ORGANIC ARCHITECTURE
2.1 Introduction

The fishes constitute one of the major sources of cheap nutrition for the human beings. The nutritional value of different fishes depends on their biochemical composition, such as protein, carbohydrates, lipids, vitamins and mineral content (Bhagwati and Rath, 1982). The variations in the biochemical constituents such as water, fat, protein, glycogen, ash and minerals along with the nutritive value in any fish are attributed to changes in growth size at maturity, sex, food and the locality from which it is caught.

Different aspects of organic constituents in some fishes were studied by different authors. Atwater (1888) was first to analyse some American species from Atlantic source. Milroy (1908) studied the chemical composition of Herring. Clark and Almy (1918) carried out series of analyses in the chemical composition of the fishes from Atlantic coast. Dill (1921) studied chemical composition of mackerels and other fishes and showed that there was no correlation between proximate chemical composition and sex in Mackerels. Pimtener (1921), Bruce (1924), Greene (1928) and Bull (1928) carried out chemical analyses in fishes. Niyogi et al (1941), Kharana et al (1943), Sethna et al. (1944), Chari (1948) and Patakoot et al. (1950) have studied the proximate composition of main varieties of commercial fishes from respective regions. Appanna and Devadatta (1942) worked on the comparative study on the nutritive value of muscles of fish and prawns from Bombay, waters. Parulekar and Bal (1964) showed the seasonal variations in Bregmaceros macclelandi.


Number of recent authoritative contributions on the biochemical composition of different fishes are available (Radhakrishnan et al., 1985; Das and Mishra 1990; Suryanarayana and Nair, 1990; Geetha et al., 1991; Pandey and Pandey, 1994).
Different fishes have been analysed for their chemical composition from time to time. Srikar et al. (1979) studied the changes in the bio-chemical composition of Clarias batrachus (Linn.). Jayaram and Shetty (1980) observed the influence of diet on the proximate body composition of Catla catla (Ham.); Labeo rohita and Cyprinus carpio (Linn). Venugopal and Kshavanath (1984) also studied biochemical composition of flesh of freshwater carp Catla catla (Ham), Cirrhina mrigala (Han) and Cyprinus carpio (Linn). Renukardhya and Virghese (1986) reported fat content in Catla and rohu. Pandey and Rumana (1987) observed biochemical composition in the freshwater fish Catla catla.

The review of literature showed that no more work had been carried out on the organic composition of the fishes in relation to body weight and sex. Hence the present study was launched to show the effect of weight and sex on organic constituents in muscle, gill, liver and kidney of the fish Channa orientalis.

2.1.1. Carbohydrate:

Carbohydrate is one of the primary constituent of the food which furnish energy. Much of the energy expended by the fish in swimming comes from oxidation of lipid or from glucose.

The glycogen content in different fishes was demonstrated by some workers. Liver and muscle glycogen was mentioned in river lamprey by Bently and Follett (1965). Virghese (1976) observed glycogen in the liver, muscle and ovary of the Pampus argenteus and Parasrometeus nigen (bloch). Mansuri (1979) also stated seasonal variations in the glycogen content in some marine fishes. Chari (1981) studied glycogen in the liver and ovary of Heteropneustes fossilis. Dasgupta and Sirkar (1985) found glycogen content in the tissues of Clarias batrachus. Renukardhya and Virghese (1986) reported glycogen in the muscle of Catla catla.

Studies on the glycogen content in relation to body weight and sex are few. Therefore an attempt was made to estimate the glycogen content in the different tissues of the fish Channa orientalis in both the sexes.

2.1.2. Protein:

Authoritative contributions on the protein content of the fishes are available. Milroy (1908) was correlated protein with spawning season. Bruce (1924) remarked protein in muscle of Herring. Sawant and Bal (1969) also carried out same studies. Jafri and Khawaja (1968) found the muscle protein in the Ophicephalus punctatus. Jafri (1968) in his studies also described the muscle protein of Mystus seenghala and Cirrhina mrigala. Parulekar and Bal (1964) studied the protein content of Bregmaceros maciellandi. Arevalo (1948) reported protein content of Trachurus trachurus in relation to body weight. Protein content in the Ophicephalus punctiatus was observed by Jafri and Khawaja (1967).

