DIETARY OVERLAP OF CARNIVOROUS FISHES IN IRAQI MARINE WATERS, NORTHWEST ARABIAN GULF

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SUMMARY

The feeding relationships of thirteen carnivorous fishes from Iraqi marine waters, northwest Arabian Gulf were described from July 1998 to June 1999. The major food items in the stomachs of each species were determined adopting index of relative importance (IRI). Most of species studied fed mainly on shrimps, fishes, crabs, bivalves and planktonic crustacean. The trophic niche breadth values were ranging from 0.18 for *Thryssa mystax* to 0.99 for *Otolithes rubber*. Schoener's overlap index showed 44 significant diet overlaps between the species.

A "conceptual" food web structure indicates that fish species in the study area can be classified into three groups: group 1 consisting six species i.e. *O. ruber, Johnieops sina, Ilisha megaloptera, Arius tenuispinis, Terapon puta* and *Saurida tumbil* fed mainly on fishes and shrimps; group 2 including *Terapon theraps*, *T. mystax, Thryssa hamiltonii, Upeneus sulphureus, Polynemus sextarius* and *Johnius belangerii* fed primarily on shrimps and the third group consisting *Cynoglossus arel* fed mostly on bivalves.

INTRODUCTION

Much of our understanding of autecology, production and ecological rule of fish population were derived from studies of the diet based on the analysis of stomach contents (1). It was also found that the distribution of fish species in a certain water body depends on the distribution of its food. Other advantages of studying fish diet is to understand inter and intraspecific relationships in fisheries management and productivity. It is well known that the feeding and trophic relationships of fish change with age, season, time of day, availability of food, locality and spatial distribution within the habitat (2).

Several indices were used to assess the fish diet. The largely used index was the relative importance index of food items (IRI). This index measures the importance of various trophic groups to a species. Other indices like forage ratio, electivity index, Murdoch's index and others deal with the preference of a species to different trophic groups by comparing the usage and availability of trophic resources. One of the steps to understand community organization is to estimate the overlap in using resources among different species. The most common resources measured in order to calculate overlap are food and space (niche). The Iraqi marine waters, northwest Arabian Gulf is lying under the effect of the Shatt Al-Arab estuary and the Gulf currents (3). Therefore, the biotic features reflect high productivity and diverse fauna with many endemic groups. The region is populated by many exclusively marine species both resident and migratory. A total of 125 fish species belonging to 60 families and five species of shrimps were recorded in the estuarine part of Iraqi marine waters (4). The area is ecologically preferred as nursery and feeding grounds for fishes (5, 6 and 7). Several studies were conducted in the region dealing with the food and feeding habits of fishes. Most of these studies concerned with one or two fish species only (8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 and 20). Few studies estimated niche breadth and diet overlap (21, 5 and 22). These studies could be considered as a database to understand fish community in the area.

The present work study is designed to throw light on feeding habits of the most dominant carnivorous fish species in the area, also to understand the feeding relationship between fish species in the area to clarify the image of food web.

MATERIAL AND METHODS

Monthly fish samples were obtained from the trawl catches of research boat 'Behar' of the Marine Science Centre, Basrah University during July 1998-June 1999 from the Iraqi marine waters, North West Arabian Gulf (Fig. 1). A total of 3534 individuals of 13 fish species were collected. After capture, the fish were injected with 7% formalin in the stomach before preservation in crashed ice for subsequent analysis. In the laboratory, fish were measured for total length (TL, mm) and weight (W, g) and the contents of the stomach were examined. The vacuity index was calculated as the number of empty stomachs divided by the number of stomachs analyzed (23). Stomach contents were identified according to (24) and (25). The total number, wet weight, and frequency of occurrence of each prey item in the stomach of the fishes were recorded. The dietary components for each species studied were expressed as a percentage of numerical composition (%N), percentage of gravimetric

