STOMACH CONTENT OF THREE TUNA SPECIES IN THE EASTERN INDIAN OCEAN

Bram Setyadji, Andi Bahtiar, and Dian Novianto
Reseach Station for Tuna Fisheries
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E-Mail : bram.setyadji@gmail.com

ABSTRACT

Feeding habit of tuna in Indian Ocean has been described around Sri Lanka, Indian Waters, Andaman Sea, western Indian Ocean (Seychelles Islands), western equatorial Indian Ocean whereas the tunas feeding habit study in Eastern Indian Oceanis merely in existence. The purpose of this study is to investigate the stomach content of three tuna species (bigeye tuna, yellowfin tuna, and skipjack tuna), apex predator in the southern part of Eastern Indian Ocean. The study was conducted in March – April, 2010 on the basis of catches of commercial tuna longline vessel based in Port of Benoa. A total of 53 individual fishes were collected, consisting of bigeye tuna (Thunnusobesus), yellowfin tuna (Thunnus albacores), and skipjack tuna (Katsuwonuspelamis). Stomach specimens were collected and analyzed.Analysis was conducted on the basis of index of preponderance method. The diet of the three tuna species showed fishes as the main diet (56–82%), followed by cephalopods (squids) as the complementary diet (0–8%), and crustaceans (shrimps) as the additional diet (2–4%). Fish prey composed of 6 families i.e. Alepisauridae, Bramidae, Carangidae, Clupeidae, Engraulidae, and Scombridae.

Keywords: ***Stomach content, bigeye tuna, yellowfin tuna, skipjack tuna, Eastern Indian Ocean.***

INTRODUCTION

Fish diets are frequently characterised by great diversity of prey species, which can be related to opportunistic predation (i.e. non-selective) (Menard *et al*., 2006). Information related to food and feeding habit is important in understanding the life history of the species concerned, including growth, migration, and potentially useful for fisheries management (Effendie, 2002). The predator-prey interactions play an important part in the structure and the dynamics of multispecies communities (Notmoorn *et al.*, 2008). Considering the fast increase of tuna catches and related species in the Indian Ocean, especially in the southern Indian Ocean, it becomes necessary to assess the impact of such kind of fisheries in the pelagic ecosystems. Research activitiesof such kind leading to a better knowledge of thropic ecology of apex predators is important nowadays in the context of ecosystem in fisheries management.

Stomach content analyses are commonly used to study both fish feeding behavior and thropic conditions (Bertrand, 2002). However, the interpretation of such data depends on fish foraging behavior for a given environment and how representative the stomach contents are to the prey distribution. The feeding habit of tuna in Indian Ocean has been described around Sri Lanka (Maldeniya, 1996; Dissanayake *et al*., 2008), Indian Waters (John, 1998; Nootmorn *et al*., 2008, Sivadas & Anasukoya, 1999; Rohit *et al*., 2010), Andaman Sea (Panjarat, 2006), Western Indian Ocean (Seychelles Islands) (Potier *et al*., 2004), Western Equatorial Indian Ocean (Potier *et al*., 2007) whereas hardly any study has been conducted in Eastern Indian Ocean.

The purpose of this study is to analyse the stomach content of three tuna species (bigeye tuna, yellowfin tuna, and skipjack tuna) collected from fishing vessels operating in Eastern Indian Ocean.

MATERIALS AND METHODS

The study was done during March – April, 2010 on boardtwo commercial tuna longline vesselsbased in Port of Benoa. A total of 272 large pelagic fishes caught,53 of themwere sampled for observation, consisting of 32 bigeye tuna (*Thunnusobesus*) with size of 50 – 165 cm (FLT/Fork Length Tape), 10yellowfin tuna (*Thunnus albacores*) of 43 – 165 cm (FLT), and 11 skipjack tuna (*Katsuwonuspelamis*) of 30 – 96 cm (FLT). Samples were taken during fishing operation in Eastern Indian Oceanas shown in Fig. 1.

Corresponding author:
Research Station for Tuna Fihseries Benoa,
Jl. Raya Pelabuhan Benoa, Denpasar Selatan, Bali.

