E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2019; 7(5): 08-13

www.fisheriesjournal.com
Received: 03-07-2019
Accepted: 07-08-2019

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Feeding ecology of two sciaenid species (*Johnius belangerii* and *Johnius dussumieri*) in the Shatt Al-Arab River, Iraq

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Abstract
The food and feeding habits of two sciaenid fish species *Johnius belangerii* and *Johnius dussumieri* in the Shatt Al-Arab river, Iraq were studied from November 2015 to October 2016. Fish were caught by gill nets, cast net and electro-fishing. The stomach contents of 220 *J. belangerii* specimens (122-235 mm total length) and 227 *J. dussumeiri* (92-225 mm total length) were examined. Results from the stomach contents analysed using the index of relative importance (IRI %) of food items showed that both species were carnivores. The main food items of *J. belangerii* were shrimps (52.9%), crabs (37.9%) and fish (9.2%). The diet of *J. dussumeiri* composed mainly of shrimps (77.4%), followed by fish (18.4%) and crabs (7.3%). The diet breadth (B_i) values indicate that *J. dussumeiri* is a high specialist feeder (B_i = 0.196) while *J. belangerii* was considered non-specialized feeder (B_i = 0.635).

Keywords: Sciaenid fish, diet composition, feeding overlap, Shatt Al-Arab River, Iraq

1. Introduction
Sciaenidae is widely distributed throughout the world and is one of the largest families of the Order Perciformes, with approximately 296 species, fish from this family being popularly known as croakers or drums due to the sound they produce using muscles associated with the swim bladder. They are mainly found in tropical and subtropical coastal waters and estuarine waters of the Atlantic, Indian and Pacific oceans, with few species are able to adapt to a wide range of salinities [1, 2]. Sciaenidae is one of the most common fish families in the Iraqi marine waters, northwest Arabian Gulf and the most abundant sciaenid species are tigertooth croaker, *Otolithes ruber*, sin croaker, *Johnieops sina* (synonym of *Johnius dussumieri*), silvery croaker, *Johnius belangerii* and blackspotted croaker, *Protonibea diacanthus* [3]. The total landing of these fish was about 2,547.8 ton for the period 2007-2011 which is about 11.8% of the total marine landings of this area [4]. Six species of sciaenid fish were recorded from the Shatt Al-Arab river namely *J. belangerii, J. dussumieri* (*Johnieops sina*), *P. diacanthus, P. anea, O. ruber* and *J.* sp., contributing around 6.5% of the fish assemblage in this river, and the first two species, locally called as 'Taateo' were the most dominant in the river [5].
The feeding ecology of a species is thoroughly linked to its population dynamics, knowledge of the feeding ecology contributes to the understanding of such subjects as resource partitioning, habitat preferences, prey selection, predation, evolution, competition and energy transfer within and between ecosystems [6].
The food and feeding habits of *J. belangerii* and *J. dussumieri* in different Iraqi waters have been investigated by many authors, such as [7-14]. Also, several studies on diet composition and trophic ecology of these two species have been done in Indian waters [15-18].
Shatt Al-Arab river has been suffered from the deterioration of the water quality during the last years as a result of agricultural runoff wastes and untreated wastewater, invasion of fish species and seawater intrusion as a result of drastically reduced in water quantity and quality related to the decline in rates of the flow from the Tigris, Euphrates and Karun Rivers [19-21].
Therefore, the present work is designed to describe the trophic status of *J. belangerii* and *J. dussumieri* in the Shatt Al-Arab River under this circumstance.

2. Materials and Method

2.1. Study area

The study was conducted at the Shatt Al-Arab River, in the southern of Iraq. The river forms from the confluence of the Tigris and Euphrates rivers at Al-Qurna town northern Basra Governorate, and flows to southeastern direction towards the Arabian Gulf. A detailed description of the river, including a map and physical-chemical properties of water, appears in [5].

2.2. Fish sampling

Fish were collected from each site by gill nets (200-500 m length with 15- 35 mm mesh size), cast net (9 m diameter with 15x15 mm mesh size) and electro-fishing by generator engine (provides 300-400V and 10A). Fish were classified to species following [22]. After capture, the fish were preserved in crashed ice prior to dissection in the laboratory.

