INT. J. BIOL. BIOTECH., 18 (3): 561-566, 2021.

A STUDY ON SEX RATIO OF TWO TERAPONID FISHES (FAMILY: TERAPONIDAE) ALONG KARACHI COAST, PAKISTAN

Musarrat-ul-Ain and Rehana Yasmeen Farooq

Department of Zoology, University of Karachi, Karachi-75270, Pakistan

ABSTRACT

This study was carried out to find the sex ratio (Male:Female) of two Teraponid species of Family Teraponidae (i.e., *Terapon jarbua* and *T. puta*) from Pakistan. The result of present investigation shows the dominance of female Teraponid over male Teraponids along Karachi coast, Pakistan.

Key words: Sex dominance, Population behavior, Reproductive biology, Pakistan.

INTRODUCTION

The sex ratio of a fish provides accurate information on appearance of male and female and domination of sex in a population (Adebiyi, 2013). According to Arocha *et al.* (2010) studies on sex ratio help to determine female fecundity. Studies on sex ratio facilitate to recognize the population behavior and fecundity as well as, to understand the seasonal differences in sexes and the growth rate between sexes (Gogoi and Goswaini, 2014). The sex ratio may differ significantly from species to species and may differ from year to year in the same population but in most cases, it is close to one *i.e.,* 1 male:1 female (Zin *et al.,* 2011). Many researchers have published their work on reproductive biology of fishes from all over the world such as, Rheman *et al.* (2002) from Bangladesh, Ozen and Balci (2012) from Turkey, Sujatha and Shrikanya (2013) from India and Kokokiris *et al*. (2014) from Greece.

The sex ratios of male and female for the different species of fishes from Pakistan have been reported by various workers including Hoda and Ajazuddin (1992) observed sex ratio 1.54 male: 1 female for *Otolithes cuvieri* and 1 male: 1.20 female for *Johnius elongates*. Khan and Hoda (1993) reported sex ratio 1 male: 1.6 female of *Euryglossa orientalis.* Khan and Imtyaz (2004) examined sex ratio 1 male: 1.36 female in *Pomadasys maculatum*. Khan *et al.* (2005) determined the sex ratio 1 male: 1.04 female for *Sardinella longiceps*. Other scientists have also worked on sex ratio in fishes from many other regions of the world, such as Mortuza and Rehman (2006) observed total sex ratio in *Rhinomugil corsula* as 1 male: 1.247 female in Rajshahi region Bangladesh. Sahinoz *et al.* (2011) found sex ratio as 1 male: 1.04 female in *Liza abu* from Turkey. These differences in sex ratio may be attributed to growth differences, sexual dimorphism, or migration (Rahman *et al*., 2012). Liao and Chang (2011) also investigated that mortality, growth rate, longevity, sex reversal, season, fishing methods and fishing grounds are the important factors which alters the distribution of sexes in a population. Adaptations in population, reproductive behavior of fishes, availability of food and environmental conditions are some other important factors which brings variations in sex ratio **(**Oliveira *et al*., 2012). According to Roomiani *et al.* (2014) sex ratio may differ due to several reasons such as, alterations in mortality, growth rate, long life, sex reversal or migration in-and-out of fishing grounds. Though, high mortality of a sex and greater longevity of other sex may also cause an alteration in sex ratio from hypothetical ratio (Rahman *et al.,* 2012). The movement towards or from the sampling area is an important factor which make differences in sex distribution in a population (Ghosh *et al.,* 2014). These alterations of sex ratio from the hypothetical ratio might be due to more active movement of males than females so, the chance of capture reduced for the male fishes (Shobikhuliatul *et al.*, 2013). According to Nzeh (2010) if females outnumber, males in a population so, there will be more chance to lay more eggs and the rate of survival will also increase. Still, these changes in sex ratio might be attributed to the natural or fishing mortalities by means of sex (Zudaire *et al*., 2010).

