Acta Parasitologica, 2005, 50(2), 171–175; ISSN 1230-2821

Nests of the white stork *Ciconia ciconia* (L.) as a habitat for mesostigmatic mites (Acari, Mesostigmata)

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Abstract

This study was intended to define the mesostigmatic mite species that occur in the nests of the white stork, and to identify their role in the life of their host. The results are derived from 38 samples from 12 nests, which contained a total of 13,352 individuals and 34 species. Among the most frequent species were *Macrocheles merdarius*, *M. robustulus*, *Uroobovella pyriformis* and *Trichouropoda orbicularis*, which represented almost 85% of all the specimens collected. There was a high frequency of coprophilous predatory mites that feed on the eggs and larvae of insects and on nematodes, which undoubtedly affects the abundance of these invertebrate groups in nests. Literature records and new observations suggest that phoresy on various beetles and dipteran phoronts can be the main mode of dispersal of mites into the nests.

Key words

Mites, Acari, Mesostigmata, *Ciconia ciconia*, nest fauna, Poland

Introduction

Birds' nests are an example of unstable, patchy microhabitats characterised by the presence of a distinctive associated invertebrate fauna. Most abundant among these are arthropods, especially mites. Large old birds' nests, such as those of white storks (*Ciconia ciconia*) and birds of prey, are especially interesting since they can contain invertebrate communities of a specific species composition. Such nests are well suited for ecological studies since they allow research on the fauna communities in this microhabitat, as well as studies of relations between the host and the invertebrates inhabiting the nest. In many cases the association between the bird and the invertebrates inhabiting its nest has a long coevolutionary history. The nests of white stork create a specific niche for invertebrates, which is characterised by seasonal variation connected with the biology of the host. Flights to and from warm countries strongly influence two parameters that are essential for the biology of mites inhabiting the nests, namely microclimate and food resources. Microclimatic conditions in the nest differ in the period between the birds' autumn and spring flights, and to a large degree depend on external conditions. The presence of a bird in the nest changes and stabilises the microclimate, especially at the time of egg-hatching, creating ideal conditions for mites. Food remains, bird excrements, and exfoliated epidermis and parts of feathers, provide rich food resources for saprophagous mites, which can appear in large numbers. These in turn provide food resources for many predatory species. Stork excrements and food remnants are also the habitat for many species of insects and nematodes. Nematodes, as well as insect eggs and larvae, are eaten by some mite species (e.g. Macrochelidae), and contribute to the development of large numbers of predatory mites in the nests. Similarly, the presence of nestlings can encourage the occurrence of parasitic mites, but such relationships have not been adequately studied. Large numbers of mites in the nest may also influence the nest's host or, even more, the nestlings. The influence of mass occurrence of nest fauna on the condition of young birds has not so far been studied. Some mite species can be vectors of viral and bacterial diseases. Preliminary studies of the species composition and community structure of nest faunas should therefore provide a basis for further studies of the ecological significance of this fauna.

The white stork is a synanthropic bird that constructs its nests in the vicinity of human habitations. Therefore, it is possible that some mite species that occur in these nests and carry disease (e.g. ticks) might become a potential threat to human or animal health. Nests built by white storks are usually isolated from each other and from other habitats that are commonly inhabited by mites (e.g. litter and soil). It is thus inter-

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esting to study the dispersal mechanisms that allow mites to move from nest to nest or from other habitats to nests.

The authors here present some initial results of studies on the acarofauna of white storks' nests, examining the richness and specificity of the communities of mesostigmatic mites.

Materials and methods

In June 2000, 38 samples were collected from 12 settled white storks' nests from the Wielkopolska region of Poland. Samples of soft plant nest building material 0.5–0.8 litres in volume, were collected with the use of a mobile crane. Material was extracted in Tullgren funnels for 7 days, and the collected mites were preserved in 75% ethyl alcohol. Specimens were identified after clearing in lactic acid or lactophenol. In order to identify mites, mite keys of Karg (1989, 1993) and Mašán (2001, 2003) were used. Values of dominance (D) and occurrence coefficient (C) were used after Błoszyk (1999). All the material was deposited in "The Invertebrate Fauna Bank" (Department of Animal Taxonomy and Ecology, Adam Mickiewicz University, Poznań, Poland).

