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Taxonomy of puffer fish (Pisces: Tetraodontidae) represented in the catches of Visakhapatnam, central eastern coast of India

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Original Article

Abstract

Fishes of the family Tetraodontidae popularly known as toad fishes, puffer fishes, blowfishes and globefishes have become regular in the trawl catches of Visakhapanam. Therefore, there is an urgent need to have proper information on these resources for sustainable development and management of non-target species. The present paper provides a record of species, descriptions and biometric data of fishes of the family Tetraodontidae off Visakhapatnam. Fifteen species belonging to six genera : *Arothron, Canthigaster, Chelondon, Lagocephalus, Takifugu* and *Torquigener* are represented mainly in trawl and trammel net by- catches and shore seine catches in the coastal waters of Visakhapatnam. *Arothron firmamentum* was first record from Indian waters and circum global species *Lagocephalus lagocephalus* was first record from mainland of India.

Keywords: *Tetraodontid fishes, taxonomy, species composition, Visakhapatnam*

Introduction

Puffers of family Tetraodontidae are commercially valuable and highly regarded as food fish, even though the presence of specific toxin still causes death of gastronomers every year (Fiedler, 1991). Furthermore, there is an increasing demand for tetraodontids in the aquarium trade. Although tetraodontids are used commercially, basic ecological knowledge of natural populations is usually scarce.

The family Tetraodontidae is considered the most speciose family in the order Tetraodontiformes incorporating twenty seven genera with about 184 species (Matsuura, 2015). Many recent ichthyologists reported new species, new records and provided key to the species of tetraodontids from different regions of the world (Abe, 1952; De Beaufort and Briggs, 1962; Matsuura and Toda, 1981; Hardy, 1983; 1984; Randall, 1985; Matsuura, 1986; 2001; 2002; Smith and Heemstra, 1986; Relini and Relini, 1995; Walker and Bussing, 1996; Nelson, 2006; Wu *et al.*, 2011; Randall *et al.*, 2012; Fricke *et al.*, 2013). In India, previous studies were carried out by Russell (1803), Day (1878), Annandale and Jenkins (1910), Munro (1955), Jones and Kumaran (1980), Talwar and Jhingran (1991), Rao *et al.* (1992), Sujatha (1995, 1996), Sujatha and Chakravarty (2003). However there remain taxonomic

problems in genera such as *Arothron, Chelonodontops, Lagocephalus, Pao, Takifugu* and *Torquigener* where, many species await description and detailed morphological and molecular comparisons to classify them into appropriate groups. The amorphous body and loose skin, proportional measurements vary greatly within species (Randall, 1985). This paper provides photographs of the species of the family Tetraodontidae, descriptions based on colour pattern, biometric data and results of multivariate analysis (Principal Component Analysis – PCA), represented in the catches of Visakhapatnam (Lat 17˚10′-18˚10′N Long. 82˚50′-84˚10′E) for correct identification of species.

Material and methods

The present study is based on random samples collected mainly from trawl by-catches at Visakhapatnam fisheries harbour during the period of January 2012 to December 2013. Samples were also collected from traditional fish landing centres (Lawson's Bay, Pudimadaka, Bheemunipatnam) from the landings by hook and line, shore seine, trammel net. The oceanic and pelagic specimens of *Lagocephalus lagocephalus* were collected from the deeper waters off Visakhapatnam from surface waters beyond shelf zone and around 55 nautical miles away from the shore. Only adult specimens are represented in hook and line catches along with flying fish (*Cheilopogan cyanopterus*). Large sized specimens of *L. lunaris* and *L. inermis* were caught with hook and line at 40m to 90m depth region, sometimes even at 110 m depth along with skipjack and yellowfin tuna.

Counts and measurements of specimens of this family were accounted following Dekkers (1975), Matsuura and Toda (1981) and Tyler (1980). Pectoral rays count include uppermost rudimentary ray. In these species, general form and shape of the swim bladder and liver, scales, pelvis, spinules, lateral line system, nasal organ structure are of diagnostic value. For the first time, the swim bladder of each species is described.

The Mean and Standard deviation relating to dorsal rays, anal rays, pectoral rays, gill rakers, head scale rows and body scale rows have been calculated from the data of pooled samples. Comparison of morphometric data of species belonging to the genera *Arothron, Chelenodon, Lagocephalus, Takifugu* and *Torquigener* are also made. Body measurements are recorded as percent of standard length and measurements of the head region are recorded as percentage of head length, with the range of values separated by a hyphen and followed by the mean value and standard deviation (S.D.) of the measurement.

