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Authors: Mariaux, Jean, and Beveridge, Ian

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A new species of *Oochoristica* (Cyclophyllidea, Anoplocephalidae) from *Varanus albigularis* (Squamata, Varanidae) in Kenya

Jean Mariaux[1, 2] & Ian Beveridge[3]

[1] *Muséum d'histoire naturelle, C.P. 6434, 1211 Genève 6, Switzerland. E-mail: jean.mariaux@ville-ge.ch ORCID: 0000-0002-9601-855X*
[2] *Department of Genetics and Evolution, University of Geneva, Boulevard d'Ivoy 4, 1205 Geneva, Switzerland*
[3] *Faculty of Veterinary and Agricultural Sciences, University of Melbourne, Parkville, Melbourne, VIC, Australia. E-mail: ibeve@unimelb.edu.au ORCID: 0000-0002-1339-9415*

Abstract: *Oochoristica varanicola* sp. nov. (Anoplocephalidae, Linstowiinae) is described from *Varanus albigularis* in Kenya. It is the third species of this cestode genus described from monitor lizards. *Oochoristica varanicola* differs from other species from *Varanus*, as well as from the numerous other species in the genus by a unique combination of characters that include a high number of testes (92-134) and a long cirrus-sac (225-290 x 63-90 µm). Both the host and the locality are new records for the genus *Oochoristica*.

Keywords: Parasites - Platyhelminthes - Cestoda - Linstowiinae - Reptilian hosts - Monitor lizards - Africa.

INTRODUCTION

Herein we describe a new cestode from the white-throated monitor *Varanus albigularis* (Daudin, 1802), collected south of Lake Turkana in the Rift Valley Province of Kenya. Species of *Oochoristica* Lühe, 1898 are commonly encountered in reptiles worldwide and about 100 species are presently known (McAllister & Bursey, 2017). Only a very few have, however, been reported from monitor lizards.

MATERIAL AND METHODS

This material was given to us by Dr M. Jirků (České Budějovice, Czech Republic) who collected it during fieldwork in the Lake Turkana area in 2006. A single *V. albigularis*, killed by a cobra, was examined. After dissection, the worms were relaxed in physiological saline, then fixed in hot 4% formaldehyde, and finally transferred to 70% ethanol. They were stained in Mayer's hydrochloric carmine, dehydrated in an ethanol series, cleared in eugenol and mounted in Canada balsam. The slides were examined with a Nikon Eclipse-80i microscope equipped with Nomarski interference contrast optics. Drawings were made with a drawing tube. Photographs were taken on the same microscope with a Jenoptik camera and treated with Progres Gryphax 1.1.8 software©. All measurements are expressed in micrometers unless otherwise indicated. Metric and meristic values are presented as the range followed by their mean and the number of measurements made in parentheses.

Abbreviations. MHNG-PLAT: Natural History Museum of Geneva, Platyhelminthes collections. BMNH: British Museum (Natural History), London.

TAXONOMIC PART

Oochoristica varanicola sp. nov.

Figs 1-5

Material examined

Holotype: MHNG-PLAT-124881; 1 complete specimen. Host: *Varanus albigularis* (Daudin, 1802), Varanidae, Squamata. Site: Small intestine. Locality: About 20 km North of South Horr, Marsabit County, Kenya. 2 16 32.91°N 36 53 6.07°E. Date: 2006. Collector: Miloslav Jirků. Field number: MJ-C-6-06.

Paratypes: MHNG-PLAT-124882; 5 complete specimens. Collection data as for holotype.

Comparative material: MHNG-PLAT-45464; *Oochoristica rostellata* Zschokke, 1905 from *Cerastes cornutus* Boulenger, 1896, Bou Saâda, Algeria, 5.1926. – MHNG-PLAT-45463; *Oochoristica rostellata* from a colubrine snake, Algeria, 1935. – BMNH 1919.11.22.17-19; *Oochoristica zonuri* Baylis, 1919 from *Cordylus*

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tropidosternum (Cope, 1869) (=*Zonurus tropidosternum* Cope, 1869), Mozambique ("Portuguese East Africa"), type material. – MHNG-PLAT-41351 and 41352; *Oochoristica cryptobothrium* (von Linstow, 1906), from *Chrysopelea ornata* (Shaw, 1802), Kurunegala, Sri Lanka, syntypes. – BMNH 1977.11.3.15-16; *Oochoristica cryptobothrium* from a lizard from Accra, Ghana.