List of nests' localities: Gniewkowo, 52°53´N 18°26´E, nest on overhead transmission line support; Gołunin, 52°28´N 17°21´E, nest on the tree; Jerzykowo, 52°29´N 17°11´E, nest on the roof; Kiszkowo, 52°35´N 17°11´E, nest on overhead transmission line support; Kocanowo, 52°30´N 17°20´E, nest on overhead transmission line support; Lednogóra, 52°31´N 17°22´E, nest on overhead transmission line support; Nowa Wieś Lednogórska, 52°31´N 16°35´E, nest on overhead transmission line support; Pobiedziska – Polska Wieś, 52°38´N 17°25´E, nest on the tree; Poznań, 52°25´N 16°58´E, nest on overhead transmission line support; Wagowo, 52°26´N 17°21´E, nest on overhead transmission line support; Wierzyce, 52°28´N 17°23´E, nest on overhead transmission line support.

Results and discussion

A total of 13,352 specimens of Mesostigmata were found in the collected material, belonging to 34 species, and including representatives of the suborders Uropodina (12 species) and Gamasina (22 species) (Table I). Below, in alphabetical order, we present a short account of the biology of the species that were most frequent and most abundant in the studied nests, with special consideration of their microhabitat preference and geographical distribution.

Dendrolaelaps longiusculus (Leitner, 1949)

This species has been recorded in manure, compost and decomposing litter (Hirschmann and Wiśniewski 1982). It has been noted in few European countries, and is new for the Polish fauna.

Macrocheles glaber (J. Müller, 1860)

Macrocheles glaber is found in decomposing organic matter, especially compost and dung (Krauss 1970). It has been noted in the nests of birds, e.g. *Accipiter gentilis*, *Acrocephalus arundinaceus*, *Anser anser*, *Ciconia ciconia*, *Cygnus olor*, *Larus ridibundus*, *Merops apiaster*, *Nycticorax nycticorax*, *Parus major*, *P. montanus*, *Passer montanus*, *Remiz pendulinus*, *Vanellus vanellus* (Mašán 2003). It is distributed from lowlands up to the mountain zone (1,330 m a.s.l.), and occurs in Europe, Asia, North America and Australia. It is carried phoretically by insects including scarabaeids of the genus *Geotrupes*, and by flies (Bregetova and Koroleva 1960, Bregetova 1977, Mašán 2003).

Macrocheles merdarius (Berlese, 1889)

Macrocheles merdarius is encountered in manure and in decomposing plant material, e.g. compost, silage and hay, and is phoretic on coprophagous beetles of the family Scarabaeidae (Bregetova and Koroleva 1960, Krauss 1970, Bregetova 1977, Mašán 2003). It is often found in dung, either fresh and wet or old and dry, and is found also in bird nests, e.g. *Turdus merula* (Mašán 2003). It is widely distributed all over the world, and has been collected in Europe, North America, South Africa, Asia, and Australia (Mašán 2003).

Macrocheles muscaedomesticae (Scopoli, 1772)

This species is found in manure, and is phoretic on insects (primarily on Diptera) (Krauss 1970). It has been collected in the nests of such birds as *Larus ridibundus*, *Merops apiaster*, and *Remiz pendulinus* (Mašán 2003). It is a cosmopolitan species noted on all continents except Antarctica (Mašán 2003).

Macrocheles robustulus (Berlese, 1904)

This is a coprophilous species, also characterised by phoresy. It is encountered mainly in dung, but has also been found in the nests of storks and other birds, such as *Larus ridibundus* and *Luscinia svecica* (Mašán 2003). It is cosmopolitan, and has been noted in Europe, Israel, USA, Argentina, Australia and New Zealand (Mašán 2003).

Parasitus fimetorum (Berlese, 1904)

This is one of the most frequent representatives of the genus *Parasitus* in Europe, and is usually found in decomposing organic matter and manure. It is also encountered in the nests of small mammals from the genera *Sorex*, *Neomys*, *Talpa*, *Microtus* and *Apodemus*, and in the nests of birds from the genera *Rissa*, *Vanellus*, *Delichon* and *Riparia*. It is frequently noted phoretic on beetles (*Aphodius*, *Geotrupes*, *Nicrophorus*) and bumblebees (*Bombus*) (Hyatt 1980), and has been collected in Europe, Siberia and North America (Hyatt 1980).

