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Estimation of the gill respiratory surface area and some features of the red muscle fibers intwo teleost species

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Abstract - The current study is a comparative analysis of the Gill Respiratory Surface Area (GRSA) and some features of the red muscle fibers including the proportions and diameters of the red muscle fibers in three body regions in two teleosts species; torpedo scad, *Megalspiscordyla*(L.) which belongs tothe carangid and the red belly tilapia, *Cotodonzillii*(Gervaias, 1848) which belongs to cichlids.Fifty fishes (25 fishes for each species) were used in the current investigation.Theyrange in length from100 to 300 mmandtheir weight ranged between66 and 305gm.The results showthat the *M. cordyla*have GRSA ranged between 78 and 100 mm^2/gm whereas it ranged between 56 and 146 mm^2/gm in *C. zillii*. The fish weight wasthe influentialfactor on the values of the relative GRSA (mm^2/gm) whilethe total length of gill filaments was the influentialfactor on the values of the total GRSA(mm^2) of the studied fishes which showed significant differences ($p<0.05$) between the studied species.The difference inthe proportions ofthe red muscle fibers among the three body regions of both species showed a significant difference ($P<0.05$)between the total length of the fish and the proportions of the red muscle fibers which ranged between8.16 and 12.80 %in *M. cordyla* whereas it was between5.42 and 9.24 % in *C. zillii*.Also the results presented anincrease in the proportions of the red muscle fibers towardsthe posteriorregion (R3) which were 8.80-12.80 % in *M. cordyla* while they were 6.24-9.24 %in*C. zillii*.The results revealed that the approximate diameters of the red muscle fibersvaried between13.70 and 47.85 µm in *M. cordyla* while they ranged between17.10 and 44.50 µm in *C .zillii* but were not statistically significant differences($P>0.05$)between thetwo species.

Keywords: Fish gill area, fish red muscle*, Megalspis, Tilapia*.

Introduction

Fish respiration involves the gas exchange between the water and the bloodthrough the gill epithelium. The abilityto acquire oxygen to sustain metabolic processes depends onthe gill respiratory surface area and the thickness of the water-blood barrier (Wegner, 2011; Wotton *et al*., 2015).The gill respiratory surface area measurements infisheshave becomeimportant parameters relatedto the growth and fish activity (Hughes,1984,1989; Mansour,2008)it wasconsideredthe primary sitefor gaseous and ionic exchange with the environment (Palzenberger and Phola,1992),due to thepresence of the different types ofcells in the secondary lamellae such as mitochondrial rich-cell and othertypes of cells (Moyla and Cech, 1996; Evans *et al*., 1999; Evan *et al*. 2005;Huang *et al*., 2011).Fish gill structure varies in relationto the activitylevel andhabitat,such as fisheswith highmetabolic

requirements generally have gill specializations and active gas transfer(Graham, 2006; Wegner *et al*.,2010).Gill components including the total length of the gill filaments (L), the number of respiratory lamellae on the filaments per mm (N), and lamellar bilateral surfacearea(Bl), are altered by selective factors to augment gill surface area and increase oxygen uptake from the water(Wegner*et al*.,2010). Roubal (1987) classify the fishes on the basisof varied factors;such as thenumbersand lengths of the gill filaments, values of the total and relative gill respiratory surface area, into threelocomotion groups;active fish,intermediate and sluggish fishes.

In sight of the musculartissueof the fish, it consist ofthreetypes ofmusclefibers; slowred muscles, fastwhite musclesand intermediatepinkmuscles.Thesetypesare different insite, color, proportionsandfunctionalrole(Bone,1966; love,1980; Rabah,2005;Peng andJoe,2009; Karahmet*et al*., 2014).The proportions of the muscle fiber typesvaried fromregion to another in the same species and different species(Love,1980). The proportions of the red muscle(0-20 %)is less than of the proportions of white muscle (80%) (Greer-Walker and Pull,1975) the results are based on 84 species of marine fish.The diameteroftheredandwhitemusclesfibershave a sigmoid characters, the redmusclesfibershave constant diametersranged from 30 to 40 µmat body length of25-35 cm,inthe same time the diameterof thewhitemusclesfibershavediameters ranged from 80 to 120 µm for the samelength (Greer,1970;Urfiand Talezera,1989; Mansour,1998; 2005; Karmahet*et al.*, 2014).The aim of the present study isto estimatethegillrespiratoryarea andto showthedifferences in proportions and diametersofthe red muscle fibers in three different regions of the body in two species ofteleosts.

Materials and Methods

Sampling:

Twenty five specimen of *Megalspiscordyla*(L.) belonging to the Carangidae, they ranged from 100 to 300 mm in total length and from 185 to 305gm in weight and25 specimen of *Cotodonzillii*(Gervaias, 1848) which belongs to the Cichlidaeranged from 100 to 300 mm T.L and from 66 to 280 gm weight).They were collected from Al-Basra market between November-2016 andJanuary-2017.

Gill Respiratory Surface Area (GRSA):

Twenty five samples from each species were collected. The gills were dissected from each sample and some measurements were made immediately on the fresh gills of one side. All measurements were made under a binocular microscope using a micrometer eyepiece.

The total number of the filaments on each gill arch was counted and the lengths of every twenty filamentswere determined. The spacing of the secondary lamellae was measured on several filaments from each of the gill arches. The area ofthe secondary lamellae is not so constant, being larger for those lamellae nearest the base of the filaments. The areas of a number of the secondary lamellae from different levels of a given filaments were measured; the measurement was repeated on filaments from different gill arches (Hughes, 1984).The total surface areas of GRSA were estimated using the method developed byHughes (1984), and calculated as follows:

$A = L\ n\ bl$ .... (Hughes, 1984).

Where (A) is the gill respiratory surface area, (L) is the mean total length of all gill filaments,(n) is the mean frequency of secondary lamellae on both sides of the filament per mm, and (bl)is the mean bilateral surface area of the secondary lamellae. The allometric relation between GRSA and body weight was expressed as follows:

$Y = aw^{b}$..................................(Satoraand Romek, 2010).

Proportions of the Red Muscle Fibers:

To calculate the proportions of red muscle fibers in both species offishes, three sections from the body of the fish were taken (R1; anterior of the dorsal fin, R2; posterior of the dorsal fin and R3; near the caudal peduncle). They were photographed and projected onto tracing paper and the outline of the red muscle traced. Tracing of the red muscle were cut and weighted and proportions of both types of fibers (red and white) were expressed as percentage of the total area of cross section(Broughton *et al.*, 1981).

