Belg. J. Zool. — Volume 123 (1993) — issue 1 — pages 3-26 — Brussels 1993

Manuscript received on 1 March 1993

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OBSERVATIONS ON MITES INHABITING NESTS OF *BUBO BUBO* (L.) (STRIGIFORMES, STRIGIDAE) IN BELGIUM

by

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SUMMARY

The acarofauna of six nests of *Bubo bubo* (L.) collected in Belgium has been studied. The number and quality of the mites collected varied markedly from nest to nest. Pyroglyphid mites (i.e. *Dermatophagoides farinae* and *Euroglyphus maynei*), which are known as important producers of bronchial asthma in man, were found in two distinct nests. Among the species collected in one nest, two are new (*Amblyseius namurensis* n. sp. and *Histiostoma trogicola* n. sp.) and six had not been recorded previously from Belgium. The hypopial stage of *Myianoetus travei* FAIN, 1976, (not the adults) is transferred into the genus *Comyianoetus* FAIN and PHILIPS, 1979, with the name *Comyianoetus puteanus* FAIN n. sp. A possible scenario depicting, in three phases, the mite-bird relationships evolving with time is proposed.

Key words : Belgium, mites (Acari), nests of *Bubo bubo*

INTRODUCTION

Relatively little is known about the associations between birds and mites, apart from ticks which have been known to plague birds (as well as people) for centuries. Mites are a very ancient and diverse group of chelicerates consisting of probably more than 2000 genera and 500000 species (KRIVOLUTSKY and DRUK, 1986; WOOLLEY, 1987; O'DOWD *et al.*, 1991). In Europe, the insects and mites associated with certain birds' nests have already been studied by NORDBERG(1936) in Finland and by WOODROFFE (1953) in England. Yet both papers, which initiated an ecological analysis of the nest arthropod community, dealt mainly with the insect fauna.

Nests of birds, and especially those built by birds of prey, usually show a mite fauna very rich in both species and individuals (FAIN and PHILIPS, 1977a and b, 1978a and b, 1979, 1981). In addition, some nests may be inhabited by mites injurious to stored food products (for instance, among Astigmata, species belonging to genera *Acarus, Glycyphagus, Lepidoglyphus* and *Tyrophagus*) or harmful to man (among Astigmata, pyroglyphid mites; and, among Mesostigmata, species of the genera *Ornithonyssus* and *Dermanyssus*; see observations by WOODROFFE and SOUTHGATE, 1952; BAKER *et al.*, 1976; FAIN *et al.*, 1991).

In their recent synthesis of data gained on free-living mites in Belgium since the beginning of the century, LEBRUN *et al.* (1989) have emphasized the fact that our current knowledge of mites occurring in nests of birds is quite fragmentary while a lot of papers have documented both the ecology and the biology of soil mites (see e.g. WAUTHY *et al.*, 1989, and VERA ZIEGLER *et al.*, 1990).

In order to partially fill the hiatus, this study is a first approach to the mite fauna associated with nests of *Bubo bubo* and captured in six nests originating from South Belgium (provinces of Namur and Luxembourg).

MATERIAL AND METHODS

Nests

In Belgium, the Eagle owl begins to lay in the second half of February. The nest is a shallow depression (diameter : app. 30 cm) scraped away by the male usually upon a cliff ledge. Being a typical cliff nester, the Eagle owl sets its nest in marked natural or artificial inclines.

Usually, a pair has on average three or four nest sites located in their territory and used consecutively year after year. The clutch consists of 2-4 eggs incubated for around 35 days. Young are altricial and nidicolous. They are cared for and fed by both parents, and when small brooded more or less continously by the female. The fledging period is 60-70 days or more. Frequently, however, the young leave the nest before fully fledged, walking in the surroundings at least if the ledge area is spacious enough.

Our survey of the mite fauna associated with nests of *Bubo bubo* refers to populations found in the organic matter gathering in the nest depression. This organic matter consists of scraps (a mixture of owl pellets made up of bird feathers, mammal hair and bones), fragments of uneaten prey and excrement, to which earthy materials may be added in more or less conspicuous quantity.

Six nests were studied and some data relating to their localization as well as to their immediate, physical and vegetational environments are shown in Table 1. For reasons of conservation, we omitted the name of the sites where the nests were found.

Mite sampling

The organic matter gathering in the depression of each nest was sampled during a single survey (dates in Table 1), when ringing the young. In each nest, in order not to disturb young, only one sample of organic matter (app. 1 dm^3 in volume) was withdrawn by hand from the centre of the depression, i.e. from this part of the

TABLE 1

Designation, number of young, short description of cliff ledge and ground organic substrate, and date of sampling for the six nests of *Bubo bubo* from distinct localities in the provinces of Namur (N) and Luxembourg (L).

Estimation of water content of organic substrate : *m*, moist ; *vd*, very dry. Composition of organic matter : *s*, prey scraps (+, very few ; + + numerous) with miscellaneous compounds (*f*, feathers ; *h*, mammal hair ; *b*, bones) possibly mixed with earthy materials (*e*) and stones (*r*).

Nest Number	Young Number	Age	Presence	Nest localization and environment	Organic substrate		Province	Date
					Composition	Moisture		
1	3	3	yes	Upon a small rocky ledge, the surface of which was completely occupied by the nest and weakly covered by earthy material ; not direct exposure to the sun owing to a bush overhanging the nest	s(+:f,b)	m	N	16.V.92
2	4	4	yes	Upon a wide earthy ledge, in the vicinity of a herbaceous area ; direct exposure to the sun ; site drought by a substantial draining of the rocky substrate	s(+ +:f,b)	vd	N	16.V.92
3	4	5	yes	Upon an elongate, earthy ledge ; direct exposure to the sun ; site covered by a cushion of short grasses	s(+ +:f,b,h),e	vd	N	28.V.92
4	2	5	yes	Upon a small, stony ledge, the surface of which was bare and almost occupied by the nest ; direct exposure to the sun	s(+:f,b),e	vd	L	28.V.92
5	3	6	yes	Upon an earthy, stony ledge ; reduced exposure to the sun owing a small shield of plants overhanging the edge ; site used for many years	s(+ +:f,b,h),e,r	m	N	6.VI.92
6	1	8	no	At the corner of a wide rocky slip covered by earthy material and invaded by vegetation ; clearly reduced exposure to the sun owing to both the wall of rock and plants ; site used for many years	s(+:f,b,h),e,r	m	N	30.VI.92

nest which usually is in contact with young birds. The mite fauna was extracted over one week in a Berlese funnel using 15 W light globes as a heat source.

