

The first report of hirudinean parasitism for a *Pelobatrachus* species in the Philippines, with a preliminary summary of leech-anuran records in Asia

Ace Kevin S. Amarga^{1,2,*}, Andrie Bon A. Flores³, Takafumi Nakano⁴, and Ming-Chung Chiu²

Hirudinea Lamarck, 1818 (commonly known as leeches) is a group of specialised clitellate annelids primarily characterised by presence of suckers at the terminal ends of their body (i.e., anterior circumoral sucker and posterior ventral sucker) (Verdonschot, 2015). Leeches are known to inhabit wide range of microhabitats in terrestrial, freshwater, and even marine ecosystems (Mann, 1962; Sawyer, 1986; Phillips et al., 2020). Additionally, a wide extent of habitat utilisation of leeches has been reflected by their diverse behavioural adaptations (Phillips et al., 2020; Kwak et al., 2021) wherein some species exhibit predatory lifestyles (Kutschera, 2003; Ye et al., 2015; Nieoczym et al., 2023) whereas other species are sanguinivorous and facultatively parasitic on different vertebrates (Schnell et al., 2012; Ocegüera-Figueroa and Kvist, 2024). Because of its sensitive nature, several leeches (especially freshwater species) have been utilised as biomonitoring agents for detecting contaminants in freshwater environment (Metcalf et al., 1984; Friese et al., 2004; Macova et al., 2009; Cortelezzi et al., 2018). Additionally, haematophagous terrestrial leeches are

recently utilised in non-invasive surveys of terrestrial vertebrates in forest ecosystems (Hanya et al., 2019; Fahmy et al., 2020, 2023; Drinkwater et al., 2021; Ji et al., 2022). Furthermore, due to its sanguinivorous feeding habit, several species of leeches have been reported to harbour pathogen indicating their potential role as mechanical vectors (Kang et al., 2016; Yang et al., 2020).

Leeches associated with herpetofauna have been reported across different groups ranging from anurans (Lai and Chen, 2010; Kambayashi and Nakano, 2015), crocodiles (Tellez, 2013), freshwater and marine turtles (Kami et al., 2007; Rodenbusch et al., 2012; Trivalairat et al., 2019; Amarga and Lin, 2023), salamanders (Takahashi et al., 2017; Fukuyama and Morishima, 2021), and even varanids (Zdunek, 2023). In amphibians, many of the published documentations of hirudinean parasitism are based on records of freshwater leeches parasitising different species of anurans, especially those inhabiting fluvial ecosystems. In addition, terrestrial leeches from the family Haemadipsidae have been reported to parasitise frogs as well. Apart from blood feeding on adults, leeches have been reported as predators of frog egg mass (Burgin and Schell, 2005; Turner, 2013).

Hirudinean-anuran association is relatively an understudied aspect of wildlife parasitology in Asia as indicated by relatively few published accounts. These include the works of Oka (1910), Lai and Chen (2010), Lai et al. (2011), Bae et al. (2018), Ghosh and Borzée (2023), and Kambayashi and Nakano (2023). Additionally, in the Philippines, only three published records of frog-leech association were reported (see Binaday and Serrano, 2017; Maglangit et al., 2020; Delima-Baron et al., 2024). In this paper, we present the first record of leech parasitism on a frog of the genus *Pelobatrachus* Beddard (Anura: Megophryidae), the endemic Mindanao Horned frog, *Pelobatrachus stejnegeri* (Taylor, 1920), and provide a summary of

¹ Department of Biology & Environmental Science, College of Science, University of the Philippines Tacloban, Leyte, Philippines; and International Union for Conservation of Nature Species Survival Commission (IUCN SSC) Parasite Specialist Group, Gland, Switzerland.

² Department of Entomology, National Taiwan University, Taipei 106, Taiwan.

³ Biodiversity Program, Taiwan International Graduate Program, Academia Sinica, Taipei 115, Taiwan; and Herpetology Lab, School of Life Science, National Taiwan Normal University-Gongguan Campus, Taipei 116, Taiwan.

⁴ Department of Zoology, Graduate School of Science, Kyoto University, Kitashirakawa-oiwakecho, Sakyo, Kyoto 606-8502, Japan.

* Corresponding author. E-mail: ace_amarga061@yahoo.com

hirudinean-anuran parasitism in Asia.