The recent investigations revealed variations in the protein content of different fishes. Medford and Mackey (1978) studied protein content in the
gonads, liver and muscle of Northern Pike, Esox lucius. Renukardhya and Virghese (1986) showed the protein in the muscle of Catla and rohu. Banerjee and Banerjee (1987) reported variations in the protein level with body length in Heteropneustes fossilis. Seasonal variations in the protein content had been observed by Medda (1993) in Puntius sophore. Medda (1994) also described protein content in the tissues of Clarius batrachus in relation to length and weight of the body.

The above studies revealed that the studies on the effect of sex and weight on the protein content seems to be scanty. Hence the present investigation was designed to determine the protein content in relation to weight and sex of the fish Channa orientalis.

2.1.3 Fat:

The fat is the greatest variable in the organic constituent of fishes. Many authors have been reported different studies on the fat content in the different fish species from time to time. Murray and Hjort (1912) showed the fat content of sprat. Lovera and Wood (1937) studied the variations in the fat of Herring. Youndeva (1939) described fat content in Munnansk herring. Iles and Wood (1965) observed the fat in the North sea herring.

Number of workers who studied the fat content in different fishes are Hornell and Naidu (1924), Sekharan (1949, 1950), Venkatraman and Chari (1951), Chidambaram et al. (1952). Ramaswami (1955) studied the fat content of mullet. Vasavan et al. (1960) carried out investigations on the variations in fat content of Indian oil sardine.

Jagnand et al. (1967) reported seasonal changes in the lipid content of cod. Jafri and Khawaja (1970) reported fat content of the Ophicephalus punctatus.

The fat content was also observed by Atwater (1888) in Albosa and Scomber. Milroy (1906, 1908) studied the fat content in relation to maturity. Dill (1921) observed fat content in Mackerel. Clark and Atmy (1918) described the fat content in shad. Greene (1919) observed the fat content in king salmon. Channon and Saby (1932) mentioned the fat content of herring. Oya et al. (1937) studied the fat content of Sardina melanosicata. Legendre (1938) remarked the fat in the Sardina. Wilson (1939) observed the fat percentage in flounders. Hickling (1947) observed the fat content in Cornish pilchard, Sardina pilchardus. Arevalo (1949) studied the fat content in the Saurel. Idler and Bitners (1958) observed the fat in the flesh of Salmon. Jafri (1968) correlated the fat content with the feeding activity.


Among the research workers Medda (1994) investigated fat content of the Clarias batrachus in relation to length
and weight. In view of the above literature the present study was undertaken to observe the effect of weight and sex on the fat content in the fish *Channa orientalis*.

### 2.2. Material and Methods:

#### 2.2.1 Collection and Maintenance of Fishes:

The fishes *Channa orientalis* were collected from localities around Amravati region. Then they were brought to the laboratory in a live condition. They were transferred to the glass aquarium and inspected for any possible injury or infection. Injured fishes were avoided. Only healthy fishes of different weights in gm and length range group of 10 mm were selected. These fishes were washed with dilute solution of potassium permanganate (K₂MnO₄, 1.0 ml/g) to remove dermal infection if any. Then the fishes were pithed. The fishes were separated into different groups according to body weight. The fishes were cut open to ascertain the sex. The tissues like muscle, gill, liver and kidney were pooled up from the fishes. After noting down the sex and weight of the fishes, the tissues were quickly weighed and used for the analysis of organic constituents. The analyses of various tissues were carried out on the wet weight basis.

