

Nematodes of five species of Dicroglossid frogs (Anura: Dicroglossidae) from Southeast Asia

By Stephen R. Goldberg*, Charles R. Bursey, and L. Lee Grismer

Abstract

Five species of dicroglossid frogs (Dicroglossidae) ($n = 29$) from Southeast Asia were examined for helminths: *Limnonectes blythii*, *L. hascheanus*, *L. khasianus*, *L. kohchangae*, *L. macrognaethus*. We found 8 species of Nematoda, consisting of gravid individuals of *Aplectana macintoshii*, *Cosmocerca ornata*, *Foleyellides malayensis*, *Icosiella innominata*, *Oswaldocruzia rohdei*, *Seuratascaris numidica* and larvae of *Abbreviata* sp. and Physalopteridae gen. sp. Dicroglossid frogs from southeast Asia are infected by generalist helminths that infect other species of frogs. Twelve new host records are reported..

*Corresponding Author E-mail: sgoldberg@whittier.edu

This **early view** paper has been peer-reviewed and accepted for publication in *Pacific Science*. However, it has not been copy-edited nor has it undergone typesetting for *Pacific Science*. The final published paper will look different due to formatting changes, but scientific content will remain the same.

Introduction

The Oriental Region (which includes Southeast Asia) has an extremely diverse amphibian fauna with approximately 1534 species recorded (Das 2002), including members of the Dicroglossidae which range from sub-Saharan Africa, South Asia to the Philippines and New Guinea, into the southwest Pacific Islands (Vitt and Caldwell 2014). The dicroglossid species in Peninsular Malaysia are small to very large, forest floor frogs (Grismer 2011). Despite having a very rich amphibian fauna, there are few reports of helminths from Southeast Asian frogs. Amphibian biodiversity from Southeast Asia is in peril due to factors that include the spread of agriculture, hunting, burning, invasive species, air pollution and urbanization (Cortlett 2010). Other threats include human consumption of large species, the pet trade and the pathogen *Batrachochytrium dendrobatidis* which causes amphibian chytridomycosis (Rowley et al. 2010). Because of these environmental threats it is important to document both invertebrate and vertebrate diversity of Southeast Asian fauna while it is still possible (Rowley et al. 2010). With the above in mind, a helminthological survey of dicroglossid frogs from Southeast Asia was undertaken to increase information of invertebrate biodiversity in frogs from a threatened area.

Blyth's giant frog, *Limnonectes blythii* (Boulenger, 1920) ranges from southern Thailand south through Peninsular Malaysia to Singapore (Grismer 2011); The hill forest frog *Limnonectes hascheanus* (Stoliczka, 1870) ranges from India east to Vietnam, south through the Malay Peninsular (Grismer 2011); the Khasi hills frog, *Limnonectes khasianus* (Anderson, 1871) is distributed from Meghalaya State, and Assam State, India to peninsular Thailand, and Sumatra (Frost 2016); The Koh Chang frog, *Limnonectes kohchangae* (Smith, 1922) is known from Thailand, southern Vietnam, Cambodia and northern Laos (Frost 2016); the green swollen-headed frog, *Limnonectes macrognathus* (Boulenger, 1917) is known from Myanmar, through northwestern and southern Peninsular Thailand to northern

Malaya and Malaysia (Frost 2016). Previous helminth records on the above dicroglossid frogs are limited to microfilariae in *L. blythii*, (Chutmongkonkul et al. 2006).

MATERIALS AND METHODS

Twenty-nine dicroglossid frogs from Southeast Asia were borrowed from the herpetology collection of La Sierra University (LSUHC), Riverside, California and examined for helminths (Appendix 1): *L. blythii* ($n = 5$; mean snout length (SVL) = 66.4 mm \pm 8.7 SD, range = 56-79 mm); *L. hascheanus* ($n = 4$; mean snout length (SVL) = 21.0 mm \pm 1.8 SD, range = 19-23 mm); *L. khasianus* ($n = 13$; mean snout length (SVL) = 37.2 mm \pm 5.5 SD, range = 28-47 mm); *L. kohchangae* ($n = 6$; mean snout length (SVL) = 38.1 mm \pm 3.7 SD, range = 31-41 mm); *L. macrognathus* ($n = 1$; snout length (SVL) = 47.0 mm). Utilization of museum collections to obtain parasite data avoids removing additional animals from the wild.