During a reconnaissance survey conducted by the second author on 18 November 2022 in Mt. Apo Natural Park, Barangay Ilomavis, Kidapawan City, North Cotabato, Philippines (7.006°N, 125.2377°E; WGS 84; ~1500 m elevation), an adult *P. stejnegeri* was encountered near a forest stream (Fig. 1). Upon closer investigation, a leech was observed attached to one of its legs and encircling the femur (Fig. 2). The leech specimen was photographed and subsequently identified as a species of the genus *Haemadipsa*, a group of terrestrial leech native to tropical and subtropical regions of Asia and commonly encountered in forested areas in Southeast Asia. A specimen photo voucher was archived in the Zoological Reference Collection of Lee Kong Chiang Natural History Museum – National University of Singapore (registered as ZRC (IMG) 1.300). In addition, our preliminary checklist of anuran-leech parasitism in Asia was compiled based on published natural history accounts as well as published taxonomic records. Names of anuran hosts follow the taxonomy of Frost (2025).

As compared to host records of leeches parasitising



Figure 1. Observation site of the *Pelobatrachus stejnegeri* and its associated leech *Haemadipsa* sp. in Mt. Apo Natural Park, Mindanao Island, the Philippines. Photo by Andrie Bon A. Flores.

on different mammals, published accounts of leech parasitism on anurans are relatively scarce. In Asia, few accounts with specified anuran hosts have been published and these represents at least three leech families: Glossiphoniidae, Haemadipsidae, and



Figure 2. *Haemadipsa* sp. attached on the femur of *Pelobatrachus stejnegeri* (in situ). Photo by Andrie Bon A. Flores.

Table 1. Preliminary checklist of frog-leech association in Asia.

Leech family	Leech species	Anuran hosts	Reported locality records
Glossiphoniidae	<i>Placobdelloides okadae</i> <i>Torix tagoi</i>	<i>Babina holsti</i> and <i>Limnonectes namiyei</i> * <i>Buergeria buergeri</i> , <i>Rana dybowskii</i> , <i>R. neba</i> , <i>R. ornativentris</i> , <i>R. pirica</i> , <i>R. sakuraii</i> , <i>R.</i> <i>tagoi</i> , and <i>R. uenoi</i>	Japan (Oka, 1925) China (Zhu et al., 2023*); Japan (Kambayashi and Nakano, 2023); South Korea (Bae et al., 2018)
Haemadipsidae	<i>Haemadipsa japonica</i>	<i>Bufo japonicus</i> , <i>Hyla japonica</i> , <i>Rana</i> <i>ornativentris</i> , <i>R. sakuraii</i> , <i>R. tagoi</i> , and <i>Zhangixalus arboreus</i>	Japan (Morishima et al., 2020)
	<i>Haemadipsa</i> sp.	<i>Pelobatrachus stejnegeri</i>	Philippines (this study)
	<i>Haemadipsa</i> sp.	<i>Philautus acutirostris</i>	Philippines (Delima-Baron et al., 2024)
	<i>Haemadipsa</i> spp.♦	Unidentified frog	Malaysia (Fogden and Proctor, 1985)
	<i>Tritetrabdella taiwana</i>	<i>Bufo bankorensis</i> , <i>Duttaphrynus</i> <i>melanostictus</i> , <i>Kurixalus idiotocus</i> , <i>Kaloula</i> <i>pulchra</i> , <i>Nidirana adenopleura</i> , <i>Odorrana</i> <i>swinhoana</i> , and <i>Zhangixalus taipeianus</i>	China (Yuen and Nakano, 2012; Nakano and Sung, 2014); Taiwan (Lai and Chen, 2010; Lai et al., 2011)
Hirudinidae	<i>Hirudinaria</i> cf. <i>manillensis</i>	<i>Rhacophorus pardalis</i>	Philippines (Binaday and Serrano, 2017)
	<i>Hirudo birmanica</i>	<i>Odorrana mawphlangensis</i>	India (Siammawii et al., 2023)
	<i>Poecilobdella granulosa</i>	Unspecified amphibians	Nepal (Nesemann and Sharma, 2001)
	<i>Whitmania pigra</i>	<i>Strauchbufo raddei</i>	China (Ghosh and Borzée, 2023)
Unspecified Hirudinea	n/a	<i>Staurois natator</i>	Philippines (Maglangit et al., 2020)
	n/a	<i>Raorchestes silentvalley</i>	India (Zachariah et al., 2016)

Remarks: * Zhu et al. (2023) reported *Torix tukubana* on *Rana dybowskii* in China. However, on the revision of Kambayashi and Nakano (2023), *T. tukubana* and *T. orientalis* were considered as synonyms of *T. tagoi*.

