Systematics of the trapdoor spider genus *Cyrtocarenum* Ausserer, 1871 (Araneae, Ctenizidae)

A. E. Decae
National Museum of Natural History,
Leiden, The Netherlands*

Summary

The genus *Cyrtocarenum* Ausserer, 1871 contains two species: *Cyrtocarenum cunicularium* (Olivier, 1811) and *Cyrtocarenum grajum* (C. L. Koch, 1836). Both species are common in Greece. Their range outside Greece is largely unknown. Four species attributed to the genus — *C. hellenum* Doleschall in Ausserer, 1871, *C. ionicum* (Saunders, 1842), *C. lapidarium* (Lucas, 1853) and *C. werneri* Kulczynski, 1903 — are placed in synonymy with *C. cunicularium.* The synonymy of *C. tigrinum* (L. Koch, 1867) and *Cteniza orientalis* Ausserer, 1871 with *C. cunicularium* is confirmed. Males and females of *C. cunicularium* and *C. grajum* are redescribed on the basis of recently collected material from the respective type localities; diagnostic characters are given and illustrated. The male of *C. grajum* is described for the first time. Keys for Mediterranean Ctenizinae and *Cyrtocarenum* species are included.

Introduction

Between 1811 and 1903, eight species were placed in the genus *Cyrtocarenum* Ausserer, 1871. No new species have been attributed to the genus since. Seven species were reported from the north-eastern Mediterranean, and one species, *C. rufidens* (Ausserer, 1871), from southern Africa.

Simon (1903) erected the genus *Stasimopus* to contain the African species, thus restricting the range of *Cyrtocarenum* to Greece and western Anatolia. The original descriptions of the seven Mediterranean species of *Cyrtocarenum* are generally brief, based on one or few, sometimes immature, specimens and always restricted to one sex only. Ausserer (1871) and Simon (1884) provided keys and descriptions for the six *Cyrtocarenum* species recognised in their time. Both authors inevitably had to base their work on the limited material and sparse information then available.

Between 1979 and 1994, *Cyrtocarenum* has been extensively collected in Greece. Comparison of this new material with types and other specimens present in major European museum collections shows that *C. hellenum* Doleschall in Ausserer, 1871, *C. ionicum* (Saunders, 1842), *C. lapidarium* (Lucas, 1853), *C. tigrinum* (L. Koch, 1867), *C. werneri* Kulczynski, 1903 and *Cteniza orientalis* Ausserer, 1871 are all synonyms of *C. cunicularium* (Olivier, 1811) and that *C. grajum* (C. L. Koch, 1836) is a separate species.

The brief and incomplete references in the older literature do not fit modern standards in systematic biology. The redescriptions and keys presented here aim at providing an improved taxonomic basis for further study of the Mediterranean ctenizid fauna.

*Mailing address: Buitenbassinweg 873, 3063 TN Rotterdam, The Netherlands.

The problematic status of the genus *Cyrtocarenum* Ausserer, 1871

Ausserer (1871) described *Cyrtocarenum* as distinct from, although closely related to *Cteniza* Latreille, 1829 and *Aepycephalus* Ausserer, 1871. In an additional note Ausserer (1871: 152) emphasised the close relationship between *Cteniza, Aepycephalus* and *Cyrtocarenum.* The general shape of the cephalic region, the configuration of the eyes and the relative sizes of the eyes were presented as characters to distinguish the three genera, but without quantification that would make verification possible. Moreover, there are good grounds to doubt the separate status of the three genera in Ausserer's work, particularly from Ausserer's own apparent confusion in this respect when he described *Cteniza orientalis* Ausserer, 1871, recognised by later workers (Roewer, 1942; Bonnet, 1956) as a synonym of *C. lapidarium* (now *C. cunicularium*). I was able to confirm this synonymy by examination of Ausserer's type of *C. orientalis* var. *mannii.*

Simon (1892) also recognised *Cteniza, Aepycephalus* and *Cyrtocarenum* as three distinct genera, using differences in the general configuration of the eyes as key characters (not the relative sizes of the eyes as Ausserer did). Additionally, Simon (1892: 93, figs. 93–94) used the morphology of the rastellum to distinguish *Cyrtocarenum* from both *Cteniza* and *Aepycephalus.* In preparation for the present study (Decae *et al.*, 1982) I found that the characters Simon used are highly constant within *Cyrtocarenum* and therefore are potentially good diagnostic characters. The morphology of the rastellum in *Cyrtocarenum,* however, is virtually identical to what I have seen in *Cteniza* and therefore cannot be used to distinguish the three genera. On the other hand, from the sparse material of *Cteniza* and *Aepycephalus* that I have seen, the differences in configuration of the eyes between the three genera seem distinct (Figs. 1–3). Whether these differences should be considered as definite diagnostic characters at the genus level remains to be investigated.

Although the question of the generic identity of *Cyrtocarenum* lies largely outside the scope of the study presented here, I will give a preliminary key for Mediterranean Ctenizinae (*sensu* Raven, 1985). Raven (1985: 142) questions the separate identity of the three genera by stating that it is only the poor availability of material that prevents him from proposing the synonymy of *Cteniza, Aepycephalus* and *Cyrtocarenum.* Notwithstanding the differences in eye configuration, I am inclined to agree, although awaiting a more detailed study of the taxonomy in this group of spiders I will use *Cyrtocarenum* for the Ctenizidae (*sensu* Raven, 1985) occurring in Greece.

Measurements, abbreviations and terminology

Measurements of the carapace, sternum and eye group were performed with the specimen in a horizontal dorsal or ventral position under the microscope. Measurements of leg and palp segments were made along the retrolateral surface of detached appendages

placed in a horizontal position as illustrated in Figs. 6–7. All measurements were made using a Wild stereomicroscope equipped with an eyepiece micrometer and are accurate to 0.1 mm.

Abbreviations used (see also Figs. 1–7, 16, 17): REF=width/height ratio of eye formation; RPT=TL/TW (see Fig. 6) ratio of male palpal tibia; RBE=bw/el (see Fig. 6) ratio of palpal organ; CL=carapace length; CW=carapace width; SL=sternum length; SW=sternum width; FL=femur length; PL=patella length; TL=tibia length; TW=tibia width; ML=metatarsus length; TaL =tarsus length; p=palp; I=leg I; II=leg II, III=leg III; IV=leg IV; ax=axis; bc=bursa copulatrix; bw=bulbus width; co=constriction; cv=closure valve; d=dorsal; ef=epigastric furrow; el=embolus length; pl=prolateral; r=receptaculum; rl=retrolateral; v=ventral. BMNH=Natural History Museum, London; FSF=Forschungsinstitut Senckenberg, Frankfurt; MNHN=Muséum National d'Histoire Naturelle, Paris; NHMW=Naturhistoriches Museum Wien; NNML=Nationaal Natuurhistorisch Museum, Leiden.

