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Community structure and dispersal of mites (Acari, Mesostigmata) in nests of the white stork (*Ciconia ciconia*)

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Abstract: The fauna of Mesostigmata in nests of the white stork *Ciconia ciconia* was studied in the vicinity of Poznań (Poland). A total of 37 mite species was recovered from 11 of the 12 nests examined. The mite fauna was dominated by the family Macrochelidae. *Macrocheles merdarius* was the most abundant species, comprising 56% of all mites recovered. Most of the abundant mite species were associated with dung and coprophilous insects. It is likely that they were introduced into the nests by adult storks with dung as part of the nest material shortly before and after the hatching of the chicks.

Key words: Acari, Mesostigmata, *Ciconia ciconia*, nest of birds, phoresy, community structure.

Introduction

Large bird nests that persist for many years provide microenvironments that are frequently inhabited by mites (Philips, 1981, 2000; Philips et al., 1983; Gwiazdowicz, 2003a, b; Gwiazdowicz et al., 1999, 2000, 2005). The relationship between nest-inhabiting mites and the host bird develop during evolution and can assume various forms. Two basic groups of organisms can be distinguished. One group includes ectoparasites of the host bird, while the other group comprises members of an accompanying fauna that is associated with the microenvironment of the nest rather than with the host itself.

Investigations of the mites that inhabit bird nests have been primarily faunistic, and in the acarology literature only brief or preliminary information about the species composition and the numbers of different groups of mites occurring in this habitat can be found.

The nest of the white stork *Ciconia ciconia* (L., 1758) is built by mature birds in the form of a large ring of sticks and twigs each, as a rule, 3–4 cm thick. The inside of the nest is filled with soft materials, such as hay, straw, fragments of sod and stalks of plants, e.g., potato, couch grass (Cramp, 1980; Creutz, 1985; Schulz, 1998; Jakubiec & Szymoński, 2000). These materials are continuously supplemented during the breeding period and may also be enriched by material of human origin. Mature birds frequently carry paper, pieces of cloth, various foils, pieces of string as well as organic material such as horse dung or manure from farmyards to their nests (Creutz, 1985; Schulz, 1998; Tortosa & Villafuerte, 1999; Jakubiec & Szymoński, 2000). Nests that have been used for several years usually have, under the new lining constructed in the current year, layers of relatively loose, rotten material deposited among twigs and sticks. These, when mixed with soil, give this layer a special consistency. Soil or peat found in the nest is introduced not only with the building material but also with food and on the feathers of mature birds. In addition, in nests utilised by the white stork for many years, other bird species can settle in the lower portions of the nest and build their own small nests among sticks and twigs, using nest materials specific for a given species. Sparrow (*Passer domesticus* L., 1758), tree sparrow (*P. montanus* L., 1758) and common starling (*Sturnus vulgaris* L., 1758) are the most frequent birds breeding in white stork nests.

The material that fills the white stork nest comes mainly from its immediate neighbourhood, within several hundred metres of the nest. Its composition depends on the phase of the breeding period and weather conditions as well as the availability of materials used by the birds to fill their nests.

During the period of egg hatching, the new top layer of the white stork nest built up every year includes a small hollow. This is the place where the eggs are laid and incubated, but later, the inside of the nest is practically level, or only slightly depressed below the rim. It is not the type of nest with a deep hollow that is characteristic of many other bird species, e.g., passerines. As a rule, the nest of the white stork is 40 to 120 cm high and has a diameter of 80 to 150 cm. Bigger nests with a diameter reaching 2.5 m have also been reported. Such nests can weigh up to two tonnes (Cramp, 1980; Schulz, 1998).

