

Trematodes of the genus *Haematoloechus* (Digenea: Plagiorchiidae) from frogs in Korea

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Abstract: Total 242 *Rana nigromaculata* and 9 *R. catesbeiana* were collected from the various localities in Korea from February 1989 to July 1991, and their lungs were examined. Five species in genus *Haematoloechus*, i.e., *H. sibiricus japonicus* (Yamaguti, 1936), *H. nanchangensis* Hsiung, 1934, *H. variegatus* (Rudolphi, 1819), *H. lobatus* (Seno, 1907), *H. lobatus koreanus*, were identified in this study. Among them, *H. lobatus koreanus* was a new subspecies and *H. variegatus* and *H. lobatus* were newly recorded from Korea.

Key words: frog, lung, *Haematoloechus*, *H. nanchangensis*, *H. variegatus*, *H. lobatus*, *H. lobatus koreanus*

INTRODUCTION

The species of the genus *Haematoloechus* are found in all zoogeographical regions and consists of about 50 species throughout the world. They are found in the lungs of various terrestrial anurans. The generic diagnosis of *Haematoloechus*, according to Prudhoe and Bray (1982), is as follows; with small ventral sucker situated in anterior or middle third of body length. Genital pore lies ventrally to pharynx or esophagus. Testes obliquely or nearly symmetrically arranged in middle region of body, or close behind. Ovary situated near to, or contiguous with, ventral sucker. Vitelline follicles disposed in regular rosettes, or in grape-like clusters or in an irregular pattern. Uterus thrown into numerous slings occupying much of hindbody and space between intestinal caeca in forebody. Lying laterally to each intestinal caecum there is a long anteriorly-directed uterine loop extending forward to varying levels beyond hinder limit

of vitelline follicles.

The first recorded species of the genus *Haematoloechus* in Korea was *H. jeholensis* by Fukui and Ogata (1938). Later two species, *H. nanchangensis major* and *H. sibiricus japonicus* were recorded (Song *et al.*, 1965; Lee *et al.*, 1976). In our thought, the most basic thing in study of parasites is to know its precise species name. However, those records were local and quite-imperfect to know what species of *Haematoloechus* were distributed in our country. So the present work undertook for the purpose of classification of *Haematoloechus* species in Korea and classified five species including one new subspecies; *H. sibiricus japonicus* (Yamaguti, 1936), *H. nanchangensis* Hsiung, 1934, *H. variegatus* (Rudolphi, 1819), *H. lobatus* (Seno, 1907), *H. lobatus koreanus* subspecies nova.

MATERIALS AND METHODS

242 *Rana nigromaculata* and 9 *R. catesbeiana* were collected from the various localities in Korea

from February 1989 to July 1991 and their lungs were examined under a stereomicroscope. Collected worms were flattened with negligible coverslip pressure and fixed with AFA, stored in 70% ethanol, stained with Semichon's acetocarmine, and mounted in Canada balsam.

RESULTS

Family Plagiorchiidae

Subfamily Haematoloechinae Teixeira de Freitas & Lent, 1939

Genus *Haematoloechus* Looss, 1899

Haematoloechus sibiricus japonicus
(Yamaguti, 1936) (Fig. 1)

Pneumonoeces sibiricus japonicus Yamaguti, 1936, Jap. J. Zool., 6:567

Body elongated and has many minute spines on body surface. Anterior body slender and body width the greatest at the level of ovary. Body length 7.20~8.65 mm, body width 1.90~2.45 mm. Oral sucker subterminal, 0.39~0.50(w) × 0.38~0.55(l) mm. Pharynx well developed, 0.18~0.22(w) × 0.16~0.22(l) mm. Esophagus is very short. Intestinal caeca extend to the posterior end of body. Ventral sucker situated in anterior body and larger than oral sucker, 0.55~0.64(w) × 0.50~0.66(l) mm.