Specimens had been previously fixed in 10% formalin and later stored in 70% ethanol. The body cavity was opened by a longitudinal incision and the gastrointestinal tract was removed by cutting across the esophagus and rectum. Nematodes were cleared in lactophenol, examined under a compound microscope and identified to species utilizing Anderson et al. (2009), Gibbons (2010) and by comparisons with the original descriptions. Nematodes were deposited in the Harold W. Manter Laboratory (HWML), University of Nebraska, Lincoln (Appendix 2). Parasite terminology is in accordance with Bush et al. (1997).

RESULTS

A total of 86 nematodes representing eight species were found: *Aplectana macintoshii* (Stewart, 1914) (infection sites: small, large intestines); *Cosmocerca ornata* Diesing, 1861 (large intestine); *Foleyellides malayensis* (Petit and Yen, 1979) (body cavity); *Icosiella innominata* Yuen, 1962 (body cavity); *Oswaldocruzia rohdei* Yuen, 1963 (small intestine); *Seuratascaris numidica* Seurat, 1917 (small intestine); *Abbreviata* sp. (stomach) and Physalopteridae gen. sp.

(stomach). Dicroglossid frog sample size, nematode number, prevalence, mean intensity of infection are presented in Table 1. Mean number of helminth species per host was 2.4 ± 1.7 SD, range = 1-5. All helminth findings (n = 12) are new host records.

DISCUSSION

Nematoda

Ascarididae. *Seuratascaris numidica* was found in one of the five dicroglossid species (Table 1). It is known to occur in a variety of anurans from Europe, Southeast Asia, New Guinea and Australia (Baker 1987). The dicroglossid *Limnonectes macrodon* (Sprent 1985) and the microhylid *Copiula fistulans* from Papua New Guinea should be added to that list (Goldberg et al. 2009a). *Seuratascaris numidica* was reported to occur in frogs from Malaysia (as Malaya) by Sprent (1985). *Seuratascaris numidica* in *L. kohchangae* from Cambodia (Table 1) is a new locality record. The genus *Seuratascaris* was proposed by Sprent (1985). The type and only species is *S. numidica*. The life cycle of *S. numidica* is not known.

Cosmocercidae. *Aplectana macintoshii* is a widely distributed nematode with representatives in the following biogeographical regions (*sensu* Holt et al. 2013): Afrotropical, Neotropical, Oceanian, Oriental, Palearctic. A host list for *A. macintoshii* is in McAllister et al. (2010). *A. macintoshii* was previously reported in Malaysia (as Malaya) by Baker (1980) and has recently been found in eight ranid species (Goldberg et al. 2017a) and two bufonid species (Goldberg et al. 2017b) from Peninsular Malaysia. *Aplectana macintoshii* in *L. kohchangae* from Cambodia (Table 1) is a new locality record. Molecular studies are warranted to ascertain if the worldwide populations of *A. macintoshii* consist of a single species. The life cycle of *A. macintoshii* is not known. *Aplectana macintoshii* was found in two of five dicroglossid species (Table 1).

Cosmocerca ornata is widespread and occurs in the Afrotropical, Neotropical, Oceanian, Oriental, and Palearctic Regions (Baker 1987). A host list is in Yilddirimhan et al. (2009).

