Ecological Analysis of Acari Recovered from Coprolites from Archaeological Site of Northeast Brazil

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Coprolite samples of human and animal origin from the excavations performed at the archaeological site of Furna do Estrago, at Brejo da Madre de Deus in the state of Pernambuco, Brazil and sent to the Paleoparasitology Laboratory at Escola Nacional de Saúde Pública-Fiocruz, Rio de Janeiro, were analyzed for mites. After rehydratation and sedimentation of the coprolites, the alimentary contents and the sediments were examined and the mites collected and prepared in definitive whole mounts, using Hoyer's medium. Mites of the following suborders and orders were recovered: suborder Acaridia; order Gamasida; order Ixodida with the familiy Ixodidae (Ixodes *sp. and* Amblyomma *sp. larvae, scutum, idiosoma, gnathosoma); order Oribatida* (Aphelacarus *sp.,* Apolohmannia *sp.,* Eophypochthonius *sp.,* Cosmochthonius *sp.,* Pterobates *sp., Poronoticae with pteromorphae not auriculate); order Astigmata with the families Atopomelidae* (Chirodiscoides caviae), *Anoetidae hypopus, Acaridae* (Suidasia pontifica), *Glycyphagidae* (Blomia tropicalis), *Pyroglyphidae* (Hirstia passericola)*; order Actinedida with the family Tarsonemidae* (Iponemus radiatae). *The present work discusses the possibility of the preservation of the mite groups found up to the present day. We also discuss their relationship with the environment and their importance to present populations.*

Key words: mite - paleoparasitology - coprolite - Northeast Brazil

Although helminths are reported frequently in paleoparasitolology, arthropods remains also preserve in archaeological deposits and can be studied. A remarkable aspect of these investigations has been the discovery of insect remains parasitic on humans, especially the flea *Pulex irritans* L. (Buckland & Sadler 1989, Sadler 1990), the louse *Pediculus* L. (Ewing 1924, Horne 1979, Bresciani et al. 1983, Mumcuoglu & Zias 1988, Sadler 1990, Araújo et al. 2000, Rick et al. 2001), and more rarely the pubic louse, *Pthirus pubis* L. (Girling 1984, Kenward 1999, Rick et al. 2001). Records of insect parasites of animals have rarely been documented in the scientific literature and refer to the finding of the lice *Bovicola ovis* (Schrank, 1781) (Sadler 1990), *Microthoracius proelongyceps* (Neumann, 1909) and *M. minor* Werneck, 1935 (Astos et al. 1999), *Felicola felis* (Werneck) 1934 (Guerra et al. 2001b), the hippoboscids *Melophagus ovinus* L. (Sadler 1990) and *Lipoptena cervi* L. (Gothe & Schöl 1994).

The Acari are ancient arthropods and the earliest record of this group dates from the Devonian age (Krantz 1978). The oldest fossil mite recorded is *Protacarus crani* Hirst, 1923. Many orders of the subclass Acari are represented in fossil records from the Paleozoic, Mesozoic and Cenozoic epoch, such as Holothyrida, Gamasida, Oribatida, Astigmata, Actinedida, and Ixodida (Krivolusky & Druk 1986, Woolley 1988). The order Ixodida includes the following records: *Ixodes tertiarius* (Scudder 1885 cited by Lane & Poinar 1986); *Ixodes succineus* (Weidner & Zecke 1964 cited by Lane & Poinar 1986); *Dermacentor reticulates* (Schille 1916 cited by Lane & Poinar 1986); *Amblyomma* similar to *A. testudines* (Lane & Poinar 1986) and *Ornithodoros antiquus* (Poinar 1995).

Mites of the families Anoetidae, Acaridae and Lardoglyphidae were recovered from human coprolites and mummified remains in Nevada (Radovsky 1970). Kliks (1988) observed numerous specimens of saprophytic astigmatic mites in fecal material from Amerindian mummies. In Brazil there are few reports of Acari in paleoparasito-logical studies. Araújo et al. (1986) found mites of the family Cheyletidae in hair fragments and tissues of a mummified body. Guerra et al. (2001a) presented preliminary results of the finding of ixodid ticks and mites of the families Tarsonemidae, Atopomelidae, Glycyphagidae, Scutacaridae, Demodecidae and of the order oribatida, in coprolites.

Studies of arthropods preserved in archaeological deposits can provide information about past human economy, resource exploitation, diet, activity and living conditions as well as about the fauna. Radovsky (1970) states that besides the supply of additional material for systematic studies, the resulting comparative data on the Acari fauna after an extended interval could be of value to the anthropologists, climatologists, and acarologists. Possible human and animal health hazards can be foreseen through these investigations since some species of Acari are able to carry and transmit bioagents.

