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DISTRIBUTION AND ABUNDANCE OF *TENUALOSA ILISHA* IN PYANMALOT RIVER, AYEYARWADY REGION IN MYANMAR

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ABSTRACT
Distribution and abundance of Tenualosa ilisha, in Pyanmalot river, Labutta Township, Ayeyarwady region was conducted from December 2017 to July 2018. Pobyae village tract, Kyutaw village tract and Kakayan village tract were designated to the study sites. Sample collection and questionnaire survey as a quick census were done monthly. A total of 5,977 individuals and 5,261 kg of T. ilisha were recorded from three study sites. A total of 3,068 individuals and 3,010 kg of T.ilisha from site III were the highest account in number of individuals and weight (kg) and the lowest account was 1,445 individuals of T. ilisha from site I and 912 kg from site II. A total of 2,802 individuals and 2,348 kg of T. ilisha in January, 2018 were observed as a peak count and 60 individuls and 64 kg were found as a lowest in June, 2018. Water temperature was ranged from 23-24 ˚C in December to 27-28 ˚C in March and April at all sites. Salinity was 0 ppt and pH value was (6-6.4) in all sites. Hilsa net (drift gill net) of fishing gears were operated in three study sites.

KEYWARDS: Fish species, distribution, population abundance, water paramaters.

1. INTRODUCTION

Tenualosa spp. belongs to the family Clupeidae. Ilisha shad, *Tenualosa ilisha* is locally known as Nga- tha- lauk in Myanmar. It occurs in the coastal shelf, estuaries, brackish waters and freshwater rivers. It is the most widespread species found from north Sumatra in the east to Kuwait in the west and the basis of important fisheries in Bangladesh, India, Myanmar, Pakistan and Kuwait (Blaber *et al*., 2001). The tropical shad of genus *Tenualosa* (family Clupidae) or locally known in Malaysia as ikan Terubok, are important estuarine fishes, both commercially and culturally in many Asian countries including Malaysia. There are currently five clupeids of the genus *Tenualosa* described worldwide; *Tenualosa ilisha*, *Tenualosa macrura*, *Tenualosa revesii*, *Tenualosa thibaudaui* and *Tenualosa toli* (Blaber *et al*., 2003). Hilsa shad, one of the most important tropical fish of the family Clupeidae under 13 genus *Tenualosa* and species *ilisha* is anadromous in nature locally known as Nga-Tha-Lauk in Myanmar, live in the sea for the most of its life but migrates at least 1,200 km up in some rivers in Indian Sub-continent for spawning (Omar, *et al*., 2014). *Tenualosa ilisha* is an important tropical fish belonging to the family Clupeidae and an anadromous fish occurring in the Indo-West Pacific region from the Arabian Gulf, along the coast of Pakistan, India, Bangladesh and Burma to South Vietnam, also it was recorded near the coasts of China (Bhaumik, 2015). Taxonomically the species has undergone a number of changes since it was first described, but not recognized, by Russel in 1803 as palasah. The Indian shad (Tenualosa ilisha), as it is most commonly referred to in the literature is an anadromous Clupeid of the Indian Ocean ascends rivers flowing into the Persian Gulf, Arabian Sea, Bay of Bengal, and the Gulf of Tongking (Pillay and Rosa, 1963). Migrations usually take place for the purposes of spawning. According to the reports of Antony Raja (1985) on the biology of *Hilsa ilisha* in India, there was a considerable variation in the route of migration depending on the changes of the environmental conditions. The distribution pattern were related to the monsoon winds, medium to high precipitation and run-off, surface temperature of 20-30 ˚C, surface currents changing with the change of monsoons, medium to low organic productivity, presence of sub-surface oxygen minimum layer and relatively low salinity of coastal waters (Pillay and Rosa, 1963). The up-stream spawning migration of T. ilisha, from the Gulf to the Shatt al Arab river to occur from early March to late October with a peak breeding season between the middle of April to June. Spawning migrations of this species are triggered by numerous environmental factors,

but rising water temperature during the spring and summer seem to have the most influence throughout its distributions (Talwar and Jhingran, 1991). Hilsa shad, T. ilisha occurs ocean from the Gulf India, the Pakistan Gulf, depth range in the Bay of Bangladesh, depth range in Myanmar and the Persian Gulf area (Wikipedia, 2014). It occurred in the foreshore areas, estuaries, brackish water lakes and freshwater rivers. It ascends the rivers for breeding and returns to the sea after completion of spawning to marine habitats. It feeds and grows mainly in the sea, but migrates to fresh water for spawning. Juveniles develop and grow in fresh water, but soon migrate to the ocean, where they spend most of their lives (Roomiani *et al*., 2014).

