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# Physical Habitat Assessment of Microphysogobio Longidorsalis in the Han River Basin

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*Abstract*

*The physical habitat was assessed for Microphysogobio longidorsalis in the Han River Basin. Field monitoring was conducted for ecological and habitat conditions for 11 stations from October 2008 to November 2009. Twenty-two species (61.8%) including M. longidorsalis and Zacco koreanus were found endemic out of the 39 species in 10 families sampled during this study period. Z. platypus (25.8%) was the most frequently found followed by Coreoleuciscus splendidus (16.5%) and M. longidorsalis (15.2%). For M. longidorsalis, the total length group of 8-10cm had the highest number of samples.. In addition, the favored habitat conditions were estimated to be 0.4-0.5 m for water depth, 0.2-0.9 m/s for flow velocity, sand (0.1-1.0 mm)-cobbles (100.0-300.0 mm) for substrate size and run for habitat type, respectively.*

## INTRODUCTION

The physical, chemical and biological characteristics of the water environment in a river have significant direct or indirect impacts on fish (Arthington et al., 2006). The physical characteristics such as water depth, flow velocity, substrate size, alignment of riffle and pool are important factors to the fish community and life cycle (Hur et al., 2009). These characteristics are related to flow rate and have a substantial influence on the composition of the biological community in a river (Bunn and Arthington, 2002). Changes in flow rate may often go so far as to threaten stabilized aquatic ecosystems (Ward, et al., 1999). Research on the habitats of fish have generally focused on ecological aspects, such as the structure of the fish community at a survey station. A study on the assessment of physical habitats was performed for *Zacco platypus* according to stream order, however basic data on the physical habitats for various species of fish required for river rehabilitation and restoration, are still insufficient (Hur et al., 2009).
Living in the Han and Geum River Basin, *Microphysogobio longidorsalis* are among Korea endemic species of fish. They are known to inhabit riffles with gravels at the bed midstream and upstream of the rivers (Kim et al., 2005). It is reported that they are recently on the decrease in terms of habitats and population due to, for example, modified water environment or river rehabilitation (Song and Son, 2003).
This study attempted to analyze the distribution and appearance patterns of *M. longidorsalis* in the Han River Basin, based on its physical characteristics, including water depth, flow velocity, substrate size, types of habitats and depth-velocity relationships according to the length of sampled fish.

## MATERIALS AND METHODS

Main survey stations in the Han River Basin, including a peak point, were selected. The survey was carried out for the period ranging from October, 2008 to November, 2009. Fish sampling was performed three or four times at the survey stations. The sampled *M. longidorsalis* were identified according to the physical characteristics of their habitats (e.g. water depth, flow velocity, substrates and types of habitat including riffle, run and pool).
Each stream order was defined using a map of scale 1 to 75000. The survey was under taken according to stream order with the smallest initial tributary of the source of a river being set at "1" in

stream order. If this tributary was confluent with another stream with the same order, the confluent stream increased by one (stream) order. If a stream met another with lower stream order, its stream order was not changed. A change in stream order resulting from artificial structures was not excluded. Figure 1 shows the location of each survey station.

