Parasitol Res (2011) 109:237–240
DOI 10.1007/s00436-011-2390-8

SHORT COMMUNICATION

The first report of *Knemidocoptes intermedius* Fain et Macfarlane, 1967 (Acari: Astigmata) in naturally infected European birds

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Received: 28 March 2011 / Accepted: 6 April 2011 / Published online: 19 April 2011

Abstract According to the latest taxonomical review, the genus *Knemidocoptes* (Epidermoptidae: Knemidocoptinae) comprises 15 species of mites responsible for skin lesions on the face, legs, or body of various wild and domestic birds. A number of 54 common ravens, *Corvus corax* (Aves: Passeriformes: Corvidae) were found dead (accidental poisoning) in March 2009, in Târgu Mureş, Romania. One individual presented bilateral symptoms of scaly leg disease. Microscopic examination revealed the presence of *Knemidocoptes intermedius* (Epidermoptidae, Knemidocoptinae) in one bird. The lesions were present on both feet (bilateral) and consisted of moderate hypertrophic crusts on the dorsal and ventral part of the toes as well as the distal part of the tarsometatarsal region. It is the first reliable record of *K. intermedius* in Europe and also the first record of this species in the common raven. The host range and specificity of this parasite is discussed, along with a revision of occurrences in wild birds.

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According to the latest taxonomical review carried out by Mironov et al. (2005), the genus *Knemidocoptes* Furstenberg, 1870 is a member of the subfamily Knemidocoptinae Dubinin, 1953 within the family Epidermoptidae Trouessart, 1892. Knemidocoptinae currently comprises 15 species grouped in six genera (number of species in parentheses): *Knemidocoptes*—the type genus (five), *Neocnemidocoptes* (four), *Procnemidocoptes* (one), *Picicnemidocoptes* (two), *Micnemidocoptes* (one), and *Evansacarus* (two) (Fain and Elsen 1967; Pence 1972; Fain 1970, 1974; Mironov et al. 2005). The family Epidermoptidae typically includes mites parasitic on the skin surface of birds, but few groups penetrate deeply into the skin or feather follicles of their hosts causing mange-like lesions (Mironov et al. 2005). All stages of these mites occur on the hosts and transmission is usually by direct contact between infected and non-infected birds (Kutzer 1964). Some Knemidocoptinae species are commonly reported from various birds, especially domestic poultry (*Knemidocoptes mutans*, *Neocnemidocoptes laevis*) or caged birds (*Knemidocoptes pilae*). Reports from wild birds are less frequent and known cases refer to Passeriformes, Piciformes, Columbiformes, Falconiformes, and Charadriiformes (Fain and Elsen 1967; Pence 1972; Schultz et al. 1989; Mainka et al. 1994; Miller et al. 2004; Wade 2006).

There are several microhabitats on the host body that may be inhabited by Knemidocoptinae mites. Some species (known as "face mites") invade feather follicles and the stratum corneum of the face and cere (e.g., *K. pilae*, *Micnemidocoptes derooi*). Others (called "scaly leg mites"—e.g., *K. mutans*, *Knemidocoptes jamaicensis*, *Knemidocoptes intermedius*) live under the scales on feet and legs (Langenscheidt 1957). Species within *Neocnemidocoptes*, *Procnemidocoptes*, *Evansacarus*, and *Picicnemidocoptes* genera typically occupy the feather bases on the

birds' body ("depluming itch mites"). There are species that may inhabit different microhabitats on the birds' body in different host species. It is the case of *K. mutans* which is a typical "scaly leg mite" in domestic fowl. However, in some cases, it inhabits also the bare face skin in poultry (Wall and Shearer 2001) and Falconiformes (Schultz et al. 1989). The same situation was described for *K. pilae*, species which can be detected normally on the face but sometimes also on the legs or vent area of budgerigars (Wall and Shearer 2001).

