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Review

# Genetic parameters for body weight and survival in the Pacific White Shrimp *Penaeus* (*Litopenaeus*) *vannamei* affected by a White Spot Syndrome Virus (WSSV) natural outbreak

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ABSTRACT

White Spot Syndrome Virus (WSSV) is a disease that causes large economic losses in the shrimp industry. Genetic improvement is a strategy for controlling some diseases in aquaculture. Genetic parameter estimates for body weight and survival in the presence of WSSV have been obtained from laboratory challenge experimental designs, but there are no studies in the presence of a WSSV natural outbreak. The aims of this study were (1) to estimate genetic parameters for body weight at 19 weeks of age and survival from 10 to 19 weeks of age in the Pacific white shrimp (*Penaeus* (*Litopenaeus*) *vannamei*) in a pond affected by a natural outbreak of WSSV, and (2) to compare these estimates with those obtained from two ponds where no WSSV was present. The estimate of the heritability for body weight was smaller in the presence of WSSV (0.09 to 0.11) than in ponds with no WSSV (0.15 to 0.33). An increase in body weight residual variance was observed in the pond affected by WSSV. The estimate of the heritability of survival for the pond affected by WSSV (0.06 ± 0.03) was larger than that estimated in the unaffected ones (0.00 to 0.02), suggesting a minor change in the additive genetic expression of this trait. Heritability estimates for body weight and survival are the first ones obtained in a population affected by a WSSV natural outbreak using pedigreed information. Results suggest that selection response for survival at harvesting in the presence of WSSV would be very small, and that selection response for body weight in the same condition would be smaller than in the absence of WSSV. Studies regarding the implications of including these and other important traits in shrimp breeding programs in the presence of WSSV are necessary.



**Contents**



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## 1. Introduction

Total biomass production in the shrimp industry depends on the number and body weight of harvested animals, which may be affected by the presence of diseases that cause partial, and in some cases, total production loss (FAO, 2012).

In Penaeid culture, viral diseases are among the main causes of economic loss (Bachere, 2000; Briggs et al., 2004; Huang et al., 2012), and among them, White Spot Syndrome Virus (WSSV) outbreaks have had a detrimental impact in many regions of the world since its first appearance in 1992 (Chou et al., 1995; Lin et al., 2011; Miao and Yuan, 2007; Zhan et al., 1998). Elimination, control, and eradication of WSSV are difficult goals due to its rapid rate of spread and the broad range of possible hosts for the pathogen (Huang et al., 2012).

Breeding shrimp for disease resistance is a costly and lengthy process that is justified only when a pathogen has a significant economic impact on the industry and when there is no other cost-effective and fast measures to prevent or treat infection (Cock et al., 2009), as is the case of WSSV. Some authors have suggested that breeding programs could be an option for WSSV control in shrimp (Bachere, 2000; Bedier et al., 1998; Gitterle et al., 2005a, 2006a; Huang et al., 2012), and there are a few studies providing estimates of genetic parameters for economically important traits such as body weight and survival in the presence of WSSV (Gitterle et al., 2005a, 2006a, 2006b), that provide information to determine the possible inclusion of these traits in shrimp breeding programs.

Heritability for harvest body weight in the presence of WSSV has been estimated as 0.24 ± 0.05, and 0.17 ± 0.04 from two selected lines for growth and survival (Gitterle et al., 2005a) and from oral and waterborne infection protocols with estimates ranging from 0.05 to 0.31, and from 0.34 to 0.39, in those lines, respectively (Gitterle et al., 2006b).

Heritability for survival in the presence of WSSV has been estimated using different models, varying from 0.03 ± 0.01 to 0.07 ± 0.02 (Gitterle et al., 2005a, 2006a). The genetic correlation between body weight and survival in the presence of WSSV was estimated by Gitterle et al. (2005a) as ranging from −0.55 ± 0.18 to −0.64 ± 0.19.

Genetic parameter estimates for body weight and survival in the presence of WSSV have been obtained from laboratory challenge experimental designs, but there are no studies on genetic parameters for body weight and survival in the presence of a natural outbreak of WSSV from production ponds.

The aims of this study were (1) to estimate genetic parameters for body weight at 19 weeks of age and survival from 10 to 19 weeks of age in the Pacific white shrimp *Penaeus* (*Litopenaeus*) *vannamei* in a pond affected by a natural outbreak of White Spot Syndrome Virus (WSSV), and (2) to compare these estimates with those obtained from two ponds where no WSSV was present.

## 2. Material and methods

### 2.1. Data and edits

The study was carried out in three shrimp performance ponds from a Mexican hatchery, two of them located in Los Pozos, Sinaloa, and the other in Bahía de Kino, Sonora, both on the northwest coast of Mexico. Animals used were part of the *P. vannamei* growth and survival breeding line of a selection program that started in 1998 (Castillo-Juárez et al., 2007); selection procedures are described by Campos-Montes et al. (2013).

Data from body weight at 19 weeks of age (BW) and survival from 10 to 19 weeks of age from the 2011 production cycle were used. In this cycle, in a range of 17 days, the hatchery genetic nucleus generated 170 families for genetic evaluation. The families were obtained using artificial insemination, with a ratio of 1.27 females per sire. Each family was identified using colored tagged elastomers. Broodstock identification, family formation, larvae culture, and post-larvae managements to harvesting are described in Campos-Montes et al. (2013). The population structure is based on full- and half-sib families. Pedigree file included animals from 2002 to 2011.

At around nine weeks of age and 2 g of body weight, shrimp of each selected family were tagged. A week later, shrimp were seeded in the performance ponds to be evaluated under commercial-like management conditions, using 35 shrimp per family per pond.

### 2.2. Performance ponds description

Two performance ponds of 0.2 ha each are located in Sinaloa, Mexico; these ponds are open ground and are covered by liner. Shrimp were seeded there at two different densities, 10 and 30 shrimp/$m^2$ (P10, and P30, respectively). These ponds had a 1.4 m water column with an average temperature of 30 to 34 °C, and an average salinity of 30 to 35 ppt. Daily water exchange rate varied from 5 to 20%, animals were fed with commercial pellets containing 35 to 40% protein depending on the growth stage of the shrimp. The amount provided was 3% of the pond biomass. There was no presence of WSSV in these ponds.

The third pond is located in Sonora, Mexico: This is also an open ground pond. Shrimp were seeded at a density of 15 shrimp/$m^2$ (K15). It is a 2 ha pond but the study area was limited to 0.2 ha by using a net. In the remaining area of the pond, shrimp were seeded at the same density with the commercial line produced by the same hatchery at PL10 stage. It is worthy to note that shrimp densities in P10, P30, and K15 were adjusted using non-tagged shrimp from the hatchery commercial line of about the same age.

This third pond had a 1.4 m water column temperature ranging from 30 to 34 °C while salinity ranged from 30 to 35 ppt. Water exchange rates varied from 5 to 20%, depending on the growth stage of the shrimp. Animals were fed with commercial pellets containing 35 to 40% protein depending on the growth stage of the shrimp. The amount provided was also 3% of the pond biomass. This pond presented White Spot Syndrome Virus (WSSV) clinical signs and macroscopic changes at around 110 to 115 days of age. WSSV was also present in 14 out of 16 local areas from that region of Mexico. Bahía de Kino, where this pond is located, was one of the most affected of these local areas (COSAES, 2014). The diagnostic was confirmed using PCR analysis in shrimp from the same pond, which were growing separated from the tagged shrimp by a net.

Water physicochemical parameters were in the required range during the whole growing time.