SNAIL BORNE PARASITIC ZOONOSES : ANGIOSTRONGYLIASIS

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INTRODUCTION

Snails are not a main source of protein for human consumption, but are often eaten either as delicacy or as a disease remedy. For these purposes, the snails are to be eaten raw. This practice permits the transmission of the infective stages of parasites to man.

Parasitic infections caused by eating raw snails have been reported as follows:

Trematode infections: All of the cases reported were due to echinostomes and occurred mostly in Southeast Asia. They were *Echinostoma ilocanum, E. lindoense, E. malayanum* and *E. revolutum*. The snails were *Pila scutata, Viviparus javanicus, Corbicula lindoensis, Corbicula subplanta*, and *Corbicula producta* (Faust *et al*, 1971).

Nematode infections: Two species of *Angiostrongylus* are known to cause angiostrongyliasis in man.

ANGIOSTRONGYLUS

The genus *Angiostrongylus* was established by Kamenskii (1905) for a dog lung-worm, *Strongylus vasorum*. Up to the present there are 20 species of *Angiostrongylus* described. They are as follows (Bhaibulaya, 1982):

1. *A. vasorum* Baillet, 1866 in the pulmonary arteries and right side of the heart of domestic dog, *Canis familiaris*. It has been found in Europe and South America.

2. *A. raillieti* Travassos, 1927 in the pulmonary arteries and the right ventricle of the crab-eating dog, *Canis azarae*, in Brazil.

3. *A. tateronae* Baylis, 1928 in the Kemp jerboa, *Tatera kempii* in Ibadan, West Africa. Although it was discovered in the stomach, it was believed to have its normal habitat in the lungs or air passages.

4. *A. ondatrae* Schulz *et al* (1933) in the lungs of muskrat, *Ondatra zibethica* in the USSR.

5. *A. cantonensis* Chen, 1935 in the pulmonary arteries and right side of the heart of rodents. It has been reported from many parts of the world.

6. *A. ten* Yamaguti, 1941 in the heart of the black-footed marten, *Martes melampus melampus*, in Japan.

7. *A. gubernaculatus* Dougherty, 1946 in the heart of the badger, *Taxida taxus neglecta* and the striped skunk, *Mephitis mephitis holzneri* in California, USA.

8. *A. soricis* Soltys, 1953 in the lungs of the shew, *Sorex minutus* in Poland.

9. *A. blarini* Ogren, 1954 in the lungs of the short tailed shrew, *Blarina brevicauda* in Illinois, USA.

10. *A. chabaudi* Biocca, 1957 in the pulmonary arteries and heart of the wild cat, *Felis silvestris* in central Italy.

11. *A. sciuri* Merdivenci, 1964 from the pulmonary arteries of the squirrel, *Sciuri vulgaris* in Turkey.

12. *A. michiganensis* Ash, 1967 in the bronchioles of the shrew, *Sorex cinereus cinereus* in Michigan, USA.

13. *A. sandarsae* Alicata, 1968 in the pulmonary arteries of rodents, *Mastomys natalensis* and *Gerbil tatera* in Mozambique.

14. *A. mackerrasae* Bhaibulaya, 1968 in the pulmonary arteries and the right side of the

heart of the rat, *Rattus fuscipes* in Queensland, Australia.

15. *A. dujardini* Drozdz and Doby, 1970 in blood vessels of the lungs of the wild rodent, *Cletrionomys glareorus* in South France.

16. *A. schmidti* Kinsella, 1971 in the pulmonary arteries of the rice rat, *Oryzomys palutris* in Florida, USA.

17. *A. malaysiensis* Bhaibulaya and Cross, 1971 in the pulmonary arteries *Rattus jalorensis* in Malaysia.

18. *A. costaricensis* Morera and Cespedes, 1971 in the mesenteric arteries of the cotton rat, *Sigmodon hispidus* in Costa Rica and other American countries.

19. *A. minutus* Ohbayashi *et al*, 1973 in the lungs of Japanese shrew mole, *Urotrichus talpoides* in Japan.

