Abh. Ber. Naturkundemus. Görlitz	Band 76 Heft 1	S. 51 – 56	2004

ISSN 0373-7586

Beitrag zum 4. Milbenkundlichen Kolloquium vom 26. bis 27. September 2003
im Zoologischen Institut und Museum der Ernst-Moritz-Arndt-Universität Greifswald

Mass occurrence of astigmatid mites on human remains

David J. Russell[1], Martin M. Schulz[2] & Barry M. OConnor[3]

[1]State Museum of Natural History Görlitz,
[2]Institute of Legal Medicine, University of Tübingen,
[3]Museum of Zoology, University of Michigan

Summary

The remains of a small child, wrapped in a pullover and a plastic bag, were found in a private basement. They were heavily colonised by the astigmatid mite species *Myianoetus diadematus* (Histiostomatidae), *Tyrophagus putrescentiae* and *Acarus immobilis* (both Acaridae). The only other arthropods found were empty Diptera puparia. It was unknown how old the remains were and where they had been stored. Autecological information for the species indicate that the body had most likely always been in the plastic bag in the basement. Based on observed generation times of the species and the densities present on the remains, the body was probably 1 – 1.5 years old. The different feeding behaviours of the species suggest a case of niche differentiation in this unusual habitat.

Keywords: Astigmata, forensic acarology, generation time, niche differentiation

Zusammenfassung

Massenvorkommen astigmater Milben auf menschlichen Überresten – Die in einen Pullover und eine Plastiktüte eingewickelte Leiche eines Kleinkindes wurde im Keller einer Privatwohnung gefunden. Die Leiche war stark von den astigmaten Milben *Myianoetus diadematus* (Histiostomatidae), *Tyrophagus putrescentiae* und *Acarus immobilis* (beide Acaridae) besiedelt. Ansonsten waren lediglich leere Dipterenpuppen vorhanden. Todeszeitpunkt und Lagerungsort waren den Ermittlungsbehörden unbekannt. Die Autökologie der Arten deutet darauf hin, dass die Leiche immer in der Plastiktüte im Keller war. Anhand ermittelter Generationszeiten sowie der beobachteten Dichten lag die Leiche vermutlich 1 – 1,5 Jahre. Die unterschiedliche Nahrungsaufnahme der verschiedenen Arten deutet auf einen Fall von Nischentrennung in diesem ungewöhnlichen Habitat.

1. Introduction

In summer 2003, the remains of a small, possibly newborn child were found in the basement of a block of flats. They were wrapped in a pullover and then placed in a tightly knotted plastic bag, which in turn was put into a sport bag. The remains mainly consisted of bones, which were still partly covered by adipoceratous tissue (= »corpse fat«). The tissue was heavily colonised by mites. The only other observable arthropods on or near the remains were empty Diptera puparia (probably *Calliphora* and *Lucilia* species; no dead or living flies were found in the sport bag or surrounding basement). This represents an unusual situation, since human corpses are generally quickly colonised by insects (mostly Diptera and Coleoptera), which typically cause a rapid and usually total decomposition of the tissue, especially in summer (BENECKE 2001). Due to strong competition with larger arthropods, mites usually play a very subordinate role.

Since statements by witnesses and suspects were conflicting, it was unclear when and how the child had died as well as how the body had been handled afterwards. It had been claimed both that the body had been put immediately in the basement as it had been found, as well as that the body was first buried in a nearby sandbox (either for a few days or for up to one year). Thus, it remained unknown (1) how old the remains could be, and (2) where the body had probably been placed after the child's death.

2. Methods

Living arthropods were extracted from two ca. 1 cm^3 tissue samples in a small Berlese funnel. The specimens thus obtained were conserved in 70 % ethanol and sorted and counted under the stereomicroscope at x 50 magnification. Additional specimens were sampled by hand from various parts of the remains. Ten to twenty individuals of each discernable morphospecies were embedded in Hoyer's medium and determined to species.