Diameter ofthe Red Muscle Fiber:

Tomeasure the diameters, 50 red muscle fibers in frozen sections from (R1, R2 and R3 rejoin) samples were stained with Sudan Black B, and measured directly using an ocular micrometer. Since the cross-sectional outline of the red muscle fibers are not perfectly circular, measurements were taken for the largest and the smallest diameters of the red muscle fibers (Al-Badri*et al.*, 1991).

Statistical Analysis:

In order to determine thedifferences betweentherates ofthe fish weight and components of the gill respiratory surface areaas well asthe differences between the total length ofthefishes and the proportions, diameters of the redmusclefibersfrom three different regions of the body of the fishes were used.The Statistical Package for Social Sciences (SPSS 16) was used. The significance was considered under the probability of $P<0.05$. Excel program was used to calculate the correlation coefficient between variables.

Results

The present results indicate differences in the componentsofthegill respiratory surface area which include the (L): total length of gill filaments (number of gill filaments × mean of gill filament length), N: number of secondary lamellae per mm and (bl) and area of bilateral secondary lamellae, these components had lowest values in the smallest weight groups in comparison with the largest weight groups (Tables 1 and 2). The totallength ofgillfilament in *M. cordyla*was between 11860.10 and 17830.20 mm (Table 1) whereas,they were ranging between 6830.40 and 10860.0 mm in *C. zillii*(Table 2). The statistical analysis showed that there is apositive correlation between the total length of the gill filaments and the fish weight in both species of fishes which were 0.996 and 0.993 in *M. cordyla*and *C.zillii*, respectively (Table 3 and Fig. 1).The statistical analysis showed significant differences ($P<0.05$) between the two species (Table 4). The results showedan approximate values of each (N, Bl) in the two species which were 38.40-44.30 and 0.030-0.044 mm in *M. cordyla* (Table 1),whereas they were 36.50-42.50 and 0.030-0.036 mm in *C. zillii*(Table 2).

Table 1. Means of fish weightand length and the components of the gill respiratory surface area in *M. cordyla*.

Total length groups (mm)	Mean Total length (mm)	Mean fish weight (gm)	No. of fish	Mean total length of gill filaments (mm)	Mean no. of secondary lamellae	Mean bilateral secondary lamellae area (mm)	Mean total gill area (mm²)	Mean relative gill area (mm²/gm)
100-139	135.60	185.50	5	11860.10 ±98.3	38.40 ±0.54	0.044 ±0.002	18027.20 ±220.30	100.15 ±0.98
140-179	165.80	210.0	5	12965.10 ±130.20	40.20 ±0.48	0.041 ±0.002	19944.0 ±150.60	99.72 ±0.84
180-219	210.20	240.0	5	14660.0 ±85.90	42.10 ±0.22	0.034 ±0.003	20934.5 ±105.40	87.20 ±6.30
220-259	225.80	275.40	5	16450.8 ±145.80	43.40 ±0.14	0.032 ±0.002	22108.8 ±325.10	80.39 ±4.60
260-300	275.60	305.40	5	17830.2 ±135.12	44.30 ±0.32	0.030 ±0.001	23535.6 ±95.66	78.48 ±5.20

± Standard Deviation.

Table 2. Means of fish weight and length and the components of the gill respiratory surface area in *C.zillii*.

Total length groups (mm)	Mean Total length (mm)	Mean fish weight (gm)	No. of fish	Mean total length of gill filaments (mm)	Mean no. of secondary lamellae	Mean bilateral secondary lamellae area (mm)	Mean total gill area (mm²)	Mean relative gill area (mm²/gm)
100-139	125.60	66.10	5	6830.40 ±72.90	36.5 ±0.54	0.036 ±0.003	8786.80 ±130.50	146.40 ±5.26
140-179	160.40	96.10	5	7582.10 ±180.15	39.16 ±0.75	0.034 ±0.002	9586.40 ±215.18	112.78 ±10.22
180-219	200.10	145.82	5	8480.36 ±260.76	40.50 ±0.54	0.032 ±0.002	10547.10 ±94.50	87.89 ±23.20
220-259	225.80	207.08	5	9504.17 ±267.37	41.50 ±0.60	0.032 ±0.003	11852.80 ±124.13	69.26 ±18.70
260-300	275.60	280.10	5	10862.0 ±22.80	42.50 ±0.52	0.030 ±0.002	13658.40 ±120.40	56.90 ±12.28

± Standard Deviation.

Table 3. Correlation coefficients (r) between means of fish weight and the components of the gill respiratory surface area in *M. cordyla*and *C. zillii*.

The Studied Features	*M.cordyla*	*C. zillii*

Total length of gill filaments	0.996	0.993
No. of secondary lamellae per mm	0.979	0.919
Bilateral secondary lamellae area	-0.973	-0.946
Total gill surface area	0.981	0.997
Relative gill surface area	-0.967	-0.978