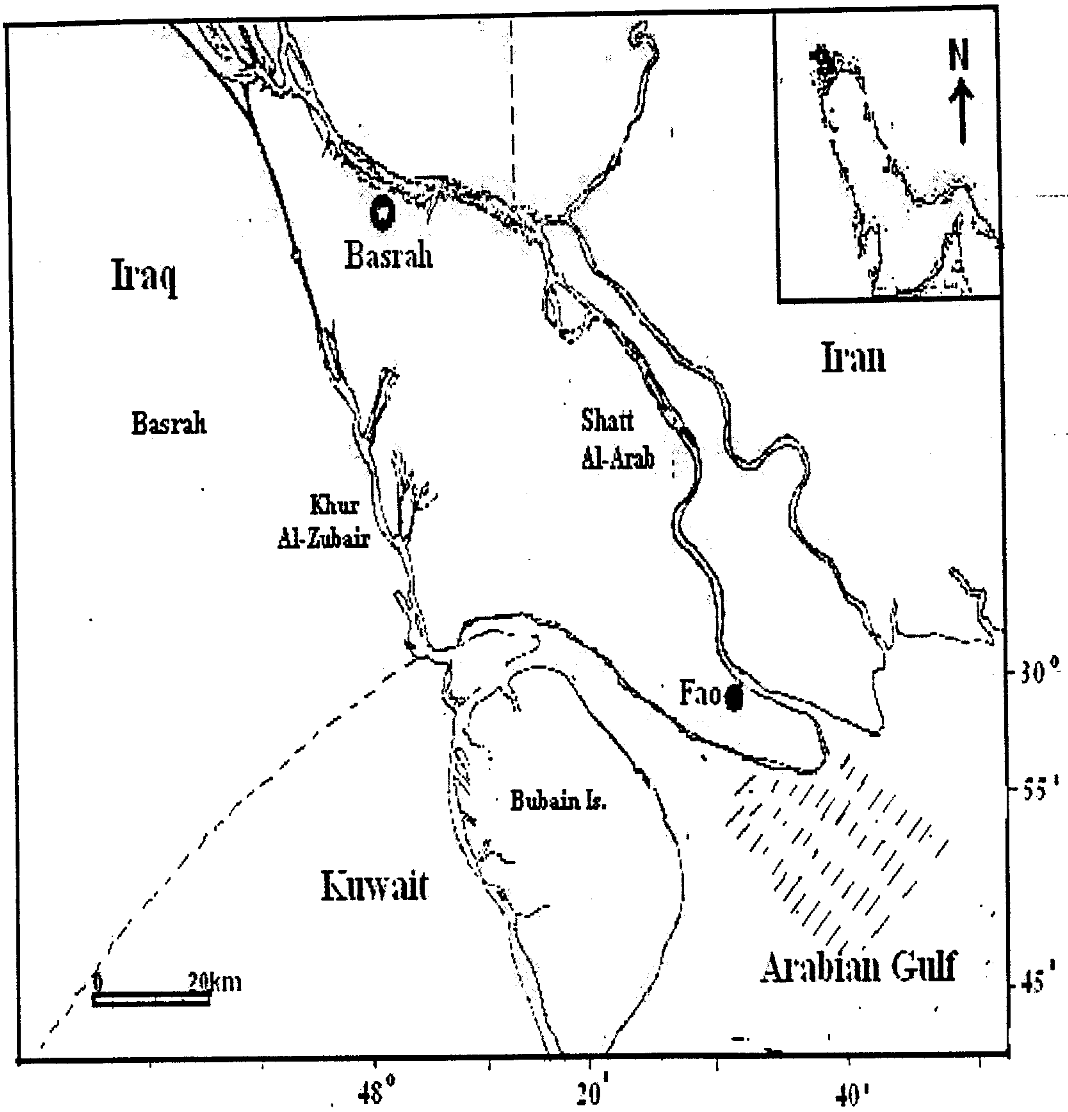


Figure 1. Location of study area in the Iraqi marine waters, northwest Arabian Gulf.

composition (%W) and percentage of frequency of occurrence (%O) (1). The importance of food item was determined by using the Index of Relative Importance (IRI) of (26):

AI = (%N + %W) %O and IRI %= AI / ΣAI * 100

A three dimensional graphical representations of population level stomach content data were used after (27) for the studied species. This graph will be defined as Cortés cube throughout the study.

Trophic niche breadth was calculated according to the formula proposed by (28):

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

where, B is Levins index of niche breadth and Pi is proportion of food group (i) in the diet. To standardize niche breadth on a scale from 0-1, the modification suggested by (29) was adopted as follows:-

$$B_A = B-1/ n-1$$

where, B_A is Levins standardized niche breadth, B is Levins index of niche breadth and n is number of food groups.

The Schoener's overlap index was used to quantify the dietary overlap between species (30):

$$\text{Diet overlap (Pjk)} = 1- 0.5 \sum[Pij - Pik]$$

where Pij and Pik are the proportion of trophic group (i) in the diet of species (j) and (k).

Values over 0.60 are considered biologically significant (31).