Nests as microenvironments for mites are characterised by considerable dispersion and isolation, except for nests of birds living in colonies. Conditions in nests undergo cyclic changes and depend on the biology of the host. Throughout the year, two periods can be distinguished during which the microclimate of the white stork nests differs significantly. After the departure of the birds (November to March), the nest remains under the exclusive influence of external climatic conditions. During this period, the invertebrate fauna is affected by abiotic factors, such as air temperature, precipitation and wind. During the period when the host is present (April to August), the mites are affected by biotic factors that are modified by the nesting birds, especially during the period of hatching and when the young birds remain in the nest. The results of this study refer to the period when chicks are present in the nests, because it was assumed that more mite species might be present in the nest at this period.

The aim of the research was to investigate the species composition of Mesostigmata communities in nests of the white stork, and to determine which species are dominant, most frequent or characteristic of this microenvironment. An attempt was also made to determine whether the communities found in individual nests are consistent or are made up entirely of accidental sets of species. It is the first study of this kind, based on a significant number of samples derived from multiple nests collected at the same period of time.

Material and methods

The present study was based on material collected during an investigation of the breeding success of a local population of the white stork situated within a radius of 50 km of Poznań (W Poland). The experimental material comprised 38 samples collected from 12 white stork nests in June 2000.

Quantitative samples of 0.5 to 0.8 L were collected from the lining of the nest, both from the central part and the rim. The samples were subjected to 98 h extraction in Tullgren funnels, and the invertebrates were preserved in 75% ethanol. Mites were identified under a microscope using temporary slides in lactophenol or lactic acid.

Dominance (D) and occurrence coefficient (C) were calculated after Błoszyk (1999). The dominance coefficient is a measure of the relative abundance of a species, and the occurrence coefficient is a measure of the frequency of a species in the collected samples. For dominance (D) the following classes were distinguished: eudominant (D5) > 30.0%, dominant (D4) 15.1–30.0%, subdominant (D3) 7.1–15.0%, recedent (D2) 3.0–7.0%, subrecedent (D1) < 3.0%. For frequency (C) the following classes were distinguished: euconstant (C5) > 50.0%, constant (C4) 30.1–50.0 %, subconstant (C3) 15.1–30.0%, accessory species (C2) 5.0–15.0%, accidental species (C1) < 5.0%. Results were evaluated statistically using Mann-Whitney U test.

All material is deposited in the Invertebrate Fauna Databank, Natural History Collections, Faculty of Biology, AMU, Poznań.

The nest sites were as follows. [UTM: XU30]: (G1) Poznań (52°25′ N, 16°58′ E), nest on overhead transmission line pylon; [UTM: XU41]: (G2) Jerzykowo (52°29′ N, 17°11′ E), nest on a roof. [UTM: XU51]: (G3) Gołunin (52°28′ N, 17°21′ E), nest in a tree; (G4) Kocanowo (52°30′ N, 17°20′ E), nest on overhead transmission line pylon; (G5) Wagowo (52°26′ N, 17°21′ E), nest on overhead transmission line pylon; (G6) Pobiedziska – Polska Wieś (52°38′ N, 17°25′ E), nest in a tree; [UTM: XU52]: (G7) Gniewkowo (52°53′ N, 18°26′ E), nest on overhead transmission line pylon. (G8, G9) Kiszkowo (52°35′ N, 17°11′ E), nest on overhead transmission line pylon; [UTM: XU61]: (G10) Wierzyce (52°28′ N, 17°23′ E), nest on overhead transmission line pylon; [UTM: XU62]: (G11) Lednogóra (52°31′ N, 17°22′ E), nest on overhead transmission line pylon; (G12) Nowa Wieś Lednogórska (52°31′ N, 16°35′ E), nest on overhead transmission line pylon.

Results

Characteristics of the Mesostigmata fauna

Of the 12 nests examined, eleven were inhabited by mites. There was only one nest (G3) in which no mites were found. A total of 13,355 individuals belonging to 37 species of Mesostigmata were identified (Tab. 1). The number of species per nest ranged from 11 to 20, and the number of specimens from 276 to 3,330 per nest.

