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Food of giants – field observations on the diet of *Syrinx aruanus* (Linnaeus, 1758) (Turbinellidae) the largest living gastropod

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Abstract – Field observations and analysis of faeces from *Syrinx aruanus*, the largest living gastropod, show that it feeds on large polychaete worms including species of *Polyodontes* (Acoetidae), *Loimia* (Terebellidae) and *Diopatra* (Onuphidae). This is consistent with the known food of other species of Turbinellidae which regularly include polychaetes in their diet.

INTRODUCTION

Syrinx aruanus (Linnaeus, 1758) which inhabits the coasts of western and northern Australia to Irian Jaya (Wells, 2002) is recognised as the largest living gastropod with shells reaching up to 91cm in length (Hawaiian Shell News, 1982). Despite its familiarity in books, shell collections and as ornaments little is known of the biology of this species including the question of what it eats. Large *Syrinx* are a popular target of shell collecting activities and populations in easily accessible habitats are certainly diminished. Conservation of the species is desirable but there is little biological information on which to base any measures. The only information concerning the diet of *Syrinx* is a brief sentence by Wilson (1994) who notes p. 59: "The author has observed this animal feeding on large, tubiculous polychaete worms on a Western Australian sand flat." The discovery of a small population of *Syrinx* in intertidal habitats around the Burrup Peninsula, Dampier (Figure 1) enabled us to make some observations on the diet of these large gastropods which are reported here.

The complex nomenclatural history of the *Syrinx aruanus* was documented by Harasewych & Petit (1989). They also showed, using details from the anatomical study by Kesteven (1904), that from characters of radula, proboscis, protoconch, operculum and egg case, *Syrinx* should be included in the subfamily Turbinellinae of the Turbinellidae rather than the Melongenidae where it had been traditionally placed. The only available illustrations of the radula of *S. aruanus* are the drawings in Kesteven (1904 pl. 42, fig. 3) so, additionally, we provide SEM images of the radula teeth taken from a small specimen from Dampier.

METHODS

Between 25 July – 8 August 2000 a few individuals of *Syrinx* were observed inhabiting the low intertidal, muddy sand flats of Withnell Bay on the Burrup Peninsula near Dampier, north

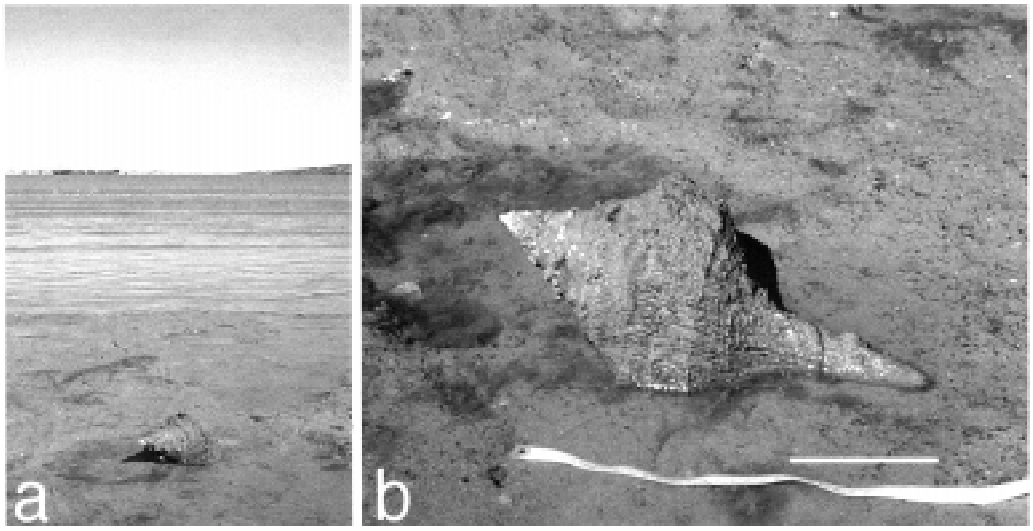

Figure 1 **a** & **b**. Emersed *Syrinx aruanus* on intertidal sand at low water spring tide, Withnell Bay, Burrup Peninsula, Dampier. Scale bar in Figure b = 10cm

Western Australia. By easing the animals gently away from the sediment it was seen that some individuals had proboscides inserted into large polychaete tubes, other individuals were located above large empty polychaete tubes and in other cases the *Syrinx* were resting in depressions in the sediment. *Syrinx* were measured in the field with a tape measure and the polychaete tubes dug from the sediment. Because of the nature of the sediment below the surface, which comprised coarse shell debris, it was not possible to remove complete polychaete tubes. A tube length of 57 cm was the maximum we were able to extract.