#### 2.2.2 Estimation of carbohydrate:

For the estimation of glycogen the tissues muscle, gill, liver and kidney were weighed from male and female. The glycogen content was estimated by the method of *Hassid* and *Abraham* (1957) using anthrone reagent. The amount of glycogen was calculated by multiplying the glucose value by the factor 0.927. The glycogen content is expressed as mg of glycogen per gm wet weight of tissue.

#### 2.2.3 Estimation of Protein:

For the estimation of protein the tissues muscle, gill, liver and kidney were weighed. The protein content of the tissue was estimated by the method of *Gornall et al.* (1949). The protein content was determined in terms of mg protein per gram wet weight of the tissue.

#### 2.2.4 Estimation of fat:

For the estimation of fat the tissues of muscle, gill, liver and kidney were weighed. The fat was estimated with solvent ether in a soxhlet apparatus. The fat content was indicated by mg fat per gm of the tissue.

### 2.3 Observations and Results

The tissues muscle, gill, liver and kidney were analysed for studying the various organic constituents in them. Present investigation was designed to work out the effect of weight and sex on various organic constituents in all the tissues. The males and females having 10 mm length range and of different weights were analysed separately.

#### 2.3.1 Organic constituents in the male *Channa orientalis*:

The organic constituents showed the following relation with body weight in the muscle, gill, liver and kidney.
The glycogen content decreased gradually with body weight in all the tissues. The glycogen content exhibited as 2.55 to 3.88, 2.08 to 3.21, 4.23 to 8.77 and 0.48 to 1.08 mg/g in muscle, gill, liver and kidney respectively (Fig. 2.1). The content was higher in the liver, less in muscle, lesser in the gill and least in the kidney. The difference in the content was more in smaller groups and less in larger groups. (Fig. 2.1)

![Glycogen content graph](image)

**Fig. 2.1**

The decrease in the content with body weight was high in kidney, less in gill, lesser in the muscle and least in the liver. This difference might be due to different physiological activities of different tissues. The decline of glycogen with body weight indicated higher physiological demand of glycogen with increase in weight.

Protein content showed gradual decrease in the different tissues with body weight. The content was obtained as 193.00 to 232.00, 190.70 to 226.00, 230.00 to 298.00 and 162.00 to 198.00 mg/g in the muscle, gill, liver and kidney. The content was higher in the liver, less in muscle, lesser in gill and least in the kidney respectively (Fig. 2.2).

![Protein content graph](image)

**Fig. 2.2**

Decrease in the content was observed in the liver. The difference in the content was more in larger weight group than smaller fishes. This indicated that proteins might be necessary for the growing fishes.

Fat content was increased with body weight in all the tissues. The content was found to be 21.70 to 41.13, 7.45 to 11.49, 30.61 to 48.57 and 5.21 to 7.59 mg/g in the muscle, gill, liver and kidney respectively (Fig. 2.3). The content was higher in liver less in muscle, lesser in gill and least in the kidney. The difference in the content was more in small weight groups and less in large weight groups. (Fig. 2.3)

![Fat content graph](image)

**Fig. 2.3**

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The increase in the content was more in liver with body weight, less in muscle, lesser in gill and least in the kidney. The high content in the liver might be because of storage activity of the liver.

2.3.2 Organic constituents in the female Channa orientalis

The organic constituents showed following relation with body weight and sex in the muscle, gill, liver and kidney.

The glycogen content decreased with body weight in all the tissues. The content was observed as 2.10 to 3.50, 1.98 to 3.10, 3.55 to 7.88 and 0.38 to 1.06 mg/g in muscle, gill, liver and kidney respectively (Fig. 2.4). The content was higher in liver, less in muscle, lesser in gill and least in the kidney. The difference in the content more in smaller fishes and less in the larger fishes. The decrease in the content was high in the kidney, less in gill, lesser in the muscle and least in the liver. The depletion of glycogen with body weight showed that higher physiological demand of glycogen with increase in weight.

