Gametogenic Ecology of Antarctic Brittle Star: *Ophionotus victoriae*

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1. Background

- West Antarctic Peninsula has a highly seasonal photoperiod against a stable background temperature[1].

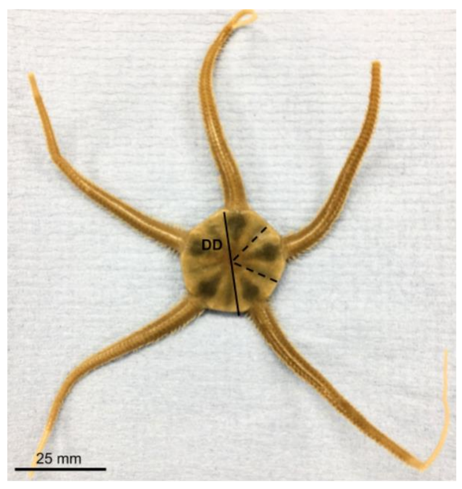

Fig. 1. *O. victoriae*, bar= 25 mm

- Benthic communities make up ~80% of the Southern Ocean biodiversity, where 50 - 97% are endemic[2].
- Antarctic benthic invertebrates are stenothermal and have extended reproductive cycles[3,4]
- Successful reproduction allows survival amid climate change, but few long-term data studies assess Antarctic reproductive ecology [4,5].
- *Ophionotus victoriae*, a circum-polar brittle star, has been collected for Rothera Time Series (RaTS) since 1997 [(3,4)].

4. Result: Sex Ratio 1:1

Frequencies did not differ significantly between sexes (χ^2 = 7.54, p = 0.673).

Ratio variations occur due to ecological differences in behaviour[4]

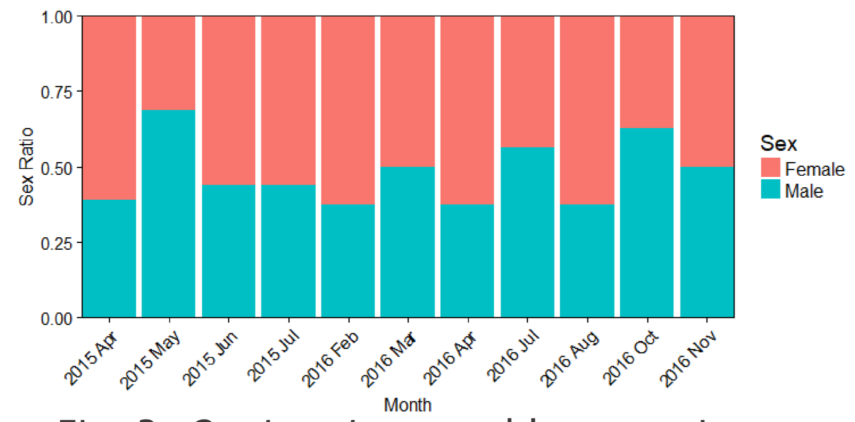

Fig. 3. *O. victoriae* monthly sex ratio

2. Aims

The aim of this study is to measure the reproductive ecology of *O. victoriae* over time. This includes:

- Using gonad index, oocyte diameter and male maturity staging to identify seasonal cycles.
- Comparing male and female frequencies and maturity.
- Assessing reproductive relationships with environmental data

5. Result: Annual Variation

Gonad index, oocyte diameter and male maturity stages differed significantly over time.

- Gonad index (Two- way ANOVA, $F_{(10,156)}$ = 3.08, p = 0.001).
- Oocyte diameter ($\chi2$ = 4149.2, p < 0.001).
- Male maturity staging ($\chi2$ = 435.5, p-value < 0.001).

Each increased February to November before decreasing November-January (austral summer), indicating spawning.

