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Could Parasitological Investigations Assist in the Diet Assessment of an Endangered Species? Case of the Northern Bald Ibis (*Geronticus eremita*)

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Short communication

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In addition to direct classical methods for assessing diet in wildlife, non-invasive techniques are a suitable alternative, especially in the case of endangered species. As in forensic investigations, a faecal parasitological examination could be a useful approach for a diet assessment in threatened wild birds, such as the Northern Bald Ibis (*Geronticus eremita*). Seven faecal samples were collected from birds from the remaining wild population of Bald Ibis in the Souss Massa region (southwest Morocco). The samples were microscopically analysed, and two of them showed the presence of *Pharyngodon* spp. eggs, which is a ubiquitous intestinal parasite of saurian reptiles. By compiling our findings and the local bibliographic data, we were able to confirm that small endemic Moroccan lizards, especially of the *Acanthodactylus pardalis* group, are among the elements that compose the diet of the Northern Bald Ibis.

Key words: coprology, diet analysis, lizards, Morocco, wildlife conservation.

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Globally, 14% of the avifauna population is threatened with extinction and 47% is in decline (MCCLURE & ROLEK 2020). The Northern Bald Ibis (*Geronticus eremita* Linnaeus, 1758) is one of those threatened birds. It appears on the red list of the International Union for Conservation of Nature (IUCN) as an 'endangered species', whose last main wild population remains in the Souss-Massa region of Morocco (BIRDLIFE INTERNATIONAL 2018).

The study of trophic behaviour is an important element in any conservation programme. It can employ a multitude of means; in particular, direct observation when feeding and inspections of the contents of their gizzards, regurgitates, nests and faeces (TORNBERG & REIF 2007; HORVATH *et al*. 2018; MILLER & PITTMAN 2020; ZAHORODNYI *et al.* 2021). For the faeces, a macroscopic examination is based on an analysis of the undigested fragments found in the bird pellets, as in the case of some raptors (RAE *et al.* 2021). Nevertheless, a diet composition analysis in endangered wild birds could be also done using some novel methods, such as molecular or nuclear techniques (BORRAY-ESCALANTE *et al.* 2020; HOENIG *et al.* 2022). There are also some low-cost alternatives based on a microscopic faecal analysis to search for specific markers, particularly in carnivorous birds; namely, the parasitic forms naturally encountered in their prey! This approach seems particularly helpful in many species of birds that are notorious to have totally digested excrement, which does not allow for the recognition of excreted prey fragments in detail.

Known to be a carnivorous bird, the Northern Bald Ibis feeds on insects, arachnids, small reptiles and amphibians (SERRA *et al.* 2008); hence, our approach was aimed at investigating specific parasites of the birds' prey, by analysing its faeces using coprological microscopy techniques.

Materials and Methods

Seven fresh individual faecal pellets were collected, in the morning, from identified ibises in Tamri's colony (30°41′46″N / 9°49′47″W). The samples were transported to the lab and kept at +4°C until their use. When looking for parasitic nematode eggs, a simple tube flotation test was carried out by mixing 4 grams of faeces with 56 ml of Sheather's solution (DRYDEN *et al.* 2010), and the microscopic observations were done at x100, x200 and x400 magnifications. The egg forms were identified using the morphological identification keys (FOREYT 2001). The image captures and processing were done with the Motic Images Plus 2.0 software.

Results and Discussion

By carrying out the flotation tests, we were able to isolate egg forms, in two of the seven samples, belonging to a nematode parasite (*Pharyngodon* spp.) of lizards. The eggs measured approximately 180 x 50 µm (Figure 1).

Very prevalent in lizards (HALLINGER *et al.* 2019), *Pharyngodon* spp. belongs to the Pharyngodonidae family of the Oxyurida order. It is a ubiquitous and harmless parasite infecting the large intestines of many species of lizards and other reptiles, and is generally considered non-pathogenic in free-ranging conditions (ANDERSON 2000; ROM *et al.* 2018). It is easily distinguishable from avian-specific Oxyurids, which are commonly represented by two rare genera: *Syphaciella* spp. and *Eudromoxyura* spp. (HUGOT 1989; HUGOT *et al.* 1991).

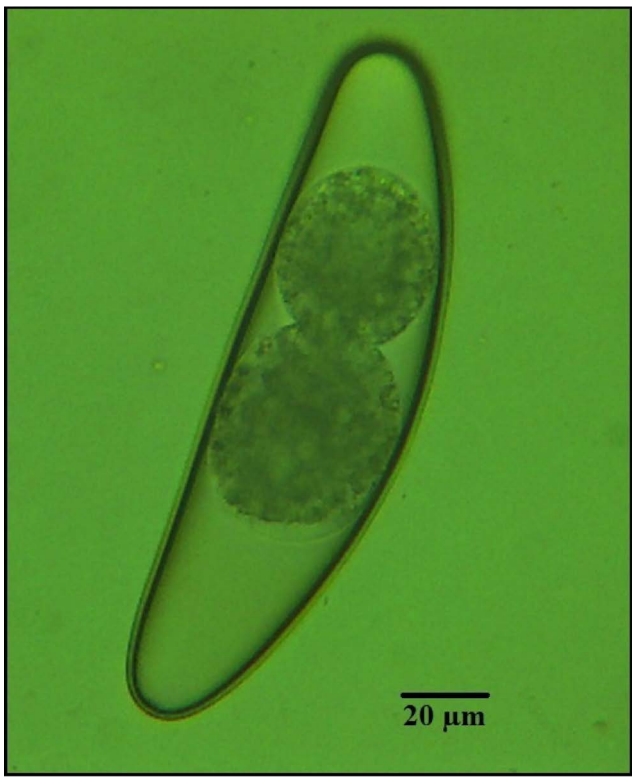

Fig. 1. Original image of two-cell embryonic stage egg of *Pharyngodon* spp.

Finding egg forms of this lizard-specific parasite in the faeces of some individuals of the Northern Bald Ibis leads us to think that this bird could occasionally incorporate lizards into its diet. Being careful, due to the small number of the analysed samples, when we combine this finding with a previous macroscopic study mentioning the presence of fragments of small lizards in Bald Ibis faecal samples (BOWDEN *et al.* 2008) and the documented list of the lizards found in this part of Morocco (BOUAZZA *et al.* 2021), we could suppose that the reported small endemic *Acanthodactylus* lizards, especially the group of *Acanthodactylus pardalis* could be a possible ingredient in the diet of the Northern Bald Ibis. However, the findings of our current study need to be strengthened by another study, possibly covering a larger number of analysed samples and by a molecular identification of the parasites.

As it has already shown its utility in forensic investigations (CARDOSO *et al.* 2017), ecological parasitology is a polyvalent scientific discipline that could serve in many scientific fields, such as the diet assessment of threatened wild birds and in other animal conservation programmes.

Author Contributions

Research concept and design: A.S.; Collection and/or assembly of the data: A.S., W.O. Data analysis and interpretation: A.S., W.O.; Writing of the article: A.S.; Critical revision of the article: W.O.

Conflict of Interest

The authors declare no conflict of interest.

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