Multivariate data analysis includes Principal Component Analysis (PCA) of all morphometric characters of the closely related species of the genera *Arothron* and *Lagocephalus* using SPSS (13.0) software. Before computation, all these characters were adjusted to pool information from different characters into a comparable scale following standard procedure of Thorpe (1983). Because of the variation in size of fish, morphometric data was statistically adjusted to permit comparative analysis in terms of shape independent of size. The factor loadings for first three principal components were taken and characters for which factor loadings above 0.9 were considered. The variance explained by three components was 75% in genus *Arothron* and 72% in genus *Lagocephalus*. Tuk*ey* test was carried out only for those characters that became significantly different for morphometric and meristic characters among the four species of genus *Arothron* and five species of *Lagocephalus*.

Results and discussion

Species of the genus *Arothron* Muller, 1841, five species, genus species of *Canthigaster*, Swainson, 1839, two species of genus *Chelonodon* Muller, 1839, 5 species of genus *Lagocephalus* Swainson, 1839, one species of genus *Takifugu,* Abe, 1949, and one species of genus *Torquigener,* Whitley, 1930, are represented in the catches of Visakhapatnam (Table 1). Salient meristic data of all the fifteen species belonging to five genera is given in (Table 2).

Genus *Arothron*: Morphometric data of *A. firmamentum*, *A. hispidus, A. immaculatus, A. reticularis* and three different size groups of *A. stellatus* is given in (Table 3). PCA for morphometric and meristic data of four closely related species *A. hispidus, A. immaculatus, A. reticularis* and *A. stellatus* was carried out. Based on PCA the following characters *viz.* body depth, preanal distance, dorsal base, anal base, dorsal length, anal length and eye diameter were considered significant. Results of Tukey test ($p<0.05$) given in (Table 4).

Diagnostic characters of five species of genus *Arothron* given below:

A. firmamentum **(Temminck and Schlegel, 1850):** Dorsally well separated spinules from interorbital region to origin of dorsal fin; interorbital convex (Fig. 1).

A. hispidus **(Linnaeus, 1758)*:*** Spinules not well separated dorsally; dorsal spinules starts from norstrils to anterior half of caudal peduncle; inter orbital broad, deeply concave; mean pre pectoral distance 42.18 % in standard length; mean pre orbital distance 45.39 %, mean eye diameter 14.68% in head length. Swim bladder horse shoe shaped (Fig. 2).

Table 1. Systematic list of fishes of the family Tetraodontidae represented in the catches of Visakhapatnam

	n*	Sex			Length range (mm TL)	Max length in Fishbase 2013 (mm TL)
		J	F	M		
Arothron Muller 1841						
A. firmamentum (Temminck & Schlegel, 1850)	1	1	-	-	152	440
A. hispidus (Linnaeus, 1758)	4	3	-	1	237-260	540
A. immaculatus (Bloch and Schneider, 1801)	60	26	31	3	120-375	300
A. reticularis (Bloch and Schneider, 1801)	5	-	4	1	325-590	540
A. stellatus (Bloch & Schneider, 1801)	19	13	4	2	79-570	1200
Canthigaster Swainson, 1839						
C. solandri (Richardson, 1844)	4	4	-	-	71-85	120
Chelonodon Muller, 1839						
C. fluviatilis (Hamilton Buchanan, 1822)	3	3	75	-	33-110	170
C. patoca (Hamilton, 1822)	178	87		16	65-290	480
Lagocephalus Swainson, 1839						
L. guentheri (Ribeiro, 1915)	95	39	40	16	80-360	260
L. inermis (Schlegel. 1850)	37	25	4	8	100-565	1060
L. lagocephalus (Linnaeus, 1758)	30	-	6	24	205-310	610
L. lunaris (Bloch & Schneider, 1801)	148	47	69	32	85-280	550
L. sceleratus (Forster, 1788)	38	38	-	-	70-185	1330
Takifugu Abe, 1949						
T. oblongus (Bloch, 1786)	141	67	32	42	155-340	400
Torquigener Whitley, 1930						
T. hypselogeneion (Bleeker, 1852)	16	16	-	-	60-130	100

*number of specimens for which meristic and morphometric data taken ; Underline represents maximum recorded size of the species

Table 2. Salient meristic data of fifteen Tetraodontid species represented in the catches of Visakhapatnam

Species	n	Dorsal	Anal rays	Caudal rays	Pectoral rays	Total gill rakers
Genus *Arothron*						
A.firmamentum	1	14	13	10	21	-
A.hispidus	4	-9(in one)-10	10	8-9	17,19	12
A.immaculatus	60	9-11	9-11	8-10	15-17	11
A.reticularis	5	10-11	10-11	10-11(in one)	17-18	9
A. stellatus	19	10-12	9-12	9-10	17-19	19
Genus *Canthigaster*						
C. solandri	4	9	9	10	16-17	
Genus *Chelenodon*						
C. fluviatilis	3	14	12	11	22	
C. patoca	178	9-10	8	8,10	14-17	7
Genus *Lagocephalus*						
L. guentheri	95	12	10-11	8,10	16-17	13
L. inermis	37	11-13	10-11	8-10	16-17	11
L. Lagocephalus	30	14-15	11-12	5,10	14-15	12
L. lunaris	148	11-12	10	8-9	14-15	11
L. sceleratus	38	10	8-10	8,10	13, 15-16(in one)	(12-14)
Genus *Takifugu*						
T. oblongus	141	12-13	10-12	7-10	16-17	13
Genus *Torquigener*						
T. hypselogeneion	16	8	7	8	15	9

