Overcoming the Challenges Facing Spiny Lobster Mariculture in Small Island Developing States (SIDS)

Superando los Obstáculos a los que se Enfrenta la Maricultura de la Langosta Espinosa en los Pequeños Estados Insulares en Desarrollo (SIDS)

Surmonter les Difficultées Liées à la Mariculture de la Langouste Blanche dans les Petits États Insulaires en Développement (PIED)

MATTHEW B. SANDERS[1]*, ALLENA JOSEPH[2], PETER MITCHELL[3], IAN TEW[1], ADAM KENNERLEY[1], JOSEPH SHEPHARD[2], MICHELLE STONE[1], STUART ROSS[1], DIANA MINARDI[1], DAVID BASS[1], RONNY VAN AERLE[1], MARK FREEMAN[4], VAUGHN SEVERIEUX[2], LISA BENSON[3], RICCARDO AROSIO[3], and KELLY BATEMAN[1]

[1]*Cente For Environment Fisheries and Aquaculture Science (Cefas)*
Barrack Road, Weymouth, Dorset, Dt4 8ub, United Kingdom.
*Matthew.Sanders@Cefas.co.uk

[2]*Ministry of Agriculture, Fisheries, Physical Planning, Natural Resources and Co-Operatives*
Pointe Seraphine, Castries, Saint Lucia.

[3]*Cente For Environment Fisheries and Aquaculture Science (Cefas)*
Pakefield Road, Lowestoft, Suffolk, Nr33 0ht, United Kingdom.

[4]*School of Veterinary Medicine — Ross University, Basseterre, St Kitts.*

EXTENDED ABSTRACT

Introduction

Small island developing states (SIDS) have growing populations which are often limited in land-based resources but frequently have access to abundant marine resources. Aquaculture is the fastest growing food sector worldwide and has the potential to provide greater food security in a changing environment and economic benefits for local communities (FAO 2018). The majority of aquaculture occurs in China (> 60%) with minor (< 10%) contributions from India, Indonesia, Vietnam, and Bangladesh. Of concern is that there is evidence for some regions, including the Caribbean, that aquaculture production is declining (FAO 2016). The CRFM Fisheries and Aquaculture Research Agenda (2014) identified a priority need for research to evaluate the social and economic performance of fisheries and aquaculture at a regional level with a pressing need for research to identify and develop "alternative livelihood opportunities for fishers and other vulnerable groups in the coastal zone".

Caribbean spiny lobster, *Panulirus argus*, is an economically and culturally important commercial species in the Caribbean. The complexity of the early life stages makes modern hatchery-based aquaculture practices currently unobtainable. However, collection of early post settlement lobsters and 'on-growing' in culture or 'ranch' conditions is an established practice in SE Asia. This project investigate whether methods used in SE ASIA could be employed in Caribbean SIDs to initiate accessible mariculture , support economic development, develop employment opportunities for disadvantaged people, ensure food security and reduce fishing pressure on existing lobster stocks.

Funded under the Commonwealth Marine Economies Programme, the project is a partnership between Cefas and the St. Lucia Department of Fisheries (DoF) to overcome the challenges facing spiny lobster mariculture in SIDs. The project assessed the health status of the local fishery, tested trapping and seed collection protocols and identified suitable mariculture sites. A pilot project is collecting growth, feeding and stocking data to inform an aqua-economic model developed to evaluate sustainability and profitability. In partnership with the DoF and other international aid programmes the project also provides mariculture training to stakeholders.

Methodologies

A baseline health assessment was conducted on fished populations of adult lobsters from sites around St. Lucia. Animals were subjected to a full histological and molecular screening. Carapace length, sex and gross pathologies were noted by visual examination. Hemolymph was taken for molecular analysis. Heart, hepatopancreas, gill, gonad, muscle, nerve, cuticular epithelium, carapace, antennal gland, and gut samples were taken for histological analysis. Samples of gill, hepatopancreas and heart were sampled for electron microscopy and molecular analysis. A complete animal metagenomic analysis was undertaken on selected animals from each sample site using Illumina technologies.

