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Pelvic Spine Deficiency of *Pungitius tymensis* in Hokkaido

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The distribution of the Sakhalin stickleback, *Pungitius tymensis* is almost restricted to three areas in Hokkaido, Japan (Takata *et al.*, 1984). During the course of study on the geographic distribution and morphological variation of the genus *Pungitius* in Hokkaido, several individuals without pelvic spines were found in two local populations of *P. tymensis*.

Deficiency of the pelvic complex in sticklebacks has been reported in *Pungitius pungitius* from Ireland and Canada (Nelson, 1971), in *Culaea inconstans* from Canada (Nelson and Atton, 1971) and in *Gasterosteus aculeatus* from North America (Reimchen, 1980) and Scotland (Giles, 1984). However, the deficiency of the pelvic spine in sticklebacks has never been recorded from the Far East.

In the present study, the proportion of *P. tymensis* without pelvic spines to the total individuals in each population was compared among several populations in Hokkaido, and the relationship between the deficiency of the pelvic spine and sex or other meristic characters were considered.

Material and methods

Specimens of *Pungitius tymensis* used in the present study were collected from April 1979 to July 1980 in 7 rivers of the Ishikari River system, i.e., the Rurumappu, Osatsu, Shukubai, Ebetsu and Shimamatsu rivers, No. 14 Main Drainage and No. 4 West Drainage, flowing into the Sea of Japan through the central part of Hokkaido; from July to August 1980 in the Fukunaga River, which is a tributary of the Teshio River system flowing into the Sea of Japan, and the Masuhoro River flowing into the Soya Straits through the northern part of Hokkaido; in August 1980 in the Bettoga and Bekanbeushi rivers flowing into the Nemuro Straits through the eastern part of Hokkaido (Fig. 1). All specimens were captured with a dip net and preserved in 10% formalin.

Specimens were examined under a dissecting microscope with the aid of sharp tweezers to determine the presence or absence of the pelvic spine. Parts of the specimens were stained with alizarin red S and cleared with 2% KOH and 0.1% H_2O_2, in order to observe the development of the pelvic spine and pelvic skeletons. The sex of all specimens collected in the Osatsu River was determined by direct observation of the gonads. All specimens collected in the Rurumappu River were counted by the method of Matsubara (1955) in the following characters: anterior plates, posterior plates, total plates, dorsal spines, dorsal rays, anal rays and pectoral rays. Although there were variations to a certain extent in the development of the pelvic spine and pelvic skeletons, individuals with vestigial pelvic spines were regarded as the normal morph.

Results

Specimens of *P. tymensis* lacking the pelvic spine were collected only in the Ishikari River system and the Bettoga River (Table 1). Thirty-seven of 91 specimens (40.7%) from the Rurumappu River lacked both pelvic spines, 6.6% lacked the left pelvic spine and 4.4% the right. One hundred and thirty-four of 3,108 specimens (4.3%) from the Osatsu River lacked both pelvic spines, 2.8% lacked the left pelvic spine and 2.1% the right. Twenty of 160 specimens (12.5%) from No. 14 Main Drainage lacked both pelvic spines, 6.3% lacked the left pelvic spine and 4.4% the right. In specimens from the Shukubai River, 3 of 14 specimens (21.4%) lacked both pelvic spines, and the remainder possessed complete pelvic spines. Only one specimen was collected each in the Ebetsu and Shimamatsu rivers, and they lacked both pelvic spines. All 5 specimens collected in No. 4 West Drainage had normal pelvic spines.

All 177 and 11 specimens collected from the Fukunaga and Masuhoro rivers, respectively, possessed normal pelvic spines. All specimens collected from the Bekanbeushi and Bettoga rivers had normal pelvic spines except one specimen lacking the left pelvic spine from the Bettoga River.

