Assiut Univ. J. of Zoology
46(1), p-p1- 12(2017)

MORPHOMETRICAL AND HISTOLOGICAL STUDY OF THE DIGESTIVE SYSTEM IN *SCOMBER JAPONICUS*

***Kamal Ahmed Baaoom and *Manal Haj Obbed**

**Department of Biology, Faculty of Science, Hadhramout University, Yemen.*

Tel: 00967739700122, (ayhembaaoom @gmail.com)

Received: 9/10/2016 **Accepted:** 8/1/2017

Chub mackerel *Scomber japonicus* (Scombridae) is a pelagic species that inhabits warm and temperate coastal waters of the Atlantic, Indian and Pacific Oceans. Morphometrical and histological study of the digestive system of *Scomber japonicus*, are described based on 32 specimens (average length 215.88 - 357.63 mm) collected from landing site at coast of Mukalla (Gulf of Aden). External morphometrical parameters as well as internal morphometrical measurements of weights were taken and data were recorded in tables and expressed as linear curves and histograms. Histological sections were processed and studied using a light microscope and images were taken, then analyzed and described. The results showed nearly equal lengths of body and alimentary canal is longer than body cavity length represented by snout- vent length. This can be related to the coiling aspect of the intestine. This study may help us to characterize the alimentary canal of *S. japonicus* as a type that belong to omnivorous mode of nutrition.

Keywords: *Scomber japonicus*, Gulf of Aden, alimentary canal, Histological sections, light microscope, omnivorous fish.

INTRODUCTION

Chub mackerel *Scomber japonicus* Houttuyn (1782), is middle size pelagic species, with a very wide distribution over the continental shelf of the tropical and subtropical regions of the Atlantic, Indian, Pacific oceans and adjacent seas, it is primarily coastal species, found from the surface down to 300 m depth [15 and 35]. Along its distribution the species is found in isolated population with complex intraspecific structure [26]. *Scomber japonicus* is a key component in the marine food web of many tropical and subtropical areas of the Atlantic and Pacific oceans. In the Pacific Ocean they are eaten by albacore *Thunnus alalunga* [40 and 13]. Scombrid fishes (Family Scombridae) are considered as one of the important fishery resource in the Gulf of Aden. They are caught by the pursesein fishery. Their average landing has been estimated to be around 2202 tons, contributing about 12% of the total purse seine catch. Because of the great importance of *Scomber japonicus* to economy of Yemeni fisheries, (Gulf of Aden and adjacent area). It was studied by [18 and 19]. [6 and 10], they investigated, Biometric, Length weight relationship and growth parameters of *S. japonicus*. Fish play an important role in the development of nation. Apart from being a cheap source of highly nutritive protein, it also contains other essential nutrients required by the body [10]. Understanding the relationship between body structures and fish diet could be important for predicting the diet of how

they feed and the mechanics of feeding [2]. The gross anatomy, morphology and histology of the digestive tract of many teleostean fish species have been studied [1; 16; 39; 21; 3; 34 and 14]. The digestive tract of fish also, show marked diversity in its morphology and function. This is related to both the taxonomy and different feeding habits, as well as to body shape [23; 36; 33; 16; 17; 42; 3; 34; 14 and 27]. The digestive system of fish is similar to the digestive system of other animals [43]. The alimentary tract is complete, having a mouth at one end and anus at the other in all vertebrates [44; 24 and 5]. The tunica muscularis of stomach consists of two layers of striated muscle: an outer circular and an inner longitudinal layer [41; 32; 4 and 30]. There is general relationship between the lengths of the intestine and feeding habits, the intestine in carnivorous fish is shorter than that of omnivores and herbivores [41; 28 and 7]. This paper provides information on structures related to feeding, and on the basic histology of the digestive tract of *Scomber japonicus*. These morphological features are discussed a histological and functional and assuming that feeding habits will be reflected in these structures.

MATERIALS AND METHODS

Specimens of *Scomber japonicus* (Fig. 1) were collected from fishermen at Mukalla Sea (Gulf of Aden) (Fig. 2). These were brought to the laboratory of Biology, Faculty of science, Hadhramout University. Fishes were weighed and external fish parameters were measured and recorded: Total length (TL), Fork length (FL), Standard length (SL), Alimentary canal length and Intestinal length (Int. L). Data have been represented in the form of histograms using Microsoft office excel. The body cavity was opened, and removed the digestive tract: (stomach and intestine) and it washed in a physiological saline solution from its food contents and blood [11]. Stomach and intestine were fixed in 10 % neutral buffered formalin. They were dehydrated, cleared and put in paraffin wax. Samples were sectioned (6-8µ thick) and stained with the counter stain haematoxylin and eosin (H&E) [9 and 38]. Then, they studied under microscope with digital camera for photography.

