

Five New Species of *Isospora* from Hawaiian Birds*

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SYNOPSIS. The following species are described from Hawaiian birds: *Isospora brayi* sp. n., with oocysts $27 \times 26 \mu\text{m}$ and sporocysts $19 \times 12 \mu\text{m}$, from the Japanese white-eye, *Zosterops japonicus* Temminck & Schlegel; *Isospora cardinalis* sp. n., with oocysts $24 \times 23 \mu\text{m}$, and sporocysts $16 \times 10 \mu\text{m}$, from the cardinal, *Cardinalis cardinalis* (Linnaeus); *Isospora ivensae* sp. n., with oocysts $26 \times 25 \mu\text{m}$, and sporocysts $18 \times 12 \mu\text{m}$, from the spotted or white-throated munia, *Lonchura punctulata* (Linnaeus); *Isospora loxopis* sp. n., with oocysts $26 \times 23 \mu\text{m}$, and sporocysts $16 \times 13 \mu\text{m}$, from the amakihi or honeycreeper, *Loxops virens* (Gmelin); and *Isospora phaeornis* sp. n., with oocysts $27 \times 19 \mu\text{m}$, and sporocysts $16 \times 11 \mu\text{m}$, from the omoa or Hawaiian thrush, *Phaeornis obscurus* (Gmelin). All the host birds belong to the order Passeroida.

Index Key Words: *Isospora brayi* sp. n.; *Isospora cardinalis* sp. n.; *Isospora ivensae* sp. n.; *Isospora loxopis* sp. n.; *Isospora phaeornis* sp. n.; Hawaiian birds.

DURING 1978 and 1979 the parasites and other characteristics of wild birds in Hawaii were studied by the junior authors under a contract from the National Park Service to the Cooperative National Park Resources Studies Unit of the University of Hawaii. The present paper is based on a study of fecal samples from 157 wild birds belonging to 14 species.

MATERIALS AND METHODS

The fecal samples were placed in 2% (w/v) $\text{K}_2\text{Cr}_2\text{O}_7$ solution, kept at room temperature for a week to allow any oocysts present to sporulate, stored in the refrigerator at 4 C, and examined for coccidia. Positive samples were forwarded to the senior author for final identification. They were examined after flotation in Sheather's sugar solution. Drawings of oocysts were made at a magnification of 1,250 \times . Measurements were made with a calibrated ocular micrometer.

DIAGNOSES

All measurements are in μm .

Isospora brayi sp. n.

(Fig. 1)

Diagnosis.—Oocysts spherical to subspherical, 27×26 ($26-28 \times 25-27$); wall smooth, colorless, single-layered, 0.5 thick; no micropyle, residuum, or polar granule. Sporocysts ovoid to piriform, 19×12 ($18-21 \times 11-13$); wall smooth, colorless, ~ 0.2 thick; with Stieda body, substiedal body, and prominent residuum composed of large granules; sporozoites elongate, lying lengthwise in sporocysts, with clear globule at one end; sporozoites and sporocyst residuum enclosed together by membrane.

Type Host.—Japanese white-eye, *Zosterops japonicus* Temminck & Schlegel. Hawaiian Islands.

Location in Host.—Unknown; oocysts found in feces.

This species, found in 17 of 59 *Z. japonicus*, is named in honor of Dr. R. S. Bray, Imperial College Field Station, Ashurst Lodge, Sunningdale, Ascot, Berkshire, England.

Isospora cardinalis sp. n.

(Fig. 2)

Diagnosis.—Oocysts spherical or subspherical, 24×23 ($22-26 \times 20-25$); wall smooth, colorless to pale yellowish, single-layered ~ 0.8 thick; no micropyle or residuum; polar granule

present. Sporocysts ovoid, 16×10 ($15-17 \times 10$); wall smooth, colorless ~ 0.2 thick; with knob-like Stieda body and barely discernible substiedal body; with or without small, membrane-bounded residuum; sporozoites sausage-shaped, lying lengthwise in sporocysts, with clear globule at each end and nucleus in middle.

Type Host.—Cardinal, *Cardinalis cardinalis* (Linnaeus). Hawaiian Islands.

