INT. J. BIOL. BIOTECH., 8 (1): 41-46, 2011.

COMPARATIVE STUDY OF DIFFERENT PARAMETERS OF CTENOID SCALES IN FIVE SPECIES OF GENUS *LUTJANUS* (PERCIFORMES: LUTJANIDAE) COLLECTED FROM FISH HARBOR, KARACHI, PAKISTAN

***Zubia Masood and Rehana Yasmeen Farooq**

Department of Zoology, University of Karachi, Karachi-75270, Pakistan.
**email: masoodzubia@gmail.com.*

ABSTRACT

Comparative study of ctenoid scales was conducted with reference to the total body length of species belongs to *genus Lutjanus* of the family Lutjanidae collected from Karachi fish harbor. The main objective of this study was to find out the relationship among the total length of fish and its scales parameters. About 351 samples were collected during survey from Karachi fish harbor, in the years 2007-2008. The total catch samples contained 87 individuals of *L.johnii*; 87 of *L.lutjanus*; 80 of *L.russellii*; 52 of *L.malabaricus* and 45 of *L.fulvus. L.johnii* and *L.lutjanus* were equally abundant, while *L.fulvus* was less abundant in number. Present work about the detailed structure of fish scales can be helpful in identification of fish up to major groups or species levels.

Key words: Ctenoid Scales, Scales types, *Lutjanus*, Karachi coast.

INTRODUCTION

Fish scales are remarkable structures. The number of rows as well as the scale types are characteristics considered for species identification. The morphological diversity and function of scales in fish always attracted the many researchers. Surprisingly few studies have contributed a considerable significantly to knowledge of fish scale morphology as it related to taxonomy of bony fishes. A great number of papers are dedicated to the special study of the fish scale. Agassiz (1833) was the first who divided the fishes into four groups on the basis of structure of their scales, (i) Placoidei (ii) Ganoidei (iii) Ctenoidei (iv) Cycloidei (Creaser, 1926). Main specific features of scales in representative of the large taxa of bony fishes have been described in the papers of Cockerell (1913). In his study, he described the various characters, such as, scale length, breadth, different types and shapes of ctenii, different position of focus and radii in different families of fishes. He also studied the scales of gray snapper (*Neomaenis griseus)* and mutton snapper *(Neomaenis analis)* of family Lutjanidae. He gives the arrangement of ctenii, radii and circulii on the scales of these two species (on page 160). Hubbs (1921) observed the character of ctenii in Mugilid species are of considerable taxonomic importance. As revealed from this study, the size, shape, structure and development of the scales of these species show marked specific variations and these characters provide a reliable key for their correct identification. Lagler (1947) noted the character "least usable for diagnostic purposes even at the major taxonomic level of families are absolute size, shape and number of various countable structures and the position of focus on fish scales". Pillay (1951) discussed the affinities of Mugilid scales and their importance in evolution. Van Oosten (1957) recognized desirable features of scales from the view point of species identification. Mc Cully (1961) studied the comparative anatomy of serranid fish scales. Later the scale morphology became more important in systematics and phylogeny after the introduction and development of scanning electron microscopy (De Lamates and Courtenay, 1974; Hughes, 1981). Batts (1964) provided a key based on the morphological characters of scales, e.g. radii, circulii, position of focus and ctenii for the identification of species of flat fishes found in Puget Sound. Jenkins and Lachner, (1971) studied the scale characters in American fish belong to the genera *Nocomis* and *Hybopsis.* They studied the relationship of the number of radii with increase in body length in the specimens of these two genera. Hughes (1981) described the development of ctenii in the posterior field of ctenoid scales of family Platycephalidae. Growth of scale in the posterior margin proceeds by the addition of new rows of ctenii behind the old ones. Therefore the size of scale is increases with the addition of new rows of ctenii and this character varies within the species. Her findings were significant in establishing fish scale microstructure as useful taxonomic character. Roberts (1993) described the morphology of spined scales of teleostei by using scanning electron microscopy. He classifies these fishes on the basis of their scales (i) crenate (ii) spinoid (ii) ctenoid. Jawad (2005) identify the most useful scale characters and their systematic importance in Tripterygiidae. Ferrito *et al.*, (2009) explained the distribution and morphology of ctenii in genus *Aphanius* (family Cyprinodontidae) by using scanning electron microscopy.