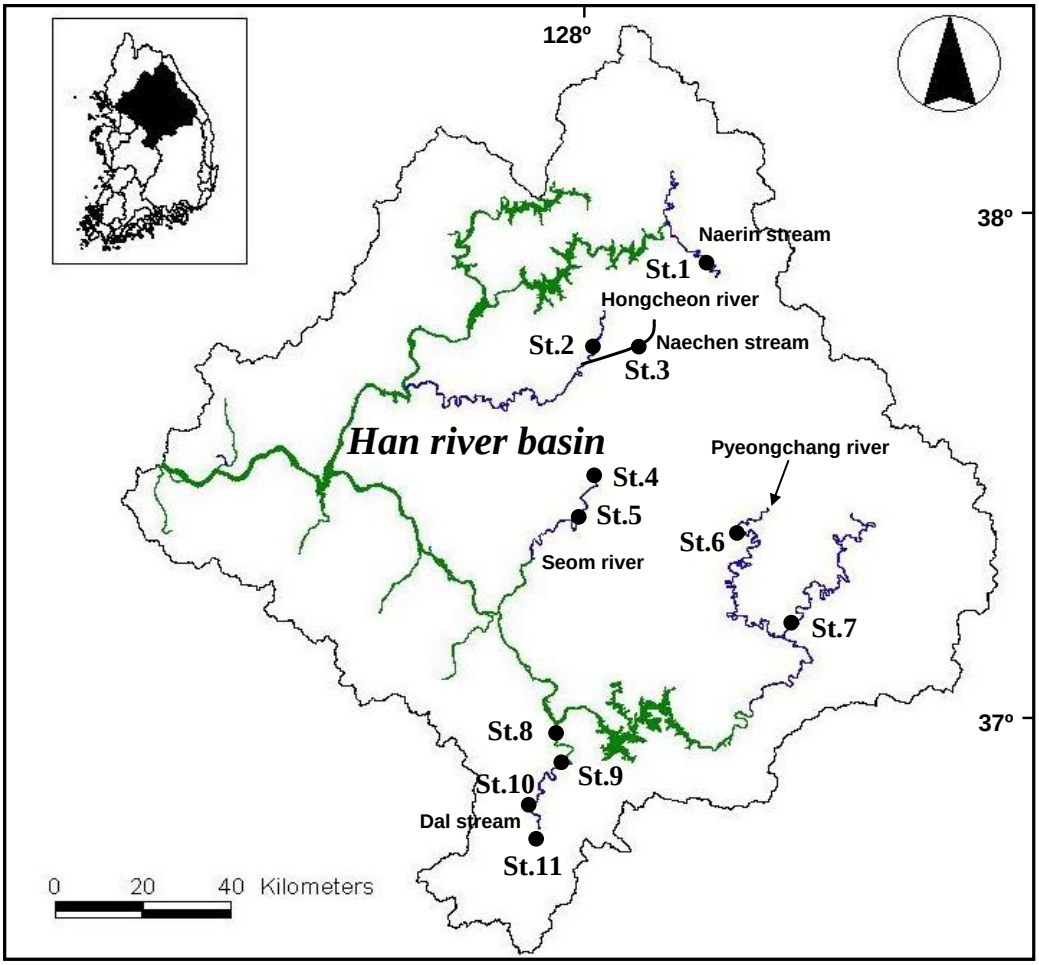



**Figure 1. Location map of the survey stations.**

Fish sampling was performed approximately 200 m upstream and downstream of the peak point, equally, for 60 minutes. Fish sampling coverage included pool, riffle and run. A cast net (mesh size: 5×5 mm) and kick net (mesh size: 3×3 mm) were used depending on river characteristics. When the former was used, it was thrown 20 times every fish sampling to carry out a quantitative survey. The latter was used for sampling fish hiding behind water plants and around cobbles at the river banks. The number of times that the cast net was thrown in a pool, riffle and run, was made as equal as possible; as was the time of fish sampling using the kick net. Fish sampling was carried out zigzagging from downstream to upstream in the river. Sampled fish were identified in situ, and then released. Where fish samples in-situ classification and identification was difficult, these were then fixed using buffered formalin solution (10%), and identified in the laboratory. Their classification and identification were carried out according to those of Kim and Park (2002).

Flow velocity, water depth, substrate size and types of habitats at stations where netting was undertaken were measured. Flow velocity and water depth were measured using an electromagnetic flow meter (Model 801, Valeport, UK) and the bathymetric rod of the flow meter, respectively. Based on substrate size classes as proposed by Woo (2004), bed substrates were subdivided according to their size: silts (1, 0.1 mm or smaller), sand (2, 0.1 to 1.0 mm), fine gravels (3, 1.0 to 50.0 mm), coarse gravels (4, 50.0 to 100.0 mm), cobbles (5, 100.0 to 300.0 mm), and boulders (6, 300.0 mm or larger). Types of habitats were classified into pool, riffle and run (Kim and Kim, 2009): subdivided into open-ended and close-ended types, pools are riparian zones with low flow velocity or in a steady state. Riffles are subject to a steep-slope change in topography and river bed, which results in higher flow velocity. When there is a decrease in flow rate, the river bed gets exposed. The run was demarcated into upstream and downstream zone bordering a riffle.

