



# *Isospora phainopepla* n. sp. (Apicomplexa: Eimeriidae) from *Phainopepla nitens* (Swainson) (Passeriformes: Ptiliognatidae) in the Joshua Tree National Park, USA

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**Abstract** *Isospora phainopepla* n. sp. is described from the faeces of *Phainopepla nitens* (Swainson) collected in Joshua Tree National Park, California, USA. To our knowledge, there are no metazoan or protist parasites described yet from any species in the Ptiliognatidae of the Americas. Sporulated oöcysts of the isosporan are ellipsoidal, 30–35 × 22–29 (32.9 × 25.4) µm, with a length/width (L/W) ratio 1.20–1.35 (1.30); one rice-shaped polar granule is present, but both oöcyst residuum and micropyle are absent. Sporocysts are elongate-ellipsoidal, 22–27 × 11–14 (23.9 × 12.0) µm, with L/W ratio 1.97–2.02 (2.00); prominent Stieda and sub-Stieda bodies are both present, but para-Stieda body is absent. Sporocyst residuum of many scattered granules is present and the sporozoites have prominent anterior and posterior refractile bodies. This parasite is clearly new to science and represents the first species of *Isospora*

hosted by a New World bird species from this small family of silky flycatchers (Ptiliognatidae). This article was registered in the *Official Register of Zoological Nomenclature* (ZooBank) as 7F664B0D-DF0E-4CAD-8CEA-45D79C8BBF92. This article was published as an Online First article on the online publication date shown on this page. The article should be cited by using the doi number. This is the Version of Record.

## Introduction

The Phainoplea, *Phainopepla nitens* (Swainson), is a flycatcher (Aves: Passeriformes: Ptiliognatidae) that inhabits arid woodlands and deserts of southwestern USA and Mexico (Chu & Walsberg, 1999).

The coccidia is a polyphyletic group of parasites, which are all obligate intracellular parasitic protists. Some species are homoxenous and are thought to be reasonably host-specific, while other species have complex heteroxenous life-cycles that involve a broad range of different host species (Tenter et al., 2002). To date, no coccidian species have been identified from any flycatcher in the Ptiliognatidae. Here we describe a new species of *Isospora* from *P. nitens*.

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## Materials and methods

During a two-days trip to Joshua Tree National Park (33°41'42"N, 115°48'7"W; 33°43'26"N, 115°48'51"W; 33°44'51"N, 115°49'36"W; 34°1'49"N, 116°8'49"W; 34°1'45"N, 116°9'3"W), CA, USA, phainopepla birds (*P. nitens*) were observed and photographed. Birds were perched atop mesquite or palo verde trees, and fruiting shrubs. Birds were observed fruiting desert mistletoe (*Phoradendron californicum*) and swallowing berries whole. During photographic sessions at different locations, 5 adult male phainopepla left droppings that we collected. Each fresh faecal sample (with whole mistletoe berries) was placed into a separate 1.5 ml plastic vial containing 2.5% (w/v) potassium dichromate solution (K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>) at a ratio of 1:4 (v/v); each sample was studied under a light microscope (Duszynski & Wilber, 1997). Five days after, samples were placed into petri dishes and maintained at 20–26°C. Morphological observations, photomicrographs and measurements (n = 30) were taken according to Duszynski & Wilber (1997) and Berto et al. (2014a).

## Results

Four of the 5 faecal samples examined (80%) contained oöcysts. Five days after collection of samples, more than 70% of the oöcysts were sporulated (under the conditions used in this study).

### *Isospora phainopepla* n. sp.

*Type-host*: *Phainopepla nitens* (Swainson) (Aves: Passeriformes: Ptiliognaditidae).

*Type-locality*: Joshua Tree National Park, CA, USA (33°41'42"N, 115°48'7"W; 33°43'26"N, 115°48'51"W; 33°44'51"N, 115°49'36"W; 34°1'49"N, 116°8'49"W; 34°1'45"N, 116°9'3"W).