The pattern, presence and absence of various types of setae is important in the description and recognition of the species of *Cyrtocarenum.* The following terms are used: *hook*=massive setiform structure associated with the leg claspers in males (Figs. 22–23); *spines*=macro setae that occur on all appendages (Fig. 13); *short spines*=setiform structures as illustrated in Fig. 14; *spiny setae*=conspicuously long strong setae that occur on some legs (e.g. on femur III and IV of the spiders illustrated in Figs. 18–19) and on the cymbium of *C. grajum* (Fig. 21); *setae*=hair-like cover of most body parts (Fig. 15); *teeth*=strong and rigid structures in the rastellum and much smaller structures lining the cheliceral furrow; *denticles*=knob-like structures within the cheliceral furrow; *cuspules*=knob-like structures on maxillae and labium.

Material examined

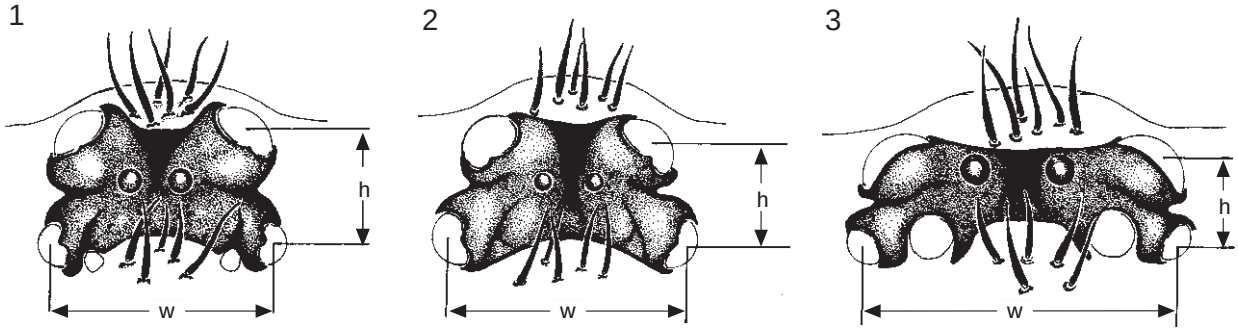
The *Cteniza* and *Aepycephalus* material examined is all in the collection of the MNHN and consists of 4 specimens labelled *Cteniza sauvagesi*, (Rossi, 1788), 7 specimens labelled *Cteniza moggridgei* O. P.-Cambr., 1874, one specimen labelled *Aepycephalus brevidens* Doleschall, 1871 from Sardinia and one undetermined trapdoor spider also from Sardinia that obviously belongs to the same genus. The *Cyrtocarenum* material came from the extensive sample described below.

The species-level taxonomy of *Cyrtocarenum* presented here is based on a sample of 224 spiders newly collected throughout southern Greece between 1979 and 1994. The sample was found to contain two different species. 170 females and 3 males were preliminarily classified as "species A", 45 females and 6 males were preliminarily classified as "species B". Species A was found to be identical to *C. cunicularium,* species B was found to be *C. grajum.* Because the original descriptions of both species were based on females, one female of each species, newly collected at the respective type locality (Naxos for *C. cunicularium* and Argolis for *C. grajum*), was selected for redescription. Adult males occur for only a very short period each year. Therefore they are difficult to find in nature and extremely rare in museum collections. The males described here were collected as juveniles and reared in captivity. The described male of *C. cunicularium* originated from the island of Tinos, that of *C. grajum* from the island of Kythira.

Type material was studied thanks to the co-operation of the BMNH (*C. grajum, C. ionicum, C. tigrinum*) and the NHMW (*C. hellenum, C. lapidarium* var. *mannii*=*Cteniza orientalis* var. *mannii, C werneri*). The type of *C. cunicularium* could not be located.

Further material was made available by the BMNH (*C. cunicularium* 4♀ from Corfu and the Ionian Islands, *C. grajum* 1♀ from an unknown locality), NHMW (*C. cunicularium* 5♀ from Kalamos, Tinos and Crete, *C. grajum* 2♀ from Kalamos), MNHN (*C. cunicularium* 3♀ from Crete and Ithea, *C. grajum* 1♀ from Corfu), FSF (*C. cunicularium* 13♀ from Crete and Attica, *C. grajum* 7♀ from Attica and Skopelos). The material collected between 1979 and 1989 by myself and Gilbert Caranhac (including all spiders of both sexes described here) is deposited in the NNML. Rhodos can be included in the distribution range of *C. cunicularium* thanks to one specimen collected by Dr C. L. Deeleman-Reinhold and kept in her collection. Material collected by myself after 1989 is at present kept in my private collection and will eventually be placed in an institutional collection.

Map 1 shows the geographical distribution of *Cyrtocarenum* specimens included in this study.



Figs. 1–3: Eye formations of European Ctenizinae (dorsal views). REF=ratio describing shape of eye-formation: width (w)/ height (h), measured as indicated. **1** *Cteniza sauvagesi* (Rossi, 1788), REF=1.9; **2** *Aepycephalus* sp., REF=2.2; **3** *Cyrtocarenum cunicularium* (Olivier, 1811), REF=3.6.

Procedure and Conclusions

The aim of this study is to clarify the species-level taxonomy of *Cyrtocarenum.* The first approach has been to obtain a sufficiently large sample of specimens accompanied by a set of reliable field data and collected at locations that together form a cross-section of the distribution range of the genus in Greece (from the Ionian island of Sakynthos to the island of Rhodos near the Anatolian coast). Within this sample of 215 female and 9 male spiders a search for diagnostic characters at the species level was carried out.

Two species could be distinguished by the presence or absence (in both sexes) of a double row of trichobothria on the palpal tibia (Figs. 8–9) combined with the presence or absence of concentrations of spigots on the lateral spinnerets (Figs. 10–11). These two characters were found to be stable throughout the sample and to correlate fully with a distinctly different morphology of the spermatheca in the females (Figs. 16–17) and the palp, palpal organ and clasper morphology in the males (Figs. 18–23). On this basis 170 females and 3 males were classified as members of "species-A" (single row of trichobothria on palpal tibia combined with concentrations of spigots on the spinnerets) and 45 females and 6 males as members of "species-B" (double row of trichobothria on palpal tibia combined with the absence of concentrations of spigots on the spinnerets).

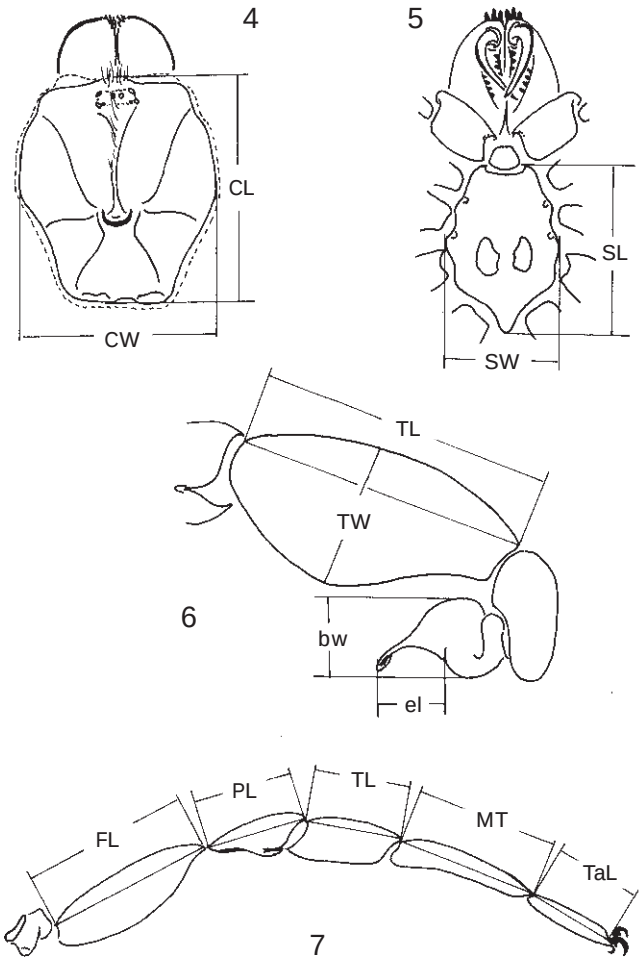
Comparison of "species-A" and "species-B" with the available type material and other specimens in museum collections led to the following conclusions:

