

A new species of *Choleoeimeria* (Apicomplexa: Eimeriidae) from Oustalet's chameleon, *Furcifer oustaleti* (Sauria: Chamaeleonidae)

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Abstract: One of three (33%) captive specimens of Oustalet's chameleon, *Furcifer oustaleti* (Mocquard) originally from Madagascar and housed at the Oklahoma City Zoological Park Herpetarium, Oklahoma County, Oklahoma, USA, was found to be passing an undescribed species of *Choleoeimeria* in its faeces. Oocysts of *Choleoeimeria fischeri* sp. n. were cylindroidal, 30.3×16.8 ($28\text{--}34 \times 15\text{--}18$) μm , with a smooth, bilayered wall and a length/width ratio (L/W) of 1.8. A micropyle and oocyst residuum was absent but a fragmented polar granule was often present. Sporocysts were ovoidal, 9.6×8.0 ($9\text{--}10 \times 7\text{--}9$) μm , with an L/W of 1.2. Stieda, sub-Stieda, and para-Stieda bodies were absent. The sporocyst residuum consists of large globules dispersed between sporozoites. Sporozoites were elongate, 8.6×2.9 ($8\text{--}10 \times 2\text{--}3$) μm , with an elongate posterior refractile body. The new species represents the second coccidian described from this lizard.

Keywords: Coccidia, *Choleoeimeria*, *Furcifer oustaleti*, Oustalet's chameleon, taxonomy

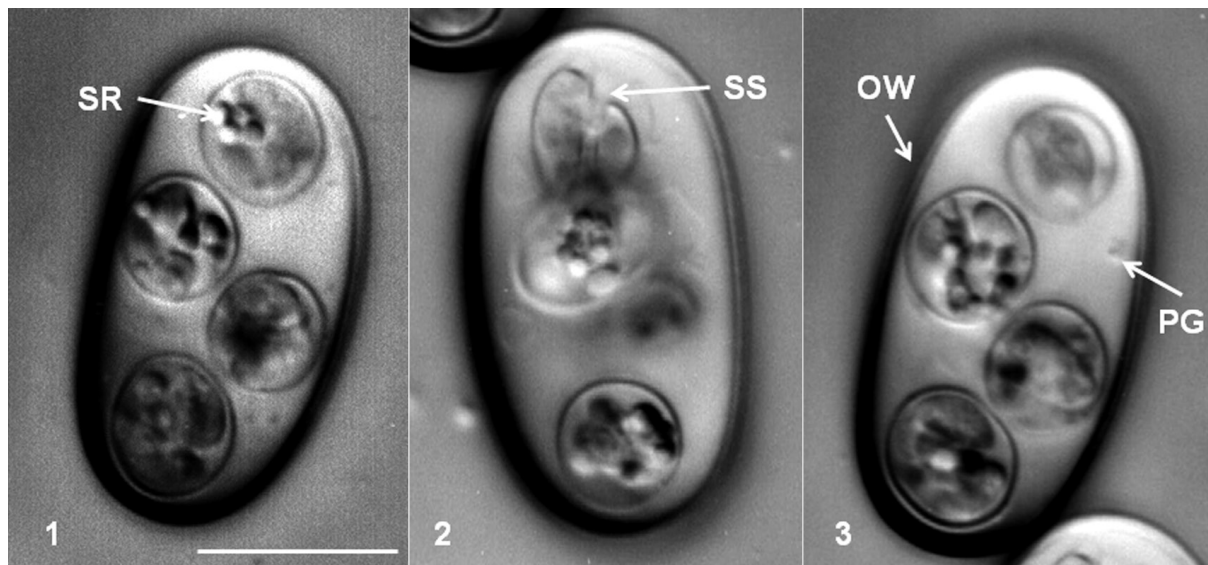
The Malagasy giant chameleon or Oustalet's chameleon, *Furcifer* (= *Chamaeleo*) *oustaleti* (Mocquard, 1894) is a very large species (maximum length = 68.5 cm) that is endemic to Madagascar (LeBerre et al. 2000, Glaw and Vences 2007). It may be found in a wide variety of habitats, most often among degraded areas and agricultural land and human settlements, but also occurs in undisturbed dry forest, montane savannah and, rarely, in tropical rainforest. Its diet includes a variety of invertebrates, especially large insects (LeBerre et al. 2000).