In Myanmar, fish export sector becomes one of the vital sectors for economic development. Fish is one of the valuable fishery resources and a very valuable export commodity for Myanmar. The fish is popular food amongst the people of South Asia and in the Middle East, but especially with Myanmar fish curry is highly flavored source food by the consumers. Ilisha role is also popular as a side dish. Ayeyawady Region is deltaic plain, and is abundant in fisheries. Fishery is one of the important economic products of this delta. Most of the aquatic products from Pyanmalot river is exported to fishery depot of Yangon. Fish were essential to maintain as the natural resources in the fishery purpose and ecosystem. For performing such the purpose, initial and practical work like the species composition and catch weight of fishes were basically necessary.

Therefore, this present study was amied to investigate the occurrence, distribution and abundance of *T.ilisha* in the study area.

2. MATERIALS AND METHOD

Ayeyarwady Region is situated in the lower part of Myanmar. Labutta Township of Ayeyarwady Region located between latitudes 16˚ 08' 48″ N and longitude 94˚ 45'40″ E. Pyanmalot river located around latitude 16˚ 17′ 8.48″ N and 95˚ 1′ 11.77″ E was originated from the plain near Pobyae village. It flows down near Kyutaw and Kakayan village tracts before entering into Andaman sea. Three different study sites namely Pobyae village tract, Kyutaw village tract and Kakayan village tract were designated as the study sites in this study. Study site I is Pobyae village tract. It is located around latitude 16˚ 20′ 0″ N and longitude 95˚0′0″ E and includes eight villages. Study site II is Kyutaw village tract. It is located around latitude 16˚ 17′ 30″ N and longitude 95˚0′0″ E and includes six villages. Study site III is Kakayan village tract. It is located around latitude 16˚15′0″ N and longitude 95˚2′30″ E and includes 11 villages. Kyutaw village tract is about two miles from Pobyae village tract. Kakayan village tract is about three miles far from Kyutaw village tract. Specimens were collected on a monthly basis in collaboration with the fishery depots of three study sites. The study period lasted from December 2017 to July 2018. A total of 10 samples from *Tenualosa ilisha* were randomly collected from the study sites. Identification was made based on different prominent morphological characteristics of specimens according to the standard key of Talwar and Jhingran (1991). Water samples from the study sites were monthly collected. Water temperature was recorded by using the mercury thermometer. Salinity of water was also measured by refractometer. pH of water was measured by pH meter. The samples were recorded for estimation of weight of fish in fresh condition. Later they were converted into monthly figures. The total catches of *Tenualosa* species were calculated as productivity and correlated with number of samples and catch weight by using SPSS software, version 22 test.