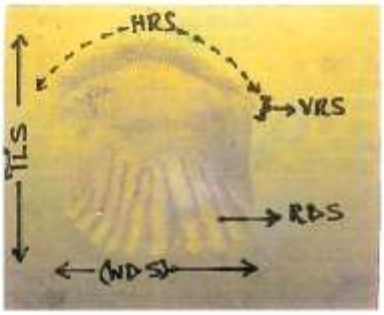
Fish scales are divided into four main types i.e. placoid, cosmoid, ganoid and leptoid scales. Leptoid scales are further divided into two types, (i) Cycloid (ii) Ctenoid scales. Families like Clupeidae, Cyprinidae, Ammodytidae,

Anabantidae, Balitoridae, Carangidae, Anguillidae, Anarhichadidae, Cryptacanthodidae, Dactyloscopidae, Echeneidae, Eleotridae, Kurtidae, Labridae, Labrisomidae, Leiognathidae, Ncmaristiidae, Microdesmidae, Opistognathidae, Scaridae and Zaproridae possess only cycloid scales. Families that contain ctenoid scales are; Scatophagidae, Acanthuridae, Acropomatidae, Achiridae, Centrarchidae, Cichlidae, Mugilidae, Osphronemidae, Pomacentridae, Percidae, Rhyacichthyidae, Serranidae, Scombidae, Cynoglossidae, Tripterygiidae, Lutjanidae. Families that contain both cycloid scales and ctenoid scales included Solidae, Bothidae, Gobiidae, Cichlidae, Sparidae, Apogonidae, Channidae, Cirrhitidae, Eleotridae, Helostomatidae.

The present study based on comparative study of ctenoid scales with reference to the total body length of fishes belongs to the genus *Lutjanus*. The main objective of this study was; (I) to find out the correlation between the scale characteristics of fishes and its total length/size of the body; (II) also measure the size/length and width of scales collected from the different regions of the body; (III) if the length of fish increases then the size and width of scales present on the body of fish also increases accordingly; (IV) also study the arrangement of ctenii present on the ctenoid scales; (V) study the relationship between total length of fish and number of ctenii, which are arranged on each scale, in horizontal and vertical rows; (VI) if the size/length of fish increases then whether the number of ctenii present in horizontal rows, vertical rows and numbers of radii on each ctenoid scale also increases. For comparative study of ctenoid scales the following species of genus *Lutjanus* of family Lutjanidae were selected, i.e. *L.lutjanus, L.malabaricus, L.russellii, L.johnii, L.fulvus.*

MATERIALS AND METHODS

Lutjanid fishes for study were collected during the period of June 2007 – Nov. 2008 from the landing specimens on Karachi fish harbor. Each specimen was identified up to the species level. Species identification was made with the help of field guide of Bianchi (1985). Total length (TL) in centimeters was measured from the tip of snout (close mouth) to the tip of caudal fin. The scales samples were taken from the following regions of the body of specimen, such as, **HS** (head scales); **LLS** (lateral line scales); **LLP** (lateral line pored scales) and **CS** (caudal scales). At least 4 scales were taken from the above each region of the body and then placed them in envelops for future studies. Scales were taken from envelop and soak them in a small jar or beaker of warm water containing a few drops of 10% NaOH/KOH solution. By stirring the water vigorously, they can remove much of the mucus and other materials from the scales and makes the scales more transparent and clean. Now removed the scales from water solution and transfered them in petri dish contained 96% ethanol solution for dehydration and hardening prior to examination under stereo microscope. At least 4-5 scales were mounting on each clean microscopic slide. The scales for study were mounted in glycerine in order to prevent drying. For comparative study of ctenoid scales, scales were mounted under the stereo microscope (4x10) and studied for their length, width, radii, and the horizontal rows and vertical rows of ctenii. Photograph of the scales were taken by SMZ Stereo microscopy with camera (Figures 1-4). The following parameters were used for studying the ctenoid scales of fishes (Figure 1) such as, **TLS** = Total length of scale; **WDS** = Width of scale; **HRS** = No.of ctenii in horizontal rows of scale; **VRS** = No. of ctenii in vertical rows of scale and **RDS** = No. of radii on scale. By using all these parameters, we can find out the different relationships between total length of fish and different scale parameters.



