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ECOLOGY, DISTRIBUTION AND VULNERABILITY OF *MACROTHELE CALPEIANA* (WALCKENAER) (ARANEAE, HEXATHELIDAE)

Helsdingen, P. J. van & A. E. Decae, 1992. Ecology, distribution and vulnerability of *Macrothele calpeiana* (Walckenaer) (Araneae, Hexathelidae). – Tijdschrift voor Entomologie 135: 169-178, figs. 1-2, tabs. 1-4. [ISSN 0040-7496]. Published 1 December 1992.

Data on distribution, habitats, local densities, and observations on the biology of *Macrothele calpeiana* (Walckenaer) are presented. A distribution-map (5 × 5 km UTM-grid) is provided. Our results confirm the earlier published distribution in Spain. Sites where the species was not found are also indicated. The occurrence in North Africa is discussed. The inclusion of this species in Appendix II of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) is criticized.

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Keywords. – Araneae, Hexathelidae, *Macrothele calpeiana*, ecology, distribution, Spain, Bern Convention.

Macrothele calpeiana (Walckenaer, 1805) was described early in the 19th century as *Mygale calpeiana* after a male specimen from the Gibraltar region. Hardly any new records have been published since and Gibraltar (type locality of *M. calpeiana*), Algeciras (type locality of the junior synonym *Mygale luctuosa* Lucas, 1855), Malaga and Ronda in Spain, and El-Arouch in Algeria remained the recorded localities of this species until very recently. Then suddenly and for reasons unknown the species received new attention from two sides independently.

Blasco & Ferrandez (1986) produced a substantial morphological and taxonomical account on *M. calpeiana*, and settled the discussion on the synonymy of *M. luctuosa* with *M. calpeiana*. Blasco & Ferrandez (1986) also presented an updated distribution based largely on recently collected material.

Snazell & Allison (1989) published an important paper on the species in which they repeated the distributional and ecological data published earlier by Snazell (1986). They also included and discussed the distribution data of Blasco & Ferrandez (1986) and of others which were not available in 1986. Furthermore they, elegantly, corroborated the synonymy of *M. calpeiana* with *M. luctuosa*. It appeared that a subadult male of *M. calpeiana* had not been recognized as such and described as the female of a new species (*M. luctuosa*), an understandable mistake for any one who knows these animals. Snazell & Allison (1989) presented additional morphological details and information on the prey, a description of the nest and web, observations on courtship and mating in captivity, and finally a description of the second European representative of the genus, *M. cretica* Kulczyński 1903.

As to its ecology, Snazell (1986) emphasized the relationship of *M. calpeiana* with undisturbed Cork Oak (*Quercus suber* L.) woodland in the southernmost part of Spain, which he refers to as the optimum habitat for this species. He suggested an apparent inability of the spiders to survive in situations more than a few metres away from the woodland, although populations are said to survive on bare banks of roads and streams for some time even though the surrounding woodland has almost entirely degenerated. Extensive areas of Cork Oak woodland are still present in the region and, he says, there seems to be no immediate problem for *M. calpeiana* in Spain. However, according to him, intensive cultivation of the woodland and the development of housing projects currently undertaken in the area might become a serious threat. Collins & Wells (1987) picked up this message and, treating *M. calpeiana* as a bio-indicator for Cork Oak woodland, included the species in their selection of endangered invertebrate species to be listed in the Bern Convention. In the same year the species was placed on Appendix II of the Convention.

Not being convinced by Snazell's (1986) arguments for the strict habitat requirements of *M. calpeiana*, we decided to carry out an independent survey. The fieldwork was carried out in 1989 by A. E. Decae and A. Hallensleben during two trips to

Table 1. Synopsis of localities in Spain and their main characteristics where *M. calpeiana* was found. Density refers to the counted number of nests of adult spiders within an area of approximately 20 m^2 around the first nest observed; (number of collected specimens in brackets); no number means webs and/or spiders observed but not counted.

