THE LIFE-STORY OF "TUA CHID" (GNATHOSTOMA SPINIGERUM OWEN).[1]

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It is a great honour to be invited by this Section of the Thailand Research Society to address its members on the life-story or life-cycle of Gnathostoma spinigerum (Tua Chid = ตัวจ๊ิด), which is the common parasitic round worm of human beings as well as animals of this country and of her neighbours. An adult Gnathostoma spinigerum was first discovered and named by a British worker, Richard Owen in 1836, who discovered the worm causing a tumour in a tiger's stomach. It has been then reported by many workers in various animals such as leopards, wild cats and dogs, minks and pigs from India, Malay States, China, Japan and Australia. Dr. Luang Chalerm (C. Prommas) and I of the Department of Pathology, Siriraj Hospital, Chulalankarana University, (1933), also found that about 25% of cats and dogs examined in Thailand have the adult worms in their stomachs in nature.

There have been up to the present, 25 human cases reported in the medical literature, 16 of which from Thailand (Levinsen 1889, Leiper 1909, Robert 1922, C. Prommas and S. Daengsvang 1934, C. Rhithibaed and S. Daengsvang 1937, S. Daengsvang 1939); one from Malay States (Samy 1918); 3 from China (Tamura 1921, Morishita and Faust 1925); one from Japan (Morishita 1924) and 5 from India (Maplestone 1929, 1931 and 1937, Datta and Maplestone 1930, Maplestone and Sundar 1939). However there are still many more unreported cases in the records of Siriraj Hospital.

There are two species of Gnathostome found in human beings; one is Gnathostoma spinigerum and the other is Gnathostoma hispidum; the former is commonly found in Thailand, India China and Malay States and the latter has only once been reported from

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Japan. The adult worm has been found in various parts of the human body outside the digestive tract, i. e., face, eyes, mouth, breast, respiratory tract, birth canal, urinary organ, arm, leg, etc. It causes some mild—and also severe discomfort, especially localized temporary and migratory swelling associated with more or less pain and a mild degree of itching, as well as signs of localized inflammation. It is with deep regret to say that two cases of blindness, resulting from the migration of this worm into the eyes, have been seen at Siriraj Hospital. One case of intestinal obstruction, treated at Siriraj Hospital about two years ago, was also caused by this parasitic worm.

In an animal the adult worm has been found causing localized swelling with long standing inflammation and perforation of the digestive tract and sometimes the infested animals may die on account of the damage done by worms.

Zoologically the worm has been classified as follows:—

Phylum	—	Nemathelminthes
Class	—	Nematoda
Order	—	Filarioidea
Family	—	Gnathostomidae
Genus	—	Gnathostoma
Species	—	Gnathostoma spinigerum
		Gnathostoma hispidum

Morphology of Gnathostoma spinigerum

The Adult worm has been accurately described by previous workers as follows:—The body is cylindrical in shape and is more or less tapering at both ends. It is reddish in colour and slightly transparent with a globular cephalic swelling or head separated from the rest of the body by a cervical constriction. The head bears two large fleshy lips that guard its mouth which opens directly into the large and long muscular esophagus, which is enlarged posteriorly. This is followed by the intestine, which opens posteriorly into a subterminal anal pore. Four large club-shaped contractile cervical secretory glands are seen symmetrically within the body cavity around the esophagus and their ducts fuse in pairs on either side of the head to open into a common duct that perforates the adjacent lip.

The skin or an outer surface of the worm is transversely wrinkled and provided with leaflike spines, which are aboundantly seen in the region immediately behind the cervical constriction and become less conspicuous toward the midddle part. The skin of the cephalic bulb or the head is covered with eight rows of single pointed spines. The anterior—most body spines have three sharp terminal points while the posterior—most ones are narrow and have only a single point. The posterior part of the body shows no definite spines and its skin is entirely smooth in Gnathostoma spinigerum but the spines can be easily seen as far as the post end of the body in Gnathostoma hispidum (Japanese Gnathostome).

The adult male measures about 11 to 25 mm. in length and 1—1.5 mm. in breadth and is slightly smaller and shorter than the adult female, which is about 25—54 mm. in length and 1.5 to 2.0 mm. in breadth. The male specimen can also be recognized by the presence of a cuticular expansion at its posterior end with four pairs of papillae around the cloasa. There are two unequal spicules or penis at its posterior end. Other parts of the male genital organ consist of testis, collecting tubule and an ejaculatory duct which opens posteriorly into the cloaca.

