SOME ASPECTS OF RESEARCH ON MITES (ACARI) IN ARCHAEOLOGICAL SAMPLES

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ABSTRACT: The use of mites (Acari) in archaeology, acaro-archaeology, is shown to provide useful information about ecological conditions in the past. The results of four samples are presented.

KEYWORDS: Mites, Acari, archaeology, palaeo-ecology.

1. INTRODUCTION

Mites form one of the most successful groups within the Phylum Arthropoda. Not only have they found their way to nearly all habitats from the Tropics to the Arctic, but they also tend to occur, especially in the soil, in amazingly high densities. Apart from their omnipresence mites possess a number of qualities which make them very useful for archaeozoological purposes. The exoskeleton of mites is composed of chitin, a highly resistant organic substance. The remains of mites will therefore often be preserved in a surprisingly good condition, allowing an identification up to species level (fig. 1). Furthermore a fair number of species of mites live only within a restricted habitat-range or on a specific host plant or animal. Finally, there are few problems with the numerical interpretation of the results, since each mite is recovered as one entire specimen, instead of the disarticulated sclerites commonly encountered in insect death assemblages. In spite of these advantages there has only been one previous attempt to use mites in archaeology (Denford, 1978). In this paper the possibilities and impossibilities of research on mites in archaeological samples will be illustrated by presenting the results of three samples.

2. MATERIAL AND METHODS

Mites constitute one of the eleven subclasses of the Arachnida, and are therefore closely related to the more familiar spiders (Krantz, 1970). Mites, however, are usually much smaller than spiders, only rarely exceeding one millimetre in length. The subclass of the mites can be further subdivided into eight orders (van der Hammen, 1973). Of these eight orders only two, the Gamasida and the Oribatida (Moss mites), are frequently found in archaeological samples, while the Acaridida are very rarely encountered.

Gamasid mites are usually free-living with a preference for habitats with a high quantity of decaying organic material such as compost-heaps, cesspits and other 'dirty' places, where many of them feed upon the bacteria and nematodes that thrive in these surroundings. On the other hand the Oribatida, as their English name already suggests, tend to occur in more 'natural' surroundings. They usually dominate the mite-fauna of the soil but they are also found in a wide variety of vegetations. A considerable amount of literature on the habitat preference of Oribatid mites is available. One of the most useful works for the interpretation of archaeological samples is that of Strenzke (1952). This author constructed a number of *synusiae* or recurring groups of species which characterize a set of habitats. The ecological preferences of the Gamasid mites are less well-known, in fact the only useful information is provided by Hirschmann and Zirngiebl-Nicol (1960-1967) for the cohort Uropodina and by Karg (1970) for the cohort Gamasina.

The method of extraction of mites from an archaeological sample depends upon the nature of the sample. In most cases, however, the paraffin-flotation method as described by Kenward, Hall and Jones (1980) gives excellent results, provided that the float is retained over a 100 μm mesh sieve instead of the 300 μm sieve recommended. In my opinion it is, however, not necessary to perform three consecutive 'paraffinings' as they recommend. In figure 2 it is shown how many mites were recovered from the sample Leeuwarden (Nieuwe Buren) in each consecutive 'paraffining' (P1, P2, P3) followed by the subsequent 'floats' (F1, F2, F3, F4). After P1 and P2 already 88% of the total number of mites was extracted. Since the sorting of the P3 took about as much time as the sorting of P1 and P2 together, on account of the larger amount of