Testes elliptical shape, disposed diagonally and anterior margin of upper testis reaches to the mid-line of body. Anterior testis 0.53~0.61(w) × 0.93~1.10(l) mm, posterior testis 0.52~0.63(w) × 1.20~1.40(l) mm, size variation between testes diverse according to individuals. Ovary elliptical shape and often has irregular lobes, borders posterior margin of ventral sucker. Size of ovary 0.50~0.63(w) × 0.70~0.93(l) mm and smaller than that of testes. Receptaculum seminis very large, located lateral side of ovary. Cirrus sac long, contained extended seminal vesicle and cirrus. Genital pore opened foot of oral sucker. Extracaecal uterine loops long, extending to ventral sucker. Intracaecal uterine loops shaped transverse folds between upper region of ventral sucker and diverging point of intestinal caecum. Vitellaria rosette-like fol-

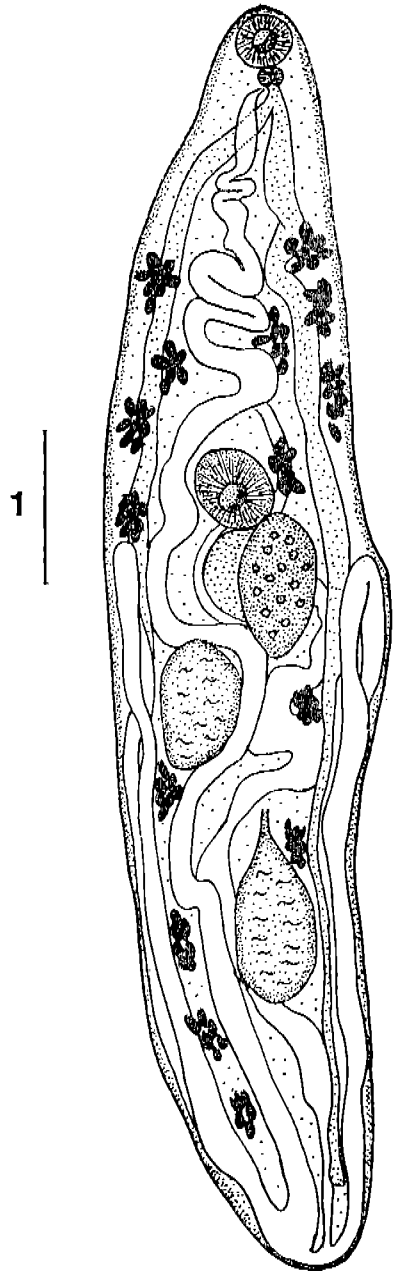


Fig. 1. *Haematoloechus sibiricus japonicus*.

icles and about 20 in number, dispersed evenly through of body. Intrauterine eggs 0.018~0.029(w) × 0.028~0.030(l) mm.

Host : *Rana nigromaculata*

Habitat : lung

Locality : Kangwon-Mt. Duta (21 May, 1990),
Chungnam-Sapsido (9 Aug., 1990), Kyong-

nam-Koje Kohyon (2 Jul., 1989)

Haematoloechus nanchangensis Hsiung, 1934 (Fig. 2. a, b)

Haematoloechus nanchangensis Hsiung, 1934, Bull. Fan. Meml. Inst. Biol., 5 : 5; Odening, 1958, Mitt. Zool. Mus. Berl., 34 : 70, 95.

Pneumonoeces nanchangensis major Yamaguti, 1936, Jap. J. Zool., 6 : 569~570.

Body elongated and tapering to anterior extremity. Body length 2.63~4.30 mm, body width 0.80~1.53 mm. Tegument with minute spines. Oral sucker subterminal, 0.25~0.27(w) × 0.23~0.25(l) mm. Pharynx 0.11~0.15(w) × 0.09~0.11(l) mm. Esophagus short and intestinal caecum extends to posterior end of body. Ventral sucker situated in anterior body and slightly smaller than oral sucker, 0.19~0.24(w) × 0.19~0.23(l) mm.

Testes oval or elliptical, parallel to each other,

0.20~0.23(w) × 0.23~0.36(l) mm. Ovary elliptical, located in postero-lateral margin of ventral sucker and larger than testes, 0.17~0.27(w) × 0.27~0.42(l) mm. Receptaculum seminis well developed, located postero-lateral portion of ovary. Genital pore opening just behind oral sucker. Extracaecal uterine loops extending to testes area, Intra-caecal uterine loops has 2~3 transverse folds between posterior extremity and ventral sucker. Vitellaria in two groups anterior and posterior. Intrauterine eggs 0.023~0.025(w) × 0.035~0.038(l) mm.

