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Chapter 16

PENTASTOMIDS

by Alex Fain

PENTASTOMIDS constitute a highly aberrant group of arthropods (Fain 1961; Heymons 1935). They have a wormlike and generally annulated appearance. The body is white, legless, and either cylindrical or flat.

These arthropods are typically heteroxenous parasites. In the most evolved species, the adults live in the respiratory tract of carnivorous animals, usually snakes, and the larvae develop in the tissues of various animals, usually mammals.

The intermediate host becomes infected by drinking water or eating food contaminated by fecal material or by mucus from the respiratory tract of an animal harboring adult pentastomids; the definitive host becomes infected by eating animals or viscera containing nymphs.

The development in the intermediate host generally takes several months. The developmental stages include a primary or migrating larva; a secondary or resting larva which molts several times; and a tertiary larva or nymph which encysts in the tissues of the host, generally in the peritoneal cavity. The tertiary larva usually remains encysted until ingested by the definitive host, but sometimes, for reasons not clearly understood, it escapes from its cystic envelope and migrates through the tissues of the intermediate host, causing acute peritonitis and possibly death (Chalmers 1899).

Natural infections have been reported in some endothermal species occasionally used in the laboratory. Experimental infections have also been produced. The pentastomids that may be encountered in endothermal laboratory species are listed in Table 16.1. The most important species are described below.

Linguatula serrata

(Tongue Worm)

Linguatula serrata, a relatively benign parasite, is found throughout the world, but its exact incidence is unknown. It is commonest in Europe, especially eastern Europe (Heymons 1942), and has been reported from the United States (Stiles 1895), South America (Gelormini and Roveda 1938), South Africa (Ortlepp 1934), Asia (Faust 1927; Heymons 1935), the Philippine Islands (Tubangui and Masiluñgan 1936), Australia (Pullar 1936), and New Zealand (Gurr 1953).

Adults occur in the nasal passages of the dog and other canids, and rarely in domestic farm species and man (Heymons 1942). The nymph sometimes occurs in the wild Norway rat, black rat, guinea pig, rabbit, cat, titi monkey, gelada baboon, and man (Bochefontaine 1876; Heymons 1942; Kuntz, Myers, and Vice 1967; Strong, Shattuck, and Wheeler 1926). It is common in domestic farm species. A report of canine nymphal linguatulosis in Japan

is of doubtful validity (Yamashita and Ohbayashi 1954). The nymph was probably *Armillifer moniliformis.*

The incidence of *L. serrata* in laboratory specimens is unknown. It is not likely to be encountered except in dogs obtained from pounds or in rodents obtained from their natural habitat. The mouse, guinea pig, and rock squirrel *(Otospermophilus beecheyi)* have been infected experimentally (Heymons 1942; Hobmaier and Hobmaier 1940; Koch 1907).

MORPHOLOGY

The adults have a transparent, tongue-shaped body with approximately 90 annuli (Fig. 16.1) (Sambon 1922). The anterior end has two pairs of simple retractile hooks. The female is 80 to 130 mm long and 10 mm wide, and reddish orange eggs are visible along the median line of the body; the male is 20 mm long and 3 to 4 mm wide. The nymph, sometimes called *Pentastomum denticulatum,* is 4 to 6 mm long and 1 mm wide (Fig. 16.2). It has spinous body rings and two pairs of binate hooks (Fig. 16.3). The egg is oval, about 70 to 90 μ in diameter, and is individually enclosed in a thin bladderlike envelope containing a clear fluid. It has a thick chitinous shell containing an embryo with rudimentary mouthparts and four short legs, each bearing two clawlike hooks. On the back of the embryo is the so-called dorsal organ or facette.

