Directly Ageing the Caribbean Spiny Lobster, *Panulirus argus*

Envejecimiento Directo de la Langosta Espinosa del Caribe, *Panulirus argus*

Vieillissement Direct de la Langouste des Caraïbes, *Panulirus argus*

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EXTENDED ABSTRACT

Introduction

The life history traits of marine animals - such as growth, mortality, and reproduction - are often age-dependent rather than size-dependent. Thus, information on the age structure of populations subject to fishing often produces more accurate stock assessments than those based on size (Campana 2001). But knowledge of age structure in crustaceans is lacking because they grow through the process of ecdysis (i.e., molting), which has long been thought to result in the loss and replacement of all calcified structures that typically bear information on age. So the methods used to age other marine species (e.g., bands in fish otoliths and mollusc shells) are believed to be inapplicable to crustaceans. In lieu of methods to directly age crustaceans, scientists and fishery managers have instead relied on indirect methods to estimate their age. Those methods include: modal analysis of size frequency distributions, approximations of size and growth from tag-recapture studies, and the accumulation of the pigment lipofuscin in neural tissues (Vogt 2012). However, indirect methods are often strongly influenced by environmental conditions, which compromises their accuracy and widespread applicability for fishery management (Campana 2001).

In 2011, Leland and colleagues (Leland et al. 2011) noted the existence of banding in the ossicles of the gastric mill of several decapods. The following year a group of scientists led by Raouf Kilada (Kilada et al. 2012) demonstrated that age could indeed be estimated from banding in the gastric ossicles in four temperate decapods, and the technique has since been applied to a few other crustaceans. Here we present an overview of the results of an ongoing study funded by the NOAA MARFIN program (#NA16NMF4330160) to examine whether bands deposited in the gastric mill can be used to directly age the Caribbean spiny lobster *Panulirus argus*.

We sought to develop such a method because *P. argus* supports one of the Caribbean's most economically valuable fisheries, whose management can benefit if the age and size of individuals can be differentiated. Our project has three broad objectives:

i) Develop an accurate and precise method of directly estimating age in *P. argus*,
ii) test if the deposition of bands on gastric ossicles is potentially confounded by molt frequency (e.g., growth rate) or seasonality, and
iii) use the technique to examine the age-size relationship of lobsters in subpopulations where that relationship differs due to regional differences in life history or environmental conditions.

Details on objectives 1 and 2 appear in the first of our peer-reviewed papers stemming from this project (Gnanalingam et al., *In press*).

Methodologies

Lobsters for this project came from two sources: field collections of lobsters from the Florida Keys and Dry Tortugas, Florida (USA) were made using traps and hand-collections by divers. Unique to this study was also the availability of known-age (1.5 - 10 years) lobsters that we collected as postlarvae and reared at the Fish and Wildlife Research Institute (Marathon, FL) for up to 10 years in large mesocosms equipped with flow-through seawater and at ambient temperatures and daylight conditions. To test if molt frequency (i.e., growth rate) effects band deposition we reared another group of postlarval lobsters for 1.5 years at ambient and high temperature regimes. Processing of gastric ossicles for analysis was done following the methods of Kilada et al. (2015), which are similar to those employed for fish otoliths. In brief, sample processing involved the dissection of the gastric ossicles from lobster stomachs, embedding the ossicles in epoxy, serially sectioning the ossicles using a low-speed saw, and counting bands on the ossicles from images photographed from a compound microscope. Precision of the method was estimated by comparing band readings from four trained readers, and

accuracy determined from age estimates based on banding observed on ossicles from known-age lobsters.

Conclusions

Our results demonstrate that the age of *P. argus* can be reliably determined from lobsters collected in Florida, particularly those large enough to be part of the legal-sized fished population (i.e., 2 years or older) (Figure 1). We are currently conducting a laboratory experiment with Barium tagged lobsters to test whether we can identify a settlement scar and potentially the difference between summer versus winter settlement cohorts. We are also gathering samples from lobsters in various locations in the Caribbean to determine if seasonal differences in temperature affect banding patterns and to examine geographic patterns of age -size structure.

KEYWORDS: Lobster, aging, *Panulirus*

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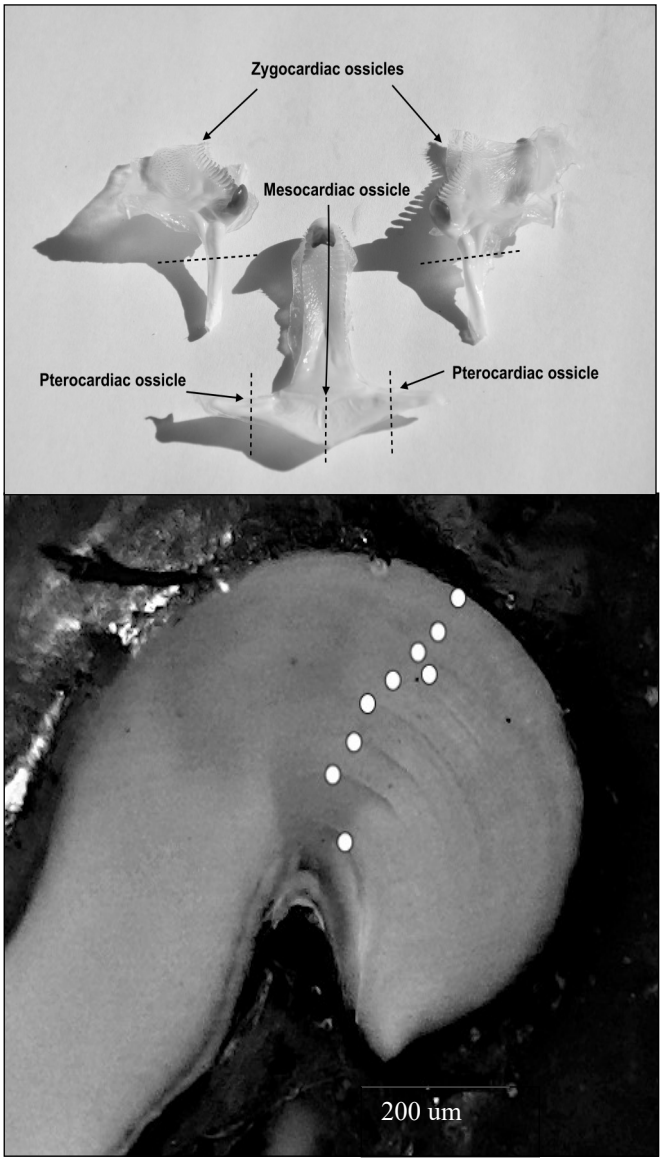

Figure 1. (Top) Gastric ossicles dissected from the stomach of a *P. argus* showing the paired zygocardiac ossicles, the mesocardiac ossicle, and the paired pterocardiac ossicles. The dotted lines depict the cutting axis for each ossicle cross-section. (Bottom) Cross-section from a zygocardiac ossicle showing growth bands for a female *P. argus* 151 mm carapace length of a known age of 8 years 7 months post-settlement; white dots are a reader's identification of growth bands indicating an estimated age of 9 years.