

A new species of *Moaciria* (Nematoda, Heterakidae) and other helminths in the red Mawatta frog, *Hylophorbus* cf. *rufescens* (Anura, Microhylidae) from Papua New Guinea

Charles R. Bursey^{1*}, Stephen R. Goldberg² and Fred Kraus³

¹Department of Biology, Pennsylvania State University, Shenango Campus, Sharon, Pennsylvania 16146;

²Department of Biology, Whittier College, Whittier, California 90608;

³Bishop Museum, Department of Natural Sciences, 1525 Bernice Street, Honolulu, Hawaii 96817; USA

Abstract

Moaciria moraveci sp. nov. (Nematoda, Heterakidae) from the large intestine of *Hylophorbus* cf. *rufescens* from Papua New Guinea is described. *Moaciria moraveci* sp. nov. represents the 9th species assigned to the genus and the 5th from the Australo-Papuan region. It is distinguished from congeners by the distribution pattern of the caudal papillae of the male, spicule length and vulvar position.

Key words

Nematoda, *Moaciria moraveci* sp. nov., Anura, *Hylophorbus* cf. *rufescens*, Papua New Guinea

Introduction

In a helminthological survey of frogs of Papua New Guinea, 10 of 21 (48%) red Mawatta frogs, *Hylophorbus* cf. *rufescens* Macleay (Microhylidae), were found to harbor an undescribed species of *Moaciria* Freitas, 1956. The systematics for the genus *Hylophorbus* Macleay from eastern New Guinea are unresolved; however, several unnamed species are involved and members of the genus occupy the whole of Papua New Guinea from sea level to 3570 m as well as the offshore d'Entrecasteaux and Louisiade archipelagos and Woodlark Island (Zweifel 1972, Menzies 2006). Type locality for *Hylophorbus rufescens* is Katow in southwestern Papua New Guinea (Zweifel 1972) and the host specimens discussed herein represent a closely related but yet-to-be determined species. To our knowledge, there are no helminthological reports for this frog. *Moaciria* was established by Freitas (1956) to receive *Moaciria alvarengai* Freitas, 1956, a newly described nematode from the lizard *Mabuya maculata* (Gray) collected at Ilha Fernando de Noronha, Brazil. The purpose of this paper is to describe the 9th species assigned to *Moaciria* and to provide an initial parasite list for this host.

Materials and methods

Twenty-one adult *Hylophorbus* cf. *rufescens* from Fergusson Island, Milne Bay Province, Papua New Guinea in the collec-

tion of the Bernice P. Bishop Museum, Honolulu, Hawaii (BPBM) were examined for helminths: 12 (BPBM 16181, 16184-16187, 16192-16194, 16196, 16197, 16199, 16204) collected on Oya Tabu, 12–26 August 2002; 9 (BPBM 16206-16214), collected 9–14 September 2002 on Oya Waka. The abdominal cavity of each frog was opened and the gastrointestinal tract was removed, opened longitudinally and searched for helminths using a dissecting microscope. The coelom was also searched. The helminths, fixed in situ, were cleared in lactophenol on a glass slide and examined using a compound microscope. Illustrations were made with the aid of a microprojector. Measurements are given in micrometers, unless otherwise stated, as mean \pm 1 SD with range in parentheses. Type specimens were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland; voucher specimens in USNPC and BPBM.

Results

Twenty-six nematodes, 3 mature males and 23 mature females, of a species of *Moaciria* were found in the large intestines of 10 of 21 *Hylophorbus* cf. *rufescens*. Mature individuals of three species of Nematoda, *Cosmocerca novaeguineae* Moravec et Sey, 1990, *Cosmocerca tyleri* Bursey, Goldberg et Kraus, 2006, and *Oswaldocruzia bakeri* Moravec et Sey, 1986, and larvae (in cysts) of another nematode, *Physocephalus* sp., as well as acanthocephalan cystacanths were also

Table I. Site of infection, number of helminths, prevalence, mean intensity, range of infection and USNPC and BPBM accession numbers for voucher specimens of 6 helminth species from *Hylophorbus* cf. *rufescens* from Papua New Guinea

