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Short communication

Mendelian inheritance of golden shell color in the Pacific oyster *Crassostrea gigas*

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ABSTRACT

Shell coloration in many molluscs is highly variable. A shell color segregation study with progenies from a full factorial cross generated among Pacific oysters exhibiting distinct shell colors (golden, white and black) was conducted to investigate the inheritance of the golden shell color and its correlation with dark pigmentation. Random samples from twenty-three full-sib families were obtained and the shell coloration of offspring within each family was recorded. Results revealed that golden coloration was inherited in a different pattern from dark pigmentation, indicating its different genetic basis. Dark pigmentation was identified as a foreground color while golden or white color were background ones. The locus controlling background colors has two alleles with the allele for golden background being dominant to the allele for white background. In addition, the overlying foreground pigmentation of shells with a golden background was significantly lighter than that of shells with a white background, which suggested an epistatic effect of background color on shell foreground pigmentation. All these findings will facilitate the selection of elite oyster lines with desired shell coloration for aquaculture.

1. Introduction

Molluscs are a large group of invertebrate animals presenting variable shell shapes and colorations, which have attracted many naturalists and collectors. Moreover, consumers tend to choose live seafood in the market according to their colors, which endows the coloration with product value of great importance (Alfnes et al., 2006). Pacific oyster (*Crassostrea gigas*) has the largest production among all cultured aquatic animals (FAO, 2011) and its coloration is of interest to the whole oyster industry (Brake et al., 2004; Kang et al., 2013). The oysters with golden shell coloration are rarely seen in the market and are sold at much higher prices than others (Nell, 2001). In our selective breeding practice of Pacific oyster, we obtained a number of golden shell variants, and established a set of full-sib families using these golden shell oysters as parents (Cong et al., 2014). These provided great materials to unravel the genetic basis of the golden coloration that remains unknown at present.

Mollusca shell color is known to be inheritable and affected by environmental factors, such as lights, salinity and substratum (Heath, 1975; Lindberg and Pearse, 1990; Sokolova and Berger, 2000). Several studies investigating the genetic basis of shell coloration with limited data from experimental crosses reported one or two loci with dominance to control shell coloration (Adamkewicz and Castagna, 1988; Cole, 1975; Innes and Haley, 1977; Kobayashi et al., 2004; Liu et al., 2009; Wada and Komaru, 1990; Winkler et al., 2001; Zheng et al., 2013).

Pacific oyster shell pigmentation exhibits a continuous variation from near-white, pigment-free shells to near-black, fully pigmented shells, which was defined as foreground pigmentation. The shell pigmentation has been considered as a quantitative trait that is controlled by many genes with small-effects (Brake et al., 2004; Evans et al., 2009; Imai and Sakai, 1961). However, in some cases, only a small amount of major genes were identified to control shell coloration (Evans et al., 2009; Hedgecock et al., 2006). Our recent study also identified a SCAR marker which was well correlated with Pacific oyster shell pigmentation of black and white, suggesting a major locus that is responsible for foreground pigmentation (Ge et al., 2014). However, the genetic basis and mechanism of shell coloration in Pacific oyster are still inconclusive, especially for specific colors, such as golden coloration, which is clearly different from those dark pigmentation phenotypically. Does golden coloration possess a same genetic basis as the black pigmentation? If not, what are the genetic loci controlling golden coloration and is there any correlation between golden coloration and typical dark pigmentation?

In the present study, we performed controlled crosses between oysters showing different shell colors to determine the inheritance of golden coloration in *C. gigas* and to examine the relationship between golden coloration and typical dark pigmentation, which will facilitate the selection of elite oyster lines with desired coloration patterns.

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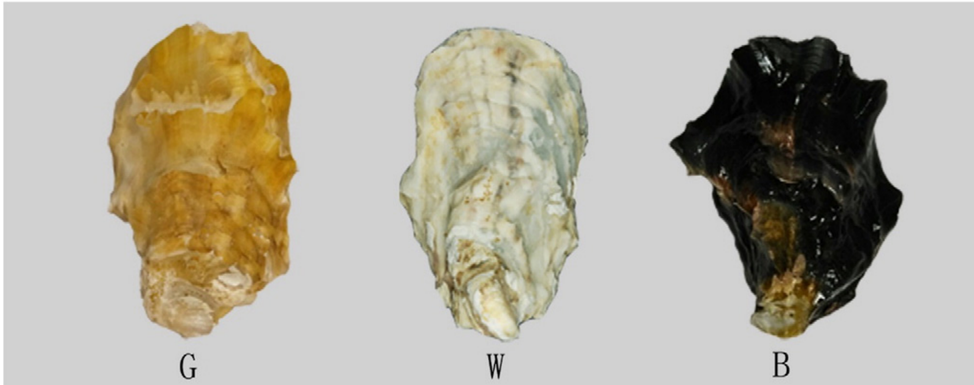

Fig. 1. Representative parents of three shell coloration patterns. G = Golden; W = White; B = Black.