## RESULTS AND ANALYSES

Fish amounting to a total of 3,886 were sampled (39 species within 10 families in total) at all survey stations (Table 1). Of these, 23 species belonged to the family Cyprinidae which were the majority (91.1%) of those sampled. Species belonging to other families were comprised of Gobiidae (2.9%), Centropomidae (2.2%) and Cobitidae (1.9%). 22 species including *Acheilognathus koreensis*, *Acheilognathus yamatsutae*, *Pseudopungtungia tenuicorpa*, *Coreoleuciscus splendidus*, *Gobiobotia macrocephala*, *G. brevibarba*, and others were found to fall under Korea endemic species; these occupied as high as 61.8% of the sampled fish. Species designated as endangered wild animals (e.g. *Acheilognathus signifer* (0.08%), *P. tenuicorpa* (0.41%), *G. macrocephala* (0.36%) and *G. brevibarba* (2.08%)) were also sampled. Of 39 species sampled at all the survey stations, *Z. platypus* was the dominant species by occupying 25.8% of the total sampled, and *C. splendidus* were subdominant species (16.5%). *M. longidorsalis* (15.2%), *Z. koreanus* (13.4%), *Pungtungia herzi* (4.5%), and other species were also sampled.

According to Song and Son (2003) who reported that, upstream of the Seom River, the Song and the Hongcheon River, the appearance rate of *M. longidorsalis* was 12.9%, and were found to be the third dominant species in the Han River, following *Z. koreanus* (24.8%) and *Z. platypus* (18.9%). It was also known that their appearance rate was 8.3% (Lee et al., 2006) in the Pyeongchang River, 8.3% (Song et al., 1995) in the Seom River, 4.4% (Nam et al., 1998) in the Naerin River, and 6.0% (song and Kwon, 1993) and 4.5% (Yang et al., 1991) in the Hongcheon River. In this study, their appearance rate was found to be a littler higher at 15.2% than the foregoing findings. It can be assumed that this resulted from a difference in sampling stations.

*M. longidorsalis* have developed so as to eat attached algae (on gravels or at the river bed) by having the mouth downward of their own head (Kim et al., 2005). Similar to most other fish inhabiting rivers in Korea, they lay spawn in April to June (Song and Son, 2003). This study found that they spawned during the same season, and competed for a similar ecological niche as *Z. koreanus*, *Z. platypus* and *C. splendidus*. Song and Son (2003) similarly reported that *M. longidorsalis* lived together with *Z. koreanus*, *Z. platypus*, *C. splendidus* and *P. herzi*. Since *Z. platypus* and *Z. koreanus* are dominant species and subdominant species, respectively, midstream and upstream of rivers in Korea, it is assumed that *M. longidorsalis* will compete for an ecological niche with *C. splendidus* and *P. herzi* as the third dominant species.

Figure 2 shows the appearance rate of *M. longidorsalis* by length, according to flow velocity, water depth, substrate size and types of habitats. Of the 590 in total sampled at all the survey stations, those of 8 to 10 cm length occupied the majority (50.8%). It was found that 93.9% inhabited streams had flow velocity of 0.2 to 0.9 m/s and 32.5% of the inhabited streams were 0.4 to 0.5 m in water depth. Nearly all (97.5%) inhabited streams with sand (0.1 to 1.0 mm) and coarse gravels (50.0 to 100.0 mm) at the river bed. With regard to their types of habitats, 62.2%, 32.5% and 5.3% lived in runs, riffles and pools, respectively.

*M. longidorsalis* of length 7.0 cm or lower, 7.0 to 11.0 cm and 11 cm or higher, were reported as one-year, two-year and three-year and older fish(Song and Son, 2003). On the other hand, Uchita (1939) reported *M. longidorsalis* with 4.0 to 5.0 cm, 6.0 to 9.0 cm and 10 cm or higher in length as one-year, two-year and three-year and older fish. In this survey, *M. longidorsalis* ranging from 3 cm to 14 cm in length were sampled. According to the previous studies, it can be said that one-year to three-year ones were all sampled. Judging from the length of *M. longidorsalis*, there were young fish found among the sampled ones since June, while, in March and April, relatively full-grown fish were sampled. This tendency in appearance by length was similar to those of Song and Son (2003).

