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Original article

Fundamental Morphological Study of 16 Genera of Chironomid Larvae in Korea

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Abstract Chironomids are a large group of invertebrates that live in various aquatic habitats. The distribution range of these invertebrates has become varied due to anthropogenic impacts; as such, their distribution can be used as an indicator of environmental health. Adult chironomids are well known in South Korea; however, the larvae have rarely been studied due to difficulties associated with morphological classification. To address this lack of information, we collected larvae from four important rivers in South Korea and summarized their taxonomic morphological characteristics. The antennae, mandible, and mentum were used for larval taxonomic characterization. In this study, we describe the basic morphological features and key pictorial features of 20 species of chironomids, representing 16 genera.

Key words: chironomid larvae, morphological character, antenna, mentum, mandible, Chironomidae

INTRODUCTION

Chironomids have an important role in the food network of aquatic communities, representing a major link between producers and secondary consumers (Tokeshi, 1995). Chironomidae is a large group of invertebrates found in various water worldwide, with a reported diversity of 8,000~20,000 species (Armitage, 2012). Although adult chironomids inhabit areas near the riparian zone of rivers or lakes, the larvae are aquatic organisms distributed in diverse aquatic habitat patches (Pinder 1986, 1995). Chironomid larvae was potentially represent more than 70% abundance of the total arthropod numbers in hypersaline waters and are opportunistic omnivores, ingesting a wide variety of food sources (Cummins and Klug, 1979). In general, these larvae ingest five kinds of food such as algae, detritus and associated microorganisms, macrophytes, wood debris, and other invertebrates (Berg, 1995). Moreover, recent eDNA metabarcoding-based gut content analysis of chironomid larvae indicated the presence of various small planktons, such as *Desmodesmus armatus*, *Eolimna minima*, and *Tetradesmus dimorphus*, in the weirs (Jo *et al.*, 2020).

Kwak (2015) introduced 24 genera and 43 species of chironomid larvae based on visibly identified taxonomical adult stages in South Korea. The morphological studies of larvae are scarce: Yoon and Chun (1992) described the abdomen characteristics through simple drawings of eight *Chironomus* larval species. Ree (1981, 1998) described the larva of *Cricotopus oryzaphagos*. In this study, we provide the detailed pictorial features and morphological keys to 16 genera present in Korea.

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MATERIALS AND METHODS

Chironomid larvae were collected from four important freshwater rivers in South Korea from April to June in 2018 and 2019. Collections were made using a Ponar grab (20 cm × 25 cm) and a sieve (mesh size: 500 μm). The samples were fixed and preserved using 90% ethanol and about 16.9°C (range: 8.76~23.35°C) the field water temperature was measured using portable equipment (Model: YSI Professional Plus, Ohio, USA).

Specimens were dissected and the dissected parts were mounted on slides using a glycerol mounting medium. The dissection was performed on a glass slide under a microscope (Olympus SZX12). The body was dissected with a needle and appendages were used to prepare the slides. The sandwich method was used for setting the position and rotating the specimen. The permanent mount slide was sealed with transparent nail varnish. All drawings were made using a drawing tube on an Olympus BX51 differential interference contrast microscope. The descriptive terminology follows Epler (2001).

RESULTS AND DISCUSSION

A total of 16 genera and 20 species were identified from four major rivers in Korea (Table 1). The classification criteria were determined according to the morphological characteristics. Chironomid larvae have a cylindrical body shape and are well-segmented. Some appendages located on head capsule and posterior part is very important for identification.

1. Major pictorial characteristics of chironomid larvae

1) Antenna (Fig. 2)

The antenna is located in the front of the head capsule (Fig. 1), with a possibility of putting it in and out. The shape and length are diagnostic for many taxa. In general, the characteristic is used for identification by segment number and ratio. This is the length of the basal segment divided by the remaining segments. The placement and shape of the Lauterborn organ sensory structures often located on the second seg-

Table 1. List of the 16 genus of Chironomids in South Korea.

