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FATAL *CARYOSPORA* INFECTION IN A FREE-LIVING JUVENILE EURASIAN KESTREL (*FALCO TINNUNCULUS*)

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Infections in birds of prey by *Caryospora* spp. are a common and often serious problem in captive breeding stations (Heidenreich 1996). In British breeding centers, nestlings of Merlins (*Falco columbarius*) fall ill due to infections with *C. neofalconis* (Forbes and Simpson 1997). Typically, symptoms are displayed at an age of 28 to 55 d and may include regurgitation, hemorrhagic feces, depression, and reduced appetite. Peracute or acute death with or without clinical signs may occur also. The possible explanation for this disease in young birds at this particular age is waned maternal immunity and incomplete development of their own active immunity. In experimentally-infected adult Eurasian Kestrels (*F. tinnunculus*) the prepatency of *C. neofalconis* was 8–10 d and the patency 10–93 d, and for *C. kutzeri* 8–13 d and 4–34 d, respectively (Böer 1982). The developmental cycle can be either direct or indirect. In captivity caryosporans apparently utilize the direct life cycle, possibly also using paratenic hosts, such as earthworms (Heidenreich 1996); free-living birds of prey acquire infection by feeding on infected prey (Cawthorn and Stockdale 1982).

Previously, 16 species of *Caryospora* have been described in raptors, 10 from birds in Europe and six from North America, including one which also occurs in Venezuela (Upton et al. 1990, Klüh 1994). Because most publications on *Caryospora* (Yamikoff and Matschoulsky 1936, Wetzel and Enigk 1937, Schellner and Rodler 1971, Böer 1982) consider only captive birds of prey, the distribution and significance of *Caryospora* in free-living birds of prey remains unclear. No *Caryospora* oocyst could be found in 72 free-living Merlins examined in Great Britain (Forbes and Fox 2000), nor in 247 birds of prey (including 35 Eurasian Kestrels, four Hobbys [*F. subbuteo*] and 22 Peregrine Falcons [*F. peregrinus*] from Germany [Krone 1998]). However, *C. boeri* was found in seven of 15 free-living Eurasian Kestrels from Germany in another study (Klüh 1994). Furthermore, in free-living Eurasian Kestrels from Austria, oocysts of *C. falconis* and oocysts of *Caryospora* spp. were diagnosed (Kutzer et al. 1980).

CASE REPORT

A juvenile Eurasian Kestrel observed in Berlin on 29 August 2000 showed distinct signs of a general weakness. The bird was conspicuous, it demonstrated a reduced-flight distance, and when chased away, the bird flew only short distances. On 30 August 2000 the kestrel was captured and a hemorrhagic diarrhea was reported. On the morning of 31 August 2000 the kestrel died. Post-mortem findings indicated a heavy protozoan infection which lead to death from associated severe dehydration and cachexia.

As the bird was banded its history was known. The bird and its clutch mates had been banded on 11 July 2000 at an age of 18–19 d in a nesting box. The bird was found less than 500 m away from the nesting box. The necropsy of the 69-d-old male Eurasian Kestrel revealed a poor condition and a mass of 101 g. A heavy *Caryospora* spp infection (Fig. 1) resulting in a severe hemorrhagic enteritis was documented during the examination of the digestive tract. The highest level of oocysts (ca. 100/visual field at magnification of 200×) were detected in the first third of the jejuno-ileum.

Oocysts were mixed with potassium dichromate solu-

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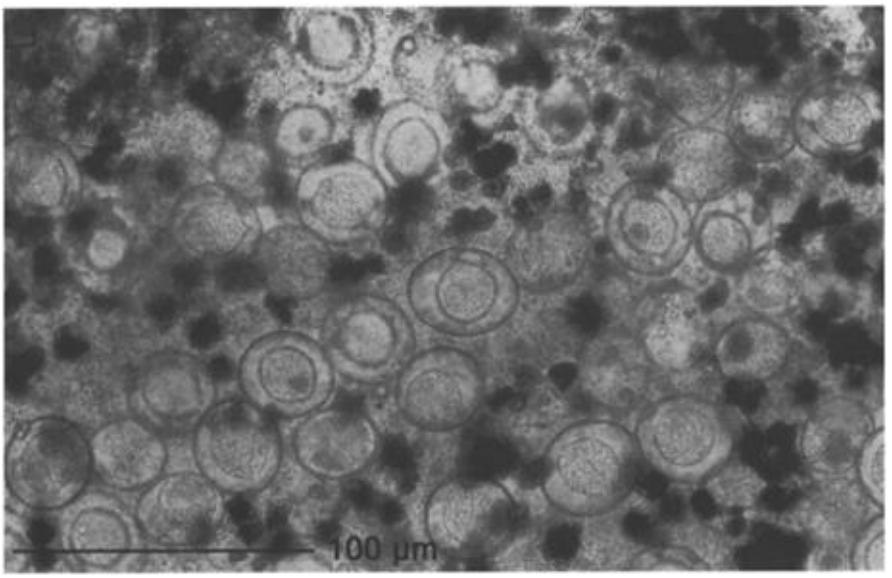

Figure 1. Unsporulated oocysts of *C. kutzeri* from the Eurasian Kestrel (*F. tinnunculus*) found in Berlin, Germany.

tion and sporulated in Petri dishes at room temperature (22–24°C) within three days.

