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Late Holocene Environmental Changes indicated by Fossil Remains of Mites (Arthropoda; Acari) in the Marsh of Gravgaz, Southwest Turkey

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ABSTRACT: This paper presents the analysis of the remains of mites (Acari) in a sediment core extracted from the marsh of Gravgaz in southwest Turkey. The distribution of species found in the subsamples allows a reconstruction of the considerable local changes in the ecological parameters. This is the first successful study of subfossil arthropod remains to reconstruct a past environment in Turkey.

KEYWORDS: MITES, ACARI, LATE HOLOCENE, ENVIRONMENTAL RECONSTRUCTION, TURKEY

RESUMEN: En este trabajo se presentan los análisis de los restos de ácaros (Acari) en una columna sedimentaria extraída del pantano de Gravgaz en Turquía sudoccidental. La distribución de especies en las muestras permite una reconstrucción de los notables cambios locales que se produjeron en determinadas variables ecológicas. Se trata del primer análisis exitoso de restos de artrópodos subfósiles que ha permitido reconstruir un ambiente pretérito en Turquía.

PALABRAS CLAVE: GARRAPATAS, ÁCAROS, HOLOCENO TARDÍO, RECONSTRUCCIÓN AMBIENTAL, TURQUÍA

INTRODUCTION

During the nineteen-sixties British researchers found that remains of insects in general and beetles (Coleoptera) in particular were useful indicators of past climates and environments in quaternary studies (Coope, 1967). Soon after these initial geological applications the use of arthropod remains in an archaeological context was demonstrated, again mostly by British researchers such as Buckland (1974), Kenward (1974) and Osborne (1973). Since then many other researchers all over the world have adopted this "new" science and Quaternary Entomology and Entomo-Archaeology became established disciplines (Elias, 1994). Although initially only beetles were used, nowadays many other groups of arthropods are successfully used to reconstruct past ecological conditions. One of these groups is formed by the mites (Acari) which constitute a relatively unknown group within the phylum Arthropoda. The very first records of fossil mite remains date back to the middle of the 19th century and refer to finds in amber (Koch & Berend, 1854). Even though the remains of mites in quaternary deposits have been described as early as 1901 by Nordenskiöld, their role as ecological indicators has only been recognized in the last few decades. Although some have doubted the value of mites as palaeoecological indicators (Taylor & Coope, 1985) others such as Krivolutsky & Druk (1986) and Erickson (1988) have stressed their importance and potential.

The first serious attempts to use mites in an archaeological context were by Denford (1976) who identified the mite remains from Roman deposits in York (UK). These pioneer studies, as well as the Dutch research (Schelvis, 1992) inspired by these studies, were based on the good preservation conditions which are usually found in northwestern European waterlogged archaeological sites. In more arid areas the conditions for the preservation of chitinous remains are considerably less favorable. However, Arillo *et al.* (1992) have demonstrated that mite remains were present (and identifiable) in Spanish rock shelters and cave deposits as old as 34.800 BP.

The results of a methodological pilot study (Sanz Breton & Schelvis, 1994) indicate that the extraction techniques for arthropod remains developed in northwestern Europe are also applicable in Mediterranean contexts. Furthermore, the study showed that the interpretation of archaeological mite faunas from these arid deposits have to take into account the presence of representatives of burrowing mites of the cohort Dichosomata. Subsequent studies of archaeological deposits from classical sites in Greece (Schelvis, 2003) led to the conclusion that the combined effects of less favorable preservation conditions and the danger of (sub-) recent contamination of the mite death assemblage reduces the potential of mite remains as environmental indicators under these conditions.

Therefore, when numerous attempts to retrieve useful arthropod remains from the archaeological site of Sagalassos, southwest Turkey (Schelvis, 1997, 1998, 1999, 2000) failed, it was decided to look for the nearest deposits with more favorable preservation conditions to shed more light on environmental changes in the surrounding area. Rich sediments were found in the marshy depression of Gravgaz situated 25 kilometers southwest of Sagalassos (Figure 1) in the middle of the territory of Roman Sagalassos (Waelkens *et al.*, 1997). In that way, the study became part of an interdisciplinary research project, aiming to reconstruct the palaeoenvironment of the Sagalassos territory, and to determine the impact of the former inhabitants of the area on the landscape.