The mite fauna was dominated by species of the genus *Macrocheles* (Tab. 1). The most numerous species, *M. merdarius*, comprised 56% of all identified mites (D = 56%), and was present in all of the samples examined (C = 100%). Representatives of this genus constituted from 30 to 91% of the specimens in each sample. The proportion of mites from the suborder Uropodina ranged from 1 to 64% in individual nests. The most numerous representative of this suborder, *Uroobovella pyriformis*, was the third most numerous mite. Other common species included *Macrocheles robustulus*, *M. glaber, Trichouropoda orbicularis*, *Parasitus mustelarum*, *P. fimetorum* and *Uropoda orbicularis* (Tab. 1). No significant differences were found in the number of mites inhabiting the inner part and the

Table 1. List of mesostigmatic mite species with total numbers of specimens in nests of the white stork, and categories of dominance and frequency.

	Species	n	F	M	DN	P	L	C	D	Nest	Species
1	*Alliphis halleri* (G. et R. Canestrini, 1881)	1	1	–	–	–	–	C1	D1	1	C
2	*Androlaelaps casalis* (Berlese, 1887)	11	10	1	–	–	–	C3	D1	5	B
3	*Cornigamasus lunaris* (Berlese, 1882)	13	–	–	13	–	–	C2	D1	4	B
4	*Dendrolaelaps longiusculus* (Leitner, 1949)	156	102	7	47	–	–	C3	D1	10	B
5	*Dendrolaelaps* sp.	4	1	–	3	–	–	C2	D1	4	B
6	*Eulaelaps stabularis* (C.L. Koch, 1839)	5	5	–	–	–	–	C2	D1	4	B
7	*Gamasodes spiniger* (Trägårdh, 1910)	1	–	–	1	–	–	C1	D1	1	C
8	*Glyptholaspis confusa* (Foà, 1900)	22	16	6	–	–	–	C2	D1	5	B
9	*Halolaelaps* sp.	17	10	6	1	–	–	C3	D1	5	B
10	*Hypoaspis brevipilis* Hirschmann, 1969	3	–	3	–	–	–	C1	D1	1	C
11	*Hypoaspis lubrica* Voigts et Oudemans, 1904	7	7	–	–	–	–	C2	D1	2	C
12	*Lasioseius confusus* Evans, 1958	1	1	–	–	–	–	C1	D1	1	C
13	*Macrocheles ancyleus* Krauss, 1970	12	12	–	–	–	–	C2	D1	1	C
14	*Macrocheles glaber* (Müller, 1860)	210	182	27	1	–	–	C5	D1	11	A
15	*Macrocheles mammifer* Berlese, 1918	14	12	2	–	–	–	C2	D1	2	C
16	*Macrocheles merdarius* (Berlese, 1889)	7467	7380	87	–	–	–	C5	D5	11	A
17	*Macrocheles muscaedomesticae* (Scopoli, 1771)	263	199	64	–	–	–	C4	D1	9	B
18	*Macrocheles robustulus* (Berlese, 1904)	1589	1281	308	–	–	–	C5	D3	11	A
19	*Macrocheles* sp.	1	1	–	–	–	–	C1	D1	1	C
20	*Nenteria breviunguiculata* (Willmann, 1949)	13	9	4	–	–	–	C3	D1	5	B
21	*Parasitus beta* Voigts et Oudemans, 1904	5	1	4	–	–	–	C2	D1	4	B
22	*Parasitus coleoptratorum* (L., 1758)	32	4	3	25	–	–	C3	D1	7	B
23	*Parasitus consanguineus* Voigts et Oudemans, 1904	39	22	16	1	–	–	C2	D1	4	B
24	*Parasitus fimetorum* (Berlese, 1904)	267	25	16	226	–	–	C5	D1	11	A
25	*Parasitus mustelarum* Oudemans, 1903	386	28	2	356	–	–	C5	D1	8	B
26	*Proctolaelaps pygmaeus* (J. Müller, 1860)	1	1	–	–	–	–	C1	D1	1	C
27	*Trichouropoda karawaiewi* (Berlese, 1903)	1	1	–	–	–	–	C1	D1	1	C
28	*Trichouropoda orbicularis* (C.L. Koch, 1839)	904	294	231	326	53	–	C5	D2	11	A
29	*Trichouropoda ovalis* (C.L. Koch, 1839)	8	4	4	–	–	–	C1	D1	1	C
30	*Trichouropoda* sp.	11	7	4	–	–	–	C2	D1	2	C
31	*Uroobovella flagelliger* (Berlese, 1910)	297	64	40	136	55	2	C4	D1	8	B
32	*Uroobovella marginata* (C.L. Koch, 1839)	8	2	4	2	–	–	C2	D1	3	B
33	*Uroobovella pyriformis* (Berlese, 1920)	1378	577	462	306	33	–	C5	D3	10	B
34	*Uroobovella* sp.	1	–	1	–	–	–	C1	D1	1	C
35	*Uropoda minima* (Kramer, 1882)	1	1	–	–	–	–	C1	D1	1	C
36	*Uropoda orbicularis* (O.F. Müller, 1776)	180	8	1	169	2	–	C5	D1	11	A
37	*Uroseius infirmus* (Berlese, 1887)	26	7	2	16	1	–	C3	D1	8	B
	Total	13355	10275	1305	1629	144	2				

