiating the genera *Siro* and *Cyphophthalmus*

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<tr>
<th>Siro</th>
<th>Cyphophthalmus</th>
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<td>Ventral prosomal complex (Fig. 1C) – lobes II diverging posteriorly, medially fused on the anterior half of their length.</td>
<td>Ventral prosomal complex (Fig. 1D) – lobes II with almost straight posterior margins, medially fused along their length.</td>
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<tr>
<td>lobes III short (much shorter than wide at the narrower part), anterior medial portions protruding sharply, fan-shaped posteriorly; the narrowest portion is in line with or lateral to the coxal gland orifices.</td>
<td>lobes III long (longer than wide at the narrower part), straight anterior margins, posteriorly abruptly narrowing to widen out fan-like; the narrowest portion positioned at its width’s distance medially to coxal gland orifices.</td>
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<td>Spermatopositor (Fig. 1A) – only inner pair of movable fingers developed, with diverging tips; terminal lobe short and covered with minute denticles; carrying more than 16 setae.</td>
<td>Spermatopositor (Fig. 1B) – well developed exterior pair of strong movable fingers with converging tips, inner movable fingers less developed; terminal lobe elongated and smooth; carrying 14–16 setae.</td>
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The stated differential characters of the genera may look insignificant at first sight. However, if analysed on the level of the whole family Sironidae, it is clear that they are of considerable significance and suggest a much deeper phylogenetic separation between the two genera. Based on the same criteria the genus *Siro* is much closer to the genus *Suzukielus* from Japan than *Cyphophthalmus* [the differential character of the doubled tarsus IV in *Suzukielus sauteri* (Roewer, 1916) is a plesiomorphic feature preserved independently even in phylogenetically very remote species].

The presence of exterior movable fingers on the spermatopositor, in addition to the inner ones, is considered indicative, very stable and unique for the genus *Cyphophthalmus*. This character was a new quality which caused varying degrees of reduction of inner movable fingers. Inner movable fingers are significantly shorter than in members of *Siro*. The absence of the inner movable fingers in the species *Cyphophthalmus eratoae*, as noted by Juberthie (1968) in his description, is likely to be because of him having overlooked them, because in some species, and in particular the Aegean phyletic line (Karaman, 2005b) that this species belongs to, they may be truly inconspicuous. Specimens from Lefkas island in Greece, which look very closely related to *C. eratoae* do have inner movable fingers. Actual absence of inner movable fingers in *C. eratoae* would thus be a unique, apomorphic characteristic of this species. Unfortunately, I have had no opportunity to study the specimens on which Juberthie based his description. However, all other species from the Balkan Peninsula, including species I studied myself and those described in the literature with regard to spermatopositor anatomy (more than 30 species), do have inner movable fingers in addition to the exterior ones.

The exterior movable fingers, as completely new structures, may have originated from the similar structures found in *Parasiro coiffaiti* Juberthie, 1956, *Parasiro minor* Juberthie, 1958 (Juberthie, 1956: fig. 13; 1958: fig. 13), *Odontosiro lusitanicus* as well as *Troglosiro* species (Juberthie, 1979; Shear, 1993).

The difference in the numbers of anal glands in members of the genera *Siro* and *Cyphophthalmus* may not be only a quantitative one. The unpaired, third, median anal gland pore in the members of *Siro* I have studied [*Siro exilis* Hoffman, 1963 (Fig. 2C) and *Siro cf. acaroides* (Ewing, 1923)] is considerably narrower than the two lateral ones. It is very likely that the median anal gland, absent in the species of the genus *Cyphophthalmus* (Fig. 2D), secretes a different type of secretion than the paired anal glands [which does not necessarily contradict Juberthie's (1967a) observation that the medial and lateral glands have the same structure].

The ventral prosomal complex in the species of the genus *Cyphophthalmus* is very specific and unique compared to all other genera of the family Sironidae. This uniqueness is reflected primarily in the structure of lobes II and III.

Spiracles also show striking differences between the two genera. In *Siro* species the spiracle is more or less circular, whereas in *Cyphophthalmus* species it is semicircular with a strong conical cuticular projection on its posterior margin (Fig. 2B). This characteristic of the genus *Cyphophthalmus* is evidently apomorphic and unique. Such a structure probably provides species of this genus with an active control over the spiracle's closing. The stated differences are easily noticeable in the photographs provided in the paper by de Bivort & Giribet (2004: fig. 36). It is interesting to note that the North American species *S. exilis* and *S. cf. acaroides* (the *Siro* species that I have had the opportunity to study) have denticles inside the lumen of spiracle (Fig. 2A), which are absent in the species of the genus *Cyphophthalmus*.

It is also of significance to note differences regarding the spermatozoid structure (Alberti, 1995), i.e. the presence or absence of the acrosomal complex in the species *S. rubens* and *C. duricorius*, respectively. As the latter was considered a member of *Siro*, Alberti treated these differences as an illustration of diversity of the spermatozoid structure at the level of the same genus. It is likely that the stated differences have differential value for the genera *Siro* and *Cyphophthalmus*.

The presence of scale-like ornamentation at the base of the second cheliceral article in species of the genus *Cyphophthalmus* and its absence in *Siro* species (Boyer et al., 2005) is another distinction between the genera.

The genus *Tranteeva* shows no significant differences compared to other Balkan sironids, except for extremely elongated appendages and body, which alone are not sufficient for its classification in a separate genus (Dunlop & Giribet, 2003). The prominent fusion line of sternite and tergite in corona analis, which Juberthie (1991) designated as a key distinguishing character validating the genus, is not specific to the species *T. paradoxa*. This line is more or less noticeable in male members of the minutes-group of the genus *Cyphophthalmus* found in different caves. It can certainly be considered plesiomorphic and present, or more prominent, in species with a thinner integument, i.e. cavernicolous species. This characteristic alone is not enough to justify separation of *T. paradoxa* into a new genus. However, the presence of an additional pair of tubercles on coxosternites of legs III (Juberthie, 1991) is specific to this species, although of unclear significance in the light of present knowledge of the genus *Cyphophthalmus*. © 2009 The Linnean Society of London, Zoological Journal of the Linnean Society, 2009, 156, 260–318
The additional pair of tubercles on coxosternite III is found in the species Cyphophthalmus ohiidanus (Hadži, 1973: fig. 7g), in traces in certain members of the species Cyphophthalmus gordani sp. nov., Cyphophthalmus cf. gjorjevici, and in a taxon from western Macedonia related to C. gjorjevici but of an undetermined taxonomic status. In contrast to T. paradoxa the tubercles, when present in these species, are positioned paramedially. This feature may suggest a possible plesythetic relationship between T. paradoxa and the gjorjevici-group of the genus Cyphophthalmus. Female specimens of two unknown species, obtained from pits and a cave in Mount Velebit (Croatia), also have extremely elongated appendages and show affinity to the C. gjorjevici-group. Besides the elongated appendages, this species shows no other similarities with the species T. paradoxa. Based on the arguments presented so far the genus Tranteeva is considered synonymous with the genus Cyphophthalmus.

Kratochvíl (1938) divided European species of the genus Siro into three groups. According to this division, the first group, exemplified by the species C. duricorius, comprised other endogean species and included S. rubens, but such a group formed of phyletically very remote species cannot be justified. The other two groups correspond to troglobitic species: group II, exemplified by Cyphophthalmus tcyrovskyi and included also Cyphophthalmus silhavyi, whereas group III was exemplified by C. gjorjevici and included C. minutus. Group II and C. minutus from group III correspond by their composition to the Dinaric phyletic line pointed out in the present paper. The species C. gjorjevici, however, has a completely separate position in the present analysis.

**Siro Latreille, 1796**

*Diagnosis:* The current composition of the genus does not provide clear distinctive features that would be specific to the genus within the family Sironidae.

*Type species:* Siro rubens Latreille, 1804.

*Distribution:* Parts of western and middle Europe, and North America. According to the current status this genus includes seven recent and one fossil species:

- **Siro rubens** Latreille, 1804 – widely distributed in the south and south-east of France (Juberthie, 1991).
- **Siro valleorum** Chemini, 1990 – slopes of the Alps in Lombardy (north Italy).
- **Siro crassus** Novak & Giribet, 2006 – eastern parts of Slovenia.
- **Siro carpaticus** Rafalski, 1956 – small areas in the northern Carpathian Mountains in Poland and Slovakia.

**Siro acaroides** (Ewing, 1923) – according to Shear (1980) this species is dispersed from northern California along the western coast of North America, slopes of the Coast Ranges, to the furthest northwestern parts of the state of Washington (almost the whole western coast of the USA). However, the validity of such a distribution is questionable. It is more likely that this is a distribution of a complex of species. A small portion of Shear’s material that I reviewed supports this assumption.

**Siro exilis** Hoffman, 1963 – distributed in a region in the Appalachian Mountains (eastern USA).

**Siro sonoma** Shear, 1980 – known from a locality in California. By a range of its unique characteristics, this species does not show any relationship to other sironids known to date and should be separated into a new genus related to Siro.

**Siro platypedibus** Dunlop & Giribet, 2003 – the only fossil Cyphophthalmi species known to date, described on the basis of a female found in the Bitterfeld amber in Germany, estimated to be between 20 to 40 million years old. This specimen has no one visible relevant detail that could establish its belonging to any genus. Although its belonging to the genus Siro may be logically assumed, its definite position in this genus is a mere speculation. The character of laterally flattened articles of some legs, emphasized by the authors as an apomorphic trait and an indication of a kind of speciation, is in my opinion wrongly interpreted. The flattened legs of this specimen are likely to be the consequence of the animal’s fall into the resin that conserved it. This happens frequently when the appendages are submerged in a concentrated viscose medium (Faure’s medium or Canada balsam) used in making slides – a difficulty I have encountered many times.

The monotypic genus *Neosiro* Newell, 1943 was synonymized with *Siro* by Shear (1980), in my opinion without strong evidence. *Neosiro kamiakensis* Newell, 1943 distributed in the north-west of the USA (Washington and Idaho) is therefore excluded from the genus *Siro* in the present paper.

**Cyphophthalmus Joseph, 1868**

Revalidated from the synonymy of *Siro*


*Diagnosis:* Distinct from all other sironids by the specific structure of the coxosternal complex, spermatopositor with a pair of well-developed exterior movable fingers with opposing tips, and presence of two anal glands.

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Type species: *Cyphophthalmus duricorius* Joseph, 1868 by monotypy.

**Distribution:** The Balkan Peninsula and western Asia Minor.

According to the published data, the genus *Cyphophthalmus* defined in this way contains 18 species:

- *Cyphophthalmus duricorius* Joseph, 1868 – wide distribution in Slovenia and border regions of Austria, Italy, and Croatia. According to the available data, this species has the largest known distribution area within the genus.
- *Cyphophthalmus gorgjevici* (Hadži, 1933) – known from a cave near Skopje, Macedonia.
- *Cyphophthalmus beschkovi* (Mitov, 1994) comb. nov. – a cave in western Stara Planina Mountain, Bulgaria.
- *Cyphophthalmus bithynicus* (Gruber, 1969) stat. nov. – Uludağ Mountain near Bursa (north-west Asia Minor, Turkey).
- *Cyphophthalmus corfianus* (Kratochvíl, 1938) stat. nov. – Corfu, Greece.
- *Cyphophthalmus yalovensis* (Gruber, 1969) stat. nov. – near Yalova in north-west Asia Minor (Turkey).
- *Cyphophthalmus eratoae* (Juberthie, 1968) – several localities in central and western Greece.
- *Cyphophthalmus minutus* (Kratochvíl, 1938) – a cave on the southern slopes of Orjen Mountain in Konavli (southern Dalmatia, Croatia).
- *Cyphophthalmus montenegrinus* (Hadži, 1973) – a cave near Virpazar (Montenegro). Despite repeated attempts this peculiar species could not be found in its type locality (cave Velja Spila near Seoce). In this cave and some others in the close vicinity another two species of the genus *Cyphophthalmus* sympatrically appear: *Cyphophthalmus cf. teyrovskyi* and *C. cf. minutus*. *Cyphophthalmus cf. teyrovskyi* may correspond to *C. montenegrinus* by some, primarily morphometric, characteristics; however the absence of the most prominent and distinct characteristics according to Hadži (lateral tooth-like projections on claws IV and the specific ‘inner’ longitudinal and transverse thickenings of the dorsal scutum cuticle) prevents one from drawing definite conclusions about the status of these species. Considering that the type material has been lost this species could be transferred to *nomina dubia*.
- *Cyphophthalmus noctiphilus* Kratochvíl, 1940 – from a cave near Split, Dalmatia.

*Cyphophthalmus silhavyi* Kratochvíl, 1938 – from a cave in Konavli, southern Dalmatia – Croatia.

*Cyphophthalmus teyrovskyi* Kratochvíl, 1938 – from a cave on the island Mljet, Dalmatia – Croatia.

*Cyphophthalmus paradoxus* (Kratochvíl, 1958) comb. nov. – from caves in western Mount Stara Planina, Bulgaria.


*Cyphophthalmus markoi* Karaman, 2008 – from Demir Kapija, Macedonia.