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The purpose of this paper is to discuss the finding of members of the subclass Acari in coprolites, supposing that further studies in this field will allow a better understanding of mites and ticks and their relationship with the environment and their hosts.

MATERIALS AND METHODS

Excavations were performed at the state of Pernambuco, Brazilian Northeast, in the archaeological site of Furna do Estrago (8°11'36"S, 36°20'14"W), in Brejo da Madre de Deus municipal district, by the staff of the Universidade Católica de Pernambuco. This site consists in a rock granite shelter composed of a single chamber of 125.10 m^2, with an opening measuring 19 m, maximum height of 4.80 m, and depth of 8.80 m. It was occupied by hunters-gatherers corresponding to different periods, dated to 11,060 ± 90 yr BP, 9,150 ± 50 yr BP, and 8,495 ± 70 yr BP Intercepting this assemblage there is a more recent pre-historic occupation, when the shelter was used as a cemetery, dated to 1,860 ± 50 yr BP, 1,730 ± 70 yr BP, and 1,610 ± 70 yr BP (C^{14} Smithsonian Institution). Dating was obtained from hearths and human bones (Lima 1991).

A total of 209 coprolites were collected and sent to the laboratory of Paleoparasitology, at Escola Nacional de Saúde Pública-Fiocruz, where their zoological identification was made. The zoological origin of the coprolites was obtained by comparisons with photographical archive of Chame (1988), material compiled at the laboratory, and alimentary content analysis. They were identified as *Homo sapiens* L. (n = 49 samples), Felidae (n = 96), Myrmecophagidae (n = 2), Cervidae (n = 3), Taiassuidae (n = 7), Caviidae (n = 25), Echimyidae (n = 15). In five samples the zoological origin could not be determined.

The coprolites were rehydrated in aquous solution of trissodium phosphate (Callen & Cameron 1960) and after 72 h a spontaneous sedimentation technique was used (Lutz 1919). The alimentary remains and the sediments were stored in Raillet and Henry solution in individual vials, and sent to the Laboratory of Ixodides, IOC-Fiocruz, to search for mites.

First, each sample of alimentary remains and sediments were placed individually on Petri dishes and examined under a stereomicroscope. Mites were permanently mounted in Hoyer's medium before examination. The slides were heated at 60ºC, their edges closed with a sealing wax, and placed in a sterilizer to dry. The specimens were examined under an optic microscope. The ticks that remained in the screens during the filtering process were mounted in Canada balsam after the treatment in phenol and creosote (Amorim & Serra-Freire 1995).

Initially, Acari identification was made according to Krantz (1978) and Woolley (1988), and complemented by specific literature for each group found, as follows: Clifford and Anastos (1960), Webb et al. (1990), Amorim and Serra-Freire (1999) (Ixodidae); Hirst (1917), Flechtmann (1986), Fain et al. (1990) (Astigmata), Lindquist (1969) (Actinedida), Balogh (1961, 1965), Balogh and Balogh (1988) (Oribatida).

RESULTS

In the total of coprolites samples examined, 50 mites were recovered; 13 from *Homo sapiens* coprolites; 32 from Felidae coprolites; three from Caviidade coprolites; one from Cervidae coprolites and one from a coprolite of unknown zoological origin.

Order Ixodida - The four larvae of ticks identified as *Amblyomma* Koch, 1844, when compared among them, demonstrated different morphological features, allowing us to state that they belong to two different species (*Amblyomma* sp.1 and *Amblyomma* sp. 2) (Figs 1, 2). However, they differ morphologically from the ones included in the identification key proposed by Amorim and Serra-Freire (1999). Two larvae were identified as *Ixodes* sp. Latreille, 1795 (Fig. 3). Two scutum with eyes (Fig. 4), a gnathosoma with dentition formula 2:2 (Fig. 5), and a larval idiosoma with festoons and eyes (Fig. 6) were also recovered. These fragments belong to ticks of the Ixodidae family because of the presence of scutum and the gnathosome morphology. All these specimens and fragments were recovered from Felidae coprolites.

Order Gamasida - Three specimens of this order occurred in *Homo sapiens* coprolites (Fig. 7a). The presence of a pair of lateroventral stigmatal openings at the level of coxae III-IV associated with elongate peritremes made the identification possible (Fig. 7b). However, due to the poor preservation of these specimens, we could not go further in the identification.