Cosmocerca ornata was recently reported in the gecko *Cnemaspis mcquirei*, four ranid species, and the toads *Ingerophrynus parvus* and *Phrynoidis aspera* from West Malaysia (Burse et al. 2014, Goldberg et al. 2017a, 2017b). *Cosmocerca ornata* in *L. kohchangae* from Cambodia (Table 1) is a new locality record. While the life cycle of *C. ornata* is not known, Fotedar and Tikoo (1968) reported larvae of the congener *C. kashmirensis* penetrated the skin of *Bufo viridis* (as *Bufo viridis*) and adults were recovered 10 to 14 days post-infection. *Cosmocerca ornata* was found in three of five dicroglossid species (Table 1).

Molineidae. *Oswaldocruzia rohdei* was described from *L. macrodon* from Pahang State, Peninsular Malaysia by Yuen (1963). *Limnonectes blythii* is the second host found to harbor *O. rohdei*. *Oswaldocruzia* occur in the intestinal tract of amphibians and reptiles throughout the world (Anderson 2000). The life cycle of *O. rohdei* is not known, but *Oswaldocruzia filiformis* and *O. pipiens* have been shown to have direct life cycles (Anderson 2000). *Oswaldocruzia rohdei* was found in one of the five dicroglossid species (Table 1).

Onchocercidae. The Onchocercidae have evolved blood or skin-inhabiting microfilariae and are transmitted by blood sucking arthropods (Anderson 2000). The onchocercid *Foleyella brachyoptera* is transmitted by mosquitoes (Causey 1939). *Foleyellides malayensis*, was found in one of five dicroglossids (Table 1). It was originally described as *Waltonella malayensis* by Petit and Yen (1979) but was moved to *Foleyellides* by Esslinger (1986). It was previously reported from Malaysia in *Pulchrana glandulosa* (as *Rana glandulosa*) by Petit and Yen (1979) and *Limnonetes macrodon* (as *Rana macrodon*) and *Amolops larutensis* by Mak and Yong (1981). *Icosiella innominata* was previously reported in *Phrynoidis asper* (as *Bufo asper*) and *Fejervarya cancrivora* (as *Rana cancrivora*) from Perak and Johor States, West Malaysia by Yuen (1962). The life cycle of *Icosiella* are similar to those of *Foleyella* (Baker 2007). Desportes (1941) reported a biting midge (Ceratopogonidae) and sand fly (Psychodidae) as probable

vectors of the congener *Icosiella neglecta*. *Icosiella innominata* was found in one of five Dicroglossidae (Table 1).

Physalopteridae. *Abbreviata* sp., and Physalopteridae gen. sp. larvae are commonly found in the stomachs of snakes and lizards (Jones 1995). Insects have been shown to serve as intermediate hosts for species of *Physaloptera* (Anderson 2000). The final (definitive host) can become infected directly by ingesting insects containing larvae or through paratenesis in which a temporary host harbors the larva, with no further development occurring. As we found no adult *Abbreviata* or *Physaloptera* in any frogs from Southeast Asia in this study or other studies from Southeast Asia (Goldberg et al. 2017a, b), Papua New Guinea (Goldberg et al. 2009b, c) or elsewhere (Goldberg and Bursey 1991, 2010; Goldberg et al. 1996), we suspect those anurans with cysts containing larvae may act as paratenic hosts for members of the Physalopteridae while those without cysts represent incidental infections through diet. *Abbreviata* sp. has previously been reported from the frog *Pulcharana glandulosa* and *Physaloptera* sp. from the toad *Phrynoidis asper* from Peninsular Malaysia (Goldberg et al. 2017a, 2017b).

The data presented herein indicate that Southeast Asian dicroglossids are infected by nematode generalists. All nematodes found in the current study are known to occur in other species of frogs. As further representatives of *L. blythii*, *L. hascheanus*, *L. khasianus*, *L. kohchangae*, and *L. macrognathus* as well as other species are examined, we anticipate the helminth list for dicroglossids from Southeast Asia will grow. Further investigations should also document presence of helminths of other categories (Cestoda, Digenea, Acanthocephala) in dicroglossid frogs. With at least 15 species of dicroglossid frogs known from Peninsular Malaysia alone (sensu Chan et al. 2010), further work is needed to document the helminths occurring in this family in Southeast Asia.