Locality	UTM grid-reference	date	altitude in m	site	vegetation type	density (number collected)
El Captan	UF 1846	30.iii	200	hillside	cork oak cult.	1 (1)
El Captan	UF 1847	30.iii	250	hillside	cork oak cult.	1 (0)
Guadiario	TF 9419	05.iv	20	coastal zone	olive cult.	10 (4)
Gaucin	TF 9445	17.ix	600	highlands	cork oak	6-7 (1)
Crestellina	TF 9242	17.ix	500	hilltop	oak/olive	3 (0)
Nuevo Castellar	TF 8220	18.ix	70	lowlands	dense oak	1 (1)
Almoriama	TF 8020	18.ix	80	lowlands	oak/eucal./pine	13 (1)
Castellar de la Frontera	TF 7923	19.ix	260	hilltop	castle wall	10-15 (2)
Sotogrande	TF 9218	20.ix	20	lowlands	cork oak cult.	0-5 (0)
Jimena de la Frontera	TF 8036	20.ix	200	hilltop	castle wall	
La Tienera Vieja	TF 7839	20.ix	200	hillside	shrubs/oak/pine	1-2 (0)
La Tienera Vieja	TF 7740	20.ix	300	highlands	oak/shrubs	6-8 (0)
Sambana	TF 8832	20.ix	100	hillside	shrubs	7 (1)
Ronda-Grazalema	TF 9773	23.ix	720	highlands	oak cult.	1-Ó (1)
Grazalema	TF 8770	23.ix	920	mountainside	grass/herbs	1 (0)
Puerto de la Boya	TF 8570	23.ix	1100	mountain pass	pine cult.	4-6 (1)
Sierra Grazalema	TF 8371	23.ix	960	highlands	oak/shrubs	
Benamahona	TF 7871	23.ix	900	highlands	pine	
El Bosque	TF 6972	23.ix	200	highlands	grass/olive	5 (1)
Arcos de la Frontera	TF 5470	23.ix	200	highlands	oak/pine	8 (1)
El Santiscal	TF 5172	23.ix	100	highlands	acacia cult.	1 (0)
San José del Valle	TF 5556	23.ix	120	hillside	olive cult.	
Tempul	TF 6058	23.ix	100	river valley	shrubs/gallery	1-2 (0)
Cortes de la Frontera	TF 7346	23.ix	500	highlands	oak forest	2-3 (0)
Puerto del Bujeo	TE 7596	26.ix	150	roadside	cork oak	
Jubrique	TF 9851	26.ix	300	hilltop	oak/pine/olive	10-14 (0)
Santuaria de la Luz	TF 6301	27.ix	30	lowlands	oak forest	8 (2)
Almodovar/Sierra del Niño	TF 6106	27.ix	50	roadside	oak/grass	1-3 (1)
Sierra del Niño	TF 6408	27.ix	150	hillside	oak forest	1 (1)
Sierra del Niño	TF 6504	27.ix	250	hillside	oak forest	1 (0)
Sierra del Niño	TF 6503	27.ix	250	hillside	oak forest	1-2 (0)
Puerto de Ojén	TF 6707	27.ix	350	hillside	oakforest	4-5 (1)
Los Barros	TF 7008	27.ix	200	hilltop	shrubs	4 (0)
Los Barros	TF 7109	27.ix	200	hillside	oak forest	7 (1)
Casares	TF 9935	28.ix	180	hillside	oak forest	7-9 (5)
Casares	TF 9636	29.ix	500	hilltop	shrubs	1-2 (1)
Casares	TF 9737	29.ix	400	hillside	olive cult.	11 (6)
Estepona	UF 0836	18.ix	80	hillside	eucalyptus cult.	1 (1)
Sierra Bermeja	UF 0738	18.ix	450	hilltop	oak/pine	1-3 (3)
Sierra Bermeja	UF 0240	18.ix	500	mountainside	pine/oak	1-2 (0)
Sierra Bermeja	UF 0642	18.ix	600	mountainside	chestnut	4 (0)
Sierra de Palmetera	UF 1749	25.ix	450	mountainside	shrubs	1 (1)
Sierra de Palmetera	UF 1755	25.ix	900	mountainside	roadside/pine	1-3 (0)
Acueducto	UF 1170	25.ix	700	highlands	grass/roadside	1-2 (0)
Puerto del Viento	UF 2073	25.ix	1180	mountain pass	shrubs/roadside	3-4 (2)
Genalguacin	UF 0048	26.ix	400	hillside	olive cult.	3-5 (0)
Buenas Noches	UF 0131	28.ix	20	lowlands	eucalyptus	15 (3)
Casares	UF 0033	28.ix	100	hillside	oak/olive	1-2 (0)
Puerto de Piñas Blancas	UF 0643	26.ix	700	hillside	oak/pine	6 (1)
Sierra Bermeja	UF 0642	21.ix	450	hilltop	oak/pine	4 (0)
Puerto de Piñas Blancas	UF 0643	21.ix	700	hillside	pine cult.	5 (2)
Jubrique	UF 0848	21.ix	500	hilltop	pine cult.	
Jubrique	UF 0448	21.ix	350	hilltop	oak/pine	
Jubrique	UF 0150	21.ix	300	highlands	cork oak cult.	6-8 (0)
Ronda	UF 0769	21.ix	750	canyon/ruins	almond cult.	12 (4)
Ronda	UF 0769	22.ix	750	city park	palmtrees	1 (0)
Estación de la Indiana	UF 0372	23.ix	750	roadside	cork oak	

Andalusia. They collected both ecological and distributional data.

Methods

A first trip was made in the period between 25 March and 8 April 1989. The coastal region, roughly bordered by the lines Gibraltar-Ronda in the West, Ronda-Lanjarón in the North and Lanjarón-Albuñol in the East, was surveyed for the presence of *M. calpeiana*. Twenty localities were investigated. In only three localities, all of them West of the city of Málaga, *M. calpeiana* was found (fig. 1). Approximately ten specimens were collected (females and juveniles) and taken home for further study.