Order Astigmata - Two adult specimens (Fig. 8a) of the suborder Acaridia and one larva (Fig. 8b) were found. The adult specimens were collected from *Homo sapiens* coprolites, and the larva was only from Felidae. Two Anoetidae hypopodes (Fig. 9) were recovered from Felidae coprolites. Two specimens of the family Atopomelidae were recovered. One of them was a female of *Chirodiscoides caviae* Hirst, 1917 (Fig. 10) and the other, a female exuviae (Fig. 11). Both of them were from Felidae coprolites. Several mites of the family Acaridae were found. Five of them were identified as *Suidasia pontifica* Oudemans, 1905 (Fig. 12), collected from *Homo sapiens*, Felidae and Caviidae coprolites. Another seven mites of this family were recovered from coprolites of the same zoological origin and from one coprolite of unknown zoological origin. One specimen of the family Glycyphagidae, recovered from Felidae coprolite, was identified as a female of *Blomia tropicalis* Bronswijck, Cock and Oshima, 1973 (Fig. 13). One specimen of the family Pyroglyphidae was identified as a male of *Hirstia passericola* Hull, 1931 (Fig. 14), from Felidae coprolite.

Order Actinedida - Two specimens of the family Tarsomenidae, a female fragment (Fig. 15), from Felidae coprolite, and a female of *Iponemus radiatae* (Lindquist and Bedard, 1961)(Fig. 16), from Cervidae coprolite.

Order Oribatida - Mites of this order were identified as *Apolohmannia* Aoki, 1960 (Fig. 17); *Aphelacarus* Grandjean, 1932 (Fig. 18); *Pterobates* Balogh and Mahunka, 1977 (Fig. 19); *Eohypochthonius* sp. Jacot, 1938 (Fig. 20); *Cosmochthonius* Berlese, 1910, (Fig. 21) similar to *C. lanatus foveolatus* Beck, 1962. This last genus was the most numerous considering the amount of exuviae found (Fig. 22) in comparison to the others genus that

