ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Three coccidian parasites from Moorish gecko, *Tarentola mauritanica* (Gekkonidae) 2– *Eimeria alexandriensis* n. sp. (Apicomplexa: Eimeriidae)

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Manuscript Info

Manuscript History:

Received: 11 August 2013
Final Accepted: 19 August 2013
Published Online: September 2013

Key words:
Moorish gecko,
Tarentola mauritanica;
Gekkonidae; *Eimeria*.

Abstract

Only three out of twenty geckos were found to be natural hosts of three coccidian parasites: two *Hepatozoon* spp. (only one of them has been previously described) and *Eimeria alexandriensis* n. sp. which is here described. The three infected geckos were captured in Sidi–Krrer, Alexandria Governorate. Freshly–collected oocysts were non–sporulated, colourless, ellipsoidal, with a smooth double–layered wall. Micropyle and oocyst residuum were observed, while polar granules were absent. Oocysts measured 22.7–29.6 µm in length and 14.4–19.5 µm in width, with an average of 26.5–17.0 µm (L×W). Shape index (L/W) was 1.6. Sporocysts were ellipsoidal in shape, measuring 9.6–16.7 µm in length and 5.6–8.4 µm in width, with an average of 13.2×7.0 µm (L×W). Shape index (L/W) was 1.7. Sporocyst residuum and stieda body were present, but substieda body was absent. Sporozoites measured 9.6×4.5 µm in an average size. Sporulation took place within 80 h. at room temperature. Endogenous stages of the parasite were found in the epithelial cells of the middle third of intestine. They were also measured and described.

Introduction

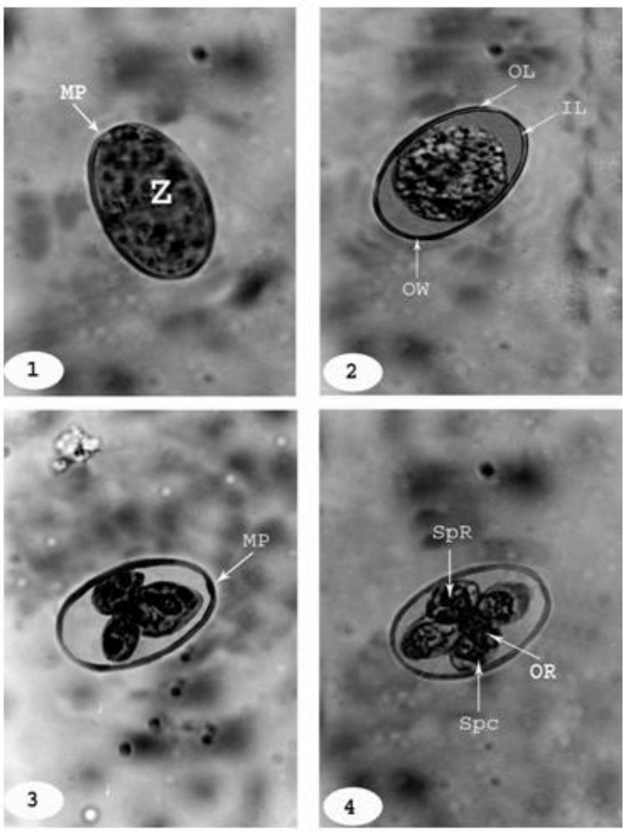
Reptiles are hosts of different coccidian parasites including *Eimeria*, *Isospora*, *Caryospora*, *Cyclospora*, *Cryptosporidium*, *Sarcocystis*, *Haemogregarina* and *Hepatozoon* species. Eimeriid coccidians generally inhabit the intestinal tract, although extraintestinal development has been recorded. In the last two decades, several studies concerning intestinal coccidia infecting reptiles in Egypt have been carried out (e.g. Daszak and Ball, 1991; El–Toukhy, 1994; Sakran *et al*., 1994; Abdel–Gawad, 1994; Abdel–Gawad *et al*., 1995; Abdel–Aziz, 1995, 2001; El–Toukhy *et al*., 1997; Fayed, 1997; 2003 and Abou El–Nour, 2005). The present study describes the exogenous and endogenous stages of *Eimeria alexandriensis* n. sp. parasitizing *Tarentola mauritanica* from Sidi–Krrer, Alexandria Governorate by light microscopy.

