The Larval developmental stages of *Pagellus natalensis* in the nearshore waters of KwaZulu-Natal, South Africa

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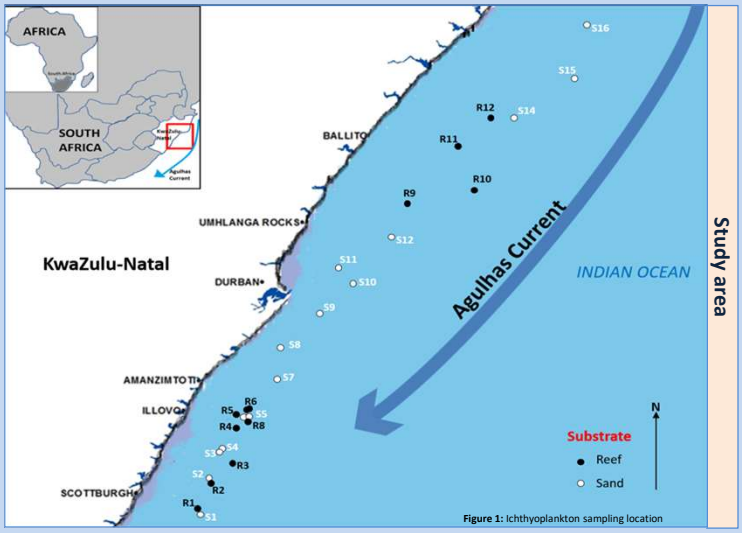
Introduction

The larvae of Sparidae, *Pagellus natalensis* (also known as Sand soldier or Tjor tjor) widely dominates the continental shelf of the KwaZulu-Natal (KZN) coast (Mabotja et al., 2018). This species occurs from the Madagascar to Mossel Bay (Western Cape Province) in the South Western Indian Ocean (Smith and Heemstra, 1986). The adult members of *P. natalensis* are amongst the most abundant (Dalton et al., 2020; Fennessy 2016; Connell 2012), and also of importance to the KZN offshore commercial and recreational linefisheries (Penney et al., 1999). Most of the species caught by the linefishery in the KZN are currently considered threatened or endangered, with only small and less favoured species such as the Sand soldiers now being caught while bigger sizes of fish species are rarely found (Toral-Granda et al., 1999; Hutchings et al., 2002). Therefore, proper management such as Marine Protected Areas (MPAs) in the KZN waters are needed to safeguards the wide ranging movement of sparids and further to achieve their persistence.

Knowledge of the larval fish distribution patterns is an important prerequisite for identifying key habitats for the implementation of MPAs (Maxwell et al., 2011).

The aim of the study is to investigate the distribution and abundance of the larval developmental stages of the *P. natalensis* between the reef and sand substrate types for marine conservation planning



Study area

Figure 1: Ichthyoplankton sampling location

Methods

Field Sampling & Laboratory Procedure

1. Plankton net 500um

2. Preservation 4% Formaldehyde

3. Washing the sample

5. Taxonomic identification using a microscope

4. Sorting fish larvae from the rest of the zooplankton

- Triplicate samples were collected at **13 reef** and **16 sand stations**
- A total of **87 samples** were collected
- All the samples were collected between **45-80m depth**
- Aboard ***R/V Angra pequena*** *over a two-month period during May and June 2014*
- After each trawl, **a SeaBird CTD water parameter probe** was deployed and measurements of physico-chemical water quality parameters were recorded at each station.

