

HUMAN *BERTIELLA STUDERI* (FAMILY ANOPLICEPHALIDAE) INFECTION OF PROBABLE SOUTHEAST ASIAN ORIGIN IN MAURITIAN CHILDREN AND AN ADULT

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Abstract. Morphologic studies on preserved and recently collected *Bertiella* specimens obtained from Mauritian children and an adult indicate that human infection is caused by *Bertiella studeri* instead of *B. mucronata*. This cestode might have been accidentally introduced onto the island of Mauritius from the Southeast Asia along with monkeys in the 17th century. We present information that will help identify *B. studeri* and provide a correct diagnosis. The case reports indicate gastrointestinal disturbances in human bertiellosis. Human infection with *Bertiella studeri* is reported for the first time in a Mauritian adult.

INTRODUCTION

Bertiella studeri (Blanchard, 1891) is an intestinal cyclophyllidean tapeworm (Cestoda) that belongs to the family anoplocephalidae (Stiles and Hassall, 1902). This tapeworm, which is typically found in primates, has been sporadically reported in humans in India, the Far East, and Africa. Cases have also been reported in the former Soviet Union, Great Britain, Spain, and the United States.^{1–3} Of the 29 species in the genus *Bertiella*, two species, *B. studeri* and *B. mucronata* are known to infect humans, mostly children.⁴ Human bertiellosis is acquired by accidental ingestion of Oribatid mites that act as intermediate hosts. There have been more than 50 cases of human bertiellosis cited in the literature, including four from Mauritius.^{5–8} No new cases of bertiellosis were reported in Mauritius until 1995 when the local health authorities reported three new cases of infection with *B. mucronata*⁹ in 3–7-year-old children. Subsequently, two additional cases in a 3.5-year-old child and a 32-year-old man (agricultural laborer) were recently reported. Based on these reports and available specimens, the purpose of this study was to identify the species responsible for bertiellosis in Mauritius. These observations should help local health authorities in increasing public awareness about human bertiellosis and also provide information on the diagnosis and clinical manifestations of this disease.

CASE REPORTS

The infected children and the man had common signs and symptoms. All of these cases had intermittent epigastric pain after meals accompanied by nausea, diarrhea, and anorexia, with no fever and loss of weight. Except in one child, the abdomen was soft and tender. Furthermore, they had no pets, never had traveled abroad, and did not have any previous helminthic infections. Stool examinations showed white chains of proglottids (3–23 in number) without a scolex that resembled a *Bertiella* species. However, laboratory findings did not show any other helminth ova or bacterial infections. The hematologic indices and differential leukocyte counts were within normal limits. The man and the parents of the children indicated that the gastrointestinal disturbances occurred after having consumed *Psidium cattleianum* Sabine (family Myrtaceae) (“strawberry guava”) one month earlier during a trip in the nearby forest inhabited by monkeys.

MATERIALS AND METHODS

Sufficient number of preserved *Bertiella* proglottids in neutral formalin from reported cases were kindly provided along with an entire specimen bearing a scolex by the Central Laboratory, Ministry of Health and Quality of Life, Victoria Hospital (Candos, Mauritius) for comparative morphologic studies. The specimens (9.98 mm × 1.82 mm) ranged from mature to gravid proglottids. Sections (7 µm) of the proglottids from recent and previous specimens were also stained as per the standardized methods and mounted in distrene plasticizer xylene (BDH, Ltd., Poole, United Kingdom) for future reference. Some gravid proglottids were gently squeezed on clean microscopic slides to release the eggs. Both stained and unstained (wet preparation) of eggs were microscopically studied using a trinocular microscope (Model BX 60; Olympus, Tokyo, Japan) fitted with a Nomarski prism and a photographic attachment that included a 35-mm camera Model SC 635; Olympus) and an automatic exposure control unit (Model PM 20; Olympus). Morphometric studies of oribatid mites were also carried out.