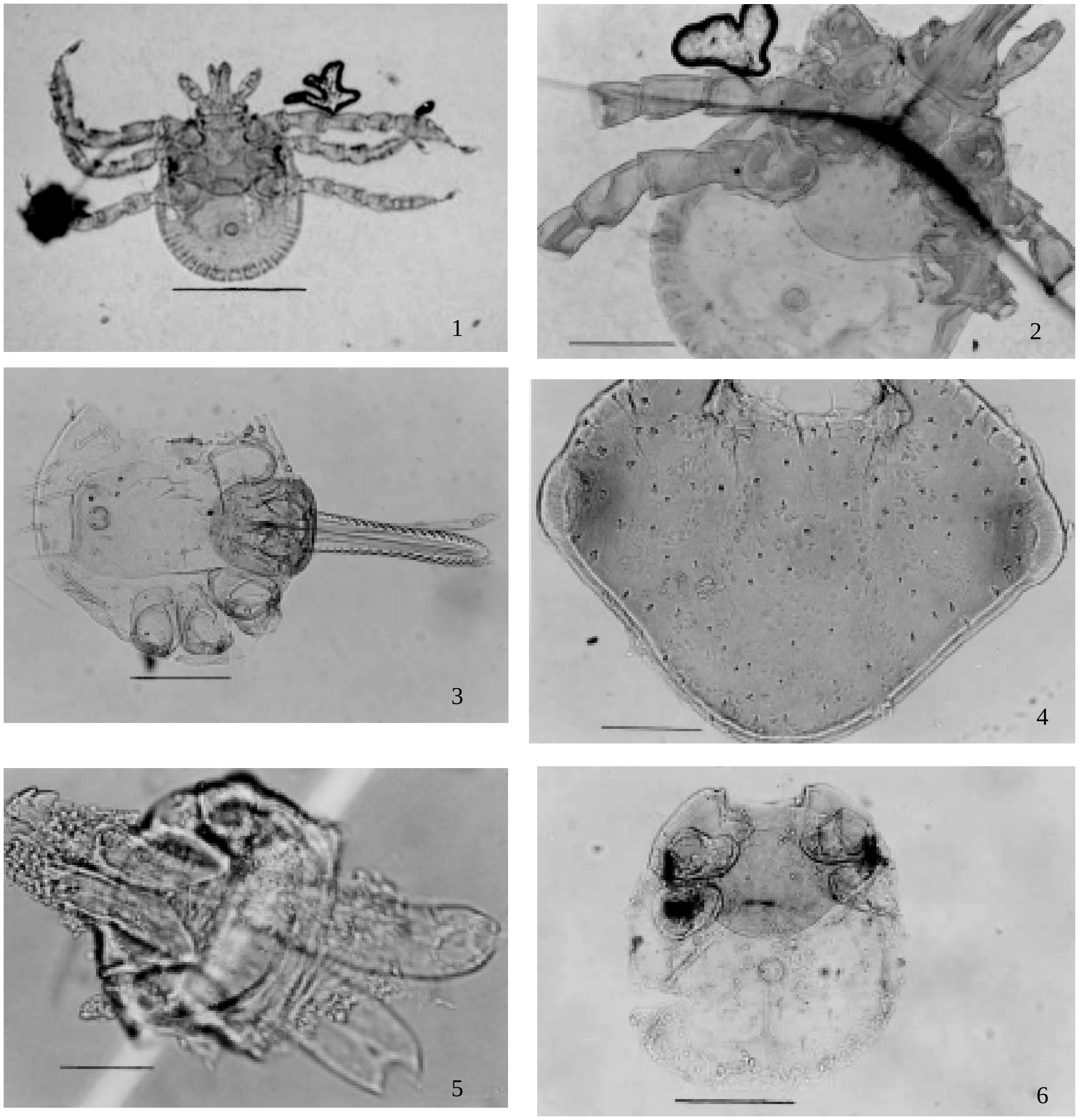

Fig. 1: *Amblyomma* sp.1 (bar = 500 µm). Fig. 2: *Amblyomma* sp. 2 (bar = 200 µm). Fig. 3: *Ixodes* sp. (bar = 200 µm). Fig. 4: scutum of ixodid tick (bar = 200 µm). Fig. 5: gnathosoma of ixodid tick (bar = 200 µm). Fig. 6: idiosoma of larva of ixodid tick (bar = 200 µm)

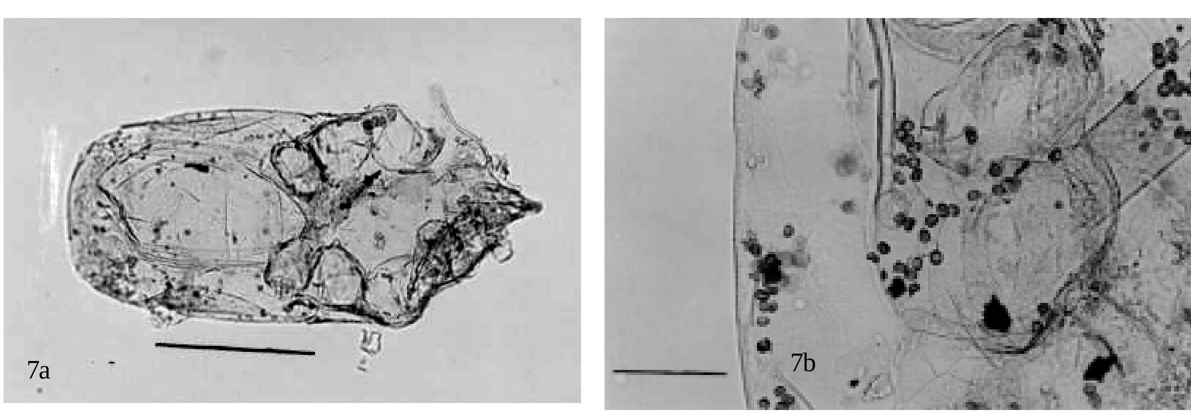

Fig. 7: order Gamasida - a: gamasid mite (bar = 200 µm); b: stigmatal opening associated with elongate peritreme (bar = 50 µm)

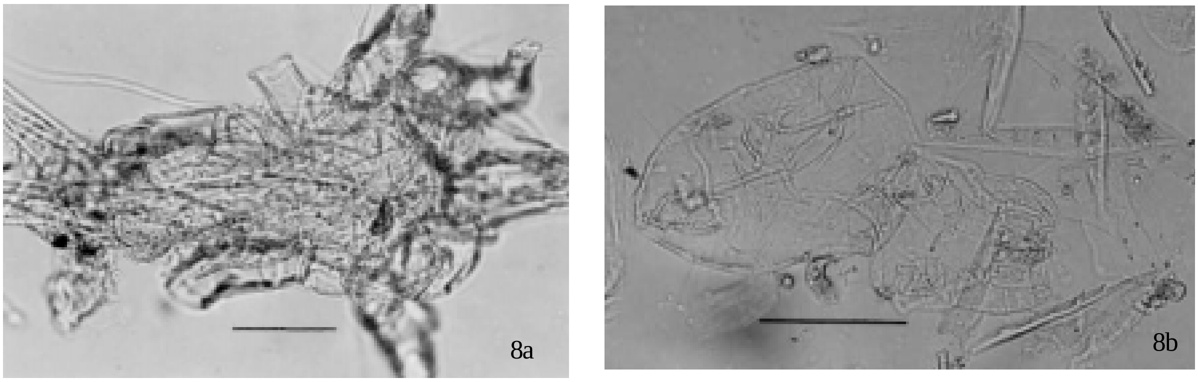

Fig. 8: mites of the suborder Acaridia - a: adult (bar = 200 µm); b: larva (bar = 200 µm)

Fig. 9: hypopus of the family Anoetidae (bar = 50 µm). Fig. 10: *Chirodiscoides caviae*. Female (bar = 200 µm). Fig. 11: exuviae of atopomelid mite (bar = 200 µm)