♦ Fogden and Proctor (1985) recorded feeding behavior of *Haemadipsa zeylanica* and *H. picta* from Sarawak, Malaysia. However, the authors did not specify which of the leech species were found feeding on an unidentified frog.

■ Both host species were reported under the genus *Rana* (i.e., *R. holsti* & *R. namiyei*) by Oka (1925) based on the materials collected in Amami archipelago, Japan.

Hirudinidae. Though the table compilation is far from complete, we attempt to present the first listing of leech species with published specified frog and toad hosts in Asia (see Table 1). Glossiphoniidae represents a group of “rhynchobdellid” (proboscis-bearing) leeches exclusively inhabiting freshwater habitats including streams, rivers, and ponds (Phillips et al., 2020). Many Asian glossiphoniid leeches have been reported to parasitise freshwater herpetofauna on several occasions such as *Orientobdelloides siamensis* (Oka, 1917) from Thailand, *O. sirikanchanae* (Trivalairat et al., 2019) from Thailand, and *Placobdelloides stellapapillosa* (Govedich et al., 2002) from Singapore (Trivalairat et al., 2019; Govedich et al., 2022). Among the Asiatic glossiphoniid leeches associated with anurans, the East Asian species *Torix tagoi* (Oka, 1925) was well-documented in terms of host reports. This freshwater species is distributed from China, Japan, extending to South Korea and known to parasitise several rhacophorid and ranoidean frogs including the Kajika Frog, *Buergeria buergeri* (Temminck & Schlegel, 1838), the Dybowski’s Frog, *Rana dybowskii* Günther, 1876, Neba Tago’s Brown Frog, *R. neba* Ryukzaki et al., 2014, the Nikko Frog, *R. ornativentris* Werner,

1903, the Ezo Brown Frog, *R. pirica* Matsui, 1991, the Napparagawa Frog, *R. sakuraii* Matsui & Matsui, 1990, the Tago Frog, *R. tagoi* Okada, 1928, and the Korean Large Brown Frog, *R. uenoi* Matsui, 2014. Additionally, Hirudinidae is another group of freshwater-inhabiting leeches known to parasitise a wide range of vertebrate hosts. Apart from slow moving rivers and streams, hirudinids also inhabit ponds, rice paddies, and irrigations (Lai and Chen, 2010). Although many species within this family have been reported on mammals (including medicinal leeches), a few species were reported parasitising anurans as well. These include *Hirudo birmanica* Blancard, 1894 parasitising the Mawphlang Wart Frog, *Odorrana mawphlangensis* (Pillai & Chanda, 1977), from India and *Whitmania pigra* (Whitman, 1884) parasitising the Mongolian Toad, *Strauchbufo raddei* (Strauch, 1876), from China (Ghosh and Borzée, 2023; Siammawii et al., 2023). However, the latter record is questionable, as *Whitmania* leeches are strictly predatory rather than hematophagous (e.g., Sawyer, 1986; Lai and Chen, 2004). On the other hand, Haemadipsidae represents a group of jawed leeches specialising in terrestrial environments. This monophyletic arhynchobdellid is

endemic to the tropical and subtropical forests of Indo-Pacific (Phillips et al., 2020). Haemadipsid leeches are commonly encountered on low-lying vegetation as well as soil and leaf litters (Lai and Chen, 2020). Among the Asiatic haemadipsids, *Tritetrabdella taiwana* (Oka, 1910) is relatively well-documented in terms of its amphibian hosts. This East Asian species is primarily parasitic to anurans (Lai and Chen, 2010) and known to exhibit wide host range including rhacophorids, bufonids, microhylids, and ranids. Reported host species for *T. taiwana* include the Central Formosa Toad, *Bufo bankorensis* Barbour, 1908, the Asian Common Toad, *Duttaphrynus melanostictus* (Schneider, 1799), the Temple Treefrog, *Kurixalus idiootocus* (Kuramoto & Wang, 1987), the Banded Bullfrog, *Kaloula pulchra* Gray, 1831, the Olive Frog, *Nidirana adenopleura* (Boulenger, 1909), the Swinhoe's Brown Frog, *Odorrana swinhoana* (Boulenger, 1903), and the Taipei Treefrog, *Zhangixalus taipeianus* (Liang & Wang, 1978) (Lai and Chen, 2010; Yuen and Nakano, 2012; Nakano and Sung, 2014).