20. *A. siamensis* Ohbayashi, Kamiya and Bhaibulaya, 1979 in the mesentery arteries of *Rattus sabanus* in Thailand.

Of the 20 species, so far reported, only *A. cantonensis* and *A. costaricensis* have been known to cause disease to man. However, due to the close relationships and biological similarity between *A. mackerrasae, A. malaysiensis* and *A. cantonensis*, and between *A. siamensis* and *A. costaricensis*, the former (*A. mackerrasae* and *A. malaysiensis*) and *A. siamensis* are considered herein to be possible causative agents of human disease.

ANGIOSTRONGYLUS CANTONENSIS

A small filariform nematode of the superfamily *Metastrongyloidea* was first described by Chen in 1935 as *Pulmonema cantonensis*. Ten years later Nomura and Lin (1945) reported the first clinical case of human infection with *Haemostrongylus ratti*. These two nematodes were shown to be synonymous (Dougherty, 1946) and have since been known as *Angiostrongylus cantonensis*.

An adult *A. cantonensis* normally lives in the pulmonary arteries and right ventricles of rodents; they have a filariform body which tapers at both ends, and is transparent with a smooth cuticle and transverse striae. The males possess a well developed, kidney-shaped single-lobed caudal bursa with characteristic bursal rays. The ventral ray branches on the distal, at a point about two-thirds of its length, into a small ventro-ventral ray and a large latero-ventral ray. The postero-lateral ray is always shorter than the medio-lateral ray. Males range in size from 12.0–27.7 mm long and 0.2–0.4 mm wide, and have two equal spicules and a gubernaculum. The size of spicule ranges from 1.00-1.46 mm. Females are characterized by the milky white uterine tubules winding spirally around the blood filled intestine, thus making the pattern of a "Barber's Pole". Females range in size from 15.0–34.0 mm long and 0.24–0.50 mm wide. They have a long thin walled vagina measuring 1.50–3.25 mm and the vulva and anus are close together near the posterior end. The tail is round and with no projection at the tip.

Life cycle (Bhaibulaya, 1975a, b)

After copulation in the pulmonary artery the females produce eggs which develop into first-stage larvae (0.25–0.29 mm long, 0.014–0.018 mm wide). The first-stage larvae penetrate the alveoli and migrate through the respiratory tract into the alimentary tract and pass out of the definitive host in the feces. After gaining access to the molluscan intermediate host, either by being swallowed or penetration, the first-stage larvae moults in the muscular tissue 7–9 days after infection. The second moult occurs 12–16 days after infection or 5–7 days after the first moult. The larvae then become second and third-stage larvae, respectively, and still retain the sheaths of the first and second stages. The third-stage larvae coil in the muscular tissue of the molluscan intermediate host.

The third-stage larva is slender in shape with a rhabditoid esophagus and is 0.46–0.52 mm long and 0.02–0.03 mm wide. Its tail is characterized by possessing a constriction before tapering to the blunt end.

The third-stage larvae enter the rodent definitive host usually when the rodent eats an infected mollusc. The larvae penetrate the wall of the gastrointestinal tract and reach the lungs by venous circulation. From the lungs they are dispersed to various tissues by pumping

action of the left heart, but most of them migrate to the brain. The third-moult occurs in the brain tissue 4–6 days after infection of the rodent. The fourth-stage larvae cast off the third-stage sheath and migrate to the subarachnoid space and further develop. The fourth moult occurs in the subarachnoid space 7–9 days after gaining access to the rodent. The young adult sheds the fourth-stage sheath and migrates into the pulmonary arteries through venous sinuses of the brain. Most of the young adults reach the pulmonary arteries 26 to 35 days after infection. The prepatent period ranges from 42 to 45 days.

The host (Bhaibulaya, 1982)

A. cantonensis has been found to have low host specificity, both definitive and intermediate hosts.

Natural definitive host

So far at least 24 species of rodent had been reported to be natural definitive hosts of *A. cantonensis*, but *Rattus norvegicus* and *R. rattus* are responsible for the wide distribution of the nematode.