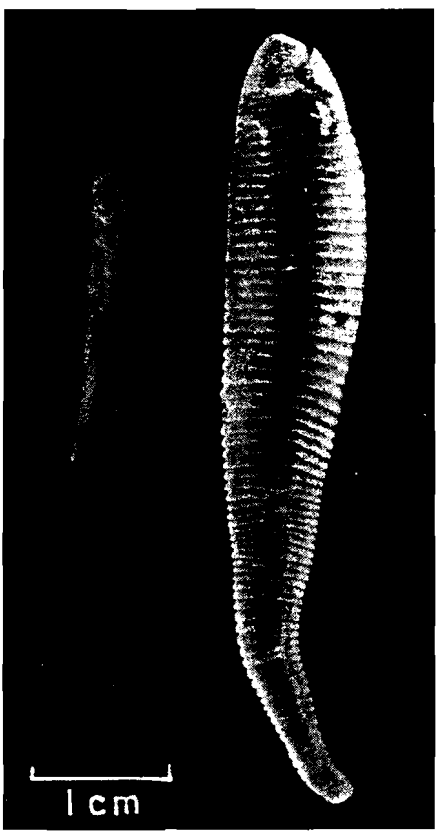

FIG. 16.1. *Linguatula serrata. (Left)* Male. *(Right)* Female. (Courtesy of A. Fain, Institut de Médecine Tropicale Prince Léopold.)

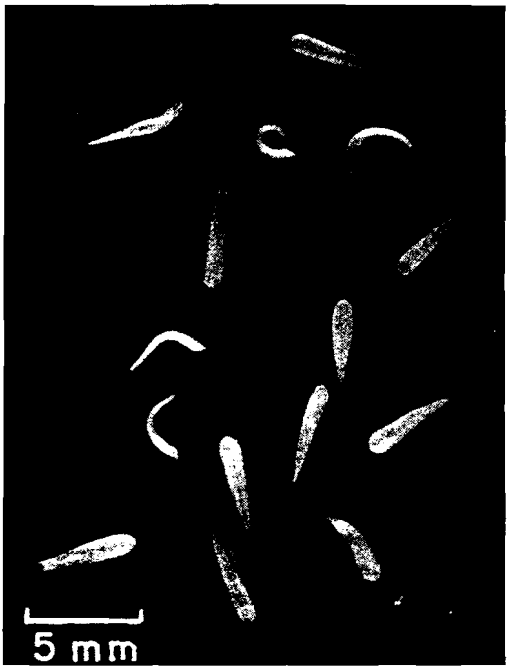

FIG. 16.2. *Linguatula serrata* nymphs. (Courtesy of A. Fain, Institut de Médecine Tropicale Prince Léopold.)

LIFE CYCLE

Eggs are expelled from the definitive host in the nasal mucus or are swallowed and passed in the feces (Hobmaier and Hobmaier 1940). When ingested by an intermediate host, they hatch in the intestine. The resultant larvae migrate to the internal organs, usually the mesenteric lymph nodes, and after about 6 months and nine molts, they develop into infective nymphs. These nymphs remain viable in

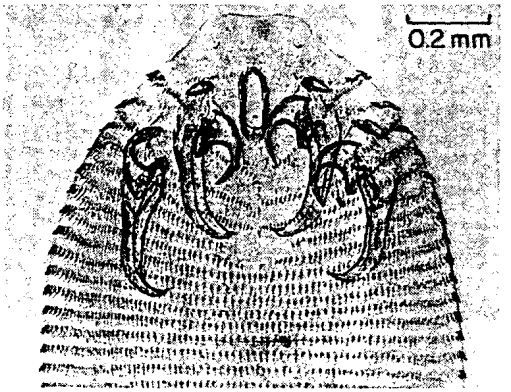

FIG. 16.3. *Linguatula serrata* nymph. Note spinous body rings and the two pairs of binate hooks. (Courtesy of A. Fain, Institut de Médecine Tropicale Prince Léopold.)

the intermediate host for over 2 years. The definitive host becomes infected by ingesting viscera containing the infective stage, but the method by which nymphs get to the nasal cavities is unknown. This may occur while contaminated food is being masticated or possibly later during emesis. Adults survive about 2 years in the definitive host. They feed on nasal mucus and secretions and occasionally on blood (Heymons 1942).