(1) all type specimens and other specimens in museum collections fitted either "species-A" or "species-B" and no other morphs (species) were discovered;
(2) the types of *C. hellenum, C. ionicum, C. lapidarium* var. *mannii* (=*Cteniza orientalis* var. *mannii*), *C. tigrinum* and *C. werneri* all conform to "species-A";
(3) the type of *C. grajum* conforms to "species-B".

The holotype of *C. cunicularium* could not be located. The type locality for this species, however, is the island of Naxos where, as on all islands in the Cyclades archipelago, only "species-A" was found and "species-B" does not occur. This observation and the fact that Ausserer's (1871: 157–158) description of *C. arianum* (= *C. cunicularium*) clearly indicates "species-A" (spigot concentrations are mentioned) provides sufficient grounds to regard *C. cunicularium* as "species-A" and to designate a neotype (newly collected specimen from Naxos).

The general conclusion therefore must be that the genus *Cyrtocarenum* in Greece contains two known species, *C. cunicularium* ("species-A") and *C. grajum* ("species-B").

Several other morphological structures were found to be unique to either *C. cunicularium* or *C. grajum* but restricted to one sex only. The morphology of the spermatheca (Figs. 16–17), the presence or absence of particular spines on the tibia and metatarsus of leg IV (Figs. 12–13) and the pattern of setiform structures dorso-distally on tibia II (Figs. 14–15) are good diagnostic characters in females. The relative length of the palps (Figs. 18–19), the morphology of the palpal organ (Figs. 20–21) and the structure of the clasper on leg I (Figs. 22–23) are diagnostic characters in males.



Figs. 4–7: Methods of measurements. All measurements made with the specimen or appendage in horizontal position under the microscope with both points of measurement simultaneously in focus. Legs and palps measured along retrolateral side after removing them from the spider. **4** Carapace, CL=carapace length, CW=carapace width; **5** Sternum, SL=sternum length, SW=sternum width; **6** Distal end of male palp, TL= tibia length, TW=tibia width, el=embolus length, bw=bulbus width; RPT (TL/TW)=ratio describing shape of male palpal tibia, RBE (bw/el)=ratio describing shape of palpal organ; **7** Leg segments, FL=femur length, PL=patella length, TL=tibia length, MT=metatarsus length, TaL=tarsus length.

Other characters such as colour variation, relative lengths of appendages, variations in spine pattern and measurement ratios of different body parts are valuable in the study of geographical variation within the two species, but are not further considered here.

European Ctenizidae

Raven's (1985) reclassification of mygalomorph spiders of the family Ctenizidae leaves four representative genera in the Mediterranean: *Ummidia* Thorell, 1875 in Spain and *Cteniza, Aepycephalus* and *Cyrtocarenum* in a more or less disrupted curved zone from the extreme south-east of France via the islands of Corsica, Sardinia

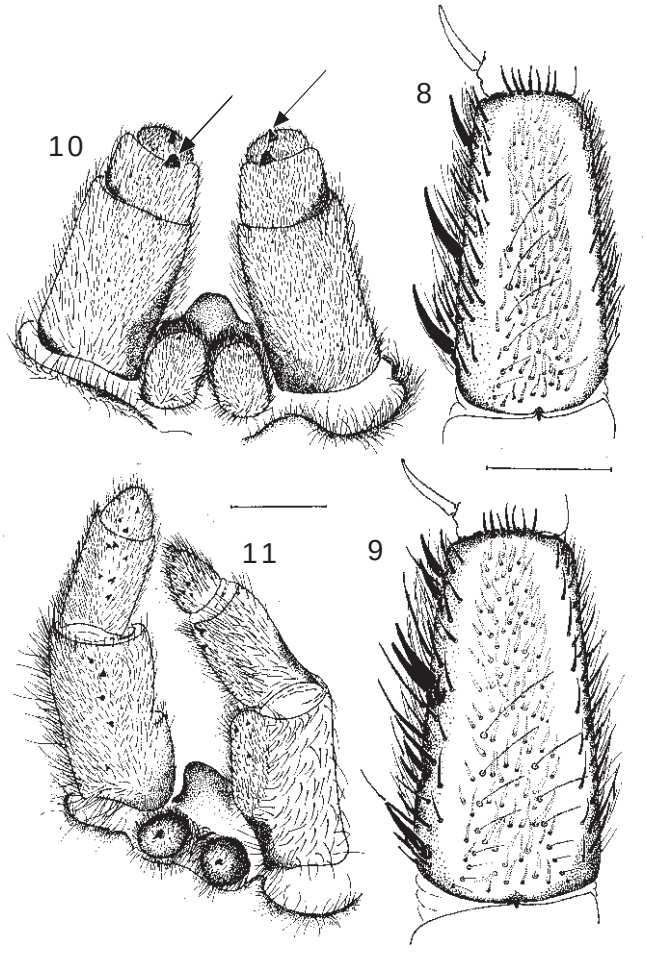
and Sicily into Greece and Anatolia. *Cteniza* occupies the north-west part of this area, *Aepycephalus* the centre and *Cyrtocarenum* the south-east. *Ummidia* is placed in the subfamily Pachylomerinae and will not be further discussed here. *Cteniza, Aepycephalus* and *Cyrtocarenum* represent the European Ctenizinae (Raven, 1985).

Key to the European Ctenizinae

1. REF>2.5 (Fig. 3) ..... *Cyrtocarenum*
— REF<2.5 (Figs. 1, 2) 2
2. Median eyes reduced or absent (Fig. 2) ..... *Aepycephalus*
— Median eyes not reduced (Fig. 1) ..... *Cteniza*

Key to the species of *Cyrtocarenum*

1. Trichobothria on palpal tibia in one row (Fig. 8); spigots concentrated in groups apically on median and terminal segments of the lateral spinnerets (Fig. 10) ..... *C. cunicularium*
— Trichobothria on palpal tibia in two rows (Fig. 9); spigots not concentrated (Fig. 11) ..... *C. grajum*



Figs. 8–11: **8,9** Right palp tibia, dorsal view. **8** *C. cunicularium,* one row of trichobothria (pl to longitudinal ax); **9** *C. grajum,* two rows of trichobothria. **10,11** Spinnerets, ventral view. **10** *C. cunicularium,* spigots in concentrations on lateral spinnerets (arrowed), distal segment domed; **11** *C. grajum,* spigot concentrations lacking, distal segment digitiform. All figures drawn from females, but males similar. Scale lines=1.0 mm.

