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Research article

PARASITIC INFECTIONS IN CAPTIVE ELEPHANTS IN ALGERIA (NORTH AFRICA): A FIRST COPROLOGICAL REPORT

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Due to sequestration and anthropogenic stress factors, as in zoopark conditions, animals held in captivity are more likely to contract pathogen infections, particularly parasites. Animal health management in zooparks requires regular monitoring of the infection status, especially for gastrointestinal parasites, to guide the zoopark decision makers in making targeted interventions. For conservation purposes, this becomes more important when we deal with endangered species, such as the African elephant (*Loxodonta africana*), which is categorized as endangered on the IUCN Red List. Hence, this study aimed at the gastrointestinal parasite status in elephants hosted at the Ben Aknoun zoopark in Algeria. For that, a coprological survey was conducted from October 2020 to June 2021.A total of 90 fresh fecal samples were collected and analyzed using tube flotation and McMaster techniques. Parasite prevalence, intensity, and infection levels were calculated, and seasonal variations were also evaluated. Three parasite genera were identified: *Oxyuris*, *Anoplocephala*, and *Strongyloides*. *Oxyuris* and *Anoplocephala* showed a prevalence of 100%, indicating continuous exposure. However, *Strongyloides* was only detected in 36.7% of samples, with a significant peak in winter. Mean egg counts differed significantly among genera, with *Oxyuris* showing the highest burden, (5,443 eggs per gram, EPG) and infection level (L4: 94.4%), followed by *Anoplocephala* (1,142 EPG; L3: 78, 90%), while *Strongyloides* remained low (26.1 EPG; L1:26,7%-L2:10%).The results of this first coprological survey of gastrointestinal parasites in captive elephants in the Algerian and north African geographical area highlight the importance of regular fecal monitoring, improved hygienic management, targeted treatment strategies, and a One Health approach to enhance animal welfare and support conservation efforts.

Keywords: Captive elephants, gastrointestinal parasites, coprology, infection levels, One Health

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INTRODUCTION

Globally, wildlife diversity is decreasing, and animal populations are threatened by multiple factors, which may be abiotic (climate change, human activities) or biotic, such as pathogens, especially parasites, particularly in semi-captive or captive conditions [1].

Parasitic infections are encountered worldwide across diverse wildlife species. In North Africa, several studies have been conducted on different animal groups, including carnivores and rodents [2], antelopes [3], birds [4], and Erinaceidae [5], among others. Nevertheless, such studies are rare or absent in other wildlife species, particularly elephants in this geographical area. Recent advances in wildlife parasitology have further highlighted the scarcity of data on parasite distribution and epidemiology in wild animal populations. For instance, [6] reported the occurrence and geographical expansion of Setaria tundra in wildlife hosts, emphasizing that parasitic infections may remain underdiagnosed despite their epidemiological relevance. These findings underline the importance of continuous epidemiological surveillance of parasitic infections in both wild and captive animals in order to better understand their distribution dynamics and transmission patterns.

Elephants are the largest terrestrial mammals and among the world's most iconic yet endangered species [7]. Only three species remain: the Asian elephant (*Elephas maximus Linnaeus*, 1758), the African savanna elephant (*Loxodonta africana* Blumenbach, 1797), and the forest elephant (*Loxodonta cyclotis Matschie*, 1900) [8]. In captivity, elephants are highly susceptible to infectious diseases due to confinement, limited space, and inadequate hygiene conditions, which favor the persistence and transmission of gastrointestinal (GI) parasites [9-10]. Parasitic infections can also influence population dynamics and biodiversity, particularly when habitat fragmentation and animal translocation increase interspecific contact [11].

Zoological facilities play essential roles in conservation, education, and research, but may inadvertently facilitate parasite transmission due to high animal density, environmental constraints, and captivity-induced stress [12]. Imported animals may introduce exotic parasites, and cross-transmission between captive wildlife, local fauna, and zoo personnel has been documented, posing a potential public health risks under a One Health framework [13-15]. Helminths such as *Oxyuris*, strongyles, and *Anoplocephala*, as well as protozoa, are commonly reported in captive elephants and may negatively affect body condition and welfare [16-18]. Studies in Sri Lanka, Thailand, and China show that even small captive populations may harbor diverse parasite communities, influenced by husbandry practices, environment, and host density [11,19-20]. Parasitic infections may vary seasonally depending on climate, diet, and stress, emphasizing the need for year-round coprological monitoring to anticipate infection peaks and implement targeted control strategies [12,21-22].