TLS= Total length of scale; WDS= Width of scale; HRS= No. of ctenii arranged in horizontal rows on scale; VRS= No. of ctenii arranged in vertical rows on scale; RDS= No. of radii or grooves on scale.

Figure 10: Caudal scale of *L. fulvus* showing the scale measurement.

The relationship between the all above mention parameters were calculated by linear regression equation as given by Niel (1995).

Y=a + b X

Where Y= dependent variable (scale length/width/ number of radii/ number of ctenii in horizontal or vertical rows), X=fish length (independent variable), a=constant/ intercept, b=regression slope.

RERULT AND DISCUSSION

The two variables correlation coefficients are given in the tables 1-4. When our studied shows the meristic differences in the number of ctenii and radii present on scales, we undertook a comprehensive survey, although we were aware about considerable variations in many aspects of scale structure existed in any single species.

Note that the values of correlation coefficient 'r' (r= 0.8 or 0.7) between TL and TLS; TL vs WDS; TL vs HRS; TL vs RDS for *L.russellii* is highly significant indicating that strong correlation is found between total body length and all above scales parameters. There is moderate or weak correlation found between numbers of ctenii arranged in vertical rows (VRS) and total body length (TL). But in *L.fulvus*, there is no correlation (negatively) between body length and all its scale parameters. While the remaining three species shows the moderate and weakest partial correlation. From the overall result it has been concluded that there is strong relationship found between TL vs TLS; TL vs WDS, while moderate and weak correlation found between total body length ad different scale parameters.

Figure 12: Head scale of *L.malabaricus*. TLS= 5.0 mm; WDS= 5.0 mm; HRS= 84; VRS= 15; RDS= 19.

Figure 13: Lateral line scale of *L.lutjanus*. TLS= 7.0 mm; WDS= 6.0 mm; HRS= 93; VRS= 14; RDS= 29.

Figure 14: Lateral line pored scale of *L.russellii*. TLS= 6.0 mm; WDS= 7.0 mm; HRS= 77; VRS= 12; RDS= 15.

All scales of similar length did not contained same number of HRS, VRS, and RDS, i.e. in 27.5cm long female, head scale with 6.0mm length and 6.0mm wide, contained 114 HRS and 4 VRS, while the head scale with 6.0mm length and 5.0mm wide contained 68 HRS and 4 VRS. Though the size and width of head and caudal scales were small but the number of horizontal rows of ctenii on head and caudal scales were large in number as compared to the LLS and LLP scales because the size of ctenii found on head and caudal scales were small so they occupied the less space. The length of lateral line scale (LLS) and lateral line pored scale (LLP) is greater than its width, so they have no circular shape. Focus is absent on these scales. Lateral line pored scale (LLP) has canal lies along anterior and posterior axis with two opening (Esmaeili *et al.*, 2007). Due to the presence of canal, ctenii are arranged in groups away from each other (Fig, 3&4). From the result, it is concluded that the scale studies can be

valuable tools in investigating systematic relationships among the species of different genera or families of fishes. By using these meristic characters of fish scales, Cockerell (1913) was able to separate the various groups of fishes

Table 1. The relationship between total body length (TL) and different parameters of caudal scales (CS)

No. of Obs.	Name of Species	No. of scales	TL vs TLS			TL vs WDS			TL vs HRS			TL vs VRS			TL vs RDS		
		(N)	a	b	r	a	b	r	a	b	r	a	b	r	a	b	r
1	*L. johnii*	147	1.79	0.836	0.481	2.51	0.0468	0.298	61.6	0.369	0.116	6.37	0.176	0.257	16.6	0.0014	0.002
2	*L. lutjanus*	152	3.19	-0.1005	-0.003	2.77	0.0135	0.051	54.4	0.306	0.073	9.27	-0.0943	-0.096	10.4	0.0145	0.013
3	*L. malabaricus*	50	1.64	0.0596	0.24	0.147	0.106	0.402	44.8	0.78	0.136	0.6	0.249	0.277	19.7	-0.218	-0.177
4	*L. russelli*	121	2.15	0.0952	0.737*	1.73	0.0824	0.71*	46.6	1.22	0.492**	3.06	0.226	0.525**	7.62	0.144	0.394***
5	*L. fulvus*	56	3.58	0.018	0.082	4.49	-0.0212	-0.081	57	0.692	0.157	16.7	-0.15	-0.143	28.7	-0.465	-0.561