Material and Methods

A total of twenty Moorish geckos *Tarentola mauritanica* (Family: Gekkonidae) were collected from both Sidi–Krrer, Alexandria Governorate (10 geckos) and district of Al–Tahreer, Beheira Governorate (10 geckos). Geckos were brought alive to the laboratory and identified according to Saleh (1997). They were microscopically examined for blood and intestinal coccidian parasites. For blood parasites, thin blood films and sections of the infected tissues were prepared, stained and examined as previously described (Abdel–Aziz *et al*., 2010). For intestinal parasites, the alimentary canal of each gecko was removed, divided into segments. Wet smears from intestinal contents (from successive parts), gall bladder as well as kidneys were immediately prepared and microscopically examined. The progress of sporulation was followed up and sporulation time was determined. Sporulated oocysts and sporocysts were carefully examined and measured. For studying the endogenous stages of the parasite, small pieces of liver, gall bladder and of the infected parts of intestine of the positive specimens were immediately fixed in 70 % ethanol. Processing was done by the usual technique. Finally, stained slides were carefully examined microscopically and various developmental stages of the parasite were measured and photographed.

Results

Only three out of twenty geckos were found to be natural hosts of three coccidian parasites: two *Hepatozoon* spp. (one of them have been previously described) and *Eimeria alexandriensis* n. sp. (Apicomplexa: Eimeriidae) which is here presented. The three infected geckos were captured in Sidi–Krrer, Alexandria Governorate and none of the reptiles collected from district of Al–Tahreer, Beheira Governorate were found to be parasitized.



Figs. (1–4): Photomicrographs of **exogenous stages** of *Eimeria alexandriensis* n. sp. naturally infecting *Tarentola mauritanica*. **(1):** Fresh non–sporulated oocyst. **(2&3):** Events during sporulation. **(4):** Sporulated oocyst. IL=Inner layer of oocyst wall; Mp=Micropyle; OL=Outer layer of oocyst wall; OR=Oocyst residuum; OW=Oocyst wall; Spc=Sporocyst and SpR=Sporozoite; Z=Zygote. All photos x 1500

***Eimeria alexandriensis* n. sp.**

Exogenous stages (Figs. 1–4)

Oocysts of *Eimeria alexandriensis* were seen in the intestinal contents. Freshly–collected oocysts were non–sporulated (Fig. 1) and colourless. They were ellipsoidal in shape, with a smooth bilayered wall, each layer measured about 0.5 µm in thickness. Micropyle and oocyst residuum were observed. Oocysts measured from 22.7–29.6 µm in length and 14.4–19.5 µm in width, with an average of 26.5–17.0 µm (L×W). Shape index (L/W) was 1.6. Sporocysts were ellipsoidal, measuring 9.6–16.7 µm in length and 5.6–8.4 µm in width, with an average of 13.2×7.0 µm (L×W). Shape index (L/W) was 1.7. Sporocyst residuum and stieda body were present, but substieda body was not observed. Sporozoites measured 9.6×4.5 µm in an average size. Sporulation occurred outside the host within 80 h. at room temperature. Different sporogonic stages of the parasite: condensation and cleavage of cytoplasm, sporocyst formation and sporozoite differentiation were recognized (Figs. 2–4).

