A comparative study of the arthropod fauna in stork, barn swallow and common pigeon nests

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Abstract

An analysis was conducted on the arthropod fauna collected from stork, swallow, and pigeon nests during summer 2018 in three regions of north-eastern Algeria (Guelma, El-Tarf, and Annaba). A total of 40 nests was examined, of which 58% were infested with arthropods. Arthropods were less abundant and species rich in swallow nests than in pigeon or stork nests, where a greater dominance of mesostigmatic mites (78.71% and 72.41%, respectively) was found. *Dermanyssus gallinae* was the most abundant (33.05%) and most frequent (73.33%) mesostigmatic mite in pigeon nests, while *Uropodina* mites were dominant (41.37%) in white stork nests with a frequency of 76.92% of the nests analysed. In swallow nests, the following arthropods were found: *Psocodea, Hemiptera, Hymenoptera* and *Coleoptera* belonging to the class *Insecta* and *Isopoda* belonging to the class *Malacostraca*. This is the first comparative survey of arthropods occupying the nests of these bird species in northern Algeria. It is anticipated that these data, that highlight the richness of the arthropod fauna in the nests of these bird species, will motivate further research aimed at characterising the arthropod community in different bird nests and determining the nature of the relationships between them.

Key words: *arthropodofauna; bird nest; white stork; barn swallow; rock pigeon*

Introduction

Bird nests are specialised structures with the primary function of accommodating eggs and fledglings by offering favourable conditions (Deeming and Mainwaring, 2015). They also represent an important habitat for several groups of parasitic arthropods where they find shelter and food. A micro-ecosystem is created in many bird nests, involving highly variable interactions between birds and nesting arthropods, and is characterised by a multitude of adaptive strategies that allow invertebrates to inhabit the microenvironments of different host species.

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Furthermore, several factors control the abundance and diversity of arthropods in bird nests such as nest-building materials, geographical location, nest size, and host species (Fryderyk and Izdebska, 2009; Mainwaring et al., 2014; Boyes and Lewis, 2018; Carvallo et al., 2020). Because information on nest arthropods is scarce, there are even fewer studies on the drivers of nest arthropod diversity. We characterized arthropod diversity in cup- and dome-shaped nests along a 130 km latitudinal gradient in the mediterranean-type region of Central Chile and, we assessed whether nest dimensions and climatic factors explain richness (alpha-diversity).

Parasitic arthropods of bird nests constitute an extremely varied group that exhibit different ecological functions. These arthropods can be detritivorous, saprophagous or predatory. Some are strictly confined to bird nests, taking advantage of the favorable habitat without affecting birds, while other species of external parasites can be highly pathogenic or vectors of severe pathogens, harming their hosts (Goodenough and Hart, 2012; Roy et al., 2013; Deeming and Mainwaring, 2015; López-Rull and García, 2015).

Most research on bird nests has been focused on ectoparasites and their impacts on avian fitness, productivity, and population dynamics (Goodenough and Hart, 2012). It is important to note that parasites represent only a small proportion of the arthropod community present in birds' nests, whereas the whole arthropod fauna of birds' nests is much more diverse. However, the diversity and ecological roles of nest arthropods have been neglected in many studies (Proctor, 2003; Mainwaring et al., 2014), especially as this fauna may exhibit large variations among different bird species. All these considerations led us to conduct this study by expanding our approach to arthropods in the bird's nest ecosystem.

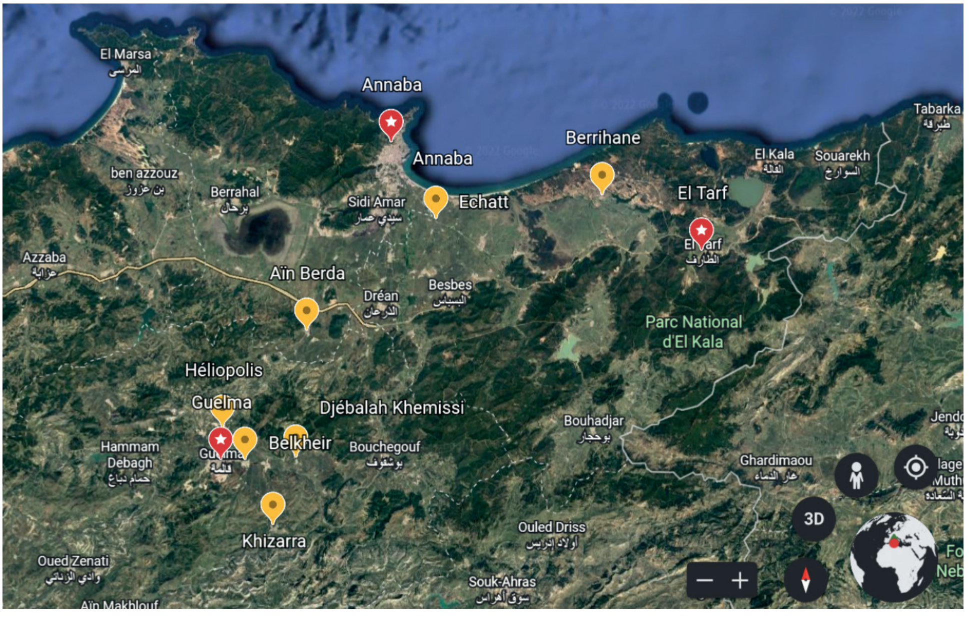

Figure 1. Map with tagged sampling locations

The aim of this study was to compare the abundance and species richness of arthropods in the nests of white stork (*Ciconia ciconia*: Pelecaniformes, *Ciconidae*), barn swallow (*Hirundo rustica*: Passeriformes, *Hirundinidae*), and rock pigeon (*Columba livia*: Columbiforme, *Columbidae*).

