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A NEW *SYPHACIA* SPECIES (NEMATODA: OXYURIDAE) COLLECTED FROM *BUNOMYS* SPP. (RODENTIA: MURIDAE) IN CENTRAL SULAWESI, INDONESIA

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ABSTRACT: *Syphacia (Syphacia) rifaii* sp. n. (Nematoda: Oxyuridae) is described from endemic *Bunomys chrysocomus* and *Bunomys prolatus* (Rodentia: Muridae) on Sulawesi Island, Indonesia. The new species is closest morphologically to *Syphacia (Syphacia) sulawesiensis*, parasitic in *Rattus xanthurus* from Sulawesi Island, by having large vesicular lateral alae in males, but is readily distinguished by having a smaller body, a round cephalic plate in both sexes, the absence of lateral alae in females, a longer relative distance between excretory pore and vulva, and smaller eggs. *Syphacia (S.) rifaii* is surmised to be a specific parasite of *Bunomys* spp. and has evolved from a common ancestor with *S. (S.) sulawesiensis* on Sulawesi Island.

Sulawesi is due east of the famous zoogeographical transition area between the Oriental and Australian regions. This island has a unique mammalian fauna that is not only species rich, but also features a very high level of endemism (Musser, 1987). The Sulawesian murine rodents represent about 30% of the total mammalian species and approximately 52% of all the endemic species (Musser and Durden, 2002). *Bunomys* is one of the endemic rat genera of Sulawesi, of which 7 species are currently recognized (Suyanto et al., 1998). Although *Bunomys* spp. have been known to harbor specific heligmonellid nematodes (Hasegawa and Mangali, 1996), their helminth fauna is still insufficiently known. Recently, we examined the yellow-haired hill rat *Bunomys chrysocomus* (Hoffmann, 1887) and the long-headed hill rat *Bunomys prolatus* Musser, 1991 and found nematodes that represent a new species of *Syphacia* Seurat, 1916 (Oxyuridae: Syphaciinae). The new species is described herein.

MATERIALS AND METHODS

Bunomys chrysocomus were captured using small cage traps, 28 × 12 × 12 cm, in Donggala, Central Sulawesi. The rats were killed using ether alcohol and then necropsied in the laboratory. The viscera were removed and opened with scissors. Contents of the each portion of the alimentary canal were rinsed separately in physiological saline. Scrapings taken from each portion of the alimentary canal were also examined for nematodes. The worms were then fixed and stored in 70% ethanol. Later, the worms were examined using a compound Olympus BH series microscope (Olympus Company, Tokyo, Japan), equipped with a drawing tube, and a JEOL JSM5310LV scanning electron microscope (SEM) (JEOL Company, Tokyo, Japan). For light microscopy, the specimens were cleared in glycerol-alcohol solution by evaporation. Measurements were made with an ocular micrometer. For SEM, the specimens were fixed in glutaraldehyde, dehydrated through an ethanol series, freeze-dried using a Labconco Model 79480 (Labconco Co., Kansas City, Missouri), and coated with gold at 5–8 mA for 5 min using an ion coater Eiko IB-2 (Eiko Co., Tokyo, Japan). Measurements (range, followed by mean in parentheses) are given in micrometers unless otherwise stated. Pinworms collected from the caecum of a long-headed hill rat, *Bunomys prolatus*, in Lore Lindu, Central Sulawesi in 2001, by Dr. Ibnu Maryanto, were also examined by light microscopy. Specimens are deposited in the Museum Zoologicum Bogoriense (MZB), Indonesia, and the National Science Museum, Tokyo (NSMT), Japan.

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RESULTS

DESCRIPTION

***Syphacia (Syphacia) rifaii* n. sp.**
(Oxyuroidea: Oxyuridae: Syphaciinae)
(Figs. 1–17)

Diagnosis: Small worm. Cuticle with transverse striations. Cephalic vesicle present (Figs. 1–3, 7–12). Esophagus of typical oxyuroid form (Figs. 1, 2, 7–9). Cervical alae absent. Deirids not seen. Cephalic plate round; mouth surrounded by 3 weakly elevated lips, 1 dorsal and 2 subventral; 4 cephalic papillae large, arranged almost squarely; amphidial pores with porous patches laterally (Figs. 3, 12, 15–17). Excretory pore posterior to esophago-intestinal junction (Figs. 1, 2, 7–9).

