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SHORT COMMUNICATION

Fecundity and Oocyte Development of the White-spotted Rabbitfish *Siganus canaliculatus* (Park 1797) in Palompon, Leyte, Eastern Visayas, Philippines

LIEZEL CORDEL PARABOLES* and WILFREDO LOPEZ CAMPOS

OceanBio Laboratory Division of Biological Sciences, College of Arts and Sciences, University of the Philippines Visayas, 5023 Miagao, Iloilo, Philippines

Abstract

The demand for boneless siganid, primarily the white-spotted rabbitfish *Siganus canaliculatus* (Park 1797) in Palompon, Leyte has increased continuously over the years; resulting in intensive fishing of the species. This study was conducted to investigate some of the reproductive characteristics of this species. The fecundity and oocyte development of *S. canaliculatus* were studied for 64 spawning female individuals ranging from 7.1–15.5 cm standard length (SL) from catches of drive-in gillnet and spearfishing from Palompon, Leyte. Samples were collected monthly and only the females were used for histological examination to determine the oocyte developmental stages. Fecundity was estimated following the volumetric method. Oocyte development and sizes were determined using the histological slides. Fecundity estimates ranged from 18,350–306,850 eggs.ind^{-1}, and increased significantly with fish length, back-calculated age, body weight and gonad weight. Earlier stage oocytes still occurred with the most advanced cells, indicating a group-synchronous oocyte development. Mature oocyte diameter increased significantly with standard length, showing a 25 % increase over a size range of 7.1–13.9 cm SL. Results from the present study provide useful inputs in the formulation of suitable management measures of *S. canaliculatus*.

Keywords: fecundity, oocyte development, Palompon, Leyte, *Siganus canaliculatus*

*Corresponding author. E-mail: liezparaboles@gmail.com

Introduction

The white-spotted rabbitfish, *Siganus canaliculatus* (Park 1797), dominates the catches of the major fishing gears used in Palompon, Leyte. In 2010, siganids contributed at least 420 $mt.yr^{-1}$ to total fisheries production with *S. canaliculatus* making up about 80 %. Due to its popular demand, adults and juveniles are targeted for dried boneless fish production, making the municipality known for this commodity. A kilogram of dried siganids costs from PhP 800–850 (or US$ 16–17) in the local market and the price increases from PhP 1,000–1,200 (or US$ 20–24) when transported to adjacent municipalities and cities, particularly Cebu City where the bulk is destined. The increased demand and high value of the product has resulted in intensive fishing of the species over the years. In addition, the estimated fisher density (59.3 $fisher.km^{-2}$) in Palompon is among the highest among fishing grounds in the central portion of the country (Paraboles and Campos 2018). Together, these conditions translate to overfishing of the species. The reported declining siganid production in the municipality is consistent with this resource being overfished.

This study was conducted to examine some of the reproductive aspects of *S. canaliculatus* such as oocyte development, fecundity and egg sizes in relation to female size. The findings on the reproductive aspects of *S. canaliculatus* will provide useful inputs in the formulation of suitable management plans and policies to avoid further exploitation and collapse of the stock in Palompon and similar waters in the Philippines.

Materials and Methods

The study was conducted in Palompon, Leyte at latitude 11° 05’ N and longitude 124° 38’ E. Samples were collected monthly from June 2011 to July 2012 around the new moon phase. Thirty to fifty specimens were randomly collected, measured (standard length) and labelled with assigned codes. Gonads were preserved in Bouin’s fixative solution and the middle portion was dissected out for histological analysis following the protocol described by Humason (1972). Staging of the gonad was done using a compound microscope and based on the appearance of most advanced cells (West 1990) and other related information in the literature (Alcala and Alcazar 1979; El-Halfawy et al. 2007; Branco et al. 2013).

Fecundity was determined volumetrically and was estimated on spawning stage individuals. A linear regression was used to determine the relationship between fish fecundity and standard length (SL). Regressions between log-transformed gonad and body weight with log-transformed fecundity were similarly computed. The oocyte developmental stages were identified following the criteria described by Hoque et al. (1998) and information available in the literature (Ganias et al. 2004; Branco et al. 2013) on oocyte development. Egg diameters were determined by taking pictures of randomly selected eggs in each ovary under low magnification (100X) in a compound microscope calibrated against a stage micrometre. Measurements were done using the Image J software.