Host : *Rana nigromaculata*

Habitat : lung

Locality : Chungnam-Kongju (6 May, 1990), Asan-gun Baebang-myon (30 Jun., 1990)

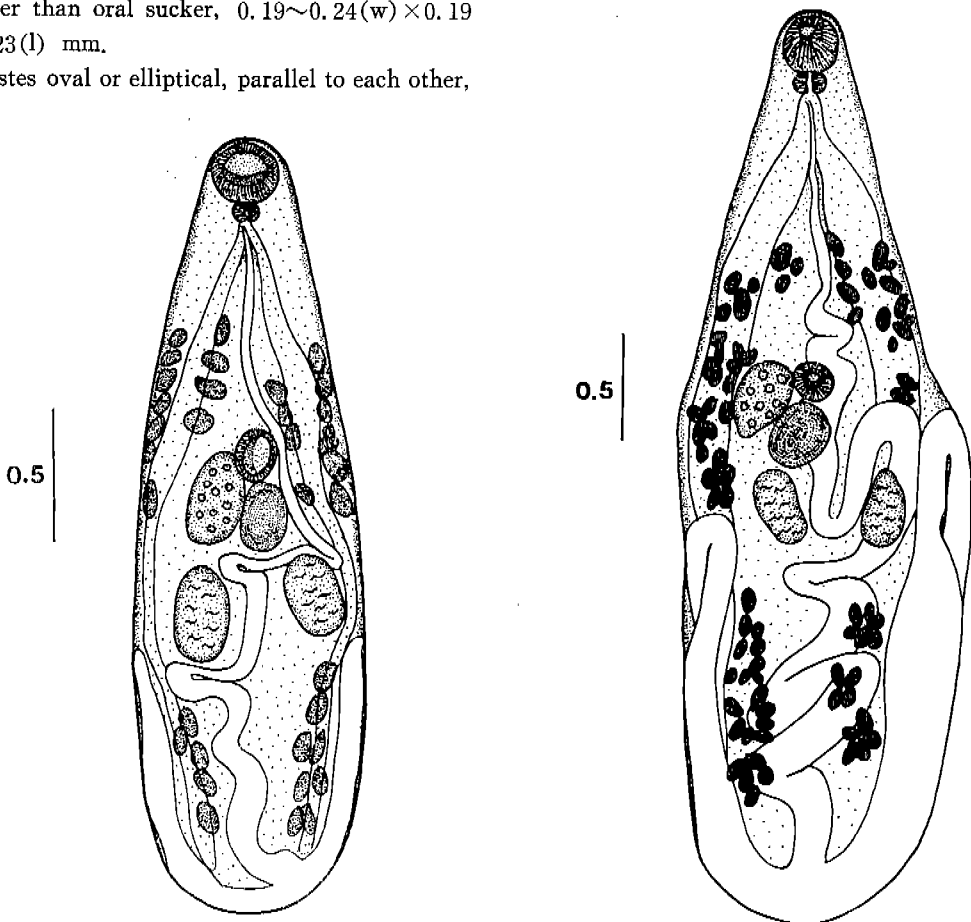


Fig. 2. a. *Haematoloechus nanchangensis*

b. *Haematoloechus nanchangensis major* classified as a synonym of *H. nanchangensis*

***Haematoloechus variegatus* (Rudolphi, 1819)** (Fig. 3)

Distoma variegatum Rudolphi, 1819, 2(2):89, 356

Pneumonoeces variegatus Looss, 1902, Zool. Jb. (Syst.), 16:411-894

Body elongated, tapering to anterior extremity. Body length 6.30~12.10 mm, body width 1.36~3.17 mm. Tegument nonspinous. Oral sucker subterminal, 0.31~0.65(w) × 0.30~0.65(l) mm. Pharynx 0.21~0.29(w) × 0.18~0.26(l) mm. Esophagus short. Intestinal caecum extends to posterior end of body. Ventral sucker 0.20~0.49(w) × 0.20~0.40(l) mm, oral sucker: ventral sucker ratio about 2 : 1~4 : 3.