Location in Host.—Unknown; oocysts found in feces.

This species was found in one of one *C. cardinalis*.

Isospora ivensae sp. n.

(Fig. 3)

Diagnosis.—Oocysts spherical to subspherical, 26×25 , with smooth, colorless wall, single-layered wall, ~ 0.6 thick; no micropyle or residuum; with polar granule(s). Sporocysts ovoid, 18×12 ($18 \times 11-12$); with smooth, colorless wall ~ 0.3 thick; with Stieda body, without substiedal body; with residuum composed of very small granules, not membrane-bounded; sporozoites elongate, lying lengthwise in sporocysts, with one or more clear globules at ends, with central nucleus.

Type Host.—Spotted or white-throated munia, *Lonchura punctulata* (Linnaeus). Hawaiian Islands.

Location in Host.—Unknown; oocysts found in feces.

This species, found in 3 of 19 *L. punctulata*, is named in honor of Professor Virginia R. Ivens, College of Veterinary Medicine, University of Illinois, Urbana.

Isospora loxopis sp. n.

(Fig. 4)

Diagnosis.—Oocysts subspherical, 26×23 ($25-26 \times 22-25$); wall smooth, colorless, 2-layered; 0.8 thick (each layer 0.4 thick); without micropyle, residuum or polar granule. Sporocysts broadly ovoid, 16×13 ($16-17 \times 12-13$); wall smooth, colorless, 0.2 thick; knob-like Stieda body and granular residuum; no substiedal body; sporozoites elongate, lying lengthwise in sporocysts, with clear globule at each end; sporozoites and sporocyst residuum enclosed in membrane.

Type Host.—Amakihi (honeycreeper), *Loxops virens* (Gmelin). Hawaiian Islands.

Location in Host.—Unknown; oocysts found in feces.

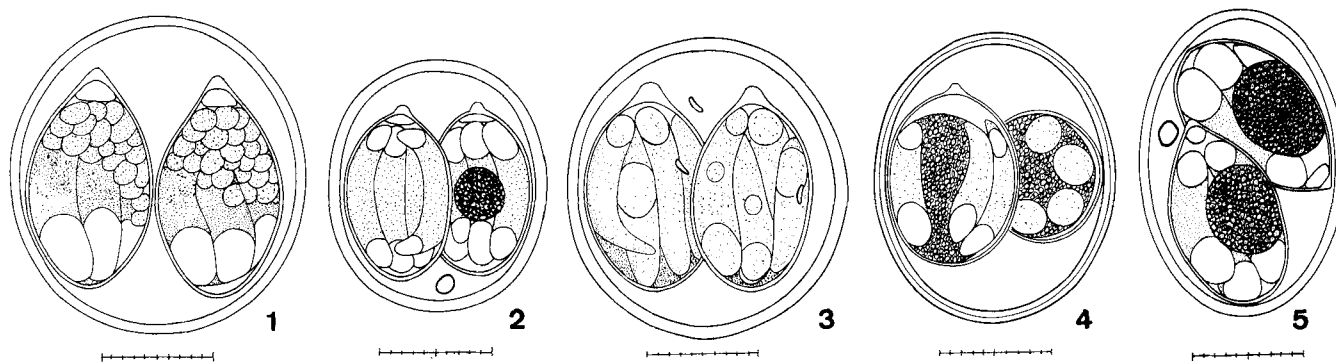
This species was found in 3 of 24 *L. virens*.

Isospora phaeornis sp. n.

(Fig. 5)

Diagnosis.—Oocysts ellipsoidal, sometimes with one side convex and the other almost straight, measuring 27×19 ($25-28 \times 18-20$); wall smooth, colorless to pale yellowish, single-

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Figs. 1-5. [Sporulated oocysts of new species of *Isospora* from Hawaiian birds. Scale line = 10 μm .] 1. *Isospora brayi* sp. n. from *Zosterops japonicum*. 2. *Isospora cardinalis* sp. n. from *Cardinalis cardinalis*. 3. *Isospora ivensae* sp. n. from *Lonchura punctulata*. 4. *Isospora loxopis* sp. n. from *Loxops virens*. 5. *Isospora phaeornis* sp. n. from *Phaeornis obscurus*.

layered, 0.8 thick, lined by membrane; no micropyle or residuum; polar granule present. **Sporocysts** ovoid, 16×11 ($15-18 \times 10-11$); wall smooth, 0.2 thick; with Stieda body and substiedal body; with membrane-bounded residuum; sporozoites sausage-shaped, lying lengthwise in sporocysts, with clear globule at one end.

