

**A STUDY OF FOOD AND FEEDING OF GREY MULLET IN THE
SOUTHERN OF THE CASPIAN SEA.**

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Introduction

There are many factors that potentially influence both the amount and type of food found in the digestive tracts of fish, including the diel cycle, seasonal changes, size of fish, food availability, and differential digestion rates (Bowen and Allanson, 1982).

A great deal has been published about the food of the mullet (Mugilidae) and it has been summarized by Pillay (1953), Thomson (1963, 1966), Odum (1968 *a, b*, 1970), Hickling (1970), Zismann, *et al.*, (1975). Mullet have been described variously as vegetarian, omnivorous, planktophagous, and as devouring small crustaceans. They have been named "mud eaters" by Zenkevich (1963), "iliophagous" by Pillay (1953), "detritus feeders" by Rajan (1964), "algal feeders" by Hiatt (1944), "feeders on micro and meio benthos" by Hickling (1970), "interface feeders" by Odum (1970), "deposit feeders" by Fagade and Olaniyan (1973) and "soft bottom feeders" by Blaber (1976).

Differences in diet are quite evident according to age and size of the fish. A study of the stomach contents of *Liza aurata* and *L. ramada* revealed an ontogenetic change in the diet (15-40 mm SL, 4-5 months old) (Vallet, *et al.*, 1970). Young individuals fed on Copepoda, Amphipoda and Nematoda, indicating an essentially carnivorous diet. However, older fish (larger than 50 mm SL) feed on diatoms, plant fragments, sand and mud, indicating that they were mainly herbivorous and detritivorous.

That juvenile mullet are initially carnivorous and planktonic feeders and the adults detritivorous has also been noted by Hickling (1970); and Odum (1970). It has been suggested that ingested sand acts as a grinding paste for the degradation of plant cell walls in the pyloric portion of the stomach (Thomson, 1966).

The change of food from animal to plant material is not sudden but gradual. Copepoda and Cladocera appear to be the most important components in the diet of mullet up to 30 mm, with insect larvae, algae and detritus also consumed. Over 60 mm total length, the stomach contents include Polychaeta, Cladocera, Insecta, *Sagitta*, detritus, blue-green algae, diatoms and a small amount of sand (Anon, 1976).

The Caspian Sea's grey mullet (*L. aurata* and *L. saliens*) were introduced from the Black Sea to the Caspian Sea between 1930 to 1934 (Nikolskii, 1961). The suitable environment has enabled the population to increase in numbers rapidly. Nowadays they provide one of the principal fishing resources, especially in the southern part of the Caspian Sea.

The aim of present study was to determine any difference between the diet of juvenile and adult grey mullet in the southern Caspian sea and to observe any differences between the diets of *L. aurata* and *L. saliens* in this region. The number of pyloric caeca were also recorded.

MATERIALS AND METHODS

Specimens

Specimens of *Liza aurata* and *Liza saliens* were collected during 1993-1995 by traditional beach seine from four fishing areas with 91 sample sites along the Iranian side of the Caspian Sea; Anzali, Kiashahr, Babolsar, and Bandar Torkman. A subsample (n= 1280, 10% of the total sample) were examined and were comprised of 713 *L. aurata* and 567 *L. saliens*. The age of the specimens were estimated using scales.

Methods

The stomach contents were obtained after killing the fish. Stomachs were removed, the number of pyloric caeca for each specimen was counted and the stomach contents were weighed and preserved in 4% formalin for subsequent identification. Prey items were identified to as low a taxonomic level as possible.

The diet was determined by two methods: (a) frequency of occurrence, and b) percent composition by number. The frequency of occurrence (F) of prey items was calculated by the following equation: $F (\%) = \text{number of fish which food item occurred} \times 100 / \text{total number of fish}$

Food items were quantified by Numerical percentage (N) using the following equation:

$$N (\%) = \text{number of organism per fish} \times 100 / \text{total number of organisms}$$

Both diet analysis were calculated for different length classes for both species.

RESULTS

Number of pyloric caeca

The results show that the number of pyloric caeca in both species varied. In *Liza aurata* the range varied from 6-10, although most of the fish had 8 pyloric caeca (Table 1).

