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Occurrence of Asian tapeworm *Bothriocephalus acheilognathi* (Yamaguti, 1934) in aquaculture systems of North East Hill region of India

SUNILA THAPA[1] and SANJAY KUMAR DAS[2]

ICAR Research Complex for NEH Region, Umiam, Barapani, Meghalaya 793 103 India

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The North East region of India comprising of Arunachal Pradesh, Asom, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura are blessed with rich biodiversity and fisheries resources. In semi-intensive aquaculture, fish sometimes suffer from various diseases resulting in large scale mortality of farmed fish. The Asian tapeworm *Bothriocephalus acheilognathi* is an important parasite in aquaculture in Asia and Europe. It causes great economic losses in fish hatcheries and fish farms. We recently encountered an Asian tapeworm, *Bothriocephalus acheilognathi* in the intestine of pond reared grass carp (*Ctenopharyngodon idella)* in Meghalaya. This is the first report on occurrence of *Bothriocephalus acheilognathi* in farmed fish under mid hill condition.

Among all the cultured species, silver carp (*Hypopthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella)* and common carp (*Cyprinus carpio*) perform better in composite culture system in the mid altitude conditions. With increasing intensification of fish culture, there is increasing number of recognized infectious diseases due to the changing climate. Therefore, research on the pathogenesis and pathology of these diseases, their prevention and control has become essentially required. The Asian tapeworm *Bothriocephalus acheilognathi* is an important pathogen in aquaculture in Asia and Europe (Bauer *et al.* 1981, Heckmann *et al.* 2009) . The *Bothriocephalus* species infects a wide variety of freshwater fishes worldwide causing great economic losses in fish hatcheries and fish farms. The tapeworm, *Bothriocephalus acheilognathi* (Cestoda: Bothriocephalidea), is the most important pathogenic cestode of cyprinid fish (Woodland 1924), which causes bothriocephalosis and is one of the most dangerous helminth parasites of cultured carps (Bauer *et al.* 1977, Molnar and Murai 1973).

In 1924, Woodland recorded *Bothriocephalus pycnomerus* from the freshwater fish, *Ophiocephalus marulius*. Pool and Chubb (1985) reported the occurrence of another interesting form of *Bothriocephalus ganapatii* from the present host, Grass carp (*Ctenopharyngodon idella).* The species is listed as a 'Pathogen of Regional Concern' by the US Fish and Wildlife Service in 2010. The parasite requires only a couple of weeks to complete its development in the intermediate host (Korting 1975). *B. acheilognathi* may cause severe damage to the intestinal tract, physiological disturbance, reduced growth, condition loss and death. Heavy tapeworm burden causes blockage of the intestine and severe pathological changes, leading to reduced growth, condition and survival (Scholz 1997, Granath and Esch 1983, Hansen *et al.* 2006, Hoole and Nissan 1994).

B. acheilognathi which is indigenous to East Asia has been reported under more than 20 different specific names and the most frequently used are *Bothriocephalus gowkongensis* (Yeh 1955) and *Bothriocephalus opsariichthydis* (Yamaguti 1959, Woodland 1924). According to Pool and Chubb (1985) and Pool (1987), all descriptions of *Bothriocephalus* tapeworms from the cyprinid hosts represent the same parasite, the worm.

Previous light microscopic studies have described the general morphological features of *B. acheilognathi* (Molnar and Murai 1973, Yamaguti 1934, Yeh 1955), but very less work has been done on the ultrastructural studies of this species. In this study, scanning electron microscopy was used to study the scolex and tegument of immature, mature and gravid segments of *B. acheilognathi.*

Out of 22 grass carps examined from the fish farm of ICAR NEH Region, Barapani, Meghalaya only 2 hosts were found infected with 5 cestode parasites recovered from the intestine. The guts of infected fishes were removed and the recovered parasites were first stretched and relaxed in warm water before gently flattening them between a slide and a cover glass and fixed overnight in 70% ethyl alcohol. A few worms were fixed in neutral buffered formalin (NBF) for SEM studies. The selected specimens were rinsed in 0.65% saline solution, fixed overnight in 3% glutaraldehyde and kept in 0.1 M sodium cacodylate buffer (pH 7.1). They were again transferred for buffer rinse (15 min) and dehydrated in ascending grades of acetone. Specimens were critical-point dried, processed in TMS (tetra methyl silane)

Present address: [1]skdas01@yahoo.com.

for 15 min. Later mounted on aluminium stubs with double-stick cellophane tape, sputter-coated with gold to view under a JEOL JSM - 6360 VP scanning electron microscope at accelerating electron voltage ranging between 10–20 KV.

