THE SPREAD OF ANGIOSTRONGYLIASIS: THE GLOBETROTTING RAT LUNGWORM

John H Cross

Uniformed Services University of the Health Sciences, Bethesda, MD, USA

Abstract. *Angiostrongylus cantonensis* is recognized as one of the major causes of eosinophilic meningitis. The dissemination at one time was believed to be by the spread of the snail *Achatina fulica*. Indeed this intermediate host may have been involved with the early spread in Asia; however, the spread of the parasite to other places probably has been due to the movement of rats. Public health authorities should be made aware that angiostrongyliasis might become a problem.

THE SPREAD OF ANGIOSTRONGYLIASIS

*Angiostrongylus cantonensis* is recognized as one of the major causes of eosinophilic meningitis. The nematode was first reported from China in 1935 (Chen, 1935) and the first human infection was from Taiwan in 1945 (Nomura and Lin, 1945). Eosinophilic meningitis was reported occurring in the Pacific Islands for a number of years (Bailey, 1948), but the etiology was not known until the parasite was found in the brain of a mental patient in Hawaii (Rosen et al, 1962). This was followed by reports of the diseases in Southeast Asia and the Pacific Basin. The parasitosis is now being reported worldwide (Cross, 2004).

In the rat definitive host, the parasite is located in the pulmonary arteries. Eggs produced by the female worms hatch, and the larvae migrate to the intestine and pass in the feces. Molluscan intermediate host acquire the infection, and the larvae develop into the infective third stage. When the intermediate molluscan host is ingested by rats, the larvae are digested out of the tissues, migrate to the central nervous system, develop into young adults that migrate to the pulmonary arteries, and become sexually mature. When humans ingest an infected intermediate or paratenic host, the released larvae migrate to the CNS and cause disease. The parasites usually die in the CNS; however, occasionally they migrate to the eye and rarely to the lung where they can become sexually mature (Cross, 1987).

A number of *Rattus* and *Bandicota* species are known definitive host of *A. cantonensis*. *Rattus norvegicus* and *R. rattus* are the rats most commonly infected internationally, followed by regional rats such as *R. argentiventer, R. exulans, R. jalorensis*, and *R. rattus alexandrinus* (Bhaibulaya, 1982).

Various species of mollusc serve as an intermediate host. The giant African land snail, *Achatina fulica*, is considered a major source of infection in Asia and the Pacific Basin, and many other terrestrial and aquatic molluscan species can also be intermediate hosts. Species of aquatic snails (Ampullariidae) imported from South America are evolving as important host in China and Taiwan. Other snails such as *Pila* spp, *Bradybaena similaris*, and *Subulina octona* and slugs such as *Vaginulus plebeius, Veronicella leydigi* and *Deroceras laeve* are also known vectors of the parasite. A great number of other mollusc species have been shown experimentally to be susceptible to infection (Richards and Merritt, 1967) and aquatic snail *Biomphalaria glabrata* has been used in the laboratory to maintain the life cycle (Alicata and Jindrak, 1970; Bhaibulaya, 1982). Other animal species are known as paratenic or transport host for the parasite. The land planarians are accidental hosts; aquatic and terrestrial crabs, prawns, and shrimps have been associated with epidemics. Frogs, toads, and monitor lizards are paratenic host and
are reported to be sources of human infection.

The spread of *A. cantonensis* throughout the world initially was attributed to the dissemination of the great African snail from Madagascar to Mauritius, and on to India, Sri Lanka, Malaysia, China, Taiwan, Southeast Asia, the Pacific Islands, and Australia. The snail, along with the parasite, may have been transported around the Pan-Pacific area during and after World War II (Kliks and Palumbo, 1992). Mead (1961) has depicted the spread with dates of dispersal of the *A. fulica* in the nineteenth century. Alicata and Jindrak (1970) subsequently speculated that the spread of *A. cantonensis* was by the snail as it was transported to various parts of the world (Fig 1).

Since 1962, angiostrongyliasis has been reported primarily from Asia and the Pacific Basin. The disease was later reported from Africa in 1970 (Kliks and Palumbo, 1992). The first report of the parasite and the disease in the Western Hemisphere was from Cuba (Pascual *et al*, 1981; Aguiar *et al*, 1981). Rats and local molluscs were found infected. The parasite was later reported from the Dominican Republic, Haiti, Jamaica, Puerto Rico, and the Bahamas. The disease demonstrated serologically was also reported from Guadalupe (Cross, 2004). *Rattus* spp and local molluscs have also been found infected in the Caribbean Islands. *Achatina fulica*, however, has not been implicated. The means of transmission of the parasite is not known in the islands, and infection in humans is believed to be due to the accidental ingestion of an intermediate or paratenic host.

The parasite was not reported in rats or molluscs in the United States until Campbell and Little (1988) found rats in New Orleans, Louisiana, infected. They did not find infected molluscs but were able experimentally to infect local snails with the parasite. During the 1960s and 1970s, rats in New Orleans were examined routinely for parasitic infection, but *A. cantonensis* was never found. The authors speculated that infected rats arrived in New Orleans by ship and introduced the nematode to the area in the 1980s.

