Neglected rare human parasitic infections: Part III: Acanthocephaliasis

Review Article

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ABSTRACT

Human acanthocephaliasis is a zoonotic parasitic infection with acanthocephalan species. Reports documenting human infection with acanthocephalans are relatively rare in the literature. Nonetheless, man has been infected with acanthocephalans since ancient times. Despite their economic and medical significance, acanthocephalans were found to be good indicators of environmental pollution. This review summarizes current knowledge of acanthocephalans as human parasites and their beneficial uses.

Acanthocephalans (Phylum Acanthocephala) are a mysterious group of parasites. Adults are cylindrical unsegmented worms. They vary greatly in length from a few millimetres to 65 cm as in *Macracanthorhynchus hirudinaceus*. However, most of the known species have an average length of 10-35 mm. Worms are characterized by having an invaginable proboscis armed with spines used to attach to the intestinal wall of the vertebrate host. They have a hollow trunk which contains the excretory, reproductive and nervous systems in psuedocoelomic fluid. Acanthocephalans are dioecious, with separate male and female worms. They lack an alimentary tract, and the absorption of nutrients occurs entirely through the body wall. They have a pair of oval bodies called lemnisci, which hang from the anterior wall of the body and extend into the trunk. Each lemniscus serves as a fluid reservoir when the proboscis is invaginated, and may also have a function in fat metabolism[1,2]. Phylogenetic studies have indicated that acanthocephalans are highly derived rotifers[3].

Acanthocephalans are exclusively parasitic in all classes of vertebrates, especially in fish and birds. They have complex life cycles which involve at least two hosts (Figure 1). In species with known life cycle, juveniles colonise arthropods (crustaceans or insects), and adults colonise vertebrates (fish, amphibians, reptiles, birds or mammals). The eggs are passed in faeces of the final host to be eaten by the intermediate host. Some species have more than one intermediate host. Some vertebrates act as paratenic hosts for the larval stages that need to be ingested by the appropriate vertebrate host in order to develop into adults[1].

The phylum Acanthocephala comprises four classes: Archiacanthocephala, Eoacanthocephala, Palaeacanthocephala, and Polyacanthocephala.

Adults of the class Archiacanthocephala are microscopic parasites that attach themselves to the intestinal wall of terrestrial vertebrates. They infect mainly predacious birds and mammals. Adults of the class Eoacanthocephala are parasites of fishes and less frequently amphibians and reptiles. The class Palaeacanthocephala is the largest and most diversified class of acanthocephalans. Adults of this class parasitize fishes, amphibians, reptiles, birds, and mammals throughout the world. The class Polyacanthocephala comprises only one monogeneric family that parasitizes crocodiles and probably fish in South America and Africa, respectively[4-7].
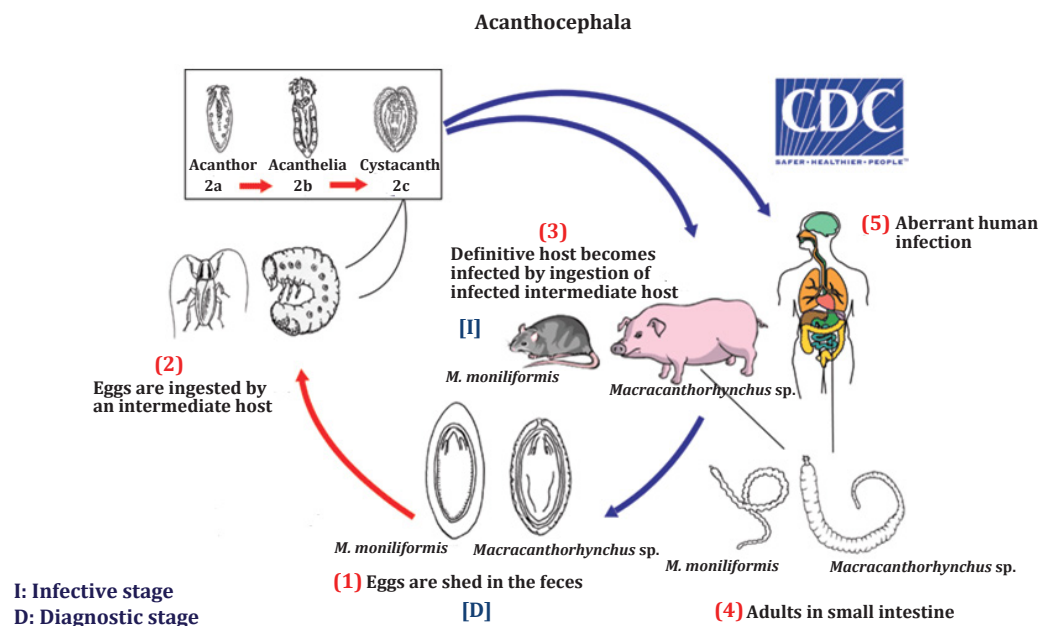
Human acanthocephaliasis

Humans have been associated with acanthocephalans since antiquity. Their eggs were detected in fossilized human excrement (coprolites) that was dated to the prehistoric era[8, 9]. Human cases of acanthocephaliasis are only common in certain foci in China, and remain sporadic in the rest of the world[10]. Many acanthocephalan species are known to have low host specificity but fortunately, for ecological reasons, are not likely to be ingested by man[11]. Man was reported to be infected with at least nine acanthocephalan species, among them, *Macracanthorhynchus hirudinaceus* and *Moniliformis moniliformis* are the most common species[12,13]. Most reported cases of acanthocephaliasis have involved the gastrointestinal tract. Acanthocephalans of medical importance are found only in two classes, Archiacanthocephala, and Palaeacanthocephala. Species of the former class are relatively large, while species of the latter are small.

