

Uropodine mite communities (Acari: Mesostigmata) in birds' nests in Poland

Jerzy Błoszyk^{1,2}, Daria Bajerlein³, Dariusz J. Gwiazdowicz⁴, Robert Bruce Halliday⁵ & Magdalena Dylewska³

¹ Dept. of General Zoology, Adam Mickiewicz University, Umultowska 89, PL-61-614 Poznań, Poland.

² Natural History Collections, Faculty of Biology, Adam Mickiewicz University, Umultowska 89, PL-61-614 Poznań, Poland.

³ Dept. of Animal Taxonomy and Ecology, Adam Mickiewicz University, Umultowska 89, PL-61-614 Poznań, Poland.

⁴ Dept. of Forest and Environment Protection, August Cieszkowski Agricultural University, Wojska Polskiego 71C, PL-60-625 Poznań, Poland.

⁵ CSIRO Entomology, GPO Box 1700, Canberra ACT 2601, Australia.

Corresponding author : J. Błoszyk, e-mail : bloszyk@amu.edu.pl

ABSTRACT. Knowledge of uropodine mite communities in birds' nests in Poland and surrounding areas is very poor. We therefore conducted a survey of 338 nests belonging to 36 bird species, and found that they contained 28 species of Uropodina. The most frequent species were *Trichouropoda orbicularis*, *Apionoseius infirmus*, *Uroobovella pyriformis*, *Uropoda orbicularis*, *Nenteria pandioni*, and *T. ovalis*. The dominant species were *T. orbicularis*, and *U. pyriformis*, which constituted up to 68% of the total specimens. The majority of species of these mites reproduce sexually. The species whose populations consist only of females, reproducing by thelytoky, are rather rare. There is distinct variation in the species composition and dominance structure of uropodine communities in the nests of particular bird species, which seems to be largely caused by differing types of nests. The most species-rich uropodine communities were found in large, perennial nests (white stork and raptors), the poorest ones (usually one or two species) occurred in the material collected from nest boxes.

KEY WORDS : mites, Uropodina, nesting biology, nest of birds, unstable microhabitats

INTRODUCTION

More than 70 years have passed since the first attempts to examine the relationship between birds and the invertebrate inhabitants of their nests, including mites (NORDBERG, 1936). Much of the research on this subject has been essentially faunistic in character (*e. g.* PATAN, 1969; ZUKOWSKI & BITKOWSKA, 1973; KACZMAREK, 1977, 1981a, 1981b, 1982a, 1982b, 1986; PHILIPS, 1981; CHMIELEWSKI, 1982; PHILIPS *et al.*, 1983; KACZMAREK & PAJKERT, 1987; AMBROS *et al.*, 1992; FAIN *et al.*, 1993; MAŠAN & ORSZAGHOVA, 1995; FENDA & PINOWSKI, 1997; KRUMPAL *et al.*, 1997; FENDA *et al.*, 1998; MADEJ & STAŃSKA, 1999; FENDA & SCHNIEROVA, 2004), or has discussed parasitic groups of mites (HAILINGER, 1987; PHILIPS, 2000). Few studies have involved mites of the suborder Uropodina occurring in birds' nests.

The first mention of the presence of Uropodina in nests may be found in NORDBERG'S (1936) work in Scandinavia. Nordberg found, among other groups of invertebrates, 12 species of Uropodina in the nests of 28 species of birds. PHILIPS (1981) found two specimens of Trachytidae in the nests of the Northern Goshawk *Accipiter gentilis*, and BŁOSZYK & OLSZANOWSKI (1985, 1986) recorded nine species of Uropodina in nest boxes and nests of eight species of passeriform birds. MAŠAN & KRIŠTOFIK (1993, 1995) recorded three species of Uropodina in the nests of the Sand Martin *Riparia riparia* and five species in the nests of the Penduline Tit *Remiz pen-*

dulinus. KRIŠTOFIK *et al.* (2001) found four species associated with the Reed Warblers *Acrocephalus arundinaceus* and *A. scirpaceus*, GWIAZDOWICZ *et al.* (1999, 2000) and GWIAZDOWICZ (2003) recorded 11 species in raptors' nests, and TRYJANOWSKI *et al.* (2001), found six species in the nests of the Red-Backed Shrike *Lanius collurio*. The state of knowledge of Uropodina in birds' nests in Europe is summarised in Table 1.

