

Answer to April 2024 Photo Quiz

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The structures were subsequently identified as eggs of *Paragonimus* spp. In lung tissue, asymmetric structures with a size of 84 μm (range from 80 μm to 120 μm) and yellow-brownish color are characteristic features of *Paragonimus* spp. eggs (1). Moreover, these structures had an elongated shape and a thick shell with a flattened end. In addition, at the larger end, the distinctive operculum was clearly visible, and the abopercular end was thickened (2). These eggs are unembryonated in the sputum or alternatively are swallowed, and excreted in the feces. There are more than 30 *Paragonimus* species but only 10 have been reported to infect humans. *P. westermani* and *P. heterotremus* are the most common species reported in human paragonimiasis, called “the oriental lung fluke,” followed by *P. kellicotti* (3). The genus level identification and diagnosis of *Paragonimus* spp. are established by microscopy. However, these eggs are indistinguishable between *Paragonimus* species, and molecular techniques are required for species level identification. The adult trematode specimens are ovoid with a size of approximately 1 cm and are located only in the lungs.

Several parasites should be included in the differential diagnosis of pulmonary helminthiasis. The *Ascaris lumbricoides* third-stage filariform larvae (L3) could migrate to the lungs, after ingestion of infective eggs and subsequent invasion of the intestinal mucosa. *A. lumbricoides* larvae mature further in the lungs, penetrate the alveolar walls, ascend the bronchial tree to the throat, and are swallowed. However, *A. lumbricoides* eggs have a size of 45–90 μm , are rounded, found only in feces, and they have a thick shell with a mammillary outer layer (4). Hydatid disease caused by *Echinococcus* spp. results in hydatid cysts in the liver and lung. However, *Echinococcus* spp. eggs are only present in definitive animal hosts and are not found in humans (5). *Strongyloides* spp. third-stage filariform (L3) larvae penetrate the skin and may migrate through the bloodstream and lymphatic system before coughing up and swallowing. *Strongyloides* spp. larvae are more likely to be recovered from the lungs, however, in cases of disseminated disease and hyperinfection. *Ancylostoma* spp. and *Necator americanus* filariform larvae L3 also penetrate the skin and are transported through the blood vessels to the heart, and then to the lungs. However, *Strongyloides* spp., *Ancylostoma* spp., and *Necator americanus* eggs are only found in feces, as well as *Ascaris* spp., but not in lung tissue (5). Pulmonary dirofilariasis caused by *Dirofilaria immitis* occurs when an infected mosquito introduces L3 larvae into the skin when taking a blood meal. In humans, these L3 larvae or possible L4 larvae can die in the small pulmonary arteries and cause infarcts (6). Therefore, the presence of characteristic operculated eggs (80–120 μm long) in sputum, feces, or lung tissue suggests *Paragonimus* spp. infection.

Paragonimiasis is distributed throughout the Americas, Africa, and Southeast Asia. *P. westermani* and *P. heterotremus* are located in Southeast Asia and Japan. However, *P. kellicotti* is endemic to North America. Otherwise, *P. kellicotti* and *P. mexicanus* extend

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to Central and South America. However, although the molecular analysis was not performed, *P. mexicanus* is one of the most frequent species in Ecuador (7, 8).

The parasite cycle begins when the embryonated egg hatches and miracidium penetrates the soft tissues of the snail (first intermediate host). In snails, miracidia are transformed into sporocyst, rediae, and cercariae. The cercariae penetrate crustaceans such as a freshwater crab or crayfish (second intermediate host) and are transformed into metacercariae. This is the infective specimen for humans. Paragonimiasis infection is caused by the ingestion of pickled or inadequately cooked freshwater crustaceans with these metacercariae. We hypothesized that the patient could have been infected by ingesting a homemade ceviche when she traveled to Jipijapa, Ecuador. The patient reported that this recipe could have been prepared by her family using freshwater crab or crayfish. Some freshwater crustaceans (second intermediate host) have been reported in Ecuador, such as members of the genus *Hypolobocera* spp. (9).

After the consumption, metacercariae from the duodenum penetrate through the intestinal wall into the peritoneal cavity, and through the abdominal wall and diaphragm into the lung tissue in approximately 1 week. In the lungs, metacercariae become encapsulated and develop into adult specimens in approximately 5–6 weeks. Manifestations depend on the duration and probably the intensity of paragonimiasis infection (10). During the chronic stage, when adult specimens reside in the lungs and produce eggs, chronic cough is frequent (10).

The diagnosis is based on the microscopic demonstration of eggs mainly in feces or sputum. The eggs are expectorated and either expelled or swallowed, and passed in the feces. The time from infection to the oviposition and the presence of eggs in stool or sputum is around 65–90 days (1). However, *Paragonimus* spp. eggs were not found in the stool or sputum samples of our patient. The presence of eggs in the effusion fluid or biopsy material, as in this case, is uncommon. Moreover, these eggs can be calcified in lung tissue over time as in our case (11). However, the paragonimiasis infection can persist for 20 years in humans without symptoms (2, 3). Serological testing could be useful for confirming the diagnosis of paragonimiasis and monitoring the treatment. The immunoblot assay for *P. westermani* presents high sensitivity and specificity (10, 12). However, this serological test is mainly used by the Centers for Disease Control and Prevention.

The patient was treated with praziquantel 75 mg/kg/day administered in three doses for 2 days based on recommendations from observational studies and expert opinion with positive response to pharmacological treatment (2).

Paragonimiasis is a food-borne trematodiasis considered by the World Health Organization to be one of the most neglected tropical diseases, with pulmonary paragonimiasis being the most frequent presentation (7). There are other manifestations, such as cerebral or hepatic paragonimiasis, but they are less prevalent (13, 14). Ecuador reported the highest prevalence of human paragonimiasis in America in 2011, and it is considered a public health problem. Moreover, the second intermediate hosts have been reported in the providence of Jipijapa (8, 9). Between 1978 and 2007, the annual incidence was 85.5 cases per 100,000 population in 19 out of 24 provinces of Ecuador, with an estimated risk of infection of around 17.2% of the population (7).

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