RESULTS

Food bulk proportions

Table 1 provides information on numbers, sizes, vacuity index and food compositions of the investigated species. The vacuity index values are ranging from 22.0 to 56.2%. The highest was recorded for *Upeneus sulphureus* and the lowest for *Cynoglossus arel.* Five modes could be distinguished in Table 1. The first one included three species (*Arius tenuispinis, C. arel* and *Johnius belangerii*) which fed on shrimps, fishes, crabs and bivalves. The second mode included two species (*Ilisha megaloptera* and *Thryssa mystax*) which fed on shrimps, fishes and planktonic crustaceans. The third mode included three species (*U. sulphureus, Polynemus sextarius* and *Johnieops sina*) which fed on shrimps, fishes, crabs and planktonic crustaceans. The fourth mode included two species (*Terapon puta* and *Terapon theraps*) which fed on shrimps, fishes and crabs. The last mode included three species (*Otolithes*

Table 1. % of relative importance (IRI) of various trophic groups ingested by different fish species.

Species	No. of fish	Total length (mm)	Vacuity index	Niche breadth	Food items				
					Shrimp	Fish	Crabs	Planktonic Crustacean	Bivalves
Arius tenuispinis	288	55-282	24.9	0.25	31.8	64.6	0.3	-	3.3
Cynoglossus arel	239	82-243	22.0	0.27	1.8	0.3	6.0	-	91.9
Johnius belangerii	245	41-223	28.2	0.51	63.6	3.8	21.5	-	11.1
Ilisha megaloptera	409	63-315	37.5	0.43	75.0	9.1	-	15.4	-
Thryssa mystax	212	53-161	43.7	0.18	98.9	0.8	-	0.3	-
Upeneus sulphureus	272	67-136	56.2	0.26	76.5	0.7	0.03	22.7	-
Polynemus sextarius	212	88-251	29.8	0.37	89.5	2.3	0.4	5.8	-
Johnieops sina	473	51-254	34.4	0.38	76.7	22.7	0.2	0.4	-
Terapon puta	212	57-187	24.2	0.39	36.9	59.2	3.9	-	-
Terapon theraps	252	48-192	26.8	0.22	79.8	19.1	1.1	-	-
Otolithes ruber	193	101-324	31.0	0.99	66.7	33.3	-	-	-
Saurida tumbil	288	69-354	31.9	0.29	3.8	96.2	-	-	-
Thryssa hamiltonii	239	43-217	23.6	0.69	95.1	4.9	-	-	-

ruber, Saurida tumbil and *Thryssa hamiltonii*) which fed on shrimps and fishes.

Fishes occupied the first position in order of relative importance in diet of *A. tenuispinis* (64.6%), followed by shrimps (31.8%), bivalves (3.3%) and crabs (0.3%). *C. arel* preyed mainly on bivalves (91.9%), other prey groups were crabs (6.0%), shrimps (1.8%) and fishes (0.3%). *J. belangerii* preyed upon shrimps (63.6%), crabs (21.5%), bivalves (11.1%) and fishes (3.8%).

I. megaloptera fed mainly on shrimps (75.0%), followed by planktonic crustaceans (15.4%) and fishes (9.1%). Shrimps represented

98.9% of the diet of *T. mystax*, followed by fishes (0.8%) and planktonic crustaceans (0.3%).

Shrimps were the most important prey for *U. sulphureus*, comprising 76.5% in relative importance, followed by bivalves (22.7%), fishes (0.7%) and crabs (0.03%). *P. sextarius* preyed mainly on shrimps (89.5%), bivalves (5.8%), fishes (2.3%) and crabs (0.4%). *J. sina* preyed mostly on shrimps (76.7%) and fishes (22.7%), followed by bivalves (0.4%) and crabs (0. 2%).

T. puta fed on fishes (59.2%), shrimps (36.9%) and crabs (3.9%), whereas *T. theraps* preyed mainly on shrimps (79.8%), followed by fishes (19.1%) and crabs (1.1%).

O. ruber, S. tumbil and *T. hamiltonii* depend mainly in their diets on shrimps and fishes. Shrimps represented 66.7% of the diet of O. *ruber*, followed by fishes (33.3%), whereas *S. tumbil* preyed mostly on fishes (96.2%) and *T. hamiltonii* on shrimps (95.1%).

