

MORPHOLOGY OF *ENTEROBIUS (COLOBENTEROBIUS) COLOBIS* VUYLSTÉKE, 1964 (NEMATODA: OXYURIDAE: ENTEROBIINAE) COLLECTED FROM AN ASHY RED COLOBUS, *PROCOLOBUS RUFOMITRATUS TEPHROSCELES* (ELLIOT, 1907) (PRIMATES: CERCOPITHECIDAE: COLOBINAE), IN UGANDA

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ABSTRACT: *Enterobius (Colobenterobius) colobis* Vuylstéke, 1964 (Nematoda: Oxyuridae) is redescribed based on males and females collected from an ashy red colobus, *Procolobus rufomitratu tephrosceles* (Elliot, 1907) (Primates: Cercopithecidae: Colobinae), in Uganda. Two morphotypes are recognized among females, which are readily distinguished by tail length, termination level of lateral alae, and egg size. The relative position of cellular wall greatly varied in the ovjector, indicating its limited systematic value. The males possess a much shorter spicule than those in previous descriptions, suggesting the presence of polymorphism.

The pinworms of the subgenus *Colobenterobius* Quentin et al., 1979 of *Enterobius* Leach, 1853 (Nematoda: Oxyuridae: Enterobiinae) are parasitic in monkeys of the Colobinae (Primates: Cercopithecidae) in Africa and Asia (Hugot et al., 1996; Hugot, 1999; Hasegawa et al., 2002, 2003). From Africa, 5 representatives have been described: *Enterobius (Colobenterobius) colobis* Vuylstéke, 1964 from *Procolobus rufomitratu tholloni* (Milne-Edwards, 1886) (referred to as *Colobus badius* Kerr, 1792); *Enterobius (Colobenterobius) guerezae* Hugot, 1987, and *Enterobius (Colobenterobius) paraguerezae* Hugot, 1987 from *Colobus guereza* Rüppell, 1853; and *Enterobius (Colobenterobius) pesteri* Wahid, 1961 and *Enterobius (Colobenterobius) inglisi* Wahid, 1961 from *Colobus* sp. (Wahid, 1961; Vuylstéke, 1964; Hugot, 1987a). However, morphology of some species has not been adequately understood. For example, only 1 male of *E. (C.) colobis* and 2 males of *E. (C.) inglisi* have been available for study, and females of the latter species remain unknown. We recently had an opportunity to collect both male and female pinworms from an adult female ashy red colobus, *Procolobus rufomitratu tephrosceles* (Elliot, 1907), in Uganda, and found several interesting morphological features of the parasites as described herein.

MATERIALS AND METHODS

An adult female red colobus monkey that died from complications associated with falling from the forest canopy on 1 August 2002, was collected from the K-13 logging compartment of Kibale National Park, Uganda (0°38'N and 30°22'E) (see Gillespie, Greiner et al., 2005b for a description of red colobus and Gillespie, Chapman et al., 2005a for a description of Kibale National Park). Pinworms were recovered alive from the intestine of the colobus as part of an opportunistic necropsy as described in Gillespie (2006). They were fixed and preserved in 70% ethanol, and later cleared in alcohol-glycerol solution by evaporating alcohol, mounted on glass slides with 50% glycerol solution, and observed with a light microscope equipped with a Nomarski interference contrast illumination. Figures were made with the aid of a drawing tube attached to the microscope. Measurements, range followed by mean in

parentheses, are given in micrometers unless otherwise stated. Systematics of African primates follows Grubb et al. (2003) and Struhsaker and Grubb (2008). Specimens are deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland. Type specimens of *E. (C.) colobis* were not available for examination.

RESULTS

A total of 64 pinworms, comprising 5 males and 59 females, were collected. Two morphotypes of females, herein called morphotype A (37 individuals) and morphotype B (20 individuals), were recognized. The remaining 2 females were immature and typing was not possible. All males and 10 females of each morphotype of females were measured.

DESCRIPTION

Enterobius (Colobenterobius) colobis Vuylstéke, 1964 (Figs. 1–18)

General: Cephalic expansion well developed with strong transverse markings in posterior 2/3 (Figs. 2, 12). Cuticle with clear transverse striations (Figs. 6, 12). Cephalic end with 3 developed lips, each concave apically, housing superstructure of pharynx (Figs. 3–5, 10). Superstructure of pharynx oval, internally supported by spearlike cuticular support (Figs. 3, 10). Esophageal corpus club-shaped; esophageal bulb spherical, with valve; isthmus absent (Figs. 1, 9, 12).