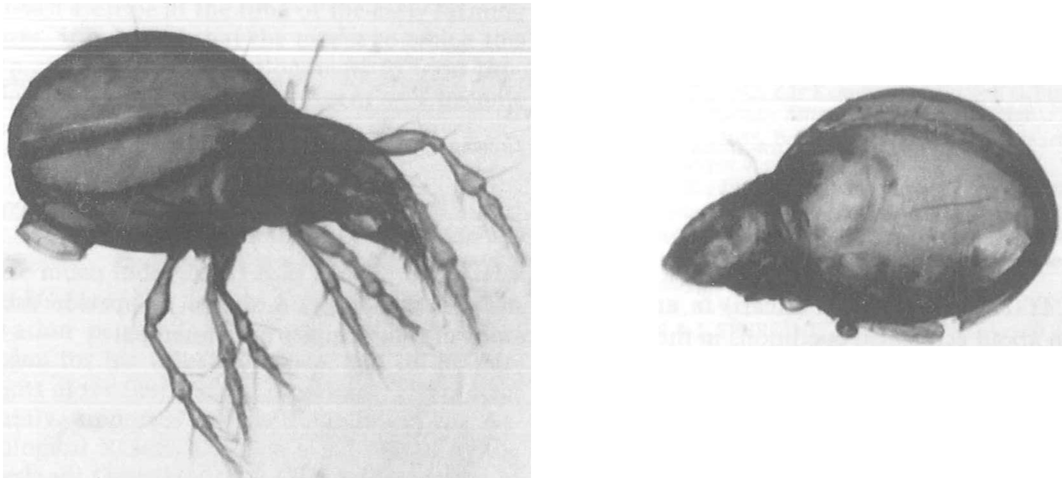

Fig. 1. A recent (l) and a subfossil (r) individual of the mite *Oppia nitens* C.L. Koch 1836.

floating plant material in P3, and since there was only one individual of a 'new' species in P3, it seems acceptable to perform only two 'paraffinings'.

Normally one hundred mites is considered to be the minimum for a meaningful interpretation of a sample. Usually 1 kg of sample will yield a sufficient number of mites but this of course also depends upon the origin and composition of the sample.

From medieval Leeuwarden two samples were studied: from Speelmanstraat and Nieuwe Buren. The sample from Speelmanstraat consisted of 1 kg of black mud and was taken from an occupation level dated to the 12th century (de Langen, in prep.). The sample from Nieuwe Buren was dated to the 10th-11th century and consisted of mud sticking to a concentration of fishbones.

The Cellar-BAI sample was formed by the 'original' content of a pot from the cellar of the Biological Archaeological Institute (B.A.I.) in Groningen. This 2nd-century pot (fig. 3) is typical of the *terpen* district in the north of the Netherlands. The exact location of the findspot is unfortunately no longer known.

The mites of the Usselo sample were collected in 1975 together with a great variety of other micro- and macrofossils (van Geel, de Lange & Wiegers, 1984). These mites have been extracted from a series of subsamples, ranging in age from c. 12,800 BP to c. 11,000 BP.

The mites were identified, using Karg (1971) for the Gamasina, Hirschmann and Zirngiebl-Nicol (1960-1967) for the Uropodina and Willmann (1931), Sellnick (1960) and Balogh and Mahunka (1983) for the Oribatida.

3. RESULTS

3.1. Leeuwarden: Speelmanstraat

Of the 173 mites found in Speelmanstraat 150 (87%) could be identified to species level. Table 1 shows the number of individuals for each identified species. Furthermore we can see that most of the mites (153) found here belonged to the Oribatida while only a small number (20) belonged to the Gamasida.

A species is termed superabundant when it makes up more than 10% of the assemblage. Although this term is arbitrarily defined, we can use it as evidence of local breeding in most cases (Kenward, 1978). In the sample from Speelmanstraat there are three species that are superabundant: *Oribatula tibialis*, *Scheloribates pallidulus* and *Oribatella quadricornuta*. The first species, *O. tibialis*, is a very common species that occurs in a wide variety of habitats and is therefore only of limited interest in an archaeological interpretation. The second species, *S. pallidulus*, is normally found on moss-covered solid surfaces (Strenzke, 1952) although other authors like Willmann (1931) and Sellnick (1960) give decaying wood as the most frequented habitat. Both habitats will surely have been present in a medieval town. The last of the three superabundant species, *O. quadricornuta*, is the most characteristic of a man-made habitat. Strenzke (1952) finds it exclusively in dry moss on solid surfaces like walls and roofs and only exceptionally on trees. He considers it as one of the character-species of the *Zygoribatula exilis-synusia* which inhabits moss- and lichen-

Table 1. Number (n) and percentage (%) of the mites found in Leeuwarden (Speelmanstraat). In Uropodina: F = Female; M = Male; D = Deutonymph; ? = Unknown sex or developmental stage.

