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Survey for Hemoparasites in Imperial Eagles (*Aquila heliaca*), Steppe Eagles (*Aquila nipalensis*), and White-tailed Sea Eagles (*Haliaeetus albicilla*) from Kazakhstan

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ABSTRACT: Prevalence of hemoparasites has been investigated in many avian species throughout Europe and North America. Basic hematologic surveys are the first step toward evaluating whether host-parasite prevalences observed in North America and Europe occur elsewhere in the world. We collected blood smears from 94 nestling imperial eagles (*Aquila heliaca*), five nestling steppe eagles (*Aquila nipalensis*), and 14 nestling white-tailed sea eagles (*Haliaeetus albicilla*) at Naurzum *Zapovednik* (Naurzum National Nature Reserve) in Kazakhstan during the summers of 1999 and 2000. In 1999, six of 29 imperial eagles were infected with *Leucocytozoon toddi.* Five of 65 imperial eagles and one of 14 white-tailed sea eagle were infected with *L. toddi* in 2000. Furthermore, in 2000, one of 65 imperial eagles was infected with *Haemoproteus* sp. We found no parasites in steppe eagles in either year, and no bird had multiple-species infections. These data are important because few hematologic studies of these eagle species have been conducted.

Key words: Aquila heliaca, Aquila nipalensis, Haliaeetus albicilla, hemoparasite, imperial eagle, Kazakhstan, *Leucocytozoon,* steppe eagle, white-tailed sea eagle.

Although eagles have been studied extensively in North America and in parts of Europe, research on parasites of large eagles from Asia is sparse. In fact, an extensive literature search that included foreign language papers revealed studies reporting only *Leucocytozoon toddi* in Germany's white-tailed sea eagle (*Haliaeetus albicilla*) and lesser spotted eagles (*Aquila pomarina*; Krone et al., 2001); and *Leucocytozoon* spp. from lesser spotted eagles in the Czech Republic (Svobodova and Votypka, 1998).

Basic hematologic surveys are the first step toward evaluating whether host-parasite prevalences observed in North America and Europe occur elsewhere in the world. For example, hemoparasites have been linked to decreased body condition of birds during breeding season in many regions (Dawson and Bortolotti, 2000; Merino et al., 2000). Kazakhstan, in the former Soviet Union, is situated at the borders of Asia and Europe. This area supports a remarkably diverse but poorly known raptor community, and to our knowledge, parasites rarely have been evaluated in raptors in this region (Yakunin, 1972).

We evaluated blood parasites from nestlings of three eagle species (imperial eagles [*Aquila heliaca*], white-tailed sea eagles, and steppe eagles [*Aquila nipalensis*]) that coexist at the Nature Reserve in north-central Kazakhstan. The goal of this research was to survey these species for blood parasites that could be transmitted by arthropod vectors, such as locally common mosquitoes and black flies (*Simulium* spp.), found on the nestlings or in the nest material. Such parasites have been shown to have negative effects on the survival of chicks and fledglings, directly or indirectly (Val'kiunas, 1989; McFadzen, 1994; Rohner and Hunter, 1996; Hunter et al., 1997; Evans and Otter, 1998). These data are additionally relevant because each of these species is listed as threatened or endangered on national or international red lists (Kovshar, 1996; IUCN, 2002).

This research was conducted during summers 1999–2000 at the Naurzum *Za-*

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povednik (National Nature Reserve) in the Kostanay Oblast of north-central Kazakhstan (51°N, 64°E). The *Zapovednik* is dominated by pine (*Pinus sylvestris*), birch (*Betula* spp.), and aspen (*Populus* spp.) forest surrounded by dry grassland, shrub-steppe, and wetlands. The forest provides primary nesting habitat for tree-nesting eagles, and all species primarily forage throughout the steppe (Katzner, 2002). Nesting biology could affect ectoparasite and vector density (Ashford et al., 1991). In this region, white-tailed sea eagles nest in pine trees; imperial eagles nest in aspen, birch, and pine trees; and steppe eagles usually nest on the ground. Samples were taken in the course of field work on the ecology and coexistence of these eagle species (Katzner, 2002). Field work for this project was generally conducted during daylight between 9:00 AM and 7:00 PM.

