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Trophic Interrelationships of the Demersal Fish Assemblage in the Northwest Arabian Gulf, Iraq

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Abstract

The food composition of 12 fish species collected from the northwest Arabian Gulf in January-August 1990 was examined. Crabs, fish, shrimp and molluscs were the most extensively utilized. Food partitioning among the predators showed three categories: pelagophagous, mesophagous and benthophagous. According to the diet breadth of each species, three degrees of feeding specialization were noted: specialized (*Trachionotus blochi, Chirocentrus dorab, Arius thalassinus, Otolithes ruber, Triacanthus biaculeatus* and rays), less specialized (*Upeneus sulphureus, Scolopsis phaeops* and *Johnius sina)* and generalized feeders (sharks, *Atropus atropus* and *Therapon theraps*). The fish assemblage divided significantly into seven groups depending on the diet overlap between each pair of species. The overlap among the investigated species was 12.4%.

Introduction

Food consumption usually provides information about the niche a species occupies in its habitat. It is also helpful in deciphering some of the higher level trophic relationships in an ecosystem. Horn (1966) noted that prey taken by a predator constitutes an essential parameter in connection with niche breadth and it complements studies that refer to competition and spatial overlap. Gulland (1977) mentioned that knowledge of the feeding ecology of noncommercial as well as commercial species is necessary for implementing a multispecies approach to fisheries management. The emphasis in fish community studies has been on trophic relationships (Helfman 1978), and food habit studies of fish communities in the marine environment are becoming increasingly popular (Hacunda 1981).

Recent comparative studies of feeding relationships using the diet overlap as an indicator of trophic relationships have received attention in different habitats (Kislalioglu and Gibson 1977; Keast 1978; Hacunda 1981; Hansson 1984; Clark 1985; Hallacher and Roberts 1985).

The food habits of some of the investigated species and similar species have been locally studied (Hussain and Abdulla 1977; Ahmed and Al-Muktar 1982; Euzen 1987; Wright 1988; Naama et al. 1989; Yousif and Naama, in press).

The present study was initiated to assess the trophic relationships among fish species in the northwest Arabian Gulf through (a) quantitative determination of the major food items, and (b) examination of food resources division and relationships among the fish assemblage.

Materials and Methods

Fish

Fish were collected during bottom trawling operations by the research vessel *Jamiat Al-Basrah* in the northwest Arabian Gulf (Fig. 1) in January-August 1990. The depth of the fishing ground was 6-14 m and its sediments are a mixture of sand, silty sand, clay-sand and sand-silt-clays (Darmoian and Lindquist 1988). Fish were frozen immediately after processing.

Food Analysis

A total of 757 stomachs of 12 species (species of rays and sharks were each treated as one species) were examined. In this study only adults of common species of the fish assemblage were considered. Stomachs were removed from the fish in the laboratory and preserved in 5% formalin. For each stomach, the food items were counted and their wet weights recorded. The index of relative importance (George and Hadley 1979) was used to analyze the stomach contents. This index, which is obtained by the combination of three basic food analysis methods to express single values, seems to be the most suitable solution for the estimation of food composition as previously reviewed by Hyslop (1980):

