Korean J. Ichthyol. 19(2), 128~131, 2007

Total Length Estimation from Head Dimensions of Artificially Propagated Brown Croaker *Miichthys miiuy*

In-Seok Park*, Young Ja Kim[1], Hee Jung Choi[2], Sung-Young Oh[2], Choong Hwan Noh[2] and Seung-Hwan Lee[3]

Division of Marine Environment and Bioscience, College of Ocean Science and Technology, Korea Maritime University, Busan 606-791, Korea
[1]Research Institute of Marine Science and Technology, Korea Maritime University, Busan 606-791, Korea
[2]Marine Resources Research Division, Korea Ocean Research and Development Institute, Ansan 425-600, Korea
[3]Yeongnam Sea Grant College, Korea Maritime University, Busan 606-791, Korea

Head length, snout length, postorbital length, and eye diameter were measured in 209 brown croaker, *Miichthys miiuy*, ranging from 3.0 to 650.0 mm in total length (TL). All of the four head dimensions were regressed against the TL respectively and were increased linearly with the relative size of the head. The determination coefficients (r^2) ranged from 0.9823 to 0.9916, and all analysis of variance values were significant ($P < 0.0001$). Those results suggest that these head dimensions may be useful indicators for detecting morphological deformities or for individual and population growth histories to aid in the successful rearing of brown croaker fingerlings.

Key words : artificial propagation, brown croaker, head dimensions, *Miichthys miiuy*

Introduction

The fields of marine cultivation and sea farming of food species are continually expanding, and many advances in hatchery technology and rearing techniques have been developed recent years. The availability of cultured broodstocks will allow the year-round production of fingerlings, and provide increased opportunities in a variety of research efforts, including genetic and nutritional studies, to improve the performance of domesticated stocks (Denson and Smith, 1996).

Hatchery-reared fish released into the wild as juveniles is exposed to the different environments during maturation that is different markedly from that in wild fish (Hard *et al*., 2000). As hatchery-reared fish (hereafter referred to as reared fish) are generally poorly equipped to survive in a natural environment (Hughes *et al.*, 1992; Mann and Kawamura, 2002), most of reared fishes die during early stages like larvae and juveniles (Seo, 2004) or some of them survive with various morphological abnormalities (Kanazawa, 1993; Dedi *et al.*, 1997). Therefore in an effort to improve post-release survival rates in marine species, morphological research on the early stages of reared fish is clearly required.

On the west coast of Korea, the number of fish caught by fishermen has recently decreased considerably, which is attributable primarily to the high turbidity caused by well-developed tidelands, as well as the pricipitious drops in water temperature during winter (Han *et al.*, 2002). Therefore recently the commercial production and artificial propagation of brown croaker, *Miichthys miiuy* (Basilewsky), a species that is fairly well-adapted to such an environment (Seo, 2004;

*Corresponding author: ispark@hhu.ac.kr

Park *et al.*, 2006) is more important. However, the available information for improving the survival as growing rate of larval and juvenile brown croaker reared in tanks are very limitted (Takita, 1974; Taniguchi *et al.*, 1979; Kinoshita and Fujita, 1988; Han *et al.*, 2002; Park *et al.*, 2006). As well as the breeding of spawner and egg collections (Takeshi *et al.*, 1988) have been described for some Sciaenid species.

Previews regarding specific morphological differences during growth imply crucial information for enhancing the survival of reared brown croaker (Crane *et al.*, 1987; Serafy *et al.*, 1996; Choi, 2005; Park *et al.*, 2006), but specific approaches for the estimation of growth rates in reared fish still infancy. Recently, we have been successfuly produce the domesticated brown croaker, which have been reared in tanks and grow up until 650 mm in total length. To facilitate scientific assessment and effective fish resource management, we studied the relationship, between specific head measurements and the expected size or growth of reared brown croaker which are 3.0 mm to 650.0 mm in TL.

Materials and Methods

Measurements of brown croaker propagated and raised in the Fishery Genetics and Breeding Science Laboratory Aquarium (Department of Marine Environment and Bioscience, Korea Maritime University, Korea) were conducted according to the methods described by Serafy *et al.* (1996). We used standard linear regression methods (Neter *et al.*, 1985) to develop several single-independent variable models, using statistical analysis system software (SPSS Inc., 1997). In this phase of the study, we measured 209 individuals, ranging in TL from 3.0 to 650.0 mm.