RESULTS

Morphometrical Study

The external parameters measured for *Scomber japonicus* as well as for the length, weight and length of alimentary canal are listed in Tables (1- 5) and (Fig. 3). The length of the first group (G1) of *S. japonicus* range from 195 mm to 235mm. The second group (G2) length range from 235mm to 244 mm while the third group (G3) length ranges from 250 mm to 355 mm. Finally, the forth group (G4) length range from 355 mm to 365 mm. Total body mean lengths of the four groups of *Scomber japonicus* are 215.88 mm, 239.5 mm, 327.63 mm and 357.63 mm respectively. The alimentary canal mean length (G1) is 239.38 mm, (G2) is

256.88 mm, (G3) is 274.63 mm and (G4) is 439.75 mm. While mean weight (G1) is 93.671 gm, (G2) is 123.65 gm, (G3) is 371.24 gm and (G4) is 441.88 gm. The intestine mean length (G1) is 206.88 mm, (G2) is 215 mm, (G3) is 318.88 mm, (G4) is 385.63. The relationship between length and weight is measured and listed in (Fig. 4).

Histological Study

Stomach in *S. japonicus* is u-shape, and divided into two portions; cardiac stomach (anterior region) and pyloric stomach (posterior region). The stomach in *S. japonicus* has the same histological structures as in the intestine. Both of the cardiac and pyloric regions are nearly similar in morphological features with the exception of few modifications and differences have been observed. Histological findings showed that the basic organization of stomach and the intestine wall is similar to that in other vertebrates and is formed by tunica mucosa with mucosa, submucosa, muscularis (inner circular and outer longitudinal smooth muscles) and serosa layers in Figures (5 and 6). Intestinal wall is relatively short and it has uniform histological structure throughout its entire length. Microscopic examination of the transverse sections of the intestine of *S. japonicus* showed that the wall is composed of mucosa, folds, stratum compactum, mucous cells, submucosa, muscularis (circular and longitudinal muscle layers) and serosa as shown in figures (7and 8).

Figure 1. The morphology of *Scomber japonicus*

Figure 2. Gulf of Aden, Hadhramout coast, the study region

Table 1. Lengths (mm) and weights (gm) of *S. japonicus* (G1)

Parameters	S1	S2	S3	S4	S5	S6	S7	S8	Mean
TL	195	195	205	210	222	230	235	235	215.88
FL	185	180	188	195	190	215	215	215	197.88
SL	170	175	180	185	175	208	210	205	188.5
W	80	80	80	80	80	115.13	119.85	114.39	93.671
AL.CL.	215	205	220	225	250	270	240	290	239.38
Int.L	185	175	195	190	230	235	205	240	206.88

Table 2. Lengths (mm) and weights (gm) of *S. japonicus* (G2)

Parameters	S9	S10	S11	S12	S13	S14	S15	S16	Mean
TL	235	237	240	240	240	240	240	244	239.5
FL	215	220	225	222	221	220	220	224	220.88
SL	210	214	220	215	215	210	205	215	213
W	101.72	124.38	130.26	128.93	136.5	130.76	109.91	126.73	123.65
AL.CL.	240	265	235	250	260	285	270	250	256.88
Int.L	190	230	190	220	215	250	220	205	215

Table 3. Lengths (mm) and weights (gm) of *S. japonicus* (G3)

Parameters	S17	S18	S19	S20	S21	S22	S23	S24	Mean
TL	250	304	333	335	345	350	350	354	327.63
FL	230	278	316	314	323	320	325	323	303.63
SL	220	271	308	305	313	311	317	314	294.88
W	120.90	240	395	370	510	440	490	404	371.24
AL.CL.	290	393	379	378	400	440	342	375	374.63
Int.L	240	336	331	324	340	380	292	308	318.88

Table 4. Lengths (mm) and weights (gm) of *S. japonicus* (G4)

Parameters	S25	S26	S27	S28	S29	S30	S31	S32	Mean
TL	355	355	355	355	358	358	360	365	357.63
FL	323	323	328	329	324	332	330	343	329
SL	315	314	320	323	315	323	323	333	320.75
W	405	385	465	455	445	400	450	530	441.88
AL.CL.	480	376	429	438	450	440	430	475	439.75
Int.L	410	320	383	390	400	377	380	425	385.63

