

Scorpions of Slovenia: a faunistic and biogeographical survey

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Summary

Four species of the genus *Euscorpilus* (Scorpiones: Euscorpiidae) are known from Slovenia; their distribution appears to be defined mainly by climatic features. While *E. italicus* (Herbst, 1800) is found strictly in the warmest coastal zone and *E. carpathicus* (L., 1767) all over the sub-Mediterranean area, *E. gamma* Caporiacco, 1950 occupies almost all of Slovenia, except the dry sub-Pannonian area in the north-east and the dry, *E. carpathicus*-dominated, sub-Mediterranean area in the south-west. *E. germanus* (C. L. Koch, 1837) is found only in the wettest north-western part of the country, where it is sympatric with *E. gamma*. Both species were also found syntopically. They occur from forested lowlands up to elevations exceeding 1500 m. We present a detailed list of all known localities of the four species, and discuss their biogeography in Slovenia. It seems that both Mediterranean species are not susceptible to drought, and *E. italicus* could even be a xerophile. The area to which they are confined has a high average annual temperature, with the January average above freezing. In contrast, both montane species, *E. germanus* in particular, occur only at high humidity, whatever the temperature regime.

Introduction

Biogeographically, Slovenia, lying between 45°25' N and 46°55' N, is a very diverse country. Its short stretch of sea coast in the south-west is influenced by the Mediterranean climate, the lowlands in the north-east are Pannonian influenced, in the north there are the high Southern Alps, and between these areas there is a more or less hilly and climatically moderately continental country. The southern half is the Dinaric karst with a rich endemic fauna, particularly in cryptic habitats. In fact, the Southern Alps are a less emphasized part of the same (Dinaric) system, enriched with some Alpine elements. Detailed

studies of the distribution and ecology of endemic and little-known invertebrates add to our knowledge of historical and ecological biogeography in this important "hot spot of Europe" (Sket *et al.*, 1991; Mršič, 1997; Sket, 1998).

The scorpion fauna of Slovenia belongs to a single genus, the common European *Euscorpilus* Thorell, 1876 (Euscorpiidae) (Fet & Sissom, 2000), and has been studied for a long time. The first record of *Euscorpilus* sp. from near Maribor was by Poda (1761); important data were published by Hadži (1929, 1931, 1943), Capra (1939), Caporiacco (1950) and Bonacina (1980). However, only recently has it become possible to discern the true species composition of the

	Mean annual temperature	Mean January temperature	Mean annual/summer precipitation (mm)	Difference between summer precipitation and potential evapotranspiration (mm)
<i>E. italicus</i>	11°C or higher (to >12°C)	ca +5°C	<1100/250–300	-300 to -200
<i>E. carpathicus</i>	10°C or higher (to >12°C)	+3°C or higher (to +5.5°C)	<1100–1600/250–450	-300 to +200
<i>E. gamma</i> *	4°C to 12°C	-4°C to +3°C	1100 or higher (to 3000)/ 300 or higher (to 650)	0 or higher (to +400)
<i>E. germanus</i>	4°C to 10°C	-4°C to -1°C	1500 or higher (to 3000)/ 450 or higher (to 650)	+100 or higher (to +400)

Table 1: Climatic conditions within the range of *Euscorpis* species in Slovenia. For sources of data see **Material and methods**. Values in parentheses are extreme values reached in Slovenia (except in elevations above 1500 m) (**E. gamma* may only exceptionally be found in a warmer area)

Alpine scorpion fauna, with application of molecular (allozyme and mitochondrial DNA) techniques (Gantenbein *et al.*, 1999, 2000; Scherabon *et al.*, 2000). Here we present a detailed analysis of scorpion distribution in Slovenia, recognizing four species found in this country and discussing their ecology and biogeography.

Material and methods

We analysed the University of Ljubljana (UL) collection, which had its origin in collections of the late Jovan Hadži and has been enriched by staff scientists and students of the Biology Department during their field trips, mainly from 1960 to 2000. Scorpions of that rich collection are mainly a bycatch or a part of ecological samples; only exceptionally were they collected purposely. Specimens were mostly found under stones or in rotted tree trunks. Labels usually do not designate the habitat type or even type of landscape. In addition, V.F. studied scorpion specimens collected in Slovenia from the Naturhistorisches Museum Wien, Austria (NMW); the Museo Zoologico "La Specola", University of Florence, Italy (MZUF); and the Museum of Comparative Zoology, Harvard University, USA (MCZ). Some specimens are in the private collections of V.F. and M.K. Trichobothrial scores were taken according to the standard convention (Gantenbein *et al.*, 1999, 2000). Total number of specimens analysed was 834 (*Euscorpis italicus* 23, *E. carpathicus* 108, *E. germanus* 199, and *E. gamma* 504).

