

Morphologic descriptions of *Taenia asiatica* sp. n.

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Abstract: Among taeniid tapeworms infecting humans through pork or beef, *Taenia solium* Linnaeus 1758 and *Taenia saginata* Goeze 1782 have already been known. Based on the morphologic characteristics of adult and metacestodes of Asian *Taenia saginata*, the third kind of human taeniid tapeworm known to distribute in Asian countries, a new species name of *Taenia asiatica* is proposed. In addition to the known biology in their intermediate hosts, *T. asiatica* was different morphologically from *Taenia saginata* Goeze 1782 in having the unarmed rostellum on the scolex of adult, the large number of 'uterine twigs' and the existence of 'posterior protuberance'. These structures in the gravid proglottids were used as taxonomic keys in taeniid tapeworms for the first time. *T. asiatica* metacestode (*Cysticercus viscerotropica*) was different morphologically from *T. saginata* metacestode (*Cysticercus bovis*) in having wartlike formations on the external surface of the bladder wall.

Key words: *Taenia asiatica* sp. n., Asian *T. saginata*, *T. saginata taiwanensis*, *Cysticercus viscerotropica*, uterine twigs, posterior protuberance, morphologic description

INTRODUCTION

Asian *Taenia saginata*, first recognized in Taiwan and subsequently in many other Asian countries including Korea by pioneering efforts of P.C. Fan and his colleagues in Taiwan, is a distinct tapeworm which is different from classical *T. saginata* (*Taenia saginata* Goeze 1782) in some aspects.

The life cycle of this cestode was different from classical *T. saginata* in its intermediate host animals as well as in the infected organs (Fan *et al.*, 1986 & 1988; Fan, 1988; Eom, 1991; Eom and Rim, 1992a; Eom *et al.*, 1992). Unlike classical *T. saginata* which is infecting

the skeletal muscle of cattle, Asian *T. saginata* infects visceral organs such as the liver, omentum, serosa and lung of pigs in its larval stage (Eom *et al.*, 1991). The liver of cattle is also an infected organ of Asian *T. saginata* metacestodes (Fan, 1988, Fan *et al.*, 1988; Eom *et al.*, 1992). Its evolutionary and epidemiologic significance is yet to be properly evaluated. However, the infectivity of the metacestodes from both natural and experimental pigs or cattle was evidently proved in experimental human host (Fan *et al.*, 1986; Chao *et al.*, 1988; Eom and Rim, 1992b).

Conclusive morphological evidence to define the taxonomic status of Asian *T. saginata*, however, is not available at present. Though molecular analysis showed differences in ribosomal DNA between Asian and classical *T. saginata* (Zarlenga *et al.*, 1991), the 33rd SEAMEO-TROPMED (South-east Asian Ministries of Education Organization Regional Tropical Medicine and Public Health) Regional

* Received Nov. 17 1992 and accepted Jan. 7 1993.

* This study was supported by a grant from the KOREA SCIENCE & ENGINEERING FOUNDATION (No. 911-0412-001-1), 1991.

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Seminar on emerging problems in food-borne zoonosis held in Thailand, 14-17 November 1990 (Cross and Murrell, 1991) agreed to call this parasite a strain *T. saginata taiwanensis* tentatively until 1992.

In this study, we describe the morphological characteristics which are unique in adult and larval stages of Asian *T. saginata* and propose its new species name.

MATERIALS AND METHODS

Two strobilae of adult Asian *T. saginata*, one with and another without scolex, were obtained from a 37 year-old Korean male volunteer after treatment with a 2 g dose of niclosamide. The volunteer had been experimentally infected orally with five metacestodes which were obtained from livers of naturally infected domestic pigs two years ago (Eom and Rim, 1992a). The recovered strobilae were stained with Semichon's acetocarmine after pressing and fixing with Alcohol-Formalin-Acetic acid. Some free gravid proglottids were dropped in AFA bottle for fixation while they were showing motility. Measurement was based on one of the two recovered worms, the one with scolex. Living metacestodes of Asian *T. saginata* were collected from experimental pigs which were infected with eggs obtained from the above volunteer. The metacestodes were collected from the pigs on 30-150 days after infection. Scolex of an adult worm and the surface of bladder worms were observed by scanning electronmicroscopy after fixing and coating with gold ion. The number of testes was counted with enlarged photomicrography.

DESCRIPTION

Genus *Taenia* Linnaeus, 1758

Taenia asiatica sp. n.