Subfamily	Genus	Korean name
Tanypodinae	*Conchapelopia*	민다리깔따구속
	Tanypus	늪깔따구속
Chironominae	*Chironomus*	깔따구속
	Cryptochironomus	음깔따구속
	Einfeldia	다모깔따구속
	Glyptotendipes	조각깔따구속
	Harnischia	무깔따구속
	Microtendipes	꼬마깔따구속
	Polypedilum	무늬깔따구속
	Stictochironomus	반지깔따구속
	Tanytarsus	장부깔따구속
Orthocladinae	*Chaetocladius*	–
	Cricotopus	아기딸따구속
	Diplocladius	쌍깔따구속
	Orthocladius	깃깔따구속
	Tokunagayusurika	빨간도꾸나가깔따구

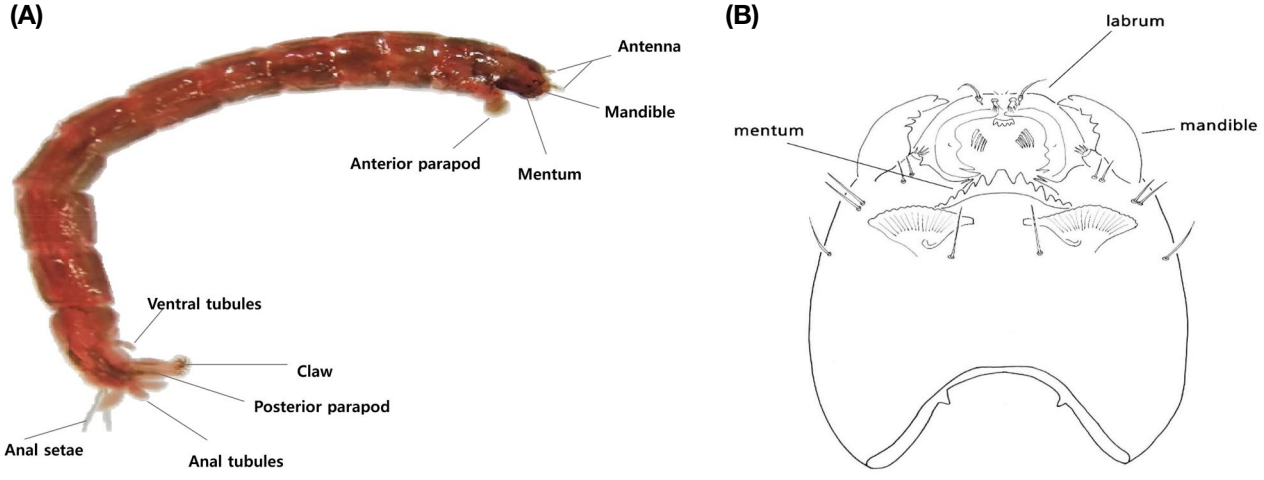

Fig. 1. The general morphological structure of chironomid larvae (A) and the main locations of the ventral head capsule (B).

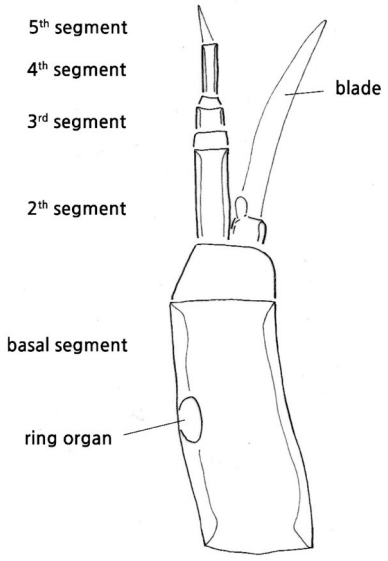

Fig. 2. Basic structure of the antenna in the head capsule (*Einfeldia dissidnus*).

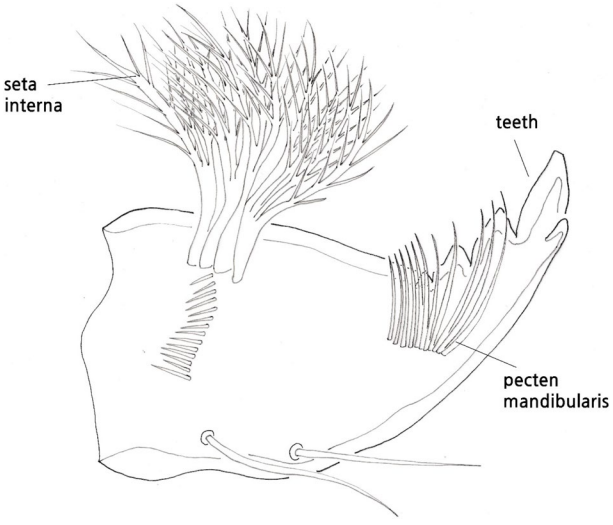

Fig. 3. Basic structure of the mandible in the head capsule (*Chironomus* sp.).

ment or at its apex are important, as is the location of the ring organ.