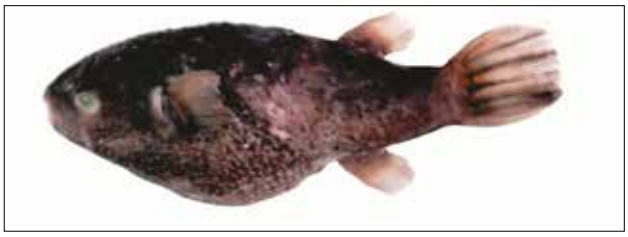

Fig. 1. *Arothron firmamentum*, 152 mm TL

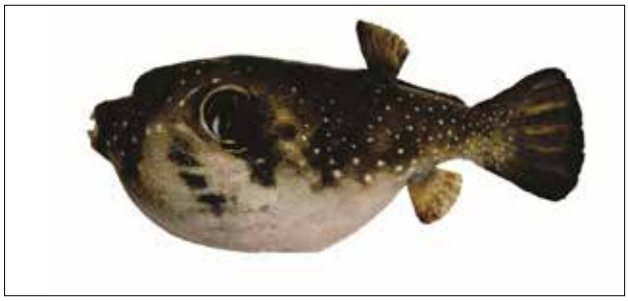

Fig. 2. *Arothron hispidus,* 206 mm TL, female

A. immaculatus **(Bloch and Schneider, 1801):** Spinules not well separated dorsally; dorsal spinules starts from nostril to origin of dorsal fin, ventrally from chin to before anus, interorbital flat; mean pre pectoral distance 36.96 % in standard length; mean eye diameter 16.82% in head length; swim bladder bilobed and both lobes equal in size (Fig. 3).

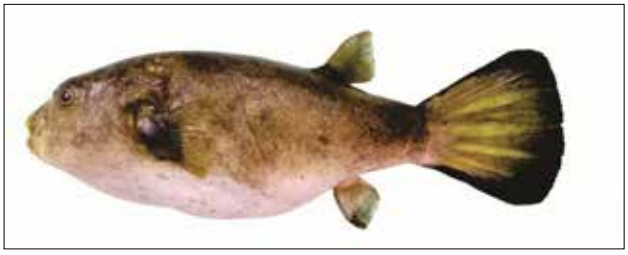

Fig. 3. *Arothron immaculatus,* 375 mm TL, female

A. reticularis **(Bloch and Schneider, 1801):** Spinules not well separated dorsally; dorsal spinules starts from before nostrils to end of caudal peduncle and all fin bases; interorbital broad and flat; mean pre pectoral distance 32.26 % in standard length ; pre orbital distance 42.78 %, mean eye diameter 13.08 % in head length; swim bladder bilobed, both lobes elongated, left lobe relatively large (Fig. 4).

A. ***stellatus*** **(Bloch and Schneider, 1801):** Spinules not well separated dorsally; dorsal spinules starts from just behind the lips to anterior part of the caudal peduncle. Interorbital broad and flat; swim bladder horse shoe shaped (Fig. 5a-d).

Fig. 4. *Arothron reticularis,* 590 mm TL, female

Fig. 5a. *Arothron stellatus*, 570 mm TL

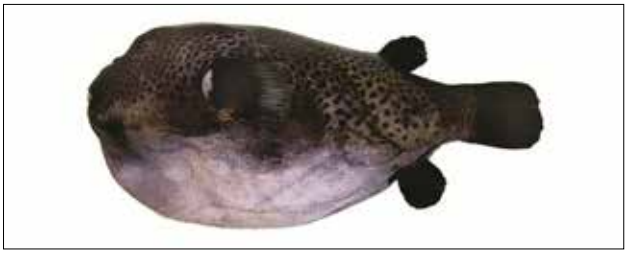

Fig.5b. *Arothron stellatus*, 232 mm TL

Fig. 5c. *Arothron stellatus*, 128 mm TL

Fig. 5d. *Arothron stellatus*, 75 mm TL

Of the five species of *Arothron*, *A. immaculatus* is more common and is represented in both trawl and shore seine catches throughout the year. *A. hispidus* and *A. reticularis*

Table 3. Comparison of morphometric data of six species belonging to two genera *Arothron* and *Canthigaster* represented in the catches of Visakhapatnam