Male (holotype and 12 paratypes): Length 0.60–0.78 (0.67) mm, maximum width 74–109 (89). Distance between amphidial pores 14. Lateral alae large, vesicular, extending from esophageal bulb level to posterior mamelon level (Figs. 1, 2). Total esophagus, including pharynx, corpus, and bulb, 167–198 (178) long: pharynx 9–13 (11) long, corpus 122–151 (134) long and 20–31 (24) wide, bulb 34–46 (41) long by 37–52 (44) wide. Nerve ring 80–96 (88), and excretory pore 266–332 (301) from cephalic end, respectively. Mamelons at ventral posterior body, 3 well developed, anterior mamelon 41–53 (46) long, middle mamelon 40–56 (45) long, and posterior mamelon 27–48 (35) long (Figs. 1, 2). Distance from cephalic end to anterior edges of anterior, middle, and posterior mamelons 354–423 (386), 396–500 (438), and 467–607 (526), respectively. Spicule thin, needle-shaped, 61–70 (65) long, i.e., 7.9–11.5% (9.8%) of worm length (WL); gubernaculum stout, hook-shaped, 22–27 (25) long; accessory piece of gubernaculum relatively thin, unornamented (Figs. 1, 5, 6). Caudal papillae in 3 pairs, 2 pairs near cloaca and 1 posterior pair protruding posterolaterally (Figs. 5, 6). Tail including short process 35–60 (44) long, i.e. 5.5–8.1% (6.6%) of WL (Figs. 1, 5).

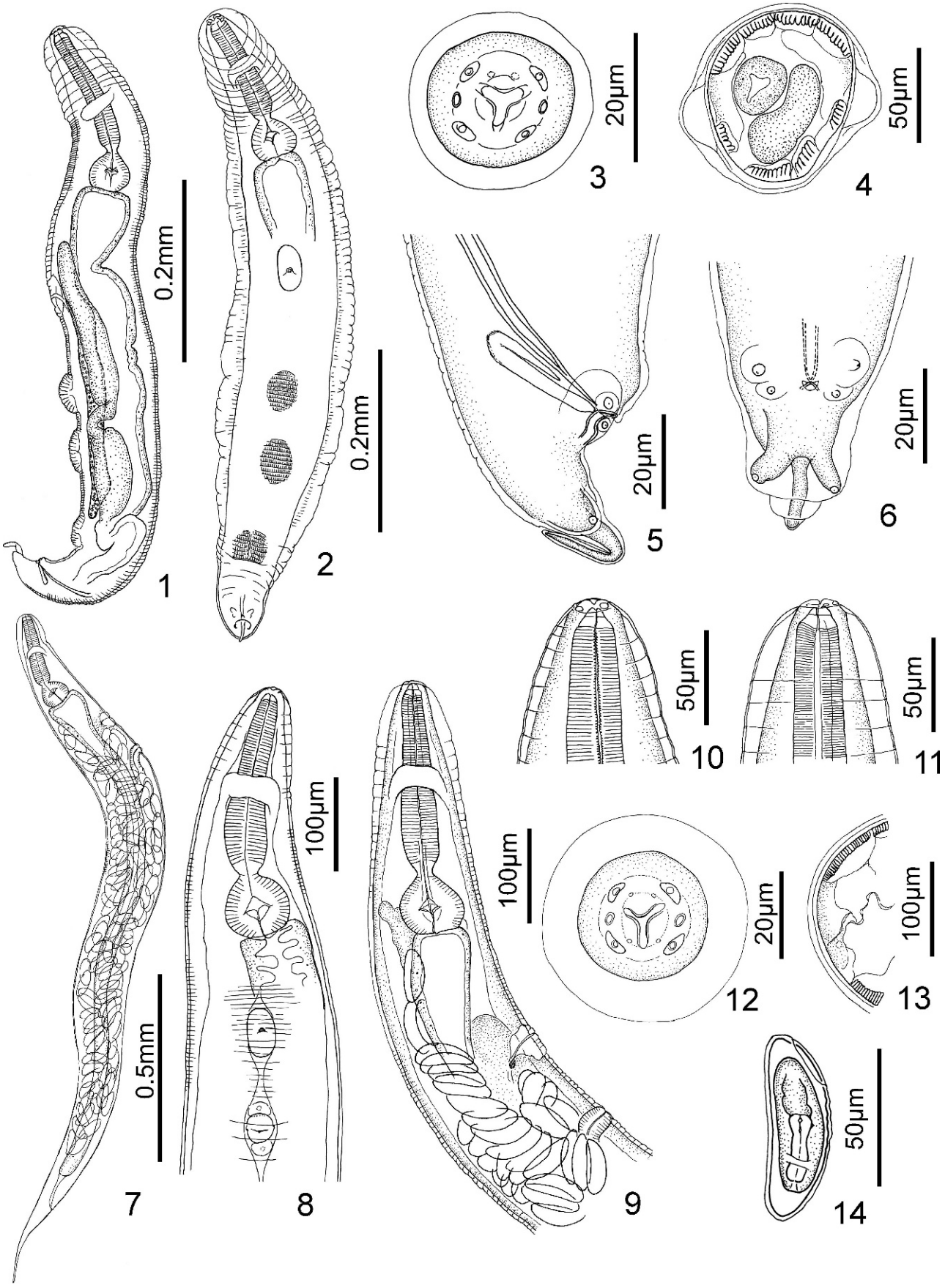
Female (allotype and 13 paratypes): Length 1.40–2.19 (1.82) mm, maximum width 147–244 (182) (Fig. 7). Distance between amphidial pores 16. Lateral alae absent (Figs. 8–11, 13). Total esophagus, including pharynx, corpus, and bulb, 246–277 (262) long: pharynx 12–16 (15) long, corpus 171–206 (189) long and 30–45 (36) wide, bulb 49–68 (59) long by 58–75 (66) wide. Nerve ring 80–108 (99), excretory pore 322–454 (388) from cephalic end. Vulva not protruding, 449–582 (503), i.e., 22–37% (28%) of WL from cephalic end; vagina and ovejector directed posteriorly (Figs. 7–9). Distance between excretory pore and vulva 95–145 (115), i.e., 4.8–8.4% (6.4%) of WL. Eggs oval, asymmetrical, operculated, concaved side with wrinkled shell, embryonated in uteri, 68–70 (69) × 23–29 (27) (Fig. 14). Uterus extending anteriorly to the esophageal bulb and ending posteriorly near anus. Tail conical, relatively short, 181–274 (222), i.e., 8.9–15.0% (12.3%) of WL (Fig. 7).

