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PATHOLOGY CAUSED BY THE TREMATODE *CIRCUMVITELLATREMA MOMOTA* IN FREE-RANGE WILD BLUE-CROWNED MOTMOTS (*MOMOTUS MOMOTA*) IN CENTRAL AMERICA

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Abstract: Wildlife conservation law in Costa Rica protects common motmots (*Momotus momota*), limiting the specimens available to study their health and biology. This report describes the finding of the trematode *Circumvitellatrema momota* in the trachea, air sacs, lung, and celomatic cavity of two free-living *M. momota*. Histiocytic air sacculitis and pleuritis with granulomas containing trematodes, as well as adhesions between the air sacs and pericardium, were observed. In addition, histiocytic pneumonia, air sacculitis, celomitis, ulcerative tracheitis, and necrotizing histiocytic hepatitis showing intralesional parasites were detected. Eggs with morphology compatible with *C. momota* were found in the feces of both birds. To our knowledge, this is the first report of *C. momota* in motmots of Central America. As may be seen in the second case, severe respiratory compromise was possibly affecting the bird's capacity to fly. Longitudinal studies of the host, parasite, and environment are necessary to understand the implication for *C. momota* infection to the health and survival of the common motmot.

INTRODUCTION

There are six species of motmots (Coraciiformes: Momotidae) in Costa Rica, with *Momotus momota* being synonymous with *Momotus lessonii*.⁸ The blue-crowned motmot, known as “momoto común” or “pájaro bobo,” is a large bird of colorful plumage.⁵ Motmots live in tropical forests, gullies with trees, coffee plantations, and shaded gardens. These birds eat spiders, earthworms, insects, lizards, and small snakes.¹¹

There are few descriptions of Digenea trematodes causing disease in free-ranging birds, including motmots. In Costa Rica, *Cyclocoelom (Hyptiasmus) costaricensis* (now *Phoenicopterus costaricensis*),^{1,3,5} was recorded in the air sacs and coelomic cavity of *M. momota* and *Orthinotrema momoti* (Microphalidae) was found in the intestine.¹

Trematode infection in captive blue-crowned motmots from two different zoos has also been

described. One was from a 6-yr-old bird under human care in quarantine at the Philadelphia Zoo.⁶ Another was a 4-mo-old bird at the Montpellier Zoo.¹⁰ The first bird did not show clinical signs, and the cyclocoelids were diagnosed by fecal examination. Laparoscopy allowed extraction of the celomatic cavity's flukes for identification as *C. momota*.¹⁰ The second case did not show symptoms and was treated in a quarantine facility after being attacked by an older bird of the same species. This motmot had respiratory distress and died. Necropsy was performed and a high load of trematodes *C. momota* were found in the coelomic cavity, the lungs, and around the heart.¹⁰

After the first report in 1962, there were no other cases of natural trematode infections in wild motmots from Central America or Costa Rica. The goal of this work was to report a trematodiasis in the air sacs and coelomic cavity of two blue-crowned motmots through morphological and histological studies.

MATERIALS AND METHODS

Two blue-crowned motmots were submitted for postmortem examination in the Laboratory of Avian Pathology, School of Veterinary Medicine, National University of Costa Rica (EMV-UNA; Supplemental Figure 1). The first case was attended in the Hospital de Especies Menores y Silvestres with a right femur fracture. After 3 days of hospitalization, the bird died without signs of systemic disease. The second case was a free-range bird found dead in the gardens of the EMV-UNA.

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Note: This article contains supplemental material found in the online version only.

