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Coccidial Infection in Mouflon, *Ovis musimon*, in Central Spain

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ABSTRACT: From February to September 1993, ten adult female mouflons (*Ovis musimon*) and their five offspring from central Spain were examined weekly for coccidial infection. All adult mouflons had *Eimeria* spp. infections with mean (±SD) intensity of 1,869 (±1,264) oocysts per gram of feces the day of capture, increasing progressively during the first two months in captivity and later returning to the initial values (1,869 ± 1,547). The mean (±SD) oocyst shedding in young animals was 16,800 (±966) oocysts per gram at 1 mo and 18,796 (±1,220) at 1.5 mo of age and more than 40,000 (40,250 to 52,000) at 3 mo of age; this high intensity was associated with a transient diarrhea. The species involved, in order of frequency, were *E. bakuensis* (syn. *Eimeria ovina*), *E. ovinoidalis, E. crandallis, E. caprovina, E. parva, E. faurei, E. granulosa* and *E. intricata,* and one more not previously described and recorded as *Eimeria* sp.. The predominant species for both age groups was *E. bakuensis.*

Key words: *Eimeria* spp., mouflon, *Ovis musimon,* intensity of infection.

Little information is available concerning *Eimeria* spp. infection in mouflon (*Ovis musimon*) and other game species (Levine, 1988). Coccidiosis is very common in sheep and goats, including in Spain (Hidalgo Arguello and Cordero del Campillo, 1987b; De la Fuente and Alunda, 1992). Animal husbandry procedures and other environmental conditions are responsible for epizootics of coccidial diarrhea and for high losses in small ruminant productivity (Foreyt, 1990). Domestic sheep usually have multispecifies coccidial infections and most of the species can be clearly differentiated by the morphological characteristics of the sporulated oocysts (Catchpole et al., 1975). In spite of the high host specificity of *Eimeria* spp., cross-transmission between ovine and caprine species is recognized for *E. pallida, E. caprovina* and for the controversial species *E. punctata* (Levine, 1985). Our objective was to determine the intensity of infection supported by young and adult mouflons and the *Eimeria* spp. involved in it.

Adult mouflons came from a wildlife reserve (400 ha) located in central Spain (El Hosquillo, Cuenca; 2°00′N, 40°30′W, 800 m above sea level), where they coexist with Spanish red deer (*Cervus elaphus hispanicus*) and fallow deer (*Dama dama*). In February 1993, five pregnant (3 to 4-yr-old) and five nonpregnant (1 to 2-yr-old) female mouflons were isolated from the other species. Along the study period they were maintained indoors in a sand floor stable, 200 m^2 in size, and fed with a controlled quantity of a complete ration (Ovinanta®, Nanta S. A., Madrid, Spain) supplemented with barley grain, barley straw, and dry alfalfa. Five offspring of both sexes were born in March 1993. From February to September 1993, fresh fecal samples from these ten adult females and from their offspring were individually collected at 7-day intervals and analyzed by a McMaster modified method as recomended by the British Ministry of Agriculture, Fisheries and Food (1977). After the determination of *Eimeria* spp. oocyst shedding by each animal, fecal samples were incubated in a shallow layer of 2.5% (w\v) aqueous potassium dichromate solution, kept at 18 to 20 C and examined periodically to identify species and to determine sporulation times. When possible, 100 sporulated oocysts from each species were measured with a 40× objective and 10× ocular lens. At least 50 oocysts were observed from each species found in low numbers. Species were identified on the

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basis of morphological and morphometric characteristics described for oocysts of ovine species and for caprine species cross-transmitted to sheep (Pellérdy, 1974; Norton and Catchpole, 1976; Lima, 1980; Levine, 1985).

All adult mouflons were infected by *Eimeria* spp., with a mean (±SD) intensity of 1,874 (±1,264) (range: 466 to 3,900) oocysts per gram of feces (opg) the day of capture. After the first sampling, the intensity increased in all animals to a mean (±SD) of 7,410 (±7,738), ranging from 500 to 25,000 opg. Two months later oocyst output decreased to 2,250 (±2,999) opg (range: 300 to 9,000 opg), stabilizing to 1,869 (±1,547) opg (range: 250 to 4,800) thereafter. Oocyst production was not related to age or time of gestation. In the five pregnant mouflons, no increase was detected 15 days after parturition. Newborn animals were positive at 1 mo of age, shedding a mean (±SD) of 16,800 (±966) and 18,796 (±1,220) opg at 5 and 7 wk of age, respectively, and ranging from 40,250 to 52,000 opg at 3 mo of age. Afterwards, intensities decreased in all young animals and stabilized at 1,783 (±1,014) opg (range: 350 to 2,500) at 6 mo of age. High oocyst intensities (>10,000 opg) were associated with transient diarrhea in young animals but were not found in adults.