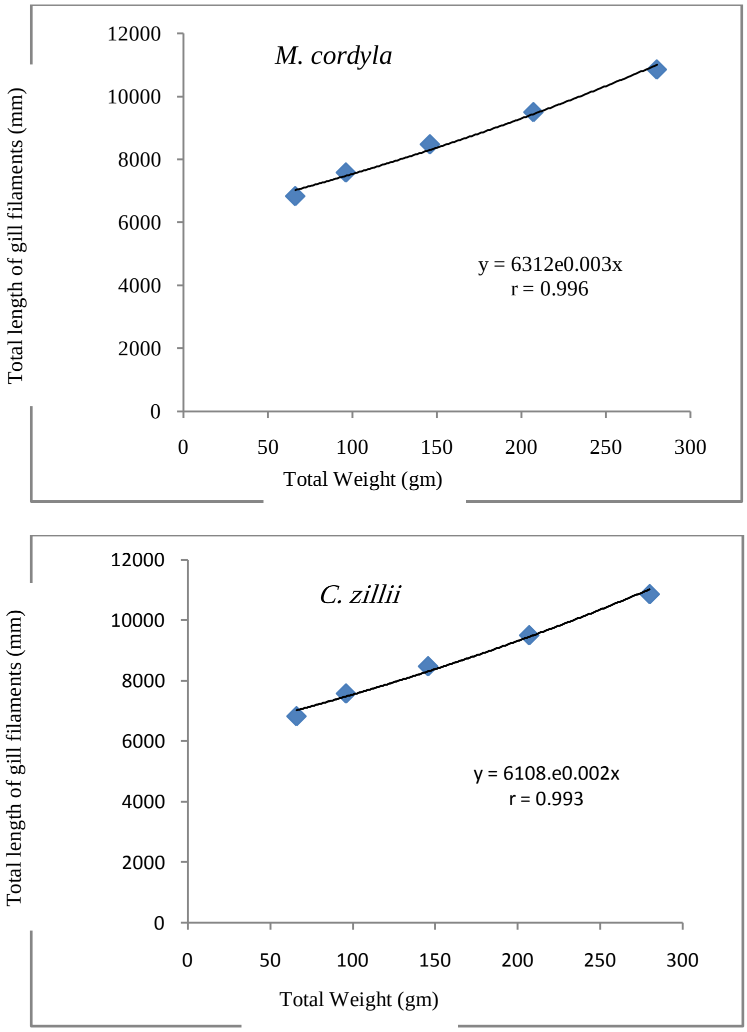


Figure 1. The relationships between the total length of gill filaments and total weight in *M.cordyla and C.zillii.*

Table 4. Statistical analysis of the components of gill respiratory surface area in *M. cordyla*and *C. zillii.*

The Studied Features	F - values	Values of significant level	Statistical Differences
Total length of gill filaments	21.881	0.02	Significant
No. of secondary lamellae per mm	1.459	0.262	Non-significant
Bilateral secondary lamellae area	2.667	0.141	Non-significant
Total gill surface area	62.016	0.000	Significant
Relative gill surface area	0.33	0.860	Non-significant

However, thestatistical analysis of N and Bl indicate no significant differences (P>0.05) between the two species of fishes(Table 4), while the current results showed different values of the correlation coefficient between the two fish species in N andBlwhich were 0.979 and 0.919 in *M.cordyla* and *C. zillii*, respectively (Table 3), whereasthe values were recorded -0.973and -0.946 in*M.cordyla*and *C.zillii,*respectively (Table 3).

The current results showed a difference in the values of the total gill respiratory surface area (mm^2) between both species, *M.cordyla*had the largest values compared with *C.zillii*, as the range were 18027.20 and 23535.6 mm^2 in *M.cordyla*(Table 1), whereas the total gill area were ranged between 8786.80 and 13658.40 mm^2 in*C.zillii*(Table 2).

The statistical analysis results showed a positive correlation between the total respiratory surface area and fish weight in both fishes which were 0.981 and 0.997 in*M. cordyla* and *C.zillii*, respectively (Table 3 and Fig. 2). Moreover, the statistical analysis showed significant differences ($P<0.05$) between the two species of fish (Table 4).

The results indicate difference in thetwo fish species in the values of the relative gill respiratory surface area (mm^2/gm) which wasranging between 78 and 100 mm^2/gm in *M.cordyla*andbetween 56 and 146 mm^2/gm in *C.zillii*(Tables 1 and 2), but there were nosignificant differences ($P>0.05$) between the two species of fishes (Table 4).

In spite of the difference studied fishes in weights of the two species (Tables 1 and 2), the results showed anegative correlation between the relative gill respiratory surface area and the fish weight in bothspecies: -0.967, -0.978in *M. cordyla* and *C.zillii*(Table 3 and Fig. 3),respectively.

Tables (5 and 6) showed therates of the proportions and diametersofthe red muscle fibers in the twospecies. The results elucidated the differences in the proportions of the red muscle fibers in the three different regions of fish. They ranged between 8.16 and 11.14 % in R1 in *M.cordyla*and between 5.42 and 8.36 % in R1 in *C.zillii* (Tables 5 and 6) while they ranged from 8.40 to 12.20 % andfrom 5.82 to 8.50 % in the second region (R2) in *M.cordyla* and *C.zillii*,respectively.Whereas, theyranged from 8.80 to 12.80 % and from 6.24 to 9.24 % in the third region(R3) for*M.cordyla*and *C.zillii*, respectively (Tables 5 and 6).

The current results showed increasing proportions of the red muscle fibers towards the third region (R3) in the two species. The results showeda positive correlation between the proportions ofthe red muscle fibers and fish length in both species which were 0.971, 0.944, 0.987 in R1, R2 and R3, respectively in *M. cordyla* and 0.992, 0.985,0.976 in R1, R2 and R3, respectively in *C.zillii*,respectively(Table 7 and Figs. 4 and 5). Theresultselucidated significant differences($P<0.05$) between the two species and in the three regions (Table 8).

Theapproximate means of the diameters of the red muscle fibers in studied regions (R1,R2 andR3)was found to be ranging from 23.98 to 47.85 μ in R1 in *M.cordyla*(Table 5) whereas in R1 in *C. zillii*was26.30-44.50 μ(Table 6). In R2 and R3 the diameters of the red muscle fibers in *M. cordyla*ranged from 17.30 to 45.26 μ andfrom 13.70 to 40.30 μ in *M.cordyla*(Table 5), whereas it ranged from 20.50 to 41.20 μand from 17.10 to 38.25 μ in R2 and R3 of*C.zillii*(Table 6). However, the results did not show significant differences ($P>0.05$)between the two species(Table 8).

