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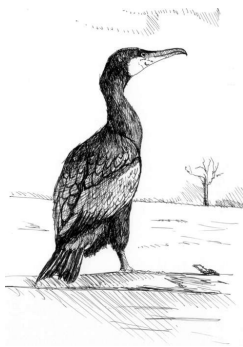
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Birds as a living environment for parasitic arthropods

Ptaki jako środowisko życia stawonogów pasożytniczych

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Abstrakt: Ptaki stanowią środowisko życia wielu grup stawonogów pasożytniczych spośród owadów i roztoczy, które odgrywają w ich życiu ogromną rolę, jako gatunki patogenne, wektory groźnych patogenów, ale też wpływają na zachowania, czy różne aspekty funkcjonowania i adaptacji środowiskowych, np. termoregulację. Charakteryzują się mnogością strategii adaptacyjnych przystosowujących je do zasiedlenia mikrośrodków w obrębie różnych gatunków żywicieli – mogą być pasożytami czasowymi, bytującymi w dalszym lub bliższym otoczeniu żywiciela, nawet w gnieździe lub pasożytami stacjonarnymi zasiedlającymi pióra, powierzchnię i wnętrze skóry, czy nawet jamę ciała i narządy wewnętrzne. Spośród owadów niewątpliwie najważniejsze będą specyficzne dla ptaków wszóły (*Phthiraptera*: *Ischnocera*, *Amblycera*), pchły *Siphonaptera*, pluskwiaki *Hemiptera*, czy muchówki *Diptera*; roztocze związane z ptakami należą do szeregu rodzin z rzędu *Ixodida* (*Argasidae*, *Ixodidae*), *Mesostigmata* (*Dermanyssidae*, *Rhinonyssidae*), *Prostigmata* (*Harpyrhynchidae*, *Syringophyllidae*), *Astigmata* (*Ascoucaridae*, *Cheylabidae*, *Cyrtoditidae*, *Dermoglyphidae*, *Epidermoptidae*, *Gabuciniidae*, *Knemidokoptidae*, *Kramerellidae*, *Laminosiptidae*, *Psoroptoididae*, *Pterolichidae*, *Turbinoptidae*, *Xolalgidae*).

Key words: *Aves*, parasitic arthropods

Introduction

Birds as parasite hosts provide a huge mosaic of habitats for several groups of parasitic arthropods adapted to life in specific types of such microhabitats. They are an excellent example showing correlation between diversity of parasites and variety of types of environments offered by organisms with a complex body structure (Combes 1999).

Parasitic arthropods of birds, which represent different groups of insects and mites, play in their life an important role as parasites can influence bird behaviour or various aspects of life and environmental adaptations, e.g. thermoregulation; they can be also highly pathogenic species or vectors of serious pathogens, causing significant loss in population size, particularly of immature individuals.

Birds respond to parasite nuisance by evolving particular behaviour called avoiding behaviour. This phenomenon was described, e.g. in a study on Great Tits *Parus major*, which were offered empty nest boxes and more attractive ones – with the nests already inside; still the tits preferred the boxes with the nests inside only if they were free of parasites and definitely avoided experimental boxes with the nests deliberately infested with hen fleas *Ceratophyllus gallinae* (Oppliger et al. 1994).

Parasitic arthropods of birds are an extremely varied group showing both taxonomic and ecological diversity. Chewing lice *Phthiraptera*, which are specific for birds are undoubtedly the most important among insects, but there are also fleas *Siphonaptera*, bugs *Hemiptera* and flies *Diptera*; mites associated with birds represent several families of the order *Ixodida* (*Argasidae*, *Ixodidae*), *Mesostigmata* (*Dermanyssidae*, *Rhinonyssidae*), *Prostigmata* (*Harpyrhyndidae*, *Syringophilidae*, *Trombiculidae*), *Astigmata* (*Ascouracaridae*, *Cheylabididae*, *Cytoditidae*, *Dermoglyphidae*, *Epidermoptidae*, *Gabuciniidae*, *Knemidokoptidae*, *Kramerellidae*, *Laminosioptidae*, *Psoroptoididae*, *Pterolichidae*, *Turbinoptidae*, *Xolalgidae*).