Material and methods

Study areas and arthropod collection

In accordance with the national protection regulations (executive decree 12-235 of May 24, 2012) relating to the protection and conservation of avifauna, this study was conducted after obtaining authorisation from the environmental protection departments of all three regions of study.

During summer 2018, arthropods were collected from a total of 40 bird nests: 12 swallow, 15 pigeon, and 13 stork nests. These nest samples were collected from seven sites in three provinces: El Taref, Annaba and Guelma (Figure 1). All nests were taken from supports located near human dwellings, hence the importance of identifying the arthropods they contain. In the spring, some swallow nests present in rural buildings were monitored, and nests not occupied during the entire breeding period were collected. These nests were constructed of mud pellets containing grass stalks and feathers, they were fixed at the junction of two walls at an inner corner. Their interiors were filled with feathers, grasses and dead bird carcasses. Pigeon nests built more than three months ago on the roofs of the houses were shaken to recover part of the building materials before being re-installed.

For storks, we targeted easily accessible nests found in trees (at a height of about four meters). In addition, because of the very large size of the stork nests, much of the twigs, leaves and litter available at the bottom of the nest (about 7–8 kg per nest) were systematically removed.

None of the examined nests contained eggs. However, young birds were occasionally observed in pigeon and stork nests.

The nest material was transported in sealed plastic bags to the parasitology laboratory of the Chadli Benjedid University of El-Tarf, where it was placed in a Berlese funnel (De Lillo, 2001) for a minimum of 48 hours. Also, the plastic bags containing the nest material were stored in the refrigerator to decrease arthropod activity. Collected arthropods were stored in labelled tubes containing 70% ethanol.

All collected arthropods were identified (Leng and Mutchler, 1920; Snodgrass, 1935; Krantz, 1971; Herring, 1976; Hyatt, 1980; Smithers, 1990; Masan, 1999; Mackay, 2002; Kalúz and Fenda, 2005; Bal and Özkan, 2006; Moraza et al., 2009; Thyssen, 2010; Di Palma et al., 2012; Keum et al., 2016; Mackay and Shultz, 2018; Gomes-Almeida and Pepato, 2021). Mites were transferred to slides using Hoyer's mounting medium (Faraji and Bakker, 2008) and examined under a light microscope (Leica microsystems). All insects were identified and photographed using a binocular zoom stereomicroscope (Zeiss Axio Zoom.v16).

The arthropod material was analysed using the following methods: dominance (ratio between the number of individuals of a given species compared to the number of all individuals in the study, as a percentage), frequency (percentage of nests in which the species occurred), and abundance (ratio between the number of arthropods and the number of examined nests) (Bloszyk et al., 2005).

Table 1. Parasites detected in the present study and their prevalence (D: Dominance; F: Frequency)

Arthropods			Swallow-nests		Pigeon-nests		Stork-nests	
Order	Family	Species	D%	F%	D%	F%	D%	F%
Ixodida	*Ixodidae*		/	/	/	/	1 (0.38%)	1 (7.69%)
Mesostigmata	*Dermanyssidae*	-*Dermanyssus gallinae*			118 (33.05%)	11 (73.33%)		/
	Macronyssidae	-*Ophionussus sp.*	/	/	/	/	10 (3.83%)	2 (15.38%)
	Laelapidae	-*Hypoaspis aculeifer.*	/	/	6 (1.68%)	2 (13.33%)	7 (2.68%)	2 (15.38%)
	Ascidae	-*Asca sp.*	/	/	7 (1.96%)	1 (6.66%)	3 (1.14%)	1 (7.69%)
	Parasitidae	-*Parasitus beta*			5 (1.40%)	1 (6.66%)	7 (2.68%)	2 (15.38%)
		-*Parasitus fucorum.*	/	/	6 (1.68%)	1 (6.66%)	2 (0.76%)	1 (7.69%)
		-*Pergamasus sp.*			5 (1.40%)	2 (13.33%)	3 (1.14%)	1 (7.69%)
	Uropodidae		/	/	(27.73%)	6 (40%)	(41.37%)	10 (76.92%)
		-*Uropoda orbicularis*	/	/	51 (14.28%)	6 (40%)	45 (17.24%)	8 (61.53%)
		-*Uroobovella pyriformis*	/	/	48 (13.44%)	4 (26.66%)	63 (24.13%)	7 (53.84%)
	Trematuridae	-*Trichouropoda ovalis.*	/	/	35 (9.80%)	4 (26.66%)	48 (18.39%)	5 (38.46%)
Prostigmata	*Trombididae*		/	/	5 (1.40%)	1 (6.66%)	/	/
Araneae	*Segestriidae*		1 (7.69%)	1 (8.33%)	8 (2.24%)	4 (26.66%)	/	/
Pseudoscorpiones	*Chernetidae*		6 (5.40%)	4 (33.33%)	9 (2.52%)	5 (33.33%)	5 (1.91%)	3 (23.07%)
Psocoptera	*Trogiidae*		3 (2.70%)	1 (8.33%)	21 (5.88%)	5 (33.33%)	7 (2.68%)	2 (15.38%)
		-*Lepinotus reticulatus*	/	/	4 (1.12%)	1 (6.66%)	/	/
		-*Trogium pulsatorium*	3 (2.70%)	1 (8.33%)	17 (4.76%)	4 (26.66%)	7 (2.68%)	2 (15.38%)
Hemiptera	*Lyctocoridae*	-*Lyctocoris campestris.*	11 (9.90%)	3 (25%)	13 (3.64%)	3 (20%)	9 (3.44%)	3 (23.07%)
Hymenoptera	*Formicidae*		3 (2.70%)	1 (8.33%)	5 (1.40%)	2 (13.33%)	7 (2.68%)	3 (23.07%)
Isopoda	*Armadillidiidae*	- *Armadillidium vulgare.*	7 (6.30%)	2 (16.66%)	5 (1.40%)	2 (13.33%)	8 (3.06%)	3 (23.07)
Coleoptera	*Scarabaeidae*	- *Aphodiinae*	/	/	2 (0.56%)	1 (6.66%)	/	/
	Tenebrionidae		10 (9%)	3 (25%)	8 (2.24%)	2 (13.33%)	19 (7.27%)	5 (38.46%)
			2 (1.80%)	1 (8.33%)	8 (2.24%)	2 (13.33%)	12 (4.59%)	5 (38.46%)
		-*Nalassus dryadophilus*	8 (7.20%)	2 (16.66%)	/	/	7 (2.68%)	2 (15.38%)
	Staphylinidae	-*Alphitobius diaperinus*	2 (1.80%)	1 (8.33%)	/	/	5 (1.91%)	2 (15.38%)
	Histeridae		/	/	/	/	2 (0.76%)	1 (7.69%)
	Dermestidae		/	/	/	/	10 (3.83%)	2 (15.38%)
			68 (61.26%)	6 (50%)	/	/	/	/
		- *Anthrenus amandae*						
		-*Larvae*						
	Total		111	12	357	15	261	13