The geographic coordinates (see **Appendix**) presented for the locality data were extracted

from a digital map of Slovenia (*Atlas Slovenije*). For evaluation of distributional data the following climatological documents were used (Table 1). Temperature data were extracted from Gams (1998) and Pleško & Šinik (1969). Precipitation and soil moisture data are from Bernet (1998) and Bergant & Kajfež-Bogataj (1998), as well as from some manuscript reports of the latter authors; data are long-term averages (for 1961–1990). For the summer period (June–August), potential evapotranspiration was calculated as for grassy areas (Thornwait's method). Note that *E. gamma* and *E. germanus* are found in mostly forested areas, and therefore data are only indirectly applicable. These sources will not be cited further in the text.

Results

All known localities for the four scorpion species found in Slovenia, and some locality data for the neighbouring areas, are listed in the **Appendix**. The maps (Figs. 1–2) show known records of the species in Slovenia. Species distributions are briefly summarized below.

***Euscorpis italicus* (Herbst, 1800)**. Recorded for Slovenia (Caporiacco, 1950; Fet & Sissom, 2000). In Slovenia this Mediterranean species is limited to a narrow strip at the Adriatic coast and extends less than 10 km inland. This shale and sandstone (flysch) area below the limestone cliff of the Kras is mainly open hill country of up to 200 m. The exception to this distribution pattern are findings in the city of Ljubljana.

***E. carpathicus* (L., 1767)**. Recorded for Slovenia (Caporiacco, 1950; Fet & Sissom,

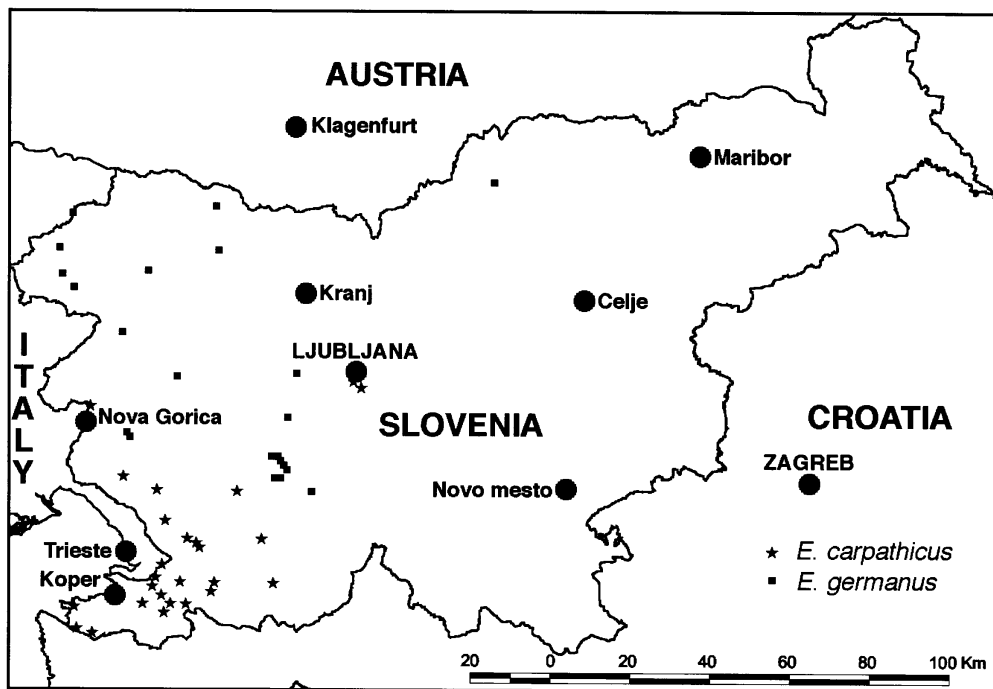


Fig. 1: Distribution of *Euscorpius carpathicus* and *E. germanus* in Slovenia.

2000). The species inhabits the sub-Mediterranean part of Slovenia including the coast and flysch hills as well as the limestone karst plateau of Kras and surrounding valleys of Vipava and Soča-Isonzo. It reaches elevations up to 400 m. It also occurs in the cities of Ljubljana and Postojna.

E. germanus (C. L. Koch, 1837) *sensu stricto*. Recorded for Slovenia (Capra, 1939; Caporiacco, 1950; Valle *et al.*, 1971; Bonacina, 1980; Fet & Sissom, 2000). In Slovenia, this species is limited to the elevated country in its western part including Julijske Alpe (Julian Alps) and the extreme northwestern parts of the Dinaric karst, ranging in elevations from 150 to 1150 m. This is mainly a karst area in a belt of coniferous or mixed forests.

E. gamma Caporiacco, 1950. Described from the Soča (Isonzo) Valley as *E. germanus gamma* (Caporiacco, 1950; Valle *et al.*, 1971); elevated to species status by Scherabon *et al.* (2000). The type series (MZUF) includes the following localities from Slovenia: Predel (= Predil), Kamno, Vrsno, and Mt Krn and Trenta (= Val Trenta) in Soča (= Isonzo) watershed in western Slovenia; Panovec (= Panovizza) and the mouth of Rižana (= Risano) river in south-western Slovenia. The

specimen from Rižana (MZUF) has been designated as a lectotype by Scherabon *et al.* (2000). The species inhabits most of the Slovenian territory; however, its distribution is patchy in the sub-Mediterranean area in the south-west (inhabited mainly by *E. carpathicus*, see above). It seems to be absent from the sub-Pannonian parts in the east and north-east. It occurs at all elevations from the coast up to 1700 m, mostly in forests of different types and on carbonate as well as on silicate substrates.