Both birds were evaluated postmortem. Fresh feces and parasites were examined in saline solution, and Digeneans were fixed in alcohol/formalin/acetic acid fixative (AFA).⁹ During necropsy, air sacs, lungs, heart, liver, trachea, kidney, and digestive tract were collected. All tissues were fixed in 10% buffered formalin, embedded in paraffin, trimmed at 3 μm, and stained with H&E. Photographs were taken using a BX53 trinocular microscope (Olympus), a DF73 digital camera, and cellSens Entry CS photography program. Digeneans were fixed in AFA, dehydrated using an ascendent series of ethanol, stained with modified hydrochloric carmine, and mounted with Canada balsam.⁴ Six flukes were used for morphological identification of the parasites found.⁷ Measurements of the main morphological characteristics (mean ± SD) are given in micrometers, except with the length of the body that was given in millimeters. The average and SD were calculated. The parasite identification was performed using published keys.⁵ The prevalence and infection intensity of the parasites were calculated.²

The worms were deposited in the parasitology collection located in the parasitology laboratory of the National University of Heredia, Costa Rica.

RESULTS

Parasite description

Body flat, narrow front and wide back; 7.8 ± 0.5 mm long × 2.2 ± 0.1 mm wide; oral sucker 238.3 ± 20.4 μm long × 266.7 ± 23.4 μm wide; pharynx well developed, 370.0 ± 15.5 μm long × 296.7 ± 8.2 μm wide; acetabulum absent; ovary forms a triangle with the testes, 291.7 ± 44.5 μm wide; mean testes wide 583.3 ± 53.2 μm; intertesticular space long, 513.3 ± 82.9 μm (Supplemental Figure 4). Posttesticular space, 705 ± 104.8 μm long; eggs, 136.7 ± 5.2 μm long × 68.8 ± 1.8 μm wide; vitelline fields were confluent anteriorly and posteriorly, forming a complete loop (Supplemental Figure 4). Table 1 compares the measurements of *M. momota* identified in this study and the species cited by Dronen and Blend.⁴

Parasitological summary

Host: *Momotus momota* (Linnaeus, 1776) (Coraiciiformes: Momotidae); the blue-crowned motmot. Locality: Santo Domingo de Heredia, Costa Rica (PA-193-17); Ulloa, Barreal de Heredia, Costa Rica (PA-044-22). Site of infection: trachea, lung, air sacs, and coelomic cavity. Infection intensity: 100% (2/2); 4 (A208-17), 168 (A47-22), respectively. Number of worms: 172 flukes. Deposited specimens:

Table 1. Comparison of the morphological measurements and proportions of *Circumvitellatrema momota* obtained in this study, with *Circumvitellatrema* spp. and *Psophiatrema* spp., according to Dronen and Blend.⁵

Species	<i>Circumvitellatrema momota</i> (n = 6)	<i>C. momota</i> (Dronen, Greiner, Iallegio & Nolan, 2009)	<i>C. phasidi</i> (Stunkard, 1929)	<i>Psophiatrema costaricensis</i> (Brenes & Arroyo, 1962)	<i>Psophiatrema grainieri</i> (Dronen & Kinsella, 2009)
Body length (μm)	7,300–7,800	7,400–10,500	12,000–13,000	9,800–12,200	840–11,000
Oral sucker width (μm)	243.3–289.8	170–220	ND ^a	ND	265
Pharynx width (μm)	288.5–304.2	300–380	350–450	391–453	360–390
Pharynx/oral sucker ratio	1:1.05–1:1.2	1:1.5–1:1.9	ND	ND	1:1.4
Cirrus sac length (μm)	ND	390	1340	ND	340–390
Ovary width (μm)	288.5–247.2	310–390	270–360	338–416	350–450
Mean testes width (μm)	530.1–636.5	665–795	810	1031	580–1,055
Testes wide/ovary width	1:1.8–1:2.1	1:1.9–1:1.25	1:2.6–1:3.0	1:1.25–1:2.9	1:1.6–1:2.0
Intertesticular space length (μm)	430.4–596.2	1,225	1,080	1,530	1,600
Posttesticular space length (μm)	600.2–809.2	470–860	985	540	350–800
Egg length (μm)	131.5–141.9	137–146	130	133–144	117–137
Egg width (μm)	67–70.6	68–78	64	66–77	57–78
Host	<i>Momotus momota</i>	<i>M. momota</i>	<i>Guttera plumifera</i>	<i>M. momota</i>	<i>Psophia crepitans</i>
Locality	Santo Domingo and Barreal, Heredia, Costa Rica	New Orleans, LA, USA	Democratic, Republic Congo	Quepos, Puntarenas, Costa Rica	Guyana

^a ND, not determined.