	n	%
Oribatida		
Oribatula tibialis (Nicolet 1855)	44	25
Scheloribates pallidulus (C.L. Koch 1840)	28	16
Oribatella quadricornuta (Michael 1884)	22	13
Trichoribates trimaculatus (C.L. Koch 1836)	12	7
Oppia nitens C.L. Koch 1836	6	3
Trichoribates incisellus (Kramer 1897)	4	2
Liebstadia similis (Michael 1888)	4	2
Limnozetes sphagni (Michael 1884)	3	2
Acrogalumna longipluma (Berlese 1904)	3	2
Scutovertex sculptus Michael 1879	3	2
Eupelops acromios (Hermann 1804)	2	1
Scheloribates latipes (C.L. Koch 1844)	2	1
Hydrozetes converfae (Schrank 1781)	2	1
Nanhermannia sellnicki Forsslund 1958	1	1
Scheloribates laevigatus (C.L. Koch 1836)	1	1
Metabelba propexus (Kulczynski 1902)	1	1
Phauloppia lucorum (C.L. Koch 1841)	1	1
Platynothrus peltifer (C.L. Koch 1839)	1	1
Indet.	31	8
Gamasida (Uropodina)		
Uroobovella pyriformes (Berlese 1920)	1F 3M	2
Trichouropoda ovalis (C.L. Koch 1839)	1F 1M	1
Trichouropoda orbicularis (C.L. Koch 1839)	1M	1
Phaulodinychus repleta (Berlese 1903)	1F	1
Uropoda orbicularis (O.F. Müller 1776)	1? 1F 1M 1D	1
Indet.	1? 1F 1M 1D	2
Gamasida (Gamasina)		
Hypoaspis oblonga (Halbert 1915)	1	1
Indet.	6	3

covered solid surfaces. A further indication of the local breeding of these three superabundant species is given by the observation that together they provide 50% (n=11) of all the mites found to contain eggs or embryos.

Only 20 (12%) of the mites found in Leeuwarden belonged to the Gamasida. Of these 20 mites only 10 could be identified, 9 Uropodina and 1 Gamasina. As already mentioned above there is only limited ecological information available on these groups. According to Hirschmann & Zirngiebl-Nicol (1960-1967) all of the Uropodina found in Leeuwarden occur in decaying organic substances like compost and dung. *Trichouropoda orbicularis* is also recorded from damp ships and warehouses. The only Gamasida, *Hypoaspis oblonga* occurs in moss and under the bark of dead trees according to Karg (1971).

3.2. Leeuwarden: Nieuwe Buren

The sample from Nieuwe Buren was primarily taken because of the presence of a concentration of fishbones. The mud surrounding these bones, however, was found to contain a large quantity of mites. Table 2 shows the numbers of individuals of the identified species.

It is evident from this table that there is a considerable overlap between the species found in Speelmansstraat and in Nieuwe Buren. One of the main differences is the enormous abundance of *Limnozetes sphagni* in the Nieuwe Buren sample. This difference may be genuine and may therefore reflect a real difference between the ecological conditions in the past at these two sites, but it may also have been evoked by a difference between the two samples in the method of extraction. The Speelmanstraat sample was washed over a 212 μm sieve while the Nieuwe Buren sample was washed over a 106 μm sieve. *Limnozetes sphagni* has a maximal length of c. 285 μm and a maximal width of c. 150 μm, and it may therefore well be that the 106 μm sieve was more efficient in recovering these minute mites.

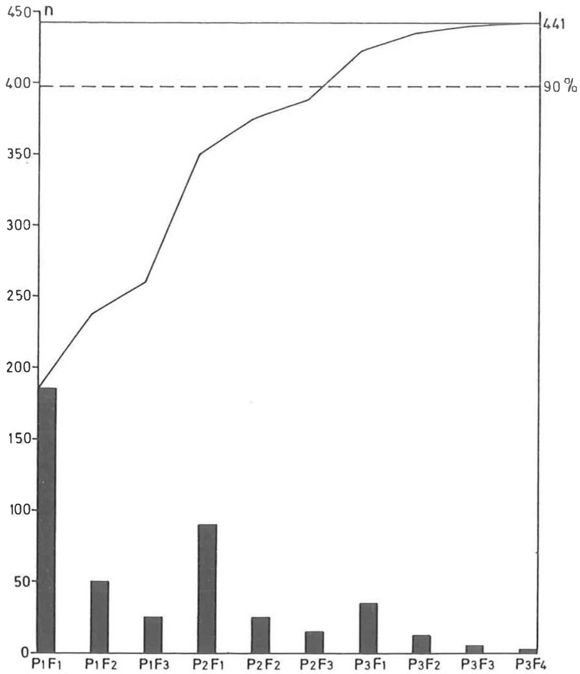

Fig. 2. Number of mites found in each consecutive 'paraffining' (P's) and 'float' (F's) in the Leeuwarden (Nieuwe Buren) sample.