DISCUSSION

The clinical signs including the cachexia are similar to those described in captive-bred birds, in which the disease is well-known. This is the first record of a fatal caryosporan infection in a free-living bird of prey species in Europe. In his survey, Cawthorn (1993) did not identify any cases of a fatal coccidiosis in a raptor, but stated that clinical coccidiosis is uncommon in free-living birds of prey. Measurements of oocysts and sporocysts (Table 1) were within the range for *C. kutzeri* given by Böer (1982). Due to their round oocysts, *C. falconis* and *C. boeri* were excluded as potential candidates. *C. megafalconis* is too large and *C. neofalconis* too small to be considered as candidates in this case. *C. henryae* were described with a triple oocyst wall. *C. kutzeri* is a specific parasite of the genus *Falco* as determined by cross infection experiments with the genera *Buteo, Accipiter, Milvus, Bubo* and *Asio* where transmission was unsuccessful (Böer 1982). Species identification solely based on measurements of oocysts and sporocysts is difficult and uncertain. Five of 10 *Caryospora* species from Europe are still described inadequately or have only been found on one occasion. More reliable identification would be derived from cross-transmission experiments and a comparison using molecular genetics

Table 1. Measurements of *Caryospora kutzeri.*

	LENGTH (µm)	WIDTH (µm)
Oocysts (N = 15) ×	37.58	32.54
SD	3.07	1.77
Range	32.5–43.13	30.0–35.0
Length-width-ratio	1.15	
Sporocysts (N = 15) ×	24.17	21.96
SD	2.45	2.66
Range	18.75–28.75	18.75–28.75
Length-width-ratio	1.1	
Residual body (N = 3) ×	10.8	10.8

The extremely low prevalence of species of *Caryospora* in free-living birds of prey from central Europe contrasts with the high prevalence found in captive birds of prey. Böer (1982) diagnosed a prevalence of 9% of caryosporan oocysts in fecal samples of captive Falconiformes (N = 628) from Germany. In contrast to *Caryospora*, oocysts of *Sarcocystis/Frenkelia* spp. occur at much higher prevalence (31.4%, N = 194) in free-living birds of prey from Germany (Krone 1998). One reason could be that *Caryospora* spp. are found predominantly in young birds at an age of 28–55 d and these birds are examined less frequently than older ones in the wild. Another explanation could be the geographic distribution of the protozoa The parasite may not occur naturally in central Europe, but may have been introduced with birds used for falconry (mainly Saker Falcons [*F. cherrug*]). This would imply that the parasite has its natural nidus in the distribution range of the Saker Falcon and its appropriate intermediate host. If an infected bird is imported into a breeding station, the parasite can infect many other falcons either due to its direct developmental cycle or pos-

sibly via an intermediate host. Cawthorn and Stockdale (1982) have demonstrated that mice (*Mus musculus*) can act as experimental intermediate hosts for *C. bubonis* from the Great Horned Owl (*Bubo virginianus*) in North America. Nothing is known about possible intermediate hosts of *Caryospora* spp. in Europe.

Currently, we do not know whether endemic areas exist around captive breeding facilities where falcons are frequently exchanged, with a high possibility for caryosporan infections to be introduced to wild birds. In captive-breeding programs in which birds of prey, especially of the genus *Falco*, are planned to be reintroduced into the wild, birds should be checked for *Caryospora* spp. before release.

RESUMEN.—Una infección cariospórica fatal fue diagnosticada en un macho inmaduro de cernícalo euroasiático (*Falco tinnunculus*) encontrado moribundo en Berlín, Alemania. Las señales clínicas de esta enfermedad coccidial incluyen diarrea hemorrágica, depresión, y una distancia de vuelo reducida. El ave murió debido a la alta infección de *Caryospora kutzeri* dando como resultado deshidratación y caquexia. En aves de presa silvestres en Europa *Caryospora* spp. no ha sido registrada, mientras que las infecciones en aves cautivas son comunes.

[Traducción de César Márquez]

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