

Five New Species of *Isospora* from Hawaiian Birds*

NORMAN D. LEVINE, SANDRA VAN RIPER and CHARLES VAN RIPER, III

College of Veterinary Medicine and Agricultural Experiment Station, University of Illinois, Urbana, Illinois 61801
and Hawaii Field Research Center, Hawaii Volcanoes National Park, Hawaii 96718

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.

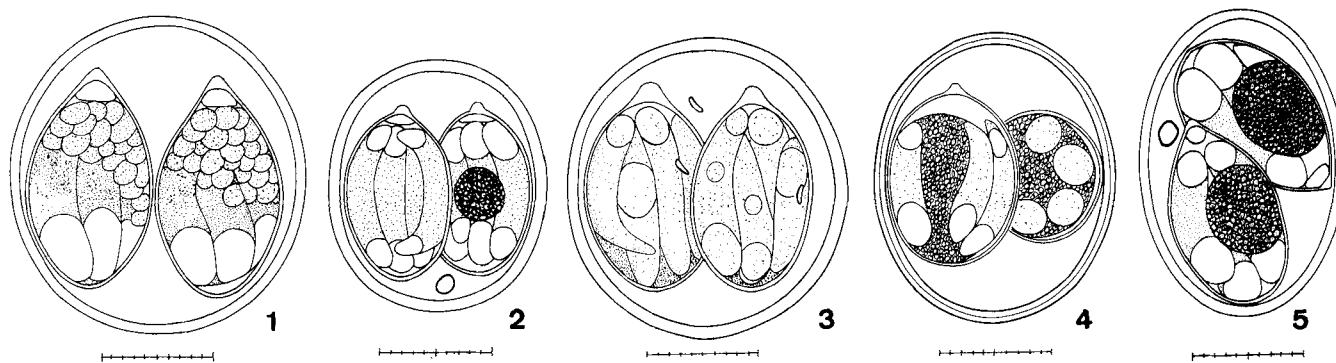
This species was found in 3 of 24 *L. virens*.

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-

* This investigation was supported in part by National Park Service contract CX8000 7 009 to the Cooperative National Park Resources Studies Unit, University of Hawaii, Honolulu and by Research Grant AI 15367-01, from National Institute of Allergy and Infectious Diseases, U.S. Public Health Service.



Figs. 1-5. [Sporulated oocysts of new species of *Isospora* from Hawaiian birds. Scale line = 10 μ m.] 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 $25-26 \times 21 \mu$ 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 $18-22 \times 13-20 \mu$ m, a double- rather than a single-layered wall, and smaller, more elongate sporocysts ($15-18 \times 11 \mu$ m rather than $18-21 \times 11-13 \mu$ 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*.