These parasitic arthropods are characterized by a multitude of adaptation strategies enabling them to inhabit microhabitats of different host species, which are the 1st order environment of parasites; while birds live in various habitats and those are the 2nd order environment of parasites. According to their ecology parasitic arthropods of birds can be temporary parasites, living in the vicinity or close to the host, even in bird nests, or stationary parasites living on the feathers, skin surface or inside the skin, and even in body cavities or internal organs.

Temporary parasites

Temporary parasites of birds, which periodically utilize their host (e.g. during feeding) are represented mainly by *Ixodida* (*Metastigmata*) – hard ticks *Ixodidae* (fig. 1d) and soft ticks *Argasidae* (fig. 1e), as well as by various groups of flies.

Ticks are obligatory parasites of high epidemiological significance. Several different factors influence their choice of living environment, like specific climate conditions, plant cover, soil characteristics, host availability, and according to ecological aspects non-nidicolous and nidicolous are distinguished. Among Polish fauna 19 species are indigenous, while 11 were introduced (4) or were observed on introduced vertebrates (7) (Siuda 2008); among ticks recorded in Poland exclusively ornithophilous are *Ixodes arboricola* (observed on different species of owls, swallows, tits, sparrows, as well as on the Nuthatch *Sitta europaea*, Redstart *Phoenicurus phoenicurus*, Starling *Sturnus vulgaris*), *I. lividus*

(on swallows), *I. caledonicus* (falcons, Starling *Sturnus vulgaris*, Hooded Crow *Corvus cornix*, Rock Sparrow *Petronia petronia*, Fulmar *Fulmarus glacialis*, Feral Pigeon *Columba livia*, Common Swift *Apus apus*, Alpine Swift *Tachymarptis melba*, Wheatear *Oenanthe oenanthe*, Jackdaw *Corvus monedula*, Common Raven *Corvus corax*), *I. frontalis* (Rook *Corvus frugilegus*, Marsh Warbler *Acrocephalus palustris*). While ornitophilous species for which birds are the main but not exclusive hosts, are *Argas polonicus* (Feral Pigeon *Columba livia* is a typical host), *A. reflexus* (most often Feral Pigeon *Columba livia*), *Ixodes festai* (Blackbird *Turdus merula*). Generally ornitophilous (juvenile stages feed on birds, while adult ones attack other vertebrates) are *I. persulcatus*, *I. ricinus* (recorded on 42 bird species in Poland), *Haemaphysalis punctata*, *H. concinna*, *Hyalomma marginatum* (this species was introduced to Poland by birds). Accidentally ornitophilous species (typical of other vertebrates, but sometimes found on birds) are *Ixodes trianguliceps*, *I. crenulatus*, *I. hexagonus*, *I. apronophorus*, *Dermacentor marginatus*, *D. riculatus*, *Rhipicephalus rossicus* (Siuda 1993).

Among ornitophilous species *Ixodes arboricola* there is a very interesting one – it is a nidicolous parasite mainly of hole-nesting birds. These ticks mostly attach to the base of the beak, around eyes and on eyelids, sometimes on other parts of head, while rarely on other parts of the body. Usually only single individuals are recorded on a host – an exception was reported from Denmark in the 30ties of the last century – 95 specimens of different stages were noted on one bird (Haarlov 1962). So far, their significance is not well-known. It is assumed that these ticks could spread ornithoses among birds (Lachmajer 1965). *I. lividus*, nidicolous parasite, is one of a few species highly host-specific – almost exclusively parasiting the Sand Martin *Riparia riparia*. In Poland this species was also recorded on the Barn Swallow *Hirundo rustica* (Kaczmarek 1982). It was found that ticks could spread, e.g. Russian spring-summer encephalitis virus or rickettsia of Q fever (Filippowa 1977).