Distribution of trophic groups in Cortés cube

The three dimensional graphical representations of distribution of trophic groups for each species (Cortés cube) are presented in figures 2-4. Five modes could be distinguished from these cubes:

- Species fed mainly on shrimps and weight of this trophic group contributes more than its abundance, included four species (*J. belangerii, T. theraps, T. mystax and U. sulphureus*).
- Species fed mainly on shrimps and abundance of this trophic group contributes more than its weight, included five species (*I. megaloptera, J. sina, O. rubber, P. sextarius* and *T. hamiltonii*).
- Species fed mainly on fishes and abundance of this trophic group contributes more than its weight, included two species (*A. tenuispinis* and *S. tumbil*).
- Species fed mainly on fishes and weight of this trophic group contributes more than its abundance, included one species (*T. puta*).
- Species fed mainly on bivalves and abundance of this trophic group contributes more than its weight, included one species (*C. arel*).

Trophic niche breadth

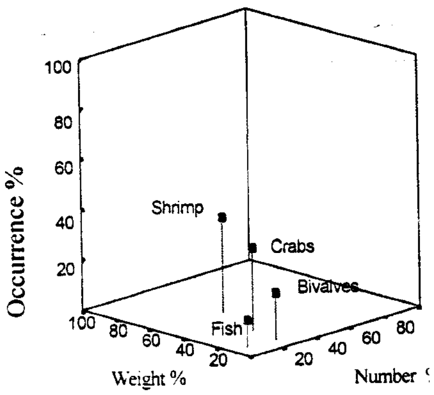
Levins index of trophic niche breadth of each species are given in Table (1). The trophic niche breadth values are ranging from 0.184 for *T. mystax* to 0.99 for *O. rubber*. Fish species having breadth <0.5 were considered as specialized feeders (*U. sulphureus, T. mystax, T. theraps, T. puta, S. tumbil, P. sextarius, J. sina, I. megaloptera, C. arel and A. tenuispinis*), while those having diet breadth >0.5 were classified as generalized feeders (*T. hamiltoni, O. rubber* and *J. belangerii).*

Trophic niche overlap

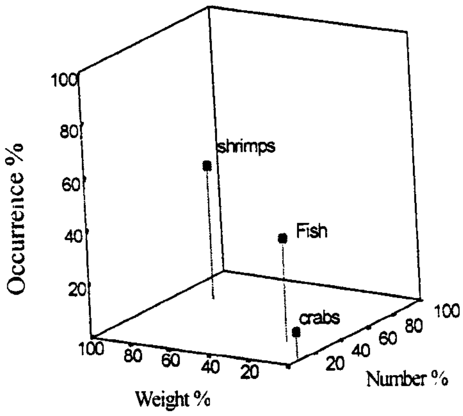
Schoener's overlap index between each pair of species is given in Table 2. The index showed 44 significant diet overlaps between the species. *C. arel* was the only species showed insignificant overlap with other species. *S. tumbil* showed insignificant diet overlaps with other species except with *A. tenuispinis*. On the contrary, *I. megaloptera* exhibited significant overlaps with other species except with *C. arel* and *S. tumbil*. *O. rubber* and *J. sina* showed significant overlaps with the same species, and the same for *P. sextarius* and *T. theraps*.

The diet overlap indices of all species were subjected to cluster analysis (Fig. 5). The cluster identified three groups of similar diets. The first group

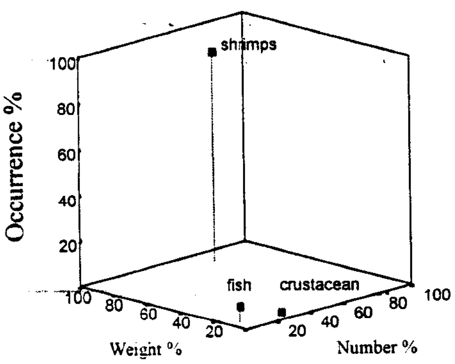
Johnius belangerii



Terapon theraps



Thryssa mystax



Upeneus sulphureus

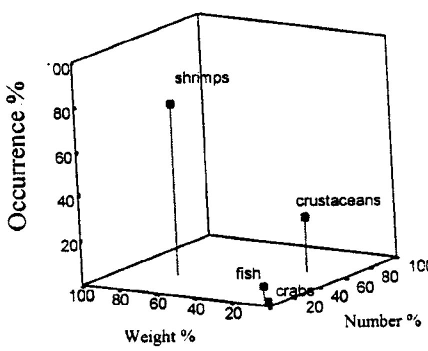


Fig. 2. Three dimensional graphical representations of distribution of trophic groups for *J. belangerii, T. theraps, T. mystax* and *U. sulphureus*.