Discussion

Slovenia is inhabited by two Mediterranean and two more narrowly distributed species. All four show pronounced dispersion abilities, a rather unusual attribute of such cryptic animals. This is most evident in the Mediterranean *E. italicus* and *E. carpathicus*, which are regularly encountered in bigger urban centres outside their natural climatic zones. The synanthropic occurrence of both species in Ljubljana is doubtlessly allochthonous, as most probably is the occurrence

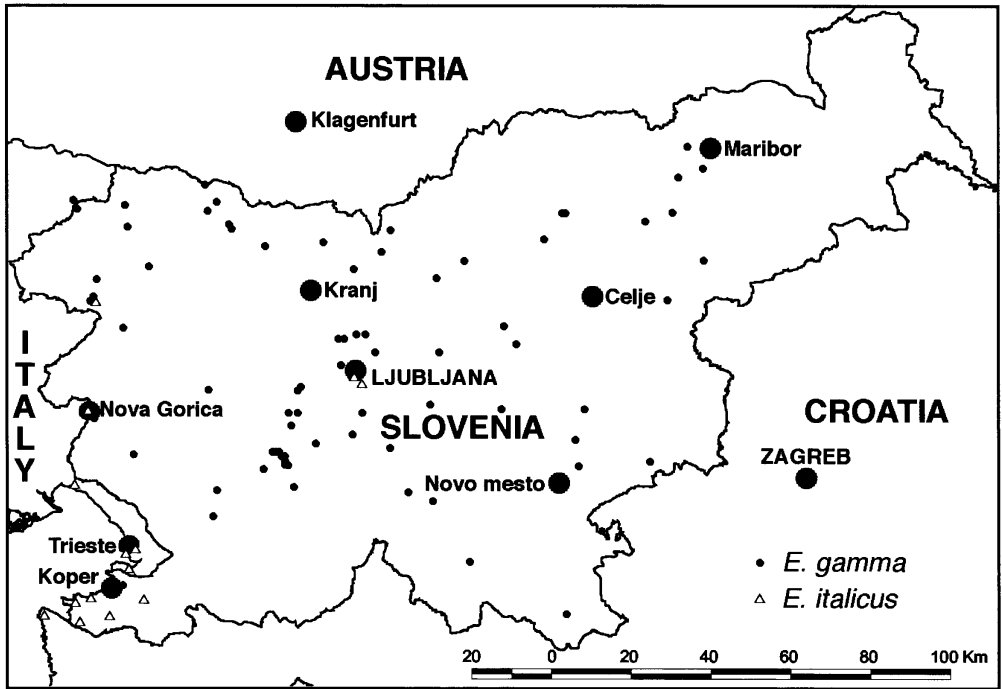


Fig. 2: Distribution of *Euscorpius gamma* and *E. italicus* in Slovenia.

of *E. carpathicus* in Postojna. Remarkably, the second author has collected large specimens of both species in his residence situated in a marshy suburb of Ljubljana (Galjevica), a habitat very different from the natural environment of this species. Introductions of *E. italicus* and *E. carpathicus*, particularly close to the larger urban centres, are common (Fet & Gruodis, 1987; Goyffon, 1992); in the past, these species were possibly displaced along with firewood but now they may migrate with tourist traffic.

In the "continental" species *E. germanus* and *E. gamma*, which are evidently confined to humid forest or montane environments and seldom encountered in townships, the dispersion abilities are evident by their presence all over supposedly acceptable climatic areas. This is independent of the geology and predominant vegetation type, and thus the historical origins of the species are largely masked.

E. italicus seems to be confined to either high mean temperatures or mild maritime climates. Most of its Slovenian localities have a mean annual temperature of more than 12 °C and mean winter daily temperatures seldom below 0 °C. In

the coastal Koper, the mean monthly temperature is 22.9 °C in July and 5.3 °C in January. This species is rarely found even in those sub-Mediterranean areas where the annual temperature range is higher. In Slovenia the distribution of some other Mediterranean (or mero-Mediterranean) biota is similarly limited including, among other cryptic arachnids, the spiders *Filistata insidiatrix* (Forskål, 1775), *Spermophora senoculata* (Dugès, 1836), and *Segestria florentina* (Rossi, 1790) (Kuntner, 1997a, b); and among other animals, the mantid *Empusa fasciata* Brullé, 1832 (Us, 1992; Gomboc, 2000), the lizard *Podarcis sicula* (Rafinesque, 1810), the snakes *Malpolon monspessulanus* Hermann, 1804 and *Elaphe quatuorlineata* (Lacépède, 1789); and among plants, the ground orchid *Orchis simia* Lamarck, 1787, the tree *Celtis australis* L., 1758 (Wraber & Skoberne, 1989), and a number of other species. The range of *E. italicus* in Slovenia lies within the wider range of *E. carpathicus*, which has always been the more numerous in their joint localities.

