REPTILES & AMPHIBIANS

First Record of an Asian Tongueworm, *Raillietiella orientalis* (Pentastomida: Raillietiellidae), Parasitizing a Tokay Gecko, *Gekko gecko* (Squamata: Gekkonidae): A Novel Interaction between Two Non-native Species in Florida

Thomas W. Fieldsend[1], Madison E.A. Harman[2], and Melissa A. Miller[3]

[1]Department of Biological Sciences, Florida International University, Miami, Florida 33199, USA (thomasfieldsend@hushmail.com)
[2]Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida 32611, USA
[3]Fort Lauderdale Research and Education Center, University of Florida, Fort Lauderdale, Florida 33314, USA

The Tokay Gecko, *Gekko gecko* (Linnaeus 1758) (Fig. 1), is native to Asia (Rösler et al. 2011), but was introduced to Florida in the 1960s (King and Krakauer 1966) and is now firmly established in the state (Krysko et al. 2019; Fieldsend et al. 2021). The pentastome, *Raillietiella orientalis* (Hett 1915) (Fig. 1 insert), an obligate parasite that infects the lungs of snakes as its primary host, is native to Asia, Africa, and possibly Italy (Ali et al. 1982; Christoffersen and De Assis 2013); it is co-invasive with the Burmese Python (*Python bivittatus*) in Florida (Miller et al. 2018). *Raillietiella orientalis* has spilled over from pythons to infect 14 of Florida's native species of snakes (Miller et al. 2018, 2020; Metcalf et al. 2019), and is expanding its range northward beyond the range of the Burmese Python via these highly competent novel snake hosts (Miller et al. 2020), with *R. orientalis* detected in native snakes as far north as Alachua County (Walden et al. 2020). Herein we report the first record of *R. orientalis* parasitizing *G. gecko*.

On 7 January 2016, we examined by necropsy the lungs, oral cavity, trachea, and body cavity (Paré 2008) of two adult male Tokay Geckos collected on 29 August 2015 in Miami-Dade County, Florida (25°37'3.48"N, 80°28'16.39"W) for the presence of pentastomes. We recovered three adult pentastomes of the genus *Raillietiella* from one host individual. None of these pentastomes were males, preventing species identification through morphological examination of copulatory spicules. We thus attempted to sequence a ~400 base pair (bp) fragment of the nuclear 18s ribosomal RNA gene as per Miller et al. (2018) and compare the results to available GenBank sequences. We successfully obtained sequence data for one specimen (402 bp), which was found to be genetically identical to 51 specimens of *R. orientalis* recovered from native snakes and invasive Burmese Pythons in Florida (Miller et al.