PATHOLOGIC EFFECTS

Usually there are no signs of infection, but a severe catarrhal or suppurative rhinitis and epistaxis sometimes occur (Enigk and Düwel 1957; Heymons 1942). Restlessness, sneezing, and difficult breathing are occasionally seen. The sense of smell is often reduced or abolished.

The nymph generally does not produce signs and is an incidental necropsy finding, appearing as a small fibrous or calcified tubercle in the viscera. A massive infection has caused peritonitis in an experimentally infected guinea pig (Koch 1907).

DIAGNOSIS

Diagnosis is based on clinical signs and the presence of *L. serrata* eggs in the feces or nasal mucus.

CONTROL

Newly acquired dogs showing signs of upper respiratory disease should be examined for this parasite. Infected dogs can be treated by spraying the nasal passages with an aerosol containing ascaridol (the active ingredient in chenopodium oil) (Enigk and Düwel 1957), or the parasites can be removed surgically (Olt and Ströse 1914).

There is no treatment for nymphal infections.

PUBLIC HEALTH CONSIDERATIONS

This parasite is not an important public health problem (Fain 1960). The nymph and, very rarely, the adults have been reported in man.

Porocephalus

Porocephalus crotali occurs in North and South America, *P. clavatus* occurs in South America, and *P. subulifer* is confined to tropical Africa (Fain 1961, 1966; Heymons 1935). *Porocephalus* nymphs are occasionally found in the viscera of some endothermal laboratory species. They are relatively benign parasites. Adults usually live in the lung of large snakes.

The *P. crotali* nymph has been found in deer mice and the cotton rat in the United States (Layne 1967; Self and McMurry 1948), and there is a doubtful record in a marmoset *(Saguinus)* (Heymons 1935). The nymph of *P. clavatus* has been reported from the common marmoset (Heymons 1935), from laboratory tamarins *(Saguinus nigricollis)* in the United States (Cosgrove, Nelson, and Gengozian 1968; Nelson, Cosgrove, and Gengozian 1966), and, erroneously, from African primates and man (Fiennes 1967). The nymph of *P. subulifer* has been found in a guenon (Heymons 1935) and in a galago (Fain 1961), and nymphs of an unidentified species of *Porocephalus* have been recovered from a squirrel monkey (A. Fain, unpublished data).

The rat, mouse, and hamster have been experimentally infected with eggs of *P. crotali* (Esslinger 1962a, b), and the mouse, rat, and guinea pig have been experimentally infected with eggs of *P. clavatus* (da Fonseca 1939).

Porocephalus clavatus is apparently common in laboratory tamarins obtained from their natural habitat, and an incidence of 29% has been reported (Self and

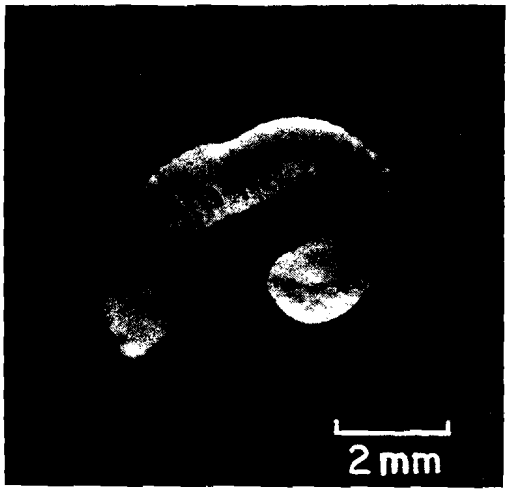

FIG. 16.4. *Porocephalus* nymph. (Courtesy of A. Fain, Institut de Médecine Tropicale Prince Léopold.)

Cosgrove 1968). The incidence of *P. crotali* and *P. subulifer* in laboratory specimens is unknown. They are not likely to be encountered except in some primates and wild rodents obtained from endemic areas.