MATERIALS AND METHODS

During January 2013 to December 2014, a total of 1298 specimens of Teraponid fishes (*Terapon jarbua* and *T. puta*) were collected from commercial landings at Karachi coast, Pakistan. Sex ratio of Teraponid fishes was calculated by dividing the number of females with the number of males. The results for sex ratio were tested with Chi-square test (x^2) for both Teraponid species. The significance level was set at 5% (α= 0.05) to test the observed sex ratio against the expected ratio of 1:1.

$$x^2 = \Sigma(O - E)^2/\mathrm{E}$$

Where,

O = observed quantities/ numbers

E = expected quantities/ numbers

Following equation was used to calculate the expected frequencies,

$$E = R.C/n$$

Where,

R= rows; C= columns; n= total number

RESULTS

From the present investigation, it was revealed that the monthly frequencies of male and female *Terapon jarbua* ranged from 33.33% to 66.67%, respectively (Table 1). During the year 2013, the overall sex ratio of *T. jarbua* was found as 1 male: 1.12 female that was not significantly departed from the hypothetical sex ratio that was 1 male: 1 female (x^2= 8.331; p > 0.05). The overall sex ratio recorded for *T. jarbua* in the year 2014 was 1 male: 1.06 female and proved to be not significant (x^2= 7.304; p > 0.05). Whereas the overall sex ratio during the whole study period from January 2013 to December 2014 for *T. jarbua* was found to be at 1:1.08 which was close to the hypothetical ratio of 1 male: 1 female and found to be not significantly depart from the hypothetical sex ratio 1 male: 1 female (x^2= 15.75; p > 0.05).

Table 1. Monthly variation in sex ratio of *Terapon jarbua* (Jan 2013 to Dec 2014).

Month	Total No.	No. of Males	% Males	No. of Females	% Females	Ratio M:F
January	18	12	66.67	6	33.33	1:0.50
February	26	10	38.46	16	61.54	1:1.60
March	38	18	47.37	20	52.63	1:1.11
April	22	9	40.91	13	59.09	1:1.44
May	19	9	47.37	10	52.63	1:1.11
June	15	5	33.33	10	66.67	1:2.00
July	17	6	35.29	11	64.71	1:1.83
August	11	5	45.45	6	54.55	1:1.20
September	24	13	54.17	11	45.83	1:0.85
October	21	13	61.90	8	38.10	1:0.62
November	28	13	46.43	15	53.57	1:1.15
December	11	5	45.45	6	54.55	1:1.20
Total 2013	250	118	47.20	132	52.80	1:1.12^{C}
January	44	25	56.82	19	43.18	1:0.76
February	29	12	41.38	17	58.62	1:1.42
March	31	14	45.16	17	54.84	1:1.21
April	37	18	48.65	19	51.35	1:1.06
May	21	7	33.33	14	66.67	1:2.00
June	17	8	47.06	9	52.94	1:1.13
July	19	9	47.37	10	52.63	1:1.11
August	67	33	49.25	34	50.75	1:1.03
September	42	26	61.90	16	38.10	1:0.62
October	32	14	43.75	18	56.25	1:1.29
November	62	29	46.77	33	53.23	1:1.14
December	25	12	48.00	13	52.00	1:1.08
Total 2014	426	207	48.59	219	51.41	1:1.06^{C}
Total (Jan 2013 to Dec 2014)	676	325	48.07	351	51.92	1:1.08^{C}

Note: ^{C} on sex ratio indicates that Chi-square test (x^2) was not significant at 5% level (p>0.05).

Table 2. Monthly variation in sex ratio of *Terapon puta* (Jan 2013 to Dec 2014).