The intensity of infection supported by mouflons seemed similar to that reported in sheep and goats in Spain (Hidalgo Argüello and Cordero del Campillo, 1987b; De la Fuente and Alunda, 1992). A postpartum rise in the adults was not detected but oocyst production seemed to be affected by transport and change in breeding conditions as evidenced by the increase detected during the first 2 mo they were maintained in captivity. High intensity following changes in social environment, nutrition, or travel stress has been reported in other host species (Gregory, 1990) and higher incidence of coccidial infection and reinfection is associated with indoor housing (Foreyt, 1990). The rate of oocyst production in young mouflons was similar to that observed in naturally acquired infections in lambs but with intensities ten times lower in mouflon (Pout, 1973). As observed in domestic sheep (Pout et al., 1966), parent mouflons do not reflect in their feces the high environmental contamination produced by young mouflons.

We observed nine species of *Eimeria* as identified by their morphological characteristics: *E. ahsata, E. bakuensis* (syn. *E. ovina*), *E. granulosa, E. crandallis, E. intricata, E. faurei, E. ovinoidalis, E. parva* and *E. caprovina* (Table 1). Oocysts with morphological characteristics not previously described in sheep or goats were detected in adult mouflons and recorded as oocysts of *Eimeria* sp. (Figs. 1 and 2). Although in a very low intensity (1% of total population of oocysts), they were detected in fecal samples of all adult mouflons and throughout the whole study period. These oocysts measured 31 to 34 μm by 19 to 24 μm (mean: 32 by 23 μm), they were ovoid or ellipsoid, with a 5 to 6 μm wide micropyle covered by a 7 to 8.5 μm wide by 0.6 to 1.5 μm long (mean: 1 by 8 μm) transparent cap (Fig. 1). Sporulated oocysts possessed an oocyst residuum, about 2 μm in diameter (Fig. 1). Sporocysts measured 12 to 13 μm by 7 to 8 μm. The sporocyst residuum consisted of a compact group of granules and the sporozoites enclosed one or two clear globules.

Eimeria bakuensis was the predominant species in the two groups of age (67% and 57% of total oocysts in adult and in young animals, respectively) followed by *E. ovinoidalis* in adult (18% of total oocysts) and *E. ahsata* in young mouflons (21% of total oocysts). *Eimeria crandallis* was more frequent in young than in adult mouflons (12% versus 5% of total oocysts). Neither *E. ahsata* in adult animals, nor *Eimeria* sp. in young mouflons were detected. *Eimeria intricata* was detected only in the fecal samples of one adult animal and not until reaching 3 mo of age in young ones. *Eimeria faurei* and *E. parva* were detected

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TABLE 1. Morphometric characteristics of the oocysts of nine *Eimeria* spp. detected in fecal samples of mouflons from central Spain, 1993.

Species	Oocyst (μm)	Shape index	Sporont (range μm)	Micropyle	Micropyle cap (μm)	Sporocyst (μm)	Sporulation time (hr)
E. ahsata	42 × 25[a] (40–43 × 22.5–28)	1.49 ± 0.1[b]	19–20[c]	+[d]	2.7 × 10[a] (2–3.5 × 8–11)	20 × 8.6[a] (18–21 × 7–10)	72–96
E. bakuensis	31 × 21.8 (30–35 × 17.5–22)	1.68 ± 0.1	15–17	+	2 × 7 (1.5–3 × 5–8)	16.5 × 7 (13–18 × 6–8)	48–72
E. faurei	32 × 23 (25–38 × 20–27)	1.38 ± 0.1	15–17	+ (2.5)	–	13.9 × 9.2 (11–15 × 8–9)	72–96
E. granulosa	29 × 20 (28–31 × 19–22)	1.44 ± 0.1	15–16	+	2 × 7 (1.5–3 × 5–8)	13 × 8.6 (12–15 × 7–9.5)	72–96
E. intricata	50 × 40.3 (48–52 × 39–42)	1.25 ± 0.08	22–24	+	4 × 14 (3–4.5 × 13–15)	20 × 11 (18–22 × 13–10)	120–144
E. crandallis	22 × 18 (20–26.5 × 15–20)	1.25 ± 0.07	14–15	+	0.8 × 4.6 (0.7–1 × 4.6)	10.6 × 7.3	72–96
E. ovinoidalis	25 × 20.8 (27–28 × 18.7–22.5)	1.20 ± 0.07	16–18	+	–	12.5 × 7.9 (10–15 × 6–8)	72–96
E. parva	17.8 × 16.5 (17.5–22.5 × 15–18)	1.26 ± 0.1	12	–	–	10 × 7	48
E. caprovina	27.7 × 22.4 (28–31 × 20–23)	ND[e]	17	+ (6.5)	–	12.5 × 7.9	72–96

[a] Mean (ranges).
[b] Mean ± SD.
[c] Range.
[d] +, present (size); –, absent.
[e] ND, not done.