In the Philippines, there are only three published accounts of leech parasitism on anurans to date (Fig. 3). Maglangit et al. (2020, p. 315) claimed to have published the first account of anuran-leech parasitism in the Philippines based on their documentation of an unidentified leech parasitising a Mindanao Foot-flagging Frog, *Staurois natator* (Günther, 1858), collected from Mt. Hamiguitan Range Wildlife Sanctuary in Mindanao Island. However, this claim can be refuted by the earlier report of Binaday and Serrano (2017) documenting the parasitism of supposedly *Hirudinaria* cf. *manillensis* (Lesson, 1842) on a Gliding Treefrog, *Rhacophorus pardalis* Günther, 1858, observed from Malinao volcano, Luzon Island. Moreover, Delima-Baron et al. (2024) provided an additional account of leech-anuran record based on the documentation of an unidentified *Haemadipsa* parasitising Pointed-snouted Treefrog, *Philautus acutirostris* (Peters, 1867), collected from Mt. Matutum Protected Reserve in Mindanao Island. Furthermore, our account provides an additional record for anuran-leech parasitism in the Philippines and the first record of haemadipsid leech parasitising the endemic *P. stejnegeri*. Also, our account represents the first published record of leech parasitism on the genus *Pelobatrachus* (Megophryidae) in Asia.

Apart from hidden diversity and undescribed species, several aspects of leech biology remained understudied, especially its contribution to disease ecology. Since leeches are sanguinivorous, they can serve as

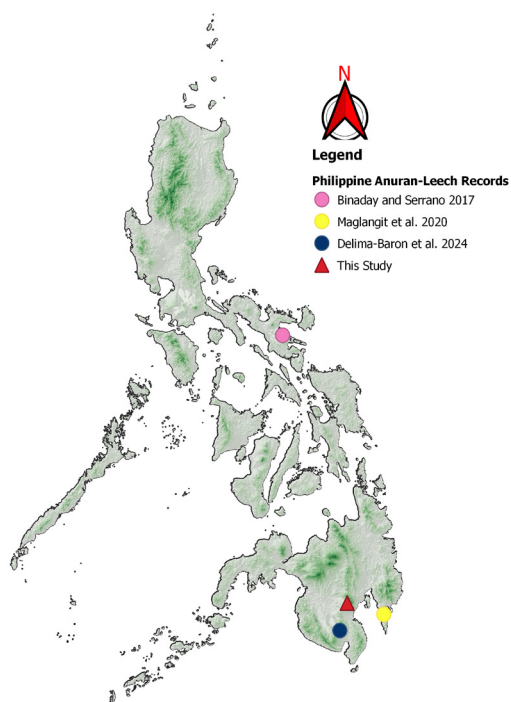


Figure 3. Reported localities of anuran-leech parasitism in the Philippines.

mechanical vectors to several microbes during feeding (Oceguera-Figueroa and Kvist, 2024). In recent years, a few studies have reported *Haemadipsa* leeches from Asia can harbour microbes including *Trypanosoma* and *Bartonella* spp. (Hamilton et al., 2005; Kang et al., 2016). Additionally, the East Asian Leech (*Hirudo nipponia*) have been detected to harbour *Klebsiella pneumoniae*, a pathogenic bacterium that can cause illness in humans (Yang et al., 2020). Furthermore, the extent of host affinity, particularly those leeches associated with herpetofauna needs further assessment and documentation as well as impact of leech infestation on anuran fitness in wild populations.

Acknowledgments. We thank Ms. Meljory Corvera (National Museum of the Philippines) for reviewing our paper as part of the pre-peer review process of the journal. This research was funded by a grant from the National Science and Technology Council, Taiwan (113-2621-B-002-002-MY3) and Ministry of Agriculture, Taiwan (114AS-1.3.2-AS-27) to Dr. Ming-Chung Chiu.

References

- Amarga, A.K.S., Lin, Y.-S. (2023): *Cyclemys dentata* (Asian leaf turtle). Ectoparasite. *Herpetological Review* **54**: 446–447.