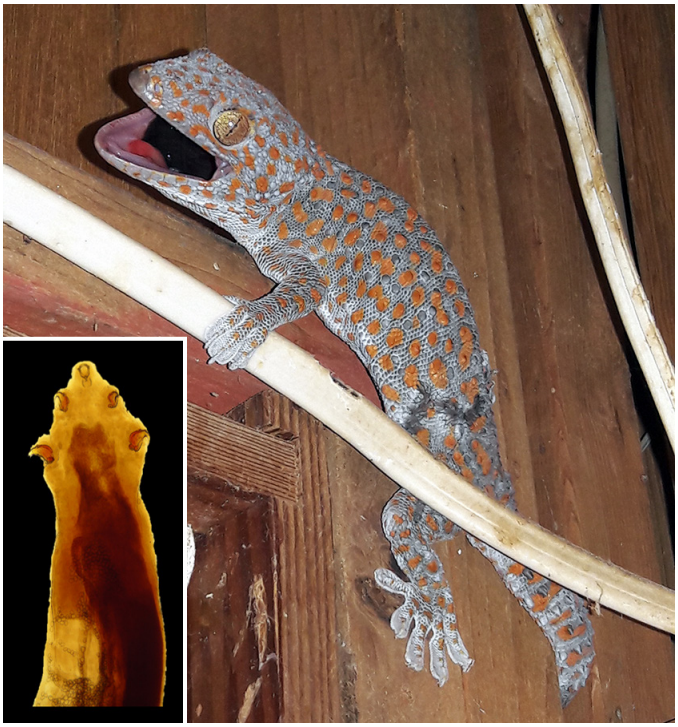

Fig. 1. An adult Tokay Gecko (Gekko gecko) on Key Largo, Monroe County, Florida. Insert: A female Asian tongueworm (*Raillietiella orientalis*). Photographs by Thomas W. Fieldsend and John M. Kinsella (insert).

Reptiles & Amphibians ISSN 2332-4961

2018). This sequence was deposited into GenBank under the Accession Number MW692107.

Geckos serve as definitive hosts for several species of *Raillietiella* (Ali and Riley 1983), and *Gekko gecko* is parasitized by at least three species (i.e., *R. affinis*, *R. indica* [syn. *R. frenatus*], and R. *gehryae*; Reese et al. 2004). Additional species of *Raillietiella* might have been present and undetected in our sample, but pentastomes are difficult to definitively identify to species through morphological analyses alone (Kelehear et al. 2011; Westfall et al. 2019).

To the best of our knowledge, this represents the first record of *R. orientalis* parasitizing any gecko, and only its second lizard host, having recently been reported from the Argentine Giant Tegu (*Salvator merianae*) (Goetz et al. 2021). Our finding is surprising, given that adults are known to parasitize snakes (Ali et al. 1982; Miller et al. 2020) and that the species is not reported to parasitize *G. gecko* in their sympatric native range (e.g., Burma, India, Philippines; Ali et al. 1982; Rösler et al. 2011). The exploitation of novel hosts by *R. orientalis* might result from its ability to exhibit host-specific phenotypic plasticity (Westfall et al. 2019), which, when coupled with the plethora of immunologically naïve hosts within the pentastomes' North American invasive range, may ultimately enable this parasite to infect a variety of novel intermediate and definitive hosts in Florida. *Gekko gecko* has established itself as far north as Leon County, Florida (Means 1996), which borders Georgia and is substantially farther north than the current northernmost record of *R. orientalis* from Alachua County (Walden et al. 2020). Thus, the potential exists for *R. orientalis* to expand its range farther northward through parasitism of *G. gecko*.

Acknowledgements

We thank Timothy M. Collins, John M. Kinsella, and Christina M. Romagosa.

Literature Cited

Ali, J. and J. Riley. 1983. Experimental life-cycle studies of *Raillietiella gehyrae* Bovien, 1927 and *Raillietiella frenatus* Ali, Riley and Self, 1981: pentastomid parasites of geckos utilizing insects as intermediate hosts. *Parasitology* 86: 147–160. https://doi.org/10.1017/S0031182000057255.

Ali, J., J. Riley, and J. Self. 1982. A revision of the taxonomy of *Raillietiella boulengeri* (Vaney & Sambon, 1910) Sambon 1910, *R. orientalis* (Hett, 1915) Sambon, 1922 and *R. agcoi* Tubangui & Masilungan, 1956 (Pentastomida: Cephalobaenida). *Systematic Parasitology* 4: 285–301. https://doi.org/10.1007/BF02185516.

Christoffersen, M., and J.E. De Assis. 2013. A systematic monograph of the Recent Pentastomida, with a compilation of their hosts. *Zoologische Mededelingen* 87: 1–206.

Fieldsend, T.W., K.L. Krysko, P. Sharp, and T.M. Collins. 2021. Provenance and genetic diversity of the non-native geckos *Phelsuma grandis* Gray 1870 and *Gekko gecko* (Linnaeus 1758) in southern Florida, USA. *Biological Invasions* 23: 1649–1662. https://doi.org/10.1007/s10530-021-02463-1.