2) Mandible (Fig. 3)

The mandible is located on the right and left side of the body at the front of the head capsule (Fig. 1). Strong teeth are located foremost, which used for holding on tightly to food. Several complex characteristics was used for identification, including the number and shape of the inner apical teeth, the

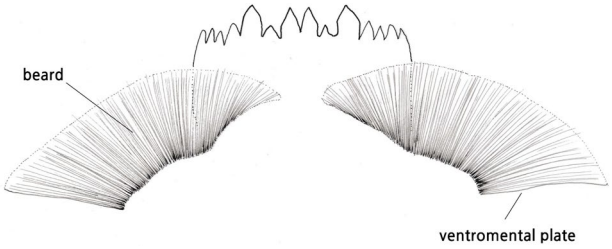

Fig. 4. Basic structure of the mentum in the head capsule (*Dipocladius* sp.).

present or absence of a seta interna, the morpho-type of seta subdentalis, and the pectin mandibularis.

3) Mentum (Fig. 4)

The strong teeth with ventromental plates are located at the center of the head capsule. The shape and number of teeth are the most important characteristics for identification. The shape of the ventromental plate and the presence or absence of a beard are noticeable features.

2. Morphological key for the 16 genera of the chironomid larvae in South Korea

1. Posterior parapods long, relatively; the ratio of length/width of the head capsule is 1.5∼2.0 times ····· (Tanypodinae)····· 2
- Posterior parapods short; the ratio of length/width of the head capsule is 1.0 to 1.3 times ····· (Chironominae / Orthocladinae) ····· 3
2. The shape of the ligular teeth is V-shaped type (Fig. 5A) ····· genus *Conchapelopia*
- The shape of the ligular teeth is aligned (Fig. 5B) ····· genus *Tanypus*
3. Antenna extremely elongated (Fig. 6A); Mandible with 1 to 2 apical teeth ····· 4
- Antenna not elongated (Fig. 6B) ····· 5
4. The first segment of the antenna with a seta, located in the middle part of the segment ····· genus *Tanytartus*
- First segment of the antenna without seta ····· *Tokunagayu surika*
5. Labrum with naked or simple seta ····· 6
- Labrum with plumose seta ····· 8
6. Ring organ in antenna located above 1/2 (Fig. 6C) ····· 7
- Ring organ in antenna located under 1/2 (Fig. 6D) ····· genus *Chaetocladius*, genus *Cricotopus**, genus *Diplocladius*, *Einfeldia dissideus*, genus *Glyptotendipes*, *Orthocladius suspensus*

*- The ratio of the first segment of the antenna is not long

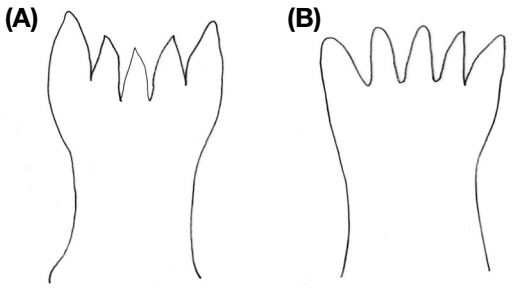

Fig. 5. Representative structure of the ligular in the head capsule. (A) *Conchapelopia* sp., (B) *Tanypus* sp.

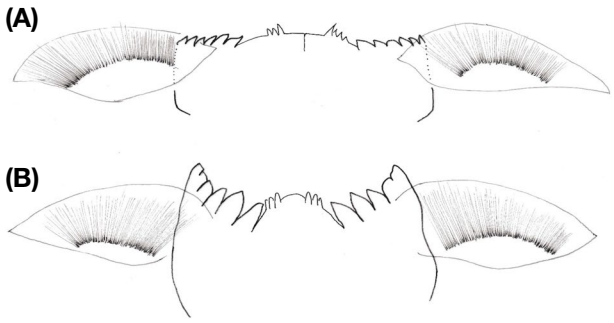

Fig. 7. Representative structure of the mentum in the head capsule. (A) *Harnischia* sp., (B) *Cryptochironomus* sp.