The wetland of Gravgaz is a well-vegetated marsh that is fed by several water sources situated in the west (Figure 1). The wetland area measures approximately 800 by 350 m. The water flows through the wetland to the east in two main streamlets, where the water disappears in a karstic outlet. Several freshwater plants, *Schoenoplectus lacustris* being the most dominant one, form a dense vegetation pattern, with a dark patchy appearance. Cereal fields, especially in

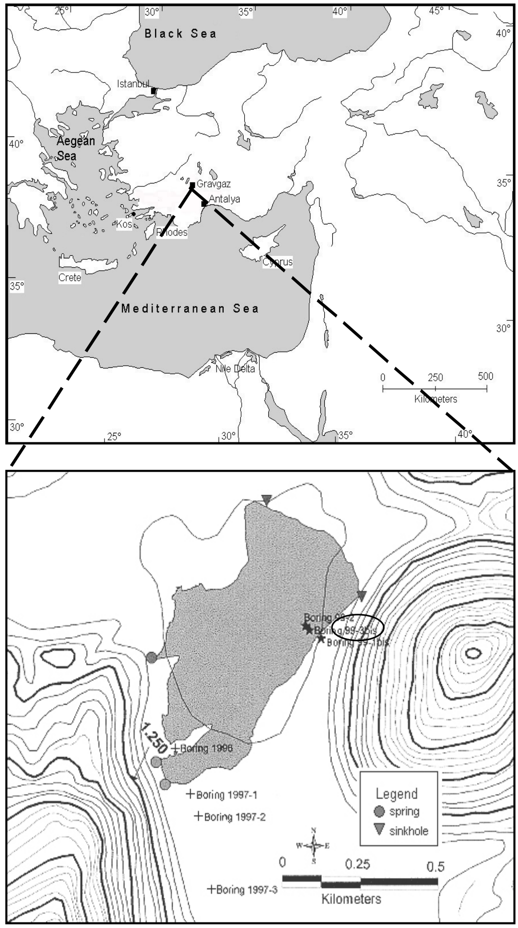

FIGURE 1
Localisation of the Gravgaz marsh and core 99-3.

the south of the marsh, occur very close to the wetland (Vermoere, 2002).

On the 4th of August 1999 samples were taken from the marsh of Gravgaz at an altitude of 1215 meters. The core (drilling 99-3, Figure 1) was collected using a peat sampler to a depth of 4.65 meters below the surface (the section from 2.30-2.65 meters was not included in this study, since it was used to replace a lost section for geomorphological analysis). Next, the core was divided into several units based upon visual differences in color and/or texture. In this way, five lithologies could be differentiated (Figure 2). The recovery of plant remains made it possible to fully date the sediment column. Three samples were taken and used for radiocarbon dating (Table 1). Calibration was performed via Oxcal v3.5 Bronk Ramsey (2000).

depth (m)	Lab number	C14 (BP)	C14 (Cal BC/AD)
1,605	NOSAMS 25331	1410 +/-55	530-770AD
4,205	Beta-142070	2220+/-50	400-160BC
4,445	Beta-142069	2270+/-50	410-200BC

The results of the radiocarbon dating of the Gravgaz sequences indicate that the older parts of the section studied for arthropod remains dates back more than two millennia. Peat sample Beta-142069 from above-ground plant material at a depth of 443-446 centimeters produces an age range of 2270 ± 50 BP, which corresponds with the calibrated calendar years 410-200 BC (Van Thuyne, 2000).