The status of the subspecies *Siro duricorius bolei* Hadži, 1973 from the cave Vilina Jama in Boka Kotorska, Montenegro, is unclear because it appears that the type and only specimen of this species (a female) has not been preserved. In the same cave I collected specimens which belong to the complex of the species *C. minutus* (troglobite), and in a wider area of the region (the hill Vrmac) there exists an endogean species – *Cyphophthalmus martensi* sp. nov. (related to the species *C. duricorius*). The rather rough description of *S. duricorius bolei* corresponds to neither of the two species that I found in that area (Karaman, 1993). The morphometric characteristics given in the description would correspond more to the species *C. cf. minutus*, but none of the most distinct morphological characteristics of this species are mentioned in the description. It is likely that this taxon also should be transferred to *nomina dubia*.

**Remarks:** Results of the long-standing work on collecting and studying Balkan sironids indicate that this group has a rich fauna, with a long and complex genesis. Distinctiveness of characters in relation to other sironids and the numerous taxa often with overlapping distribution areas indicate an independent, long and dynamic history of the genus. According to my own records and P. Mitov’s unpublished data, including described as well as collected but as yet undescribed species, the genus *Cyphophthalmus* has more than 50 species. The number may further increase, considering that there are still wide areas poorly studied or unexplored as regards this fauna (Turkey, Bosnia and Herzegovina, Albania etc.) and given the high levels of endemism of the taxa known to date.

Two decades of my more or less intensive work on the collection and taxonomic classification of Balkan Cyphophthalmi (I have had the opportunity to explore in more detail some parts of former Yugoslavia), together with material I have been given to analyse, resulted in a thorough study of around 50 species of the genus *Cyphophthalmus*. Of these number, more than 30 are new species awaiting formal description.
In this paper I decided to describe 12 species that represent the diversity of morphological characters in the genus. This will be enough to illustrate the significance of differences that may seem of minor value for some colleagues in the field. Descriptions of the remaining species will be published at a later time.

The genus Cyphophthalmus has a special and distinct position within the family, owing primarily to the ventral prosomal complex and spermatopositor morphology. However, although the results of molecular analyses clearly indicate a monophyletic origin of the genus, its precise position in the family has not yet been established (Boyer et al., 2005).

**TAXONOMICALLY SIGNIFICANT CHARACTERS OF THE GENUS CYPHOPHTHALMUS**

The complex taxonomy of the rich Balkan Cyphophthalmi fauna, with overlapping distribution areas of older and younger troglobitic and endogean species and groups of species (where species sympatrically occur in four cases, two endogean and two in caves), recommend them as a ‘benchmark’ in determining the criteria for the importance of certain taxonomic characters amongst the family.

Conservativeness of morphological characters is a characteristic of Cyphophthalmi, most prominent in the members of the genus Cyphophthalmus. Therefore the study of this genus requires a special approach in determining the criteria of significance of certain taxonomic characters and is actually based on discovering the minute stable differences that will define a species whose members appear more or less distinct by some of their quantitative characteristics and proportions. A series of new valid taxonomic characters was defined in addition to the known ones, of which some have proved significant in determining phylogenetic relationships within the genus.

The male external genital anatomy in opilionids is one of the most valuable differential characteristics of the order and an extremely distinctive one. The morphology of copulatory apparatus shows a certain degree of conservativeness and is therefore a considerably reliable character in phylogenetic studies as well (Martens, 1976). The application of this character in the study of opilionids started relatively late (1930s) and considerably improved the taxonomy of the whole group. As regards this character and its applicability Cyphophthalmi significantly differ from other opilionids. The discovery of spermatophores in this group (Karaman, 2005a) has revealed a different role of male external genitals compared to other opilionids. Male genital apparatus in the Cyphophthalmus species has a role of producing spermatophores; therefore the adequate term to designate its external part is spermatopositor (first used for this group by van der Hammen, 1985). Such an apparatus is exposed primarily to the selective pressure of its functionality and efficacy. In opilionids from other suborders (known to date) male external genitals have the role of a penis, conveying sperm into distal parts of a female’s ovipositor by direct and active penetration through the female’s genital opening. Such an apparatus suffers additional selective pressure from relevant female genital structures, functioning like a key and lock. This advanced way of insemination entails co-evolution of the two structures (i.e. male and female genitals), and often also a complex behavioural pattern that accompanies the copulation act, providing and stimulating reproductive isolation. The structure of male genitals is thus specific in many of its details.

The character of the spermatopositor is the most prominent and distinctive feature of the genus Cyphophthalmus, and a considerably conservative one. This conservativeness is reflected primarily in its qualitative characteristics, and in this sense variations from a typical structure (Fig. 1C) are almost negligible on the level of the whole genus Cyphophthalmus. On the one hand, the conservativeness is reflected in the function of male genitals in this genus. On the other hand, there is some, primarily quantitative, variability which makes it hard to single out valid and taxonomically applicable characteristics of the spermatopositor anatomy. Although habitual differences in the general spermatopositor appearance amongst individual taxa may sometimes appear striking (Figs 23A, 29A), a more detailed analysis reduces the differences to only a small number of structural characters:

1. Middle movable fingers (digiti mobiles mediales) are considerably reduced compared to other members of the family Sironidae. A similar degree of reduction is usually common to a group of related taxa. There are two basic types of middle movable fingers in a genus: well developed (as long as lateral movable fingers) (Fig. 2F) with tips bent dorsally; or considerably reduced (shorter than lateral movable fingers, sometimes inconspicuous), with anteriorly directed tips (Fig. 2E). The reduced size and soft structure make them almost unnoticeable in some cases. This could explain their ‘absence’ in the species C. eratoae, which its author regarded as the species’ most distinctive characteristic.

2. Lateral movable fingers (digiti mobiles laterales) have the appearance of strong claws (Fig. 2E, F) and are unique to the members of the genus Cyphophthalmus. The tips of these ‘claws’ are curved inwards, opposing one another. The extent
of curving and sclerotization, their length, width at the base, and presence or absence of terminal dentations, although variable to a certain degree, indicate species-specific characteristics.

3. The terminal lobe is one of the most valuable taxonomic characters of spermatopositor morphology in the genus *Cyphophthalmus*. Unfortunately, because of its simple structure this character does not have a variety of forms and often has no differential value unless combined with other characters. As a result of its soft structure it often suffers deformation in the preparation-making process and thus makes an unreliable character in small series of available specimens. Setae (four) distributed on the tip of the terminal lobe, often with specific distribution and length, add significance to the character of terminal lobe. Setae ventrales (three), positioned ventrally on the terminal lobe, have an inconsistent distribution and sometimes also number, and are therefore an unreliable character.

4. Lateral lobes (lobi laterales) are variable as regards their size and the number of setae they carry (three to five), but in some cases they can be valuable.

5. Trunk (spermatopositor from its base to the transverse fold) is a character which can be defined descriptively as long or short. A long trunk is characteristic for some troglobitic species.

6. Setae dorsales (four) are in some cases useful as taxonomic characters. Basically there are two types: the type with a narrow median pair (narrower to considerably narrower in their basal parts compared to the lateral pair) and the type with a wide median pair (as wide as or wider in their basal parts compared to the lateral pair) (Figs 7A, 9A, 17A).

The number of anal gland pores (two) is another character unique to the genus *Cyphophthalmus*. Distance between the anal gland pores, their orientation, and ornamentation of the posterior opisthosoma are significant in distinguishing phyletic lines within the genus, distinctive in certain phyletic lines and less frequently in a single taxon (Figs 8E, 12E). Two basic types of the structure can be clearly distinguished in the species of the genus *Cyphophthalmus* analysed in the present paper. In the Aegean phyletic line (Figs 34E, 30E, 32E) the pores are arranged one by the other on the protruded middle portion of the posterior margin of tergite VIII, ventrally orientated, whereas in the Dinaric phyletic line (Figs 14E, 24E, 26E) the anal gland pores are wide apart on the posterior margin of tergite VIII, orientated terminally. The studied species from the Gjorgjevici phyletic line are similar to the Dinaric line, the only difference being a smaller distance between the pores (Fig. 10E).

Coxal lobes in males (and to some degree in females) with their specific structure represent another differential character of the genus *Cyphophthalmus*. The shape and structure of the coxal lobes (ventral prosomal complex) of legs II–IV show taxonomically significant characteristics:

1. Coxa of legs II are a stable character occurring in several forms (Figs 7B, 21B, 31B), useful in combination with other characters. This character is equally applicable in males and females. The number and distribution of setae may vary.

2. Coxal lobes of legs III, primarily by their relative length and sometimes by their profile, clearly distinguish some taxa, and are significant in combination with other characters.

3. Coxal lobes of legs IV, by the position of tubercles in the posterior portion and less significantly by their profile, are a clear differential character of certain taxa complexes (Figs 21B, 31B). (Not of universal significance, however, because in some taxa in which tubercles are not arranged on the anterior margin of the male genital orifice, the position of tubercles and the coxal lobes profile can vary.)

Opisthosomal tip, from a dorsal view, can be rounded or flat to concave. These two shapes can differentiate some phylogenetic lines of the genus *Cyphophthalmus*.

Lateral profile of dorsum appears in two main shapes: deep (more arched), rounded posteriorly; and shallow (less arched), elongated posteriorly. These two forms generally correspond to some phyletic lines in the genus. Females from the Dinaric phyletic line have as a secondary sex characteristic lateral folds on opisthosomal tergites VII–XI, forming a longitudinal dorsally oriented rim on each side, most prominent on tergite IX (see Karaman, 1993, 2008). On the ventral portion of opisthosoma, opposite the rims, there are ventrolateral distinctly convexly widened sternites of segments IX–XII. The edges of these two structures make dorsal and ventral borders along almost flat surfaces of the lateral sides of that part of opisthosoma. This character, more or less expressed, may be indicative for some species and its presence or absence differentiates the phyletic lines of the genus. This structure may be regarded as a synapomorphy of the Dinaric phyletic line. It is interesting that this characteristic is most prominent in troglobitic members of this line and most reduced in species more adapted to endogean life in ‘arid’ conditions (*Cyphophthalmus martensi* sp. nov.). Although the purpose of this prominent characteristic is not fully understood, it is believed to be a
hindrance and ballast for animals originating from primarily terricolous ancestors, adapting to life in endogeal conditions. If we accept as correct the hypothesis that Cyphophthalmi are primarily terricolous cryptobionts, then the conditions in troglobitic subterranean habitats are closest to the original conditions, which may explain how they retained this characteristic.

The anterior margin of prosoma shows some variability, conspicuous and even peculiar in some cases (C. conocephalus sp. nov.) (Fig. 20B).

The ozophore orientation and profile can be distinctive. The ozophores are always situated laterodorsally, but their orientation can be lateral (Fig. 10F) to laterodorsal (Fig. 12F). The profile itself can vary from short (length smaller than basal width) to elongated (length greater than basal width) (Figs 10F, 12F).

The operculum analis can be distinctive in some taxa, despite a certain amount of variability (Martens, 1978). Differences pertain to the width and height of longitudinal carina in males (Fig. 3). The carina is extremely well developed in some taxa. This character is one of the most important characters delineating (one of) the three main phylogenetic lines of the genus Cyphophthalmus. The width of the posterior portion of the carina corresponds to the distance between anal gland pores (with rare exceptions), indicating their functional association. This is corroborated by a series of SEM photographs of the posterior body of various Cyphophthalmi species provided in the paper by de Bivort & Giribet (2004). Those photographs clearly show the absence of longitudinal carina of the operculum in species lacking anal gland pores (or having them in unusual positions).

The ovipositor shows certain variation amongst taxa, primarily with regard to the proportions of terminal articles and terminal lobes. Principally, we may differentiate species with stout and with narrow terminal lobes (Figs 4D, 5C). However, deformation during the slide-making process is possible, so this character is not always fully reliable. Branched apical setae on lobes can be of the type with branches starting from the base of a seta or the type with branches growing from the elongated ‘trunk’ of a seta, including all intermediate types. My studies have shown the most important differences to be in the structure of receptacula seminis (Figs 4, 5). A few main types of the seminal receptacle characterize groups of related taxa and form the basis for defining the three main phyletic lines of the genus. There are three basic types: sigmoid (Fig. 4A–D); saccate with bifurcated bottom (Fig. 4E–G); and simple saccate (Fig. 5). Generally, there are no significant differences in the structure of seminal receptacles amongst closely related taxa. The distribution and number of simple setae on the terminal lobe of the ovipositor may be distinctive. In most species the terminal lobe is covered with 13 more or less typically distributed setae. The presence of one more seta is characteristic for some species. This seta is positioned mediodorsally at the approximate midpoint of the lobe’s length (Fig. 4C).

Appendages can define a species by their size and proportion, together with other characters. Chelicerae can differ amongst species in article elongation only, i.e. by the relative ratio of the article length and width (they are extremely long in some troglobites, Fig. 23F). Pedipalps differ in apotele length in addition to article length. Legs are often clearly distinguishable amongst species by article length and some other specific characteristics (Figs 23C–D, 27C–D).

The male adenostyle and tarsus IV carrying it are often the most valuable characteristics of appendages, defining a species. The adenostyle appears in two basic shapes, with intermediate forms: spiniform (Fig. 17G), and tubular (Figs 7G, 29G). The position of the adenostyle on the tarsus also differs amongst species. The tarsal article of leg IV may be characteristic by the relative length and width ratio, as well as by its lateral profile.