There was a distinct difference in the distribution of *M. longidorsalis* between less than 0.5 m and 0.5 m or higher in water depth, however the fish were widely distributed at 0.2 m/s or higher in flow velocity. With regard to the distribution of *M. longidorsalis* in the Han River, it was known that they lived in the river with 0.3 to 0.6 m/s and 0.3 to 0.5 m in flow velocity and water depth, respectively, while in spawning season or the young-fish stage, and that preferred the river with 0.3 to 0.8 m/s and 0.3 to 0.8 m in flow velocity and water depth, respectively, while they were in the adult-fish stage (Kim, 1999). These ranges of flow velocity and water depth required for their habits are consistent with those of this study. About 6% appeared in streams with even 0.1 m/s or lower in flow velocity. Most of these were young fish of 5cm or less in length, and captured, mainly, since June (Figure 3). As with other species of fish, *M. longidorsalis* spend their young stage at the river bank areas rather than in the center where there is a high level of water depth and flow velocity. In Korea, rivers get shallow (in water depth) and slow (in flow velocity) at the bank areas as the drought season (March to April) shifts to the rainy season (June). These conditions contribute to the growth of annual and perennial plants, which, in turn, helps young fish escape from predatory animals.

**Table 1. The list and individual number of collected fish at each survey stations in the Han River Basin**

| Species \ Stations | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Total | RA(%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cyprinidae** | | | | | | | | | | | | | |
| °˘*Acheilognathus signifer* | | | 1 | | | | | 1 | | | 1 | 3 | 0.08 |
| °*Acheilognathus koreensis* | | | | | | | | | | 1 | | 1 | 0.03 |
| °*Acheilognathus yamatsutae* | | | | | | | | 63 | 23 | 29 | 8 | 123 | 3.17 |
| *Acheilognathus rhombeus* | | | | | | | | 3 | | 2 | | 5 | 0.13 |
| *Pungtungia herzi* | 5 | 8 | 11 | 29 | 3 | 17 | 12 | 14 | 22 | 13 | 42 | 176 | 4.53 |
| °˘*Pseudopungtungia tenuicorpa* | | 1 | 1 | | | | | | | 2 | 12 | 16 | 0.41 |
| °*Coreoleuciscus splendidus* | 11 | 26 | 23 | 76 | 11 | 94 | 47 | 99 | 124 | 48 | 82 | 641 | 16.50 |
| °*Sarcocheilichthys variegatus wakiyae* | | | | | 1 | 1 | | 15 | 9 | 14 | 4 | 44 | 1.13 |
| °*Squalidus gracilis majimae* | | | 1 | | | | | | | | | 1 | 0.03 |
| *Hemibarbus labeo* | | | | | 6 | | | 13 | 3 | 5 | 12 | 39 | 1.00 |
| *Hemibarbus longirostris* | 1 | 31 | 21 | 7 | 3 | 7 | 1 | 1 | 1 | 3 | 5 | 81 | 2.08 |
| °*Hemibarbus mylodon* | | | | | | 3 | 2 | | | | | 5 | 0.13 |