A second trip was made in the period between 17 and 29 September 1989. During this trip attention was focussed on the ecology and natural history of *M. calpeiana* rather than on the geographical distribution. The region surveyed was largely the same as Snazell's (1986) study area. Eighty localities were surveyed, in 58 of which *M. calpeiana* was found.

In table 1 we have listed all localities where *Macrothele calpeina* has been found. We have included information on the relative population densities (number of nests within approximately 20 m^2). Fifty adult specimens were collected, among which three adult males. All specimens are deposited in the collection of the Rijksmuseum van Natuurlijke Historie (National Museum of Natural History) at Leiden, The Netherlands. Table 2 lists all the localities where the species could not be found, an equally important observation. In the tables we have listed our localities with a 1×1 km UTM-grid, but visualized the distribution on the map with a 5×5 km accuracy.

Results

Habitat

The most western localities visited during the first trip lie within the region where Snazell (1986) found *M. calpeiana* most commonly and predominantly in association with Cork Oak. The reported frequent occurrence of *M. calpeiana* in Cork Oak vegetations in that region (mainly cultivated and often fenced in forestland) was confirmed, although dense populations of *M. calpeiana* were also found in very different situations, such as along roadsides, in picnic areas, in fruit orchards, in pine- and *Eucalyptus* plantations, on recently burnt grassy slopes, on rubbish dumps, in old stone walls, on cliff faces and even in the Palm-trees of the city parks in Ronda. Further to the East, in the coastal region east of the city of Malaga, an area not surveyed by Snazell, *M. calpeiana* was not found. This seems to support Snazell's (1986) remark on the very restricted distribution of *M. calpeiana* in Spain.

During the second trip large and dense populations of *M. calpeiana* were found, in association with Cork Oak as well as in very different situations. It appeared that *M. calpeiana*, rather than being dependent on undisturbed Oak-wood, is a culture following species that profits from human modifications of the landscape.

Counts of nests showed that in some of these localities population densities reach higher levels than in Cork Oak forests (see tables 1 and 3). Population densities in the relatively undisturbed forests of the 'Parque Natural Sierra de Grazalema', the 'Reserva Nacional de Cortez de la Frontera' and the 'Reserva Torrecilla de Serranía' were found to be lower than in typically man-made habitats such as stone walls and rubbish dumps (see table 3).

Table 4 illustrates the relationship of the occurrence of *M. calpeiana* with more or less disturbed habitats. The following classification was designed for the purpose:

Category 1. – Non-cultivated/non-forested: includes the typical mediteranean Garigue with *Cistus* sp., *Thymus* sp., *Lavandula* sp., *Trifolium stellatum* L., *Quercus coccifera* L., *Chamaerops humilis* L., etc., barren mountain passes and exposed river beds;

Category 2. – Relatively undisturbed mixed forest: Maquis with *Pinus pinea* L., *Quercus ilex* L., *Q. suber* L., *Laurus nobilis* L., *Pistacia lentiscus* L., *Ruscus aculeatus* L., *Myrtus communis* L., etc., with a dense understorey;

Category 3. – Cultivated Cork Oak stands: a forest type of almost entirely Cork Oak (*Q. suber*) from which the understorey is cleared; most of these woods are apparently private property and all are in use for the production of cork;

Category 4. – Unmanaged culture land: includes road sides, old walls, rubbish dumps and generally polluted picnic grounds;

Category 5. – Managed culture land: includes city parks, gardens, parking lots and development areas.

The first two categories contain habitat types which have developed as a result of historical human activities and possible changes in climate but which are currently relatively free of human influences. Reproducing females of *M. calpeiana* were found in the typical 'garigue' (cat. 1) as well as in the dense, almost inpenetrable 'maquis' (cat. 2) type of habitat, but population densities in both these 'undisturbed' habitat types were relatively low. Population densities were even lower in the fifth recognized category (managed culture land), although nests of adult spiders were found even in such thoroughly maintained places as private gardens, city parks and parking lots.

The optimum habitat for *M. calpeiana* in Southern

Spain obviously lies in terrains that are easily accessible to man. These habitats, here placed in categories 3 and 4, are either man-made origin or to some extent exploited by man. As far as road sides, old walls and rubbish dumps are concerned this needs no further explanation. Cork Oak woodland is very common and regarded as a natural resource in the region. This leads to a careful management that, as far as our observations go, rarely has adverse effects on the *M. calpeiana* populations. In 20 out of the 22 Cork Oak forests thus managed *M. calpeiana* populations were found. In one case, where clearing went as far as bulldozing all the understorey, *M. calpeiana* apparently still managed to retain a foodhold by becoming arboreal. Here numerous webs of adult spiders were found more than 2.5 meters above the ground on the trunks of the Oak trees.

Summarizing we may conclude that *M. calpeiana* thrives on sites with open and accessible soil with some form of shade and cover.

Biology

Males

Adult males have a body length (excluding the spinnerets) of approximately 25 mm. In contrast to most mediterranean Mygalomorphae, males of *M. calpeiana* are present virtually all year round. Males were collected in the period February - June (Blasco & Ferrandez 1986 and Snazell 1986) and in September (this study).