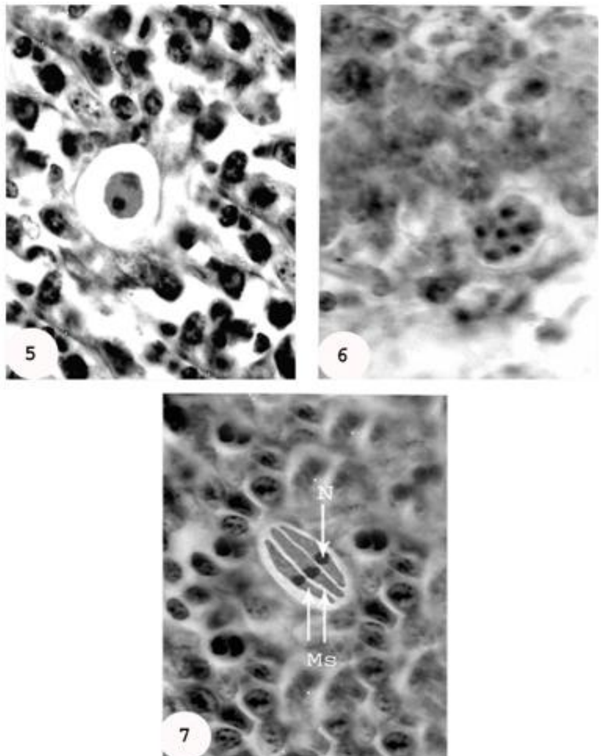
Endogenous stages

Merogonic stages (Figs. 5–7)

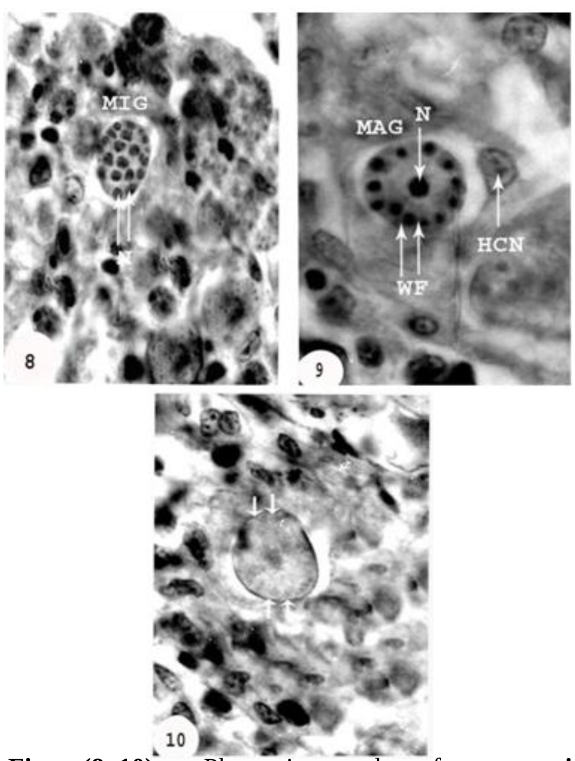
Developmental stages of the parasite were observed in the epithelial cells of the middle third of intestine. Early meronts were observed (Fig. 5). They were enclosed within a clear parasitophorous vacuole. Multinucleated meronts (Fig. 6) were subspherical in shape, measuring about 15.4×13.7 µm. Mature meronts with fully differentiated merozoites, measuring about 20.8×17.6 µm (LxW), were also detected (Fig. 7). They were subspherical in shape, each contained (2–5) banana–shaped merozoites. No residual body after differentiation of merozoites could be seen in such meronts. Merozoites measured 12.4×5.3 µm in an average size (LxW) and had a darker–stained and a centrally placed nucleus.

Gamogonic stages (Figs. 8–10)

Microgamonts (Fig. 8) were characterized by the presence of a large number of small nuclei, randomly spread in the cytoplasm. They measured about 15.0×13.5 µm in an average size. Microgametes were not obvious enough to be photographed with light microscopy. On the other hand, macrogamonts (Fig. 9) were spherical to subspherical in shape, measuring 21.6×16.5 µm in average size. They contained a central nucleus and several dark homogenous granules. These granules were known as wall–forming bodies, they arranged at the periphery of the cytoplasm. This arrangement indicated the development of macrogamonts into macrogametes. Fig. (10) showed that wall–forming bodies began to condensate at the periphery of the resultant zygote and fused together forming the typical two layered of oocyst wall.