2. Materials and methods

2.1. Parental source

One-year-old oysters with desired shell coloration were selected from nine full-sib families to conduct cross mating. All families were the first-generation selective families and were produced using wild oysters with specific shell colors in Rushan, China (Cong et al., 2014). Oysters with three shell coloration patterns were used as parents in this study (Fig. 1), including those with golden shell (*G*) and two extreme foreground pigmentation patterns of solid white shell (*W*) and solid black shell (*B*).

2.2. Mating experiment and rearing

A full factorial cross among oysters with the three shell color patterns was performed to generate 27 families with 9 cross-mating groups

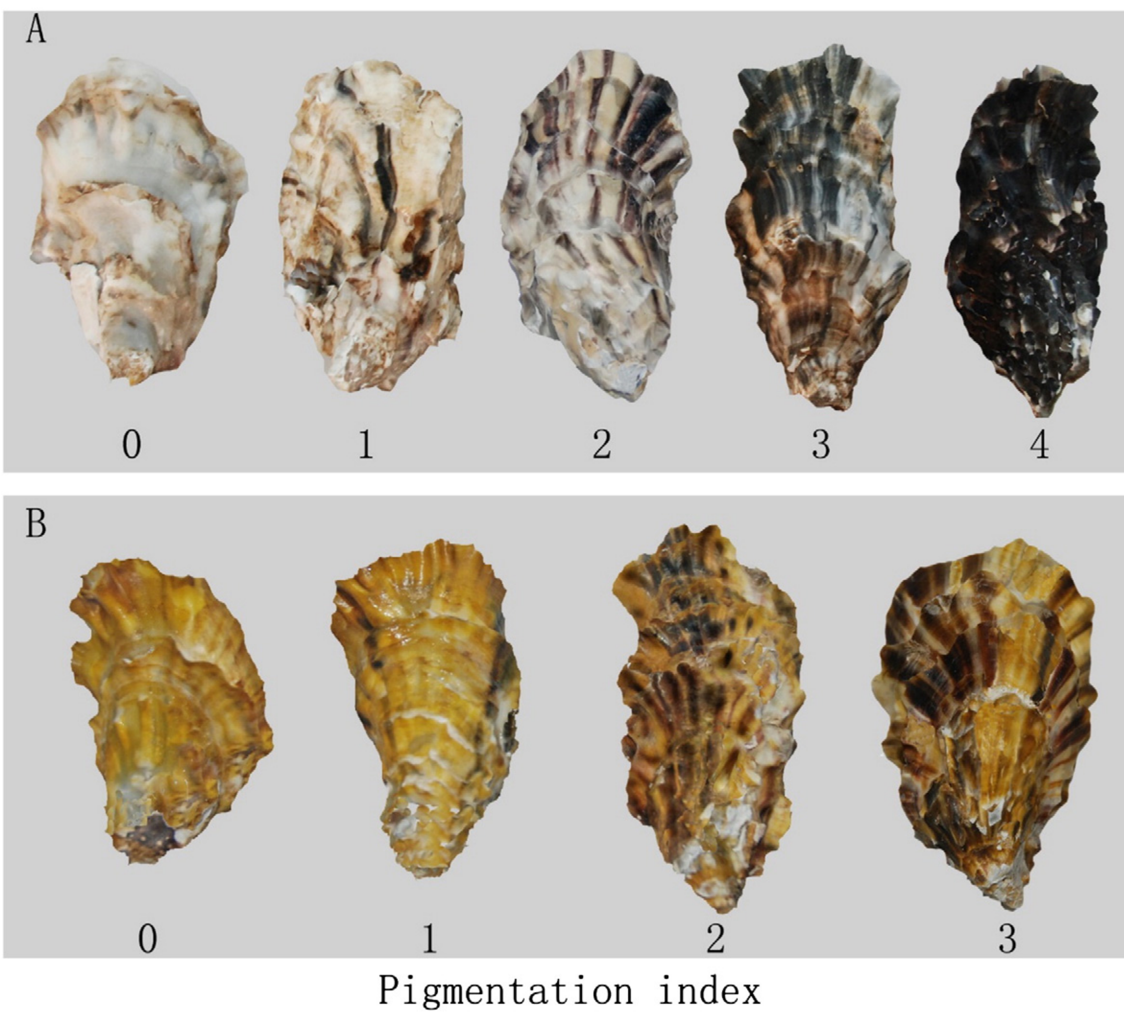

Fig. 2. Representative shell color morphs of offspring. (A) Offspring with white background and different foreground pigmentation (pigmentation index: 0–4); (B) offspring with golden background and different foreground pigmentation (pigmentation index: 0–3).