Etymology: The species name refers to generic name of the host.

Description

Cyclophyllidea: Anoplocephalidae. Body small, up to 12.3 mm long. Average width about 1.5 mm, maximum width 1.8 mm at level of early gravid proglottides. Up to 182 proglottides. Proglottides acraspedote, wider than long, becoming square at postmature level and progressively elongating to about 1.5 to 1.7 times longer than wide when fully gravid. Scolex rounded, massive, not delineated from neck, 670-800 (736, n=6) in diameter (Fig. 1). Suckers rounded to oval 250-310 x 205-270 (286 x 237, n=24) strong, muscular, unarmed. Rostellar apparatus lacking. Proglottization distinct about 1.5 mm behind posterior margin of suckers. Genital pores situated in anterior 25-30% of lateral proglottis margin, irregularly alternating, usually in short series, e.g. … 4, 2, 2, 2, 1, 1, 4, 2, …, but occasional long unilateral series possible (up to 13 consecutive pores observed on a single side). Ventral osmoregulatory canals up to 80 wide, connected posteriorly in each proglottis by complex, reticular, transverse anastomosis across testicular field (Fig. 2). Dorsal osmoregulatory canals 11-27 wide, overlying ventral canals. Genital ducts passing between osmoregulatory canals in most proglottides but occasionally also dorsal (all specimens show several proglottides with dorsal genital ducts). Genital atrium large, 80-112 (97, n=31) deep; surrounded by a compact layer of glandular cells. Atrium sometimes evaginating to form crateriform protrusion (observed in gravid proglottides).

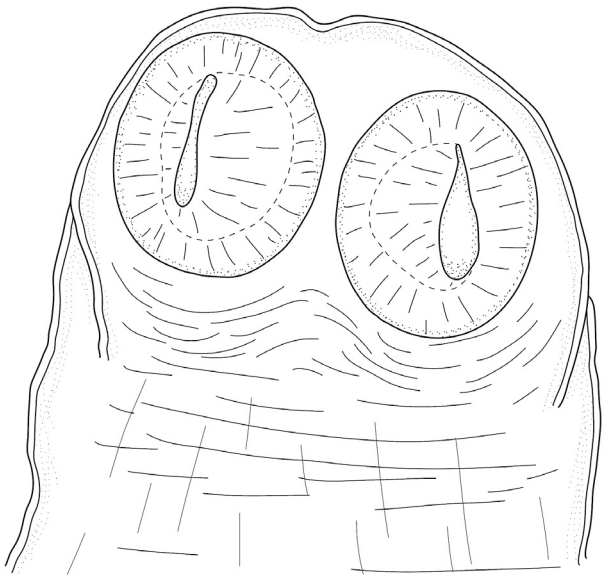

Fig. 1. *Oochoristica varanicola* sp. nov. Scolex. Scale bar: 250 µm.

Testes 92-134 (109, n=27) in number; in one or occasionally two layers, in one continuous posterior field, extending on lateral sides of proglottis to anterior extremity of vitellarium, and antero-porally to posterior level of ovary, often overlapping, or even external to, osmoregulatory canals. External vas deferens convoluted, surrounding proximal extremity of cirrus-sac. Cirrus-sac thick-walled, triangular, widest at its truncated distal extremity, 225-290 x 63-90 (255 x 79, n=56); extending just beyond osmoregulatory canals. Long retractor muscles attached at its proximal tip. Cirrus and internal vas deferens forming several coils. Cirrus unarmed (Fig. 3).