Korean name: Asiajochoong

(아시아조충, 亞細亞條蟲)

(Figs. 1-6)

General: Body large sized with 712 segments, yellowish white, measured 341 cm (pressed and fixed) in total length with maximum width of 9.5 mm. Scolex spheroidal, with cuspidal rostellum, measured 0.81 mm in width. Four simple suckers, 0.24-0.29 mm in

diameter, were directed anterolaterally. Cervical swelling distinct (Fig. 1). Proglottids rectangular, increasing in size regularly throughout the length of the strobila. Anterior proglottids wide and short; posterior, long and narrow. Free proglottids, with posterior protuberance, measured 12.4 mm (9.5-16.0) long and 5.0 mm (4.2-5.8) wide in unpressed, fixed specimens (n = 32) (Fig. 2); but 30.9 mm (21.0-34.0) long in fully relaxed, unfixed specimens (n = 27). Gravid proglottids unisegmentally apolytic and a wet segment weighed 66.5 mg (n = 107).

Male reproductive organs (Fig. 3): Testes numerous, 868-904 (n = 3) with 81.7 μ m (60-110) in diameter (n = 25) (proglottids between 365th and 405th), none posterior to vitelline gland. Cirrus pouch sac-shaped, measuring 316.3 μ m (290-350) long and 126.9 μ m (90-150) wide (n = 6), but not extending to excretory vessels. Cirrus unarmed, measured 41.4 μ m (35-50) in diameter (n = 4).

Female reproductive organs (Figs. 3-4): Ovary bilobed, unequal in size. Vitelline gland postovarian. Vaginal opening posterior to cirrus. Vaginal sphincter round to oval, measures 56.1 μ m (50-60) by 47.2 μ m (40-50) in diameter (n = 13). Genital apertures irregularly alternating. Uterus a median stem with numerous lateral branches 18.3 (16-21) (n = 18) and with numerous redivided uterine twigs 81.4 (57-99) (n = 18).

Eggs (Fig. 5): Eggs round to oval, brown, fragile with thin shell, measuring 35.7 μ m (33.8-40.0) by 34.4 μ m (33.5-37.5) in diameter of embryophore with hexacanth embryo (n = 50).

Larva (Fig. 6): Metacestode a cysticercus, subspherical to ovoid, milky-white bladder with a head invaginated into the bladder, measuring 2.09 mm (2.07-2.14) by 2.00 mm (1.98-2.01) (n = 8). Outer bladder surface covered with wartlike formations (21.5-36.7 μ m in diameter) (n = 14). Wartlike formations composed of numerous microtriches. Rudimentary hooklets in some scoleces, usually uncountable, numbering 1 to 37.

Taxonomic summary

Diagnosis: The presence of rostellum on the scolex; a large number of uterine twigs in the gravid proglottids (more than 57 on each side);