Figs. (5–7): Photomicrographs of **merogonic stages** of *Eimeria alexandriensis* n. sp. from the epithelial cells of the middle third of the intestine. **(5):** Early meront. **(6):** Multinucleated meront. **(7):** Mature meront showing three visible merozoites (Ms). All photos x 2500



Figs. (8–10): Photomicrographs of **gamogonic stages** of *Eimeria alexandriensis* n. sp. from the epithelial cells of the middle third of the intestine. **(8):** A microgamont (MIG), note the presence of a large number of small nuclei (N) randomly spread in the cytoplasm. **(9):** A macrogamete (MAG) contained a large nucleus (N) and wall–forming bodies (WF), note the host cell nucleus (HCN) was clearly appeared. **(10):** Showing the fusion of wall–forming bodies to form the oocyst wall (Arrows). All photos x 2500

Discussion

To identify the present eimerian, a comparative data of the previously described *Eimeria* spp. infecting gekkonid hosts was given (Table 1), some of them have been unnamed. The comparison was based on certain significant criteria such as host species, its geographical distribution and characteristics of oocyst and sporocyst. It is known that no eimerian from lizards has ever been shown to cross generic boundaries, although this has not been tested (Aquino–Shuster *et al*., 1990). Pellerdy and Durr (1969) and McLoughlin (1969) concluded also that "although there were only few acceptable records of the transmission of *Eimeria* spp. from one host genus to another, the host specificity of an *Eimeria* species is strong and it is rare for such parasite to occur naturally or to complete the endogenous development in more than one host genus". So, the description of *Eimeria* from lizard hosts as a new species has been only based on the differences in hosts and their geographical distribution. Considering the above mentioned reasons and according to the available data given in Table (1), it was found that shape of oocysts as well as sporocysts of the present eimerian was similar to those of *E. telfordi* from *Gehyra mutilata* in Japan (Bovee, 1971), *E. scinci* from *Hemidactylus flavividiris* in Tunisia (Pellardy, 1974), *E. lineri* from *Hemidactylus turcicus* in USA (McAllister *et al*., 1988) and *E. lineri* from *Hemidactylus turcicus* in Egypt (El–Toukhy *et al.*, 1997). However, the present oocysts as well as sporocysts differed from them (except *E. telfodi*) by having much smaller size. The present parasite differed from *E. telfordi* by having polar granules and from *E. lineri* by having polar granules and sporocyst residuum. Further, the present sporocysts were the only among those of the above eimerians in having a stieda body. There were also host and geographic differences (except *E. lineri*) among the present eimerian and the above mentioned parasites. It seems to be justified to consider the present *Eimeria* as a new species. It is suggested to be named *Eimeria alexandriensis.*

Table (1): Comparative data of *Eimeria* spp. from gekkonid hosts including the present one