It is not clear if there is a particular mating season. During September fully adult males were found to hunt actively from their own nests. Males of mediterranean mygalomorphs more usually abolish feeding to become reproductively active.

Females

Adult females of *M. calpeiana* range in body length (excluding the length of the spinnerets) from approximately 25 mm to 37 mm. The relatively large variation in body size of adult females indicates the existence of several year-classes in this group. This in turn would mean that, as is usual in Mygalomorphae, *M. calpeiana* females are reproductively active for several years after reaching adulthood.

Juveniles

In September several females were found to have young with a body length of approximately 3 mm in their nests. These juveniles were moving freely in their mothers' nests and presumably represented the generation which would disperse. Juvenile spiders of intermediate sizes were observed to inhabit individual nests.

Activity rythms

M. calpeiana, unlike most other mediterranean mygalomorphs, is not strictly nocturnal in its activities. Prey-capture was observed both at night and during daylight hours. At night some, but not all spiders in a colony took up positions in the entrance of their nests near the web. Occasionally spiders were observed in this position during daylight. Other activities such as dispersal, nestbuilding, or mating were not observed.

The nest

The nest of *M. calpeiana* is composed of an exposed 'sheetweb' and a set of underground silk tubes. Sometimes the sheetweb is absent and the exposed part of the nest is reduced to a densely woven closed silk cell. The web extends from the nest entrance and may cover an irregularly shaped area up to 1600 cm^2. It may be directly attached to the substrate or be suspended between low vegetation around the nest entrance. The web consists of a more or less dense mesh of very fine silk strands spun in an irregular criss-cross pattern. Some aerial strands may extend to some 20 cm above the nest entrance. In general smaller spiders spin smaller webs, although the size and density of the web may vary considerably within all spider size classes.

M. calpeiana spins silk continually as it moves. When the spider re-enters the nest after a short sally on the web, it covers the entrance behind itself with a few flimsy strands of silk.

The nest entrance may consist of one, two or more silk funnels converging towards the inside of the nest in one main nest tube. The main tube may have one or more flimsy side tubes and is suspended in a pre-existing cavity. This cavity may be a deserted rodent burrow, a rock crevice or washout, a hollow tree etc. Depending on the conditions the main nest tube may extend more than fifty centimetres underground. Indigestible remains of prey are attached to the side tubes or to the outside of the main tube.

Prey-capture

Natural prey-capture behaviour was not observed. Prey-capture could only be induced in spiders having a sheetweb extending from the entrance of their nests. Those having a closed silkcell at the entrance were not actively hunting and were probably moulting. Skincasts were found both in sheetweb nests and in 'cellnests'.

A whole range of arthropods placed in the web of *M. calpeiana* induced prey-capture behaviour. The capture behaviour is rather straightforward and stereotyped, regardless of the type of prey. Movements of the prey in the web cause the spider to come to the entrance of the nest where it pauses for some time,

Table 2. Synopsis of localities and their characteristics where *M. calpeiana* could not be found in 1989.

Locality	UTM grid-reference	date	altitude in m.	site	vegetation type
Santuaria de la Luz	TE 6395	27.ix	30	lowlands	grass
Manilva	TF 9928	17.ix	50	lowlands	vine cult.
Manilva	TF 9632	17.ix	200	hilltop	shrubs
Casares	TF 9536	17.ix	400	highlands	shrubs
Crestellina	TF 9239	17.ix	400	highlands	olive/shrubs
Crestellina	TF 9341	17.ix	450	hilltop	olivebush
San Martin de Tesserillo	TF 9224	19.ix	20	river bed	gallery forest
San Martin de Tesserillo	TF 8624	19.ix	30	creek bed	shrub/gallery
Castelar/Ferro Caril	TF 8324	19.ix	40	river bed	gallery forest
Sotogrande	TF 8619	19.ix	50	undulating	cork oak cult.
Charco les Hurrones	TF 6757	23.ix	160	highlands	grass
Puerto de Galiz	TF 6750	23.ix	540	highlands	oak forest dense
Gibraltar	TF 8802	05.iv	40	hillside	maquis
Sotogrande	TF 9218	05.iv	10	coastal zone	cork oak cult.
Sierra Bermeja	UF 0738	21.ix	200	hillside	pine
Puerto del Viento	UF 1773	25.ix	1190	mountain pass	shrubs
Sierra de Palmetera	UF 1355	25.ix	1050	mountainside	barren
Paruta	UF 1260	25.ix	1000	highlands	pine forest
Sierra de Palmetera	UF 1655	25.ix	800	mountainside	pine forest
Estepona	UF 0534	24.ix	10	lowlands	shrubs
Puerto de Alija	UF 1647	25.ix	400	mountainside	barren
Yunquea	UF 3169	30.iii	700	highlands	maquis
Tolox	UF 3161	30.iii	300	highlands	olive cult.
Rio Grande	UF 3661	30.iii	250	highlands	garigue
Puerto de Abejas	UF 2969	30.ii	820	highlands	olive cult.
Mirador del Guarda Forestal	UF 2471	30.iii	1000	highlands	pine forest
El Burgo	UF 2872	30.iii	800	highlands	garigue
Moclinejo	UF 8869	03.iv	100	hillside	maquis
Benamargosa	UF 9377	03.iv	200	hillside	maquis
Puente Tablata	UF 9876	02.iv	100	highlands	olive cult.
Estepona	UF 0837	18.ix	150	hilltop	shrubs/pine
Frigliana	VF 1772	27.iii	300	highlands	olive cult.
Cueva de Nerja	VF 2369	29.iii	20	coastal zone	garigue
Motril	VF 5570	28.iii	20	coastal zon	road side
Pénon del Fraile	VF 6181	28.iii	900	highlands	garigue
Haza de Lino	VF 7275	28.iii	1250	highlands	cork oak cult.
Popolos	VF 7674	28.iii	600	hillside	olive cult.
Puerto Camacho	VF 6878	18.iii	1220	highlands	olive cult.
Frigliana	VF 1870	27.iii	250	highlands	olive cult.
Cueva de Nerja	VF 2471	7.iv	30	coastal zone	garigue

