CARYOSPORA MATATU N. SP.,
A NEW COCCIDIAN PARASITE (APICOMPLEXA: ELMERIIDAE)
FROM THE HORNED BUSH-VIPER, Atheris ceratophorus Werner, 1895
FROM TANZANIA

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Introduction

Coccidian parasites of the genus Caryospora Léger, 1904 are widespread among ophidian hosts. So far, about 43 species are described from snakes, including four named species parasitising members of the snake family Viperidae (Modrý, 1999; Upton et al., 1986). The majority of known Caryospora species are probably monoxenous. However, experimentally studied Caryospora spp. from vipers and rattlesnakes possess a distinct heteroxenous mode of the life cycle (Koudela, 1993; Wacha & Christiansen, 1982). An oocyst infection leads to a dermal caryosporosis and a development of subcutaneous caryocysts in a secondary hosts, i.e. rodents (Koudela, 1993; Modrý et al., 1997; Upton & Barnard, 1988; Wacha & Christiansen, 1982). Recently, a severe combined immunodeficient (SCID) mice were used and suggested as a model for testing the heteroxenity of Caryospora spp. (Koudela et al., 2000).

In this study, a new species of Caryospora is described from the horned bush viper, Atheris ceratophorus, a species endemic to northern part of the Eastern Arc Mts. in Tanzania. Furthermore, we used the SCID mice to test the heteroxenity of the species.

Materials and Methods

Parasite isolation and examination

In 2000, faecal samples from four newly imported adult specimens of Atheris ceratophorus Werner, 1895 were collected in quarantine facilities. The snakes imported by a pet trader from Tanzania were kept individually in glass terraria and fed on suckling mice, the faecal samples were collected repeatedly from cages during the period of four weeks. The fresh faecal samples were then placed into the plastic vials with 2.5 % (w/v) potassium dichromate (K₂Cr₂O₇),...
mixed thoroughly and transported to the laboratory for immediate examination. The samples containing unsporulated coccidian oocysts were allowed to sporulate in Petri dishes at room temperature (19-21°C) and examined daily to determine the stage of sporulation. All faecal samples were examined microscopically after concentration by flotation with modified Sheather's sugar solution (s. g. 1.30) and stored at 4-5°C. The oocysts were measured and photographed using Nomarski differential contrast optics (NIC) with Olympus PROVIS microscope. Measurements were made using a calibrated ocular micrometer and are reported in micrometers, as means, followed by the range in parentheses.

**Experimental Infection**

Experimental SCID mice were used as described in Koudela *et al.* (2000). A total of five SCID mice 11 weeks old were used in experimental trial. The sporulated oocysts (~ 2 x 10^3) were administered orally to each mouse; the mice were monitored daily for clinical signs of a disease. On day 15, 22, 30 post inoculation (DPI) mice were euthanised and examined as described previously (Koudela *et al.*, 2000).

**Results**

A coprological examination revealed the presence of oocysts of an undescribed species of *Caryospora* Léger, 1904 (Apicomplexa: Eimeriidae) in one of four vipers examined. The type host was shedding the oocysts during the entire period of four weeks in the quarantine. Neither clinical signs of dermal coccidiosis nor caryosporan developmental stages were observed in any of the five experimental SCID mice.

*Caryospora matatu* n. sp. (Figs 1-3)

Description: oocysts spherical or, rarely, slightly sub-spherical, 19.8 (16-23) in diameter, n = 30; shape index (SI, length: width ratio) 1.0-1.05. A micropyle and an oocyst residuum absent, however, in some oocyst 2-5 very small granules occur in the oocyst content. A single distinct polar granule present in all oocysts examined, usually ~ 1 in diameter. An oocyst wall bilayered, 1.5 thick (inner layer much thinner, < 0.5), brownish, distinctly pitted; various debris and contaminant bacteria tend to adhere to the oocyst surface, giving the oocyst wall distinctly rough appearance. Sporocysts ellipsoidal, 15.6 (12.5-17.0) x 10.1 (8-12), n = 30; sporocyst SI = 1.55 (1.42-1.67). Typically, the sporocyst tightly fits the internal diameter of the oocyst. A Stieda body is dome-like, ~ 1 high and 2-3 wide. The substieda body barely distinguishable, in some sporocysts ellipsoidal, two high and four wide. In the majority of the sporocysts, substieda body appears as slightly irregular mass forming a distinct halo between the Stieda body and the sporozoites. A sporocyst residuum present, consisting of numerous small granules scattered among the sporozoites and concentrated in the central part of the sporocyst. The eight sporozoites are vermiform, possessing slightly striated surface and

Figs 1-2. – Nomarski interference contrast photographs of oocyst of *Caryospora matatu* n. sp., both in the same scale. Fig. 1. Sporulated oocyst. Scale bar = 10 μm. Fig. 2. Surface of the oocyst wall showing distinct pitting.
Site of infection: unknown, oocysts recovered from faeces.
Sporulation: exogenous, fresh oocysts recovered from faeces were unsporulated, complete sporulation occurs within five days (at 19-21°C).
Type material: photo-syntypes deposited under the collection No. R 03/2002 at Dept. of Parasitology, University of Veterinary and Pharmaceutical Sciences Brno.
Etymology: the specific epithet matatu, given as a noun in apposition, is adopted from the a local term describing the most common mean of public transportation in East Africa.