Results

Of the 40 nests examined, 85% (34/40 = arthropod prevalence) contained arthropods. Only some of the swallow nests were without arthropods. A total of 729 specimens belonging to 10 taxonomic orders were collected (Table 1), representing an overall parasite load of around 18.2. Arthropod communities were more abundant and species rich in pigeon and stork nests than in swallow nests, with a parasite load of 23.8 (357 arthropods/15 pigeon nests) and 20.07 (261 arthropods/13 stork nests) vs 9.25 (111 arthropods/12 swallow nests).

Pigeon and stork nests were more frequently inhabited by mesostigmatic mites (78.71% and 72.41% respectively), which was also the highest species diversity. This group included hematophagous, predatory, and phoretic mites belonging to the families: *Dermanyssidae, Laelapidae, Ascidae, Parasitidae, Uropodidae*, and *Trematuridae*.

The haematophagous mite *Dermanyssus gallinae* (De Geer, 1778) (Figure 2) was recurrently collected in pigeon nests and was the most abundant mesostigmatic mite at a rate of 33.05%. This mite was isolated from 73.33% of pigeon nests. Similarly, Uropodid mites (Figure 2) included two species: *Uropoda orbicularis* (O.F. Mÿller, 1776) and *Uroobovella pyriformis* (Berlese, 1920), with a dominance of 27.73% and 41.37% in pigeon and stork nests respectively.

More than 26% of pigeon nests and 38% of stork nests were inhabited by *Trichouropoda ovalis* (Koch, 1839), while the highest abundance was observed in the stork nests. The other identified mites

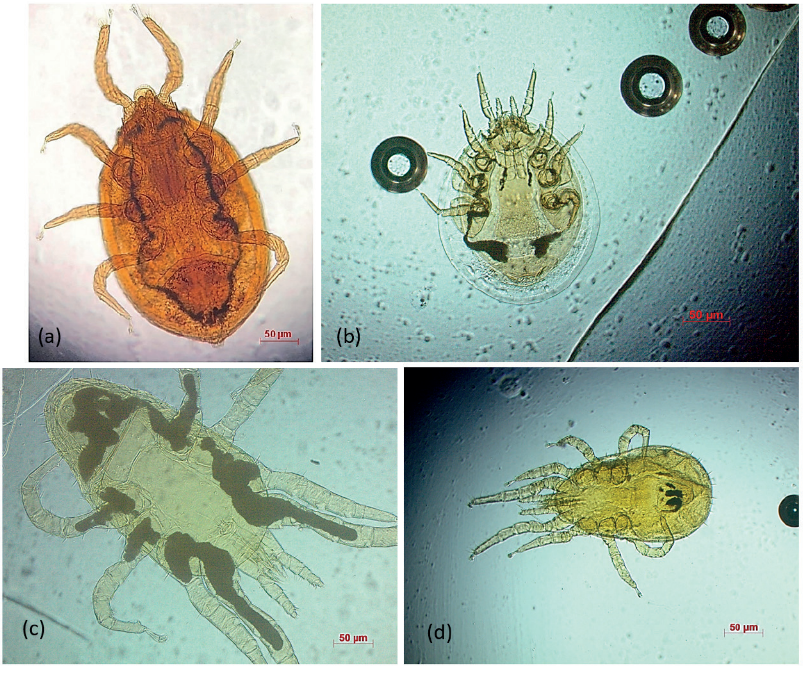

Figure 2. (a) *Uroobovella pyriformis*; (b) *Uropoda orbicularis*; (c) *Ophionyssus* sp.; (d) *Dermanyssus gallinae*