Parameter	*A.immaculatus* n=58	*A.reticularis* n=5	*A.firmamentum* n=1	*A.hispidus* n=4	*A.stellatus* n=4	*A. stellatus* n=3	*A. stellatus* n=12	*C.solandri* n=4
SL	90-290	264-478	123	185-204	79-95	100-155	160-458	57-65
TL as % SL	125-1376	118-125	123	124-128	123-128	121-1265	116-125	124-133
Body depth	30-42	34-41	47	28-39	35-45	36-41	31-45	35-46
Head length	27-36	33-36	37	36-41	40-43	41-43	34-42	38-45
Predorsal distance*	63-76	73-81	74	70-76	75-79	73-79	69-78	70-83
Prepectoral distance*	31-46	34-40	38	40-43	44-48	46-47	34-45	41-47
Preanal distance	72-84	72-82	77	78-86	84-93	76-91	7-89	74-83
Dorsal base	6-11	7-9	14	7-9	8-10	7-9	7.-11	9-13
Anal base	6-11	7-8	10	7-8	11-13	12-16	9-12	9-11
Pectoral base*	8-12	10-12	12	10-12	7-8	7-9	7-10	11-15
Dorsal length	10-18	16-19	16	16-17	13-14	18-25	14-20	15-20
Pectoral length*	11-17	13-16	15	11-16	17-19	15-19	11-20	17-19
Anal length	12-20	15-17	14	15-18	15-16	14-26	12-18	12-17
Caudal peduncle length	31-42	15-22	17	15-19	14-16	15-21	16-22	20-22
Caudal peduncle depth	15-20	21-27	22	18-22	15-20	19-29	18-25	24-33
As percentage of head length:								
Head depth*	84-98	92-100	96	75-87	73-86	84-85	93-98	108-114
Head width*	79-90	88-93	93	68-77	63-68	68-84	72-95	46-66
Preorbital*	39-49	40-51	41	43-50	53-55	47-56	51-60	64-68
Postorbital*	33-46	44-53	50	32-41	31-39	38-46	35-48	25-36
Snout length	33-47	38-44	39	42-48	20-52	46-58	48-57	59-63
Nostril to snout*	30-44	30-36	30	29-35	36-42	34-44	35-43	54-64
Eye diameter*	11-20	9-15	17	14-16	11-18	14-17	11-16	21-26
Interorbital width	42-54	51-62	59	39-49	42-44	41-49	41-53	29-36

*Significant characters obtained from Tukey test

Table 4. Results of Tukey test for morphometric characters between four species of genus *Arothron: hispidus, immaculatus, reticularis* and *stellatus* represented in the catches of Visakhapatnam

Characters	F value	p
Predorsal distance	5.162	0.003
Prepectoral distance	6.117	0.001
Pectoral base	5.116	0.003
Pectoral length	4.996	0.003
Head length	7.056	<0.001
Head depth	6.385	0.001
Head width	6.601	<0.001
Preorbital	9.644	<0.001
Postorbital	9.640	<0.001
Interorbital width	8.582	<0.001
Nostril to snout	5.119	0.003

are rare however, the former was recorded for the first time from Visakhapatnam, north of Chennai. The maximum size recorded in *A. immaculatus* was 375 mm TL and that of *A. reticularis* was 590 mm TL. Only one specimen of *A. firmamentum* measuring 152 mm TL has been captured by hook and line in August 2013. This is the first occurrence of the starry toad fish in Indian waters. A comparative account of meristic data of *A. firmamentum* to those reported from literature is given in Table 5. It is a relatively deep water species, caught at a depth range of 30-80 m (Hardy, 1983). This is listed under marine species of conservation concern in South Australia as Data Deficient (DD) due to its rare occurrence in South Australia.

Kuthalingam *et al.* (1973) reported some growth stages and food of *A. stellatus* from Vizhinjam. The colour descriptions in the present study agree with Kuthalingam *et al.* (1973). The controversial characters in the colour pattern in the different growth stages of *A. stellatus* have been examined and photographs given in Fig. 5a-d. This species is rare in trawl catches and common in shore seine catches. The study incorporates detailed descriptions of all size groups of *A. stellatus* represented in the waters of Visakhapatnam after Russell (1803).

Table 5. Meristic data – correspond to those reported in the literature for *A. firmamentum*

Author	Length	D	A	P	C	VERT
Hardy 1980	45-335 mm SL	13-15 (14)	13-15 (14)	15-17 (16)	11	20
Masuda et al., 1984	350 mm SL	14	13-14	16	-	-
Goman et al., 1986	130 mm TL	13-15	13-15	15-17	11	-
Matsuura and Tyler 1997	242 mm SL	16	14	16	-	-
Fishbase 2009	35 cm SL	14-14	13-14	-	-	-
Abe 1954	63 mm TL	14-15	14-15	16	11	-
Present data	123 mm TL	14	13	21	10	-

() indicates Mean

Genus *Canthigaster:* Species *Canthigaster solandri* (Fig. 6) Morphometric data given in Table 3. Diagnostic characters that aid in identification of this species are: nostrils very small and inconspicuous. Dorsal ridge well developed from posterior part of dorsal fin; lateral line inconspicuous; the skin feeling rough when stroked from tail to head. This beautiful species is valued as aquarium fish (Sujatha, 2003).