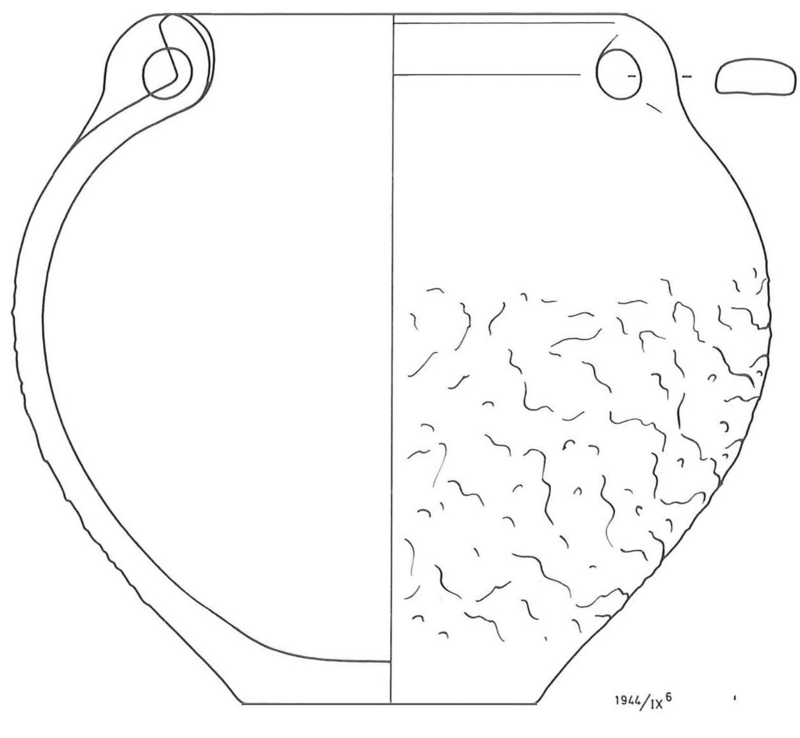

Fig. 3. The pot from the *terpen* district which was found to contain 343 mites.

Table 2. Number (n) and percentage (%) of the mites found in Leeuwarden (Nieuwe Buren). + = present, less than 1%. In Gamasida: F = Female; M = Male; D = Deutonymph; ? = Unknown sex or developmental stage.

	n	%
Oribatida		
Limnozetes sphagni (Michael 1884)	272	62
Tectocepheus velatus (Michael 1880)	16	4
Oppiella nova (Oudemans 1902)	11	2
Limnozetes rugosus Sellnick 1923	8	2
Nanhermannia sellnicki (Forsslund 1958)	7	2
Scutovertex sculptus Michael 1879	7	2
Trichoribates incisellus (Kramer 1897)	5	1
Ceratozetes parvulus (Sellnick 1922)	5	1
Chamobates incisus van der Hammen 1952	5	1
Trichoribates trimaculatus (C.L. Koch 1836)	4	1
Punctoribates hexagonus Berlese 1908	3	1
Ramusella clavipectinata (Michael 1885)	3	1
Peloptulus montanus Hull 1915	3	1
Melanozetes mollicomus (C.L. Koch 1840)	2	+
Liebstadia similis (Michael 1888)	2	+
Scheloribates latipes (C.L. Koch 1844)	1	+
Scheloribates pallidulus (C.L. Koch 1840)	1	+
Pantelozetes paolii (Oudemans 1913)	1	+
Oribatella quadricornuta (Michael 1884)	1	+
Acrogalumna longipluma (Berlese 1904)	1	+
Hydrozetes lemnae Coggi 1899	1	+
Oppia nitens C.L. Koch 1836	1	+
Oribatida nymphs indet.	23	5
Oribatida adults indet.	22	5
Gamasida (Uropodina)		
Phaulodinychus undulata Hirs. & Zirng. 1964	1D 1M	+
Phaulodinychus vitzthumi Hirs. & Zirng. 1967	1M	+
Gamasida (Gamasina)		
Hypoaspis oblonga (Halbert 1915)	1F	+
Gamasina indet.	9	2
Acaridida		
Dermatophagoides sp.	1D	+

3.3. Cellar-B.A.I.

This sample that had been 'stored' for over 40 years in an open pot in the cellar of the B.A.I. still proved to be useful.