apparently to locate the source of disturbance. After a short interval it dashes straight at the prey, grabs it with the fangs and drags it in reverse back to the nest entrance.

Prey

Captures of the following arthropods were observed: Oniscoidea (two species), Orthoptera, Cerambycidae, Staphylinidae, Carabidae, Diplopoda, Scorpionida. Escaping from the web very quickly was a *Scolopendra* spec.

Snazell & Allison (1989) reported a very broad range of different arthropod prey being captured and consumed by *M. calpeiana*. This strongly indicates general or opportunistic feeding habits of this species and suggests that the availability of food is unlikely to limit the natural distribution.

Our investigations of prey remains found in ten webs support this idea. Oniscoidea, Coleoptera and Formicidae constitute the bulk of the prey both in biomass and number of individual prey. Interesting is the large discrepancy in the sizes of individual prey animals found in single webs. Remains of beetles with body lengths of approximately 20 mm were found together with the remains of ants of hardly 2 mm. It has still to be investigated if adult spiders catch this extraordinary range of prey sizes or that maybe the small prey is captured by juveniles actively hunting in their mother's web.

Very few mygalomorphs are known to capture flying prey. The presence of a bee (family Apidae) reported by Snazell & Allison (1989) and a Hymenopteron in one of our samples indicates that *M. calpeiana* is an exception.

Ectoparasites

Virtually all specimens collected were heavily infested with Acari which clung in large numbers to the carapace, usually concentrating in the fovea, and sometimes to the abdomen of the spiders. This is in agreement with what Snazell & Allison (1989) found. Numerous mites may be present on one individual without the spider seeming to suffer very much. Spiders kept in captivity were all very quickly free of mites. It is not known what caused the disappearance of the mites. The mite was described by Baker (1991) as a new species of parasitic mite (*Androlaelaps pilosus*) after specimens collected by Snazell.

Distribution in Spain

The recent work by others (Snazell 1986, Blasco & Ferrandez 1986, Snazell & Allison 1989) and oursel-