Fig. 6. *Canthigaster solandri*, 80 mm TL

Genus *Chelenodon:* Meristic data of *Chelenodon fluviatilis* and *C. patoca* given in Table 2. Morphometric data given in Table 3. Diagnostic characters that help in identification of these species are given below:

***C. fluviatilis* (Hamilton Buchanan, 1822):** Body oblong; interorbital space broad and convex; fleshy lips with papillae; nasal organ close before superior half of eye consisting of a short stem with two rounded tentacles; gill opening not reaching below lower ray of pectoral fin base; caudal fin truncate; lateral line inconspicuous; spinules absent on lateral sides of body; back and sides of the body with large dark brown vertical bands, dorsal, anal, pectorals, caudal hyaline, caudal with yellow tinge (Fig.7).

This fish is very poisonous to human beings, it is hardy, attractive and not too aggressive, it is a suitable aquarium fish.

***C. patoca* (Hamilton, 1822):** Body oval; interorbital space flat; lips fleshy with papillae; nasal organ with two flaps,

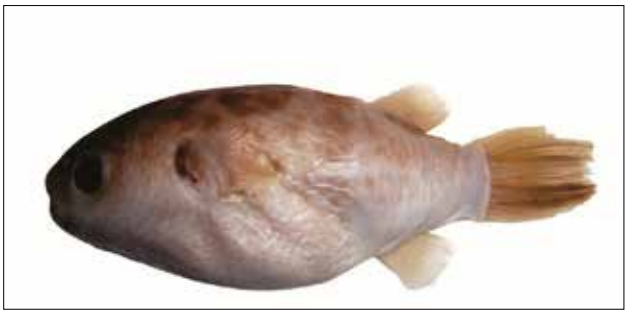

Fig. 7. *Chelenodon fluviatilis*, 110 mm TL

Fig. 8. *Chelenodon patoca*, 70 mm TL

posterior one larger than anterior; gill opening simple anterior to pectoral fin, not reaching below lower rays of pectoral fin base; caudal truncate; two lateral lines; spinules absent on lateral sides of body; swim bladder bilobed, equal in size attached anteriorly and free posteriorly. Body with round and oval blue spots, greenish yellow on sides; lips light orange in colour; dorsal and pectoral fins yellow, anal pale yellow, its base white; caudal yellow (Fig. 8).

Much variation is observed in the meristic characters of *C. fluviatilis* and *C. patoca* (Table 2). *C. fluviatilis* is rare in the catches and recorded for the first time from Visakhapatnam, north of Chennai. Matsuura (2015) included the species *patoca* in genus *Chelonodontops* Smith 1958, although *Tetrodon patoca* Hamilton, 1822 has long been placed in *Chelonodon* Miiller 1841. Matsuura (2002) reviewed two species of *Chelonodon*, *Chelonodon laticeps* Smith 1948 and *Chelonodon patoca*, both of which belong in *Chelonodontops*. Kottelat (2013) stated that the oldest available name for a

Table 6. Comparison of morphometric data of nine species belonging to four genera *Chelenodon*, *Lagocephalus*, *Takifugu* and *Torquigener* represented in the catches of Visakhapatnam

Parameter	*C. patoca*, n=178	*C. fluviatilis* n=3	*L. inermis* n=38	*L. lagocephalus* n = 30	*L. sceleratus* n=38	*L. lunaris* n=148	*L. guentheri* n=95	*T. oblongus* n=141	*T. hypselogeneion* n=16
SL	51-235	22, 83	82-470	175-270	57-144	70-223	65-285	125-276	
TL as % SL	117-128	150, 132	110-123	115-119	114-128	113-129	117-128	116-135	121-128
Body depth	24-35	50, 44	24-36	23-32	16-21	26-39	25-36	27-40	26-38
Head length	27-37	45,36	27-39	30-33	29-38	25-37	28-35	29-40	35-40
Predorsal distance	70-83	86, 73	62-73	63-73	61-73	64-75	60-73	65-78	64-73
Prepectoral distance	32-43	54, 42	30-40	37-35	31-41	31-42	30-39	32-44	36-45
Preanal distance	69-79	91, 77	63-75	65-76	63-74	63-74	60-72	66-78	69-76
Dorsal base	7-10	18, 14	8-12	9-11	6-9	9-13	8-14	9-14	6-11
Anal base	7-10	18, 12	6-11	8.4-11	4-9	8-12	7-11	7-13	5-8
Pectoral base	7-13	18,12	7-11	6-8	7-10	9-15	6-12	8-12	9-11
Dorsal length	13-20	23,16	15-20	14-18	13-17	12-20	15-21	17-26	17-20
Pectoral length	11-20	18,13	13-20	15-19	15-19	15-25	15-20	11-21	16-19
Anal length	11-19	23,16	12-20	14-17	12-17	10-21	15-21	14-24	14-16
Caudal peduncle length	22-27	18,18	24-23	11-19	24-29	23-27	21-27	21-23	25-26
Caudal peduncle depth	15-20	27,24	14-18	10-15	10-14	13-25	10-19	14-26	13-17
As percentage of head length:									
Head depth	72-84	80,90	79-89	57-66	56-67	83-97	84-97	83-95	75-84
Head width	70-83	80,87	55-67	40-49	50-60	63-75	64-77	81-95	61-70
Preorbital	39-49	50,47	54-66	40-48	36-47	43-54	42-53	43-57	42-53
Postorbital	32-45	40,37	31-42	31-41	25-37	32-42	30-41	36-48	35-41
Snout length	28-39	30,33	50-63	26-34	32-45	41-54	37-49	41-54	32-44
Nostril to snout	28-39	40,36	35-46	38-44	28-37	30-44	30-44	35-48	-
Eye diameter	22-32	30,27	23-33	20-26	37-48	27-37	24-77	10-21	26-31
Interorbital width	42-53	70,63	33-44	31-43	30-45	42-55	37-49	54-66	43-44