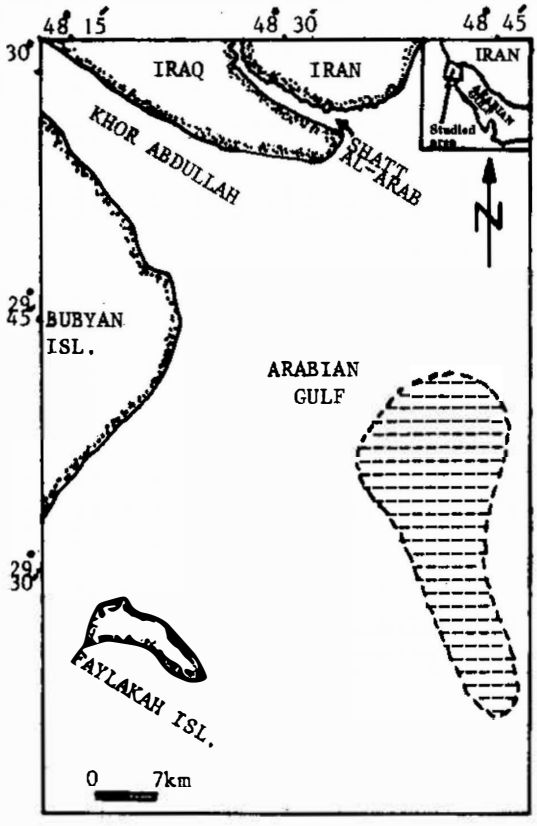

Fig. 1. Map of the northwest Arabian Gulf, showing location of sampling site (shaded).

$$AI = \% \text{ frequency occurrence} + \% \text{ total numbers} + \% \text{ total weights}$$

where AI is absolute importance index of each food item, and

$$RI = \frac{100AI}{\sum_{1}^{n} AI}$$

where RI is relative importance index, n is the number of different food types consumed.

The diet breadth for each species was calculated from the formula (Levins 1968):

$$B = \left(\sum Pi^2\right)^{-1}$$

where B is diet breadth, and Pi is the proportion of the ith item in the diet. This index was used to test the feeding specialization of each species. Low values (1<B<2) indicate specialist feeders, median values (2.1<B<3) indicate less specialist feeders, and high values (B>3) represent generalist feeders.

The diet overlap between each pair of species was determined using Schoener's method (Schoener 1970):

$$\% \text{ diet overlap} = 100\left(1 - 0.5\sum 1\left[P_{xj} - P_{yj}\right]1\right)$$

where P_{xj} and P_{yj} are the proportion of prey item j in the diets of species x and y.

The overall diet overlap among studied species was calculated according to the following formula (Kislalioglu and Gibson 1977):

$$\% \text{ diet overlap} = \frac{\text{Total number of re-occurrences of prey groups}}{\text{Total number of possible re-occurrences}}$$

The total number of possible re-occurrences is obtained as the number of fish species minus one, multiplied by the number of food items. The total number of re-occurrences of prey groups among predators is calculated as total number of prey in the diet of all species minus the number of food items.

Results

Food Composition

The food compositions of the investigated species are given in Table 1. Food items which represented more than 10% relative importance were considered to be major items in the diet of each species. It appeared that most species depend on one or two major food items except *Therapon theraps* Cuvier, *Atropus atropus* (Bloch & Schneider) and sharks. Crabs, fish, shrimps and molluscs were more extensively utilized than other food items.

Three modes could be distinguished in Table 1. The upper one included three pelagic species [*Otolithes ruber* (Schneider), *Chirocentrus dorab* (Forsskal) and *At. atropus*] which fed on nektonic organisms (pelagophagous). The middle mode included four

Table 1. The relative importance (%IRI) of food items of Northwest Arabian Gulf fish assemblage (only food items constituting greater than 10% of IRI are included).

	Rays	*Triacanthus biaculeatus*	*Trachionotus blochi*	*Arius thalassinus*	*Therapon theraps*	*Upeneus sulphureus*	*Scolopsis phaeops*	*Johnius sina*	Sharks	*Otolithes ruber*	*Chirocentrus dorab*	*Atropus atropus*	No. re-occurrence
Fish eggs	-	-	-	-	-	-	-	-	-	-	-	15.2	1
Brachyuran larvae	-	-	-	-	-	-	-	-	-	-	-	25.9	1
Copepods	-	-	-	-	-	-	-	-	-	-	-	37.3	1
Fish	-	-	-	-	-	-	-	39.8	33.2	96.0	100	19.0	5
Cuttle fish	-	-	-	-	-	-	-	-	26.2	-	-	-	1
Shrimp	-	-	-	-	-	48.7	58.9	51.6	35.7	-	-	-	4
Sea cucumber	-	-	-	-	34.0	-	-	-	-	-	-	-	1
Crab	24.0	-	100	96.0	13.5	45.3	29.9	-	13.9	-	-	-	7
Mollusca	73.1	65.6	-	-	17.6	-	-	-	-	-	-	-	3
Polychaets	-	34.4	-	-	-	-	-	-	-	-	-	-	1
Sea anemones	-	-	-	-	20.9	-	-	-	-	-	-	-	1
No. of major food items	2	2	1	1	4	2	2	2	4	1	1	4	26
No. of fish examined	43	54	44	98	94	76	62	82	57	42	60	45	
Diet breadth	1.6	1.8	1.0	1.1	4.6	2.3	2.3	2.3	3.7	1.1	1.0	3.8	