Table 1: Frequency of specific number of pyloric caeca in *Liza aurata* in different fishing areas along the Iranian side of the Caspian Sea

| Area | 1 | 2 | 3 | 4 |
|----------------------|--------|----------|----------|----------------|
| No. of pyloric caeca | Anzali | Kiashahr | Babolsar | Bandar Torkman |
| 6 | 3 | 1 | 3 | 0 |
| 7 | 43 | 12 | 22 | 29 |
| 8 | 131 | 75 | 99 | 143 |
| 9 | 41 | 21 | 26 | 53 |
| 10 | 2 | 1 | 2 | 6 |

In *Liza saliens*, the range of number of pyloric caeca was between 6-9, although most of the fish had 7 (Table 2).

Table 2: Frequency of specific number of pyloric caecae in *Liza saliens* in different fishing areas along the Iranian side of the Caspian Sea

| Area | 1 | 2 | 3 | 4 |
|-----------------------|--------|----------|----------|----------------|
| No. of pyloric caecae | Anzali | Kiashahr | Babolsar | Bandar Torkman |
| 6 | 10 | 8 | 13 | 9 |
| 7 | 95 | 59 | 63 | 172 |
| 8 | 29 | 18 | 31 | 51 |
| 9 | - | 2 | 3 | 4 |

Frequency of occurrence (F value in %)

In all four fishing areas, the major components of the stomach contents of *Liza aurata* and *Liza saliens* were fine sand and detritus. However, there were differences relating to the age: while adult fish had a considerably higher amount of fine sand and detritus juvenile fish had a very low amount and in many cases none.

Results of frequency of occurrence show that for *Liza aurata*, in all fishing areas and in length class 10.1 to 20 cm, all organisms were present. Calanoida were the only organisms that were present in all the length classes. The sum of the percentage of occurrence of organisms in all length classes is given in Table 3. As can be seen in this table, Foraminifera had the maximum percentage of occurrence whereas Ostracoda and Nematoda had the minimum.

Table 3: Frequency of occurrence (%) of different organisms in the stomach content of *Liza aurata* in different length classes in all four fishing areas.

| Organisms | Bivalvia | Foramini- fera | Ostracoda | Nematoda | Calanoida | Cyclopoida | Eggs* | <i>Nereis</i> | Number of fish |
|-------------|----------|-------------------|-----------|----------|-----------|------------|-------|---------------|-------------------|
| length (cm) | | | | | | | | | |
| 0-10 | - | - | 50 | - | 100 | 50 | - | - | 2 |
| 10.1-20 | 41 | 29 | 18 | 6 | 35 | 12 | 6 | 18 | 17 |
| 20.1-30 | 50 | 41 | - | - | 38 | - | 9 | 19 | 248 |
| 30.1-40 | 42 | 57 | - | - | 34 | 15 | - | 23 | 233 |
| 40.1-50 | 33 | 23 | 7 | 17 | 13 | - | 30 | 47 | 30 |
| F value(%) | 45 | 46 | 1 | 1 | 35 | 7 | 6 | 22 | Total 530 |

* These eggs belong to the calanoida and other organisms but not to the fish.

Results of frequency of occurrence show that for *Liza saliens*, in all fishing areas and in most length groups, Bivalvia and Foraminifera were present. The sum of the percentage of occurrence of

organisms in all length classes is given in Table 4. As can be seen in this table, Bivalvia and Foraminifera had the maximum percentage of occurrence whereas Nematoda had the minimum.

Table 4: Frequency of occurrence (%) of different organisms in the stomach content of *Liza saliens* in different length classes in all four fishing areas.

| Organisms | Bivalvia | Foramini- fera | Ostracoda | Nematoda | Calanoida | Cyclopoida | Eggs | <i>Nereis</i> | Number of fish |
|-------------|----------|-------------------|-----------|----------|-----------|------------|------|---------------|-------------------|
| length (cm) | | | | | | | | | |
| 0-10 | - | - | 43 | - | 87 | 38 | - | - | 60 |
| 10.1-20 | 71 | 64 | 16 | 7 | 56 | 31 | - | - | 45 |
| 20.1-30 | 65 | 59 | - | - | - | - | 20 | 34 | 158 |
| 30.1-40 | 83 | 60 | - | 23 | - | - | 28 | 68 | 40 |
| F value(%) | 55 | 49 | 11 | 4 | 25 | 12 | 14 | 26 | Total 303 |

In general the results illustrate that Bivalvia, Foraminifera, Calanoida, and *Nereis* had high percentage of occurrence in both *Liza aurata* and *Liza saliens*. On the other hand, Ostracoda, Nematoda, Cyclopoida, had low percentage of occurrence. However, the percentage of occurrence of Ostracoda, Nematoda and eggs in *Liza saliens* were higher than in *Liza aurata* (Table 5).