LITERATURE CITED

- Anderson, R. C. 2000. Nematode parasites of vertebrates: Their development and transmission. 2nd ed. CABI Publishing, Oxon, United Kingdom.
- Anderson, R. C., A. G. Chabaud, and S. Willmot, eds. 2009. Keys to the nematode parasites of vertebrates. Archival Vol. CABI Publishing, Wallingford, Oxfordshire, United Kingdom.
- Baker, D. G. 2007. Flynn's parasites of laboratory animals, second ed., Blackwell Publishing, Ames, Iowa.
- Baker, M. R. 1980. Revision of old world species of the genus *Aplectana* Railliet & Henry, 1916 (Nematoda, Cosmocercidae). Bull. Mus. natn. Hist. nat., Paris 2: 955-998.
- Baker, M. R. 1987. Synopsis of the Nematoda parasitic in amphibians and reptiles. Memorial Univ. Newfoundland, Occas. Pap. Biol. 11:1-325.
- Burse, C. R., S. R. Goldberg, and L. L. Grismer. 2014. New species of *Bakeria* (Nematoda; Strongylida; Molineidae), new species of *Falcaustra* (Nematoda; Ascarida; Kathlaniidae) and other helminths in *Cnemaspis mcguirei* (Sauria; Gekkonidae) from Peninsular Malaysia. Acta Parasitol. 59:643-652.
- Bush, A. O., K. D. Lafferty, J. M. Lotz, and A. W. Shostak. 1997. Parasitology meets ecology on its own terms: Margolis et al. revisited. J. Parasitol. 83:575-583.
- Causey, O. R. 1939. Development of the larval stages of *Foleyella brachyoptera* in mosquitoes. Amer. J. Hyg. 30:67-71.
- Chan, K. O., B. Daicus, and A. Norhayati. 2010. A revised checklist of the amphibians of Peninsular Malaysia. Russian J. Herpetol. 17:202-206.
- Chutmongkonkul, M., W. Khonsue, and P. Pariyanonth. 2006. Blood parasites of six species of wild amphibians from Khun Mae Kuang forest area, Thailand. Proceedings of the 2nd

- Symposium on Asian Zoo and Wildlife Medicine and the 1st Workshop on Zoo and Wildlife Pathology (AZWMP 2006): 48.
- Cortlett, R. T. 2010. *The Ecology of Tropical East Asia*. Oxford University Press, Oxford, U.K.
- Das, I. 2002. *An Introduction to the Amphibians and Reptiles of Tropical Asia*. Natural History Publications (Borneo), Kota Kinabalu. 207 pp.
- Desportes, C. 1941. Nouvelles recherches sur la morphologie et sur l'évolution d'*Icosiella neglecta* (Diesing, 1851), filaire commune de la grenouille verte. *Annal. Parasitol. Hum. Comp.* 18:46-66.
- Esslinger, J. H. 1986. Redescription of *Foleyellides striatus* (Ochoterena and Caballero, 1932) (Nematoda: Filarioidea) from a Mexican frog, *Rana montezumae*, with reinstatement of the genus *Foleyellides* Caballero, 1935. *Proc. Helm. Soc. Wash.* 53:218-223.
- Fotedar, D. N., and R. Tikoo 1968. Further studies on the life cycle of *Cosmocerca kashmirensis* Fotedar, 1959, common oxyurid nematode parasite of *Bufo viridis* in Kashmir. *Proc. Indian Sci. Cong. Assoc.* 55:460.
- Frost, D. R. 2016. Amphibian species of the world, an online reference, Version 6.0 (Accessed 19 August 2016) electronic database accessible at <http://research.amnh.org/herpetology/amphibia/index.html>. American Museum of Natural History, New York, USA.
- Gibbons, L. M. 2010. *Keys to the nematode parasites of vertebrates*. Suppl. Vol. CABI Publishing, Wallingford, Oxon, United Kingdom.
- Goldberg, S. R., and C. R. Bursey. 1991. Helminths of three toads, *Bufo alvarius*, *Bufo cognatus* (Bufonidae) and *Scaphiopus couchii* (Pelobatidae) from southern Arizona. *J. Helmi. Soc. Wash.* 58:142-146.

