The Proposal that Nudibranch Jorunna funebris 'Juvenile' is Precocious, a Distinct Phenotype or a New Species

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THE PROPOSAL THAT NUDIBRANCH *JORUNNA FUNEBRIS* 'JUVENILE' IS PRECOCIOUS, A DISTINCT PHENOTYPE OR A NEW SPECIES.

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During a survey of nudibranch diversity and abundance in Cambodian waters, two pairs of what has been heretofore regarded as the juvenile form of *Jorunna funebris* (Kelaart, 1859) were observed mating. At that time, it was not possible to collect specimens for further physiological investigation, so it cannot be concluded that this is actually a new species. This paper brings considerations from previous works to bear on the options that can explain this situation and suggests a course of action to investigate the hypotheses.

Keywords: Nudibranch, juvenile form, heterometaboly, taxonomy

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INTRODUCTION

Nudibranchs are very diverse in appearance and habit. They are often brightly and exquisitely coloured; each family different in colour, ornamentation and body shape, often with considerable variation in number or size of identification features (Camacho-Garcia and Gosliner, 2008; Wells and Bryce, 1993). Nudibranchs are often referred to as sea slugs and are soft bodied animals within the subclass *Opisthobranchia,* and have mostly evolved the loss of the protective shell present in some members of the *Gastropoda* class (Behrens, 2005; Karuso ,1987). Nudibranch means "naked gill", as that structure is usually exposed towards, or at, the rear of the mantle (although some nudibranch families, e.g. *Phyllidiidae*, have hidden gill structures, between their mantle and foot) (Behrens, 2005). Taxonomic investigations have concluded that phenotypical variation is common and plasticity between juveniles and adults occurs (Camacho-Garcia and Gosliner, 2008). Across the group, nudibranch nutritional strategy ranges from herbivory, carnivory (including cannibalism) and omnivory. Most species are specialist feeders and many have the ability to incorporate their prey's defence mechanism and use it to defend themselves from predators. Examples of this include sequestration of prey defence toxins (or their toxic metabolites), and even the consumption and subsequent incorporation of functioning nematocysts (Ottuso, 2009; Wells and Bryce, 1993; Faulkner and Ghiselin, 1983). Not all nudibranch defences are derived from their food. Cryptic- as well as warning-colouration is evident and some species, such as *Jorunna funebris*, have developed patches of unpalatable spines, known as spicule-bearing tubercles (Figure 1) (Behrens, 2005; Rudman, 1991).

Nudibranchs can be found all over the marine world, in a range of habitats including the Polar regions and the tropics; they are found in both shallow, coastal areas and the oceanic depths (Chavanich *et al*., 2013). However, despite their global distribution, little is known about their biology and ecology. The study of nudibranchs is comparatively in its infancy, with new species regularly being discovered and genetic data records on individual species still at a rudimentary stage (Picton, pers. com., 2014; Wells and Bryce, 1993). It is therefore not surprising that revisions in the taxonomic status of specimen forms are currently likely.

Figure 1: Spicule-bearing tubercles found in circular patches on *Jorunna funebris* 'adult' (Cobb and Willan, 2006).

OBSERVATION

In the summer of 2015, a general survey was carried out, with Marine Conservation Cambodia, to investigate the abundance and diversity of the nudibranch species found populating the coastal waters surrounding Koh Rong Samloem Island, Cambodia, as little, if any such work had previously been carried out in Cambodian waters. Diversity and distribution have been observed in neighbouring Thailand (Chavanich *et al*., 2013), and this provided preparatory insight. The survey at Koh Rong Samloem took place over nine months starting in Cambodia's monsoon season (June 2013) and ending during the windy season (March 2014). In this study, the most abundant species was recorded as *Jorunna funebris* (Kelaart, 1859), which was also the only species with a preference for blue sponge, *Xestospongia* sp. (Figure 2). An interesting observation was made of the activity of individual specimens of *J. funebris*, which are formally regarded as juvenile and adult forms (Debelius and Kuiter, 2007). 'Juveniles' were twice observed mating (Figure 3).

Figure 2: *J. funebris* on its common choice of substrate, blue sponge *Xestospongia sp.* The 'adult' form is on the left, the 'juvenile' form is on the right and, in this case, slightly smaller (Kilburn, 2015).