Oocyte bimodal distribution follows right to left skew over year (maturation), unimodal in austral summer (spawning)

Oocyte retention during summer = 18-24 month oogenesis

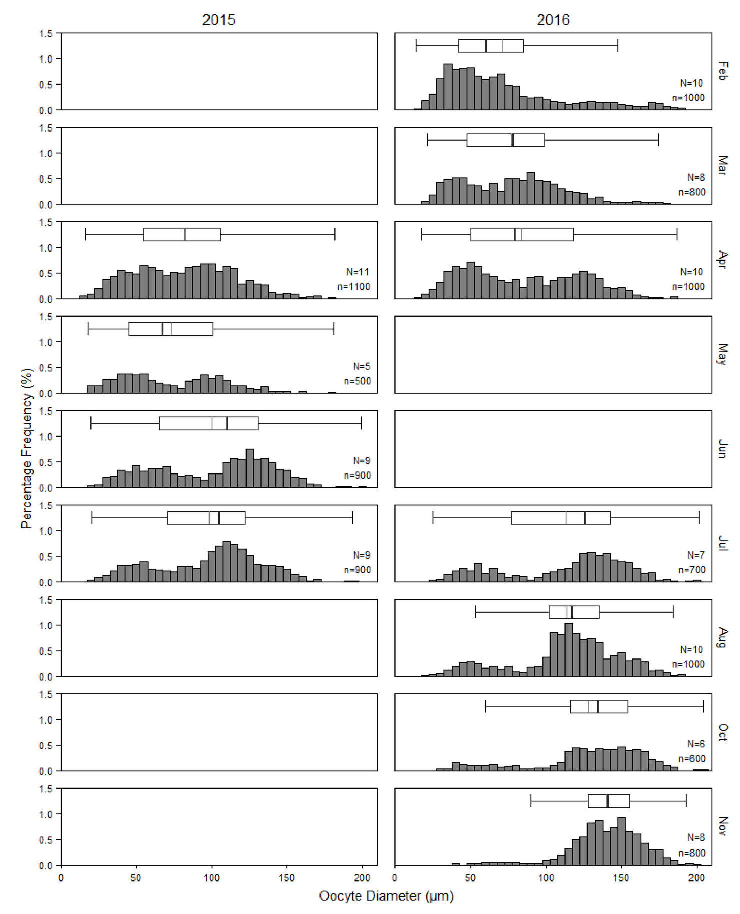

Fig. 4. Monthly oocyte diameter in 5μm bins. Blank=no data. N= 9300

3. Methods

Hand collected, N = 178, n = 16 – 18 :

- Rothera Research Station, West Antarctic Peninsula (67˚34' S, 68˚08' W).
- 11 months between 13/4/2015 to 10/11/2016 at 15 m.
- Obtained environmental data from RaTS.

Gonad wet mass (GW, g) and disk diameter (DD, mm) used to calculate Gonad index (GI, %):

$$GI = \frac{GW \times 100}{DD}$$

Fig. 2. Histological testes sections of *Ophionotus victoriae*

Histological sections of gonads photographed.

Egg diameter calculated as equivalent circular diameter (ECD) of egg area (A):

$$ECD = \sqrt{\frac{4A}{\Pi}}$$

Male maturity index was measured as a comparison of testes photographs with staging key (Fig. 2).