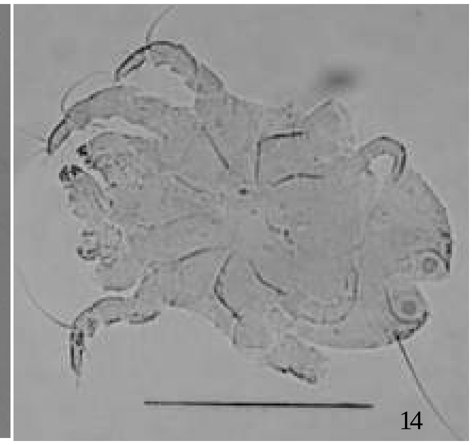

Fig. 12: *Suidasia pontifica*. Male (bar = 200 µm). Fig. 13: *Blomia tropicalis*. Female (bar = 200 µm). Fig. 14: *Hirstia passericola*. Male (bar = 200 µm)

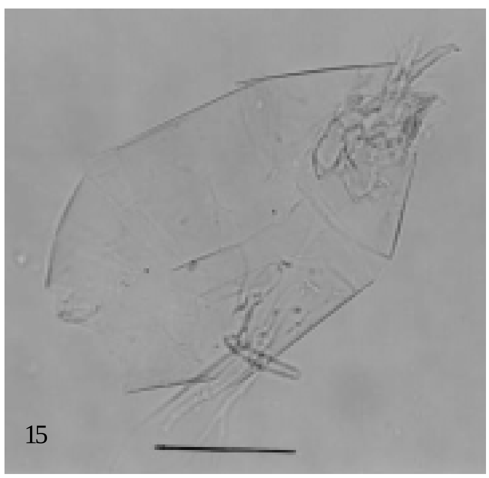


Fig. 15: fragment of mite of the family Tarsonemidae. Female (bar = 50 µm). Fig. 16: *Iponemus radiatae*. Female (bar = 50 µm)

were represented by one specimen. One specimen of the Poronoticae group with pteromorphae not auriculate was also recovered. All specimens from this order were collected from Felidae coprolites, except for the seven exuviae of *Cosmochthonius* that were from *Homo sapiens* coprolites.

DISCUSSION

Ticks are arthropods, and are obligate blood feeders on mammals, reptiles, and birds. They may cause injury to their hosts through exsaguination, secondary infection, irritation at the attachment sites, or through the transmission of disease organisms (Krantz 1978). Ticks serve as reservoirs and vectors for viruses, bacteria, sporozoa (Krantz 1978), rickettsias (Lemos et al. 1977a,b), and spirochaetes (Yoshinari et al. 1997). They also have been observed to produce motor paralysis (Serra-Freire 1983).

The larvae of *Amblyomma* and *Ixodes*, the scutum, gnathosoma, and larval idiosoma, were recovered from Felidae coprolites. We suppose that they were ingested with the felid prey since in the archaeological site, coprolites of animals of the families Myrmecophagidae, Taiassuidae, Cervidae, Caviidae and Echimyidae were also examined. Moreover, Lima (1991) observed that in this archaeological site, food supply was obtained through the hunting of small and medium sized animals around 9,000 yr BP and 2,000 yr BP, respectively. Therefore, these animals occurred in the region and they are possible prey for felids.

Species of *Amblyomma* have already been reported biting humans (Famadas et al. 1997, Lemos et al. 1997a,b) as well as those of the genus *Ixodes* (Webb et al. 1990). Some species of these genera are confirmed vectors of bioagents (Webb et al. 1990, Schaffner & Standaert 1996, Lemos et al. 1997a,b). These larvae could be carrying a disease agent for their hosts. The observations above are in agreement with those of Persing et al. (1990), who detected the presence of *Borrelia burgdorferi* DNA in museum tick specimens, and Poinar (1995), who suggested that argasid fossil ticks could be carrying a primitive spirochete to their hosts.

The finding of ticks in archaeological material can give rise to investigations in human and animal remains to detect the presence of organisms transmitted by them and address the possible antiquity of certain tick-borne diseases.

The presence of ixodid ticks at Furna do Estrago, reveals the possibility of exposure of the ancient human population to tick-borne diseases.

The majority of gamasid mites are free-living but many species are ecto and endoparasites of reptiles, birds and mammals, or invertebrates (Krantz 1978, Woolley 1988). The specimens of this order were found in *Homo sapiens* coprolites, indicating that they could have been carried to the feces by other arthropods, possibly those associated with vegetal tissues observed by Lima (1991) at the human burials. They also could be present in the coprolites since they are soil and feces predators.

Mites of the family Tarsonemidae are, in large part, associated with other arthropods (Krantz 1978). This is the case of *Iponemus* species, which prey on the eggs of bark beetles and live as commensals in beetle galleries (Lindquist & Bedard 1961). Considering the biological behavior of this genus, the most probable hypothesis is that the mite invaded the coprolites after defecation.