1. Class: Archiacanthocephala
Macracanthorhynchus hirudinaceus (Pallas, 1781)
Synonyms: *Taenia hirudinaceus* (Pallas, 1781); *Gigantorhynchus gigas* (Pallas, 1781).

Fig. 1. The life cycles of *Macracanthorhynchus* sp. and *Moniliformis moniliformis*, and transmission of human acanthocephaliasis (source: https://www.cdc.gov)

This species has a cosmopolitan distribution[14]. The definitive hosts of this species are pigs and other suids, and very rarely dogs and human. Adult worms colonize the small intestine of the mammalian host, and embryonated eggs, containing a fully developed acanthor, are expelled with the faeces. To continue their development, the egg must be ingested by a beetle, usually a dung beetle. Inside the intermediate host, the egg hatches in the midgut and the freed acanthor larva migrates to the body cavity of the insect, where it continues its development to reach the acanthellae stage, then encysts to form the cystacanth stage. When a definitive host ingests a parasitized insect, the larva sheds its cystic envelope and, after 2-3 months, reaches maturity and begins oviposition[15].

Human infection usually occurs in regions of high prevalence of *M. hirudinaceus* in pigs and human habits of consumption of raw or under roasted insects, for dietary or medicinal purposes[10]. After ingestion, the parasite attaches itself firmly to the intestinal mucosa by using its proboscis. This may result in inflammation and granuloma formation. The parasite may penetrate the intestinal wall to reach the peritoneum. Mechanical damage caused by the insertion of the armed proboscis into the intestinal wall may result is acute abdominal pain, eosinophilic enteritis and possibly intestinal perforation with peritonitis and abscess formation. Some cases in China have had acute abdominal colic with multiple perforations in the jejunum[16].

In 1859, Lambl documented the first report of acanthocephaliasis in man when he diagnosed a child infection in Prague, Czech lands[17]. More cases were reported from Russia[18-20], Brazil[21], Thailand[22-25], Madagascar[26], Papua New Guinea[27], and China[16,28].

Macracanthorhynchus ingens Meyer, 1933

This species exists almost exclusively in North America[29]. The life cycle of *M. ingens* is greatly like that of *M. hirudinaceus*. Definitive hosts for *M. ingens* include raccoons, wolves, badgers, foxes, skunks, opossums, mink, bears, ring-tailed cats, moles and dogs[30,31]. The definitive host becomes infected by ingesting an intermediate host, a millipede, containing the infective cystacanth stage of the parasite or by ingesting a paratenic host, such as a rodent or a snake, containing encysted cystacanths. After ingestion, the cystacanth hatches in the small intestine of the host, attaches its proboscis deep into the intestinal wall, and matures to the adult stage[32]. It was reported that *M. ingens* was not a significant zoonotic parasite but was diagnosed in few cases of children in Texas, USA[29,33].

Moniliformis moniliformis (Bremser, 1811) Travassos, 1915

This species is a common parasite found in most parts of the world[12]. The life cycle is like the above mentioned two archiacanthocephalans. The definitive host for *M. moniliformis* is typically a rat, although other rodents, carnivores, and primates including man, may serve as accidental hosts. The parasite's eggs are ingested by an intermediate host (typically a cockroach or beetle), which is subsequently eaten by the definitive host, resulting in infection. Infected cockroaches showed reduced predator avoidance behaviour, a phenomenon that presumably benefits the parasite by increasing the likelihood that its cockroach host will be

ingested by a rodent, a necessary event for the parasite to complete its life cycle[34]. Amphibians and reptiles may serve as paratenic hosts[35].

Humans, especially children, may acquire the infection by ingesting cockroaches and beetles containing infective larvae[36,37]. It is probable that human infection is acquired by eating a raw paratenic host. In infected human hosts, the worms seldom mature or mature but do not produce eggs. In Zimbabwe, spurious human infections were reported in people for whom rodents comprised part of their diet[38]. One of the interesting reports was that by Grassi and Calandruccio in 1888 who reported the symptoms shown by the second author after voluntarily infecting himself with *M. moniliformis*[39]. Manifestations described in the different reports varied from asymptomatic passage of worms to loss of appetite, weight loss, severe abdominal pain, diarrhoea, fever, general malaise, vomiting, retarded development, and irritability[37].