RESULTS

Assemblage composition : richness and density

A total of 33 species and more than 700 mite specimens were found in the six nests surveyed. Table 2 illustrates both the specific attributes of mite assemblages established in each nest and the numerical size of mite populations at the time of sampling.

Among the six nests studied, the assemblage of nest no. 6 appeared to be the one with the highest species richness (25 species, Table 2) while the others consisted at best of three species. In addition, abundances registered in nest no. 6 were patently high since population size of five species was over the noticeable value of 100 individuals per 1 dm^3 of organic substrate. In the same way, the assemblage of nest no. 3 diverged from others by one population showing substantial establishment (*Tyrophagus palmarum*, Table 2).

Species composition : taxonomy, trophic behaviour, medical and economical importance

From a taxonomic point of view, Acari are triphyletic in origin GRANDJEAN, 1970) and are subdivided into seven orders. The mites collected in the nests of *Bubo bubo* belonged to 24 families and five orders : Metastigmata (1 species) ; Mesostigmata (4 species) ; Prostigmata (6 species); Astigmata (13 species) ; and, Oribatida (9 species).

Where feeding habits of mites are concerned, a distinction between free-living forms and parasitic ones is required. Free-living mites are predaceous, phytophagous, microbivorous (i.e. feeding on fungi, yeasts, bacteria or algae, or combining two or more of these habits), saprophagous, coprophagous or necrophagous organisms (KRANTZ, 1978). In addition, two blood-sucking parasites of man and animals were found in nests surveyed, i.e. *Ixodes ricinus* and *Ornithonyssus sylviarum*. Another parasitic form (*Leporacarus gibbus*) known as feeding on hair follicle secretions of its vertebrate host was likewise registered among mites occurring in the nest no. 6.

On the other hand, several species captured in the nests of *Bubo bubo* are well-known pests of stored food and have thereby a great economic importance (e.g. *Acarus* spp., *Tyrophagus* spp., and *Lepidoglyphus destructor*). Finally, two other taxa (i.e. *Dermatophagoides farinae* and *Euroglyphus maynei*), which usually live in house dust, are able to cause bronchial asthma in man.

TABLE 2

List of mite species found in six nests (no. 1, 2, 3, 4, 5 and 6) of *Bubo bubo* sampled in South Belgium. Registered densities at the time of sampling and usual feeding habits are indicated. Feeding habits : [*b*], blood suckers ; [*c*], organisms able to feed on corneous material of the skin of birds ; [*f*], phytophagous organisms ; [*m*], microbivorous ; [*p*], predators ; [*s*], saprophagous ; [*t*], ectoparasite feeding on secretions of its vertebrate host ; [*u*], unknown or unidentified. Ontogenetic stages : A^f, female ; A^m, male ; *n2*, deutonymph ; *n1*, protonymph ; *h*, hypopus ; *n*, nymphal stage when only one exists ; *i*, unidentified immature stage. Number of individuals : +, few (i.e. < 10) ; + +, numerous (i.e. > 50).

	Nest					
	1	2	3	4	5	6
Ixodes ricinus [b]						n : 1 l : 7
Ornithonyssus sylviarum [b]		A^f : 6				
Macrocheles penicilliger [p]					A^f : +	A^f > 100 n2 : + n1 : +
Amblyseius namurensis [u]						A^f : 2
Pelethiphis sp. [u]						n : 2
Bdella sp. [u]				n : 1		n : 1
Linopodes motatorius [u]						A^f : 1
Tarsonemus sp. [u]						A^f : 4 A^m : 1
Bryobia praetiosa [f]		A^f : 1				
Cunaxoides croceus [p]						A^f : 1
Neophyllobius saxatilis [u]			A^f : 1			
Acarus siro [m + s]	A^f : + A^m : +				A^f : + A^m : +	
Acarus farris [m + s]				A^f : + h : + i : +		A^f : + + h : + + i : + +
Tyrophagus similis [m + s]					A^f : + + i : + +	A^f : + + i : + +
Tyrophagus palmarum [m + s]			A^f > 100 i : + +			A^f > 100 i : + +
Lepidoglyphus destructor [m + s]	A^f : + A^m : + i : +			A^f : + A^m : + i : +		

TABLE 2

	Nest					
	1	2	3	4	5	6
Dermacarus sciurinus [m + s]						h : 1
Dermatophagoides farinae [c]	A^f : 8 A^m : 4 n : 2					
Euroglyphus maynei [c]		A^f : 2				
Histiostoma trogicola [u]						h : 24
Scheucheria mongolica [u]						h : 1
Myianoetus turkorum [u]						h : 25
Comyianoetus denticulatus [u]						h : 13
Leporacarus gibbus [t]						A^m : 1
Nothrus sp. [m + s]						n1 : 1
Trhypochthonius tectorum [m]						n2 : 1
Suctobelbella subtrigona [m]						A^f : 1
Tectocepheus sarekensis [m + s]						A^f : 1
Micreremus brevipes [u]						A^f : 1
Trichoribates trimaculatus [u]						A^m : 1
Galumna cf. lanceata [u]						A^f : 1 n1 : 1
Dometorina pl. plantivaga [m]						A^f : 1
Oribatula tibialis [m + s]						A^f : 2

Study of the species

Data on the density and the number of nests where the following species of mites were registered are shown in Table 2.