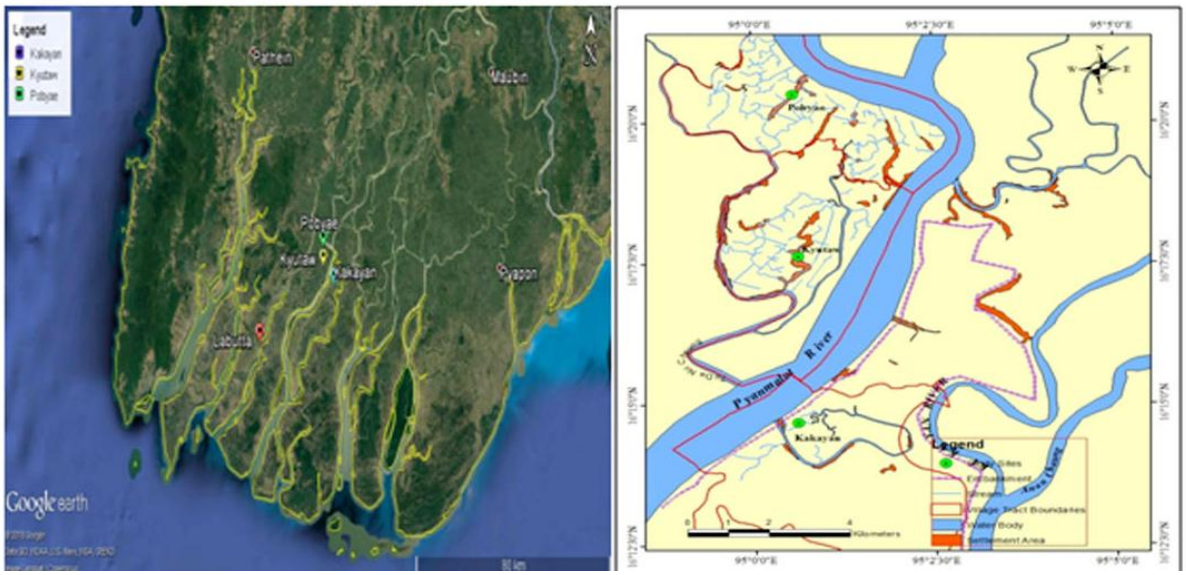

Fig. 1: Map of Pyanmalot River, showing the locations of the study sites (I, II, II).

3. RESULTS

3.1 General description of *Tenualosa ilisha* (Hamilton, 1822)

Body is fusiform, deep and laterally compressed. In *T. ilisha* the belly has 30-33 scutes. Distinct median notch found in upper jaw. Gill raker are fine and numerous, about 100 to 250 on lower part of arch. Fins are hyaline. A dark blotch is behind gill opening, followed by a series of small spots along flank in juveniles. Color in life is silver shot with gold and purple. Usually of as bronze color along the dorsal, with silvery sides and a burnished silvery band going above the eye to the upper half of the caudal fin. Caudal fin is often deeply edged with black, in its entire circumference. Gill raker are straight or slighty curved, fine and numerous. No teeth on jaws 45 to 47 scales in lateral series (Plate. 1).

Plate 1: *Tenualosa ilisha* (Hamilton, 1822).

3.2 Monthly recorded individuals of *Tenualosa ilisha* in different study sites

In site I, total 1,445 individuals including 251 individuals in December, 435 individuals in January, 363 individuals in February, 193 individuals in March, 111 individuals in April, 57 individuals in May, 35 individuals in June were observed in seven months of study period. Highest production of *T. ilisha* was found in January, 2018 and lack in July, 2018. In site II, total 1,464 individuals including 207 individuals in December, 920 individuals in January, 191 individuals in February, 119 individuals in March, 18 individuals in April, nine individuals in June were observed during six months study period. Highest production of *T. ilisha* was found in January, 2018 and lack in May and July, 2018. In site III, total 3,068 individuals including 402 individuals in December, 1,447 individuals in January, 901 individuals in February, 266 individuals in March, 28 individuals in April, eight individuals in May, 16 individuals in June were observed in seven months study period. Highest production of *T. ilisha* was found in January, 2018 and lack in July, 2018.

3.3 Monthly recorded catch weight of *Tenualosa ilisha* in different study site

In site I, total of 1,339 kg including 132 kg in December, 523 kg in January, 333 Kg in February, 183 kg in March, 77 kg in April, 55 kg in May and 36 kg in June were observed throughout the study period. Highest catch weight of *T. ilisha* was found in January, 2018 and lack in July, 2018. In site II, total of 912 kg including 200 kg in December, 417 kg in January, 171 Kg in February, 96 kg in March, 18 kg in April and 10 kg in June. Highest catch weight of *T. ilisha* was found in January and lack in May and July, 2018. In site III, total of 3,010 kg including 411 kg in December, 1,408 kg in January, 897 kg in February, 213 kg in March, 49 kg in April,14 kg in May and 18 kg in June. Highest catch weight of *T. ilisha* was found in January, 2018 and lack in July, 2018.

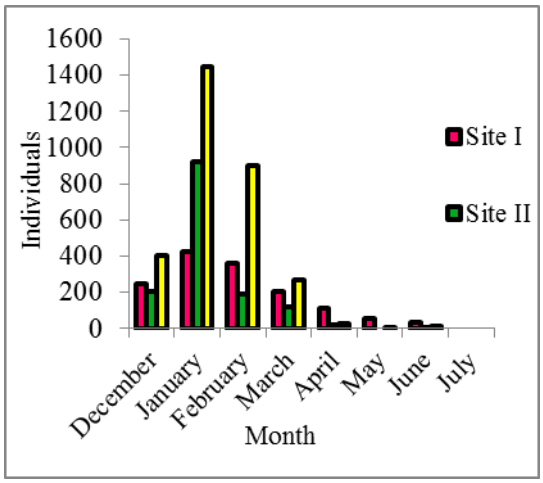

Fig. 2: Monthly recorded individuals of *T ilisha* in different study site.