Cases of human infection by *M. moniliformis* have been reported from Israel[40], USA[41-45], Madagascar[46], Iran[12,47-50], Zimbabwe (Rhodesia)[51], Egypt[52], Iraq[53], Australia[54,55], China[56], Japan[57], Nigeria[58,59], and KSA[37].

2. Class: Palaeacanthocephala

Compared with the class Archiacanthocephala, acanthocephalans belonging to this class were reported relatively few times in humans.

Acanthocephalus rauschi Golvan, 1969

Little is known about the geographical distribution of this parasite. This species infects humans very rarely with only one documented report. The life cycle is unknown. It was suggested that infection may result from ingestion of an infected intermediate or paratenic host. The parasite was recovered from the peritoneum of an Inuit (Eskimo) in Alaska[60].

Bolbosoma Porta, 1908 (unidentified species)

Only scanty information is available about the biogeography of the different species belonging to this genus. In addition, the life cycle of the genus *Bolbosoma* has not yet been completely confirmed. It has been suggested that marine mammals, especially whales, are the definitive host, and crustaceans are the first intermediate host. Most probably, some species of marine fishes may act as a paratenic host[61,62]. Accidentally, these worms may infect humans. The parasite inhabits the human jejunum and may cause acute peritonitis by perforating the intestinal wall. The specimens recovered from most cases were incomplete or sexually immature, hence species identification is unconfirmed. Up to now, at least seven cases of human *Bolbosoma* infection, all from Japan, have been reported[63-70]. These cases are most probably infected by eating infected raw marine fish as "sashimi", a traditional Japanese dish[63].

Corynosoma strumosum (Rudolphi, 1802) Lühe, 1904

The precise biogeography of this parasite is unknown. Definitive hosts of this species are fish-eating mammals, particularly seals, and birds. The intermediate host is probably a crustacean. Many species of fish serve as paratenic hosts[62]. This species was reported once from man, but accidental parasitism of Eskimos is probably common. One juvenile specimen was recovered from the stools of an Eskimo male in Alaska after treatment with atabrine. It is probable that the man became infected by eating raw fish containing an encysted worm[11].

Corynosoma validum Van Cleave, 1953

Little is known about the biogeography of this species. Its life cycle is like that of *C. strumosum*. The definitive hosts are mainly walruses and seals[71]. The intermediate host is probably a crustacean. Several species of fishes are known to be paratenic hosts[72]. Human infection with fully mature *C. validum* worm was reported only once in Japan[14].

Plagiorhynchus sp. Lühe, 1911

Adult worms of the genus *Plagiorhynchus* are intestinal parasites of birds in different parts of the world. The intermediate host of this species is usually an arthropod. There is only one unusual report of an immature acanthocephalan, probably *Plagiorhynchus* sp., retrieved from a gardener's eye in Kent, England. Most probably the parasite was accidentally transferred from the environment to the pateints's eye, possibly by his own hands[73].

Pseudoacanthocephalus bufonis (Shipley, 1903) Petrochenko, 1956
Synonym: *Acanthocephalus bufonis* (Shipley, 1903) Southwell and Macfie, 1925.

Adult worms of this species are long known common parasite of amphibians in south-eastern Asia[74,75]. It was recently introduced into Hawaii[76]. The life cycle and the intermediate hosts are unknown. In 1954, four male acanthocephalans were recovered from the small intestine of an Indonesian man during a routine autopsy at the Medical School in Djakarta, Indonesia. The worms were reported as *Acanthocephalus* sp.[77]. However, the species was identified later as *Pseudoacanthocephalus bufonis*[11].

Beneficial use of acanthocephalans: The different acanthocephalan species have been found to accumulate high quantities of heavy metals compared to their hosts. Thus, it was recommended to use them as bioindicators of heavy metal pollution and environmental deterioration especially in aquatic ecosystems[78-81].

Prevention and control: Almost all species of acanthocephalans can only be transmitted to human by ingestion of an infected arthropod intermediate host, or a vertebrate paratenic host. In other words, most

acanthocephaliasis cases are due to dietary mistakes, either because of eating raw fish or of ingesting insects. Thus, the most effective mean of prevention is avoiding ingestion of the incriminated species in a raw form. In case of *M. hirudinaceus*, swine should be kept under hygienic conditions and provided with abundant food to discourage rooting and ingestion of beetles.

Treatment: Pyrantel pamoate[42] and ivermectin[59] have been reported as the drug of choice for the treatment of moniliformiasis. In many cases diagnosis is made after emergency surgery. However, in some reports the adult worm was expelled and identified after the patient was treated with piperazine citrate[82].

Conclusion: Few human cases of acanthocephaliasis have been reported worldwide, most of which have been caused by the species *M. moniliformis*. None of the reported species are a specific human parasite or occur regularly in him. Human infection seems to reflect localised dietary habits or aberrations. Despite their economic and medical significance, acanthocephalans were found to be good bioindicators of heavy metal pollution and environmental deterioration especially in aquatic ecosystems.

Conflict of interest: There is no conflict of interest.

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