Due to this rather superficial knowledge of the uropodine fauna of nests, we conducted a survey to examine this microhabitat in more detail. We evaluated museum-based nest collections to investigate the effects of a number of factors on the mite communities of these nests in particular, the bird species present, nest size and durability; the building material and location of the nest; and the biology of the host.

MATERIAL AND METHODS

Bird nests and material from nest boxes were collected over a period of more than 40 years from a variety of regions and habitats in Poland. Whole nests were collected from passerines and from birds using nest boxes, while samples of 0.5 - 0.8 litres of material were collected from the large perennial nests of birds of prey (raptors), and the white stork. A total of 338 samples were collected from the nests and nest boxes of 36 species of birds. In 15 nests (4%) it was impossible to determine the species of the host (Table 2).

TABLE 1
List of the uropodine mites reported in birds' nests in Europe

Mite species	Bird species	Reference	Region
<i>Trachytes aegrota</i> (C.L. Koch, 1841)	Stock dove (<i>Columba oenas</i>), Starling (<i>Sturnus vulgaris</i>), House martin (<i>Delichon urbica</i>), Great tit (<i>Parus major</i>), Fieldfare (<i>Turdus pilaris</i>), Bullfinch (<i>Pyrrhula pyrrhula</i>), Carrion crow (<i>Corvus cornix</i>), Pied flycatcher (<i>Ficedula hypoleuca</i>)	Nordberg 1936	Scandinavia
	Blackbird (<i>Turdus merula</i>)	Błoszyk & Olszanowski 1985	Poland
	Dipper (<i>Cinclus cinclus</i>)	Fenda et al. 1997	Slovakia
	Greylag Goose (<i>Anser anser</i>)	Fenda et al. 1998	Slovakia
	Great spotted eagle (<i>Aquila clanga</i>)	Gwiazdowicz et al. 1999	Poland
<i>Apionoseius infirmus</i> (Berlese, 1887)	Starling (<i>Sturnus vulgaris</i>), Nuthatch (<i>Sitta europaea</i>)	Błoszyk & Olszanowski 1985	Poland
	Sand martin (<i>Riparia riparia</i>)	Masan & Kristofik 1993	Slovakia
	Tree sparrow (<i>Passer montanus</i>)	Fenda et al. 1998	
	Great spotted eagle (<i>Aquila clanga</i>), White-tailed Sea Eagle (<i>Haliaeetus albicilla</i>), Osprey (<i>Pandion haliaetus</i>)	Gwiazdowicz et al. 1999, 2000	Poland
<i>Polyaspinus cylindricus</i> Berlese, 1916	Red-backed shrike (<i>Lanius collurio</i>)	Tryjanowski et al. 2001	Poland
	Yellow bunting (<i>Emberiza citrinella</i>)	Fenda et al. 1998	Slovakia
<i>Uroseius hunzikeri</i> Schweizer, 1922	Sand martin (<i>Riparia riparia</i>)	Masan & Kristofik 1993	Slovakia
	Bee-eater (<i>Merops apiaster</i>)	Masan 2001	
<i>Nenteria breviunguiculata</i> (Willmann, 1949)	Mallard (<i>Anas platyrhynchos</i>), Collared Flycatcher (<i>Ficedula albicollis</i>),	Fenda et al. 1998	Slovakia
	Great reed warbler (<i>Acrocephalus arundinaceus</i>)	Kristofik et al. 2001	
<i>Nenteria floralis</i> Karg, 1986	Great spotted eagle (<i>Aquila clanga</i>)	Gwiazdowicz et al. 1999	Poland
<i>Nenteria hirschmanni</i> Wiśniewski, 1979	White-tailed Sea Eagle (<i>Haliaeetus albicilla</i>)	Gwiazdowicz et al. 2000	Poland
<i>Nenteria pandioni</i> Wiśniewski et Hirschmann, 1985	Penduline tit (<i>Remiz pendulinus</i>)	Masan & Kristofik 1995	Slovakia
	Great spotted eagle (<i>Aquila clanga</i>), White-tailed Sea Eagle (<i>Haliaeetus albicilla</i>), Osprey (<i>Pandion haliaetus</i>)	Gwiazdowicz et al. 1999, 2000	Poland
<i>Nenteria stylifera</i> (Berlese, 1904)	Great reed warbler (<i>Acrocephalus arundinaceus</i>)	Kristofik et al. 2001	Slovakia
<i>Trichouropoda longiovalis</i> Hirschmann et Zirngiebl-Nicol, 1961	Sand martin (<i>Riparia riparia</i>)	Masan & Kristofik 1993	Slovakia
	Great tit (<i>Parus major</i>)	Fenda et al. 1998	
	Great spotted eagle (<i>Aquila clanga</i>), White-tailed Sea Eagle (<i>Haliaeetus albicilla</i>), Osprey (<i>Pandion haliaetus</i>)	Gwiazdowicz et al. 1999, 2000	Poland
<i>Trichouropoda orbicularis</i> (C.L. Koch, 1839)	Blackbird (<i>Turdus merula</i>), Starling (<i>Sturnus vulgaris</i>), Tree sparrow (<i>Passer montanus</i>), Nuthatch (<i>Sitta europaea</i>), Pied flycatcher (<i>Ficedula hypoleuca</i>), Great tit (<i>Parus major</i>), Blue tit (<i>Parus caeruleus</i>), Redstart (<i>Phoenicurus phoenicurus</i>)	Błoszyk & Olszanowski 1985, Błoszyk & Olszanowski 1986	Poland
	Mallard (<i>Anas platyrhynchos</i>), Collared Flycatcher (<i>Ficedula albicollis</i>), Tree sparrow (<i>Passer montanus</i>), Song Thrush (<i>Turdus philomelos</i>)	Fenda et al. 1998	Slovakia
	Great reed warbler (<i>Acrocephalus arundinaceus</i>)	Kristofik et al. 2001	