Dogs and the mongoose (*Herpestes urva*) have been reported to serve as experimental definitive host of *A. cantonensis*. However, later observations showed that neither the first stage-larvae nor the adults of *A. cantonensis* could be recovered from the experimentally infected dog or mongoose (*Herpestes auropunctatus*).

Natural intermediate host

Various molluscs are reported to serve as natural intermediate hosts of *A. cantonensis*. *Achatina fulica*, a terrestrial snail, is believed to be responsible for the wide spread of the nematode, whereas aquatic snails, *Pila* spp., are a major source of human infection in Thailand.

Various species of molluscs have been reported to serve as the experimental intermediate host.

Paratenic or transport hosts

Different animals are reported to serve as the natural and experimental paratenic or transport hosts. Although, human angiostrongyliasis has never been reported from the eating of paratenic or transport hosts, some population eat raw fish, crab, shrimp, pork and beef and these animals could be suspected as the potential sources of infection for man.

ANGIOSTRONGYLIASIS

Angiostrongyliasis is infection of animals and man by members of the genus *Angiostrongylus*. *A. cantonensis* causes eosinophilic meningitis or eosinophilic meningoencephalitis, and *A. costaricensis* causes an abdominal angiostrongyliasis. Only eosinophilic meningoencephalitis is discussed here.

Eosinophilic meningoencephalitis is characterized by severe headache, signs of meningeal irritation and eosinophilia in the peripheral blood and the cerebrospinal fluid. Man acquires the infection by eating either raw meat of intermediate, paratenic or transport host animals infected with the nematode or green vegetables contaminated with infective third-stage larvae. The incubation period ranges from 1–3 weeks after ingestion of infective larvae. The onset of the disease is usually insidious, but sometimes sudden, and the course of the disease varies from several days to several months.

The clinical manifestations include the following: Headache, the most common symptom of eosinophilic meningoencephalitis, is characterized by a throbbing sensation. The bitemporal, frontal and occipital regions are the common sites of headache; the ocular region less common. The headache may persist for as long as 6 weeks. Stiffness of neck and back, which usually disappears in a short period of time. Intermittent or remittent fever may persist longer than any other symptoms and can last more than 4 weeks. The body temperature varies from normal to 40° C depending on the severity. Symptoms which have been recorded are burning sensations, exaggerated sensitivity to touch, pain, numbness, tingling sensation and itching. Paresthesia occurs asymmetrically in distribution and as night paroxysms. It may appear on the ears, back of neck, shoulders, limbs and the trunk. Paresthesia occurs early in the course and persists less than 2 weeks.

Facial paralysis, paralysis of the rectus lateralis muscle supplied by the sixth cranial nerve, and loss of ability to taste, which is supplied by the ninth cranial nerve have been reported. Paresis and paralysis of the limbs are also frequently found. Blurring of vision, unilateral impairment of vision, photophobia and diplopia are ocular symptoms. The above symptoms and signs may be accompanied by nausea, vomiting, chills, malaise, anorexia, mental change, general aches and abdominal discomfort. Cerebral hemorrhage occurs in cases with heavy infection.

Laboratory findings include the following: White blood cell counts range from normal to slight increases in eosinophils with differential counts ranging from 5–63%. In cases with headache, cerebrospinal pressure is moderately increased and is usually proportional to the intensity of the symptom. The pressure ranges from normal to 280 mm of water column. The appearance of the cerebrospinal fluid in most cases is slightly cloudy. However, xanthochromia has been observed in some cases. The protein contents range from normal to moderately elevated. Pleocytosis with eosinophilia is found in all cases of angiostrongyliasis. The average cell count ranges from 200-5,000 cells per ml and the eosinophil count ranges from 26–75%. Young adult *A. cantonensis* may be recovered from the cerebrospinal fluid.

