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Feeding ecology of three sympatric species of stingrays on a tropical mudflat

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Abstract

Periodic fish ingressions into intertidal areas during high tide are known to occur on tropical mudflats. This study aimed to elucidate the feeding ground function of coastal mudflats for three common stingray species in the Klang Strait, Malaysia. Stingrays (disc width range from 5.65–54.50 cm) sampled over 17 months using a large barrier net (~2 ha enclosure) at two sampling sites were examined for their diet composition, prey frequency and prey volume according to predator species and maturity. The index of relative importance and Schoener's index of diet overlap were calculated. The three stingray species fed on relatively similar prey items which varied in size and contribution. *Brevitrygon heterura* fed on the widest range of prey taxa (28) whereas *Hemitrygon bennetti* (22) and *Telatrygon biasa* (17) showed higher prey specialization. The Penaeidae (dominantly *Metapenaeus brevicornis* and *M. affinis*) were the most important food item in the stingray diet which also included Actinopterygii, Amphipoda, Brachyura and Calanoida. The stingray diet showed an ontogenetic shift, with young stingrays tending to be generalists whereas the more mature stingrays (except *H. bennetti*) become more specialized in their feeding habits. This shift in feeding strategy reflects the diversity of prey taxa abundantly available to young stingrays on the mudflats, while the larger stingrays adapt to feed on larger prey once they enter deeper waters.

Introduction

There are currently more than 90 published works on the feeding biology of the Myliobatiformes based on the literature review by Jacobsen & Bennett (2013) and 17 additional works reported between 2013 and 2018. This can be considered a dramatic increase considering that about 28% of these works were carried out between 1961 and 2000. However, there are currently only 14 published works on the feeding biology of the Myliobatiformes in regions close to Malaysia; 12 of these are from Australian waters and the other two from Japan. Stingray dietary studies in these areas are hampered by sampling costs, lack of fresh samples or an inability to adequately process frozen samples (Jacobsen & Bennett, 2013). In the Indo-Pacific region, stingray markets tend to be from artisanal fisheries (Blaber *et al.*, 2009; White & Kyne, 2010), although large catches are thought to be unaccounted for due to the pervasive problem of illegal, unreported and unregulated fishing (White & Kyne, 2010).

Current studies on the feeding biology of myliobatoids are quite similar to those prior to 2000, focusing on general diet (Navarro-González *et al.*, 2012; Bornatowski *et al.*, 2014), ontogenetic diet shift (Jacobsen & Bennett, 2012; López-García *et al.*, 2012), spatial and temporal diet variation (some relate this to habitat utilization) (Navia *et al.*, 2011; Woodland *et al.*, 2011; Shibuya & Zuanon, 2013), resource or dietary partitioning (Jacobsen & Bennett, 2012; O'Shea *et al.*, 2013; Varghese *et al.*, 2014) and feeding movement (Corcoran *et al.*, 2013). However, published works up to 2018 covered only 35% of species (80 out of 229 species in Eschmeyer & Fong, 2015) within the Myliobatiformes.

Stingrays in the Indo-Pacific region received even less attention. The few identification texts available such as White *et al.* (2006) and Last *et al.* (2010) have provided some general descriptions of their diet. Nevertheless, the word 'presumably' was commonly used to describe the diet of almost every species indicating the uncertainty or lack of knowledge of stingray food habits in the region. This is unfortunate since understanding their feeding ecology is crucial for conservation given the increasing human threats to critical coastal ecosystems such as mangroves, mudflats and coral reefs, which may serve as essential feeding or nursery areas for these fishes (Chong *et al.*, 1990; Beck *et al.*, 2001; Cerutti-Pereyra *et al.*, 2014). For instance, previous (e.g. Sasekumar *et al.*, 1992) and preliminary work have indicated that juvenile stingrays enter shallow coastal mudflats in waves following tidal inundation.

Coastal mudflats can be very productive habitats as a result of high nutrient inputs from fluvial discharge (Trott & Alongi, 1999; Teoh *et al.*, 2016) and outwelling from adjacent mangrove forests (Tanaka & Choo, 2000; Alongi, 2009). Such mudflats are known feeding grounds of fishes (Chong *et al.*, 2012; Lee *et al.*, 2016), penaeid shrimps (Leh & Sasekumar, 1984; Marsitah & Chong, 2002), mysid shrimps (Ramarn *et al.*, 2015), hermit crabs (Teoh &