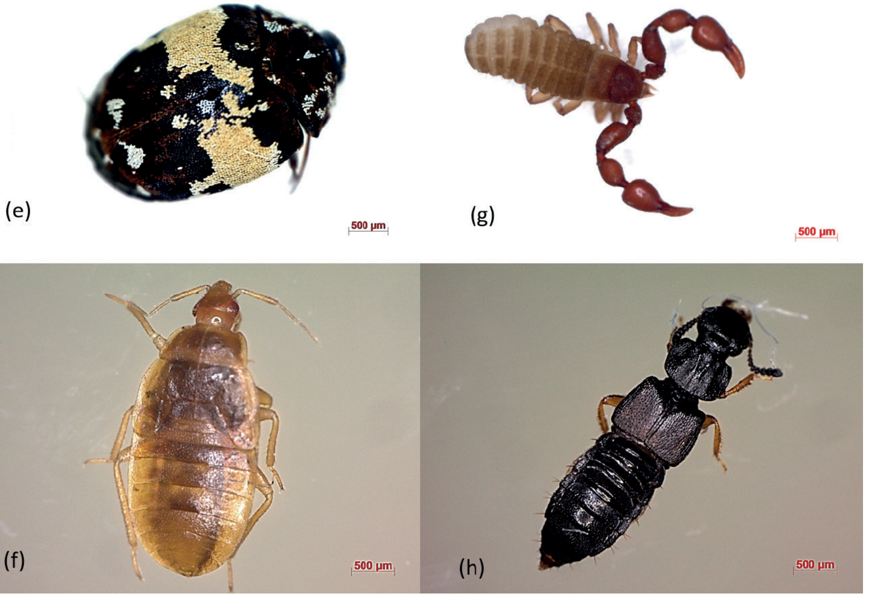

Figure 3. (e) *Anthrenus amandae*; (f) *Lyctocoris campestris*; (g) Pseudoscorpione; (h) Rove beetle (Staphylinidae)

showed a low dominance and their occurrence was occasional (Table 1).

The arthropods present in the various examined bird nests belonged to the Insect (*Psocodea Hemiptera*, *Hymenoptera*, and *Coleoptera*) group and Malacostraca group (*Isopoda*). Most of these insects were identified at the species level. *Lepinotus reticulatus* (Enderlein, 1905) was isolated from a pigeon nest. Insect species i.e., *Trogium pulsatorium* (Linnaeus, 1758), *Lyctocoris campestris* (Fabricius, 1794) (Figure 3), *Formicoidea*, and Isopoda species, *Armadillidium vulgare* (Latreille, 1804) were found in all three host species.

The largest number of specimens belonged to the order of Coleoptera, with 120 specimens isolated, belonging to five families: *Scarabaeidae (Aphodiinae), Tenebrionidae, Staphylinidae* (Figure 3), *Histeridae and Dermestidae*. Unfortunately, the *Dermestidae,* representing 61.26% of the arthropod community colonizing swallow nests, were mainly *Dermestidae* larvae. These larvae had a frequency of 50%.

Also, we noted the presence of the orders *Oribatida, Araneae* and *Pseudoscorpiones* (Figure 3). In particular, these three orders of arthropods were recorded in pigeon nests. The total numbers of identified specimens per taxonomic group are summarised below (Table 1).

Discussion

This study aimed to compile a checklist of the arthropods present in the nests of three bird species from northeastern Algeria: rock pigeon (*Columba livia*), white stork (*Ciconia ciconia*) and barn swallow (*Hirundo rustica*) and to compare the diversity of the arthropod fauna among these bird species. Although similar research has focused exclusively on arthropods in the stork nest ecosystem in the El Tarf province (Mammeria, 2014), this study highlights the diversity of the arthropod fauna in both stork nests and other bird nests, displaying the richness of this fauna in the three study regions in northeast Algeria. This is based on the assumption that abundance and species diversity are strongly influenced by several factors, e.g., nest building materials, nest size, and host behaviour. Therefore, the fauna colonising the nests of the three bird species studied would be expected to differ.

Through this study, we recorded the presence of arthropod-free/poor/rich nests. We determined 10 taxonomic orders; some specimens could not be identifies to the species level due to alterations of the body or immature stage, and thus the diversity analysis of arthropods remains incomplete.

The low abundance and diversity in barn swallow nests were unexpected, as previous studies have reported contrasting results. Here, all swallow nests were absolutely free of mites, in contrast to Babbitt and Burtt (1991) who identified blood-sucking, predatory and detritivorous mites in tree swallow nests. Generally, barn swallows are faithful to their nesting sites throughout their lives.

When they return in the spring, they reoccupy the nests used the previous year (Møller, 1990). However, heavy use of the nests each year increases their parasite abundance and the nest parasite pressure can be so strong that birds can abandon the nest or change locations. This is well documented by the studies on behaviour of brown pelicans and barn swallows, whose nests were infested with ticks or hemipterans (Fryderyk and Izdebska, 2009). Also, Barclay, (1988) Møller (1993, 2000) found that barn swallows avoid using old nests containing haematophagous mites and in the same way, cliff swallows (*Hirundo pyrrhonota*), after their return, choose clean nests or build new ones (Brown and Brown, 1986).

Similarly, there are many reasons why barn swallows abandon their nests, including: death of birds during migration or in their wintering area, or due to a predator (cat, birds of prey) or if the area has become too poor in insects (increasing urbanisation, chemicals sprayed on crops) (Gorenzel and Salmon, 1994; Jenni-Eiermann et al., 2008), which may explain the presence of these unoccupied nests during the breeding season.

In the nests of rock pigeons, mites were very numerous and diversified, and included the presence of haematophagous, predatory, phoretic mites with a dominance of the species *D. gallinae*, a ubiquitous parasite of domestic fowl also commonly found on wild birds. When these hosts are not available, the red poultry mite (*D. gallinae*) bites mammals (Moroni et al., 2021). In addition, this mite is capable of transmitting viral, rickettsial and protozoan diseases to birds (Clayton and Tompkins, 1995). The species was recorded in 73.33% of the nests studied. In the study by Šustek et al. (1992), the blood-sucking species *D. gallinae* was reported as the most abundant mite in bird's nests. This mite has a short generation time and can rapidly build huge populations. A very large number can be present in a single nest (Richner and Heeb, 1995). The presence of this mite in rock pigeon nests has been reported in several studies. Also, it has been recorded in the nests of several bird species, including barn swallow nests, contrary to our results (Mašán et al., 2014). On the other hand, we reported the absence of these haematophagous parasites in stork's nests (*Ciconia ciconia*) but we still recorded various mesostigmatic mites.