Males (5 worms): Posterior body bent ventrally (Fig. 1). Worm length 2.24–2.88 (2.52) mm, and maximum width in midbody 128–173 (147). Distance between amphidial pores 35 (n = 1). Cephalic expansion 109–128 (120) long and 66–83 (76) wide. Lateral alae absent. Total length of esophagus including pharynx, corpus, and bulb 468–572 (513) long; maximum width of corpus 46–59 (53); esophageal bulb 97–112 (105) long by 85–104 (97) wide. Nerve ring 122–139 (129) (n = 4), excretory pore 702–780 (741) (n = 2) from anterior extremity. Caudal papillae 4 pairs: first pair large, protruding laterally; second and third pairs grouped, second pair globular; third pair slender, smaller than second pair; fourth pair projecting posterolaterally at caudal end; phasmids opening posterior to third pair of papillae (Figs. 6–8). Testis directed anteriorly, not recurved, ending far posterior to middle of worm (Fig. 1). Spicule weakly curved ventrally, slightly narrowed at distal 1/4; distal end pointed in dorsoventral view, weakly knobbed in lateral view, 91–107 (98) long (Figs. 6–8). Proximal mass of spicule expanded laterally (Figs. 6, 7).

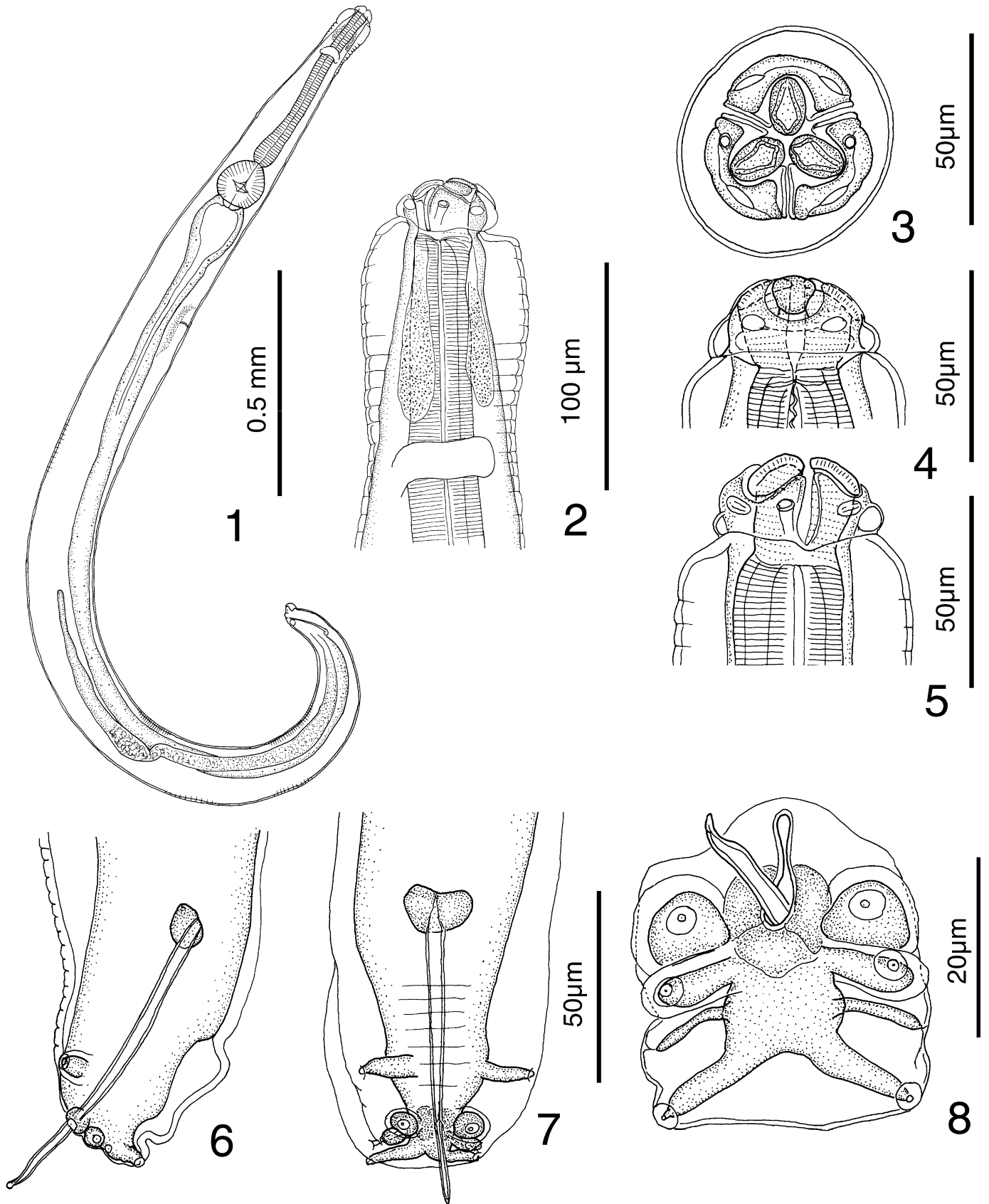
Females (morphotype A; 10 worms): Body tapering to both extremities, 5.79–6.31 (6.05) mm long, 286–377 (309) in maximum width (Fig. 9). Distance between amphidial pores 46 (n = 1). Lateral alae present, apically rounded in cross section (Fig. 11), commencing at level far posterior to esophagointestinal junction and terminating at posterior end of middle 1/3 of tail (Figs. 12, 14). Total esophagus length 643–728 (679) (occupying 11–12% [11.6%] of worm length): pharynx short, 29–32 (31) long; esophageal corpus narrow, becoming stouter posteri-