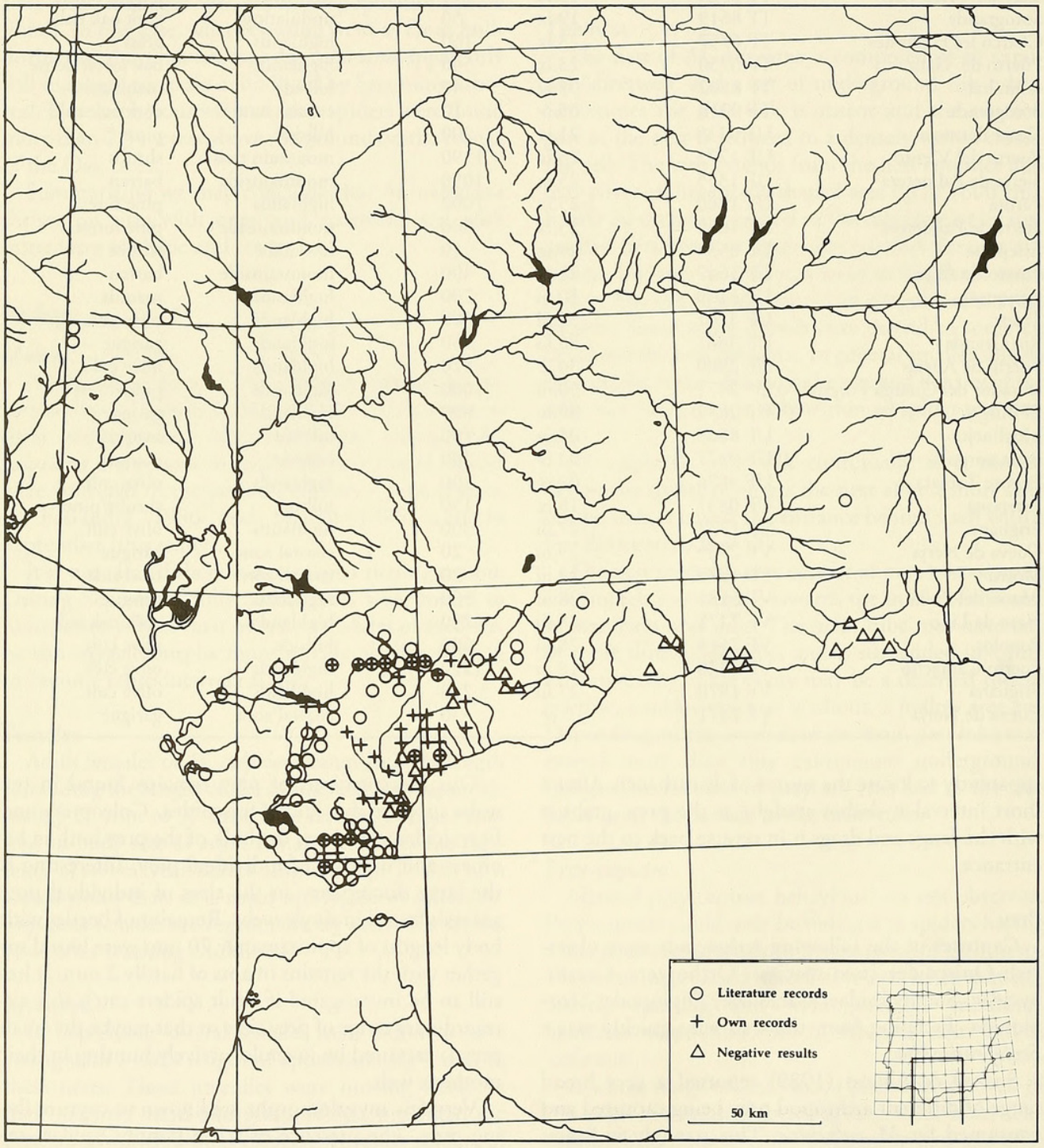

Fig. 1. Distribution map of *Macrothele calpeiana* (Walckenaer) with 5×5 km accuracy on UTM-grid; early record from Algeria indicated.

ves certainly has broadened our knowledge of *Macrothele calpeiana*. Our own investigations affirm and reinforce the distribution pattern which emerges from the literature. But science is exigent and never satisfied. Many questions remain yet unanswered.

In Europe *M. calpeiana* remains restricted to the South of Spain, the region of Andalusia, mainly in the provinces of Cadiz and Malaga. The occurrence in the province of Huelva, based on old and recent records (Blasco & Ferrandez 1986) demonstrates a disjunct distribution with the valley of the Guadalquivir as a possible lowland ecological barrier (open, unshaded, lowland area). The three Huelva records represents the northernmost as well as the westernmost finds so far.

The population to the southeast of the Guadalquivir reaches from Malaga in the East to the City of Cadiz in the West and from 37° North latitude down to Tarifa, the very southern tip of the peninsula. In this region we may call *M. calpeiana* a common species. Our attempts to find the species East of Malaga remained without success. However, Barbara York Main from Nedlands, Western Australia, has found a small population (a juvenile and some cast skins were collected) at Las Nimbres, 1.5 km E of Puento de la Mora, at an elevation of 1390 m, in the Sierra Harana north of Granada (Snazell & Allison 1989: 69; also pers. comm.), which means a considerable eastward extension of the known range. The presently known northern limit of the distribution in the province of Malaga at 37° N does not seem a very natural one at first sight and we may expect new records more to the north.

The three Huelva records indicate the occurrence on at least the southern slopes of the Sierra Morena. This region, the northern halves of the provinces of Huelva, Sevilla and Cordoba probably is undercollected.

Which factors limit the distribution of *M. calpeiana* is not known. The species seems to prefer cover and shade over exposed open soil. From this we may infer that the animal is sensitive to low and high temperature extremes. Humidity may also be a regulating factor. The discovery of populations at higher altitudes, where the temperature will be lower on the average, indicates a fair rate of tolerance. We have found a population at 1100 m in a pine forest, on a south-facing slope on a mountain pass at Puerto de la Boya (36°46′N, 5°24′W; province of Cadiz), and another one at 1180 m on a roadside bank on a north-facing slope on a mountain pass near Puerto del Viento (36°48′N, 5°01′W; province of Malaga). The population established by B. Y. Main at the Sierra Harana at ca 1400 m also proves the ability of *M. calpeiana* to survive under the climatic conditions at high altitudes.

Snazell & Allison (1989) stress the correlation of the distribution of *M. calpeiana* with the area of relatively high rainfall (80-200 cm), warm winters and high summer temperatures. They also link the species firmly to oakwoods with the Cork Oak (*Quercus suber* L.) as dominant species. The Cork Oak has a much wider distribution in Spain and certainly is not restricted to Andalusia. Other parts of Spain than the presently known distribution area of *M. calpeiana*, in particular the southern slopes of the Sierra Morena, have precipitations about as high as the Cadiz-Malaga mountainous region. This supports the hypothesis of a more extensive distribution along these slopes.