MORPHOLOGY

The *Porocephalus* nymph has a cylindrical, smoothly annulated body which is often club shaped (Fig. 16.4) (Heymons 1935). Nymphs of *P. crotali* and *P. clavatus* are about 8 to 14 mm long; the nymph of *P. subulifer* is 7 to 15 mm long and 1.2 to 1.5 mm wide. Each nymph has approximately 30 to 45 annuli. Two unequal pairs of hooks are located at the anterior end around the mouth. The inner pair is simple; each of the outer hooks has an accessory spine. The adults are similar, only larger.

LIFE CYCLE

The life cycle resembles that of *Linguatula serrata* except that the adults occur in snakes instead of in the dog and other canids. Adults of *P. crotali* are common in rattlesnakes *(Crotalus)* and also occur in the cottonmouth water moccasin *(Ancistrodon piscivorus);* adults of *P. clavatus* occur in boas *(Boa, Epicrates* and *Eunectes);* and those of *P. subulifer* occur only in file snakes *(Mehelya)* (Fain 1961, 1966; Heymons 1935; Penn 1942; Self and McMurry 1948).

PATHOLOGIC EFFECTS

In deer mice and the cotton rat, the nymph locates in the viscera, mesentery, and abdominal and thoracic walls (Layne 1967). It produces no signs or serious pathology.

In primates, the nymph encysts in many tissues (Fig. 16.5, 16.6), including the liver, lungs, peritoneum, and meninges, but produces little or no injury (A. Fain, unpublished data; Nelson, Cosgrove, and Gengozian 1966). Inflammatory reaction is minimal (Fig. 16.7) unless the nymph dies; then a foreign body reaction and gradual resorption occur (Fig. 16.8).

DIAGNOSIS

Since this parasite usually does not produce signs or lesions, diagnosis is made by finding the nymph at necropsy.

CONTROL

No special procedures other than routine sanitation are necessary. The *Porocephalus* nymph can occur only in laboratory species permitted to ingest food contaminated with feces of infected snakes. There is no treatment.

PUBLIC HEALTH CONSIDERATIONS

Porocephalus is of no known public health importance. All reports of the nymph in man are of doubtful validity (Fain 1960).

Armillifer armillatus

This relatively benign parasite occurs naturally only in tropical Africa, where it is common. The nymphs develop in various endothermal species and are frequently found in the rhesus monkey, other macaques, galagos, guenons, mangabeys, baboons, the chimpanzee, dog, and man (Fain 1960, 1961, 1966; Fiennes 1967; Heymons 1935). There is a report of the occurrence of the nymphs in a New World monkey, a capuchin, from a European zoo (Desportes and Roth 1943), but this infection was probably acquired in the zoo. Adults of *Armillifer armillatus* live in the lung of large snakes.

The incidence of *A. armillatus* in lab-

FIG. 16.5. *Porocephalus clavatus* nymphs *(arrows)* in the liver and lungs of a tamarin *(Saguinus nigricollis)*. (From Nelson, Cosgrove, and Gengozian 1966. Courtesy of American Association for Laboratory Animal Science.)

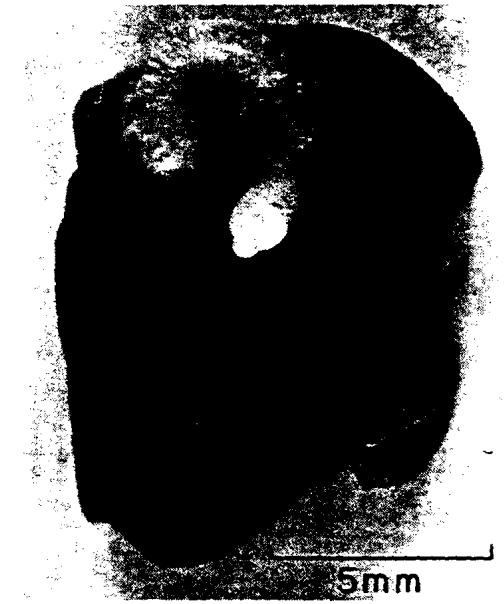

FIG. 16.6. *Porocephalus* nymph on the liver of a squirrel monkey. (Courtesy of A. Fain, Institut de Médecine Tropicale Prince Léopold.)