According to palynological analysis based on several cores (Vermoere, 2002), this date corresponds with the onset of the so-called Bey?ehir Occupation Phase. This arboricultural phase is characterized in the cores from southwest Turkey by the appearance of cultivated trees such as *Olea europaea*, *Juglans regia*, *Fraxinus ornus*, *Castanea sativa* and *Vitis vinifera* (Bottema & Woldring, 1984). For the Gravgaz cores, the arboriculture phase corresponds with the Hellenistic, Roman, and late Roman periods. These are periods of welfare, prosperity and, at least the last two, also of stability in the territory of Sagalassos. The pollen proved that during these periods the olive tree was the main cultivated tree species in the Gravgaz basin and that small stands of walnut trees may have occurred near the wetlands (Vermoere, 2002). This cultivation phase abruptly came to an end during early Byzantine times (± 7th century AD). The aim of this article, however, is the study of the mites performed on core 99-3. In a next phase, attempts will be made to fully incorporate the results of complementary specialized studies like palynology, geomorphology (sedimentology) and entomology, whereby information provided by other cores will also be included.

MATERIAL AND METHODS

The core was subdivided in the field in 28 subsamples of 10-20 centimeters which were sealed for subsequent analysis in the laboratory. The mite remains were extracted from the samples by means of an adapted version of the Paraffin Flotation Method as described by Kenward *et al.* (1980). Because of their size the mite remains needed to be retrieved on a fine mesh sieve of 106 mm. After the flotation the mite remains were sorted from the small amount of botanical material under a low power stereomicroscope. Subsequently they were transferred to a strong (80%) lactic acid solution. This solution not only preserves the remains, it also makes the exoskeleton more or less transparent, which is essential for identification. The mites were then observed individually under a light microscope with a magnification of at least 400X using Grandjean's half open slide technique as described by Balogh & Mahunka (1983). The mites were identified using Pérez-Iñigo (1993), Sellnick (1960), Siepel (in press) and Willmann (1931) for the Oribatida and Karg (1971, 1989) for the Gamasida.

RESULTS

From the 28 subsamples a total of 709 mites were identified to species or genus using the method described. This resulted in the recovery of the 29 taxa of which the ecological preferences are given in Appendix 1. Table 1 presents the distribution of the identified mites found in the subsamples and the depth of the samples in which they were found. Overall, the mean density of mite remains in all of the 28 subsamples taken together was approximately of 180 individuals/kg sediment. Although this density is not as high as sometimes encountered in peat samples from north-western Europe, it is much higher than in any of the archaeological samples previously taken from the site of Sagalassos. Furthermore, the quality of preservation of the chitinous remains was much better. As a result of the waterlogged conditions the samples from Gravgaz yielded remains which were as well preserved as mites found in north-west European samples taken from similar deposits. Even fragile remains such as wings of aphids and the juvenile stages of oribatid mites were found. Around 80% of the mites found could be identified to species or genus level. Although still high, this percentage is somewhat lower than in comparable Dutch samples. As we have seen, this is not the result of a lower quality of preservation, but should be attributed to unfamiliarity with the Turkish acarofauna. Although new species are added regularly to the official Turkish list of mite species recorded, by 1994 for instance only 73 representatives of the Oribatida had been recorded in Turkey (Özkan *et al*, 1994). Since the similar sized adjacent Caucasus and Crimea region is known to be inhabi-

Species in taxonomical order → / Depth in cm ↓	Trimalaconothrus sp.	Licnodamaeus costulae	Microzetorchetes sp.	Tectocepheus sarekensis	Tectocepheus velatus	Oppiella uliginosa	Suctobelbella palustris	Hydrozetes lemnae	Hydrozetes parisiensis	Hydrozetes lecustris	Limnozetes ciliatus	Passalozetes africanus	Bipassalozetes bidactylus	Zygoribatula frisiae	Oribatula tibialis	Zygoribatula type Gravgaz	Scheloribates cf pallidulus	Scheloribates laevigatus	Xylobates capucinus	Zetomimus furcatus	Ceratozetes laticuspidatus	Punctoribates hexagonus	Punctoribates sellnicki	Eupelops cf ureaceus	Oribatella cf meridionalis	Achipteria coleoptrata	Galumna lanceata	Neojordensia levis	Sejus cf cassiteridium	Plesiosejus italicus	Trichoptera Indet.
50-60				1		28		4																		1					
60-70						11		9														1							1		
70-80						4																1				1					
80-90						1																1									
90-103						1			1					1	1											2					
103-120					1			49							1				1			2									2
120-135				2		4		15									1		1		1	25									
135-150																						2									
150-165						1		2		3																					
165-180				1		2				5				1				1				9				3					
180-195		1		1		2		1						2								4				3					
195-215																						1									
215-230	2							6		8							2														
265-275																						11									
275-285																						2									
285-295														1																	
295-310				1				1					2																		
310-325						5		3																							
325-345		1	1			10						1										1			1						
345-360						4																									
360-375						6											1														
375-395				1		4																									
395-405						1					20					1				2		2		4							
405-415				3		10		3			40				2	1	1							4		1				1	
415-425				2		7	2	11			46				3											1	4				1
425-435				1	2	6	3	21		1	1				15					8			1		1			1		1	4
435-445				3	1		1	25		3	1				4					12			6		1	1					4
445-465					1			23		1					1								5								4
Total	2	2	1	16	5	107	6	173	1	21	108	1	2	5	27	2	5	1	2	22	1	62	12	8	3	13	4	1	1	2	15