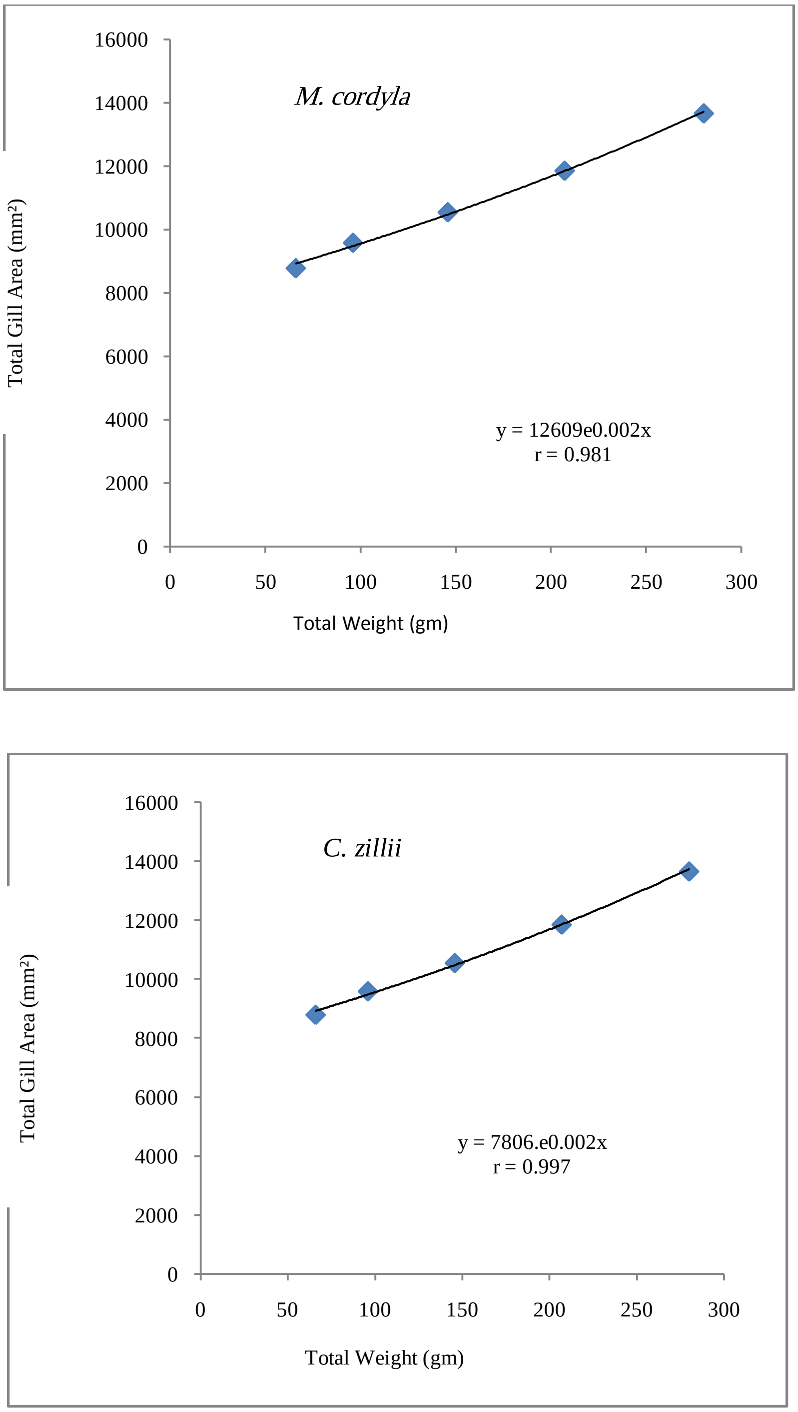
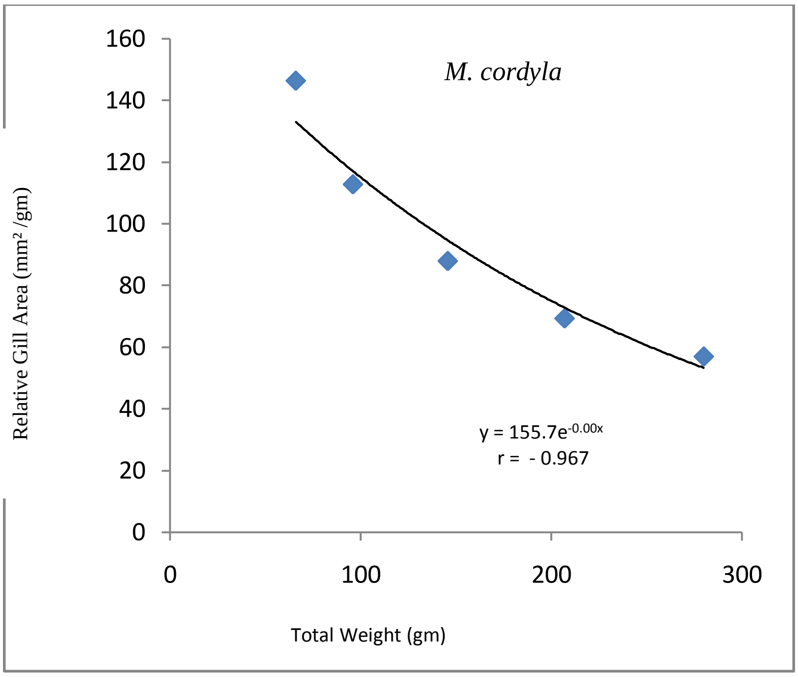


Figure 2. The relationships between the total gill area and total weight in *M.cordyla*and *C.zillii.*



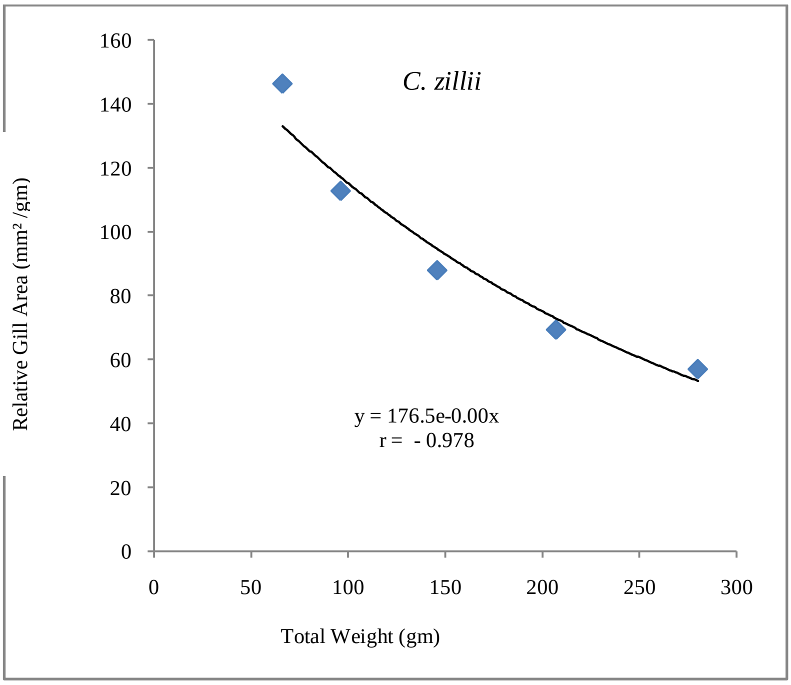


Figure 3.The relationships between the relative gill area and total weight in *M.cordyla*and *C.zillii*.

