DIET ANALYSIS OF DASYATID STINGRAYS (ORDER RAJIFORMES; FAMILY DASYATIDAE) IN THE WATERS OFF KOTA KINABALU, SABAH

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#### ABSTRAK

Kajian ini menyelidik diet pari dasyatid daripada perairan Kota Kinabalu (iaitu termasuk perairan Teluk Sepanggar, Teluk Gantian, Teluk Likas dan Teluk Gaya). Spesimen-spesimen yang ditangkap telah diidentifikasikan spesies dan jenis makanan utamanya (ditunjuk oleh indeks kepentingan relatif) di mana jenis dietnya diselidik menerusi analisis kandungan perut. Empat stesen penyampelan telah dipilih dan tempoh masa penyampelan adalah 8 bulan (Jun 2007 hingga Januari 2008). Spesimen-spesimen adalah ditangkap dengan menggunakan alat-alat menangkap ikan pasif (pukat tangsi tiga lapis, pancing dan rawai set dasar), dan masa yang sama spesimen juga didapati daripada nelayan artisanal yang memancing di kawasan itu. Semua spesimen telah dianalisa dalam tempoh 3 jam selepas ditangkap atau disejukbekukan (-20°C) terlebih dahulu. Dalam penganalisisan diet spesimen, perut spesimen-spesimen telah dibedahkan. Secara kesimpulan, sejumlah 30 ekor spesimen daripada 5 spesies telah berjaya disampelkan dalam tempoh masa penyampelan. Spesies-spesies tersebut adalah Dasyatis kuhlii atau nama umumnya pari lalat (ni=14), Himantura walga atau nama umumnya pari tanjung (ni=8), Himantura gerrardi atau nama umumnya pari bintik putih (ni=6), Himantura pastinacoides atau nama umumnya pari bulat (ni=1) dan Taeniura lymma atau nama umumnya pari reben (ni=1). Semua perut spesimen telah dibedah untuk mengkaji kandungan perutnya. Walau bagaimanapun, hanya spesies-spesies yang jumlahnya melebihi seekor telah dianalisa untuk menentukan indeks kepentingan relatif jenis makanan serta dietnya. Hipotesis yang mangandaikan bahawa sumber marin laut dibahagi dan disaing antara dasyatid-dasyatid adalah disokongkan melalui pemerhatian persamaan makanan utama dan habitat antara 3 spesies tersebut.



#### ABSTRACT

This study examined the diet of dasyatid stingrays from the waters off Kota Kinabalu (that is including the water of Sepanggar Bay, Gantian Bay, Likas Bay and Gaya Bay). Specimens caught were firstly identified and their important food items (shown as an index of relative importance, IRI) and dietary type were investigated from analysis of the stomach contents. Four sampling stations were selected and the sampling period was 8 month (July 2007 to January 2008). Specimens were caught using passive fishing gears (three-layered gillnet, handline and bottom set long-line), while specimens were also obtained from artisanal fishermen fishing in the area. All specimens were either dissected within 3 hours after being caught, or frozen (-20°C) first. To analyse the diet, the stomach of each specimen was dissected. In total, 30 specimens from 5 species were caught, or obtained from fishermen during the study period. The species are Dasyatis kuhlii named commonly bluespotted stingray (n=14), Himantura walga named commonly dwarf whipray (ni=8), Himantura gerrardi named commonly whitespotted whipray (ni=6), Himantura pastinacoides named commonly round whipray (ni=1) and Taeniura lymma named commonly bluespotted ribbontail ray (ni=1). All the stomach of specimens was dissected to study their stomach content. However, only species that had more than one individual were analysed for their IRI of food item and type of diet. The hypothesis of dasyatids partitioning and competing living marine resource is supported by the observation of the similarities of important food and habitat between the 3 species.