The protein content gradually decreased with body weight in all the tissues. The content was noted as 191 to 230, 203 to 224, 223 to 286 and 158 to 186 mg/g in the muscle, gill, liver and kidney respectively (Fig. 2.5). The content was higher in liver, less in muscle, lesser in gill and least in the kidney. Difference in the content was more in larger fishes than smaller fishes. Decrease in protein with body weight proved that higher physiological demand of protein with body weight at specific physiological state of the tested fish. (Fig. 2.5)

![Fig. 2.4](image)

**Fig. 2.4**

The fat content increased with body weight in all the tissues. The content was exhibited as 22.86 to 43.35, 8.71 to 12.56, 31.86 to 49.72 and 6.00 to 7.80 mg/g in the muscle, gill, liver and kidney respectively (Fig. 2.6).

![Fig. 2.5](image)

**Fig. 2.5**

![Fig. 2.6](image)

**Fig. 2.6**

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The content was higher in liver, less in muscle, lesser in gill and least in the kidney. The difference in the content was more in smaller weight groups and less in larger weight groups. The increase in the content was more in liver with body weight, less in muscle, lesser in gill and least in kidney. The high content in liver indicated storage activity of liver.

2.3.3 Comparison of organic constituents between male and female:

Organic constituents in the different tissues showed following relationship with body weight and sex.

Glycogen content gradually decreased with body weight in all the tissues of both the sexes. The content was appeared slightly higher in male than female (Fig. 2.1 and 2.4).

The protein content gradually decreased with body weight in all the tissues of both the sexes. The protein content was higher in male than females (Fig. 2.2 and 2.5).

Fat content increased with body weight in all the tissues of both sexes. Fat content was higher in female than male (Fig. 2.3 and 2.6).

The present study revealed that little significant difference was exhibited in the organic constituents of the male and female Channa orientalis. However, the organic constituents vary in different tissues with body weight. Glycogen and protein content decreased with body weight while the fat increased in body weight in all the tissues of both the sexes.

2.4 Discussion:

Glycogen, protein and fat are important organic constituents of the fishes. They vary in different fishes with size, maturity, sex, food and their locality. The present work had been carried out to show the effect of sex and weight on these organic constituents in the muscle, gill, liver and kidney.

Glycogen:

Some studies on the glycogen variation in the tissues of fishes are available. The diminution in the glycogen value during the maturation period was reported by Greene (1921) and Black et al. (1960). Depletion in liver and muscle glycogen during spawning migration in Lamprey was observed by Bentley and Follett (1965). Vurghese (1976) reported that glycogen in the liver and muscle varies with the maturation cycle and spent stage of the fish. Chari (1981) studied decrease in glycogen content in the Heteropneustes fossilis during various stages of development. Dasgupta and Sirkar (1985) also found variation in glycogen level in relation to breeding cycle.

The literature showed that more studies on the glycogen content in relation to body weight are not available. While the present study correlated the glycogen content with body weight. The content decreased with body weight (Fig. 2.1 and 2.4). The content was high in smaller weight groups due to high demand for glycogen. The glycogen content was different in all the tissues because of the difference in the physiological activities of the tissue.
Little significant difference was noted in the glycogen content between the male and female *Channa orientalis*.

**Protein:**

Number of investigators have been revealed the protein content in different fishes. Milroy (1908) was noted and the lowest percentage of protein when the fat is at its highest. Bruce (1924) has remarked that in herring the protein in muscle decreased in advancing age and progressive maturation of gonads in the fat content was found to rise. Sawant and Bal (1969) stated that there was no significant difference in the percentage of protein in male and female *Bregmaceros macellandi*. Jafri and Khawaja (1968) found the muscle protein to remain high in *Ophicephalus punctatus* with the peak maturity. Jafri (1968) found the muscle protein of *Myiopsitta monogama* and *Cirrhina mrigala* showed the highest value in the mature fishes and the lowest in the immature ones. Parulekar and Bal (1964) have noted the protein to increase with the advance of maturity in *Bregmaceros macellandi*. Medford and Mackay (1978) investigated that the muscle protein were higher before spawning and low after spawning. Jafri and Khawaja (1968) stated that the liver maintained a high protein level throughout the spawning period in *Ophicephalus punctatus*.