Table 5. Total length (TL) in mm, mean weight (W) in gm, alimentary canal mean length (Al.C.L) in mm and intestinal mean length (Int.L.) in mm of *S. japonicus*

Fish	Mean TL.	Mean Wt.	Mean Al.C.L.	Mean Int.L
G1	215.88	93.671	239.38	206.88
G2	239.5	123.65	256.88	215
G3	327.63	371.24	374.63	318.88
G4	357.63	441.88	439.75	385.63

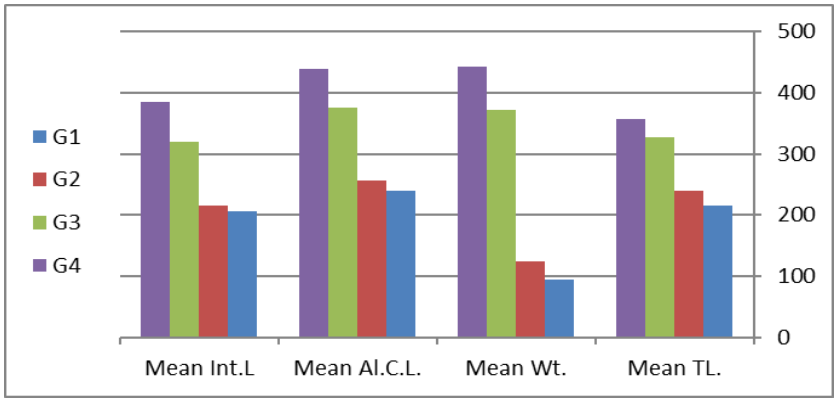

Figure 3. Histogram representing mean length, weight (index) of the alimentary canal of S. japonicus

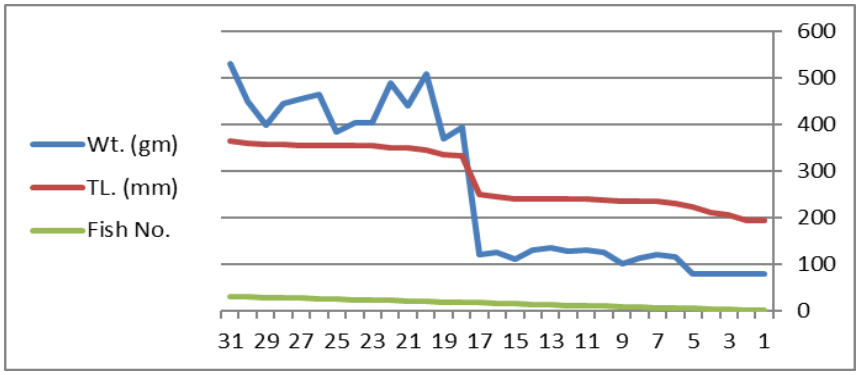

Figure 4. Length – Weight Relationships:($W=cL^n$) of *S. japonicus*

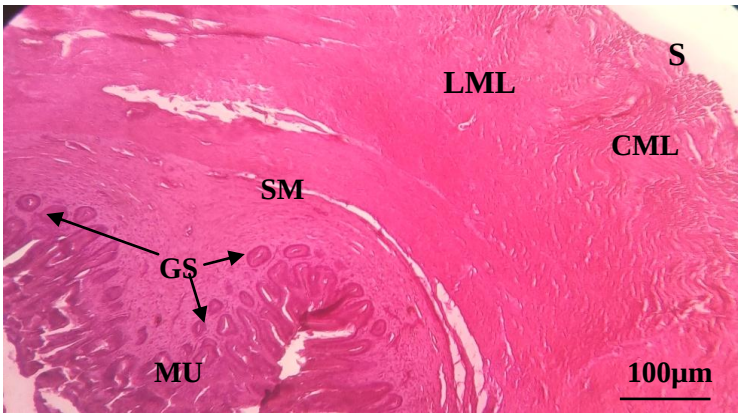

Figure 5. Photomicrograph of transverse section of the anterior part of the stomach of *S. japonicus* showing MU: mucosa, GS: gastric glands, SM: submucosa, CML: circular muscle layer, LML: longitudinal muscle layer, S: serosa (H&E, X 100).