Parasitus mustelarum Oudemans, 1903

Parasitus mustelarum is usually found in dung and compost, occasionally in soil and litter. It is carried phoretically by in-

Table I. List of mite species occurring in the nests of *Ciconia ciconia*

Species	Total	F	M	D	P	L	D%	C%
Androlaelaps casalis (Berlese, 1887)	11	10	1	0	0	0	0.08	15.79
Cornigamasus lunaris (Berlese, 1882)*	13	0	0	13	0	0	0.10	13.16
Dendrolaelaps longiusculus (Leitner, 1949)	156	102	7	47	0	0	1.17	26.32
Dendrolaelaps sp.	4	1	0	3	0	0	0.03	7.89
Eulaelaps stabularis (C.L. Koch, 1839)	5	5	0	0	0	0	0.04	13.16
Halolaelaps sp.	17	10	6	1	0	0	0.13	18.42
Hypoaspis brevipilis Hirschmann, 1969	3	0	3	0	0	0	0.02	2.63
Hypoaspis lubrica Voigts et Oudemans, 1904	7	7	0	0	0	0	0.05	0.03
Lasioseius confusus Evans, 1958	1	1	0	0	0	0	0.01	2.63
Macrocheles ancyleus Krauss, 1970*	12	12	0	0	0	0	0.09	5.26
Macrocheles confusa (Foa, 1900)*	22	16	6	0	0	0	0.16	13.16
Macrocheles glaber (J. Müller, 1860)*	210	182	27	1	0	0	1.57	63.16
Macrocheles mammifer Berlese, 1918*	14	12	2	0	0	0	0.10	7.89
Macrocheles merdarius (Berlese, 1889)*	7,467	7,380	87	0	0	0	55.92	78.95
Macrocheles muscaedomesticae (Scopoli, 1771)*	263	199	64	0	0	0	1.97	39.47
Macrocheles robustulus (Berlese, 1904)*	1,589	1,281	308	0	0	0	11.90	68.42
Nenteria breviunguiculata (Willmann, 1949)*	13	9	4	0	0	0	0.10	15.79
Parasitus beta Voigts et Oudemans, 1904*	5	1	0	4	0	0	0.04	10.53
Parasitus coleoptratorum (Linnaeus, 1758)*	32	4	3	25	0	0	0.24	23.68
Parasitus consanguineus Voigts et Oudemans, 1904*	39	2	0	8	1	0	0.29	10.53
Parasitus fimetorum (Berlese, 1904)*	267	25	16	226	0	0	2.00	68.42
Parasitus mustelarum Oudemans, 1903*	386	28	2	356	0	0	2.89	57.89
Proctolaelaps pygmaeus (J. Müller, 1860)	1	1	0	0	0	0	0.01	2.63
Trichouropoda karawaiewi (Berlese, 1904)*	1	0	1	0	0	0	0.01	2.63
Trichouropoda orbicularis (C.L. Koch, 1839)*	904	294	231	326	53	0	6.77	73.68
Trichouropoda ovalis (C.L. Koch, 1839)*	8	4	4	0	0	0	0.06	2.63
Trichouropoda sp.	11	7	4	0	0	0	0.08	5.26
Uroobovella flagelliger (Berlese, 1910)*	297	64	40	136	55	2	2.22	31.58
Uroobovella marginata (C.L. Koch, 1839)*	8	2	4	2	0	0	0.06	13.16
Uroobovella pyriformis (Berlese, 1920)*	1,378	577	462	306	33	0	10.32	65.79
Uroobovella sp.	1	0	1	0	0	0	0.01	2.63
Uropoda minima Kramer, 1882	1	1	0	0	0	0	0.01	2.63
Uropoda orbicularis (O.F. Müller, 1776)*	180	8	1	169	2	0	1.35	55.26
Uroseius infirmus (Berlese, 1887)*	26	7	2	16	1	0	0.19	26.32
Total	13,352	10,252	1,286	1,639	145	2	100.00	

F – female, M – male, D – deutonymph, P – protonymph, L – larva, D% – dominance, C% – occurrence coefficient, *phoresy was observed.

sects and mammals, e.g. *Mustela* (Karg 1993), and has been noted in Europe and Siberia (Hyatt 1980).