Serological tests are available to provide a presumptive diagnosis with variable results. An intradermal test using adult *A. cantonensis* as crude antigen have provided unreliable results. Complement fixation tests on sera or spinal fluid, using somatic and metabolic antigens, often give positive results but the results were usually inconclusive. The indirect hemagglutination test using adult worm antigens are also unsatisfactory since false positive results were often obtained from the control group. The indirect hemagglutination test in rats demonstrated a correlation between the appearance of antibody and the maturation and fecundity of the female worms. Experiments with infected rats, using lipid free extract of the nematode, showed that latex agglutination antibody could be detected as early as 5 days and as long as 11 months after infection. When adult *A. cantonensis* antigens were used against sera of infected rats, a single precipitation line occurred at 6 days and lasted up to 11 months with the gel diffusion test. By using adult worm antigens, a high positivity was obtained for eosinophilic meningoencephalitis cases by immunoelectrophoresis. Blood donors as controls yielded negative results. The indirect fluorescent antibody test, using third-stage larvae as antigen against the sera of infected monkey, gave positive reactions on the second day of infection and the highest titer occurred 1 month after infection. The enzyme-linked immunosorbent assay was carried out using either adult or young adults of *A. cantonensis* as antigens. Promising results were obtained, although some authors obtained cross-reaction with *Toxocara canis, Ascaris suum* and *Metastrongylus apri* infections.

DIAGNOSIS

In most cases, the diagnosis has been made by obtaining a history of ingesting snails, slugs and green vegetables, along with the clinical manifestations and eosinophilia in the peripheral blood and cerebrospinal fluid. On some occasions, the diagnosis was made by recovering young adults from the cerebrospinal fluid.

TREATMENT

Although several drugs have been tried on various stages of *A. cantonensis*, either *in vitro* or in experimental animals, satisfactory results have not yet been obtained.

EPIDEMIOLOGY

A. cantonensis and its disease have been recorded from most of the continents and islands of the western Pacific. According to Alicata (1990) the spread of *A. cantonensis* occurred with the help of *A. fulica* which migrated to Eastern Asia from West Africa in infected rats and humans. The dispersion occurred in all directions, reaching other parts of Asia, Western Pacific Islands, Australia, Europe, Africa, North, Central and South America.

In Thailand, the eating of *Pila* spp. snails plays a significant role in the transmission of infections to humans, while in other countries transmission has been traced to eating raw

veronicellid slugs, achatinid snails and green vegetables which were not washed thoroughly. Various kinds of animals can serve as natural paratenic and transport hosts of third-stage larvae of *A. cantonensis*; therefore, human infections could occur if those animals are eaten raw. In Thailand eating the raw flesh and liver of a reptile of *Varanus* sp. has been involved in a recent case of eosinophilic meningoencephalitis.

The disease has been observed to be more prevalent during the rainy season, although it can be found year round. Most cases occur in adults, but are more prevalent among males.

CONCLUSION

A. cantonensis and the diseases it causes has been known for more than five decades and the biology as well as the epidemiology have been well studied. We have known that before reaching maturity and the final habitat, ie, the pulmonary arteries, the larval stages of this nematode must migrate through the brain and remain for a period of time in the subarachnoid space of the rodent definitive host. In humans the larvae of *A. cantonensis* also migrate to the brain, but they normally do not continue on to the pulmonary arteries. Pathological changes and damage occurs while the nematodes are in the subarachnoid space of the brain, causing disease to animals and man. The wide distribution of the nematode and the disease involve such factors as low host specificity, both definitive and intermediate hosts, eating of raw intermediate and paratenic hosts to satisfy taste or a belief that the animal tissue is a vitalizing food. Some believe that the meat is also a disease remedy. Nevertheless, two significant aspects concerning the disease in man, ie, diagnosis and treatment, remain of concern. Preventive measures including health education regarding angiostrongyliasis have had little attention. Such unawareness directly affects human health and indirectly on agricultural products. Meats and vegetables contaminated or suspected to be contaminated with infective third-stage larvae of *A. cantonensis* would be of concern to local and foreign consumers of these products.

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