TABLE 1
List of the uropodine mites reported in birds' nests in Europe

Mite species	Bird species	Reference	Region
<i>Trichouropoda ovalis</i> (C.L. Koch, 1839)	Pied flycatcher (<i>Ficedula hypoleuca</i>)	Nordberg 1936	Scandinavia
	Blackbird (<i>Turdus merula</i>)	Błoszyk & Olszanowski 1985	Poland
	Penduline tit (<i>Remiz pendulinus</i>)	Masan & Kristofik 1995	Slovakia
	Great reed warbler (<i>Acrocephalus arundinaceus</i>)	Kristofik et al. 2001	
	Sparrow (<i>Passer</i> sp.)	Fenda et al. 1998	Slovakia
	Mallard (<i>Anas platyrhynchos</i>)	Fenda & Pinowski 1997	Poland
	Great spotted eagle (<i>Aquila clanga</i>), White-tailed Sea Eagle (<i>Haliaeetus albicilla</i>), Osprey (<i>Pandion haliaetus</i>)	Gwiazdowicz et al. 1999, 2000	Poland
	Red-backed shrike (<i>Lanius collurio</i>)	Tryjanowski et al. 2001	
<i>Trichouropoda</i> cf. <i>tuberosa</i> (Hirschmann et Zirngiebl-Nicol, 1961)	Blackbird (<i>Turdus merula</i>)	Błoszyk & Olszanowski 1985	
	Tree sparrow (<i>Passer montanus</i>), Great tit (<i>Parus major</i>)	Fenda et al. 1998	Slovakia
<i>Dinychus carinatus</i> (Berlese, 1903)	Penduline tit (<i>Remiz pendulinus</i>)	Kristofik et al. 1993	Slovakia
<i>Dinychus inermis</i> (C.L. Koch, 1841)	Mallard (<i>Anas platyrhynchos</i>), Great Reed Warbler (<i>Acrocephalus arundinaceus</i>)	Fenda et al. 1998 Fenda & Schnierova 2004	
<i>Dinychus perforatus</i> Kramer, 1882	Great tit (<i>Parus major</i>)	Fenda et al. 1998	Slovakia
	Great spotted eagle (<i>Aquila clanga</i>)	Gwiazdowicz et al. 1999	Poland
<i>Urodiaspis panonica</i> (Willmann, 1952)	Blackbird (<i>Turdus merula</i>)	Błoszyk & Olszanowski 1985	Poland
<i>Urodiaspis tecta</i> (Kramer, 1876)	Common gull (<i>Larus canus</i>), Water pipit (<i>Anthus spinoletta</i>), Carrion crow (<i>Corvus cornix</i>), Goldcrest (<i>Regulus regulus</i>), Redstart (<i>Phoenicurus phoenicurus</i>)	Nordberg 1936	Scandinavia
	Blackbird (<i>Turdus merula</i>)	Błoszyk & Olszanowski 1985	Poland
	White-tailed Sea Eagle (<i>Haliaeetus albicilla</i>)	Gwiazdowicz et al. 2000	
<i>Uroobovella advena</i> (Trägårdh, 1912)	Magpie (<i>Pica pica</i>), Chaffinch (<i>Fringilla coelebs</i>), Fieldfare (<i>Turdus pilaris</i>), Song thrush (<i>Turdus philomelos</i>), House sparrow (<i>Passer domesticus</i>), Treecreeper (<i>Certhia familiaris</i>), Great tit (<i>Parus major</i>), House martin (<i>Delichon urbica</i>), Jackdaw (<i>Corvus monedula</i>), Black woodpecker (<i>Dryocopus major</i>)	Nordberg 1936	Scandinavia
<i>Uroobovella fimicola</i> (Berlese, 1903)	Penduline tit (<i>Remiz pendulinus</i>)	Masan & Kristofik 1995	Slovakia
<i>Uroobovella marginata</i> (C.L. Koch, 1839)	Eagle owl (<i>Bubo bubo</i>), Carrion crow (<i>Corvus cornix</i>), Swallow (<i>Hirundo rustica</i>), Jackdaw (<i>Corvus monedula</i>), Starling (<i>Sturnus vulgaris</i>), Great spotted woodpecker (<i>Dendrocopos major</i>), Stock dove (<i>Columba oenas</i>)	Nordberg 1936	Scandinavia
<i>Uroobovella nova</i> (Oudemans, 1902)	Northern Lapwing (<i>Vanellus vanellus</i>)	Fenda et al. 1998	Slovakia
<i>Uroobovella obovata</i> (Canestrini et Berlese, 1884)	Great spotted eagle (<i>Aquila clanga</i>)	Gwiazdowicz et al. 1999	Poland
<i>Uroobovella pyriformis</i> (Berlese, 1920)	Blue tit (<i>Parus caeruleus</i>)	Błoszyk & Olszanowski 1986	
<i>Discourella modesta</i> (Leonardi, 1899)	Red-backed shrike (<i>Lanius collurio</i>)	Tryjanowski et al. 2001	
<i>Uropoda hamulifera</i> Michael, 1894	Great spotted eagle (<i>Aquila clanga</i>)	Gwiazdowicz et al. 1999	
<i>Uropoda minima</i> (Kramer, 1882)	Blackbird (<i>Turdus merula</i>)	Błoszyk & Olszanowski 1985	
<i>Uropoda orbicularis</i> (Müller, 1776)	Penduline tit (<i>Remiz pendulinus</i>)	Masan & Kristofik 1995	Slovakia
	Mallard (<i>Anas platyrhynchos</i>)	Fenda et al. 1998	
	White-tailed Sea Eagle (<i>Haliaeetus albicilla</i>)	Gwiazdowicz et al. 2000	Poland
	Red-backed shrike (<i>Lanius collurio</i>)	Tryjanowski et al. 2001	