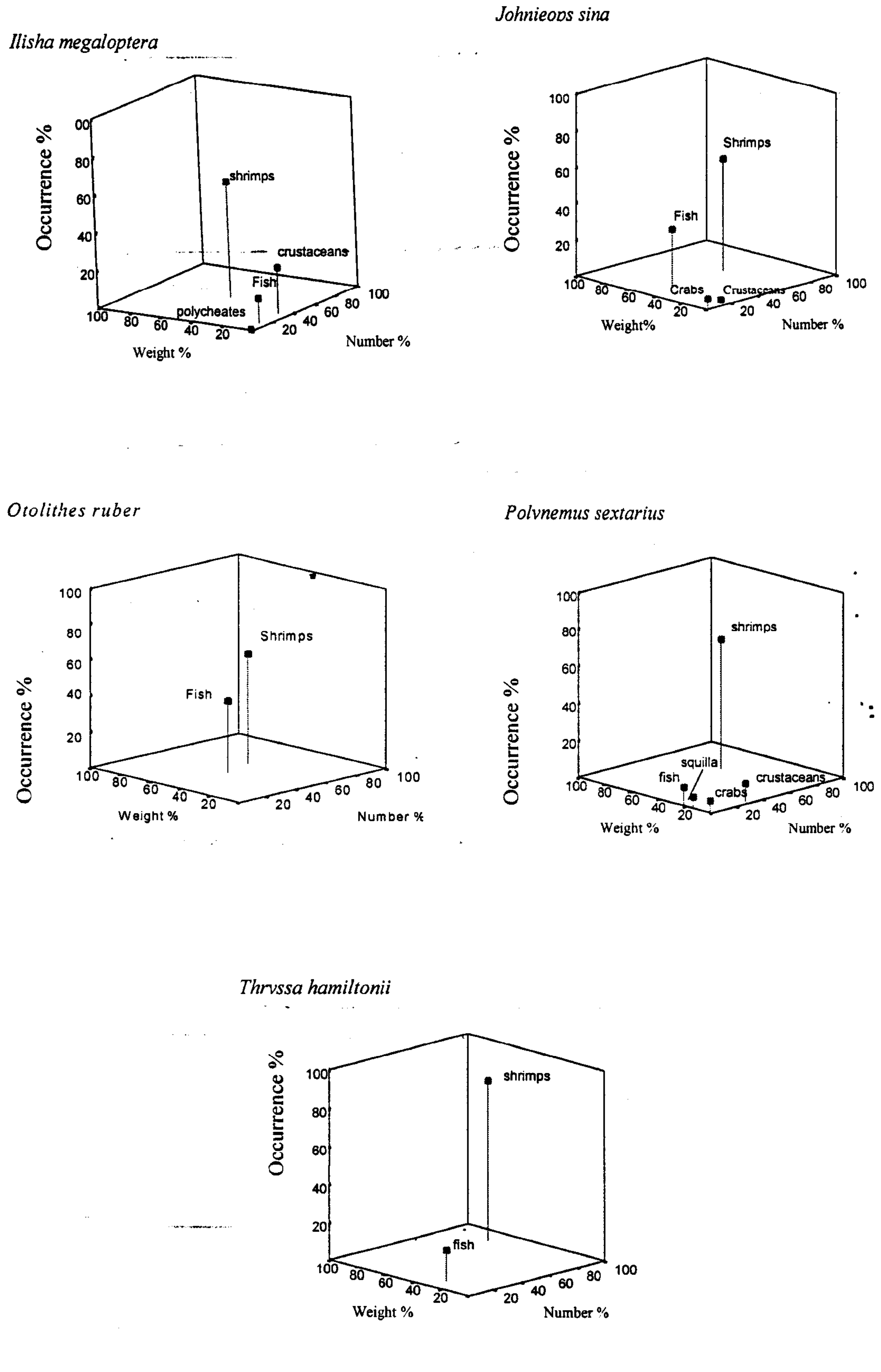


Fig. 3. Three dimensional graphical representations of distribution of trophic groups for *I. megaloptera, J. sina, O. rubber, P. sextarius* and *T. hamiltonii*

