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Health & Welfare

Strong biosecurity and genetic foundation being built for domesticated black tiger shrimp in Brazil

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Study results indicate this population would provide a suitable starting point to initiate a breeding program

A collaborative study reports the strong biosecurity and genetic foundation of a domesticated black tiger shrimp population in northern Brazil, which could enhance the country's shrimp farming industry. Results indicate this population would provide a suitable starting point to initiate and be a blueprint for a breeding program for *P. monodon*. Photo courtesy of Genics.

A recent paper by researchers and commercial companies from Brazil and Australia reports that there are populations of black tiger shrimp (*Penaeus monodon*) established in the wild across the north of Brazil that could provide an alternative for shrimp aquaculture systems.

Such systems in place today are primarily suited for the culture of Pacific white shrimp (*Litopenaeus vannamei*), the shrimp species primarily produced (99 percent of farmed shrimp) in the Americas and globally.

Pathogen screening for 96 shrimp in this study, using molecular diagnostics and histopathology, revealed no significant pathogens, establishing the population as a potential foundation for a specific pathogen-free (SPF) breeding program.

The **study** (https://doi.org/10.1155/are/9086659)explores how one such population of *P. monodon* was sourced from the state of Ceará in Brazil, and was used to evaluate husbandry and breeding systems, and was assessed for pathogen incidence and genotyped to evaluate inbreeding, genetic diversity, and population structure after 10 generations of domestication.

(https://bspcertification.org/)

“This work highlights a significant opportunity for Brazilian shrimp producers to diversify farmed production of black tiger shrimp with a pathogen-free, genetically diverse population already established for aquaculture purposes,” Dr. Melony Sellars, CEO of Genics and one of the corresponding authors of the study, told the *Advocate*. “The study also demonstrates the ability of ShrimpID [Genics’ genotyping tool for penaeid shrimp] to differentiate between genetically different black tiger shrimp populations around the world.”

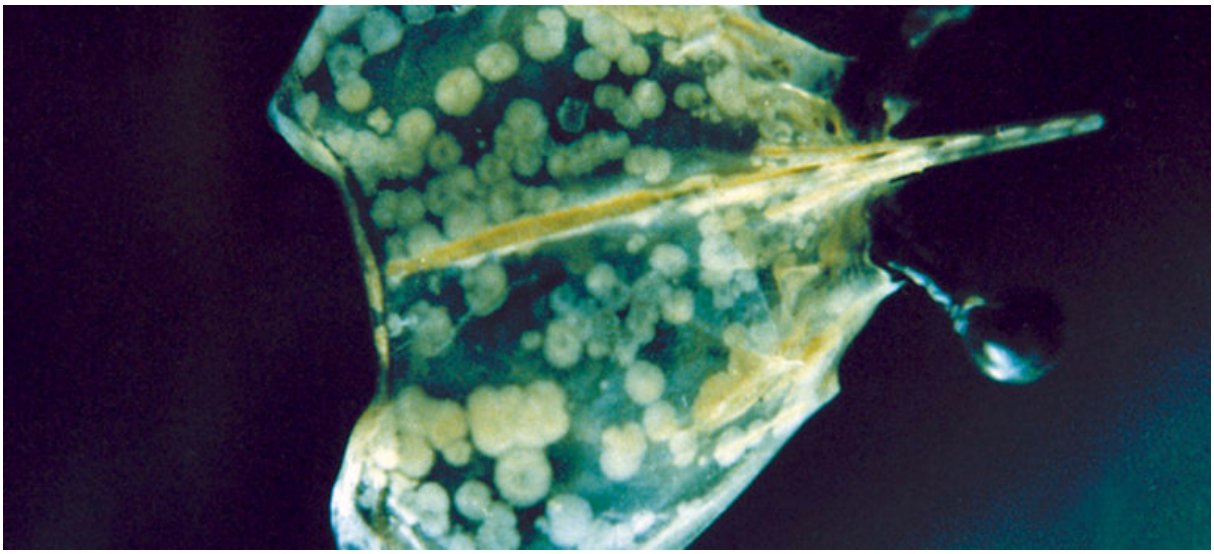
Marine shrimp farming in Brazil has developed into a significant industry with more than 3,300 producers in more than 300 municipalities, providing 130,000 jobs. Originally the industry was primarily based on the commercial culture of various other penaeid species – including some introduced (such as *Penaeus japonicus*, *P. monodon* and *P. stylirostris*) and some native ones, like *P. brasiliensis* and others – until *L. vannamei* was introduced around 1983.