The pathology associated with Knemidocoptinae infection in birds is very diverse, according to the location of the parasites. The conditions are well described in domestic and caged birds. The "scaly leg mite", *K. mutans* of Galliformes causes a white, scaly appearance of the feet which hardens in time and forms a crusty proliferative mass. Heavy infections may cause lameness and deformity of the feet, legs, and claws due to extensive hypertrophy of the stratum corneum (hyperkeratosis). As the disease progresses, birds stop feeding and death may occur (Wall and Shearer 2001). Among "face mites", the most well-known pathology is in budgerigars infected with *K. pilae*, characterized by beak overgrowth and deformity which impairs normal feeding and grooming behavior (Wall and Shearer 2001). The "depluming itch mite" *N. laevis* of domestic Galliformes and Anseriformes burrows into the base of feather shafts particularly on the back, head, and neck causing intense scratching and feather loss (Wall and Shearer 2001). Histologically, the skin inflammation is invaded by heterophyles (Pass 1989).

Our paper reports for the first time the presence of *K. intermedius* in naturally infected birds (*Corvus corax*) from Europe with the description of the gross lesions caused by this mite.

A number of 54 common ravens, *C. corax* (Aves: Passeriformes: Corvidae) were collected on March 28, 2009, in Târgu Mureş, Central Romania (46.5376 N; 24.6088 E). All birds died of accidental poisoning in the previous few days and were transported to the laboratory in order to process a full veterinary survey. One individual presented bilateral symptoms of scaly leg disease. A skin scraping from the hyperkeratotic crusts was performed and cleared in lactophenol. Examination using regular light microscopy showed the presence of Knemidocoptinae mites. Under a binocular microscope, mites were individually collected and washed in 70% ethanol, mounted on slides using the Faure medium (Evans 1992) and examined under Olympus BX51 light microscope with Nomarski Differential Interference Contrast (DIC). Photos were made using a digital camera DP71 and processed by Helicon Focus 5.1.19 Pro and Helicon Filter 4.93.2 software. All measurements were done using the Cell_D v.2.8.1235 software and are given in micrometers (μm). The nomenclature of morphological features and body and leg chaetotaxy follows that of Gaud and Atyeo (1996) adopted for epidermoptoid complex by Mironov et al. (2005).

The *Knemidocoptes* species found on *C. corax* belongs to the group of three *Knemidocoptes* species that are very similar to each other and difficult to distinguish: *K. jamaicensis* Turk, 1950; *K. pilae* Lavopierre et Griffiths, 1951; and *K. intermedius* Fain et Macfarlane, 1967. While *K. pilae* is a common parasite of parrots (Psittaciformes), the two remaining species are found on various Passeriformes, including Corvidae. The main distinguishing features between *K. intermedius* (Fig. 1) and *K. jamaicensis* are significantly larger dimensions of the former species (Table 1).

Out of the 54 examined birds, only one showed hyperkeratotic lesions on feet and claws (Fig. 2). The lesions were present on both feet (bilateral) and consisted of moderate hypertrophic crusts on the dorsal and ventral part of the toes as well as the distal part of the tarsometatarsal region.

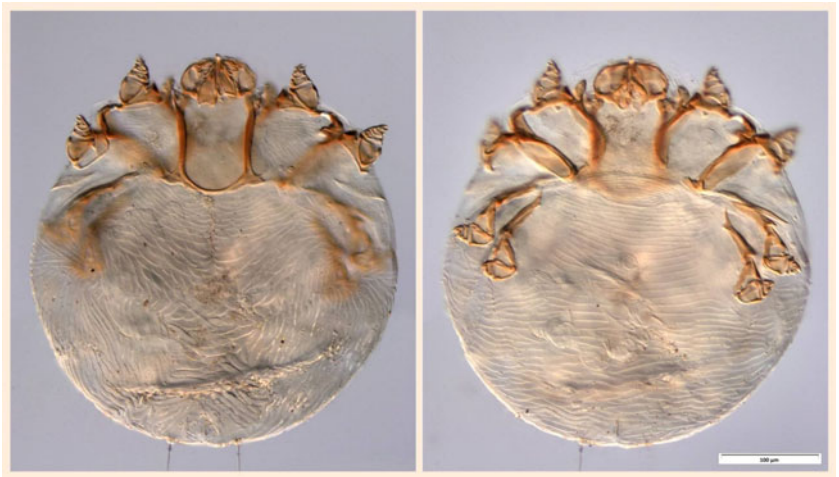

Fig. 1 Female *K. intermedius* from the legs of *C. corax* in Romania. *Left*, dorsal view. *Right*, ventral view (outlines of larvae are visible in the opisthosoma of the female)