Along the rest of the north-eastern shores of the Adriatic *E. italicus* seems to be limited to the coastal strip. One exception is an inland locality in Ohrid (Macedonia) (Hadži, 1930), at more than 700 m elevation and with a mean annual temperature of only 11°C; the local climate might be milder there because of the presence of a large lake.

The remote urban occurrence in Ljubljana is certainly not capricious; the same might be so for some other inland localities like Kamno in the upper Soča Valley.

E. carpathicus is also a Mediterranean element but it inhabits a wider sub-Mediterranean area in Slovenia, up to the elevated mountains in the south-west. With few exceptions, its localities are still within the region with mean annual temperatures greater than 10°C, but sometimes with very cold winter conditions (compared to *E. italicus*), under the influence of the “burja” wind (Croatian “bura”, Italian “bora”). In Vipava, the mean monthly temperatures are 20.9°C in July and 2.9°C in January; the monthly minimum is -0.4°C and the absolute minimum -12.8°C. We suppose that the few localities with mean annual temperatures less than 10°C (in the Brkini-Cičarija area) have milder winters than the central parts of Slovenia. This would be consistent with reports of exceptional local spider species richness in the Brkini forest (Kuntner, 1997b).

The Slovenian distribution of *E. carpathicus* is comparable to those of some other Mediterranean arachnids such as the cryptic spiders *Uroctea durandi* (Latreille, 1809) (Kuntner, 1997a) and *Zoropsis spinimana* (Dufour, 1820) (Kuntner & Kostanjšek, 2000), or the web-builders *Neoscona subfusca* (C. L. Koch, 1837) (Kuntner, 1997b; Kuntner & Kostanjšek, 2000) and *Uloborus walckenaerius* (Latreille, 1806) (Kuntner, pers. obs.). Other remarkable Mediterranean animals with a comparable distribution in Slovenia include the grasshopper *Saga pedo* (Pallas, 1771) (P. Trontelj, pers. comm.), the centipede *Scolopendra cingulata* Latreille, 1817 (Attems, 1929; our data), and also some thermophile, and therefore seemingly Mediterranean, epigeal Dinaric (or west Balkanic) endemics such as lizards *Podarcis melisellensis* (Braun, 1877) and *Algyroides nigropunctatus* (Dumeril et Bibron, 1839) (Sajovic, 1913; Mršič, 1997), or the plant *Campanula pyramidalis* L., 1758.

E. carpathicus, like most scorpion species, seems to be absent from the continental sub-Pannonian east and north-east Slovenia, where the mean annual temperatures are similar, above 10°C, but with a much higher annual temperature range, i.e. slightly lower winter temperatures. In Murska Sobota the mean January temperature is -2.5°C and the absolute minimum is -31.0°C. *E. carpathicus* is widely present in similar climates in Serbia (see Hadži, 1930, 1931; Čurčić, 1971). The apparent absence of the species from north-eastern Slovenia may be due to undersampling, because there are records of some other Mediterranean animals from the area, notably the famous wolf spider (“tarantula”), *Hogna radiata* (Latreille, 1817), recorded in sub-Pannonian Slovenia (Kuntner, 1999) and Austria (Kropf & Horak, 1996). The sub-Alpine country around Warmbad Villach (Austria) immediately north of the Slovenian border is inhabited by a viable population of *E. carpathicus*, though probably of an anthropogenic origin (Scherabon, 1987; Huber *et al.*, 2001).

Because *E. italicus* occurs only within the part of Slovenia with the driest summers, while *E. carpathicus* lives within a wide spectrum of precipitation regimes, it seems that only the temperature regime defines the boundaries of distribution; *E. italicus* could be even more xerophile. *E. carpathicus* occurs in regions with less than 1100 mm to those with more than 1600 mm precipitation per year—a summer precipitation/evapotranspiration difference from -300 to +200 mm.

Subspecific taxonomy of *E. carpathicus* is extremely complicated (Fet & Sissom, 2000). C. L. Koch (1837) described two species from the environs of Trieste, *Scorpius aquilejensis* and *S. tergestinus*. Caporiacco (1950) considered these forms to be valid, sympatric subspecies of *E. carpathicus* (L., 1767). Fet & Sissom (2000) listed *E. tergestinus* as a tentative species but its status remains unclear. Specimens collected in Slovenia do not exhibit considerable morphological variation.