High-resolution bathymetry data were collected by the United Kingdom Hydrographic Office (UKHO) around key high vessel traffic areas of St. Lucia for the purposes of updating navigational charts. To support sustainable marine spatial planning, Cefas conducted an overlapping seabed imagery survey which provided baseline biodiversity data around the leeward coast of St Lucia. Observed taxa were grouped into community assemblages which were then integrated with bathymetry data to produce high resolution seabed habitat maps.

P. argus pueruli and juveniles are being collected by larval traps deployed in locations around St. Lucia to provide seedstock for the pilot programme. Animals are stocked in seabed container systems that are manufactured in country. These are monitored to assess biological and economic parameters which are used to inform an aqua-economic model (AEM) developed to generate projections of small-scale spiny lobster aquaculture viability in SIDS.

Results and Discussion

The baseline health screen indicated that lobsters from St. Lucia were healthy and free from known pathogens suggesting the area is suitable for the development of lobster mariculture. A commensal organism, a barnacle belonging to the Octolasmis genus, was found in lobsters at all sites (Figure1). It appears to cause little harm but under intensive aquaculture it could become an emerging issue. Shell damage and uropod rot was noticed in many lobsters, typical of opportunistic chitinoclasitic bacterial infections. Excessive shell disease could be treated with antibiotics but control through optimal culture conditions would be preferable. Histological analysis identified a few digenean infections, and while lobsters are known to be intermediate hosts of these parasites, the low-level infection detected is of little concern. A pathology was identified in the hepatopancreas, cells were shown to be sloughing away from the tubule membranes causing areas of degeneration. The cause of this pathology is unknown and will need to be monitored to identify if this could be an emergent condition.

The full metagenomic study of the lobsters identified a range of bacteria, most of which are thought to be commensal organisms. Many Vibrio species were identified, several of which are implicated in spiny lobster diseases (Shields et al. 2011) and could be responsible for the uropod rot observed. Milky disease, a condition responsible for significant economic losses of farmed lobsters in Vietnam, and Gaffkaemia, a disease of clawed lobsters are caused by bacterial infections. These infections were not detected in metagenomic data from this survey nor were fungal and oomycete species known to infect spiny lobsters (*Fusarium solani, Atkinsiella panulirata, Haliphthoros spp., Didymaria palinurid* and *Ramularia branchiales*). Viral pathogens exert the most significant constraints on the growth and survival of cultured crustaceans. *Panulirus argus* Virus 1 (PaV1) is a pathogenic virus present in Caribbean Sea region, which typically infects juvenile lobsters. In the Caribbean, fisheries declines have been associated with apparent emergence of this pathogenic virus (Shields and Behringer 2004). In addition to killing