Mites were extracted from nests or nest material using Tullgren funnels and preserved in 75% ethanol. Temporary slide preparations were made in lactophenol in order to examine the specimens using a light microscope. When specimens were particularly valuable or difficult to identify, permanent preparations were made in polyvinyl alcohol. The specimens were deposited in the Invertebrate

Databank Collection in the Department of Animal Taxonomy and Ecology, Adam Mickiewicz University, Poznań and the Department of Forest and Environment Protection, August Cieszkowski Agricultural University, Poznań. The classification of birds used in this paper is in accordance with 'Checklist of Animals of Poland' (WIŚNIEWSKI, 1997).

TABLE 2
List of Uropodina mites found in the investigated nests of birds

Mite species / Bird species	White stork (<i>Ciconia ciconia</i>)	Black kite (<i>Milvus migrans</i>)	Red kite (<i>Milvus milvus</i>)	White-tailed Sea Eagle (<i>Haliaeetus albicilla</i>)	Marsh harrier (<i>Circus aeruginosus</i>)	Greater Spotted Eagle (<i>Aquila clanga</i>)	Osprey (<i>Pandion haliaetus</i>)	Rock dove (<i>Columba livia</i>) f. <i>domestica</i>	Tawny Owl (<i>Strix aluco</i>)	White wagtail (<i>Motacilla alba</i>)	Wren (<i>Troglodytes troglodytes</i>)	Redstart (<i>Phoenicurus ochruros</i>)	Blackbird (<i>Turdus merula</i>)	Goldcrest (<i>Regulus regulus</i>)	Pied flycatcher (<i>Ficedula hypoleuca</i>)	Blue tit (<i>Parus caeruleus</i>)	Great tit (<i>Parus major</i>)	Nuthatch (<i>Sitta europaea</i>)	Treecreeper (<i>Certhia</i> sp.)	Starling (<i>Sturnus vulgaris</i>)	Tree sparrow (<i>Passer montanus</i>)	Unknown	Numbers of mite specimens	Dominancy %	Frequency %	Maximum number of specimens in nest	
Type of nest (A-perennial nests; B – one-year nests, C – nest boxes)	A	A	A	A	B	A	A	B	B	B	B	C	B	B	C	C	C	B	B	C	B						
<i>Trachytes aegrota</i> (C.L. Koch, 1841)			+		+					+	+		+	+	+							+		19	0.32	2.3	6
<i>Polyaspinus cylindricus</i> (Berlese, 1916)								+																1	0.02	0.3	1
<i>Polyaspis patavinus</i> Berlese, 1881									+															2	0.03	0.3	2
<i>Apionoseius infirmus</i> (Berlese, 1887)	+			+	+	+		+					+						+	+				509	8.55	7.3	183
<i>Nenteria pandioni</i> Wiśniewski et Hirschmann, 1985	+	+	+	+		+	+																	551	9.25	5.5	386
<i>Nenteria floralis</i> Karg, 1986						+																		2	0.03	0.3	2
<i>Trichouropoda elegans</i> (Kramer, 1882)											+													7	0.12	0.3	7
<i>Trichouropoda karawatei</i> (Berlese, 1904)	+									+			+											93	1.56	0.8	85
<i>Trichouropoda obscurasimilis</i> (Hirschmann et Zirngiebl-Nicol, 1961)																						+		29	0.49	0.3	29
<i>Trichouropoda orbicularis</i> (C.L. Koch, 1839)	+											+	+		+	+	+	+		+	+	+		2708	45.48	20.1	630