Four individual *Syrinx* were removed from the shore and kept in containers of seawater (changed twice daily) to collect faecal samples for analysis. Three of the four captive gastropods produced faecal strings. Samples from the faecal strings were mounted on glass slides in Aquamount and examined microscopically for remains of prey. The gastropods were subsequently returned to their original shore positions.

RESULTS

Faecal samples

Faecal samples were obtained from three *Syrinx* specimens. From an animal 370mm long the faeces consisted of a mass of fine golden fibres with setae. The long fibres and the morphology of the setae indicate that the remains derived from a species of the polychaete family Acoetidae. The setae are most similar to *Polyodontes australiensis* (McIntosh, 1885) illustrated in Pettibone (1989, figs 73–74). This species is reported from Queensland, New South Wales and Victoria, however, the Acoetidae of Australia are rather poorly collected and studied and there are likely more species present.

Included amongst the Acoetidae are some of the largest polychaetes known, some reaching lengths of over one metre. The tubes are substantial with thick walls made up of a dense matt of fine silken fibres produced by the spinning glands of the parapodia.

The two other faecal samples from animals of 340mm and 128mm shell lengths yielded abundant setae and uncini from a species of the polychaete family Terebellidae. The shapes of the uncini are similar to the two species, *Loimia ingens* (Grube, 1878) see Hutchings & Glasby (1988 fig. 11) and *L. ochracea* (Grube, 1878), illustrated in Hutchings (1997 fig. 6). Identification on setal characters alone is difficult but the uncini in our samples lack a projection below the teeth suggesting the latter species as the most likely prey.

Additionally, faecal remains dissected from the rectum of a small subtidal specimen of *Syrinx* 76mm height, dredged off Dampier in 1999, contained setae similar to *Loimia ingens*.

Tubes being attacked by or situated under *Syrinx*

In addition to the faecal samples *Syrinx* were observed with proboscides extended into polychaete tubes or the gastropods were lying above tubes. Eight such tubes were collected. Five of the tubes (15–30mm diameter) were identified from the matt of silken fibres as being constructed by a *Polyodontes* species; two of these had apertural diameters of 27 and 30mm indicating large worms. Three other tubes (diameters 8–12.5mm) had the characteristic form with a parchment inner layer and an outer layer of attached shells indicating construction by a *Diopatra* species.

Radula

In a specimen of shell height 127mm the radula was around 950 µm in width.

Each radular row (Figure 2) consists of a central rachidian tooth flanked by lateral teeth to each side. The central tooth is broad (550µm) but relatively narrow (150µm), tapering laterally, with curved anterior and posterior margins. The posterior edges are raised and sharp. Each tooth possesses a large pointed central cusp with a broad base flanked by two smaller pointed cusps that are separated from the central cusp by deep grooves. The lateral teeth have broad bases with a single, awl-shaped, strongly curved cusp located on the inner edge of the tooth. The radula is very similar in morphology to that of *Turbinella pyrum* (slide preparation in NHM London, and Harasewych, 1987 fig. 21).

DISCUSSION

The limited results from the faecal and field observations show that *Syrinx aruanus* is a predator of large tubiculous polychaetes, including species of *Polyodontes*, *Loimia* and *Diopatra* confirming Wilson's (1994) anecdotal observation. Although polychaete feeding is a common behaviour amongst smaller neogastropod species (Kohn, 1983: Taylor, 1984a) it seems to be an unusual specialization amongst larger predatory gastropods. However, large polychaetes are abundant within shallow water and intertidal muddy sand substrates of northern Australia and provide a potential food resource for large gastropods. The possession of a long extensible proboscis is essential to exploit these large worms which can retreat a long way back into the tubes. Some of the *Syrinx* observed in the field had narrow proboscides extended for at least 250mm into the worm tubes.