Key: n – number of individuals; F – female; M – male; DN – deutonymph; P – protonymph; L – larva; C (%) – frequency, D (%) – dominance (for categories C1–C5 and D1–D5 see Material and methods); Nest – number of nests where the species were found; A – universal species; B – intermediate species; C – rare species.

rim of the nests (Mann-Whitney U test, $U = 38062.5$, $z = 0.24$, $P > 0.05$, Fig. 1).

Gender and age structure of mite populations

Females were by far the most numerous among adult mites. Males were less numerous and, in some cases, no males were found. The age structure of individual species varied (Fig. 2). Species of *Macrocheles, Eulaelaps* and *Hypoaspis* were represented almost exclusively by adult specimens. A similar age structure was observed in *T. ovalis* and *Trichouropoda* sp. A second group comprised those species in which adult specimens constituted a clear majority (> 50%), e.g., *Halolaelaps* sp., *U. pyriformis*, *Dendrolaelaps longiusculus*. In the remaining species (e.g., *Uroobovella flagelliger*, *Dendrolaelaps* sp., *Parasitus coleoptratorum*), there was a clear majority of juvenile specimens.

Comparison of the fauna of different nests

Among the 37 species of Mesostigmata found, three groups of species with different frequencies could be distinguished (Tab. 1). The first group comprised six species that occurred in all 11 nests containing mites; these species comprised over 79% of all specimens and included *M. glaber*, *M. merdarius*, *M. robustulus*, *T. orbicularis*, *U. orbicularis* and *P. fimetorum* (group A). In contrast, there were 14 accidental or rare species which occurred only in one or two nests (see group C in Tab. 1). The remaining species, which occurred in three to ten of the nests examined, made up 20% of all specimens (group B).

Mesostigmata communities of the nests differed in the proportion of *M. merdarius*, and formed two groups. The first group, in which *M. merdarius* comprised over 50% of the mites present, included nests 1, 7–9 and 12.

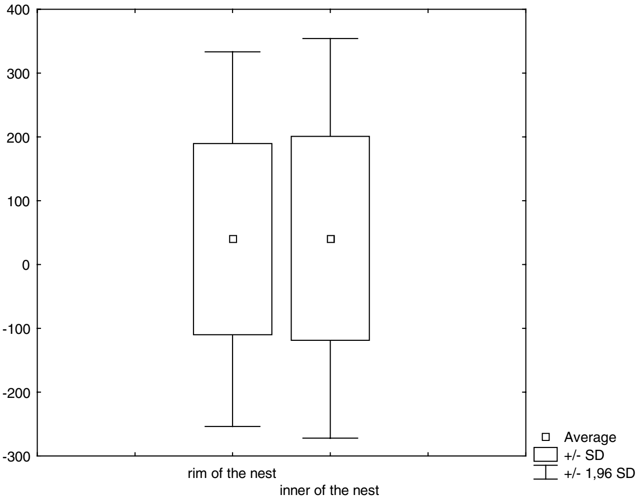

Fig. 1. The average number of mites inhabiting the rim and the inner part of the white stork nest.

