

Feeding Ecology of Al-Naqim (*Pomadasys maculates*) from the Red Sea Coast of Hodeidah, Yemen

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ABSTRACT. The diet of different size groups of Naqim (*Pomadasys maculates*) ranging in length from 160-400 mm collected from Red Sea coast near Hodeidah City, Yemen was investigated, during the period from Nov. 2000 to May 2001. Contents of 140 stomachs were analyzed using fullness index, percentage of occurrence, volume and relative importance. Crabs, shrimps and other crustacean comprise the most important food source occurred in 59% of the examined stomachs and 26% of the total volume of diet on average. Clams and snails (Molluscs) were the second most important food group (47% & 23% respectively). Other items include worms and algae comprising 5 and 7% only. Detritus and unidentified digested materials occurred in all examined stomachs. Wide variations in feeding habits were noticed among different size groups. Crabs and aquatic plants increased while mollusks decreased with increasing fish length. Diet composition in relation to time period was studied. Autumn months revealed the highest feeding intensity followed by Spring and Winter months, with the lack of Summer samples. Little variations in filling index and food composition between male and females were detected among medium-sized fish, possibly due to state of maturation. The feeding spectrum analysis and relative gut length measurements suggest that Al-Naqim feeds as an active predator feeding just above the bottom, utilizing mainly pelagic or bottom invertebrates and few algae.

Introduction

Al-Naqim (*Pomadasys maculates*) is a bottom living fish, widely distributed among tropical and subtropical seas, such as Red Sea. It prefers the shallow coastal waters and coral reef habitat (Al-Suramy, 1998). The species is usually preferred by people of Red Sea coasts due to its delicious taste and acceptable body size, giving it high commercial value. Feeding and searching for food are

factors, which regulate or at least influence the distribution, migration and growth of fish (Papaconstantinou and Caragitsou, 1992). Data concerning feeding ecology of *P. maculatus* along Red Sea coasts are scarce. The present study, therefore, aimed at providing information on the composition of the diet of *P. maculatus*. Relative importance of each food item by weight, volume and frequency occurrence was calculated. Variations of feeding habits were tested in relation to length groups, sex and seasons.

Materials and Methods

Random fish samples were collected during the period between November 2000 to May 2001 by gill nets from the Red Sea offshore coasts near Hodeidah, Yemen. A total of 140 fish ranging in length between 160-400 mm deviated into six length groups. Total length (TL) of each fish was measured to the nearest mm. They were then dissected to remove the whole gut which was measured to the nearest mm. Relative gut length (RGL) was then calculated for each fish using the formula $RGL = \text{Gut length} / TL \times 100$. Gut samples were then cleaned and preserved in 5% formalin.

Stomachs were removed and dissected. Food contents were wet weighed. Index of fullness was calculated as: $100 \text{ Weight of stomach} / \text{Weight of fish}$, following the formula suggested by Berhaut (1973). Furthermore, food contents volume was estimated by water replacement in graduated cylinder. Food items were identified as far as content groups and percentage occurrence was estimated. Ranking index, which exclude the numerical contribution of the diet and rely on the volumetric (%V) and occurrence (%F), is quite useful with the uncountable items such as aquatic plants and algae. These indexes were calculated for each time period, sex and length groups, according to Windell and Bowen (1978).

Results

Feeding Intensity

The examination of 140 stomachs of *Pomadasys maculatus* revealed that only three stomachs (2.1%) were completely empty of food. Filling index data showed minimum values in the largest length group 361-400 mm while maximum values were recorded among small-sized fish (161-200 mm). Fish ranging in length between 201-360 mm having fullness index value of approximately 1 (Fig. 1). Differences in fullness index between length groups were not significant ($P > 0.05$). Differences between the smallest and the largest length groups, however, were significant ($p < 0.01$). The majority of examined fish were among the length groups (201-360 mm). It does not approve the assumption that feeding intensity of large fish is lower than that of small fish.

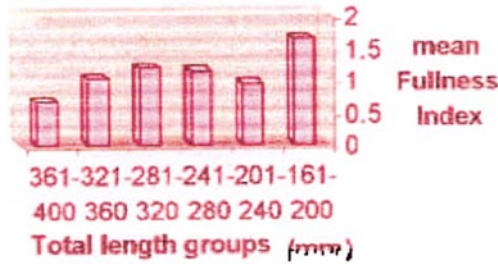


FIG. 1. Variation of fullness index with length groups.

Variations of fullness index with sex are shown in Fig. (2). Due to the dominance of females in the fish samples (sex ratio 2.25 female: 1 male) male fish have not appeared in all length groups. Comparing fullness index values in male and female fish ranging in length group between 201-320 mm showed that feeding intensity was higher in female fish. Differences, however, were not significant ($P > 0.05$).