| *Pseudogobio esocinus* | 1 | 5 | 10 | 2 | 6 | | | 4 | 3 | | 1 | 32 | 0.82 |
| *Abbottina rivularis* | | | | | 2 | | | 4 | | 2 | 1 | 9 | 0.23 |
| °*Abbottina springeri* | | | | | 3 | 2 | | 13 | 55 | 6 | 4 | 83 | 2.14 |
| °˘*Gobiobotia macrocephala* | | | | | | | 6 | 3 | 2 | 3 | | 14 | 0.36 |
| °˘*Gobiobotia brevibarba* | 5 | 1 | 3 | 1 | 1 | 28 | 42 | | | | | 81 | 2.08 |
| °*Microphysogobio yaluensis* | | 10 | 13 | | | 2 | | 13 | 6 | | 9 | 53 | 1.36 |
| °*Microphysogobio longidorsalis* | 21 | 161 | 229 | 24 | 3 | 27 | 67 | 20 | 25 | 3 | 10 | 590 | 15.18 |
| *Rhynchocypris oxycephalus* | | | | | | | 1 | | | | | 1 | 0.03 |
| °*Zacco koreanus* | 42 | 60 | 98 | 16 | 9 | 66 | 199 | | | | 31 | 521 | 13.41 |
| *Zacco platypus* | 16 | 206 | 90 | 30 | 36 | 24 | 45 | 171 | 102 | 82 | 202 | 1004 | 25.84 |
| *Opsariichthys uncirostris amurensis* | | | 1 | | 1 | | | 1 | 2 | 4 | 7 | 16 | 0.41 |
| **Cobitidae** | | | | | | | | | | | | | |
| *Misgurnus anguillicaudatus* | | | 1 | | | | | | | | | 1 | 0.03 |
| °*Iksookimia koreensis* | | 9 | 5 | 7 | 1 | | 5 | 3 | | | | 30 | 0.77 |
| °*Koreocobitis rotundicaudata* | 1 | | | 2 | | 16 | 14 | 4 | 3 | | 2 | 42 | 1.08 |
| **Bagridae** | | | | | | | | | | | | | |
| °*Pseudobagrus koreanus* | | | | | | | | 1 | 1 | | | 2 | 0.05 |
| *Leiocassis ussuriensis* | | | | | | | | | 1 | | | 1 | 0.03 |
| **Amblycipitidae** | | | | | | | | | | | | | |
| °*Liobagrus mediadiposalis* | 2 | 2 | 8 | 5 | | 5 | 1 | 8 | 9 | 2 | 1 | 43 | 1.11 |
| °*Liobagrus andersoni* | | 1 | | | | 5 | 5 | 1 | 4 | | | 16 | 0.41 |
| **Osmeridae** | | | | | | | | | | | | | |
| *Plecoglossus altivelis* | | | | | | | | 1 | | | | 1 | 0.03 |
| **Salmonidae** | | | | | | | | | | | | | |
| *Oncorhynchus masou masou* | | | | | | | 1 | | | | | 1 | 0.03 |
| **Centropomidae** | | | | | | | | | | | | | |
| *Siniperca scherzeri* | | | | 1 | | | | 2 | | | | 3 | 0.08 |
| °*Coreoperca herzi* | 4 | 1 | 8 | 2 | 1 | 2 | 12 | 17 | 28 | 2 | 4 | 81 | 2.08 |
| **Odontobutidae** | | | | | | | | | | | | | |
| °*Odontobutis platycephala* | | | 2 | 1 | | | | 2 | | 2 | 1 | 8 | 0.21 |
| °*Odontobutis interrupta* | | | | | | | | 2 | 1 | | | 3 | 0.08 |
| **Gobiidae** | | | | | | | | | | | | | |
| *Rhinogobius giurinus* | | | | | | | | 2 | | | | 2 | 0.05 |
| *Rhinogobius brunneus* | | 1 | 1 | 16 | | | | 18 | 1 | 58 | 17 | 112 | 2.88 |
| **Centrachidae** | | | | | | | | | | | | | |
| **Micropterus salmoides* | | | | | | | | | | 1 | | 1 | 0.03 |
| *Number of species* | 11 | 15 | 19 | 15 | 15 | 15 | 16 | 28 | 21 | 20 | 21 | 39 | |
| *Number of individual* | 109 | 523 | 527 | 219 | 87 | 299 | 460 | 499 | 425 | 282 | 456 | 3886 | |