The female specimen has a tapering posterior end and is without cuticular expansion. The vulva is at a short distance behind the center of the body from which a short tubular vagina arises, which is then divided into two long small uterine tubes and ovaries. These organs are coiled back and forth in the body cavity of the worm. Many young and old ova may be easily seen in the female genital organ.

The Life-Story.

One cannot tell the method by which the definite host such as animal or man may get the infestation of the worm, unless its life-story or life-cycle has been thoroughly worked out. Since Richard Owen had discovered this worm in 1836, some workers from India China, Japan and Australia had suggested and tried various ways to prove its life-story and methods of transmission. But none of them could satisfactorily elucidate the problem. Chandler (1925) in India

discovered the larvae of the worm in the mesentery of snakes (Rock Python or Python reticulatus ; King cobra or Naja bungarus ; and the common cobras or Naja tripudians). However he was not quite certain that they were the larvae of Gnathostoma spinigarum since he could not make them develop into an adult stage one month after feeding to a cat which is the definite host of adult Gnathostoma spinigerum.

Heydon 1929 in Australia was the first to show that, the eggs of Gnathostoma spinigerum could develop into free-living small embryos and each with a voluminous thin sheath. This worker also failed to grow them into an adult stage in cats.

Dr. Luang Chalerm (C. Prommas) and I were very much interested in the subject and attempted to investigate its problem in 1932 after thoroughly studied findings and suggestions of previous workers from available literature. Fortunately we were able to demonstrate successfully for the first time the complete life-story or life-cycle and methods of transmission of the worm in 1936 as follows :—

Human beings, cats and dogs in Thailand are the definite hosts of Gnathostoma spinigerum in which the adult worm is found. The worm is normally found in the stomach wall of the animal and the female lays eggs, almost all of which are in a one or two-cell stage, into the lumen of the digestive tract and are then passed out with the animal's stool. The egg is oval in shape with greenish transparent egg-shell and has a knob or plug at one pole. Its average size is 68.7 microns in length and 36.7 microns in width. The egg after being kept in a small amount of water at room temperature for about 8–10 days develops into an embryonated one and a few days later, the embryo normally comes out through the knob of the egg-shell. Let me call this newly hatched young worm or larva—"the first larval stage" which cannot be seen by naked eyes. But under microscopic examination it is measured 265.2 microns in length and 15.8 microns in diameter and its structure is entirely different from that of the adult worm. It is cylindrical in shape and enclosed by a thin smooth voluminous sheath. The skin or body cuticle is also smooth and shows no visible striae. The anterior extremity is

rounded and armed with a minute solid spine-like structure, while the posterior end is more pointed. A rudimentary digestive tract, surrounded by rows of granular cells, is markedly observed. This first-stage larva dies within 48 to 72 hours if kept in tap water at room temperature (about 25° c.); but it can live indefinitely and undergo further development to a certain extent only after being eaten by a cyclop which is a fresh-water crustacean. Soon after being eaten the larva loses its sheath and then pierces through the cyclop's stomach wall into the body space where the young worm lives happily and presumably on the expense of the cyclop. It is measured 372.5 microns in length and 61.6 microns in diameter at 14 days of age and is now called the second larval stage. The smooth cuticle is now becoming transversely striated and at about its anterior fourth is covered with transverse rows of minute rudimentary spines. The head or cephalic bulb is definitely seen with four transverse rows of many singlepointed spines. The digestive tract is also fully formed together with two pairs of contractile cervical sacs in its anterior half. A germinal body or primitive sexual organ is also seen in the middle part of the body as a small group of cells. Once the larva has attained the above size and structure it shows no further change, even when kept in the cyclop's body space up to one month. The movement is at first very active then gradually diminishes as it becomes older and finally almost ceases with the exception of the occasional slow motion of its head; but it can be stimulated to move actively again by 0.4% solution of hydrochloric acid or a solution of gastric juice. The development of this second larval stage in the cyclop has also been confirmed by Prof. Sadao Yoshida of Osaka Imperial University, Japan, in 1934. This second larval stage must be taken up by some species of fresh-water fish, frogs, eels, snakes, etc. in order to make any further change up to the third stage larva or the stage that may be able to infect the normal host, cats, dogs or human beings. We have experimentally discovered that Pla Dook (ปลาดุก) (Clarius batrachus-Linnaeus) and Pla Chon (ปลาช่อน) (Ophicephalus striatus-Bloch) are the second intermediate hosts; in these the third larval stage can develop and encyst in the flesh and in visceral organs within 10–14 days and then wait for a chance to be eaten