2.3. Food analysis

For each fish specimen total length measured to the nearest 0.1 cm. Each fish was dissected and the alimentary tract removed. The degree of fullness of the stomach was assessed on a 0-20 points scale [23], thus 0, 5, 10, 15 and 20 points were allotted to: empty, ¼ full, ½ full, ¾ full and fully stomach, respectively. Each stomach contents were emptied into a Petri dish and diet composition was determined microscopically. The food materials were identified with the aid of keys provided by [24, 22]. Feeding intensity and feeding activity for each monthly sample were calculated after [25, 26], respectively. The feeding index was determined after [27]. The vacuity index was calculated as the number of empty stomachs divided by the number of stomachs analyzed [28]. The index of relative importance (%IRI) proposed by [29], based on the frequency of occurrence (%F), percent of total number (%*N*) and percent of total weight, %W [30] was used to assess the most important food items. The IRI was calculated as:

$$\%IRI = (\%N + \%W) \times \%F$$

Feeding selectivity (PX_i) was measured according to the following equation [31]:

$$PX_i = X_i / \Sigma i$$

Where X_i = quantity of item i in stomach of specie (i) and Σ i= sum of item (i) in all stomachs of all species.

The trophic niche breadth for each species was calculated according to the formula proposed by [32]:

$$B = 1/\Sigma P_i^{\wedge 2}$$

Where, B is Levin's index of niche breadth and P_i is proportion of food group (I) in the diet. To standardize niche breadth on a scale from 0 to 1, the modification suggested by [33] was adopted as follows:

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

Where, B_A is Levin's standardized niche breadth, B is Levin's index of niche breadth and n is number of food groups for each species. This index was used to test the feeding specialization of each species. The highly specialized feeder's species fall within the range of 0.0-0.25, while the low specialized feeders between 0.26-0.49 and non-specialized (generalized) feeders are within the range of 0.50-1.0.

3. Results

3.1. Feeding intensity and feeding activity

A total of 447 fish specimen from both species were examined: *J. Belangerii* (TL= 122-235 mm, n= 220) and *J. Dussumieri* (TL= 92-225 mm, n= 227). Monthly variations in the feeding intensity and feeding activity of *J. Belangerii and J. Dussumieri* in the Shatt Al-Arab River are illustrated in Figure 1. The feeding intensity of *J. Belangerii* varied from 6.4 point/fish in August to 12.0 point/fish in December, and the feeding activity ranged from 79.2% in February to 100% in November and December. While, the feeding intensity of *J. Dussumieri* fluctuated from 6.9 point/fish in October to 12.3 point/fish in April, and the feeding activity varied from 68.2% in April to 91.3% in March.

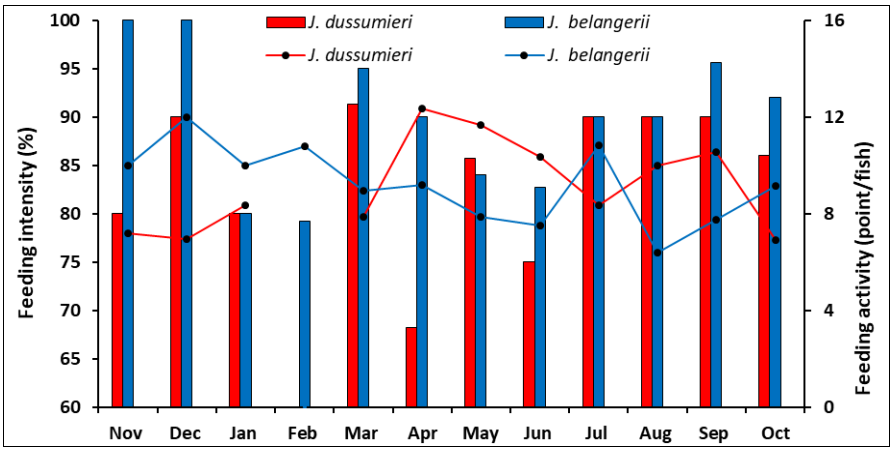

Fig 1: Monthly variations in feeding intensity and activity of the two species

3.2. Feeling and vacuity indices

Figure (2) explained the monthly fluctuations in the feeding and vacuity indices of *J. Belangerii and J. Dussumieri* in the river. The feeding index of *J. Belangerii* varied from 31.9% in August to 60.0% in December, and for *J. Dussumieri* ranged from 34.62% in October to 61.7% in April. The overall values were 46.0% and 41.9% for both species, respectively. The vacuity index of *J. Belangerii* varied from 0% in October and November to 20.8% in February, with overall value was 10.1%, and for *J. Dussumieri* ranged from 8.7% in March to 31.8% in April, with overall value was 14.4%.