Genus *Cyrtocarenum* Ausserer (Fig. 3)

Mygale Walckenaer, 1805: 6; Olivier, 1811: 86; Saunders, 1842:160.
Cteniza C. L. Koch, 1836: 39; 1851, 71; L. Koch, 1867: 882; Kirby, 1871: 67.
Cyrtocephalus Doleschall (ms), 1852: 26; Lucas, 1853: 514.
Mygalodonta Simon, 1864: 75.
Cyrtocarenum Ausserer, 1871: 126, 154–161; 1875: 134; Simon, 1892: 93–96; 1903: 891–892; Gerhardt & Kästner, 1938: 586; Roewer, 1942: 157; Bonnet, 1956: 1350–1352; Decae (ms), 1983: 1–59, figs. 2–4, 12–17; 1986: 39–43; 1993: 75–82; Raven, 1985: 141–143; Wunderlich, 1990: 7–10, figs. 17, 19; Platnick, 1993: 84.

Type species: Cyrtocarenum arianum [=*C. cunicularium* (Olivier, 1811)].

Diagnosis: Differs from all other European Ctenizinae in the shape of the eye-formation (Fig. 3; REF>2.5).

Description: Females are squat, short-legged spiders that inhabit "cork type", fully silk-lined trapdoor burrows of various design and complexity; with or without linear litter (Main, 1957), with or without an inverted trapdoor at the bottom of the burrow (Saunders, 1842). Colour of sclerotised parts in alcohol varies from maroon to a light yellowish brown (geographical variation). Abdomen purplish to greyish. Carapace length (CL) of reproducing females ranges from 6.0 to 11.7. Leg formula: 4132 or 4312 (geographical variation in *C. cunicularium*). Males (CL: 5.8 to 8.0) are robust, long-legged spiders. Colour of sclerotised part in alcohol dark- to light brown. Abdomen greyish. Distal end of tibia I and proximal end of metatarsus I modified to form a strong clasper (Figs. 22–23).

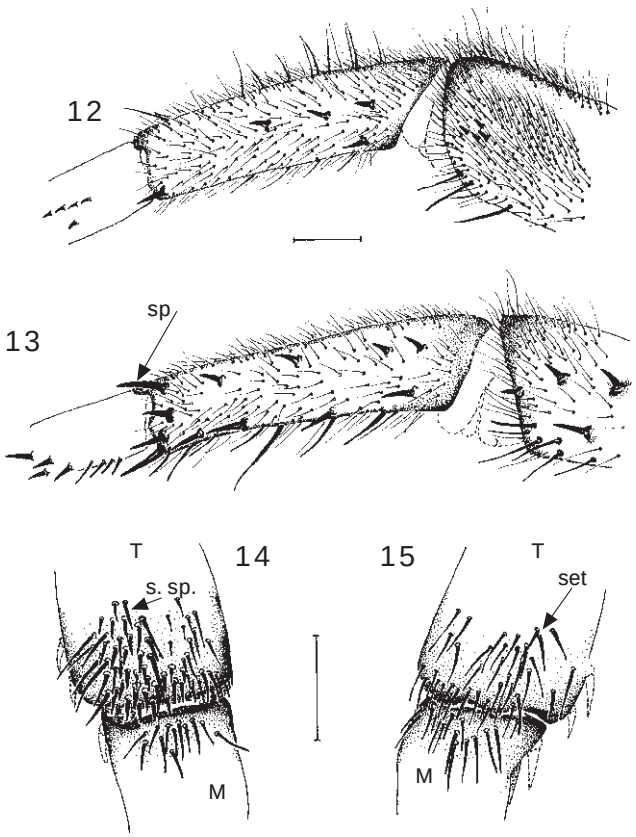
Cyrtocarenum cunicularium (Olivier, 1811) (Figs. 3, 8, 10, 12, 14, 16, 18, 20, 22)

Mygale ariana Walckenaer, 1805: 6 (n. nud.); Walckenaer, 1837: 239; Latreille, 1818: 126.
Mygale cunicularia Olivier, 1811: 85–86 (=*ariana*), type not located, from Naxos.
Mygale ionica Saunders, 1842: 160, two female syntypes from Ionian Islands, at BMNH (examined). **Syn. nov.**
Mygalodonta ariana: Simon, 1864: 75.
Cteniza tigrina L. Koch, 1867: 882, male holotype from Syros, at BMNH (examined).
Cteniza ariana: Erber, 1868: 905; Moggridge, 1873: 131, 135, 141, 143.
Cteniza ionica: Kirby, 1871: 67; Moggridge, 1873: 131, 143; 1874: 210.
Cteniza orientalis Ausserer, 1871: 154, var. *mannii,* three female syntypes from Brussa, at NHMW (examined); Simon, 1892: 96.
Cyrtocephalus hellenus Doleschall (ms), 1852: 26, female holotype at NHMW (examined). **Syn. nov.**
Cyrtocephalus lapidarius Lucas, 1853; 514, type lost, from Crete. **Syn. nov.**
Cyrtocephala lapidaria: Simon, 1864: 81.
Cyrtauchenius corcyroeus Thorell, 1870: 166.
Cyrtauchenius lapidarius: Thorell, 1870: 165.
Cyrtocarenum arianum: Ausserer, 1871: 158; Moggridge, 1873: 143.
Cyrtocarenum ionicum: Ausserer, 1871: 161; Moggridge, 1873: 131, 143; Pavesi, 1877: 327; 1878: 381; Simon, 1880: 115 (=*corcyraeum*); 1884: 346; 1892: 96; Carlini, 1901: 79; Bristowe, 1935: 739; Drensky, 1936b: 9; Roewer, 1942: 158 (*jonicum*); Bonnet, 1956: 1351.
Cyrtocarenum lapidarium: Ausserer, 1871: 161; Pavesi, 1876: 68; Simon, 1884: 346, 348; 1892: 96; Fage, 1921: 99; Caporiacco, 1929: 223; Bristowe, 1935: 738; Drensky, 1936a: 110; 1936b; 9; Hadjissarantos, 1940: 19; Roewer, 1942: 158; Bonnet, 1956: 1352; Platnick, 1993: 84.