METASTIGMATA

Ixodes ricinus (LINNAEUS, 1758)

This tick is wide-spread in Belgium. Larvae and nymphs occur frequently upon birds. *I. ricinus* is the main vector of Lyme disease in our country (FAIN, 1990).

MESOSTIGMATA

Macronyssidae

Ornithonyssus sylviarum (CANESTRINI and FANZAGO, 1877)

This haematophagous parasite is commonly found in birds' nests and on wild and domestic birds (e.g. pigeons, chickens, etc.) as well as on cage birds (canary, etc.). The manipulation of contaminated birds may induce an itching dermatitis in man.

Macrochelidae

Macrocheles penicilliger (BERLESE, 1904)

Mites of the family Macrochelidae are predators of nematodes or feed on eggs or larvae of numerous insects, especially Diptera. Although widely distributed in Europe and reported from the U.S.A. and New Zealand, *M. penicilliger* had so far never been collected in Belgium. Note the relatively high abundance of the two populations we recorded (clearly higher in nest no. 6 than in nest no. 5 ; see Table 2) and the lack of males in both populations.

Phytoseiidae

Phytoseids are efficient predators of phytophagous mites, viz. Tetranychidae and Eriophyidae, which are able to injure severely a great variety of cultivated plants. Therefore, phytoseids have been used with patent success for the biological control of these pests.

***Amblyseius namurensis* nov. spec.**

Material : 2 females (holotype and 1 paratype), deposited in the Institut royal des Sciences naturelles de Belgique, Bruxelles.

Description of the holotype female (Figs 1-3).

Idiosoma : 360 µm long and 240 µm wide (maximum width).

Scutum : 330 µm long, and maximum width, 210 µm. The scutum carries 17 pairs of setae measuring as follows (in µm) : *j1* 18 ; *j3* 33 ; *j4* 19 ; *j5* 6 ; *j6* 8 ; *z4* 27 ; *z5* 9 ; *s4* 24 ; *s5* 42 ; *r3* 30 ; *J2* 8 ; *J5* 10 ; *Z1* 12 ; *Z4* 50 ; *Z5* 57 ; *S2* 33 ; *S4* 10 ; *S5* 12 ; *R1* 19. The scutum bears, anterolaterally and outside of setae *z4* and *s4*, two or three oblique striations while the rest of the scutum is devoid of any line or striation.

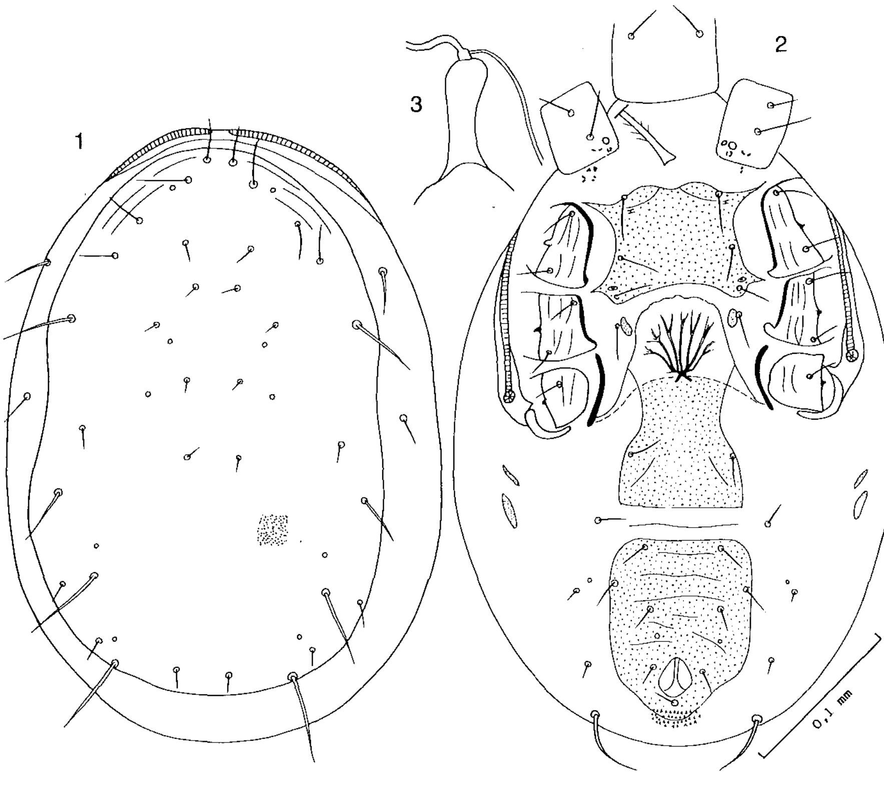
Venter. Sternal shield : 57 µm long (in midline), and 75 µm wide (at the level of setae *st2*). Genital shield with lateral margins slightly divergent behind the genital setae ; maximum width, 75 µm. Ventrianal shield : 105 µm long, and maximum width, 87 µm.

Chelicerae badly oriented, not observable. Inseminating organ as in *Amblyseius graminis* (CHANT, 1956) : the atrium and the calyx, together, are 18 µm long and 4.5 µm wide (in middle).

Type locality : Near Namur (nest no.6).

Remark

This species is rather close to *Amblyseius graminis*. It differs however from the latter by the following characters : (1) the shape of the genital shield with the lateral margins, behind the genital setae, almost parallel (these margins are strongly divergent in *A. graminis*) ; (2) the two pairs of metapodal shields are very unequal (they are subequal in *A. graminis*) ; (3) the long setae of the genu, tibia and tarsus IV are shorter (42, 30 and 56 µm in *A. namurensis* instead of 47, 33 and 70 µm in *A. graminis*) ; and, (4) the setae *Z5* are shorter (57 µm instead of 70-100 µm in *A. graminis*). See CHANT (1956) and KARG (1971).



Figs 1-3. *Amblyseius namurensis* n. sp., holotype female. — 1. in dorsal view. - 2. in ventral view. - 3. inseminating organ.