TABLE 1

Number of identified individuals of arthropods of each species found in the subsamples taken at Gravgaz at various depths.

ted by more than 725 oribatid species (Karppinen *et al*, 1987) it is obvious that the actual size of the Turkish acarofauna is grossly underestimated. Therefore, it is neither surprising nor worrying that most of the mite species identified at Gravgaz during this study had not been reported before in Turkey.

To facilitate the interpretation of the mite remains at various depths, 3 to 4 subsamples taken together were attributed to 9 zones of 30-50 centimeters as indicated in Table 2 (A-I).

As we move from bottom to top the following picture emerges from the interpretation of the species composition of the Gravgaz mite fauna in the subsequent zones:

Zone A (425-465 cm)

In this zone a high density and species richness of mites as well as the highest density of Caddis Flies (Trichoptera) was found. Since larval stages of Caddis Flies are restricted to aquatic habitats these remains are considered to be an indication for the presence of fresh open water. This is corroborated by several mite species found in this zone such as *Zetomimus furcatus, Hydrozetes lacustris* and *Hydrozetes lemnae*. Larvae of the latter species only reproduce in the presence of gibbous duckweed (*Lemna gibba*) (Athias-Binche & Fernández, 1986) and thus serve as a proxy indicator for this aquatic plant species which is otherwise virtually impossible to distinguish from other representatives of the genus *Lemna*. Other mites found only in this zone such as the oribatids *Punctoribates sellnicki* and *Suctobelbella palustris* and the gamasid *Neojordensia levis* are also characteristic for very wet conditions such as found in moorland.

Zone B (395-425 cm)

Again a zone with high densities and about 15 different species of mites. Many of the species were also found in zone A but the numbers of truly aquatic mite remains are lower in zone B. Furthermore, only a single frontoclypeus of a Caddis Fly larvae was found. Therefore, it seems that the amount of open water is decreasing during this stage. There are still many mite species indicative of very wet conditions such as the representatives of the genera *Eupelops* and *Galumna.* However, the dominant species in zone B is *Limnozetes ciliatus* of which 106 individuals were recovered. In zone A there were only two specimens of this species and it is completely lacking from the rest of the deposit. As a characteristic species of ecological group XI (Schelvis, 1990) it is commonly found in constantly soaking wet mosses, especially *Sphagnum spp*., in moorland and peat bogs. It seems that the transition from zone A to B reflects a change in the trophic level of the water in the marsh. The initial mesotrophic conditions favored by species such as *Hydrozetes lacustris, H. lemnae, Punctoribates sellnicki* and *Tectocepheus velatus* are replaced by an oligotrophic situation in which *Limnozetes ciliatus* thrives. The most obvious cause would be that there was a change in the water regime in the Gravgaz area allowing a raised bog to develop. However, palaeobotanical studies have yielded very few indications for such a local environment although remains of *Sphagnum* have been found (Vermoere, 2002).

Zone C (345-395 cm)

In this zone all indications for a raised bog or a *Sphagnum* vegetation have abruptly dissappeared again. The only three mite species found (in very low densities) are generalists found in a variety of habitats. Somehow the marsh dried up (locally?) leaving only some eurytopic species. This low species richness may have been the result of a period of disturbance in which the mite fauna was not able to develop.