- _____. 2010. Helminth biodiversity of Costa Rican anurans (Amphibia: Anura). *J. Nat. Hist.* 44:1755-1787.
- Goldberg, S.R., C. R. Bursey, and L. L. Grismer. 2017a. Nematoda of eleven species of ranid frogs (Anura: Ranidae) from southeast Asia. *Pac. Sci.* (in press).
- _____. 2017b. Nematodes of five species of bufonids (Anura: Bufonidae) from Peninsular Malaysia. *Pac. Sci.* (in press).
- Goldberg, S. R., C. R. Bursey, and F. Kraus. 2009a. Helminths of 26 species of microhylid frogs (Anura: Microhylidae) from Papua New Guinea. *J. Nat. Hist.* 43:1987-2007.
- _____. 2009b. Endoparasites of eleven species of ranid frogs (Anura: Ranidae) from Papua New Guinea. *Pac. Sci.* 63:327-307.
- _____. 2009c. Gastrointestinal helminths from fifteen species of *Litoria* and *Nyctimystes* (Anura: Hylidae) from Papua New Guinea. *J. Nat. Hist.* 43:509-522.
- Goldberg, S. R., C. R. Bursey, B. K. Sullivan, and Q. A. Truong. 1996. Helminths of the Sonoran green toad, *Bufo retiformis* (Bufonidae), from southern Arizona. *J. Helm. Soc. Wash.* 63:120-122.
- Grismer, L. L. 2011. Amphibians and Reptiles of the Seribuat Archipelago (Peninsular Malaysia) – A Field Guide. Edition Chimaira, Frankfurt Am Main.
- Holt, B. G, J.-P. Lessard, M. K. Borregaard, S. A. Fritz, M. B. Araújo, D. Dimitrov, P.-H. Fabre, C. H. Graham, G. R. Gravez, K. A. Jonsson, D. Nogués-Bravo, Z. Wang, R. J. Whittaker, J. Fjeldsa, and C. Rahbek. 2013. An update of Wallace's Zoogeographic realms of the world. *Science* 339:74-78.
- Jones, J. J. 1995. Pathology associated with physalopterid larvae (Nematoda: Spirurida) in the gastric tissues of Australian reptiles. *J. Wild. Dis.* 31:710-715.

- Mak, J. W., and H. S. Yong. 1981. New hosts of *Waltonella malayensis* Petit and Yen, 1979. Southeast Asian J. Trop. Med. Publ. Hlth. 12:617-618.
- McAllister, C. T., C. R. Bursey, and P. S. Freed. 2010. *Aplectana macintoshii* (Nematoda: Cosmocercidae) from two species of anurans (Bufonidae, Pyxicephalidae) from the Republic of Namibia, Southwest Africa. Comp. Parasitol. 77:100-104.
- Petit, G., and P. Yen. 1979. *Waltonella malayensis* n. sp., une nouvelle filaire de batracien en Malaise. Bull. Mus. Natn. Hist. Nat. ser. 4, sect A. Zool. 1:213-218.
- Rowley, J., R. Brown, R. Bain. M. Kusrini, R. Inger, B. Stuart, G. Wogan, N. Thy, T. Chan-ard, C. Tien Trung, A. Diesmos, D. T. Iskandar, M. Lau., L. Tzi Ming, S. Makchai, N. Quang Truong, and S. Phimmachak. 2010. Impending conservation crisis for southeast Asian amphibians. Biol. Lett. 6:336-338.
- Sprent, J. F. A. 1985. Ascaridoid nematodes of amphibians and reptiles: *Seuratascareia* n. g. Ann. Parasit. Hum. Comp. 60:231-246.
- Vitt, L. J., and J. P. Caldwell. 2014. Herpetology, An introductory biology of amphibians and reptiles. 4th ed. Elsevier, London (UK). 757 pp.
- Yildirimhan, H. S., C. R. Bursey, and S. R. Goldberg. 2009. Helminth parasites of the Caucasian parsley frog, *Pelodytes caucasicus* from Turkey. Comp. Parasitol. 76:247-257.
- Yuen, P. H. 1962. On a new species of *Icosiella* Seurat, 1917 from Malaya with a key to the species of *Icosiella*. J. Helminthol. 36:237-242.
- Yuen, P. H. 1963. A new species of *Oswaldocruzia* Travassos (Nematoda- Trichostrongylidae) from a Malayan frog. Parasitology 53:55-58.