Mesostigmata from the family *Laelapidae* are known to be the most aggressive predators of arthropods in the soil (Walter and Proctor, 2013). We recorded the presence of killer mite (*Hypoaspis aculeifer)* (Canestrini, 1884). This predatory soil mite has already been identified in bird nests (Gwiazdowicz et al., 1999; Krištofík et al., 2003; Fenda and Lengyel, 2007), and even in starling nest boxes, it is considered to be a true predator of poultry red mites and its use in biological control seems to be one of the various control option (Lesna et al., 2009).

Other predatory Mesostigmata (*Ascidae, Parasitidae)* identified in this study were recurrently isolated from bird nests. Several species of the family *Ascidae* (a soil-dwelling mite) were found in the nests of Red-backed and Grey shrikes (Tryjanowski et al., 2001; Gwiazdowicz et al., 2006) and specimens of the genus *Parasitus* were frequently identified in stork nests (Šustek et al., 1992; Bajerlein et al., 2006). Most of the *Parasitidae* determined in our study are deutonymphs, which is similar to what was found by Bloszyk et al. (2005) and Roy et al. (2013) in stork nests.

We also report the presence of specimens belonging to the families *Uropodidae* and *Trematuridae*, these phoretic mites mainly associated with bird nests are either directly transported with building materials or transported phoretically by insects (Bloszyk et al., 2005). However, their role in community structure is still unknown (Bajerlein and Bloszyk, 2004). Phoresy is an efficient dispersal strategy, which can lead to parasitism. Several authors have reported the presence of Uropodina in bird nests worldwide (Mammeria, 2014).

Insects appeared in the nests of all three host species, with a total of 225 specimens belonging to 5 orders (Table 1). The highest number of individuals and species was Coleopterans (Figure 3). Several specimens of detritivorous Coleopterans have been noted in many nests by Babbitt and Burtt (1991) and Roy et al. (2013). These insects are not specific to bird nests, but have found a convenient habitat in the nest, probably due to the presence of animal substances, which are widely available in insectivorous bird nests (Tryjanowski et al., 2001; Sazhnev et al., 2022). Also the bug *Lyctocoris campestris* (Fabricius, 1794) is present in bird nests, living as a predator of small invertebrates, such as moth larvae that feed on debris (Saulich and Musolin, 2009).

We found Pseudoscorpions in the nests of all the three host species. Pseudoscorpions are occasionally but regularly found in swallow nests *(Hirundo rustica)*, feeding on moth larvae and mites, lice, beetles and ants (Krištofík et al., 2007; Hodgson et al., 2008). These arachnids are sometimes phoretic, clinging to the legs of flies, beetles and other insects (Mammeria, 2014).

The occurrence of some arthropods (specimens of the order *Isopoda, Psocoptera, Hymenoptera* and *Aranea*) in bird nests is incidental: specimens from the order Isopoda were collected in 17.5% of nests, terrestrial isopods belonging to the suborder *Oniscoidea* were generally found in soil and trees (Tajovsky et al., 2012). The order *Psocoptera* includes omnivorous insects that feed mainly on moulds, algae and fungi and grow on various substrates, *Trogium pulsatorium* (Linnaeus, 1758) species found in our results, lives in nature where it can be found in trees and dry litter. Finally, specimens of the orders *Hymenoptera* and *Araneae* found in the nests were probably brought in with the bird's diet.

It is commonly known that many components of bird nest fauna are inadvertently introduced into the nest using construction material (Tryjanowski et al., 2001) which may partially explain the identification of certain arthropods found in this study.

Hard ticks (*Ixodidae*) are obligate temporary parasites of vertebrate animals, alternating between parasitic and free-living life cycles on one or more host animals. All species have three developmental stages: larva, nymph and adult. Coupling can take place on and off the host. The blood meal taken by the females is necessary for egg laying and once engorgement is over they drop to the ground, where over time they lay a batch of eggs. However, the life cycles of hard ticks are categorized by the number of times their stages feed and whether they moult on the host or leave their hosts for moulting in the environment. Accordingly, species are classified as one-host, two-host, or three-host ticks (Anderson and Magnarelli, 2008; Bonnet et al., 2017).

The majority of hard ticks feed on mammals and some of them are specific parasites of birds. Several species belonging to the genera: *Ixodes*, *Haemaphysalis* and *Dermacentor* have been identified in bird nests (Krumpál et al., 2016). In this study, collected ticks appear to belong to the genus *Dermacentor*, knowing that the immature stages of *D. marginatum* feed mainly on birds. Also, this tick is found in the cooler and more humid parts of the Mediterranean climate zone (Walker, 2003).

Conclusion

In conclusion, on the basis of our findings, we were able to identify the diversity of arthropod fauna colonizing the nests of these three bird species. Mites are the most abundant and frequent arthropods inhabiting the nests of rock pigeon and white stork. The mite fauna is dominated by *D. gallinae* that was recorded in 73.33% of pigeon nests and *Uropodidae* with are accidentally transmitted to bird nests by phoresis; these phoretic mites are present in 40% of pigeon nests and 76.92% of stork nests. Also, we noted the presence of insects belonging to five different taxonomic orders in the nests of the three avian species and one larvae *Dermacentor* sp. in a stork nest. Many parasites realize successive passages through hosts belonging to different species. These transfers are an essential key to the ecology and evolution of parasites. These results show the diversity of host-parasite relationships with adaptation strategies for all environments and provide essential data for other future fundamental ecological studies.