Results and Discussion

The oocyte development stages include the following: oogonia, peri-nucleolus, oil droplet/cortical alveoli, primary yolk, secondary yolk, tertiary yolk, migratory nucleus and mature stage (Fig. 1). The oocyte development of *S. canaliculatus* is reported to be group-synchronous (Hoque et al. 1999). Findings in a parallel study on gonad development for the same species (Paraboles and Campos 2018) show a similar pattern of oocyte development. Such a strategy allows fish to spawn several times, and hence is considered as multiple spawners (Hoque et al. 1998).

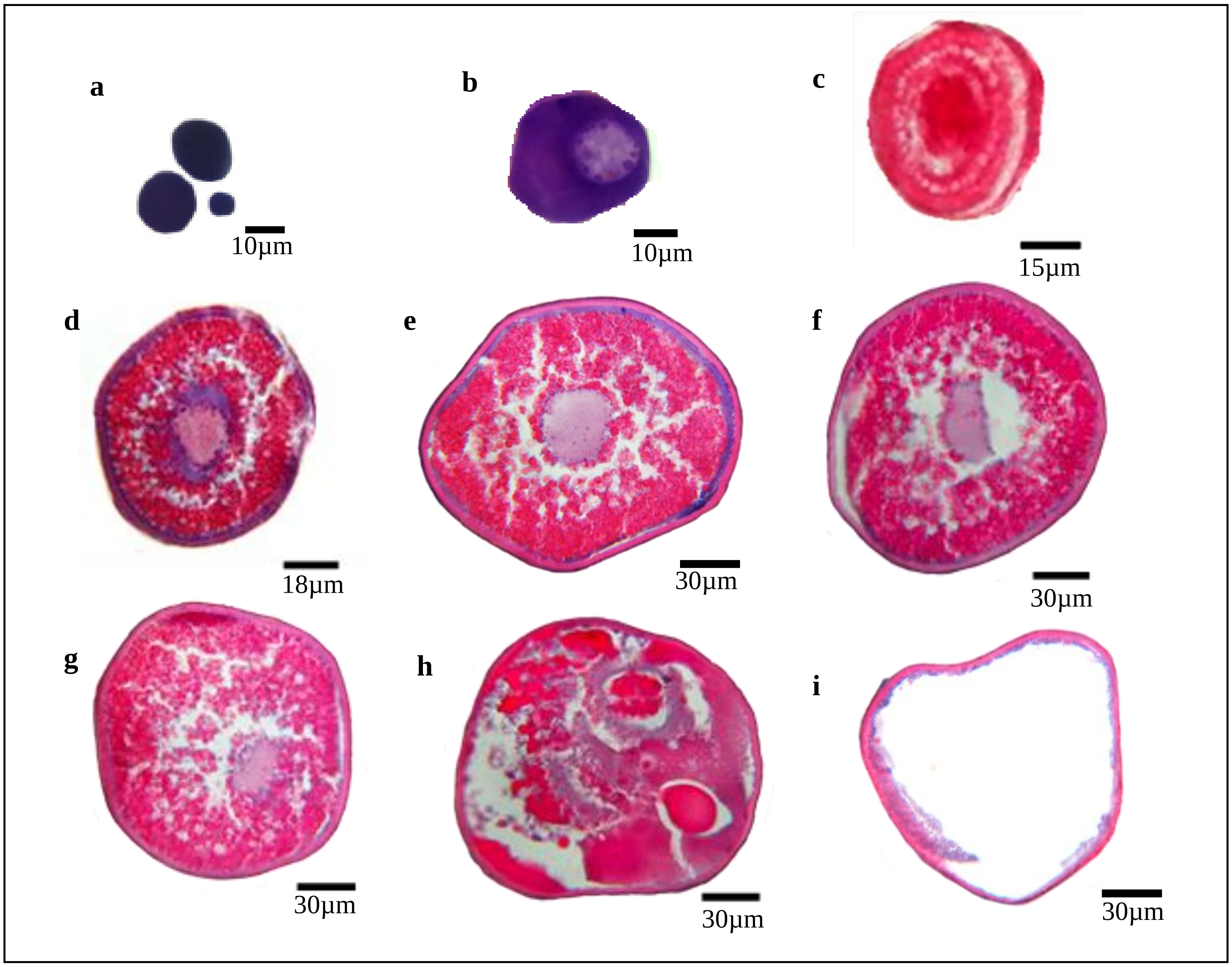

Fig. 1. Observations of oocyte growth and development of *Siganus canaliculatus* based on histological characteristics: a) Oogonia, b) Peri-nucleolus/primary growth oocyte, c) Cortical alveoli, d) Primary yolk stage, e) Secondary yolk stage, f) Tertiary yolk stage, g) Migratory yolk stage, h) Mature stage, and, i) Empty follicle.