Vitellarium central and poral, more or less densely multilobed, often with detached lobes scattered among testes, highly variable in shape. Ovary antero-poral, bilobate, multilobulate, with deeply separated irregular lobules, about 14-20 lobules in total. Seminal receptacle small, elongated between ovarian wings. Vagina opening posteriorly to male pore, runs transversely, parallel to cirrus-sac, but often making curve or loop at mid length of cirrus-sac and often turning sharply anteriorly at level of opening into genital atrium (Fig. 3) surrounded by regular sheath of large rounded cells; sphincter absent.

Uterus appearing antero-ventrally and centrally as small cavity, quickly transforming into a discrete labyrinthine, thin-walled network, developing posteriorly to middle of proglottis and progressively disappearing. Eggs developing in parenchyma, and occupying entire median and lateral fields, in one continuous field across many proglottides. Fully developed eggs in large, thin walled capsules, 75-100 (89, n= 35) in diameter; entirely filling terminal gravid proglottides (Fig. 4). Oncospheres 27-36 in diameter (30.5, n=50) surrounded by irregular inner membrane. Central embryonic hooks 18-20 (19, n=27) long; thin with straight blade; lateral hooks shorter 16-18 (17, n=32); inner lateral hooks of lateral pair more massive with stronger guard than outer hooks (Fig. 5).

REMARKS

Our material belongs to the genus *Oochoristica* Lühe, 1898, a taxon with a complex history as summarized e.g. in Hughes (1940); Spasskii (1951); Della Santa (1956); Beveridge (1994, 2008); or Masová *et al*. (2012). The most recent generic diagnosis (Beveridge, 1994) has been subsequently emended by Masová *et al*. (2012) for a number of minor details as well as removing the

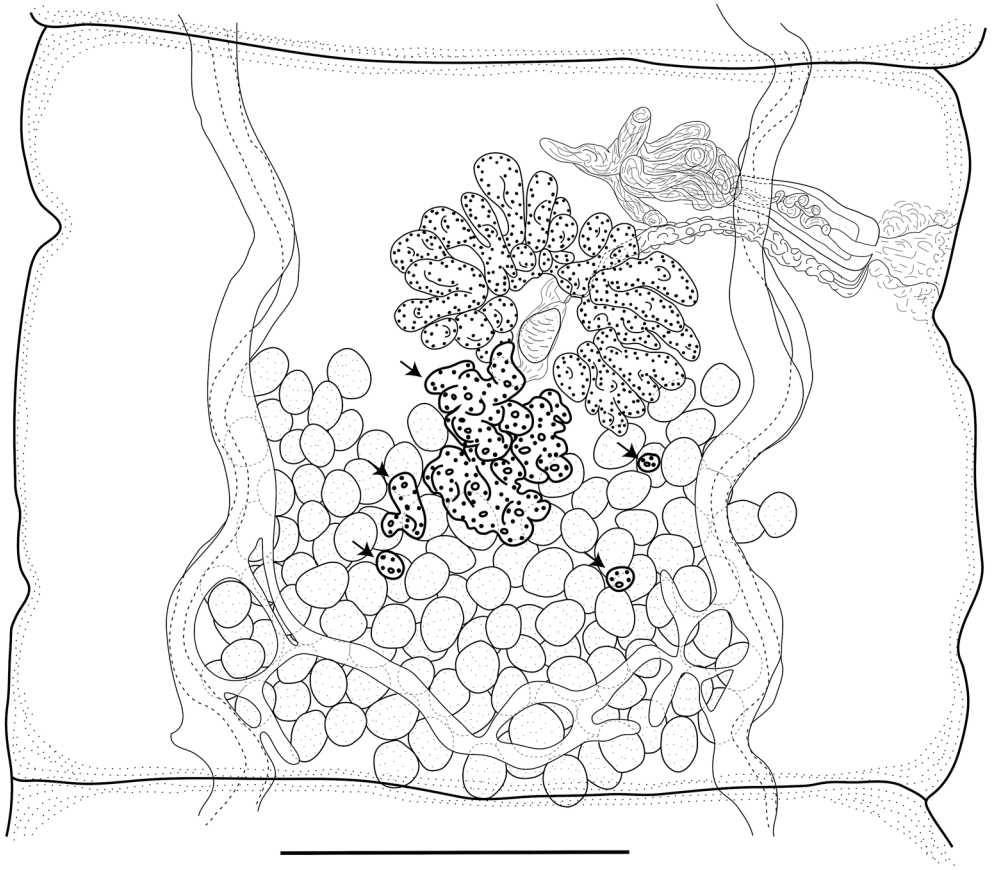

Fig. 2. *Oochoristica varanicola* sp. nov. Mature proglottis. Ventral view. Note the multilobed vitellarium (arrows). Scale bar: 500 µm.

