

Habitat Preference of the Stream Fish, *Sinogastromyzon puliensis* (Homalopteridae)

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Shyi-Liang Yu and Teh-Wang Lee (2002) Habitat preference of the stream fish, *Sinogastromyzon puliensis* (Homalopteridae). *Zoological Studies* 41(2): 183-187. Understanding habitat preference is an important consideration for the management of fish populations. We used multiple regression to describe relationships between environmental variables and catch-per-unit-effort (CPUE) of *Sinogastromyzon puliensis* (Homalopteridae). Fish and habitat data were collected in the Kaoping, Tsengwen, Choshui, and Tatu Rivers from July 1997 to June 1999 in western Taiwan. Electrofishing was used to collect fish in grids, and environmental variables in the sampled areas were measured immediately after sampling. Multiple regression showed that the most parsimonious model includes the linear effects of depth, velocity, and conductivity. The highest behavioral preference for depth occurred at 60 cm; it was similar between 20 and 40 cm and declined for very shallow and very deep water. *S. puliensis* preferred a wide range of velocities of between 0.8 and 2 m/s. Preference of substrate was highest for small rocks, and similar for pebbles and big rocks.
<http://www.sinica.edu.tw/zool/zoolstud/41.2/183.pdf>

Key words: Fish population, Endemic species.

Many environmental variables have been considered to be important for influencing habitat preference by fish in aquatic ecosystems (Hynes 1970, Bovee 1982, Baltz et al. 1987, Moyle and Cech 1988). Yu and Peters (1997) indicate that habitat availability affects habitat selection by fish. Most of the habitat models that have been established are capable of dealing with a single factor only, such as depth, velocity, substrate, or stream cover (Sheppard and Johnson 1985, Leonard and Orth 1988). Their multiple use produces interacting models for habitat suitability (Bovee 1982).

Selection of habitat by fish depends on the availability of appropriate depth, velocity, substrate, and cover in a stream (Bovee 1982). Lee et al. (1998) indicate that depth, water temperature, and elevation have significant effects on the local abundance of the deep-body shovelnose minnow (*Varicorhinus alticorpus*) in the Baynan River, eastern Taiwan. Many authors have documented interspecific differences in habitat use (Moyle and Baltz

1985, Leonard and Orth 1988, Yu and Peters 1997). Fish may utilize various habitats to reduce interspecific competition for space. How fish species shift their habitat use is important for understanding interspecific interactions.

Sinogastromyzon puliensis (Homalopteridae) is an endemic freshwater species in Taiwan. The morphology and distribution of the species have been investigated (Liang 1974, Tzeng 1986, Shen 1993). It is found in the Kaoping, Tsengwen, Choshui, Tatu, and Tachia Rivers in the western portion of the island. This study was designed to: (1) determine the environmental variables that affect habitat use by *S. puliensis* and (2) develop a habitat preference index for use in the conservation and management of the species.

MATERIALS AND METHODS

Fish and habitat data were collected from July

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1997 to June 1999 in the Kaoping, Tsengwen, Choshui, and Tatu Rivers in western Taiwan. At each sampling site, we systematically established three 20-m transects perpendicular to the bank. For each transect, the 1st sampling grid (2 m wide x 5 m long) was set in the first 5 m near the shore, and subsequent sampling grids were at 4-m intervals. The grid was placed on the bottom of the river for at least 30 min before fishing with a backpack electrofishing unit made of 12-V batteries. For fish specimens collected from each grid, the species were identified, their numbers counted, and their lengths and weights were individually measured, and then they were returned to the river. Hydraulic variables in the middle and at each corner of the sampling grid were measured immediately after fishing. Water depth and current velocity were determined with a graduated wading rod (cm) and a pygmy current meter (m/s); water temperature with a thermometer with a precision to 0.1 °C; conductivity, dissolved oxygen, pH, and total dissolved solids with a water quality analysis device; and turbidity with a turbidity meter. Dominant substrate type was determined visually and coded as silt, sand, small gravel, big gravel, pebbles, small rocks, or big rocks (Bozek and Rahel 1992).

We used multiple regression analysis to relate environmental variables and catch-per-unit-effort (CPUE) of the species (SAS 1985). Habitat preference, which is utilization divided by availability, was calculated for each environmental variable at a significant level of 0.5% (Bovee 1982).