<i>Trichouropoda ovalis</i> (C.L. Koch, 1839)	+			+	+	+		+	+			+	+	+	+									92	1.55	5.2	26
<i>Trichouropoda penicillata</i> (Greim, 1952)																					+			9	0.15	0.3	9
<i>Trichouropoda structura</i> (Hirschmann et Zirngiebl-Nicol, 1961)													+											1	0.02	0.3	1
<i>Trichouropoda</i> sp.	+																							11	0.18	0.5	10
<i>Dinychus arcuatus</i> (Trägårdh, 1922)											+													1	0.02	0.3	1
<i>Dinychus perforatus</i> (Kramer, 1882)					+					+			+	+										3	0.05	0.8	1
<i>Urodiaspis pannonica</i> (Willmann, 1952)													+											1	0.02	0.3	1
<i>Urodiaspis tecta</i> (Kramer, 1876)													+									+		4	0.07	0.5	3
<i>Uroobovella flagelliger</i> (Berlese, 1910)	+																							297	4.99	3.1	258

TABLE 2
List of Uropodina mites found in the investigated nests of birds

Mite species / Bird species	White stork (<i>Ciconia ciconia</i>)	Black kite (<i>Milvus migrans</i>)	Red kite (<i>Milvus milvus</i>)	White-tailed Sea Eagle (<i>Haliaeetus albicilla</i>)	Marsh harrier (<i>Circus aeruginosus</i>)	Greater Spotted Eagle (<i>Aquila clanga</i>)	Osprey (<i>Pandion haliaetus</i>)	Rock dove (<i>Columbia liva</i> f. <i>domestica</i>)	Tawny Owl (<i>Strix aluco</i>)	White wagtail (<i>Motacilla alba</i>)	Wren (<i>Troglodytes troglodytes</i>)	Redstart (<i>Phoenicurus ochruros</i>)	Blackbird (<i>Turdus merula</i>)	Goldcrest (<i>Regulus regulus</i>)	Pied flycatcher (<i>Ficedula hypoleuca</i>)	Blue tit (<i>Parus caeruleus</i>)	Great tit (<i>Parus major</i>)	Nuthatch (<i>Sitta europaea</i>)	Treecreeper (<i>Certhia</i> sp.)	Starling (<i>Sturnus vulgaris</i>)	Tree sparrow (<i>Passer montanus</i>)	Unknown	Numbers of mite specimens	Dominancy %	Frequency %	Maximum number of specimens in nest
<i>Uroobovella marginata</i> (C.L. Koch, 1839)	+			+																			9	0.15	1.6	3
<i>Uroobovella obovata</i> (Canestrini et Berlese, 1884)						+																	17	0.29	0.5	12
<i>Uroobovella pyriformis</i> (Berlese, 1920)	+										+						+						1381	23.19	7.0	546
<i>Uroobovella</i> sp.	+																						1	0.02	0.3	1
<i>Discourella cordieri</i> (Berlese, 1916)										+													3	0.05	0.3	3
<i>Uropoda hamulifera</i> Michael, 1894						+																	12	0.20	0.5	8
<i>Uropoda minima</i> (Kramer, 1882)	+												+										2	0.03	0.5	1
<i>Uropoda orbicularis</i> (Müller, 1776)	+	+			+					+													188	3.16	6.5	49
<i>Uropoda sellnicki</i> (Hirschmann et Zirngiebl-Nicol, 1969)											+												1	0.02	0.3	1
Total																							5954	100		
Number of collected nests	12	2	2	12	2	4	2	14	1	2	3	2	43	1	79	15	78	3	1	36	9	15				
<i>Numbers of mite species</i>	12	2	2	4	1	8	3	1	2	6	6	1	9	3	4	2	1	2	1	2	2	4				
Average numbers of mite specimens	74	4	24	16	3	157	10	>1	6	50	10	1	1	6	1	7	3	31	1	33	10	1				