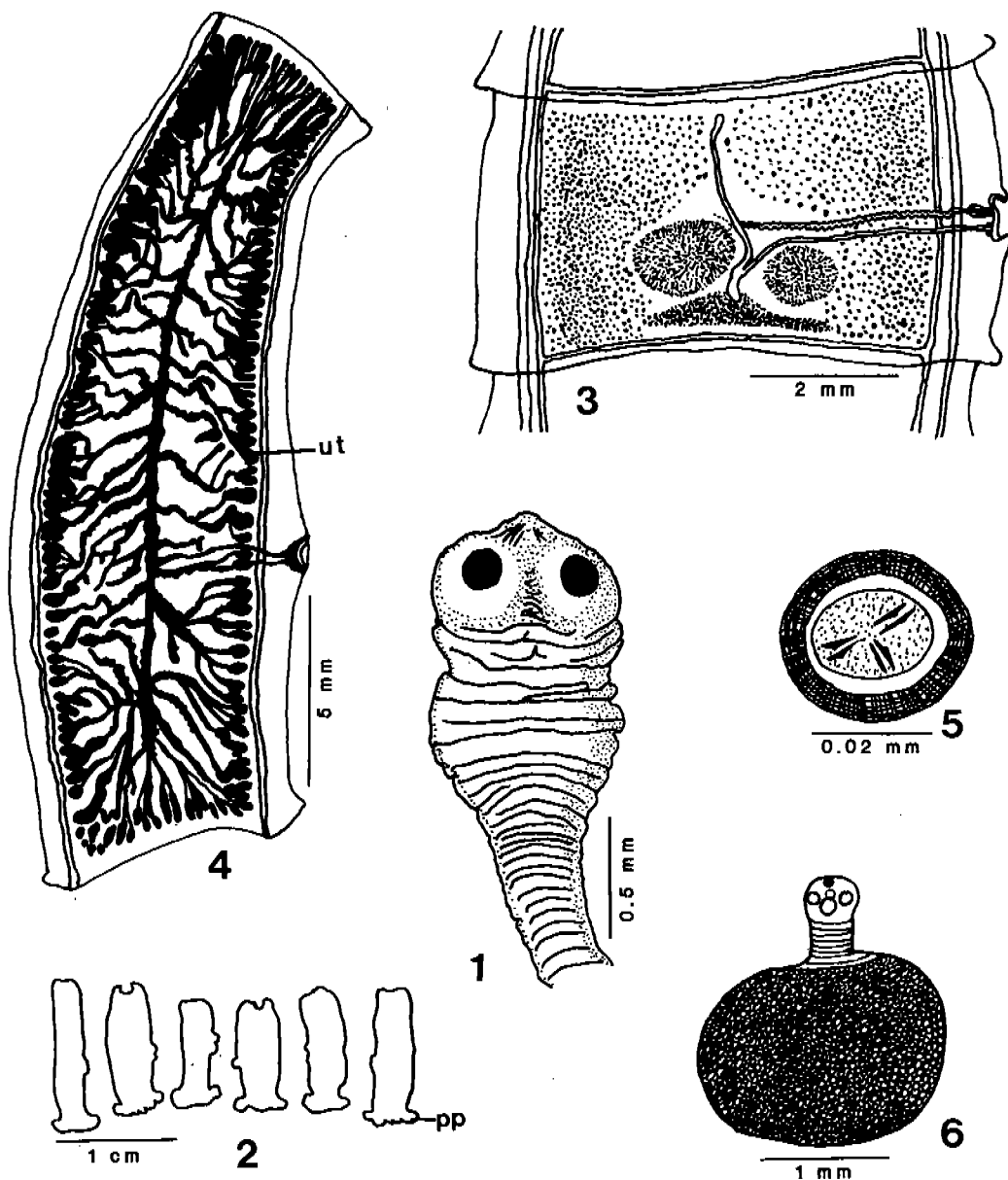


Fig. 1. Scolex of Asian *T. saginata* with rostellum. **Fig. 2.** Gravid proglottid (unpressed), pp: posterior protuberance. **Fig. 3.** Mature proglottid. **Fig. 4.** Gravid proglottid (pressed), ut: uterine twigs. **Fig. 5.** Egg. **Fig. 6.** Metacestode with wartlike formations on the bladder surface.

and the prominence of posterior protuberance in the gravid proglottids of this adult differ from *T. saginata*, the most similar cestode. The presence of wartlike formations on the surface of the larvae differ from *T. saginata* metacestodes.

Specimens deposited: CBNU Parasitological

Collection, Department of Parasitology, College of Medicine, Chungbuk National University, Chongju City, Korea.

Holotype: CBNU Helm. Coll. No.910906

Paratypes: CBNU Helm. Coll. No.901208, No.910926

Host: *Homo sapiens sapiens*

Locality: Chongju City, Chungbuk, Republic of Korea

Habitat: Intestine

Date of collection: September 6, 1991

Etymology: Species name derived from geographic distribution, Asia.

DISCUSSION

The rostellum is a structure of taxonomic importance in Taeniidae. Unlike *Taenia asiatica*, the classical *T. saginata* does not have rostellum on its scolex (Wardle and McLeod, 1952; Verster, 1967; Schmidt, 1986). The existence of the rostellum on its scolex observed by scanning electronmicroscopy is the most important feature of *T. asiatica* to be a different species of human tapeworm in our study.

Uterine twigs have never been described before by any author in the classification of taeniid tapeworms. Here, we suggest their usefulness in taxonomic characterization. *T. asiatica* has many more uterine twigs and a larger ratio of twigs/branches than classical *T. saginata*. The details will be described elsewhere.

Presence of posterior protuberances in gravid proglottids also has never been described. Its existence is best seen in naturally discharged unpressed specimen and may be useful in field diagnosis. Classical *T. saginata* has less prominent or no posterior protuberances and this will be described elsewhere too.

Total number of proglottids in *T. asiatica* was recorded less than 1,000 segments by Kang *et al.* (1965), who were not aware of distinctiveness of *T. asiatica*, based on the collected 327 worms. Fan (1988) reported that Taiwan *Taenia* had 260 to 1,016 (mean = 674) proglottids; but classical *T. saginata* has 1,000 or more proglottids (Verster, 1967).

Metacestodes of *T. asiatica* have wartlike formations on their whole bladder surface instead of rugae. The rugae is a characteristic structure which is observed in *Cysticercus bovis* (Slais, 1970). We think the existence of rudimentary hooklets on the scolex of *T. asiatica* metacestode is not a fixed characteristic. Slais and Machinicka (1976) and Zdarska (1976) also have reported on the hook anlagen

in *Cysticercus bovis*.

