Journal of Fisheries International 6 (3): 52-58, 2011
ISSN: 1817-3381

Population Dynamics of *Labeo senegalensis* Valenciennes 1842 (Pisces: Cyprinidae) in the Oueme River, Benin

[1,2]E. Montchowui, [2]A. Chikou, [3]M. Ovidio, [2]P. Laleye and [4]P. Poncin
[1]National Higher School of Agricultural Sciences and Techniques,
Ketou University of Abomey-Calavi, BP 95 Ketou, Republic of Benin
[2]Laboratory of Hydrobiology and Aquaculture, Faculty of Agricultural Sciences,
University of Abomey-Calavi, 01BP 526 Cotonou, Republic of Benin
[3]Laboratory of Fish Demography and Hydroecology, University of Liege,
10 Chemin de la Justice, 4500 Tihange, Belgium
[4]Behavioural Biology Unit, University of Liege, 22 Quai Van Beneden, 4020 Liege, Belgium

Abstract: The present study was conducted to understand the population parameters of *Labeo senegalensis* in Benin. Growth and mortality parameters, exploitation rates and annual recruitment patterns were estimated from monthly length-frequency samples between April, 2005 and March, 2006 for *Labeo senegalensis* in the Oueme river. Total length of the sampled 1436 fish ranged from 6.3-52.7 cm. The Von Bertalanffy Growth Function (VBGF) was fitted to the 12 consecutive month's length-frequency data to obtain a VBGF with the following parameters: L_∞ = 57 cm TL, K = 0.30 year^{-1}. The growth performance index ($\varnothing'$) was calculated as 2.99. The total mortality estimates from the catch curve analysis was Z = 1.47 year^{-1} with a natural mortality M of 0.68 year^{-1} for a mean environmental temperature of 28°C. The fishing mortality F estimates was 0.79 year^{-1}. The maximum of recruitment was recorded in June to September, indicating recruitment of one cohort year^{-1}. The estimated potential longevity T_{max} was 10 years. The exploitation ratio was 0.55 indicating that the *Labeo senegalensis* stock is on the verge being overfished. The results are discussed and compared to previously available information on *Labeo senegalensis* in others rivers.

Key words: Growth, mortality, exploitation rate, von bertalanffy GF, *Labeo senegelensis*, rivers

INTRODUCTION

The fish family Cyprinidae displays a worldwide distribution in fresh waters from tropics to cold temperate zones (Leveque, 2003). In Africa, the Cyprinidae have a pan-African distribution and form the most widespread fish family from the Maghreb region in North-western Africa to the coastal streams of the Cape in the South (Skelton *et al*., 1991). The vast majority of African species are included in only two genera: Barbus and Labeo.

Fishes species of the genus Labeo are widely distributed throughout Africa and consist of at least 80 species which comprise 16.5% of the African Cyprinid ichthyofauna (Skelton *et al*., 1991). Most *Labeo* species are commercially important throughout the African continent having contributed significantly to various fisheries (Weyl and Booth, 1999; Delaney *et al*., 2007). The species, *Labeo senegalensis* is widely distributed throughout West Africa (Leveque, 2003). It attains a length of 65.0 cm TL, a maximum weight of close to 4 kg and a maximum age of 6 years (Leveque and Daget, 1984). *Labeo senegalensis* locally known as gbogbe is one of two Labeo species present in the Oueme basin (Laleye *et al*., 2004). It is the largest species of the Labeo genus in the Oueme basin. *L. senegalensis* is becoming increasingly an important commercial cyprinid fish in the beninese fisheries and it is used as a popular food fish. The growing demand, the increased fishing intensity and technological advances in catching has allowed a high fishing pressure on this species (Montchowui *et al*., 2008).

Despite its commercial importance and possible use as an aquaculture species in the tropics (Omoreigie, 2001), only very limited and disparate information exists on its reproductive biology, ecology and exploitation levels in Benin in general and the Oueme river in particular. With the Benin continuously increasing fishing effort on the fish stocks in the Oueme basin, *L. senegalensis* is in

Corresponding Author: Elie Montchowui, Laboratory of Hydrobiology and Aquaculture,
National Higher School of Agricultural Sciences and Techniques, Ketou University of Abomey-Calavi,
01BP 526 Cotonou, Benin

danger of being overfished unless baseline research data are provided for its rational exploitation and management. Among studies of fisheries stock assessment for rational exploitation and conservation of resources, growth studies are an essential instrument in the sustainable management of fisheries resources because these studies contribute to estimates of production, stock size, recruitment and mortality of fish population (Issac, 1990; Abohweyer and Falaye, 2008). These studies provide a background for the elaboration of management plans envisioning optimum long-term exploitation of natural aquatic resources (Hilborn and Walters, 1992; Nassar, 1999). In order to contribute to a proper understanding of the life history of *L. senegalensis* in the Oueme river, this study investigated several aspects of population parameters such as growth, mortality, exploitation rates and recruitment patterns. Estimates of these population parameters are lacking for *L. senegalensis* in the Oueme river.