Goetz, S.M., D.A. Steen, M.A. Miller, C. Guyer, J. Kottwitz, J.F. Roberts, E. Blankenship, P.R. Pearson, D.A. Warner, and R.N. Reed. 2021 Argentine Black and White Tegu (*Salvator merianae*) can survive the winter under semi-natural conditions well beyond their current invasive range. *PLoS ONE* 16: e0245877. https://doi.org/10.1371/journal.pone.0245877.

Kelehear, C., D.M. Spratt, S. Dubey, G.P. Brown, and R. Shine. 2011. Using combined morphological, allometric and molecular approaches to identify species of the genus *Raillietiella* (Pentastomida). *PLoS ONE* 6: e24936. https://doi.org/10.1371/journal.pone.0024936.

King, W. and T. Krakauer. 1966. The exotic herpetofauna of southeast Florida. *Quarterly Journal of the Florida Academy of Sciences* 29: 144–154.

Krysko, K.L., K.M. Enge, and P.E. Moler. 2019. *Amphibians and Reptiles of Florida*. University of Florida Press, Gainesville, Florida, USA.

Means, D.B. 1996. *Gekko gecko* (Tokay Gecko). *Herpetological Review* 27: 152.

Metcalf, M.F., A. Marsh, W. Brosse, and J.E. Herman. 2019. *Crocatus adamanteus* (Eastern Diamondback Rattlesnake). Endoparasite. *Herpetological Review* 50: 389.

Miller, M.A., J.M. Kinsella, R.W. Snow, B.G. Falk, R.N. Reed, S.M. Goetz, F.J. Mazzotti, C. Guyer, and C.M. Romagosa. 2020. Highly competent native snake hosts extend the range of an introduced parasite beyond its invasive Burmese python host. *Ecosphere* 11: e03153. https://doi.org/10.1002/ecs2.3153.

Miller, M.A., J.M. Kinsella, R.W. Snow, M.M. Hayes, B.G. Falk, R.N. Reed, F.J. Mazzotti, C. Guyer, and C.M. Romagosa 2018. Parasite spillover: indirect effects of invasive Burmese pythons. *Ecology and Evolution* 8(2): 830–840. https://doi.org/10.1002/ece3.3557.

Paré, J.A. 2008. An overview of pentastomiasis in reptiles and other vertebrates. *Journal of Exotic Pet Medicine* 17: 285–294. https://doi.org/10.1053/J.JEPM.2008.07.005.

Reese, D.J., J.M. Kinsella, J.M. Zdziarski, Q. Zeng, and E.C. Grenier. 2004. Parasites in 30 captive Tokay Geckos, *Gekko gecko*. *Journal of Herpetological Medicine and Surgery* 14(2): 21–25. https://doi.org/10.5818/1529-9651.14.2.21.

Rösler, H., A.M. Bauer, M.P. Heinicke, E. Greenbaum, T. Jackman, T.W. Nguyen, and T. Ziegler. 2011. Phylogeny, taxonomy, and zoogeography of the genus *Gekko* Laurenti, 1768 with the revalidation of *G. reevesii* Gray, 1831 (Sauria: Gekkonidae). *Zootaxa* 2989: 1–50. https://doi.org/10.11646/zootaxa.2989.1.1.

Walden, H.D., M.E. Iredale, A. Childress, J.F.X. Wellehan, Jr., and R.J. Ossiboff. 2020. Case report: Invasive pentastomes, *Raillietiella orientalis* (Sambon, 1922), in a free-ranging Banded Water Snake (*Nerodia fasciata*) in north central Florida, USA. *Frontiers in Veterinary Science* 7: 467. https://doi.org/10.3389/fvets.2020.00467.

Westfall, A.K., M.A. Miller, C.M. Murray, B.G. Falk, C. Guyer, and C.M. Romagosa. 2019. Host-specific phenotypic variation of a parasite co-introduced with invasive Burmese pythons. *PLoS ONE* 14: e0209252. https://doi.org/10.1371/journal.pone.0209252.