Cyrtocarenum tigrinum: Ausserer, 1871: 158; Moggridge, 1873: 143; Pavesi, 1877: 327; 1878: 381.
Cyrtocarenum hellenum: Ausserer, 1871: 159; Pavesi, 1877: 327; 1878: 381; Simon, 1892: 96; Bristowe 1935: 739; Drensky, 1936b: 9; Roewer, 1942: 158; Bonnet, 1956: 1351.
Cyrtocarenum cunicularium: Pavesi, 1877: 327; 1878: 380; Simon, 1884:347; 1892: 75, 96; Bristowe, 1935: 739; Drensky, 1936b: 9; Gerhardt & Kästner, 1938: 586; Roewer, 1942: 157; Bonnet, 1956: 1351; Buchli, 1969: 182; Glatz, 1973: 47; Decae, Caranhac & Thomas, 1982: 410–419, figs. 1–8; Decae (ms), 1983: 1–59; Coyle, 1986a: 294; Decae, 1986: 39–43; 1993: 75–82.
Cyrtocarenum werneri Kulczynski, 1903: 627, 632; Roewer, 1942: 158; Bonnet, 1956: 1352. **Syn. nov.**

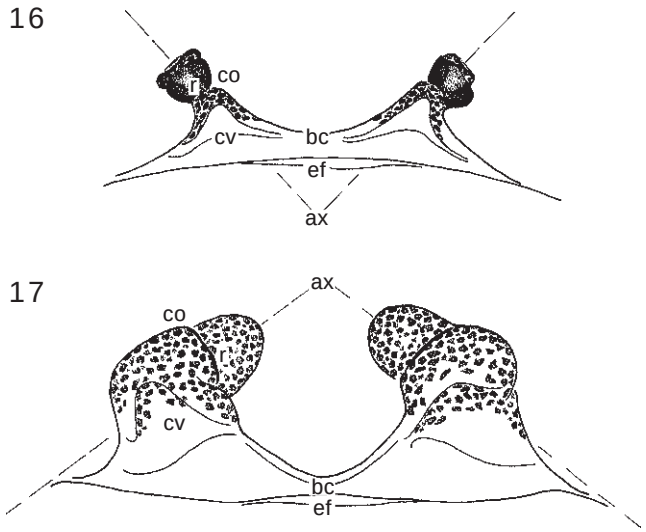
Diagnosis: Trichobothria on d palp tibia in one row (Fig. 8); spigots concentrated in distinct groups apically on v surfaces of median and terminal segments of lateral spinnerets (Fig. 10). *Females:* CL of reproducing females 6.0–9.5. Spermatheca ''mushroom shaped'' and with a thick, annular wall of glandular tissue; lines drawn through central axes of receptacula converge on ef (Fig. 16); tibia II with a field of short spines dorso-distally (Fig. 14); pl tibia IV without spines or with vestigial spines (Fig. 12); pl metatarsus IV with only one spine ventro-distally (Fig. 12); leg formula 4132. *Males:* CL 6.2–8.0. Palps long and slender, reaching beyond tibial-metatarsal joint of leg I (Fig. 18); tibia/metatarsus of leg I modified to form a ''clasper'' (Coyle, 1986b) with one strong hook distally on rl tibia (Fig. 22); embolus terminating in a bent pointed tip (Fig. 20); leg formula 4123.

Description: Female: Neotype (no. N 81-10 NNM) collected in May 1981 on Naxos (type locality of *C. cunicularium*). *Measurements:* CL=8.3; CW=7.1; SL=5.1; SW=4.1; FLp=4.3; PLp=2.6; TLp=2.5; TaLp=3.2; FL I=5.1; PL I=3.6; TL I=3.0; ML I=2.8; TaL I=1.3; FL II=4.5; PL II=3.5; TL II=2.6; ML II=2.6; TaL II=1.3; FL III=3.9; PL III=3.6; TL III=2.2; ML III=3.3; TaL III=2.0; FL IV=5.6; PL IV=4.0; TL IV=3.5; ML IV=4.4; TaL IV=2.2. *Carapace:* Brown. Caput steeply arched with concentrations of setae on clypeus and posterior to eye-formation (Fig. 3). Fovea deep, procurved. Thoracic region glabrous. *Eye-formation:* REF=3.6. Eyes on low tubercle marked by dark pigmentation of integument. Median eyes smaller than laterals, anterior row procurved, posterior row recurved (Fig. 3). *Chelicera:* Basal segment dark reddish brown. Setae concentrated along d margin, merging distally with rastellum and in a narrow longitudinal zone of thin setae on retrolateral surface. Promargin of cheliceral furrow with 7 or 8 teeth (distals stronger). Retromargin with scopula and row of 5 teeth (proximals stronger), small denticles on furrow bottom. Rastellar process in ventral view triangular with apically two (paired) teeth and one (singular) tooth placed more retrolaterally (Fig. 5). *Maxillae:* With distinct distal anterior lobe (Fig. 5). Few cuspules along proximal margin anterior to labium. *Labium:* Trapezoidal, wider than high. Small group of cuspules near anterior margin. Separated from sternum by a wide shallow groove. *Sternum:* Flat, widest between coxae II and III. Posterior projection between coxae IV. Two large central sigilla and two pairs of indistinct sub-



Figs. 12–15: **12,13** Female, metatarsus IV and distal end of tibia IV, prolateral view. **12** *C. cunicularium,* note reduced number of spines on metatarsus (compared with *C. grajum,* Fig. 13) and vestigial spines (often absent) on tibia; **13** *C. grajum,* the spine dorso-distally on metatarsus IV (sp, arrowed) always present in this species but never in *C. cunicularium.* **14,15** Female, tibia II dorso-distally. **14** *C. cunicularium,* field of short spines (s. sp.); **15** *C. grajum,* ordinary setae (set). T=tibia, M=metatarsus. Scale lines=1.0 mm.

marginal sigilla. *Setae:* All sclerotised parts, except carapace, more or less evenly covered with black setae. *Palps:* One row of trichobothria dorsally on proximal half of tibia, pl to longitudinal ax (Fig. 8). Spination: patella pl 2–2, tibia pl 3–3 rl 5–5, tarsus pl 9–10 rl 16–16. Spines on pl patella and pl tibia in longitudinal rows, those on rl tibia and both sides of tarsus in longitudinal groups in which more ventrally placed spines are stronger. Tarsal claw with two teeth, proximal largest. *Leg I:* Spination: tibia pl 13–12 rl 7–5, metatarsus pl 12–14 rl 15–12, tarsus pl 8–8 rl 7–7. Spines on pl tibia in a longitudinal row, other spines concentrated in longitudinal groups in which more ventrally placed spines are stronger. Paired claws with one tooth, 3rd claw smooth. *Leg II:* Spination: tibia pl 2–2 rl 4–3, metatarsus pl 10–8 rl 10–10, tarsus pl 8–9 rl 4–3. Group of short spines on d distal tibia (Fig. 14). Setting of spines and claws as leg I. *Leg III:* Spination: patella pl 3–3, tibia pl 1–1 rl 4–3, metatarsus pl 6–8, tarsus pl 5–5. Spiny setae distally on d femur and d patella. Dense concentrations of short spines on d tibia and metatarsus. Claws as leg I. Thin tarsal scopula present. *Leg IV:* Spination: metatarsus pl 5–4 v 2–0, tarsus pl 8–8. Concentrations of short spines dorsally on both sides of femur/patella joint; rl of paired claws largest, with one tooth, pl smaller and smooth, 3rd



Figs. 16–17: Spermathecae (dorsal view). **16** *C. cunicularium;* **17** *C. grajum.* ax=axis line (see text), bc=bursa copulatrix, co=constriction, cv=closing valve, ef=epigastric furrow, r=receptaculum. Scale line=0.5 mm.

claw smooth. Thin tarsal scopula present. *Spinnerets* (Fig. 10): Laterals ventrally three-segmented (dorsally the basal segment is diagonally divided giving the spinnerets a four-segmented appearance); basal segment twice as long as two terminal segments together; apical segment very short and domed. Spigot concentrations distally on median and apical segments. Median spinnerets small, one-segmented, with few spigots. *Spermathecae* (Fig. 16): Membranous bursa copulatrix (bc) forms a continuous slit in anterior wall of epigastric furrow (ef) with, on each side of longitudinal body axis, a valve (cv) to close off entrance to a receptaculum (r) that consists of a proximal and a distal part separated by a constriction (co) in the receptaculum wall. A pronounced thickening in glandular tissue of the distal part of the receptaculum gives the structure a peculiar mushroom shape.