Eimerian species	Host (s)	Oocyst		Sporocyst		Locality	Author (s)
		Shape	Size µm	Shape	Size µm		
E. boveroi	***Hemidactylus mabouia***	**Roundish**	**18.3**	**Ovoid**	**7.6 × 6.0**	**Brazil**	**Carini & Pinto (1926)**
E. rochalimai	***H. mabouia***	**Elliptic**	**30.6 × 16.8**	**Round**	**8.0- 9.0**		
E. gekkonis	***Gekko japonicus***	**Ovoid**	**17.0-20.0 × 13.0 – 15.0**	**No data**	**No data**	**Japan**	**Tanabe (1928)**
***E.* species**	***Hemidactylus frenatus***	**No data**	**17.8 – 22.3 × 13.3 – 19.6**	**No data**	**No data**	**Taiwan**	**Yamamoto (1933)**
***E.* species**	***H. frenatus***	**Elongate - ellipsoid**	**26.0- 27.6 × 14.4- 15.6**	**No data**	**No data**		
E. flaviviridis	***H. flaviviridis***	**Elliptic - cylindroid**	**25.0- 34.0 × 11.0-14.0**	**Ovoid - elongate**	**7.0-9.0 × 5.0 – 7.0**	**India**	**Setna & Bana (1935)**
E. hemidactyli	***H. flaviviridis***	**Lemon - shaped**	**18.4 (17.0-20.4) ×15.1 (13.6-17.0)**	**No data**	**No data**	**India**	**Knowles & Das Gupta (1935)**
E. knowlesi	***H. flaviviridis***	**Spherical - ovoid**	**18.0 (15.3-21.2) ×16.2 (13.6-20.4)**	**No data**	**No data**	**India**	**Bhatia (1936)**
E. koidzumii	***Gekko japonicus***	**Elongate – ellipsoid**	**30.0 × 14.0**	**No data**	**13.0 × 9.0**	**Japan**	**Matubayasi (1941)**
***E.* species**	***Phelsuma lineata***	**No data**	**No data**	**No data**	**No data**	**Madagascar**	**Brygoo (1963)**
***E.* species**	***Uroplatus fimbriatus***	**No data**	**No data**	**No data**	**No data**		
E. gehyrae	***Gehyra vartegata***	**Cylindroid**	**32.8 (29.6-34.6) × 20.5 (19.7-21.8)**	**No data**	**13.6 (13.3-14.0) × 7.7 (7.4-8.3)**	**Australia**	**Cannon (1967)**
E. japonicus	***Gekko japonicus***	**Cylindroid**	**31.0 (28.0-35.0) ×15.0 (14.0-19.0)**	**Ellipsoid**	**12.0 (11.0-14.0) × 7.0 (7.0-10.0)**	**Japan**	**Bovee (1971)**
E. michikoa	***G. japonicus***	**Subspherical**	**26.0 (20.0-29.0) × 24.0 (19.0-26.0)**	**Ellipsoid**	**9.0 (7.0-9.0) × 11.0 (10.0-12.0)**		
E. telfordi	***G. mutilata***	**Ellipsoid**	**23.0 (19.0-25.0) ×19.0 (16.0-21.0)**	**Ellipsoid**	**8.0 (8.0-10.0) × 7.0 (6.0-8.0)**		
E. scinci	***Hemidactylus flavividiris***	**Ellipsoidal**	**36.0 × 25.0**	**Ellipsoidal**	**14.0 × 10.0**	**Tunisia**	**Pellérdy (1974)**

Table (1): Cont.