Helminth species	Site of infection	Number	Prevalence	Mean intensity ± SD	Range	Accession number SNPC	BPBM
<i>Cosmocerca novaeguineae</i>	large intestine	24	5/21 (23%)	4.8 ± 2.7	1–7	99596	H205
<i>Cosmocerca tyleri</i>	large intestine	274	9/21 (42%)	30.4 ± 24.6	4–73	99597	H206
<i>Moaciria moravecii</i> sp. nov.	large intestine	26	10/21 (48%)	2.6 ± 3.0	1–11	99598	H207
<i>Oswaldocruzia bakeri</i>	large intestine	18	6/21 (28%)	3.0 ± 2.2	1–7	99599	H208
<i>Physocephalus</i> sp. (cysts)	stomach wall	18	2/21 (10%)	9.0 ± 11.3	1–17	99600	H209
<i>Acanthocephalan</i> cystacanths	body cavity	14	4/21 (19%)	3.5 ± 1.3	2–5	99601	H210

found. Numbers of individuals, prevalence and mean intensity for each helminth species are presented in Table I. Description of the new species follows.

Moaciria moravecii sp. nov. (Figs 1–8)

General: Heterakidae Railliet et Henry, 1912; Spinicaudinae Travassos, 1920; *Moaciria* Freitas, 1956. Small, stout nematodes, females larger than males. Body cylindrical, fusiform, however posteriorly truncated in males. Cuticle with transverse striations. Narrow lateral alae extending along entire length of body. Mouth with three lips offset from body, dorsal lip with 2 sessile papillae, each ventrolateral lip with a sessile papilla and a stalked amphid. Oesophagus divisible into anterior pharynx, corpus and posterior valved bulb. Somatic papillae present. Males with caudal sucker and caudal alae supported by papillae.

Male (holotype and 2 paratypes): Length 2.75 ± 0.14 mm (2.59–2.85 mm), width at midbody 267 ± 55 (204–306). Narrow alae beginning at base of lips and ending at caudal truncation. Length of lips 15 ± 3 (12–18); pharynx 47 ± 3 (43–49) long; corpus 433 ± 18 (415–451) long; bulb 102 ± 7 (98–110) long, 100 ± 15 (82–110) wide. Nerve ring 266 ± 19 (250–287) and excretory pore 467 ± 85 (395–561) from anterior end. Eight longitudinal rows of equally spaced somatic papillae. Twelve pairs of caudal papillae: 4 pairs precloacal, 2 pairs anterior to sucker, 2 pairs lateral to sucker; 2 pairs adcloacal, 1 pair lateral, 1 sublateral; 6 pairs postcloacal, 2 pairs on truncation, pair adjacent to cloaca small, posterior pair largest of the papillae present; 4 pairs on caudal filament, 2 pairs lateral in position, 2 pairs ventral. Spicules, similar, equal, 246 ± 3 (244–250) long, proximal end truncate, distal end with blunt point; gubernaculum 169 ± 9 (159–177) in length. Caudal end with well-developed, sclerified sucker, 33 ± 2 (31–34) in diameter, 35 ± 2 (33–37) deep. Cloaca 124 ± 12 (110–134) from posterior end of body; caudal filament conical, 78 ± 8 (68–84) in length, terminating in sharp point and supporting 4 pairs of the caudal papillae.

Female (allotype and 9 paratypes): Length 3.64 ± 0.47 mm (2.94–4.16), width at level of vulva 384 ± 52 . Narrow alae extending from base of lips to near middle of tail. Cuticle thick, fine transverse striations approximately 6 apart, equally spaced somatic papillae in longitudinal 8 rows. Lips 21 ± 3

(15–24) in length; pharynx 54 ± 4 (49–61) in length; corpus 601 ± 47 (537–671) in length; bulb 139 ± 12 (122–159) long, 150 ± 23 (116–183) wide. Nerve ring 293 ± 11 (275–305), excretory pore 542 ± 33 (485–599) from anterior end, respectively. Vulva, slightly post-equatorial, transverse slit, lips slightly salient, 1.91 ± 0.26 mm (1.60–2.27; 52–54% of body length) from anterior end. Ovijector muscular, directed posteriorly, joining 1 anteriorly and 1 posteriorly directed uterus. Uteri containing a small number of eggs. Eggs in ovijector with thick, punctate shell, cylindrical in profile, 82 ± 3 (79–85) × 30 ± 2 (27–34). Conical tail 350 ± 31 (299–415) in length, terminating in sharp point. Phasmids just posterior to middle of tail.

