

## Some Biological Aspects of Mudskippers (Gobiidae, Oxudercinae) from Langkawi Island

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**ABSTRACT** Eight species of mudskippers belonging to five genera were found to occur in the coastal areas of Langkawi Island. This includes a new record for Peninsular Malaysia i.e. *Periophthalmus walailakae*. This species was found to exist sympatrically with *Periophthalmodon schlosseri*, *Periophthalmus novemradiatus*, *Periophthalmus gracilis*, *Periophthalmus pilotus* and *Boleophthalmus boddarti* in the five study stations of the mangrove forest floor within the Kisap Forest Reserve, Bukit Tepoh and the riverine areas of Sungai Tapa that were sampled. *Periophthalmus chrysopilos* and *Scartelaos histophorus* were found along the sandy-beaches of Tanjung Rhu and mudflat of Kuah. The feeding habits were determined by the analysis of stomach contents of the genus *Periophthalmus* and *Boleophthalmus* using the method of percentages of occurrence and volumetric compositions. This was further illustrated graphically by interpretation of the Resultant Indices.

**ABSTRAK** Lapan spesies ikan tembakul daripada lima genera telah ditemui di kawasan perairan pantai Pulau Langkawi. Bilangan ini termasuklah satu rekod baru bagi Semenanjung Malaysia iaitu *Periophthalmus walailakae*. Spesies ini ditemui wujud secara simpatrik dengan *Periophthalmodon schlosseri*, *Periophthalmus novemradiatus*, *Periophthalmus gracilis*, *Periophthalmus pilotus* dan *Boleophthalmus boddarti* di lima stesyen kajian dalam Hutan Simpan Bakau Kisap, Bukit Tepoh dan Sungai Tapa. *Periophthalmus chrysopilos* dan *Scartelaos histophorus* ditemui di kawasan pantai berpasir Tanjung Rhu dan dataran lumpur Kuah. Tabiat pemakanan ikan-ikan tembakul ini dikenal pasti melalui analisis kandungan perut iaitu dengan menggunakan kaedah peratusan kehadiran dan kaedah volumetrik. Kemudiannya, analisis tersebut diterjemahkan secara grafik dengan menggunakan Indeks-Indeks Resultant.

(Langkawi, mudskippers, stomach contents, resultant indices)

### INTRODUCTION

Mudskippers are members of the subfamily Oxudercinae belonging to the family Gobiidae, the largest family of marine fishes [1]. Ten genera have been identified including 37 species worldwide [1, 2 and 3] and 14 of them have been reported to exist in Peninsular Malaysia [4]. A recent discovery in southern Thailand added another species to the genus *Periophthalmus* [5].

Various species are found to be sympatrically living in a habitat due to resource partitioning in utilizing food resources, for example *Boleophthalmus* is known to be herbivorous, *Periophthalmus* having a carnivorous but plant supplemented diet in contrast to

*Periophthalmodon* being exclusively carnivorous [6, 7].

Mudskippers are unique among the mangrove fauna since they are highly active and spending most of their time out of water [8, 9 and 10]. Foraging behaviors are predominant with some social interactive displays during peak activity periods when the tidal mudflats are exposed [11, 12 and 13]. They have a widespread distribution as they are able to tolerate a wide range of salinity [14]. Clayton [15] reported that mudskipper distribution was restricted to the soft bottom muddy shore of the intertidal, estuarine and mangrove areas of the Indo-Pacific region.

Mudskippers are known to be economically important in the Langkawi traditional medicinal trade. It is commonly commercialized as an

ointment or traditional tablets. While other nationalities find them palatable as favorite dishes, some locals consume them fresh or processed claiming as enhancement to the physical well being [10]. Hence over exploitation of these animals in the trade might prove destructive for the local population.

The objective of this paper is to compile a preliminary mudskipper species list, report on the general occurrence of distribution in the Langkawi Islands and some insights into the feeding biology of mudskippers.

### MATERIALS AND METHODS

Studies on mudskippers with regards to the diversity, distribution and feeding biology were conducted during the Langkawi Scientific Expedition in the mangrove areas of Langkawi Island from 8<sup>th</sup> - 14<sup>th</sup> April 2003. Field work conducted included direct sampling and observations, whilst laboratory studies were confined to analysis of gut contents to investigate the aspects of feeding biology.