At each nest, we took blood by clipping a talon of eagle chicks and made a thin blood smear using the coverslip-slide method (Campbell and Dein, 1984). The slides from 1999 were not fixed and stained until 1 yr after preparation. In 2000, all slides were fixed in methanol within 24 hr of preparation and stained 6 mo later. Slides were stained with a Wrights-Giemsa quick stain kit (Vol-u-Sol, Salt Lake City, Utah, USA). The staining protocol for avian blood smears was 5 min in stain, 5 min in buffer, and ten 1-sec dips in rinse. We scanned the entire slide under low power (10×) for microfiliaria and *Trypanosoma* sp. We then scanned the continuous monolayer area for 30 min under oil immersion (100×) for other hemoparasites.

During both years, blood samples were collected from most chicks when they were between the ages of 30 and 50 days. In rare occasions ($n<10$), we climbed into nests and sampled chicks that were 20–30 days old. During 1999, we bled 29 imperial eagle chicks and four steppe eagle chicks. We also evaluated 18 imperial eagle nests, two steppe eagle nests, and five white-tailed sea eagle nests for ectoparasites and potential hemoparasite arthropod vectors. For both types of invertebrates, we closely examined each chick visually for 5 min, scanning the entire body and checking under feathers and down. We also searched for arthropod vectors in the surface layer of the nest substrate (ca. first 5 cm), where they could fall after feeding on the nestlings. During 2000, we sampled blood from 65 imperial eagles, 14 white-tailed sea eagles, and one steppe eagle. Ectoparasites and arthropod vectors were not evaluated in 2000. Samples were collected with the appropriate Arizona State University protocols (00538R) and with the permission of the associated National Park authorities.

The 1999 slides contained a large amount of white blood cell and red blood cell degeneration because of the delayed fixation. The 2000 slides contained intermittent cellular distribution with no continuous monolayer present. For these reasons, no reliable intensity data could be calculated. However, we were able to calculate prevalence data for both years. Six of 29 (21%) imperial eagles were infected with *L. toddi* in 1999. In 2000, five of 65 (8%) imperial eagles were infected with *L. toddi.* Also in 2000, one of 14 (7%) white-tailed sea eagles was infected with *L. toddi.* Additionally, one of 65 imperial eagles was infected with *Haemoproteus* sp. Steppe eagles had no parasites in either year ($n=5$), although the absence of parasites on a blood smear does not necessarily mean the bird is uninfected because peripheral blood smears can underestimate presence of hemoparasites (Apanius, 1991). No microfilaria were found in either year, although blood smear techniques also can underestimate microfilarial parasite infections (Bennett, 1962).

Individuals of a single species of an unidentified invertebrate ectoparasite were found on the bodies of imperial eagle chicks at nine of 18 (50%) nests surveyed in 1999. Ectoparasites were not found on the bodies of chicks of any other eagle species. However, black flies were found at 15

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of 18 (83%) imperial eagle nests, three of five (60%) sea eagle nests, and one of two (50%) steppe eagle nests. It is not known whether this particular black fly species is a vector species for *L. toddi.* Nevertheless, black flies have been reported as a vector for blood parasites in other raptor species (Smith et al., 1998). Black flies were present at each of the four sites where both blood parasites were found and arthropods were evaluated. The unidentified ectoparasites were found at one of those nests.

Typically, chicks have a higher intensity of parasitic infection than adult birds during the initial acute infection period (Garnham, 1966; Davidar and Morton, 1993; Allander and Bennett, 1994; Fedynich et al., 1995; Allander and Sundberg, 1997). Infected adults usually have reached an equilibrium state with the parasite through acquired immunity by previous exposure (Allander and Bennett, 1994). Fatalities attributed to parasitic infections usually occur within the first year of infection (Davidar and Morton, 1993; Evans and Otter, 1998). As such, our results might overestimate the blood parasite prevalence in the postfledgling population of imperial eagles.

Differences in parasitic infection occur for many reasons, including variations in parasite resistance (Bennett and Bishop, 1990; Figuerola et al., 1996), breeding biology (Kucera, 1981; Hollmen et al., 1998), or vector density (Ashford et al., 1991). When variability of resistance has been implicated, molting patterns, immune function, geographic range, and microhabitat use all have been implicated as potential causative agents for this variability (Post and Enders, 1970; Tella et al., 1999; Deviche et al., 2001). These factors also could have contributed to the differences that we observed within this eagle association. However, the small size of our sample of steppe and white-tailed sea eagles should be remembered when interpreting our results.

Others have shown links between arthropod vectors and hemoparasite presence (Smith et al., 1998). Although those links might exist in this system, we did not find blood parasites in all nests where we observed black flies. Future studies into the immune system, breeding biology, and nesting differences of steppe eagles compared with imperial eagles and white-tailed sea eagles might explain the hemoparasite differences we observed among these Central Asian eagles.

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