acraspedote nature of proglottides as a generic character. This latter character however would imply the synonymy of *Mathevotaenia* Akhumyan, 1946, whose members are primarily parasites of mammals, with *Oochoristica*, found essentially in reptiles (although exceptions do exist) (Beveridge, 1994). Although certainly needing investigation, this character is the single feature allowing separation of both genera. We thus consider here the genus *Oochoristica sensu* Beveridge, 1994, and accept only part of the emendation of Masová *et al*. (2012) in recognizing that testes can also be lateral to the vitellarium in some species.

A recent list, including almost 100 valid species of *Oochoristica,* was provided by McAllister & Bursey (2017), who also listed selected major discriminating characters for these species. In their table, these authors list eight species from the Afrotropical region. To our knowledge no other species in this genus has been described more recently.

Although the genus is widely diversified in the Squamata, especially in the Lacertilia, only two species of *Oochoristica* have been reported from Varanidae. *Oochoristica varani* Nama & Khichi, 1972 was found in Jodhpur (Rajasthan) in "*Varanus monitor*", a taxon which does not exist: the authors most likely referring to *V. bengalensis* (Daudin, 1802) the common local monitor, or, possibly, to *V. flavescens* (Hardwicke & Gray, 1827) although this species is morphologically quite distinct and would probably have been correctly identified. *Oochoristica varani* can easily be distinguished from our material by its smaller scolex (270-412 µm) and suckers (150-200 x 140-170 µm), shorter cirrus-sac (140-210 µm) and lower number of testes (40-55) (Nama & Khichi, 1972).

Oochoristica tuberculata (Rudolphi, 1819) has been reported from a number of lizards, mostly Lacertidae, Scincidae and Agamidae (Della Santa, 1956), but also from *V. griseus* (Daudin, 1803), in Tunisia (Joyeux, 1923) and in Iran (Dollfus, 1965). Those reports should however be considered with caution as the Tunisian material is composed of a few young specimens that were only tentatively attributed to *O. truncata*, and the Iranian material is composed of "quelques débris en mauvais état" (several fragments in a poor state (of preservation) that "il est possible que l'on puisse rapporter les débris... à… *O. tuberculata*" (may possibly be attributed to *O. truncata*). The presence of this species in *Varanus* is thus highly questionable. In any case, *O. tuberculata*