Table 1 Comparative morphology of *K. intermedius* and *K. jamaicensis*

Character	*K. intermedius* (after Fain and Elsen 1967)	*K. intermedius* (present study)	*K. jamaicensis* (after Fain and Elsen 1967)
Female idiosoma (L)	414–465	414–455	315–359
Female idiosoma (W)	370–390	360–389	260–330
Propodosomal shield (L)	54–66	53–59	40–46
Propodosomal shield (W)	106–117	109–119	78–99
Chelicerae (L)	42–45	43–44	36–40
Setae cp (L)	10–15	17	6
Setae h2 (L)	118–150	122–124	45–60
Anus (distance from margin)	Subterminal (24–45)	Subterminal (34)	Terminal (–)

L length, *W* width; all sizes are in micrometers)

Knemidocoptes intermedius was described by Fain and Macfarlane (in Fain and Elsen 1967) from the legs of a rufous-breasted accentor, *Prunella strophiata* (Passeriformes: Prunellidae) held captive in a private collection from England. This original account is rather confusing, at least from its epidemiological point of view. The type host, *P. strophiata* was imported in 1961 from the Himalaya region, somewhere between Pakistan and Upper Burma (exact locality not given). Initially, the bird was housed for 18 months together with other birds (species not given) and subsequently transferred to the London Zoo. After 9 months spent in the zoo, the bird was moved to a private collection where it was caged together with a congeneric black-throated accentor, *Prunella atrogularis* (the later bird originated from the Ural Mountains—locality not given). The leg lesions appeared during the 3 years spent together with *P. atrogularis*. Thus, with high probability, the type host of *K. intermedius*, *P. strophiata*, was infected from *P. atrogularis*. Based on the circumstances of its initial find, one may question the geographical origin of the holotype. After its mysterious description, *K. intermedius* has been reported from various passeriform birds (Fain and Elsen 1967; Jaensch et al. 2003; Holz et al. 2005). The single report in Corvidae was from *Corvus tasmanicus* from Australia (Mason and Fain 1988). Other reports of knemidocoptiasis in corvids refer to *K. jamaicensis*, collected from the American crow, *Corvus brachyrhynchos* in USA (Pence 1972) and from the rook, *Corvus frugilegus* in England (Keymer and Blackmore 1964). Thus, the present record of *K. intermedius* is the first collection from the common raven, *C. corax* and, to our knowledge, the first report of this mite species in a wild bird of genuine European origin.

Fig. 2 The gross appearance of the lesions produced by *K. intermedius* in *C. corax*

Among Knemidocoptinae, some species are known as oviparous some as viviparous. However, there are still several species for which the reproductive biology is not elucidated. Our observations show that *K. intermedius* is a viviparous species (Fig. 1, right).

The gross lesions noted by us are consistent with other observations of *K. intermedius* infections in wild birds showing this species is a leg specialist (Fain and Elsen 1967; Mason and Fain 1988; Jaensch et al. 2003; Holz et al. 2005).

Overall, our findings raise two problems concerning the taxonomy and ecology of Knemidocoptinae mites. The very fine and ambiguous morphological differentiation characters between species create a question: are we facing oligoxenous Knemidocoptinae mites parasitizing phylogenetically and geographically distant host species, or are these mites phenotypically indistinguishable cryptic species? This question may be resolved only by means of molecular barcoding (Yang et al. 2011). Secondly, there is probably a serious gap in our knowledge about biodiversity and host specificity of Knemidocoptinae mites even in the relatively well-investigated European region.

Acknowledgments The publication of this paper was supported from grants CNCSIS IDEI-PCCE 7/2010 (to Mihalca A.D. and Sándor A.D.) and POSDRU/88/1.5/S/60185 (to Sándor A.D.).

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