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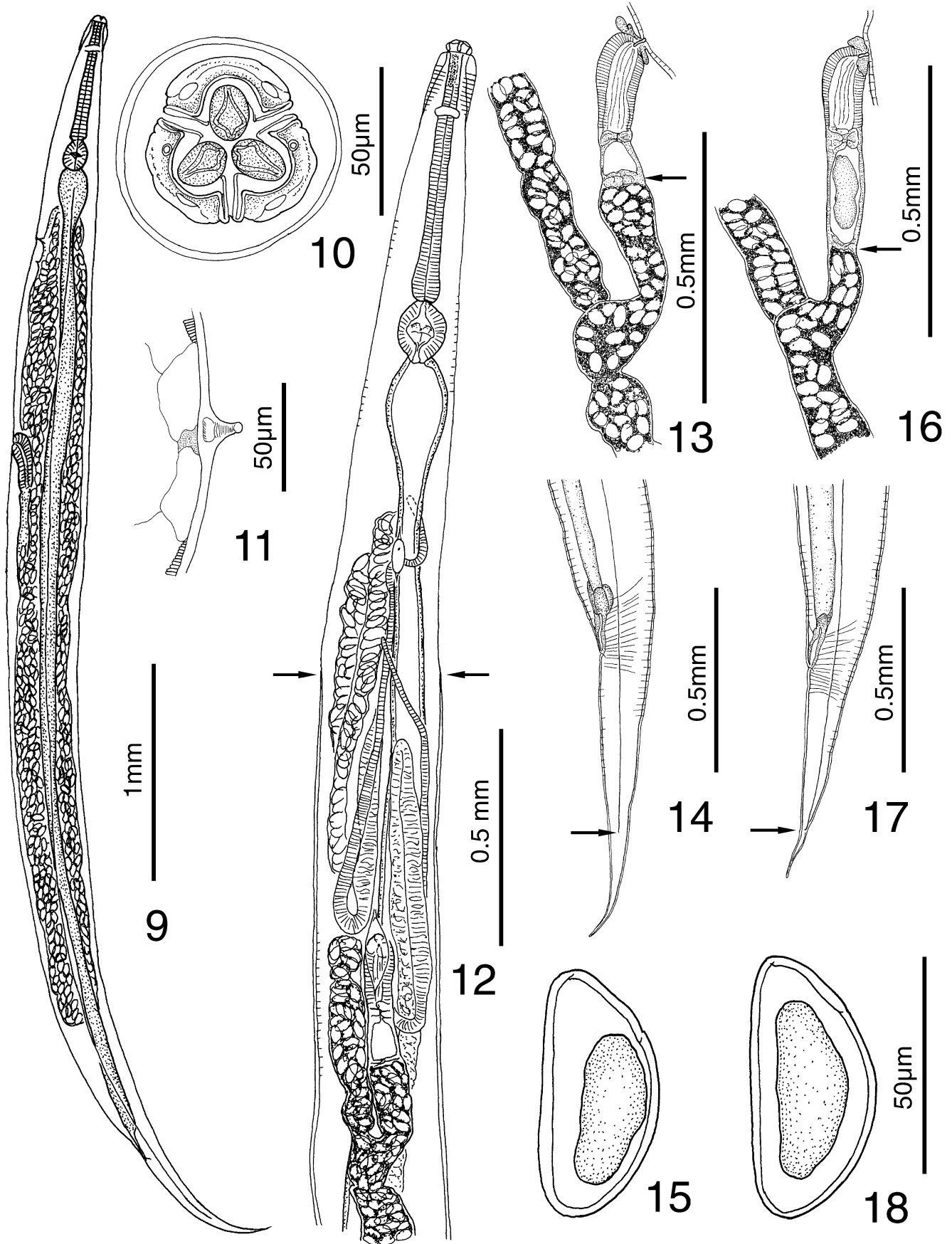
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FIGURES 1–8. Male of *Enterobius (Colobenterobius) colobis* Vuylstéke, 1964 collected from ashy red colobus, *Procolobus rufomitratus tephrosceles*. (1) Whole worm, right lateral view. (2) Anterior end, right lateral view. (3–5) Cephalic apex, apical view (3), dorsal view (4), and left lateral view (5). (6–8) Posterior end, left lateral view (6), ventral view (7), and caudal view (8).