RESULTS

Psidium cattleianum Sabine (family Myrtaceae) (“strawberry guava”) is shown in Figure 1, and *B. studeri* segments obtained from preserved specimens provided by the Central Laboratory are shown in Figure 2. The scolex head from a preserved specimen measured approximately 800 × 580 µm, was globular in shape, and was devoid of hooks and a rostellum. The neck was short (2.65 mm in length) and slender (Figure 3). The eggs were spherical with a ranging in size from 50.0 to 65 µm × 30.0 to 45 µm (mean = 58.05 µm × 39.2 µm; n = 9) and covered with a thin transparent shell 6–8 µm thick (Figure 4). The oncospheres varied in size between 15 and 19 µm and had 6–8 slender hooklets each 7–9 µm long. The pyriform apparatus ranged in size between 23 and 25 µm (mean = 24.25 µm, n = 4) and terminated into two clear arms (3.88 µm thick). Two filaments were also present, each consisting of a series of horn-like structures 11.6 µm in length (inset in Figure 5) with two rounded or knob-like structures (each 8 µm × 6.5 µm) at the extremities. The conspicuous thick muscular cirrus sac had a size of 600–900 µm (mean = 726.67 µm, n = 3) × 220–250 µm (mean = 240 µm, n = 3) and was located on the lateral margin anterior to the vagina (Figure 6). It was composed of 1) a cirrus canal 340 µm in

