

Geographic Variation and Distribution of Rock Shell, *Thais clavigera* (Gastropoda: Muricidae) in the Korean Coasts

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Introduction

In general, intertidal gastropods display a considerable amount of intraspecific shell variation (De Wolf *et al.*, 1998). Particularly, thaisid species, including *Thais clavigera* (= *T.c.*), have been shown a variety of shell variation in the world ocean (e.g. *T. emerginata* in Kitching, 1976). Nomura (1926) noted local variation of shell morphology based on five Japanese populations. Abe (1985) classified Japanese *T.c.* into two forms (Form-C & -P). In the Korean waters, a strong variation in nodule shape of *T.c.* shell has also been noted by Choe & Park (1997). Taxonomy of *T.c.* is controversial so far. To understand the processes involved in the maintenance and divergence of species, it is necessary to identify intraspecific patterns of geographic variation of species (Gianniny & Geary, 1992). To examine the foregoing controversial aspect on *T.c.*, we questioned as follows: 1. is it possible and significant to separate *T.c.* shell into two morph types?, 2. is there any trend in geographic distribution of the possible morph types? and 3. is there any environmental factor which is significantly correlated with incidence of the morph types? To answer these questions, we sampled specimens of *T.c.* along the Korean coasts, and their shell characters, geographic distributions and environmental conditions of the sites were examined.

Materials and Methods

Samples of *T.c.* were collected from intertidal area of 24 exposed rocky and/or rocky and boulder sites along the Korean coasts from Sept. 1998 to Nov. 1999. To avoid a possible effect of ontogenetic morphological variation of the shell, sexually immature specimens (Tong, 1988) were discarded prior to measuring and analysis. Prior to measuring and scoring for the shell characters, specimens of each site were examined by using of visual inspection, and grouped tentatively into western (Type-W) and eastern types (Type-E) based on 3 distinguishable shell characters which were recognized from a preliminary study. Incidence of each morph type at the sites was represented as % composition. Temp. and sal. were examined as environmental factors of the study area. The Korean coasts were divided putatively

into 3 parts (western: Sts. 1-10, southern: Sts. 11-16, eastern: Sts. 17-24) based on a direction to which the coast facing.

Results

Shell morphology of *T.c.* differed between Type-W and -E, and ca. 89.3% of shells were correctly separated by Discriminant function analysis (DFA). The DFA correctly classified 86.7% of Type-W and 91.8% of Type-E. Shells of Type-E was significantly thicker than those of Type-W (ANCOVA; $df=1, 821; F=81.892, P<0.001$); was significantly heavier than those of the Type-W (ANCOVA; $df=1, 821; F=1594.528; P<0.001$). Mean shell size of Type-W (20.94 ± 2.6) was significantly larger than that of Type-E (19.47 ± 2.4) (t -test, $t=8.19, p<0.0001$). Type-W and Type-E occurred mainly in the western (St. 1-10) and eastern coasts (St. 17-24), respectively. In the southern sites (St. 11-16), the two types usually occurred sympatrically. Percent composition of the two morph types showed a clinal change from western coast to eastern coast and *vice versa*. Temperature ($r=\pm 0.66$) and salinity ($r=\pm 0.72$) were significantly correlated with % composition of morph types (Pearson's correlation coefficient, $p<0.001$).

Discussion

T.c. distributed as two distinct habitat-specific morph types (Type-W vs Type-E) along the Korean coasts, and composition of the morph types was significantly correlated with ambient temp. and sal., although the two types co-occurred in the southern coast showing an intermediate environment between the western and eastern coasts, so far as temp. and sal. were concerned. Thinner, lighter and larger shells (Type-W) mainly observed in the western coast, and heavier and smaller ones (Type-E) mainly observed in the eastern coast. Morphological variation of shells of *T.c.* might be an ecophenotypic response of the shells, in part, to habitat-specific environmental factors, so far as temperature and salinity are concerned, even though role of environment in producing or selecting this variation in the present study remains obscure and no empirical data about causal factor(s) is not available.

Selected References

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- Kitching, J.A. & Lockwood, J., 1974. Observations on shell form and its ecological significance in thaisid gastropods of the genus *Lepsiella* in New Zealand. *Mar. Biol.*, 28, 131-144.