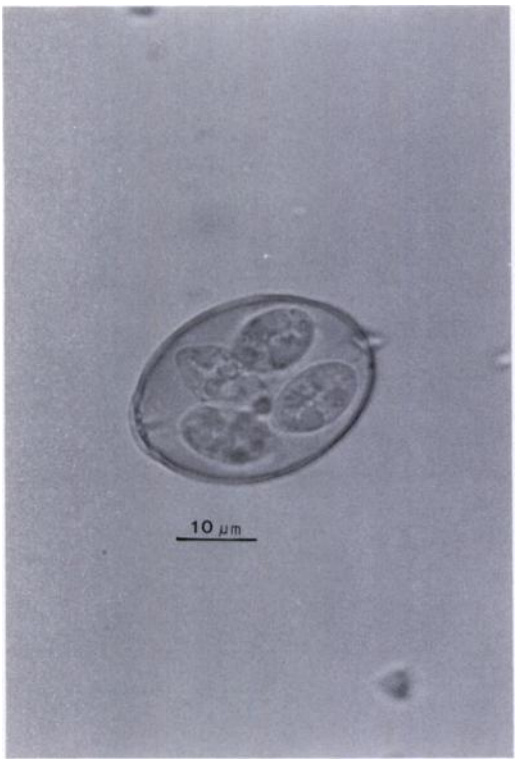


FIGURE 1. Photomicrograph of the oocyst of *Eimeria* sp. detected in fecal samples of mouflon from Central Spain, 1993.

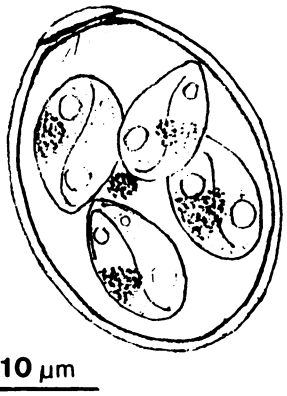


FIGURE 2. One drawing of oocyst from Figure 1.

in all animals but in a low intentisy (1% and 3% of total oocysts, respectively).

Of interest is the detection in fecal samples of young and adult mouflons of *E. granulosa* (1 to 4% of total oocysts) and *E. caprovina* (1 to 3% of total oocysts), species not previously described in mouflon (Levine, 1988). *Eimeria caprovina* has been identified as a goat species (Lima, 1980) and, although experimentally transmitted to domestic sheep, it has not been reported in natural infections in *Ovis* spp. (Levine, 1988).

Eimeria bakuensis and *E. ovinoidalis* also were the predominant species detected in adult mouflons in Bulgaria (Golemanski and Yusev, 1977) and in natural infection in domestic sheep (Catchpole et al., 1975). *Eimeria ahsata*, *E. faurei* and *E. parva* accidentally were detected in mouflon in Bulgaria (Golemanski and Yusev, 1977), whereas similar parasite intensity to that detected in young mouflons has been reported for *E. ahsata* in adult sheep in Spain (Hidalgo-Argüello and Cordero del Campillo, 1988). In contrast to what was observed in mouflon, *E. faurei* and *E. parva* are very common in domestic sheep (Catchpole et al., 1975; Hidalgo-Argüello and Cordero del Campillo, 1985). *Eimeria crandallis*, *E. granulosa* and *E. intricata* intensities detected in mouflon were quite similar to those reported in domestic sheep in Spain (Hidalgo-Argüello and Cordero del Campillo, 1984, 1986, 1987a).

In spite of the great number of species identified, *E. pallida* and *E. weybridgensis*, which are common in domestic sheep (Pout et al., 1973; Catchpole et al., 1975), were not detected in mouflon sheep. Also, oocysts with the morphological characteristics described for the ovine coccidial species *E. gonzalezi* or *E. marsica* were not detected in fecal samples of mouflon.

Of interest is the detection of oocysts with a partial similarity to *E. bakuensis*, but with a lower and transparent micropyle cap and oocyst residuum. Other structural characteristics, as the size of sporocysts and the sporocyst residuum, also are quite different from *E. bakuensis* (Table 1, Figs. 1 and 2). We have not found reports about an *Eimeria* sp. with similar characteristics in small ruminant species. Although oocyst morphologic characteristics can be a variable according

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to the status of the host, the high differences between these oocysts and those previously described point to the possibility of a new species whose identity will be further investigated. A type specimens was deposited as phototypes with the reference MNCN No. 35.01/1 into the Museo Nacional de Ciencias Naturales, Madrid.

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