Month	Total No.	No. of Males	% Males	No. of Females	% Females	Ratio M:F
January	20	13	65.00	7	35.00	1:0.54
February	31	10	32.26	21	67.74	1:2.10
March	39	16	41.03	23	58.97	1:1.44
April	29	6	20.69	23	79.31	1:3.83
May	16	8	50.00	8	50.00	1:1.00
June	16	12	75.00	4	25.00	1:0.33
July	11	2	18.18	9	81.82	1:4.50
August	17	8	47.06	9	52.94	1:1.13
September	25	8	32.00	17	68.00	1:2.13
October	21	4	19.05	17	80.95	1:4.25
November	33	5	15.15	28	84.85	1:5.60
December	27	10	37.04	17	62.96	1:1.70
Total 2013	285	102	35.79	183	64.21	1:1.79[a]
January	18	11	61.11	7	38.89	1:0.64
February	45	17	37.78	28	62.22	1:1.65
March	59	19	32.20	40	67.80	1:2.11
April	31	4	12.90	27	87.10	1:6.75
May	23	10	43.48	13	56.52	1:1.30
June	10	2	20.00	8	80.00	1:4.00
July	16	4	25.00	12	75.00	1:3.00
August	14	5	35.71	9	64.29	1:1.80
September	19	7	36.84	12	63.16	1:1.71
October	28	6	21.43	22	78.57	1:3.67
November	49	15	30.61	34	69.39	1:2.27
December	25	11	44.00	14	56.00	1:1.27
Total 2014	337	111	32.94	226	67.06	1:2.04[C]
Total (Jan 2013 to Dec 2014)	622	213	34.24	409	65.76	1:1.92[a]

Note: [a] on sex ratio indicates that Chi-square test (x^2) was significant at 5% level ($p<0.05$)
[C] on sex ratio indicates that Chi-square test (x^2) was not significant at 5% level ($p>0.05$).

During January 2013 to December 2014, the monthly percentage of male and female *Terapon puta* was observed as 33.33% to 66.67% (Table 2). For the duration of January 2013 to December 2013, the sex ratio of *T. puta* was 1 male: 1.79 female which was significantly different from the hypothetical sex ratio (x^2= 34.323; $p < 0.05$). The overall sex ratio of *T. puta* during January 2014 to December 2014 was found as 1 male: 2.04 female that was not significantly different (x^2= 18.328; $p > 0.05$) from the expected ratio of 1:1. The overall sex ratio of *T. puta* during the whole study period (January 2013 to December 2014) was observed as 1 male: 1.92 females, which were significantly different (x^2= 53.565; $p < 0.05$) from hypothetical ratio.

DISCUSSION

Teraponids examined in this study (*Terapon jarbua* and *T. puta*) were found to have different sex ratios than what has been reported in other studies on these species (Nandikeswari *et al*., 2013 and 2014). Sex ratios reported in the present study indicated that females were more abundant than males in both Teraponid species. This result differed from Nandikeswari *et al*. (2013) for *T. puta* and Nandikeswari *et al*. (2014) for *T. jarbua* where in both studies from India, males were found to be more abundant than females. The differences in sex ratio of same species from different localities might be due to the difference in the time of the study, sampling methods or environmental conditions (Al-Jufaili, 2013). High mortality of a sex and greater longevity of other sex may also cause an alteration in sex ratio from the hypothetical ratio (Chang *et al.,* 2008; Rahman *et al.,* 2012). The abundance of females in this study might be due to the gear bias. Females are larger and heavier than males of the same size and have larger gonads because they are coming into spawn and therefore, they get stuck in the nets easily (Jency *et al*., 2008; Gandhi *et al.,* 2013 and 2014). These differences in sex ratios might be ecologically or genetically or due to the combination of these two factors (Lawson *et al*., 2010). Sex ratio may alter due to sampling strategies or gear selectivity (Nandikeswari *et al*., 2013). Further, sex reversal was not observed in the present studies, therefore differences in sex ratios may be associated with mortality, growth rate or fishing strategies.

Parallel to this study, many scientists have examined the dominance of females over males for different fish species from many areas of the world such as, Mousavi-Sabet *et al*. (2012) have reported the supremacy of females over males for *Cobitis faridpaki.* Guclu and Kucuk (2011) also found the female to male sex ratio as 1.10:1.00 for *Aphanius mento*; Shamsan and Ansari (2010) have reported most females for *Sillago sihama*. Deshmukh *et al*. (2010) also investigated the domination of females for *Sardinella longiceps.* However, other scientists have reported that male outnumbered female in many fishes such as, Lawson and Olagundoye (2011) established the sex ratio for *Polydactylus quadrifilis* as 1 male: 0.49 females; Vicentini and Araujo (2003) examined the dominance of males over females for *Micropogonias furnieri*. There are several reasons which affect the distribution of sexes in a population such as different habitats (Vicentini and Araujo, 2003), availability of food (Lawson and Doseku, 2013), gear selectivity (Mortuza and Rahman, 2006) and migration (Eryilmaz and Meric, 2005).