As shown in Fig. 1, we assessed four different head dimensions in each specimen : head length (most anterior extension of the head to most posterior end of the operculum), postorbital head length (most posterior end of the eye to most posterior end of the operculum), snout length (most anterior extension of the head to most anterior end of the eye), and eye diameter (major axis). The dimensions were measured using digital vernier calipers (Mitutoyo, Japan), which were accurate to 0.1 mm, generating TL measurements of 14.4 to 30.8 mm for fish older than 37 days of age. Larvae, which ranged from 3.0 to 14.0 mm in TL, were measured to the nearest 0.1 mm, using a microscope (Zeiss Axioskop 40 FL, Germany) with an attached video camera (Zeiss AxioCam MRm, Germany) connected to a computer and coupled with image analysis software (Zeiss

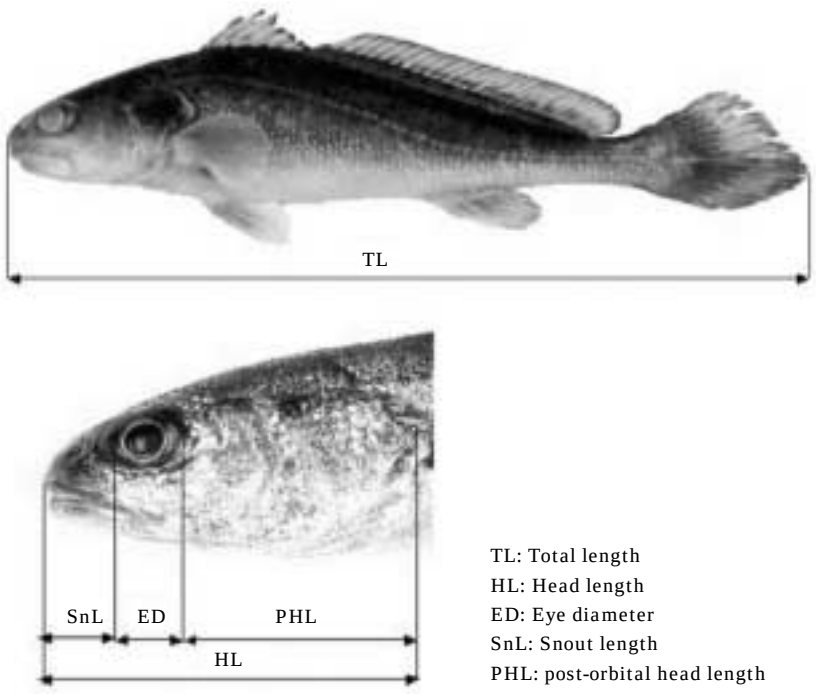

Fig. 1. Definitions of the four brown croaker, *Miichthys miiuy* head dimensions.

Table 1. Linear regression coefficients and goodness-of-fit statistics of head dimensions of the artificially propagated brown croaker *Miichthys miiuy*

Dimension	b_o*	b_1*	r^2	F	P
Head length	−1.5252	1.0042	0.9916	24453.131	$P<0.0001$
Eye diameter	−2.2561	0.8536	0.9901	20589.931	$P<0.0001$
Postorbital head length	−2.6677	1.1155	0.9900	20437.699	$P<0.0001$
Snout length	−2.4733	0.8641	0.9823	11548.078	$P<0.0001$

*b_o and b_1 refer to intercept and slope values, respectively.

AxioVision 4, Germany). The identification of developmental stages was conducted as described by Russell (1976) and Han *et al.* (2002).

Results and Discussion

The linear regression model coefficients associated with fingerlings of reared brown croaker are presented in Table 1, along with goodness-of-fit statistics regarding the relationships between head dimensions and TL. All head dimensions of brown croaker examined in this study increased linearly with increases in the relative size of the head. The model gave high determination coefficients (r^2), ranging between 0.9823 and 0.9916, and all analysis of variance (ANOVA) values were significant ($P<0.0001$). These results indicate that this regression model may be a pertinent parameter for the detection of growth and morphological abnormalities in the early stages of brown croaker reared in tanks.

In the fields of both fishery biology and aquaculture, morphological considerations are crucial to understanding environmental preferences within the early life stages of reared fish. The head dimensions measured in our study may be useful in the assessment of post-release growth in stock fish (Serafy *et al.*, 1996). The evaluation of changes in these specific head dimensions will provide more precise knowledge of the expected growth of reared fish, which may be helpful in detecting and eliminating early morphological deformities or in estimating individual and population growth histories in hatchery-reared brown croaker.

Some researchers have previously theorized that accurate estimations of total length could be made from measurements of head dimensions, and some reports have included models assessing the relationship between head dimensions and the expected size of the animals. Crane *et al.* (1987) used eye diameter to estimate the fork length of the spiny oreo dory, *Allocyttus* sp., and Serafy *et al.* (1996) presented a model employing the relationship between TL and head dimensions to accurately estimate the total length of red drum, *Sciaenops ocellatus*. Choi (2005) reported that head dimensions constituted a good predictor for the estimation of total length and growth in reared dark-banded rockfish, *Sebastes inermis*. Therefore, we believe that our regression model, which uses four head dimensions to estimate total length, will prove successful in facilitating the rearing of fingerlings, as a part of the brown croaker stock enhancement project.

Acknowledgements

This research was supported by a project grant (KRF-2006-005-J00501) from Korea Research Foundation Grant. The authors would like to express their gratitude to the technical staffs of the Laboratory for Fishery Genetics and Breeding Science at Korea Maritime University for helpful supports, and the anonymous reviewers who greatly improved the quality of this manuscript.

References

Choi, H.J. 2005. Study on the early growth and gonadogenesis of dark-banded rockfish, *Sebastes inermis* Cuvier in Korea. Master's Thesis. Korea Maritime University, Busan, Korea, 45pp.