The tarsus of leg I may be valuable because of the differences in the length and width ratio, as well as by its lateral profile.

Tarsal claws are generally simple; however, in some taxa (mostly troglobitic) they may have a specific form. The members of the C. ognjenovici subgroup of the C. minutus species-group has enlarged, distinctly falciform claws on legs III, even more prominent on legs IV (Figs 11E, 23D). In the members of the C. teyrovskyi subgroup these claws are apically dors-ventrally flattened, almost spoon-like.

Integument ornamentation can be a very valuable character, often showing the most prominent differences amongst species. However, inclusion of this character in taxonomic analyses requires SEM, because the study of minute details of ornamentation requires great magnification (sometimes more than 1000 times). Differences amongst the species are expressed in the size, shape, distribution, and density of the granules of the first, second, and third rank (Fig. 6).

The basic criterion for defining a particular Cyphophthalmus species must start from the phylogenetic species concept as the only applicable concept, because the species are almost exclusively found as isolated populations or series of isolated populations. The species are here defined as populations or aggregations of populations with a unique combination of character states. However, the determined criteria
that define a particular species may also comply with the biological species concepts that I tend to respect, the fact that I have found in rare so far discovered sympatric populations. Herewith presented characteristics of two relatively close species C. minutus and Cyphophthalmus kratochvili sp. nov., which are sympatric in one cave, are perhaps the best illustration of how some seemingly minor differences in certain characters are indicative in the differentiation and definition of the species of the genus Cyphophthalmus.

The applied criteria have shown to be very stable in geographically very distant populations of rare so far known species of the genus Cyphophthalmus, which have a wider distribution range – C. duriocirius and Cyphophthalmus serbicus, as well as in species with somewhat narrower distribution ranges – C. martensi sp. nov. and C. ere.

The presented descriptions are rationalized with a set of unique combinations of character states given in the diagnosis of each species.

**SPECIES DESCRIPTIONS**

**CYPHOPHTHALMUS PARAGAMIANI SP. NOV.**

(Figs 4B, 7, 8)

*Material examined:* Katayfi Cave, Agios Dimitrios, Messinia, Peloponnesus, Greece, 10 m a.s.l., 27.ix.1997, leg. K. Paragamian, 1 ♀ holotype; *ibid.*, 20.v.1996, 1 ♀ paratype.

Holotype (inv. no. KPPC000856) and paratype (inv. no. KPPC000855) in Kaloust Paragamian Personal Collection (KPPC) hosted by the Hellenic Institute of Speleological Research (HISR) in Iraklion (Greece).

*Etymology:* The species is dedicated to Kaloust Paragamian, a well-known biospeleologist from Iraklion (Greece), the collector of the specimens.

*Diagnosis:* Small troglobite species with elongated appendages. Integument of dorsal scutum covered with elongated setae and sparse, small oval convex tubercles. Spermatopositor terminal lobe, conical in shape, terminally rounded, with equally distant setae terminales. Receptacles bilobal. Coxal lobes II, at their narrower part as wide as long; coxal lobes III in males are somewhat shorter than coxal lobes IV. Telotarsi I and IV are somewhat more than four times as long as wide in their median part. Adenostyle tubular. Pores of anal glands situated close to each other and terminally orientated. Longitudinal carina on male anal plate wide and not pronounced. Opisthosomal laterodorsal folds in females absent.

*Description:* Male holotype body length 1.55 mm. Body uniformly light yellowish – amber in colour.

Scutum: anterior margin of dorsal scutum (Fig. 8F) with closely situated terminal bristles. Ozophores as long as wide in their bases, dorsolaterally orientated. Granulation of opisthosomal part of dorsal scutum (medial area) as in Figure 8C and D. The very sparsely distributed small convex tubercles slightly elongated and oval in shape. Granules of second rank small, sparsely distributed.

Anal plate with wide, low longitudinal carina; posterior margin of dorsal scutum almost straight. Pores of anal glands close to each other, laterally situated on transversal tubercle (Fig. 8E), terminally orientated.

Chelicerae slightly elongated (Fig. 7F): basal article 0.84 mm long; second article 0.77 mm long.

Pedipalps elongated (Fig. 7E), 1.47 mm long (without coxa and apotele); apotele elongated.

Legs elongated. Tarsus I shape as in Figure 7C. Telotarsus I length to width (l : w; at the midpoint of its length) ratio – 4.5. Telotarsus IV (l : w ratio – 4) with adenostyle on the first quarter of its length (Fig. 7D); adenostyle tubular (Fig. 7G); sensory seta (positioned on proximal basal part of the adenostyle) remarkable longer than adenostyle.

Measurements of legs (without coxae and claws, in mm): I = 2.23; II = 1.88; III = 1.64; IV = 1.98.

Ventral prosomal complex (Fig. 7B): coxal lobes II, at their narrower part as wide as long; posteriorly abruptly narrowing on the first half of their length. Coxal lobes III and IV almost of equal length; conical processes of the coxal lobes IV situated at the midpoint of their length.

Spermatopositor (Fig. 7A) – distal margin of terminal lobe, conical in shape, terminally rounded. Setae terminales almost of the same length, equally distant from each other; setae dorsales of almost equal width in their basal part. Lateral movable fingers elongated, remarkably longer than median movable fingers.

Description of the female: 1.80 mm body length. Body from tergite IX posteriorly conically narrowing (Fig. 8B). Ovipositor apical lobes (Fig. 4B) with sigmoidal receptacles. Openings of receptacles situated at terminal half of the apical lobes. Each apical lobe bearing one multibranchied and 13 simple setae. Posterior margin of dorsal scutum almost straight. Opisthosomal laterodorsal folds absent.

*Distribution and habitat:* Known only from the type locality (Fig. 35B) as troglobite.

*Remarks:* By the shape of receptacles and dorsal profile of the female, this species shows affinity to the Gjorgjevici phyletic line (Karaman, 2005b).
CYPHOPHTHALMUS THRACICUS SP. NOV.
(FIGS 4C, 9, 10)


Holotype (inv. no. 1409/1) and paratypes are deposited in the author’s collection at the Department of Biology and Ecology, University of Novi Sad (Serbia).

Etymology: After the name of the region (Thrace), where the specimens were collected.

Diagnosis: Small endogean species with short appendages. Ozophores short, dorsolaterally orientated. Integument of dorsal scutum uniformly and relatively densely covered with rounded to oval convex tubercles. Terminal lobe of the spermatopositor widely rounded, with protruding bases of setae terminales. Receptacula seminis sigmoid. Coxal lobes II longer than wide (at their narrower part); coxal lobes III in males shorter than coxal lobes IV. Telotarsi I and IV are more than three times as long as wide in their median part; adenostyle tubular. Pores of anal glands widely separated and terminally orientated. Longitudinal carina on male anal plate wide, not pronounced. Opisthosomal laterodorsal folds absent in females absent.

Description: Male holotype body length 1.68 mm (male paratypes 1.56–1.68 mm, gynandromorph 1.72 mm); body uniformly brown in colour.

Scutum: anterior margin of dorsal scutum (Fig. 10F) with closely situated terminal bristles. Ozophores short, shorter than wide (in their base), laterally orientated. Granulation of opisthosomal part of dorsal scutum (medial area) as in Figure 10C and D. The convex tubercles round to oval in shape, uniformly and relatively densely distributed; granules of second rank small.

Anal plate with wide, low longitudinal carina; posterior margin of dorsal scutum convex. Pores of anal glands laterally situated on elongated transversal tubercle (Fig. 10E), terminally orientated.

Chelicerae short (Fig. 9F): basal article 0.75 mm long; second article 0.66 mm long.

Pedipalps short (Fig. 9E), 1.27 mm long (without coxa and apotele); apotele short.

Legs short. Tarsus I shape as in Figure 9C. Telotarsus I : w (at the midpoint of its length) ratio – 3.5. Telotarsus IV (1 : w ratio – somewhat more than 3) with adenostyle on the first third of its length (Fig. 9D); adenostyle tubular (Fig. 9G); sensory setae (positioned on proximal basal part of the adenostyle) longer than adenostyle.

Measurements of legs (without coxae and claws, in mm): I = 1.86; II = 1.59; III = 1.395; IV = 1.74.

Ventral prosomal complex (Fig. 9B): coxal lobes II longer than wide at their narrower part; abruptly narrowing posteriorly on the first half of their length; coxal lobes III somewhat shorter than coxal lobes IV; conical processes of the coxal lobes IV situated closer to the posterior margin of the coxal lobes III than to the anterior margin of the gonostome.

Spermatopositor (Fig. 9A) – distal margin of terminal lobe widely rounded in shape with protruding bases of setae terminales. Setae terminales equally distant from each other, median pair slightly longer than lateral pair; setae dorsales of almost equal width in their basal part. Lateral movable fingers elongated, longer than median movable fingers.

Description of the female: 1.66–1.70 mm body length. Coxal lobes II longer than wide at their narrower part. Ovipositor apical lobes (Fig. 4C) with sigmoid receptacles, with enlarged bottom. Openings of receptacles situated at terminal half of the apical lobes. Each apical lobe bearing one multibranched and 14 simple setae. Opisthosomal laterodorsal folds absent.

Distribution and habitat: Known only from the type locality (Fig. 35B) as endogean form.

Remarks: By the shape of the receptacles this species shows some affinity to the Gjorgjevici phyletic line. However, it is this very character that indicates that the species could be singled out in a separate complex of the genus CYPHOPHTHALMUS – Thracian species complex (together with some other species not mentioned in this paper) related to the Gjorgjevici phyletic line. A female specimen I have studied from Evros region in Thrace, Greece is closely related to this species but clearly different in the shape of the ventral prosomal complex and the shape of the receptacles (Fig. 4D). This is evidently another species of the Thracian complex which should be described based on more specimens, including males. This specimen collected by J. Gruber is deposited in the Vienna Museum collection. The other related species I have superficially studied are from Greek Thrace, eastern Thessaly, and Halkidiki. All species from the Thracian complex show affinity to the cave species C. paragamiani sp. nov. from Peloponnesus.

CYPHOPHTHALMUS MINUTUS (KRATOCHVIL, 1938)
(FIGS 5A, 11, 12)


*Cyphophthalmus minutus*: Boyer et al., 2005: 565.

**Material examined:** Škrabuljica Cave, Mali Orah, Snježnica Mountain, Konavli, Dalmatia (Croatia), 7.xi.2003, leg. R. Ozimec, 1 ♀ neotype, 3 ♂ ♀ topotypes. The neotype (inv. no. OP11101) and topotypes are deposited in the Roman Ozimec Collection (ROC), part of the Croatian Biospeleological Society Collection (CBSC), hosted by the Croatian Natural History Museum (CNHM) in Zagreb. I designate here the neotype according to ICZN Article 75 as is required when the type specimen is believed to be lost and it is necessary to define the nominal taxon objectively.

**Diagnosis:** Small troglobite species with elongated appendages. The integument of the dorsal scutum uniformly covered with small, oval convex tubercles. The distal margin of the terminal lobe of the spermatopositor elongated and rounded, protruding terminally. The medial pair of setae terminales positioned on the protrusion. Receptacula seminis saccate. Coxal lobes II, at their narrower part, wider than long; coxal lobes III in males are equal in length to coxal lobes IV. Telotarsi I are more than four times as long as wide in their median part (Telotarsi IV somewhat more than three times). Adenostyle spiniform, elongated (Fig. 11H); sensory seta (positioned on proximal basal part of the adenostyle) somewhat longer than adenostyle.

Measurements of legs (without coxae and claws, in mm): I = 2.12; II = 1.88; III = 1.67; IV = 1.92.

**Ventral prosomal complex (Fig. 11B):** coxal lobes II wider (at their narrowest part) than long; abruptly narrowing posteriorly at the midpoint of their length. Coxal lobes III are of equal length to coxal lobes IV; conical processes of the coxal lobes IV are somewhat closer to the anterior margin of the gonostome than to the posterior margin of the coxal lobes III.

Spermatopositor (Fig. 11A) – distal margin of terminal lobe elongated, rounded in shape, terminally with protruding base of median pair of setae terminales. Setae terminales equal in length and equally distant from each other; median setae ventrales narrower in their basal part than lateral setae ventrales. Median movable fingers surpassing in their length the most terminal parts of lateral movable fingers; lateral movable fingers elongated and smooth.

**Description:** Male neotype body length 1.62 mm. Body uniformly light amber yellowish in colour.

Scutum: anterior margin of dorsal scutum (Fig. 12F) with closely situated terminal bristles. Ozo- phores longer than wide (in their base), dorsolaterally orientated. Granulation of opisthosomal part of dorsal scutum (medial area) as in Figure 12C and D. The uniformly distributed small convex tubercles are oval in shape. Granules of second rank small and densely distributed.

The anal plate with wide, low longitudinal carina, posterior margin of dorsal scutum slightly concave. Pores of anal glands laterally situated on short transversal tubercles (Fig. 12E), terminally orientated. Compared with all other *Cyphophthalmus* species from the Dinaric lineage, the pores are not so distinctly positioned from each other as in other species. Chelicerae elongated (Fig. 11G): basal article 0.90 mm long; second article 0.85 mm long.