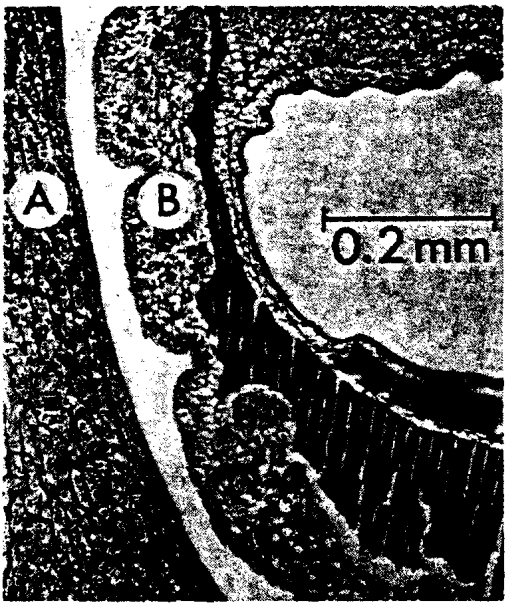

FIG. 16.7. Histologic section of encysted *Porocephalus clavatus* nymph in the liver of a tamarin. *(A)* Liver tissue. *(B)* Parasite. Note absence of inflammation. (From Nelson, Cosgrove, and Gengozian 1966. Courtesy of Ameri-

FIG. 16.8. Histologic section of the liver of a tamarin containing degenerating *Porocephalus clavatus* nymph. Note inflammatory reaction. (From Nelson, Cosgrove, and Gengozian 1966. Courtesy of American Association for Laboratory Animal Science.)

oratory specimens is unknown. It is not likely to be encountered except in primates obtained from tropical Africa.

MORPHOLOGY

The nymphs have a cylindrical, annulated body about 13 to 23 mm long (Fig. 16.9) (Fain 1961). The annuli are thick and projecting, and their number varies from 15 to 19 in the male nymph and from 18 to 22 in the female nymph. The hooks are simple. Adults closely resemble the nymphs but are larger.

LIFE CYCLE

The adults live in the lung of large African snakes *(Python, Bitis)* (Broden and Rodhain 1907, 1908–1909, 1910). The intermediate host becomes infected by swallowing food contaminated by snake feces or saliva.

PATHOLOGIC EFFECTS

Encysted nymphs are commonly found in the peritoneal cavity (Fig. 16.10) (Fain

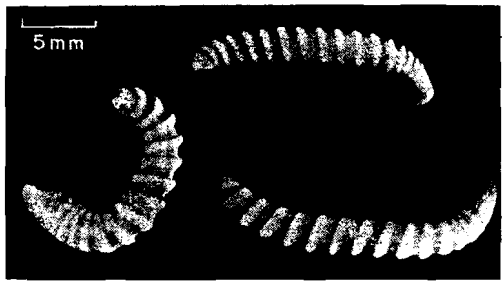

FIG. 16.9. *Armillifer armillatus* nymphs. (From Fain 1961. Courtesy of Musée royal de l'Afrique Centrale.)

1961). Often they are located beneath the capsule or are embedded in the superficial layers of the liver. They usually cause little or no reaction in the host even at high levels of infection, but there is one report of peritonitis and death caused by *Armillifer* nymphs in 7 of 24 laboratory mangabeys (Whitney and Kruckenberg 1967).

DIAGNOSIS

Diagnosis is based on finding nymphs at necropsy.

FIG. 16.10. *Armillifer armillatus* nymphs encysted in the omentum of a green monkey. (From Fain 1961. Courtesy of Musée royal de l'Afrique Centrale.)

CONTROL

Other than routine sanitation, no special control procedures are necessary. Infection can only occur if laboratory species are permitted to ingest eggs passed in the feces or saliva of infected snakes. There is no treatment.

PUBLIC HEALTH CONSIDERATIONS

In some parts of tropical Africa man is frequently infected (Bouckaert and Fain 1959; Cannon 1942), but the parasite in endothermal laboratory species is of no public health importance. Man can only be infected by ingesting eggs passed in snake feces or saliva.

