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Specialization, competition and diet overlap of fish assemblages in the recently restored southern Iraqi marshes

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Abstract

Trophic competition,feeding specialization and diet overlap of fishes had been studied in three restored marshes(Al-Huweyza, Suq Al-Shuyoak and East Al-Hammar). Data obtained revealed that most of species studied were specialized and few were generalized ,depend on the percentage of environmental restoration in each of the three marshes. Four pairs of trophic competition showed positive cases(*Carassius auratus*, *Barbus luteus*, *Cyprinus carpio*; *Barbus xanthopterus*, *Acanthobrama marmid ; Alburnus mossulensis, Aspius vora* and *Silurus striostegus*)

Three trophic groups of multi species (carnivorous, omnivorous and herbivorous) and two single species trophic groups(detritovorous and benthivorous) were reached.

It seemed that fish species in the restored marshes alter their diets than previously known including native and alien . C.*auratus* alter its food habits Other species including *C. carpio become* omnivorous., *A.vorax and S. striostegus* become pscivorous species.

1-Introduction

The southern marshes of Iraq are populated by many freshwater species both native, alien and few diadromus marine species. The southern marshes ecologically referred as nursery and feeding grounds for many fish species (Hussain *et al.*2008a; Mohamed *et al.* 2009). Several studies before desiccation in the nineties were conducted in the marshes dealing with the food and feeding habits of fishes(e.g. Barak and Mohamed, 1982, Al-Mukhtar,1982 ; Naama, 1982 ; Dawood 1986 ; Al-Sayab, 1988 and Jasim, 1988). Most of previous studies concerned with one or two fish

species, these were reviewed by Hussain and Ali (2006). Only two were focused on feeding relationships and competition between species (Al-Kanaani, 1989 and Hussain *et al.*,1992).

Hyslop (1980) stated that studies of diet of fishes help to understand the autecology of fish assemblage and ecological role of fish assemblages .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 between species and productivity the area.

However no specific study was conduct on the trophic specialization and diet overlap of fishes in the southern marshes before the drainage during the nineties, as step to understand the food nature of different species living in the restored marshes.

The present work study is designed to throw light on trophic specialization, feeding habits, diet overlap, competition between species, mainly of the most dominant fish species in the three of the restored southern marshes.

2- Materials and Methods

Field works:

Monthly fish samples were collect from six stations, two in each marsh Al-Huweyza , Suq al-Shuyaok and East Al- Hammar as below, during the period from November 2004 to June 2006 ,using fixed gill net ,cast net and electrical fishing device .The fish preserved in cold ice box until reaching to the laboratory. Small fish preserved in 4% formaldehyde and bigger fishes in deep freeze.

Marsh	Station	GPS	Environment	Status
Huweyza	Um Aaaj	N 31 38 30 E 47 35 21	Openness marsh	Natural station
Huweyza	Taraba	N 31 29 48 E 47 31 48	Dense Vegetation marsh	Desiccated station
Suq Al-Shuyaok	Amia	N 30 51 41 E 46 38 13	Channel marsh	Desiccated station
Suq Al-Shuyaok	Al Wineas	N 39 51 50 E 46 40 42	Openness marsh	Desiccated station
East Al-Hammer	Saddah	N 30 40 04 E 47 38 06	Tidal Channel marsh	Natural station
East Al-Hammer	Burkah	N 30 40 22 E 47 33 03	Tidal Openness marsh	Desiccated station

Laboratory examinations:

Fishes were identified after Beckman, (1962) and Coad , (1991) .

The digestive canals of fishes are removed and preserved in 4% formaldehyde until examination, then open in Petri dish and give the degree of fullness (0 for empty 5, 10, 15, 20) and counts of different food items. Frequency and point methods are used to analysis fish diet (Hynes, 1950). Edmondson (1959), Schmitt (1965), Smith (1971), Macan (1972) and Pielon *et al*. (1977) were used for food identification. Relative important index (IRI) was calculated according to Stergiou(1988) formula .

Trophic niche breadth was calculated according to the formula proposed by Levins (1968) :

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

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 was estimated after Krebs (1989) 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.