E. cicaki	***Gehyra mutilate & Hemidactylus frenatus***	**Ellipsoid**	**24.0 (20.0-26.0) × 21.0 (18.0-23.0)**	**Ellipsoid - ovoid**	**12.2 (11.0-13.0) × 9.0 (8.0-10.0)**	**Malaysia**	**Else & Colley (1975)**
E. helenae	***Hemidactylus brookei***	**Ellipsoid**	**22.2 (20.3-23.2) ×15.2 (13.9-16.2)**	**No data**	**8.0 (7.0-9.3) × 6.9 (6.4-7.5)**	**Gambia**	**Bray (1984)**
E. tarentolae	***Tarentola mauritanica***	**Ellipsoid**	**17.8 (17.6-18.7) × 13.5 (12.9-14.0)**	**Round**	**6.8 (6.4-7.0)**	**Minorca**	**Matuschka & Bannert (1986a)**
E. delalandii	***Tarentola delalandii***	**Cylindrical**	**45.1 (42.3-47.9) × 21.7 (19.9-26.0)**	**No data**	**13.8 (12.3-15.3) × 10.3 (9.4-11.2)**	**Tenerife Canary Islands**	**Matuschka & Bannert (1986b)**
E. brygooi	***Phelsuma madagascariensis grandis***	**Spherical – subspherical**	**23.0 (18.8-25.2) × 21.3 (16.4-23.2)**	**Ovoid**	**9.2 (8.0-10.0) × 7.9 (7.2-8.8)**	**Madagascar**	**Upton & Barnard (1987)**
E. gallotiae	***Gallotia galloti***	**Elongate - ellipsoidal**	**30.6 (29.1-32.6) ×16.0 (14.0-17.9)**	**Ellipsoidal**	**14.6 (12.2-17.3) × 9.2 (8.2-11.2)**	**Canary Islands**	**Matuschka & Bannert (1987)**
E. turcicus	***H. turcicus***	**Elongate & cylindrical**	**38.2 (35.2-40.8) × 17.9 (16.8-20.0)**	**Ovoid**	**11.0 (10.0-12.0) × 8.8 (8.0-9.4)**	**USA**	**Upton *et al.* (1988)**
E. lineri	***H. turcicus***	**Ellipsoidal**	**24.8 (21.6-28.0) ×19.5 (18.4-21.6)**	**Ellipsoidal**	**9.0 (8.2-9.6) × 7.8 (7.2-8.8)**	**Texas, USA**	**McAllister *et al.* (1988)**
E. boveroi	***H. mabouia***	**Spherical to subspherical**	**19.1 (16.0-21.6) × 18.2 (16.0-20.8)**	**Ovoid**	**8.6 (7.6-9.6) × 7.3 (7.2-8.0)**	**Mexico**	**McAllister & Upton (1989)**
E. dixoni	***H. frenatus***	**Spherical or subspherical**	**20.8 (17.0-22.0) × 19.7 (17.0-21.0)**	**Ovoid**	**9.3 (8.0-11.0) × 7.8 (7.0-8.0)**	**USA**	**McAllister *et al.* (1990)**
E. furmani	***H. frenatus***	**Ellipsoidal**	**20.5 × 16.9**	**No data**	**No data**	**Madagascar**	**Upton *et al.* (1990)**
E. phelsumae	***Phelsuma madagascariensis grandis***	**Cylindroidal**	**32.0 × 15.0**	**Ellipsoidal**	**9.8 × 7.0**	**Madagascar**	**Doszak & Ball (1991)**
E. rangei	***Palmatogecko rangei***	**Ellipsoidal**	**26.9 (25.0-29.0) ×18.8 (18.0-19.5)**	**Subspherical to Ellipsoidal**	**9.7 (9.0-10.5) × 8.3 (8.0-9.0)**	**Namibia**	**Upton *et al.* (1991)**