species [*Upeneus sulphureus* Cuvier, *Scolopsis phaeops* (Bennett), *Johnius sina* (Cuvier) and sharks] which fed through the water column on nektonic and near bottom prey (mesophagous). The lower mode included five demersal species [*Triacanthus biaculeatus* (Bloch), *Trachionotus blochi* (Lacepede), *Arius thalassinus* (Ruppell), *Th. theraps* and rays] which fed on benthic forms (benthopagous).

Table 1 illustrates the food composition of each species. Rays and *Triacanthus biaculeatus* preyed primarily on molluscs which comprised more than two-thirds of their diet; other prey groups were crabs (24%) for the rays, and polychaetes (34%) for *T. biaculeatus*. Crabs were the most important prey for *A. thalassinus* and *Trachionotus blochi,* comprising more than 96% in relative importance. Fish was the principal food item for *O. ruber* and *C. dorab*, constituting 96% and 100%, respectively. Sharks and *J. sina* depend mainly in their diets on shrimp and fish. *U. sulphureus* and *S. phaeops* also preyed on shrimp but with crabs as the second important food item. The major prey of *Th. theraps* was sea cucumber (34%); molluscs, crabs and sea anemones were other prey identified. *At. atropus* fed largely on copepods (37%); other groups were brachyuran larvae and fish.

Diet Breadth

On the basis of dietary composition, the diet breadth (B) of each species was calculated (Table 1). Fish species having breadth of $1<B<2$ were classified as specialized feeders *(Trachionotus blochi, C. dorab, Ar. thalassinus, O. ruber, Triacanthus biaculeatus* and rays), while those having median diet breadth ($2<B<3$) were classified as less specialized feeders (*U. sulphureus, S. phaeops* and *J. sina*), and the species which exhibited greater breadth ($B>3$) were classified as generalized feeders (sharks, *At. atropus* and *Th. theraps*).

Diet Overlap

The diet overlaps between each pair of species are listed in Table 2 and plotted as a dendrogram in Fig. 2. Any value greater than 60% was considered a "significant" diet overlap (Zaret and Rand 1971). Seven "significant" diet overlaps were obtained (Table 2).

It is possible to subdivide these fish species according to their food priority into seven distinct groups (Fig. 2). Group I consists of

Table 2. The % diet overlap values among fish species of the northwest Arabian Gulf.

	Ar. thalassinus	*At. atropus*	*C. dorab*	*J. sina*	*O. ruber*	Rays	*S. phaeops*	*Th. theraps*	*Tra. blochi*	*Tri. biaculeatus*	Sharks	*U. sulphureus*
Ar. thalassinus		○	○	○	○	○	○	○	●	○	○	○
At. atropus	6	○	○	○	○	○	○	○	○	○	○	○
C. dorab	4	19	○	○	●	○	○	○	○	○	○	○
J. sina	13	22	40	○	○	○	●	○	○	○	●	●
O. ruber	4	19	96	44	○	○	○	○	○	○	○	○
Rays	27	6	3	12	3	○	○	○	○	●	○	○
S. phaeops	30	3	0	60	4	27	○	○	○	○	○	●
Th. theraps	18	10	7	23	11	34	31	○	○	○	○	○
Tra. blochi	96	3	0	9	0	24	30	14	○	○	○	○
Tri. biaculeatus	0	0	0	0	0	66	3	18	6	○	○	○
Sharks	18	22	25	69	29	17	50	34	14	0	○	○
U. sulphureus	48	5	2	60	4	30	81	26	45	4	52	

● Significant diet overlap (>60%)
○ Insignificant diet overlap (<60%)