Trichouropoda orbicularis (C.L. Koch, 1839)

This is a species associated mainly with bird nests (Błoszyk 1999). It is found sporadically in other microhabitats such as soil, moss, decomposed organic matter, tree holes, ant nests, and mammal nests (Wiśniewski and Hirschmann 1993). The optimum altitude for its occurrence is below 500 m a.s.l. It is one of the few species of Uropodina found in stored food products (Hughes 1961). It has been found in Europe, Algeria and India (Wiśniewski and Hirschmann 1993).

Uroobovella flagelliger (Berlese, 1910)

This species is associated with dead wood, but has also been noted in moss and under bark (Wiśniewski and Hirschmann 1993). It is a phoretic species (Athias-Binche 1993), which is widely distributed in Europe (Wiśniewski and Hirschmann 1993).

Uroobovella pyriformis (Berlese, 1920)

This is a species clearly associated with unstable microhabitats such as dead wood, and especially tree holes (Błoszyk 1999). It has also been noted in litter and compost (Wiśniewski and Hirschmann 1993) especially in lowland areas below 500 m a.s.l. It is carried phoretically by dipterans (Athias-Binche and Habersaat 1988, Błoszyk *et al*. 2003). It has been found only in Europe (Wiśniewski and Hirschmann 1993, Błoszyk 1999, Mašán 2001).

Uropoda orbicularis (O.F. Müller, 1776)

Uropoda orbicularis is found in mammals' and birds' nests and other unstable microhabitats (animal excrements, composted soil). It is often noted in ant hills (Wiśniewski and

Hirschmann 1993), and is phoretic on insects (Faasch 1967; Makarova 1995; Kofler and Schmölzer 2000; Bajerlein and Błoszyk 2003, 2004).

Community characteristics

Zoocoenological analysis showed that the most frequent, and also the most abundant, species in the nests was *Macrocheles merdarius* which constituted with *Macrocheles robustulus*, *Uroobovella pyriformis* and *Trichouropoda orbicularis*, nearly 85% of all the mites collected. A relatively high occurrence coefficient (C%), characteristic for most species, proves that they can inhabit storks' nests. As many as 9 species (*Macrocheles glaber*, *M. merdarius*, *M. muscaedomesticae*, *M. robustulus*, *Parasitus fimetorum*, *P. mustelarum*, *Trichouropoda orbicularis*, *Uroobovella pyriformis*, *Uropoda orbicularis*) are euconstants, found in almost all nests. Four species (*Uroobovella flagelliger*, *Dendrolaelaps longiusculus*, *Parasitus coleoptratorum*, *Uroseius infirmus*) were found in over half of the studied nests, and another 6 (*Androlaelaps casalis*, *Eulaelaps stabularis*, *Macrocheles confusa*, *Nenteria breviunguiculata*, *Parasitus beta*, *P. consanguineus*) in one-third of the nests. The number of species accidental for this habitat was relatively low and consisted of 4 taxa. Among the Gamasina, the families Macrochelidae and Parasitidae dominated, and among the Uropodina, the families Trematuridae and Urodinychidae were most abundant. Macrochelidae occurred mostly as adult forms, mainly females. Males of these species were rarely found and were only 5.2% of all the individuals found. The sex ratio (female:male) of particular species ranged from 1:1 to 85:1. On the contrary, the representatives of the family Parasitidae were mostly deutonymphs, which constituted 85% of all the individuals found. Mites of the family Macrochelidae are usually found in dung, compost, and the nests of birds and mammals (especially with a residue of excrements). They are often phoretic, as adult females, on coprophilous and necrophilous insects, such as dung beetles, burying beetles and synanthropic flies. They are often found in accumulations of decomposing organic matter such as compost, and only occasionally in litter, fallen leaves and rotten wood (Hyatt and Emberson 1988). Mašán (2003) described some macrochelid species, e.g. *Macrocheles glaber*, *M. merdarius*, *M. muscaedomesticae* and *M. robustulus* as common coprophilous detriticoles. Another group of mites that is common in white storks' nests are representatives of the subfamily Parasitinae, among them three species of the genus *Parasitus*. The studied nests did not contain any representatives of the more numerous subfamily Pergamasinae, which is characteristic of litter and heterogeneous soil detritus. Experimental studies suggest that mites of the genus *Parasitus* feed mainly on nematodes and dipteran larvae (Karg 1993). Therefore, they may play an important role in regulating the numbers of these invertebrates in the nests.