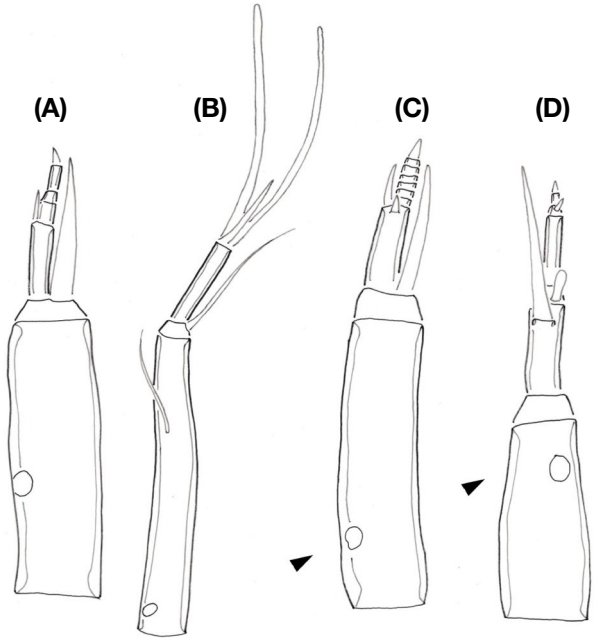

Fig. 6. Representative structure of the antenna in the head capsule. (A) *Chironomus* sp., (B) *Tanytartus* sp., (C) *Chaetocladius* sp., (D) *Cryptochironomus* sp.

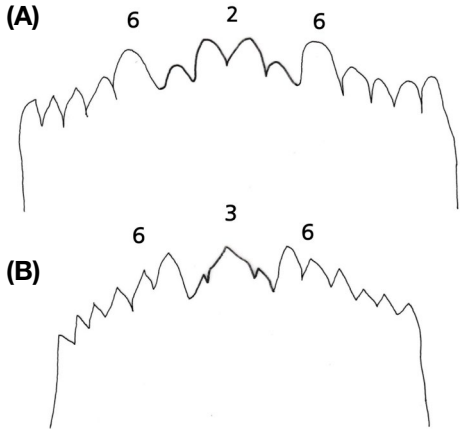

Fig. 8. Representative structure of the mentum in the head capsule. (A) *Polypodium scalaenum*, (B) *Chironomus* sp.

(about 3.5 times) ····· *C. sylvestris*
- The ratio of the first segment of the antenna is long (about 10 times) ····· *C. oryzaphages*

7. The mentum is a plate-type (Fig. 7A) · genus *Harnischia*
- The mentum is a V-shaped type (Fig. 7B) ····· genus *Cryptochironomus*

8. Antenna with 5-segmented ····· 9
- Antenna with 6-segmented ····· 10

9. Tubules presented; Mentum teeth is 6 : 3 : 6 (Fig. 8A) ····· genus *Chironomus***
- Tubules absent; Mentum teeth is 6 : 2 : 6 (Fig. 8B) ····· *Polypodium scalaenum*

** includes *Chironomus kiiensis*, *C. flaviplumus*, *C.* sp.

10. Median part of mentum is pale ····· genus *Microtendipes*
- Median part of mentum is dark ··· genus *Stictochironomus*

3. Taxonomic account

1) Subgenus Tanypodinae

Diagnosis. Posterior parapods long. The ratio of length/width of the head capsule is 1.5 to 2.0 times. Antenna 4-segmented, retractile into the head capsule, Anal tubules usually well developed in Korean freshwater species. Genus *Conchapelopia* and *Tanypus* can easily be distinguished by the shape of the ligular teeth.

Ecology. This subfamily consists of free-swimming or crawling predators; some burrow in the bottom mud. *Conchapelopia* and *Tanypus* are identified and recognized from different water temperature. *Conchapelopia* is found at a high temperature (19.80°C), *Tanypus punctipennis* is a low (9.30°C).

2) Subgenus Chironominae

Diagnosis. Posterior parapods short. The head capsule is mostly of the same aspect ratio (1.0 to 1.3 times). Antenna usually 4 to 6-segmented. Mentum teeth is 6 : 3 : 6, well sclerotic teeth, sometimes reduced. Anal tubules usually present.

Ecology. The most abundant subfamily in South Korea. 9 genera and 11 species are recognized. According to Epler (2001), this group also inhabits brackish and marine water. Most larvae build tubes using sediment. The genus *Chironomus* has hemoglobin, exhibits a red color, and could survive in low oxygen conditions. The *Chironomus* species occur under ordinary temperature conditions (15～22°C) in April and May. Three species were identified *C. kiiensis*, *C. flaviplumus*, *C.* sp. Species of genera *Microtendipes* and *Tanytarsus* could occur under low temperature conditions in early spring.

3) Subgenus Orthocladinae

Diagnosis. Posterior parapods short, sometimes reduced. Antenna with 3～7 segments; sometimes strongly reduced or could be longer than the head capsule. Mentum well sclerotized. There are two recognized *Cricotopus* species that could be easily identified by the ratio of the first antennal segment.

Ecology. Orthoclad larvae are found in a variety of freshwater habitats. Most larvae are scrapers, collectors. Five genera and 7 species have been recognized in this study. These species are found in the spring season (March to June) and can survive at 13°C.

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