

Sex ratios and Hermaphroditism of *Cobitis lutheri* (Pisces, Cobitidae) from Korea

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The sex ratio and gonadal histology were investigated in the *Cobitis lutheri* Rendahl collected from the Tamjin River of Chollanam-do Province, Korea. The ratio of males declined in proportion to increase in size, while that of females increased in proportion to increase in size. Hermaphrodites were found in the intermediate size fishes. They had degenerating testicular tissue and developing ovarian tissue simultaneously. These phenomena were discussed in relation to skewed sex ratios.

Introduction

Cobitis lutheri was described from the Ussuri River of Siberia in 1935 by Rendahl as a subspecies of *Cobitis taenia*. Through the study of the genus *Cobitis* from Korean Peninsula, this subspecies was raised to species rank and remarked in some biological characters in distinction from *C. taenia* of Europe (Kim and Lee, 1988 ; Kim and Jeong, 1988).

In the occurrence of the hermaphroditic individuals of *C. taenia* in Italy based on the histological examination of gonad, Lodi (1967) reported that this phenomenon might be related to the protandrous sex reversal, and Rasotto (1992) suggested that this gonochoristic species have been some males occasionally containing a small number of oocytes in their testis.

During the courses of a study on the sex pattern and histological observation on the Korean cobitid fishes, many hermaphroditic individuals were found in *C. lutheri*. The objective of this paper is to describe the sex pattern of *C. lutheri* to the protandrous sex reversal accompanied.

Materials and Methods

The fishes were obtained using a electrofishing in the Tamjin River, Kangjin-gun, Choll-

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lanam-do, Korea from October 1987 to September 1988. All 1,838 specimens collected were preserved in 10% formalin. Sex distinction between male and female in the adult specimens was based on the presence of the organ of Canestrini at the base of pectoral fins as a external sex character of male (Vladykov, 1935). Also, histological observations of gonads were accompanied for sex determination of young specimens or hermaphroditic individuals. According to histological method, gonads were later embedded in paraffin and sectioned at 5μ and stained with hematoxylin-eosin for histological examinations.

Results

The unbalanced sex ratios in the different size showed that males were present among the smaller specimens and females were present among the larger ones (Table 1). Hermaphroditic individuals were found in the intermediate size range from 31-65mm SL and the ratio declines at both ends of size spectrum with a peak at 51-55mm SL (Table 1). In the 1,838 specimens observed, the hermaphroditic gonads were found in 72 individuals which have the base of pectoral fin with lenticular swelling like as that of typical males.

The gonad of males consisted of a bilobed testis and the that of female have a single ovary, and most of hermaphrodites had also a bilobed testis. In the histological study,

Table 1. Relationship between standard length and sex phase of *Cobitis lutheri* collected from Oct. 1987 to Sep. 1988, Kangjin, Cholanam-do (Tamjin River)

Standard length (mm)	Specimens examined	Sex Phase							
		Males		Hermaphrodites		Females		Hermaphrodites	
		No.	%	No.	%	No.	%	No.	%
16-20	2	2	100.0			0	0.0	0	0
21-25	31	26	83.9			5	16.1	0	0
26-30	97	64	65.9			33	34.1	0	0
31-35	63	23	41.3	3	11.5	37	58.1	0	0
36-40	85	30	38.8	3	9.1	52	61.2	0	0
41-45	118	26	28.8	8	23.5	84	71.2	0	0
46-50	238	86	43.3	17	16.5	135	56.7	0	0
51-55	283	148	60.7	24	14.0	111	39.3	0	0
56-60	225	55	31.1	15	21.4	155	68.9	0	0
61-65	249	9	4.4	2	0.2	238	95.6	0	0
66-70	268	2	0.7			266	99.3	0	0
71-75	141					141	100.0	0	0
76-80	34					34	100.0	0	0
81-85	4					4	100.0	0	0
Total	1,838	471		72	15.3	1,295		0	0

* Hermaphrodites frequency is hermaphroditic individuals/total males in different size classes.

these hermaphroditic gonads with a bilobed testis had a few perinucleolar oocytes surrounded by testicular tissue(Fig. 1, A, B). In contrast with these gonadal shape, however, a few hermaphroditic gonads(n=3) consisted of single structure with fused testes that were found as ovary-like organ and a small swollen testes at the posterior end. As a result of histological observations of these hermaphroditic gonads, the fused testes exhibited hermaphroditism containing and the small swollen testes were typical testes(Fig. 1, D).