E. germanus and *E. gamma*. Capra (1939) was the first to indicate the presence in western Slovenia of more than one form belonging to the complex which was traditionally treated as *E. germanus* (Hadži, 1929). Caporiacco (1950) described a new subspecies, *E. germanus gamma* from the Soča valley and other points in western

Slovenia. According to Bonacina (1980), this form belonged to the species *E. mingrelicus* (Kessler, 1874). Fet & Sissom (2000) listed the Slovenian subspecies as *Euscorpius mingrelicus gamma*. More detailed studies of both *E. germanus* and *E. mingrelicus* (Scherabon, 1987; Fet, 1993; Komposch & Scherabon, 1999; Gantenbein *et al.*, 2000; Scherabon *et al.*, 2000) demonstrated that the form found in the Julijske Alpe (Julian Alps) and Karavanke (Karawanken Alps) deserves species status as *E. gamma* Caporiacco, 1950 (Scherabon *et al.*, 2000).

At the same time, *E. germanus s.s.* was also recorded from western Slovenia (Caporiacco, 1950; Bonacina, 1980; Fet & Sissom, 2000). Bonacina (1980) analysed populations from several points in Slovenia, and found that in Bovec, Jesenice, Trenta and Laze the two species were sympatric. In Kobarid, a pure population of *E. germanus* was found, and only *E. gamma* was recorded (as *E. mingrelicus*) by Bonacina (1980) in Senožeče and in the eastern part of Slovenia (Velenje, Celje, and Oplotnica). We record here an incidence of syntopy between *E. germanus* and *E. gamma* in the karst area of Planinsko polje (Central Slovenia).

Regarding the subspecific division of *E. germanus*: after the recent revisions of Gantenbein *et al.* (2000) and Scherabon *et al.* (2000), only two subspecies remain valid: the nominotypical *E. g. germanus* (C. L. Koch, 1837) (Italy, Austria, Switzerland, and Slovenia) and *E. g. marcuzzii* Valle *et al.*, 1971. The latter was described from the "refugial massifs of the Venetian Pre-Alps (Italy) and from northern Slovenia". The sole morphological character distinguishing this taxon from other subspecies is the presence of 3 trichobothria (instead of 4) in the accessory basal series ($eb_a=3$) on the external aspect of the pedipalp. It is unclear whether this character is diagnostic. Bonacina (1980) mentioned a number of populations from north-eastern Italy and Slovenia, some "pure" *E. g. marcuzzii* and others mixed (and "hybrid", i.e. asymmetric $eb_a=3-4$ or $4-3$) with *E. g. germanus*. Most Slovenian specimens examined by us have $eb_a=3$; however, further molecular analysis of all populations are necessary to clarify the status of *E. g. marcuzzii*, which currently appears to be a taxon of a dubious validity (Gantenbein *et al.*, 2000).

Both *E. germanus* and *E. gamma* appear to be Alpine, montane forms. However, whereas *E. gamma* is widely found in Slovenia, *E. germanus* seems to be restricted to the western part of the country. Thus, the eastern boundary of the range of this species is within Slovenia. Although *E. germanus* and *E. gamma* occur distinctly allopatrically in Austria (Komposch & Scherabon, 1999), they are sympatric in north-western parts of Slovenia (Scherabon *et al.*, 2000) where the *E. germanus* area is completely enclosed within the *E. gamma* range.

There is, however, a remarkable area of syntopic occurrence of both taxa in central Slovenia. Rich mixed samples originate from the localities above the north-eastern margins of Planinsko polje¹, mainly from the karst doline² Vranja jama. The free part of the rocky but forested bottom of the doline is 90 × 50 m (it continues into a wide cave entrance), but most of specimens were collected in an approximately 100 m² area in its upper part, mostly under the bark of fallen trees. During the period 1992–1995, 36 *E. gamma* and 20 *E. germanus* were collected, while in nearby localities outside Vranja jama in 1982–1985 and 1991–1994, 24 *E. gamma* and 76 *E. germanus* were found. In *E. gamma* the female:male ratio in this area was 28:13, it was even more imbalanced in *E. germanus* with 65:6. No cases of hybridization have been noted in the rich samples from this important area, which justifies their species status.

E. germanus could be characterized as a southern Alpine element with its range extending into the nearby parts of Dinarides. It does not show any thermal limitations, and is found in the Alps well above 2000 m (Braunwalder, 2001). Remarkable, however, is the coincidence of its area with the least drought-affected area in 2000 (see Anonymous, 2000); this is the area of 450–650 mm of precipitation in summer months and within the area of the positive 100 mm of the average difference between precipitation amount and potential evapotranspiration (see **Material and methods**). It is an area along most of the mountainous belt behind (inland of) the *E. carpathicus* area with an extension north-east towards eastern Karavanke from where a single sample of this species originates.