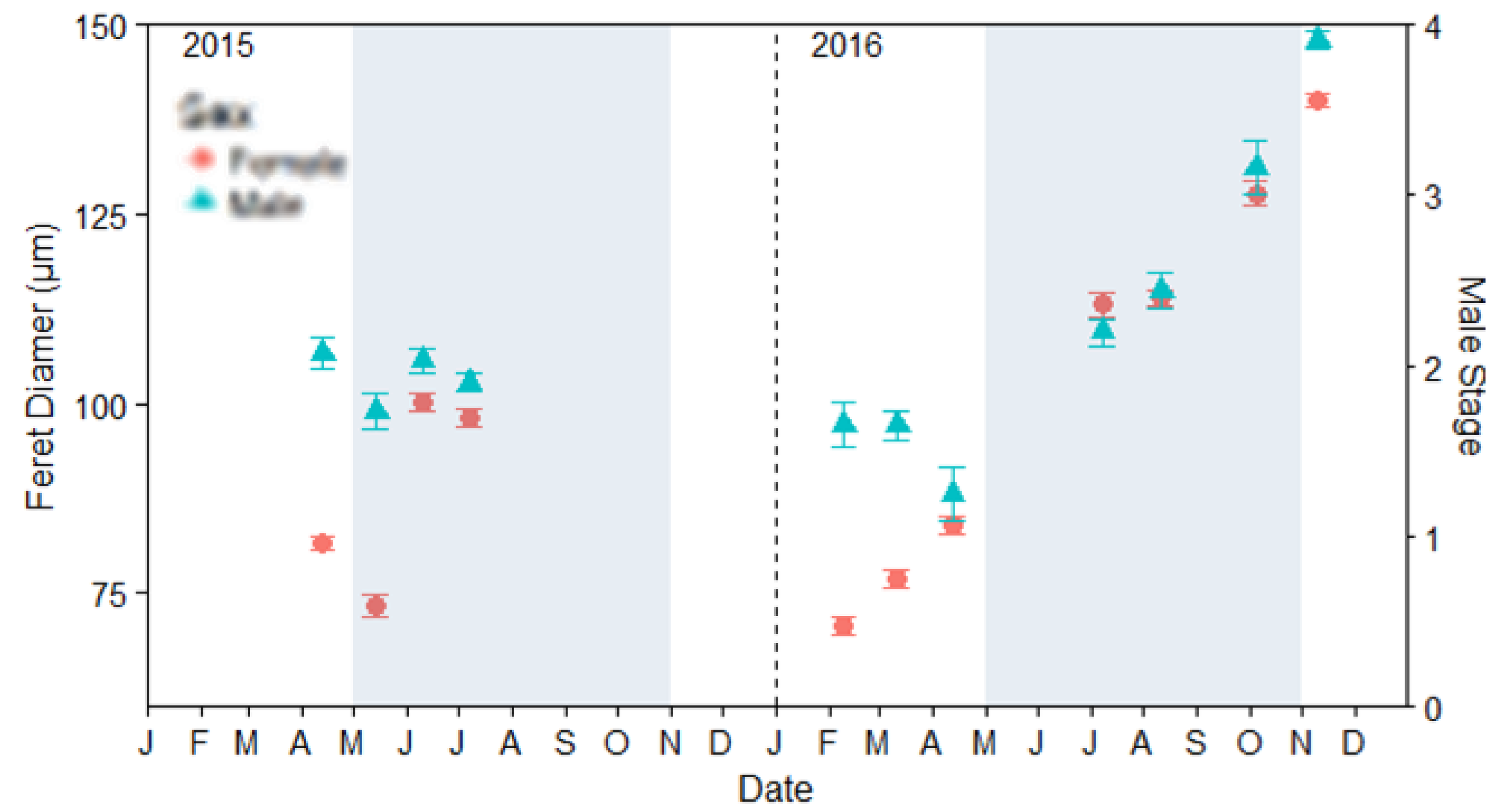

Fig. 5. Average oocyte diameter and male maturity stage (±SE, from spent (0) to mature (4)). Grey shading= winter

6. Result: Synchrony

No significant difference between male/female gonad indexes.

Oocyte diameter and male maturity stages were synchronous throughout year (Fig. 5, Spearman's rank ρ= 0.84, p-value = 0.003).

Males spawned later than females. Could increase fertilisation success. Present in other ophiuroids[6].

7. Result: High correlation with local environment data

- Positive temperature correlation. Common in ophiurid reproductive cycles as co-varies with seasons[6].
- Positive sea-ice correlation low due to subjective data. Sea-ice indirectly impact *O. victoriae* via influence of photoperiod and scouring events[7].
- Positive total chlorophyll correlation, both reproduction and phytoplankton bloom not directly linked.
- Southern Oscillation Index (SOI) positive correlation. SOI influences inter-annual trends in temperature, sea-ice and wind[8]. SOI may be an over-arching factor influencing *O. victoriae* gametogenic cycles