Eviphididae

***Pelethiphis* sp.**

The lack of adult individuals in the sample taken within the nest no. 6 did not allow a specific determination of both nymphs collected. Note, however, that all the known species of the genus *Pelethiphis* live in association with necrophagous Coleoptera.

PROSTIGMATA

Bdellidae

***Bdella* sp.**

Here also the lack of adults in our collection did not allow a specific identification of the two nymphs found in nests no.5 and 6. Some species of the genus *Bdella* prey on other mites.

Eupodidae

Linopodes motatorius (LINNAEUS, 1758)

As early as 1935, WILLMANN reported on the finding of this taxon in Belgium. It occurs in soil litter, in mosses and upon rocks.

Tarsonemidae

***Tarsonemus* sp.**

The biology of the species of the genus *Tarsonemus* is variable. Some taxa show clear predatory habits, feeding on eggs of tetranychid mites. Other species are commensal organisms associated with bark beetles. In Europe and North America, two species (*T. granarius* LINDQUIST, 1972, and *T. fusarii* COOREMAN, 1941) are commonly found in stored grains where they feed on fungi such as *Penicillium*, *Aspergillus*, etc.

Tetranychidae

Bryobia praetiosa C. L. KOCH, 1836

This world-wide distributed species is regarded as a major phytophagous pest on account of damage it inflicts on many cultivated plants, especially fruit-trees.

Cunaxidae

Cunaxoides croceus (C. L. KOCH, 1838)

Recently revised by SMILEY (1992), the species of the family Cunaxidae are predators of other microarthropods which inhabit mosses or soil organic horizons.

Although *C. croceus* shows a world-wide distribution, our finding is its first report from Belgium.

Camerobiidae

Neophyllobius saxatilis HALBERT, 1923

A single female specimen found in nest no.3 is assigned to *N. saxatilis*. This species, so far unrecorded from Belgium, was succinctly described by HALBERT (1923). The typical specimens were collected by HALBERT in the vicinity of Dublin (Ireland). VAN EYNDHOVEN (1938), from specimens collected in dunes near the city of Vogelzang (west coast of the Netherlands), redescribed this species. Note that the biology of camerobiid mites is still quite unclear.

ASTIGMATA

Acaridae

Acarus siro (LINNAEUS, 1758)

Being a major contaminant of stored products, this species may cause important depredations to flour, grain, cheese, etc. The heteromorphic deutonymphs (= hypopi) are motile organisms which attach to various species of insects.

Acarus farris (OUDEMANS, 1905)

Just as the previous species, *A. farris* occurs in stored food and show motile hypopi. In addition, it is usually captured in nests of birds (FAIN *et al.*, 1991).

Tyrophagus similis VOLGIN, 1949

Relatively ubiquitous, this species has been recorded from soil, grassland and diverse cultivated plants such as spinach, mushrooms, etc. (HUGHES, 1976).

Tyrophagus palmarum OUDEMANS, 1924

This taxon is an usual inhabitant of both stored food products and nests of birds (WASYLIK, 1963 ; FAIN *et al.*, 1991). Note that no male was found among the individuals we captured in this survey (Table 2).

Glycyphagidae

Lepidoglyphus destructor (SCHRANK, 1781)

This species is an important and very common pest of stored food, and is frequently found associated with *A. siro*. *L. destructor* is essentially mycophagous and is able to survive on different species of fungi. It produces hypopi of the « immobile » type.

Dermacarus sciurinus (C. L. KOCH, 1841)

As the adult stage of this taxon is reported to be a strict inhabitant of nests of the squirrel, it is very likely that the finding of one hypopus individual in nest no. 6 has to be inferred from the predatory activities of Eagle owl parents.

Pyroglyphidae

Dermatophagoides farinae HUGUES, 1961

This species is a common dweller in both mattresses and house dusts. In man, its pathogenic role is quite important since it may induce bronchial asthma.

Euroglyphus maynei (COOREMAN, 1950)

As the previous species, it is likewise a domicolous mite implicated in bronchial diseases of man.

Histiostomatidae

***Histiostoma trogicola* nov. spec.**

Material : 24 heteromorphic deutonymphs (holotype and 22 paratypes deposited in the Institut royal des Sciences naturelles de Belgique, Bruxelles ; one paratype deposited in the British Museum, Natural History, London).

Description of the holotype (Figs 4-9).

Idiosoma : 156 µm long ; maximum width, 115 µm ; length and width in two paratypes : 167 × 114 and 153 × 108 µm, respectively. Posterior margin of body nearly straight in all our specimens.

Dorsum. Hysterosoma with numerous, small and rounded depressions especially well developed in the lateral parts of the body. Propodonotum with small depressions confined to the anterior part of the body. Length of setae (in µm) : *sce* and *sci*, 10-12 ; *d1* to *d3* thick, and 80, 66 and 65 long, respectively ; *d4*, *d5*, *l1* to *l4*, *h* and *sh* very small and thin (6-9 long). Setae *l5*, 18-20 µm long.

Venter. Palposoma, 16 µm long and 6 µm wide, bearing a pair of solenidions, 40 µm long. Suctorial plate, 70 µm wide ; anterior suckers, 7 µm wide ; posterior suckers, oval, 14 µm long and 11 µm wide. The setae *CxI, CxIII* and *gp* are conoids. Two pairs of conoids (lateral and paramedian ones) are present on the suctorial plate (see FAIN, 1973).

Legs. Length of tarsi : 42, 33, 27 and 30 µm, respectively (ambulacra not included). Tarsi I-III with an apical claw, and a long and wide foliate seta. Tarsus IV bearing a strong seta, 75 µm long. Length of solenidions *phi* I-IV : 55, 32, 31 and 9 µm long, respectively.

Habitat

Holotype and three paratypes, all hypopial deutonymphs, were found in nest no. 6 (near Namur). Twenty paratypes (hypopi) attached to a *Trox scaber* were found in the same nest.