Zone D (295-345 cm)

The drying trend in zone C continues in zone D and it is in this zone that we find species such as *Passalozetes africanus* and *Bipassalozetes bidactylus*, characteristic of Mediterranean environments with xerophylic vegetation (Pérez-Iñigo, 1993). On the other hand, we find low numbers of the aquatic *Hydrozetes lemnae* again in Zone D. This could indicate the presence of temporary open water such as ephemeral pools in an otherwise dry environment.

Zone E (265-295 cm)

Another zone poor in species and individuals with only *Punctoribates hexagonus* represented by a dozen individuals and a single specimen of *Zygoribatula frisiae*. The first species is considered a characteristic mite of salt marshes in northwestern Europe, but in Spain it has also been recorded at inland sites in wet habitats such as flo-

Zone >	Species >	*Neojordensia levis*	*Oribatella* cf *meridionalis*	*Punctoribates sellnicki*	*Tectocepheus velatus*	Trichoptera Indet.	*Zetomimus furcatus*	*Oribatula tibialis*	*Hydrozetes lemnae*	*Tectocepheus sarekensis*	*Suctobelbella palustris*	*Plesiosejus italicus*	*Limnozetes ciliatus*	*Eupelops* cf *ureaceus*	*Galumna lanceata*	*Zygoribatula* Type Gravgaz 01	*Oppiella uliginosa*	*Microzetorchestes* sp.	*Passalozetes africanus*	*Bipassalozetes bidactylus*	*Xylobates capucinus*	*Ceratozetes laticuspidatus*	*Hydrozetes parisiensis* Grandjean	*Punctoribates hexagonus*	*Achipteria coleoptrata*	*Hydrozetes lacustris*	*Trimalaconothrus* sp.	*Licnodamaeus costulae*	*Scheloribates* cf *pallidulus*	*Zygoribatula frisiae*	*Scheloribates laevigatus*	*Sejus* cf *cassiteridium*
I	50-60								4	1							28								1							
	60-70								9								11							1								1
	70-80																4							1	1							
	80-90																1							1								
H	90-103							1									1						1		2					1		
	103-120				1	2		1	49												1			2								
	120-135								15	2							4				1	1		25					1			
G	135-150																							2								
	150-165								2								1									3						
	165-180									1							2							9	3	5				1	1	
F	180-195								1	1							2							4	3			1		2		
	195-215																							1								
	215-230								6																	8	2		2			
E	265-275																							11								
	275-285																							2								
	285-295																													1		
D	295-310								1	1										2												
	310-325								3								5															
	325-345		1														10	1	1					1				1				
C	345-360																4															
	360-375																6												1			
	375-395									1							4															
B	395-405						2						20	4		1	1							2								
	405-415							2	3	3		1	40	4		1	10								1				1			
	415-425					1		3	11	2	2		46		4		7								1							
A	425-435	1	1	1	2	4	8	15	21	1	3	1	1				6									1						
	435-445		1	6	1	4	12	4	25	3	1		1												1	3						
	445-465			5	1	4		1	23																	1						
	Totaal	1	3	12	5	15	22	27	173	16	6	2	108	8	4	2	107	1	1	2	2	1	1	62	13	21	2	2	5	5	1	1

TABLE 2
Distribution of the oribatid mite remains in the 9 zones in which the Gravgaz deposit was split.

odplains (Pérez-Iñigo, 1993). It could well be that zone E represents a period in which the Gravgaz area shows the same extreme seasonal fluctuations in water level as for instance found today in nearby YarŸl Gölü, a shallow lake which during the summer almost entirely dries up, leaving extensive salt marshes and mudflats (Magnin & Yarar, 1997). It seems likely that species which in north-western Europe are considered characteristic of brackish environments such as grassland with a marine influence are elsewhere commonly found in ion-rich situations, which are not necessarily rich in chloride. A similar situation occurs in the higher plants found today at Gravgaz and nearby ÇanaklÏ (pers. comm. Leo Vanhecke). *Bulboschoenus maritimus* (Seaside Bulrush) was found at both locations and both *Hordeum marinum* (Sea Barley) and *Trifolium fragiferum* (Strawberry Clover) at Çanaklı. These three species are indicators for brackish environments in the Low Countries just like the oribatid *Punctoribates hexagonus.*

The single individual of *Zygoribatula frisiae* may easily have entered the deposit from the nearby environment since this species, which is well adapted to dry conditions, is commonly found in mosses and lichens on rocks and trees (Pérez-Iñigo, 1993).