RESULTS

Species composition and community structure of Uropodina in birds' nests

Among the 338 nests and boxes examined, 134 (39.6%) contained uropodine mites, belonging to 28 species (total 5954 specimens) (Table 2). No mites were found in the nests of the Buzzard (*Buteo buteo*), Lesser spotted eagle (*Aquila pomarina*), Kestrel (*Falco tinnunculus*), Peregrine falcon (*Falco peregrinus*), Barn owl (*Tyto alba*), Woodpecker (*Dendrocopus* sp.), Sand martin (*Riparia riparia*), Fieldfare (*Turdus pilaris*), Crested tit (*Parus cristatus*) and Coal tit (*Parus ater*). Single species of mites were found in the nests of the Marsh harrier (*Circus aeruginosus*), Rock dove (*Columbia liva* f. *domestica*), Redstart (*Phoenicurus ochruros*), Great tit (*Parus major*), and Treecreeper (*Certhia* sp.).

More than 77% of nests and boxes where Uropodina were recorded were occupied by two species at most, while the highest number of species of Uropodina found in a single nest was six. *Trichouropoda orbicularis* and *T.*

ovalis occupied the nests of the highest number of bird species, (nine). *Trachytes aegrota* and *Apionoseius infirmus* were found in the nests of eight species of birds, and *Nenteria pandioni* in six. *Dinychus perforatus* and *Uropoda orbicularis* were found in the nests of four bird species, while *Trichouropoda karawaiawi* and *Uroobovella pyriformis* in nests of three bird species. The remaining species of mites were recorded in the nests of one, or rarely two, bird species.

The most abundant species of mites were *Trichouropoda orbicularis* and *Uroobovella pyriformis*, which made up more than 68% of all specimens. *Nenteria pandioni*, *Apionoseius infirmus*, *Uroobovella flagelliger*, *Uropoda orbicularis*, *Trichouropoda karawaiawi* and *T. ovalis* were also quite numerous, while the remaining 20 species occurred only sparsely, and constituted 2% of the total mites. The most frequent species (i. e., the species that occurred in the highest proportion of nests), was *T. orbicularis* (Frequency F = 20.1%). Other frequently occurring species were *U. pyriformis* (F = 7.0%) and *A. infirmus* (F = 7.3%), *U. orbicularis* (F = 6.5%), *N. pandioni* (F = 5.5%), and *T. ovalis* (F = 5.2%).

Variability of mite communities across nest types

The collected samples came from nest boxes, one year nests, and perennial nests. The majority of uropodine species (19) were found in one year nests, and a minority (6) in nest boxes. Perennial nests were occupied by 17 mite species.

The dominance structure of particular nest types was diverse. One-year nests were dominated by *T. orbicularis*, whose specimens made up more than 82% of the total number of Uropodina found there. The second most abundant species was *T. karawaiewi*, approaching almost 8%. The low frequency of occurrence of particular mite species in one-year nests (below 10%) is quite remarkable. The average number of mite specimens in these nests was 15.

The communities of mites in perennial nests were dominated by two species, *U. pyriformis* and *T. orbicularis*,

which constituted 62% of all Uropodina found there. The frequency of occurrence of both species was also relatively high, more than 35%. The average number of specimens was much higher than in the other nest types, at more than 50 specimens per sample.