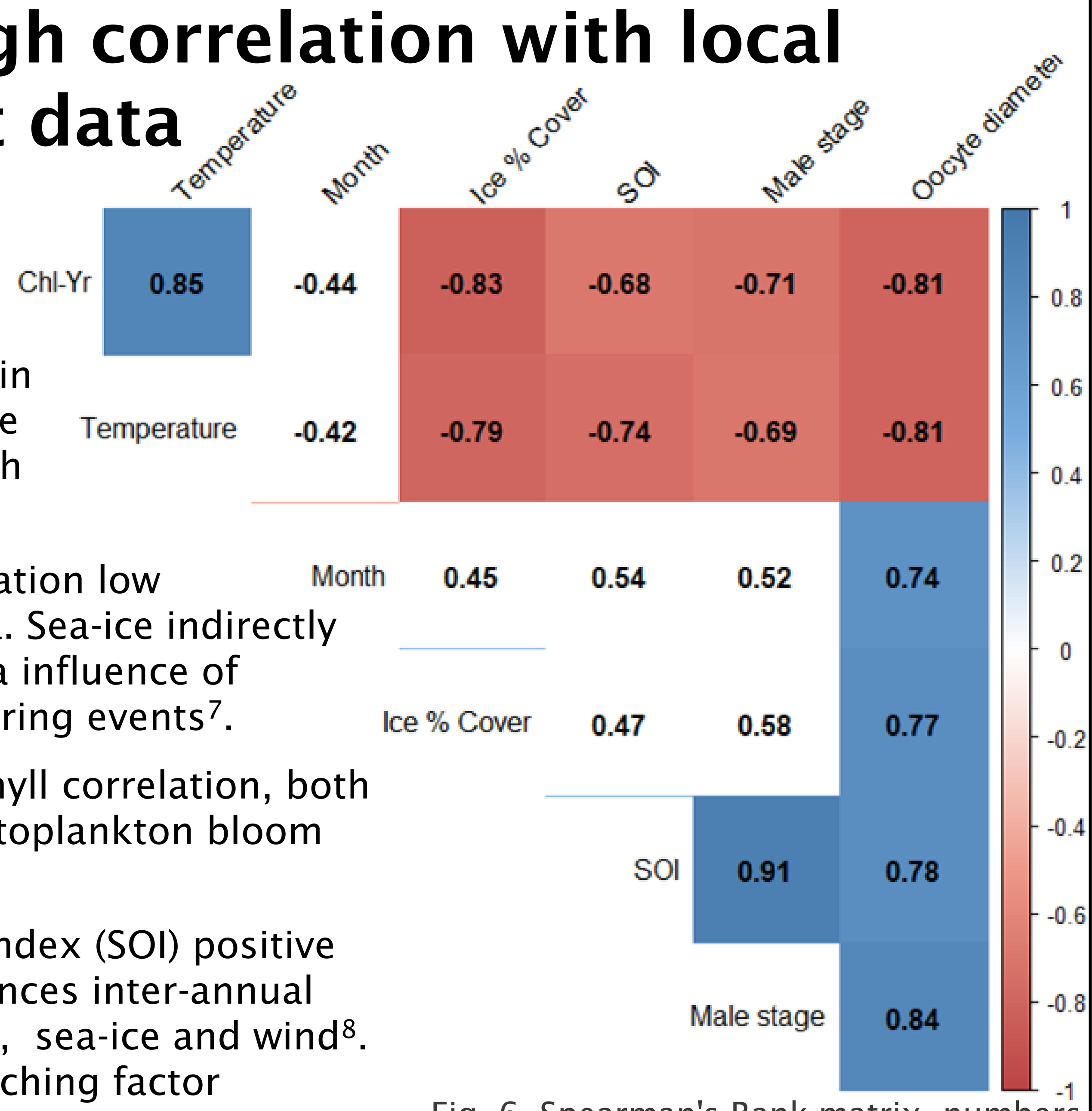

Fig. 6. Spearman's Rank matrix, numbers represent Spearman rank value and cells highlighted have p-value <0.05.

8. Conclusions

- *O. victoriae* gametogenesis has **seasonal cycles**.
- *O. victoriae* have ***synchronous*** male/female reproductive cycles which improves fertilisation success and is controlled throughout the cycle.
- *O. victoriae* have extended **18 – 24 month oogenesis** allowing energy investment without trade-off with somatic system
- Reproductive cycles are **fundamentally linked with environmental processes** and are at high risk to climate change

References

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