After prolonged soaking the sample could be treated as any other sample. The mites found in this pot (table 3) indicate a rather wet environment in a coastal habitat. Strenzke (1952) gives *Trichoribates incisellus*, *Punctoribates hexagonus* and *Peloptulus phaenothus* as the characteristic species of his *Oribatella arctica litoralis-synusia* found in *Salzwiesen und feuchte Meeresstranden*. The other superabundant species *Platynothrus peltifer* is not characteristic of these surroundings but is found in nearly every habitat as long as its demands of a high degree of moisture are met.

3.4. Usselo

The total number of mites in all the Usselo subsamples taken together was 429, with the Oribatida being the most important group with 426 individuals. The other three mites were two Uropodina and one Gamasina.

In the Usselo sample there are only two species that are superabundant: *Hydrozetes lacustris* and *Limnozetes sphagni/rugosus* (table 4). The former species is one of the few truly aquatic Oribatids and is found in eutrophic waters as well as in peat-bogs and brook-marshes (Strenzke, 1952). Further evidence for the local breeding of this species, that is capable of parthenogenetic reproduction, was given by the find of six females containing one or two fully developed embryos. The other superabundant 'species', *Limnozetes sphagni/rugosus* is actually formed by the two closely related species *L. sphagni* and *L.*

Table 3. Number (n) and percentage (%) of the mites found in the Cellar-BAI sample. + = present, less than 1%. In Gamasida: F = Female; M = Male; D = Deutonymph; ? = Unknown sex or developmental stage.

	n	%
Oribatida		
Platynothrus peltifer (C.L. Koch 1839)	65	19
Trichoribates incisellus (Kramer 1897)	60	18
Punctoribates hexagonus Berlese 1908	25	7
Trichoribates trimaculatus (C.L. Koch 1836)	24	7
Ramusella clavipectinata (Michael 1885)	18	5
Scheloribatus laevigatus (C.L. Koch 1836)	16	5
Eupelops occultus (C.L. Koch 1836)	8	2
Liebstadia similis (Michael 1888)	7	2
Oppia nitens C.L. Koch 1836	6	2
Oribatula tibialis (Nicolet 1855)	6	2
Tectocepheus velatus (Michael 1880)	5	2
Cosmochtonius lanatus (Michael 1887)	4	1
Oribatella arctica litoralis Strenzke 1950	2	1
Scutovertex sculptus Michael 1879	2	1
Camisia segnis (Hermann 1804)	2	1
Trichoribates novus (Sellnick 1928)	2	1
Haplochtonius simplex Willmann 1930	1	+
Peloptulus phaenothus (C.L. Koch 1844)	1	+
Oribatella quadricornuta (Michael 1884)	1	+
Oppiella nova (Oudemans 1902)	1	+
Oribatida indet.	25	9
Oribatida nymphs indet.	1	+
Gamasida (Uropodina)		
Uroobovella pyriformes (Berlese 1920)	11F 6M 1D	6
Nenteria stammeri Hirs. & Zirng. 1962	6F	2
Uroobovella marginata (C.L. Koch 1839)	1M	+
Trichouropoda orbicularis (C.L. Koch 1839)	1F	+
Nenteria breviunguiculata (Willmann 1949)	1D	+
Indet.	4	1
Gamasida (Gamasina)		
Pachylaelaps ineptus Hirschmann & Kraus 1965	1F	+
Indet.	4	1
Acaridida		
Dermatophagoides sp.	12	4

rugosus. These two species are quite difficult to distinguish; there is, however, no real reason to do so since they both inhabit the same specific habitat. They are both commonly found in very moist Sphagnum moss where they always occur together, *L. sphagni* however usually outnumbers *L. rugosus* (van der Hammen, 1952). *L. sphagni* and *L. rugosus* are the only mites that have been previously recorded as subfossils in the Netherlands (van Eyndhoven, 1946). The order of occurrence of the two superabundant species corresponds very well with the reconstruction of the vegetational succession (van Geel, 1984). An initially oligotrophic shallow pool gradually became more eutrophic until the vegetation at the mire surface lost contact with the ground water and a Sphagnum-dominated vegetation developed. This process started before the Bølling period and lasted till the end of the Allerød period, a timespan of more than 1500 years.

4. CONCLUSIONS AND DISCUSSION

As we have seen in these four examples, mites can be found in a variety of archaeological samples ranging from late-glacial palaeo-ecological samples to medieval ones, and may give additional information about the ecological conditions in the past.