Type host: *Hylophorbus* cf. *rufescens* Macleay, 1878, red Mawatta frog; symbiotype, BPBM 16199; collected 21 August 2002, Oya Tabu.

Type locality: E. slope Oya Tabu, (9°27'S, 150°47'E, 1100 m), Fergusson Island, Milne Bay Province, Papua New Guinea.

Site of infection: Large intestine.

Type specimens: Holotype male, USNPC 99593; allotype female, USNPC 99594; paratypes USNPC 99595; voucher specimens USNPC 99598, BPBM H207.

Etymology: The new species is named for František Moravec, Institute of Parasitology, Academy of Sciences of the Czech Republic, in recognition of his contributions on the helminths of Papuan anurans and as the first to report (Moravec 1990) the presence of Spinicaudinae in amphibians.

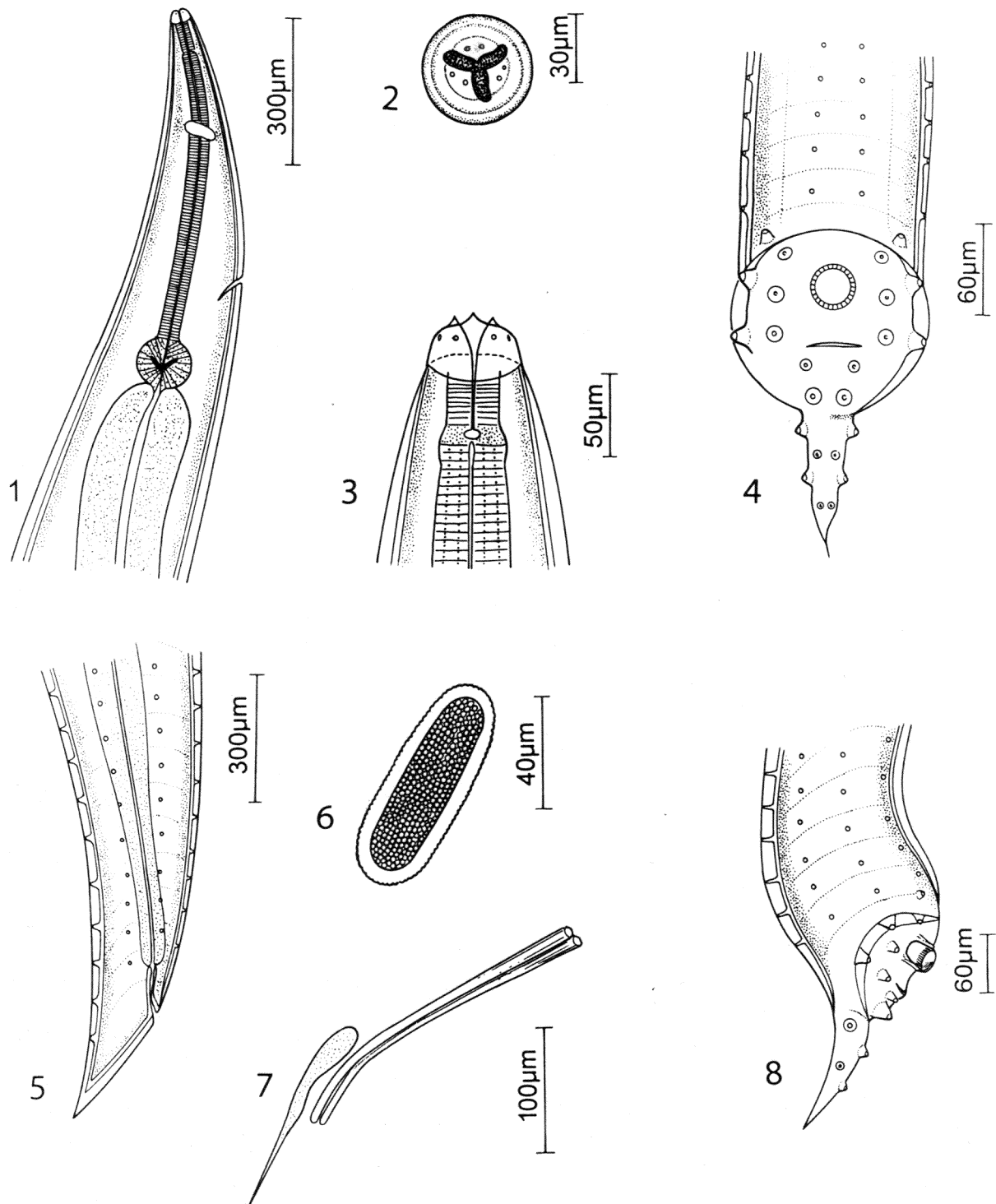
Remarks

Moravec (1990) collected 3 female specimens, which he assigned to Spinicaudinae, 2 from the large intestine of *Callurops humicola* (Zweifel) and 1 from *C. stictogaster* (Zweifel) (Microhylidae). Although these specimens are larger than ours, 4.73–6.85 mm vs. 2.94–4.16 mm, the ratio of distance of vulva to total body length is in agreement (50–52% vs. 52–54%). The only species of Spinicaudinae reported from New Guinea is *Moaciria chondropythonis* Gibbons, 1979, which has a much larger body size (Gibbons 1979) (see Table II). Three additional species, *Moaciria butleri* Jones, 1979, *M. etnae* Jones, 1979, and *M. sphenomorphi* Jones, 1979, are found in the Australo-Papuan region, but at this time are known only

