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The cave spider *Meta menardi* (Araneae, Tetragnathidae) – occurrence in Finland and notes on its biology

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Fifteen years ago the cave spider *Meta menardi* (Latreille, 1804) was known in Finland in two locations only. Partly due to extensive search it is to date known from 20 sites, all however located in the south-westernmost parts of the country. *M. menardi* is known to prefer stable and relatively warm subterranean habitats. Our temperature data from a cave on the Åland Islands in Finland indicates that the populations of *M. menardi* on the northern limit of its distribution could be more cold tolerant than the previously studied populations in Central Europe. In this paper all known locations in Finland are mapped and presented in a table with habitat data. A note on the strategy for catching mosquitoes with the orb web is given and the possible importance of the prey-catching function of the orb web is briefly discussed.

Introduction

The large cave spider *Meta menardi* (Latreille, 1804) is the most conspicuous of our cave-dwelling spiders. The species is geographically widely distributed and occurs throughout most parts of the Palaearctic region (Platnick 2011). Due to its size and colouration it is relatively easy to recognize, but can be mixed up with other congeneric species not occurring in Finland. The body length is 9.9 to 12.6 mm in males and 12.9 to 15 mm in females (Roberts 1995, Almquist 2005). The colouration is generally quite dark; the cephalothorax is reddish brown, the abdomen pale or dark brown, both with black markings. Anteriorly the abdomen typically has a pair of dorsolateral dark flecks, sometimes resembling a pair of sunglasses (Figs. 1–3). These are even more conspicuous in small juveniles (Fig. 3). The legs are long and dark brown with black annulations. Also the large whitish egg sacs (Fig. 4) with a diameter of 2–3 cm, hanging from a short thread, are easy to recognize.

Although an orb web weaving spider, *M. menardi* tends to spend much of its time near the cave wall (Eckert & Moritz 1992) from where it is known to catch crawling prey such as myriapods, wood lice, beetles and even snails (Eckert & Moritz 1992, Smithers 2005). According to Smithers (2005) it appears that *M. menardi* has specialized in capturing members of the soil/litter fauna that stray into underground chambers, but will respond opportunistically to any additional prey that walks the inner surface of the underground chamber. Due to the hunting behaviour without reliance on the web, the relatively small orb web of 20–30 cm with widely spaced spirals has been interpreted as highly rudimentary (Eckert & Moritz 1992).

M. menardi lives in subterranean caves, cellars, mineshafts and within stone runs. In caves *M. menardi* lives mainly near the entrances in the

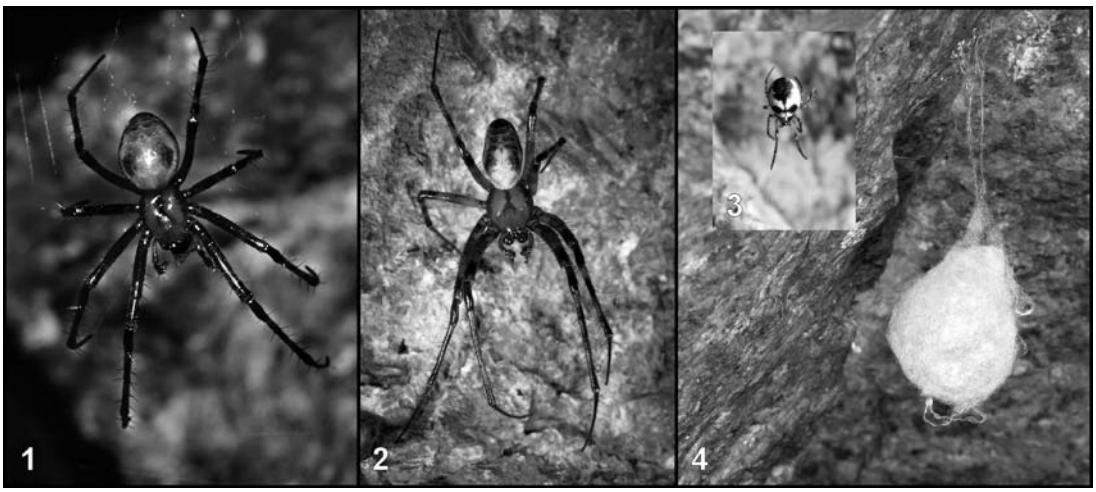
summertime, seldom in total darkness (Hippa et al. 1984). Small juveniles can be found near and also outside the entrance in trees and low vegetation, especially in early spring, and this behaviour is connected to their dispersal (Nielsen 1931, Pennington 1979). According to Eckert & Moritz (1992) *M. menardi* clearly prefers relatively warm caves with moderate humidity without draught and with a constant temperature of 7°C. They state that only in such caves can egg sacs be found in which the eggs can develop to hatching. In addition, *M. menardi* has an exceptionally high supercooling point (the temperature when a liquid chilled below its equilibrium freezing point spontaneously crystallizes) (–4°C; Kirchner 1987) indicating little resistance to cold even when adult.