Taxonomic summary

Type host: Bunomys chrysocomus (Hoffmann, 1887) (Yellow-haired hill rat) (Rodentia: Muridae).

Other host: Bunomys prolatus Musser, 1991 (Long-headed hill rat) (Rodentia: Muridae).

Site of infection: Caecum.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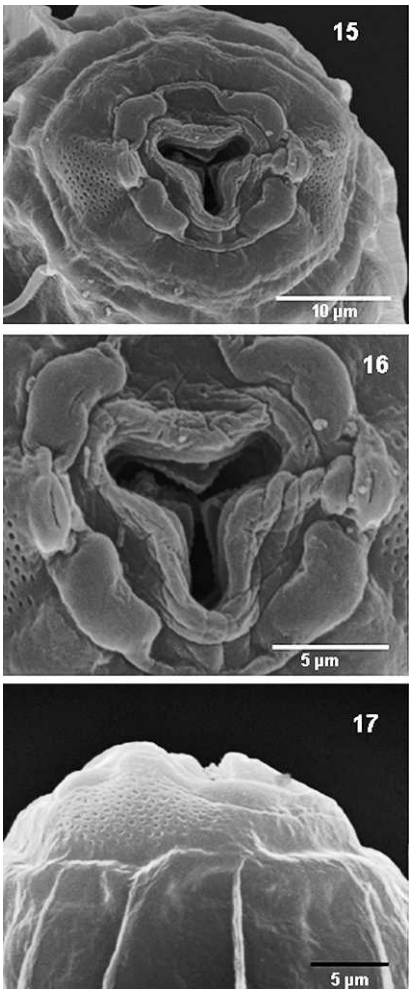

FIGURES 15–17. Scanning electron microscopy of *Syphacia (Syphacia) rifaii* n. sp. collected from *Bunomys chrysocomus* in Central Sulawesi. (**15**) Cephalic end of female, apical view. (**16**) Enlarged view of cephalic apex of female, apical view. (**17**) Cephalic end of female, lateral view.

Type locality: Donggala, Central Sulawesi, Indonesia (1°13′52″S, 119°57′23″E, alt. 161 m).

Other locality: Lore Lindu, Central Sulawesi, Indonesia (1°08′03″S, 120°07′32″E, alt. 740 m).

Date of collection: 25 June 2008 (host: *B. chrysocomus*), 16 June 2001 (host: *B. prolatus*).

Specimens deposited: Holotype male and allotype female (MZB Na 418), 9 male and 9 female paratypes (MZB Na 423), 2 male and 4 female paratypes (NSMT-As 3607) (host: *B. chrysocomus*); 12 females (MZB Na 216) (host: *B. prolatus*).

Etymology: Species epithet is dedicated to Prof. Mien A. Rifai, Indonesian Academy of Sciences (LIPI).