Pedipalps elongated (Fig. 3C), 1.46 mm long (without coxa and apotele); apotele elongated.

**Distribution and habitat:** Known only from the type locality (Fig. 36A) as troglobite.

**Remarks:** A whole complex of troglobite species related to this species is found in a wide area of the western Balkan Peninsula, from southern Dalmatia and eastern Herzegovina to south-eastern Montenegro. Except for the easternmost caves in the distribution area of this complex, all other caves are located at altitudes of over 500 m. (It is worth noting that in caves located at lower altitudes in the same area troglobitic species of the *C. teyrovskyi* complex occur.) Lack of comparative material significantly hindered determination of the status of troglobite populations of Cyphophthalmi closely related to *C. minutus*. Only recently did Roman Ozimec find a cave in the locality Mali Orah in Snježnica Mountain, the same locality (referred to slightly differently as Mali ora) where Kratochvíl (1938) in ‘an unnamed cave’ found and described the species *C. minutus*. As Mali Orah is the only locality known by this name in the small Snježnica Mountain, and the cave Škrabuljica is the Snježnica Mountain, and the cave Škrabuljica is the...
only cave in this area, there is no doubt that this is the type locality of this species. In this cave two troglobite Cyphophthalmus species were found. Specimens of one of them correspond fully with the type description of C. minitus.

The definite status of the population from the cave Vilina Jama (Karaman, 1993) as well as of many others close to this species from a wider area of the southern Dinaric Alps will be a subject of a separate study.

**CYPHOPHTHALMUS GORDANI SP. NOV.**

(Figs 2F, 5B, 13, 14)

Cyphophthalmus gordani: Boyer et al., 2005: 565 nomen nudum.

**Material examined:** Unnamed small cave in Čafa pjes-atica by Fundina, Podgorica, Montenegro, 21.ii.2001 leg. I. Karaman: 1 ♂ holotype, 3 ♂♂ and 9 ♀ paratypes; ibid. 6.ii.1997, 5 ♂♂, 10 ♀; ibid., 9.1.1993, 8 ♂♂, 10 ♀; ibid., ix.1997, 1 ♂♂, 2 ♀.

Holotype (inv. no. 1316/1), and paratypes are deposited in the author's collection at the Department of Biology, University of Novi Sad (Serbia).

**Etymology:** The species is dedicated to Dr Gordan Karaman, renowned carcinologist from Podgorica, Montenegro.

**Diagnosis:** Medium sized, troglobite species with elongated appendages. Integument of dorsal scutum uniformly covered with sparse oval to elongated small convex tubercles. Distal margin of the terminal lobe of the spermatopositor widely rounded and protruding terminally. Setae terminales positioned on protrusions. Receptacula seminis saccate. Coxal lobes II, at their narrowest part, somewhat wider (at their narrowest part) than long; abruptly narrowing posteriorly almost at the midpoint of their length. Conical processes of the coxal lobes IV are somewhat closer to the posterior margin of the coxal lobes III than to the anterior margin of the gonostome, situated from anterior margin of the gonostome for about one-seventh of the whole length of coxal lobes II–IV. Spermatopositor (Fig. 13A) – distal margin of terminal lobe short, rounded in shape, terminally with protruding bases of setae terminales. Setae terminales equally distant from each other, median pair slightly longer than the lateral pair; setae ventrales of almost equal width in their basal part. Median movable fingers surpassing in their length the most terminal parts of lateral movable fingers; lateral movable fingers elongated and smooth.

**Description of the female:** 1.72–1.94 mm body length. Ovipositor apical lobes (Fig. 5B) with saccate receptacles. Openings of receptacles situated halfway along the apical lobes. Each apical lobe bearing one multibranched and 13 simple setae. Opisthosomal laterodorsal folds present and pronounced.

**Distribution and habitat:** Known only from the type locality – limestone cave from the slopes of Žijevo Mountain above Podgorica, Montenegro (Fig. 36A).

**Remarks:** The species clearly belongs to the Dinaric phyletic line (Karaman, 2005b). It may represent the sister group of the remaining Dinaric troglobitic species (C. ognjenovici and C. teyrovskyi species complex united and presented as C. minitus complex in Boyer et al., 2005). It is found at the south-eastern end of the known distribution of the Dinaric phyletic line.
**CYPHOPHTHALMUS NERETVANUS SP. NOV.**

*(Figs 5C, 15, 16)*

**Material examined:** Pit Jama Bobaj 2 by Kula Norinska, valley of Neretva river, Dalmatia (Croatia), 400 m a.s.l., 6.v.2001 leg B. Jalžić: 1 ♂ holotype; 5 ♂, and 4 ♀ female paratypes.

Holotype (inv. no. OP10101), 3 ♂ and 2 ♀ paratypes are deposited in the Roman Ozimec Collection (ROC), part of the Croatian Biospeleological Society Collection (CBSC), hosted by the Croatian Natural History Museum (CNHM) in Zagreb; 2 ♂ and 2 ♀ paratypes in the author’s collection at the Department of Biology and Ecology, University of Novi Sad (Serbia).

**Etymology:** After the name of the Neretva river, on the edge of whose valley is the locality Jama Bobaj 2.

**Diagnosis:** Medium sized troglobite species with slightly elongated appendages. Integument of dorsal scutum uniformly covered with sparse and oval small convex tubercles. Distal margin of the terminal lobe of the spermatositor slightly elongated and rounded terminally, with equally distant setae terminales. Receptacula seminis saccate. Coxal lobes II, at their narrowest part, somewhat wider than long; coxal lobes III in males as long as coxal lobes IV. Telotarsi I and IV are 3.5 times as long as wide in their median part. Adenostyle tubular and short. Pores of anal glands slightly elongated appendages. Integument of dorsal scutum (medial area) as in Figure 16C and D. The sparsely distributed small convex tubercles oval in shape. Granules of second rank large.

**Description:** Male holotype body length 1.7 mm (male paratypes 1.66–1.86 mm). Body uniformly amber – yellowish in colour.

Scutum: anterior margin of dorsal scutum (Fig. 16F) with closely situated terminal bristles. Ozo- phores as long as wide in their bases, dorsolaterally orientated. Granulation of opisthosomal part of dorsal scutum (medial area) as in Figure 16C and D. The sparsely distributed small convex tubercles oval in shape. Granules of second rank large.

Anal plate with wide, low longitudinal carina; posterior margin of dorsal scutum slightly concave. Pores of anal glands laterally situated on transversal tubercles (Fig. 16E), terminally orientated.

Chelicerae elongated (Fig. 15F): basal article 0.90 mm long; second article 0.84 mm long.

Pedipalps elongated (Fig. 15E), 1.62 mm long (without coxa and apotele); apotele elongated.

Legs elongated. Tarsus I shape as in Figure 15C. Telotarsus I l : w (at the midpoint of its length) ratio 3.5. Telotarsus IV (l : w ratio – 3.5) with adenostyle on the first third of its length (Fig. 15D); adenostyle tubular (Fig. 15G); sensory seta (positioned on proximal basal part of the adenostyle) longer than adenostyle.

Measurements of legs (without coxae and claws, in mm): I = 2.32; II = 1.94; III = 1.70; IV = 2.05.

Ventral prosomal complex (Fig. 15B): coxal lobes II wider (at their narrowest part) than long; abruptly narrowing posteriorly almost at the midpoint of their length. Coxal lobes III and coxal lobes IV almost of equal length; conical processes of the coxal lobes IV are closer to the posterior margin of the coxal lobes III than to the anterior margin of the gonostome; situated from the anterior margin of the gonostome for somewhat less than one-quarter of the whole length of coxal lobes II–IV.

Spermatositor (Fig. 15A) – distal margin of terminal lobe slightly elongated and terminally rounded with equally distant setae terminales. Median pair of setae terminales slightly longer than lateral setae terminales; setae dorsales membranous and of almost equal width in their basal part. Median movable fingers surpassing in their length the most terminal parts of the lateral movable fingers.

Description of the female: 1.80–1.96 mm body length. Coxal lobes II wider (at their narrower part) than long. Ovispositor apical lobes (Fig. 5C) with saccate receptacles. Openings of receptacula seminis situated at the midpoint of the apical lobes. Each apical lobe bearing one multibranched and 13 simple setae. Opisthosomal laterodorsal folds present, slightly pronounced.

**Distribution and habitat:** Known only from the type locality – a limestone pit (Fig. 36A).

**Remarks:** The species clearly belongs to the Dinaric phyletic line (Karaman, 2005b) with an unclear phylogenetic position at this moment.

**CYPHOPHTHALMUS KRATOCHVILI SP. NOV.**

*(Figs 17, 18)*

**Material examined:** Škrabuljica Cave, Mali Orah, Snježnica Mountain, Konavli, Dalmatia (Croatia), 7.xi.2003, leg. R. Ozimec, 1 ♂ holotype, 1 ♂ paratype; ibid., 7.xi.2003, leg. M. Lukić, 1 ♂ paratype, 1 ♀ paratype.

Holotype (inv. no. OP12503), 1 ♂ and 1 ♀ paratypes are deposited in ROC, part of CBSC, hosted by CNHM in Zagreb; 1 ♀ paratype in the author’s collection at the Department of Biology and Ecology, University of Novi Sad (Serbia).
**Etymology:** The species is dedicated to Dr J. Kratochvíl, renowned Czech arachnologist, who has made a remarkable contribution to the knowledge of Balkan Cyphophthalmi.

**Diagnosis:** Medium sized, troglobite species with slightly elongated appendages. Integument of dorsal scutum uniformly and densely covered with big oval convex tubercules. Distal margin of the terminal lobe of the spermatopositor elongated, widely conical in shape. Medial pair of setae terminales widely separated. Coxal lobes II, at their narrowest part, wider than long; coxal lobes III in males remarkably longer than coxal lobes IV. Telotarsi I are 4.5 times as long as wide in their median part (telotarsi IV somewhat more than 3x). Adenostyle spiniform, short. Pores of anal glands distant from each other and terminally orientated. Longitudinal carina on male anal plate wide and not pronounced. Opisthosomal laterodorsal folds in females present and pronounced.

**Description:** Male holotype body length 1.76 mm (1.74–1.86 mm). Body uniformly light brown in colour.

Scutum: anterior margin of dorsal scutum with closely separated terminal bristles. Ophores slightly longer than wide (at their base), dorsolaterally orientated (Fig. 18F). Granulation of opisthosomal part of dorsal scutum (medial area) as in Figure 18C and D. The convex tubercules are big, oval in shape and uniformly and densely distributed. Granules of second rank small and sparsely distributed. Anal plate with wide, low longitudinal carina; posterior margin of dorsal scutum slightly concave. Pores of anal glands laterally situated on elongated transversal tubercules (Fig. 18E), terminally orientated. Granules of second rank small and sparsely distributed. Analsegment with wide, low longitudinal carina; posterior margin of dorsal scutum slightly concave. Pores of anal glands laterally situated on elongated transversal tubercules (Fig. 18E), terminally orientated. Granules of second rank small and sparsely distributed. Analsegment with wide, low longitudinal carina; posterior margin of dorsal scutum slightly concave. Pores of anal glands laterally situated on elongated transversal tubercules (Fig. 18E), terminally orientated.

Chelicerae elongated (Fig. 17F): basal article 0.87 mm long; second article 0.81 mm long. Pedipalps elongated (Fig. 17E), 1.63 mm long (without coxa and apotele); apotele short.

Legs elongated. Tarsus I shape as in Figure 3A. Telotarsus I 1 : w (at the midpoint of its length) ratio = 4.5. Telotarsus IV (1 : w ratio – somewhat more than 3) with adenostyle on the beginning of the second third of its length (Fig. 3B); adenostyle spiniform, short (Fig. 3E); sensory seta (positioned on proximal basal part of the adenostyle) longer than adenostyle. Measurements of legs (without coxa and claws, in mm): I = 2.28; II = 1.80; III = 1.61; IV = 1.97.

The ventral prosomal complex (Fig. 17B): coxal lobes II wider (at their narrowest part) than long; abruptly narrowing posteriorly at the midpoint of their length, posterior margin of the wider part of coxal lobes II almost parallel with the frontal margin. Coxal lobes III are remarkably longer than coxal lobes IV; conical processes of the coxal lobes IV are somewhat closer to the posterior margin of the coxal lobes III than to the anterior margin of the gonostome.

Spermatopositor (Fig. 17A) – distal margin of the terminal lobe widely conical in shape, elongated. Median pair of setae terminales widely separated, longer than lateral pair. Median setae ventrales narrower in their basal part than lateral setae ventrales. Median movable fingers surpassing in their length the most terminal parts of the lateral movable fingers; lateral movable fingers elongated and smooth.

Description of the female: 1.96 mm body length. Coxal lobes II wider (at their narrowest part) than long. Opisthosomal laterodorsal folds present and pronounced. The ovipositor of the only female specimen was unfortunately lost during dissection.