Due to the bedrock in Finland being mainly composed of granite, caves are infrequent and usually small in size compared to e.g. Sweden, Norway and Estonia. Therefore cave animals, including spiders, have been studied more intensively in Scandinavia (e.g. Hippa et al. 1984) than in Finland (Biström & Hippa 1987). Fennoscandian caves are young due to the Ice Age, and there are no endemics, no real troglobite nor obligatory cave-spiders (with special adaptations: reduced eyes, long appendages, colourlessness); the spiders living in our caves are troglophile and can live also outside of caves.

M. menardi was selected the European spider of the year 2012 and also the cave animal of the year (Hörweg 2011).

Occurrence in Finland

In Finland, *M. menardi* is known in 20 locations. It is restricted to the south-westernmost corner of the country: the Åland Islands and a small area near Turku (Fig. 5). The first report on the spider in Finland was by Väisänen (1983), who found it in a crevice close to the cave known as Djupviksgrottan, in Geta in the northern part of the Åland Islands. Three years later a specimen was found indoors in Mariehamn (Terhivuo 1993) in a floor cellar (H. Appelqvist, pers. comm. 2011). During the 2000s *M. menardi* was actively searched for and was found in several locations on the Åland Islands (Table 1 and Fig. 5). Also the population in the Djupviksgrottan cave was checked several times. The first record of *M. menardi* outside the Åland Islands was made in an old stone cellar in Parainen (Pargas) near Turku in 1998 (Koponen 2003). Later it was also found in two other cellars and in two caves in the area. In the 2000 Red List of Finnish species (Rassi et al. 2001) the species was considered endangered (EN). Due to new records and its possible spreading it is listed as a



Figs. 1–4. *Meta menardi* in the Djupviksgrottan cave. 1: adult female; 2: adult male; 3: juvenile; 4 egg sac. Photos: N. R. Fritzén.

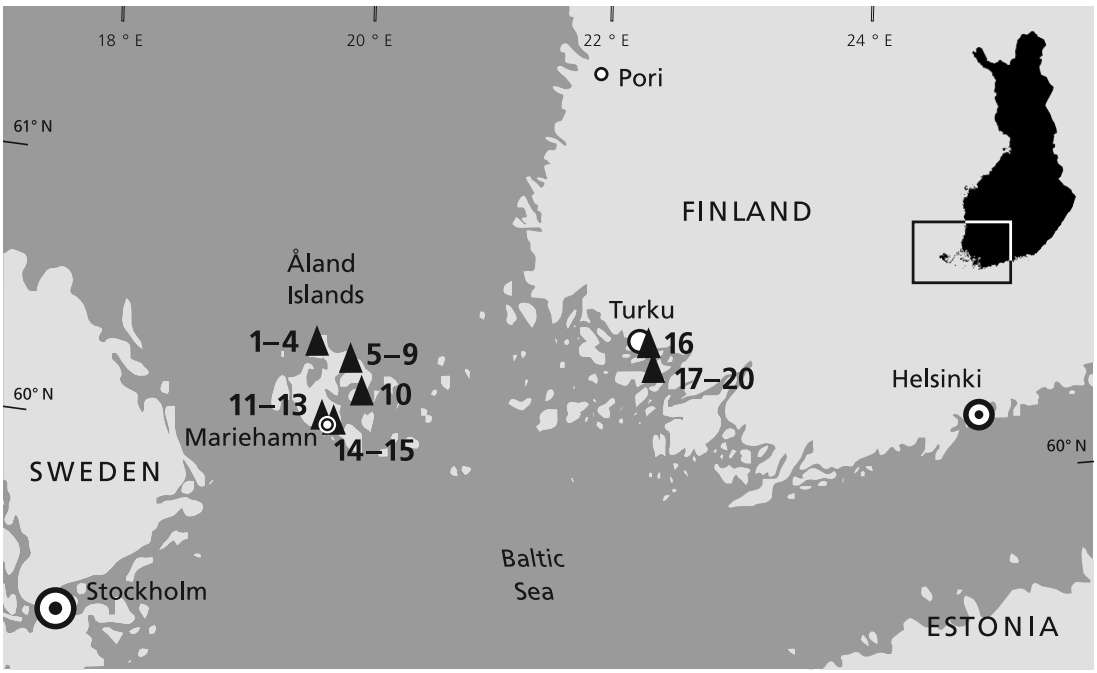


Fig. 5. Distribution map of the locations of *Meta menardi* in Finland. Numbers refer to Table 1.

vulnerable (VU) species in the recent Red Data Book of Finland (Pajunen et al. 2010).