Collections were conducted during the low tides in the mangrove areas of:

- Kisap Mangrove Reserve Forest (this included 5 localities, i.e. areas within Kilim Jetty, Kampung Sungai Air Hangat, Kampung Belanga Pecah, adjacent to Barn Thai Restaurant and Kampung Kubang Badak)
- Tanjung Rhu sandy-beach areas,
- Mangrove areas near Jetty Sungai Tapa and
- Surrounding areas of Bukit Tepoh
- Mudflat areas of Kuah.

For areas which are impossible to do manual sampling, direct observation and identifications were made with the aid of a paired of 8x40 Pentax binoculars. On the mangrove forest floor, mudskippers were captured using hand nets and placed in 10% formalin to ensure termination of further digestive actions of the gut. All the specimens collected were brought back to the laboratory in the University of Malaya for further analysis.

The stomach contents from all individuals of collected were examined. The specimens were first dissected and their stomachs removed and preserved in 5% formalin. The gut contents were extracted and placed into individually labelled vials containing 5% formalin.

The gut contents were identified using an Olympus Model CH-2 microscope. The results obtained were analysed based on the frequency of occurrence (O) and volumetric composition (V) as suggested in Hynes [16]. The results derived from these two methods were conjugated by the Resultant Indices following the formula in Mohan & Sankaran [17].

The Indices obtained were graphically plotted against the corresponding values of the angle  $\theta$ . If the value of O is high and the V is low,  $\theta$  will be small and vice versa ( $0^\circ < \theta < 90^\circ$ ). If  $\theta$  approaches  $45^\circ$  this will equate the values of O and V. It is also possible to have different values of  $\theta$  but having the various food items with similar values of index ( $R_s$ ). Thus, to enable comparisons to be done, a Weighted Resultant Index ( $R_w$ ), based on the correction for the deviation has been derived by Mohan & Sankaran [17] which takes into account the deviation from mid-way and grading the food items in the order of importance.

### RESULTS AND DISCUSSIONS

A total of 8 species was recorded from this study, i.e. *Periophthalmodon* (Pn.) *schlosseri*, *Periophthalmus* (Ps.) *chrysopilos*, *Ps. novemradiatus*, *Ps. gracilis*, *Ps. spilotos*, *Ps. walailakae*, *Boleophthalmus* (B.) *boddarti* and *Scartelaos* (S.) *histophorus*.

Figure 1 shows the composition of species found in the mangrove areas of the Langkawi Island. Figure 2 clearly revealed that *Ps. novemradiatus* was distinctly abundant and well distributed especially on the loamy mud in the mixed forest of *Sonneratia alba* and *Rhizophora* sp. of Kampung Sungai Tapa and in the *Rhizophora* sp. forest floor of the Kisap Mangrove Reserve Forest and Bukit Tepoh mangrove forest areas. This species was found sympatrically living with *Ps. gracilis*, *Ps. spilotos*, *Ps. walailakae*, *B. boddarti* and *Pn. schlosseri*. In contrast, Tanjung Rhu and Kuah, had a high population of *Ps. chrysopilos* and *S. histophorus* utilizing areas of mixed sand and mud in the forests of *Avicennia alba* and *Sonneratia alba* reaching edges of the bund.

Analyses of the stomach contents of the genus *Periophthalmus* revealed six groups of food items, i.e. Crustacea (crabs, shrimps, copepods, isopods and other crustacean larvae), worms

(Polychaetae, Nematoda and Sipunculids), molluscs (bivalves and gastropods), insects (diatoms) and some unidentified materials. By using the Resultant Indices for the genus *Periophthalmus*, it is shown that Crustacea was highly ranked followed by worms, insects, molluscs, plant materials and others (Figure 3).

(Hymenoptera), plant materials (algae and *Boleophthalmus*, on the other hand had majority of diatoms (Bacillariophyceae) as contents and followed by algae (Cynophyceae and Chlorophyceae), plant detritus and other unidentified materials (Figure 4).