RESULTS

Table 1 summarizes the mean values of sampled fish and environmental variables in the study areas. The analysis shows that water discharge is significantly positively correlated with river width, depth, and current velocity, and negatively correlated with elevation, turbidity, conductivity, and total dissolved solids. In order to avoid multicollinearities, we examined correlation coefficients among independent variables and excluded the highly correlated variables (i.e., $r^2 > 0.5$) from the models. Therefore, the most parsimonious model (Table 2) includes the 3 variables, depth, velocity, and conductivity, that showed linear effects. No other variables met the significance level for entry into the model. To facilitate comparison of variables, we included nonsignificant coefficients of depth (Table 2).

Available habitat mostly occurred in shallow water of less than 40 cm and with water velocities less than 1.2 m/s (Figs. 1, 2). The greatest frequency

occurrence of available substrate was for pebbles (Fig. 3). Our collections show very little available habitat in water depths greater than 60 cm or with current velocities faster than 1.4 m/s.

S. puliensis occurred most frequently in shallow water at depths of between 20 and 40 cm but current velocity varied from 0.6 to 1.4 m/s (Figs. 1, 2). Substrate use was highest in pebbles (Fig. 3). No fish were collected from rivers with depths > 90 cm. *S. puliensis* was less abundant at locations with velocities > 1.8 m/s and infrequently collected on silt, sand, small gravel, and big rock substrates. The preferred habitats of *S. puliensis* are at depths of 20-60 cm, with water velocities of 0.8-2 m/s, and with a substrate of pebbles, and small and big rocks. The optimal habitats for depth occurred at 60 cm and for water velocity at 1.6 m/s with a substrate of small rocks.

Table 1. Minimum, maximum, and mean values of sampled fish and environmental variables in the study areas

Variables	Minimum	Maximum	Mean
No. of fish	0	134	5.8
Elevation (m)	25	340	198
Width (m)	14	141	53
Depth (m)	0.07	0.9	0.36
Velocity (m/s)	0.12	2.32	0.90
Discharge (m ³ /s)	0.18	102.6	18.77
Substrate (cm)	0.1	114	24.2
Temperature (°C)	17.9	29.8	22.9
Turbidity (NTU)	1.16	6744	154.3
Conductivity (umhos/cm)	90	649	376
Dissolved oxygen (mg/l)	4.92	9.68	8.1
pH	6.2	10.9	8.2
Total dissolved solids (mg/l)	47	419	228

Table 2. Regression coefficients of the most parsimonious model on *Sinogastromyzon puliensis*

Variable	Regression coefficient	Standard error	F	Prob > F
Intercept	-0.3466	1.5720	0.05	0.8257
Velocity	3.8257	0.7304	27.43	0.0001
Conductivity	0.0062	0.0028	4.85	0.0284
Depth	-0.0328	0.01967	2.78	0.0964

DISCUSSION

The results of this study show that depth, velocity, and substrate are important hydraulic and physical variables for habitat selection by *S. puliensis*. The species tends to occur in shallow water with medium velocities and medium- to large-sized substrate. However, preferred habitats of *S.*

puliensis occupied moderate depths with fast velocities and moderate to large substrate. This may be due to the fact that fish are less susceptible to collection by electrofishing in deep and fast water. Yu et al. (1995) discussed the biases and limitations associated with electrofishing sampling. Our collections took place at depths of less than 1 m, and this may limit the application of our model for deep wa-