from Australia and only from reptiles. Morphological characters of these 3 species are different from *M. moraveci* sp. nov. (see Table II).

Discussion

All helminths found during this study represent new host records for *Hylophorbus cf. rufescens*. *Cosmocerca novaegui-*



Figs 1–8. *Moaciria moraveci* sp. nov.: 1. Female, anterior extremity, lateral view. 2. Female, anterior extremity, en face view. 3. Female, anterior extremity, ventral view. 4. Male, posterior end, ventral view. 5. Female, posterior end, lateral view. 6. Egg. 7. Spicules and gubernaculum, lateral view. 8. Male, posterior end, lateral view

Table II. Selected characters of males of species of *Moaciria*

Male characters	Length (mm)	Spicule (μm)	Gubernaculum (μm)	Sucker diameter (μm)	Caudal papillae
<i>M. alvarengai</i> Freitas, 1956	3.01–3.93	230–290	150–160	42–50	7 pairs, 3 single
<i>M. butleri</i> Jones, 1979	6.37	450	290	80	19 pairs, 2 single
<i>M. chondropythonis</i> Gibbons, 1979	10.89–12.06	633–912	524–599	117–152	15 pairs, 1 single
<i>M. etnae</i> Jones, 1979	4.95	350	220	60	16 pairs
<i>M. freitasi</i> Chabaud et Brygoo, 1960	4.2	260	150	25	11 pairs, 1 single
<i>M. icosiensis</i> (Seurat, 1917)	4.95	360	180	not stated	7 pairs
= <i>A. pharyngeodentata</i> Belle, 1957	3.9–4.5	380–420	180	–	11 pairs
<i>M. komodoensis</i> (Pinnell et Schmidt, 1977)	5.73	457	295	79	9 pairs
<i>M. moraveci</i> sp. nov.	2.59–2.85	244–250	159–177	31–34	12 pairs
<i>M. sphenomorphi</i> Jones, 1979	4.65–4.95	290–300	180–200	40	12 pairs, 1 single