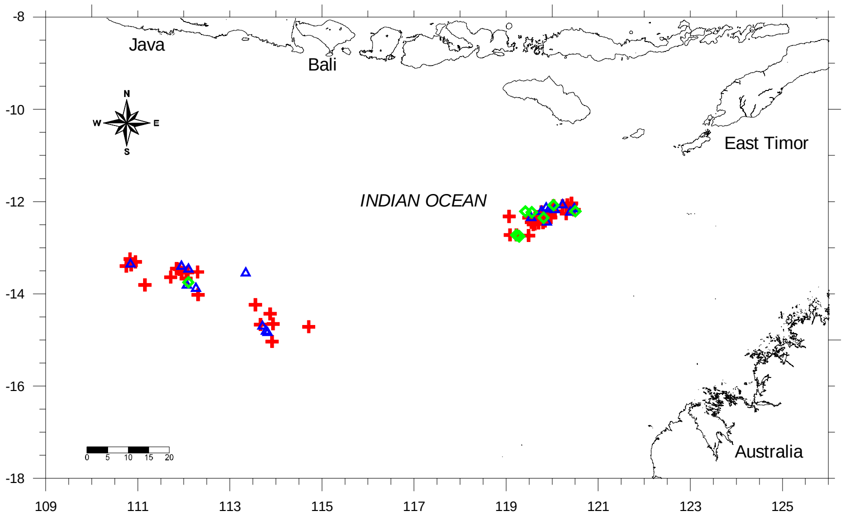

Figure 1. Station distribution of samples collection (**+** :bigeye tuna; **" :** yellowfin tuna; ◊: skipjack tuna) in Eastern Indian Ocean

Stomach Analysis Procedures

Stomach analysis were conducted following this procedure: 1) the entire stomach was removed from the freshly caught fish when hauled on board; 2) size of the predator (fork length) and sex were recorded for each fish; 3) then a three-step activities were conducted: (a) total weight of the stomach contents was measured; (b) the stomach content was sorted by large categories (fish, mollusks, crustaceans); and (c) the weight of each category was recorded and; 4) classification was made to the lowest possible taxon using keys and descriptions of Nakabo (2002), FAO (1998) and Gloerfelt-Tarp and Kailola (1984).

Data Analysis

Index of Preponderance was used in order to analyze the main diet of an organism, developed by Natarjan & Jingran, (1962) *after* Mardlijah, (2008) with equation:

$$IP = \frac{(vi \times oi)}{\Sigma (vi \times oi)} \times 100\% \quad \text{.............................(1}$$

Where:

IP : *Index of preponderance* for specific type of diet

vi : Percentage of weight of one particular type of diet (%)

oi : Frequency of Occurrence (FO) (%)

The value of *oi*or FO was obtained throughthe following equation (Mardlijah, 2008):

$$FO = \frac{A}{B} \times 100\% \quad \text{................................(2}$$

Where:

FO : Frequency of Occurrence (%)

A : Degree of occurrence to one particular type of diet in organism

B : Total number of organism with non-empty stomach

The calculation of IP was modified by replacing *vi*or percentage of coverage of particular type of diet with percentage of weight, so the result expected to be more accurate. Based on index of preponderance the result can be classified into three categories (Nikolsky, 1963):

IP > 40% : Categorised as main diet.

4% $\geq$ IP $\geq$ 40% : Categorised as complementary diet.

IP < 4% : Categorised as additional diet.

RESULTS

Bigeye Tuna (Thunnus obesus)

Of the total number of stomachs examined, 6 (11.5%) were empty. Out of 26 remaining stomachs (88.46%), 31.10% prey were digested and the rest (68.9%)as shown in Table 1. On a mass basis, undigested prey were recorded consisting of mackerel scad (family Carangidae) (29.0%), lancetfish (family Alepisauridae) (10.0%), sardines (family Clupeidae) (9.9%), sickle pomfret(family Bramidae) (3.3%), anchovy (family Engraulidae) (1.5%), unidentified fishes (2.6%), followed by squids (8.7%) and shrimps

(3.9%)(Fig. 2). Based on group of prey, fishes were likely favorable for main diet (48.31%), while cephalopods as the complementary diet (4.18%) and crustacean as the additional diet (2.57%).

Table 1. Number of bigeye, yellowfin, and skipjack stomachs sample with percentage of empty and non-empty stomachs.