CONCLUSION

The results of sex ratio illustrated the abundance of female Teraponids (*T. jarbua* and *T. puta*) in total catches which might be a bias of fishing gear. Slow movement and heavier body of females than males increased the chance of capture, resulting in the increased numbers of females of Teraponid species (*T. jarbua* and *T. puta*) in commercial catches around Karachi Coast, Pakistan.

REFERENCES

Adebiyi, F. A. (2013). The sex ratio, gonadosomatic index, stages of gonadal development and fecundity of sompat grunt, *Pomadasys jubelini* (Cuvier, 1830). *Pakistan Journal of Zoology,* 45 (1): 41-46.

Al-Jufaili (2013). Sex ratio variation of the Omani Indian oil sardine *Sardinella longiceps* (Valenciennes, 1847). *International Journal of Marine Science,* 3 (47): 402-407.

Arocha, F., L. Marcano and J. Silva (2010). Sex ratio at size of sailfish (*Istiophorus albicans*) from the Venezuelan fishery off the Caribbean Sea and adjacent areas. *Collective Volume of Scientific Papers ICCAT,* 65 (5): 1633-1640.

Chang, L-M., S-J. Joung, C-C.Wu, W-C. Su and L-J. Wu (2008). Reproductive Biology of Thornfish *Terapon jarbua* from the Southwestern Waters off Taiwan. *Journal of the Fisheries Society of Taiwan,* 35 (4): 335-350.

Deshmukh, A.V., S.R. Kovale, M.S. Sawant, M.M. Shirdhankar and A.B. Funde (2010). Reproductive biology of *Sardinella longiceps* along Ratnagiri coast off Maharashtra. *Indian Journal of Marine Sciences,* 39 (2): 274-279.

Eryilmaz, L. and N. Meric (2005). Some biological characteristics of the tub gurnard, *Chelidonichthys lucernus* (Linnaeus, 1758) in the Sea of Marmara. *Turkish Journal of Veterinary Animal Sciences,* 29: 367-374.

Gandhi, V., V. Venkatesan and N. Ramamoorthy (2014). Reproductive biology of the spotted scat *Scatophagus argus* (Linnaeus, 1766) from Mandapam waters, south-east coast of India. *Indian Journal of Fisheries,* 61 (4): 55-59.

Gandhi, V., V. Venkatesan and P.U. Zacharia (2013). Biometry analysis, length-weight relationship and sexual dimorphism of the Spotted Scat, *Scatophagus argus* (Linnaeus, 1766) (Perciformes: Scatophagidae) from Gulf of Mannar, southeast coast of India. *Journal of the Marine Biological Association of India,* 55 (1): 12-16.

Ghosh, S., M.V.H. Rao, P. Rohit, K. Rammohan and G. Maheshwarudu (2014). Reproductive biology, trophodynamics and stock structure of ribbonfish *Trichiurus lepturus* from northern Arabian Sea and Northern Bay of Bengal. *Indian Journal of Geo-Marine Sciences,* 43 (5): 755-771.

Gogoi, R. and U.C. Goswami (2014). Length-Weight relationship and sex ratio of fresh water fish *Amblypharyngodon mola* (HAM-BUCH) from Assam. *International Journal of Fisheries and Aquatic Studies,* 1 (4): 68-71.

Guclu, S.S. and F. Kucuk (2011). Reproductive biology of *Aphanius mento* (Heckel in: Russegger, 1843) (Osteichthyes: Cyprinodontidae) in Kırkgöz Spring (Antalya-Turkey). *Turkish Journal of Fisheries and Aquatic Sciences,* 11: 323-327.