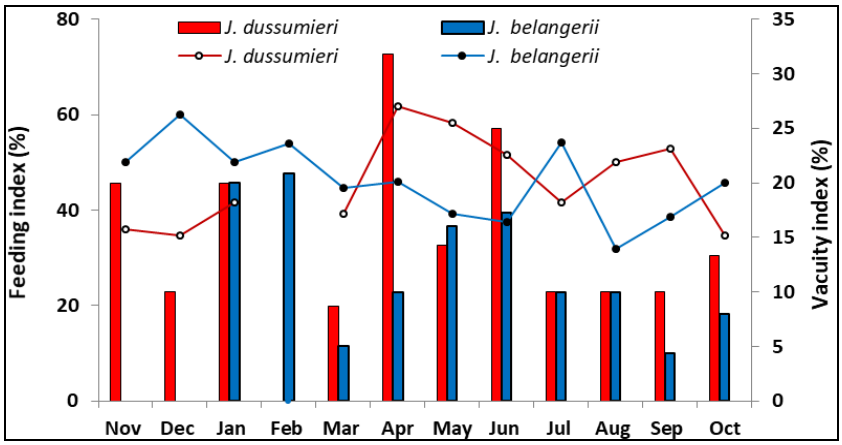

Fig 2: Monthly variations in the feeding and vacuity indices of the two species

3.3. Monthly variations in diet composition

Monthly changes in index of relative importance (IRI) of various ingested food items in the diet of *J. Belangerii* is shown in Figure 3. Shrimps came first position in order of relative importance in diet of the species, and varied from 0.39% in October to 92.7% in November. Crabs occupied the second position and ranged from 5.7% in July to 99.0% in May. Fish were occupying the third position and ranged from 0.9% in August to 62.1% in March. The overall diet composition of *J. Belangerii* was comprised of shrimps (52.9%), crabs (37.9%) and fish (9.2%).

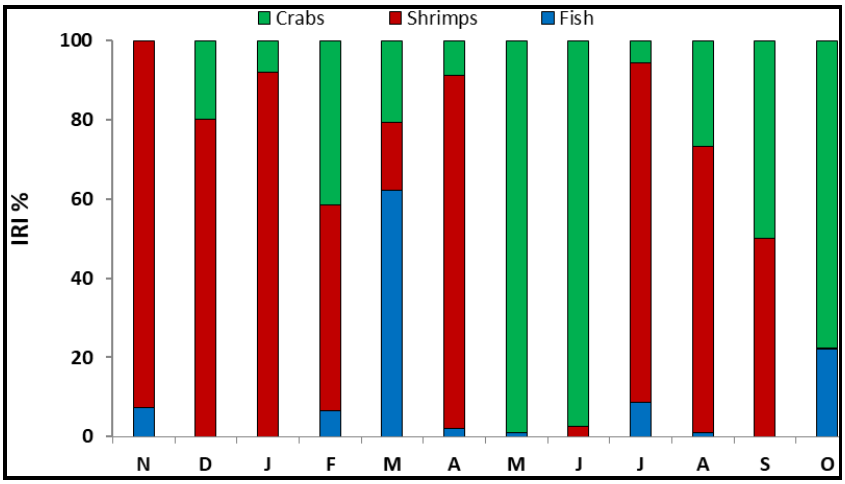

Fig 3: Monthly changes in the relative importance index (IRI %) of food items (*J. Belangerii*)

Monthly fluctuations in index of relative importance (IRI) of food items in the diet of *J. Dussumieri* is illustrated in Figure 4. Shrimps occupied the first position in order of relative importance in diet of the species, and the percentage contribution ranged between 13.8% in September and 99.9% in November. Fish were occupying the second position and ranged from 0.88% in December to 49.8% in September. Crabs came third and fluctuated from 0.32% in November to 36.5% in September. Generally, the diet of *J. Dussumieri* was comprised of shrimps (77.4%), followed by fish (18.4%) and crabs (7.3%).