**Distribution and habitat:** Known only from the type locality – a limestone cave (Fig. 36A).

**Remarks:** This species occurs sympatrically with C. minutus, to which it is phyletically related. Morphoanatomically, it can be assumed to be a more recent troglobite than C. minutus. In mixed material the species is easily distinguished by its distinctive differences as regards elongation of chelicerae, ophores, and body dimensions. In addition to the cave Škrabuljica, I recorded the sympatric occurrence of two species of the genus Cyphophthalmus in the caves Vela spila (locus typicus of C. montenegrinus) and the nearby Vilina pećina in south-eastern Montenegro. In these caves, respectively, species close to C. teyrovsyki and C. minutus can be found. In Snježnica Mountain (and a considerably wider area) the third species of this genus, the endogeann C. martensi sp. nov. occurs.

**Cyphophthalmus conocephalus sp. nov.**

**(FIGS 19, 20)**

**Material examined:** Cave Vizbaba, Bijeljani, Dabarsko Polje, East Herzegovina, (Bosnia and Herzegovina), 17.vi.2003, leg. I. Karaman, 1 ♀.

Male holotype (inv. no. 1521) is deposited in the author’s collection at the Department of Biology, University of Novi Sad (Serbia).

**Etymology:** After conical protrusion of frontal prosomal margin.

**Diagnosis:** Small troglobite species with slightly elongated appendages. Anterior margin of dorsal scutum with frontally orientated conical protrusion. Integument of dorsal scutum uniformly covered with sparsely distributed oval convex tubercles. Distal margin of the terminal lobe of the spermatopositor...
short, widely conical in shape and slightly protruding terminally. Medial pair of setae terminales positioned on the protrusion. Coxal lobes II, at their narrowest part, wider than long; coxal lobes III and IV are almost equal in length. Telotarsi I are 4.5 times as long as wide in their median part (telotarsi IV almost 4x). Adenostyle spiniform, short. Pores of anal glands distant from each other and terminally orientated. Longitudinal carina on male anal plate wide and not pronounced. Opisthosomal laterodorsal folds in females present.

**Description:** Male holotype body length 1.60 mm, body uniformly light brown in colour.

Scutum: anterior margin of dorsal scutum (Fig. 20A, B, F) with frontally orientated conical protrusion. The protrusion is granulated like the rest of the scutum, below with closely situated terminal bristles. Ozophores as long as wide (at their base), dorsolaterally orientated. Granulation of opisthosomal part of dorsal scutum (medial area) as in Figure 20C and D. The convex tubercles are small, oval in shape and uniformly distributed. Transversal rows of convex tubercles on the posterior margin of segments are slightly pronounced. Granules of second rank small and relatively densely distributed.

Anal plate with wide, low longitudinal carina; posterior margin of dorsal scutum slightly concave. Pores of anal glands laterally situated on transversal tubercles (Fig. 20E), terminally orientated.

Chelicerae elongated (Fig. 19F): basal article 0.81 mm long; second article 0.74 mm long.

Pedipalps elongated (Fig. 19E), 1.41 mm long (without coxa and apotele); apotele elongated.

Legs elongated. Tarsus I shape as in Figure 19C. Telotarsi I l : w (at the midpoint of its length) ratio – 4.5. Telotarsi IV (l : w ratio – almost 4) with adenostyle on the beginning of the second third of its length (Fig. 19D); adenostyle spiniform (Fig. 19G); sensory setae (positioned on proximal basal part of the terminal lobe of the spermatopositor short, rounded terminally. Coxal lobes II, at their narrowest part, remarkably wider than long; coxal lobes III in males are longer than coxal lobes IV. Telotarsi I are 4.5 times as long as wide in their median part (telotarsi IV almost 4x). Adenostyle spiniform, short. Pores of anal glands distant from each other and terminally orientated. Longitudinal carina on male anal plate wide and not pronounced. Opisthosomal laterodorsal folds in females present.

**Distribution and habitat:** Known only from the type locality, a limestone cave (Fig. 36A).

**Remarks:** In the same cave a subadult female specimen was collected and sent to Giribet’s laboratory at Harvard University for molecular analysis, which unfortunately failed. It is significant to note that also in this specimen the anterior margin of the dorsal scutum had the characteristic conical protrusion. Therefore, this peculiar characteristic cannot be regarded as an aberration in the single specimen analysed in the present paper. This unusual characteristic, so far unrecorded in Cyphophthalmi, is found in various opilion groups, independently and in various forms, and its functional significance is not clear. It may be considered a form of atavism.

**Cyphophthalmus trebinjanus sp. nov.**

(Figs 5D, 21, 22)

Cyphophthalmus trebinjanum: Boyer et al., 2005: 565 nom. nudum.

**Material examined:** Vučija pećina Cave, Leotar, Trebinje, eastern Herzegovina (Bosnia and Herzegovina), 16.vi.2003, leg. I. Karaman, 1 ♀ holotype, 9 ♂, 6 ♀ paratypes.

Holotype (inv. no. 1416) and paratypes are deposited in the author’s collection at the Department of Biology and Ecology, University of Novi Sad (Serbia).

**Etymology:** After the name of the town Trebinje, in the surroundings of which is the locus typicus of the species.

**Diagnosis:** Small, troglobite species with elongated appendages. Integument of dorsal scutum uniformly covered with oval convex tubercles. Distal margin of the terminal lobe of the spermatopositor short, rounded terminally. Coxal lobes II, at their narrowest part, remarkably wider than long; coxal lobes III in males are longer than coxal lobes IV. Telotarsi I are 4.5 times as long as wide in their median part (telotarsi IV almost 4x). Adenostyle spiniform, short. Pores of anal glands distant from each other and terminally orientated. Longitudinal carina on male anal plate wide and not pronounced. Opisthosomal laterodorsal folds in females present.

**Description:** Male holotype body length 1.50 mm (1.48–1.56 mm); body uniformly brown in colour.

Scutum: anterior margin of dorsal scutum (Fig. 22F) with closely paired terminal bristles. Ozophores short, as long as wide (in their base), dorsolaterally orientated. Granulation of opisthosomal part of dorsal scutum (medial area) as in Figure 22C and
D; convex tubercles are small, oval in shape, and uniformly distributed. Transversal rows of convex tubercles on the posterior margin of segments are bigger and slightly pronounced. Granules of second rank small and relatively densely distributed.

Anal plate with wide, low longitudinal carina; posterior margin of dorsal scutum slightly concave. Pores of anal glands laterally situated on elongated transversal tubercle (Fig. 22E), terminally orientated.

Chelicerae elongated (Fig. 21F): basal article 0.81 mm long; second article 0.75 mm long. Pedipalps elongated (Fig. 21E), 1.46 mm long (without coxa and apotele); apotele elongated.

Legs elongated. Tarsus I shape as in Figure 21C. Telotarsus I l : w (at the midpoint of its length) ratio – 4.5. Telotarsus IV l : w ratio – almost 4) with adenostyle on the end of the first third of its length (Fig. 21D); adenostyle spiniform (Fig. 21G); sensory seta (positioned on proximal basal part of the adenostyle) longer than adenostyle. Claws I elongated. Claws IV falciform, terminally slightly flattened.

Measurements of legs (without coxae and claws, in mm): I = 2.01; II = 1.72; III = 1.52; IV = 1.77. Ventral prosomal complex (Fig. 21B): coxal lobes II remarkably wider (at their narrowest part) than long; abruptly narrowing posteriorly for the second half of their length. Coxal lobes III and IV are equal in length. Coxal lobes III longer than coxal lobes IV; conical processes of coxal lobes IV are somewhat closer to the anterior margin of the gonostome than to the posterior margin of coxal lobes III.

Spermatopositor (Fig. 21A) – distal margin of the terminal lobe short, terminally rounded. Median pair of setae terminales longer than lateral pair, equally distant from each other. Median setae ventrales narrower in their basal part than lateral setae ventrales. Median movable fingers surpassing in their length the most terminal parts of the lateral movable fingers; lateral movable fingers short and smooth.

Description of the female: 1.54–1.70 mm body length. Coxal lobes II wider (at their narrowest part) than long. Ovipositor apical lobes short with saccate receptacles. Receptacula seminis opening at the midpoint of the length of the apical lobes. Each apical lobe bearing one multibranched and 13 simple setae. Opisthosomal laterodorsal folds present and remarkably pronounced.

Distribution and habitat: Known only from the type locality, a limestone cave (Fig. 36A).

Remarks: By some characteristics this species seems closely related to C. conocephalus, from which it is clearly different by the absence of the conical protrusion, the structure of spermatopositor, and the ventral prosomal complex. Molecular analyses showed the relationship of this species with species related to C. minutus (Boyer et al., 2005).

CYPHOPHTHALMUS OGNJENOVICI SP. NOV.
(FIGS 3E, 5E, 23, 24)
Cypophthalmus oganjnovici: Boyer et al., 2005: 565 nomen nudum

Material examined: Cave Lepirnica, Fatnica, Fatničko polje, eastern Herzegovina (Bosnia and Herzegovina), 18.vi.2003, leg. I. Karaman, 1 ♂ holotype, 35 ♂♂ and 18 ♀ paratypes.

Holotype (inv. no. 1520) and paratypes are deposited in the author’s collection at the Department of Biology and Ecology, University of Novi Sad (Serbia).

Etymology: The species is dedicated to Siniša Ognjenović, biospeleologist from Belgrade, who supplied me with very valuable cave material.

Diagnosis: Large, troglobite species with elongated appendages. Integument of dorsal scutum uniformly covered with sparsely distributed small, oval convex tubercles. Distal margin of the terminal lobe of the spermatopositor short, conical in shape, protruding terminally. Medial pair of setae terminales positioned on the protrusion. Coxal lobes II, at their narrowest part, wider than long; coxal lobes III and IV in males are equal in length. Telotarsi I are 5.5 times as long as wide in their median part (telotarsi IV somewhat more than 4×). Adenostyle spiniform, elongated. Pores of anal glands distant from each other and terminally orientated. Longitudinal carina on male anal plate wide and not pronounced. Opisthosomal laterodorsal folds in females present and slightly pronounced.

Description: Male holotype body length 1.90 mm (1.76–1.94 mm); body uniformly amber yellow in colour. Scutum: anterior margin of dorsal scutum with closely paired terminal bristles. Ozophores longer than wide (in their base), dorsolaterally orientated (Fig. 24F). Granulation of opisthosomal part of dorsal scutum (median area) as in Figure 24C and D; convex tubercles are small, oval in shape, and sparsely distributed. Granules of second rank small and relatively densely distributed.

Anal plate with wide, low longitudinal carina; posterior margin of dorsal scutum straight. Pores of anal glands laterally situated on elongated transversal tubercles (Fig. 24E), terminally orientated.

Chelicerae elongated (Fig. 23F): basal article 0.99 mm long; second article 0.95 mm long. Pedipalps elongated (Fig. 23E), 1.72 mm long (without coxa and apotele); apotele elongated.

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Legs elongated. Tarsus I shape as in Figure 23C. Telotarsus I : w (at the midpoint of its length) ratio – 5.5. Telotarsus IV : w ratio – somewhat more than 4) with adenostyle on the second third of its length (Fig. 23D); adenostyle strong, elongated, and spiniform (Fig. 23G); sensory seta (positioned on proximal basal part of the adenostyle) as long as adenostyle. Claws markedly elongated. Claws IV strong, sickle basal part of the adenostyle) as long as adenostyle.

Measurements of legs (without coxae and claws, in mm): I = 2.59; II = 2.34; III = 2.01; IV = 2.31.

Ventral prosomal complex (Fig. 23B): coxal lobes II wider (at their narrowest part) than long; abruptly narrowing posteriorly for the second half of their length. Coxal lobes III and IV are equal in length; conical processes of the coxal lobes IV are close to the anterior margin of the gonostome.

Spermatopositor (Fig. 23A) – distal margin of the terminal lobe short, conical in shape, protruding terminally. Medial pair of setae terminales closely paired on the protrusion, somewhat longer than lateral pair. Median setae ventrales narrower in their basal part than lateral setae ventrales. Median movable fingers short, not reaching in their length the most terminal parts of the lateral movable fingers; lateral movable fingers short, smooth, falciform.

Description of the female: 1.86–2.04 mm body length. Coxal lobes II wider (at their narrowest part) than long. Ovipspositor apical lobes short with saccate receptacles (Fig. 5E). Receptacula seminis opening on the terminal half of the apical lobes. Each apical lobe bearing one multibranched and 13 simple setae. Opisthosomal laterodorsal folds present and slightly pronounced.

Distribution and habitat: Known only from the type locality as a true troglobite (Fig. 36A).

Remarks: At the time of my visit to this cave the population was extremely numerous, which is unusual for cavernicolous Cyphophthalmi. I have encountered similarly large populations in species related to C. teyrovskyi. From the pit Golubinka (near the cave Vizbaba, locus typicus of C. conocephalus sp. nov.) on the neighbouring karstic field Dabarsko Polje, a male closely related to this species was collected. It shows some differences in the shape of the spermatopositor terminal lobe and ventral prosomal complex. The final conclusion about its taxonomic status will be possible only after more specimens are studied.

Cyphophthalmus martensi sp. nov.
(Figs 5G, 6C, 25, 26)


Cyphophthalmus martensi: Boyer et al., 2005: 564 nomen nudum.