Despite the success that Brazilian producers have experienced using *L. vannamei*, **problems with pathogens** (https://doi.org/10.1016/j.aquaculture.2022.738159) such as Infectious Myonecrosis Virus (IMNV) and White Spot Syndrome Virus (WSSV) have led to financial losses in the region. *P. monodon* provides an alternative species of shrimp with different levels of susceptibility to the major pathogens that limit productivity. For example, *P. monodon* has been found to be somewhat **more resistant** (https://www.int-res.com/articles/dao2005/63/d063p261.pdf) to infection with IMNV than *L. vannamei* and has the capacity to develop a level of **resistance** (https://doi.org/10.1111/tbed.13715) against WSSV. In the market, *P. monodon* could **complement** (https://doi.org/10.1016/j.aquaculture.2023.740178) *L. vannamei* production by offering a species with distinct advantages on prices and which is well suited for small-scale farm production.

In 2022, after some previous attempts to launch a joint research program – with Dr. Melony Sellars (when she was at CSIRO) and other colleagues from James Cook University in Australia – focused on Brazilian *P. monodon*, the accredited Crustaceans Diseases Diagnostic Laboratory (LAQUA-UEMA at State University of Maranhão) began a close collaboration with Marine Aquacrusta Ltd. and Flavors of the Coast, a company recognized for its organic shrimp production), as well as Genics and CSIRO from Australia. This partnership marked the renewal of a strong collaboration in 2024 with other authors of this study, all considered leaders in global *P. monodon* genetics using high-resolution SNP markers.

This collaborative research – conducted between **Genics** (https://www.genics.com/) with researchers from LAQUA-UEMA, CSIRO, and Coastal Tastes/Marine Aquacrusta – assessed the pathogen load and genetic diversity of a domesticated population of black tiger shrimp from Ceará, Brazil, across 10 generations. Pathogen screening of 96 *P. monodon* shrimp using molecular diagnostics and histopathology revealed no significant pathogens, establishing the population as a potential foundation for a specific pathogen-free (SPF) breeding program.

“This is a pivotal finding for the Brazilian shrimp farming sector,” said Dr. Sellars. “By demonstrating that local black tiger shrimp populations are pathogen-free and genetically diverse, we’re providing the industry with the tools to enhance resilience, reduce disease risk, and foster sustainable production systems … Pathogen-free, genetically diverse populations are essential for aquaculture sustainability … This research not only provides a blueprint for the Brazilian shrimp industry but also demonstrates the potential for local breeding programs to reduce reliance on imported stocks and mitigate the spread of infectious diseases.”



WSSV and TSV: Diseases as drivers in the shrimp-farming industry

Key to avoiding the cyclical rise and fall of production and prices is the move toward controlled reproduction of shrimp to perform within the structure chosen, whether that is disease coping or disease avoidance.

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Genetic analysis using single nucleotide, SNP, markers [SNPs can act as biological markers to help locate genes associated with diseases] showed a low inbreeding coefficient of 0.03, comparable to international populations in Vietnam and Australia. The findings suggest that the Brazilian broodstock is well-positioned to serve as the foundation for a structured breeding program focused on disease resilience and sustainable growth.

“This study represents the first effort in Brazil to simultaneously screen domesticated *P. monodon* for a broad list of pathogens and assess its genetic profile in detail,” Dr. Thales Passos de Andrade, lead author of the study, told the *Advocate*. “Its SPF-status and exceptionally low inbreeding coefficient, allied to natural its tolerance to key pathogens like IMNV, combined with a favorable market profile, confirms this domesticated Brazilian *P. monodon* as a viable and strategic alternative for shrimp producers. Together, we have demonstrated the strong biosecurity and genetic foundation of this domesticated *P. monodon* lineage, reinforcing its value in building a resilient and diversified shrimp farming sector in Brazil.”