*Type-material*: Oöcysts in dichromate solution, phototypes and line drawings of sporulated oöcysts are deposited and available in the Repository ([www.ibirds.org](http://www.ibirds.org)) of the Institute for Biodiversity Research, Development & Sustainability (iBIRDS). Photographs of the type-host specimens (symbiotypes) are deposited in the same collection. The repository number is ESV-27/2019. Photomicrographs of sporulated oöcysts are deposited and available in the Repository

of iBIRDS ([www.ibirds.org](http://www.ibirds.org)). The repository number is ESV-27/2019.

*Prevalence*: Oöcysts of this species were found in 4/5 (80%) of the fresh faecal samples examined.

*Site of infection*: Unknown. Oöcysts were recovered from fresh faecal droppings.

*ZooBank registration*: The Life Science Identifier (LSID) for *Isospora phainopepla* n. sp. is urn:lsid:zoobank.org:act:01DADE99-E625-4928-9043-8F0376D8D291.

*Etymology*: The specific epithet is derived from the genus name of the type-host.

### Description (Figs. 1, 2)

#### *Sporulated oöcyst*

Oöcysts (n = 30) ellipsoid to ovoid, 30–35 × 22–29 (32.9 × 25.4), with smooth bi-layered wall (c.1.2 thick); length/width (L/W) ratio 1.2–1.35 (1.3). Micropyle absent; one polar granule present, rice-shaped (0.9 × 2.0) (Fig. 2).

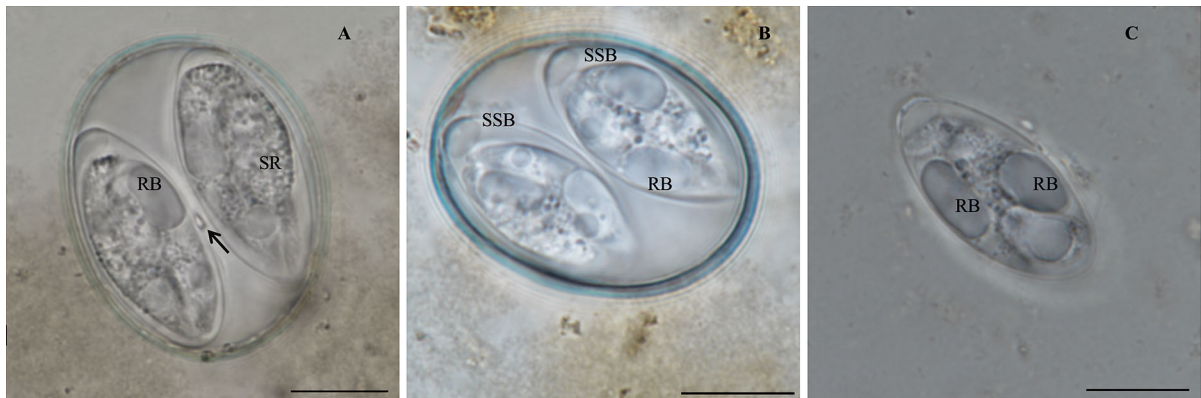
#### *Sporocyst and sporozoites*

Sporocyst (n = 30) bottle-shaped, 22–27 × 11–14 (23.9 × 12.0); length/width (L/W) ratio 1.97–2.02 (2.0). Stieda body present, half-moon shaped (0.75 thick); sub-Stieda body present, rounded, prominent, 2.0–2.4 high × 3.8–4.7 wide; para-Stieda body absent. Sporocyst residuum present, consisting of many spherules of different sizes (0.5–0.8). Sporozoites 4, vermiform, 3.4–3.6 × 16.8–18.1, with posterior refractile body (7.5 in length) and anterior refractile body (2.0 in diameter) (Figs. 1A–C, 2).