Zones F (180-230 cm) and G (135-180 cm).

In these two zones we find a more diverse acarofauna with the return of some of the characteristic species of wet vegetations found in lower deposits such *as Achipteria coleoptrata, Scheloribates laevigatus, Hydrozetes lacustris* and *H. lemnae*. The only two representatives of the genus *Trimalaconothrus,* which were found in zone F, are also strong indications for the return of marshland habitats.

Zone H (90-135 cm)

Even stronger than in the previous two zones species characteristic of mesotrophic aquatic conditions occur in this zone in densities comparable to those found in Zone A. However, besides aquatic species like *Hydrozetes lemnae* and another two Trichoptera remains this zone also yields remains of other indicators of wet environments not found in any other section of the deposit such as *Xylobates capucinus* and *Hydrozetes parisiensis*. Furthermore, zone H is different from zone A because of the high density of *Punctoribates hexagonus* found in the younger deposits. It seems that during the period of deposition of zone H the Gravgaz area had a rather varied marshland vegetation.

Zone I (50-90 cm)

The topmost zone resembles a washed down version of zone H with less species present and an increasing preponderance of the generalist *Oppiella uliginosa,* one the five species of mites which were found in 8 out of the 9 zones. The other four oribatids found in zone I (*Hydrozetes lemnae, Tectocepheus sarekensis, Punctoribates hexagonus* and *Achipteria coleoptrata)* are also the other four species found in more than 6 zones. These four species are all more or less characteristic of wet habitats as is the only predatory gamasid mite found in zone I: *Sejus* cf *cassiteridium*. All species in the genus *Sejus* have special adaptations at their tarsi, the so-called pulvilli, which enable the mite to walk on the surface of the water.

SYNOPSIS

From the distribution of arthropod species found in the deposit at Gravgaz it is clear that there were substantial fluctuations in the ecological conditions in the area. Notably the water level must have shown dramatic changes during the period of deposition. In the oldest phase we find the strongest indications for very wet conditions including open water rich in nutrients. Gradually this situation is replaced by the development of a raised bog characterized by species found in *Sphagnum* mosses. This period abruptly ends during the deposition of zone C which marks a transition phase from pure marsh habitats to a more complex situation in which both semi-aquatic species and species adapted to arid conditions are found in the mite death assemblage of zone D. Subsequent zones show somewhat variable arthropod faunas which are all more or less characteristic of open, wet terrain but which never contain the species found in *Sphagnum* in bogs.

We should keep in mind that every reconstruction of the environment based on the remains of Acari reflects the strictly local environment. Even though remains of mites can be transported by wind or water over considerable distances most of the remains found in a particular deposit will have originated from an area of only a few square meters up to perhaps one or two hectares. Therefore, future studies on both pollen and geomorphology will be carried out to assess if these local reconstructions indeed reflect the sequence of ecological changes in the whole of the Gravgaz area.