again by the definite host in order to develop into an adult worm. The larva of the third stage is slightly larger and longer than the larva of the 2nd stage and can be easily seen by naked eyes. Our experimental development of the 3rd larval stage in the flesh of the fresh-water fish has also been confirmed by the work of Dr. C. M. Africa and co-workers of the University of Philippines in 1936; the encysted Gnathostome larvae were found in nature in 25 per cent of Pla Chon (ปลาช่อน) (Ophicephalus striatus,) 100 per cent of Glossogobius and 12.6 per cent of Therapon argenteus. Dr. Pradit Tansurat and I in 1938 also found that 30% of Pla Dook (ปลาดุก) (Clarias batrachus), 37.5% of Pla Chon (Ophicephalus striatus), 80% of eels (Monopterus albus), and 91.67% of frogs (Rana rugulosa) bought from Ban Kamin and Ta Tien markets, and 3 unidentified species of aquatic snakes caught at the Siriraj Hospital ground were positive for ensysted larvae, or the third larval stage in nature. The development of the adult worm takes place about 6½ months after the living larva of the third stage has been eaten by an animal or human being.

Dr. Pradit Tansurat of the Department of Pathology has lately shown that some larvae of the third stage could be found living in Som-Fuk of 7 days old. Som-Fuk is mainly made of raw flesh of fresh-water fish, cooked rice, pepper and garlic and then wrapped up in a piece of banana leaf. It is usually eaten raw about two days after being subjected to the above preparation. Thus there is no doubt that one who eats Som-Fuk, especially in the raw condition, does sometimes ingest the third larval stage of the worm with it.

Protection Measures.

I also have recently found that the living larva of the third stage in the flesh of the fresh water fish etc. could be killed by being treated at least 5 minutes in boiling water; but it may take a little longer time, if the piece of fish muscle in which it lives is very thick. Cold has no effect whatever on the larvae, even when kept in the temperature of 4°c. for one month. Vinegar can kill almost all the third stage larvae only after being left for at least 5½ hours, but they are found living after being treated with lime-juice for 93 hours, at room-temperature. Therefore one must bear in mind that only boiling heat

Fig. 1

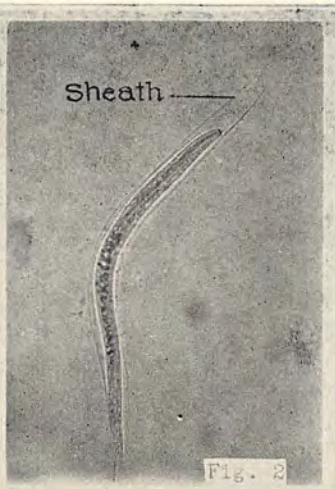


Fig. 2

Fig. 3

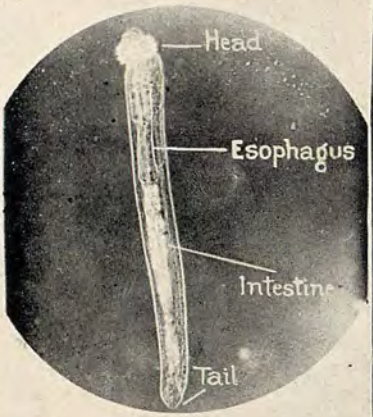


Fig. 4

Fig. 5

Fig. 6

Fig. 1 Microphotograph of ova of Tua Chid (Gnathostoma spinigerum).

Fig. 2 Microphotograph of a newly hatched embryo or the first larval stage of Tua Chid.

Fig. 3 Microphotograph of the larvae of the second stage in a cyclop's body space.

Fig. 4 Microphotograph of a larva of the second stage showing the development of striations of the cuticle, a cephalic bulb with four transverse rows of spines and a pair of lips, cervical sacs and an alimentary system.

Fig. 5 Microphotograph of an encysted third stage larva found in the body muscle of Pla dook = ปลาดุก (Clarius batrachus-Linnaeus). The actual size of the cyst = 1.14 mm. in diameter).