The first report of possible spread *A. cantonensis* in the Americas was a report of fatal meningoencephalitis in a howler monkey in the Audubon Park and Zoological Gardens in New Orleans (Gardiner *et al*, 1990). The same paper reported infection in a white handed gibbon in the Ardastra Gardens and Zoo, Nassau, Bahamas. In 1999, Aguilar *et al* (1999) reported angiostrongyliasis in seven other monkeys

Fig 1- Geographical distribution of murine and human angiostrongyliasis in the tropical and subtropical regions. Arrows indicate theoretical easterly migration of the parasite. (Modified from Alicata and Jindrak, 1970).
in the New Orleans Zoo. The parasite was also found in snails and slugs after the second report in the New Orleans Zoo. A human case of angiostrongyliasis was reported from an 11 year old boy in New Orleans who acquired the infection by ingesting a snail on a dare from his sister (New et al, 1995). A miniature horse from Picayune, Mississippi, was reported infected with the parasite and at the same time R. norvegicus trapped in Baton Rouge, Louisiana, was found infected (Costa et al, 2000). In 2002, a lemur from the New Iberia Louisiana Zoo was found with a CNS infection, and infection was found in a wood rat and possums from Baton Rouge, Louisiana (Kim et al, 2002). A second human infection was reported from Louisiana in a man who ate two raw legs from a green tree frog on a dare (Cuneo et al, 2006). Further evidence of the spread of A. cantonensis in the United States was a report in a white-handed gibbon in the Miami Metrozoo in Miami (Duffy et al, 2004). An epidemic of eosinophilic meningitis caused by A. cantonensis was reported in 12 medical students who ate a common meal of Caesar salad in Jamaica (Slom et al, 2002). Symptoms were experienced few days after returning to the United States and serological diagnoses made. There have been reports of finding the parasite in Rattus spp and snails in Jamaica, and a fatal case was documented in a young male with worms found in the brain and lung (Lindo et al, 2002).

COMMENTS

Angiostrongylus cantonensis and eosinophilic meningitis, due to infection with the nematode, have now been reported globally. The dissemination at one time was believed to be by the spread of the snail, Achatina fulica. Indeed this intermediate host may have been involved with the early spread in Asia; however, the spread of the parasite to other places probably has been due to the movement of rats. Rats easily gain access to ships and it is likely that infected rats “jump ship” at various ports. Many species of snails are susceptible to infection and rats passing larvae in the feces can easily be picked up by local snails and slugs, thus is establishing the parasite (Kliks and Palumbo, 1992). Cargo being shipped from endemic areas may harbor rats and molluscs, and drug trafficking may have been involved. Without question, the parasite will spread and propagate, especially in the warmer parts of the world. The southern United States should be concerned. The intermediate, definitive, and paratenic hosts are available and are susceptible to infection. Two human infections have been reported from Louisiana and Public Health authorities should be made aware that angiostrongyliasis might become a problem.

REFERENCES


Cross JH. Iterant Angiostrongylus (Para-
strongyliasis) cantonensis. In: Proceedings of
the European Multicolloquium on Parasitology,

Cuneo P, Clement S, Sokol T. Eosinophilic
meningitis and angiostrongylus cantonensis.
Louisiana Morbid Rep 2006;17:1.

Duffy MS, Miller CL, Kinsella JM, deLahunta A.
Parastrongylus cantonensis in a non-human
primate, Florida. Emerg Infect Dis 2004;10:
2207-10.

Gardiner CH, Wells S, Gutter AE, et al.
Eosinophilic meningoencephalitis due to
Angiostrongylus cantonensis as the cause of
death in captive non-human primates. Am J

Kim DY, Stewart TB, Bauer BW, Mitchell M.
Parasstrongylus (Angiostrongylus) cantonensis
now endemic in Louisiana wildlife. J Parasitol

Kliks MM, Palumbo NF. Eosinophilic meningitis
beyond the Pacific basin: the global dispersion
of a peridomestic zoonosis caused by
Angiostrongylus cantonensis, the nematode
212.

Lindo JF, Waugh C, Hall J, et al. Enzootic Angio-
strongylus cantonensis in rats and snails after
an outbreak of human eosinophilic meningitis

Mead AR. The great African snail: a problem
of economic malacology. Chicago, IL:

New D, Little MD, Cross JH. Angiostrongylus
cantonensis infection from eating raw snails.

Nomura S, Lin PH. First case report of human
infection with Haemostrongylus ratti
Yokogawa. Taiwan no Ikai 1945;3:589-92
(in Japanese).

Pascual JE, Bouli RP, Aguiar H. Eosinophilic
meningoencephalitis in Cuba, caused by

Richards CS, Merritt JW. Studies on
Angiostrongylus cantonensis in molluscan
intermediate hosts. J Parasitol 1967;53:
382-8.

Rosen L, Chapell R, Lacquer GL, Wallace GD,
Weinstein PP. Eosinophilic meningoence-
phalitis caused by metastrongylid lungworm

Slom TJ, Cortese MM, Gerber SI, et al. An
outbreak of eosinophilic meningitis caused
by Angiostrongylus cantonensis in travelers
returning from the Caribbean. N Engl J Med
2002;346:668-75.