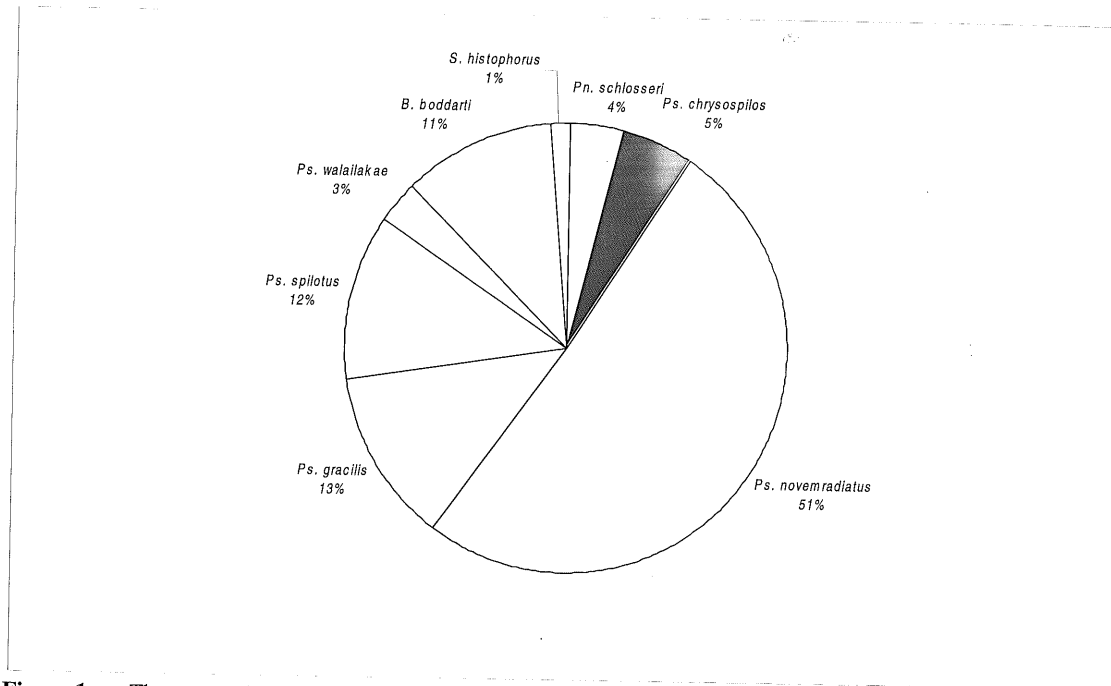


Figure 1. The compositions of mudskippers present in the mangrove areas

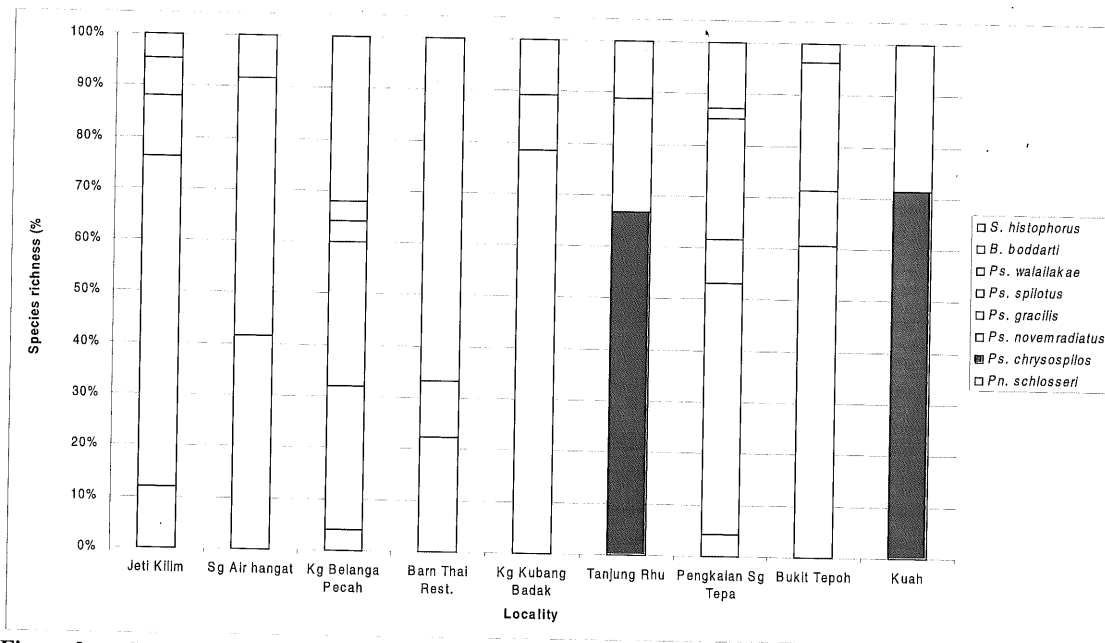


Figure 2. Species distribution and abundance in the study localities of the mangrove areas