Remark

This species is characterized by the aspect of the dorsal chaetotaxy showing only three pairs of very long and strong median setae while all the other dorsal setae are very thin and short. Other distinctive features are as follows : (1) the great size of conoids ; (2) the presence of large lanceolate setae on tarsi I-III ; and, (3) the pitted shape of the dorsum.

Scheucheria mongolica MAHUNKA, 1969

This species is represented in our collection by a single hypopus collected in nest no. 6. This species was described from Mongolia. Our specimen corresponds very closely to the original description of *S. mongolica.*

The genus *Scheucheria* MAHUNKA, 1969, includes another species, which is the type of the genus, *Wichmannia stammeri* SCHEUCHER, 1957, and whose hypopi were collected by SCHEUCHER (1957) from a staphylinid beetle in Erlangen, Germany. MAHUNKA (1969) did not examine the hypopus of this species when he described his *S. mongolica,* and it is possible that the differences he noted between the two species could be explained by an inadequate description of *S. stammeri.* In order to check this eventuality we asked the Director of the Institute of Zoology, University of Erlangen, Nürnberg, to send us the type specimen of *S. stammeri.* Unfortunately « there exists no prepared material of that species in that Institute » (in litt. Prof. H. W. Scheloske). *Scheucheria mongolica* had so far not been recorded from Belgium.

Myianoetus turkorum SCHEUCHER, 1957

About 20 specimens of this species, all heteromorphic deutonymphs, were collected in nest no. 6, and five specimens were collected from a *Trox scaber* found in the same nest. It is the first record of this species from Belgium.

Genus *Comyianoetus* FAIN and PHILIPS, 1979

So far, the genus *Comyianoetus* included only the type species *Comyianoetus denticulatus* FAIN and PHILIPS, 1979. These hypopi differ from those of the genus *Myianoetus* OUDEMANS, 1929, (see also MAHUNKA, 1972) by the following characters : (1) claws I and II not divided by a deep median cleft, but normally shaped, and with a small preapical tooth (Fig. 10) ; this tooth is anteroventral on both claws I and II, and posteroventral on claw III ; (2) in *Comyianoetus,* the anterior suckers of the suctorial plate are vestigial and replaced by small rings ; and, (3) the conoids located behind the posterior suckers are vestigial and replaced by very small setae.

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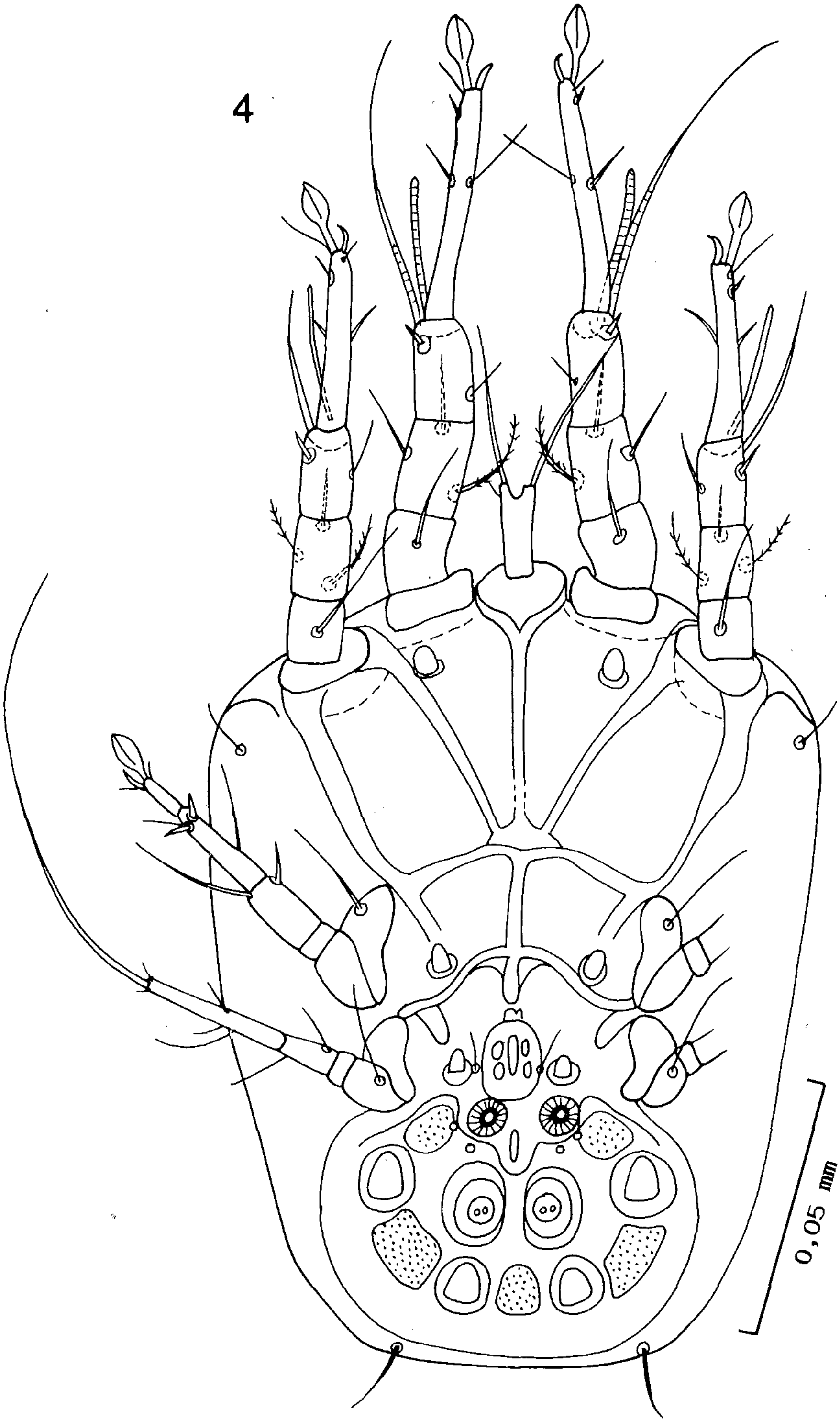

Fig. 4. — *Histiostoma trogicola* n. sp., heteromorphic deutonymph in ventral view.