Where: r = coefficient of correlation * shows the strong correlation ** shows moderate correlation

*** represent weak correlation

TLS = length of scale WDS = Width of scales HRS = No. of ctenii arranged in horizontal row of scale VRS = No. of ctenii arranged in vertical row of scale

Table 2. The relationship between total body length (TL) and different parameters of head scales (HS)

No. of Obs.	Name of Species	No. of scales	TL vs TLS			TL vs WDS			TL vs HRS			TL vs VRS			TL vs RDS		
		(N)	a	b	r	a	b	r	a	b	r	a	b	r	a	b	r
1	*L. johnii*	144	3.81	0.0461	0.196	3.44	0.024	0.127	45.3	0.511	0.116	4.02	0.363	0.421	8.9	0.134	0.134
2	*L. lutjanus*	135	4.27	0.0141	0.054	3.76	0.0274	0.064	54.6	0.674	0.12	13.2	-0.0323	-0.028	14.6	-0.235	-0.17
3	*L. malabaricus*	68	-0.109	0.193	0.607**	-1.18	0.2	0.538**	-25.9	3.65	0.598**	-5.01	0.532	0.531**	6.63	0.111	0.109
4	*L. russelli*	199	-0.131	0.2	0.895*	1.11	0.134	0.785*	22	2.03	0.67*	0.45	0.357	0.542**	4.51	0.207	0.424**
5	*L. fulvus*	52	3.84	0.0571	0.193	2.82	0.0683	0.218	12.4	1.95	0.39	2.15	0.358	0.178	22.2	-0.383	-0.319

Table 3. The relationship between total body length (TL) and different parameters of Lateral line scales (LLS)

No. of Obs.	Name of Species	No. of scales	TL vs TLS			TL vs WDS			TL vs HRS			TL vs VRS			TL vs RDS		
		(N)	a	b	r	a	b	r	a	b	r	a	b	r	a	b	r
1	*L. johnii*	130	0.548	0.269	0.77*	0.51	0.24	0.77*	22	2.8	0.718*	-0.21	0.586	0.57**	-2.11	1.14	0.742*
2	*L. lutjanus*	136	3.5	0.0958	0.295	2.06	0.157	0.4	36.6	2.35	0.394	13.2	0.144	-0.091	5.73	0.355	0.307
3	*L. malabaricus*	66	0.799	0.188	0.585**	0.59	0.211	0.537**	32.3	2.15	0.344	-1.31	0.403	0.476**	19.4	-0.233	-0.242
4	*L. russellii*	130	0.555	0.272	0.772*	0.522	0.246	0.793*	22.1	2.92	0.738*	-0.2	0.592	0.573**	-2.143	1.11397	0.781*
5	*L. fulvus*	51	5.5	0.0466	0.177	6.72	-0.0138	-0.053	65.8	1.27	0.187	8.05	0.132	0.079	30.7	-0.475	-0.215

Table 4. The relationship between total body length (TL) and different parameters of lateral line pored scales (LLP).

No. of Obs.	Name of Species	No. of scales	TL vs TLS			TL vs WDS			TL vs HRS			TL vs VRS			TL vs RDS		
		(N)	a	b	r	a	b	r	a	b	r	a	b	r	a	b	r
1	*L. johnii*	118	0.617	0.211	0.696*	2.85	0.129	0.523	22.3	0.73	0.343	6.62	0.223	0.272	2.58	0.896	0.626*
2	*L. lutjanus*	128	0.992	0.172	0.571	0.918	0.187	0.555	35.1	0.701	0.141	2.57	0.378	0.413	12	0.105	0.107
3	*L. malabaricus*	68	0.968	0.158	0.54	-0.415	0.199	0.582**	13.7	1.44	0.234	1.92	0.387	0.526**	24.6	-0.261	-0.188
4	*L. russellii*	118	0.651	0.218	0.67*	2.3	0.119	0.51	21.2	0.74	0.353**	6.58	0.214	0.254	2.48	0.874	0.614*
5	*L. fulvus*	52	4.17	0.0648	0.257	1.34	0.0856	0.379	59.2	-0.592	-0.117	21.5	-0.281	-0.178	5.59	0.547	0.414

It is for the first time that the genus *Lutjanus* is being studied from this point of view in Pakistan. Previously, many researchers have studied the fish scales included. Jenkins and Lachner (1971) studied the relationship between total body length and number of radii. Hughes (1981), Robert (1993) and Ferrito *et al.,* (2009) have studied in detail the ctenii of ctenoid scales.