The protein content declined with increase in size of *Ophicephalus punctatus* (Khawaja and Jafri, 1967). However, increase of protein with increase in weight was mentioned by several workers (Arevalo, 1948; Khawaja and Jafri, 1967; Devold, 1970).

Banerjee and Banerjee (1987) reported that protein decreased with increase in body length in *Heteropneustes fossilis*. This decrease must be due to requirement of protein energy during growth of the fishes. Medda (1993) investigated that protein increased with length weight variation in *Puntius sophorae*. Increase in protein content with body weight in *Clarias batrachus* was also showed by Medda (1994).

In the present investigation the variation in protein content with body weight was similar to the findings of Khawaja and Jafri (1967) in *Ophicephalus punctatus*.

**Fat:**

Studies on the fat content in different fish species have been made earlier. Milroy (1906, 1908) in his study observed an increase in fat content with maturity and decrease after spawning. Dill (1921) observed increase in fat content in *Mackerel* like fishes. Clark and Almy (1918) observed that shad loses fat during spawning. Greene (1919) observed the decrease of fat during and after the spawning in King salmon. Channon and Saby (1932) indicated a rise in the fat content of herring in spawning followed by a fall after spawning. Oya et al. (1937) studied the seasonal variations in the fat content of *Sardina melanosticta* in summer and winter. Legende (1938) remarked that in Sardine, the immature fish showed low fat content whereas the mature fish showed high values.

Hickling (1947) observed the depletion of fat during and before
spawning in *Sardinia pilchardus*. Arevalo (1949) observed that fat content increases with the rise of full maturity. Sekharan (1950) found that fluctuations in the muscle fat of Indian herring were related to the spawning, migration and feeding activity.

Venkatraman and Chari (1951) stated that the fat content varies directly with the amount of food available in the sea in mackerel. Chidambaram et al. (1952) observed that fishes of larger size show greater percentage of fat than those of the smaller group in the same season. Jafri (1968) stated that depletion in the muscle fat was due to spawning activity in *Cirrhina mrigala*. Jafri and Khawaja (1968) have recorded the highest value in the liver fat preceded peak ripeness and on the onset of spawning the liver fat decreased. They observed the minimum value of liver fat in the spent fish.

In the present investigation the findings found to be similar to those of Legendre (1938) and Chidambaram et al. (1952) the fishes having smaller weight group showed low fat content and of larger weight group showed high fat content in the *Channa orientalis*. (Fig. 2.3 and 2.6)

Some workers explained the variation of fat with body weight and length Arevalo (1948) showed the increase of lipid content with increase in size of *Trachurus Trachurus*. He also pointed out fall of lipid value in largest size group. Khawaja and Jafri (1968) recorded increase in the lipid content in the muscle of *Wallago attu* and *Mystus Seenghola* with increase in age. Devold (1970) observed the increase of lipid with increase in weight. An increase in lipid content of muscles from fingerlings to mature stage in *Pampus argenteus* and *Parastromateus niger* was reported by Virghese (1976). Medda (1993) stated that lipid increased with weight group variation in *Puntius sophore*. An increase in lipid with weight was also investigated in *Clarius batrachus* by Medda (1994). Similar observations were found in present investigation (Fig. 2.3 and 2.6). Fat content increased with body weight in all the tissues of male and female *Channa orientalis*. But Khawaja and Jafri (1967) remarked that lipid declines with increase in size of *Ophiocephalus punctatus*. Due to high fat content in the liver of *Channa orientalis*, it can be said that the liver acts as a store house of energy. Little significant difference was observed in the fat content between the male and female *Channa orientalis*.

The glycogen, protein and fat content of the fish *Channa orientalis* showed that they fall under the category of high protein and low fat content. Therefore, they are of considerable nutritional importance.