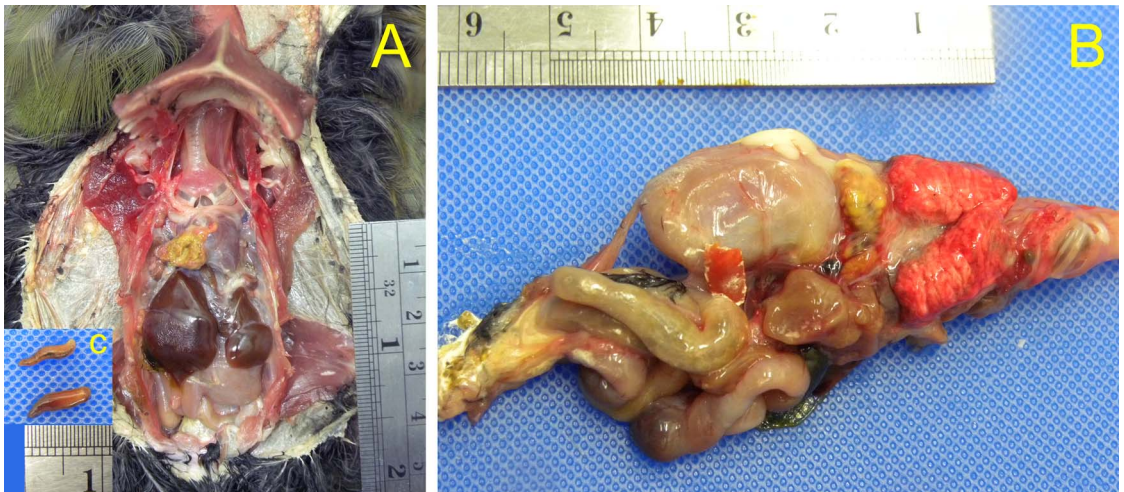


Figure 1. A. Gross image of the first motmot showing slight parasite colonization of the coelomic cavity. Note the yellow granuloma in the right side of the heart and multiple *C. momota* adult flukes in the thoracic air sacs and ventral to the lung. Hepatomegaly was also observed. B. Organs were removed from the cavity, allowing to observe the granuloma adhering also to the caudal part of the right lung and gizzard. Pulmonary edema and dilated bowel loops were also noted. C. Inserted in photo A is a photograph showing the flukes in detail and their measurement of approximately 9 mm.

reference codes of the worms are PA-193-17 and PA-044-22.

Pathology

The first bird showed poor body condition. Turbid appearance of the air sacs and a yellow-caseous granuloma of 2-cm diameter were found in the right cranial region of the coelomic cavity (Fig. 1A). Adherence of the granuloma to the pericardium, peritoneum of gizzard, and lungs was observed (Fig. 1B). Four trematodes of 9 mm in length were detected in the coelomic cavity (Fig. 1A). In addition, approximately five trematodes occupied 50% of the tracheal and bronchial lumen. Catarrhal enteritis was observed, and trematode eggs were identified in feces. Hepatomegaly was also observed (Fig. 1A). Microscopically, multifocal hemorrhages attributed to trematodes in the lung and infiltration of macrophage-laden pigment in air capillaries were observed (Supplemental Figure 2). Trematode eggs were identified in the lumen of the bronchi and the lung parenchyma. Proliferation of epithelioid macrophages and giant cells was also recorded in the air sac walls; they were covered with fibrinous exudate containing trematode eggs, degenerate mononuclear cells, and cellular debris (Supplemental Figure 2).