Male (no. GR80-11, NNM): collected as a juvenile in July 1980 on Tinos and reared in captivity. *Measurements:* CL=7.1; CW=6.1; SL=4.0; SW=3.4; FLp=5.7; PLp=3.5; TLp=5.1; TaLp=1.3; FL I=6.9; PL I=3.6; TL I=4.1; ML I=3.8; TaL I=2.2; FL II=6.1; PL II=3.2; TL II=3.8; ML II=4.2; TaL II=2.8; FL III=5.0; PL III=3.0; TL III=2.8; ML III=4.7; TaL III=3.0; FL IV=7.3; PL IV=3.4; TL IV=5.0; ML IV=6.7; TaL IV=3.0. *Carapace:* Uniformly golden brown with a sharp line of darker pigmentation along edges of cephalic region. Caput less steep than in female, with setae concentrations on clypeus and directly posterior to eye-formation. Fovea procurved and deep. Thoracic region glabrous. *Eye-formation:* REF=3.4. Eyes on low tubercle marked by black pigmentation of integument. Anterior row slightly procurved; posterior row recurved. *Chelicerae:* Slightly darker in colour than carapace, otherwise as female. *Maxillae:* As female. *Labium:* Approximately twice as wide as high, anteriorly more rounded than in female. Cuspules absent. Separated from sternum by wide but shallow groove. *Sternum and Setae:* As female. *Palps:* RPT=4.6. Long and slender, when extended reaching beyond tibial-metatarsal joint of leg I (Fig. 18). Trochanter, femur, patella and tibia conspicuously elongated. One row of trichobothria on d tibia as in female. Spines absent. Few spiny setae dorso-distally on femur. Cymbium apically bilobed. Embolus with narrow tip (Fig. 20). Palpal organ, RBE=0.96. *Leg I:* Tibial-metatarsal junction modified and strongly sclerotised to form a "clasper", with one strong hook retrolaterally on enlarged distal end of tibia (Fig. 22). Spines concentrated on pl and rl patella, and pl and v tibia. Two spines, one pl and one rl, distally on v metatarsus. No metatarsal spines associated with clasper (Fig. 22), tarsal spines absent. Spiny setae on d and pl faces of femur. Paired claws with single comb of teeth, 3rd claw absent (or vestigial). Scopula only on tarsus. *Leg II:* Concentrations of spines on pl and v patella and tibia, and rl metatarsus and tarsus. One central spine on rl patella and tibia. Two distal spines on pl metatarsus. Strong spiny setae on d and pl femur. Claws and scopula as leg I. *Leg III:* Concentrations of spines and spiny setae on all leg segments. Claws and scopula as leg I. *Leg IV:* Spines and spiny setae on all except rl face of femur, on ventro-distal patella, on all faces of tibia and metatarsus, and on pl tarsus. On rl tarsus spines form small distal group. Paired claws as leg I, 3rd claw present. Tarsal scopula absent. *Spinnerets:* As female (Fig. 10).

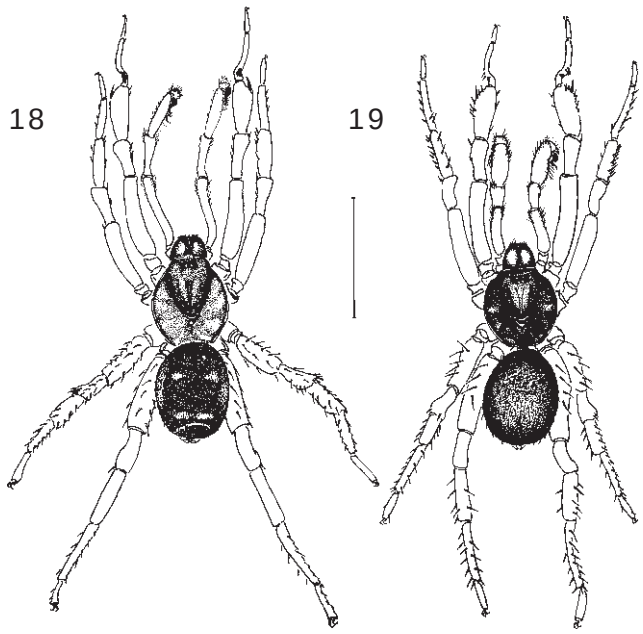
Cyrtocarenum grajum C. L. Koch, 1836 (Figs. 9, 11, 13, 15, 17, 19, 21, 23)

Cteniza graja C. L. Koch, 1836: 39, female holotype at BMNH (examined); 1851: 71.
Mygalodonta graja: Simon, 1864: 75.
Cyrtocarenum grajum: Ausserer, 1871: 158; Pavesi, 1877: 327; 1878: 381; Simon, 1884: 347–348; 1892: 96; Bristowe, 1935: 739; Drensky, 1936b: 9; Roewer, 1942: 158; Bonnet, 1956: 1351; Decae (ms), 1983: 1–59; 1986: 39–43; 1993: 75–82.

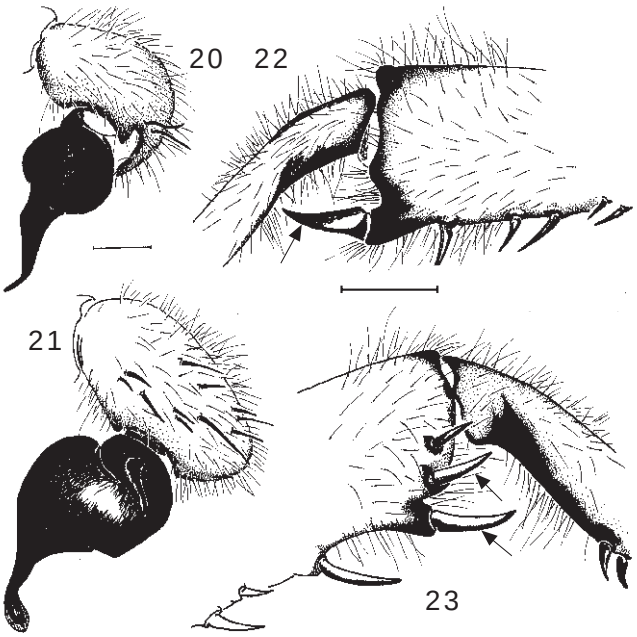
Diagnosis: Trichobothria on d palp tibia in two rows (Fig. 9); spigots evenly distributed over ventral surfaces of median and terminal segments of lateral spinnerets (Fig. 11). *Females:* CL of reproducing females 6.3–11.7. Spermatheca "bottle shaped", evenly covered with glandular tissue; lines drawn through central axis of receptacula diverge on epigastric furrow (Fig. 17); tibia II lacks short spines dorso-distally (Fig. 15); pl surface of tibia IV with some well-developed spines (Fig. 13); pl metatarsus IV distally with both a v and a d spine (Fig. 13); leg formula 4132. *Males:* CL 5.8–7.1; palp stout, not elongated, and not reaching beyond tibial-metatarsal joint of leg I (Fig. 19); clasper on tibia I with three strong hooks distally (Fig. 23); embolus with spatulate tip (Fig. 21); leg formula 4123.