Little is known about the coccidian parasites of *F. oustaleti*. Brygoo (1963) reported endogenous stages of a gall-bladder eimerian from *F. oustaleti* which fit characteristics of the genus *Choleoeimeria* (sensu Paperna et Landsberg 1989) but, unfortunately, did not provide a formal description. In addition, he (Brygoo 1963) provided information on an eimerian from *F. oustaleti* showing stages in intestinal epithelium but, again, did not provide a formal description. These have been variously referred to as *Eimeria* sp. 1 and *Eimeria* sp. 2 of Brygoo, 1963, respectively, on the Coccidia of the World website (<http://www.biology.unm.edu/biology/coccidia/home.html>). A figure of both unsporulated and sporulated oocysts of an unknown eimerian (possibly *Choleoeimeria*) from *F. oustaleti* was provided by Will (1975, fig. 2). Modrý et al. (2001a) described *Eimeria worthi* Modrý, Daszak, Volf, Veselý, Ball et Koudela, 2001 from a single *F. oustaleti* imported from Madagascar by a pet trader. Nothing else, to my knowledge, has been published on coccidia from

this lizard. Herein I provide a description of a new species of *Choleoeimeria* from *F. oustaleti*.

MATERIALS AND METHODS

During February 1993, fresh faeces from three captive adult *F. oustaleti* chameleons housed in quarantine at the Oklahoma City Zoological Park Herpetarium (OCZPH) in Oklahoma City, Oklahoma, were collected for examination of coccidia. These chameleons had originated from an unknown locality in Madagascar. Samples were placed in individual vials containing 2.5% (w/v) aqueous potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) and examined for coccidia by light microscopy after flotation in Sheather's sugar solution (specific gravity = 1.18). A single sample contained fully sporulated oocysts and measurements were taken on 25 oocysts using a calibrated ocular micrometer and reported in micrometres (μm) as the means followed by the ranges in parentheses; photographs were taken using Nomarski interference-contrast optics. Oocysts were ~60 days old when measured and photographed. Descriptions of oocysts and sporocysts follow guidelines of Wilber et al. (1998) as follows: oocyst length (L) and width (W), their ranges and ratios (L/W), micropyle (M), oocyst residuum (OR), polar granules (PG), sporocyst length (L) and width (W), their ranges and ratio (L/W), Stieda body (SB), sub-Stieda body (SSB), para-Stieda body (PSB), sporocyst residuum (SR), sporozoites (SP), refractile bodies (RB), and nucleus (N). Voucher specimens of *F. oustaleti* were originally accessioned into the OCZPH as Nos. 5524-19, 5766-23, and 5816-25. Phototypes of sporulated oocysts were accessioned into the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA. Lizard taxonomy follows the TIGR reptile database (Uetz 2011).



Figs. 1–3. *Choleoeimeria fischeri* sp. n., Nomarski interference-contrast photomicrographs of oocysts. **Fig. 1.** Sporocyst residuum (SR). **Fig. 2.** Sporocyst suture (SS). **Fig. 3.** Oocyst wall (OW); polar granule (PG). Scale bar for all figures = 10 μ m.

RESULTS

One of three (33%) *F. oustaleti* was found to be passing oocysts of an undescribed species of *Choleoeimeria*. The description follows:

Choleoeimeria fischeri sp. n.

Figs. 1–4

Description (based on 25 sporulated oocysts): Oocyst shape cylindroidal; bilayered wall, ~ 1.0 thick, smooth outer layer ~ 0.5 , inner layer ~ 0.5 ; $L \times W$ 30.3×16.8 ($28\text{--}34 \times 15\text{--}18$); L/W 1.8 (1.6–2.1). M and OR absent; PG present, often fragmented. Sporocysts (SP) ($n = 20$) ellipsoidal, $L \times W$ 9.6×8.0 ($9\text{--}10 \times 7\text{--}9$); L/W 1.2 (1.1–1.3); smooth single-layered wall ~ 0.5 thick; SB, SSB and PSB absent; SR ($n = 20$) spherical or subspherical, 4.6×4.2 ($4\text{--}5 \times 3\text{--}5$) composed of 10–12 large globules. SP ($n = 10$) elongate, $L \times W$ 8.6×2.9 ($8\text{--}10 \times 2\text{--}3$) *in situ*, lying along one side of sporocyst. Each SP with ellipsoidal posterior RB ($n = 10$), 3.0×2.4 ($2\text{--}3 \times 2\text{--}3$); single N slightly posterior to midpoint of body.

Type and only host: *Furcifer* (= *Chamaeleo*) *oustaleti* (Mocquard), the Malagasy giant or Oustalet's chameleon (Sauria: Chamaeleonidae); adult female No. 5524-19, weight = 230 g. Individual died of hepatitis on 18 August 1993.