From additional tissue samples, live mite cultures were established, kept at 20 °C and fed with pork. Eggs were isolated and times from their hatching until hatching of the F_1 generation were recorded; this time period was then taken as the observed generation time. Only rough calculations of potential developmental times of the observed densities were possible, since factors necessary for determining true population development (mortality, overlapping generations etc.) would be entirely speculative. Assuming the body had only been in the basement (with constant temperatures of approx. 15 – 20 °C), potential population growth was calculated iteratively as $N_T = N_{T-1}*R$ (alternatively: $N_T = N_O*R^T$), with N_{T-1} being the number of individuals of the previous generation (N_O = the number of initial gravid females), R the average number of eggs observed in gravid females (taken as the fundamental net reproductive rate) and T the observed generation time. Hereby, pure exponential population growth with no density dependence was assumed, and differences due to male/female ratios etc. (see above) were ignored. Therefore, the results can only be assumed to be rough estimates of baseline potential growth times.

3. Results

Three species were found living on the tissue. Approximately 50 % of the individuals belonged to *Myianoetus diadematus* Willmann, 1937 (Histiostomatidae). The remaining individuals were species of Acaridae: *Acarus immobilis* Griffiths, 1964 and *Tyrophagus putrescentiae* (Schrank, 1796). Based on tissue samples, total densities were estimated to be between 275 000 and 473 000 individuals. The *M. diadematus* populations collapsed soon after the body remains were found and unpacked; the populations of the acarid species appeared to remain unaffected.

Gravid female specimens (usually of only the Acaridae species) were observed to bear an average of 4 eggs (3 – 5). In culture, generation times of the acarid species amounted to 28 – 30 days, which is consistent with previous findings (Rivard 1959, Barker 1967). Assuming an initial colonisation of five gravid females and density-independent population growth as well as discrete populations, approx. 8 – 8.5 months would be needed to reach the observed densities (Fig. 1). Increasing the original founder colonisation up to 30 individuals only shortened development times to 6.5 – 7 months. Even with only one gravid female, the densities could have been theoretically reached within 9 months.

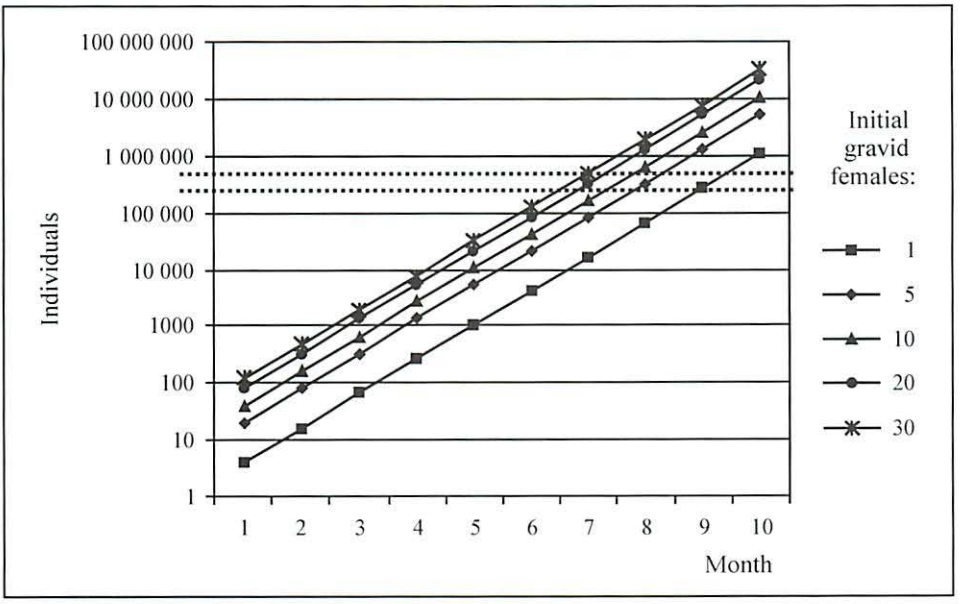

Fig. 1 Calculated potential population growth for the Acarid species based on different numbers of initially colonising females. Horizontal dotted lines represent the range of mite densities observed on the body remains