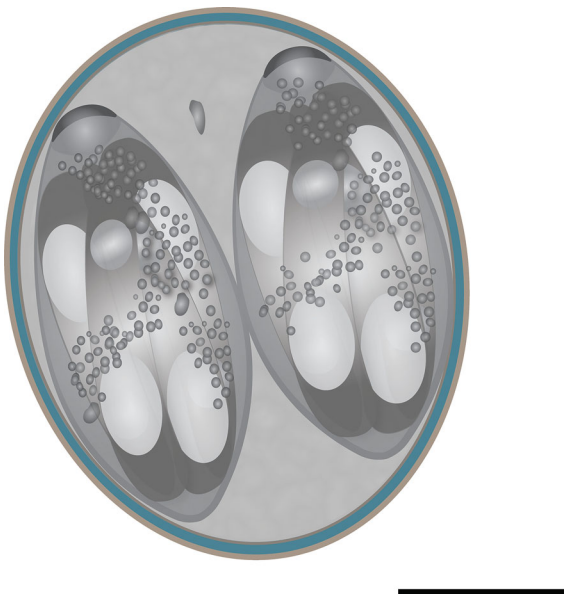
## Discussion

Coccidian species have not been identified previously in any flycatcher species in Ptiliognaditidae of the Americas. Two *Eimeria* species (Soriano-Vargas et al., 2015, 2017; McAllister & Hnida, 2019), and a total of 17 *Isospora* species have been identified from birds of the order Passeriformes in North America (Berto et al., 2011, 2014b; Berto & Lopes, 2013; Salgado-Miranda et al., 2016; Luna-Castrejón et al., 2018).

Mean dimensions of sporulated oöcysts (32.9 × 25.4 µm) and sporocysts (23.9 × 12.0 µm) of *I. phainopepla* n. sp., appear to be larger than those in all



**Fig. 1** Photomicrographs of sporulated oocysts and sporocysts of *Isospora phainoepela*. A, Two sporocysts with a polar granule between them (*arrow*). Both sporocysts residua (SR) and the elongate refractile bodies (RB) of the sporozoites are clearly visible; B, Two sporocysts facing the same direction with sub-Stieda bodies (SSB) clearly visible. C, A single sporocyst released from its oocyst showing the refractile bodies (RB) of two of the four sporozoites. *Scale-bars*: 10  $\mu$ m



**Fig. 2** Line drawing of a sporulated oocyst of *Isospora phainoepela* collected from *Phainoepela nitens*. *Scale-bar*: 10  $\mu$ m

species of *Isospora* identified from Passeriformes in the Americas (Berto et al., 2011; Berto & Lopes, 2013). To date, the larger sporulated oocyst identified (32.1  $\times$  28.9  $\mu$ m) is for *I. bocamontensis* Pereira, Berto, Flausino, Lovato & Lopes, 2011, described from the yellow cardinal *Gubernatrix cristata* (Vieillot) in Brazil (Pereira et al., 2011), and the larger sporocyst identified (23.4  $\times$  11.8  $\mu$ m) is for *I. sayacae* Berto, Balthazar, Flausino & Lopes, 2009, described

from the sayaca tanager *Thraupis sayaca* (Linnaeus) in Brazil (Berto et al., 2009). It appears that *I. phainoepela* n. sp. is the largest *Isospora* species identified in passerines of the New World.

Four of five phainoepela faecal samples contained oocysts of *I. phainoepela*. To establish a more accurate prevalence of the parasite in these natural populations, further studies with a higher number of bird and/or faecal samples are needed. As small berries and flying insects are the main foods taken by phainoepela (Chu & Walsberg, 1999), there is a low possibility that isosporans observed in collected faeces samples were spurious parasites of the phainoepela we photographed and from which faeces were collected. Some of the southern populations of this bird species are located at a desert into the Reserva de la Biósfera Cuicatlán-Tehuacán, Puebla, Mexico (Howell & Webb, 1995). Phylogenetic analysis of isosporans from both phainoepela populations are needed (Ogedengbe et al., 2018).

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**Compliance with ethical standards**

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** All applicable institutional, national and international guidelines for the care and use of animals were followed.

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