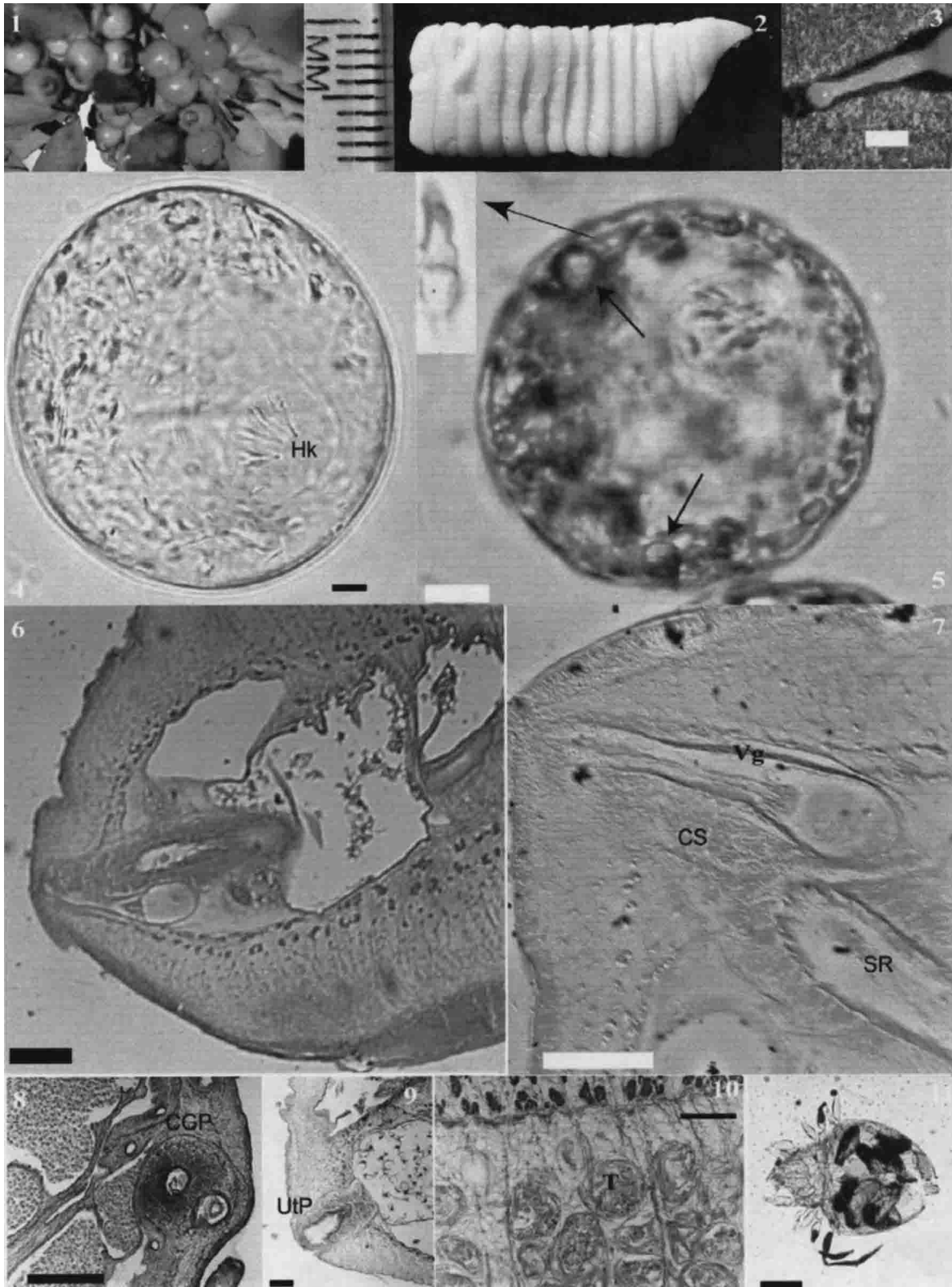


FIGURE 1. **1**, Strawberry guavas (*Psidium cattleianum* Sabine), family *Myrtaceae* from local forests in Mauritius. **2**, *Bertiella studeri* proglottids. **3**, A *Bertiella studeri* scolex from a preserved laboratory specimen. Scale bar = 2 mm. **4**, A *Bertiella studeri* egg showing the shell membrane, pyriform apparatus, and oncosphere with hooklets (**Hk**) (magnification $\times 1,000$, scale bar = 10 μm). **5**, A *Bertiella studeri* egg showing a horn-like filament (**inset**) and two knob-like structures (**arrows**) (magnification $\times 1,000$, scale bar = 10 μm). **6**, Transverse section of a proglottid of *Bertiella studeri* passing through the cirrus sac and funnel-like vagina (magnification $\times 50$, scale bar = 20 μm). **7**, Transverse section of a proglottid of *Bertiella studeri* showing the glandular vagina (**Vg**), the muscular cirrus sac (**CS**), and the seminal receptacle (**SR**) (magnification $\times 100$, scale bar = 10 μm). **8**, Transverse section of the common genital pore (**CGP**) of *Bertiella studeri* showing the glandular region of the vaginal pore (magnification $\times 100$, scale bar = 10 μm). **9**, Transverse section of the muscular uterine pore (**Utp**) of *Bertiella studeri* (magnification $\times 100$, scale bar = 10 μm). **10**, Transverse section of the proglottid of *Bertiella studeri* passing through testes (**T**) and longitudinal and transverse muscles (magnification $\times 400$, scale bar = 20 μm). **11**, A *Schelorbitid* mite found in the local forests of Mauritius (magnification $\times 100$, scale bar = 10 μm).

length running along the muscular portion to open into the common genital pore (diameter = 300 μm), 2) a seminal receptacle ranging in size between 360 and 900 μm (mean = 583.6 μm , $n = 5$) and 200 and 450 μm (mean = 350 μm , $n = 5$), and, 3) an anterior spherical portion (230 \times 200 μm). In contrast, the funnel-shaped vagina was 330–540 μm (mean = 523 μm , $n = 3$) in length (Figure 7), was relatively smaller than the cirrus sac. It consisted of a glandular portion (270 μm \times 140 μm) and a tube-like neck (270 μm \times 50 μm) that opened into the glandular portion (300 μm) of the common genital pore below the male opening (100 μm), as shown in Figure 8. The single tube uterus appeared as anterior and posterior like pockets running across the gravid segment to open into the muscular uterine pore (200 μm \times 180 μm), which alternated irregularly between the right and left margins (Figure 9). The ovary was lobular and measured 1.15 mm \times 0.38 mm. In mature proglottides, the intervacular testes (Figure 10) were numerous (range = 214–225, mean = 220.2, $n = 5$) with an average diameter of 75.83 μm \times 69.16 μm and occupied most of the anterior part of the proglottides below the longitudinal and transverse muscles. A *Schelorbitid* mite, which is commonly found in forests in Mauritius, measured 420 μm \times 305 μm (Figure 11).