° :Korea Endemic Species ˘ :Endangered Species * :Exotic Species RA :relative abundance

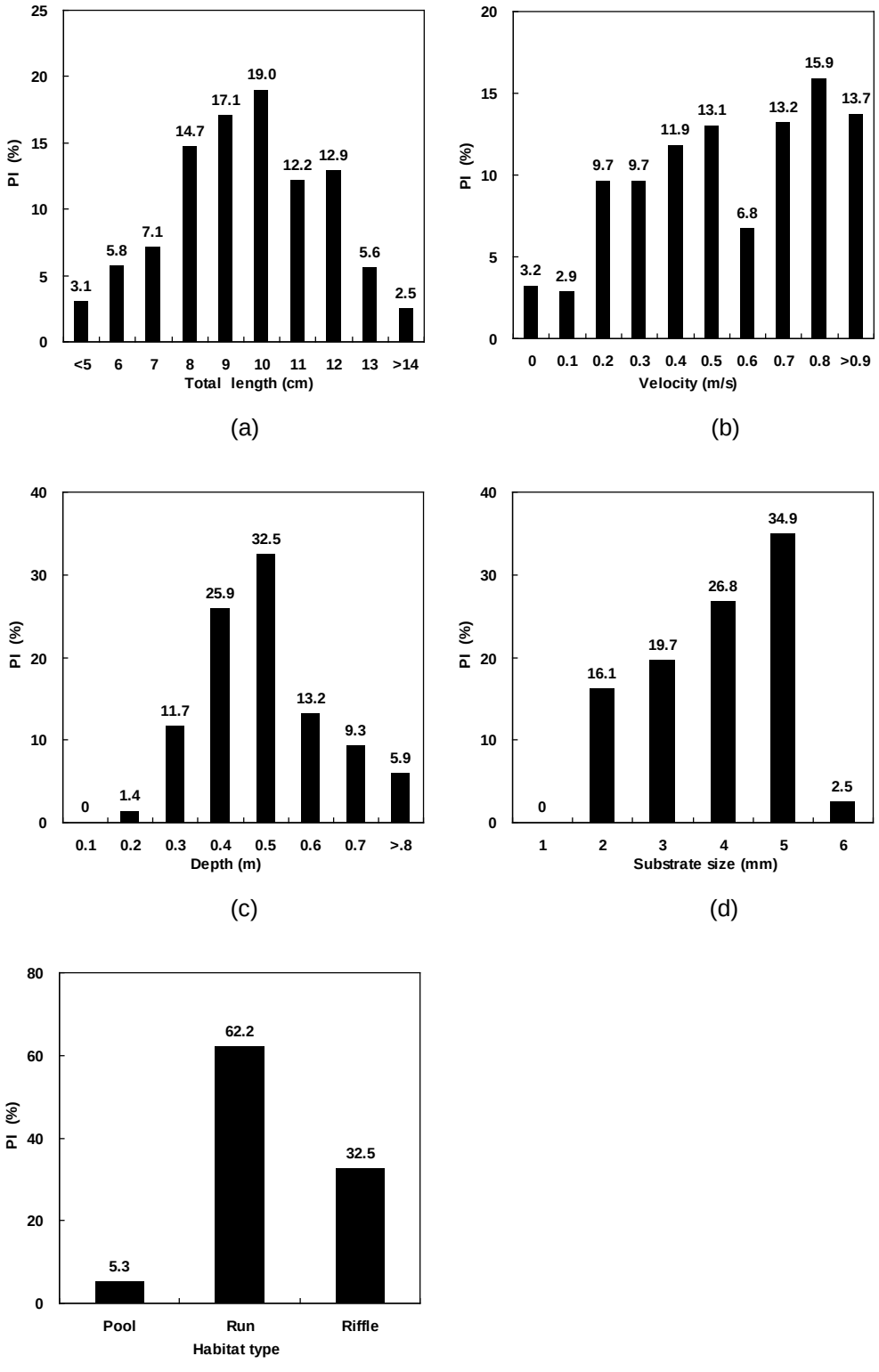
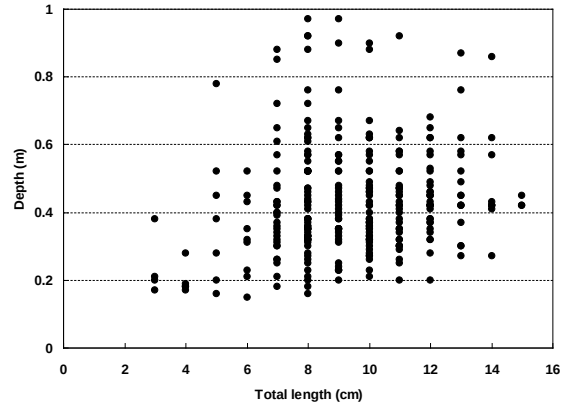
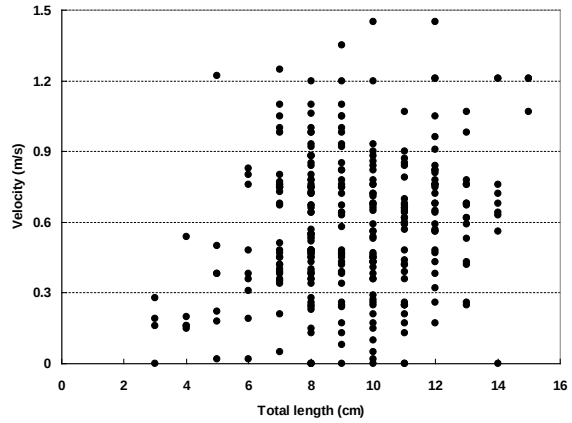


