



Asymmetry of Eye Peduncle Length in *Euprotomus Iredalei* (Abbott, 1960) (Mollusca: Neostromboidae: Strombidae)

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Abstract

This study examines the difference in right and left ommatophore length of *Euprotomus iredalei* from Karratha, Western Australia. In all specimens examined ($n = 39$, Males = 21, Females = 18) there was no evidence of imposex in terms of sexual organ abnormality or gonadal form, and all animals had right and left ommatophores that were of different lengths. This length difference was significant ($t(38) = 10.315$, $p < 0.001$) in the length of the ommatophore with the right longer ($8.86 \text{ mm} \pm 0.23 \text{ SE}$) than the left ($7.32 \text{ mm} \pm 0.19$), and the effect size was large ($d = 1.05$). There was no sexual dimorphism in the difference in proportional length of the ommatophore between males and females ($t(38) = 0.056$, $p = 0.955$). This paper indicated that the difference between the left and right ommatophore in the target species and not a consequence of imposex.

Keywords: Eye Stalk; Hermaphroditism; Imposex; Gastropoda; Sexual Dimorphism; Shell International Journal of Zoology and Animal Biology (IZAB)

Introduction

Stromboideans are a complex of gregarious herbivorous marine gastropods found in tropical and subtropical waters. This study examined the Australian endemic species, *Euprotomus iredalei* [1] for which no previous anatomical studies have been conducted to date. This study examined the ommatophore of 39 specimens that were collected by commercial aquarium fishermen off the Western Australian coast near Karratha. The ommatophore, which in the case of Strombidae, consist of consists of the eye stalk with a cephalic tentacle attached towards the terminal end.

Recent studies have indicated that stromboideans are sensitive to pollutants and this has been found to cause

imposex in affected populations [2]. One of the purported indicators of imposex is the asymmetry in eyestalk length found in Philippine *Canarium urceus* [3]. Historical studies into the stromboidean eyestalk have centred on its regeneration following amputation [4,5], or the behaviour of the eyes during burrowing [6]. This is the first study to investigate further the length of the right and left ommatophore using *Euprotomus iredalei* from a pristine location [7].

Methods

A sample ($n = 39$, Males = 21, Females = 18) of *Euprotomus iredalei* [1] adult animals were obtained from a collector, and were originally collected in Karratha, Western Australia by commercial aquarium fishers, in late 2022,

diving in 10 m on clean sand near a coral reef. This area is considered a pristine marine environment [7]. The maturity of this species was confirmed by the collector, evidenced by a thickened outer lip and formed anterior siphonal canal: this indicates that the shell had achieved terminal growth. Following collection, animals were preserved in ethanol until the time of examination for this study. Sex was determined and the animals examined for evidence of imposex, particularly the development of malformed verge on females. The eye peduncles were measured at the base where it was attached to the body of the animal. Each of the peduncles was classified as left and right relative to the position of the proboscis. Peduncles were straightened with forceps and their length measured using a digital caliper with an accuracy of ± 0.01 mm. A two-sided paired samples t-test was carried out on the data to determine if there was a significant difference within the species between the lengths of the right and left peduncles. Additionally, the effect size of this difference was determined. The proportional sizes for each animal between left and right peduncle were calculated and a two-sided independent samples T-test conducted to determine if there was significant difference in proportional lengths between males and females.

Results

There was no evidence for imposex, with all animals having normal external sex organs. In all organisms examined, the left peduncle ($7.32 \text{ mm} \pm 0.19$), was significantly shorter ($t(38) = 10.315$, $p < 0.001$) than the right ($8.86 \text{ mm} \pm 0.23$ SE). The effect size was large ($d = 1.05$). There were no differences in the proportional length of peduncles between females and males ($t(38) = 0.056$, $p = 0.955$).

Discussion

The finding of this study showed that all animals examined had two peduncles of differing lengths. In previous studies, this difference was considered an abnormality [3], but this study provides contradictory results indicating it is a natural anatomical trait in the target species. Stromboideans have three distinct shell growth phases: the first twelve to thirty-five days are spent in a pre-metamorphic larval form that is followed by a growth phase where the shell coils and, finally, the flaring lip growth phase which indicates the commencement of sexual maturation [8-10]. The verge in males and gonads only develop once the maturing phase has commenced after the shell has reached terminal growth defined as the formation of the out lip [11,12]. Therefore, studies that do not exclude juveniles are prone to false positive imposex results with respect to undertaking comparative physiology, as males have yet to develop their mature verges. This may offer an explanation for this inconsistency as the body form, such that verges and gonads

are not fully developed until the animal has reached sexual maturity.

Stromboideans have evolved to have a shell with two anterior sinus that enable the eye peduncles to extend past the outer lip while maintaining the aperture face down or allowing the animal to see while partially buried [13]. The differing peduncle length reflects this, with the right peduncle being longer, as it is more anterior than the left and the eye stalk has further to reach the more anterior sinus of the outer lip. Therefore, we contend that the differing lengths of eye peduncles are an evolutionary adaptation that has co-evolved with the shape and form of the basal sinuses on the outer lip in the species under consideration.

In conclusion, there is widespread sexual dimorphism in the stromboidean complex in shell size, with larger females than males [1,14-20]. Furthermore, sexual dimorphism is known in relative body size, some organs and the radula [21,22], and more generally, morphological and molecular differences observed in non-sexual organs of male and female animals that can affect many aspects of their biological traits [23]. However, this study determined that sexual dimorphism in peduncle length was not present in the target species [24].

Declaration of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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