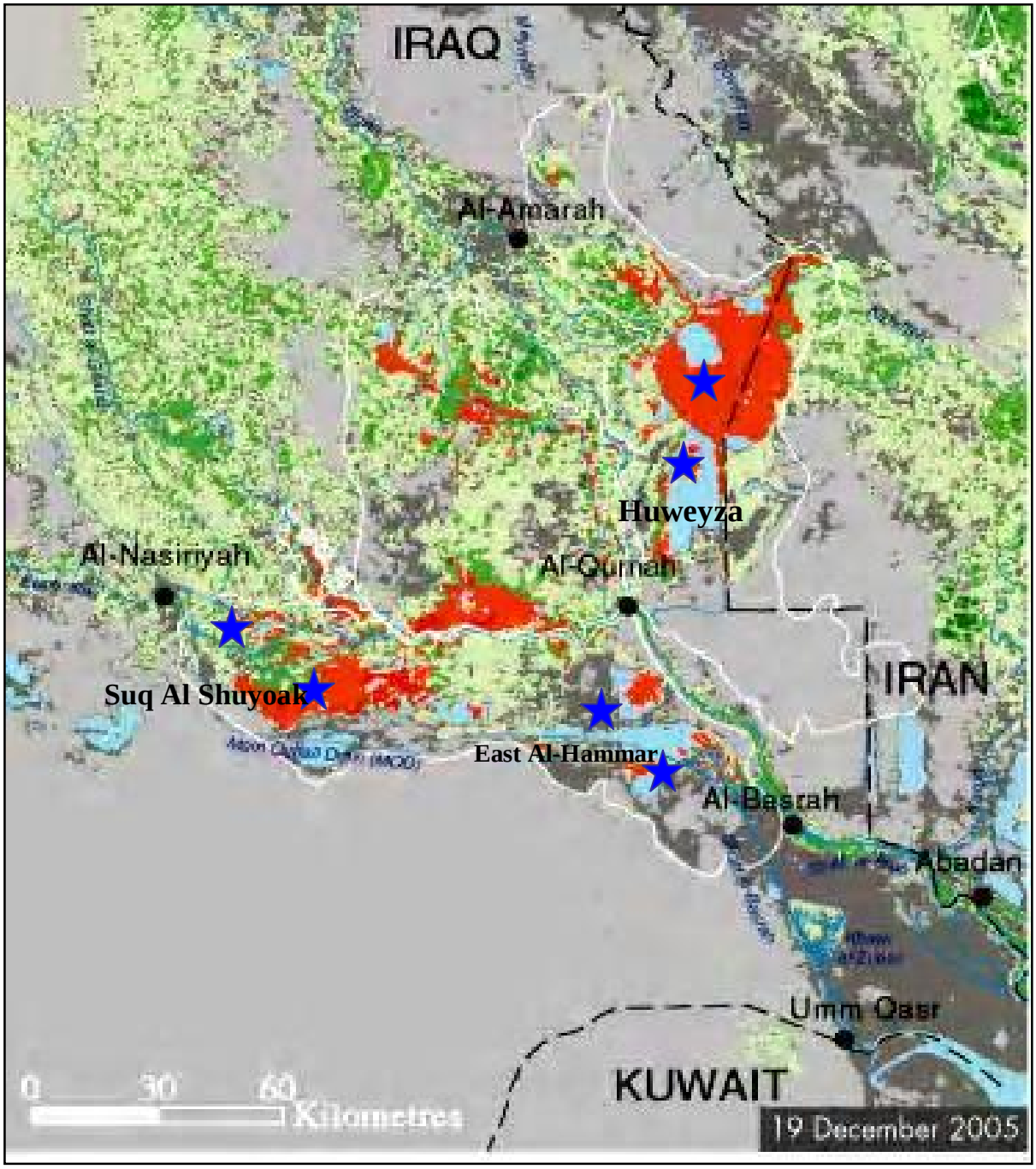
The Morisita overlap index was used to quantify the dietary overlap between species (Krebs 1989).

$$C =2\sum Py\ Pj/\sum Py+ \sum Pj$$

C= Morisite s index of overlap between species j and y.

Py Pj=proportion resources j is of the total resources used by two species.

The similarity among fish species based on their diet was calculated according to Jaccard similarity coefficient, using SPSS software (ver. 11, 2001) statistical package.



Fig(1): Southern Iraqi restored marshes showing three studied marshes and sampling stations.