- Bae, Y., Borzée, A., Heo, J., Jang, Y. (2018): *Rana uenoi* (Ueno's brown frog). Leech Parasitism. Herpetological Review **49**: 519.
- Binaday, J.W.B., Serrano, M.J.I. (2017): *Rhacophorus pardalis* (Gliding tree frog). Ectoparasites. Herpetological Review **48**: 416.
- Burgin, S., Schell, C.B. (2005): Frog eggs: unique food source for the leech *Bassianobdella fusca*. Acta Zoologica Sinica **51**: 349–353.
- Cortezzi, A., Gullo, B.S., Simoy, M.V., Cepeda, R.E., Marinelli, C.B., Capitulo, A.R., Berkunsky, I. (2018): Assessing the sensitivity of leeches as indicators of water quality. Science of the Total Environment **624**: 1244–1249.
- Delima-Baron, E.M., Tagoon, M.D.T., Bosabica, Z.C., Vitor-Maluya, K.C. (2024): First account of a leech attached to *Philautus acutirostris* (Peters, 1867) in southern Mindanao, Philippines. Herpetology Notes **17**: 499–501.
- Drinkwater, R., Jucker, T., Potter, J.H.T., Swinfield, T., Coomes, D.A., Slade, E.M., et al. (2021): Leech blood-meal invertebrate-derived DNA reveals differences in Bornean mammal diversity across habitats. Molecular Ecology **30**: 3299–3312.
- Hanya, G., Morishima, K., Koide, T., Otani, Y., Hongo, S., Honda, T., et al. (2019): Host selection of hematophagous leeches (*Haemadipsa japonica*): Implications for iDNA studies. Ecological Research **34**: 842–855.
- Fahmy, M., Andrianoely, D., Wright, P.C., Hekkala, E. (2023): Leech-derived iDNA complements traditional surveying methods, enhancing species detections for rapid biodiversity sampling in the tropics. Environmental DNA **5**: 1557–1573.
- Fahmy, M., Williams, K.M., Tessler, M., Weiskopf, S.R., Hekkala, E., Siddall, M.E. (2020): Multilocus metabarcoding of terrestrial leech bloodmeal iDNA increases species richness uncovered in surveys of vertebrate host biodiversity. Journal of Parasitology **106**: 843–853.
- Fogden, S.C.L., Proctor, J. (1985): Notes on the feeding of land leeches (*Haemadipsa zeylanica* Moore and *H. picta* Moore) in Gunung Mulu National Park, Sarawak. Biotropica **17**: 172–174.
- Friese, K., Frommichen, R., Witter, B., Muller, H. (2004): Determination of trace metals in the freshwater leech *Erpobdella octoculata* of the Elbe river – Evaluation of the analytical protocol. Acta Hydrochimica et Hydrobiologica **31**: 346–355.
- Frost, D. (2025): Amphibian Species of the World: An Online Reference. Version 6.2. <https://amphibiansoftheworld.amnh.org/>. American Museum of Natural History, New York, USA. Accessed on 14 February 2025.
- Fukuyama, R., Morishima, K. (2021): First record of ectoparasite by a land leech on Anderson's spiny crocodile newt, *Echinotriton andersoni* (Caudata: Salamandridae). Herpetology Notes **14**: 1379–1380.
- Ghosh, D., Borzée, M. (2023): *Strauchbufo raddei* (Mongolian toad). Parasitism. Herpetological Review **54**: 444.
- Govedich, F.R., Bain, B.A., Davies, R.W. (2022): *Placobdelloides stellapapillosa* sp. n. (Glossiphoniidae) found feeding on crocodiles and turtles. Hydrobiologia **474**: 253–256.
- Hamilton, P.B., Stevens, J.R., Gidley, J., Holz, P., Gibson, W.C. (2005): A new lineage of trypanosomes from Australian vertebrates and terrestrial bloodsucking leeches (Haemadipsidae). International Journal of Parasitology **35**: 431–443.