Description: Female (no. 27/10/92-1, NNM); collected at Ahladokabos (23 km west of Nauplion along road to Tripolis), province Argolis (type locality of *C. grajum*). *Measurements:* CL=8.1; CW=7.9; SL=6.6; SW=4.8; FLp=4.8; PLp=2.8; TLp=2.8; TaLp=3.5; FL I=5.7; PL I=3.8; TL I=3.5; ML I=3.0; TaL I=1.4; FL II=4.8; PL II=3.5; TL II=2.7; ML II=2.9; TaL II=1.5; FL III=4.4; PL III=3.5; TL III=2.6; ML III=3.6; TaL

III=1.7; FL IV=6.8; PL IV=3.9; TL IV=3.7; ML IV=4.8; TaL IV=2.1. *Carapace:* Maroon. Caput steeply arched with concentration of setae around eye-formation. Fovea deep, procurved. Thoracic region glabrous. *Eye-formation:* REF=3.0, otherwise as *C. cunicularium. Chelicerae:* Setae as *C. cunicularium.* Promargin of cheliceral furrow with 8 teeth (distals stronger); retromargin with scopula and row of 7 teeth (proximals stronger); numerous denticles on furrow bottom. *Maxillae:* As *C. cunicularium. Labium:* Trapezoidal, wider than high. Cuspules absent. *Sternum and Setae:* As *C. cunicularium. Palps:* Two rows of trichobothria (one on either side of longitudinal central axis) dorsally on proximal half of tibia (Fig. 9). Spination: patella pl 2–1, tibia pl 6–9 rl 9–7, tarsus pl 11–10 rl 20–21. Spine setting as *C. cunicularium.* Tarsal claw with one tooth. *Leg I:* Spination: patella v 1–1, tibia v 1–1 pl 4–4 rl 13–13, metatarsus pl 14–15 rl 20–18, tarsus pl 7–8 rl 8–8. Spine setting (except for v spines on patella and tibia that are absent in *C. cunicularium*) as *C. cunicularium.* Claws as *C. cunicularium. Leg II:* Spination: patella v 1–1, tibia v 1–1 pl 4–4 rl 8–9, metatarsus pl 13–12 rl 4–4, tarsus pl 5–7 rl 6–6. Dorsal short spines absent (Fig. 7b). Spine setting and claws as leg I. *Leg III:* Spination: patella pl 8–5, tibia pl 3–2, metatarsus v 2–2 pl 11–12 rl 3–4, tarsus pl 6–6. Few spiny setae distally on d femur. Concentrations of spiny setae on d patella, tibia, metatarsus and tarsus. Thin scopula on tarsus. Claws as leg I. *Leg IV:* Spination: tibia pl 6–5, metatarsus pl 16–16 rl 2–2, tarsus rl 10–8. Concentrations of spiny setae and short spines distally on d femur and d patella. Scattered spiny setae on d tibia, metatarsus and tarsus. Paired claws with two teeth on pl claw; rl paired claw and 3rd claw smooth. *Spinnerets* (Fig. 11): Segmentation of laterals as in *C. cunicularium,* basal segment slightly longer than two distal segments together; apical segment digitiform.



Figs. 18–19: Dorsal habitus, male. **18** *C. cunicularium,* note elongated palps; **19** *C. grajum.* Spiny setae on dorsal femur III and IV (see text). Scale line=10.0 mm.



Figs. 20–23: **20,21** Cymbium and palpal organ, prolateral view. **20** *C. cunicularium,* embolus with narrow tip, bulbus width/embolus length, RBE=0.96 (see also Fig. 6); **21** *C. grajum,* embolus with spatulate tip, RBE=1.20. Note different orientation of emboli which may be related to different orientation of spermatheca in females (Figs. 16–17), and spiny setae on cymbium of *C. grajum.* Scale line=0.5 mm. **22,23** Leg claspers on tibia I and metatarsus I of male. **22** *C. cunicularium,* left leg, one hook (arrow); **23** *C. grajum,* right leg, three hooks (arrows). Scale line=1.0 mm.

Spigots more or less evenly distributed over ventral surfaces of all three segments. Median spinnerets small, one-segmented, with few spigots. *Spermathecae* (Fig. 17): Membranous bursa copulatrix (bc) and valve (cv) similar in structure but larger than in *C. cunicularium.* Receptacula large, somewhat "bottle-shaped", with wide proximal part and narrower distal part both evenly covered with glandular tissue.

Male (no. Car. 8/82-1, NNM): collected as a juvenile in August 1982 on Kythira by Gilbert Caranhac and reared in captivity. *Measurements:* CL=7.1; CW=6.4; SL=4.2; SW=3.8; FLp=4.6; PLp=2.2; TLp=3.8; TaLp= 1.9; FL I=7.1; PL I=3.5; TL I=4.1; ML I=6.0; TaL I=2.9; FL II=6.6; PL II=3.3; TL II=3.8; ML II=5.1; TaL II=2.6; FL III=5.1; PL III=2.6; TL III=3.2; ML III=4.6; TaL III=2.6; FL IV=7.2; PL IV=3.1; TL IV=4.4; ML IV=6.2; TaL IV=2.8. *Carapace:* Caput low, few setae around eye-formation. Fovea procurved. Thoracic region glabrous. *Eye-formation:* REF=3.3, general features as *C. cunicularium. Chelicerae:* Setae as *C. cunicularium.* Promargin of cheliceral furrow with 9 teeth, retromargin with scopula and row of 8 teeth, numerous denticles on furrow bottom. Few, but conspicuously long, spiny setae in rastellar area. *Maxillae:* Cuspules absent, otherwise as *C. cunicularium. Labium and Sternum:* As *C. cunicularium. Palps:* RPT=2.6. Not elongated. Two rows of trichobothria dorsally on proximal half of tibia as in female. Spiny setae concentrated on cymbium, embolus with spatulate tip (Fig. 21). Palpal organ, RBE=1.20.

One dorso-distal spine on tibia. Spiny setae on d and v femur, ventro-distal patella and v tibia. *Leg I:* Clasper with three hooks retrodistally on tibia and two v spines on metatarsus (Fig. 23). Other spines on v patella, rl, v and pl tibia (spines on v tibia very strong, fitting description of hooks). No distal spines on metatarsus. Spiny setae on d femur. Paired claws as *C. cunicularium* male, 3rd claw present. Scopula extending over v tarsus and distal 1/3 of metatarsus. *Leg II:* Spines concentrated on pl tibia, proximal metatarsus, v and rl tibia, and rl metatarsus. One ventro-distal spine on rl patella and one on ventro-distal pl metatarsus. Spiny setae on d and pl femur. Claws and scopula as leg I. *Leg III:* As *C. cunicularium* male. *Leg IV:* Spines and claws as *C. cunicularium* male. Scopula present. *Abdomen:* Lateral and d almost black, v brown, cover as *C. cunicularium. Spinnerets:* As female (Fig. 11).