Testes elliptical, arranged in vertical or diagonal each other. Anterior testis 0.40~0.98(w) × 0.61~1.53(l) mm, posterior testis 0.30~1.05(w) × 0.65~1.74(l) mm. Cirrus pouch long and slender, contained elongated seminal vesicle, pars prostatica and cirrus. Ovary oval or kidney shape, smaller than testes, 0.45~0.81(w) × 0.72~1.10(l) mm. Receptaculum seminis well developed, larger than ovary. Extracaecal uterine loops extends to anterior portion of upper testis along both lateral body. Intra-caecal uterine loops intensely winded between anterior region of oral sucker. Vitellaria is rosette form. Intrauterine eggs 0.016~0.018(w) × 0.025~0.030(l) mm.

Host : *Rana nigromaculata*

Habitat : lung

Locality : Kyonggi-Pyongtaik (5 May, 1990), Kangwon-Yangu (12 Jun., 1990), Chonnam-Temple Baikyang (29 Jun., 1990), Kyongbuk-Mt. Chuwang (5 Jun., 1989), Kyongnam-Koje Kohyon (2 Jul., 1989)

***Haematoloechus lobatus* (Seno, 1907)** (Fig. 4)

Pneumonoeces lobatus Seno, 1907, Zool. Mag.

Tokyo, 19:354; Uchida & Itagaki, 1976, Jap. J. Parasit., 25(5):360-365

Body elongated, tapering to anterior extremity. Body length 7.25~11.70 mm, body width 1.56~2.55 mm. Tegument nonspinous. Oral sucker subterminal, 0.51~0.58(w) × 0.49~0.53(l) mm. Pharynx 0.17~0.22(w) × 0.23~0.30(l) mm. Ventral sucker situated in anterior body, 0.16~