Species	Number of sample	Length (FLT)	Empty stomach		Non-empty stomach	
			n	%	n	%
Bigeye tuna	52	50 - 165	6	11.5	46	88.5
Yellowfin tuna	16	43 - 165	-	-	16	100.0
Skipjack tuna	9	30 - 96	-	-	9	100.0

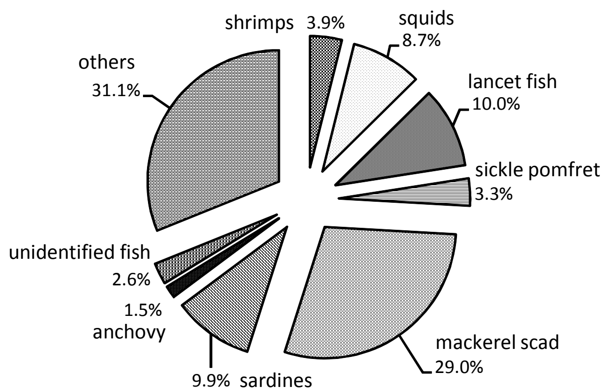

Figure 2. Diet composition of bigeye tuna (*Thunnusobesus*).

***Yellowfin tuna* (*Thunnusalbacares*)**

Disregarding the digested prey (15.5%), the diet proportion of yellowfin tunas showed a domination ofmackerel scad (53.9%), followed by lancetfish (7.9%), sardines (7.5%), mackerel (3.8%), anchovy (1.0%), sickle pomfret (0.2%), and finally followed by shrimps (2.1%) and squids (8.1%). (Fig. 3).Fishes placed as main diet for yellowfin tuna (67.7%),while cephalopods (1.5%) and crustacean (0.3%) as additional diet.

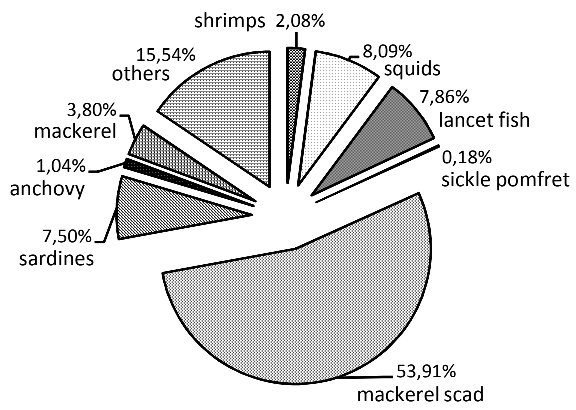

Figure 3. Diet composition of yellowfin tuna (*Thunnusalbacares*).

***Skipjack Tuna* (*Katsuwonuspelamis*)**

Only 9 skipjack tunas were observed. Less varied composition which probably due to small number of samples. Unidentified fishes (39.74%) dominated the diet composition, followed by mackerel scad (27.95%), sardines (7.42%), lancetfish (6.99%), and shrimps (3.93%), while the rest was filled by group of digested prey(Fig. 4). Fishes were likely as main diet (71.17%) and crustacean as additional diet (0.97%).

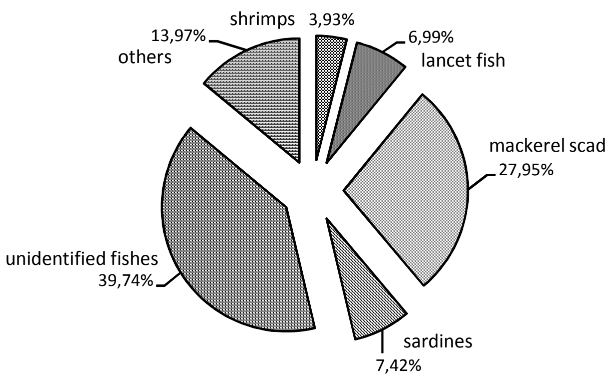

Figure 4. Diet composition of skipjack tuna (*Katsuwonuspelamis*).

DISCUSSION

Disregarding the proportion of digested food, the diet proportion of the three tuna species were dominated by group of fishes category as the main diet (56–82%), cephalopods (squids) as the complementary diet (0–8%), and crustaceans (shrimps) as the additional diet (2–4%).Similar result reported by Allain (2005a) in Western and Central Pacific for albacore, bluefin, yellowfin and skipjack tuna where the important prey groups found in the stomachs (measured by weight) were fish (64–88%), mollusks (6–25%) and crustaceans (0.2–9%). While in the Bay of Bengal (Notmoorn *et al.*, 2008) group of cephalopods were dominant in the diet composition for frigate tuna, skipjack tuna, bigeye, yellowfin and swordfish (60.7%), followed by group of fishes (38.8%). Observing stomach content on structure-associated aggregation conducted by Grubbs *et al.*(2001) found that bigeye tuna preyed on vertically migrating fishes rather than crustaceans on FAD-associated environment, while on seamount-associated environment, crustacean were likely became the main diet rather than teleost fishes.