3-Results

Diets composition:

Five species (*Liza abu, L.subviridis , L. kleningeri, Barbus sharpeyi* and *Ctenophryngodon idella*) depend on detritus,plankton and aquatic plants.Four species (*Carassius auratus, Acanthobrama marmid, B.luteus* and *Cyprinus carpio*) were omnivorous fed mainly on mixed diets of detritus, diatoms ,algae, aquatic plants, insects ,crustaceans and snails**.** Carnivorous group consisted of four species (*Alburnus mossulensis, B.xanthopterus, B.grypus* and *Acanthopagrus latus*) consumed on insect, crustaceans and snails. Pescivorous group formed of five species (*Heteropneustes fossilis, Mastacembellus mastacembelus, Aspius vorax, Silurus triostegus* and *Thryssa mystax*) take specifically crustaceans and fish with different ratio as illustrated in table (1).

Trophic breadth:

1-Al-Hammar marsh

Levins index of trophic niche breadth of each species from East Al- Hammer are given in Table (2). The trophic niche breadth values are ranging from 0.00 for *C.idella* to 0.67 for *C.carpio* for freshwater species and for migratory marine species 0.00 for *T.mystax* and *A.latus* and 0.02 for *L.subviridis* . Fish species having breadth <0.5 were considered as specialized feeders (*B.sharpeyi, C.auratus, A.vorax, S.triostegus, L.abu, A.marmid, A.mossulensis ,C.idella, B.grypus, M.mastacembelus, L.subviridis, L.kleningeri, T.mystax* and *A.latus*), while those having diet breadth >0.5 were classified as generalized feeders (*B.luteus* and *C.carpio).*

2-Huweyza marsh

Levins index of trophic niche breadth of each species from Huweyza marsh are given in Table (3). The trophic niche breadth values are ranging from 0.00 for *M.mastacembelus* to 0.67 for *C.carpio* for freshwater species. Fish species having breadth <0.5 were considered as specialized feeders (*B.sharpeyi,B.luteus C.auratus ,A.vorax, S.triostegus, L.abu, A.marmid, ,C.idella, B.grypus, M. mastacembelus, H.fossilis* and *B.xanthopterus*) while those having diet breadth >0.5 were classified as generalized feeders (*A.mossulensis* and *C.carpio).*

Table (1): Diets of the studied species both freshwater and diadromous species occurred in three marshes expressed as IRI (Index of relative importance) score.

Species	Detritus	Diatoms and Clay	Algae	Aquatic plants	Insect	Crustacean	Snail	Fish
Liza abu	112.5	5273.5	1260					
L. subviridis		4200	1200					
L. klenzingeri	4300	1200						
Barbus sharpeyi			889.8	8339.5				
Ctenophryngodon idella				1000				
Carassius auratus	2976		4709.5	152.6	55.5	468.7		
Barbus luteus			5000	146.4	120	1531.4	120	
Acanthobrama marmid	231.6		221.7		1665	2441.5		
Cyprinus carpio	2190.3	904.6		47.6		3333.3	2500	
Alburnus mossulensis					714	2043.1	2142.5	
B.xanthopterus	2500						3500	
B.grypus						1000		
Acanthopagrus latus						3000	600	600
Heteropneustes fossilis						1750		3250
Mastacembelus mastacembelus						4800		2400
Silurus triostegus						659.3		5614
Aspius vorax						1665		3330
Thryssa mystax						900		7200

Table (2): Degree of feeding specialization of resident freshwater species and migratory marine species in East Hammar marsh.

Species	High specialization 0.0-0.25	Low specialization 0.26-0.49	Generalized 50
A.vorax i	0,00		
C.idella	0,00		
M.mastacembelus	0.01		
A.marmid	0.15		
B.sharpeyi	0.15		
S.triostegus	0.20		
L.subviridis	0.02		
L.klenzingeri	0.01		
T.mystax	0.00		
A.latus	0.00		
B.grypus		0.40	
L.abu		0.44	
C.auratus		0.46	
B.luteus			0.50
C.carpio			0.67

Table (3): Degree of feeding specialization of resident freshwater species in Suq Al-Shuyaok marsh.