4. Discussion

Both acarid species found here are common inhabitants of human homes (»house-dust fauna«) as well as stored products (KRANTZ 1978, RACK 1984). They do not form phoretic deutonymphs and depend on random dispersal for colonising new food resources (RACK 1984). Thus, they probably originated from the home where the child died, possibly together with the pullover or from the basement where the body was found. Deutonymphs of *Myianoetus* species form obligate phoretic associations with Diptera (SCHEUCHER 1959, MORITZ 1993). *M. diadematus*, which has been previously collected from caverns in central Europe (SCHEUCHER 1959), was thus probably introduced with the Diptera from which only empty puparia were found. Therefore, it is highly unlikely that the body had been buried, since colonisation by other invertebrates would have occurred and competition would have prohibited such large mite densities.

Interesting in this regard is that these species all have specific habitat requirements. Histiostomatidae prefer and need organic-rich, very moist habitats in which they feed by filtering organic material and microorganisms (SCHEUCHER 1959, KRANTZ 1978). The fact that the populations collapsed after the body was unpacked indicates moist environmental conditions inside the plastic bag. *T. putrescentiae* also needs and is highly competitive in moist conditions (CUTCHER 1973, HODGSON 1976, RACK 1984). Interestingly, adipocere development also requires very moist and O_2-poor conditions. This all speaks for long residence times within the plastic bag.

Some species of Acaridae are known to attack and eat competitors (MORITZ 1993, H. ANSORGE, pers. comm.); however, only at large densities. No other arthropods other than the empty puparia were found in or around the plastic bag. Only sclerotised remains of adult Diptera could be found. Thus, Diptera larvae (which can usually colonise a body within hours) survived long enough to pupate (i.e., before the mites reached high densities), but adults did not survive (nor did they obviously disperse out of the containers).

The estimated developmental times show that the observed densities could have been reached in less than one year. Different factors, however, could have affected population growth rates. Mortality and male/female ratios, which will slow down calculated growth rates, were not taken into consideration in the calculations. On the other hand, data on multiple egg production by females and overlapping generations were also not available, which would increase calculated developmental times. Furthermore, the reduced amount of tissue must be considered. Before tissue decomposition, total mite densities could have been theoretically much larger, taking longer to develop. On the other hand, most Histiostomatidae have a much shorter generation time (i.e., less than 6 days: HUGHES & JACKSON 1958, SCHEUCHER 1959), so that they will have developed much more quickly. Furthermore, in culture, the acarid species rapidly consumed human tissue as well as pork (1 cm^3 in less than 4 weeks). Also, Diptera, which had initially colonised the body, are known to very rapidly decompose internal organs etc., especially of juvenile corpses (BENECKE 2001). Thus, a decay of the tissue within 1 to 1.5 years (one testimony) is quite possible. Therefore, these different factors possibly cancel each other out, rendering the estimated potential time period for population development plausible. Considering the mite densities as well as the amount of tissue present at the time the body was found, a corpse age of three years (another assertion) is highly unlikely.

Considering that species of the families here attack and eat competitors (see above and also HODGSON 1976), it seems surprising that multiple species occurred. It appears, however, that they partly possess different feeding behaviours. All Histiostomatidae species are filter feeders, filtering microorganisms (i.e. bacteria) from moist substrates (KRANTZ 1978, MORITZ 1993). *T. putrescentiae* and *A. immobilis* are common »house-dust« mites, feeding on dead, decaying or stored organic matter (SAMSINAK 1962, KRANTZ 1978, RACK 1984). *Tyrophagus* species may also be fungivorous (RIVARD 1959, HUBERT & MOUREK 2002) and even nematophagous, turning coprophagous in the absence of prey (BILGRAMI & TAHSEEN 1992, BILGRAMI 1994). MALDONADO-CAPRILES et al. (1990) reported *T. putrescentiae* feeding on fungi in body cavities of a recently embalmed human corpse. *A. immobilis* also feeds directly on stored grains etc. (KRANTZ 1978). In culture, the two Acaridae species were observed feeding directly on the tissues, rapidly reducing the biomass. These species are thus obviously particulate feeders. The different feeding behaviours of the two families, which were found in an approximately 50 : 50 mix on the body, could thus be a case of niche differentiation, allowing their concomitant occurrence.