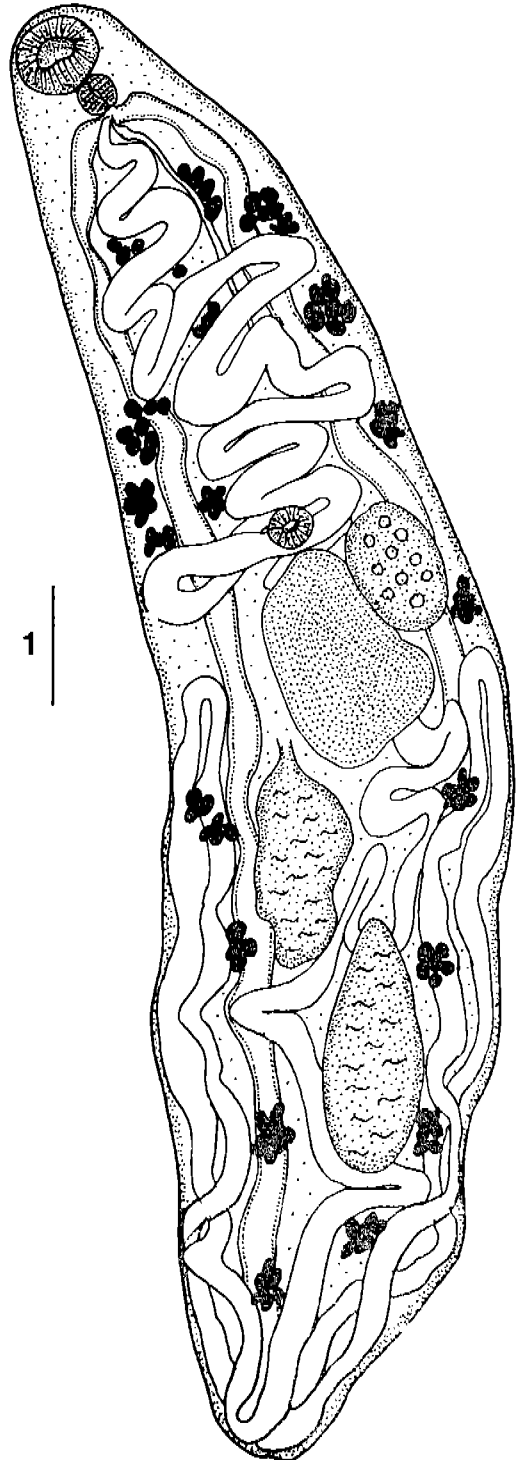


Fig. 3. *Haematoloechus variegatus*

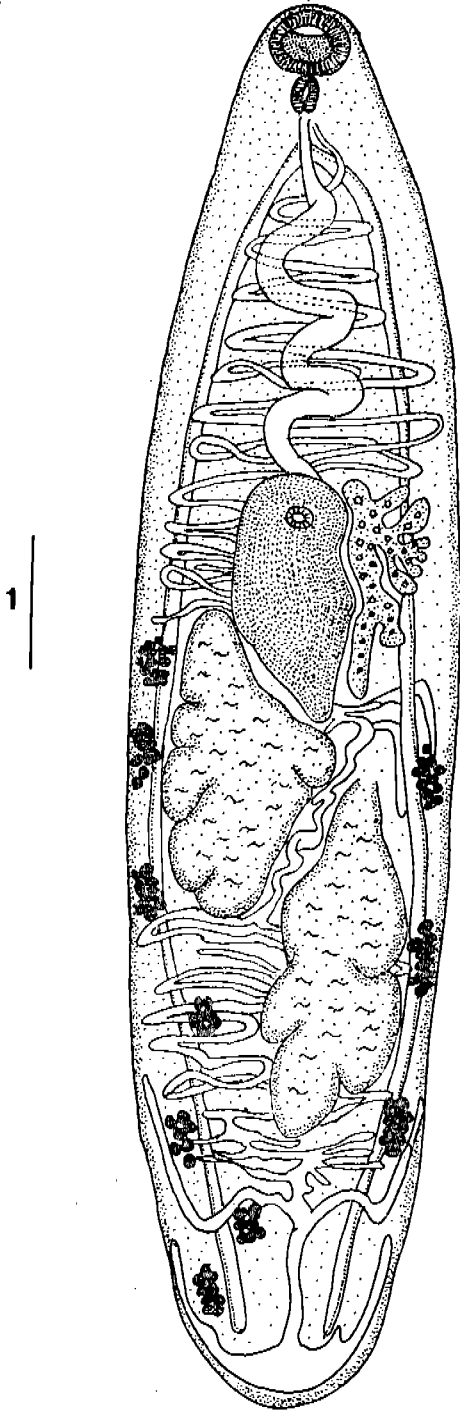


Fig. 4. *Haematoloechus lobatus*

0.21(w) × 0.15–0.16(l) mm, oral sucker: ventral sucker ratio is 2.7~2.8 : 1.

Testes arranged in oblique each other, long

elliptical and bumpy shape by deep grooves. Anterior testis 0.57~1.25(w) × 1.16~2.21(l) mm, posterior testis 0.60~1.10(w) × 1.22~2.77(l) mm. Cirrus pouch elongated. Genital pore opened just behind of the oral sucker. Ovary located lateral portion of ventral sucker and divided into several long lobes. Receptaculum seminis well developed. Extracecal uterine loops extend to middle region of posterior testis. Intracecal uterine loops wind severely through whole body. Vitelline glands shaped like flower and distribute from branching point of caecum to posterior end of body. Intrauterine eggs 0.023~0.014(w) × 0.019~0.020(l) mm.

Host : *Rana catesbeiana*

Habitat : lung

Locality : Chonnam-Kohung Podu (18 Sep., 1990)

***Haematoloechus lobatus koreanus* subspecies nova** (Fig. 5)

Body elongated. Body length 3.10 mm, body width 0.94 mm. Tegument nonspinous. Oral sucker subterminal, 0.19(w) × 0.23(l) mm. Pharynx lies bottom of oral sucker, 0.11(w) × 0.23(l) mm. Esophagus short and intestinal caecum extends to posterior end of body. Ventral sucker lies anterior body, 0.095(w) × 0.095(l) mm. The ratio of oral sucker: ventral sucker is 2.3 : 1.

Testes arranged in oblique each other, smooth and long elliptical shape. Anterior testis 0.18(w) × 0.40(l) mm, posterior testis 0.22(w) × 0.55(l) mm. Genital pore opened just behind oral sucker. Ovary is located at middle region of body and adjacent to ventral sucker, divided into several lobes. Receptaculum seminis well developed and lies lateral to ovary. Extracecal uterine loops extends shortly. Intracecal uterine loops show many horizontal bends. Intrauterine eggs 0.016~0.018(w) × 0.020~0.021(l) mm.