Table 5. Means of fish weight and length and the proportions and diameters of the red muscle fibers in *M. cordyla*.

Length groups (mm)	Total length (mm)	Fish weight (gm)	No. of fish	Mean proportions of red muscle fibers in R1	Mean proportions of red muscle fibers in R2	Mean proportions of red muscle fibers in R3	Mean diameters of red muscle fibers in R1	Mean diameters of red muscle fibers in R2	Mean diameters of red muscle fibers in R3
100-139	135.60	185.50	5	8.16 ±0.06	8.40 ±0.05	8.80 ±0.04	23.98 ±2.34	17.13 ±2.45	13.70 ±3.80
140-179	165.80	210.0	5	8.40	9.80	10.20	27.40	24.12	20.55

				±0.08	±0.08	±0.06	±1.69	±1.80	±2.68
180-219	210.20	240.0	5	9.24 ±0.06	10.40 ±0.08	10.90 ±0.08	37.67 ±5.58	34.25 ±4.60	27.50 ±3.84
220-259	225.80	275.40	5	10.32 ±0.08	10.80 ±11.20	11.40 ±0.04	44.52 ±3.82	41.20 ±2.60	36.15 ±2.69
260-300	275.60	305.40	5	11.14 ±0.06	11.20 ±0.08	12.80 ±0.07	47.85 ±1.94	45.26 ±2.80	40.30 ±3.68

± Standard Deviation.

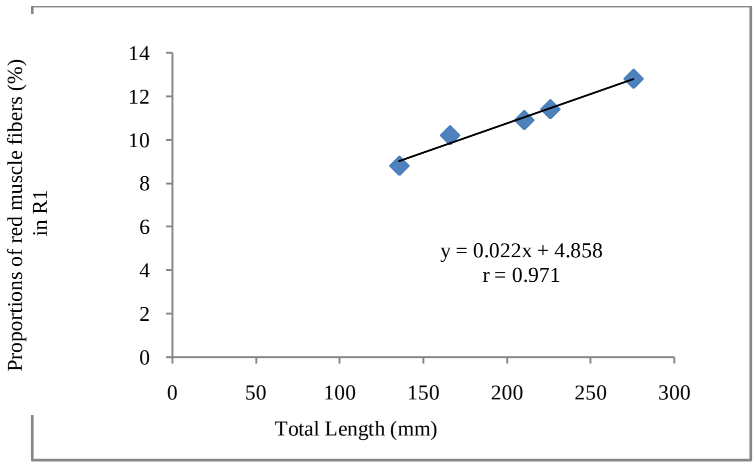
Table 6. Means of fish weight and length and the proportions and diameters of the red muscle fibers in *C. zillii*.

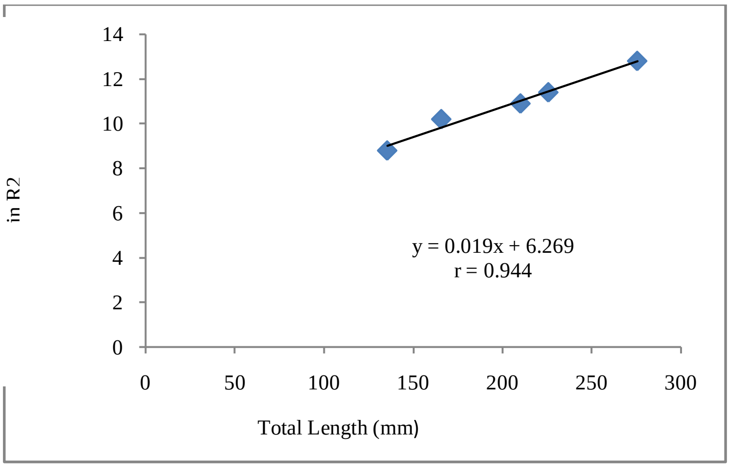
Length groups (mm)	Total length (mm)	Fish weight (gm)	No. of fish	Mean proportions of red muscle fibers in R1	Mean proportions of red muscle fibers in R2	Mean proportions of red muscle fibers in R3	Mean diameters of red muscle fibers in R1	Mean diameters of red muscle fibers in R2	Mean diameters of red muscle fibers in R3
100-139	125.60	66.10	5	5.42 ±0.24	5.82 ±0.23	6.24 ±0.22	26.30 ±2.65	20.50 ±2.40	17.10 ±1.82
140-179	160.40	96.10	5	6.24 ±0.34	6.36 ±0.18	6.58 ±0.16	30.82 ±2.48	27.40 ±3.24	20.40 ±1.38
180-219	200.10	145.82	5	6.82 ±0.24	7.12 ±0.20	7.48 ±0.23	37.60 ±3.68	34.25 ±4.60	30.80 ±3.24
220-259	225.80	207.08	5	7.28 ±0.35	7.32 ±0.10	7.82 ±0.18	40.20 ±1.50	37.60 ±1.46	35.15 ±2.40
260-300	275.60	280.10	5	8.36 ±0.47	8.50 ±0.44	9.24 ±0.16	44.50 ±1.72	41.20 ±2.25	38.25 ±1.50

± Standard Deviation.

Table 7. Correlation coefficients (r) between means of fish length and the proportions and diameters of the red muscle fibers in*M. cordyla*and *C.zillii.*

The Studied Features	*M. cordyla*	*C. zillii*
Rate of proportions of red muscle fibers in R1	0.971	0.992
Rate of proportions of red muscle fibers in R2	0.944	0.985
Rate of proportions of red muscle fibers in R3	0.988	0.976
Rate of diameters of red muscle fibers in R1	0.972	0.993
Rate of diameters of red muscle fibers in R2	0.978	0.985
Rate of diameters of red muscle fibers in R3	0.976	0.978