Culicidae, *Carnidae* and *Hippoboscidae* are the most important bird parasites among flies. In mosquitoes (*Culicidae*), haematophagous parasites are adult females, for which blood is necessary for egg-production; adult forms also feed on other liquid food like flower nectar; they attack different species of vertebrates, while some species of mosquitoes prefer birds. *Carnidae* is a small, but specific family of flies (ca 90 species). The most well-known species is *Carnus hemapterus*, which lives in the nests of 20 bird species. Adult insects (females) when they find the nest – break their wings and spend the rest of their life in this nest. They feed on blood or skin excretions of the hosts. *Hippoboscidae* are recorded on all continents; in Poland 11 species were noted (Draber-Mońko 2007). Adult forms are ectoparasites, they feed on blood of warm-blooded vertebrates, $\frac{3}{4}$ of all known species are parasites of birds. Most species of *Hippoboscidae* have a broad range of hosts, e.g. *Ornithophila metallica* is a parasite of several hundreds of bird species (Borowiec 1984), while *Ornithomya biloba* lives mainly on the Barn Swallow. Keds or louse-flies (*Hippoboscidae*) could be vectors of many bacterial and viral diseases, e.g. *Pseudolynchia canariensis* is

an important vector of viroses in pigeons. Moreover these flies could carry some chewing lice and ticks, like e.g. *Ornithomya avicularia* (Walter 1989), which is the most common representative of this family in Poland.

Summarising Diptera are recorded in 27% of bird species in Poland; they play an important role in transmission of pathogens. They can transmit, e.g. highly parasitic hemospororids, which are parasites of blood cells and other body tissues of birds.

Nest parasitofauna

Parasitic arthropods' fauna of bird nests includes fleas, cimicid bugs (*Hemiptera: Cimicidae*), mites – nidicolous ticks, as well as Chicken Mite (*Dermanyssidae*).

Fleas (Siphonaptera) (fig. 1a) are holometabolic insects; adult stages (imagines) are haematophagous parasites, while larvae are saprophagous and live in a nest of a host. They are mainly parasites of mammals – only ca 6% of species are parasites of birds (seabirds and passerines); in Poland this category includes oligoxenous or polixenous fleas of the family *Ceratophyllidae*, e.g. *Dasypsyllus gallinulae* and 12 species of the genus *Ceratophyllus* (Bartkowska 2007).

Cimicid bugs (*Cimicidae*) are ectoparasites feeding exclusively on blood of warm-blooded animals, therefore also birds. After they finish feeding, they leave the host and hide in its nest or find another shelter in the vicinity. In Poland several species of cimicid bugs were recorded, however they are quite rare. Bird parasites include *Cimex columbarius* that attacks hole-nesting pigeons (in Poland: the Stock Dove *Columba oenas*). In the nest of the House Martin *Delichon urbicum* and rarely in other species one can find *Oeciacus hirundinalis*. This bug waits through the non-breeding period in the nest of the host, and feeds during its nesting period (Dolling 1991).

The Chicken Mite (*Dermanyssus gallinae*) is one of the most well-known bird parasites among tiny mites. This haematophagous mite lives and develops in the nest of the host (or in its vicinity) and attacks the host usually during the night. It is mainly a parasite of the poultry; however during mass occurrence it can also attack domestic mammals and men causing itching rash.

Obviously abundance of parasites in bird nests increases frequency and intensity of ectoparasite infestation. When nests are used intensively, every year, the number of infested chicks is higher – this was shown in a study on the tick *Ixodes uriae* infestation of the Kittiwake *Rissa tridactyla* (Danchin 1992). Most probably this phenomenon also has an influence on the escape of the chicks from the nesting place – the higher infestation, the shorter time they spend in the nest (Brown & Brown 1992). The nest parasites' pressure can be so strong that birds can abandon the nest or change the place – this is well-documented by the studies on behaviour of brown pelicans (King et al. 1977), Barn Swallows *Hirundo rustica*, whose nests were infested with ticks or hemipterans *Oeciacus vicarius* (Loye & Carroll 1991, Loye & Regan 1991, Kopachena et al. 2000).