Remarks

The new species belongs to *Syphacia* by having 3 mamelons in males, a non-protruding vulva, and eggs with small operculum at one end (Petter and Quentin, 1976). It is assigned to the subgenus *Syphacia* according to the round cephalic plate, less-developed lips, and the absence of cervical alae and developed deirids (Hugot, 1988). There are about 30 species in the subgenus, although some species have not been adequately described. Presence of large vesicular lateral alae in males is an exceptional character for the subgenus, being shared only by *Syphacia (Syphacia) sulawesiensis* Hasegawa and Tarore, 1996, a parasite in *Rattus xanthurus* (Gray, 1867) in northern Sulawesi, Indonesia (Hasegawa and Tarore, 1996). However, *S. (S.) sulawesiensis* differs from *S. (S.) rifaii* by having a much larger body (males 1.65–1.91 mm long; females 3.87–5.14 mm long), laterally-elongated cephalic plate in both sexes, moderately developed lateral alae in females, a shorter distance between excretory pore and vulva (corresponding to 2.3–3.8% of worm length), and larger eggs (77–86 × 24–29 µm) with coarsely pitted shells (Hasegawa and Tarore, 1996).

In addition to the vesicular lateral alae in males, *S. (S.) rifaii* is easily distinguished from other representatives of the subgenus known from Indo-Australian regions by having a round cephalic plate, i.e., *Syphacia (Syphacia) abertoni* Weaver and Smales, 2006, *Syphacia (Syphacia) brevicaudata* Weaver and Smales, 2008, *Syphacia (Syphacia) darwini* Hugot and Quentin, 1985, *Syphacia (Syphacia) longaecauda* Smales, 2001, and *Syphacia (Syphacia) obvelata* (Rudolphi, 1802), *Syphacia (Syphacia) ohtaorum* Hasegawa, 1991, and *Syphacia (Syphacia) pseudomyos* Weaver and Smales, 2008 possess a laterally-elongated cephalic plate (Quentin, 1971; Hugot and Quentin, 1985; Hasegawa, 1991; Smales, 2001; Weaver and Smales, 2006, 2008), while *Syphacia (Syphacia) australasiensis* Smales, 2004, *Syphacia (Syphacia) millardiae* Hugot, 2005, and *Syphacia (Syphacia) muris* (Yamaguti, 1935) possess a quadrangular cephalic plate (Quentin, 1971; Smales, 2004; Hugot, 2005).

DISCUSSION

Syphacia species generally have a co-evolutionary relationship with their hosts, with each *Syphacia* species often showing specificity with the host genus (see Hugot, 1988). Recovery of *S. (S.) rifaii* from 2 *Bunomys* species suggests that this pinworm is host genus-specific. It is of special interest that the new species and *S.* (*S.*) *sulawesiensis*, which was collected from an endemic rat, *R. xanthurus*, of Sulawesi, share a common characteristic, i.e., the large vesicular lateral alae in males. *Bunomys* spp. and native *Rattus* spp., including *R. xanthurus*, on Sulawesi are considered as new endemics; their relatives are distributed on the Sunda shelf (Musser, 1981, 1987; Musser and Newcomb, 1983). Presumably, both *Syphacia* species are derived from a common ancestor who was introduced by the ancestor of the rat that colonized Sulawesi and subsequently speciated on this island.

Beyond Wallace's line, *Syphacia* has extended its distribution to Sulawesi and Sahul, where both old endemic and new endemic murids harbor specific species (Hugot and Quentin, 1985; Smales, 2001, 2004; Weaver and Smales, 2006, 2008). Some of the Australian species, such as *S. (S.) australasiensis*, have a square cephalic plate while others have oval, laterally elongated cephalic plates, suggesting the occurrence of plural lineages. Further helminthological survey on Sulawesi rats, especially on old

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FIGURES 1–14. Line drawings of *Syphacia (Syphacia) rifaii* n. sp. collected from *Bunomys chrysocomus* in Central Sulawesi, Indonesia. (**1**) Holotype male, left lateral view. (**2**) Paratype male, ventral view. (**3**) Cephalic end of male, apical view. (**4**) Cross section of male midbody. (**5**) Posterior end of paratype male, right lateral view. (**6**) Posterior end of male, ventral view. (**7**) Allotype female, right lateral view. (**8**) Anterior portion of allotype female, ventral view. (**9**) Anterior portion of paratype female, right lateral view. (**10**) Cephalic end of paratype female, ventral view. (**11**) Cephalic end of paratype female, right lateral view. (**12**) Cephalic end of paratype female, apical view. (**13**) Lateral field of female, mid-body in cross section. (**14**) Egg.

endemic rats such as species of *Crunomys*, *Echinothrix*, *Tateomys*, and *Melasmothrix* may reveal more specific *Syphacia* spp. Hopefully, the employment of DNA sequence analysis will reveal evolutionary relationships among the *Syphacia* species from Indonesia to Australia (cf. Okamoto et al., 2007).

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