Fig. 6 Microphotograph of the third stage larva dissected out from the cyst wall. (The actual size of the larva = 2.70×0.29 mm).

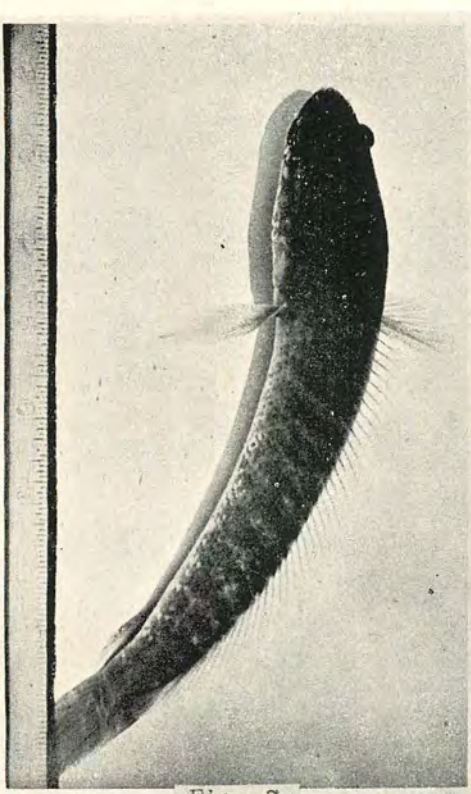


Fig. 7a

Fig. 7b

Fig. 7c

Fig. 7a. Pla chon = ปลาช่อน (Ophicephalus striatus-Bloch).
Fig. 7b. A frog (Rana rugulosa).
Fig. 7c. Pla dook = ปลาดุก (Clarius batrachus-Linnaens).