Appendix 1

The microglossid frogs from Southeast Asia from the herpetology collection of La Sierra University (LSUHC), Riverside, California examined for this study.

Limnonectes blythii ($n = 5$): LSUHC 7098, March 2005, West Malaysia, Kedah State, Lubuk Semilang, Pulau Langkawi, 6°20'42"N, 99°47'60"E; LSUHC 8270, June 2012, West Malaysia, Terengganu State, base of Gunung Lawit, 1°23'59.99"N, 112°59'45.99"E; LSUHC 9940 September 2010, LSUHC 10185, LSUHC 10208, September 2011, West Malaysia, Johor State, Gunung Berlumut, 2°2'32.99"N, 103°33'39.95"E.

Limnonectes hascheanus ($n = 4$): LSUHC 3761, July 2001, LSUHC 4607, July 2002, West Malaysia, Pahang State, Pulau Tioman, 2°47'24.71"N, 104°10'11.27"E; LSUHC 9443, September, 2009, West Malaysia, Kedah State, Pulau Langkawi, 6°20'59.9994"N, 99°47'59.9994"E; LSUHC 10351, July 2011, West Malaysia, Penang State, 5°26'14.30"N, 100°17'10.80"E.

Limnonectes khasianus ($n = 13$): LSUHC 7674, August 2005, West Malaysia, Johor State, Endau-Rompin, 2°25'13.08"N, 103°25'40.7994"E; LSUHC 8062, August 2006, West Malaysia, Pahang State, Fraser's Hill, 3°42'42.84"N, 101°44'11.76"E; LSUHC 8183, September 2006, West Malaysia, Johor State, Selai, 2°13'44.00394"N, 103°25'40.7994"E; LSUHC 8273, LSUHC 8274, June 2012, West Malaysia, Terengganu State, Gunung Lawit, 5°25'0.01"N, 105°34'59.99"E; LSUHC 9396 LSUHC 9397 September 2009, West Malaysia, Terengganu State, Pulau Redang, 5°47'3.83"N, 103°0'24.84"E; LSUHC 9680, March, 2010, West Malaysia, Kedah State, Hutan Lipur, Sungai, Tupah, 5°37'36.2166"N, 100°27'54.5904"E, LSUHC 9710, LSUHC 9711, March 2010, West Malaysia, Perak State, Bukit Larut, 4°51'44.28"N, 100°47'4.8"E,; LSUHC 9943, West Malaysia, Johor State, Gunung

Belumut, 2°2'32.99"N, 103°33'39.95"E; LSUHC 10193, September 2011, West Malaysia, Johor State, Gunung Berlumut, 2°2'32.9994"N, 103°33'39.9594"E; LSUHC 10252, September, 2011, West Malaysia, Pahang State, Cameron highlands, 4°28'19.56"N, 101°22'48.36"E.