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References

1. ANDERSON, J. F. and L. A. MAGNARELLI (2008): Biology of Ticks. Infect. Dis. Clin. North Am., Tick-borne Diseases, Part I: Lyme Disease 22, 195-215. 10.1016/j.idc.2007.12.006
2. BABBITT, G. A. and E. BURTT (1991): Occurrence and demography of mites in tree swallow, house wren and eastern bluebird nests. Bird-Parasite Interact. - Oxf. Ornithol. Ser.
3. BAJERLEIN, D., J. BLOSZYK, D. J. GWIAZDOWICZ, J. PTASZYK and B. HALLIDAY (2006): Community structure and dispersal of mites (Acari, Mesostigmata) in nests of the white stork (Ciconia ciconia). Biologia (Bratisl.) 61, 525-530. 10.2478/s11756-006-0086-9

4. BAJERLEIN, D. and J. BlOSZYK (2004): Phoresy of Uropoda orbicularis (Acari: Mesostigmata) by beetles (Coleoptera) associated with cattle dung in Poland. Eur. J. Entomol. 101, 185-188. 10.14411/eje.2004.022
5. BAL, D. A. and M. ÖZKAN (2006): Trichouropoda turcicaovalis sp. nov., a new uropodine mite (Acari: Mesostigmata: Trematuridae) from Turkey. Zootaxa 1132, 31. 10.11646/zootaxa.1132.1.2
6. BARCLAY, R. M. R. (1988): Variation in the Costs, Benefits, and Frequency of Nest Reuse by Barn Swallows (Hirundo rustica). The Auk 105, 53-60. 10.1093/auk/105.1.53.
7. BLOSZYK, J., D. J. GWIAZDOWICZ, D. BAJERLEIN and R. B. HALLIDAY (2005): Nests of the white stork Ciconia ciconia (L.) as a habitat for mesostigmatic mites (Acari, Mesostigmata). Acta Parasitol. 50, 171-175.
8. BONNET, S., K. HUBER, G. JONCOUR, M. RENE-MARTELLET, F. STACHURSKI and L. ZENNER (2017): 2. Biologie des tiques, in: Boulanger, N., McCoy, K. D. (Eds.), Tiques et Maladies à Tiques : Biologie, Écologie Évolutive, Épidémiologie, Didactiques. IRD Éditions, Marseille, pp. 53-84. 10.4000/books.irdeditions.9020
9. BOYES, D. H. and O. T. LEWIS (2018): Ecology of Lepidoptera associated with bird nests in mid-Wales, UK. Ecol. Entomol. 44. 10.1111/een.12669
10. BROWN, C. R. and M. B. BROWN (1986): Ectoparasitism as a cost of coloniality in Cliff Swallows (Hirundo pyrrhonota). Ecology 67, 1206-1218. 10.2307/1938676
11. CARVALLO, G. O., M. LOPEZ-ALISTE, M. LIZAMA, N. ZAMORA and G. MUSCHETT (2020): Assessing climatic and intrinsic factors that drive arthropod diversity in bird nests. Gayana Concepc. 84, 25-36. 10.4067/S0717-65382020000100025
12. CLAYTON, D. and D. M. TOMPKINS (1995): Comparative effects of mites and lice on the reproductive success of Rock Doves (Columba livia). Parasitology 110 (Pt 2), 195-206. 10.1017/S0031182000063964
13. DE LILLO, E. (2001): A modified method for Eriophyoid mite extraction (Acari: Eriophyoidea). Int. J. Acarol. 27, 67-70. 10.1080/01647950108684228
14. DEEMING, D. C. and M. MAINWARING (2015): Functional properties of nests, pp. 29-49. 10.1093/acprof:oso/9780198718666.003.0004
15. DI PALMA, A., A. GIANGASPERO, M. A. CAFIERO and G. S. GERMINARA (2012): A gallery of the key characters to ease identification of Dermanyssus gallinae (Acari: Gamasida: Dermanyssidae) and allow differentiation from Ornithonyssus sylviarum (Acari: Gamasida: Macronyssidae). Parasit. Vectors 5, 104. 10.1186/1756-3305-5-104
16. FARAJI, F. and F. BAKKER (2008): A modified method for clearing, staining and mounting plant-inhabiting mites. Eur. J. Entomol. 105, 793-795. 10.14411/eje.2008.105
17. FENDA, P. and J. LENGYEL (2007): Roztoče (Acarina, Mesostigmata) v hniezdach orliaka morského (Haliaeetus albicilla) na Slovensku. [Mites (Acarina, Mesostigmata) in nests of the white-tailed sea eagle Haliaeetus albicilla (L.) in Slovakia]. Entomofauna Carpathica 19, 48-50.
18. FRYDERYK, S. and J. N. IZDEBSKA (2009): Birds as a living environment for parasitic arthropods. pp. 61-69.
19. GOMES-ALMEIDA, B. and A. R. PEPATO (2021): A new genus and new species of macronyssid mite (Mesostigmata: Gamasina: Macronyssidae) from Brazilian caves including molecular data and key for genera occurring in Brazil. Acarologia 61, 501-526. 10.24349/acarologia/20214447
20. GOODENOUGH, A. and A. G. HART (2012): Bird nests: An overlooked ecosystem opportunity for specialised nest-dwelling arthropods. Antenna 16-20.
21. GORENZEL, W. P. and T. P. SALMON (1994): SWALLOWS. Handb. Prev. Control Wildl. Damage. 73. E-121-E-128
22. GWIAZDOWICZ, D. J., J. BLOSZYK, D. BAJERLEIN, R. B. HALLIDAY and T. MIZERA (2006): Mites (Acari: Mesostigmata) inhabiting nests of the white-tailed sea eagle Haliaeetus albicilla (L.) in Poland. Entomol. Fenn. 17, 366. 10.33338/ef.84359.
23. GWIAZDOWICZ, D. J., T. MIZERA and M. SKORUPSKI (1999): Mites in Greater Spotted Eagle nests. J. Raptor Res. 33, 257-260.
24. HERRING, J. L. (1976): Keys to Genera of Anthocoridae of America North of Mexico, with Description of a New Genus (Hemiptera: Heteroptera). Fla. Entomol. 59, 143. 10.2307/3493963.
25. HODGSON, E. W., A. H. ROE and B. LAMBERT (2008): Pseudoscorpions 2. Utah State Univ. Ext. Utah Plant Pest Diagn. Lab. 2.
26. HYATT, K. H. (1980): Mites of the subfamily Parasitinae (Mesostigmata: Parasitidae) in the British Isles. Bull. Br. Mus. Nat. Hist. Zool. 38, 237-378. 10.5962/p.12620
27. JENNI-EIERMANN, S., E. GLAUS, M. U. GRÜEBLER, H. G. SCHWABL and L. JENNI (2008): Glucocorticoid response to food availability in breeding barn swallows (Hirundo rustica). Gen. Comp. Endocrinol. 155, 558-565.10.1016/j.ygcen.2007.08.011
28. KALUZ, S. and P. FENDA (2005): Mites (Acari, Mesostigmata) of the family Ascidae of Slovakia. Institute of Zoology, Slov. Aca. Sci., NOI Press Bratisl, 168 pp. ISBN: 80-89088-44-9
29. KEUM, E., S. KACZMAREK and C. JUNG (2016): A new record of Hypoaspis sardous (Canestrini, 1884) (Acari: Mesostigmata: Laelapidae) from Korea. J. Species Res. 5, 477-482. 10.12651/JSR.2016.5.3.477
30. KRANTZ, G. W. (1971): A Manual of Acarology - O.S.U. Book Scores. Inc, Corvallis, Oregon.
31. KRIŠTOFIK, J., P. MASAN and Z. ŠUSTEK (2007): Arthropods (Pseudoscorpionidea, Acarina, Coleoptera, Siphonaptera) in nests of the bearded