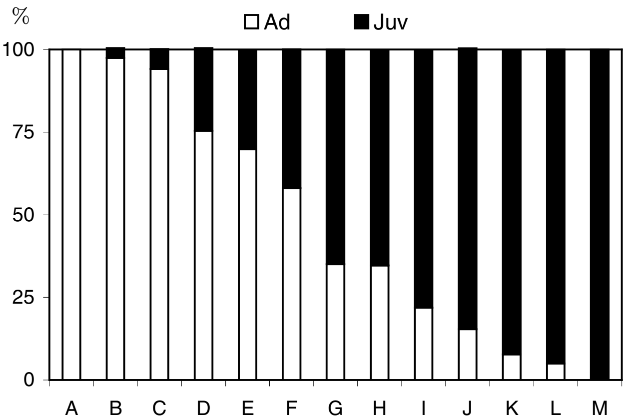

Fig. 2. Age structure of particular species of mesostigmatic species in white stork nests. A – *Androlaelaps casalis*, *Glyptholaspis confusa*, *Macrocheles ancyleus*, *M. mammifer*, *M. merdarius*, *M. muscaedomesticae*, *M. robustulus*, *Nenteria breviunguiculata*, *Trichouropoda* sp. (adults only); B–F: B – *Parasitus consanguineus*, C – *Halolaelaps* sp., D – *Uroobovella pyriformis*, E – *Dendrolaelaps longisculus*, F – *Trichouropoda orbicularis* (mostly adults); G–L: G – *Uroobovella flagelliger*, H – *Uroseius infirmus*, I – *Parasitus coleoptratorum*, J – *P. fimetorum*, K – *P. mustelarum*, L – *Uropoda orbicularis* (mostly juveniles); M – *Cornigamasus lunaris* (juveniles only).

In the remaining nests, the proportion of *M. merdarius* was considerably lower and did not exceed 45%.

Phoresy

The following mite species were observed to be phoretic: *U. pyriformis* (10 deutonymphs) found on larvae of Dermestidae (3 specimens) and Staphylinidae sp. (one specimen), *Dermestes lardarius* L., 1758 and *D. bicolor* F., 1781 (Dermestidae, one specimen each), *U. orbicularis* (1 deutonymph) found on *Carcinops pumilio* (Erichson, 1834) (Histeridae, one specimen). *M. merdarius* (3 females), *Macrocheles* sp. (1 female), *M. muscaedomesticae* (1 female), *Gamasodes spiniger* (1 deutonymph), *Dendrolaelaps* sp. (1 deutonymph) and *Alliphis halleri* (1 female) were found on dipterans.

Discussion

The present paper represents the first study of the species composition and community structure of Mesostigmata inhabiting nests of the white stork in Poland. Some of the mite species reported here have been found in nests of other bird species. These include *Uroobovella pyriformis* (BŁOSZYK & OLSZANOWSKI, 1986), *U. marginata* (NORDBERG, 1936), *Trichouropoda orbicularis* (BŁOSZYK & OLSZANOWSKI, 1985, 1986; KRIŠTOFÍK et al., 2001), *T. ovalis* (NORDBERG, 1936; BŁOSZYK & OLSZANOWSKI, 1985; MAŠÁN & KRIŠTOFÍK, 1995; GWIAZDOWICZ et al., 1999, 2000; KRIŠTOFÍK et al., 2001; TRYJANOWSKI et al., 2001), *Nenteria breviunguiculata* (KRIŠTOFÍK et al., 2001), *Cornigamasus lunaris* (Berlese, 1882), *Eulaelaps stabularis* (Koch, 1836), *Macrocheles ancyleus* (KRAUSS, 1970), *Parasitus fimetorum*, *P. pygmaeus* (GWIAZDOWICZ, 2003a, b). On the other hand, *M. glaber*, *M. merdarius* and *M. robustulus* have been reported in nests of the white stork in an earlier study (MAŠÁN, 2003).