The tapeworm is identified as *Bothriocephalus acheilognathi* based on morphological characters (Fig.1A) such as presence of arrowhead or heart shaped, fleshy scolex with its anterolaterally directed narrow slit like openings which is unique among *Bothriocephalus* spp. The anterior portion of *Bothriocephalus acheilognathi,* when viewed in SEM, is composed of heart-shaped scolex with pear-shaped bothria (Fig. 1B). The outer portion of the scolex tegument is composed of uniformly and densely placed microtriches which are distinct from those of strobila. Presence of numerous dome-shaped tumuli which are densely and uniformly spaced in the scolex region (Fig 1C, D) were also observed. No other surface structures were observed in association with the tumuli. Tumuli were less numerous on immature segments (Fig. 1E) and were entirely absent in matured and gravid proglottids (Fig. 1F). The dome-shaped tumuli are uniformly spaced on the surface of the scolex of *B. acheilognathi*. The distribution of tumuli varies greatly among scolex, immature, mature and gravid segments of *B. acheilognathi*, the structure being most dense on the scolex, fewer in number on immature segments, and completely absent from mature and gravid proglottids. The functional significance of tumuli has not been elucidated, so it is difficult to explain the distribution of these structures along the strobila. Sofi and Fayaz (2012) used both scanning electron microscopy (SEM) and transmission electron microscopy (TEM) to study the scolex and tegument of immature, mature, and gravid forms of *Bothriocephalus acheilognathi* (Yamaguti 1934) from *Schizothorax* species of Kashmir. They also reported the occurrence of large number of tumuli in the scolex tegument and very less number of tumuli in the mature and gravid tegument of the worms.

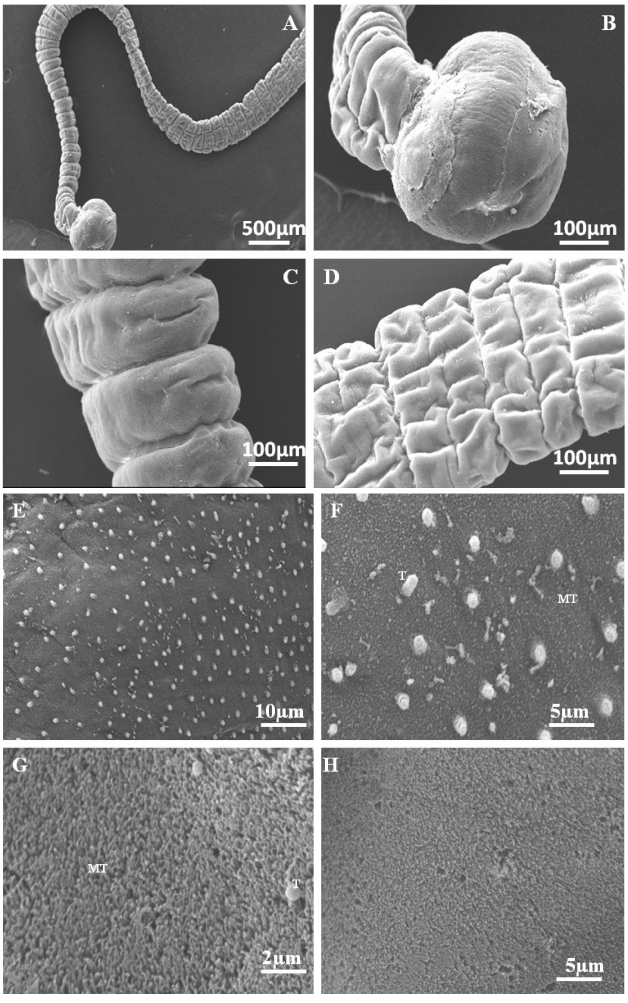

Fig. 1 (A-H). **A.** Entire worm. **B.** Enlarged view of the scolex. **C.** Enlarged view of the mature segment. **D.** Enlarged view of the gravid segment. **E.** Scolex tegument showing numerous scattered tumuli (T). **F.** Enlarged view of the scolex tegument showing microtriches (MT) and tumuli (T). **G.** Tegument of immature segment showing less number of tumuli (T). **H.** Tegument of mature segment showing absence of tumuli (T).