Fecundity ranged from 18,350–306,850 in fish ranging in size from 7.1–15.5 cm SL. The fecundity showed a linear relationship with standard length and it increased significantly ($P < 0.05$) with the increase in standard length (Fig. 2a) at a rate of about 28,400 eggs per 1 cm increase in SL.

Similarly, fecundity significantly increased with body ($P < 0.05$) and ovary weight ($P < 0.05$) (Figs. 2b and 2c). The back-calculated age of specimens (Guarte 2015) also showed linear and significant relationship ($P < 0.05$) with oocyte numbers (Fig. 2d).

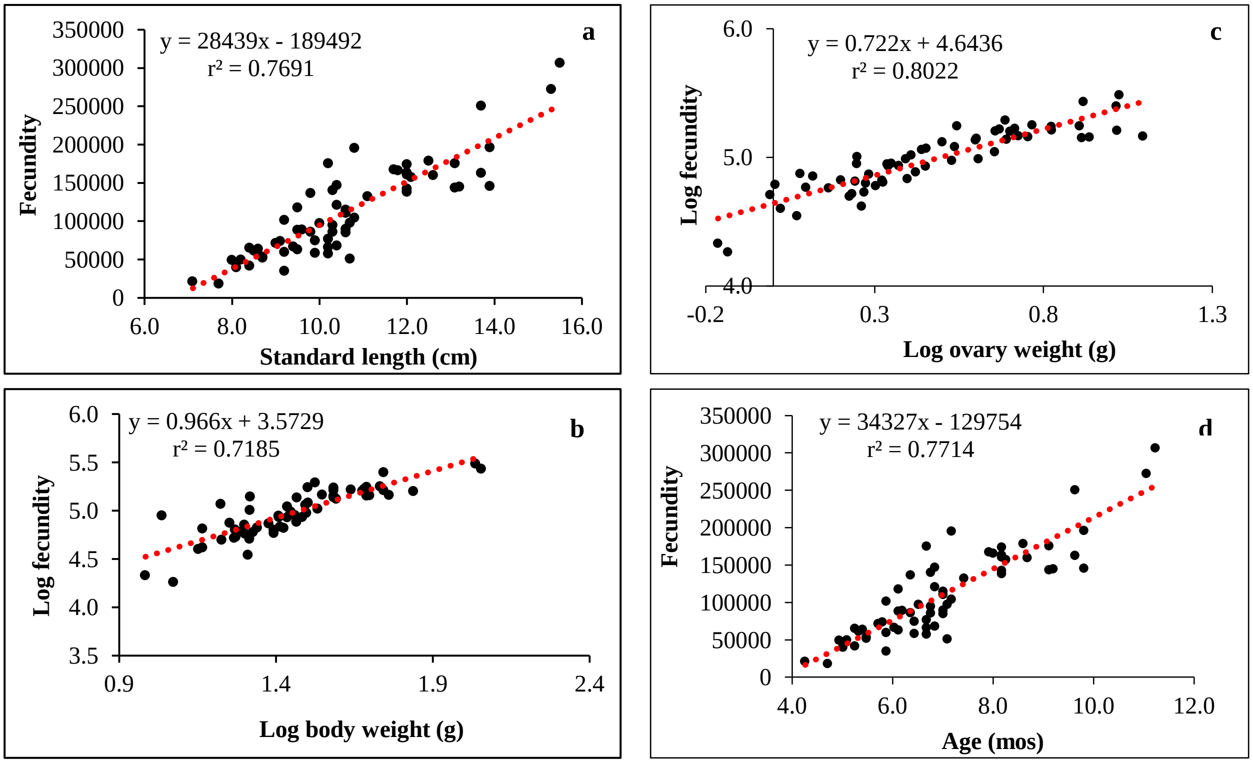

Fig. 2. Fecundity in relation to a) standard length b) body weight c) gonad weight and d) back-calculated age of *Siganus canaliculatus* in Palompon, Leyte.