The second case was a free-range bird with five semilunar penetrating wounds in the anterior region of the pectoral thoracic muscles. Adherences between air sacs and parietal and visceral

peritoneum were also recorded. We noted 168 trematodes were distributed in the pleural, hepatic, and intestinal celomatic cavities (Fig. 2A, B). Nine trematodes were collected from the epiglottis, trachea, and syrinx. Fibrinous perihepatitis and focal hemorrhage associated with a granuloma of 1.5-cm diameter were observed on the left side of the heart (Fig. 2C, D). Hepatomegaly, fibrinous perihepatitis, and multiple yellowish white 1- to 3-mm-diameter necrotic foci were recorded in the liver (Fig. 2C). Renomegaly and urate deposits were observed in the kidney. Microscopically, ulcerative tracheitis with multiple gravid trematodes and yellowish eggs were observed in the tracheal and bronchial lumen (Fig. 3A, B, E, F). Multifocal hemorrhages, lymphohistiocytic pneumonia, and presence of trematode eggs were also observed in the lung and air sacs. Epithelial hyperplasia, lymphohistiocytic inflammation, hemorrhages, and an extensive focal area of caseous necrosis associated with trematodes were found in the right thoracic air sac (Fig. 3C, D). In addition, multifocal hemorrhages, lymphohistiocytic inflammation, biliary conduct hyperplasia, caseous necrosis, and intralesional trematodes were identified in the liver (Fig. 3G, H). Samples of feces and a detailed examination of the fluke uterus content revealed the operculated eggs (Supplemental Figure 3).

DISCUSSION

Few diseases in *M. momota* in Central or South America are described. In Costa Rica, wildlife is