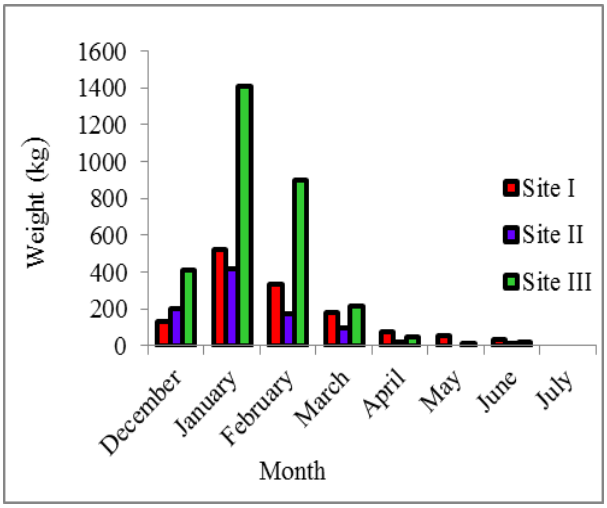

Fig. 3: Monthly recorded catch weight (kg) of *T.ilisha* in study sites.

3.4 Total individuals and catch weight of *T. ilisha* from different study sites

A total of 5,977 individuals (5,261 kg) of *T.ilisha* were recorded in these study sites. Among them, site III was recorded as a peak count 3,068 individuals (3,010 kg) followed by 1,464 individuals (912 kg) from site II, and 1,445 individuals (1,339 kg) from site I respectively.

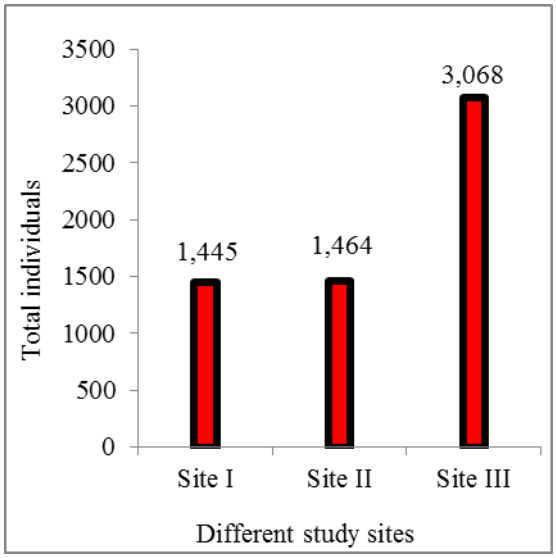

Fig. 4: Total individuals of *T. ilisha* in different study sites.

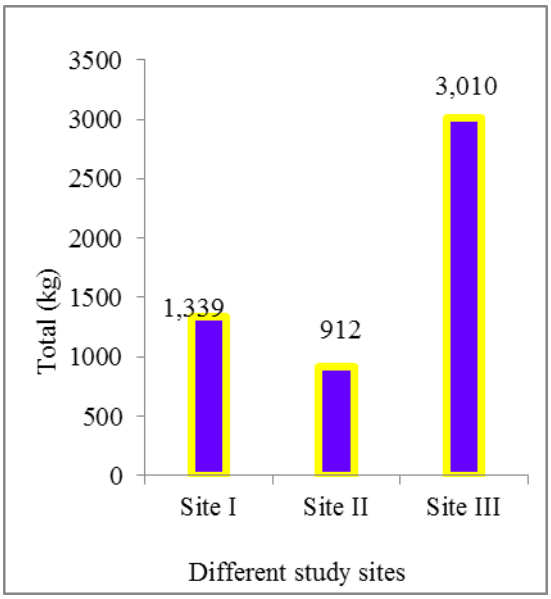

Fig. 5: Total catch weight (kg) of *T. ilisha* in different study sites.