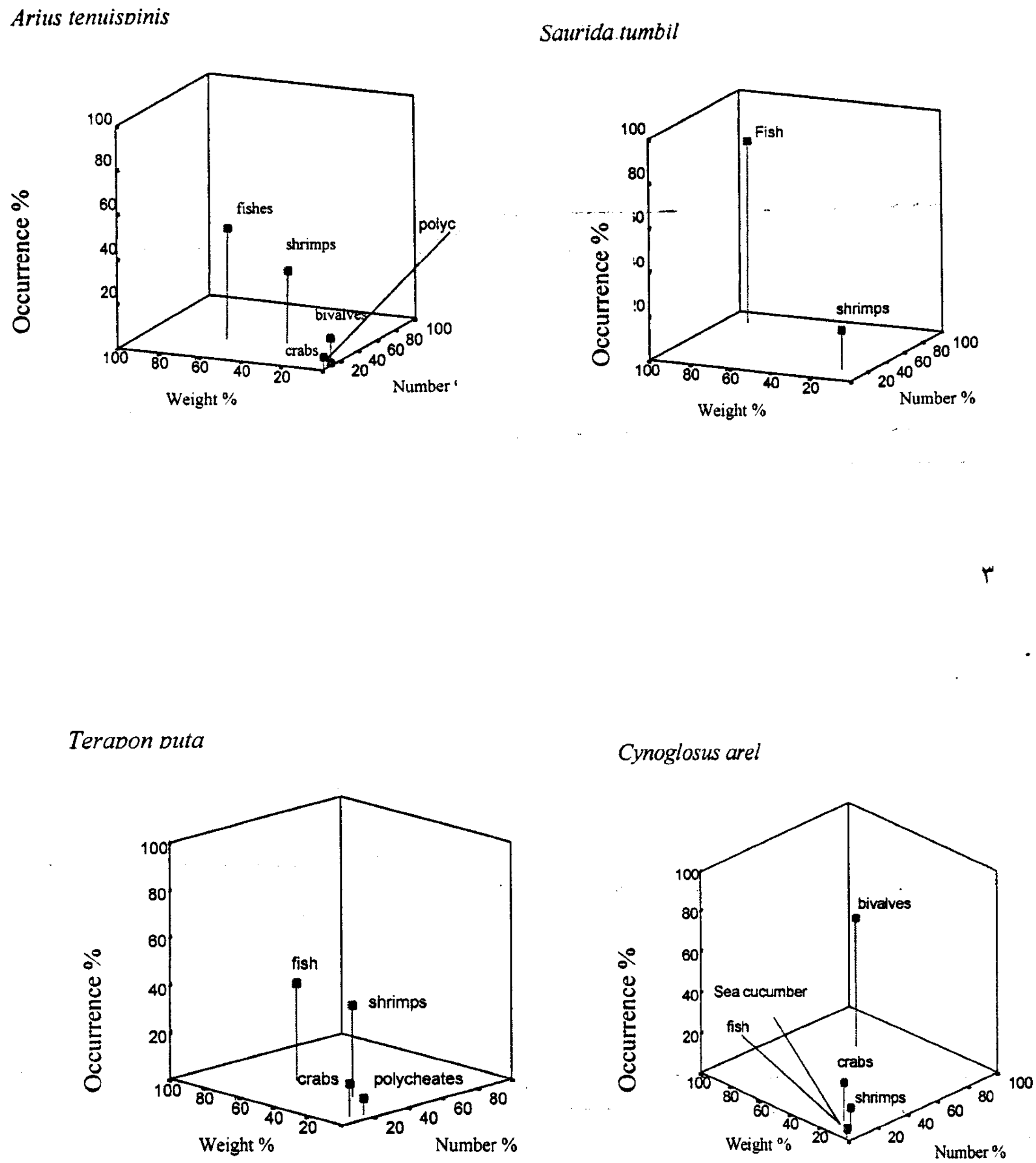


Fig. 4. Three dimensional graphical representations of distribution of trophic groups for *A. tenuispinis, S. tumbil, T. puta* and *C. arel.*

Table 2. Niche overlap among the studied fish species according to Schoener's overlap index.

Species	A. t	C. a	I. m	J. b	J. s	O. r	P. s	S. t	T. p	T. t	T. h	T. m
A. t												
C. a	0.16											
I. m	**0.7۷**	0.12										
J. b	**0.94**	0.38	**0.60**									
J. s	**0.81**	0.14	**0.94**	0.27								
O. r	**0.80**	0.12	**0.92**	**0.64**	**0.96**							
P. s	0.58	0.14	**0.75**	**0.67**	**0.77**	**0.77**						
S. t	**0.74**	0.12	0.55	0.23	0.58	0.59	0.35					
T. p	**0.90**	0.18	**0.73**	0.45	**0.76**	**0.74**	0.53	**0.73**				
T. t	0.53	0.13	**0.67**	**0.66**	**0.70**	**0.72**	**0.77**	0.30	0.47			
T. h	**0.63**	0.12	**0.78**	**0.65**	**0.79**	**0.83**	**0.81**	0.41	0.57	**0.89**		
T. m	0.44	0.12	**0.62**	**0.65**	**0.63**	**0.64**	**0.71**	0.23	0.39	**0.91**	**0.82**	
U. s	0.40	0.13	**0.61**	**0.61**	0.59	0.59	**0.68**	0.17	0.35	**0.77**	**0.76**	**0.79**