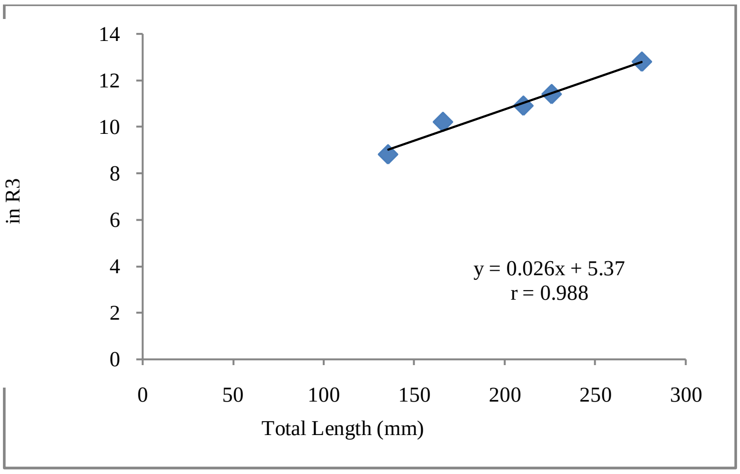
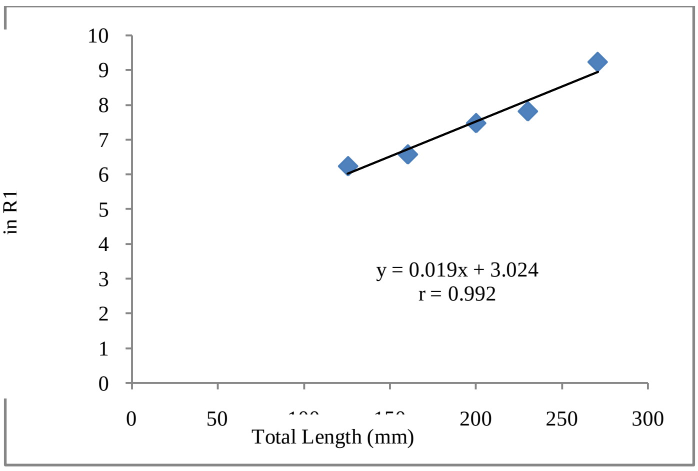


Figure 4. The relationships between the proportions of red muscle fibers and total length in three regions (R1, R2 and R3) in *M.cordyla*.



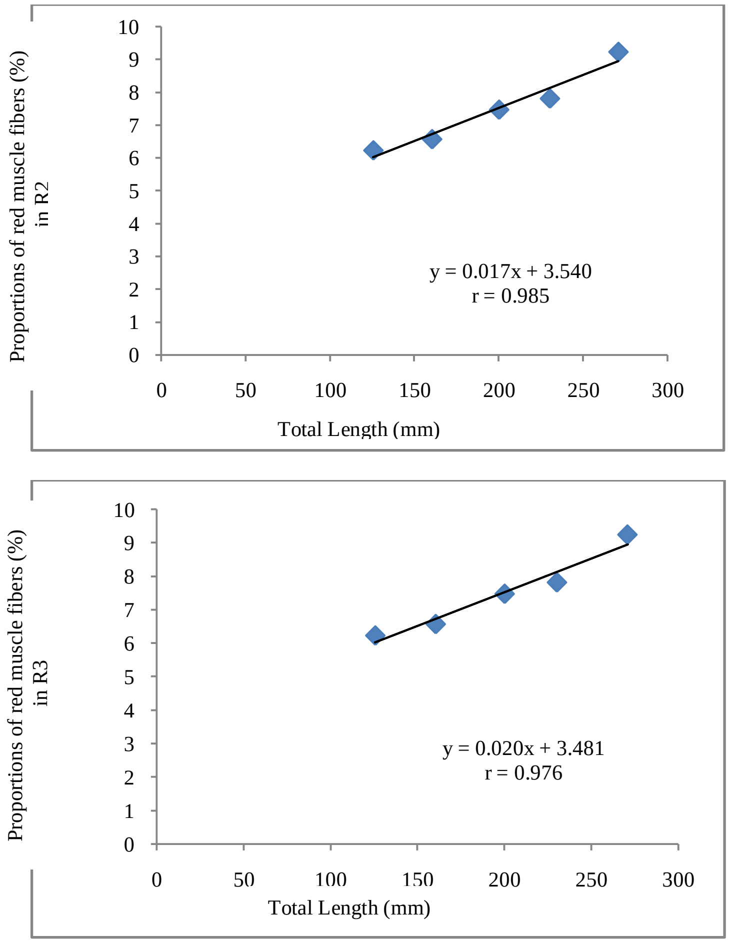
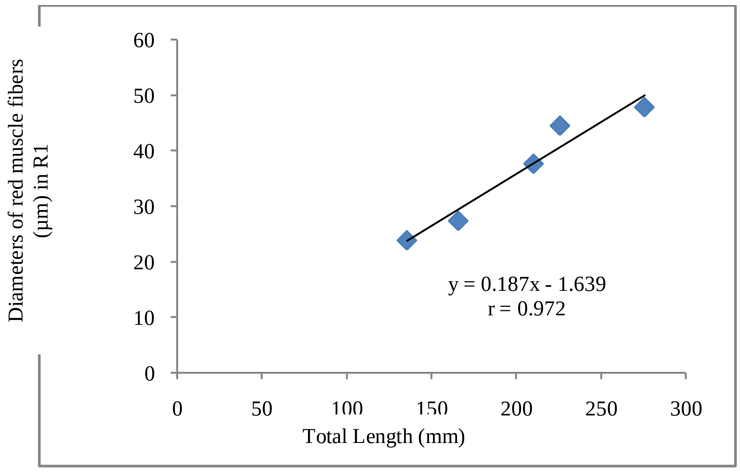
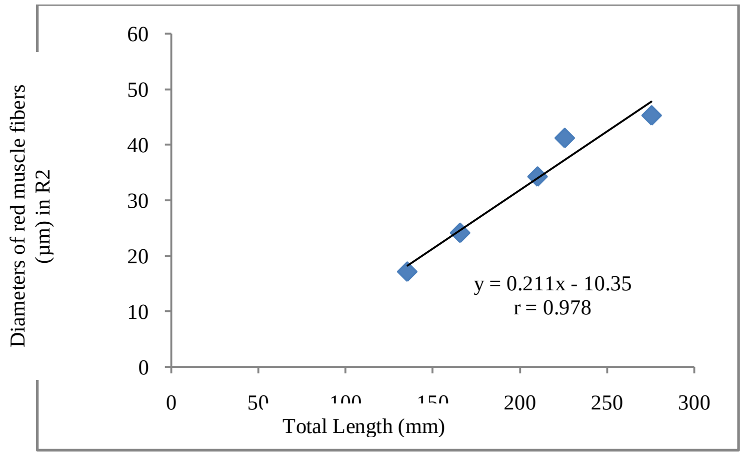


Figure 5. The relationships between the proportions of red muscle fibers and total length in three regions (R1,R2and R3) in *C. zillii*.