Hoda, S.M.S. and S. Ajazuddin (1992). Some aspects of reproductive biology of two sciaenids, *Otolithes cuvieri* Treavas and *Johnius elongates* Mohn: maturation, spawning, sex ratio and fecundity. *Pakistan Journal of Marine Science,* 1 (2): 95-110.

Jency, P., S. Honey, N.D. Inasu and C.O. Joshi (2008). Sexual Dimorphism in spotted scat *Scatophagus argus* (Linnaeus). *Journal of Bombay Natural History Socity,* 105 (3): 349-351.

Khan, M.A. and Imtyaz (2004). Studies on the fecundity and sex ratio of grunt fish, *Pomadasys maculatum* (Bloch, 1797) (Family: Pomadasyidae) from Karachi coast, Pakistan. *International Journal of Biology and Biotechnology,* 1 (1): 111-115.

Khan, M.A. and S.M.S. Hoda (1993). Sex ratio of the sole, *Euryglossa orientalis* (Bal and Schneider) (Family: Soleidae) from Karachi coast. *Pakistan Journal of Marine Sciences,* 2(2): 157-159.

Khan, M.A., M.U.A. Hashmi and K. Yousuf (2005). Studies on the fecundity and sex ratio of *Sardinella longiceps* (Family: Clupidae) from Karachi coast. *International Journal of Biology and Biotechnology,* 2 (1): 57-59.

Kokokiris, L., A. Stamoulis, N. Monokrousos and S. Doulgeraki (2014). Oocytes development, maturity classification, maturity size and spawning season of the red mullet (*Mullus barbatus barbatus* Linnaeus, 1758). *Journal of Applied Ichthyology,* 30: 20-27.

Lawson, E.O. and A.U. Olagundoye (2011). Growth Patterns, diet composition and sex ratios in giant African threadfin, *Polydactylus quadrifilis* from Ologe Lagoon, Lagos, Nigeria. *International Journal of Agriculture & Biology,* 13 (4): 559-564.

Lawson, E.O. and P.A. Doseku (2013). Aspects of biology in round sardinella, *Sardinella aurita* (Valenciennes, 1847) from Majidun Creek, Lagos, Nigeria. *World Journal of Fish and Marine Sciences,* 5 (5): 575-581.

Lawson, E.O., S.O. Akintola and O.A. Olatunde (2010). Aspects of the biology of sickle fin mullet, *Liza falcipinnis* (Valenciennes, 1836) from Badagry creek, Lagos, Nigeria. *Nature and Science,* 8(11): 168-182.

Liao, Y-Y., and Y-H. Chang (2011). Reproductive biology of the needlefish *Tylosurus acus melanotus* in waters around Hsiao-Liu-Chiu Island, Southwestern Taiwan. *Zoological Studies,* 50 (3): 296-308.

Mortuza, M. G. and T. Rahman (2006). Length-weight relationship, condition factor and sex-ratio of freshwater fish, *Rhinomugil corsula* (Hamilton) (Mugiliformes: Mugilidae) from Rajshahi, Bangladesh. *Journal of Bio-science,* 14: 139-141.

Mousavi-Sabet, H., A. Kamali, M. Soltani, A. Bani and H. Rostami (2012). Age, sex ratio, spawning season, gonadosomatic index, and fecundity of *Cobitis faridpaki* (Actinopterygii, Cobitidae) from the Siahrud River in the Southeastern Caspian Sea basin. *Caspian Journal of Environmental Sciences,* 10 (1): 15-23.

Nandikeswari, R., M. Sambasivam and V. Anandan (2013). Study on sex ratio of *Terapon puta* (Cuvier, 1829) from Puducherry coast, India. *Journal of Environmental Science, Computer Science and Engineering & Technology,* 2 (4): 1396-1400.

Nandikeswari, R., M. Sambasivam and V. Anandan (2014). Estimation of fecundity and gonadosomatic index of *Terapon jarbua* from Pondicherry coast, India. *International Journal of Biological, Veterinary, Agricultural and Food Engineering,* 8 (1): 67-71.