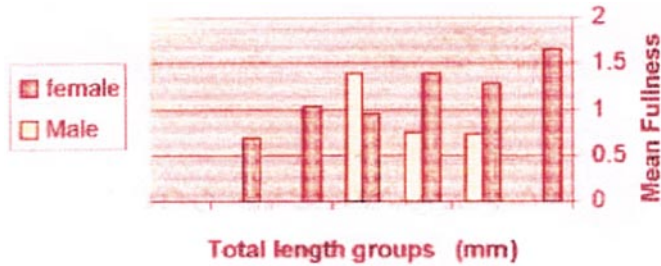


FIG. 2. Variations of fullness with sex.

As far as time period is concerned, feeding intensity was in its highest rate during Autumn followed by Spring and Winter respectively (Fig. 3). A season overlapping is a common phenomenon in tropical and sub-tropical areas. Only differences in fullness index between Autumn and Winter samples were significant ($P < 0.05$). Unfortunately, data of Summer period was not available in this paper due to academic holiday.

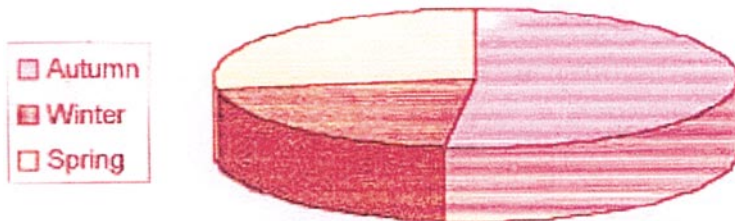


FIG. 3. Variations of fullness index with seasons (%).

Food Spectrum

Composition of the diet of *P. maculatus* expressed as % occurrence and % volumetric importance is shown in Fig. (4) and Table (1) they revealed that crustacea and mollusca although exchanging positions are the most important items numerically and volumetrically. They also occurred more frequently in the stomachs containing food than other dietary items.



FIG. 4. Relative volumetric abundance of stomach contents.

TABLE 1. Variations of food items with length groups of *P. maculatus*, values are expressed as % frequency of occurrence (%F) and volumetric importance (%V).

Food items	Length Groups (mm)											
	161-200		201-240		241-280		281-320		321-360		361-400	
	%F	%V	%F	%V	%F	%V	%F	%V	%F	%V	%F	%V
Crustacea												
Crab	33.3	29.0	25.0	1.7	29.4	12.1	55.6	18.7	50.0	25.8	100	217
Shrimp	-	-	62.5	16.2	23.5	9.6	44.4	9.7	-	-	100	4.4
Mollusca												
Clams	66.7	8.3	75.0	20.4	35.3	35.3	33.3	25.1	50.0	10.1	-	-
Snails	33.3	2.1	25.0	1.3	-	-	-	-	-	-	-	-
Worms	-	-	12.5	3.8	-	11.1	8.3	-	-	-	-	-
Algae	-	-	-	5.9	1.8	11.1	1.7	50.0	2.3	-	-	-
Sandyclay	100	41.4	100	24.4	29.4	4.9	44.4	3.3	-	-	100	8.7
Detritus	100	19.3	100	31.6	82.9	36.1	77.8	33.2	100	61.8	100	65.2

As for crustacea they occurred in 59% of the examined stomachs comprising 24% of the total food volume. They were dominated by true crabs comprising 38% & 15% of the total crustacean percentages respectively followed by other crustacean species such as prawn shrimp and crayfish which constitute as a whole 36% & 9% respectively.

Molluscs stand second among food items of *P. maculatus*. They occurred in 46% of the examined stomachs reaching 26% of the total volume. Among molluscs, snails of various species were the dominant item comprising 46% and 25% respectively. Other molluscs species belong to clams group, with modest occurrence since they occurred in nine stomachs (7%) and occupying only 0.5% of the total volume. Other food items were minor components represented by worms (5% and 3%) and algae (7.7% and 1.3% respectively), non living components along with unrecognizable decayed materials.

Variation of Food Components with Size

Fish in the present investigation ranged in length between 160-400 mm, enabling reasonable comparison of food spectrum in different size groups. Percentage volumetric contribution of food components showed insignificant ($P > 0.05$) variations between small and large-sized fish (Table 1). Crustaceans, mainly crayfishes and crabs dominated stomach contents of all fish sizes. Differences between various length groups were not significant ($P > 0.05$). On contrary mollusks especially snails appeared only in the stomachs of small fish (up to 240 mm). Clams composed the main food item of medium-sized fish, increasing significantly from 8.3% to 35.3% ($P < 0.05$). Worms and algal materials showed no relationship with fish size due to their irregular occurrence in different size groups. Inert materials such as sand and clay dropped significantly in the bigger fish. Detritus materials, on the other hand, increased significantly ($P < 0.05$) with size. Percentage occurrence of various food items has not revealed sharp conclusion in their relation with fish size.