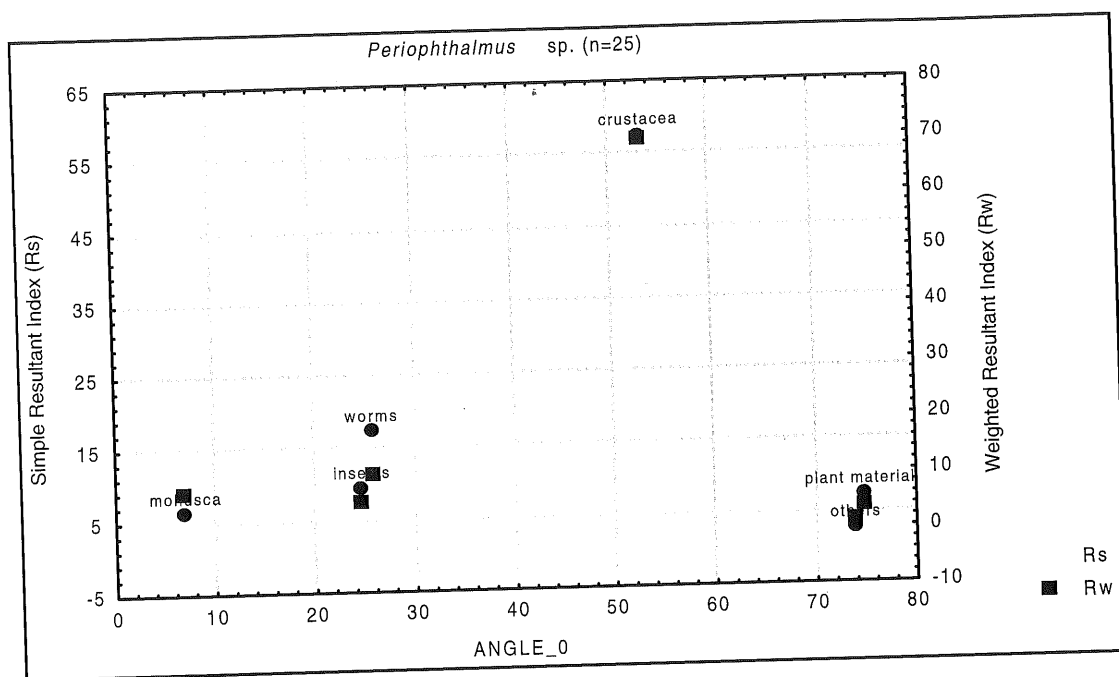


Figure 3. Graph showing the Resultant Indices of the stomach contents of the genus *Periophthalmus* represented by *Ps. chrysopilus*, *Ps. novemradiatus*, *Ps. gracilis*, *Ps. spilatus* and *Ps. walailakae*.