Type host : *Rana nigromaculata*

Habitat : lung

Type locality : Chonnam-Kohung Podu (18 Sep., 1990)

Holotype : Preserved at Institute for Tropical Endemic Diseases in Korea University

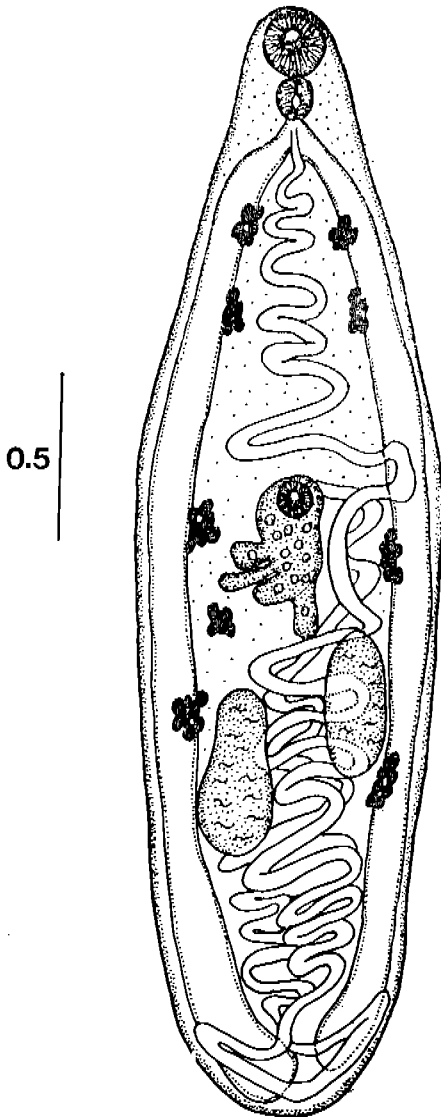


Fig 5. *Haematoloechus lobatus koreanus*.

DISCUSSION

The genus *Haematoloechus* was established by Looss (1899) and *Haematoloechus variegatus* (Rudolphi, 1819) was chosen as the type species. Later Looss (1902) changed the generic name *Haematoloechus* to *Pneumonoeces* as hemipteran (Class: Insecta) genus *Haematoloecha* had established in 1874. The name *Pneumonoeces* had been in common use for nearly 30 years, but

Harwood (1932) pointed out that a generic name is not to be considered preoccupied when it differs only in ending from a genus already published on the ground of the International Code of Zoological Nomenclature. Therefore *Haematoloechus* prevail over *Pneumonoeces*.

Odening (1960) classified subfamily Haematoloechinae into four genera—*Haematoloechus*, *Neo-haematoloechus*, *Ostiolooides*, *Ostiolum*. The genus *Haematoloechus* was divided into three subgenera (*Haematoloechus*, *Anomolecithus*, *Skrjabinoeces*) by Odening (1960). He divided subgenus *Haematoloechus* into five groups (*variegatus-schulzei*, *sibiricus*, *breviplexus*, *longiplexus*, *vario-plexus*) and subgenus *Anomolecithus* into three groups (*asper*, *nanchangensis*, *tumidus*) and subgenus *Skrjabinoeces* into one group (*similis*). Among them, the species belonged to *variegatus-schulzei* group, *sibiricus* group, *nanchangensis* group are found in our country, but *Haematoloechus lobatus* was not mentioned in Odening (1960).

Yamaguti (1936) distinguished *H. sibiricus japonicus* from *H. sibiricus* merely by the difference of egg size. Odening (1960) distinguished between *H. sibiricus japonicus* and *H. sibiricus* by not only egg size but also intracaecal uterus shape and existence of fine cuticular spines. It is evident from following respects that the present author's specimens belong to *H. sibiricus japonicus*, that is, the present specimens agree with *H. sibiricus japonicus* in egg size, existence of fine cuticular spines and many folds of intracaecal uterine loops (Table 1). Odening (1960) recognized four subspecies in *sibiricus* group—*H. sibiricus sibiricus*, *H. sibiricus japonicus*, *H. sibiricus tientsinensis*, *H. sibiricus jeholensis*. The distribution locality of *H. sibiricus sibiricus* is West Siberia, and that of *H. sibiricus tientsinensis* is China, *H. sibiricus jeholensis* is China and North Korea (? , probably Manchuria), *H. sibiricus japonicus* is Korea and Japan. From this geographical distribution pattern, it is evident that each subspecies has a characteristic emigration pathway and conjectured that why *H. jeholensis*, which was