5. References

BARKER, P. S. (1967): The effects of high humidity and different temperatures on the biology of *Tyrophagus putrescentiae* (Schrank) (Acarina: Tyroglyphidae). – Can. J. Zool. **45**: 91 – 96

BENECKE, M. (2001): A brief history of forensic entomology. – Forens. Sci. Int. **120**: 2 – 14

BILGRAMI, A. L. (1994): Predatory behaviour of a nematode feeding mite, *Tyrophagus putrescentiae* (Sarcoptiformis: Acaridae). – Fundam. Appl. Neamtol. **17**: 293 – 297

– & Q. TAHSEEN (1992): A nematode feeding mite, *Tyrophagus putrescentiae* (Sarcoptiformis: Acaridae). – Fundam. Appl. Nematol. **15**: 477 – 478

CUTCHER, J. (1973): The critical equilibrium activity of nonfeeding *Tyrophagus putrescentiae* (Acarina: Acaridae). – Ann. Ent. Soc. Amer. **66**: 609 – 611

HODGSON, R. K. (1976): *Tyrophagous putrescentiae* (Acarina: Tyroglyphidae) in cultures of *Dermatophagoides farinae* (Acarina: Pyroglyphidae) controlled by low humidity. – J. Med. Ent. **13**: 223 – 224

HUGHES, R. D.& C. G. JACKSON (1958): A review of the family Anoetidae (Acari). – Virginia J. Sci **9**: 5 – 198

HUBERT, J.& J. MOUREK (2002): The feeding interactions of astigmatid mites (Acari: Astigmata) and microfungi in stored grain habitats. – Integr. Protect. Stored Prod. **25**: 45 – 52

KRANTZ, G. W. (1978): A Manual of Acarology, 2nd edn. Oregon State Univ. Bookstores, Corvallis, 509 pp.

MALDONADO-CAPRILES, J., E. ABREU, C. CORDERO & D. RODRIGUEZ (1990): Presencia del acaro *Tyrophagus putrescentiae* (Schrank) (Acarina: Acaridae) sobre un cadaver embalsamado. – Science-Ciencia. **17**: 62 – 63

MORITZ, M. (1993): Unterordnung Acaridida. – In GRUNER H. E. (ed): Lehrbuch der speziellen Zoologie, 4th Edn. I: Wirbellose Tiere 4. Arthropoda (ohne Insecta). Fischer, Jena Stuttgart New York: 392 – 402

RACK, G. (1984): Systematik, Morphologie und Biologie von Milben (Acari) in Häusern und Vorräten sowie Milben von medizinischer Bedeutung. – Prakt. Schädlingsbek. **36**: 13 – 16

RIVARD, I. (1959): Influence of humidity on longevity, fecundity, and rate of increase of the grain-infesting mite *Tyrophagus castellani* (Hirst) (Acarina: Acaridae) reared on mould cultures. – Can. Entomol. **91**: 31 – 35

SAMSINAK, K. (1962): Beiträge zur Kenntnis der Gattung *Tyrophagous* Oudemans. – Acta Soc. Entomol. Czechosl. **59**: 266 – 280

SCHEUCHER, R. (1959): Systematik und Ökologie der deutschen Anoetiden. – In STAMMER, H. J. (ed): Beiträge zur Systematik und Ökologie mitteleuropäischer Acarina. I. Tyroglyphidae und Tarsonemidae. Akademische Verlagsgesell. Leipzig: 233 – 284

Manuscript accepted: 27 October 2004

Authors' addresses:

Dr. David J. Russell
State Museum of Natural History Görlitz, Dept. of Soil Zoology
Postfach 300 154
02806 Görlitz, Germany

Dr. Martin M. Schulz
University of Tübingen, Institute of Legal Medicine
Nägelestr. 5
72074 Tübingen, Germany

Prof. Barry M. OConnor
Museum of Zoology, University of Michigan
1109 Geddes Ave., Ann Arbor, Michigan
48109-1079, USA