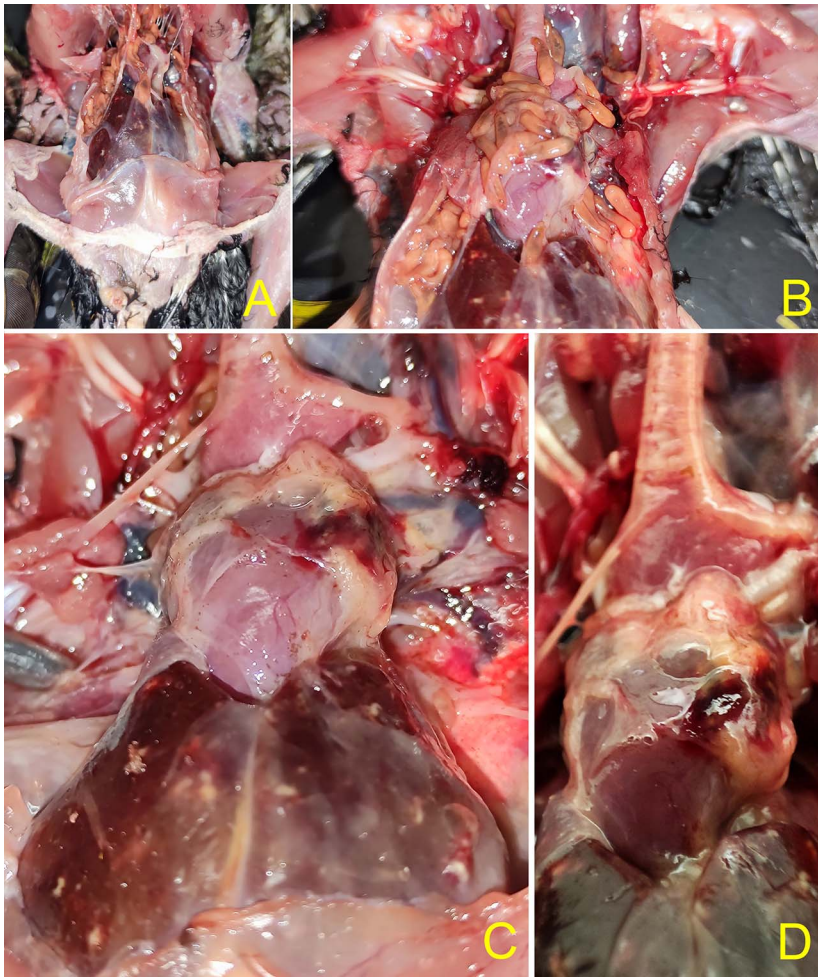


Figure 2. A. Gross image of the second motmot showing severe infection with trematodes in the celomic cavity and multifocal white foci of necrosis in the liver, as well as fibrinous perihepatitis and adherences of pericardium with the parietal peritoneum. B. Multiple *C. momota* adult flukes were found around the heart causing hemorrhages, fibrinous pericarditis, and formation of a granuloma. C. Detail of the granuloma in the left side of the heart showing a focally extensive hemorrhage, fibrinous pericarditis, and perihepatitis. C, D. Multiple cream-to-white foci of necrosis were observed in the liver.

protected by law and access to wild birds is restricted. Consequently, it is rare to find *M. momota* under human care and more rare for full pathologic investigations to be performed when a bird dies. Birds in this report were free-range birds found sick, predated, and injured and were brought to the laboratory for pathologic evaluation. It was remarkable that both were infected with the trematode *C. momota* and presented extensive lesions such as granuloma in the coelomic cavity and ulcerative tracheitis. In addition, flukes were observed in the lungs, consequently affecting their respiratory capacity. However, how *C. momota* impacts the health of *M. momota* in their natural habitat is uncertain.

In captivity, infected birds can be asymptomatic, and under stressful conditions, could develop acute dyspnea and die.^{6,10} One report attributed the bird's death to the numerous trematodes, cells fragments, fibrin, and proteinaceous material obstructing the bronchi, and parabronchi.¹⁰ Similarly, trematodes were found obstructing the trachea and bronchi in this study.

Morphological examination of the trematodes found in both birds showed characteristics that match those described for members of the Cyclocoelidae (Supplemental Figure 7).⁴ Based on morphological keys,⁵ trematodes found in both cases belong to the genus *Circumvitellatrema*, with vitelline fields