Basically tunas are opportunistic predators (Menard *et al*., 2006) feeding on a great variety of suitably sized forage fishes,crustaceans and squids (Collete & Nauen, 1983; Rohit *et al*., 2010, Vaske & Castello, 1998; Blunt, 1960; Nakamura, 1965).In the western tropical Indian Ocean, crustaceans were almost the exclusive food source of surface-swimming bigeye tuna,in the meantime bigeyetuna fed predominantly on cephalopods and mesopelagic fish, for which this predator appeared to be the most active chaser (Potier, 2004).

Among three tuna species in this study, the yellowfin tuna showed to have the most diverse prey (Fig 2,3, & 4 for comparison). Percentage occurrence of major prey items from the previous research in Indian Ocean presented: a) **Arabian Sea (Southern)** – The prey items identified in 42 specimens in the order of preference are teleost fish (42.9%), squids (88.8%), crab (14.3%) and cuttle fish (4%); b) **Bay of Bengal** - The dominant prey items identified in 58 specimens are squids (39%), teleost fish (26.8%), crab (22%), shrimps (12.2%); c) **Andaman and Nicobar waters** – The important food items in 368 specimensidentified are squids 45.1%), teleost fish (33.5%), crabs (17.8%), Octopus (2.1%), Cuttle fish (1.2%) and Stomatopods (0.3%) and; d) **Arabian Sea (Northern)** - The gut content studies of 850 specimens from Arabian Sea (Northern), method indicates preponderence of squids (52.8%) and fin-fishes (40.7%). The other components observed were Cuttle fish (3.1%), Crabs (2.4%) and Octopus (1%)[1].With few exceptions, previous stomach content studies concluded that yellowfin tuna are opportunistic predators (Collete & Nauen, 1983; Menard *et al*., 2006) that feed on a tremendously diverse forage base, although the majority of the diet often comprises only a few families of epipelagic teleosts and crustaceans (Graham *et al.*, 2006). Crustaceans also became the main diet for yellowfin tuna, which is higher than fishes or cephalopods according to percentage index of relative importantance for each food (IRI) as reported by Dissanayake *et al.* (2008) but by weight, fish prey was the most important prey with mackerel and lancetfish were likely became its main, ignoring sardines as bait. The diversity in food consumption in different sectors is indicative of the non-selective feeding nature of the species whereas the difference in the percentage composition of food items could be inferred as the availability of particular prey species rather than selection of preferred food items (Somvanshi, 2002).

Skipjack tuna landed in Bitung, North Sulawesi had Mackerel scad (57%) as the main prey item, followed by sardines and mackerel (Mardlijah, 2008). In Lakshadweep, Pakistan, the percentage composition by volume of the stomach contents excluding live baits show that fishes formed 70%, crustaceans 11 % and cephalopod 19% with *Decapterus*sp as one of the main prey (Sivadas & Anasukoya, 1999). While in Canary Islands Chub mackerel was the main prey, either as live bait or natural food (Ramos *et al*., 1995) because of the abundance of this species in the area. Similar result appeared in this study, with lancetfish, anchovy, and sickle pomfret also found. The presence of lancetfish in all three tuna species' stomachs wasinteresting because itbecame bycatch in almost every longline fisheries in Indonesia (Nugraha & Wagiyo, 2006; Barata & Prisantoso, 2009; Prisantoso *et al*., 2010; Nugraha & Triharyuni, 2009; Nugraha & Nurdin, 2006). This happened because lancetfish plays an important role on pelagic food chain i.e. as predator on micronekton organisms(Romanov *et al*., 2008) alongside tunas (Bertrand *et al*., 2001)and as prey for billfshes and tunas (Potier *et al*., 2007). The multiplicity of prey found in this or previous studies indicate that perhaps skipjack or tunas in general are non-selective feeders and that stomach contents are probably determined by prey availability (Ramos *et al.*, 1995).

Diet studies provide information on basic biology and behaviour of the fish but they are also an important part of the parameterization of ecosystem models (Allain, 2005b); and information such as prey diversity, size of the prey, composition of diet can be used as ecosystem indicators in conjunction with other indicators to detect changes in the ecosystem (Kirby *et al*., 2005).

CONCLUSION

The diet proportion of three tuna species were dominated by group of fishes as the main diet (56–82%), followed by cephalopods (squids) as the complementary diet (0–8%), and crustaceans (shrimps) as the additional diet (2–4%). Fish prey composed of 6 families i.e. Alepisauridae, Bramidae, Carangidae, Clupeidae, Engraulidae, and Scombridae. Tunas in general are non-selective feeders and that stomach contents indicate by prey availability.

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