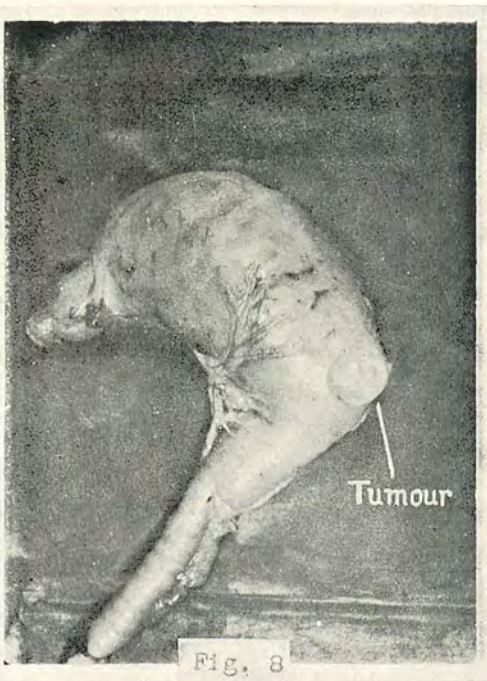


Fig. 8

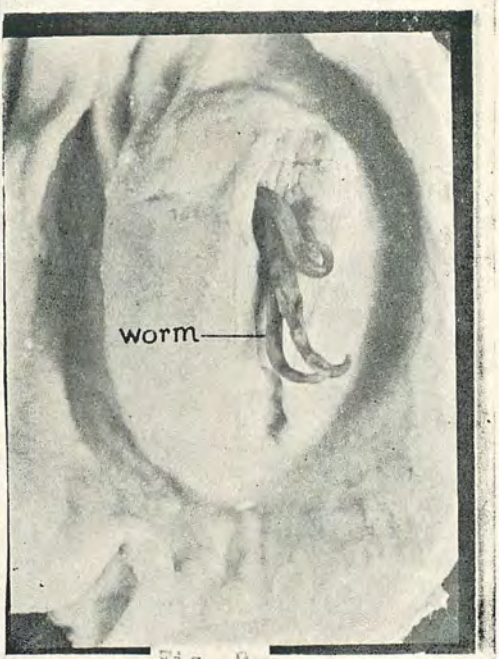


Fig. 9

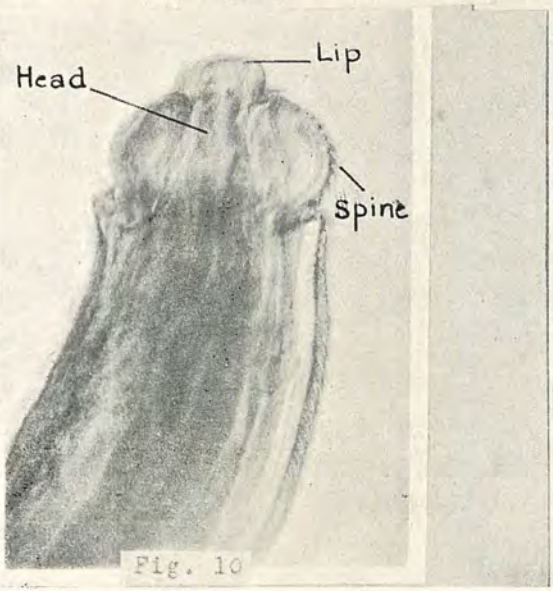


Fig. 10

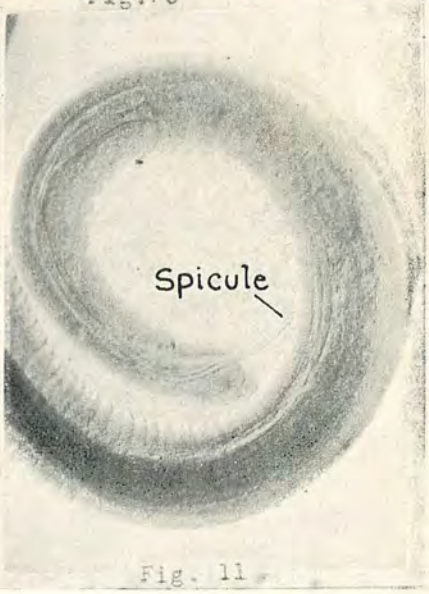


Fig. 11

Fig. 8 The stomach of a cat showing Gnathostome tumour protruding outward. (The actual size of the tumor $2.6 \times 2. \times 1.$ cm.).

Fig. 9 The same stomach as fig. 8, after dissection showing three protuding adult Tua Chid.

Fig. 10 Microphotograph of the anterior end of an adult Tua Chid showing spines, lips, head, neck and anterior part of the body.

Fig. 11 Microphotograph of the posterier end of an adult male Tua Chid showing spicules.