Table 1. Comparison of described characters among *H. sibiricus* (Issaitschikov, 1927), *H. sibiricus japonicus* (Yamaguti, 1936) and the present specimens (Unit: mm)

Characters	<i>H. sibiricus</i> (Issaitschikov, 1927)	<i>H. sibiricus japonicus</i>	
		(Yamaguti, 1936)	Present study, 1992
Body length	1.46~11.20	6.0~8.7	7.20~8.65
Body width	0.6 ~ 3.7	1.0~2.4	1.90~2.45
Cuticle	smooth	densely beset with fine spines	densely beset with fine spines
Oral sucker		0.30~0.45×0.34~0.50	0.39~0.50×0.38~0.55
Ventral sucker		0.4~0.8 in diameter	0.55~0.64×0.50~0.66
Testes	elongate	elongate, 0.9~1.7×0.3~0.7	0.93~1.40×0.52~0.63
Ovary	smaller than testes	irregularly lobed, 0.65~1.0×0.28~0.57	lobed, 0.70~0.93×0.50~0.63
Vitellaria	18~22 in number	16~20 in number	about 20
Eggs	0.022~0.027×0.014~0.016	0.026~0.033×0.015~0.021	0.028~0.030×0.018~0.020

recorded in Korea by Fukui & Ogata (1938), was not found through the present study.

H. nanchangensis was first described by Hsiung (1934) in China and two subspecies, *H. nanchangensis bychovskii* Odening, 1958 in USSR, *H. nanchangensis major* (Yamaguti, 1936) in Japan were recorded. Odening (1960) classified those three species as a *nanchangensis* group and distinguished this group from other species of *Haematoloechus* by parallel arrangement of testes. The distinguishing character between *H. nanchangensis* and *H. nanchangensis bychovskii* is following. In *H. nanchangensis* the size of testes is similar to ovary, while in *H. nanchangensis bychovskii* the size of testes much larger than that of ovary. Yamaguti (1936) recorded *H. nanchangensis major* as a new subspecies and described the differences between this subspecies and *H. nanchangensis* as following. "The body is larger than *H. nanchangensis* and the genital organs are also proportionally larger. The oral sucker is usually just as large as the acetabulum, but may be slightly larger or smaller. The nearly symmetrical testes may well touch each other." However, considered size variation of digenean species according to individuals, these differences cannot be characters of species level. So we thought this subspecies as a inter-specific variation and classified *H. nanchangensis major* as a synonym of *H. nanchangensis* in the present

work.

H. variegatus is distinguished from *nanchangensis* group by diagonal arrangement of testes and from *sibiricus* group by oral sucker clearly larger than ventral sucker. This species widely distributed through North America, Europe, USSR and recorded for the first time in Korea. In Japan, *H. variegatus* was recorded by Seno in 1907. From examination of characters in the figure given in Seno's paper, however, the ventral sucker is clearly larger than the oral sucker, so it is obviously not *H. variegatus*. But there are lacking detailed descriptions in Seno's (1907), it is very difficult to identify that species. Fukui & Ogata (1938) conjectured it as *H. jeholensis*. Recently Kifune *et al.* (1977) recorded *H. variegatus* in species of *Haematoloechus* from Japan, but there lacked description and related references. So it is indistinct that the distribution of *H. variegatus* in Japan.