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# SYMBOL LIST

cm	=	centimetre
E	=	east
g	=	gram
IRI	=	index of relative importance
Is.	=	island
Kg.	=	Kampung (Village)
TL	=	total length
m	=	metre
N	=	north
ni	=	number of individual
no.	=	number
sp.	=	species
Tg.	=	Tanjung (Cape)
UMS	=	University Malaysia Sabah
%	=	percentage
%N	=	percentage of number
%0	=	percentage of occurrence
%W	=	percentage of weight
Σ	=	summation
3D	=	three-dimension



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#### CHAPTER 1

#### INTRODUCTION

#### 1.1 Introduction to Dasyatid Stingrays

#### 1.1.1 Classification

Dasyatid stingrays are taxonomically classified under Class Chondrichthyes (cartilaginous fishes), Subclass Elasmobranchii (sharks and batoids), Superorder Batidoidimorpha (batoids or rays), Order Rajiformes (skates and rays) and Family Dasyatidae. Figure 1.1 shows this categorisation which is based on the checklist of taxonomic classification from Taylor *et al.* (2002) and Froese and Pauly (2008). Dasyatids are categorised into six non-monophyletic genera that are the *Dasyatis* (fintailed stingrays), *Himantura* (whiptailed stingrays), *Pastinachus* (feathertailed stingrays), *Pteroplatytrygon* (pelagic stingrays), *Taeniura* (ribbontailed stingrays) and *Urogymnus* (porcupine stingrays) (Campagno, 2005). Based on the latest studies, the total number of dasyatid species is 77 worldwide (Froese and Pauly, 2008), 26 in Malaysia (Yano *et al.*, 2005; Manjaji and Last, 2006) and 17 in Sabah (Fowler *et al.*, 1999; Manjaji, 2002; Last *et al.*, 2005). The total number of dasyatid species in the world, Malaysia and Sabah, and the list of species recorded from Sabah are shown in Table 1.1.





Figure 1.1 Classification of dasyatids in bold (edition based on Taylor *et al.*, 2003; Froese and Pauly 2008).



Table 1.1	The total num	ber of dasyatid spo	ecies in the wor	rld, Malaysia an	d Sabah; and
the list of	species recorde	d from Sabah.			

Canus		N	umber of spec	Species recorded from			
	Genus	World	Malaysia	Sabah	Sabah		
1	Dasyatis	42	7	3	D. kuhlii, D. microps, D. zugei		
2	Himantura	27	15	9	H. chaophraya, H. fai, H. gerradi, H. jenkinsii, H. pastinacoides, H. uarnacoides, H. uarnak, H. undulata, H. walga		
3	Pastinachus	2	2	2	P. sephen, P. solocirostris		
4	Pteroplatytrygon	1	1	0	+		
5	Taeniura	3	2	2	T. lymma, T. meyeni		
6	Urogymnus	2	1	1	U. asperrimus		
	Total	77	26	17	-		

As a member of Class Chondrichthyes, dasyatids are characterised as poikilothermic (cold-blooded) with urea-retaining blood to control osmosis, gnathostomous (jaw developed), cartilaginous endoskeleton and vertebrae (with partial calcification but no ossification or never of true bone in living form which is to reduce body weight and facilitate buoyancy), constrictive notochord by vertebrae, paired nostrils, skull without any suture, amphistylic or hyostylic, no external ear, but inner ear 3 semicircular canals on each side of head, and a pair of fleshy pectoral and pelvic fins (Lagler *et al.*, 1977; Last and Stevens, 1994; Mohsin and Ambak, 1996; Taylor *et al.*, 2002). Their gill arches are cartilaginous and are not firmly united to the brain case, but joined to it by connective tissue (Lagler *et al.*, 1977). As in other members of the



Class Chondrichthyes, the males of dasyatids have a pair of pelvic intromittent organs called myxopterygia or claspers (Lagler *et al.*, 1977).

As a member of Subclass Elasmobranchii, dasyatids have cloaca, sandpaperlike skin covered with placoid (tooth-like) scales, digestive system with J-shaped stomach and spiral valve intestine (to increase food absorption), 5 pairs of gills and visceral clefts as separate gill openings (naked without cover by operculum) on each side of the head (Lagler *et al.*, 1977; Taylor *et al.*, 2002; Allen, 2005; Hickman *et al.*, 2006).