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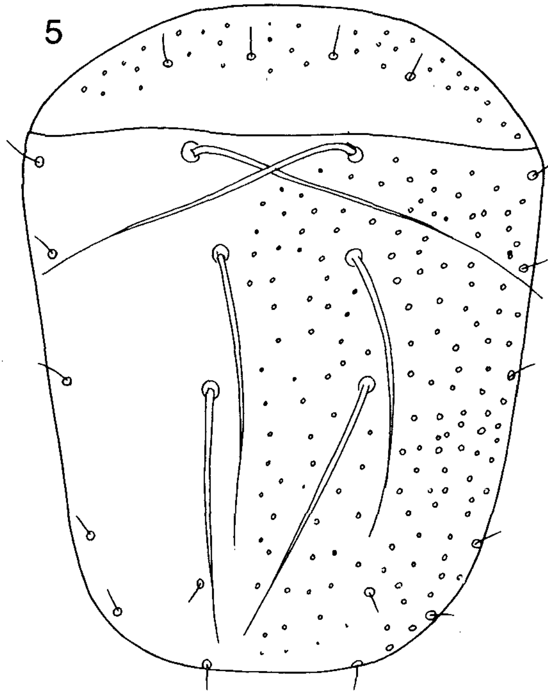

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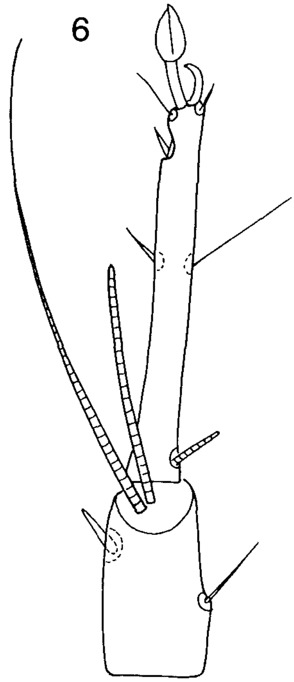

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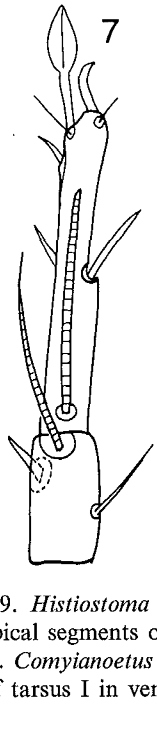

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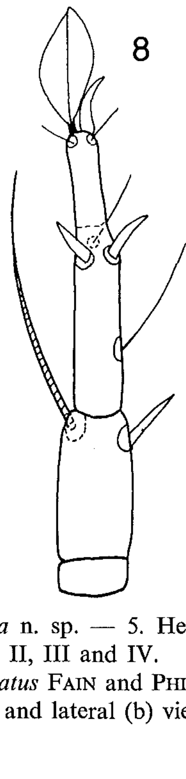

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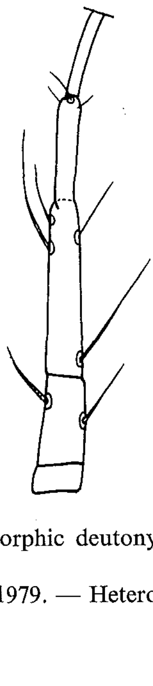

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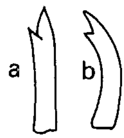

Figs 5-9. *Histiostoma trogicola* n. sp. — 5. Heteromorphic deutonymph in dorsal view. - 6-9. Apical segments of legs I, II, III and IV.
Fig. 10. *Comyianoetus denticulatus* FAIN and PHILIPS, 1979. — Heteromorphic deutonymph : claw of tarsus I in ventral (a) and lateral (b) view.

Comyianoetus denticulatus Fain and Philips, 1979

We collected 12 hypopi of this taxon in nest no. 6. In addition, one hypopus was found attached to a *Trox scaber* collected in the same nest. It is the first record of this species in Belgium. In fact, the original description was based on individuals captured in nests of several birds of prey : in U.S.A., in nests of *Asio otus, Buteo virginianus* and *Buteo albonotatus*; and, in Norway, in nests of *Aegolius funereus.*

***Comyianoetus puteanus* nov. spec.**
= *Myianoetus travei* Fain, 1976 : 309, in part (hypopus)

Previously described under the name *Myianoetus travei,* the hypopus (not the adult) is now transferred into the genus *Comyianoetus* and becomes the type of a new species, *C. puteanus* n. sp. We think now that the deutonymphal stage (but not the adults) of *Myianoetus travei* Fain, 1976, which was described from specimens collected in the Kerguelen Islands, also belongs to the genus *Comyianoetus.* In fact, the hypopi of this species were not found in either the same locality or biotope as the adults. Moreover, the holotype of the species was selected among the adults collected.

Listrophoridae

Leporacarus gibbus (Pagenstecher, 1862)

This taxon is a pilicolous parasite of the rabbit *Oryctolagus cuniculus.* The single male specimen found in nest no.6 was probably brought into this nest with prey captured by Eagle owl parents.

ORIBATIDA

All the oribatid mites were captured in nest no.6. The record of both several saxicolous and/or arboricolous taxa and one species unknown up to date in Belgium (*Trhypochthonius tectorum*) has to be emphasized. Data on saxicolous and arboricolous species originate from observations by Van Der Hammen (1952), Travé (1963), André and Lebrun (1979) and André (1984).

Nothridae

***Nothrus* sp.**

The single deutonymphal specimen we found might be referred either to *N. anauniensis* Canestrini and Fanzago, 1877, or to a species belonging to the *silvestris* group. Indeed, morphological traits allowing a definite identification to be achieved (e.g. interlamellar setae and posterior gastronotic phaneres) were unfortunately lacking or damaged.

Trhypochthoniidae

Trhypochthonius tectorum (BERLESE, 1896)

As often as not, this taxon occurs in mosses growing upon walls or rocks.