Type locality: Madagascar, detailed locality unknown.

Site of infection: Unknown, probably gall bladder (tissue samples were not available for histological examination).

Prevalence: 1 of 3 (33%) of the chameleons was found to be passing oocysts.

Sporulation: Endogenous. All oocysts were passed in the faeces fully sporulated. Prepatent and patent periods unknown.

Specimens deposited: Photosyntypes deposited as USNPC 104878.

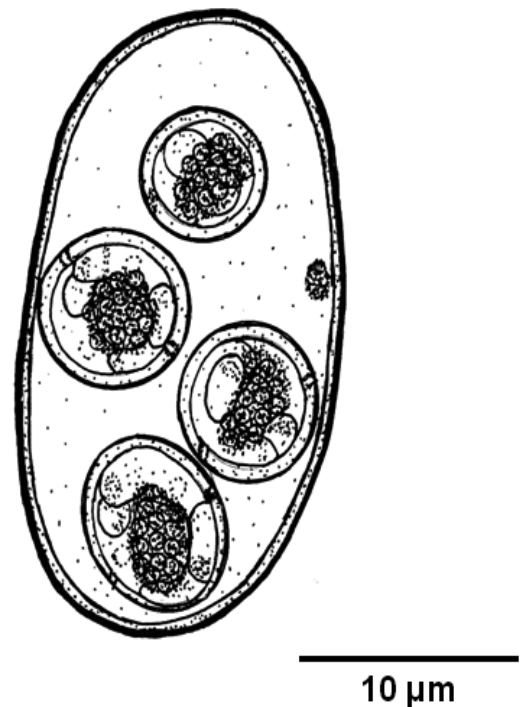


Fig. 4. *Choleoeimeria fischeri* sp. n., composite line drawing of oocyst.

Etymology: The specific epithet is given in honour of Johann von Fischer (1850–1901), former Director of the Düsseldorf Zoo and the Laboratoire d'Erpétologie in Montpellier, for his studies on chameleons (see Murphy 2005).

Remarks. Oocysts of *Choleoeimeria fischeri* sp. n. can be easily distinguished from the only other coccid-

ian (*Eimeria worthi*) previously described from *F. oustaleti* (Modrý et al. 2001a) as they are considerably larger (30.3×16.8 vs. 17.9×15.0 µm) and have a cylindrical (L/W = 1.8) vs. spherical shape (L/W = 1.2). However, oocysts and sporocysts of the new species are most similar to *Choleoeimeria tilburyi* from Jackson's chameleon, *Chamaeleo jacksonii* from Kenya (Modrý et al. 2000) but possess a considerably smaller sporocyst L/W (1.2 [1.1–1.3] vs. 1.5 [1.3–1.7]). Interestingly, although Will (1975) did not provide measurements of the unnamed eimerian from *F. oustaleti*, the L/W of oocysts (calculated from his photomicrograph) averaged ~1.9 (1.8–2.0), which is within the range of the new species. In addition, the new species differs from other eimerians described by Modrý et al. (2000, 2001a, b) and Sloboda and Modrý (2006, see their table 1) from East African and Madagascar chameleons. To my knowledge, no other lizard eimerian has been described with a combination of characters descriptive of the new species.

DISCUSSION

The separate status of *Choleoeimeria* Paperna et Landsberg, 1989, as a sister clade to the Eimeriidae was confirmed by phylogenetic analysis (small subunit rRNA gene) by Jirků et al. (2002). In addition, a taxonomic revision of tetrasporocystic coccidia from chameleons was

provided by Sloboda and Modrý (2006). In that report, these authors provided new combinations of taxa originally described as *Eimeria* spp. from various chameleons (Sloboda and Modrý 2006, table 1), and, subsequently their reclassification in the genus *Choleoeimeria* was 3-fold as follows: (1) those species infecting the biliary epithelium, (2) those possessing cylindrical oocysts, and (3) those with sporocyst sutures. Therefore, these appear to be distinct oocyst and sporocyst features of *Choleoeimeria* (see also Modrý and Jirků 2006) and, as such, the new species, which possesses all three features, is placed in this genus rather than *Eimeria*. However, some (Daszak et al. 2009) have not adopted this classification and suggest that designation of a species to either genus requires examination of the endogenous stages or molecular studies. Therefore, future studies on *Choleoeimeria fischeri* should involve histological examination of endogenous stages in the gall bladder epithelium and/or molecular analyses.

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