Anoetid hypopodes are common on insects and other arthropods but are also frequent inhabitants of humid and organic substrates (Krantz 1978). The presence of a sucker plate observed in the specimens collected indicates that they belong to species associated with insects. Therefore, the hypopodes found in Felidae coprolites probably were carried to the fresh feces by coprophilic insects. This hypothesis is in agreement with the observations of Radovksy (1970) who explained the finding of Anoetidae hypopodes in human coprolites.

Members of the family Atopomelidae are ectoparasites of mammals (Krantz 1978, Oconnor 1982). The specimens recovered from Felidae coprolites, were probably

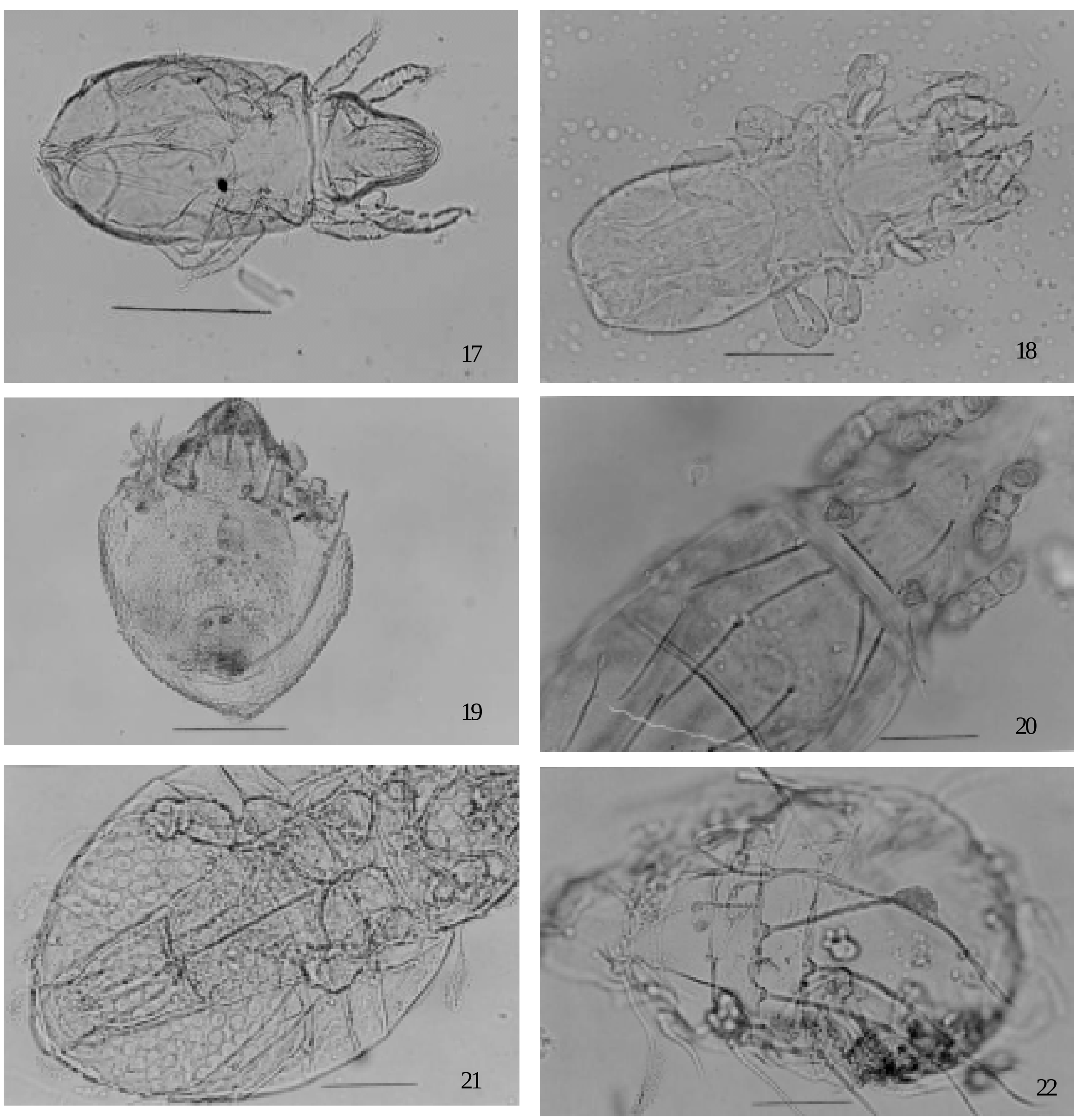

Fig. 17: *Apolohmannia* sp. (bar = 200 µm). Fig. 18: *Aphelacarus* sp. (bar = 50 µm). Fig. 19: *Pterobates* sp. (bar = 200 µm). Fig. 20: *Eohypochthonius* sp. (bar = 200 µm). Fig. 21: *Cosmochthonius* sp. (bar = 50 µm). Fig. 22: exuviae of *Cosmochthonius* sp. (bar = 200 µm)

ingested with the felid prey. Most probably a rodent prey since coprolites of Caviidae and Echimyidae were also found at the archaeological site. In addition, the alimentary contents of the felid coprolites had hairs and bone fragments. Invasion of the sample after defecation can be rejected, since these mites are permanent ectoparasites.