In all three examples a high percentage of the mites could be identified (mean 87%), especially among the Oribatids. The interpretation of these results however poses more serious problems. Kenward (1975) has already shown that for insect death assemblages a mere summing of the preferred

Table 4. Mites found in all the Usselo subsamples taken together, absolute number (n) and percentage (%). + = present, less than 1%.

	n	%
Oribatida		
Hydrozetes lacustris (Michael 1882)	241	56
Limnozetes sphagni/rugosus Hull 1916	119	28
Eupelops strenzkei (Knülle 1954)	17	4
Oribatula tibialis (Nicolet 1855)	14	3
Tectocepheus velatus/serakensis Berlese 1913	10	2
Astegistes pilosus (C.L. Koch 1840)	7	2
Trichoribates trimaculatus (C.L. Koch 1836)	2	+
Eupelops occultus (C.L. Koch 1836)	2	+
Eupelops geminus (Berlese 1916)	2	+
Zetomimus furcatus (Pearce & Warburton 1906)	2	+
Trichoribates novus (Sellnick 1928)	1	+
Tectoribates latitectus (Berlese 1908)	1	+
Liebstadia similis (Michael 1888)	1	+
Indet.	5	1
Uropodina		
Dinychus inermis (C.L. Koch 1841)	2	+
Gamasina		
Indet.	1	+

habitats of the identified species may lead to a completely wrong interpretation of the past ecological conditions. He concluded that the main reason for the inadequacy of such a naïve reconstruction is the active or passive long-distance transport of the insects. Mites, however, are flightless and therefore we do not have to worry about any substantial active long-distance movements. On the other hand, passive transport of mites may occur in a number of ways. In the Leeuwarden sample, for instance, we assume the presence of the *Zygoribatula exilis-synusia.* This recurring group of species has two varieties: a hygrophilous one of which we find no representatives at all and a xerophilous one of which we find several of the characteristic and accompanying species like *Oribatella quadricornuta, Phauloppia lucorum, Scutovertex minutes* and *Trichoribates trimaculatus.* It may therefore appear surprising to find two species, *Limnozetes sphagni* and *Hydrozetes converfae*, that are indicative of a very wet environment. However, they are only found in low numbers and may therefore well have been accidentally introduced, either by some natural force or by the deliberate gathering of their habitat by man. *L. sphagni* is the most characteristic mite of raised peat-bogs and may thus have been brought to the town within the cut peat used as fuel.

Another way in which mites can be 'passively' transported is the occurrence of certain developmental stages known as *Wandernymfen.* These phoretic nymphs, that are fully adapted for clinging to passing insects or other animals, occur within the Gamasida and the Acaridida, while among the Gamasida adults may also show phoretic behaviour in some genera (Krantz, 1970). Since the non-phoretic Oribatida clearly dominate in most archaeological samples, the interpretation of these results for the greater part reflects the ecological situation in the past of the immediate surroundings of the area that has been sampled. Nevertheless, the presence of Gamasida does give additional information about the nature of the sample. As already mentioned above, most of the Gamasida are indicative of an environment with a certain amount of rotting organic matter. Both the Leeuwarden and the Cellar-BAI sample contained some 12-14% Gamasida while the Usselo sample contained only 1% of Gamasida. The difference between the first two anthropogenic samples and the 'unpolluted' sample from the natural vegetation at Usselo is obvious.

Most of the Oribatid mites found in Usselo have been previously described as subfossils either in Denmark, Finland, Greenland or Soviet Karelia (Karppinen, 1979). As far as I know only four species have not yet been recorded as subfossils: *Eupelops strenzkei*, *E. geminus*, *Trichoribates novus* and *Tectoribates latitectus.* A more detailed interpretation of the mites from Usselo, also taking into account the less abundant species and the other micro- and macrofossils from the deposit, will be published in the near future (Schelvis & van Geel, in prep.).

One of the main problems in the interpretation of archaeological samples containing mites is the danger of (sub-)recent contamination. In the Cellar-BAI sample, for instance, we find three mites; *Cosmochtonius lanatus*, *Haplochtonius simplex* and *Dermatophagoides* sp. that are without any doubt recent contaminations. Not only are these three species unlikely to occur outside buildings and are well-known members of the mite-fauna of our institute, they could also be recognized as recent contaminations on the basis of their general appearance. Archaeological mites simply never possess eight complete legs as well as all their mouthparts. Therefore, any recent mite that is accidentally introduced at the moment when a sample is being taken or afterwards during transport or storage may be recognized as such. The greatest problems arise when you are confronted with subrecent contaminations. There is no way to tell whether a mite has been dead for ten, a hundred or several thousands of years.

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