Results

Pagellus natalensis: Distribution and developmental stages

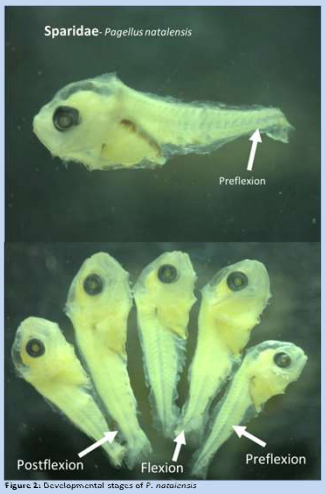


Figure 2: Developmental stages of *P. natalensis*

Total number of *P. natalensis*= **3769 larvae/100m³**

Table 1: Developmental stages of *P.natalensis* (Sand soldier) per no/100m³

	Developmental Stages[1]		
Size	**Preflexion (1.9-3mm)**	**Flexion (4.2-5.8mm)**	**Postflexion (6.3-19mm)**
No. larvae	**3015**	**571**	**177**
Days old[2]	**1-9**	**6-16**	**17**

[1]Leis et al., 2002 [2]Connell 2012

- **Table 1 & Figure 3a** shows that a large percentage **(79%)** of larvae were sampled at preflexion developmental stages.
- In contrast, flexion larvae contributed only **16%** whilst postflexion larvae contributed **5%** of the catch
- **Figure 3b** illustrates that **68%** of the *P. natalensis* were from reef sites and 32 % from sandy sites with this being significantly different **(P<0.05; Table 2)**.

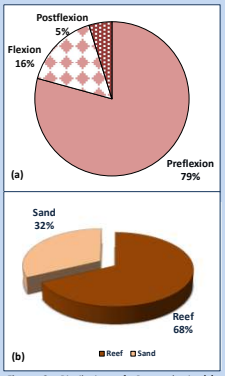


Figure 3: Distribution of *P. natalensis* **(a)** Percentage distribution of developmental stages **(b)** Distribution between the reef and sand substrate types.

Three developmental stages of *P. natalensis* (Figure 2) follow that of Kendall *et al*., 1984.

1. **Preflexion larva:** developmental stage beginning at hatching through egg yolk absorption and ending at the start of upward flexion of the notochord.
2. **Flexion larva:** this stage begins with flexion of the notochord, development of the caudal fin and fin rays in majority of species.
3. **Postflexion larva:** the formation of the caudal fin (distal margin of the hypural elements vertical).

Community Analyses

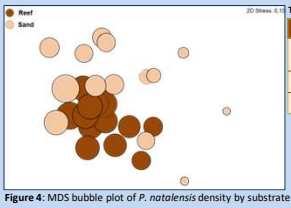


Figure 4: MDS bubble plot of *P. natalensis* density by substrate

Table 2: Results of PERMANOVA for larval fish species of *P. natalensis* sampled over different substrates

Source	df	SS	MS	Pseudo-F	P(perm)
Substrate (Reef & Sand)	1	15735	15735	9,3923	0,002
Res	20	33506	1675,3		
Total	21	49241			

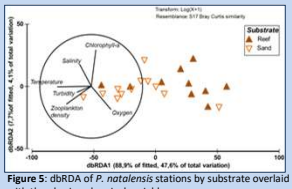


Figure 5: dbRDA of *P. natalensis* stations by substrate overlaid with the physico-chemical variables

- Single factor PERMANOVA was applied to test differences between the density of *P. natalensis* sampled between the reef and sand substrates **(Figure 4; Table 2)**.
- Results indicated that there was a significant difference **(Pseudo-F=9.39,$P_{(Perm)}$ <0002)** in the larval density of this species at the reef and sand substrate.
- The distance-based redundancy analysis (dbRDA) plot shown in **Figure 5** shows zooplankton density and temperature as the main bio-physical variables that correlated best with the *P. natalensis* larval density.
- Bio-physical variables measured accounted **89% of variation** in the larval fish density of *P. natalensis* sampled between the reef and sand substrates.
- Only **11% of variation** in larval density is unexplained.
- These observations strongly suggest that larval fish stages are sensitive to environmental variables

Conclusion

- Preflexion larvae dominated catches in the KZN shelf signifying the importance of this area for newly hatched larvae.
- The reef sites off KZN coast function as nursery areas for the pelagic phase of larval development for *P. natalensis,* and should be considered in the planning of MPAs of KZN.
- It is assumed that by including these habitats in an MPA network, the species using these habitats will by default be protected in the MPA (Dalleau et al., 2010).
- Temperature and zooplankton density were the best measured drivers of *P.natalensis.*

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