Comparison with diets of other Turbinellidae

The Turbinellidae comprises five Recent subfamilies (Harasewych, 1998) and little is known about the feeding biology of most species. Most details of diet are available for the Vasinae, Taylor (1984b) reporting details of the gut contents of 280 specimens of *Vasum turbinellus*

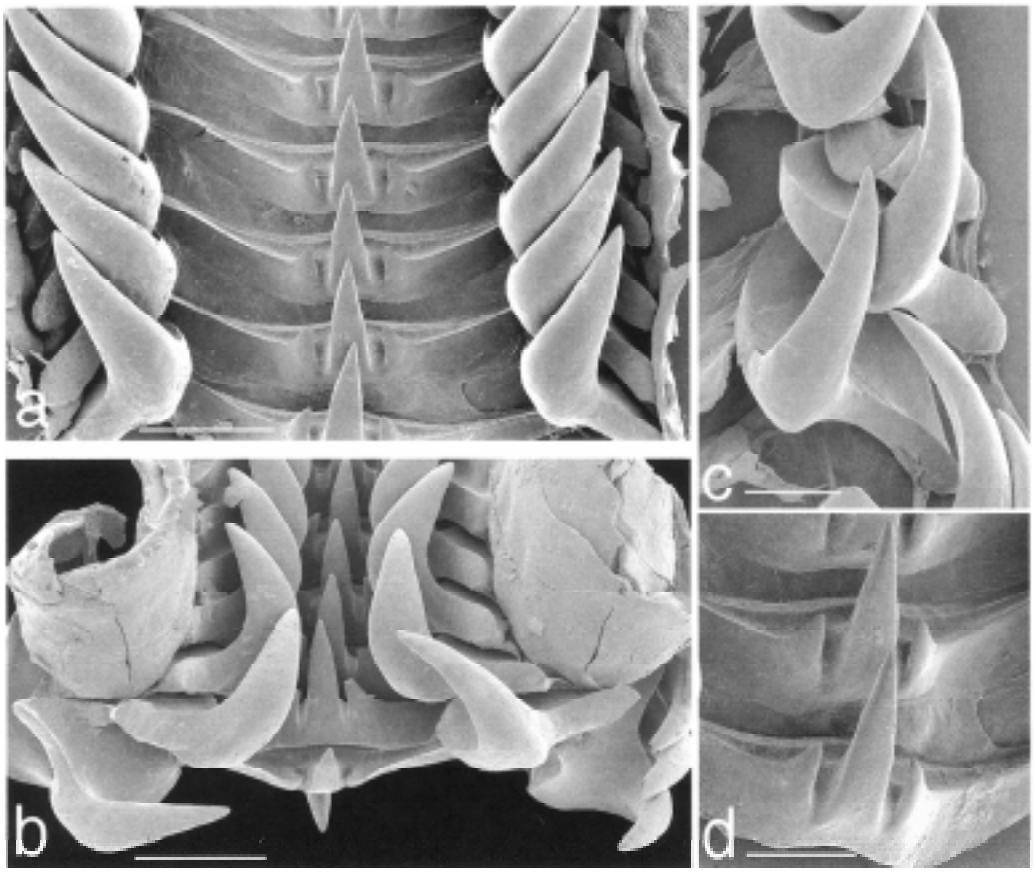

Figure 2 **a–d**. Radular teeth of *Syrinx aruanus*, Withnell Bay, Dampier, shell height 127 mm. **a**, central and lateral teeth; **b**, central and lateral teeth at bending plane; **c**, detail of lateral teeth; **d**, detail of cusps on central teeth. Scale bars: Figures a & b = 200mm, Figures c & d = 100mm

(Linnaeus, 1758) from various localities in the Indo-Pacific. The diet comprised around 50% polychaetes and 50% sipunculans, with chaetopterid polychaetes forming about 20% of food items at most locations but species of Eunicidae and Terebellidae were also common prey. *Vasum rhinoceros* (Gmelin, 1791) also ate polychaetes and sipunculans and *Vasum ceramicum* (Linnaeus, 1758) consumed eunicid polychaetes. Another vasine for which the diet is known is *Tudivasum armigera* (Adams, 1855) from Queensland (unpublished information by P.W. Arnold reported in Taylor 1984b) where gut contents from 29 individuals contained setae from the polychaete families Pectinariidae, Flabelligeridae and Chaetopteridae.

