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Morphological Analysis among Populations of Purpulish Washington Clam, *Saxidomus purpuratus* on the Korean Waters

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ABSTRACT

Morphological differences were studied using the analysis of variance between various partial length and shell length of three populations of *Saxidomus purpuratus* on the Korean waters. The Relative growth equations, that is, SH-SL, SW-SL, TW-SL of *S. purpuratus* by sex were estimated. The analysis of variance of four morphological characters proved that each population has no sexual differences ($p > 0.01$). But the three populations are significantly different in morphological characters ($p < 0.01$).

Keywords: Morphological analysis, Population, *Saxidomus purpuratus*, Relative growth, Analysis of variance (ANOVA).

INTRODUCTION

The purplish Washington clam, *Saxidomus purpuratus* is widely distributed in the coast of Korea, Japan and China (Choe *et al.*, 1999). This species is one of the important commercial bivalves in Korea, but fisheries by diving vessel of this species have been concentrated in the southern waters around Korea (Kim *et al.*, 2001).

Generally, external morphology of shells of *Saxidomus purpuratus* are different size, color, and weight of populations which habited in each the waters, that is southern waters, eastern and western water of Korea. Also flavor of food, which was material of *S. purpuratus* was different among distribution area. These differences of *S. purpuratus* were thought to be due to the characteristics of marine environment, which were sediment contents, food organisms etc. in each distribution areas.

Most reports of this species were concentrated ultrastructure of germ cell and reproductive cycle (Chung *et al.*, 1999; Kim *et al.*, 2001; Ahn, 2001) and the others were age and growth (Kim *et al.*, 2003a) and rhythm endogenous (Kim *et al.*, 2003b). Longevity of *S. purpuratus* was 10 ages (Kim *et al.*, 2003; Wei *et al.*, 1982), spawning period was from May to October (Chung *et al.*, 1999; Kim *et al.*, 2001a, b; Ahn 2001; Kim *et al.*, 2003a, b). But there were not reports of deposited environment, ecological and genetic characters which populations were distributed in each waters.

For this reason, in order to clarify the differentiation among populations, we should be examined morphological, ecological and genetic analysis. In the present study, morphological differences were studied using the analysis of variance between various partial length and shell length of three populations of *Saxidomus purpuratus* in the Korean waters.

MATERIALS AND METHODS

Approximately 200 shells among three populations were sampled in Jinhae Bay, the southern waters, Youngil Bay, the eastern waters and Gogunsan

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Islands, the western waters of Korea by SCUBA diver at April, 2003 Fig. 1. All shells sampled were measured in shell length (SL), shell height (SH), shell width (SW) to the nearest 1mm, total weight (TW) to the nearest to 0.1 g. These data were estimated the relative growth equations by the Huxley method (Huxely, 1932). Morphological differences of shell among three populations were compared with an analysis of variance. Analysis of variance (ANOVA) was used Microsoft Excel statistics system, the probability (p) level at $p < 0.01$ were evaluated the significances of differences by Zar method (Zar, 1984).

RESULTS

Morphological differences were studied using the analysis of variance between various partial length and shell length among populations of *Saxidomus purpuratus* in the Korean waters. The relative growth equations that is, SH-SL, SW-SL, TW-SL of *S. purpuratus* by sex are given in Table 1. In the analysis of variance, significant differences did not occur in both the intercept and the slope for both sexes among populations ($p > 0.01$). The relative growth equations of characters pooled both sexes by each population were shown Table 2. In this analysis, Table 3 were shown significant differences in the slope and intercept among three populations ($p < 0.01$).