In Finland *M. menardi* occurs in different habitat types such as caves, cave-like crevices, cellars and stone or boulder fields, all relatively sheltered habitats (darkness and stable humidity and temperature). Some of them are situated in old estates or manors, like the Kuitia Manor in Parainen. This stone castle has been inhabited since the late 15th century. In boulder fields (No. 5 and 11 in Table 1) *M. menardi* was documented in numbers in their webs between stones at ground level, but only as the tiny juveniles known to be the ones associated with the dispersal. The numerous juveniles at the surface indicate suitable cavities for *M. menardi* inside the boulder fields.

Notes from the Djupviksgrottan cave

During visits by the first author to the Djupviksgrottan cave some notes on the biology and habitat of *M. menardi* have been made. The size of the Djupviksgrottan cave is about 5 × 10 meters wide and about 2 meters high (Väisänen 1983). There are also cave-like crevices near the actual cave where *M. menardi* also occurs. In the cave and these crevices 47 specimens at most, including juveniles and adults, have been noted and only 2–6 egg sacs per visit have been observed. Especially in the autumn there is a rich fauna of insects that resort to the cave and the crevices for overwintering. Lepidopterans (*Aglais urticae*, *Scoliopteryx libatrix* and *Triphosa dubitata*), Culicids, Mycetophilids, and Syrphids (*Eristalis tenax*) have regularly been found overwintering in the cave. The cave is also inhabited by other spiders such as *Metellina merianae*, *Amaurobius fenestralis*, *Segestria senoculata* and *Labulla thoracica*. Only once has a slug been seen in the cave. All these taxa can regularly or occasionally be included in the diet of *M. menardi* (Smithers 2005). Three mosquitoes and one wood louse have been found wrapped with silk and hanging from a short thread in the web of *M. menardi.* On a few occasions Culicids have been seen bumping into the web of *M. menardi* without getting stuck to the silk or caught by the spider. When this happened the spider did a rapid jerk but did not manage to catch the Culicid. However, twice (a juvenile and

Table 1. The locations and type of habitat of *Meta menardi* in Finland in chronological order (first date of finding). The numbers (No.) refers to the map in Fig 5. An asterisk (*) indicates sites where also egg sacs have been found during the first or subsequent visits. The first three records have previously been published ([1)]Väisänen 1983, [2)]Terhivuo 1993, [3)]Koponen 2003).

Site	No.	Lat. N	Long. E	Date	Habitat	Leg.
Al: Geta, Getabergen, Djupviksgrottan	1	60.400	19.831	11.6.1982	Cave and crevices*	R. Väisänen[1]
Al: Mariehamn, Ytternäs	13	60.078	19.937	11.6.1985	Indoors, floor cellar	H. Appelqvist[2]
Ab: Parainen, Mutainen	20	60.299	22.342	10.1998	Cellar*	T. Tirkkonen[3]
Al: Geta, Getabergen, "Löfvingsgrottan"	2	60.391	19.836	22.9.1999	Cavelike cleft	N. R. Fritzén
Al: Geta, Getabergen, "Bogen"	3	60.401	19.831	12.9.2000	Between boulders*	N. R. Fritzén
Al: Geta, Getabergen, E of Brokträsk	4	60.394	19.828	25.3.2001	Caves	N. R. Fritzén
Al: Saltvik, Orrdals klint	5	60.323	20.118	19.6.2003	Boulder field	N. R. Fritzén
Al: Saltvik, Orrdals klint	6	60.320	20.116	19.6.2003	Cleft in rockwall	N. R. Fritzén
Al: Saltvik, Orrdals klint	7	60.315	20.113	19.6.2003	Cave	N. R. Fritzén
Al: Saltvik, Orrdals klint	8	60.316	20.112	19.6.2003	Cave (Kloddstugan)	N. R. Fritzén
Ab: Kaarina, Kuusisto Ryöväriholma	16	60.367	22.311	6.11.2004	Cave	P. Vihervaara
Ab: Parainen, Kuitian kartano	18	60.296	22.401	9.3.2005	Cellar	E. Kosonen
Al: Lemland, Knutsbodaberget	14	60.081	20.029	27.5.2006	Rock wall and between boulders	N. R. Fritzén
Al: Jomala, Sviby, Kasberg	11	60.132	19.932	28.5.2006	Boulder field	N. R. Fritzén
Ab: Parainen, Mutainen, Hakaniementie	17	60.316	22.360	2.10.2008	Cellar*	M. Salminen
Al: Mariehamn, Ytternäs	12	60.084	19.944	30.4.2009	Earth cellar*	Å. Hägg
Ab: Parainen, Pirunkallio	19	60.320	22.326	9.2010	Cave*	J. Lumikanta
Al: Sund, Finby	10	60.222	20.180	11.9.2010	Earth cellar*	K. Saramo
Al: Lemland, Knutsbodaberget	15	60.080	20.028	5.8.2011	Caves*	N. R. Fritzén
Al: Saltvik, Kasberg	9	60.348	20.057	6.8.2011	Cavelike cleft	N. R. Fritzén