tit (Panurus biarmicus). Biologia (Bratisl.) 62, 749-755. 10.2478/s11756-007-0142-0
32. KRIŠTOFIK, J., P. MASAN, Z. ŠUSTEK and B. KLOUBEC (2003): Arthropods (Pseudoscorpionida, Acari, Coleoptera, Siphonaptera) in nests of the tengmalm's owl, Aegolius funereus. Biol. - Sect. Zool. 58, 231-240.
33. KRIŠTOFIK, J., Z. ŠUSTEK and P. MASAN (2002): Arthropods (Pseudosorpionidea, Acari, Coleoptera, Siphonaptera) in the nests of red-backed shrike (Lanius collurio) and lesser grey shrike (Lanius minor). Biol. Sec. Zoo. 57, 603-613.
34. KRUMPAL, M., D. CYPRICH and M. STANKO (2016): Ticks in bird nests. Acta Zool. Univ. Comenianae. 39, 9-22.
35. LENG, C. W. and A. J. MUTCHLER (1920): Catalogue of the Coleoptera of America, north of Mexico (J. D. Sherman, Jr, Mount Vernon, N. Y.) Cosmos Press. Camb. Mass. 10.5962/bhl.title.6543
36. LESNA, I., P. WOLFS, F. FARAJI, L. ROY, J. KOMDEUR and M. W. SABELIS (2010): Candidate predators for biological control of the poultry red mite Dermanyssus gallinae. Enperimental Appl. Acarol. 48, 63-80. 10.1007/978-90-481-2731-3_8.
37. LOPEZ-RULL, I. and C. M. GARCIA (2015): Control of invertebrate occupants of nests. 10.1093/acprof:oso/9780198718666.003.0008
38. MACKAY, W. and E. MACKAY (2002): The ants of New Mexico (Hymenoptera: Formicidae). The Edwin Mellen Press, Lewiston, NY, pp. 408.
39. MAINWARING, M., L. R. HARTLEY, M. M. LAMBRECHTS and D. C. DEEMING (2014): The design and function of birds' nests. Ecol. Evol. 4. 10.1002/ece3.1054
40. MAMMERIA, A., I. BITAM, A. BOULELLIS and T. KERNIF (2015): First account of arthropods in the nest of the white stork, ciconia ciconia, in Algeria, including the flea ctenocephalides felis. Bull. Soc. Zool. Fr. 139.
41. MASAN, P. (1999): New mite species of the cohort Uropodina (Acarina, Mesostigmata) from Slovakia. Biologia (Bratisl.) 54, 121-133.
42. MASAN, P., P. FENDA, J. KRISTOFIK and B. HALLIDAY (2014): A review of the ectoparasitic mites (Acari: Dermanyssoidea) associated with birds and their nests in Slovakia, with notes on identification of some species. Zootaxa 3893, 77-100. 10.11646/zootaxa.3893.1.3
43. MØLLER, A. P. (2000): Survival and reproductive rate of mites in relation to resistance of their barn swallow hosts. Oecologia 124, 351-357. 10.1007/s004420000394
44. MØLLER, A. P. (1993): Sexual Selection in the Barn Swallow Hirundo rustica. III. Female Tail Ornaments. Evolution 47, 417-431. 10.1111/j.1558-5646.1993.tb02103.x
45. MØLLER, A. P. (1990): Effects of Parasitism by a Haematophagous Mite on Reproduction in the Barn Swallow. Ecology 71, 2345-2357. 10.2307/1938645
46. MORAZA, M. L., N. R. IRWIN, R. GODINHO, S. J. E. BAIRD and J. GOUY DE BELLOCQ (2009): A New Species Of Ophionyssus Mégnin (Acari: Mesostigmata: Macronyssidae) Parasitic On Lacerta Schreiberi Bedriaga (Reptilia: Lacertidae) From The Iberian Peninsula, And A World Key To Species. Zootaxa 2007, 58-68. 10.11646/zootaxa.2007.1.3
47. MORONI, B., A. BARLAAM, A. L. MISIA, A. PEANO, L. ROSSI and A. GIANGASPERO (2021): Dermanyssus gallinae in non-avian hosts: A case report in a dog and review of the literature. Parasitol. Int. 84, 102378. 10.1016/j.parint.2021.102378
48. PROCTOR, H. C. (2003): Feather Mites (Acari: Astigmata): Ecology, Behavior, and Evolution. Annu. Rev. Entomol. 48, 185-209. 10.1146/annurev.ento.48.091801.112725
49. RICHNER, H. and P. HEEB (1995): Are Clutch and Brood Size Patterns in Birds Shaped by Ectoparasites? Oikos 73, 435-441. 10.2307/3545973
50. ROY, L., J. C. BOUVIER, C. LAVIGNE, M. GALES and T. BURONFOSSE (2013): Impact of pest control strategies on the arthropodofauna living in bird nests built in nestboxes in pear and apple orchards. Bull. Entomol. Res. 103, 458-465. 10.1017/S0007485313000047
51. SAULICH, A. K and D. MUSOLIN (2009): Seasonal development and ecology of anthocorids (Heteroptera, Anthocoridae). Entomol. Rev. 89, 501-528. 10.1134/S0013873809050017
52. SAZHNEV, A., A. V. ARTEMYEV and A. V. MATYUKHIN (2022): Beetles (Coleoptera) in nests of the European pied flycatcher Ficedula hypoleuca (Pallas, 1764) in the southeast of the Ladoga area (Republic of Karelia). Ecosyst. Transform. 5, 35-41. 10.23859/estr-220106
53. SHULTZ, J. W. (2018): A guide to the identification of the terrestrial Isopoda of Maryland, U.S.A. (Crustacea). ZooKeys 801, 207-228. 10.3897/zookeys.801.24146
54. SMITHERS, C. N. (1990): Keys to the families and genera of Psocoptera (Arthropoda: Insecta). Tech. Rep. Aust. Mus. 2, 1-82. 10.3853/j.1031-8062.2.1990.77
55. SNODGRASS, R. E. (1935): Principles Of Insect Morphology. McGraw-Hill. 10.7591/97815017918
56. ŠUSTEK, Z., M. AMBROS and J. KRISTOFIK (1992): The mites (Acari, Mesostigmata) in the birds› nests in Slovakia. Biol. Bratisl. 47, 369-381.
57. TAJOVSKY, K., J. HOSEK, J. HOFMEISTER and J. WYTWER (2012): Assemblages of terrestrial isopods (Isopoda, Oniscidea) in a fragmented forest landscape in Central Europe. ZooKeys 176, 189-198. 10.3897/zookeys.176.2296
58. THYSSEN, P. (2010): Keys for Identification of Immature Insects. In: Current Concepts in Forensic Entomology, pp. 25-42. 10.1007/978-1-4020-9684-6_2
59. TRYJANOWSKI, P., E. BARANIAK, R. BAJACZYK, D. J. GWIAZDOWICZ, S. KONWERSKI, Z. OLSZANOWSKI and P. SZYMKOWIAK (2001): Arthropods in nests of the red-backed shrike (Lanius collurio) in Poland. Belg. J. Zool. 132, 69-74.