E. gamma distribution, as presently known, is unique in that it seems nearly to follow the geographical borders of Slovenia. However, this

picture could be altered if the extinct populations around the Austrian Steierisch Graz (Scherabon, 1985) belonged to this taxon. Taken together with its southeastern relatives (see Bonacina, 1980; Kovářik, 1997), which are not necessarily its conspecifics, *E. gamma* is roughly the Dinaric type (in its historical, not vegetational sense, see Sket, 1998) of distribution but with an enormous widening of the range in its north-western, i.e. Slovenian, part. The species seems to be absent from the dry and continental sub-Pannonian northeast of the country (see discussion under *E. carpathicus*) as well as in its most typical and similarly dry sub-Mediterranean parts. However, its absence in the north-east may be only apparent, due to undersampling, while in the south-west it is probably being outcompeted by *E. carpathicus*. Temperature conditions within the range of this species are very diverse, from more than 12 °C to approximately 4 °C annual mean and down to -4 °C January mean temperature; the situation with *E. germanus* is similar. In the whole of its contiguous distribution area the relation between precipitations and evapotranspiration in summer is positive, of 0–400 mm or more. An enigmatic exception is the type (lectotype) locality in the mouth of the Rižana river, i.e. close to the sea coast, generally the driest part of Slovenia, but probably with a locally moist soil in the estuarine area.

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Appendix

Known localities of *Euscorpious* species in Slovenia and vicinity. Division of Slovenia by provinces is somewhat arbitrary. Abbreviations to the collections as in text. Collectors of the material are listed in the **Acknowledgements**.

Euscorpious italicus (Herbst, 1800)

SLOVENIA: *Obalno Kraška*: Sečovelje-Sicciole 13.62, 45.47 (UL); Strunjan-Strugnano 13.61, 45.52 (UL); Izola-Isola, Istra 13.66, 45.53 (Guerra, 1980); Čerteže, Šmarje, Koper (UL); Dekani, Pridvor-Sv. Anton, Koper 13.83, 45.53 (UL). *Goriška*: Kamno, upper Soča valley 13.66, 46.21 (Caporiacco, 1950). *Osrednja Slovenija*: Ljubljana 14.51, 46.05 (UL, 2 records); Ljubljana, Galjevica, in house 14.53, 46.03 (MK).

ITALY: Muggia-Milje 13.78, 45.60 (Guerra, 1980); Duino-Devin Aurisina-Nabrežina 13.60, 45.79 (Guerra, 1980); Trieste-Trst, surroundings 13.80, 45.65 (Guerra, 1980); Trieste-Trst (city) 13.77, 45.64 (Hadži, 1929); Gorizia-Gorica 13.64, 45.96

CROATIA: Savudrija-Salvore, Istra 13.51, 45.49 (Guerra, 1980); Rovinj-Rovigno (Guerra, 1980); Limski kanal (=Fiord bij Rovinj) (Guerra, 1980).

AUSTRIA: Graz (city), Steiermark (Scherabon, 1985).

Euscorpious carpathicus (L., 1767).

SLOVENIA: *Obalno Kraška*: Dane, Sezana 13.90, 45.72 (UL); Divača (=Divaccia) 13.97, 45.68 (NMW, UL); Mlake, W slope of Nanos, Vipava 14.13, 45.79 (UL); Komen (Comeno) 13.76, 45.82 (Guerra, 1980); Hrastovlje 13.90, 45.51 (UL); Črni Kal, Stena 13.89, 45.55 (UL); Dekani, Pridvor-Sv. Anton, Koper-Capodistria 13.83, 45.53 (UL); Podgorje (516 m a.s.l.), Slavnik 13.97, 45.53 (UL); Glavica (620 m a.s.l.), Slavnik, 2 km S of Kozina 13.95, 45.58 (MK); near

Dimnice cave near Markovščina 14.06, 45.58 (UL); Markovščina 14.05, 45.56 (UL); Ilirska Bistrica 14.25, 45.58 (UL); near the cave Ponikevska Draga at Ponikve, Avber, Sežana 13.87, 45.79 (UL); Praproče, Podgorje 13.92, 45.53 (UL); Osp 13.86, 45.57 (UL, MK); Socerb (= San Servolo) 13.87, 45.59 (UL, MK, Guerra, 1980); Dragonja, Stena 13.67, 45.46 (UL); Sečovlje-Sicciole 13.62, 45.47 (UL) **NB**: From Sečovlje (see locality above) about 45 specimens were examined from various samples; Škocjan (= St Canzian) 14.00, 45.67 (UL); Škocjanske jame (= Grotte v. St. Canzian) 14.01, 45.66 (Hadži, 1930); Strunjan-Strugnano 13.61, 45.52 (UL); Pivka (= St Peter a. Karste, Šentpeter na Krasu) 14.21, 45.68 (Hadži, 1930). *Goriška*: Sabotin (= Monte Sabotino) 13.65, 45.98 (Guerra, 1980). *Osrednja Slovenija*: Ljubljana 14.51, 46.05 (UL); Ljubljana, Galjevica, in house 14.53, 46.03 (MK).

ITALY: Draga, 5 km of Pese-Pesek, Carso Triestino-Tržaški Kras (= Karst of Trieste) 13.89, 45.62 (Kovářk, 1997).

CROATIA: Pula (Pulj, Pola) (Hadži, 1930); Ičići, Opatija (= Abbazia) (Hadži, 1930); Opatija (= Opatia, Abbazia) (Hadži, 1930); Volosko, Opatija (Hadži, 1930); Rovinj-Rovigno (Guerra, 1980); Novigrad-Cittanova (Castelnuovo, Istra) (Guerra, 1980); Porez (= Parenzo, Istra) (Guerra, 1980).