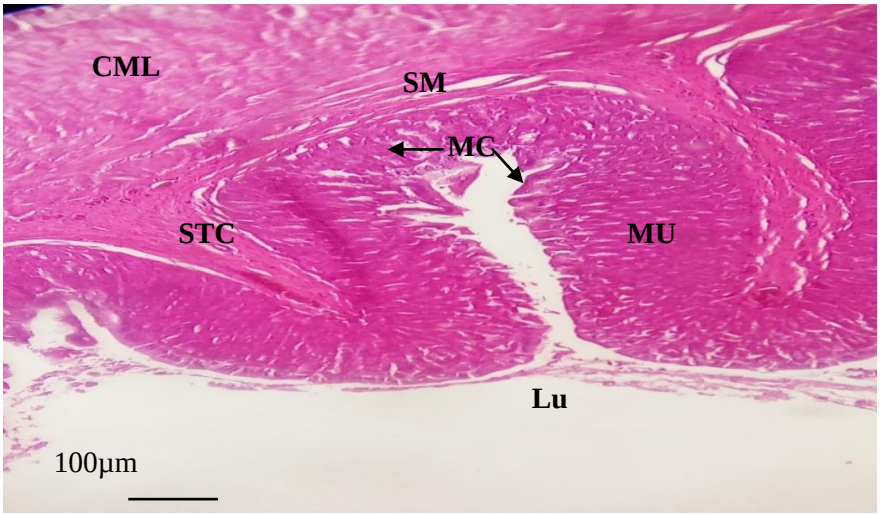

Figure 6. Photomicrograph of transverse section of the posterior part of the stomach of *S. japonicus* showing Lu: lumen, MU: mucosa, MC: mucous cells, submucosa, STC: stratum compactum, CML: circular muscle layer, S: serosa (H&E, X 100).

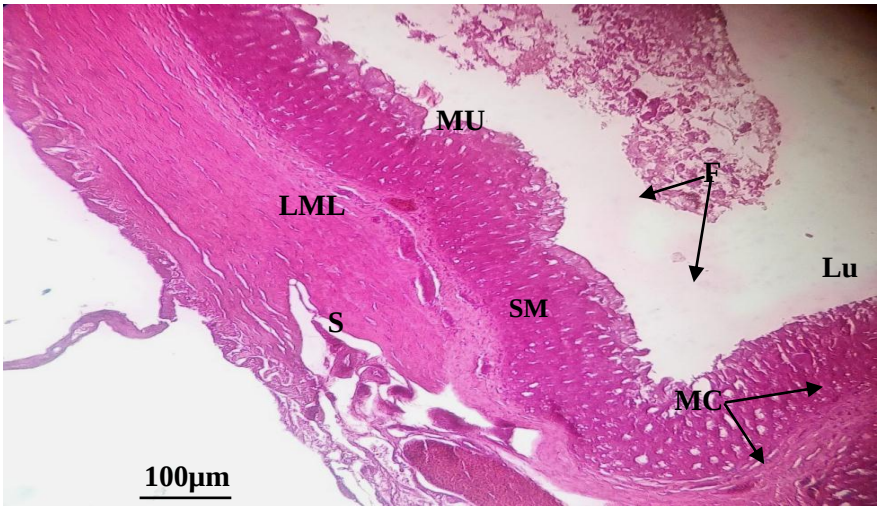

Figure 7. Photomicrograph of transverse section of the anterior part of the intestine of S. japonicus showing its general histological details F: mucosal folds, STC: stratum compactum, MC: mucous cells, Lu: lumen, MU: mucosa, SM: submucosa, LML: longitudinal muscle layer, S: serosa (H&E, X 100).

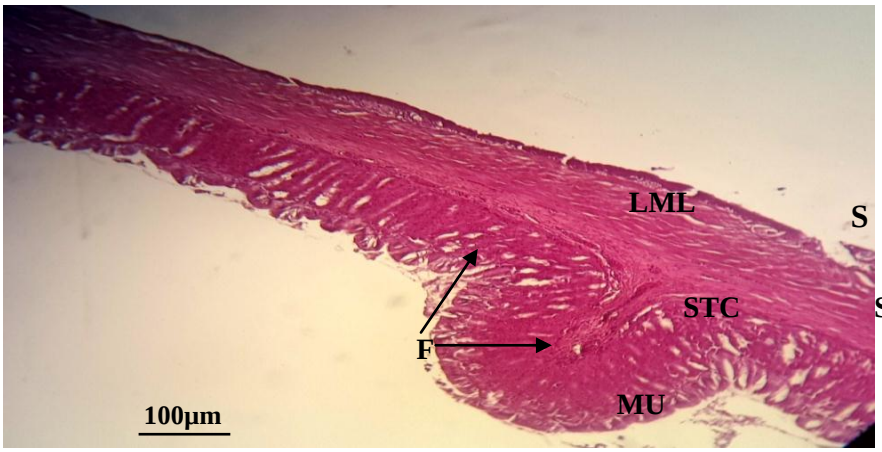

Figure 8. Photomicrograph of transverse section of the posterior part of the intestine of S. japonicus showing its general histological details F: mucosal folds, MU: mucosa, SM: submucosa, LML: longitudinal muscle layer, STC: stratum compactum S: serosa (H&E, X 100).