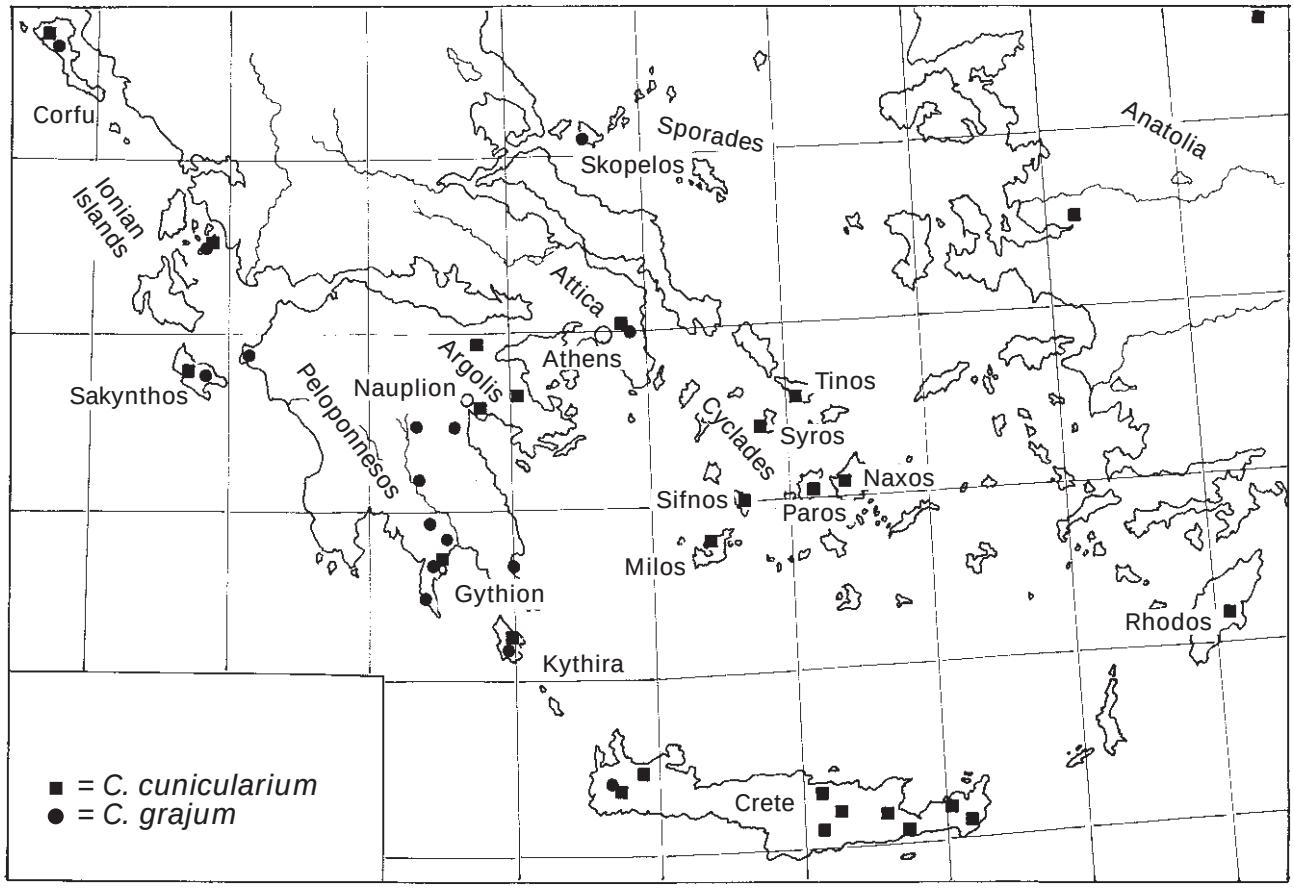
Discussion and distribution

A common problem in mygalomorph taxonomy is the limited availability of specimens and good collection data. Obtaining a workable sample of *Cyrtocarenum* spiders took some time, but finally yielded interesting and important information on the taxonomic diversity and biogeography of the genus. Although much work remains to be done, particularly on the geographical variation in morphology and behaviour, and on the relationship of *Cyrtocarenum* to *Cteniza* and *Aepycephalus,* I think that much confusion about the species-level taxonomy of the group is clarified here.

A more detailed study on the behaviour and biogeography of *Cyrtocarenum* is currently in preparation. Preliminary notes on the distribution following from the study presented here are given below.

Both species, *C. cunicularium* and *C. grajum,* occur syntopically on the Ionian islands and on Kythira and probably in some mainland areas (e.g. Attica). Samples from Sakynthos and Kythira, collected on the same roadside bank or hill slope, produced members of both species in approximately equal numbers. On the nearby Peloponnesos however, the two species exclude each other in most regions. Although one specimen of *C. cunicularium* was collected near the town of Gythion (province Laconia), this region and most of the Peloponnesos is exclusively *C. grajum* territory. The exception is the north-eastern province of Argolis where *C. grajum* is replaced by *C. cunicularium* (Map 1). Misleading in this respect is the type locality of *C. grajum* which is the town of Nauplion in Argolis. Much effort has been invested in looking for *C. grajum* in the immediate vicinity of Nauplion with negative results. An abrupt change in the *Cyrtocarenum* fauna was found on the slopes of the Parnon mountains 23 km west of Nauplion. Here the boundary between *C. cunicularium* and *C. grajum* territory was found to be very sharp.

On the Greek mainland, *Cyrtocarenum* is currently known only from Attica. Here, as on the Ionian Islands and Kythira, both species seem to occur syntopically (sample in the Senckenberg collection from Moni Penteli contains 4 females of *C. cunicularium* and 6 females of



Map 1: Present known distribution of the genus *Cyrtocarenum.*

C. grajum). From Crete only *C. cunicularium* is reported with the exception of one specimen of *C. grajum* in the Senckenberg collection labelled "Lakkos, Crete". *C. grajum* is completely absent from the Cyclades, where *C. cunicularium* is very common on most islands. All specimens hitherto reported from Anatolia and Rhodos are *C. cunicularium.* One spider in the Senckenberg collection from the Sporades island of Skopelos was found to be *C. grajum.*

Map 1 shows that the distribution of the two *Cyrtocarenum* species cannot be readily understood from the present geographical or climatological configuration. Interspecific competition or predation are apparently not forces shaping the distribution of these species, given their close cohabitation on the Ionian islands and Kythira. Because trapdoor spiders in general are an evolutionarily extremely conservative group, that combine very poor abilities for dispersal with great qualities for survival, a possible fruitful approach would be to search for correlations between the present distribution of the two species and the paleogeographic development of this tectonically tumultuous region of the Mediterranean. Such an approach seems promising in furthering our understanding of both the evolution of the European Ctenizinae and of the region in which they occur.

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