Holotype (inv. no. 1172) and paratypes are deposited in the author's collection at the Department of Biology and Ecology, University of Novi Sad (Serbia). Paratypes from Zavala in Eastern Herzegovina and from Kuna on Mount Snježnica are deposited in the Jochen Martens collection in Mainz, and the Croatian Natural History Museum in Zagreb, respectively.

Etymology: The species is dedicated to Professor Jochen Martens, renowned zoologist, whose outstanding study of Opiliones strongly influenced my work.

Diagnosis: Medium sized endogean species. Integument of dorsal scutum uniformly and densely covered with slightly elongated oval convex tubercles. Terminal lobe of the spermatopositor wide with equally distant setae terminales. Coxal lobes II, at their narrowest part, as long as wide; coxal lobes III in males are shorter than coxal lobes IV. Telotarsi I and IV are somewhat more than three times as long as wide in their median part. Adenostyle tubular, elongated. Pores of anal glands distant from each other and terminally orientated. Longitudinal carina on male anal plate wide and not pronounced. Opistho-
somal laterodorsal folds in females present and slightly pronounced. Receptacles with an attenuated bottom.

**Description:** Male holotype body length 1.82 mm (1.70–1.92 mm); body uniformly brown to brown yel-

**Distribution:** The species is known from a wide area, distributed across south-western Montenegro, south-

**Remarks:** Specimens of this species from the locality Zavala in eastern Herzegovina were partly illustrated (sub *Siro duricorius*) by Martens (1978). *Cyphophthalmus martensi* sp. nov. is closely related to the endogean species *C. duricorius* and *Cyphophthalmus rumijae* sp. nov., and in contrast to these species it occurs as endogean in somewhat more arid terrain. At the localities Dubrovnik, Trsten, and Zavala (western part of *C. martensi* sp. nov. distribution), another endogean species from the Dinaric phyletic line occurs sympatrically. Despite the other species being somewhat smaller, it is difficult to separate them for sure without study of dissected specimens. The main differences between the two species are in the spermatopositor structure, distance between anal pores, form of receptacles, and slightly in the shape of coxal lobes. Description of the second species is in progress.

**CYPHOPHTHALMUS RUMIJAE SP. NOV.**

(Figs 5F, 27, 28)


**Material examined:** Sutorman, Mount Rumija, Montenego 3.v.1991, leg. I. Karaman, 2♂, 2♀ paratypes; _ibid._, 4.v.1997, 1♂ holotype, 23♂, 43♀ paratypes; _ibid._, 1.vi.2001, 1♀ paratype.

Holotype (inv. no. 1230/4) and paratype specimens are deposited in the author’s collection at the Department of Biology and Ecology, University of Novi Sad (Serbia).

**Etymology:** After the name of Mount Rumija, where the specimens were collected.

**Diagnosis:** Small endogean species with short appendages. Integument of dorsal scutum uniformly covered with small, slightly elongated oval convex tubercles, sparsely distributed. Spermatopositor terminal lobe slightly elongated, conical in shape. Coxal lobes II longer than wide (at their narrowest part). Coxal lobes III in males are shorter than coxal lobes IV. Telotarsi I and IV are fewer than three times as long as wide in their median part. Adenostyle tubular, short. Pores of anal glands distant from each other and terminally

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Description: Male holotype body length 1.60 mm (male paratypes 1.49–1.68 mm); body uniformly brown to brown yellowish in colour.

Scutum: anterior margin of dorsal scutum with closely paired terminal bristles. Ozophores as long as wide (at their base), dorsolaterally orientated. Granulation of opisthosomal part of dorsal scutum (medial area) as in Figure 29C and D; convex tubercles small, slightly elongated oval in shape, sparsely distributed. Granules of second rank small, densely distributed.

Anal plate with wide, slightly pronounced longitudinal carina; posterior margin of dorsal scutum slightly concave. Pores of anal glands distant from each other, situated on small tubercles (Fig. 28E), terminally orientated.

Chelicerae short (Fig. 27F): basal article 0.70 mm long; second article 0.64 mm long.

Pedipalps short (Fig. 27E), 1.11 mm long (without coxa and apotele); apotele short.

Legs short. Tarsus I on the ventral side gradually tapering toward to the tip (Fig. 27C). Telotarsus I: w (at the midpoint of its length) ratio – somewhat less than 3. Telotarsus IV: w (at the midpoint of its length) ratio – somewhat less than 3) with adenostyle on the second quarter of its length (Fig. 27D). Adenostyle tubular (Fig. 27G); sensory seta (positioned on proximal basal part of the adeno-style) markedly longer than adenostyle. Claws short.

Measurements of legs (without coxae and claws, in mm): I = 1.65; II = 1.38; III = 1.23; IV = 1.56.

Ventral prosomal complex (Fig. 27B): coxal lobes II longer than wide (at their narrowest part); abruptly narrowing posteriorly at the midpoint of their length. Coxal lobes III shorter than coxal lobes IV; conical processes of the coxal lobes IV close to the posterior margin of the coxal lobes III, distance from the anterior margin of the gonostome about one-quarter of the whole length of coxal lobes II–IV.

Spermatopositor (Fig. 27A) – terminal lobe conical in shape, slightly elongated. Setae terminales equally distant from each other, median pair longer than lateral pair. Median movable fingers reaching the most terminal parts of the lateral movable fingers; lateral movable fingers short, stout and denticulated.

Description of the female: 1.50–1.70 mm body length. Coxal lobes II longer than wide (at their narrowest part). Ovipositor apical lobes short with saccate receptacles; receptacles short (Fig. 5F); openings of receptacula seminis situated at the terminal half of the apical lobes. Each apical lobes bearing one multibranched and 13 simple setae. Opisthosomal laterodorsal folds present and slightly pronounced.

Distribution and habitat: Known only from the type locality as endogeaneous in mixed deciduous forest (Fig. 36B).

Remarks: The species belongs to the Dinaric phyletic line and shows clear affinity to the endogeaneous species C. duricorius and C. martensi sp. nov. Interestingly, molecular analysis data showed this species to be phylogenetically more related to C. duricorius than to C. martensi sp. nov. (Boyer et al., 2005), which is geographically much closer to it and distributed between the distribution areas of the other two. From a locality near Budva (Fig. 36B) I have several specimens of a taxon related to this species, but its status needs clarification.

Cyphophthalmus corfianus (Kratochvıl, 1937)

Stat. Nov. (Figs 3A–B, 4E, 6A, 29, 30)

Siro duricorius corfianus Kratochvıl, 1938: 66–68.


Cyphophthalmus duricorius corfianus: Boyer et al., 2005: 564.


Diagnosis: Medium sized endogeaneous species with short appendages. Integument of dorsal scutum covered with large elongated convex tubercules. Spermatopositor terminal lobe broadly rounded, with equally distant setae terminales. Receptacles saccate with bifurcated bottom. Coxal lobes II somewhat longer than wide (at their narrowest part); coxal lobes III in males shorter than coxal lobes IV. Telotarsi I and IV are somewhat more than 2.5 times as long as wide in their median part. Adenostyle tubular. Pores of anal glands situated next to each other, ventrally orientated. Longitudinal carina on male anal plate markedly pronounced. Opisthosomal laterodorsal folds in females absent.

Description: Male body length 1.70 mm (1.56–1.74 mm). Body uniformly brown to light brown in colour.

Scutum: anterior margin of dorsal scutum (Fig. 30E) with closely situated terminal bristles. Ozophores as long as wide in their bases, laterally orientated. Granulation of opisthosomal part of dorsal scutum (medial area) as in Figure 30C and D.
convex tubercles are large, elongated, uniformly and relatively densely distributed; granules of second rank small.

Anal plate with laterally compressed, high, crest-shaped longitudinal carina (Fig. 3A, B); posterior margin of dorsal scutum rounded. Pores of anal glands situated next to each other (Fig. 30E, see arrow), ventrally orientated; followed dorsally by two transverse folds.

Chelicerae short (Fig. 29F): basal article 0.72 mm long; second article 0.65 mm long.

Pedipalps short (Fig. 29E), 1.25 mm long (without coxa and apotele).

Legs short. Tarsus I on ventral side gradually tapering toward the tip (Fig. 29C). Telotarsus I l : w (at the midpoint of its length) ratio – somewhat more than 2.5. Telotarsus IV l : w ratio – about 2.5 with adenostyle on the first third of its length (Fig. 29D); adenostyle tubular, short with widened base (Fig. 29G); sensory seta (positioned on proximal basal part of the adenostyle) somewhat shorter than adenostyle.

Measurements of legs (without coxae and claws, in mm): I = 1.86; II = 1.55; III = 1.39; IV = 1.74.

Ventral prosomal complex (Fig. 29B): coxal lobes II somewhat longer than wide at their narrowest part; abruptly narrowing posteriorly over the first half of their length. Coxal lobes III somewhat shorter than coxal lobes IV; conical processes of the coxal lobes IV close to the posterior margin of the coxal lobes III, distance from the anterior margin of the gonostome about one-quarter of the whole length of coxal lobes II–IV.

Spermatopositor (Fig. 29A) – terminal lobe broadly rounded, terminally widened. Median pair of setae terminales somewhat longer than lateral pair. Median setae ventrales narrower in their basal parts than lateral setae ventrales. Median movable fingers short, not reaching in their length the most terminal parts of the lateral movable fingers; lateral movable fingers strong, elongated and slightly denticulated.

Description of the female: 1.68–1.92 mm body length. Coxal lobes II somewhat longer than wide (at their narrowest part). Ovipositor apical lobes with elongated (more than four times as long as wide) receptacles (Fig. 4E); receptacles are saccate with bifurcate bottom, opening on at the midpoint of the length of apical lobes. Each apical lobe bearing one multibranched and 13 simple setae. Opisthosomal laterodorsal folds absent.

Distribution and habitat: Endogean on Corfu Island in Ionian sea and neighbouring inland area in Epirus, Greece (Fig. 35B).

Remarks: A whole range of characters makes this species clearly related to the Aegean phyletic line, and not to the Dinaric line to which C. duricorius belongs. On Lefkas Island in the Ionian Sea there is another yet unidentified species that is closely related to the inland species C. eratoae, and not to C. corfuanus.

**CYPHOPHTHALMUS ZETAEE SP. NOV.**

(FIGS 4F, 6B, 31, 32)

**Material examined:** Milovićka vrela, Tunjevo, Danilovgrad, Montenegro, 26.iv.1997, leg. I. Karaman, 1 $\varphi$ holotype, 39 $\sigma'$, 45 $\varphi$, 2 juv.; ibid., 11.iv.1997, 7 $\sigma'$, 6 $\varphi$, 1 juv.; ibid., 1.viii.1989, 6 $\varphi$, 1 juv.; ibid., 6.v.2003, 4 $\sigma'$, 7 $\varphi$, 1 juv.

Holotype (inv. no. 1228/2) and paratype specimens are deposited in the author’s collection at the Department of Biology and Ecology, University of Novi Sad (Serbia).

**Etymology:** After the name of Zeta river, in which valley is the locus typicus.

**Diagnosis:** Small endogean species with short appendages. Integument of dorsal scutum uniformly covered with densely distributed, markedly elongated convex tubercles. Spermatopositor terminal lobe short, terminally truncated. Coxal lobes II somewhat longer than wide (at their narrowest part). Coxal lobes III in males are shorter than coxal lobes IV. Telotarsi I and IV are somewhat more than three times as long as wide in their medial part. Adenostyle spiniform. Pores of anal glands slightly distant from each other and ventrally orientated. Longitudinal carina on male anal plate narrow and pronounced. Opisthosomal laterodorsal folds in females absent.

**Description:** Male holotype body length 1.70 mm (male paratypes 1.60–1.80 mm); body uniformly brown in colour.

Scutum: anterior margin of dorsal scutum (Fig. 32F) with closely paired terminal bristles. Ozo- phores as long as wide (in their base), laterally orientated. Granulation of opisthosomal part of dorsal scutum (medial area) as in Figure 32C and D; convex tubercles are markedly elongated and densely distributed. Granules of second rank small and relatively densely distributed.

Anal plate with narrow, pronounced longitudinal carina; posterior margin of dorsal scutum rounded. Pores of anal glands slightly distant from each other, situated on short transversal tubercle (Fig. 32E), ventrally orientated.

Chelicerae short (Fig. 33F): basal article 0.74 mm long; second article 0.65 mm long.
Pedipalps short (Fig. 33E), 1.27 mm long (without coxa and apotele).

Legs short. Tarsus I shape as in Figure 33C. Telotarsus I l : w (at the midpoint of its length) ratio – somewhat more than 3. Telotarsus IV (l : w ratio – somewhat more than 3) with adenostyle on the first third of its length (Fig. 33D); Adenostyle with widened basal part, spiniform (Fig. 33G); sensory seta (positioned on proximal basal part of the adenostyle) somewhat longer than adenostyle. Claws short.

Measurements of legs (without coxae and claws, in mm): I = 1.90; II = 1.55; III = 1.39; IV = 1.68.

Ventral prosomal complex (Fig. 33B): coxal lobes II somewhat longer than wide (at their narrowest part); abruptly narrowing posteriorly over the first half of their length. Coxal lobes III shorter than coxal lobes IV; conical processes of the coxal lobes IV close to the posterior margin of the coxal lobes III, distance from the anterior margin of the gonostome about one-quarter of the whole length of coxal lobes II–IV.