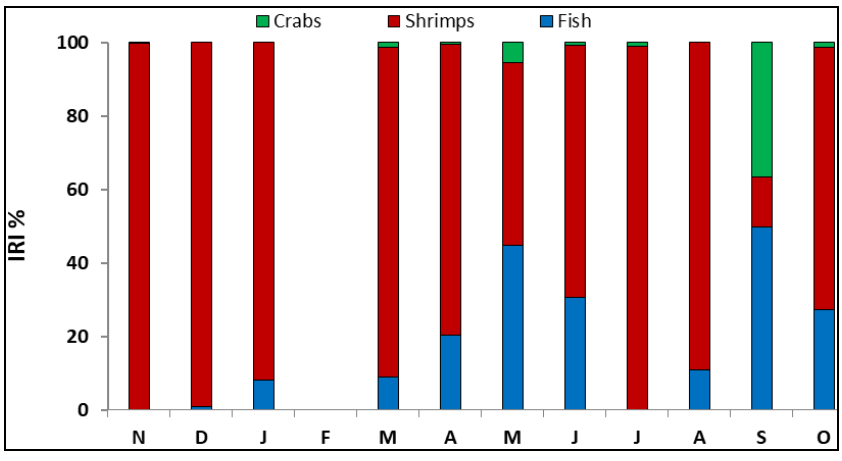

Fig 4: Monthly changes in the relative importance index (IRI %) of food items (*J. Dussumieri)*

3.4. Feeding selectivity and specialization

Figure 5 shows the percentages of the feeding selectivity index for the different food items of *J. Belangerii and J. Dussumieri* in the Shatt Al-Arab. Shrimps recorded the highest value of the index (52.3%) with the maximum value (61.9%) for *J. Dussumieri*, followed by crabs (26.5%) with the highest value (85.1%) for *J. Belangerii*. Fish ranked third with 21.2% with the maximum value (63.7%) for *J. Dussumieri*.

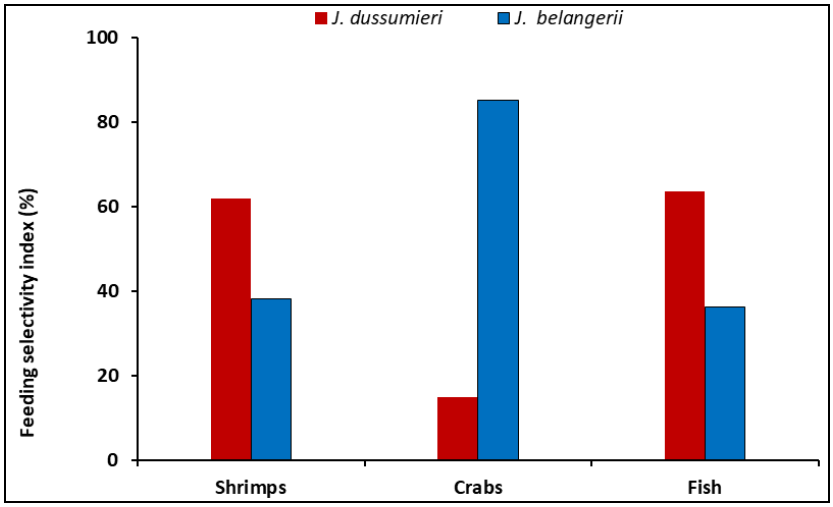

Fig 5: Feeding selectivity index for the different food items of the two species

The results of feeling spécialisation for the twa spécifs showed that the index of Levains standardise niche bréant for *J. Dussumieri* wasp high (B_i = 0.196), winch indiçâtes That This spécifs Is a high spécialiste feeder, white *J. Belangerii* wasp considère non-specialized feeder (B_i = 0.635).