Variation of Food Spectrum with Time-Period

As seen in Fig. (5), variations of food spectrum with time period were not significant ($P > 0.05$) due to the subtropical weather conditions. Obvious overlapping in food preference was noticed among different time periods. Similar availability of food items around the year exhibits such trend. Items such as crustacean crabs and crayfishes occurred within stomach contents in all periods. Molluscs and worms, however, disappeared during Autumn months. Aquatic weeds revealed insignificant occurrence during Autumn and Winter months. Detritus and sandy-clay materials dominated food spectrum all the year around. This could well be related to the bottom feeding habits of *P. maculatus* in shallow coastal area.

Variation of Food Spectrum with Sex

Despite the absence of male specimens from smallest and largest size categories, composition of food spectrum between male and female fish was possible in medium-sized fish ranging in length between 201-320 mm. According to in-

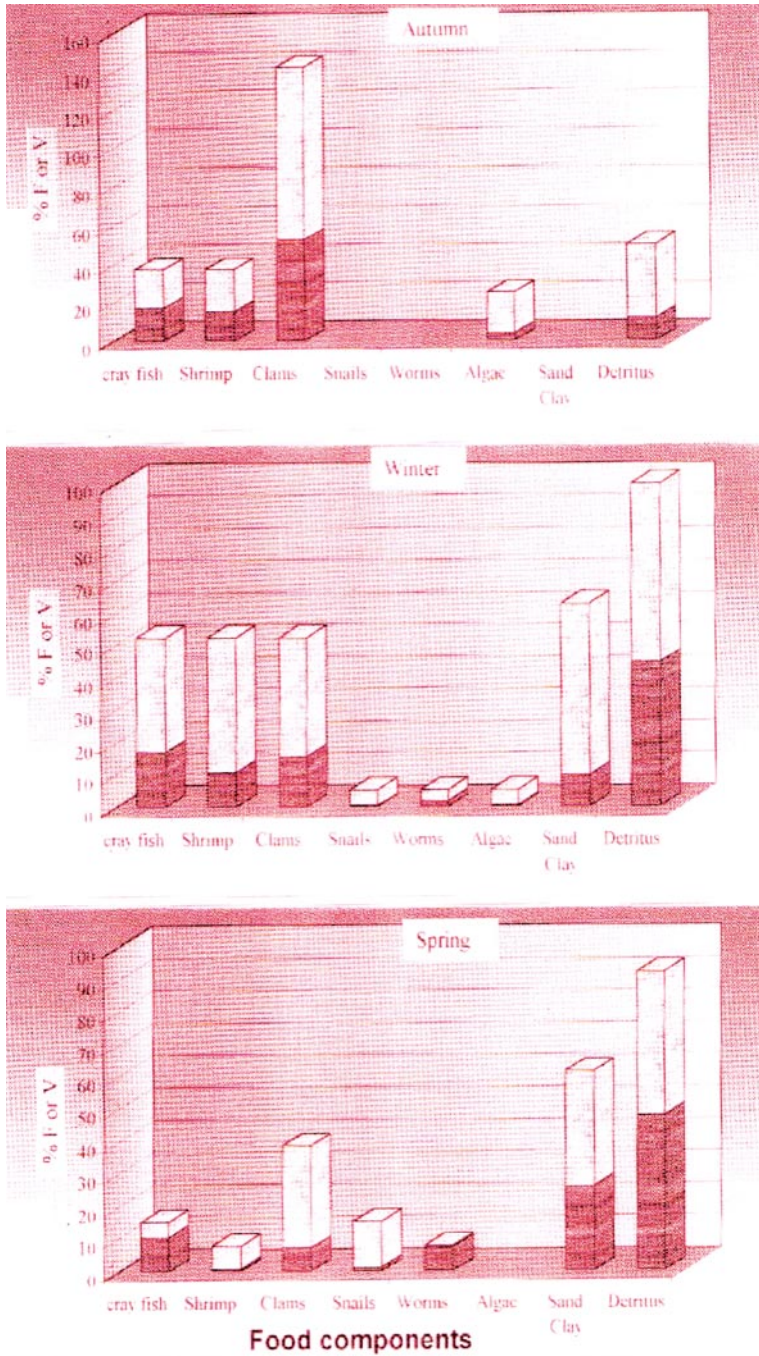


Fig. 5. Variations of food components with time period expressed as % fulness (open column) and % of volume (shaded).

formation of Fig. (6), female food spectrum was complete, containing all food items. Crustacean and molluscs are the main items contributing to 27.5% each of total food volume. In males, this contribution was significantly ($P < 0.05$) reduced to 15.3% and 18.9% respectively, with the absence of other food items such as snails and algae. Detritus materials and worms increased in males stomach to 42.2% and 10% respectively, compared with 30% and 0.9% in females.