DISCUSSION

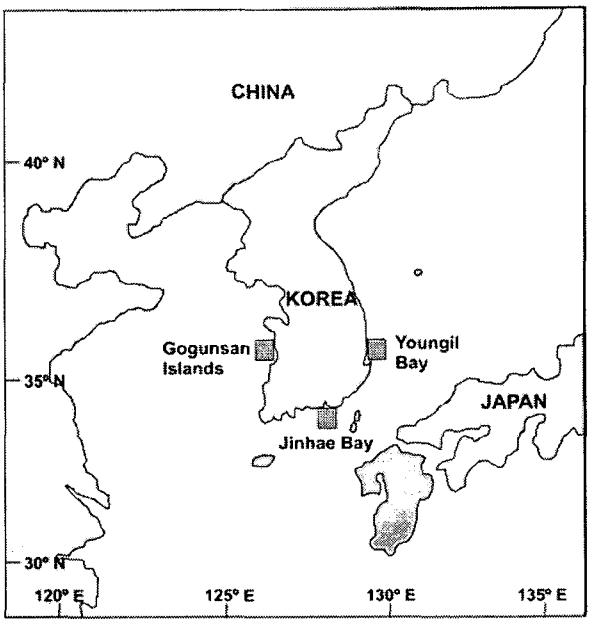

Fig. 1. Map of the study area, showing sampling locations.

The relation between shell length and shell height of *Saxidomus purpuratus* population which distributed in the western waters of Korea was not so high as any other population, whereas the relation between shell length and shell width was the smallest among three populations. The color of west population was brightly yellow ocher, those of east and south populations were black-gray.

The reason for the differences among three populations is thought to be due to depositional

Table 1. Relative growth equations between females and males for characters of *Saxidomus purpuratus* among populations in the Korean waters.

Populations	Characters	Female	Male
South	SL - SH	$SH = 3.2466 + 0.7260 \times SL$	$SH = 2.6112 + 0.7287 \times SL$
	SL - SW	$SW = -2.2669 + 0.5538 \times SL$	$SW = -3.0315 + 0.5605 \times SL$
	SL - TW	$TW = 0.00013 \times SL^{3.1520}$	$TW = 0.00013 \times SL^{3.1554}$
West	SL - SH	$SH = 13.3131 + 0.6254 \times SL$	$SH = 6.1796 + 0.6939 \times SL$
	SL - SW	$SW = 9.4517 + 0.4428 \times SL$	$SW = 2.9347 + 0.5064 \times SL$
	SL - TW	$TW = 0.00030 \times SL^{2.9610}$	$TW = 0.00011 \times SL^{3.1825}$
East	SL - SH	$SH = 7.7570 + 0.7189 \times SL$	$SH = 12.9369 + 0.6621 \times SL$
	SL - SW	$SW = 17.3838 + 0.3560 \times SL$	$SW = 15.2511 + 0.3831 \times SL$
	SL - TW	$TW = 0.00091 \times SL^{2.7421}$	$TW = 0.00171 \times SL^{2.6026}$

SL: shell length, SH: shell height, SW: shell width, TW: total weight

Table 2. Relative growth equations for characters combined both sexes of *Saxidomus purpuratus* among populations in the Korean waters.

Populations	SL - SH	SL - SW	SL - TW
South	$SH = 2.6457 + 0.7311 \times SL$	$SW = -4.5667 + 0.5785 \times SL$	$TW = 0.00141 \times SL^{3.1315}$
West	$SH = 9.5320 + 0.6617 \times SL$	$SW = 6.0396 + 0.4738 \times SL$	$TW = 0.00017 \times SL^{3.0724}$
East	$SH = -2.6003 + 0.8400 \times SL$	$SW = 1.7433 + 0.5347 \times SL$	$TW = 0.00015 \times SL^{3.1445}$

SL: shell length, SH: shell height, SW: shell width, TW: total weight

Table 3. Analyses of variance for characters combined both sexes of *Saxidomus purpurtus* populations in Korean waters. F-test values for the slope and intercept represent on the right side and on the left side, respectively.

Characters	Populations	South	West	East
SL - SH	South	-	$F_{[1,404]} = 7.040^{**}$	$F_{[1,397]} = 16.704^{**}$
	West	$F_{[1,405]} = 0.821$	-	$F_{[1,419]} = 21.921^{**}$
	East	$F_{[1,398]} = 193.963^{**}$	$F_{[1,420]} = 117.874^{**}$	-
SL - SW	South	-	$F_{[1,404]} = 15.001^{**}$	$F_{[1,397]} = 2.989$
	West	$F_{[1,405]} = 7.692^{**}$	-	$F_{[1,419]} = 2.695$
	East	$F_{[1,398]} = 105.965^{**}$	$F_{[1,420]} = 7.708^{**}$	-
SL - TW	South	-	$F_{[1,404]} = 0.404$	$F_{[1,397]} = 0.027$
	West	$F_{[1,405]} = 5.926^{**}$	-	$F_{[1,419]} = 0.362$
	East	$F_{[1,398]} = 136.909^{**}$	$F_{[1,420]} = 120.830^{**}$	-