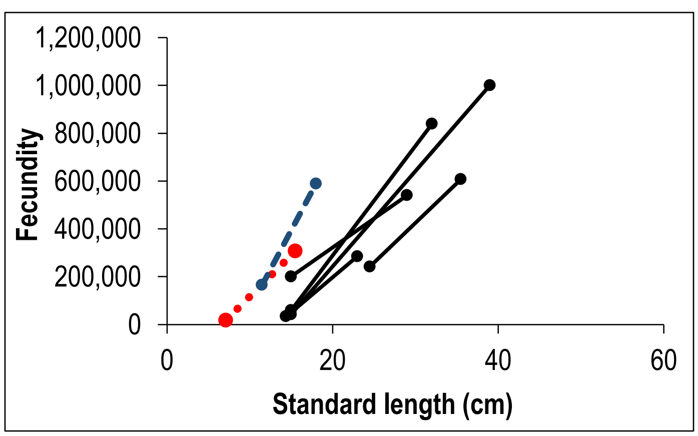

Fig. 3. Fecundity in relation to standard length of *Siganus canaliculatus.* Dotted line shows the fecundity estimate in this study; broken line denote fecundity reported in the Philippines (Alcala and Alcazar 1979) and black lines denote fecundity estimates reported from other tropical areas (Tseng and Chan 1982; Jayasankar 1990; Wassef and Hadey 1997; Tharwat 2004; Marzouqi et al. 2011).

As the sizes of mature female *S. canaliculatus* in the study area are in the lower portion of the known size range of the species, overall fecundity estimates are lower than those reported for other stocks in other tropical countries (Tseng and Chan 1982; Jayasankar 1990; Wassef and Hadey 1997; Tharwat 2004; Marzouqi et al. 2011), (Fig. 3). Interestingly, however, a plot of the reported fecundity estimates versus the size range of fish in their respective studies (Fig. 3) shows that the data from the Philippines follow a trend (curve) that is parallel to the curve of available data from other tropical areas, but for smaller sizes (Fig. 3). This indicates that in addition to a shift to a smaller size of maturity in this species (Paraboles and Campos 2018), there is also a shift in the size-fecundity curve to a smaller size as well. The mean diameter of mature oocyte (Fig. 1h) as a function of size in 17 females (7.1–13.9 cm SL) showed rather high variability ($r^2 = 0.32$), (Fig. 4), but a nevertheless significant overall increasing trend ($P < 0.05$). Based on the derived regression equation, there is a 25 % increase in oocyte size from 7.1 cm SL to 13.9 cm SL, corresponding to a doubling in volume.

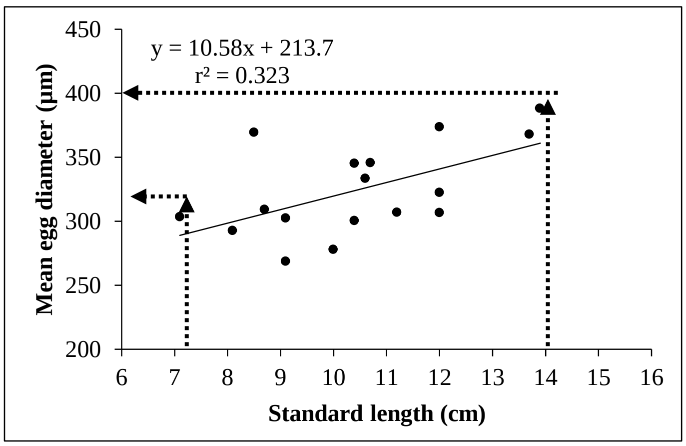

Fig. 4. Mean diameter of mature oocytes of *Siganus canaliculatus* relative to standard length of females.

This increasing pattern in oocyte size with fish length has also been reported in a number of teleost fish, including the *Merluccius merluccius* (Linnaeus 1758) (Mehault et al. 2010), *Plectropomus leopardus* (Lacepède 1802) (Carter et al. 2015) and *Seriphus politus* (Ayres 1860) (DeMartini 1990) among others. Several studies have also shown that larger larvae are the products of larger eggs with larger yolk reserves and body tissues (Marteinsdottir and Able 1992; Einum 2003), thereby increasing their survival (Braun et al. 2013) and decreasing their mortality rates (Castro et al. 2009). Egg diameters in the present study increased in larger (older) fish (Fig. 4), thus theoretically producing larvae that would have higher probability of survival. Moreover, egg size significantly increased ($P < 0.05$) as the number of eggs (fecundity) increases. Thus, larger (or older) individuals contribute more to recruitment by producing many larger eggs compared to smaller individuals. When excessive fishing removes these larger individuals, not only the population fecundity decreases but the recruitment as well. However, if this population will be allowed to grow to a larger size (>15 cm SL), not only the population fecundity increases but the reproductive output as well.

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