The species *Chirodiscoides caviae* is a common parasite of guinea pigs and has already been reported in *Cavia porcellus* L., *C. cobaya* Erxleben, 1777 and *Galea leucoblephara* Meyen, 1832 (Fain 1979). In Brazil, Flechtmann et al. (1974) reported for the first time in the state of São Paulo, the occurrence of this mite species. We are now reporting its occurrence in the state of Pernambuco.

Considering the specificity of atopomelid mites to their hosts, we suppose that the archaeological site of Furna do Estrago was occupied by caviid rodents as proved by the finding of *C. caviae*.

Most of the species of the family Pyroglyphidae are nest inhabitants, being more numerous in bird nests than in mammal nests (Oconnor 1982, Fain et al. 1990). Other species occur in stored products and house dust (van Bronswijk & Sinha 1971). Therefore, according to Fain et al. (1990), it seems that the nests of birds are the true habitat of these mites, and the domiciliary environment was secondarily invaded by pyroglyphids from passeriform birds.

The finding of a pyroglyphid mite indicates that the climate in the study region was humid and temperate, since van Bronswijk and Sinha (1971) observed that these mites seem to be more abundant in these areas. In fact, the environment was more humid in Furna do Estrago around 2,000 yr BP (Lima 1991).

The importance of the pyroglyphid mites appears to lie in their ability to induce respiratory allergies (van Bronswijk & Sinha 1971).

The genus *Hirstia* has been reported in nest of birds (Solarz 1995, Bhattacharyya 1999), and in house dust (Colloff 1998). This genus was recovered from a Caviidae coprolite and suggests an association with rodent nests. However, we did not find any references about this fact in the literature consulted. Since it has already been reported in house dust, we suppose that it has reached human dwellings through birds and/or rodents.

The family Glycyphagidae comprises a large group associated with nests of small mammals, especially of rodents (Flechtmann 1986). Many lineages invaded stored products (Oconnor 1982) but are also present in house dust (Wooley 1988, Colloff 1998).

Species of *Blomia* are well represented in stored products and Oconnor (1982) suggests that this genus is originally from South America, as evidenced by its abundance and ubiquity in house dust of the neotropical region. The finding of *B. tropicalis* in the archaeological site of Furna do Estrago corroborates with this assumption due to the antiquity of the studied material.

B. tropicalis is very abundant in tropical and subtropical regions. The climatic conditions in these regions, with mean annual temperature of 28°C and mean relative humidity of 82%, offer a good environment for the growth of this species (Mariana et al. 1996). These observations indicate that the climate in the region was humid and temperate as observed for pyroglyphid mites.

In this work, *B. tropicalis* was recovered from Felidae coprolites. Probably it was associated with small mammal nest and was ingested by the felid.

According to Colloff (1998) in essence, the pyroglyphids were originally bird-nest dwellers but underwent a shift in habitat to the human nest around the time of the first human settlement, associated with agricultural production, some 10,000 years ago. The glycyphagid inhabitants of human dwellings made a habitat shift from nests of small mammals and likewise encountered similarities with homes, with food resources in the form of seeds, cereals, and other plant materials. Given similarity of trophic niches of human dwellings to those available naturally, it is not surprising that a number of mite species have become associated with human habitations. On basis of the above observations, we can suppose that the actual characterization of some pyroglyphid and glycyphagid species living in anthropic environment has passed through an adaptation period of these mites and their hosts to a sinanthropic environment. This adaptation could have occurred when the subsistence conditions concerning dietary resources in the region become more suitable to human occupation. This fact, according to Lima (1991) occurred between 1,000 and 2,000 yr BP in the archaeological site of Furna do Estrago. The fauna attested by bone artifacts points out a more humid environment that was more favourable to human occupation than the one exploited by the hunter-gatheres around 9,000 yr BP

The Acaridae is a large assemblage of saprophagus, graminivorous, fungivorous and phytophagus species which are frequently found as contaminants of stored and processed food (Krantz 1978). However, they are not restricted to these habitats since they are also found as nidicoles of vertebrates, nidicoles of insects, and in other remains such as organic material, carrion, dung, and decaying matter.