T. orbicularis was the most abundant species in the material collected from nest boxes, with more than 81% of the total number of specimens. However, the average number of specimens per sample was low (4.2), and it occurred in only 20% of the nests.

Variability of mite communities across bird species

Eight of the 31 bird species were represented by more than 10 nests (Table 2). Some examples of the relative abundance and frequency of occurrence of mites in the nests of these species are presented in Table 3.

TABLE 3
Abundance (D) and frequency (F) of mite species in birds' nests.

Mite species / Bird species	White stork (<i>Ciconia ciconia</i>)		White-tailed Sea Eagle (<i>Haliaeetus albicilla</i>)		Black bird (<i>Turdus merula</i>)		Starling (<i>Sturnus vulgaris</i>)	
	D%	F%	D%	F%	D%	F%	D%	F%
<i>A. infirmus</i>	0.92	26.32	45.69	50.00	27.03	2.33	8.79	13.89
<i>T. orbicularis</i>	31.97	73.68			13.51	2.33	91.21	41.97
<i>T. ovalis</i>	0.28	2.63	22.34	75.00	18.92	9.30		
<i>U. minima</i>	0.04	2.63			2.70	2.33		
<i>N. pandioni</i>	0.46	15.79	31.47	50.00				
<i>T. karawaiewi</i>	0.04	2.63			18.92	2.33		
<i>U. marginata</i>	0.28	13.16	0.51	8.33				
<i>U. pyriformis</i>	48.73	65.79						
<i>Trichouropoda sp.</i>	0.39	5.26						
<i>U. flagelliger</i>	10.50	31.58						
<i>Uroobovella sp.</i>	0.04	2.63						
<i>U. orbicularis</i>	6.36	55.26						
<i>T. structura</i>					2.70	2.33		
<i>U. tecta</i>					8.11	2.33		
<i>U. pannonica</i>					2.70	2.33		
<i>T. aegrota</i>					5.41	2.33		

The richest community of mites was found in the nests of the White Stork (*Ciconia ciconia*). The frequency of mites in these samples was very high, 89.47%. The number of specimens recorded in individual nest varied from 1 to 522 (average 74 ± 234). The mite species found most frequently in nests of the white stork were *T. orbicularis*, *U. pyriformis* and *U. orbicularis*. Less frequent were *U. flagelliger*, *A. infirmus* and *N. pandioni*. The most abundant species in White Stork nests were *U. pyriformis* and *T. orbicularis*, whose population comprised 81% of the total Uropodina. The next two most numerous species, *U. flagelliger* and *U. orbicularis*, together constituted about 17% of the specimens. The remaining species were sparse or occurred only once, and it is possible that they were in the nests by accident.

The second most diverse mite community came from the nests of the Blackbird *Turdus merula*, which hosted nine species. However, the occurrence of mites was sporadic. The frequency of Uropodina reached only 16.3%, and the number of specimens per nest varied from 1 to 15

(average $0.9 \text{ specimen} \pm 2.88$). *T. ovalis* was the most frequent species in the nests of the Blackbird but its frequency was very low, less than 10%. The occurrence of other species was accidental, and the mites in general were very sparse in this habitat. *A. infirmus*, *T. ovalis*, *T. karawaiewi*, and *T. orbicularis* were the most numerous species, with populations that totalled 78.4% of the overall number of specimens. The rest of species were infrequent or occurred only once.

Four species of Uropodina was found in 79 nest boxes of the Pied flycatcher *Ficedula hypoleuca*. The frequency of mites in these nests was very low, only 16.5%, and the number of specimens from the collected nests varied from 1 to 33 (average $0.9 \text{ specimen} \pm 4.02$).

Trichouropoda orbicularis is the only species of Uropodina that occurred in the nests built in nest boxes by the Great tit *Parus major*. Its frequency was less than 10% and the number of specimens in particular nests varied from 1 to 215 (average 3.1 ± 24.36).

A similar situation was found in nests of the Blue tit *P. caeruleus*, where only *T. orbicularis* is found, except for the rare occurrence of *U. pyriformis*. The frequency of Uropodina in the nests of this bird species was higher, more than 33%, and the number of specimens varied from 1 to 103 per nest (average 7.3 ± 26.5).