In the classification by Wardle and McLeod (1952) or Schmidt (1986), the Asian *T. saginata* fits neither the genus *Taenia* nor *Taeniarhynchus*. The genus *Taenia* needs hooks on the scolex and the genus *Taeniarhynchus* needs non-rostellar scolex. Hooklets are absent and the rostellum is present in our specimen. The establishment of a new genus is inevitable in their points of view. However, the establishment of a new genus would not be necessary because we agree with the classification of Verster (1969) who did not accept the genus *Taeniarhynchus* by considering that a single character may justify the criterion of a new species but it cannot be the sole criterion for the erection of a new genus. Up until now the genus *Taenia* Linnaeus 1758 includes two kinds of well known tapeworms, i.e., *Taenia solium* Linnaeus 1758 and *Taenia saginata* Goeze 1782.

In this connection, we propose *Taenia asiatica* as a new scientific name of Asian *T. saginata*. Many Asian countries have *T. saginata*-like cestode (Fan *et al.*, 1988). Under a hypothesis that all Asian *T. saginata* have identical morphology with our Korean specimen, we suggest *T. asiatica* instead of *T. koreanus*, *T. taiwanensis* or lots of possible names.

In naming the larvae, the *Cysticercus viscerotropica* for a term corresponding to *Cysticercus bovis* or *C. cellulosae* would be good as previously suggested by Eom *et al.* (1992).

Conclusively, Asian *Taenia saginata* is most similar to classical *Taenia saginata* Goeze 1782 but it differs from classical *T. saginata* at least in four points, i.e., 1. the existence of rostellum on its scolex, 2. the posterior protuberance in gravid proglottids, 3. the large number of uterine twigs, 4. the wartlike formations on the larval bladder surface. We think those features meet the requirements for Asian *T. saginata* to be a new species, *Taenia asiatica* sp. n.

ACKNOWLEDGEMENTS

Thanks are greatly due to Professor Seung-Yull Cho, Department of Parasitology, College of Medicine, Chung-Ang University for valuable discussions as well as for providing many

taxonomic references. We thank Father Edward Whelan, Galilee House in Cheongju City for reviewing English text. We also record the help of assistant Mr. Hak-Mo Seong, Department of Parasitology, College of Medicine, Chungbuk National University.

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=국문초록=

신종 조충 *Taenia asiatica* sp.n.의 형태학적 기재

충북대학교 의과대학 기생충학교실 및 고려대학교 의과대학 기생충학교실

엄기선 · 임한중

현재 인체에 기생하는 *Taenia* 조충으로는 돼지고기의 유구낭미충(*Cysticercus cellulosae*)을 먹어서 감염되는 *Taenia solium* Linnaeus 1758(有鉤條蟲)과 쇠고기의 무구낭미충(*Cysticercus bovis*)을 먹어서 감염되는 *Taenia saginata* Goeze 1782(無鉤條蟲) 두 종이 알려져 있다. 한편 인체에 기생하는 제3의 *Taenia* 조충으로 최근 타이완, 한국, 인도네시아, 태국, 필리핀 등 아시아국가를 중심으로 발견되는 Asian *Taenia saginata* 조충은 돼지나 소의 간 또는 내장에 있는 내장형 낭미충(內臟型囊尾蟲, *Cysticercus viscerotropica*)을 먹어서 감염되는 것으로 추정된다. 그러나 이러한 생활사상의 구분에도 불구하고 형태학적으로는 본충이 *Taenia saginata* Goeze 1782와 유사하기 때문에 아직 신종으로 인정되지 않은 상태이다. 이에 연구자들은 Asian *Taenia saginata* 조충의 형태학적 구분점을 새로이 발견하고 학명으로서 *Taenia asiatica* sp. n. (한국명: 아시아조충, 亞細亞條蟲)을 제시하고자 한다. 감별점으로는 1. 성충의 두절에 있는 액취(額嘴)의 존재, 2. 성충의 수태편절에서 관찰되는 자궁세지(子宮細枝, uterine twigs)의 수, 3. 성충의 수태편절에서 관찰되는 미돌기(尾突起, posterior protuberance)의 존재 및 4. 유충의 낭벽표면에서 관찰되는 사마귀양 구조(wartlike formations)가 광학 및 전자현미경적으로 관찰되었다. 이중 '자궁세지'와 '미돌기'는 새로이 관찰하여 기재하는 구조물로서 처음으로 Taeniid의 종감별에 사용하였다.

[기생충학잡지 31(1): 1-6, 1993년 3월]