60. WALKER, A. R., A. BOUATTOUR, J. L. CAMICAS, A. ESTRADA-PENA, I. G. HORAK, A. A. LATIF, R. G. PEGRAM and P. M. PRESTON (2003): Ticks of domestic animals in Africa: a guide to identification of species. Bioscience Reports, Edinburgh.

61. WALTER, D. E. and H. C. PROCTOR (2013): Mites: Ecology, evolution & behaviour: Life at a microscale: Second Ed. 10.1007/978-94-007-7164-2

Komparativna studija faune člankonožaca u gnijezdima roda, domaćih lastavica i običnih golubova

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Analiza faune člankonožaca prikupljenih iz gnijezda roda, lastavica i golubova provedena je tijekom ljeta 2018. godine u tri regije sjeveroistočnog Alžira, Guelma, El-Tarf i Annaba. Ukupan je broj ispitanih gnijezda bio 40, od čega je u 58 % otkrivena infestacija člankonošcima kojih je bilo manje u gnijezdima lastavica nego u gnijezdima golubova i roda. Zamijećena je veća dominacija grinja reda *Mesostigmata* (78,71 %, odnosno 72,41 %). *Dermanyssus gallinae* bila je najraširenija (33,05 %) i najčešća (73,33 %) grinja reda *Mesostigmata* u gnijezdima golubova, dok su u gnijezdima bijelih roda najdominantnije bile grinje kohorte uropodina (41,37 %) s učestalošću od 76,92 % broja analiziranih gnijezda. U gnijezdima lastavica pronađene su sljedeće grinje: *Psocodea, Hemiptera, Hymenoptera* i *Coleoptera* koje pripadaju razredu *Insecta* i *Isopoda* koja pripada razredu *Malacostraca*. Ova je studija prva komparativna studija člankonožaca koji žive u gnijezdima triju vrsta ptica (bijela roda, domaća lastavica i divlji golub) u sjevernom Alžiru. Nadamo se da će ovi podatci koji su pokazali bogatstvo faune člankonožaca u gnijezdima ovih triju vrsta ptica motivirati dodatna istraživanja s ciljem karakterizacije zajednice člankonožaca prisutne u gnijezdima različitih ptica i određivanja naravi njihovog međusobnog odnosa.

Ključne riječi: *fauna člankonožaca, gnijezda ptica, bijela roda, domaća lastavica, divlji golub*