

Research

Foraging Behaviour of Three Shorebird Species on Coastal Mudflats of Southwestern Sarawak

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ABSTRAK

Many shorebirds are long-distance migrants and they congregate on intertidal mudflats for feeding throughout their non-breeding season. Despite being one of the key staging sites for migratory shorebirds, data on shorebirds foraging ecology in Sarawak is insufficient for the understanding of the interaction between shorebirds and their behaviour. This study aimed to determine the foraging behaviour of Whimbrel (*Numenius phaeopus*), Bar-tailed Godwit (*Limosa lapponica*) and Terek Sandpiper (*Xenus cinereus*) at Asajaya and Buntal mudflats. Data collection of this study was conducted at low tide, during two non-breeding seasons with a total of 12 months of sampling. Focal observations were conducted within a 50 m × 50 m quadrat. A total of 8 exclusive foraging techniques were observed for the three shorebird species, including: pecking, probing, picking, stabbing, snapping, submerging, sweeping and ingesting. Terek Sandpiper displayed all the exclusive foraging behaviours, whereas Whimbrel and Bar-tailed Godwit showed 7 and 5 behaviours, respectively. The three shorebirds also displayed non-exclusive foraging behaviours such as walking, preening and defecating. Spearman correlation test indicates a positive correlation between the foraging behaviours performed among three shorebird species. All three shorebird species adopted similar mixed foraging strategies comprising pecking and probing, with an exception on supplementary behaviours observed in Whimbrel and Terek Sandpiper. Principal Component Analysis (PCA) analysis showed a strong correlation between picking and ingesting behaviours, suggesting a high chance of foraging success with the presence of picking behaviour. The outcome of this study is crucial in understanding how shorebirds maximise their behavioural performance when foraging as well as to assist in formulating better conservation strategies for targeted migratory shorebird species and coastal mudflats.

Key words: Foraging behaviour, intertidal, migratory, Sarawak, shorebirds

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INTRODUCTION

Most shorebirds winter in tropical regions, particularly in coastal wetlands, from their breeding area in temperate regions (Sánchez *et al.*, 2005; Turpie & Hockey, 2008). A previous study by Bamford *et al.* (2008) reported that migrating shorebirds travel more than 20,000 kilometres per year during their life span. Such long-route migration requires high energy demand from the migrants. To replenish their energy during migration, many arctic shorebirds utilize terminal spring staging areas that are strategically positioned within mid-temperate latitudes, where concentrated food resources are available (Watts *et al.*, 2017). These areas are primarily wetlands that serve as an essential staging ground to provide feeding opportunities to the migrants (Ramli & Norazlimi, 2016; Watts *et al.*, 2017). As the shorebirds experience rigorous energy demands during the long migration, sufficient feeding is therefore essential for the migrating shorebirds to sustain themselves.

Previous studies revealed that migratory birds spend most of their time feeding in the non-breeding ground to gain sufficient energy to maintain their high metabolism rate throughout the long-distance flight (Landys *et al.*, 2005;

Colwell, 2010). It is considered the most crucial activity for the migratory shorebirds during their long migration across the continents. Unlike the passerine birds that can feed nearly anywhere throughout their migration, the shorebirds only have limited access to food, and they require specialized habitats such as intertidal shores, estuaries, and wetlands to recharge themselves before continuing their journey (O'reilly & Wingfield, 1995; Stroud *et al.*, 2008). These specialized habitats play a crucial role as a refugee or stopover site for the shorebirds by providing a food source, where the distribution of shorebirds is often reflected by the presence and abundance of the food source in the stopover sites (Goss-Custard, 1977; Willems *et al.*, 2010).

Foraging refers to a series of behaviours performed by an individual animal when acquiring food, including prey detection, food acquisition, and the unique techniques being used when handling or extracting prey (Schneider, 2017). Such foraging behaviour is said to be primarily influenced by food availability (Pyke *et al.*, 1977). Nonetheless, shorebirds are a diverse bird group that possesses various kinds of foraging techniques, such as pecking and probing (Finn, 2009). Differences in foraging behaviour among shorebirds are known to be closely associated with morphological factors (Jing *et al.*, 2007; Turpie & Hockey, 2008). Generally, vision is vital for the foraging shorebirds as it aids the bird in locating prey by their tracks, disturbance of substrate or entrance of burrows. However, certain shorebirds such as Red Knots (*Calidris canutus*) and sandpipers (Scolopacidae) are highly dependent on their sensory systems on the bill when locating prey (Cunningham *et al.*, 2010).