Mites of the species *Suidasia pontifica* were recovered from *Homo sapiens*, Felidae and Caviidae coprolites. The most probable hypothesis is that they were carried to fresh feces by coprophilic insects. This supposition is in accordance with the observations of Radovsky (1970) to explain the presence of Acaridae tritonymph in human coprolites and of Kliks (1988) who suggested that the astigmatid mites found in human mummies are ancient or recent pos-mortem invaders.

A similar argument for pyroglyphid and glycyphagid mites could be proposed for species of *Suidasia*, since they had already been reported in bird nests (Bhattacharyya 1999), and could have substituted their natural habitat by sinanthropic and anthopic habitat. This could have happened as a consequence of human lifestyle favoring the colonization of this mite species. At the present, *S. pontifica* is more frequently reported as contaminants of stored and processed food (Ho 1996, Sanchez-Borges et al. 1997, Olsen 1998) and at house dust (Galvão & Guitton 1986, Montealegre et al. 1997, Chew et al. 1999).

The importance of species of the families Pyroglyphidae, Glycyphagidae and Acaridae as allergens causing allergic diseases is noteworthy. This public health hazard is getting worse throughout the years and it is now considered a severe problem of modern humans. Continual investigations in archaeological material will bring, in the future, information about these mites' species allowing the understanding of their interaction with human beings.

From the oribatid mites recovered, the genus *Apolohmannia* and *Aphelacarus* had not yet been reported for the neotropical region (Balogh & Balogh 1988), however, Corvarrubias and Toro (1997) reported the species *Aphelacarus acarinus* in Chile for the first time. The present work confirms the neotropical distribution of this mite species. The genus *Apolohmannia* was reported in Japan (Balogh 1965). This is the first report of *Aphelacarus* in Brazil and of *Apolohmannia* at the American continent.

The species *Pterobates incertus* was reported in the state of Rio de Janeiro (Balogh & Balogh 1988). Now we are including the state of Pernambuco in the geographical distribution of this species. The genus *Eohypochthonius* was previously reported to North America and Circumtropical region (Balogh 1961, 1965), and is now reported in Brazil.

The genus *Cosmochthonius* was previously reported in Europe, Java and neotropical region (Balogh 1961), and the species *C. lanatus foveolatus* in Chile (Corvarrubias & Toro 1997). We confirm the neotropical distribution of this species and report it for the first time in Brazil.

Corvarrubias and Toro (1997) studied oribatid species in Chile and concluded that *A. acarinus* and *C. lanatus foveolatus* constitute the dominant fauna in ecosystems of prolonged dryness. According to Lima (1991) at the archaeological site of Furna do Estrago, the archaeological evidence reflects rigorous climate conditions – high temperatures and dryness for a long period of time, between 9,000 and 8,000 yr BP This fact is consistent with the finding of these two species of mites.

The findings of *Apolohamnnia*, *Pterobates*, *Eohypochthonius*, *Cosmochthonius* and *Aphelacarus* are indicative that the neotropical climate with humidity and temperature compatible with the development of these genera was established in the region of the archaeological site.

Members of all the families of the order Oribatida with remains that are known as fossils are still living at the present time. This is indicative of the exceptionally low rates of morphogenesis in Oribatida. Apparently, the cause of the low variability level in Oribatida lies in the stability of the soil as an environment as well as in the diversity of ecological niches available (Krivolusky & Druk 1986). These are the features that explain why a number of extremely archaic forms have survived to the present time. The preliminary results about the finding of oribatid mites in archaeological material reported by Guerra et al. (2001a) and the ones presented in this paper corroborate the observations mentioned above.

Oribatid species and species assemblages offer several advantages for assessing the quality of terrestrial ecosystems (Behan-Pelletier 1999). Therefore they could be used as bioindicators, and in this way help to reconstruct the environment conditions of the past as already demonstrated with other arthropods. Atkinson et al. (1987) reconstructed seasonal temperatures in Britain during the past 22,000 years using radiocarbon-dated beetle remains. Some soil animals, especially those with firm exoskeletons, such as the oribatids, have tendency to fossilize (Krivolusky & Druk 1986) and their remains could be used for the same purpose.

Finally, it is worth mentioning that the genus and species recovered in the present study still exist. We suppose that human action has favored the colonization of domiciliary environments by mites previously associated with animals bringing, as a result, undesired consequences to human beings. This change in habitat could have happened from the moment that human groups become more sedentary. In the archaeological site of Furna do Estrago the diversity and amount of food sources allowed human settlement, population growth, and cultural complexity around 2,000 yr BP (Lima 1991). The population exploited simultaneously the sources of the "caatinga" and of the "mata serrana do Buriti" that made possible a semi-sedentary way of life and a hunting-gathering economy (Lima 1991). This way of life made possible for the population at Furna do Estrago to interact with the region's animals and plants, and consequently with their mites.

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