Crane, S.A., J.M. Fenaughty and R.W. Gauldie. 1987. The relationship between eye diameter and fork length in the spiny oreo dory, *Allocyttus* sp. New Zeal. J. Mar. Fresh., 21 : 641～642.

Dedi, J., T. Takeuchi, T. Seikai, T. Watanabe and K. Hosoya. 1997. Hypervitaminosis A during vertebral morphogenesis in larval Japanese flounder. Fish. Sci., 63 : 466～473.

Denson, M.R. and T.I.J. Smith. 1996. Larval rearing and weaning techniques of white bass *Morone chrysops*. J. World Aquacult. Soc., 27 : 194～201.

Han, K.-H., S.-H. O, D.-S. Hwang, Y.-H. Cho and D.-C. Soo. 2002. Egg development and morphological change of larvae of the brown croaker, *Miichthys miiuy* (in Korean with English abstract). Korean J. Ichthyol., 14 : 93～99.

Hard, J.J., B.A. Berejikian, E.P. Tezak, S.L. Schroder, C.M. Knudsen and L.T. Parker. 2000. Evidence for morphometric differentiation of wild and captively reared adult coho salmon: a genometric analysis. Environ. Biol. Fish., 58 : 61～73.

Hughes, R.N., M.J. Kaiser, P.A. Mackney and K. Warburton. 1992. Optimizing foraging behavior through learning. J. Fish Biol., 41 : 77～91.

Kanazawa, A. 1993. Nutritional mechanism involved in the occurrence of abnormal pigmentation in hatchery reared flatfish. J. World Aquacult. Soc., 24 : 162～166.

Kinoshita, I. and S. Fujita. 1988. Larvae and juveniles of blue drum, *Nibea mitsukuri*, occuring in the surf zone of Tosa Bay, Japan. Jap. J. Icthyol., 35 : 25～30.

Mann, R.R. and G. Kawamura. 2002. A comparative study on morphological differences in the olfactory system of red sea bream (*Pagrus major*) and black sea bream (*Acanthopagrus schlegeli*) from wild and cultured stocks. Aquaculture, 209 : 285～306.

Neter, J., W. Wasserman and M.H. Kutner. 1985. Applied linear statistical models, 2nd ed. Richard Irwin, Homewood, Illinois.

Park, I.-S., D.-W. Seol, S.H. Cho, Y.-C. Song, H.J. Choi, C.H. Noh, J.-G. Myoung and J.-M. Kim. 2006. Morphogenesis of the eye of brown croaker (*Miichthys miiuy*). Ocean Polar Res., 28 : 287～290.

Russell, F.S. 1976. The eggs and planktonic stages of British marine fishes. Academic Press, London, pp. 523～524.

Seo, D.C. 2004. Developmental ecology and early life growth of brown croaker *Miichthys miiuy* (in Korean). Ph.D Thesis, Yosu National University, Yosu, Korea. 127 pp.

Serafy, J.E., C.M. Schmitz, T.R. Capo, M.E. Clarke and J.S. Ault. 1996. Total length estimation of red drum from head dimensions. Prog. Fish-Cult., 58 : 289～290.

SPSS Inc. 1997. SPSS base 7.5 for window, SPSS Inc., Michigan Avenue Chicago, IL.

Takita, T. 1974. Studies on the early life history of *Nibea albiflora* (Richardson) in ariake sound. Bull. Fish Fac. Nagasaki Univ., 38 : 1～55.

Takeshi, T., T. Nasu and O. Ishibashi. 1988. Studies on the seedling production of Japanese croaker *Nibea japonica* -I. breeding of spawner and egg collection. J. Fish Biol., 35 : 265～270.

Taniguchi, N., T. Kuga, Y. Okada and S. Umeda. 1979. Studies of the rearing of artificially-fertilized and early developmental stage of the nibe-croaker, *Nibea mitsukurii*. Rep. Usa. Mar. Niol. Inst., 1 : 51～58.

Received : April 13, 2007
Accepted : May 11, 2007

양식 민어의 두부형질에 의한 전장 예측

박인석*・김영자[1]・최희정[2]・오승용[2]・노충환[2]・이승환[3]

한국해양대학교 해양과학기술대학 해양환경・생명과학부,
[1]한국해양대학교 해양과학기술연구소,
[2]한국해양연구원 자원연구본부, [3]한국해양대학교 영남 씨그랜트

전장 3.0～650.0 mm의 민어, *Miichthys miiuy* 209 개체의 두장, 문장, 안와후연장 및 안경을 계측하였다. 측정된 개체들의 모든 두부형질은 전장에 대해 회귀하였고, 머리의 상대크기에 선형으로 증가하였다. 결정계수(r^2)는 0.9823～0.9916의 범위를 나타내었고, 모두 유의하게 나타났다($P < 0.0001$). 본 연구에서 사용된 두부형질들은 민어의 성공적인 사육을 위한 개체 및 집단 성장사 및 형태 변형을 감지할 수 있는 유용한 지표가 될 수 있으리라 사료된다.