SL: shell length, SH: shell height, SW: shell width, TW: total weight; * $p < 0.05$, ** $p < 0.01$

environment of bottom sediment in habitat area. In sediment environment of three habitat areas, sand dominates in the western waters whereas gravel and rocky bottom prevail in the eastern waters. The mud sediment was deposited in southern waters (Kim *et al.*, 1987). Also, it is possible that the differences were caused by exploitation period of fishing ground. The fishing ground in the southern waters was exploited continuous for a long times, exploitation rate of fishery is probably too high. But there are low of exploitation rate in the eastern and western waters, because fishing ground in the eastern waters was exploited irregularly, and that in the western waters was developed recently.

The spawning period by waters was a little difference (Chung *et al.*, 1999; Kim *et al.*, 2001a; Ahn 2001; Kim *et al.*, 2003b), because this was effected on water temperature. But these causes are currently unclear difference among three populations. Many environmental gradients, such as temperature, salinity, nutrient availability and more habitats in physical conditions should be investigated to elucidate the process of the ecological and genetic differentiation among *Saxidomus purpuratus* populations.

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REFERENCES

Ahn, S.H. (2001) Annual reproductive cycle of *Saxidomus purpuratus* (Sowerby) (Bivalvia: Veneridae) in Sacheon Bay, Korea. MS Thesis, Pukyoung National University, 35 pp. [in Korean]

Choe, B.L., Park, M.S., Jean, L.G., Park, S.R. and Kim, H.T. (1999) Commercial Molluscs from the Freshwater and Continental Shelf in Korea. 197 pp. Yemoon Press, Busan. [in Korean]

Chung, E.Y., Kim, Y.M. and Lee S.G.. (1999)

Ultrastructure of germ cell development and reproductive cycle of the purplish Washington clam, *Saxidomus purpuratus* (Sowerby). *Yellow Sea*, **5**: 51-58.

Huxely, J.S. (1932) Problems of Relative Growth. Second Edition. 312 pp. Dover Publications Inc., New York.

Kim, D.C., Song, S.T. and Yoo, B.J. (1987) Depositional environments of the continental shelf sediments between Geoje and Namhae Island. *Bulletin of the Korean Fisheries Society,* **20**: 166-174. [in Korean]

Kim, S.K., Park, K.Y., Jang, G.N., Kim, D.J. and Seo H.C. (2001a) Studies on the Ecological Aspect and Gametogenesis of *Saxidomus purpuratus* (Sowerby) in the Yellow Sea Area. *Bulletin of National Fishery Research Institute of Korea,* **59**: 152-158. [in Korean]

Kim, Y.H.., Chang, D.S. and Cha, B.Y. (2001b) Catch yield fluctuation and relative growth of the purplish Washington clam *Saxidomus purpurarus* (Sowerby) in the south sea, Korea. *Journal of Fishery Science and Technology*, **4**: 98-100.

Kim, Y.H., Ryu, D.K., Chang, D.S., Kim, J.B. and Kim S.T. (2003a) Age and growth of purpulish Washington clam (*Saxidomus purpuratus*) in Jinhae Bay, Korea. *Journal of the Korean Fisheries Society*, **36**: 495-499. [in Korean]

Kim, W.S., Huh, H.T., Je, J.G. and Han, K.N. (2003b) Evidence of two-clock control of endogenus rhythm in the Washington clam, *Saxidomus purpuratus*. *Marine Ecology*, **142**: 305-309.

Wei, L.P., Shu, Y.F., Han, Y.P. and Yu, Z.Y. (1982) A preliminary survey on the biology of *Saxidomus purpuratus*. *Journal of Fishery, China*, **6**(1): 1-8.

Zar, J.H. (1984) Biostatistical Analysis. Third Edition. 918 pp. Prentice Hall Inc, Englewood Cliffs.