**DISCUSSION**

So far, there are eight species of *Caryospora* described from snakes from a sub-Saharan Africa (Bray, 1960; Daszak & Ball 2001a, b; Hoare, 1953; Matuschka, 1982; Upton *et al.*, 1992). Only a single named species, *C. maculatus* from *Causus maculatus* Upton, Freed & Freed, 1992, originates from a member of the family Viperidae. All *Caryospora* spp. from African snakes can be easily distinguished from *C. matatu* n. sp. by the general oocyst morphology. *C. maculatus* differs greatly by smaller oocyst dimensions, smooth oocyst wall, the absence of polar granule and the different appearance of Stieda and substieda bodies. None of three species of *Caryospora* named from members of the family Viperidae from other zoogeographical regions is similar enough to be confused with *C. matatu* sp. n. All of them are typical in having smaller (10-16 μm) spherical oocysts with thin and smooth oocyst wall and different Stieda and substieda bodies.

<table>
<thead>
<tr>
<th>Species of Caryospora</th>
<th>Type host</th>
<th>Shape (S)</th>
<th>PG</th>
<th>Size</th>
<th>Shape</th>
<th>Size (μm)</th>
<th>Sb</th>
<th>ssb</th>
<th>Distribution</th>
<th>Heteroxenity</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>bigenetica</td>
<td><em>Crotalus horridus</em></td>
<td>spherical</td>
<td>+</td>
<td>13.2</td>
<td>ellipsoid</td>
<td>10.1 (8.3-11.5)</td>
<td>+/+</td>
<td>USA - Iova, Georgia</td>
<td>+</td>
<td>Wacha &amp; Christiansen, 1982</td>
<td></td>
</tr>
<tr>
<td>simplex</td>
<td><em>V. x. xanthina</em></td>
<td>spherical</td>
<td>+</td>
<td>14.9</td>
<td>ovoid</td>
<td>11.6 (10.4-12.6)</td>
<td>+/+</td>
<td>Palaearctic</td>
<td>+</td>
<td>Upton <em>et al.</em>, 1983; Modry <em>et al.</em>, 1997</td>
<td></td>
</tr>
<tr>
<td>jararacae</td>
<td><em>Bothrops jararaca</em></td>
<td>spherical</td>
<td>–</td>
<td>13.0-14.0</td>
<td>ovoid</td>
<td>9.0-10.0</td>
<td>+</td>
<td>Brazil</td>
<td>n. t.</td>
<td>Carini, 1959</td>
<td></td>
</tr>
<tr>
<td>maculatus</td>
<td><em>Causus maculatus</em></td>
<td>spherical</td>
<td>+/-</td>
<td>12.1 (11-13)</td>
<td>ovoid</td>
<td>10.1 (9.5-11)</td>
<td>+/+</td>
<td>Cameroon</td>
<td>n. t.</td>
<td>Upton <em>et al.</em>, 1992</td>
<td></td>
</tr>
<tr>
<td>sp.</td>
<td><em>Calloselasma rhodostoma</em></td>
<td>spherical</td>
<td>+</td>
<td>12.1 (11-13)</td>
<td>ovoid</td>
<td>9.5 (8.5-10)</td>
<td>+/+</td>
<td>SE Asia</td>
<td>+</td>
<td>Koudela <em>et al.</em>, 2000; Modry, unpubl.</td>
<td></td>
</tr>
<tr>
<td>matatu n. sp.</td>
<td><em>Atheris ceratophorus</em></td>
<td>spherical</td>
<td>+</td>
<td>9.8 (16-23)</td>
<td>ellipsoid</td>
<td>15.6 (12.5-17.0)</td>
<td>+/+</td>
<td>Tanzania</td>
<td>–</td>
<td>This study</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: Sb: Stieda body, ssb: substieda body, n. t.: not tested.

Table 1. – Species of *Caryospora* Léger, 1904 reported from members of the family Viperidae.
substieda bodies and can be, therefore, easily distin-
guished (Table 1).
In general, the oocyst morphology, the oocyst wall tex-
ture and the shape of the Stieda and the substieda
body distinguish C. matatu n. sp. well from the most
of the ophidian species of Caryospora. Only C. cera-
jasensis, C. constanciae, C. duszynskii, C. epicratesi,
vych
Endowment. We are indebted to Olympus C & S
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with species described herein as a new.
to distinctly pitted or striated oocyst wall rough enough
to be compared with C. matatu n. sp. (Lainson et al.,
1991; Upton et al., 1984; Upton et al., 1989; Upton et
al., 1992). However, all these species differ in the fine
oocyst morphology, dimensions, host systematics and
geographical origin and as such could not be confused
with species described herein as a new.

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