AUSTRIA: Fronleiten, Steiermark (Scherabon 1985); St Johann und Paul, Steiermark (Scherabon, 1985); Federaun near Warmbad Villach, Kärnten (Scherabon, 1987; pers. comm.; Huber *et al.*, 2001). **NB**: In Austrian Steiermark around Graz all *Euscorpium* species are considered locally extinct (Scherabon, 1985).

Euscorpium germanus (C. L. Koch, 1837)

SLOVENIA: *Gorenjska*: Jesenice 14.05, 46.44 (Bonacina, 1980; Guerra, 1980); Savica-Komna, 1050 m a.s.l., 13.83, 46.29 (UL); Bohinjska Bela 14.06, 46.34 (UL). *Goriška*: Črniče near Nova Gorica 13.8, 45.91 (Scherabon *et al.* 2000); Črniče-Osek, Šempas 13.77, 45.92 (UL); Kobarid (= Caporetto) 13.59, 46.25 (Bonacina, 1980; Guerra, 1980); Predil (= Predel) Pass 13.58, 46.42 (VF); Soča (= Isonzo) Valley (Caporiacco, 1950); Trnovo near Bovec 13.55, 46.28 (VF); Bovec 13.54, 46.34 (Bonacina 1980; Guerra, 1980); Most na Soci (= Sveta Lucija, St Lucia) 13.75, 46.15 (UL). *Notranjska*: Cerknica 14.37, 45.79 (Bonacina, 1980; Guerra, 1980); Laze, Planinsko polje 14.27, 45.86 (Guerra, 1980; Bonacina, 1980; UL), Planinsko polje, SE part (towards Rakek) 14.29, 45.84 (UL); NE edge of Planinsko polje 14.26, 45.87 (UL,

MK); north edge of Planinsko polje 14.24, 45.87 (UL); E edge of Planinsko polje 14.28, 45.85 (UL); doline Vranja jama, N of Planinsko polje 14.25, 45.87 (UL); entrance to Planinska jama, S of Planinsko polje 14.25, 45.82 (UL); Unec, doline Unska koliševka 14.27, 45.82 (UL); Gorenja Kanomlja, Močnik, Sp. Idrija 13.93, 46.05 (UL).

Osrednja Slovenija: At the Ljubljana river spring near Vrhnika 14.29, 45.96 (UL); Polhov Gradec 14.32, 46.06 (Bonacina, 1980; Guerra, 1980; UL).

Koroška: Ošven, Podgora, Ravne na Koroškem 14.96, 46.50 (UL).

AUSTRIA (localities in Scherabon 1987, as "*E. germanus*, Typische Form"): Karnische Alpen; Gailtal and Gailtaler Alpen; Drautal W of Villach-Beljak.

Euscorpium gamma Caporiacco, 1950

SLOVENIA: *Gorenjska*: Bled (500–700 m a.s.l.) 14.10, 46.38 (MCZ); Bled, Blejski Vintgar 14.09, 46.39 (UL); at the Kamniška Bistrica spring north of Kamnik 14.59, 46.33 (UL); Jesenice 14.05, 46.44 (Guerra, 1980; Bonacina, 1980); Vršič Pass, S of Kranjska Gora (localities from 1100 m to 1400 m a.s.l.) 13.75, 46.43 (UL); Hruški vrh at 1700 m a.s.l. (Karavanke, Jesenice) 14.01, 46.48 (UL); Mezakla 14.02, 46.42 (UL); Mošnje, left bank of the Dobruša river, Brezje 14.21, 46.34 (UL); Savica-Komna (at 700–950 m and at 1050 m a.s.l.) 13.83, 46.29 (UL); mountain hut under Mt Storžič (1123 m a.s.l.) 14.40, 46.35 (UL); Cerklje, Davovec 14.50, 46.29 (UL).

Goriška: Panovec (= Panovizza) forest near Nova Gorica 13.66, 45.94 (Caporiacco, 1950); Branik near Nova Gorica 13.79, 45.86 (UL); The following localities in the Soča (= Isonzo) Valley (Caporiacco, 1950): Predel (= Predil) 13.58, 46.42, Kamno 13.64, 46.21, Vrsno 13.65, 46.22, Mt Krn 13.66, 46.26; Most na Soči near Tolmin (= St Lucia bei Tolmein 13.75, 46.15; Trenta (= Val Trenta) 13.76, 46.38 (Caporiacco, 1950).