3.5 Relationship between water parameters and abundance and catch weight

The relationship of water temperature and pH with abundance and catch weight of *T. ilisha* were established through the determination of correlation coefficients (r) at all study sites. In study site I, relation between abundance number of *T. ilisha* and temperature was (r=0.197, p=0.672), followed by site II and III (r=0.095, p=o.857) and (r=0.107, p=o.819) respectively. Monthly abundance number of *T. ilisha* and temperature was observed to be positively related and not significant. Monthly abundance number of *T. ilisha* and pH (r = 0.445, p=0.317), (r=0.073, p=o.89) and (r=0.349, p=o.443) in site I, II and III were not significantly and positively related. Water temperature and total catch weight of *T. ilisha* at site I, II and III. (r = 0.039, p=0.935), (r=0.300, p=0.563) and (r=0.126, p=0.789) were not significantly and positively related. In site I, II and III, relation between pH and total catch weight of *T. ilisha*. (r = 0.215, p=0.643), (r= 0.314, p=0.545) and (r=0.372, p=0.411) were not significantly and positively related.

4. DISCUSSION

A total of 5,977 individuals and 5,261 kg of *T. ilisha* from three study sites of Pyanmalot river were recorded in this study period. Total 3,068 individuals (3,010 kg) from site III, Kakayan village tract was peak in number, 1,464 individuals (912 kg) from site II, Kyutaw village tract and 1,445 individuals (1,339 kg) from from site I, Pobyae village tract were recorded.

Win Kyi (2014) reported that only one species, *Tenualosa ilisha* with 1,249 individuals (0.47 metric tons) were recorded from Pyay fish trading dealers and 76 individuals (0.08 metric tons) from three towns (Minhla, Monyo and Letpadan but 763 individuals (0.132 metric tons) from Ayayawady River (Pyay sector). Zaw Than Oo (2015) reported that a total of 55,472 individuals and 15.9169 tons of Hilsa shad *Tenualsa ilisha* from five landing sites of Sittway environs were recorded in this study period. Total 27,158 individuals (8.0322 tons) from Myauk Oo was peak in number, followed by 19,331 individuals (5.5643 tons) from Min Pya, 6,698 individuals (1.9888 tons) from Sittway, 1,472 individuals (0.0677 tons) from Pauk Taw and 813 individuals (0.2637 tons) from Ponnagyun were recorded. It may be assumed that Ayeyawady river and Sittway environs and its relative rivers are used for only purpose of breeding ground for *Tenualosa ilisha*. Pyanmalot river is orginated flows down into the Andaman sea. Thus this area may be used for feeding ground and breeding ground.

In the present study, *T. ilisha* was collected from all study sites, but the highest number was found in site III (Kakayan) which is situated nearest the Andaman sea. The smallest number of species was obtained from site I (Pobyae) which is located at the tip of the Pyanmalot river. The total numbers of *T. ilisha* males were more abundant than females. *T. ilisha* female comes to the upstream of the river for breeding.

Al-Noor (1998) pointed out that the *T. ilisha* larvae distributed along the banks of the Shatt Al-Arab River which are characterized by slow currents due to the thick growth of aquatic plants within the area extended from 30 to 120 km from the estuary. Al-Mahdi et al. (2000) collected *T. ilisha* larvae from the Al-Jebasi to Abu flows in the Shatt Al-Arab. Al-Okailee (2010) also collected *T. ilisha* larvae from shallow banks in the northern part of the Shatt Al-Arab. The presence of high cover of aquatic plants in the marsh area and Shatt Al-Arab River this was probably due to higher water impulse to the Southern marshes which led to flourishing of aquatic plants and algae (Al-Abbawy and Al-Mayah, 2010; Hussain et al., 2012) provide a suitable shelter and

spawning ground for fish. The occurrence *T. ilisha* larvae in the region indicate that this area was the spawning ground for these fishes. Al-Noor (1998); Al-Mahdi et al. (2000) and Mohamed et al. (2012) collected *T. ilisha* larvae from the same area. A total of 2,802 individuals (2,348 kg) in January, 2018 as highest number followed by 1,455 individuals (1,401 kg) in February, 2018, 860 individuals (743 kg) in December, 2017, 578 individuals (492 kg) in March, 2018, 157 individuals (144 kg) in April, 2018, 65 individuals (69 kg) in May, 2018, 60 individuals (64 kg) in June, 2018 were recorded in these study sites. In spawning of Hilsa shad, they breeds during South- west monsoon and a shorter from January – February (Rahman, 1989 and 2005).