Suctobelbidae

Suctobelbella subtrigona (OUDEMANS, 1916)

In forest soils, this taxon is a common inhabitant of dead organic matter (litter and humus) (WAUTHY, 1982a ; LEBRUN *et al.*, 1989).

Tectocepheidae

Tectocepheus sarekensis TRÄGÅRDH, 1910

Mainly collected upon rocks, this species can also be found both upon trees and in leaf litter of forests where sometimes relatively high densities may be registered (TRAVÉ, 1963 ; WAUTHY, 1982a).

Micreremidae

Micreremus brevipes (MICHAEL, 1888)

Although exceptionally collected in soil organic matter, this species is one of the most common, arboricolous oribatid mites in Occidental Europe. It lives in lichens as well as upon leaves.

Ceratozetidae

Trichoribates trimaculatus (C .L. KOCH, 1836)

This taxon is patently a saxicolous organism. Yet, in foliose lichens growing upon trees, it can sometimes develop populations numerically important.

Galumnidae

Galumna cf. lanceata (OUDEMANS, 1900)

Galumnidae are a quite large group of oribatid species, the identification of which is still confused. Nonetheless, in Belgium, the species in question has been reported from dead organic matter of forest soils relating to distinct humus types. Its distribution displays however some preference for mull-moder soils (WAUTHY, 1982a ; LEBRUN *et al.*, 1989).

Scheloribatidae

Dometorina plantivaga plantivaga (BERLESE, 1895)

This lichenophagous organism lives upon trees much more than upon rocks.

Oribatulidae

Oribatula tibialis (NICOLET, 1855)

Although it can inhabit bark and lichens of trees, this taxon is mainly collected in litter of forests (TRAVÉ, 1963 ; LEBRUN *et al.*, 1989).

DISCUSSION

Abiotic conditions in the nests

The substrate filling up the nests from which acari were extracted appears to be a heterogeneous and constraining habitat for the mite fauna. Indeed, the substrate is usually an organic, more or less earthy material, and conceptually, this material might be regarded as a « hanging soil ». In fact, as in true soils, dead organic matter (food debris, excrement, fragments of feathers, etc.) settles continuously.

Although no attempt was made here to measure conspicuously the thermic and hydric conditions prevailing within nests, it could be fairly assumed that not only the orientation of the nest, its exposure to the sun and its neighbouring, physical environment (form of the ledge, vicinity of stones and shrubs, etc.) but also the presence of young and the « perturbating stimuli » (sensu REGIER and RAPPORT, 1978) they induce in connexion with both the intensity of their movements and the frequency of feeding and excreta are so much factors which contribute to make the nest an unpredictable habitat for mites.

Temperature and relative humidity are very important factors in the survival and the development of mites. Nothing is known about the conditions prevailing in the nests of birds but one may surmise that a temperature of 20-25° C and a RH of at least 80 % (probably more) are the optimal conditions for the species living in nests.

Richness and density

There are potentially a variety of micro-environmental variables which could influence the richness of species assemblages as well as the size of mite populations inhabiting the nests (e.g. physical structure and chemical composition of organic substrate), and these are unknown for all the sites studied. As in soils, it seems likewise that the presence of plants could have a mulching effect for thermic and hydric variations, and even a physical effect of both structuration and stabilisation of the nest habitat.

The great diversity and the high densities of mites registered within the nest no. 6 is probably explained by the fact that this nest was the most closely in conformity with the edaphic requirements. Indeed, this nest was located at the corner of an earthy ledge partially occupied by plants just along the rocky cliff. Moreover, it was shaded by various plants and rocks which most likely generated better conditions of temperature and RH than in other nests studied. It must also be added :

(1) that the site was used by the Eagle owl for many years as proved by the presence of many bones and feathers ; (2) that the departure of the young, which had left the nest some days before sampling, is another factor that we cannot neglect. Finally, one may suppose that all these conditions were particularly favourable for the development of a rich mite fauna.

Surprisingly, in nest no.3, despite its localization in a widely open site and the presence of four young, one species (*T. palmarum*) showed a clearly high, population size that might square to a demographic explosion. Such dynamics are often registered in ephemeral or temporary biotopes (see examples in SOUTHWOOD, 1977) and relate to what is known in ecological terminology as « fugitive » (sensu HUTCHINSON, 1951) or « r-strategist » (sensu MACARTHUR and WILSON, 1967) species. Despite the physical disturbance due to young, there is no doubt that *T. palmarum* found in nest no.3 conditions favourable for growing.

Species composition

Regarding the mite assemblage evolving within the nest no. 6, what struck the most was the collection of mites belonging to two orders we did not find elsewhere, i.e. Metastigmata or ticks (1 species, Table 2) and Oribatida (9 species).

While ticks are parasites, Oribatida are primarily soil organisms. From an evolutionary standpoint, oribatid mites, which are among the most important secondary decomposers in the soil (see e.g. WAUTHY, 1982b, for a review), are dwellers of a very ancient, porous substrate (« porosphere » sensu VANNIER, 1983) where energetic, thermic and hydric conditions are substantially stable and predictable.

This leads to the assumption that the presence of oribatid mites within the organic substrate could be related to two causes improving their invasion of the milieu : (1) the cessation of physical perturbations due to the young, in addition to the coming back of thermic conditions more consistent with the ones tolerated by indigeneous species ; (2) the presence of an organic substrate with both better climatic conditions and better physical structure due to plants growing upon the cliff edge. Yet, it must be noted that most populations established within the nest no. 6 belong to strictly saxicolous or arboricolous taxa. The few exceptions relate to species which up to now have been collected only in soils (i.e. *Suctobelbella subtrigona* and *Galumna cf. lanceata*) or to one species (*Micreremus brevipes*) which is a common tree dweller and originates probably from shrubs overhanging the nest.

Origins of the mites living in the nests of birds

The great heterogeneity observed in the mite fauna inhabiting birds' nests is probably directly related to the high diversity of their origins. In this connection, one may recognize three main categories of mites, as follows (see also WOODROFFE, 1953).