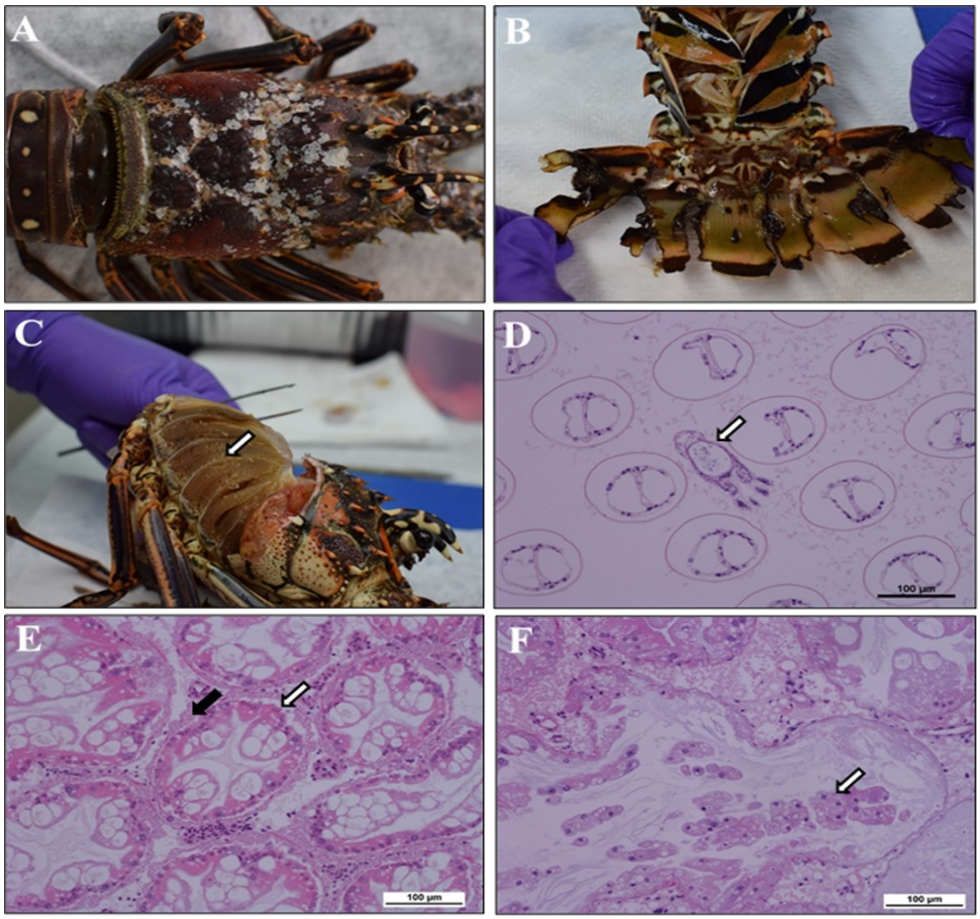

Figure 1. A) Shell disease, white marks on surface of shell indicate where shell has been damaged. B) Shell disease, erosion of tail fin of Panulirus argus. C) Commensal organism (arrow) can be seen attached to the gill filaments underneath the carapace of the lobster. The barnacle belongs to the Octolasmis genus. D) Commensal organism (arrow) present between the gill filaments. H&E stain. Scale bar = 100µm. E) Section of hepatopancreas tissue. The outer epithelial layer of the tubule is distended from the tubule cells creating a space (white arrow). The space appears to be filled with a basophilic substance (black arrow). H&E stain. Scale bar = 100µm. F) Degenerate tubule within hepatopancreas, cells can be seen sloughing from the outer epithelial layer into the lumen of the tubule (white arrow). Adjacent tubules appear unaffected (black arrow). Scale bar = 100µm.

up to 25% of wild juvenile lobsters prior to recruitment (Moss et al. 2013), PaV1 fundamentally alters lobster behaviour (Behringer et al. 2006) and affects their catchability by fishers. Although we did not identify any PaV1 infections in adults collected in this survey the region cannot be considered free from this disease until a survey of juvenile life stages is completed. While no significant disease was recorded it is vital that cultured stocks of lobsters are screened throughout the culture cycle to ensure emerging disease conditions can be detected. This is extremely important when developing an industry within a new region to ensure that both wild stocks and the developing industry are protected.

The seabed habitat maps, can be used to support a range of environmental and development projects such as the delineation of Marine Protected Areas, reducing disturbance from coastal developments and minimising stakeholder conflicts. For example, seabed habitat maps could be used by local stakeholders, regulators and potential farmers to identify suitable sites for the planning and development of mariculture in St. Lucia. The project has provided basic equipment and training to local people, to facilitate the initial assessment of lobster mariculture in SIDS. Several $2x3m^2$ seabed containers have been constructed in county and are being used to stock lobsters for culture. Initial feed is comprised of squid, crab and fish protein (waste tuna from processing) with feeding trials planned to identify alternative sources.

The AEM captures the main costs relating to revenue allowing for best practise guidelines to be made. Output was a hypothetical balance sheet that aggregated literature derived costs, based on the known biological performance of farmed spiny lobster. Figures were then upscaled until farm profitability was projected in relation to the minimum number of lobsters needed, minimum production size, time to market and sale price. Initial AEM projections indicated that small-scale grow-out enterprises would not be viable due to high fixed capital costs. However, profitability could arise if the production cycle was split between producing juveniles for grow-out and grow-out only farms. Producing lobsters for grow out farms could be profitable if 750 juveniles could be grown to 40 g within 9-months using a culture area of ~24 m^2. The production for grow-out scenario can be used to inform initial practices and future observations and feedback can be applied to develop further models that suggest how grow-out only enterprises could be viable.

The project continues to address the challenges facing lobster mariculture including training and education, appropriate sustainable protein sources, and economic assessment of realistic production scales.

KEYWORDS: Spiny lobster, aquaculture, *Panulirus argus*

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