Batoids consist of sawfishes (Order Pristiformes), torpedo or electric rays (Order Torpediniformes), guitarfishes, skates and rays (Order Rajiformes) (Froese and Pauly, 2008). Under Superorder Batidoidimorpha, dasyatids and other batoids are the fishes featured with a strongly depressed or dorsoventrally flattened body that are specialised for bottom dwelling, and two enlarged pectoral fins that are fused to the head to form lateral disc (Compagno, 1999; Hickman *et al.*, 2006). All members of this Superorder are characterised by the absence of anal fin, presence of protrusible jaws, pavement-like teeth, ventrally placed mouth and nasal aperture, ventrally gill openings present posteriorly at the side of head and invisible in lateral view, developed and large spiracles behind the eyes on dorsal surface, cornea joined directly to skin around the eyes with the absence of nictitating membrane, tight-fitting skin that is covered with asperities, spines, scales and thorns (Mohsin and Ambak, 1996; Compagno, 1999; McEachran, 2003; Nelson, 2006). The position of the spiracles on the dorsal disc surface and gill silts on the ventral disc underside means that the spiracles but not the mouth function to draw in water for respiration, which are then



expelled out through the gills (Karleskint et al., 2006). This is an adaptation of bottom existence by preventing the delicate gill filaments from becoming clogged with sand or debris (Karleskint et al., 2006).

Order Rajiformes is consisted of 10 Family of guiterfish, skates and ray. The common name and species number of Families of Order Rajiformes in the world (Froese and Pauly, 2008), in Malaysia (Yano *et al.*, 2005) and in Sabah (Fowler *et al.*, 1999; Manjaji, 2002) is shown in Table 1.2. According to Table 1.2, Family Dasyatidae has the most number of species compared to other Families of Order Rajiformes in the waters of Sabah and Malaysia.

Table	1.2	Common	name	and	species	number	worldwide,	in	Malaysia	and	Sabah	of
the Far	mily	of Order	Rajifo	rmes								

Family	Common name	Number of species		
		World	Malaysia	Sabah
Rhinobatidae	Guitarfishes	58	3	2
Anacanthobatidae	Smooth skates	10	0	0
Rajidae	Skates	236	2	0
Hexatrygonidae	Sixgill stingrays	1	0	0
Plesiobatidae	Deepwater stingrays	1	1	0
Urolophidae	Round stingrays	44	0	0
Myliobatidae	Eagle, cownose and manta rays	41	11	8
Gymnuridae	Butterfly ray	14	3	2
Potamotrygonidae	River stingrays	19	0	0
Dasyatidae	Dasyatid stingrays	77	26	17



#### 1.1.2 Morphology

The general characteristics of dasyatids or members of Family Dasyatidae are their large, circular, oval or rhomboidal discs about 1.2 times as broad as long, no dorsal fin or only indistinctly present over the tail (for the adaptation of life on the sea floor), no caudal fin, low to high and rounded to angular pelvic fin with lobes at equal position, multiple internal gill slits without gill sieves or rakers, usually denticles, thorns and tubercles present on the dorsal surface of disc and tail or quite smooth skin (as denticles have been discarded in some species) (Last and Stevens, 1994; Mohsin and Ambak, 1996; Norman, 1999; Yano *et al.*, 2005). The dasyatids are distributed in tropical to warm temperate regions ranging from shallow coastal waters to the edge of the continental shelf (McEachran, 1990).