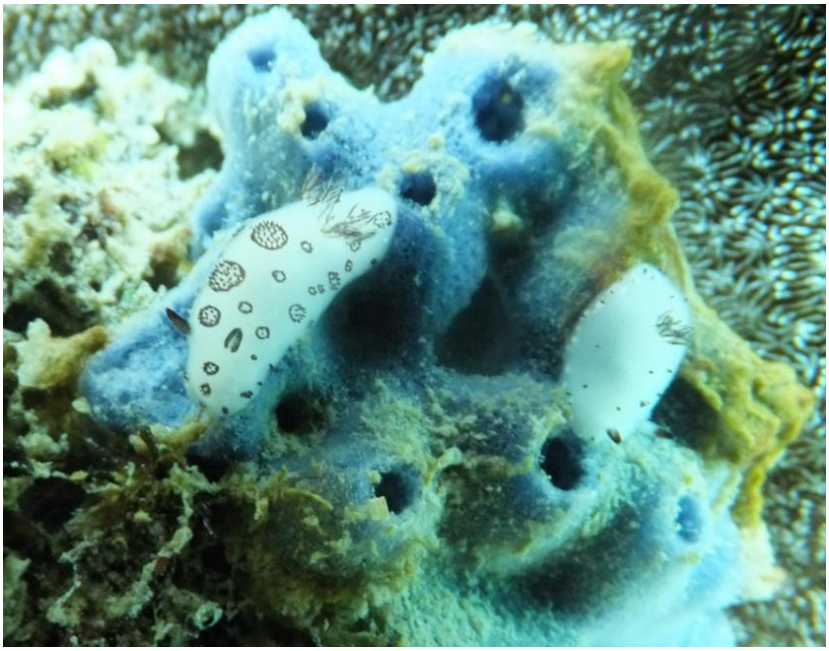

Figure 3: Two 'juvenile' *J. funebris* in the act of mating. Scale divisions: 10mm. (Kilburn, 2015)

HYPOTHESIS

What is currently regarded as the juvenile form of *J. funebris*, is a different species.

Taxonomic Status of *Jorunna funebris*

The genus *Jorunna* has recently been reviewed through a phylogenic analysis based on two historic specimens in taxonomic collections and twenty more recent specimens from a wide variety of locations in Australasia, Oceania, Indian Ocean, East China and Philippines Seas and the Gulf of Thailand (Camacho-Garcia and Gosliner, 2008). In this process, the description of *J. funebris* has been consolidated, but with no mention of the juvenile form:

> *"Background colour of dorsum and foot white to yellow/cream.*
>
> *Notum with several dark brown to black rings of different sizes, larger in middle portion of middle body.*
>
> *Dark rings not completely covered with pigment, instead each ring composed of several minute dark brown to black spots homogeneously distributed inside. Border of notum and hyponotum scattered with similar dark spots all around margins. No rings present on sole of foot; however a couple of dark brown dots at each side of notched upper lip in some specimens.*
>
> *Rhinophores white with black clubs. Branchial leaves white, rachises of first and second pinnae of each leaf with black line.*
>
> *White mantle glands present around margin of notum." (ibid., p150)*

A superficial comparison of the 'juvenile' form with the description of *J. funebris*, above, shows the following:

- Same background colour of dorsum and foot.
- Notum (mantle) does not bear dark rings, although similar dark spots - probably spicule-bearing tubercles (Cobb and Willan, 2006) - occur singly, or in groups of up to three, widely spaced across the notum.
- Rhinophores are white, but only bear black clubs on the distal half, as opposed to along the full length.
- Branchial leaves are similarly positioned and coloured.

Considerations in Support of Hypothesis

1. At two times, pairs of individuals of what has been regarded as the juvenile form were observed in mating positions. Unless the form is precocious or a phenotypical variant, this suggests an alternative adult species. Mating individuals (of both 'adult' and 'juvenile' form were only observed with like forms), so there is no evidence that the two forms can mate with each other.
2. In the surveys of this study, 84 individuals of *J. funebris* were observed, when the next most abundant species registered only 49 times, whilst the majority of species were recorded only in single figures. The high abundance would be explained by the counting of two fairly frequent species as one.
3. *J. funebris* was the species present at the most sites in the Koh Rong Samloem study.
4. The species description complied by Camacho-Garcia and Gosliner (2008) closely fits that of the adult form, but not so closely the 'juvenile'. We have not been able to find an exact description of the 'juvenile' form in current taxonomy guides.

Considerations Against the Hypothesis

1. Some nudibranch species are very specific in their choice of nutritional substrate, and there are records where mature individuals of a species exhibit different preferences to the younger (Folino, 1993). This is unlikely to be true for *J. funebris*, as the two forms were observed apparently feeding on *Xerospongi*a sp. No other nudibranch species were present on the Xerospongia *sp*. throughout the survey, suggesting it as a specialised food source for adult and juvenile *J. funebris.*
2. Nudibranch biology is not exhaustively understood and it is conceivable that these juvenile individuals may be sexually precocious.
3. Camacho-Garcia and Gosliner (2008) recount and perform a number of synonymisations as a result of microscopic examination. One such formerly distinct species, *J. zania* whose description has some similarities with the 'juvenile' is now accepted as *J. funebris*. Thus the 'juvenile' may be found to be a different phenotype of the species.

4. The two forms were of similar size range, and although the 'juvenile' form was often larger than the local 'adults', this is a misleading distraction. Mating is a very energetic process, for which individuals can divert somatic resources to reproduction, even to the extent of losing body mass (Cobb, pers. com., 2017). It is probable that nudibranchs grow until sexual maturity, after which time size varies, depending on a ratio of food availability against the energy used in mating.

CONCLUSION

Closer examination of the specimens is required to ascertain how vital *J. funebris* characteristics (*e.g.* radula serrations, atrium, copulatory spine and lip notches) compare between the two forms. Until this is done the hypothesis can be neither accepted nor refuted, but there is a case for this discrete taxonomic investigation. The abundance of this organism suggests that this will not be difficult to achieve.

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