- Ji, Y., Baker, C.C.M., Popescu, V.D., Wang, J., Wu, C., Wang, Z., et al. (2022): Measuring protected-area effectiveness using vertebrate distributions from leech iDNA. Nature Communications **13**: 1555.
- Kami, H.G., Ebrahimi, M., Esmaceli, H.R. (2007): First record of the sea turtle leech, *Ozobranchus branchiatus*, in Iranian coastal waters (Hirudinea: Rhynchobdellida). Zoology in the Middle East **40**: 118–119.
- Kambayashi, C., Nakano, T. (2023): Lumping three nominal species into one: taxonomic revision of amphibian parasitic leeches of *Torix* in Far East Asia (Hirudinea: Glossiphoniidae). Invertebrate Systematics **37**: 819–833.
- Kang, J.-G., Won, S., Kim, H.-W., Kim, B.-J., Park, B.-K., Park, T.-S., Seo, H.-Y., Chae, J.-S. (2016): Molecular detection of *Bartonella* spp. in terrestrial leeches (*Haemadipsa rjukjuana*) feeding on human and animal blood in Gageo-do, Republic of Korea. Parasites & Vectors **9**: 326.
- Kutschera, U. (2003): The feeding strategies of the leech *Erpobdella octoculata* (L.): A laboratory study. International Review of Hydrobiology **88**: 94–101.
- Kwak, H.-J., Kim, J.-H., Kim, J.-Y., Jeon, D., Lee, D.-H., Yoo, S., et al. (2021): Behavioral variation according to feeding organ diversification in glossiphoniid leeches (Phylum: Annelida). Scientific Reports **11**: 10940.
- Lai, Y.-T., Chen, J.-H. (2004): Foraging preference of the leech *Whitmania laevis* on two operculated freshwater snails. Endemic Species Research **6**: 67–78.
- Lai, Y.-T., Chen, J.-H. (2010): Leech Fauna of Taiwan. National Taiwan University Press, Taipei, Taiwan, 118 pp.
- Lai, Y.-T., Nakano, T., Chen, J.-H. (2011): Three species of land leeches from Taiwan, *Haemadipsa rjukjuana* comb. n., a new record for *Haemadipsa picta* Moore, and an updated description of *Tritetrabdella taiwana* (Oka). ZooKeys **139**: 1–22.
- Macova, S., Harustiaková, D., Kolarova, J., Machova, J., Zlabek V., Vykusova, B., et al. (2009): Leeches as sensor-bioindicators of river contamination by PCBs. Sensors **9**: 1807–1820.
- Maglangit, E.P.T., Venturina, R.E.L., Caguimbal, N.A.L.E., Warguez, D.A., Diesmos, M.L.L., Diesmos, A.C. (2020): Leech parasitism on the Mindanao foot-flagging frog *Staurois ninator* (Günther, 1858) on Mindanao Island, Philippines. Herpetology Notes **13**: 313–316.
- Mann, K.H. (1962): Leeches (Hirudinea) Their Structure, Physiology, Ecology and Embryology. New York, USA, Pergamon Press Inc.
- Metcalfe, J.L., Fox, M.E., Carey, J.H. (1984): Aquatic leeches (Hirudinea) as bioindicators of organic-chemical contaminants in fresh-water ecosystems. Chemosphere **13**: 143–150.
- Morishima, K., Nakano, T., Aizawa, M. (2020): Sika deer presence affects the host–parasite interface of a Japanese land leech. Ecology and Evolution **10**: 6030–6038.
- Nakano, T., Sung, Y.-H. (2014): A new host record for *Tritetrabdella taiwana* (Hirudinida: Arhynchobdellida: Haemadipsidae) from the Asian painted frog *Kaloula pulchra* (Anura: Microhylidae) in Hong Kong, China, with a taxonomic note on *T. taiwana*. Comparative Parasitology **81**: 125–129.
- Nesemann, H., Sharma, S. (2001): Leeches of the suborder Hirudiniformes (Hirudinea: Haemodidae, Hirudinidae, Haemadipsidae) from the Ganga watershed (Nepal, India:

- Bihar). *Annalen des Naturhistorischen Museums in Wien* **103**: 77–88.
- Nieoczym, M., Mencfel, R., Bielecki, A., Cichocka, J.M., Kloskowski, J. (2023): Abundance and composition of invertebrate-feeding leeches in relation to fish status in ponds. *European Zoological Journal* **90**: 877–888.
- Oceguera-Figueroa, A., Kvist, S. (2024): Chapter 62 – Hirudinia (Class): Parasitic Leeches. In: *Concepts in animal Parasitology*. pp. 747–755. Gardner, S.L., Gardner S.A. (eds.). Lincoln, Nebraska, USA, Zea Books.
- Oka, A. (1910): Synopsis der japanischen Hirudineen, mit diagnosen der neuen species. *Annotationes Zoologicae Japonensis* **7**: 165–183.
- Oka, A. (1925): Notices sur les Hirudinées d'Extrême Orient, V–VII. *Annotationes Zoologicae Japonenses* **10**: 327–335.
- Phillips, A.J., Govedich, F.R., Moser, W.E. (2020): Leeches in the extreme: Morphological, physiological, and behavioral adaptations to inhospitable habitats. *International Journal of Parasitology: Parasites and Wildlife* **12**: 318–325.
- Rodenbusch, C.R., Marks, F.S., Canal, C.W., Reck, J. (2012): Marine leech *Ozobranchus margoi* parasitizing loggerhead turtle (*Carretta caretta*) in Rio Grande do Sul, Brazil. *Revista Brasileira de Parasitologia Veterinária* **21**: 301–303.
- Sawyer, R. T. (1986): *Leech Biology and Behaviour*. Oxford, UK, Clarendon Press.
- Schnell, I.B., Thomsen, P.F., Wilkinson, N. Rasmussen, M., Jensen, L.R.D., Willerslev, E., Bertelsen, M.F., Gilbert, M.T.P. (2012): Screening mammal biodiversity using DNA from leeches. *Current Biology* **22**: 262–263.
- Siammawii, V., Malsawmdawngliana, F., Biakzuala, L., Muansanga, L., Lalremsanga, H.T. (2023): *Odorrana mawphlangensis* (Mawphlang odorous frog). Parasite. *Herpetological Review* **54**: 103–104.
- Takahashi, M.K., Okada, S., Fukuda, Y. (2017): From embryos to larvae: seven-month-long paternal care by male Japanese giant salamander. *Journal of Zoology* **302**: 24–31.
- Tellez, M. (2013): A checklist of host-parasite interaction of the Order Crocodylia. University of California Publications in Zoology **136**: 1–373.
- Trivalairat, P., Chiangkul, K., Purivirojikul, W. (2019): *Placobdelloides sirikanchanae* sp. nov., a new species of glossiphoniid leech and a parasite of turtles from lower southern Thailand (Hirudinea, Rhynchobdellida). *ZooKeys* **882**: 1–24.
- Turner, G.S. (2013): Leech predation of frog spawn. *The Victorian Naturalist* **130**: 49–52.
- Verdonschot, P.F.M. (2015): Chapter 20 – Introduction to Annelida and the Class Polychaeta. In: *Thorpe and Covich's Freshwater Invertebrates*, 4th edition, pp. 509–528. Thorpe, J.H., Rogers, D.C. (eds.). Academic Press, Cambridge, Massachusetts, USA.
- Yang, Y., Chen, Y., Liu, Y., Song, Y., Ai, X. (2020): *Klebsiella pneumoniae*: A pathogenic bacteria transmitted through *Hirudo nipponia* that may cause illness in humans. *Transboundary and Emerging Diseases* **68**: 2051–2058.
- Ye, F., Liu, T., Zhu, W., You, P. (2015): Complete mitochondrial genome of *Whitmania laevis* (Annelida, Hirudinea) and comparative analyses within *Whitmania* mitochondrial genomes. *Belgian Journal of Zoology* **145**: 114–128.
- Yuen, Y.-L., Nakano T. (2012): *Duttaphrynus melanostictus* (Asian common toad). *Parasitism. Herpetological Review* **43**: 461–462.
- Zachariah, A., Cyriac, V.P., Chandramohan, B., Ansil, B.R., Matthew, J.K., Raju, D.V., Abraham, R.K. (2016): Two new species of *Raorchestes* (Anura: Rhacophoridae) from the Silent Valley National Park in the Nilgiri Hills of the Western Ghats, India. *Salamandra* **52**: 63–76.
- Zdunek, P. (2023): *Varanus salvator macromaculatus* (Southeast Asian water monitor). Leech parasitism. *Herpetological Review* **54**: 476.
- Zhu, X., Zhao, Y., Wei, H., Hu, N., Hu, Q., Li, Y. (2023): The complete mitochondrial genome of *Torix tukubana* (Annelida: Hirudinea: Glossiphoniidae). *Genes* **14**: 338.