The characteristic feature of the mite communities in white stork nests was primarily a high frequency (> 50%) of three species of *Macrocheles* (*M. merdarius*, *M. robustulus, M. glaber*). In addition, *M. merdarius* was the most abundant mite species. Two species of Uropodina (*T. orbicularis* and *U. orbicularis)* and one species of Parasitidae (*P. fimetorum*) were also found in all the nests examined.

Analysis of the structure of the mite communities revealed the dominance of one species, *M. merdarius*, which was the only representative of the class of eudominants. Other more frequently occurring species were *M. robustulus* and *U. pyriformis*, which represented the class of subdominants, and *T. orbicularis* was the only recedent species. The remaining species were isolated from individual nests as single specimens.

Communities dominated by one or two species from a given taxonomic group represent a structure that is characteristic of unstable and dispersed microenvironments, exemplified by bird nests. Similar structure has been observed in mites inhabiting manure (BAJERLEIN, unpublished data) and nests of moles (BŁOSZYK, 1985).

Mite species that were most abundant in the nests of the white stork are also present in manure and compost, and are transported by phoresy (with one exception, *T. orbicularis*), usually on coprophagous beetles of the family Scarabeidae (e.g., BREGETOVA & KOROLEVA, 1960; FAASCH, 1967; KRAUSS, 1970; ATHIAS-BINCHE & HABERSAAT, 1988; KARG, 1993; MAŠÁN, 2001, 2003; BAJERLEIN & BŁOSZYK, 2004). Analysis of the age and gender structure of these species unequivocally showed the dominance of those developmental stages that are phoretic. In the case of Macrochelidae they were females, and in the Uropodina and Parasitidae they were deutonymphs.

In the present study some cases of phoresy were observed, although the majority of the beetles which were used by mites could be described as occurring in bird nests rather than typically coprophilous. Examples of mite phoresy on typical nidicolous beetles found in bird nests are given by Mašán (1993, 1994, 2001), who found *Macrocheles penicilliger* (Berlese, 1904), *M. trogicolis* Mašán, 1994, *Uroseius trogicolis* Mašán, 1999, *U. infirmus*, *Metagynella paradoxa* Berlese, 1919 and *U. orbicularis* as phoretic on beetles of the genus *Trox* originating from nests of different bird species (mostly Falconiformes).

Cases of phoresy identified here, as well as the results of Mašán (1993, 2001), confirm that the dispersal of mites by other arthropods can be one of the methods of colonisation of bird nests by these mites. However, bearing in mind that the majority of mites identified in this study included species that also inhabit manure and compost, and the fact that phoresy was sporadic, and the carriers were not coprophagous beetles, the most obvious conclusion seems to be that it was not phoresy on coprophagous beetles that served as the basic mechanism of colonisation of white stork nests by mites. This is consistent with the observation that dung beetles and other representatives of the coprophagous fauna almost never colonise dung situated more than 2 m above the ground (Wallace & Tyndale-Biscoe, 1983; Vogt, 1988). The nests examined in the present study were always situated at least 3 m above ground.

Previous studies on the biology of the white stork show that its nest has a slight hollow in the central part in which eggs are deposited. The depression is covered by straw and a thin layer of other plant material. In addition, the adult birds often bring cow manure into the nest and use it for lining of the bottom of the nest. As shown by Tortosa & Villafuerte (1999), the presence of manure in the nest helps maintain an appropriate temperature for the chicks. These authors also observed that mature storks bring in manure a week before and for three weeks after hatching of the young. It was also noticed that the majority of the manure brought into the nest was fresh and only slightly dried on its surface. It is therefore reasonable to suggest that the main way by which mites colonise the nests of the white stork is through cattle manure. We intend to carry out further investigations to verify this hypothesis.

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