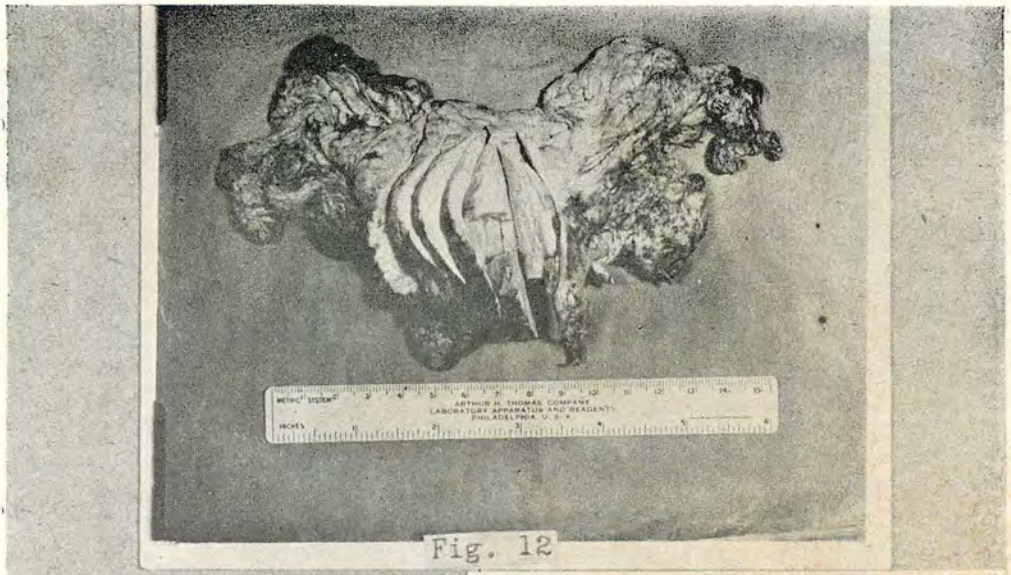


Fig. 12

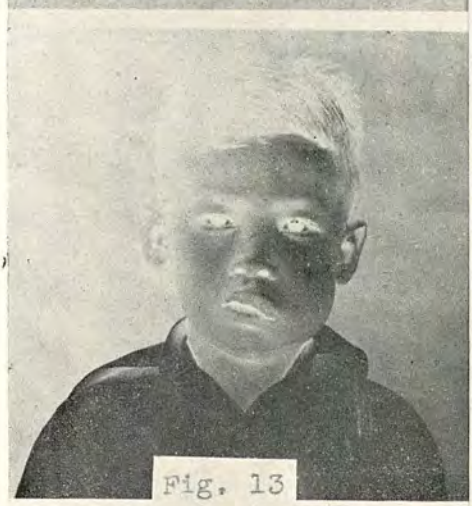


Fig. 13

Fig.14

Fig. 12 A human intra-peritoneal tumour caused by an adult Tua Chid. The tumour was removed from a case of intestinal obstruction.

Fig. 13 A case of Gnathostomiasis of the face.

Fig. 14 A case of ocular Gnathostomiasis.

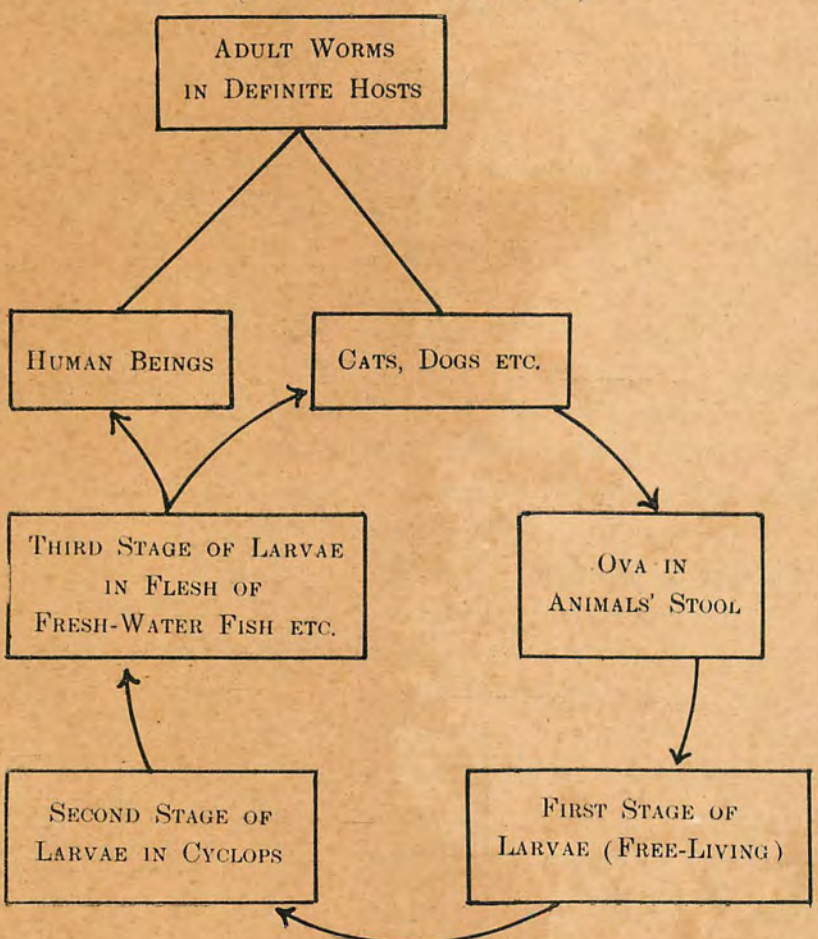
can be relied upon to kill within a short time the third stage larvae of gnathostome in the muscles of the second intermediate host.

Finally I want to emphasize that only the living third stage larvae, which inhabit the fresh-water fish, frogs, eels, etc., are able to develop into adult gnathostomes after being ingested by human beings and certain animals and then after a certain period cause various symptoms in the infested hosts as already described. The other forms of this parasitic worm cannot develop into the adult stage and therefore do not cause the disease in the definite host.

Permit me to summarize the life-story or life-cycle of Tua Chid in a form of diagram as follow :—

DIAGRAM SHOWING THE LIFE-STORY OF "TUA CHID"

(GNATHOSTOMA SPINIGERUM.)



References Cited.

AFRICA, C. M., REFUERZO, P. G. and GARCIA, E. Y. (1936 a). Observations on the life cycle of Gnathostoma spinigerum. Philipp.
Journ. Sci. 59,513.