4. Discussion

The importance of the knowledge on food and feeding habits has been well established, since the food is one of the key factors that greatly influence the distribution, growth, reproduction, migration rate and behavior of fish in the ecosystem [34, 35]. Fish like another organisms require energy for proper growth, development, reproduction and their various physiological activities [34]. The current study shown that *J. Dussumieri* and *J. Belangerii* are continuous feeders and never cease feeding all the year round with somewhat monthly fluctuations in feeding activities. Moreover, the levels of feeding intensity for both species were high in warmer periods of the year. These results were close to the observations made on dietary studies about these species by the earlier authors from Iraqi waters such as [7, 10]. This could be due to greater crustacean abundances in the study area during this period and coincided with rise in ambient water temperature. The importance of shrimps in diet composition may be due to their abundance [36] and nutritional profitability. Fish food varies from seasons to seasons because seasonal changes in temperature influence food consumption as well as the available food organisms, and from species to species [37]. Salman *et al.* (1990) stated that shrimps (*Metapenaeus affinis*) migrate from the Arabian Gulf to nursery grounds in the inland waters of Iraq through the Shatt Al-Arab river extends from May/June to January/February each year, their sizes ranging from 3–125 mm total length were found in inland waters. Water temperature is one of the most important environmental variables affecting the distribution and abundance of different species of fish, and the feeding activity and food consumption are affected by temperature due to lower temperature than ideal limits [38, 39]. Stated that the water temperature is the principal environmental factor affecting the gut fullness of fish.

Diet of *J. Belangerii* in the present investigation consisted mostly of shimpas (52.9%) and crabs (37.9%), while the contribution of fish was minimal (9.2%). Therefore, *J. Belangerii* can be said to be a carnivorous fish species. Studies in other Iraqi waters have indicated similar food preference [10, 12, and 40]. [14] Observed that *J. Belangerii* feed mainly on crabs and shrimps in the Shatt Al-Arab River. However, [13] found that *J. Belangerii* preyed fish (70%) and fish eggs (30%). [41] mentionne That the Food items of *J. Belangerii* in the north Kamara coast, India were shrimps (17.8%), fish (12.8%), polychaetes (9.0%) and crabs (8.6%). [42] Indicated that *J. Belangerii* in the Mayangan coast in the western Java province of Indonesia nurtured mainly on shrimps.

Also, the present study revealed that the *J. dussumeiri* was carnivorous in its diet, feed mainly on shrimps (77.4%), and followed by fish (18.4%). This is consistent with other studies, for example in the Iraqi marine waters [12] and in Kho Al-Dubai [9]. Shrimps were also observed in the most important food item in the diet of *J. Dussumieri* in Kori Al-Dubai [11] and in Shatt Al-Arab River [14]. [22] Also reported that shrimps and fish were the chief food items of *J. Dussumieri* in the Indian waters. [17] Found that fish had the most important items (43.7%) in the diet of *J. Dussumieri* from the coast of Malabar, south India and was followed by crustaceans (39.5%). [18] Confirmed that the *J. Dussumieri* mainly feed on crustaceans followed by fish and the juveniles mainly feed on crustaceans along the Cochin coast of India.

Despite of the overall dietary overlap (similarity) between *J. Dussumieri* and *J. Belangerii* was high, the results revealed that the individuals of *J. Dussumieri* were high specialized feeders, while the individuals of *J. Belangerii* were non-specialized feeders. Low trophic niche overlapping between the two studied species suggests a stable coexistence developed by both species, which allowed them to reach great abundance in the region [43]. However, [8] found that *J. sine* (*J. Dussumieri*) was less specialized feeder in Iraqi marine waters, northwest Arabian Gulf. [9] Stated that *J. Dussumieri* was specialized feeder and *J. Belangerii* was non-specialized feeder in Iraqi marine waters. [40, 14] found that *J. Dussumieri*

individuals were high specialized feeders in Shatt Al-Basra canal and in Shatt Al-Arab river. [44] Stated that the abundance of croaker's fish at Mad Island Marsh on the Texas Gulf coast was positively associated with relatively low salinity, beds of submerged saprophytes, and high abundance of benthic invertebrates that are potential prey. The seasonal use of estuaries by migratory fish and crustaceans has been postulated to reduce the competition for food and space [45].

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