Type Host.—Omao (Hawaiian thrush), *Phaeornis obscurus* (Gmelin). Hawaiian Islands.

Location in Host.—Unknown; oocysts found in feces.

This species was found in one of 11 *P. obscurus*.

DISCUSSION

All hosts of the aforementioned species of *Isospora* belong to the avian order Passerorida, each to a different family. *Zosterops japonicus* is a member of the family Zosteropidae, *C. cardinalis* of the family Emberizidae, *L. punctulata* of the family Ploceidae, *L. virens* of the family Drepanididae, and *P. obscurus* of the family Turdidae.

The only species of *Isospora* that has been reported from any of the above host species is *Isospora lonchurae* Mandal & Chakravarty, 1964 (2), from *L. punctulata* in India. It differs from *I. ivensae* in being more elongate, having been described as oval and $25-26 \times 21 \mu\text{m}$ and in having a double- rather than a single-layered wall, an oocyst residuum, and a substiedal body in its sporocysts.

The only other species of *Isospora* that has been reported from any of the above host genera is *Isospora zosteropis* Chakravarty & Kar, 1947 (1) from the Indian white-eye *Zosterops palpebrosa* in India. It differs from *T. brayi* in shape and size, having been described as oval, and $18-22 \times 13-20 \mu\text{m}$, a double- rather than a single-layered wall, and smaller, more elongate sporocysts ($15-18 \times 11 \mu\text{m}$ rather than $18-21 \times 11-13 \mu\text{m}$ reported for *T. brayi*).

Negative birds of other species in the present study were 6 *Carpodacus mexicanus* (Say), one *Garrulax canorus* (Linnaeus), one *Geopelia striata* (Linnaeus), 11 *Himatione sanguinea* (Gmelin), 2 *Leiothrix lutea* (Scopoli), 6 *Passer domesticus* (Linnaeus), one *Psittirostra cantans* (Wilson) and 3 *Vestiaria coccinea* (Forster). In addition, unidentifiable unsporulated oocysts were found in the feces of one of 16 *Chasiempis sandwichensis* (Gmelin).

LITERATURE CITED

1. Chakravarty M, Kar AB. 1947. A study on the coccidia of Indian birds. *Proc. Roy. Soc. Edinburgh* **62B**, 225-33.
2. Mandal AK, Chakravarty MM. 1964. Studies on some aspects of avian coccidia (Protozoa: Sporozoa). 2. Five new species of *Isospora* Schneider, 1881. *Proc. Zool. Soc. Calcutta* **17**, 34-45.

BOOK REVIEW . . .

Cook, C. B., Pappas, P. W. & Rudolph, E. D., eds. 1980. *Cellular Interactions in Symbiosis and Parasitism*. Ohio State Univ. Press, 2070 Neil Ave., Columbus, Ohio 43210. xii + 305 pp. \$25.00.

This volume resulted from a colloquium on the subject held at Ohio State University 7-9 September 1978. It contains 13 papers by 17 authors, including papers on host cell invasion by malarial parasites by M. Aikawa; interactions between immunoglobulins and the trypanosome cell surface by J. R. Seed

and M. S. Bogucki; symbiosis of bacteria with *Amoeba* by K. W. Jeon; and symbiosis as parasexuality by L. Margulis. The colloquium participants discussed the establishment of relationships, surface interactions in intact associations and aspects of genetic and metabolic integration of lichens, alga-invertebrate associations, endomycorrhizae and host-parasite associations. Protozoologists can profit not only from the discussions on protozoon-host associations but from those on other associations.—NORMAN D. LEVINE, *College of Veterinary Medicine, Univ. of Illinois, Urbana IL 61801*.