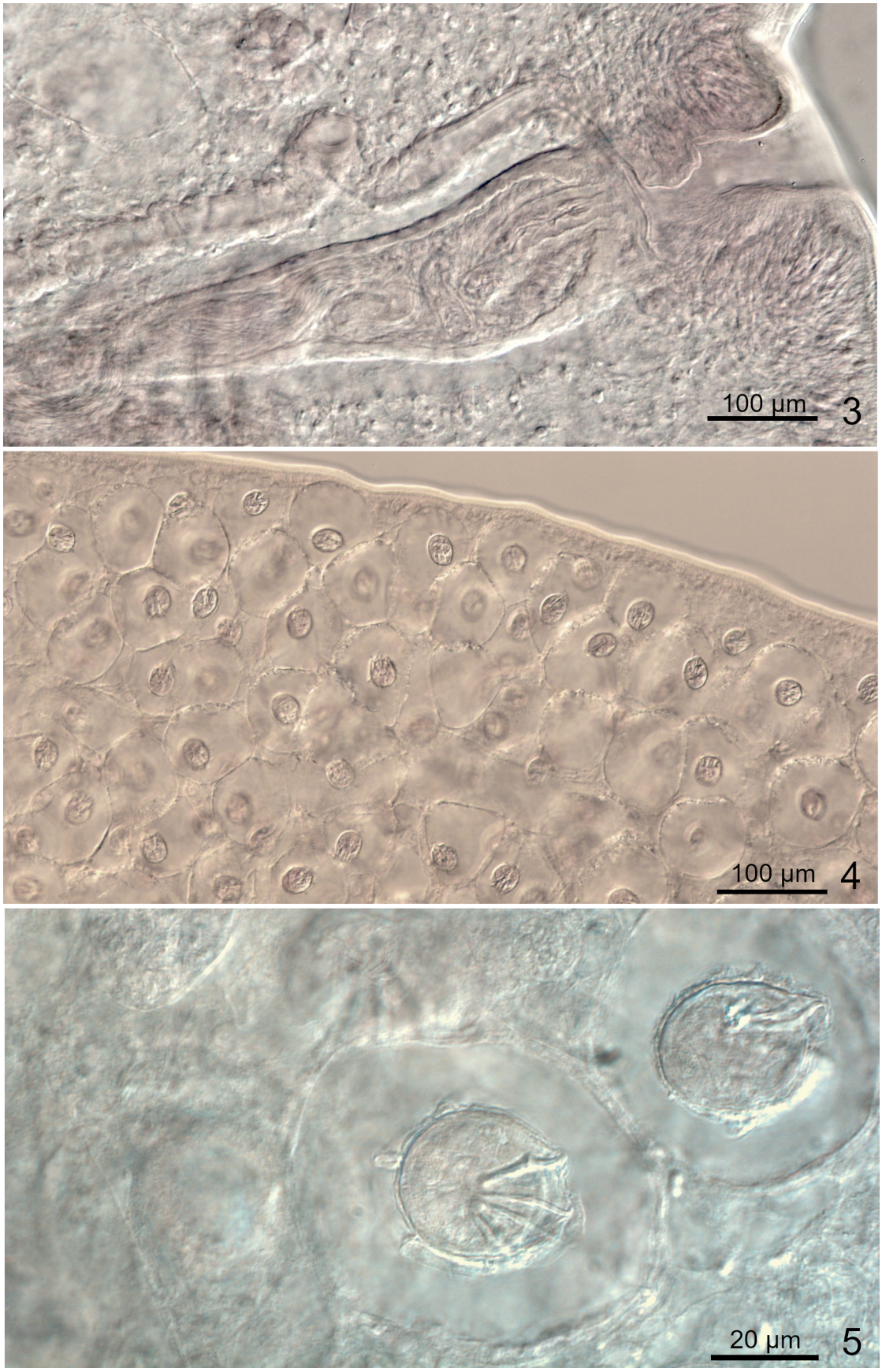

Fig. 3. *Oochoristica varanicola* sp. nov. Copulatory organs. Fig. 4. *Oochoristica varanicola* sp. nov. Eggs in gravid proglottis. Fig. 5. *Oochoristica varanicola* sp. nov. Eggs.

clearly differs from our material by its smaller scolex (160-230 µm), smaller suckers (110-140 µm), lower number of testes (20-50), and smaller number of ovarian lobules (4-6) (McAllister & Bursey, 2017).

Among the other taxa listed by McAllister & Bursey (2017) from Africa, none presents characters close to those observed in our material. The most similar species are *O. koubeki* Mašová, Tenora & Baruš, 2012, and *O. zonuri* Baylis, 1919 which possess a cirrus-sac of similar length but far fewer testes and different scolex dimensions. Our observations of the type material of *O. zonuri* also confirm that the testes extend to the anterior margin of the segment as shown in the original description (Baylis, 1919: fig. 2), which thus excludes this species from *Oochoristica sensu* Beveridge (1994).