*In *T. hypselegeneion* for specimen measuring 47 mm SL caudal peduncle length is in the range 34.04-44.68 (37.59±0.68) and caudal peduncle depth 25.53 – 26.53 (25.53±0.36)

genus including *Tetrodon fluviatilis* is *Dichotomyctere.* Froese and Pauly (2013) placed *fluviatilis* in the genus *Tetrodon* (Linnaeus, 1758). *Tetrodon patoca* and *Tetrodon fluviatilis* have a sufficient number of character differences to warrant being placed in separate genera. However in the present study, the two species *fluviatilis* and *patoca* are retained in the genus *Chelonodon* following Nelson (2006).

Genus *Lagocephalus*: Morphometric data of *L. inermis, L. lagocephalus* and *L. sceleratus, L. lunaris* and *L. guentheri* given in Table 6. Significant characters identified though PCA were body depth, predorsal distance, prepectoral distance, preanal distance, dorsal base, anal base, pectoral base, dorsal length, pectoral length, anal length, head depth, head width, preorbital, post orbital, snout length, eye diameter and interorbital width. Results of Tukey test ($p < 0.05$) given in Table 7.

Diagnostic characters that aid in identification of these species are given below:

L. guentheri (Ribeiro, 1915): Spinules on dorsal surface from

Table 7. Results of Tukey test for morphometric characters between five species of genus *Lagocephalus: guentheri, inermis, lagocephalus, lunaris* and *sceleratus* represented in the catches of Visakhapatnam.

Characters	F value	p
Predorsal distance	48.265	<0.001
Prepectoral distance	47.917	<0.001
Preanal distance	51.319	<0.001
Dorsal base	114.895	<0.001
Pectoral base	73.954	<0.001
Anal base	111.441	<0.001
Dorsal length	79.247	<0.001
Pectoral length	70.591	<0.001
Anal length	63.960	<0.001
Body depth	133.806	<0.001
Caudal peduncle depth	81.297	<0.001
Head length	48.733	<0.001
Head depth	102.007	<0.001
Head width	66.143	<0.001
Preorbital	88.406	<0.001
Postorbital	118.048	<0.001
Interorbital width	70.899	<0.001
Snout length	81.416	<0.001

nostrils to dorsal fin; Spinular patch on dorsal surface V- shaped posteriorly ending well before dorsal origin, almost to the level of middle of pectorals; ventrally spinular patch extends to anus; mean caudal peduncle depth 14.84 % in SL; mean snout length 41.92 %, mean interorbital width 43.56 % in head length; caudal fin double emarginated; swim bladder oval, posteriorly pointed attached anteriorly, free posteriorly (Fig. 9).

***L. inermis* (Schlegel, 1850) :** (Fig. 10) The spinular patch on the ventral side originating in the form of V- shape and extending to

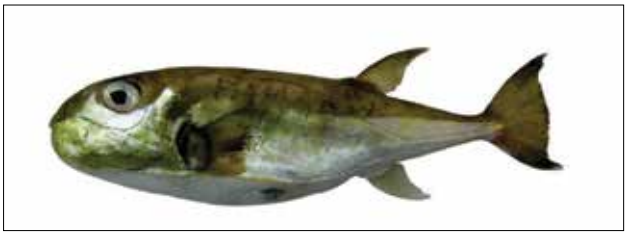

Fig. 9. *Lagocephalus guentheri*, 210 mm TL, female

anus; mean preorbital distance 59 %, mean eye diameter 26.7 % in head length; swim bladder with two lobes equal in size.