Sex ratio of 285 individuals which lacked both

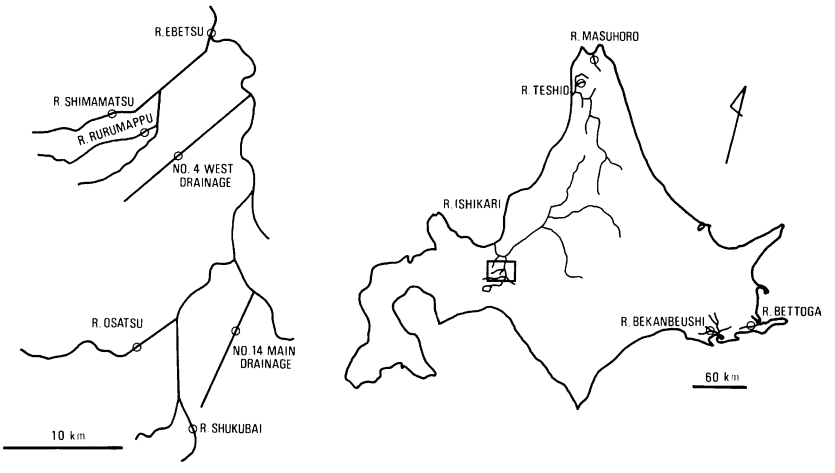

Fig. 1. Sampling localities of *Pungitius tymensis* in Hokkaido. ○, sampling station.

or either left or right pelvic spines collected from the Osatsu River is given in Table 2. There was no significant correlation between the deficiency of the spines and sex. These abnormal individuals were divided into three groups: lacking both spines, lacking the left spine and lacking the right spine. The sex ratio within each group, lacking both ($\chi^2=0.269$), lacking the left ($\chi^2=0.011$), and lacking the right ($\chi^2=0.063$), was approximately 1 : 1.

Furthermore, in order to examine whether there is a relationship between the deficiency of the pelvic spine and other meristic characters, such as the number of anterior plates, posterior plates, total plates, dorsal spines, dorsal rays, anal rays, and pectoral rays, comparisons of the characters were made among the three groups and a normal morph group collected in the Rurumappu River (Table 3). The results show no significant difference of these characters between normal morph group and each deficient morph group ($P>0.05$).

Discussion

All specimens of *P. tymensis* from the northern and eastern parts of Hokkaido possessed normal pelvic spines except one specimen lacking the left pelvic spine from the Bettoga River. The ratio of specimens without pelvic spines was much higher in the Ishikari River system than in other

Table 1. Frequencies of the deficient pelvic spine of *Pungitius tymensis* from 11 rivers. Figures in parentheses indicate the percentage of the total number (N).

Locality	N	Both absent	Left absent	Right absent	Normal
Ishikari River system					
Rurumappu River	91	37 (40.7)	6 (6.6)	4 (4.4)	44 (48.3)
Osatsu River	3,108	134 (4.3)	87 (2.8)	64 (2.1)	2,823 (90.8)
No. 14 Main Drainage	160	20 (12.5)	10 (6.3)	7 (4.4)	123 (76.8)
Shukubai River	14	3 (21.4)	0 (0.0)	0 (0.0)	11 (78.6)
Ebetsu River	1	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
Shimamatsu River	1	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
No. 4 West Drainage	5	0 (0.0)	0 (0.0)	0 (0.0)	5 (100.0)
Teshio River system					
Fukunaga River	177	0 (0.0)	0 (0.0)	0 (0.0)	177 (100.0)
Masuhoro River	11	0 (0.0)	0 (0.0)	0 (0.0)	11 (100.0)
Bettoga River	416	0 (0.0)	1 (0.2)	0 (0.0)	415 (99.8)
Bekanbeushi River	16	0 (0.0)	0 (0.0)	0 (0.0)	16 (100.0)

regions. This deficiency of pelvic spines in *P. tymensis* was however not related to sex and other morphological characters.

The proportion of individuals without pelvic spines to the total individuals in each population varied extremely among seven tributaries of the Ishikari River system. It is assumed that there is very little difference in environmental conditions among the tributaries because they are all located within 20 km of each other in the marsh of the Ishikari lowlands. The number of individuals without either the left or right pelvic spine was exceeded by the number of individuals without both pelvic spines in every tributary where the deficient morph appeared. These facts suggest that the variety of the ratio of individuals without the pelvic spine in *P. tymensis* populations is affected strongly by a genetic factor rather than environmental factors. Such genetic control was also suggested in the Irish and Canadian populations of *P. pungitius* (Nelson, 1971) and Canadian population of *Culaea inconstans* (Nelson, 1977; Nelson and Atton, 1971). The difference of the ratio among tributaries of the Ishikari River system may be due to the fact that *P. tymensis* is relatively sedentary throughout the year and consists of an independent inbreeding population in each tributary.