Our material further differs from most other known species in various hosts and localities because of its rare combination of a long cirrus-sac and high number of testes. The only species showing similar values for both traits are *O. bivitellobata* Loewen, 1940, *O. gracewileyae* Loewen, 1940, *O. leonregagnonae* Arizmendi-Espinosa, Garcia-Prieto & Guillen-Hernandez, 2005 and *O. rostellata* Zschokke, 1905. *Oochoristica bivitellobata* was reported from a member of the Teiidae in Kansas, USA. It is a very short worm consisting of only a small number of proglottides, small scolex (396 µm) and suckers (140 µm) and although both its cirrus sac length and testis number ranges overlap that of our material, they remain shorter (165 µm) and fewer (76) on average. The testes are also distinctly posterior, not reaching the lateral sides of the female organs (Loewen, 1940). *Oochoristica gracewileyae* was found in a rattlesnake in Texas. It also possesses a smaller scolex and suckers (426 µm and 145 x 152 µm respectively). Its cirrus-sac has a distinctive globular proximal extremity and does not extend beyond the excretory canals, and its testes are entirely posterior to the female genital complex (Loewen, 1940). *Oochoristica leonregagnonae* was reported from an Iguanidae in Mexico. Although similar, its average number of testes (95) is lower, and its cirrus-sac length (180-230 µm) only marginally overlaps that of our material (Arizmendi-Espinosa *et al*., 2005). Finally, *O. rostellata* was found in a colubrid snake in Italy (Zschokke, 1905). In its original description, Zschokke (1905) mentioned "2 to 3 rows of testes… each with 16 to 20 testes", although his figure 3 shows 78 testes. Other metric data are lacking from this description and more recent reports (Baer, 1927; Della Santa, 1956; McAllister & Bursey, 2017) confuse various sources including data from *O. cryptobothrium* (von Linstow, 1906) that has been synonymized with it by some authors (Baer, 1927). Apparently Zschokke's species was subsequently found in North African snakes by Joyeux (1927), who described a much shorter cirrus-sac than that in our material. Our own observations of this material also confirm a lower number of testes 51-70 (60, n=5).

Oochoristica cryptobothrium was recognized as a valid species by Spasskii (1951) and McAllister & Bursey (2017) and its suggested synonymy with *O. rostellata* by Hughes (1940) or Della Santa (1956) have contributed to the great variation in the morphological features reported for this species. Von Linstow's (1906) original description, from a colubrid snake in Sri Lanka, is not sufficient to unambiguously characterize *O. cryptobothrium* and doubts remain about the validity of this taxon. Characteristics of this species, as summarized in McAllister & Bursey (2017) are based on a redescription of the original specimens provided by Fuhrmann (1927). We studied this material in the Geneva collections and note that although some of Fuhrmann's measurements are correct, major discrepancies, especially the length of the cirrus-sac (we measured 225 to 305 µm) and, to a lesser extent, the number of testes (about 50 to 60) exist. Our observations are approximate as the available material is not well preserved, but they nevertheless allow the separation of *O. cryptobothrium* from our material on the basis of a significantly lower number of testes. Additional specimens identified as *O. cryptobothrium* from a lizard from Accra (BMNH 1977.11.3.15-16) and re-examined appear to be *O. rostellata*. A detailed revision of all of the material currently attributed to *O. cryptobothrium* and *O. rostellata* is therefore needed.

In summary, our morphological observations, together with its geographical origin and host, allow us to conclude that our material from *Varanus albigularis* in Kenya represents a new species *Oochoristica varanicola* sp. nov.

Oochoristica varanicola is only the third (or possibly the second) species of the genus reported from monitor lizards, indicating that they are probably not ideal hosts for these anoplocephalids. Brooks *et al*. (1999) suggested that species of *Oochoristica* are highly specific and that their geographical distribution is restricted. Although our results seem to corroborate this assumption, it is difficult to confirm its generality given the limited availability of comparative material.

We should finally note that, for *Oochoristica,* like many groups of cestodes lacking rostellar hooks, specific identification relies heavily on a small number of strobilar characters. In the case of *Oochoristica*, some of them, *e.g*. testis numbers, are particularly difficult to observe and may often be inaccurate. As records for most species in the genus are scarce, independent verification of this character is problematic. Molecular data are essentially lacking in the group but will undoubtedly help clarify its structure and composition in the future.

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