E. barnardi	***Rhoptropus barnardi***	**Ellipsoidal**	**24.3 (21.0-26.5) × 19.9 (16.0-22.0)**	**Subspherical**	**9.2 (8.0-11.0) × 8.3 (7.5-9.0)**	**Namibia**	**Upton *et al.* (1992)**
E. pachybibroni	***Rhoptropus barnardi***	**Ellipsoidal**	**24.3 (21.0-26.5) × 19.9 (16.0-22.0)**	**Subspherical**	**9.2 (8.0-11.0) × 8.3 (7.5-9.0)**		
E. stenodactyl	***Stenodactylus elegans***	**Subspherical**	**28.0 (26.0-32.0) × 24.0 (22.0-27.0)**	**Ovoid**	**10.0(9.0-11.0) × 8.0 (7.5-8.5)**	**Egypt**	**El- Toukhy (1994)**
E. gastrosauris	***Heteronotia binoei, Oedura monilis & Gehyra australis***	**Oblong-ellipsoid**	**No data**	**Bivalved**	**No data**	**Australia**	**Paperna (1994)**
E. vittati	***Gekko vittatus***	**Elongate – ellipsoid**	**34.3 (32.5-36.5) × 16.9 (16.5-17.5)**	**Ovoid**	**11.0 (10.0-12.5) × 6.5 (5.7-5.0)**	**UK**	**Ball & Daszak (1995)**
E. simonkingi	***G. smithii, G. Vittatus & Phelsuma lineata***	**Spherical to subspherica**	**20.5 (19.5 –22.0) ×19.4(17.5 – 21.0)**	**Ellipsoidal**	**9.2 (8.0-11.5) × 5.9 (5.5-7.0)**		
E. tokayae	***G. gecko***	**Spherical to subspherical**	**18.3(17.0-21.0) × 8.2 (13.0-20.5)**	**Ellipsoidal**	**9.2 (8.0-11.5) × 5.9 (5.5 – 7.0)**		
E. lineri	***Hemidactylus turcicus***	**Ellipsoidal**	**26.0 (25.5-28.5) × 19.8 (18.5-21.0)**	**Ellipsoid**	**10.5 (9.0-11.0) × 7.5 (7.5-8.5)**	**Egypt**	**El-Toukhy *et al.* (1997)**
E. tripolitani	***Tropiocolotes tripolitanus***	**Ellipsoid - ovoid**	**25.4 (20.5-28.3) × 18.4 (16.6-18.6)**	**Subspherical to oval**	**8.8 (6.8-9.8) × 8.1 (6.8-8.8)**	**Egypt**	**Abdel – Aziz (2001)**
E. ptyodactyli	***Ptyodactus hasselquistii***	**Spherical**	**22.5 (20.9-24.0)**	**Ovoid**	**11.0 (10.4-11.5) × 8.4 (8.0-8.8)**		
E. gizaensis	***Ptyodactlus hasselquistii***	**Oval**	**29.7 (29.0-30.0) × 23.0 (22.0-24.0)**	**Subspherical**	**9.9 (9.4-10.4) × 8.4 (7.3-9.4)**		
E. hailensis	***Ptyodactlus hasselquistii***	**Cylindroidal**	**36.7 (35.7-38.4) × 17.2 (15.5-20.0)**	**Subspherical to oval**	**10.1 (8.1-12.1) × 8.1 (7.4-8.8)**	**Saudi Arabia**	
E. dahabensis	***Tropiocolotes nattereri***	**Ellipsoid-ovoid**	**28.7 (24.4-33.0) × 20.7 (17.6-23.8)**	**Ellipsoid-ovoid**	**15.2 (13.8-16.6) × 8.6 (6.7-10.4)**	**Egypt**	**Abou El–Nour, 2005**

Eimeria stebbinsi	***Phelsuma rosagularis Vinson***	**Ellipsoidal**	**17.4 (16.0-19.2) x 11.7 (11.2-12.8)**	**Elongate - Ellipsoidal**	**7.7 (7.2-8.0) x 4.0 (3.2-5.6)**	**Mauritius**	**Daszak *et al*. (2009)**
Eimeria raleighi	***Phelsuma rosagularis Vinson***	**spheroidal to sub-spheroidal**	**17.0 (16.0-19.2) x 15.5 (14.4-16.8)**	**sub-spheroidal**	**7.8 (7.2-8.0) x 6.6 (6.4-7.2)**		
Eimeria swinnertonae	***Phelsuma rosagularis Vinson***	**Ellipsoidal**	**22.2 (20.8-24.8) x 17.8 (16.8-18.4)**	**Ellipsoidal**	**8.8 (8.0-9.6) x 7.0 (6.4-8.0)**		
E. alexandriensis	***Tarentola mauritanica***	**Ellipsoid**	**26.5 (22.7-29.6) × 17.0 (14.4-19.5)**	**Ellipsoid**	**13.2 (9.6-16.7) × 7.0 (5.6-8.4)**	**Egypt**	**The present study**

Taxonomic summary

Type host: Moorish gecko, *Tarentola mauritanica.*
Type locality: Sidi–Krrer, Alexandria, Egypt.
Oocysts: Ellipsoid in shape, with a bilayered wall, measuring 26.5 (22.7–29.6) × 17.0 (14.4–19.5) µm. L/W ratio 1.6. Polar granules and oocyst residuum present. Sporocysts ellipsoid, measuring 13.2 (9.6–16.7) × 7.0 (5.6–8.4) µm, L/W ratio 1.7, sporocyst residuum and stieda body present.
Etymology: The species name is derived from the name of the governorate from which the host was collected.

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