T. ilisha was found in site I and site III from December to June. In site II, *T. ilisha* species lack in May. The peak occurrence was during January in all study sites.

T. ilisha larvae were found in the study region from March to October and the peak occurrence was in March. No hilsa larvae were found from October to February (Al-Okailee et al. (2016). Al-Noor (1998) collected *T. ilisha* larvae in the Shatt Al-Arab River in June to October 1997, while Al-Mahdi et al. (2000) collected T. ilisha larvae in the Shatt al-Arab River in May, June and July 1997, 1998. Mohamed et al. (2012) stated that the larvae of *T. ilisha* captured in the north part of Shatt Al-Arab River. In Kuwait, coastal waters of Arabian Gulf show that *T. ilisha* spawns in May to July with a peak in June (Al-Baz and Grove, 1995). In Iran, the spawning season of *T. ilisha* in Khouzestan Provine was from May to August (Roomiani et al., 2014). Panhwar et al. (2011) reported that the spawning season in *T. ilisha* was from May to October in Pakistan. In Indian, Bhaumik (2015) reported that spawning of *T. ilisha* takes place in the month of August to November and January-March and indicating that *T. ilisha* spawns more than once in a year. The disappearance of larvae at October to February could be due to the small size of the larvae and it made them able to avoid the net. Mohamed et al. (2008) showed that the disappearance of juveniles of *T. ilisha* from the east Hammer marsh during the winter months and they concluded that *T. ilisha* may move back to marine habitat to complete their growth. These differences in the spawning periods of of population in different areas may be due to genetic and environmental factors (Roomiani et al., 2014).

In the present study abundance of *Tenualosa* population was recorded in December, January, February and March respectively declining month after month. The least fish population was obtained from April, May and June in all study sites.

Thin Thin Soe (2009) reported that water level was low in premonsoon period (March to June). During this period fish population decreased. Fluctuatious in water levels cause rapid alteration in habitat and this can be deleterious in many aquatic populations. Rapidly decreasing of water levels may result in the eggs or fry being standard (Wager and Jackson 1993). Of the various environmental cues necessary to induce spawning in native fishes, specific temperatures are one of the most critical. Between the three seasons, the highest fish population was obtained in the cool season. The lowest fish population was collected in the hot season. The lowest temperature was recorded in the cool season than the rest (Wager and Jackson, 1993).

Number of *Tenualosa* species for all study sites was low in April to June. However, local fishermen mentioned that the number of catches during fishing season of *Tenualosa* species is varied depending on the weather. The number of catches is lower condition during rainy days. During spawning season, *Tenualosa* species were not collected by fisherman. This condition is probably explained the difficulty to obtain the fish samples at all study sites in April to June in which the weather is dry and hot. *Tenualosa* fish species are mainly found in large and turbid estuary (Mohsin and Ambak, 1996) where is rich with zooplankton community that have provided the food source for the population of this species (Mohammed Hambali et al., 2011). Since 1980's the total catch landing for the *Tenualosa* species has been reported decline due to overexploitation. Due to this condition, the rule and regulation such as closed season, types of fishing gear, and number of fishing vessels to manage and sustain the fisheries resources particularly on *Tenualosa* species have been started since 1993 (Mohamed Hambali et al. 2011). The species of *Tenualosa* was recorded in wet and cool season during the study period although it was not found in the months of February, March and April (hot season) Thin Thin Soe (2009). This finding is in contrast with Thazin Lwin (1998) who recorded the presence of *T. ilisha* during hot season. The season may be probably due to different environmental conditions between seasons and thus migratory route of fish might change with the season.

In this study water temperature, salinity and pH were measured and recorded monthly during the study period from December to July. According to the data salinity was zero all the time, but high temperature (27-28˚ C) and pH 6.4 were noted in March and April in which the least population was obtained. In contrast, the highest fish population was obtained in cold winter month like December and January in which the temperature is 23-24˚ C.