For the Turbinellinae, the Indian chank, *Turbinella pyrum* (Linnaeus,1758) is known to feed upon terebellid and eunicid polychaetes (Hornell, 1915, Moses, 1923). Additionally, two out of sixteen specimens of the Caribbean chank *Xancus angulatus* (Lightfoot, 1786) were observed regurgitating the sipunculan *Siphonosoma* (Edwards, 1970, also see Kohn 1975).

The only information available for species of the deep water Ptychatractinae is a record that the stomach contents of *Benthovoluta claydoni* Harasewych, 1987 included an amphipod

(Harasewych 1987). Finally, for the Columbariinae, Harasewych (1983) reports the rectal contents of *Fulgurofusus brayi* (Clench, 1959) from the Caribbean as containing large numbers of setae from the polychaete families Serpulidae and Chaetopteridae.

In summary, for the relatively few species for which details of diet are available polychaetes and sipunculans are important components in the diet of Turbinellidae. The diet of large polychaetes recorded here for *Syrinx aruanus* is consistent with this pattern

Comparison with diets of other large gastropods

Species from several other predatory caenogastropod families (Cassidae, Ranellidae, Fasciolariidae, Melongenidae and Volutidae) reach comparable sizes to *Syrinx aruanus* and it is of interest to compare their diets.

Some of the largest living gastropods are found within the superfamily Tonnoidea namely species of *Charonia* (Ranellidae) up to 330 mm and *Cassis* (Cassidae) 350mm Species of *Charonia* are specialist feeders upon holothurians, asteroids and echinoids (Laxton, 1971, Percharde 1972; Nurgranad et al. 2000) whilst *Cassis* species are specialist on echinoids (Hughes & Hughes, 1981). Both genera utilise acidic salivary secretions (Andrews, Page & Taylor 1999) to gain access to the prey.

Amongst the Neogastropoda, several large gastropod species are found within the family Fasciolariidae. *Pleuroploca gigantea* from the Caribbean attains shell heights of 600mm and Paine (1963a) showed that they feed upon other large gastropods such as smaller conspecifics, but also *Busycon*, *Fasciolaria* and *Murex species*. In the Galapagos, *Pleuroploca princeps* (Sowerby, 1825) also feeds largely on other gastropods (Stupakoff, 1986)

A number of other large gastropods are members of the family Melongenidae. In Hong Kong *Hemifusus ternatanus* (Gmelin, 1791) (to around 330mm height) ate the bivalve *Pinna pectinata* (Morton 1986 a). Many other melongenids have a similar diet of bivalves, including *Hemifusus tuba* (Gmelin, 1791) (Morton, 1985), *Busycon* spp. (some species over 500mm) (Paine, 1963b; Kent, 1983) and *Melongena corona* (Gmelin, 1791) (Bowling, 1994) although *Pugilina cochlidium* (Linnaeus, 1758) feeds upon barnacles (Tan & Phuah, 1999)

The family Volutidae contains several large gastropod species that all seem to feed upon other molluscs. The feeding behaviour of *Melo melo* (Lightfoot, 1786) was studied by Morton (1986) who showed that it consumed other gastropods particularly *Hemifusus tuba* and *Babylonia lutosa*. *Melo amphora* (Lightfoot, 1786) co-occurs with *Syrinx* on the lower shore at Withnell Bay. A large specimen (ca 40 cm shell length) was seen feeding on a smaller conspecific (ca 20 cm) and totally enveloped in the foot. Similarly, Wilson & Gillett (1971, pl. 78) illustrate *Melo amphora* feeding on another volute *Zebramoria zebra*. From West Africa, *Cymbium glans* (Gmelin 1791), with a shell height up to 360mm also feeds on other gastropods including other species of *Cymbium* (Marche-Marchad, 1977)

In summary, most other larger predatory gastropods feed upon other molluscs including other large gastropods. The exceptions are the tonnoidians *Cassis* and *Charonia* which are specialist predators upon echinoderms. Also, large gastropod species in general tend to have similar diets to those of smaller species in their respective families, as is true for *Syrinx* compared with other species within the Turbinellidae.

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