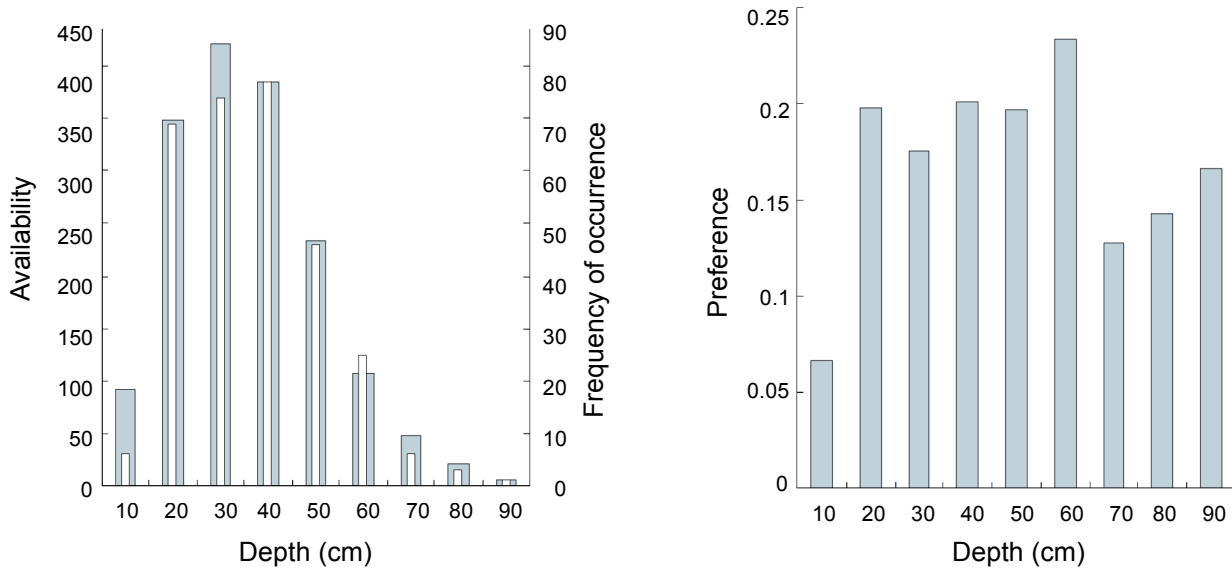


Fig. 1. Availability, frequency of occurrence, and preference by depth categories of *Sinogastromyzon puliensis*.

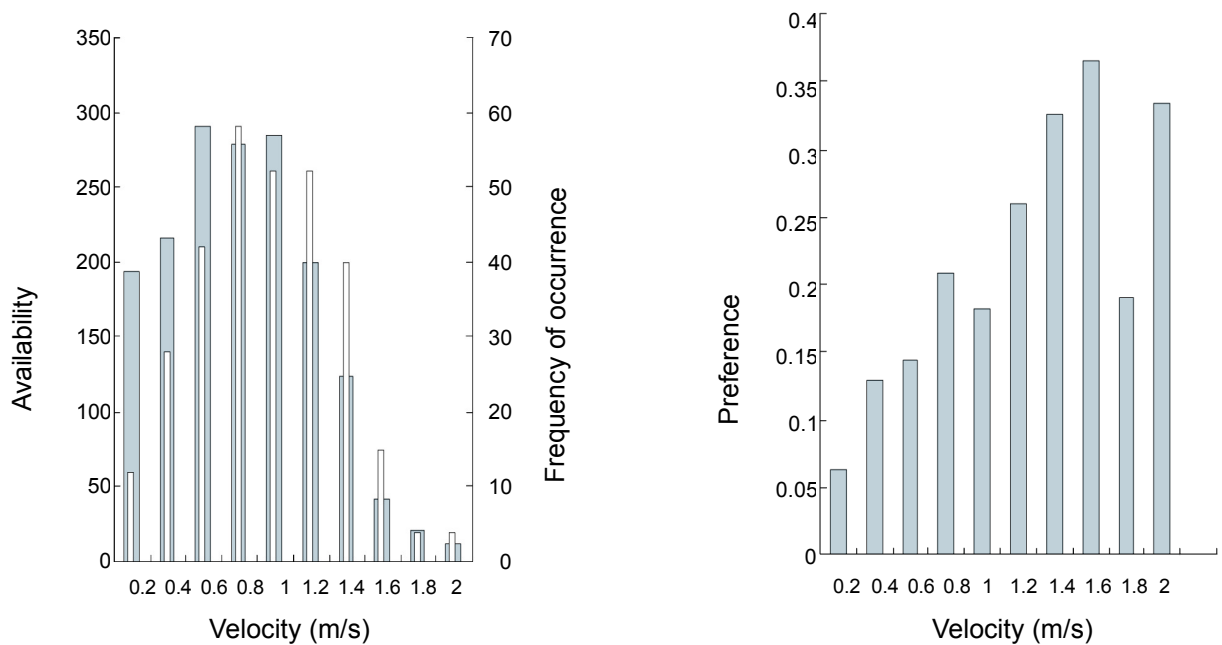


Fig. 2. Availability, frequency of occurrence, and preference by velocity categories of *Sinogastromyzon puliensis*.

ter areas used by this species.

Coefficients of multiple regression models indicate that velocity and conductivity had positive effects, and depth had a negative effect on *S. puliensis* (Table 2). Also, velocity had the greatest effect on the species, while conductivity and depth had similar influences on the species. The preferred habitat of *S. puliensis* was most concentrated in moderately shallow water at depths of between 20 and 60 cm. Conductivity having a significant effect on *S. puliensis* may be due to the fact that fish are less susceptible to collection with low-voltage fishing gear. Significant depth and velocity effects in the model indicate that these factors influence *S. puliensis* distribution. Our results concur with other instream flow studies (Sheppard and Johnson 1985, Leonard and Orth 1988) which suggest that depth and velocity need to be included in fish habitat models.