Species	High specialization 0.0-0.25	Low specialization 0.26-0.49	Generalized ≥50
A.vorax	0.00		
S.triostegus	0.04		
B.sharpeyi	0.23		
H.fossilis		0.29	
B.luteus		0.30	
L.abu		0.31	
B.xanthopterus		0.32	
M.mastacembelus		0.39	
B.grypus		0.44	
C.idella		0.47	
C.carpio			0.50
C.auratus			0.63
A.mossulensis			0.71
A,marmid			0.71

3-Suq Al-shuoak marsh

Levins index of trophic niche breadth of each species from Suq Al-shuoak marsh are given in Table (4). The trophic niche breadth values are ranging from 0.00 for *A.vorax* to 0.71 for *A.mossulensis* and *A.marmid* . Fish species having breadth <0.5 were considered as specialized feeders (*B.sharpeyi, B.luteus, A.vorax, S.triostegus, L.abu,C.idella,B.grypus, M.mastacembelus, H.fossilis* and *B.xanthopterus*) while those having diet breadth >0.5 were classified as generalized feeders (*A.mossulensis* , *A.marmid* , *C.auratus* and *C.carpio*

Trophic overlap

Morisita's overlap index between each pair of species is given in Table(5). The index showed eight low diet overlaps or insignificant between the species out of 12 examined. On the contrary four exhibited significant overlaps with other species , *C .carpio* ,*B.xanthopterus* and *B.luteus* ; *C.auratus* .

The Morisita's diet overlap index of all species were subjected to cluster analysis (Fig. 2).

The cluster identified three major groups formed of multi species and two of single species of different diets and degree of association . The first group represent carnivorous include *B.grypus, M.mastacembelus, H,fossilis, A.vorax and S.triostegus* and could be divided into two subgroups ,the first formed of the first three while the second include the last two which are predators species .Omnivorous group consisted of *A.mossulensis* , *A.marmid* , *B.luteus, C.auratus* and *C.carpio.*

Herbivourus group formed of two species (*B.sharpeyi And C.idella*) weakly associated ,due the first feed on mix diet of aquatic plants and algae and the second exclusively on aquatic plants (Fig.2).Single species group represent by *L.abu* is detritovorus feeder and *B.xanthopterus* is benthic feeder depend on snails and worms.

Table (4) Degree of feeding specialization of resident freshwater species . in Huwayza marsh.

Species	High specialization 0.0-0.25	Low specialization 0.26-0.49	Generalized ≥50
M.mastacembelus	0.00		
S.triostegus	0.02		
L.abu	0.02		
B.xanthopterus	0.02		
A.vorax	0.08		
C.idella	0.17		
A,marmid		0.37	
H.fossilis		0.38	
B.grypus		0.44	
B.luteus		0.46	
C.auratus		0.48	
C.carpio			0.53
A.mossulensis			0.67

Table (5): Degree of feeding competition between resident freshwater species . in three studied marshes(Huwayza, Suq Al-Shuyaok east Al-Hammar marshes).

species	Low compe **Low ≤50**	**Medium co Medium 50-70 competition**	High compe **High ≥ 50**-70≥
C.auratus x C.carpio	0.21		
C.auratus x A.mossulensis	0.22		
C.carpio x A.marmid	0.39		
B.luteus x A.mossilensis	0.35		
B.luteus xC.carpio	0.41		
C.carpio x A.mossulensis	0.41		
B.luteus x A.mossulensis	0.43		
A.marmid x A.mossulensis		0.51	
C.carpio x B.xanthopterus		0.69	
C.auratus x B.luteus			0.90
A.vorax x S.triostegus			0.99