an adult female) *M. menardi* has been seen managing to catch the mosquito by a rapid rush forward to the Culicid that flew into the web, and immediately rapidly wrapping it with silk. After this the spider provided the package with a short thread and carried it away in the claws of a hind leg and attached it to the web. Adult females and particularly juveniles have usually been seen in the middle of their web while adult males have more often been seen on the cave wall.

Some sporadic measurements of the temperature inside and outside the Djupviksgrottan cave in early and late autumn as well as in early spring have been made (Table 2). In mid-September 2000 the temperature in the cave was about 13°C. Already in late November the temperature inside the cave dropped to 7°C. In the early spring of 2001 the temperatures inside the cave both in the air and on the rock wall surfaces were slightly below zero. At the time of measuring, the temperature outside the cave was –2.3°C and later in the evening the temperature on the Åland Islands dropped to –6°C.

Discussion

In the Nordic countries *M. menardi* is known in southern Sweden (Almquist 2005), north to at least Sundsvall (62.2°N) (L. Jonsson, pers comm.), which is about 200 km north of its range in Finland. In Norway it has been found up to the Grønli Cave (66.4°N) near the Artic Circle in the North (Hippa et al. 1984), probably due to the mild oceanic climate and suitable large caves.

Table 2. Temperature (°C) inside and outside the Djupviksgrottan cave in early and late autumn and in early spring, and the mean temperature of the month on the Åland Islands (Ålands statistik- och utvecklingsbyrå 2010) when the temperatures at the cave were measured ([1)]in a cleft close to the cave, [2)]later in the evening –6°C on the Åland Islands).

Date (time)	Inside	Outside	Mean temp.
7.9.2000 (11:00)	[1)]13.2	14.4–14.8	9.5
12.9.2000 (17:00)	12.5, [1)]13.0	13.4	9.5
20.11.2000 (8:00)	7.0	3.2	6.2
25.3.2001 (19:00)	–1.3 to –0.6	[2)]–2.3	–2.1

On the Åland Islands, *M. menardi* is widely distributed, except in the western part, and has been found in 15 localities, some of them relatively close to each other. In continental Finland on islands close to the mainland, its range is very restricted (ca 10 × 10 km), and it has been found in two caves and three old stone cellars. Its exceptionally high supercooling point and preference for relatively warm and stable caves probably hamper its dispersal near Turku, where the climate is more continental and suitable habitats are perhaps more scattered than on the Åland Islands. However, the temperatures measured in the Djupviksgrottan cave (Table 2) indicate that the observations concerning temperature in German populations (Kirchner 1987, Eckert & Moritz 1992) are not necessarily applicable to the northernmost edge of its range with relatively small caves and a harsh climate.

The Djupviksgrottan cave is not particularly deep and is influenced by the weather outside. However, Getabergen is a massive rock accumulating heat during the summer but heating up more slowly during the spring than does the surrounding area. This makes the habitat more stable within the small caves than outside them, something that is also indicated by our observations (Table 2). According to our measurements the temperature inside the cave in mid-September is higher than the mean temperature of the month but is during daytime colder than outside the cave. As early as late November the temperature inside the cave drops to 7°C (mentioned in Eckert & Moritz (1992) as the constant temperature needed for the eggs to develop), which is slightly higher than the mean temperature of that month but clearly warmer than outside during nights and mornings (cf. Table 2). However, the temperature inside the cave has never been measured during the coldest month of the year or during exceptionally cold winters. On the Åland Islands the coldest winter month is usually February (range December to March) (Ålands statistik- och utvecklingsbyrå 2011). The mean temperature during the coldest month of the winter has in the years 1977–2011 varied between 0.7°C and –14.2°C, with measured cold peaks of e.g. –32.9°C in February 1979 and –24.5°C in February 2007 (Ålands statistik- och utvecklingsbyrå 2010). The year of 2001, when the temperature was measured in early spring with degrees below zero inside the cave, had an average winter. The mean temperature of the Åland Islands in March of 2001 was –2.1°C and the coldest month that year was February with a mean temperature of –5.3°C.