Fish spawned throughout the country year round in low or zero salinity waters. There were two periods of more intense spawning that coincided with the main monsoon (July to November) and the spring warming (February to May) in Bangladesh Zaw Than Oo (2015). The highest abundance of *T. ilisha* larvae was corresponding with the highest water temperature and low salinity the same was reached by Mohamed et al. (2012) and Brinda et al. (2010) in the marshes ecosystem the temperature influences the spawning season and abundance of fish

larvae. The results suggested the abundance of *T.ilisha* larvae are governed more directly by temperature, due to its influence on spawning, than by salinity (Charnov and Gillooly, 2004).

In the present study, monthly range of water temperature and pH were not significantly related between monthly abundance number and catch weight of *T. ilisha* in all study sites. Monthly produced number of fish and monthly range of water temperature and pH was found to be positively related in the study period. It may depend on the fisherman and fishing effort in the study area. Living organisms, especially aquatic life, function best in a pH range of 6.0 to 9.0 (Oram, 2010). In the study site, pH range from 6.1 to 6.4. It is considered that the abundance of fish and pH were no significant varation due to the pH range consists of 6.0 to 9.0 in aquatic life.

Range of temperature and salinity controlled the spawning season in the East Hammer marsh and Shatt Al-Arab River and showed positive correlations between the abundance of *T. ilisha* larvae and water temperature and negative correlations with salinity have effect on the occurrence of *T. ilisha* larvae in the East Hammer marsh and Shatt Al-Arab River (Al-Okailee, Mutlak and Younis, 2016). The highest abundance of *T. ilisha* larvae was corresponding with the highest water temperature and low salinity the same was reached by Mohamed et al. (2012) and Brinda et al. (2010) in the marshes ecosystem the temperature influences the spawning season and the abundance of fish larvae. The results suggested the abundance of *T. ilisha* larvae are governed more directly by temperature, due to its influence on spawning, than by salinity (Charnov and Gillooly, 2014).

The result has clearly shown the species occurrence of *Tenualosa ilisha*, their catch weight and their pattern of distribution along the study sites throughout the study period. The data obtained in the study revealed that inland fisheries are highly influenced by the climatic factors including human impacts. In addition, it is also dependent on the natural hazards. It is of utmost important to be aware that proper environmental conditions could be maintained if the natural resources are wisely used by man. This could then prevent hazardous conditions in nature that influence the lives of living creatures. Since in such situation of *Tenualosa ilisha* in the study area, these natural food resources need to be sustained and managed to go optimum production. Participating of the public is also of importance in preserving these resources. Public education to promote awareness and information programs should be established to protect the important ecological habitats of *Tenualosa ilisha* in Pyanmalot river.

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6. REFERENCES

1. Al-Abbawy, D.A.H. and Al-Mayah, A.A. 2010. Ecological Survey of Aquatic Macrophytes in Restored Marshes of Southern Iraq during 2006 and 2007. Marsh Bull, 5: 177-196.
2. Al-Baz, A.F. Grove, D.J.1995. Population biology of sbour *Tenualosa ilisha* (Hamilton-Buchanan) in Kuwait. *Asian Fisheries Science*, 8: 239-259.
3. Al-Mahdi, A.A., Hussain, N.A. and Al-Noor, S.S. 2000. Survey of ichthyoplankton from northern part of Shatt AL-Arab River. *Marina Mesopotamica*, 15: 571-380. (In Arabic).
4. Al-Noor, S.S.H. 1998. Reproductive biology of *Tenualosa ilisha* in the Shatt Al- Arab River. *PhD Thesis*, College of Agriculture, Basrah University, 161 pp. (In Arabic).
5. Al-Okailee, M.T.K. 2010. The spatial and seasonal composition of some ichthyoplankton and trophic relationships in north part of Shatt Al-Arab River. *PhD Thesis*, College of Agriculture, Basrah University, 207 pp. (In Arabic).
6. Al-Okailee, M.T.K, Mutlak F.M. and Younis K.H. 2016. Distribution and abundance of Hilsa, *Tenualosa ilisha* larvae in the Shatt Al-Arab River and East Al-Hammar Marsh. *Marine Science Centre, Basrah, Iraq.*
7. Antony Raja, B.T (1985). *Bay of Bengal Programme*, Marine Fisheries Resources Management in the of Bengal, Colombo, Sri Lanka, 66pp.
8. Bhaumik, U. 2015. Review of Global Studies on Food, Growth and Maturity Profile of Indian Shad (*Tenualosa ilisha*). *International Journal of Current Research.and Academic Review*., 3(10): 127-139.
9. Blaber, S.J.M; Milton D.A., Brewer D.T. and Salni J.P. (2001). Biology, Fisheries and status of Tropical shads *Tenualosa* spp. In South and Southeast Asia News and Reports, 5: 49-58. Accessible at htpp://www. Hilsashad.com.
10. Blaber, S.J.M., Milton, D.A., Chenery, S.R., Fry, G., 2003. New insights into the life history of *Tenualosa ilisha* and fishery implications. *American Fisheries Society Symposium*, 35: 223–240.
11. Charnov, E.L. and Gillooly, J.F. 2004. Size and temperature in the evolution of fish life histories. *Integrative and comparative Biology*, 44: 494-497.
12. Hussain, N.A., Ali, A.H. and Lazem, L.F. 2012. Ecological indices of key biological groups in southern Iraqi marshland during 2005-2007. Mesopot. *Journal of marshland Science*, 27(2): 112-125.
13. Mohamed Hambali Bin Tumiran, Khairul Adha A. Rahim, Shabdin Mohd. Long, Yuzine Esa, Awang