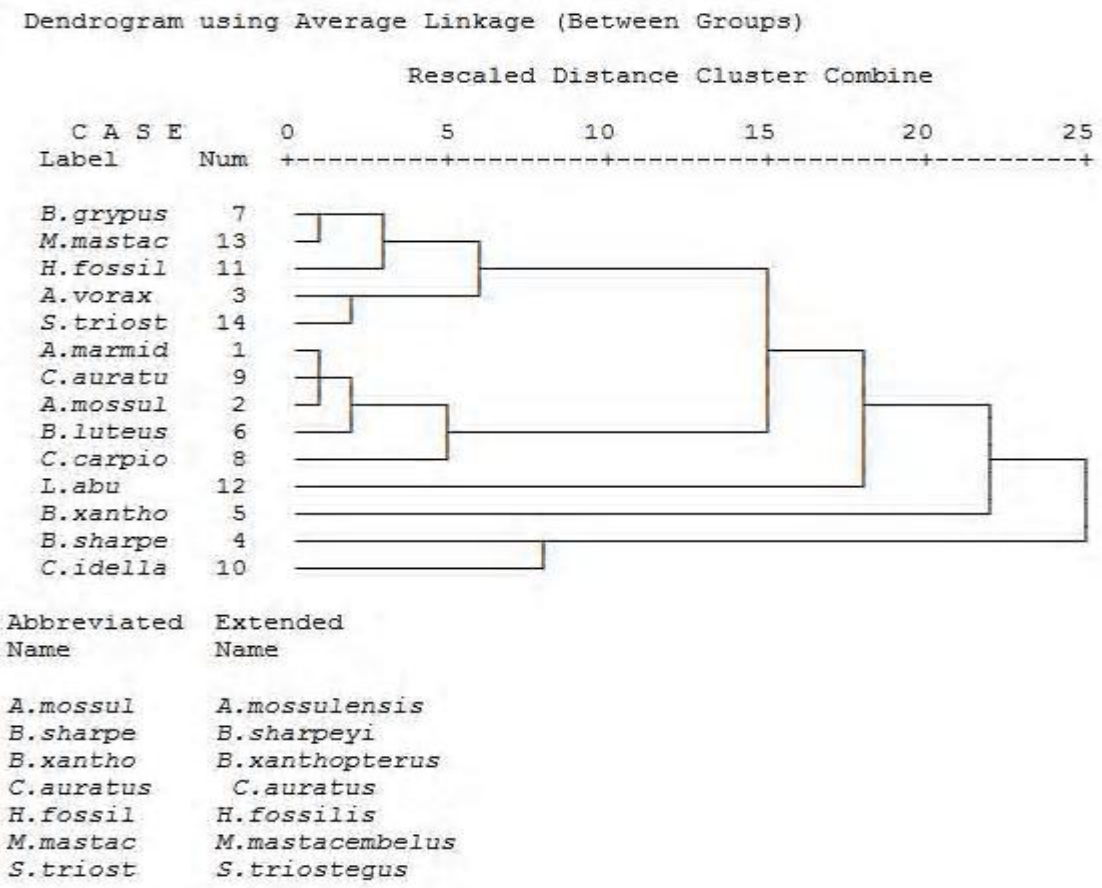


Fig.(2) Average linkage of cluster analysis of proportionalional diet overlap between the ten freshwater species from the three studied southern marshes.

4- Discussion

One of the steps to understand community structure 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) (Bagenal, 1978). Therefore, the productivity level and diverse ecology of the three studied southern marshes reflect the degree of specialization, diet overlap and competition between resident ,introduce and diadromous marine species.

Previous authors like Al-Kanaani (1989) and Hussain *et al.* (1992) postulated that the feeding competition between fish species in East Hammar marsh were neglieaibale due to the occurrence of major food items in enough quantities which offset competition and represent positive case of food partitioning .

Diet composition of examined species were impartial agreement with previous studies

concerned with food habit like (Dawood ,1986, Hussein and Al-Kanaani 1989 and 1991) on food of *C.carpio* and *A. vorax*. and Al-Daham *et al*. (1992) on *B. xanthopterus* in Al-Hammar marsh. Recently was noticed prey-predator relationship so clear in *A vorax* and *S. triostegus* that were pescivorous feeder on small fish (ARID 2006 and Hussain *et al* 2008a).

The desiccation of marshes affect the structure of the bottom soil in addition to be burn several times, led to change their properties chemically and physically from soft sediments to hard ceramic substance as stated by Fitzpatric (2004), becoming hard to be recolonized again by benthos communities which formed favorite food for several cyprinid fish species (e.g. *B. xanthopterus and B.grypus*) . *C .carpio* become unable to suck the sediments to extract the benthic organisms and forced to alter its diet to be omnivorous instead previously known as carnivorous (Dawood 1986).

It is well known that the feeding and trophic relationships of fish change with availability of food, locality and spatial distribution within the habitat (Bagenal, 1978). The desiccation of the marshes alter largely inter and intraspecific relations of the fish community and brought major changes in the structure due to harsh environment prevailing and to change in ways of productions especially primary production of aquatic plants and phytoplankton, consequently change in secondary productivity of zooplankton and macroinvertebrate.