Distribution outside Spain

Two records from North Africa indicate a wider distribution South of the Mediterranean Sea. The first is an old record from Algeria, where it was found somewhere in the surroundings of El-Arouch in the province of Constantine (Lucas 1846). Our attempts to locate the original material have failed. According to Lucas the species was not common in that locality, where it was found under stones. The second record is of more recent date. A. Blasco collected a single male in 1981 at Ceuta in Spanish Morocco (Blasco & Ferrandez 1986). Even though these two records are spaced out geographically and in time they are suggestive of a much wider distribution in the West Mediterranean. The mediterranean zone of North Africa is grossly undercollected and hardly anything is known of the Mygalomorphae of that region.

If *M. calpeiana* would be more wide-spread in North Africa, the geographically restricted occurrence in southern Spain would be easier to understand. The restricted presence in Spain would only be a bridgehead on the European continent from a much larger population in North Africa. The Atlas mountains might offer suitable habitats. Further investigation of this region will throw more light on the distribution.

It would not at all be surprising if North Africa harboured a number of *Macrothele* species. The genus now comprises five species in West Africa, *calpeiana* and *cretica* in Europe, and seven more species in India, South-east Asia, China and Taiwan. Most species have been described after one sex only, usually the female, which shows the paucity of available material.

DISCUSSION

M. calpeiana, according to our observations, is not restricted to oak woodland. No undisturbed oak woodlands persist in southern Spain today. All oakwoods, with the Cork Oak (*Quercus suber* L.) as dominant tree species, or mixed woods are the result of human interference through mild exploitation during

Table 3. The ten highest densities of *Macrothele calpeiana* nests counted in plots of approximately 20 m^2 within different types of habitat in Southern Spain. Note the absence of relatively undisturbed Oak forest (maquis) in this ranking.

	type of habitat	location	number of nests per 20 m^2
1	castle wall	Castelar de la Frontera	15
2	rubbish dump	Buenas Noches	15
3	mixed forest	Jubrique	14
4	ruin wall	Ronda	12
5	Cork Oak (cult.)	Casares	9
6	picnic place	Santuaria de la Luz	8
7	picnic place	Arcos de la Frontera	8
8	Cork Oak (cult.)	Jubrique	8
9	Cork Oak (cult.)	La Tienera Vieja	8
10	castle wall	Jimena de la Frontera	8

the long Spanish history. In these semi-natural forests *M. calpeiana* occurs at low densities if compared to other (unnatural) habitats, such as semi-cultivated Cork Oak woodland with the understorey cleared away, rubbish dumps, roadsides and old walls (table 3).

The general impression is that the species benefits from the milder activities of man and makes use of the opportunities thus offered. These observations contradict the opinion expressed by Snazell & Allison (1989: 69), who describe the optimum habitat as undisturbed *Quercus suber* woodland with a light understorey and many large to medium-size stones. Snazell & Allison maintain this view despite the several contrasting opinions and observations by others and reported by themselves in the same publication. We have shown that the population densities outside the Cork Oak woodland are often higher than within. The suggestion of Snazell that *M. calpeiana* is characteristic of undisturbed Cork Oak woodland, and that of Collins & Wells (1987) that it could serve as bio-indicator for that type of habitat has herewith become most unlikely.

Apparently the ecological spectrum of this species is very broad. It has been found in a wide variety of habitats. A species which invades new habitats and settles, temporarily or permanently, in man-made habitats is to some extent a culture follower. It is justified to call this species aggressive as to its ecological strategy. Biological strategies, such as the number of offspring, the dispersal of the young, the time and amount of food needed to reach adulthood, and the life-span are unknown so far. It is difficult, if not impossible, to analyse a possible extension of the distribution area in the past. The sequence of the earlier records may be suggestive of a recent colonization of the Iberian Peninsula. However, this is no proof of its speed of dispersal.

Table 4. Average densities of *Macrothele calpeiana* nests counted in plots of appproximately 20 m^2 within five distinguished categories of habitat in Southern Spain.

distinguished categoriess of habitat		number of counts	average density	max density
1	non-cultivated/non-forested	22	1.4	5
2	relatively undisturbed forest	20	3.0	7
3	cultivated Cork Oak	21	5.8	14
4	unmanaged culture land	33	5.3	15
5	managed culture land	14	0.4	3

Nature conservation aspects

Snazell's earlier report (Snazell 1986) on the distribution, habitat and status of *M. calpeiana* in Spain came under the notice of the IUCN Conservation Monitoring Centre at Cambridge (UK) when compiling a list of invertebrates to be used in the Bern Convention. They placed the species on their provisional list (Collins & Wells 1987) and classified it as 'vulnerable', following Snazell's (1986) description of the species status as 'fairly secure' and 'in no immediate danger' but forseeing as major threat 'the improvement of the woodlands or the spread of housing developments'. In the same year (1987) the species was officially placed on Appendix II. This second appendix lists the endangered species the habitat of which should be protected. Most species listed come from the better known groups, such as Lepidoptera, Coleoptera, Odonata, Mollusca, etc. *Macrothele calpeiana* is the only spider.