Table II (continued). Selected characters of females of species of *Moaciria*

Female characters	Length (mm)	Vulva from anterior		Egg (μm)	Shell	Reference
		mm	% body length			
<i>M. alvarengai</i>	4.12–5.49	1.91–2.41	44–46	76 × 42	smooth	Freitas (1956)
<i>M. butleri</i>	7.12–9.52	–	44–47	84 × 56	smooth	Jones (1979)
<i>M. chondropythonis</i>	11.73–16.25	not stated	–	none present	–	Gibbons (1979)
<i>M. etnae</i>	6.37–7.35	–	44–47	87 × 59	smooth	Jones (1979)
<i>M. freitasi</i>	undescribed	–	–	–	–	Chabaud and Brygoo (1960)
<i>M. icosiensis</i>	7.20	3.66	51	85 × 56	not stated	Seurat (1917)
= <i>Aplectana pharyngeodentata</i>	4.7–6.1	about middle of body	–	160 × 120	not stated	Belle (1957)
<i>M. komodoensis</i>	undescribed	–	–	–	–	Pinnell and Schmidt (1977)
<i>M. moraveci</i> sp. nov.	2.94–4.16	1.60–2.27	52–54	82 × 30	punctate	present paper
<i>M. sphenomorphi</i>	undescribed	–	–	–	–	Jones (1979)

neae was originally described by Moravec and Sey (1990) from specimens taken from the intestine of *Platymantis papuensis* Meyer (Ranidae) collected in the Torricelli Mountains, Sepik Province, Papua New Guinea and was previously known only from that host. *Cosmocerca tyleri* was originally described by Bursey *et al.* (2006) from specimens taken from the large intestine of *Genyophryne thomsoni* Boulenger (Microhylidae) collected in the nearby Cloudy Mountains, Milne Bay Province, Papua New Guinea and was previously known only from that host. *Oswaldocruzia bakeri* was originally described by Moravec and Sey (1986) from specimens taken from *Phrynomantis stictogaster* (currently, *Callulops stictogaster*) (Microhylidae) collected in the Eastern Highlands Province of Papua New Guinea. It is also known from the frogs *Callulops humicola*, *C. wilhelmanus* (Loveridge) and *Platymantis pelewensis* Peters and the lizards *Cyrtodactylus louisianensis* (de Vis) and *Sphenomorphus jobiensis* (Meyer) (Moravec and Sey 1986; Bursey and Goldberg 2004; Bursey *et al.* 2005a, b). The thick stomach worm *Physocephalus sexalatus* (Molin, 1860), a cosmopolitan species, is a common parasite of wild and domestic pigs and is occasionally found in tapirs, equines, bovines, and lagomorphs (Anderson 2000). Infective larvae have been recovered from at least 20 different genera of beetles, and encapsulated larvae have been found in amphibians, reptiles, birds, and mammals that typically feed

on beetles (Anderson 2000). Third-stage larvae are characterized by a digitiform knob at the tip of the tail (Alicata 1935). To our knowledge this is the first report of *Physocephalus* in Papua New Guinea and *H. cf. rufescens* may be an accidental host. The life cycle of acanthocephalans generally requires 2 hosts; an arthropod intermediate host and an avian or mammalian definitive host (Near 2002). Should an inappropriate host eat the infected arthropod, the cystacanth excysts then migrates from the digestive tract into the body cavity and again encysts to await an appropriate host. *Hylophorbus cf. rufescens* most likely serves as a paratenic host for acanthocephalans.

Acknowledgements. Peggy Firth prepared the illustrations constituting Figures 1–8. We thank E. Teodoro and D. Goto for assistance with dissections; F. Malesa, D. Salepuna, and J. Tekwae for field assistance; D. Mitchell and Conservation International for logistical assistance in Milne Bay Province; D. Libai, F. Malesa, and B. Salepuna for logistical assistance on Fergusson Island; the Papua New Guinea National Museum and Art Gallery for providing in-country collaborative assistance; and the Papua New Guinea Department of Environment and Conservation, Papua New Guinea National Research Institute, and Milne Bay Provincial Government for permission to work in Milne Bay Province. This work was supported by National Science Foundation grant DEB 0103794. This is contribution 2007-008 from the Pacific Biological Survey at Bishop Museum.