TABLE 16.1. Pentastomids affecting endothermal laboratory animals

Parasite	Geographic Distribution	Endothermal Host	Location in Host	Method of Infection	Incidence		Pathologic Effects	Public Health Importance	Reference
					In nature	In laboratory			
*Linguatula serrata**	Worldwide	Definitive: dog, other canids, domestic animals, man Intermediate: rat, black rat, guinea pig, rabbit, cat, titi monkey, gelada baboon, domestic animals, man	Adult: nasal cavity Nymph: mesenteric lymph nodes, viscera	Definitive: ingestion of encysted nymphs in viscera of intermediate host Intermediate: ingestion of eggs passed by definitive host	Common in dog in eastern Europe; rare in rat, rabbit, cat, titi monkey	Unknown; probably rare	Usually none; sometimes rhinitis, epistaxis, restlessness, sneezing, dyspnea in dog; tubercles in viscera in rat, rabbit, cat	Rare in man	Bochefontaine 1876 Enigk and Duwel 1957 Heymons 1942 Hobmaier and Hobmaier 1940 Kuntz et al. 1967 Strong et al. 1926
*Porocephalus crotali**	North America, South America	Intermediate: deer mice, cotton rat	Viscera, mesentery, abdominal wall, thoracic wall	Ingestion of eggs passed by definitive host (pit vipers)	Common in some areas; uncommon in others	Unknown	Benign cysts in viscera, mesentery, abdominal wall, thoracic wall	None	Layne 1967 Self and McMurry 1948
*Porocephalus clavatus**	South America	Intermediate: tamarins, marmosets	Liver, lungs, peritoneum, meninges, other tissues	Ingestion of eggs passed by definitive host (boas, other large snakes)	Unknown	Common in tamarins, marmosets obtained from natural habitat	Benign cysts in liver, lungs, peritoneum, meninges, other tissues	None	Cosgrove et al. 1968 Heymons 1935 Nelson et al. 1966 Self and Cosgrove 1968
*Porocephalus subulifer**	Tropical Africa	Intermediate: guenons, galagos	Viscera	Ingestion of eggs passed by definitive host (file snakes)	Unknown	Unknown	Benign cysts in viscera	None	Fain 1961 Heymons 1935
Porocephalus sp.*	South America	Intermediate: squirrel monkeys	Liver	Unknown; presumably by ingestion of eggs passed by definitive host	Unknown	Unknown	Benign cysts in viscera	Unknown	A. Fain, unpublished data

*Discussed in text.

TABLE 16.1 *(continued)*

Parasite	Geographic Distribution	Endothermal Host	Location in Host	Method of Infection	Incidence		Pathologic Effects	Public Health Importance	Reference
					In nature	In laboratory			
Gigliolella brumpti	Madagascar	Intermediate: lemur ape *(Cheirogaleus medius)*	Mesentery	Unknown; presumably by ingestion of eggs passed by definitive host	Unknown	Unknown	Benign cysts in mesentery	None	Chabaud and Choquet 1954
*Armillifer armillatus**	Tropical Africa	Intermediate: dog, monkey, other macaques, galagos, guenons, mangabeys, baboons, chimpanzee, man	Peritoneal cavity	Ingestion of eggs passed by definitive host (pythons, vipers)	Common	Unknown	Usually benign cysts in peritoneal cavity; rarely peritonitis, death	Common in man in endemic areas; infected endothermal laboratory animals cannot infect man	Desportes and Roth 1945 Fain 1960, 1961 Fiennes 1967 Heymons 1935 Whitney and Kruckenberg 1967
Armillifer moniliformis	Asia, Australia	Intermediate: various mammals, possibly dog, cat, cynomolgus monkey, man	Viscera, peritoneal cavity	Ingestion of eggs passed by definitive host (pythons)	Unknown	Unknown	Unknown	Rare in man	Fain 1966 Worms 1967 Yamashita and Ohbayashi 1954

*Discussed in text.

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