DISCUSSION

It is known that the weight of fish increase as a function of its length and the relation between length and weight is one of the most important biological parameters considered in fish biology [1 and 7]. The morphometric studies of different length of the fish species are important to understand their food and feeding habits. It is possible to find out the weight of a fish of known length and vice versa, the relationship between the two variables, viz. length and weight was determined by authors using the general formula $\mathbf{W=cL^n}$, where **W**= weight, **L**=length, '**c**' is a constant and '**n**' an exponent usually laying between 2.5 and 4.0 [29; 1 and 7]. In this study, the length and weight of fish species were studied in Tables (1-5). It was found that the increase of length of the body followed by increase in weight of the body and vice versa. In addition these ratios are represented by histograms (Figs. 3 & 4). The results in this study are expressing the relationships between fish length, weight and the digestive tract length for *S. japonicus* and agree well with that recorded by [23; 37; 1; 28; 7 and 5]. The results of the present study showed that the stomach and the intestine of *Scomber japonicus* have four layers similar to those of the vertebrate digestive tract: mucosa, submucosa, muscularis and serosa. These results are agreed with those of [1; 22; 12; 32; 4; 30; 8; 7 and 5]. The extent of development of the gastric glands, ranging from elaborate and complex to simple gland types, is an adaptation to the digestion times in fish with different feeding habits, and depends on the type of food items [1; 7 and 5]. The latter results are in agreement with those of the present study. The results of the present study showed that the intestinal mucosa displayed many mucous cells in the intestinal mucosa. These results have been observed in different fishes by many authors [33; 32; 4; 20; 34;

8; 7 and 5]. The stratum compactum is protective, supporting and strengthening layer which keeps the distension of the wall within bounds and is regarded as an adaptive characteristic in fish under investigation. Also it helps in absorption and transport of digested food to the intestine. These results are in agreement with those reported in many carnivorous fish by [31; 25; 1; 22 and 7]. Finally, in the present study, a possible correlation could be established between the food and feeding habits and the morphometrical and structure of the digestive system.

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دراسة مورفومترية ونسيجية في سمكة سكومبر جابونكس

كمال أحمد باعوم* ومنال حاج عبد*

قسم علوم الحياة- كلية العلوم- جامعة حضرموت (اليمن)

هاتف: ٠٠٩٦٧٧٣٩٧٠٠١٢٢ - بريد إليكتروني ayhembaaoom@gmail.com

يعيش سمك (الطبوب) سكومبر جابونكس نوع أقيانوسي، في البيئات الدافئة والمعتدلة في سواحل مياه المحيطات الأطلسي، الهندي والهادي. تم وصف القياسات المورفومترية والتركيب النسيجي للقناة الهضمية (المعدة والأمعاء) في ٣٢ عينة لسمك *S. japonicus* (بمعدل طول ٢١٥,٨٨-٣٥٧,٦٣ ملليمتر)، تم جمعها من سوق السمك في بحر المكلا (خليج عدن). شملت الدراسة المورفومترية قياسات الأطوال الخارجية للسمكة تمثلت في الطول الكلي، الطول الشوكي، الطول القياسي والوزن، كما شملت الدراسة قياس الطول الكلي للقناة الهضمية. سجلت هذه القياسات في جداول وتم التعبير عنها في رسوم بيانية خطية وعمودية وشرحت هذه الرسوم وتم تحليلها ومناقشتها. أما الدراسة النسيجية فتضمنت عمل مقاطع في مستويات مختلفة للمعدة والأمعاء، وتم دراسة المقاطع باستخدام المجهر الضوئي والتقطت الصور بواسطة كاميرا رقمية. أظهرت الدراسة المورفومترية تساوي قياسات طول القناة الهضمية بطول السمكة القياسي وزيادة طول القناة بالنسبة لطول تجويف الجسم المتمثل في المسافة بين طرف البوز وفتحة الشرج ويعود ذلك لالتفاف المعي في التجويف. تقع نتائج قياس نسبة طول القناة الهضمية إلى طول السمكة إلى نوع التغذية المختلطة (أكلة اللحوم والأعشاب).