It is important that analysis be consistent with probability distributions of the data. The high frequency of catch in our study implies that regression analysis is appropriate for the data. Although some studies used presence-versus-absence analyses (Thielke 1985, Yu et al. 1995) to estimate preferred habitat for fish in rivers, our analyses suggest that multiple linear regression models fit the observed data well. Reckhow et al. (1987) used multiple linear regression models to relate fish distribution to lake acidification. Gunst and Mason (1980) showed

that increasing the number of parameters in a model increases the correlation among parameters. Our regression model included the linear effects of depth, velocity, and conductivity. This decreased the multicollinearities and more accurately represented the observed data.

Many studies suggest that habitat availability affects habitat preference of fish (Bovee 1982, Moyle and Baltz 1985, Yu and Peters 1997). Our findings also show that habitat availability of velocity, depth, and substrate have significant effects on preferred habitats of *S. puliensis* (Figs. 1-3). The results show that velocity, depth, and conductivity combine to influence habitat use by *S. puliensis*. A single factor may not be enough to describe habitat use in complex ecosystems. Voos and Lifton (1988) suggested bivariate habitat use of depth and velocity. Recent studies of the influence of depth and velocity availability on habitat preference in instream flow studies emphasize their importance for habitat evaluation (Bovee 1982, Baltz et al. 1987, Yu and Peters 1997). Our analyses, which included habitat use, availability, and preference data, allowed us to identify the relative importance among factors and to accurately describe preferred habitats of this fish species. The observations also suggest that establishing the habitat preference of fish is important, and the information can be used to support sufficient water requirements for fish activities in rivers. Consequently, structuring river flow to match fish be-

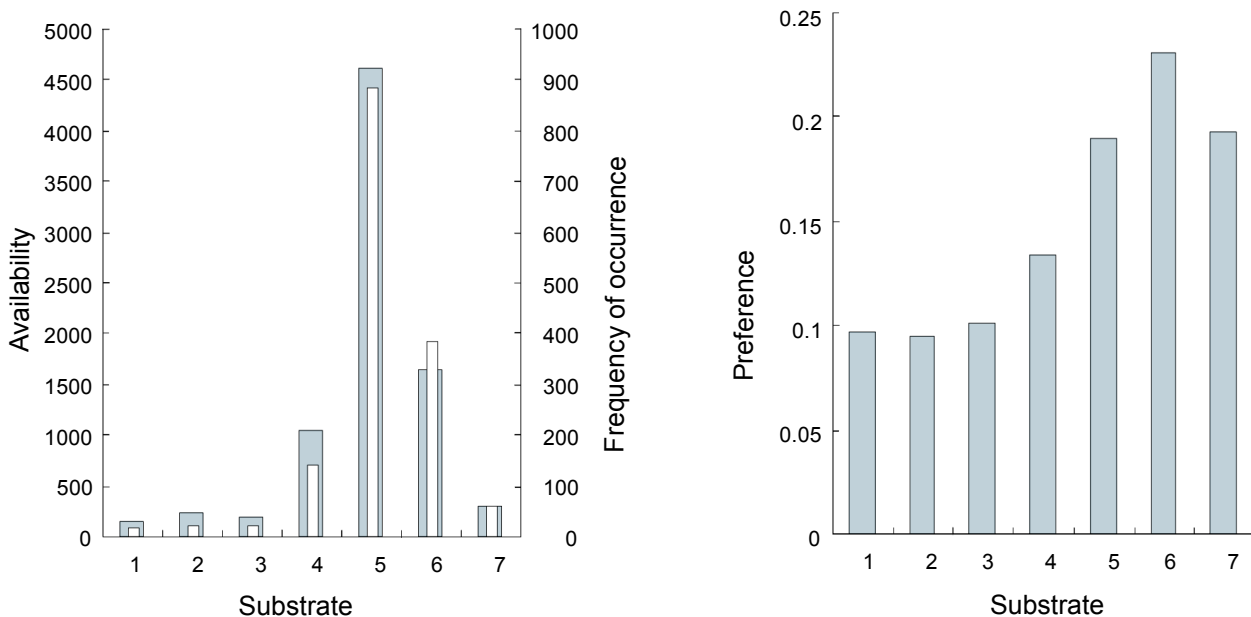


Fig. 3. Availability, frequency of occurrence, and preference by substrate categories of *Sinogastromyzon puliensis*. Note: 1, silt; 2, sand; 3, small gravel; 4, big gravel; 5, pebbles; 6, small rocks; 7, big rocks.

havior may be beneficial to fish populations and compatible with hydroelectric development.

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