Ahmad Sallehin Awang Husaini. 2011. Environmental Parameters of "core Terubok areas" and the Relationship withTerubok Sarawak Population. *International Fisheries Symposium 2011, UMT-October 2011.*

14. Mohamed, *et al.*, 2012. Variations in occurrence, abundance and diet of hilsa, *Tenualosa ilisha* larvae in the north of Shatt Al-Arab River, Basrah, Iraq. Basrah Journal of Agricultural Science, 25 (Special Issue 2).
15. Mohsin, A. K. M., & Ambak, M. A., 1996. *Marine fishes & fisheries of Malaysia and neighbouring coun- tries*. University Pertanian Malaysia Press.
16. Omar, Md. I., Haque S.A, Sharker Md R., F.Islam Md and Alam M.A, 2014. Marketing System, seasonal price variation and market integration of Hilsa (*T. ilisha*) fish in some selected areas of Bangladesh. *British Journal of Marketing Studies*, March 2014; 2(1): 101-116.
17. Oram, B., 2010. Alkalinity- The protector of the stream. Wilkes University, Center for Environmental Quality. Environmental Engineering and Earth Sciences.
18. Panhwar, S.K., Siddiqui, G. and Ayub, Z. 2011. Reproductive pattern and some biological features of fish *Tenualosa ilisha* (Family: Clupeidae) from Pakistan. *Indian Journal of Geology Marine Sciences*, 40(5): 687-696.
19. Rahman, A.K.A., 1989. *Freshwater Fishes of Bangladesh*, 1st edition, Zoological Society of Bangladesh, Department of Zoology, University of Dhaka-1000, pp. 249-251.
20. Roomiani, L., Sotudeh, A.M. and Hakimi Mofrad, R. 2014. Reproductive bology of Hilsa shad (*Tenualosa ilisha*) in coastal Waters of the Northwest of Persian Gulf. *Iranian Journal of Fisheries Sciences*, 13(1): 201-215.
21. Talwar, P.K. and Jhingran A. G., (1991). *Inland fishes of India and adjacent countries*. Vol 1. Balkema, Rotterdam. 541 pp.
22. Thazin Lwin, 1998. Assessment of the water quality from some selected regions of the Ayeyawady River. *PhD Thesis*. Department of Chemistry, University of Yangon 310 pp.
23. Thin Thin Soe, 2009. Fish species Diversity in Ayeyawady River Segment of Thayet Environs in Associated with Environmental Impact. *PhD Thesis.* Department of Zoology, University of Yangon.
24. Wager and Jackson, 1993. The Historical and Current Status of Freshwater Fish in New South Wales.
25. Wikipedia, (Internet). *Tenalosa ilisha*. http://en.wikipedia.org/wiki/Hilsa. (Accessed: October 28, 2014).
26. Win Kyi, 2014. Assessment of *Hilsa* Resources and fishery, Ayeyarwady river (Pyay Sector) Bago Region. *Departmental Research*. Pyay University.
27. Zaw Than Oo, 2015. Status of Hilsa Shad *Tenualosa ilisha* (Hamilton, 1822) Found in Sittway Environs of Rakhine State. *MSc Thesis.* Department of Zoology, Sittway University.