Bold figures mean significant diet overlap (>0.60)

A. t= *A. tinuispinis*, C. a= *C. arel*, I. m= *I. Megaloptera*, J. s= *J. sina*, J. b= *J. belangerii*, O. r=*O. ruber*, P. s= *P. sextarius*, S. t=*S. tumbil*, T. p= *T. puta*, T. t= *T. theraps*, T. h= *T. haliltonii*, T. m= *T. mystax*, U. s= *U. sulphureus*.

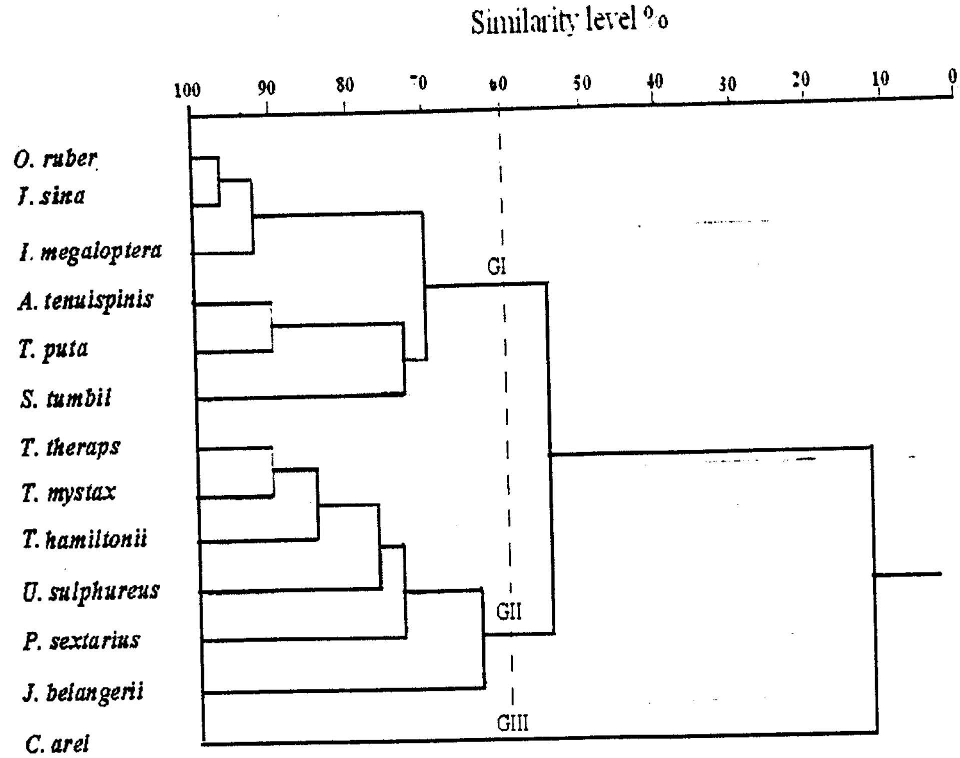


Fig. ٥. Dendrogram of the clustering of studied species based on their diet overlaps.

comprises *O. ruber, J. sina, I. megaloptera, A. tenuispinis, T. puta* and *S. tumbil*, which fed mainly on fishes and shrimps. The second group consists of *T. theraps*, *T. mystax*, *T. hamiltonii*, *U. sulphureus*, *P. sextarius* and *J. belangerii* which fed primarily on shrimps. The third group contains bivalves' feeder, *C. arel.*

DISCUSSION

Iraqi marine water described by (32) as nursery and feeding grounds for many juveniles and young marine fishes. (33) considered these waters as one of the most important shrimp fishing grounds in the Arabian Gulf (shrimp forms 20% of the total catch, 5.2kg/h). However this ratio is more than the catch of the commercial fishes (18.4% of the total catch, 4.8 kg/h). (34) postulated that shrimps mainly *(Metapenous affinis* and *Exoplomon styliferus)* were constitute a stable food supple for many fish predators such as, crockers (*O. ruber* and *Jhonius* ssp), catfishes (*Arius* ssp) and thread fin (*Eleutheronema tetradactytum*) in the Indian ocean estuaries.