L. lagocephalus (Linnaeus, 1758): Body elongate , sub

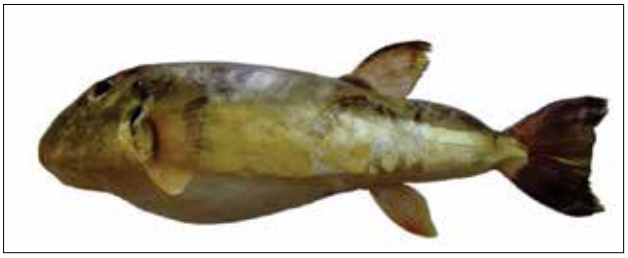

Fig. 10. *Lagocephalus inermis*, 445 mm TL, male

cyclindrical, sides of body, crowded sharp spines on belly from chin to anterior to anus; Spinules absent on dorsal side, ventral side spinular patch starts from chin extending to anus; mean preorbital distance 44.9%, mean preorbital distance 22.3% in head length; caudal emarginated; upper lobe of caudal smaller than the lower lobe, swim bladder oval in shape, posteriorly pointed (Fig. 11).

L. lunaris (Bloch and Schneider, 1801): Spinular patch on

Fig. 11. *Lagocephalus lagocephalus*, 310 mm TL

dorsal surface from nostrils to origin of dorsal fin, ventral patch extends upto some distance before anus, mean caudal peduncle depth 18.78 % in SL; mean snout length 46 %, interorbital width 46.95 % in head length; caudal fin emarginate, swim bladder oval, posteriorly pointed, attached anteriorly, free posteriorly (Fig. 12).

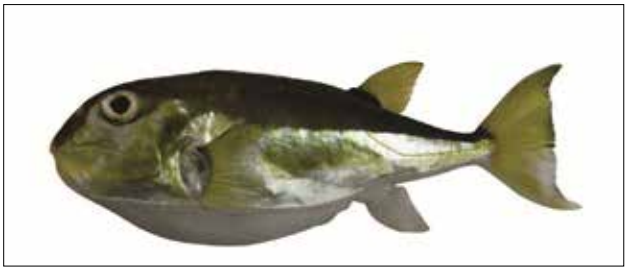

Fig. 12. *Lagocephalus lunaris*, 1247 mm TL, Female

L. sceleratus (Forster, 1788): Spinules present on dorsal side, starts from nostrils to end of caudal fin base; ventral side spinular patch starts from front boarder of eye / chin extending to anus; mean preorbital distance 42.77 %, mean eye diameter 43.39 % in head length; caudal fin double emarginated; broad silvery white band on side of body , triangular silvery patch before eye, and black gill opening; swim bladder oval, posteriorly pointed, attached anteriorly, free posteriorly (Fig. 13).

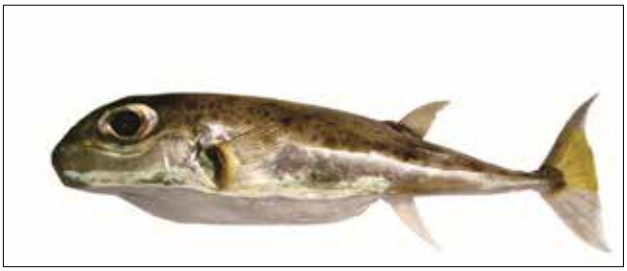

Fig. 13. *Lagocephalus sceleratus*, 150 mm TL

Of the five species that were recorded *L. guentheri* is relatively more common species being represented in both traditional gear and trawl by-catches throughout the year. *L. guentheri* of Smith and Heemstra, 1986 is similar to *L. spadiceus* (Ribeiro, 1915) but in *L. spadiceus* the rear margin of caudal is supposed to be entirely white and the patch of spinules on dorsum narrows posteriorly to a thin mesial band that extends almost to dorsal origin. This species chiefly differs from *L. spadiceus* by the spiny part of the back which does not reach to the dorsal. It is certain that the two species are not males and females of a single species; both sexes were recorded in the present study. The Indian records of *L. spadiceus* without giving a description have to be re-examined for correct identification as only specimens of *L. guentheri* were

encountered in the catches during present study. However, mostly identification has been based on cursory examination of specimens on hand.

After *L. guentheri*, *L. lunaris* is the most common species in trawl catches and rare in shore seine catches of this region. Both the species are considered as a menace by fisherman as they cause damage to other species landed and also the nets such as gill nets, purse seines etc. Recently these fish gained attention as a new fishery resource along the coast of north Andhra region.