Table 5: Frequency of occurrence (%) of different organisms in the stomach content of *Liza aurata* and *Liza saliens* along the Iranian side of the Caspian Sea.

| Organisms | Bivalvia | Foramini- fera | Ostracoda | Nematoda | Calanoida | Cyclopoida | Eggs | <i>Nereis</i> | Number of fish |
|---------------------------------|----------|-------------------|-----------|----------|-----------|------------|------|---------------|-------------------|
| Species | | | | | | | | | |
| F value(%) <i>L. aurata</i> | 45 | 46 | 1 | 1 | 35 | 7 | 6 | 22 | 530 |
| F value(%) <i>L. saliens</i> | 55 | 49 | 11 | 4 | 25 | 12 | 14 | 26 | 303 |

Numerical percentage (N value in %)

The results showed that from a total of 57992 organisms which were counted in the stomach contents of *Liza aurata* more than half were Bivalvia and about one third were Calanoida in all four fishing areas (Table 6).

Table 6: Numerical percentage (%) of different organisms in the stomach content of *Liza aurata* in different length classes in all fishing areas.

| Organisms | Bivalvia | Foramini- fera | Ostracoda | Nematoda | Calanoida | Cyclopoida | Eggs | <i>Nereis</i> | Total Number of organisms |
|------------|----------|-------------------|-----------|----------|-----------|------------|------|---------------|---------------------------------|
| FL (cm) | | | | | | | | | |
| 0-10 | - | - | 67 | - | 309 | 27 | - | - | 403 |
| 10.1-20 | 1514 | 511 | 146 | 15 | 4468 | 55 | 72 | 14 | 6795 |
| 20.1-30 | 15346 | 2301 | - | - | 3247 | - | 112 | 71 | 21077 |
| 30.1-40 | 13723 | 2732 | - | - | 2534 | 76 | - | 220 | 19285 |
| 40.1-50 | 400 | 623 | 42 | 43 | 2599 | - | 991 | 98 | 4796 |
| N value(%) | 53 | 11 | 0.4 | 0.1 | 23 | 0.3 | 2 | 0.7 | 57992 |

Results show that from a total of 33403 organisms which were counted in the stomach contents of *Liza saliens*, Bivalvia and Calanoida were the most important prey whereas Nematoda and *Nereis* had the minimum (Table 7).

Table 7: Numerical percentage (%) of different organisms in the stomach content of *Liza saliens* in different length classes in all fishing areas.

| Organisms | Bivalvia | Foramini- fera | Ostracoda | Nematoda | Calanoida | Cyclopoida | Eggs | <i>Nereis</i> | Total Number of organisms |
|------------|----------|-------------------|-----------|----------|-----------|------------|------|---------------|---------------------------------|
| FL (cm) | | | | | | | | | |
| 0-10 | - | - | 1239 | - | 6985 | 1190 | - | - | 9414 |
| 10.1-20 | 2647 | 231 | 119 | 144 | 3669 | 190 | - | - | 7000 |
| 20.1-30 | 11353 | 969 | - | - | - | - | 120 | 110 | 12552 |
| 30.1-40 | 2648 | 371 | - | 191 | - | - | 874 | 353 | 4437 |
| N value(%) | 50 | 5 | 5 | 1 | 32 | 4 | 3 | 1 | 33403 |

The results show that the consumption of Bivalvia was similar in *Liza aurata* and *Liza saliens*. However, the consumption of Foraminifera by *Liza aurata* was higher than by *Liza saliens* and the consumption of Calanoida by *Liza saliens* was higher than by *Liza aurata*. Consumption of Ostracoda, Nematoda, Cyclopoida, eggs and *Nereis* by *Liza saliens* was higher than by *Liza aurata* (Table 8).

Table 8: Numerical percentage (%) of different organisms in the stomach content of *Liza aurata* and *Liza saliens* along the Iranian side of the Caspian Sea.

| Organisms | Bivalvia | Foramini-fera | Ostracoda | Nematoda | Calanoida | Cyclopoida | Eggs | <i>Nereis</i> | Total Number of organisms |
|---------------------------------|----------|---------------|-----------|----------|-----------|------------|------|---------------|---------------------------|
| Species | | | | | | | | | |
| N value(%) <i>L. aurata</i> | 53 | 11 | 0.4 | 0.1 | 23 | 0.3 | 2 | 0.7 | 57992 |
| N value(%) <i>L. saliens</i> | 50 | 5 | 5 | 1 | 32 | 4 | 3 | 1 | 33403 |

DISCUSSION

Number of Pyloric caeca

The comparison between the results of the present study and those of previous studies with respect to the number of pyloric caeca shows that there are great variation between them. The range start varies from 3-5 to 8-9.