We are only just beginning to learn about the type of countable structures present on fish scales and their relationship with increase in total body length. Present paper should stimulate further scale studies (both micro and macro structures present in fish scales) particularly those addressing ontogeny of scale characters. We hope that present study will make a significant contribution towards obtaining a better understanding of fish evolution.

REFRENCES

Agassiz, L. (1833). *Recherches sur les poissons fossiles*. Vol. 1-5. Neuchatel: Petitpierre.

Batts, B.S. (1964). Lepidology of the adult Pleuronectiform foshes of Puget Sound, Washington, *Copeia*, 4: 666-673.

Bianchi, G. (1985). FAO species identification sheets for fishery purposes. Field guide to the commercial marine and brackish-water species of Pakistan. Prepared with the support of PAK/77/033 and FAO (FIRM) Regular Programme. Rome, FAO, 200pp.

Creaser, C.W. (1926). The structure and growth of scales of fishes in relation to the interpretation of their life history with special reference to the Sunfish *Eruponotis gibbosus*. *Miscellaneous Publications of the University of Michigan Museum of Zoology*, 17: 1-82.

Cockerell, T.D.A. (1913). Observation on fish scales. *Bull. U.S. Bur. Fish.,* 32: 117-174.

De Lamater, E.D. and W.R. Courtenay (1974). Fish scales as seen by scanning electeron microscopy. *Biological Sciences,* 37:141-149.

Esmaeili, H.R., T. Hojat Ansari and A. Teimory (2007). Scale structure of Cyprinid fish, *Capoeta damascina* (Valenciennes in Cuvier and Valenciennes, 1842) using scanning electrom microscopy (SEM). *Iranian Journal of Science and Technology, Transaction A,* 31(3): 255-262.

Ferrito, V., A.M. Pappulardo., C. Fruciano and C. Tigano (2009). Morphology of scale lepidonts in genus *Aphanius* (Teleostei: Caprinodontidae) using scanning electron microscopy. *Italian Journal of Zoology*, 76(2): 173-178.

Hubbs, C.L. (1921). Remarks on the life history and scale characters of American Mullets. *Transaction of the American Microscopical Society*, 40: 26-27.

Hughes, D.R. (1981). Development and organization of the posterior field of ctenoid scales in Platycephalidae. *Copeia*, 1981(3): 596-606.

Jawad, L.A. (2005). Comparative scale morphology and squamation patterns in triplefins (Pices: Teleostei: Perciformes: Tripterygiidae). *Tuhinga*, 16: 137-167.

Jenkins, R.E. and Lachner, E.A. (1971). Criteria for analysis and interpretation of the American fish Genera *Nocomis* Gizard and *Hybopsis* Agassiz. *Smithsonian Contribution to Zoology*, 90:15pp.

Lagler, K.F. (1947). Lepidological studies. 1. Scale characters of the families of Great Lakes fishes. *Transaction of the American Microscopical Society*, 66: 149-171.

Mc Cully, H.H. (1961). *The comparative anatomy of the scales in Serranid fishes*. Unpublished Ph.D thesis, Stanford University, San Francisco, 258pp.

Niel, A. W. (1995). *Introductory Statistics.* Addison-Wesley Publishing Company, Inc. New york. 4th edition. 938pp.

Pillay, T.V.R. (1951). Structure and development of the scales of five species of grey mullets of Bengal. *Proc. Nat. Inst. Sci*. India, 27(6): 413-424.

Roberts, C.D. (1993). Comparative morphology of spined scales and their phylogenetic significance in the Teleostei. *Bull. Mar. Sci*., 52(1):60-113.

Van Oosten, J. (1951). The skin and scales. In: *The physiology of fishes* (Margret, E.B. eds.). Academic Press, New York, 1: 207-243pp.

(*Accepted for publication September 2010*)