DISCUSSION

Human bertiellosis is prevalent in countries where primates, the natural definitive hosts, have ecologic contact with humans. Although the two species *B. studeri* and *B. mucronata* were previously regarded by some investigators to be identical,^{5,10,11} studies based on specimen identification have shown that 1) the number of follicular testes in *B. studeri* is greater than that in *B. mucronata* (120–140);^{4,7} 2) the funnel-shaped vagina in *B. studeri* is shorter and weakly developed, ending up at the level of the excretory canal, while in *B. mucronata*, the glandular portion of the vagina extends to the lateral level of the ovary; 3) *B. studeri* eggs are larger than those of *B. mucronata*; and 4) the oval or spindle-shaped cirrus sac of *B. studeri* is well developed and larger in contrast to that of *B. mucronata*. However, morphologic descriptions cited in the literature are insufficient to compare with the available preserved materials from Mauritius. In the current study, additional morphologic and morphometric analyses of newly collected specimens, as well as preserved materials of *Bertiella*, have been possible.

Our results indicate that the morphologic characteristics of the eggs and gravid segments obtained from the specimens corresponded to those of *B. studeri* since the number of testes varied between 225 and 265, the average size of the eggs was 58.05 μm \times 39.2 μm , and the conspicuous cirrus sac was 726.67 μm . These observations are consistent with those of other investigators.^{11–13}

Although no significant clinical effect was attributed to *Bertiella* infection,^{14,15} the clinical manifestations in the reported cases are intermittent diarrhea and epigastric pain, nausea, anorexia, and weight loss. Moreover, the absence of any helminth ova or bacterial infection in the stool specimen that could account for these clinical effects further supports the findings of other investigators that *B. studeri* could cause gastrointestinal disturbances and discomfort and anxiety in humans.^{4,16}

The island of Mauritius (area = 1,865 km²) is located in the Indian Ocean 800 km east of Madagascar. It is inhabited by crab-eating monkeys (*Macaca fascicularis*) that were introduced from the Malay Peninsula or Java¹⁷ in the early 17th century. Moreover, this study also showed low genetic variability among these monkeys, suggesting a bottleneck effect. It is likely that *Bertiella* species could have accidentally been introduced into Mauritius in some infected primates and have survived in their new isolated environment. This could explain their origin and presence in the island. Moreover, the specimens observed in Mauritius were similar to those reported from Thailand.¹⁶ Therefore, it would be worthwhile to screen monkeys in Mauritius for *Bertiella* species.

The rapid pace of industrialization, growth in population, deforestation, urbanization, change in life style, and the influence of humans on the environment in Mauritius may have forced the primates, whose population size is approximately 25,000–35,000,¹⁸ to occupy human habitats, which probably accounts for the occasional *Bertiella* infection reported during the last few years. Moreover, unlike few common helminth infections in Mauritius, there may be other unreported cases that have gone unnoticed due to the failure to differentiate *Bertiella* segments from other taenia species, thus resulting in misdiagnosis of this infection, as pointed out by other investigators.¹⁵ The fact that one of the cases reported here was given albendazole treatment did not rule out this possibility.

In the forest of Mauritius, *Schelorbitid* mites were found on damp soil among organic matter and occasionally on the lower branches of the small strawberry guavas trees in which monkeys live. These oribatid mites have been found to be the natural intermediate hosts for *Bertiella* (Aumeer MO, 1992. *Contribution à l'Étude de Bertiella studeri et Inermicapsifer Madagascariensis dans le Contexte Particulier de l'Île Maurice*. PhD thesis. l'Université Claude Bernard, Lyon, France). Moreover, the season for harvesting strawberry guavas coincides with the Easter School holidays, and during this period of the year, the climate is warm and ideal for outings. According to their parents, children could accidentally pick ripened guavas that have fallen on the soil and become contaminated by the intermediate host. At this time, this is the only explanation regarding the acquisition of *Bertiella* infection in the reported cases. However, other sources of infection cannot be ruled out.

This is the first report of *B. studeri* infection in a Mauritian adult. Clinical presentations could help in the proper identification and diagnosis of bertiellosis so that appropriate anti-helminthic therapy (niclosamide) could be given. These observations may help in assisting the local health authorities in their monitoring and eradication programs of helminth infections against which appropriate measures could be envisaged, especially from the standpoint of human health risk. Moreover, the habit of eating guavas, especially by children, that have fallen on the ground should be strongly discouraged.

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