Circumglobal species, *L. Lagocephalus* occurs in all tropical and temperate oceans and the Mediterranean Sea (Shipp, 2002). Some authors separate it into two species: Atlantic *Lagocephalus, Lagocephalus lagocephalus* (Linnaeus, 1758) and Indo-Pacific *Lagocephalus, Lagocephalus oceanicus* (Jordan and Evermann, 1903). The present specimens studied may be *Lagocephalus lagocephalus* (Linnaeus, 1758) in the sub specific level. *Lagocephalus lagocephalus* was reported from India (Linnaeus, 1758) and Laccadive Archipelago (Jones and Kumaran, 1980; Linnaeus, 1758) with a single specimen caught along with *Cheilopogan cyanopterus* from surface waters by hook and line. This is the first record from mainland of India.

The description of *L. sceleratus* agrees with the earlier descriptions except in the number of dorsal fin rays, 10-12 in previous reports (Day, 1878; Kyushin *et al*., 1977; Smith and Heemstra, 1986; Akyol *et al*., 2005; Kasapidis *et al*., 2007), only 10 in the present study. This species resembles *L. lunaris* but is easily recognized by broad silvery white band on the side of body, triangular silvery patch before eye and black gill opening.

Genus *Takifugu*: Morphometric data of *Takifugu oblongus* (Bloch, 1786) (Fig. 14) given in Table 6. Diagnostic characters used to identify this species are: body elongate; two simple nostrils each consisting of a short papillae pierced by two large openings; inter orbital space broad and flat (59.63% in HL); spinules present along with lateral lines; pectoral 16-17 and caudal 10-11 rays; gill opening reaching below lower ray of pectoral fin base; caudal fin double emarginated; caudal fin slightly convex; swim bladder trilobed.

Fig. 14. *Takifugu oblongus*, 260 mm TL

This species is common in boat seine and trawl catches. Of the 141 specimens, only two specimens measuring 295, 299 mm TL (spent) collected in the month of April 2012 from shore seine catches.

Genus *Torquigener:* Morphometric data of *T. hypselogeneion* (Bleeker, 1852) is given in Table 6, (Fig. 15, 15a). Diagnostic characters used to identify this species are: body elongate cylindrical; two simple nostrils each consisting of a short papillae pierced by two large openings; inter orbital space narrow and convex; chin prominent; lower edge of gill opening with a cartilaginous spur overlaid by two or three short spinules; spinules well separated; Gill opening reaching below lower ray of pectoral fin base; dorsal 8, anal 7, pectoral 15 and caudal 8 rays; caudal fin truncate; swim bladder oval.

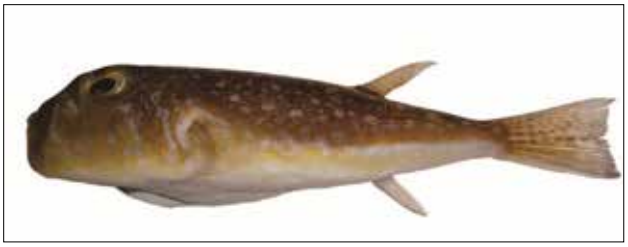

Fig. 15. Lateral view of *Torquigener hypselogeneion*, 130 mm TL

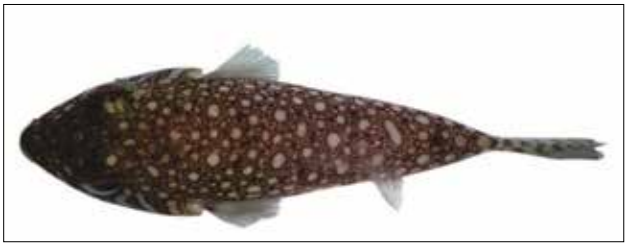

Fig. 15a.Dorsal view of *Torquigener hypselogeneion*, 130 mm TL

This species is being recorded for the first time from the east coast of India, north of Pondicherry. Maximum recorded size is 130 mm TL. Earlier recorded size is 100 mm TL (Smith and Heemstra, 1986). The present description of the species fully agrees with the description and diagram of Day, 1888 pl. clXXXiii. In a review of the status of specimens a neotype for *T. hypselogeneion* (Bleeker, 1852) has been proposed (Randall, 1985). The puffer fish *T. brevipinnis* (Regan, 1902) has been redescribed (Hardy, 1983). He stated *T. brevippinnis* differs from *T. hypselogeneion* (based on 32-81 mm SL size specimens) in relative eye diameter, caudal peduncle length (smaller dimensions in *T. hypselogeneion*) and in having more dense ventral spination. The present data (sixteen specimens of length range 60-130 mm TL) agree with both

the description of *T. hypselogeneion* and *T. brevippinnis*. Caudal peduncle depth in 47 mm SL is 25.53 and in 84-107 mm SL is 13.10-17.14. Cadual peduncle length in 47 mm SL is 34.04 - 44.68 and in 84-107 mm SL is 26.14-26.19. More length groups have to be examined to consider *T. brevippinnis* as a valid species. *T. brevippinnis* is listed under IUCN Red list as Data Deficient (DD).

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