The mite community in the nests of the European Starling *Sturnus vulgaris* included two species, *T. orbicularis* and *A. infirmus*. The frequency of mites in these nests was greater than 40%, and the number of specimens per nest varied from 1 to 630 (average 24.53 ± 105.52). *T. orbicularis* occurred in some starling nests in large numbers. *A. infirmus* was rather more sporadic, with a maximum of 4 specimens in one nest.

The perennial nests of the White-tailed Sea Eagle *Haliaeetus albicilla* were occupied by only four species of Uropodina, much poorer than those of the white stork, which are similar in construction and size. Nonetheless, the frequency and the number of mites in eagle nests were very high. The number of specimens per sample varied from 1 to 51 (average 16.33 ± 17.13).

T. ovalis, *A. infirmus* and *N. pandioni* are the most characteristic species for of this raptor's nests. Specimens may be found in every second nest, or even more frequently. *A. infirmus* is the most numerous species in the White-tailed Sea Eagle nests, and it constitutes more than 45% of the total number of Uropodina. The maximum number of specimens of this species found in one sample was 40.

DISCUSSION

Thus far, 28 mite species of the suborder Uropodina have been recorded from birds' nests in the European literature (Table 1). These results come from only Scandinavia, Poland, and Slovakia, indicating that the rest of Europe is under-researched in this particular area.

Our results show that different mite communities occur in one-year nests, perennial nests, and nest boxes. This is presumably the result of variability of life history strategies as well as the dispersal ability of the particular mite species that occur in these three microhabitats. Many soil species were found in one year nests, mainly those built by *Turdus merula*, which coats the bottom and sides of its nests with soil.

Twelve out of the 28 Uropodina species found in our material have never been seen in nests before. The low frequency of common soil species in the nest communities is noteworthy, for example, *Trachytes aegrota*, *Uropoda minima*, and *Urodiaspis tecta*.

T. orbicularis and *A. infirmus* should be considered as typical nest-inhabiting (nidicolous) species. *Uroseius hunzikeri*, *U. marginata* and *U. flagelliger* are also nidicolous, previously recorded in the nests of birds and small mammals (BŁOSZYK, 1985; KARG, 1989; MAŠAN & KRIŠTOFIK, 1993; MAŠAN 2001).

Uroobovella pyriformis, the most numerous uropodine species represented in the nests of the White Stork, was previously known in Poland as a species that is numerous and frequent in tree holes (BŁOSZYK, 1990). It is a

phoretic species which disperses on flies (Diptera) (BŁOSZYK et al., 2003).

Another species that occurs in storks' nests, *U. orbicularis*, is associated with other kinds of unstable microhabitats. It spreads phoretically, and its deutonymphs can be found in masses on coprophagous beetles (BŁOSZYK et al., 2002; BAJERLEIN & BŁOSZYK, 2003, 2004).

Phoresy may be one of the primary means of dispersal for many uropodine species found in birds' nests. In addition to *U. pyriformis* and *U. orbicularis*, *N. pandioni*, *T. ovalis*, *U. marginata*, and *A. infirmus* are also spread phoretically. Typical soil species, such as *U. tecta*, *U. pannonica*, *U. minima*, and *T. aegrota*, get into nests accidentally, sometimes brought in with building material or nest lining, or sometimes directly on the bird's feathers. Typically, soil species do not occur in perennial nests, but phoretic species are common there. Uropodine communities in nest boxes consist mainly of species which spread phoretically. This may suggest that it is possible for them to colonise nest boxes only with the help of insects.

Contrary to most soil-dwelling Uropodina, such as *T. aegrota*, *Polyaspinus cylindricus*, *U. tecta*, or *U. pannonica*, which are entirely female, the Uropodina inhabiting birds' nests consist mainly of bisexual species. All-female species found in the nests are accidental and do not play an important role in the structure of the communities. This is consistent with observations of other authors (WALTER & LINDQUIST, 1995; BŁOSZYK et al., 2004) who suggested that apogamic species colonise unstable microhabitats rather unwillingly.

It is also possible that birds' nests may have served as refuges for many Uropodina species, for which local populations survived glaciation and subsequently spread to occupy other habitats after the glacial recession in Poland, by means of phoresy on insects or birds.

Currently, due to fragmentation and isolation of forest habitats, birds' nests might again be of crucial importance for the dispersal of Uropodina mites. Both phoresy and direct spread by birds, along with the nest building material or on feathers, may enable the migration of mites between isolated 'forest islands'. This could allow for the maintenance of species diversity and gene flow within many species of Uropodina.

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