Notranjska: Laze, Planinsko polje 14.27, 45.86 (Bonacina, 1980; Guerra, 1980; UL), NE of Laze, Planinsko polje (500–515 m) 14.28, 45.86 (MK); Planinsko polje, SE part (towards Rakek) 14.29, 45.84 (UL); S side of Planinsko Polje 14.28, 45.84 (UL); NE edge of Planinsko polje 14.26, 45.87 (UL); N edge of Planinsko polje 14.24, 45.87 (UL); E edge of Planinsko polje 14.28, 45.85 (UL); doline Vranja Jama, N of Planinsko polje 14.25, 45.87 (UL); Rakov Škocjan near Rakek 14.31, 45.79 (UL); Idrija, Brusovše 14.03, 46.01 (UL); Strmca, W of Planina, near Postojna (UL). *Obalno Kraska*: Mt Nanos (= Monte Re) 14.06, 45.78 (Caporiacco, 1950; Scherabon *et al.*, 2000); mouth of

Rižana (= Risano) River 13.76, 45.56 (MZUF78 (Caporiacco, 1950; Scherabon *et al.*, 2000); Senožeče 14.05, 45.72 (Bonacina, 1980; Guerra, 1980). *Osrednja Slovenija*: at the Ljubljanica river spring near Vrhnika 14.29, 45.96 (UL); Kresnice–Sava 14.78, 46.10 (UL); Pekel gorge, Borovnica 14.38, 45.89 (UL); Planinca, Ig 14.53, 45.96 (UL); Podutik, Ljubljana 14.46, 46.07 (UL); Rasica near Ljubljana 14.51, 46.14 (UL); Sp. Dobeno, Mengeš 14.54, 46.14 (UL); Ljubljanski vrh (700 m a.s.l.), Vrhnika 14.30, 45.93 (MK); Retovje, Verd near Vrhnika 14.32, 45.96 (UL); Šmarna Gora 14.47, 46.13 (UL); Šmarna Gora, Turnc 14.45, 46.13 (UL); Vikrče, pod Turncem, Medvode 14.45, 46.13 (UL); Urbanc, Horjul near Vrhnika 14.32, 46.01 (MK); Lesno Brdo, Horjul 14.33, 46.02 (UL); Iški Vintgar, Iška vas 14.50, 45.91 (UL); Soteški hrib, Podgorica 14.57, 46.10 (UL). *Dolenjska*: Turjak, Stari grad 14.62, 45.88 (UL); Žrnovec, Žlebič 14.68, 45.78 (UL); Gradisce, Stična 14.75, 45.98 (UL); Čatež, Trebnje 14.98, 45.97 (MK); Mala Gora, Ribnica (700 m) 14.76, 45.76 (UL); Stojna, Dolga vas, Kočevje 14.88, 45.62 (UL); Otočec 15.23, 45.84 (UL); Stari grad, Podbojce, Kostanjevica 15.46, 45.85 (UL); W of Homski hrib, Sela, Skočjan (UL). *Podravje*: Maribor (= Marburg) 15.65, 46.56 (NMW); Pohorje (= Bacher Mts) near Maribor (= Marburg) 15.56, 46.50 (NMW); Brestrnica, Maribor 15.59, 46.57 (UL); Bistriški Vintgar, NW of Slovenska Bistrica 15.54, 46.42 (UL); Razvanjski potok, Pohorje, Maribor 15.64, 46.52 (UL); Oplotnica 15.45, 46.40 (Guerra, 1980; Bonacina, 1980); Modraže–Hrastje near Makole in Dravinja Valley 15.64, 46.31 (UL). *Savinjska*: Velenje, Celje 15.12, 46.36 (Bonacina, 1980; Guerra, 1980);

Logarska Dolina 14.62, 46.38 (UL); Hom (500–600 m a.s.l.), S of Radmirje 14.86, 46.31 (UL); Volčje Jame, Požešč, SW of Gornji Grad 14.77, 46.27 (UL); Pečeničnik vrh, Mislinja 15.19, 46.42 (UL); Tisnik, Mislinja 15.18, 46.42 (UL). *Zasavje*: Rove near Kotredež, Zagorje 14.99, 46.16 (UL); Trbovlje, Mitovski slap 15.03, 46.12 (UL); Križ, Telče, Sevnica 15.25, 45.97 (UL). *Bela Krajina*: Dragatuš, Nerajski Cirknik, Mali Nerajc 15.19, 45.50 (UL).

CROATIA: Učka (= Monte Maggiore) (Scherabon *et al.*, 2000; Bonacina, 1980); Risnjak Mts (Scherabon *et al.*, 2000; Bonacina, 1980).

ITALY: Cave del Predil-Rabelj (Bonacina, 1980; Guerra, 1980).

AUSTRIA: localities in Scherabon (1987), as “*E. germanus*, Karawankenform”: Karawanken-Karavanke between Villach in W and Bleiburg-Pliberk in E.

NB: In localities around Planinsko polje there have been numerous recordings of both *E. gamma* and *E. germanus*. At least 200 specimens have been examined from this area. In the list of localities the records are grouped by locality.

Notes

¹ A large karst depression (several km or tens of km long) characteristic for Dinaric karst, usually with a partly impermeable bottom (with an intermittent river or lake), with karstified margins and surroundings.

² A smaller karst depression (ten to several hundred m wide), commonly with vertical sides; can include a cave entrance.