H. lobatus was first described by Seno in 1907, but Seno's description was lack of morphological characters. Later, as Yamaguti (1936) had not discovered this species, he doubted the existence of *H. lobatus*. Recently, Uchida & Itagaki (1976) discovered this species from *Rana catesbeiana* and redescribed in detail. *Rana catesbeiana* is not our native anurans but introduced species from foreign countries. These anurans were cultured in a nursery at first, but they gradually escaped from their nursery. Recently,

Table 2. Comparison of described characters on *H. lobatus* between Uchida and Itagaki (1976) and the present study (1992) (Unit is mm)

Characters	Uchida & Itagaki (1976)	Present study (1992)
Body length	11.3~13.5	7.25~11.70
Body width	3.1~ 4.0	1.56~ 2.55
Oral sucker	0.4~0.7 in diameter	0.51~ 0.58 in diameter
Ventral sucker	0.14~0.25 in diameter	0.16~ 0.21 in diameter
OS : VS	2.7~2.9 : 1	2.7~2.8 : 1
Testes	0.88~1.25× 0.58~2.5	0.57~1.25× 1.22~2.77
Ovary	lobed	lobed
Eggs	0.017~0.020× 0.013~0.016	0.019~0.020× 0.013~0.014

these anurans multiplied considerably in wild life and occupied important ecological niche in estuaries. In the process of these events, *H. lobatus* settled down in our country. *H. lobatus* is different from other species of *Haematoloechus* except *H. breviplexus* in the morphology of ovary which branched several lobes. The similar characters between *H. lobatus* and *H. breviplexus* are found in branched ovary, in bumpy shaped testes, in the oral sucker which larger than the ventral sucker, in lack of cuticular spines and in similar size of eggs. But *Haematoloechus lobatus* is distinguished from *H. breviplexus* by following characters. In *H. lobatus*, the extra-caecal uterine loops do not go beyond middle level of posterior testis, intra-caecal uterine loops wind severely and the ratio of oral sucker to ventral sucker is 2.7~2.8 : 1, while in *H. breviplexus*, the extra-caecal uterine loops is extending beyond the anterior testis and the ratio of oral sucker to ventral sucker is 2 : 1. Measurements of *H. lobatus* by Uchida & Itagaki (1976) and by authors' are shown in Table 2.

H. lobatus koreanus subspecies nova is very similar to *H. lobatus*. However, this subspecies is distinguished from *H. lobatus* by following aspects. The size of body smaller than *H. lobatus*, the surface of testes is smooth not bumpy, the top limit of extra-caecal uterine loops shorter

than that of *H. lobatus* and the egg size is larger than *H. lobatus*. *H. lobatus koreanus* obviously distinguished from other species of *Haematoloechus* by branched ovary.

The Korean five congeneric species of the genus *Haematoloechus* are distinguishable by the following key.

1. Ovary composed of several branched lobes...2
Ovary compact not branched3
2. Surface of testes shaped bumpy lobes
..... *H. lobatus*
Surface of testes smooth not bumpy
.....*H. lobatus koreanus*
3. Testes arranged horizontally each other
..... *H. nanchangensis*
Testes arranged obliquely or diagonally each other4
4. Oral sucker obviously larger than ventral sucker*H. variegatus*
Oral sucker smaller than ventral sucker
.....*H. sibiricus japonicus*

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＝국문초록＝

한국산 개구리류에 기생하는 *Haematoloechus*속
(Digenea: Plagiorchiidae) 흡충류

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1989년 2월부터 1991년 7월에 걸쳐 전국 각지에서 채집한 *Rana nigromaculata* 242개체, *Rana catesbeiana* 9개체의 폐로부터 *Haematoloechus*속 흡충류 5종을 진출하였으며 그 결과는 다음과 같다. 이들은 *Haematoloechus sibiricus japonicus* (Yamaguti, 1936), *H. nanchangensis* Hsiung, 1934, *H. variegatus* (Rudolphi, 1819), *H. lobatus* (Seno, 1907), *H. lobatus koreanus* new subspecies이며, 이중 *H. lobatus koreanus*는 *H. lobatus*와 유사하나 고환의 형태, 맹관 바깥쪽에 분포하는 자궁의 형태, 총란의 크기 등에 뚜렷한 차이가 있어 신아종으로 분류하였으며, *H. variegatus*와 *H. lobatus*는 국내 미기록종이다. 또한 기록종인 *H. nanchangensis major* (Yamaguti, 1936)는 *H. nanchangensis* Hsiung, 1934와 몸의 크기 외에는 아종으로 구분될 만큼 명확한 형질이 없기 때문에 *H. nanchangensis*의 동종이명으로 처리하여 분류하였다.

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