FIG. 6. Variations of food components with sex, expressed as %F (open) and %Y (shaded) columns.

Relative Gut Length (RGL)

Variations in RGL with fish length are shown in Fig. (7). No obvious relationship could be obtained between the two parameters. Due to the carnivorous feeding habits of *P. maculatus*. RGL variations were narrow ranging from 0.8-1.2. Relationship of fish length with absolute gut length, however, was linear (Gut length = $2.6385 + 0.8909$ Fish length) $r = 0.8255$, indicating a positive relationship. Gut length increases as the fish grew up.

Discussion

Small spotted Grunt *Pomadasys maculatus* (Family Haemulidae), locally called Naqim in Yemeni coasts of Red Sea near Hodeidah, appeared to be a bottom feeding carnivorous fish, according to the basis suggested by Chang & Lee

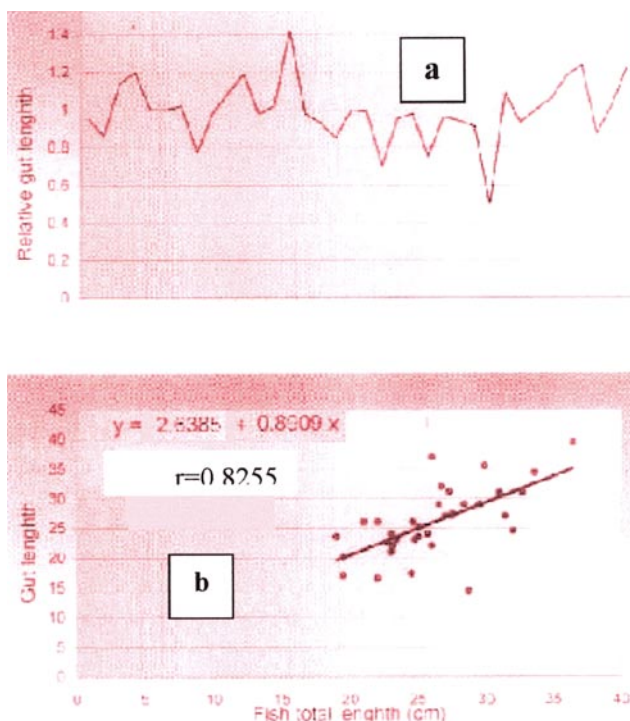


FIG. 7. Relationships between fish length and both relative (a) and absolute (b) gut length.

(1970) and the narrow range of relative gut length (RGL) values (0.8-1.2). It has also a narrow food spectrum preferring crustaceans and mollusks as its main food items with little contribution of aquatic plants and algae, putting the species in the selective feeders category. The present findings agreed with similar observations on other members of the same family in the Arab Gulf region (Salman & Al-Badri, 1996) and Red Sea (Heba, 1999). The dominant occurrence of detritus confirmed the bottom feeding habits and poor particle retention and filtering mechanism in this species (Gibson, 1988; Salman *et al.*, 1993).

The present study revealed that the percentage of empty stomachs was low (2.1%), indicating active feeding mode. It was more frequent among large-sized fish leading to the conclusion that small-sized fish actively and more frequently feeding than larger one. The phenomenon has been recorded in majority of fish species (Nikolsky, 1963). Part of filling index measurements could be explained on the basis that large-sized *P. maculatus* relies heavily on large prey items, particularly macro-crustacean and mollusks, aiming at providing food of high nutritional value for growth requirements (Ahmed & Salman, 1985). Similar explanations have been offered by Hussein & Al-Kanaani (1991) in *Aspius vorax*. The other explanation depends upon the consumption of large quan-

tity of detritus materials along with bottom sand and clay especially in small fish, suggesting detritus feeding habits.

The analysis of food spectrum by the frequency of occurrence method demonstrates what organism being consumed, but it gives no quantitative information as stated by Papaconstantinou & Caragitsou (1992). Furthermore the accumulation of the food organisms resistant to digestion is not taken into account. Therefore, another assessment method was adopted by the present study, that is the volumetric importance which is biased in favor of large and digestion-resistant items, which are ingested slowly and are more recognizable in the stomach for a long time.