Table 2. Sex ratio of *Pungitius tymensis* lacking either left or right, or both pelvic spines in the Osatsu River.

	Male	Female	Total
Both absent	70	64	134
Left absent	44	43	87
Right absent	31	33	64
Total	145	140	285

Reimchen (1980) studied the relationship between conditions of dorsal and pelvic spines of *G. aculeatus* and their predators and suggested that the deficiency of dorsal and pelvic spines was advantageous to the juvenile fish when they escaped from grappling predators such as odonate nymphs. Reist (1980a, b) also inferred a possibility that the polymorphism of pelvic spine of *C. inconstans* was developed and maintained by the existence of predators. In regard to *P. tymensis*, it is unfortunately unknown whether or not the predation pressure affecting the population in the Ishikari River system is stronger than that affecting the populations in the northern and eastern parts of Hokkaido.

Nelson and Atton (1971) reported that the deficiency of pelvic spines was observed in both *C. inconstans* and *P. pungitius* which coexist in Pine Lake in Alberta, Canada. Nelson (1977) also considered the parallel absence of pelvics in *Pungitius* and *Gasterosteus* in North America. If the factor which develops and maintains the polymorphism is related to predation, then the parallel absence of pelvic spine should also be observed between the populations of *P. tymensis* and *P. pungitius*, which are distributed sympatrically in the Ishikari River system. However, all specimens of *P. pungitius* in the Ishikari River system possessed normal pelvic spines (Takata, unpublished data). It is difficult to presume

Table 3. Means and standard errors for five characters of *Pungitius tymensis* in the Rurumappu River divided into four groups based on the presence or absence of pelvic spines.

	Both absent	Left absent	Right absent	Normal
Number of individuals	37	4	6	44
Anterior plates (left)	0.73±0.31	0.17±0.43	1.00±2.24	0.91±0.33
Anterior plates (right)	0.54±0.31	0.17±0.43	1.00±2.24	0.70±0.27
Posterior plates (left)	5.22±0.26	5.33±0.55	5.00±1.30	5.18±0.25
Posterior plates (right)	5.08±0.20	5.33±0.55	5.00±1.30	5.20±0.22
Total plates (left)	5.95±0.49	5.50±0.58	6.00±2.91	6.09±0.53
Total plates (right)	5.62±0.45	5.50±0.58	6.00±1.83	5.91±0.40
Dorsal spines	11.41±0.20	11.17±1.23	11.00±1.30	11.59±0.22
Dorsal rays	10.54±0.20	10.17±0.43	10.50±0.92	10.55±0.21
Anal rays	9.76±0.21	9.50±0.58	9.75±0.80	9.82±0.18
Pectoral rays	9.84±0.12	9.83±0.43	10.00±0.00	9.84±0.11

that predation affects only *P. tymensis*, because the two species have a similar mode of life and in the Osatsu River carnivorous vertebrates which may predate the sticklebacks are rare. Therefore, some other factors which exclusively affect *P. tymensis* probably contribute to pelvic spine deficiency in *P. tymensis* living in the Ishikari River system, though the effect of predation may not be completely rejected.

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北海道産エゾトミヨ *Pungitius tymensis* における腹棘の欠失

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道央地方の石狩川水系と道東地方の別当賀川から，腹棘の欠失したエゾトミヨ *Pungitius tymensis* が見いだされた．7 支流を調査した石狩川水系では，ルルマップ川で腹棘を欠く個体の比率が最も高く，半数以上の個体が両方，または片方の腹棘を欠いていた．一方，腹棘を欠く個体が，まったく出現しない支流もあった．道東地方の別当賀川では，片方の腹棘を欠くエゾトミヨが 1 個体採集されたにすぎなかった．道北地方の 2 河川では，腹棘を欠く個体はまったく出現しなかった．

腹棘の欠失は性とは無関係であり，また，腹棘の欠失に伴って他の計数的形質が平行的に変異することもなかった．

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