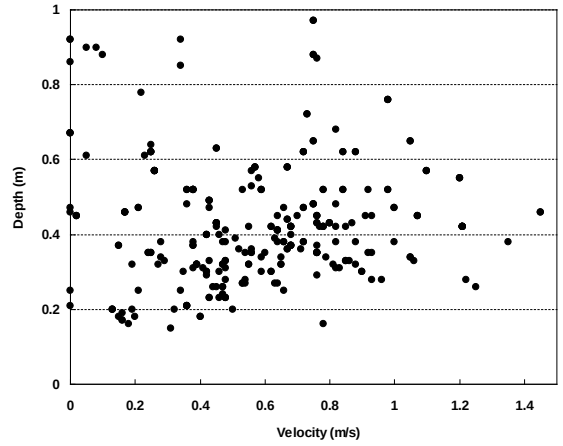

**Figure 2. Variations of percent of individual (PI) to total length, flow velocity, water depth, substrate size and habitat type in *Microphysogobio longidorsalis* (*n*=590).**




(a)




(b)




(c)

**Figure 3. Relationship between flow velocity, water depth and total length in Microphysogobio longidorsalis (n=590).**

In this study, there were no survey stations where silts were found. *M. longidorsalis* most frequently appeared at stations where cobbles were laid; the river bed in the midstream and upstream area of the Han River (containing the survey stations) mostly consists of coarse gravels and cobbles. It was judged that this is why their appearance rate was high at these stations.

Song and Son (2005) reported that the range of habitats for *M. longidorsalis* was limited to riffles midstream and upstream of the river where lots of gravels were laid. In this study, they were found to most frequently appear in riffles or the bordering zone of one riffle on another. It was postulated that finding their appearance rate was high in the run area was correlated with the fact that the area of run in the river is larger than that of riffle. As reported in Song and Son (2005), this suggested that their habit behaviors are significantly correlated with riffle.

As seen in the above results or findings, *M. longidorsalis* was the third dominant species in the Han River, (with *Z. platypus* and *C. splendidus* as dominant species and subdominant in the same river, respectively) which competed with *Z. koreanus*, *Z. platypus* and *C. splendidus* for a common ecological niche. Of 590 fish sampled in total, the majority (50.8%) were 8 to 10 cm long, and 93.9% and 32.5% appeared in streams with 0.2 to 0.9 m/s in flow velocity and 0.5 m in water depth. Also, they lived, mainly, in the bordering zone of one riffle on another where cobbles were laid. Most of the rivers in Korea consist of a series of riffles. However river straightening and leveling has caused a reduction in riffles. For river rehabilitation and protection, therefore, there is a need to identify in detail the conditions of physical habitats for various species of fish.

## CONCLUSION

For the assessment of physical habitats for *M. longidorsalis* in the Han River Basin, fish sampling was carried out at 11 survey stations, for the period ranging from October, 2008 to November, 2009. Fish amounting to a total of 3,886 were sampled (39 species within 10 families in total) at all the survey stations. 22 species, including *M. longidorsalis* and *Z. koreanus*, were found to fall under Korea endemic species; contributing to as high as 61.8% of the sampled fish. Of 39 species sampled at all the survey stations, *Z. platypus* was the dominant species by occupying 25.8% of the total sampled and *C. splendidus* was the subdominant species (16.5%). *M. longidorsalis* (15.2%), *Z. koreanus* (13.4%), *Pungtungia herzi* (4.5%) and other species were also sampled. Of *M. longidorsalis* ,590 in number (sampled at all the survey stations), the ones with 8 to 10 cm in length were in the majority. It was found that 93.9% inhabited streams had flow velocity of 0.2 to 0.9 m/s and 32.5% of the inhabited streams were 0.4 to 0.5 m in water depth. Most of the inhabited streams had sand (0.1 to 1.0 mm) to cobbles (100.0 to 300.0 mm) for the river bed. With regard to their types of habitats, the majority lived in areas of run.

## ACKNOWLEDGEMENTS

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