orly, 488–562 (520) long, 64–67 (65.5) wide at thickest portion near posterior end; esophageal bulb spherical, with valve, 122–134 (128) long by 106–125 (115) wide (Figs. 9, 12). Nerve ring 138–170 (155), excretory pore 1.09–1.18 (1.11) (n = 5) mm anterior extremity. Distance from anterior extremity to vulva 1.99–2.21 (2.07) mm, occupying 31.8–35.5% (34.2%) of worm length; muscular vagina thick, 165–278 (229) long; vagina uterina 104–180 (136) long; distance from vulva to cellular wall occupying 44–65% (56%) of distance from vulva to opening of uterus (n = 9) (Fig. 13). Amphidelphic. Both ovaries ending anterior to vulva. Tail long conical with pointed apex, 657–760 (712) long, occupying 11–12% (11.7%) of worm length (Fig. 14). Eggs ovoid, with flattened 1 side, surface smooth, with rudimentary operculum, 53–58 (55.8 ± SD 1.1) by 24–30 (26.6 ± SD 1.2) (n = 50) (Fig. 15).

Females (morphotype B; 10 worms): General features identical with morphotype A, except short tail with different terminating level of lateral alae and larger eggs. Worm length 5.77–6.85 (6.05) mm, maximum width 305–397 (341). Distance between amphidial pores 42 (n = 1). Lateral alae terminating at anterior end of posterior 1/4 of tail. Total esophagus length 652–748 (701) (occupying 9–12% [11.5%] of worm length); pharynx 29–35 (31.7) long; esophageal corpus 502–585 (539) long, 67–77 (71.7) wide at thickest portion near posterior end; esophageal bulb 118–144 (132) long by 118–134 (125) wide. Nerve ring 147–176 (156), excretory pore 1.15–1.54 (1.29) (n = 6) mm from anterior extremity. Distance from anterior extremity to vulva 1.85–2.24 (2.06) mm, occupying 30.9–35.8% (33.9%) of worm length; muscular vagina 174–255 (217) long; vagina uterina 113–255 (182) long; distance from vulva to cellular wall occupying 51–82% (61%) of distance from vulva to opening of uterus (n = 7) (Fig. 16). Tail 520–637 (576) long, occupying 8.1–10.9% (9.5%) of worm length (Fig. 17). Eggs 59–62 (60.9 ± SD 1.0) by 24–29 (26.6 ± SD 1.2) (n = 50) (Fig. 18).

Taxonomic summary

Host: Ashy red colobus, *P. rufomitratus tephrosceles* (Elliot, 1907).
Site in host: Large intestine.

Locality: Kibale National Park, Kabarole District, Uganda (0°38'N, 30°22'E).

Date of collection: 1 August 2002.