To date, no data are available on gastrointestinal parasitism in captive elephants in Algeria. This study aimed to (i) inventory GI parasites at Ben Aknoun Zoological Park,

(ii) determine their prevalence and richness, (iii) assess parasite burden and infection intensity, and (iv) identify associated risk factors, providing baseline data to support improved veterinary.

MATERIALS AND METHODS

Animals & Sampling

All fecal samples were collected non-invasively, following strict animal welfare guidelines. The study was conducted at Ben Aknoun Zoological Park (BZP), Algiers, Algeria. Fresh fecal samples (100 g each) were collected bi-monthly from October 2020 to June 2021, totaling 90 samples from four females and one male. Samples were transported to the Parasitology Laboratory of the Higher National Veterinary School of Algiers and stored at 4 °C until analysis. Parasite eggs were identified using standard morphological keys and standard flotation and McMaster fecal egg count techniques [23]. Infection intensity was classified as Level 1 (EPG < 100), Level 2 (100–499), Level 3 (500–1999), and Level 4 ((≥ 2000).

Terminology and statistical analysis

The prevalence (P %) of each parasite and its intensity were calculated as described by the standardized parasitological vocabulary [24]. Parasitological data were compiled using Microsoft Excel (version 2016). Analyses were performed using Quantitative Parasitology Software v3.0. Comparisons of prevalence and infection parameters by season and gender were conducted using Chi-square tests for qualitative variables (StatView v5.0) and Kruskal–Wallis tests for quantitative variables, according to data distribution. Statistical significance was set at P < 0.05.

RESULTS

Parasite richness and prevalence

Coprological analyses revealed low parasite richness at Ben Aknoun Zoological Park (BZP), with only three genera recorded: *Strongyloides*, *Oxyuris*, and *Anoplocephala* (Table 1). *Oxyuris* and *Anoplocephala* were detected in all samples (100%), whereas *Strongyloides* was found in 36.7% of samples, peaking in winter (56.7%; P = 0.002).

Table 1. Parasite prevalence in elephants, overall and by season

Parasites	Total (n/N,%)	Autumn (n/N,%)	Winter (n/N,%)	Spring (n/N,%)
***Strongyloides* spp.**	33/90 (37)	6/20 (30)	17/30 (56.7)	12/40 (30)
***Oxyuris* spp.**	90/90 (100)	20/20 (100)	30/30 (100)	40/40 (100)
***Anoplocephala* spp.**	90/90 (100)	20/20 (100)	30/30 (100)	40/40 (100)

n/N = number of positive samples / total number of samples; **%** = prevalence.

Parasite burden and infection levels

Oxyuris exhibited the highest mean parasite burden (5,443 EPG) and very high infection level (L4: 94.4%). *Anoplocephala* showed intermediate burden (1,142 EPG; L3: 78.9%), while *Strongyloides* remained low (26.1 EPG; L1:26,7%–L2:10%). Seasonal variations were notable only for *Strongyloides*; *Oxyuris* and *Anoplocephala* maintained consistently high prevalence and infection levels across seasons (Table 2, Figure 1).

Table 2. Parasite load in elephants, overall and by season (Mean ± SD, Min–Max)

Parasite	M ± SD (Min–Max)	Autumn	Winter	Spring
***Strongyloides* spp.**	26.11 ± 41.88 (0–200)	22.5 ± 47.23 (0–200)	36.67 ± 43.42 (0–150)	20 ± 37.21 (0–150)
***Oxyuris* spp.**	5443 ± 2022.9 (900–10050)	5560 ± 1490 (3350–8500)	6455 ± 2027 (2100–10050)	4625 ± 1924 (900–8150)
***Anoplocephala* spp.**	1142 ± 640.05 (200–3200)	1285 ± 724.04 (250–2650)	941.66 ± 498.46 (200–2100)	1221.3 ± 668.51 (250–3200)

M = mean; **SD** = standard deviation; **Min** = minimum; **Max** = maximum.