References

- Alicata J.E. 1935. Early development stages of nematodes occurring in swine. Technical Bulletin 489. United States Department of Agriculture, Washington, D.C.
- Anderson R.C. 2000. Nematode parasites of vertebrates: Their development and transmission. 2nd ed. CABI Publishing, Wallingford, UK, 650 pp.
- Belle E.A. 1957. Helminth parasites of reptiles, birds, and mammals in Egypt. IV. Four new species of oxyurid parasites from reptiles. *Canadian Journal of Zoology*, 35, 163–169.
- Bursey C.R., Goldberg S.R. 2004. A new species of *Spinicauda* (Nematoda: Heterakidae) and other endoparasites in *Platymanthis pelewensis* (Anura: Ranidae) from the Palau Islands, Republic of Belau, Oceanica. *Journal of Parasitology*, 90, 1428–1433. DOI: 10.1645/GE-3345.
- Bursey C.R., Goldberg S.R., Kraus F. 2005a. New genus, new species of Cestoda (Anoplocephalidae), new species of Nematoda (Cosmocercidae) and other helminths in *Cyrtodactylus louisianensis* (Sauria: Gekkonidae) from Papua New Guinea. *Journal of Parasitology*, 91, 882–889. DOI: 10.1645/GE-3450.1.
- Bursey C.R., Goldberg S.R., Kraus F. 2005b. Endoparasites in *Spheonomorphus jobiensis* (Sauria: Scincidae) from Papua New Guinea with description of three new species. *Journal of Parasitology*, 91, 1385–1394. DOI: 10.1645/GE-3502.1.
- Bursey C.R., Goldberg S.R., Kraus F. 2006. A new species of *Cosmocerca* (Nematoda, Cosmocercidae) and other helminths from *Genyophryne thomsoni* (Anura, Microhylidae) from Papua New Guinea. *Acta Parasitologica*, 51, 213–216. DOI: 10.2478/s11686-006-0033-5.
- Chabaud A.G., Brygoo E.R. 1960. Nematodes parasites de caméléons malgaches. *Mémoires de l'Institut Scientifique de Madagascar*, 14, 125–159.
- Freitas J.F.T. 1956. Novo parasito de réptil da Ilha Fernando de Noronha: *Moaciria alvarengai* g. n., sp. n. (Nematoda, Subuluroidea). *Revista Brasileira de Biologia*, 16, 335–339.
- Gibbons L.M. 1979. *Moaciria chondropythonis* sp. n. (Heterakidae: Spinicaudinae), a nematode from a Papuan tree python, *Chondropython viridis*. *Journal of Helminthology*, 53, 301–306.
- Jones H.I. 1979. New species of *Moaciria* Freitas 1956 (Nematoda: Heterakoidea) from Australian reptiles. *Journal of Helminthology*, 53, 133–140.
- Menzies J. 2006. The frogs of New Guinea and the Solomon Islands. Pensoft Publishers, Sofia, Bulgaria.
- Moravec F. 1990. Additional records of nematode parasites from Papua New Guinea amphibians with a list of recorded endohelminths by amphibian hosts. *Folia Parasitologica*, 37, 43–58.
- Moravec F., Sey O. 1986. Three new nematode species from *Phrynomantis* spp. (Amphibia: Microhylidae) from Papua New Guinea. *Folia Parasitologica*, 33, 343–351.
- Moravec F., Sey O. 1990. Some nematode parasites of frogs from Papua New Guinea and Australia. *Acta Societatis Zoologicae Bohemoslovacae*, 54, 268–286.
- Near T.J. 2002. Acanthocephalan phylogeny and the evolution of parasitism. *Integrative and Comparative Biology*, 42, 668–677. DOI:10.1093/icb/42.3.668.
- Pinnell J.L., Schmidt G.D. 1977. Helminths of reptiles from Komodo and Flores Islands, Indonesia, with descriptions of two new nematode species. *Journal of Parasitology*, 63, 337–340.
- Seurat L.G. 1917. Sur les oxyures des sauriens du Nord-africain. *Archives de Zoologie Expérimentale et Générale*, 56, 401–444.
- Zweifelfel R.G. 1972. A revision of the frogs of the subfamily Asteroophryinae family Microhylidae. *Bulletin of the American Museum of Natural History*, 148, 411–546.