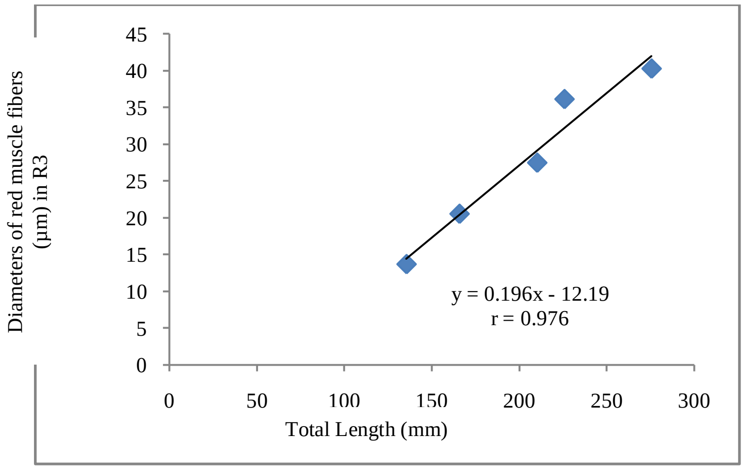
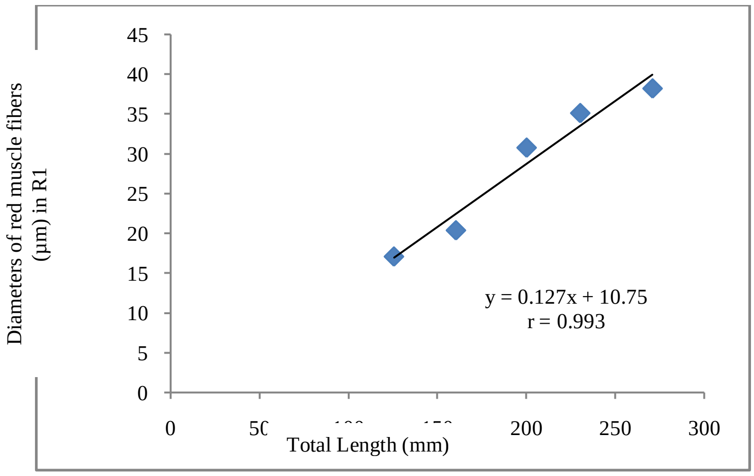
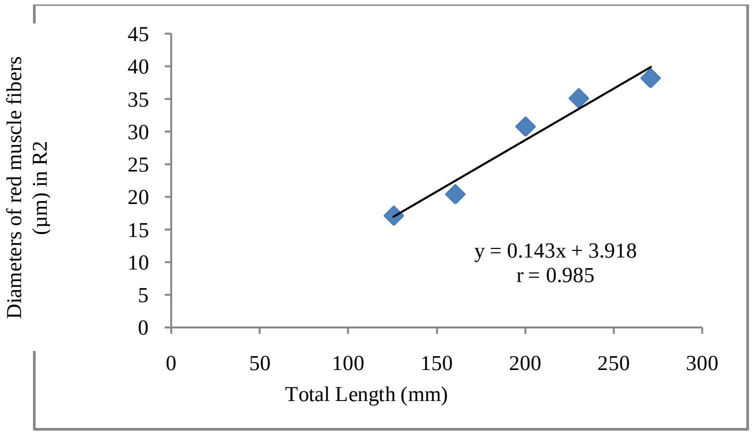


Figure 6. The relationships between the proportions of red muscle fibers and total length in three regions (R1, R2 and R3) in *M.cordyla*.





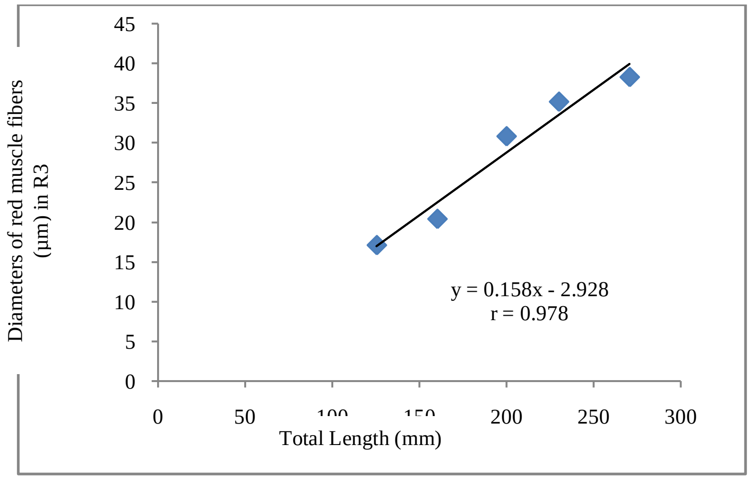


Figure 7. The relationships between the proportions of red muscle fibers and total lengthin three regions (R1, R2 and R3) in *C.zillii*.

Table 8. Statistical analysis of the proportions and diameters of red muscle fibers in *M.cordyla* and *C.zillii*.

The Studied Features	F – values	Values of significant level	Statistical Differences
Rate of proportions of red muscle fibers in R1	12.220	0.008	Significant
Rate of proportions of red muscle fibers in R2	18.268	0.003	Significant
Rate of proportions of red muscle fibers in R3	15.690	0.004	Significant
Rate of diameters of red muscle fibers in R1	0.005	0.946	Non-Significant
Rate of diameters of red muscle fibers in R2	0.001	0.976	Non-Significant
Rate of diameters of red muscle fibers in R3	0.012	0.916	Non-Significant

The current results revealed a decreasein the means of diameters of the red muscle fibers in third region (R3) in the two species, it ranged from 13.70 to 40.30 µ and from 17.10 to 38.25 µ in *M. cordyla* and *C. zillii*,respectively (Tables 5 and 6), but the average of diameters of the red muscle fibers increased with increasing the fish length in both species, therefore the results showed a positive correlation between the diameters of the red muscle fibers and fish length in both species which were 0.972, 0.978, 0.976 in R1, R2 and R3in *M. cordyla* while 0.993, 0.985,0.978 in R1, R2 and R3 those of *C. zillii* (Table 7 and Figs. 6 and 7).