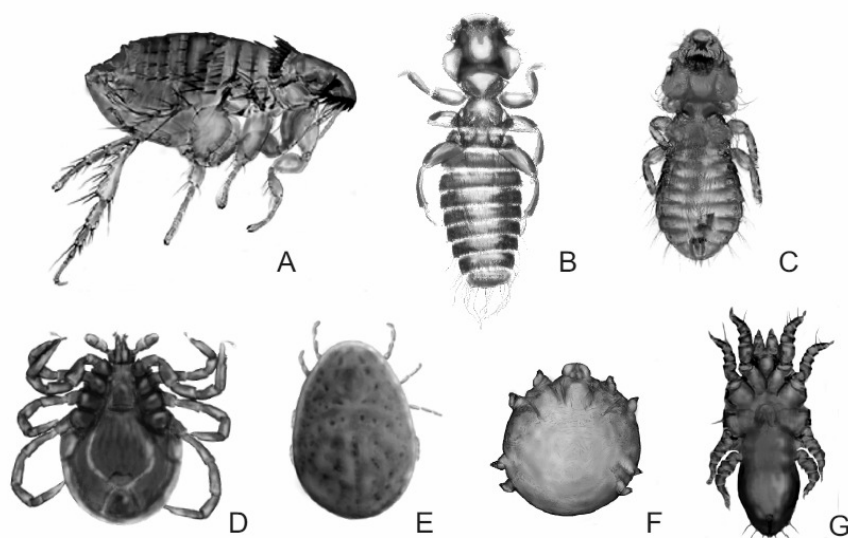


Figure 1. Parasitic arthropods of birds. A – *Siphonaptera* – *Ceratoophyllus gallinae*, B – *Amblycera* – *Colpocephalum zebra*, C – *Ischnocera* – *Neophilopterus incompletus*, D – *Ixodidae* – *Ixodes ricinus*, E – *Argasidae* – *Argas reflexus*, F – *Knemidocoptidae* – *Knemidocoptes pilae*, G – *Pterolichidae* – *Grallobia* sp.

Rycina 1. Stawonogi pasożytnicze ptaków.

Similarly Cliff Swallows *Hirundo pyrrhonota* after return migration, avoid the nests infested with parasites – they choose clean nests or build new ones (Brown & Brown 1986).

Feather parasites

This category includes mainly stationary parasites, i.e. some species of chewing lice (*Phthiraptera*: *Ischnocera*, *Amblycera*) and so called feather mites. Chewing lice are small, hemimetabolic, secondarily wingless insects characterized by usually high host specificity; they feed mainly on keratin substances of the feathers and hair of their hosts, sometimes also on desquamated epidermis, and rarely on blood or pus. All developmental stages live on the hosts, they cling to the feathers of the host, and usually immature stages live in the same environment and feed like imago; they rarely migrate to other environments, e.g. lice of the genus *Piagiatella* inhabit the throat pouch of pelicans. Frequently several species of chewing lice are recorded on birds – quite often even several specific species of *Amblycera* (fig. 1b) and *Ischnocera* (fig. 1c) are observed on a single host species (Złotorzycka & Modrzejewska 1988, Złotorzycka 1994, Fryderyk & Kadulski 2006). Moreover lice often show host site specificity – different species prefer certain parts of the body of the host. For example, *Amblycera* usually occur directly on the skin or close to the base of the feathers, hair, while

Ichnocera prefer the head area of birds, and more mobile species of this group (large and slender) can be also observed on neck, back and even wings, where they cling to the barbs and feed on the remiges. As a rule lice are absent on the feathered parts of legs and rectrices. Distribution of parasites can depend on, e.g. hair structure, access to blood vessels, parasite competition or self-cleaning of a host. Also external environment, to some extent, can influence their distribution by, e.g. insolation or heavy rain (Kadulski 2007, Izdebska & Fryderyk 2008).