Wide variations in food spectrum and filling index were detected in *P. maculatus* with increasing fish size. Rizkalla & Faltas (1997) reported similar findings in Chub Mackerel. A change of food with fish size is extensively reported as a common phenomenon in fish (Nikolsky, 1963). It could be related to differences in dietary requirements. The change in food habits, however is a practice carried out to enable the species as a whole to assimilate a variety of food (Nikolsky, 1963). These changes associated with a decrease in diversity of prey items contribute to the diet with the increase in the size of predators. A notice observed also by Hussein (1983) in *Aspius vorax*. This could explain the absence (or reduction) of snails, worms and algae in the diet of big size grunt (Naqim). The present study also indicated that large Naqim relies heavily on larger prey items particularly macrocrustaceans and mollusks, which seemed able to provide the necessary requirements of dietary items of high nutritional values (Ahmed & Salman, 1985). The study also suggests that the actual percentage composition of the various food items fluctuated within size groups with no obvious systematic changes. Similar observations have been recorded in other species (Clark, 1985; Barak *et al.*, 1994).

Variations between sexes were detected in both food composition and filling index of *P. maculatus*. These observations, however, were restricted to medium-sized fish, due to lack of male samples in the remaining length groups. Accordingly, solid conclusion could not be reached regarding the effect of sex on food and feeding habits of Naqim. Differences in dietary requirements of male and female fish especially before and during spawning seasons may explain such variations (Ahmed & Salman, 1985).

Periodical variations imposed obvious influence on feeding activity and food consumption of various fish species inhabiting temperate regions due to the wide variation of water temperature (Nikolsky, 1963). In tropical and subtropical areas, such as Hodeidah coasts, water temperature varied within few degrees. The absence of large seasonal variations beside the upwelling and downwelling phenomena in the area as stated by Abdullah & Eid (1989), have been

reflected upon the non-significant differences in feeding activity and food spectrum of *P. maculatus*. Autumn period seems to be more suitable for feeding activity of this species, possibly due to suitable bottom water temperature.

Acknowledgments

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بيئة التغذية لأسماك الناغم (*Pomadasys maculatus*) في سواحل البحر الأحمر قرب الحديدة ، اليمن

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المستخلص. تم دراسة غذاء عدة مجاميع حجمية من أسماك الناغم (*Pomadasys maculatus*) تراوحت أطوالها الكلية ما بين ١٦٠ - ٤٠٠ ملم. جمعت عينات الأسماك من سواحل مدينة الحديدة اليمنية على البحر الأحمر خلال الفترة من نوفمبر ٢٠٠٠، ولغاية مايو ٢٠٠١. تمت دراسة وتحليل محتويات المعدة في ١٤٠ عينة باستخدام دليل الامتلاء والنسبة المئوية للتواجد والأهمية النسبية الحجمية. وجد أن غذاء الناغم يتكون بالدرجة الأولى من السرطانات والجمبري وبعض القشريات الأخرى حيث شكلت الغذاء الرئيسي وتواجدت في ٥٩٪ من المعدات المفحوصة و ٢٦٪ من معدل الحجم الكلي للغذاء. أما الرخويات مثل القواقع والمحار فقد جاءت بالمرتبة الثانية في الأهمية حيث شكلت ٤٦٪ و ٢٣٪ من تكرار التواجد والأهمية الحجمية على التوالي. وشكلت بقية المكونات مثل الديدان والطحالب نسباً ضئيلة (٥٪ و ٧٪ على التوالي). كما لوحظ وجود الفتات والمواد المهضومة غير المصنفة في كل المعدات المفحوصة.

تبين من الدراسة وجود فروقات واسعة في عادات تغذية الأحجام المختلفة من أسماك الناغم. فقد ازداد تواجد السرطانات والنباتات المائية في المعدات مع تزايد طول السمكة بينما تناقص تواجد الرخويات. وعند دراسة تأثير الفترة الزمنية للجمع، ظهر أن أشهر الخريف شهدت أعلى شدة للتغذية تليها فترة الربيع والشتاء ولم تتواجد عينات لفترة الصيف. كما لوحظت تغيرات طفيفة في دليل الامتلاء وتركيب الغذاء ما بين الذكور والإناث بسبب حالة النضج الجنسي. خلصت الدراسة إلى أن سمكة الناغم سمكة مفترسة نشطة تتغذى فوق القاع بقليل وتستهلك السباحات والزحافات قرب القاع من اللاقاريات وبعض الطحالب.