The occurrence of the cestode i.e. the Asian fish tapeworm *Bothriocephalus acheilognathi* from the host fish grass carp, *Ctenopharyngodon idella* is in fact the first report of the parasite from this region. The impact of this parasite on the diversity and health of fish hosts remains unknown, but further studies are needed to assess the distribution and impact of this parasite in the fish hosts of this region. The pathogenic nature of this parasite and its capacity to spread quickly needs routine monitoring for its presence. A thorough study on the fishes of this region would reveal many hitherto helminth parasites from the fish hosts.

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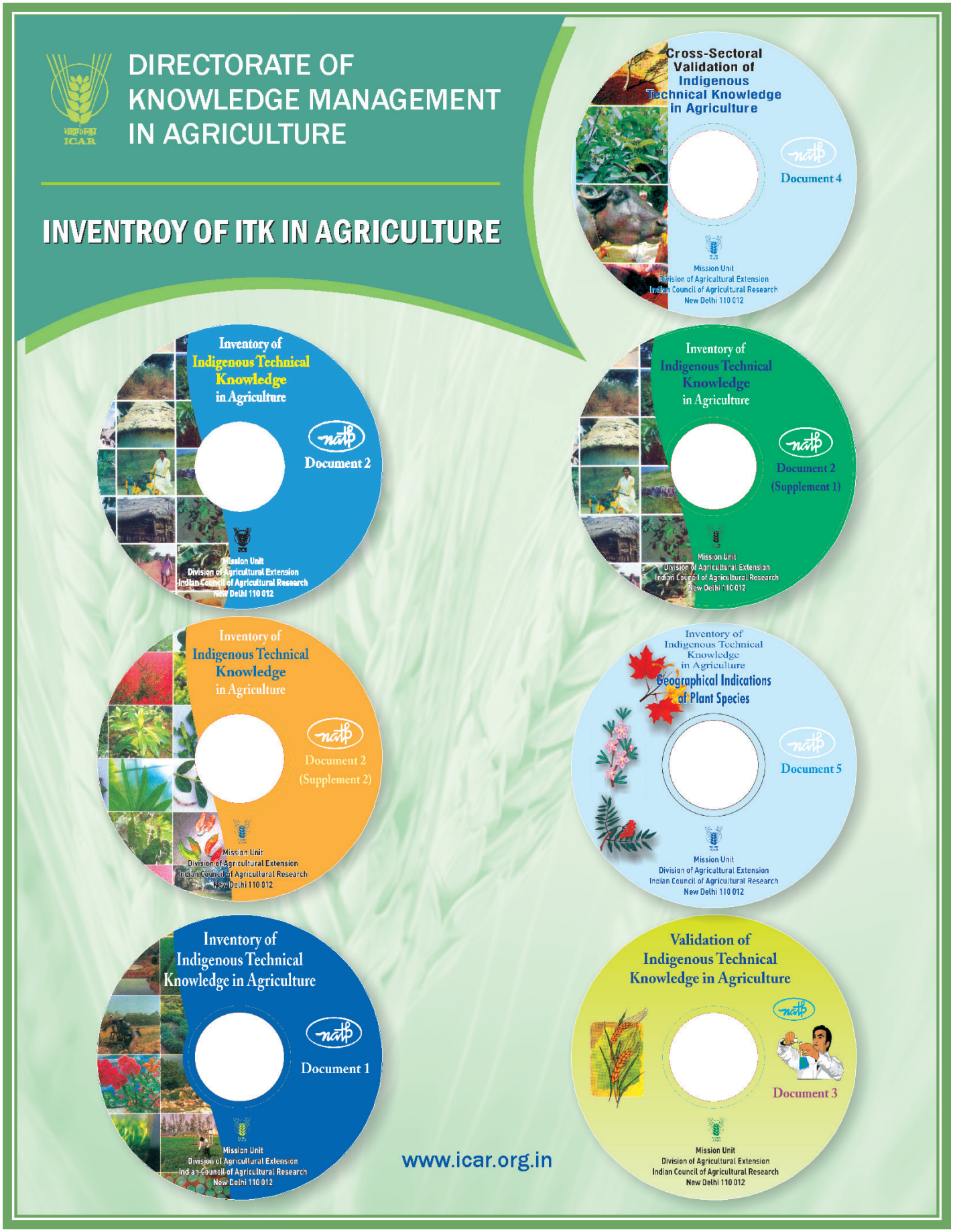
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