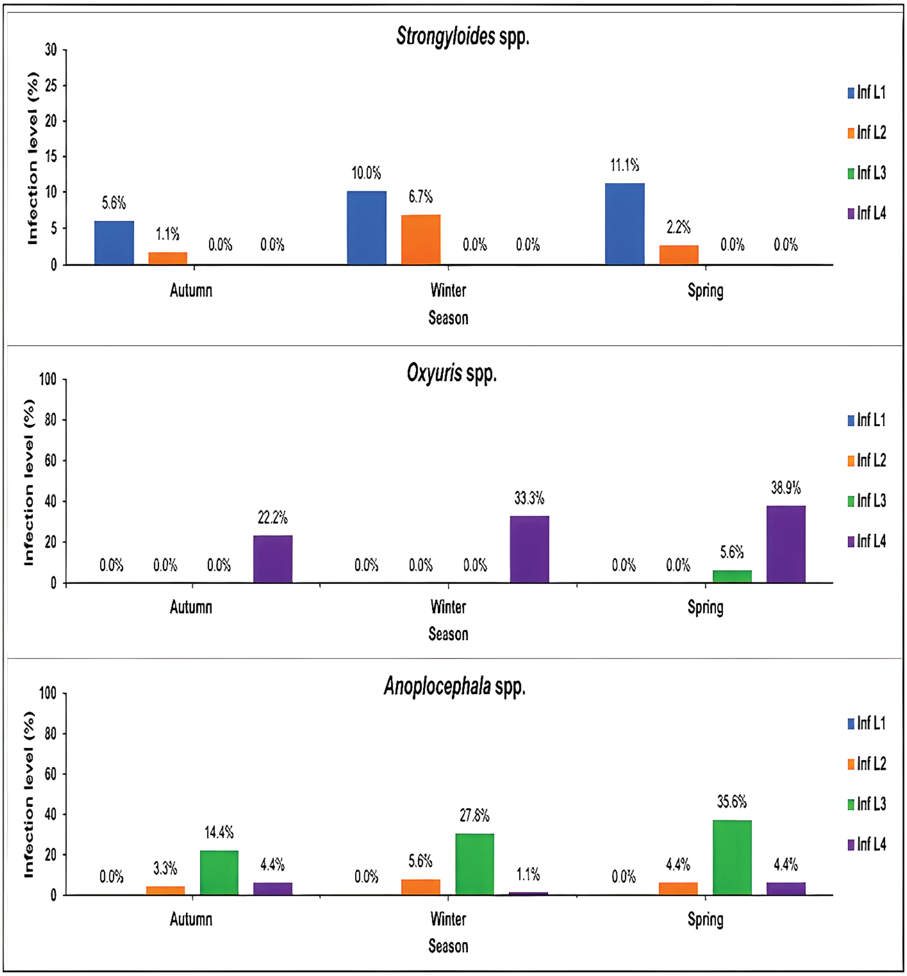

Figure 1. Seasonal variations in infection levels of the three parasite species in elephants

DISCUSSION

Captive elephants are particularly prone to gastrointestinal parasitism due to confinement, limited environmental diversity, and repeated exposure to contaminated substrates [25]. This study provides the first detailed assessment of gastrointestinal parasites in captive elephants in Algeria, filling a knowledge gap for North Africa. Similar issues have been reported in Botswana, Iran, Sri Lanka, Nepal, India, and Bangladesh [16,25-32].

Parasite richness

Parasite richness at BZP was low, with only three genera detected, fewer than the up to ten species reported in Sri Lanka and Nepal [8,32] and slightly lower than earlier records of four genera [19], but similar to observations in Indonesia [33]. Low richness is common in captive populations receiving routine anthelmintic treatments, which reduce diversity while favoring resilient genera such as *Oxyuris* and *Anoplocephala* [34]. Controlled feeding and limited contact with intermediate hosts also reduce opportunities to acquire additional species. Comparable richness (2–4 genera) has been reported in Malaysia and Iran, where management limits exposure to diverse ecological niches [34,35].

Prevalence

The 100% prevalence of *Oxyuris* and *Anoplocephala* reflects continuous exposure and environmental persistence. High prevalence despite deworming is common; studies in Sri Lanka, Nepal, and Bangladesh report 95–100% prevalence for *Oxyuris* [8,9,35]. The winter peak of *Strongyloides* aligns with observations from East Africa, Ethiopia, and Kenya, where moisture favours larval survival [21,36].

Parasite load

Higher burdens of *Oxyuris* and *Anoplocephala* follow typical macroparasite aggregation patterns [34,36,37]. Seasonal increases during cooler, humid periods likely result from improved egg survival and reinfection pressure. Persistently high EPG despite deworming raises concerns about anthelmintic resistance, as observed in zoo ruminants and now in elephants [38,39]. *Oxyuris* females lay eggs around the anus, promoting auto-infection, explaining rapid reinfection and high EPG, consistent with data from India, Thailand, and Iran [19,29,39,40].