The increase number of specialized feeders (ten specialized ones out of thirteen species studied) indicated that specialization trend characterized the tidal fish assemblages of Iraqi marine waters, the same was found by (35) in Khor Al Zubair lagoon, Iraq. Trend toward specialization is common in coastal fishes (36).

Dietary groups obtained in present study and those of (37) in Sulaibikhat Bay (Kuwait) and (35) in Khor Al Zubair lagoon (Iraq) were similar in main groups but species composition were different, due to difference in environmental criteria, in other cases were similar like *J. sina* and *I. megaloptera*. The shallowness of the sampling area allow most of the examine species to fed on the benthic organisms, consequently it is difficult to classify these species as benthic or surface feeders.

According to Levins measure, *0. ruber* showed the broadest niche for its utilize the trophic groups equally. This means that this species is not specialized and can replace a proportion trophic resource by another according to their availability. *T. mystax* had the narrowest niche breadth among the studied species. It is a specialized species to utilize shrimps more than any other feeding groups.

The only species that had no significant overlap with the other investigated species was *C. arel* for it is a benthic feeding (flat fish) depending mostly on bivalves, while other species depends on shrimps and fishes. *S. tumbil* had only two significant overlaps with *A. tenuispinis* and *T. puta.* The three species share the ability of consuming fish in relatively high proportions.

T. puta is also correlated significantly with *I. megaioptera* , *J. sina* and 0. *ruber* as well as S. *tumbil* and *A. tenuispinis* due to their consumption to shrimps. The rest of the species had a very high number of significant correlations (6-9 significant overlaps) due to the consumption of shrimps and fishes. These high numbers of significant correlation were normal, because of several of shrimp and fish consumers in the fish community.

The high numbers of significant diet overlap indicated that a theoretical competition existed on food resources in the area, but high availability of food resources offset such competition. The availability of fishes and shrimps as food-items in suitable sizes for consumption in the habitat made the species depending on them as main food. The nature of each prey type (weight and size) plays a role in weight and numbers of each species as exhibited by Cortes cube figures. According to the dendrogram (Fig. 5), the second group (GII), which consists of *T. theraps, T. mystax, T. hamiltonii, U. sulphurous, P. sextanus* and *J. belangerii* was separated for these species depending on shrimps more than fishes. The first group (GI) was of less depending on shrimps than G II. The third group (GIII) showed the lowest depending on shrimps and fishes. Only *C.*

arel was separated in group on its own as result of consummation of bivalves.

The present study emphasized the importance of Iraqi marine water as feeding ground for several marine species.

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العلاقات الغذائية لأسماكِ آكلة اللحومِ في المياهِ البحرية العراقية، شمال غرب الخليج العربي، العراق

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الخلاصة

وصفت العلاقات الغذائية لثلاثة عشر نوع من اسماك آكلة اللحوم في المياه البحرية العراقية، شمال غرب الخليج العربي خلال الفترة من تموز١٩٩٨ إلى حزيران ١٩٩٩. استعمل دليل الأهمية النسبي (IRI) في وصف طبيعة غذاء الأسماك. تتغذى كافة الأنواع بصورة رئيسية على الروبيان، الأسماك، السرطانات، المحارات ذات المصراعين والقشريات الدقيقة. تراوحت قيم trophic niche breadth بين ٠,١٨ للنوع *Thryssa mystax* الى ٠,٩٩ للنوع *Otolithes rubber*. أظهر دليل Schoener للتداخل الغذائي ٤٤ تداخلا مهما بين الأنواع. أشارت تركيبة الشبكة الغذائية بين الأنواع إلى إمكانية تقسيم الأسماك إلى ثلاث مجاميع: الأنواع (*O. ruber* ، *Johnieops sina* ، *Ilisha megaloptera*، *Arius tenuispinis* ، *Terapon puta* و *Saurida tumbil*) والتي تتغذى بصورة رئيسية على الأسماك والروبيان؛ الأنواع (*Terapon theraps*، *T. mystax*، *Thryssa hamiltonii*، *Upeneus sulphureus*، *Polynemus sextarius* و *Johnius belangerii*) والتي غذائها الرئيسي الروبيان وأخيرا النوع *Cynoglossus arel* والذي يتغذى على المحارات ذات المصراعين.