The community of Uropodina found in nests comprises mainly bisexual species, in contrast with soil communities, where parthenogenetic species are common. Only *Uropoda orbicularis* might be described as parthenogenetic. However, even in this case occasional males have been found, and the species is facultatively parthenogenetic (Faasch 1967). All species from this suborder associated with nests are phoretic, showing that they are adapted for dispersal for the location of suitable microhabitats. Published data show that the predatory mites found most frequently in white storks' nests are characteristic of unstable microhabitats such as dung. They were not common in previous studies of annual nests built by birds of the order Passeriformes (Błoszyk and Olszanowski 1985, 1986), or perennial nests of birds of the order Falconiformes (Gwiazdowicz *et al*. 1999, 2000; Gwiazdowicz 2003). Moreover, species frequently found in nesting boxes, e.g. *Androlaelaps casalis*, are only sporadically encountered in white storks' nests. This suggests a degree of specificity of the fauna of white storks' nests, probably associated with large amounts of excrements in the nests. Analysis of the mite species composition showed that all the common mite species are carried phoretically by insects, and they are probably transported to nests in this way. The most common group of insects fulfilling this role are coprophagous and coprophilous Coleoptera, especially Aphodiinae, some Histeridae and Staphylinidae. The lack of carrion in the nests limited the number of beetles of the genera *Nicrophorus*, *Oiceoptoma*, *Necrodes* and *Silpha*, and consequently mites of the genus *Poecilochirus*, characterised by very high phoretic activity (Gwiazdowicz 2000), have not been found in the nests. It is interesting to note that *Alliphis siculus* was not found in white storks' nests, although it is very frequent both in excrements, and phoretically on various scarabaeid beetles. The nests studied here contained only predators and saprophagous species, and parasitic species were not found (excluding *E. stabularis*, facultative ectoparasite of small mammals). Perhaps survival in this microhabitat is difficult for parasites, except for the individuals actually attached to birds. Predatory mites and other invertebrates that occur frequently in white storks' nests might regulate the abundance of juveniles and adults of parasitic species. Most of the coprophilous species have been shown to be predators on eggs and young larvae of muscid flies and also on nematodes and small enchytraeid worms found in birds' nests. Thus these mites may play an important role in maintaining hygiene in the nests. On the other hand, the abundance of mites in the nests might become a danger for the nestlings. This could be an indirect danger caused by induction of allergy, or they may act as vectors for viruses and mycotic diseases. Among the samples collected, specimens of *Macrocheles glaber* were found carrying large numbers of parasitic nematodes.

Conclusions

The mite fauna of white storks' nests is dominated by predatory mites of the genus *Macrocheles*, which are usually characteristic of coprophilic microhabitats. Parasitic mites have not been found. A positive function of predatory Gamasina in limiting the number of eggs and larvae of parasitic invertebrates in the nests cannot be excluded. The acarofauna of white stork nests definitely differs from that of annual nests built by passeriform birds, as well as perennial nests built by falconiform birds. The presence of mites from the suborder Gamasina was directly dependent on the birds' breeding success, i.e. the presence of nestlings in the nest. The most important mode of migration of mites to and from the nest is phoresy on coprophilous insects. It is also possible that mites may be carried to the nest accidentally by stork with building and other material.

Acknowledgements. This paper is the result of a grant sponsored by the August Cieszkowski Agricultural University of Poznań and Adam Mickiewicz University (Research Project No. 5/L/15/WJ/03). The authors wish to thank Dr Jerzy Ptaszyk and M.Sc. Marcin Stachowiak for help in collecting material. We are also very grateful to two referees and Dr hab. Krzysztof Solarz for their useful comments on the manuscript.

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(Accepted February 11, 2005)