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Geographic Distribution Records of *Macracanthorhynchus ingens* (Archiacanthocephala: Oligacanthorhynchidae) from the Raccoon, *Procyon lotor* in North America

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Running Title: *Macracanthorhynchus ingens* in North America

Macracanthorhynchus ingens is a common acanthocephalan having been reported from much of eastern North America. Although the primary definitive hosts of *M. ingens* are the raccoon, *Procyon lotor* and black bear, *Ursus americanus*, *M. ingens* has also been reported from ringtails (*Bassariscus astutus*), domestic dogs (*Canis familiaris*), coyotes (*Canis latrans*), hog-nosed skunks (*Conepatus leuconotus*), humans (*Homo sapiens*), eastern striped skunks (*Mephitis mephitis*), mink (*Mustela vison* and *Neovison vison*), hairy-tailed moles (*Parascalops breweri*), spotted skunks (*Spilogale putorius*), domestic swine (*Sus scrofa*), gray fox (*Urocyon cinereoargenteus*) (Richardson 2014) and more recently a bobcat (*Lynx rufus*) (Hiestand *et al.* 2014). Additionally, *M. ingens* has been reported from several reptilian and mammalian paratenic hosts (Richardson 2014). Richardson (2014) provided a faunal review of *M. ingens* showing that *M. ingens* is widely distributed throughout much of the eastern United States of America. Richardson (2014) noted however, that robust surveys of intestinal parasites of the raccoon conducted in the upper Midwestern United States (Michigan, Wisconsin, and Ohio) and in Saskatchewan Canada failed to reveal the presence of *M. ingens* (Schultz 1962, unpublished M.S. thesis, University of Michigan, East Lansing, Michigan; Hoberg and McGee 1982). Additionally, Richardson (2014) noted that *M. ingens* has not been reported from Canada or New England, north of Connecticut. In addition, there have been no vouchered reports of *M. ingens* from Missouri. Subsequent to the faunal review of Richardson (2014), specimens of *M. ingens* collected from several localities in Missouri and Ontario, Canada have been identified and are reported herein.

Specimens from Missouri raccoons were collected in the course of routine helminthological surveys. Specimens from raccoons in Ontario, Canada were taken from raccoons submitted to the Canadian Wildlife

Health Cooperative, Department of Pathobiology, University of Guelph, Guelph, Canada. All specimens of *M. ingens* were collected from the small intestine and ultimately fixed in formalin or ethanol. Voucher specimens were deposited with the Division of Invertebrate Zoology, Peabody Museum of Natural History at Yale University, New Haven, Connecticut (YPM IZ).

Macracanthorhynchus ingens was previously reported from Missouri by Monello and Grompper (2011) who reported prevalences of 2-3% based on observation of *M. ingens* eggs in fecal samples of 289 raccoons, although no worms were collected. In this study 7 of 28 (25.0%) raccoons examined from Boone County, Missouri were infected with 1 – 13 individuals of *M. ingens* with a mean intensity of 5.0. One of 27 (3.7%) raccoons examined from Cole County, Missouri was infected with 3 individuals of *M. ingens*. Two raccoons examined from Buford Pond in the Current River Conservation Area, Reynolds County, Missouri were infected with 1 and 3 individuals of *M. ingens*. Voucher specimens were deposited in the Peabody Museum of Natural History, Yale University, New Haven, Connecticut and assigned collection numbers (YPM IZ 078737-078740, 078778 and 078779). This represents the first vouchered report of *M. ingens* from Missouri.

The disparity in prevalence between raccoons in Boone and Cole Counties in central Missouri is interesting. The two counties are separated by the Missouri River with Boone county lying in the southern Alluvial Plain and Cole County lying in the northern Ozark Highlands of Missouri. Reynolds County in southern Missouri is located in the central Ozark Highlands. The finding of *M. ingens* from both southern and central Missouri, along with its occurrence in surrounding states (Richardson 2014) suggests that *M. ingens* likely occurs throughout Missouri.

Individuals of *M. ingens* were collected from raccoons collected in Cornwall, St. Thomas, Gordon Island, St Lawrence Islands National Park and Ohsweken in southern Ontario, Canada. This represents the first report of *M. ingens* from Canada. Because only representative specimens (YPM IZ 078750-078754) were provided from these raccoons submitted to the Canadian Wildlife Health Cooperative, Department of Pathobiology, University of Guelph, Guelph, Canada were provided, the prevalence and intensity of *M. ingens* in Ontario has not been determined although it appears to be uncommon.

Robust helminth surveys of raccoons by Schultz (1962, unpublished M.S. thesis, University of Michigan, East Lansing, Michigan) and Hoberg and McGee (1982) failed to reveal the presence of *M. ingens* in the upper Midwestern United States (Michigan, Wisconsin, and Ohio) and in Saskatchewan Canada. It appears that the distribution of *M. ingens* is patchy in the northern part of its range. More surveys are warranted to fully elucidate the distribution of this parasite. The availability of suitable intermediate hosts may be an important primary factor in determining the range of *M. ingens*. The primary intermediate host of *M. ingens* appears to be Spirobolid millipedes (Crites 1964; Fahnestock 1985a,b; Richardson 2006; Richardson *et al.* 2016) although beetles and woodroaches appear to also be competent intermediate hosts (Moore 1946; Elkins and Nickol 1983; Richardson 2014).

Specimens collected from a kinkajou, *Potos flavus*, from Carimagua, Meta, Colombia were determined by Richardson (2014) to be *M. ingens*. Further study of these specimens has led to the conclusion that they likely represent a previously undescribed species such that the occurrence of *M. ingens* in South America is questionable.

A map of the known geographic distribution of *M. ingens*, modified from Richardson (2014) is given in Figure 1. Given the known distribution of *M. ingens*, it is assumed that this parasite occurs in Iowa and Indiana, although there are no reports in the literature for these states. More surveys and raccoons and/or black bears are warranted throughout the upper Midwestern United States, New England, Canada, and Mexico to further elucidate the distribution of *M. ingens*.

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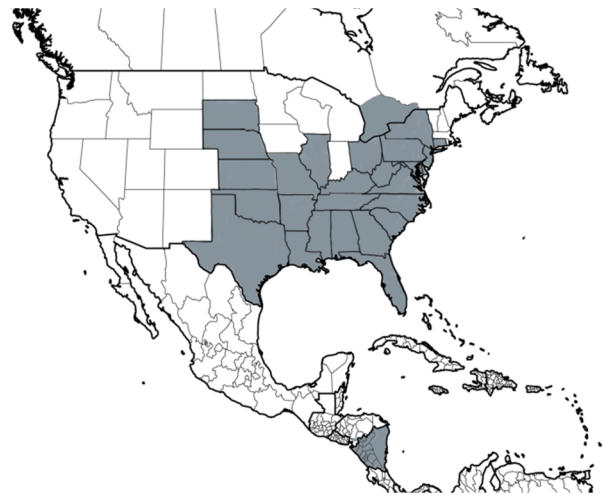


Figure 1. Documented distribution of *Macracanthorhynchus ingens* shown in gray.

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