Whimbrel (*Numenius phaeopus*), Bar-tailed Godwit (*Limosa lapponica*), and Terek Sandpiper (*Xenus cinereus*) can be found abundantly along the Sarawak coastline throughout the migrating season. Whimbrel is well-known as a non-breeding migrant to South America, Africa, and Southeast Asia as far as Australia, including Peninsular Malaysia, Sabah, Sarawak, and Singapore (Watts *et al.*, 2017). It has darker plumage, and it is physically similar to the Eurasian Curlew (*Numenius arquata*). But in terms of size, it looks smaller as compared to the Curlews. Whimbrel has a total body length ranging from 40 – 45 cm (Higgins & Davies, 1996). In addition, it possesses a long decurved bill (Finn, 2009; Myers, 2016) and an average bill length ranging from 82.0 mm to 87.1 mm (Katrínardóttir *et al.*, 2013; Norazlimi & Ramli, 2015). Adult Whimbrel has a strong pattern on its head with an eye stripe and a dark brown crown, a wingspan of 76 - 89 cm, and a weight of approximately 350 g (Higgins & Davies, 1996). Whimbrels are categorised as Least Concern (LC) in the IUCN Red List from BirdLife International (2022). It is versatile in foraging, where it often relies on visual cues and touch senses when locating prey (Finn, 2009; Norazlimi & Ramli, 2015). Whimbrel was reported to favour shelled prey, particularly on crustaceans when feeding (Dann, 1993; Zwarts & Dirksen, 1990).

Bar-tailed Godwits are known as ubiquitous species to the East Asian-Australasian Flyway (EAAF). It is a medium-sized wader distinguished from the Dowitchers by their long-upturned bill and long legs. It has a shorter yet noticeably straight yet slightly upturned bill (around 29 cm), with a prominent supercilium and curlew-like streaking upper part (Myers, 2016). Bar-tailed Godwits are long-distance migratory shorebirds that breed originally in the Arctic or Sub-arctic continents in Scandinavia, Russia, and northern and southern Alaska (Wilson *et al.*, 2007). The Bar-tailed Godwits migrate to temperate and tropical regions of basically all continents (Higgin & Davies, 1996). This bird was recorded to travel 12,000 km non-stop throughout the post-breeding migration journey (Woodley, 2022). It was also reported that Bar-tailed Godwits are found over a larger feeding area of sandy mud and sand in the outer estuaries (Greenhalgh, 1975). A study by Duijns *et al.* (2013) reported that the Bar-tailed Godwit showed a clear preference on polychaetes. A recent report by Woodley (2022) highlighted an annual decline of 2% in the Bar-tailed Godwit population, driven by the loss of habitat at one of their important staging sites – the Yellow Sea. To date, this bird is categorized as Near Threatened (NT) according to the IUCN Red List from BirdLife International (2022).

Terek Sandpiper is remarkably peculiar to the sandpipers which are easy to identify. It has a distinctive long, sharply upturned bill, with bill length ranging from 40.5 mm – 52.6 mm (Karlionova *et al.*, 2006). Terek Sandpiper possesses short bright yellow or orange legs and a uniform grey plumage overall (Karlionova *et al.*, 2006). Besides, the Terek Sandpiper is a relatively small bird with a body measurement of around 23 cm (See & Chan, 2020). They are the commonest shorebirds that can be found on the mudflats, typically in small flocks, and prefer to join the mixed flocks of waders when feeding. Similar to Whimbrel, the Terek Sandpiper was widely recognized as a crustacean specialist, feeding particularly on crabs (Piersma, 1986; Bijlsma & de Roder, 1991). This species has a vast population globally, where it is evaluated as Least Concern according to the IUCN Red List from BirdLife International (2022).

To date, the foraging ecology of shorebirds has been widely studied in many regions under the major flyways (Bamford *et al.*, 2008). Playing a crucial role as one of the important stopover sites for the