In 1991 the Habitat Directive of the European Community has been accepted by the member states. When a country ratifies the Directive it compels itself to take relevant measures for the protection of the listed species and their habitats. *Macrothele calpeiana* is, again, in the appendix to this Directive because the Bern Convention list of Invertebrates served as an example and was copied without any criticism. Spain thus is obliged to protect the habitat of *M. calpeiana* as well as the spider itself. The Habitat Directive, in contrast with the Bern Convention, is obligatory: if a country does not satisfy the set rules it can be summoned before the European Court.

Collins & Wells developed a set of seven criteria for the selection of the species for their list (Collins & Wells 1987). First of all (1) the species should be under serious threat (endangered or vulnerable) or of widespread conservation concern. Since the list is to be used as an appendix to the Convention on the Conservation of European Wildlife and Natural Habitats, generally known as the Bern Convention, (2) the species' range in Europe should not be marginal to a much wider range outside Europe. The Bern Convention has political significance in the first place

Fig. 2. *Macrothele calpeiana* (Walckenaer) on its web

and this has led to the suggestion that (3) the species must be reasonable easy to identify, and preferably familiar to members of the general public. Even though challengeable on evolutionary grounds one can understand that (4) in line with other listings in the Appendices to the Convention only full species should be considered. This is not a criterion, but a practical rule. There are three more criteria which in fact are recommendations of the compilers of the lists for the different appendices: the final selection of species (5) should come from a wide range of habitats, particularly threatened ones, and (6) from a wide variety of phyla and classes, while it should also (7) embrace a wide geographical range.

When judging a single species on the list one has to consider criteria 1 to 3. If we do this with *M. calpeiana*, we easily arrive at the conclusion that the species should not at all be listed in the Bern Convention. We have pointed out that this spider is not under threat, endangered or vulnerable in its relatively small Spanish range of distribution. It is not strictly tied to any specific habitat, but can be found in a wide variety of, often man-made, habitats. We have presented arguments in support of the hypothesis that the species has also a wider distribution outside Europe. Thus we find the first two criteria not applicable to *M. calpeiana.*

Remains the third criterion. *M. calpeiana* is a large, black spider, upto to 7 cm long (legs included), with two conspicuous 'tails', the spinnerets, at the end of its abdomen (fig. 2). The general public at the most will know its large web. The animal itself leads a cryptic life in its burrow. It is the only spider of this size, shape and habits that lives in the area and is quite conspicuous when seen (e.g. by the people who manage the oak forests). We already indicated above that this criterion is a political rather than a scientific one. It has practical implications for the enforcement of any directives in relation to the Bern Convention. For a matter so serious as the protection of Invertebrates and their natural habitats, however, this criterion has no meaning.

A species becomes threatened with extinction usually through the activities of man. The threat is aimed either directly at the animal, e.g. by hunting, overfishing or the use of selective biocides; or indirectly through the many drastic changes in the environment, such as extensive drainage schemes, the bringing into cultivation of natural habitats, the use of unselective biocides, the cutting down of forests, the construction of motorways and town-development. In the case of Invertebrates the indirect factors are usually the cause of threat. Stenoecous species with very strict habitat or food requirements are more vul-

nerable than euryoecous species which can live nearly anywhere. When a habitat is scarce and deteriorates by one of the above influences all species narrowly adapted to that habitat are threatened. If one wishes to protect such a species one has to protect or restore the habitat in general or a site in particular by warding off the threatening forces. It is the general practice in nature conservation legislation to protect a habitat through the species, i.e. the species is named and the law compels that the habitat or site be protected or managed in such a way that the species can survive.

It is a good policy to select a species of which the biology and ecology are well known, the distribution is properly mapped, and the densities measured. It must be feasible to monitor the species and follow the developments and the results of the measures eventually taken. The selection of the species should be based on such (scientific) arguments, not on the possible recognition by the general public. The general public should be interested in the lasting biological diversity in general and support politicians to develop legislation and give priority to nature conservation. The general public must be kept informed in general terms of the progress made. In our view the third criterium should read as follows: 'The species must be taxonomically unambiguous and sufficiently defined as to its biology and ecology. At the same time the reasons for its decline should be fully understood'. Species such as *M. calpeiana* then would not be listed in the Bern Convention.

Future research

As we have pointed out the distribution in Spain is as yet not clearly established, especially in the East and Northwest. Further investigation should focus on these regions, in particular the southern slopes of the Sierra Morena and the Sierra Harana north of Granada, and possibly the Sierra Nevada as well. It would also be an enticing project to investigate the northern countries of Africa, from Morocco to Algeria, or even further to the East. Investigation in this region will throw more light on the distribution of *M. calpeiana.*

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Received: 1 November 1991
Revised version accepted: September 1992