The head of dasyatids elevates slightly above pectoral fins without demarcation from the disc (Yano *et al.*, 2005). The mouth is located posterior of the nostrils, and characterised as a transverse, straight or broadly arched, and narrow feature, without prominent knobs, depressions or labial folds but sometimes wave-like, present lobate oral papillae on mouth floor and fringed margin with mouth roof (Mohsin and Ambak, 1996; Yano *et al.*, 2005). Nostrils are separated from each other by the narrow distance from the mouth and connected by broad nasoral grooves with mouth (Yano *et al.*, 2005). The nostrils possess a long and medially expanded anterior nasal flaps that fused into a broad, and elongated nasal curtain or internasal flap that overlaps the mouth (Yano *et al.*, 2005).



Dasyatids are characterised by a streamlined tail featured moderately stout to slender, depressed or cylindrical, and elongated whip-like, where on the dorsal surface of tail well behind pelvic fins distributed 1 to 4 long venomous spine with the hollow barbs connected to poison glands or a single barb at the tails' base (Yano *et al.*, 2005; Karleskint *et al.*, 2006).

The males internally fertilise the females by using a pair of their copulatory organ, the myxopterygic claspers which is modified from the pelvic girdle (McEachran, 2003). Generally, stingrays have a slow growth and maturation period, therefore to increase the survival rate of their offspring, they are able to produce eggs without laying them out from the uterus by females whereby they engage in internal fertilization using a pair of modified claspers and attached to base of pelvic fins of males (Last and Stevens, 1994; Taylor *et al.*, 2002). This specified way of reproduction is called ovoviviparous or aplacental viviparous (without placental attachment between mother and young) where stingrays produce larger and fewer litters of 2-6 fully developed young that may take up to 12 months to gestate (McEachran, 1990; Last and Compagno, 1999).

#### 1.3 Objectives

The aim of this study is to determine the diet of different species of dasyatids from the waters of Kota Kinabalu. The majority of stingrays are large predators located near the top of the marine food chain, thus they strongly affect the marine ecosystem by playing a significant role as the high level consumer of the ecological pyramid. According to Motta (2004), the studies on elasmobranchs are few and ever fewer for



batoids compared to sharks. Hence this contributes to the generally poorly known life history and biology of batoids of Southeast Asia (Allen, 1996). The knowledge of the mechanics and evolution of aquatic feeding is also poorly known since the information on elasmobranch feeding is profoundly lacking (Kapoor and Khanna, 2004). Hence this study will contribute to increase the biological knowledge of tropical stingrays especially their feeding ecology.

The objectives of this study include:

- a) to identify the species collected;
- b) to quantitatively analyse the stomach contents for the estimation of their important prey;
- c) to find out which are the homogeneous or heterogeneous diet;
- d) to demonstrate food partitioning or competition for living marine resource among the dasyatids in the study area.

This study will also test the hypothesis that food resources within the marine ecosystem of Kota Kinabalu waters are partitioned and competed between dasyatid species.



#### **CHAPTER 2**

### LITERATURE REVIEW

#### 2.1 Diet of Dasyatid Stingrays

Motta (2004) highlighted the lack of worldwide study of batoids, while Allen (1996) stated that the life history and biology of batoids is poorly known in Southeast Asia. Due to the scarce information, especially on the diet of dasyatids, the literature review of this study mostly refers to the diet literature of batoids in general. All batoids (especially skates and rays, the higher taxonomic group of dasyatids) have similar mouth morphology, therefore supposed that all of them have similar feeding behaviour, despite difference in terms of feeding strategy, either benthic or pelagic lifestyle, and preferable food items. Skates and rays are the demersal feeders that target on benthopelagic faunas swimming in vicinity, and epifauna living on the substratum and the infauna living in the substratum (Wootton, 1992). According to Cleave (1994), and Last and Stevens (1994), skates and rays scavenge the dead organisms on the seabed, but no specified species was reported to be the scavenger. The usual diet of batoids consists of crustaceans, molluscs, worms, and other small animals living in the seabed (Clarke, 1972; Banister and Campbell, 1993; Castro and Huber, 2005). According to Cleave (1994), one of the common bony fishes fed by batoids is flatfishes, even though Clarke (1972) stated that they do not even feed very much on bony fishes.



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