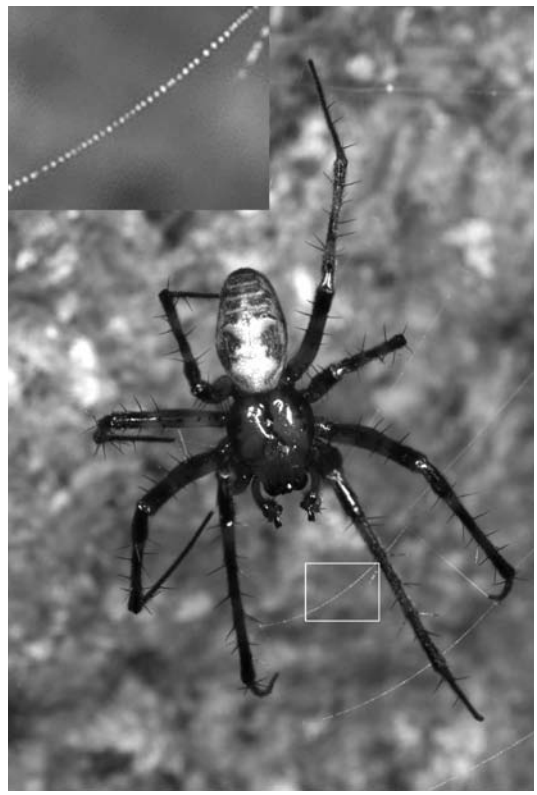


Fig. 6. An adult male of *M. menardi* at the hub of its orb web in the Djupviksgrottan cave. The sticky droplets on the catching spirals are seen in the enlarge area. Photo: N. R. Fritzén.

The small orb web of *M. menardi* could perhaps be considered ”rudimentary” (cf. Eckert & Moritz 1992), but based on our few observations on prey-catching behaviour of the spider we would feel reluctant to reduce the function of the orb web to a construction mainly or only for attaching preys caught from the cave wall (cf. Eckert & Moritz 1992, Hörweg 2011). The spirals of the web of *M. menardi* have the sticky droplets (cf. Fig. 6) whose function is to entangle flying preys. Laying down the sticky spirals is the most time-consuming stage in constructing the orb web (Foelix 1996). Our observations indicate that the sticky spirals stick to the prey only for a very short time, and, accordingly, catching mosquitoes flying into the web seems to require a rapid attack by a spider not too far away. If the major part of the mobile prey in a particular cave were Nematocerans (Culicidae, Mycetophilidae) (which is perhaps the case in the Djupviksgrottan cave), a spider producing an orb web with a sticky spiral and positioning itself on or near the rock wall out of reach of the potential prey would seem to be wasting time and energy. The significance of Nematocerans as prey might be even more important for immature specimens of *M. menardi* not able to catch large preys such as snails, wood lice and Lepidopterans. In addition, small preys are rapidly consumed and could therefore easily be underrepresented in material collected from the webs of *M. menardi*. Our observations on prey-catching behaviour and of the spiders often being positioned in the centre of the orb web in the Djupviksgrottan cave support this hypothesis and is also in accordance with a note by Bristowe (1941) about *M. menardi* in ”their normal position in the centre of their orb web”. Wichmann (1928) also states that *M. menardi* mainly feeds on Culicids and Mycetophilids, a statement whose validity is questioned in Eckert & Moritz (1992).

Our sparse data as well as previous studies (cf. Wichmann 1928) indicate that the role of Nematocerans as prey for *M. menardi* should not be neglected, and that under certain circumstances, it can play a role as a food source. Under what circumstances and how important a role require further studies. Our temperature data from the Djupviksgrottan cave indicates that the populations of *M. menardi* at the northern limits of its distribution could be more cold tolerant than the previously studied populations in Central Europe. Also this requires further studies with more accurate data during more extreme situations. However, this second study is already being planned.

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