Because of the reported absence of pathogens and lack of inbreeding, results imply that the population is well adapted to this region, making it suitable for the development of a structured breeding program to provide a reliable domestic source of genetically improved *P. monodon*. Such a program would

contribute significantly to the long-term sustainability, resilience, and productivity of the shrimp industry in north/northeast of Brazil, by reducing dependence on imported stocks and enhancing local aquaculture development.

“Together, we committed to conducting the first global/comprehensive assessment of the genetic diversity of Brazilian *P. monodon*. In parallel, my laboratory led pathogen screening efforts using molecular diagnostic tools targeting 19 different pathogens, complemented by histopathology and on-site evaluations,” said Dr. de Andrade.

“These analyses were conducted under international quality standards (ABNT NBR ISO/IEC 17025:2017) established at LAQUA-UEMA. This integrated approach has demonstrated that the Brazilian domesticated broodstock is specific pathogen free and possesses an exceptionally low inbreeding coefficient (F = 0.03), one of the lowest reported globally. These results indicate that this population holds strong potential to serve as the foundation for a structured and sustainable breeding program aimed at improving disease tolerance/resistance and supporting long-term Brazilian aquaculture productivity.”

Developing a domesticated population of specific pathogen-free (SPF) *P. monodon* from the stock that has become naturalized across the north of Brazil would provide local aquaculture operations another option for domestic shrimp production systems. Ensuring these breeding populations are free from specific known pathogens will be critical for increasing the proportion of *P. monodon* that is produced in the region.

A genetically diverse breeding population of *P. monodon* may be used to provide the Brazilian industry with an alternative *to L. vannamei* for domestic production. Initiating a breeding program with a pathogen free and genetically diverse population will ensure **production constraints** (https://doi.org/10.1038/s41467-021-23222-9) imposed by disease and inbreeding depression are avoided.

While managing the *P. monodon* population in a production environment for 10 generations provides evidence that the population that was introduced to the region is suitable for aquaculture systems, determining if the population is pathogen free will ensure investments in genetic selection may be applied for long-term improvements.

The development of breeding populations of SPF *L. vannamei* was a critical point in shifting global shrimp production from black tiger to Pacific white shrimp. Reliance on wild *P. monodon* broodstock for aquaculture has resulted in financial losses from disease in several countries. These losses have been mitigated by moving production to less intensive systems and maintaining lower stocking densities, where *P. monodon* is managed extensively with little additional feed with production targeting organic and other high-margin, low volume markets.

Improved understanding of pathogen incidence and the genetic diversity of Brazilian *P. monodon* populations could reportedly support the development of locally adapted breeding populations from the genetics that have become established in the region. Genetic diversity has a critical role in enhancing resilience by ensuring populations can adapt to change, which is essential for overcoming challenges like disease outbreaks and improving productivity. These factors were taken into account during the evaluation of the population of *P. monodon* that has been domesticated now for over 10 generations in northern Brazil.

“The source of the populations that have become established in Brazil is unknown and may result from various introductions of different populations. The process of developing maturation and hatchery

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> Developing a domesticated population of SPF P. monodon from the naturalized stock in northern Brazil would provide local shrimp farmers with another option, but these breeding populations must be free from specific known pathogens.

systems to domesticate this population has produced broodstock that are not inbred compared to other populations. The current domesticated Brazilian *P. monodon* population is most closely related to the Indonesian and Vietnamese populations that were sampled in this study. Large genetic differences observed between the Brazilian population and those from the Mozambique Channel and Western Australia make these regions desirable for providing additional genetic diversity should this be required in the future. Given the low to moderate level of inbreeding and the freedom from specific pathogens, this population would provide a suitable starting point to initiate a breeding program for *P. monodon* in the north of Brazil," concluded the authors.

Study authors include Drs. Thales Passos de Andrade and Amanda Rafaela Cunha Gomes (State University of Maranhão, Brazil); Francisco Rodrigues Norberto, Junior (Marine Aquacrusta Ltd. & Flavors of the Coast, Acaraú, Brazil); Dr. James Kijas (Commonwealth Scientific and Industrial Research Organisation, CSIRO, Australia); and Drs. Melony Sellars and Jeremy Brawner (Genics), Australia.

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