Infection level

Oxyuris dominated at very high levels, *Anoplocephala* at high intensity, while *Strongyloides* remained low to moderate [32,36,38]. Seasonal consistency for the two dominant genera suggests stable transmission within enclosures, influenced by environmental conditions and host behaviour [37]. Stable microclimates in captive housing support year-round transmission, as reported in India and Malaysia [33].

Captive elephants at BZP harbor a limited number of gastrointestinal parasite genera but show high prevalence and substantial burdens, especially of *Oxyuris* and *Anoplocephala*. Chronic parasitism may impair gastrointestinal function, reduce body condition, and increase susceptibility to secondary infections, including bacterial and viral diseases [10,28]. From a One Health perspective, persistent contamination poses environmental and cross-species risks, with certain *Strongyloides* species having zoonotic potential [40,41-43]. Persistent high parasite loads suggest possible anthelmintic resistance, inadequate treatment intervals, or ongoing reinfection. Regular parasitological monitoring, targeted treatments, improved hygiene, and adaptive management are essential to safeguard elephant health and welfare.

We hope that this scientific contribution will provide elements of epidemiological interest that will be useful to local decision-makers as well as to enrich global data. Nevertheless, this study should be completed by molecular investigations to get an accurate identification of the parasite at the species level to clarify the host-parasite specificity, track contamination routes, identify the potential parasite reservoirs, and apply an efficient deworming policy.

Authors' contributions

AB conceived and designed the study, performed the methodology, conducted the critical analysis, wrote and revised the manuscript, and gave final approval of the version to be published, while ZO contributed to the methodology and revision.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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PARAZITSKE INFEKCIJE KOD SLONOVA U ZATOČENIŠTVU U ALŽIRU (SEVERNA AFRIKA): PRVI KOPROLOŠKI IZVEŠTAJ

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Zbog sekvestracije kao i antropogenih faktora stresa u uslovima u zoološkim vrtovima, životinje koje se drže u zatočeništvu imaju veću verovatnoću i izloženost, posebno parazitskim infekcijama. Upravljanje zdravljem životinja u zoološkim vrtovima zahteva redovno praćenje statusa infekcije, posebno gastrointestinalnih parazita, kako bi se u zoološkim vrtovima preduzele ciljane intervencije. U svrhu očuvanja, ovo postaje još važnije kada se bavimo ugroženim vrstama, kao što je afrički slon (*Loxodonta africana*), koji je kategorisan kao ugrožen na Crvenoj listi IUCN-a. Stoga je ova studija imala za cilj određivanje statusa prisustva gastrointestinalnih parazita kod slonova koji žive u zoološkom vrtu Ben Aknun u Alžiru. U tom smislu je sprovedeno koprološko istraživanje od oktobra 2020. do juna 2021. godine. Ukupno 90 uzoraka svežeg fecesa je prikupljeno i analizirano korišćenjem flotacije u epruveti i Makmaster tehnikom. Izračunata je prevalencija, intenzitet i nivo infekcije parazita, a takođe su procenjene i sezonske varijacije. Identifikovana su tri roda parazita: *Oxyuris, Anoplocephala* i *Strongyloides*. *Oxyuris* i *Anoplocephala* pokazali su prevalenciju od 100%, što ukazuje na kontinuiranu izloženost. Međutim, *Strongyloides* je otkriven samo u 36,7% uzoraka, sa značajnim vrhuncem u zimskom periodu. Prosečan broj jaja značajno se razlikovao, pri čemu je *Oxyuris* pokazao najveće opterećenje (5.443 jaja po gramu, EPG) i nivo infekcije (L4: 94,4%), zatim *Anoplocephala* (1.142 EPG; L3: 78, 90%), dok je *Strongyloides* ostao nizak (26,1 EPG; L1: 26,7%-L2: 10%). Rezultati ovog prvog koprološkog istraživanja gastrointestinalnih parazita kod slonova u zatočeništvu u alžirskom i severnoafričkom geografskom području ističu važnost redovnog ispitivanja i praćenja, poboljšanog higijenskog upravljanja, ciljanih strategija lečenja i pristupa „Jedno zdravlje“ za poboljšanje dobrobiti životinja i podršku naporima za očuvanje prirode.