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APPENDIX 1

Trimalaconothrus sp.	The vast majority of *Trimalaconothrus* species recorded in Europe is known to occur in very wet mosses, especially *Sphagnum* spp., in moorland (Hammen, 1952; Strenzke, 1952; Sellnick, 1960).
Licnodamaeus costulae Grandjean, 1931	In Europe this species is recorded in moss (Krantz, 1978).
Tectocepheus sarekensis Trägârdh, 1910	A common eurytopic species.
Tectocepheus velatus (Michael, 1880)	No obvious preferred habitat; Ecological group XX (Schelvis, 1990)
Oppiella uliginosa (Willmann, 1919)	A common eurytopic species often found in wet habitats (Willmann, 1931).
Suctobelbella palustris (Forsslund, 1953)	Soaking wet moorland and grassland; Ecological group X (Schelvis, 1990)
Hydrozetes lemnae (Coggi, 1899)	Aquatic habitats; Ecological group XVIII (Schelvis, 1990) This species is found in brackish or eutrophic waters and has a specific relation with gibbous duckweed (*Lemna gibba*) (Athias-Binche & Fernandez, 1986).
Hydrozetes parisiensis Grandjean, 1948	Aquatic habitats; Ecological group XVIII (Schelvis, 1990)
Hydrozetes lacustris (Michael, 1881)	Aquatic habitats; Ecological group XVIII (Schelvis, 1990). This species occurs regularly in floating and submersed vegetation in eutrophic waters as well as in *Sphagnum* vegetations.
Limnozetes ciliatus (Schrank, 1803)	Ecological group XI (Schelvis, 1990); Constantly soaking wet mosses, especially *Sphagnum* spp., in moorland and peat bogs.
Passalozetes africanus Grandjean, 1932	A characteristic species of Mediterranean environments with xerophylic vegetation. Capable of resisting high temperatures (Pérez-Iñigo, 1993).
Bipassalozetes bidactylus (Coggi, 1900)	Of all species in this xerophylic family, this species is the most resistent to a certain degree of moisture. It is found in poor, sandy or gypsum soils (Pérez-Iñigo, 1993).
Zygoribatula frisiae (Oudemans, 1900)	Mosses and lichens on rocks and trees, well adapted to dry conditions (Pérez-Iñigo, 1993).
Oribatula tibialis (Nicolet, 1855)	No obvious preferred habitat; Ecological group XX (Schelvis, 1990).

Scheloribates pallidulus (CL Koch, 1840)	In Europe this species is commonly found in mosses, litter and decaying wood (Willmann, 1931).
Scheloribates laevigatus (CL Koch, 1836)	Moist as well as soaking wet, either fresh or salty grassland; Ecological group XIII (Schelvis, 1990).
Xylobates capucinus (Berlese, 1908)	Requires medium to high humidity and is found in grassland as well as in temperate and tropical forests (Pérez-Iñigo, 1993).
Zetomimus furcatus (Pearce & Warburton, 1905)	Usually found in reedland and swampy meadows. This is one of the few mites able to walk on the surface of the water (Willmann, 1931).
Ceratozetes laticuspidatus Menke, 1964	Not a truly xerophylic species to be found in a variety of habitats ranging in humidity and vegetation cover (Pérez-Iñigo, 1993).
Punctoribates hexagonus Berlese, 1908	In North-western Europe commonly found in salty grassland (Ecological group XIV, Schelvis 1990). In Spain it has been recorded in very wet habitats such as floodplains (Pérez-Iñigo, 1993).
Punctoribates sellnicki Willmann, 1928	Soaking wet moorland and grassland; Ecological group X (Schelvis 1990), however, in Spain it has also been recorded in relatively dry soils (Pérez-Iñigo, 1993).
Eupelops ureaceus (CL Koch, 1840)	Grassland, preferably in moist, shaded places (Willmann, 1931).
Oribatella meridionalis (Berlese, 1908)	In mosses (Willmann, 1931).
Achipteria coleoptrata (Linnaeus, 1758)	Common and widespread in mosses and litter (Willmann, 1931).
Galumna lanceata Oudemans, 1900	Dry and moist litter and mosses in woodland; Ecological group III (Schelvis, 1990). Also on tree trunks and exceptionally in arable soils (Pérez-Iñigo, 1993).
Neojordensia levis (Oudemans & Voigts, 1904)	Prefers very wet habitats and is found in meadows, swamps and in the vegetation and flotsam along banks of streams (Karg, 1971).
Sejus cassiteridium Evans & Hyatt, 1960	Prefers (soaking) wet habitats such as *Sphagnum* mosses in moorland (Karg, 1971).
Plesiosejus italicus (Berlese, 1905)	To be found in swamps and along streams in wet, decaying plant material and in the litter between roots (Karg, 1971).
Trichoptera Indet.	The larvae of caddisflies (Trichoptera) are aquatic and, therefore, their remains are considered to be reliable indicators of the presence of open water (Elias, 1994)