Limnonectes kohchangae (n= 6): LSUHC 7388, LSUHC 7433, LSUHC 7434, LSUHC 7436, LSUHC 7441, LSUHC 7449, August, 2005, Cambodia, Kampong Speu Province, Phnom Aural, 12°1'57"N, 104°10'14.87"E.

Limnonectes macrognathus (n = 1): LSUHC 7094, March, 2005, West Malaysia, Kedah State, Pulau Langawi, 6°20'53.99"N, 99°47'59.99"E.

Appendix 2

Harold W. Manter Laboratory (HWML) Accession Numbers for Helminths from dicroglossid frogs collected in Southeast Asia, taken from the herpetology collection of La Sierra University (LSUHC), Riverside, California.

Limnonectes blythii: *Aplectana macintoshii* (HWML 99941), *Cosmocerca ornata* (HWML 99942), *Foleyellides malayensis* (HWML 99943), *Icosiella inominata* (HWML 99944), *Oswaldocruzia rohdei* (HWML 99945);

Limnonectes hascheanus: *Abbreviata* sp. (larva) (HWML 99981);

Limnonectes khasianus: *Cosmocerca ornata* (HWML 99979), Physalopteridae gen. sp. (larva) (HWML 99980);

Limnonectes kohchangae: *Aplectana macintoshii* (HWML 99946), *Cosmocerca ornata* (HWML 99947), *Seuratascaris numidica* (HWML 99948);

Limnonectes macrognathus: Physalopteridae gen. sp. (larva) (HWML99949).

TABLE 1. NUMBER (n), PREVALENCE (%), MEAN INTENSITY ($X \pm SD$), AND RANGE (r) FOR NEMATODA IN 29 DICROGLOSSID FROGS (*LIMNONECTES*) FROM SOUTHEAST ASIA: *LIMNONECTES BLYTHII* (n = 5), *LIMNONECTES HASCHEANUS* (n = 4), *LIMNONECTES KHASIANUS* (n = 13), *LIMNONECTES KOHCHANGAE* (n= 6), AND *LIMNONECTES MACROGNATHUS* (n = 1). ALL ARE NEW HOST RECORDS.

| Nematoda | <i>L. blythii</i> | | | <i>L. hascheanus</i> | | | <i>L. khasianus</i> | | | <i>L. kohchangae</i> | | | <i>L. macrognathus</i> | | |
|--------------------------------|-------------------|------|------------|----------------------|------|------------|---------------------|--------|------|----------------------|------|------|------------------------|------------|------|
| | n | % | $X \pm SD$ | n | % | $X \pm SD$ | r | n | % | $X \pm SD$ | r | n | % | $X \pm SD$ | r |
| <i>Aplectana macintoshii</i> | 2 | 20 | 2.0 | ---- | ---- | ---- | ---- | 11 | 50 | 3.7±4.6 | ---- | ---- | ---- | ---- | ---- |
| | | | | | | | | (1-9) | | | | | | | |
| <i>Cosmocerca ornata</i> | 7 | 40 | 2.5 ± 2.1 | ---- | ---- | ---- | ---- | 1 | 8 | 1.0 | ---- | 3 | 50 | 1.0 | ---- |
| | | | | | | | | | | | | | | | |
| | | | (2-5) | | | | | | | | | | | | |
| <i>Foleyellides malayensis</i> | 3 | 40 | 3.0 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- |
| <i>Icosiella innominata</i> | 2 | 20 | 2.0 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- |
| <i>Oswaldocruzia rohdei</i> | 28 | 20 | 28.0 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- |
| <i>Seuratascaris numida</i> | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 1 | 17 | 1.0 | ---- |
| <i>Abbreviata</i> sp. | ---- | ---- | ---- | 1 | 25 | 1.0 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- |
| Physalopteridae gen. sp. | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 21 | 23 | 7.0±6.0 | ---- | ---- | 6 | 50 | 6.0 |
| | | | | | | | | (1-13) | | | | | | | |