Spermatopositor (Fig. 33A) – terminal lobe short, almost rectangular in shape, terminally truncated. Lateral pair of setae terminales positioned on ventral side of terminal lobe. Median setae ventrales narrower in their basal parts than lateral setae ventrales. Median movable fingers short, not reaching in their length the most terminal parts of the lateral movable fingers; lateral movable fingers short, stout, with widened basal parts.

Description of the female: 1.66–1.88 mm body length. Coxal lobes II somewhat longer than wide (at their narrowest part). Ovipositor apical lobes slender, receptacles are saccate with bifurcate bottom, openings at the midpoint of the length of the apical lobes (Fig. 4F). Each apical lobe bearing one multibranched and 13 simple setae. Opisthosomal laterodorsal folds absent.

Distribution and habitat: Known only from the type locality (Fig. 36B).

Remarks: Populations related to this species collected in five separate and remote localities, to the northeast, east, and south of the type species locality (Fig. 36B), show certain characteristics indicating that they may be members of a separate taxon or species complex, which is supported by molecular data (Boyer et al., 2005). The definitive status can be determined only after a thorough study of endogean Cyphophthalmi in the wider area of Lake Skadar.

Compared with all other known Cyphophthalmus species from the Aegean phyletic line, this species and the related species complex are unique because the anal pores are situated away from each other.

CYPHOPHTHALMUS Hlavaci sp. nov.
(Figs 2B, 4G, 33, 34)


Holotype (inv. no. 1413) and paratypes are deposited in the author's collection at the Department of Biology and Ecology, University of Novi Sad (Serbia).

Etymology: Named after its collector, entomologist Peter Hlaváč from Košice (Slovakia).

Diagnosis: Large endogean species with short appendages. Integument of dorsal scutum uniformly covered with densely distributed large convex tubercles. Spermatopositor terminal lobe slightly elongated, widely conical in shape. Coxal lobes II somewhat longer than wide (at their narrowest part). Coxal lobes III in males are shorter than coxal lobes IV. Telotarsi I somewhat fewer than three times as long as wide in their median part. Adenostyle tubular. Pores of anal glands situated close to each other and ventrally orientated. Longitudinal carina on male anal plate narrow and pronounced. Opisthosomal laterodorsal folds in females absent.

Description: Male holotype body length 1.81 mm (male paratypes 1.74–2.00 mm); body uniformly dark brown in colour. Scutum: anterior margin of dorsal scutum (Fig. 34F) with widely separated terminal bristles. Ozophores short, shorter than wide (at their base), laterally orientated. Granulation of opisthosomal part of dorsal scutum (medial area) as in Figure 34C and D; convex tubercles oval and large, densely distributed. Granules of second rank small and densely distributed. Posterior margin of dorsal scutum rounded.

Anal plate with narrow, markedly pronounced longitudinal carina. Pores of anal glands close to each other situated on short protuberance, ventrally orientated (Fig. 34E).

Chelicerae short (Fig. 33F): basal article 0.70 mm long; second article 0.66 mm long.

Pedipalps short (Fig. 33E), 1.26 mm long (without coxa and apotele); apotele slightly elongated.

Legs short. Tarsus I shape as in Figure 33C. Telotarsus I l : w (at the midpoint of its length) ratio – somewhat less than 3. Telotarsus IV (l : w ratio – 3.5)

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with adenostyle on the first third of its length (Fig. 33D); Adenostyle tubular (Fig. 33G); sensory seta (positioned on proximal basal part of the adenostyle) longer than adenostyle. Claws short.

Measurements of legs (without coxae and claws, in mm): I = 1.86; II = 1.56; III = 1.42; IV = 1.75.

Ventral prosomal complex (Fig. 33B): coxal lobes II somewhat longer than wide (at their narrowest part); abruptly narrowing posteriorly over the first third of their length. Coxal lobes III shorter than coxal lobes IV; conical processes of the coxal lobes IV close to the posterior margin of the coxal lobes III, distance from the anterior margin of the gonostome about one-quarter of the whole length of coxal lobes II–IV.

Spermatopositor (Fig. 33A) – terminal lobe slightly elongated, widely conical in shape with protruding bases of medial pair of setae terminales. Median pair of setae terminales longer than lateral pair. Median movable fingers short, not reaching in their length the most terminal parts of the lateral movable fingers; lateral movable fingers elongated, slender, and falciform.

Description of the female: 1.70–2.10 mm body length. Coxal lobes II somewhat longer than wide (at their narrowest part). Ovipositor apical lobes slender, receptacles are saccate with bifurcate bottom, openings at the midpoint of the length of the apical lobes (Fig. 4G). Each apical lobe bearing one multibranched and 13 simple setae. Opisthosomal laterodorsal folds absent.

Distribution and habitat: Known from three localities on Mount Biokovo in middle Dalmatia (Fig. 36B), a region where a troglobite species complex (still undescribed) from the Dinaric phyletic line is widely present.

Remarks: The westernmost distribution amongst the Aegean phyletic line, with wide interrupted area toward its geographically closest related species C. zetae sp. nov., and its appearance in the middle of the primary distribution area of the Dinaric phyletic line make this species zoogeographically particularly interesting.

DISCUSSION AND REMARKS

On the basis of morphoanatomical characteristics and molecular data (Boyer et al., 2005) at least three distinct phylogenetic lines can be recognized in the genus Cyphophthalmus.

The first one, the Gjorgjevici phyletic line, is for now comprised of a taxon complex from the species C. gjorgjevici and C. ohridanus from western Macedonia; C. paragamiani sp. nov. from Peloponnesus with C. thracicus complex from Bulgaria and Greece; two Cyphophthalmus species (description in progress) from Croatia; and most likely C. paradoxus from western Mount Stara Planina in Bulgaria. The Gjorgjevici phyletic line can be defined as a heterogeneous group of species of the genus Cyphophthalmus (endogeal and troglobite) with more elongated appendages and body compared to the other species of the genus. It is defined by the following set of characters: sigmoid receptacles; short male coxal lobes IV; pores of anal glands slightly distant from each other and posteriorly orientated; longitudinal carina on male anal plate wide and inconspicuous; opisthosomal laterodorsal folds in females absent; female body posteriorly conically narrowing. This phyletic line has a disjunctive distribution across the major part of the Balkan Peninsula, and judging by this fact it can be seen as the oldest. However, based on the high number of species, this heterogeneous group could be divided into a few separate (related) phyletic lines in a future detailed study. The conspicuously elongated appendages in the species of this phyletic line speak of their primarily and long terricolous lifestyle, dating from times when the climate of their habitat was significantly more humid. The easternmost Thracean species complex, better adapted to more arid conditions, shows some adaptation to an endogeal lifestyle, such as small body dimensions and shortened appendages, in comparison to the other species from the Gjorgjevici phyletic line.

The second phylogenetic line I designate as the Dinaric phyletic line. According to current knowledge of the genus this line has the highest number of species. It comprises almost all known species from the Dinaric Alps region. In the south, this line is distributed (as far as current knowledge goes) to the southernmost parts of Montenegro; in the north-east to western Serbia; and in the north-west it spreads to the south-eastern Alps. In comparison to other phyletic lines it has a rather compact distribution area, and includes predominantly troglobitic forms. It is defined by the following morphological characteristics: saccate receptacles; females with opisthosomal laterodorsal folds (always present although in some cases inconspicuous); pores of anal glands wide apart from each other and posteriorly orientated; longitudinal carina on male anal plate wide, inconspicuous. Molecular data confirm a clear monophyletic origin of this line (Boyer et al., 2005). Morphoanatomical and molecular data delineate several separate groups of species in this phyletic line. Spatially separate in the north-east (western Serbia) is the C. ere-group (endogeal C. ere and troglobite C. nonveilleri) that is also phyletically the most remote one amongst the Dinaric phyletic line species that underwent molecular analysis. All troglobitic forms of this line have a clear monophyletic origin – the C. minutus-group.
sensu Boyer et al. (2005). Currently, it is unclear whether troglobite C. neretvanus sp. nov. belongs to this group. In the C. minitus-group, a group of the oldest troglobitic species is clearly distinct, which I designate as the C. ognjenovici subgroup (C. ognjenovici sp. nov., C. minitus, C. noctipilus, C. trebinjanus sp. nov., C. conocephalus sp. nov., and a number of new still undescribed taxa in the same area of the southern Dinaric Alps). Members of this subgroup are most easily recognized by the position of the conical processes of male coxal lobes IV close to the anterior margin of the gonostome (Figs 11B, 19B, 21B, 23B). Also distinct is the C. teyrovskyi subgroup (C. teyrovskyi, C. silhavyi, and one still undescribed species from Montenegro close to C. teyrovskyi), ‘group II’ sensu Kratochvíl (1938), younger troglobites. Members of this subgroup are easily recognizable, primarily by the wide body and stepwise pronounced posterior margins of the segments of the opisthosomal part of the dorsal scutum. The status of C. kratochvili sp. nov. in this division is still unclear. Cyphophthalmus gordani sp. nov. occurs in molecular analyses (Boyer et al., 2005) as a sister group to the rest of the C. minitus-group and its morphological characteristics do not indicate that it belongs to either of the two subgroups of the C. minitus-group. All remaining endogean species of the Dinaric phyletic line (C. duricorius, C. rumijae sp. nov., and C. martensi sp. nov.) clearly belong in one group of species – the C. duricorius-group – which seems morphoanatomically close to the geographically and molecularly very remote and different C. ere-group. Molecular data (Boyer et al., 2005) indicate a close relationship amongst the species distributed in the outskirts of the distribution area of the Dinaric phyletic line – C. duricorius (westernmost parts of the Dinaric Alps and, secondarily, regions in the south-eastern Alps) and C. rumijae (southern Montenegro – south-easternmost parts of the Dinaric Alps). Both species can be characterized as endogean living in mesophytic forest habitats. Between the distribution areas of these two, there is the distribution area of the phyletically remote C. martensi sp. nov. that shows more tolerance of the type of habitat. Such a distribution of the C. duricorius-group is zoogeographically extremely interesting and suggestive. The distribution of C. duricorius (with some indication that it could be a species complex) far outside the centre of the diversity of the Dinaric phyletic line and the geographical position of species phyletically closest to it is indicative of its south-eastern origin. This is supported by the fact that there are no other known members of the Dinaric phyletic line in the areas inhabited by this species.

The third phyletic line of the genus Cyphophthalmus I designate as the Aegean phyletic line (C. serbicu-group sensu Boyer et al., 2005). This line includes a number of species inhabiting mostly the southern and south-eastern regions of the Balkan Peninsula as well as Asia Minor. The centre of gravity of the group distribution is in the Aegean region. Exclusively endogean forms occur. They are clearly defined by the following characteristics: small to medium sized species with compact body and short appendages; sacate receptacle with bifurcate bottom; spermatopositor terminal lobe wide and short; pores of anal glands close to each other or slightly distant, ventrally orientated; longitudinal carina on male anal plate narrow and remarkably pronounced; opisthosomal laterodorsal folds in females absent. By their distribution and obviously better adaptation to more arid conditions compared to members of other lines, they are probably the last expansive element of the fauna of the genus Cyphophthalmus, which probably dispersed from its original habitat in several directions to the west and north. The westernmost distribution in this dispersion is C. hlavaci sp. nov. in central Dalmatia, isolated from the main area of this phyletic line. The following species belong to this phyletic line: C. corfuanus, C. eratoae, C. bithynicus, C. yalovensis, C. serbicus, C. markoi, C. hlavaci sp. nov., and C. zetae sp. nov.

Molecular data (Boyer et al., 2005) suggest that the Dinaric and Aegean phyletic lines are more closely related to each other than either are to the Gjorgjevici line. This relationship is supported by the shape of female receptacles in these three lines. This character can therefore be singled out as an extremely indicative one. Based on the character of the receptacles, it is possible to delineate some other phyletic lines. For definite conclusions further studies are required. As regards other characters, all combinations of relationships of the three phyletic lines are possible.

The great number of newly described species presented in this paper (as well as a number of species whose description is in progress), all coming from a relatively small region, may seem exaggerated, especially considering that these are Opiliones, a group represented in the European fauna by a relatively small number of species (almost 400) and particularly because these are members of the least numerous order – Cyphophthalmi – with about 150 species known to date in the world. However, the distribution of the genus Cyphophthalmus and its phyletic lines, together with its specific phyletic position within the family Sironidae, suggest indirectly that the genus has a long and independent history associated with intensive dynamic events in the intraocean carbonate platform in the Tethys during the Tertiary and even that it may have originated in the northern regions of Gondwana. It should be stressed that the common features of the regions of the three Cyphophthalmi
diversity hotspots known to date, Sundaland, New Zealand, and the Balkan Peninsula, could be the result of their dynamic archipelago history.

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Figure 2. A–B, spiracles. A, Siro exilis Hoffman (West Virginia, Summers County), light microscopy microphotograph; B, Cyphophthalmus hlavaci sp. nov., scanning electron micrograph. C–D, outlet ducts and pores of anal glands. C, S. exilis Hoffman (West Virginia, Summers County); D, Cyphophthalmus serbicus (Hadži). E–F, spermatopositor movable fingers (digititi mobiles). E, Cyphophthalmus cf. zetae sp. nov. (Manastir Morača, Montenegro); F, Cyphophthalmus gordani sp. nov. Not to scale.