Nzeh, C.G.A. (2010). Fecundity, condition factor, sex ratio and length-weight relationship of the Characidae (Tiger Fish) and Cyprinidae (African carp) from a reservoir in Ilorin, Nigeria. *Asian Journal of Experimental Biological Sciences,* 1 (4): 898-901.

Oliveira, M.R., E.F.S. Costa, A.S. Araujo, E.K.R. Pessoa, M.M. Carvalho, L.F.M. Cavalcante and S. Chellappa, S. (2012). Sex ratio and length-weight relationship for five marine fish species from Brazil. *Journal of Marine Biology & Oceanography,* 1 (2): 1-3.

Ozen, M.R. and B.A. Balci (2012). Histological study on reproductive pattern and sex reversal of dusky grouper *Epinephelus guaza* in natural environment of Antalya Bay of Mediterranean in Turkey. *Turkish Journal of Fisheries and Aquatic Sciences,* 12: 157-164.

Rahman, M.M., M.Y. Hossain, M.A. Hossain, F. Ahamed and J. Ohtomi (2012). Sex ratio, length-frequency distributions and morphometric relationships of length-length and length-weight for spiny eel, *Macrognathus aculeatus* in the Ganges River, NW Bangladesh. *World Journal of Zoology*, 7 (4): 338-346.

Rheman, S., M.L. Islam, M.M.R. Shah, S. Mondal and M.J. Alam (2002). Observations on the fecundity and Gonadosomatic index (GSI) of grey mullet *Liza parsia* (Ham.). *Online Journal of Biological Sciences*, 2 (10): 690-693.

Roomiani, L., A.M. Sotudeh and R.H. Mofrad (2014). Reproductive biology of Hilsa shad (*Tenualosa ilisha*) in coastal Waters of the Northwest of Persian Gulf. *Iranian Journal of Fisheries Sciences*, 13 (1): 201-215.

Sahinoz, E., Z. Dogu, F. Aral, R. Sevik and H.H. Atar (2011). Reproductive Characteristics of Mullet (*Liza abu* H., 1843) (Pisces, Mugilidae) in the Atatürk Dam Lake, Southeastern Turkey. *Turkish Journal of Fisheries and Aquatic Sciences*, 11: 07-13.

Shamsan, E.F. and Z.A. Ansari (2010). Studies on reproductive biology of Indian sand whiting *Sillago sihama* (Forsskal). *Indian Journal of Marine Sciences*, 39 (2): 280-284.

Shobikhuliatul, J.J., S. Andayani, J. Couteau, Y. Risjani and C. Minier (2013). Some aspect of reproductive biology on the effect of pollution on the histopathology of gonads in *Puntius javanicus* from Mas River, Surabaya, Indonesia. *Journal of Biology and Life Science*, 4 (2): 191-05.

Sujatha, K. and K.V.I. Shrikanya (2013). Reproductive biology of striped grouper *Epinephelus latifasciatus* (Temminck and Schlegel, 1842), off Visakhapatnam, Middle East coast of India. *Indian Journal of Geo-Marine Sciences*, 42 (2): 183-

Vicentini, R.N. and F.G. Araujo (2003). Sex ratio and size structure of *Micropogonias furnieri* (Desmarest, 1823) (Perciformes, Sciaenidae) in Sepetiba Bay, Rio de Janeiro, Brazil. *Brazilian Journal of Biology, São Carlos*, 63 (4): 559-566.

Zin, T., A.A. Than and T.T. Naing (2011). Fecundity (F), gonadosomatic index (GSI), hepatosomatic index (HSI), condition factor (K) and length-weight relationship (LWR) in *Channa orientalis* Bloch & Schneider, 1801. *Universities Research Journal*, 4 (2): 47-62.

Zudaire, I., H. Murua, M. Grande, M. Korta, H. Arrizabalaga, J. Areso and A. Delgado-Molina (2010). Reproductive biology of yellowfin tuna (*Thunnus albacares*) in the Western and Central Indian Ocean. IOTC-2010- WPTT-48.

(*Accepted for publication July 2021*)