Discussion

The gills are related to many important functions offishes, they are considered the main respiratory sites ofgas exchange,excretion and osmoregulation in all fishes(Moyle and Cech, 1996).While the secondary function is related to feeding habits where the organization ofgill filaments andrakersreflected the feedinghabits of the fish (Fernandes*et al.*, 2003; Kumari*et al.*, 2009).Therefore, the results of the present study showed differences in the average total length of the gill filaments and number of the secondary lamellae which variedwith the body weight of*Megalspiscordyla*and *Cotodonzillii*, all of these factors affectthe values of the gill respiratory surface area.Especially the total length of the gill filament which wereinfluential factor on the values of the total respiratory gill area inthe two species.

In addition, increasing the length of gill filaments in the gills reflects the activity and growth of fish, which leads to the growth of new gill filaments with the fish grows (Hughes, 1989;Mazon*et al.*,1998).These results agree with many previous studies such as those of Mansour (2005), Karakatsouli*et al.*(2006),Satora and Romek (2010),Oda(2015).

However, measurements of other factors (N,bl)does not affecton values of total respiratory surface area, this is probably because of the values approximation ofthe number and bilateral secondary lamellea (N, bl) in both fishspecies.The current resultsdetected a negative relationships between the body weight and thegill surface area in both species,and this is in accordance with the results ofHughes(1984).This indicate thatthe lowestweight groups had high gill surface area

compare with high weight groups which had lowgill surface area which represents anincreasingactivities of the smallerfishes comparedwith larger fishesand that is a reflection tothe mode oflife and metabolic requirements offish (Hughes, 1989;Mazon*et al.*, 1998,Mansour,2005; Saliu and Olonire, 2008;Wenger *et al.*, 2010).Thus,*M. cordyla*and *C. zillii* may have anintermediate activity,according to the classification ofRoubal(1987).

The muscular tissue constitute up to 60-80%ofthe fish body weight. The fish swimusinga combination of paired, unpaired fins and undulations of the myotomal muscles (Johnston, 1981; Altringham and Ellerby, 1999; Adamek*et al.*, 2017).Red muscle fibers usually constitute less than10 %of the myotomalmusculature. Also, the red muscle fibers are called slow fibers and usedmainly for sustained swimming(Sanger and Stoiber, 2001).

The fish show variations in the proportions of the red muscle fibers which reflect the differences in the distribution ofred muscle in the body of the fish (Love, 1980), in addition to the increaseof the proportions of red muscle towardsthe posterior region of thefish which indicates an increase in the numbers of the fibers(hyperplasia) (Karahmet*et al.*, 2014; Oda, 2015; Adamek*et al*, 2017).Also, the current results showed anincrease in the proportions of the red muscle fibers with the increase offish length in both species whichrepresents the growth and development of the redmuscle fibers, this increaselends to supportthe hypothesis that red muscle is associated with sustained speeds (Greer-Walker,1970;Al-Badri,1985;Mansour,2005).

Musclegrowth is associated with the recruitments of new fibers (hyperplasia) and/or the increase in the volume of muscle fibers (hypertrophy), such that the muscle may contain fibers with a wide range of diameters, the red muscle fibers usually are small in diameter (25-45 µm) (Kiessling*et al.*, 2006; De Mello *et al.*, 2016).

The present study showed differences in the diameters ofred muscle fibers in different regions inthe two species and a decrease in diameters of the red muscle fibers in the posterior region (caudal peduncle) which represents amuscle growth and development in the fish by the two processes; hyperplasia and hypertrophy (Adamek*et al.*, 2017). The increase of the numbers of muscle fibers in theposterior region of the fish reflectsthe importanceof thisregion in fish locomotion(Al-Badri, 1985;Mansour, 1998, 2005).

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تقدير المساحة السطحية التنفسية للغلاصم وبعض الخصائص للعضلات الحمر في نوعين من الأسماك العظمية

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المستخلص - تناولت الدراسة الحالية إجراء مقارنة للمساحة السطحية التنفسية للغلاصم وبعض الخصائص للعضلات الحمر التي تضمنت نسب وأقطار الألياف العضلية الحمر

في ثلاث مناطق جسمية في نوعين من الأسماك العظمية هما سمكة *Megalspiscordyla*(L.)التي تعود إلى عائلة Carangidaeوسمكة *Cotodonzillii* (Gervaias, 1848) التي تعود إلى عائلة Cichlidae. استخدمت25 سمكة من كل نوع تراوحت أطوالهابين100 و 300 ملم وأوزان بين66 و 305 غم. أوضحت النتائج امتلاك *M. cordyla* مساحة تنفسية نسبية تراوحت بين 78-100ملم^2/غم بينما تراوحت بين 146-56ملم^2/غم في*C.zillii*، وكان وزن الأسماك العامل المؤثر في قيم المساحة التنفسية النسبية للغلاصم بينما كان معدل الطول الكلي للخيوط الغلصمية العامل المؤثر في قيم المساحة التنفسية المطلقة (ملم ^{2}) والتي أظهرت اختلافات معنوية (P>0.05) بين الأنواع المدروسة. أظهر الاختلاف في نسب الألياف العضلية الحمر بين المناطق الجسمية الثلاث في كلا النوعين المدروسين وجود اختلافات معنوية (P>0.05) بين الطول الكلي للأسماك ونسب الألياف العضلية الحمر والتي تراوحت بين 12.80%-8.16 في *M. cordyla* بينما كانت 5.42-9.24% في *C. zillii*، كما أوضحت النتائج زيادة نسب الألياف العضلية الحمر باتجاه المنطقة الخلفية للجسم (R3) والتي تراوحت بين 8.80 و 12.80%في *M. cordyla* بينما تراوحت بين6.24 و9.24%في *C. zillii*. بينت النتائج الحالية تقاربا في قيم أقطار الألياف العضلية الحمر في الأنواع المدروسة والتي تراوحت بين 13.70 و 47.85مايكرون في *M. cordyla* بينما تراوحت بين17.10 و 44.50مايكرون في *C. zillii* لكن النتائج الإحصائية لم تظهر اختلافات معنوية (P<0.05) بين الانواع المدروسة.

الكلمات المفتاحية: مساحة الغلاصمللأسماك، عضلات الأسماك،Tilipia ، Megalspis