Figure 3. Male anal regions. A–B, Cyphophthalmus corfuanus (Kratochvíl); C, Cyphophthalmus serbicus (Hadži); D, Cyphophthalmus ere Karaman; E, Cyphophthalmus ognjenovici sp. nov.; F, Cyphophthalmus duricorius Joseph.

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Figure 4. Distal portion of ovipositor (left terminal lobe excluded), ventral view. A, *Cyphophthalmus gjorgjevici* (Hadži), (Rašče, Macedonia); B, *Cyphophthalmus paragamiani* sp. nov.; C, *Cyphophthalmus thracicus* sp. nov.; D, *Cyphophthalmus* cf. *thracicus* (Evros, Greece); E, *Cyphophthalmus corfuanus* (Kratochvíl) (Corfu); F, *Cyphophthalmus zetae* sp. nov.; G, *Cyphophthalmus hlavaci* sp. nov. Circles represent insertion of ventral setae; x represent insertion of dorsal setae. Scale bar = 100 μm.
Figure 5. Distal portion of ovipositor (left terminal lobe excluded), ventral view. A, *Cyphophthalmus minutus* (Kratochvíl) topotype; B, *Cyphophthalmus gordani* sp. nov.; C, *Cyphophthalmus neretvanus* sp. nov.; D, *Cyphophthalmus trebinjanus* sp. nov.; E, *Cyphophthalmus ognjenovici* sp. nov.; F, *Cyphophthalmus rumijae* sp. nov.; G, *Cyphophthalmus martensi* sp. nov. Circles represent insertion of ventral setae; x represent insertion of dorsal setae. Scale bar = 100 μm.
Figure 6. Detail of integument ornamentation of the third opisthosomal segment, dorsal. A, *Cyphophthalmus corfuanus* (Kratochvil); B, *Cyphophthalmus zetae* sp. nov.; C, *Cyphophthalmus martensi* sp. nov.; D, *Cyphophthalmus beschkovi* (Mitov); E, *Cyphophthalmus* sp. (Cave, Mt. Biokovo, Dalmatia); F, *Cyphophthalmus noctiphilus* (Kratochvil).
Figure 7. *Cyphophthalmus paragamiani* sp. nov. (holotype). A, spermatopositor (dorsal view); B, ventral prosomal complex; C, basitarsus and telotarsus of leg I; D, basitarsus and telotarsus of leg IV; E, tibia and tarsus of pedipalp; F, chelicera; G, adenostyle. Scale bars: A, G = 100 μm; B–F = 400 μm.
Figure 8. *Cyphophthalmus paragamiani* sp. nov. (holotype except B, D – female paratype). A, male dorsum; B, female dorsum (partially damaged); C, dorsum granulation (fifth to ninth tergite); D, detail of granulation (convex tubercles) at the border of eighth to ninth tergite; E, terminal posterior part of the male dorsum with pores of anal glands; F, dorsum, frontal view.
Figure 9. *Cyphophthalmus thracicus* sp. nov. (holotype). A, spermatopositor (dorsal view); B, ventral prosomal complex; C, basitarsus and telotarsus of leg I; D, basitarsus and telotarsus of leg IV; E, tibia and tarsus of pedipalp; F, chelicera; G, adenostyle. Scale bars: A, G = 100 μm; B–F = 400 μm.
Figure 10. *Cyphophthalmus thracicus* sp. nov. (holotype except B, F – female paratype). A, male dorsum; B, female dorsum; C, dorsum granulation (fifth to ninth tergite); D, detail of granulation (convex tubercles) at the border of eighth to ninth tergite; E, terminal posterior part of the male dorsum with pores of anal glands; F, dorsum, frontal view.
Figure 11. Cyphophthalmus minutus (Kratochvil) (neotype except C – tootype). A, spermatopositor, dorsal view; B, male ventral prosomal complex; C, female ventral prosomal complex; D, basitarsus and telotarsus of leg I; E, basitarsus and telotarsus of leg IV; F, tibia and tarsus of pedipalp; G, chelicera; H, adenostyle. Scale bars: A, H = 100 μm; B–G = 400 μm.
Figure 12. Cyphophthalmus minutus (Kratochvil) (neotype except B, F – toptotye). A, male dorsum; B, female dorsum; C, dorsum granulation (fifth to ninth tergite); D, detail of granulation (convex tubercles) at the border of eighth to ninth tergite; E, terminal posterior part of the male dorsum with pores of anal glands; F, dorsum, frontal view.
Figure 13. *Cyphophthalmus gordani* sp. nov. (holotype). A, spermatopositor (dorsal view); B, ventral prosomal complex; C, basitarsus and telotarsus of leg I; D, basitarsus and telotarsus of leg IV; E, tibia and tarsus of pedipalp; F, chelicera; G, adenostyle. Scale bars: A, G = 100 μm; B–F = 400 μm.
Figure 14. *Cyphophthalmus gordani* sp. nov. (holotype except B, F – female paratype). A, male dorsum; B, female dorsum; C, dorsum granulation (fifth to ninth tergite); D, detail of granulation (convex tubercles) at the border of eighth to ninth tergite; E, terminal posterior part of the male dorsum with pores of anal glands; F, dorsum, frontal view.
Figure 15. *Cyphopthalmus neretvanus* sp. nov. (holotype). A, spermatopositor (dorsal view); B, ventral prosomal complex; C, basitarsus and telotarsus of leg I; D, basitarsus and telotarsus of leg IV; E, tibia and tarsus of pedipalp; F, chelicera; G, adenostyle. Scale bars: A, G = 100 μm; B–F = 400 μm.
Figure 16. Cyphophthalmus neretvanus sp. nov. (A, F – holotype, B–D – female paratype, E – male paratype). A, male dorsum; B, female dorsum; C, dorsum granulation (fifth to ninth tergite); D, detail of granulation (convex tubercles) at the border of eighth to ninth tergite; E, terminal posterior part of the male dorsum with pores of anal glands; F, dorsum, frontal view.
Figure 17. *Cyphophthalmus kratochvili* sp. nov. (holotype). A, spermatopositor (dorsal view); B, ventral prosomal complex; C, basitarsus and telotarsus of leg I; D, basitarsus and telotarsus of leg IV; E, tibia and tarsus of pedipalp; F, chelicera; G, adenostyle. Scale bars: A, G = 100 μm; B–F = 400 μm.
Figure 18. *Cyphophthalmus kratochvili* sp. nov. (holotype except B – paratype). A, male dorsum; B, female dorsum; C, dorsum granulation (fifth to ninth tergite); D, detail of granulation (convex tubercles) at the border of eighth to ninth tergite; E, terminal posterior part of the male dorsum with pores of anal glands; F, dorsum, frontal view.
Figure 19. *Cyphophthalmus conocephalus* sp. nov. (holotype). A, spermatopositor (dorsal view); B, ventral prosomal complex; C, basitarsus and telotarsus of leg I; D, basitarsus and telotarsus of leg IV; E, tibia and tarsus of pedipalp; F, chelicera; G, adenostyle. Scale bars: A, G = 100 μm; B–F = 400 μm.

Figure 20. *Cyphophthalmus conocephalus* sp. nov. (holotype). A, male dorsum; B, anterior margin of dorsum (dorsal view); C, dorsum granulation (fifth to ninth tergite); D, detail of granulation (convex tubercles) at the border of eighth to ninth tergite; E, terminal posterior part of the male dorsum with pores of anal glands; F, dorsum, frontal view.
Figure 21. *Cyphophthalmus trebinjanus* sp. nov. (holotype). A, spermatopositor (dorsal view); B, ventral prosomal complex; C, basitarsus and telotarsus of leg I; D, basitarsus and telotarsus of leg IV; E, tibia and tarsus of pedipalp; F, chelicera; G, adenostyle. Scale bars: A, G = 100 μm; B–F = 400 μm.
Figure 22. *Cyphophthalmus trebinjanus* sp. nov. (A – holotype, B–D, F – female paratype, E – male paratype). A, male dorsum; B, female dorsum; C, dorsum granulation (fifth to ninth tergite); D, detail of granulation (convex tubercles) at the border of eighth to ninth tergite; E, terminal posterior part of the male dorsum with pores of anal glands; F, dorsum, frontal view.
Figure 23. Cyphophthalmus ognjenovici sp. nov. (holotype). A, spermatopositor (dorsal view); B, ventral prosomal complex; C, basitarsus and telotarsus of leg I; D, basitarsus and telotarsus of leg IV; E, tibia and tarsus of pedipalp; F, chelicera; G, adenostyle. Scale bars: A, G = 100 μm; B–F = 400 μm.
Figure 24. *Cyphophthalmus ognjenovici* sp. nov. (A, F – holotype, B–D – female paratype, E – male paratype). A, male dorsum; B, female dorsum; C, dorsum granulation (fifth to ninth tergite); D, detail of granulation (convex tubercles) at the border of eighth to ninth tergite; E, terminal posterior part of the male dorsum with pores of anal glands; F, dorsum, frontal view.
Figure 25. *Cyphophthalmus martensi* sp. nov. (holotype). A, spermatopositor (dorsal view); B, ventral prosomal complex; C, basitarsus and telotarsus of leg I; D, basitarsus and telotarsus of leg IV; E, tibia and tarsus of pedipalp; F, chelicera; G, adenostyle. Scale bars: A, G = 100 μm; B–F = 400 μm.
Figure 26. *Cyphothalmus martensi* sp. nov. (paratypes from Žanjica). A, male dorsum; B, female dorsum; C, dorsum granulation (fifth to ninth tergite); D, detail of granulation (convex tubercles) at the border of eighth to ninth tergite; E, terminal posterior part of the male dorsum with pores of anal glands; F, dorsum, frontal view.
Figure 27. Cyphophthalmus rumijae sp. nov. (holotype). A, spermatopositor (dorsal view); B, ventral prosomal complex; C, basitarsus and telotarsus of leg I; D, basitarsus and telotarsus of leg IV; E, tibia and tarsus of pedipalp; F, chelicerae; G, adenostyle. Scale bars: A, G = 100 μm; B–F = 400 μm.
Figure 28. *Cyphophthalmus rumijae* sp. nov. (A, C, F – holotype, B – female paratype, D–E – male paratype). A, male dorsum; B, female dorsum; C, dorsum granulation (fifth to ninth tergite); D, detail of granulation (convex tubercles) at the border of eighth to ninth tergite; E, terminal posterior part of the male dorsum with pores of anal glands; F, dorsum, frontal view.
Figure 29. *Cyphophthalmus corfuanus* (Kratochvíl) (male 1.70 mm from Corfu). A, spermatopositor (dorsal view); B, ventral prosomal complex; C, basitarsus and telotarsus of leg I; D, basitarsus and telotarsus of leg IV; E, tibia and tarsus of pedipalp; F, chelicera; G, adenostyle. Scale bars: A, G = 100 μm; B–F = 400 μm.
Figure 30. Cyphophthalmus corfuanus (Kratochvíl) (Corfu). A, male dorsum; B, female dorsum; C, dorsum granulation (fifth to ninth tergite); D, detail of granulation (convex tubercles) at the border of eighth to ninth tergite; E, dorsum, frontal view; F, terminal posterior part of the male dorsum with pores of anal glands.
Figure 31. Cyphophthalmus zetae sp. nov. (holotype). A, spermatopositor (dorsal view); B, ventral prosomal complex; C, basitarsus and telotarsus of leg I; D, basitarsus and telotarsus of leg IV; E, tibia and tarsus of pedipalp; F, chelicera; G, adenostyle. Scale bars: A, G = 100 μm; B–F = 400 μm.
Figure 32. *Cyphophthalmus zetae* sp. nov. (A, C, D, F – holotype, B – female paratype, E – male paratype). A, male dorsum; B, female dorsum; C, dorsum granulation (fifth to ninth tergite); D, detail of granulation (convex tubercles) at the border of eighth to ninth tergite; E, terminal posterior part of the male dorsum with pores of anal glands; F, dorsum, frontal view.
Figure 33. *Cyphophthalmus hlavaci* sp. nov. (holotype). A, spermatositor (dorsal view); B, ventral prosomal complex; C, basitarsus and telotarsus of leg I; D, basitarsus and telotarsus of leg IV; E, tibia and tarsus of pedipalp; F, chelicera; G, adenostyle. Scale bars: A, G = 100 μm; B–F = 400 μm.
Figure 34. *Cyphophthalmus hlavaci* sp. nov. (paratypes from Bast). A, male dorsum; B, female dorsum; C, dorsum granulation (fifth to ninth tergite); D, detail of granulation (convex tubercles) at the border of eighth to ninth tergite; E, terminal posterior part of the male dorsum with pores of anal glands; F, dorsum, frontal view.
Figure 35. A, geographical distribution of the three phylogenetic lines of the genus Cyphophthalmus (signs often cover more than one locality); B, distribution of presented species in south-eastern part of the Balkan Peninsula.
Figure 36. Distribution of presented *Cyphophthalmus* species in the Dinaric Alps. A, troglobite; B, endogeian.