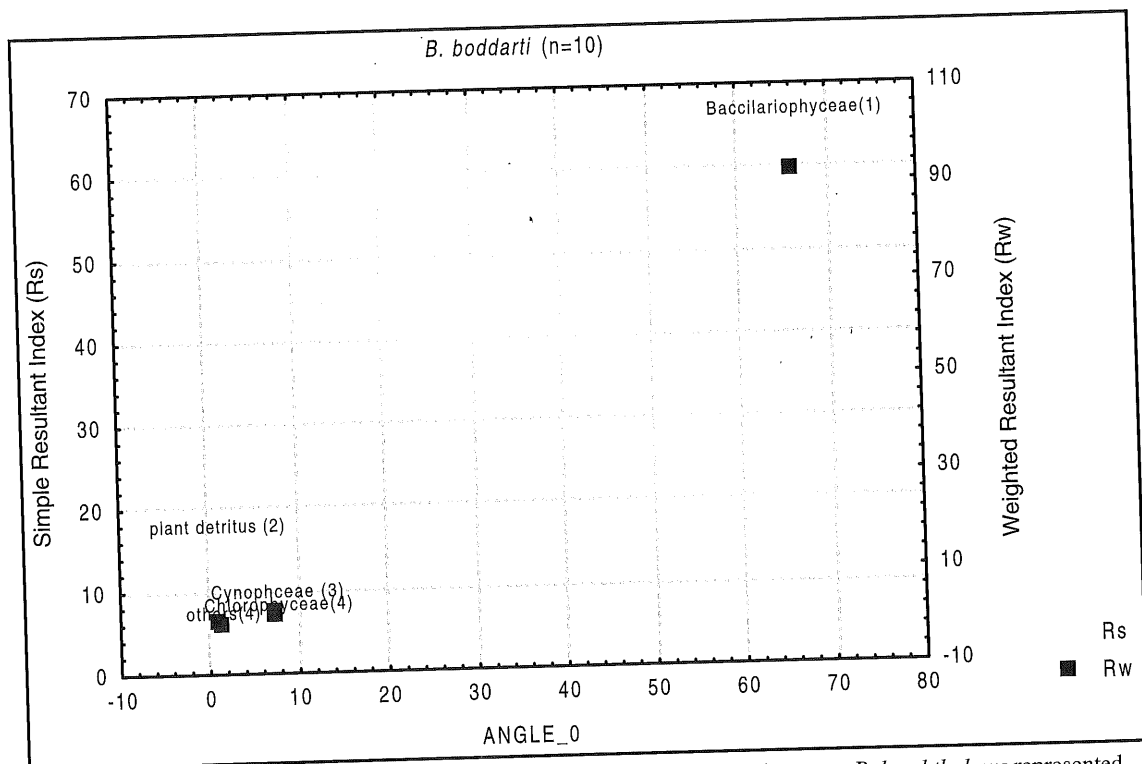


Figure 4. Graph showing the Resultant Indices of the stomach contents of the genus *Boleophthalmus* represented by *B. boddarti*.

Takita *et al.* [18] reported the presence of 12 species of mudskippers distributed along the Straits of Malacca and eight species were found to be present in Peninsular Malaysia. This number had been updated by our subsequent studies in the Klang Straits to 14 species, with two re-discoveries, i.e. *Ps. argentilineatus* and *B. dussumieri* and 4 new records, i.e. *Ps. spilotus* [19], *Pn. septemradiatus* [20], *Parapocryptes serperaster* [21] and *Ps. walailakae* here reported for the first time.

The genus *Periophthalmus* is shown to have carnivorous habits as most of the items found were in the form of animal prey, e.g. Crustacea. This was supported by work on the *Periophthalmus* sp. from the Klang Straits [7] and other species, *Ps. waltoni* [13] and *Ps. novaeguineensis* [6]. The crustaceans were also found to dominate the stomach contents of *Ps. novemradiatus*, *Ps. spilotus* and *Ps. walailakae* (no other previous reports of the stomach contents of this species before). *Boleophthalmus* was shown to have a herbivorous feeding habit as the stomach contents were highly ranked for plant materials especially diatoms (Bacillariophyceae) and algae (Chlorophyta, Cynophyta). Similar studies done by Clayton & Vaughan [22], performed on *B. dussumieri* [12] and for *B. pectinirostris* [23] confirmed the herbivory habits of this genus.

The distribution of the mudskippers would be naturally influenced by the habitat conditions. Contributing factors encompass the types of sediment, salinity differences, exposure to wet or dry conditions, canopy coverage and the inclination of the habitat [18, 24, 25]. *Ps. chrysopilos* and *S. histophorus* are known to inhabit sandy coastal habitats and littoral zone of sea-shore [14].

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