Specimens deposited: USNPC 100478 (males and morphotype A females) and 100479 (morphotype B females).

Remarks

Because it has oval superstructures of the pharynx, the present species is identified as *E. (C.) colobis*, which was described based on 1 male and 22 females collected from a Tshuapa red colobus, *P. rufomitratus tholloni* in Kasongo, Maniema, Zaire (Congo) (Vuylstéke, 1964), a neighboring area of the present locality. Previous descriptions of this species were apparently based on the same type material (Vuylstéke, 1964; Hugot, 1987a), but there are some discrepancies in the measurements. According to Vuylstéke (1964), the male was 2.40 mm long and its spicule was 120 µm long, whereas Hugot (1987a) recorded the body and spicule lengths as 2.06 mm and 137 µm, respectively. The present males possess a significantly shorter spicule than the type material described earlier. Both of the previous authors presented measurements of only 1 female, and their tail lengths (700 or 750 µm) and egg size (55 × 26 µm) coincide with those of the morphotype A of the present females (Vuylstéke, 1964; Hugot, 1987a).

DISCUSSION

It is remarkable that pinworms of colobine monkeys are often composed of 2 species, which have often been found concurrently in the same host individual, e.g., *E. (C.) guerezae* and *E.*

(C.) paraguerezae in *C. guereza*, and *E. (C.) pesteri* and *E. (C.) inglisi* in *Colobus* sp.; *Enterobius (Colobenterobius) zakiri* Siddiqi et Mirza, 1954 and *Enterobius (Colobenterobius) entellus* Hugot, 1987 in *Semnopithecus entellus* (Dufresne, 1797) (Wahid, 1961; Vuylstéke, 1964; Hugot, 1987a, 1987b). Morphological differences between 2 coinfecting pinworms in the Colobinae are usually associated with the cephalic structures and spicule length (Wahid, 1961; Hugot, 1987a, 1987b). It has been suggested that these parasites may be sister species formed by duplication or cospeciated species having made a host switch (Hugot, 1999). If speciation is the case, the present 2 morphotypes of females may represent 2 sister species, and the morphotype B females may represent a new taxon.

Coinfection with sister pinworm species is rare in monkeys and apes, having been only reported in humans other than Colobinae (Hugot, 1999). However, the postulated sister species of pinworms in humans have been recently confirmed to be synonymous by DNA sequence analysis of mitochondrial *cox1* gene and nuclear ITS2 regions (Nakano et al., 2006). Moreover, there are many examples of polymorphism in Oxyurida. For example, *Oxyuris equi* (Schrank, 1788) (Oxyuridae) has 2 morphotypes of females, which are distinguished by tail length (Skryabin et al., 1960). In Pharyngodonidae, male dimorphism has been often observed and some species produce 2 types of eggs (cf. Chabaud and Golvan, 1957; Adamson, 1981; Ainsworth, 1990; Hasegawa and Uchida, 2006). Based on these characteristics, we withhold proposition of a new taxon for the morphotype B of the present females. A final decision on identity should be made following DNA sequence analysis of the 2 morphotypes.

The position of the cellular wall of ovjector has been considered as a key feature in systematics of Enterobiinae. It is located closer to the uterine opening than to the vulva in *Enterobius* spp. from Old World primates, whereas its position is at the middle or closer to the vulva in *Trypanoxyuris* spp. of New World primates (Hugot et al., 1996). However, the length of vagina uterina greatly varied in the present species, making the relative position of the cellular wall uneven. The variation of the relative position of the cellular wall in every pinworm species should be studied to establish its value in classification clearly.

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FIGURES 9–18. Females of morphotypes A and B *Enterobius (Colobenterobius) colobis* Vuylstéke, 1964 collected from ashy red colobus, *Procolobus rufomitratus tephrosceles*. Morphotype A: (9) Whole worm, left lateral view. (10) Cephalic apex, apical view. (11) Lateral ala in cross section of midbody. (12) Anterior body, ventral view (arrows indicate commencing level of lateral alae). (13) Ovjector, right lateral view (arrow indicates cellular wall). (14) Tail, right lateral view (arrow indicates terminating level of lateral alae). (15) Egg. Morphotype B: (16) Ovjector, right lateral view (arrow indicates cellular wall). (17) Tail, right lateral view (arrow indicates terminating level of lateral alae). (18) Egg.

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