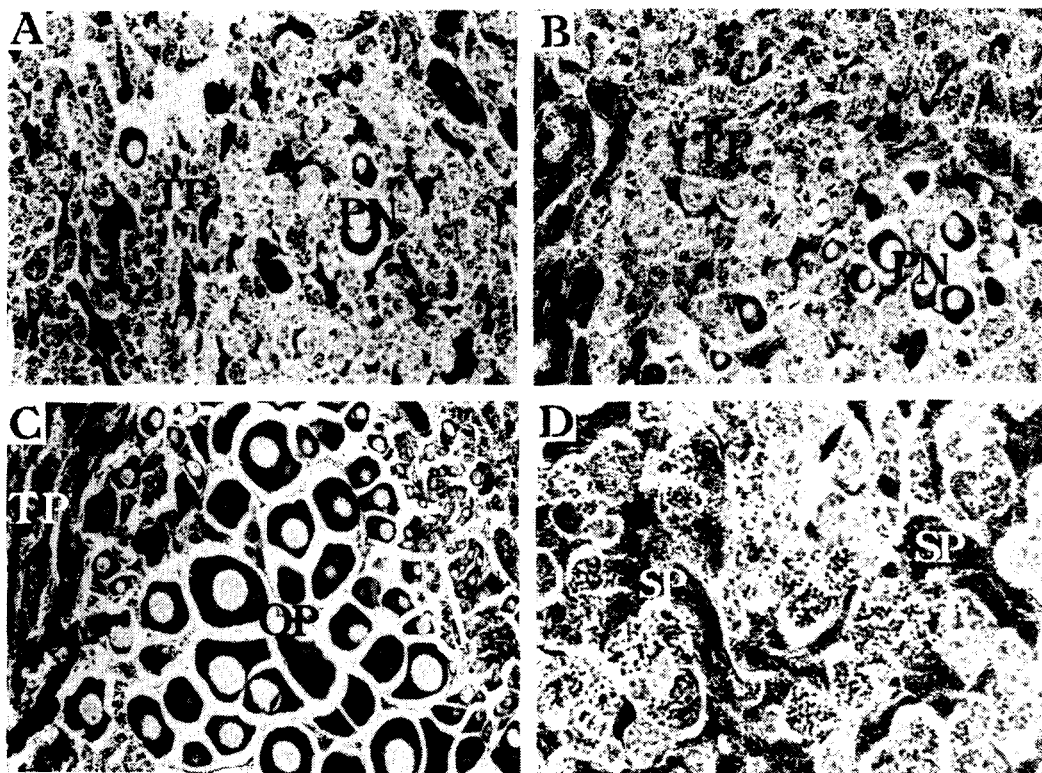


Fig. 1. Histomicrographs to transverse section of the hermaphroditic gonads of *Cobitis lutheri*.

A. testis and some oocytes are intermixed into testicular tissue(48.0mm SL). x 125 ; B. testis and oocytes are invaded gradually into testicular tissue(54.2mm SL). x 125 ; C. the fused testis with degenerating testis and developing ovary(55.1mm SL). x 125 ; D. the swollen testis with typical testicular tissue in C. x 250. OP, ovarian part ; PN, perinucleolar oocytes ; TP, testicular part ; SP, spermatids

Discussion

Lodi(1967) reported that the sex dimorphism in size and presence of an hermaphroditic gonads in *C. taenia* might be related to the protandrous sex reversal. However, Rasotto

(1992) indicated that *C. taenia* with hermaphroditic gonads was a gonochoristic species with a few males containing a few oocytes in their testes. And he revealed from the gonad histology in developing fry that the two gonadal anlagen remain paired in males whereas in females they fused to form a single ovary.

In most teleosts, the testes are elongated paired organs attached to the posterior-dorsal midline of the peritoneal cavity and the ovaries are a single organ (Nagahama, 1983). In contrast with these facts, the *C. lutheri* showed to constitute of a fused single structure with the degenerating testicular tissue and developing ovarian tissue simultaneously. And the small swollen structure of the posterior portion was observed in typical testes. In the present study, males also predominated in the small size range and females in the larger one. And the hermaphroditic individuals occur only in the intermediate size. In regard to this fact, we recognized that testicular tissues originating from the bilobed organ were sporadically intermixed by the oocytes and the oocytes invaded gradually into testicular tissues.

These features that showed size-related sex ratio change and presence of intermediate hermaphroditic gonad have been used to define the protandry (Liem, 1968 ; Okiyama and Kawaguchi, 1974 ; Miya and Nemoto, 1984 ; Pollock, 1985 ; Sadovy and Shapiro, 1987 ; Siscard *et al.*, 1990).

The results of the present study on the sexual pattern of *C. lutheri* suggest that it may be protandrous hermaphroditism which accompanied sex reversal male to female.

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한국산 점줄종개 *Cobitis lutheri*의 성비와 자웅동체성

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저서성 담수어류인 기름종개과의 점줄종개 *Cobitis lutheri*를 1987년 10월부터 1988년 9월까지 전라남도 강진군 강진읍 남포리(탐진강)에서 1년간 채집하여 암, 수의 성비와 생식소를 조사하였다. *C. lutheri*는 크기가 작은 개체에서는 수컷의 빈도가 아주 높은 반면 큰 개체에서는 암컷이 높은 빈도로 나타나는 체장별 불균형 성비를 보였다. 한편, 생식소의 육안적, 현미경적 관찰 결과, 중간 크기의 수컷 정소에서는 정소조직의 퇴화와 난소조직의 발달이 동시에 존재하는 자웅동체성(Hermaphroditism)의 개체가 발견되어 이에 관하여 논의하였다.