1. *Species directly linked to birds.* In this category are the parasitic mites which live upon birds and may be occasionally collected within the nest.

2. *Species introduced into the nest :* (1) with food products (e.g. Acaridae, Glycyphagidae, etc.) ; (2) with prey (diverse ectoparasites of mammals and birds) ; or (3) with coprophagous insects (Diptera or Coleoptera) attracted by the droppings of the birds. These insects may carry hypopi (i.e. heteromorphic deutonymphs) of astigmatid mites or phoretic adults or deutonymphs of some Mesostigmata (e.g. Macrochelidae and Uropoda).

3. *Mites originating from the nest itself.* Some are present in the soil on which the nest is built (e.g. Oribatida) while others are introduced into the nest with the vegetal material used by the bird for making its nest. This is the case for the Dipper (*Cinclus cinclus aquaticus*) which lives in very wet habitats and whose nests are constructed with mosses which usually contain a rich fauna of Prostigmata. Some of these mites are able to survive for a long time in these nests (FAIN *et al.,* 1991).

Astigmatid mites and their evolution

Our current data on mites associated with *Bubo bubo* as well as data gained with other species of birds emphasize the fact that Astigmata clearly characterize and feature in all known mite assemblages found in nests of birds. In addition, as indicated above, several species of mites found in nests are clearly phoretic organisms : they belong either to the order of Astigmata, especially involved in phoresy, or to the order of Mesostigmata. Moreover, most hypopi use insects for moving, but a lot of others attach to hair of mammals with peculiar, very elaborate organs (FAIN, 1969).

Regarding the evolution of Astigmata, it seems very likely that parasitism has started in nests. It has been postulated that all the parasitic Psoroptidia of mammals and all the parasitic Analgoidea of birds could have been derived from the nidicolous Pyroglyphidae (FAIN, 1963). These mites occupy an intermediate position between free-living and parasitic forms. Ecologically, the Pyroglyphidae are still free-living mites. However, from a morphological standpoint, they show all the characteristics of the parasitic Psoroptidia. In this group of mites, it seems, firstly, that the regressive evolution towards parasitism has preceeded the invasion of the host as if there were a « pre-adaptation », and secondly, that this has probably been induced both by the repeated contacts between hosts and mites and by the fact that these mites feed mainly on the corneous material desquamating from the skin of their host (FAIN, 1979).

Structural and temporal organisation of mite assemblages

From an ecological standpoint, only the mite assemblage of nest no.6 appeared to be structurally organized. Indeed, this assemblage showed, in addition to haematophagous parasites feeding directly on birds, all the trophic levels known in decaying systems (predators, phytophagous organisms, and sapro-microbirous ones ; see Table 2).

This observation and previous considerations lead us to propose a possible scenario depicting the mite-bird relationships evolving with time, as follows.

Phase 1. Although no observations on the mite fauna living in any nest site were conducted before the setting up of the nest by the male owl, it could be assumed that the activities of the male (choosing of the nest place, scraping of the substrate, etc.) generate a gap (i.e. a « catastrophe » sensu HOLLING, 1973) for mite populations which inhabit not only the exact place where the nest is burrowed but also its neighbourhood.

Phase 2. From the incubation period and mainly as soon as the young have hatched, the nest is refilled more or less rapidly with organic matter that may be regarded as a milieu chemically (e.g. toxins) and physically (compression, temperature, etc.) disturbed. Clearly, mites do not seem to create resident assemblages within nests during this phase. In addition, the number of species registered in nests as well as their population size does not seem to be linked with the number of young (Table 2). Yet, the too small number of nests studied does not lead us to reject the possibility that mites either develop specific assemblages subject to population change generated by perturbations (see SUTHERLAND, 1981, for examples, and CASWELL and COHEN, 1991, for a model) or might evolve according to successive stages just as it is known in insects inhabiting dung (see e.g. HANSKI, 1980).

Phase 3. Although in this survey only one nest already abandoned by young has been studied (nest no. 6), the observation in it of mites, which were not recorded in other nests before the departure of young, leads us to assume that from the time of departure of the young a population succession could occur in nests. If after the departure of young mites show such population successions, these clearly relate to successions following a perturbation. This means that the rate and pattern of populations occurring successively depend on diverse factors among which the most important, where mites are concerned, appear to be the invasive power and the reproductive traits of species living in the vicinity of the nests (see SOUSA, 1984, for theoretical considerations).

CONCLUSION

The previous scenario is today quite hypothetical, and it is obvious that the survey of a greater number of nests is necessary to confirm or not its relevance.

Yet, at this point of our study of mite-bird relationships, the results herein gained highlight the adequacy of the model « nest of *Bubo bubo* ». Indeed, all else being equal, this model appears to be relatively simpler than the one exemplified by nests of other species of birds. For instance, stronger, both biotic and abiotic perturbations due to the constant addition of organic matter to the nest occur in *Cinclus cinclus* during all the time for which the young grow up. However, due to the localization of nests of *Bubo bubo*, the sampling of organic matter filling in nest depressions is conspicuously difficult (and even dangerous for the sampler!), and has to be carefully conducted in order to not disturb the young.

The model « nest of *Bubo bubo* » will certainly allow a better knowledge of non-parasitic relationships involving in Nature mites and other animals to be inferred, and this is certainly a quite wide programme. Finally, it should also be added that besides the mite fauna inhabiting nests of birds one finds very regularly a varied, sometimes very rich fauna of insects. Relationships prevailing in nests between mites and insects are another fascinating aspect of the study of these peculiar biotopes.

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ACKNOWLEDGEMENTS

Thanks are due to M. R. D. Kime who reviewed the english manuscript. We are also grateful to Prof. Hans-Werner Scheloske, Friedrich-Alexander Universität

Erlangen, Nürnberg, for information about the typical material described by Dr. R. Scheucher and to M. W. Roggeman and Dr. P. Devillers (IRSNB) for support in Eagle Owl investigations.