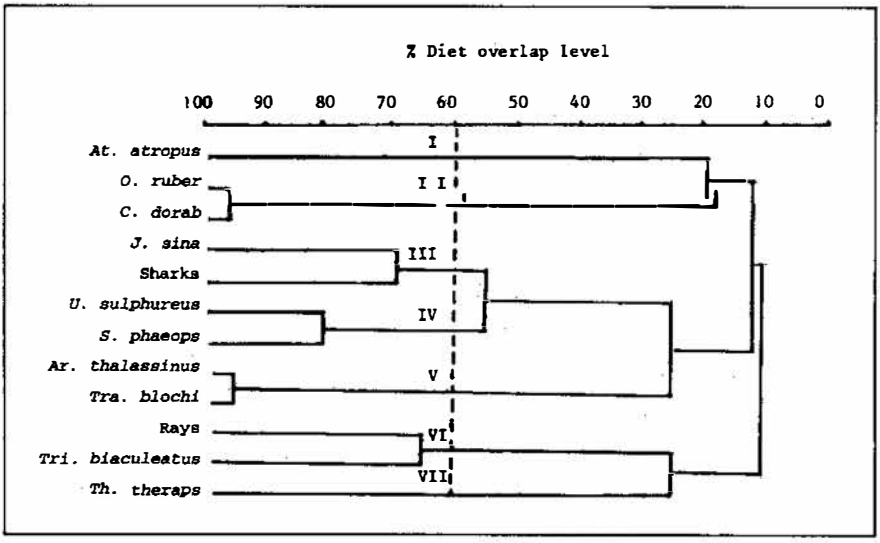

Fig. 2. Dendrogram of percentage similarity among fish species of the northwest Arabian Gulf based on % diet overlap between each pair of species.

one generalized pelagophagous species *(At. atropus)* loosely associated with group II, which includes two piscivorous species *(O. ruber* and *C. dorab)*. Group III comprises *J. sina* and the sharks which consumed shrimp and some fish. Group IV includes *U. sulphureus* and *S. phaeops* which mainly take shrimps and to lesser extent crabs. Group V includes two benthophagous crab feeders *(Ar. thalassinus* and *Trachionotus blochi)*. Group VI includes rays and *Triacanthus biaculeatus* for which molluscs seem to be the major food item. Finally, Group VII is a single generalized benthophagous species *(Th. theraps)*.

The overall diet overlap among fish species obtained in the northwest Arabian Gulf was 12.4%.

Discussion

Examination of the stomach contents of the investigated fishes has shown that while the diet varied among the fish species, most of them depend on one or two major food items.

Results of food studies of similar species are consistent with those presented here: Hussain and Abdulla (1977), Ahmed and Al-Muktar (1982) and Euzen (1987) on *O. ruber;* Yousif and Naama (in

press) on *J. sina;* and Euzen (1987) on sharks. A comparison with feeding studies on *At. atropus* and *Ar. thalassinus* reveals that the former is more of a generalized than piscivorous feeder, as mentioned previously by Euzen (1987). It was found that *Ar. thalassinus* feeds mainly on crabs and not bivalves as recorded by Euzen (1987) and Naama et al. (1989).

Tyler (1972) and Kislalioglu and Gibson (1977) suggested that marine fish communities of temperate and coastal regions are characterized by considerable division of food resources among predators. Our results exhibited three modes of feeding (pelagophagous, mesophagous and benthophagous) within seven distinct groups (according to their food priority) and low overall diet overlap. This may indicate a clear partitioning of food resources between the investigated species.

Allen (1982) stated that estuaries and coastal regions are characterized by high productivity levels and that many fish species utilize those regions as nursery and feeding grounds. The study region is an estuary affected by freshwater from Shatt-Al Arab (Fig. 1), resulting in high productivity exceeding 1 $g \cdot m^{-3} \cdot hour^{-1}$ and benthic biomass equal to 23.4 $g \cdot m^{-2}$ as mentioned by Al-Kholy and Soloviov (1978).

In general, offshore fish from the northwest Arabian Gulf feed on a wide range of zooplankton, crustaceans, fish and molluscs. Information on composition and abundance of potential food items is necessary to define adequately the degree of specialization of predators, but it seems likely that feeding specialization or selectivity is common among these species.

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