Some authors (Gunther, 1861 and Nikolskii, 1961) have reported that there is no intraspecific variation in the number of pyloric caeca. However, other authors, such as Perlmutter (1957), Trewavas (1972), and Oren (1981), have observed that there such variation in the number of pyloric caeca does occur.

With respect to *Liza aurata* the present results are in agreement with those of Oren (1981), and partially in agreement with those of Gunther (1861), Perlmutter (1957), and Nikolskii (1961). With respect to *Liza saliens* the present results are in agreement with Oren (1981) about the variation of the number of the pyloric caeca within the species. However, the present study does not support the most frequent number of pyloric caeca which is 8. Moreover, the present study with respect to *Liza saliens* is not in agreement with other previous studies. In the present study, all the sampled fish (*Liza saliens*) had 3 elongated pyloric caeca which was used to identify this species from *Liza aurata*. In *Liza aurata* all pyloric caeca were in the same length. The comparison of the results of present and previous studies are given in Table 9.

Table 9: Comparison between the number of pyloric caecae of grey mullet in the present and previous studies.

| Studies | Gunther (1861) | Perlmutter (1957) | Nikolskii (1961) | Trewavas (1972) | Oren (1981) | Present (1996) |
|---------------------|----------------|-------------------|------------------|-----------------|---------------|----------------|
| Fish species | | | | | | |
| <i>Liza aurata</i> | 8 | 8-9 | 8 | - | 6-11 mostly 8 | 6-10 mostly 8 |
| <i>Liza saliens</i> | 8 | 3-5 | 8 | 3-5 | 6-9 mostly 8 | 6-9 mostly 7 |

Frequency of occurrence (F value in %)

The stomach content of all the adult fish *Liza aurata* and *Liza saliens* in all the fishing areas are predominantly full of fine sand particles, plant and animal origin detritus. However, beside the sand and detritus, considerable number of organisms were taken in by the fish.

The predominant prey item which occurred in all the fishing areas and in the largest number of the fish stomach contents *Liza aurata* and *Liza saliens* was bivalvia. The next predominant prey item which occurred in all the fishing areas and in the largest number of the fish stomach contents *Liza aurata* and *Liza saliens* was Foraminifera. Another predominant prey item which occurred in all the fishing areas and in the considerable number of the fish stomach contents *Liza aurata* and *Liza saliens* was Calanoida. The other food items have not occurred in very many fish stomach content.

The results do show that grey mullet species which live in the Caspian Sea somehow select the food items. On the lower length class (juvenile class) Ostracoda, Calanoida, and cyclopoida seems to appear more than other organisms. However, On the adult fish classes of both species, Bivalvia, Foraminifera, and *Nereis* seems to occur more than other species.

Numerical percentage (N value %)

The results of frequency of occurrence alone can not be based for observing the exact value of food items of fish then further analysis of numerical percentage of food items was done to achieve somehow an accurate estimation of the value of food items in the diet of Caspian Sea grey mullet species.

The predominant prey item which had the highest number in all the fishing areas and in the largest number of the fish stomach contents *Liza aurata* and *Liza saliens* was bivalvia. The next predominant prey item which had the higher number than other organisms in all the fishing areas and in the large number of the fish stomach contents *Liza aurata* and *Liza saliens* was Calanoida. Another predominant prey item which had quite a lot of number in all the fishing areas and in the considerable number of the fish stomach contents *Liza aurata* and *Liza saliens* was Foraminifera. The other food items have not had considerable number in very many fish stomach contents.

CONCLUSIONS

- 1- The number of pyloric caeca varies between and within *Liza aurata* and *Liza saliens* in the southern part of the Caspian Sea. In *Liza aurata* it varies from 6 to 10 (mostly 8) and in *Liza saliens* it varies from 6 to 9 (mostly 7).
- 2- Large amounts of sand particles and detritus were observed in the stomach contents of all fish.
- 3- Using the frequency of occurrence method, the predominant food items for both mullet species were Bivalvia, Foraminifera and Calanoida
- 4- According to numerical percentage method the predominant food items for both mullet species were Bivalvia, Calanoida, and Foraminifera .
- 5- Grey mullet species of the southern part of the Caspian Sea seems to select the food items. Juveniles prefer to consume more Ostracoda, Calanoida, and Cyclopoida. Adults prefer to feed more on Bivalvia, Foraminifera, and *Nereis*.

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