Huge occurrence of alien species like *C.auratus* effect the marsh feeding relationships and competed with native species like benni *B.sharpeyi* and Himree *B.luteus*. It was known that the occurrence of exotic species like C.carpio affect the abundance of other native species like *B. xanthopterus* and *B.kersin* .(Al-Kanaani 1989) The same was noticed in Shadegan marshes/southern Iran by introduction *C.auratus and Hypophthalmichys molitrix* which competed heavily with *B.sharpeyi* (Evans 2002).

Levens breadth index of the three studied marshes showed difference in species specialization because these marshes were ecologically different ,East Al.Hammar is brackish tidal marsh, Al-Huweyza is freshwater non-tidal marsh and Suq Al-shuyoak is oligosaline non-tidal marsh, consequently they were different in production level and food webs existed in each of them. *C. carpio* is generalized feeder in the three marshes,*A.mossulensis* only in two of non-tidal marshes(Al-Huweyza and Suq Al-shuyoak) .The higher number of generalized feeders was in Suq Al-shuyoak could be to low restoration percentage in comparison with other two studied marshes (IMRP, 2006 and ARID, 2006). Degree of specialization of species was variable from one marsh to another like *L.abu* score 0.44,0.02and0.31 in East Hammar, Al-

Huweyza and Suq Al-shuyoak respectively ,the same for *B.sharpeyi*. Other species were strictly specialized like *A.vorax* and *S.triostegus* because they are predator species.

High competition and trophic overlap exist between *C.auratus* and *B.luteu* , the first is alien or introduce species ,the second is native one. *C.auratus* is more abundant in the three studied southern marshes than *B.luteus* according to Hussain *et al*. (2008b).

Fierce competition between *S.triostegus* and *A.vorax* both species fed on small fishes even they occupied different niche, the first is ambush feeder between aquatic plants while the second is open water chaser. Before desiccation *A.vorax* supplemented its diet with insect and crustacean by50% because benthos communities did not recover enough to support it, while *S.triostegus* previously had mixed diet of fishes, frogs and crabs.

Mild overlap and diet competition (0.69) existed between *B.xanthopterus* (native species) and *C.carpio* (alien species), the first occur in low numbers in comparison with the second, competition was previously noticed by Al-Kanaani (1989) i.e before drainage of the marshes.

Cluster analysis of Morisita index of present study was fundamentally different from that before desiccation (Hussain and Ali, 2006) and even the species association were altered due to change in food resources availability and destructive effect of desiccation on the marshes environment.

Further comprehensive studies concerning with food partitioning and diet overlap among different species might be considered particularly important in case of introduced species (alien species) with native species.

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التخصص والتنافس والتداخل الغذائي لتجمع الأسماك في الاهوار المسترجعة في جنوب العراق

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ملخص

التنافس والتخصص والتداخل الغذائي درس في ثلاثة اهوار مسترجعه وهي (الحويزة ,سوق الشيوخ, وشـــرق الحمـــار).أن النتـــائج المستحصلة تفيد بأن غالبية انواع الاسماك المدروسة هي متخصصة والاقلية هي عامة التغذية وتعتمد على نسبة استرجاع بيئة هذه الاهـــوار الثلاث وتوفر الغذاء المناسب .

وجدت أربعة حالات موجبة من التنافس الغذائي بين الكاراسين والحمري والكارب والكطان و السمنان العريض والسمنان الرفيع والشلك والجري . (*Carassius auratus, Barbus luteus,Cyprinus carpio;Barbus xanthopterus ,Acanthobrama marmid ;Alburnus mossulensis,* *Aspius vora* and *Silurus striostegus*)

ثلاث مجاميع تغذوية تحتوي على عدة انواع وهي (اللواحم ,القوارت, العواشب) ومجموعتين تحويان على انواع مفردة وهي الفتاتيه والقاعيه .

يبدو أن الانواع المدروسة تغيير غذائها عما عرف عنها سابقا وتضم الانواع النهرية بشقيها (المستوطنة والدخيلة) ,مثلاً ان الكاراسين غيير من عاداته الغذائية وكذلك الكارب الذي اصبح قارت, أما الشلك والجري فتحولت الى مفترسة للاسماك.