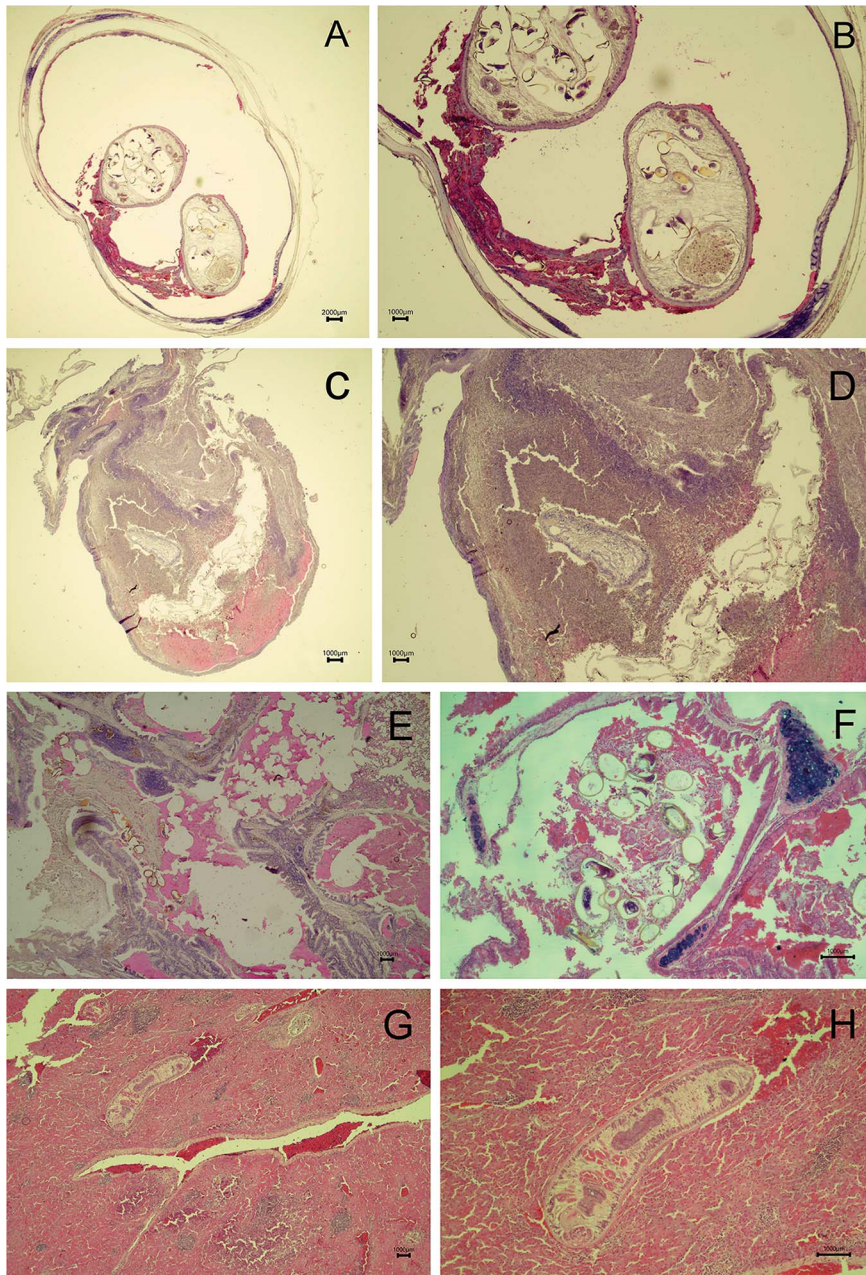


Figure 3. A. Histological image showing two adult trematodes in the lumen of the trachea, causing severe ulceration of the epithelium and hemorrhage. B. Epithelial cell and hemorrhage debris was noted in the lumen along with the trematodes (H&E; scale bar, 1,000 μm). C, D. Lower power magnification image showing a granuloma in the air sacs, which consist of an extensive area of necrosis, severe infiltration with macrophages, and presence of a trematode (H&E; scale bar, 1,000 μm). E, F. Yellow trematode eggs were observed in the bronchial lumen along with cell debris and erythrocytes. G. Trematodes were observed in the liver causing multifocal necrosis, hemorrhage, and infiltration of lymphocytes and macrophages. H. Trematode causing hemorrhage in the liver (H&E; scale bar, 1,000 μm).

confluent anteriorly and posteriorly as their main morphologic features.⁵ Characteristics of the specimens collected in this study, such as body length, pharynx/oral sucker ratio, mean testes width, testes width/ovary width, intertesticular space long, posttesticular space length, and egg length and width were within the range described for *C. momota* (Table 1);⁵ also, these flukes differ from *Circumvitellatrema phasidi* in their length, with these being larger. In addition, *C. momota* differs from *Psophiatrema* in that the latter has only vitelline fields confluent posteriorly.⁷

More studies about the diseases that affect *M. momota* and other birds are important to guarantee their conservation status. It is also valuable to determine specifically which intermediate host is involved in the life cycle of *C. momota* and to confirm the findings by using genetic studies.

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Supplemental Figure 1. Blue-crowned motmots evaluated in this case report. The tail feathers were removed before arrival to the laboratory in the first specimen.

Supplemental Figure 2. A, B. Microscopy image showing the yellow trematode eggs in the bronchial lumen. A, B. Histiocytic infiltration with presence of epithelioid pigment-laden macrophages peri bronchial and in air capillaries was observed (H&E; scale bar, 1,000 µm). C, D. Multiple egg remnants and cell debris were observed in the granuloma that was surrounded by epithelioid macrophages, giant cells, lymphocytes, and proliferation of fibroblast (H&E; scale bar, 1,000 µm).

Supplemental Figure 3. A, B. Operculated *C. momota* eggs within the parasite uterus and in feces (scale bar, 150 µm (A) and 20 µm (B)). Samples were examined in saline solution.

Supplemental Figure 4. Adult *C. momota*, from the air sacs, showing the characteristic genitalia, the vitelline field, and the rudimentary oral sucker.