Chewing lice exert varied influence on birds, particularly on the condition of the hosts. The studies on chewing lice of several bird species showed that feeding lice damaged the skin surface and feathers causing their breakage, which could impair thermoregulation and consequently influence the host condition, moreover undoubtedly it is a stress factor; a damage of the remiges could possibly impair the flight of a bird as well. It was observed that healthy birds avoided contact with individuals heavily infested with lice; e.g. Clayton (1990) showed that females of the Rock Dove *Columba livia*, when choosing a partner among males of similar morphological characters, preferred healthy individuals, and rejected those infested with lice (*Columbicola columbae* and *Campanulotes bidentatus*). According to this author, the presence of lice influenced thermoregulation, and consequently (though indirectly) courtship display of birds; presence of parasites suggested not only poorer condition or resistance of a given partner – infestation could also have detrimental effects on females lowering their fertility. Birds host many lineages of parasitic mites, but the greatest diversity is shown by the three superfamilies of astigmatan feather mites: *Analgoidea*, *Pterolichoidea*, and *Freyanoidea*. Mites of this grouping have colonized all parts of the avian integument from their ancestral nidicolous habitat. Feather mites are a large group representing the order *Astigmata* (with about 440 genera and over 2000 species); they live exclusively on the body surface, mostly on or in the feathers, but occasionally on or in the skin (Dabert et al. 2001). They feed on corneous mass, desquamated epidermis and uropygial oil (Boczek & Błaszak 2005). Although some feather mites are true parasites, causing feather damages (e.g., *Ascouracaridae*) or skin lesions (e.g., some *Epidermoptidae*), most are commensals. Their entire life cycle takes place on the host body (Dabert et al. 2001). Abundance and location of vane-dwelling mites is affected by season, temperature, light, humidity, and host body condition; transmission between hosts usually depends on host body contact. For example the family *Pterolichidae* (fig. 1g) with about 400 species (in Poland – 9 species) is the largest and most diverse taxon among the feather mites. Representatives of this family are found on diverse non-passerine birds, mostly on terrestrial ones. Among hosts of these mites are also birds-of-prey *Falconiformes*. However, the main part of falconiform acarofauna are numerous members of the family *Gabuciniidae* (Dabert & Labrzycka 2009). Mites of the family *Syringophilidae* (*Prostigmata*) can also live inside feather calamus and rachis. All species of syringophilid mites (about 140 described species) are obligatory and permanent ectoparasites of birds. They live and reproduce within the quills of the primaries, secondaries,

tail-feathers, coverts and occasionally in body feathers or only inside body feathers (Skoracki & Glogowska 2008).

Bird skin parasites

Bird skin is populated by stationary parasitic mites representing several different groups. *Syringophyllidae* (*Prostigmata*) live on the skin surface as well as inside feather calamus and rachis; they feed on, e.g. excretions surrounding feathers, consequently weakening them and finally causing their falling out. Mites of the families *Dermoglyphidae*, *Epidermoptidae* (*Astigmata*) are skin parasites of many bird orders, they cause the falling out of feathers. Representatives of *Laminosioptidae* and *Knemocoptidae* (*Astigmata*) (fig. 1f) are parasites living in epidermis and forming characteristic cysts.

Endoparasites

Bird endoparasites include mites of the family *Rhinonyssidae* (*Mesostigmata*), which are parasites of respiratory tract; a similar preference for parasiting respiratory tract is also found in mites representing the families *Turbinoptidae* and *Cytoditidae* (*Astigmata*), of which the genus *Cytonyssus* occurs in the nasal cavity of cranes *Gruidae*, while *Cytodites* in the air sacs and lungs of *Galliformes*, cuckoos *Cuculidae*, doves and pigeons *Columbidae*, passerines *Passeriformes* and parrots *Psittacidae*.

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