AFRICA, C. M., REFUERZO, P. G. and GARCIA, E. Y. (1936 b). Further observations on the life cycle of Gnathostoma spinigerum. Ibid ; 61,221.

Chandler, Asc. C. (1925) A contribution to the life-history of a Gnathostome. Parasitology. No. 3, August 1925. p. 237.

Daengsvang, S. (1939) An abdominal tumour caused by Gnathostoma spinigerum (Owen 1836). Indian. Med. Gaz. Vol. LXXIV, No. 7, July 1939.

Daengsvang, S. and Tansurat, P. (1938)
A contribution to the knowledge of the second intermediate hosts of Gnathostoma spinigerum (Owen 1836). Ann. Trop. Med. and Parasit. Vol. 32, No. 2, August 2, 1938.

Datta, S. and Maplestone, P. A. (1930).
Infection by a Gnathostome simulating Mastoiditis.
Indian Med. Gaz. Vol. LXV, p. 314.

Levinsen, G. M. R. (1889) Om en ny Rundorm hos mennesket Cheiracanthus siamensis N. sp. Vidensk. Meddel. fra Naturh. FOREN. i. Kjbenhaven. f. 1889 p. 323.

Leiper, R. T. (1909) The structure and relation-ship of Gnathostoma siamense (Levinsen) Parasitology, Vol. II. p. 77.

Maplestone, P. A. (1929). A case of Human infection with a Gnathostome in India. Indian Med. Gaz. Vol. LXIV, p. 610.

Maplestone, P. A. (1931). Annual report of the Calcutta School of Tropicial Medicine for 1931.

Maplestone. P. A. 1937. Gnathostomiasis in human beings. Indian Med. Gaz. Vol. LXXII p. 713. Dec. 1937.

Maplestone, P. A. and Sundar (1939). A case of Gnathostomiasis with some interesting features. Indian. Med. Gaz. August 1939. p. 479.

Morishita K. O. R. and Faust, E. C. (1925).
Two new cases of human creeping disease (Gnathostomiasis) in China, with a note on the infection in Reservoir hosts in the China areas. Jour. Parsit. Vol. XI. p. 158.

Morishita, K. O. R. (1924). A pig nematode Gnathostoma hispidum Fedchenko as a human parasite. Ann. Trop. Med. and Parasit. Vol. XVIII, p. 23.

Prommas, C. and Deangsvang, S. (1933).
Preliminary report of a study of the life cycle of Gnathostoma spinigerum. The Jour. Parasitology. June 1933. Vol. XIX, No. 4.

Prommas, C. and Daengsvang, S. (1934).
Nine cases of human gnathostomiasis Indian Med. Gaz. Vol. LXIX, No. 4. April 1934, p. 207.

Prommas, C. and Daengsvang, S. (1936).
Further report of a study on the life cycle of Gnathostoma spinigerum. The Jour. Parasit. Vol. 22, No. 2. April 1936.

Prommas, C. and Daengsvang, S. (1937).
Feeding experiments on cats with Gnathostoma spinigerum larvae obtained from the second intermediate host. The Jour. Parasit. Vol. 23, No. 1. Feb. 1937.

Robert, P. L. (1922) La Gnathostomose Humaine oedeme Ambulant Siamois du a Gnathostomum Spinigerum (R. Owen 1836) Bull. Soc. Path. Exot. Vol. XV, p. 854.

Samy, P. C. (1918) Gnathostomum Siamense or Gnathostoma spinigerum (Owen) Indian. Med. Gaz. Vol. LIII, p. 436.

Tamura, H. (1921) On Creeping disease. Brit. Jour. Dermat. and Syph. Vol XXXIII, p. 81.

Yoshida. S, 1934. Contribution to the study on Gnathostoma spinigerum (Owen 1836), Cause of esophageal tumour in the Japanese mink, with especial reference to its history. Trans. Ninth. Congress Far East. Assoc. Trop. Med. Nanking. Vol. I, p. 625-630.

ประดิษฐ ตัณสุรัตน์ (พ. ศ. ๒๔๘๑) อาหารบางอย่างที่นำโรคพยาธิตัวจี๊ด (Gnathostoma spinigerum) มาสู่คน จดหมายเหตุทางแพทย์ของแพทยสมาคมแห่ง

ประเทศไทย เล่ม ๒๑ ตอน ๔ มกราคม พ. ศ. ๒๔๘๑ หน้า ๕๗๐.

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