MATERIALS AND METHODS

Study site: The Oueme river (Fig. 1) is the largest fluvial basin in Benin with a 50.000 km^2 catchment area and extends to about 510 km in length originating from the Taneka mountains in the North of the country. The major

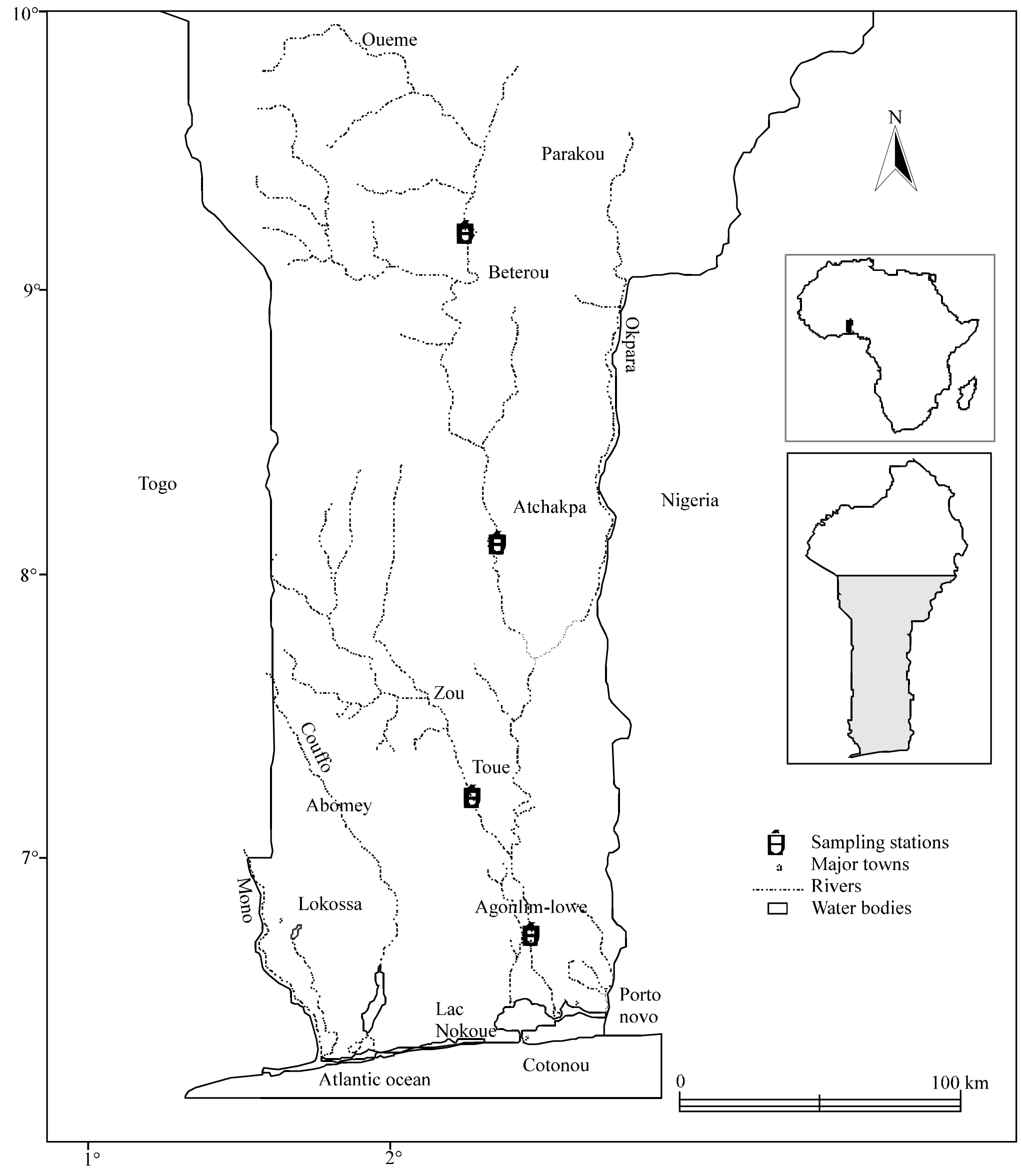

Fig. 1: Map of the Oueme river showing the four sampling stations

tributaries are the Okpara river (200 km long) and Zou river (150 km long). Peak discharge is rapid and occurs in August and September. The Oueme river goes through many agro-ecological zones and reaches the Eastern side of Lake Nokoue that is connected to the Atlantic ocean. It has an average slope of 0.9 m km^{-1} except along the upstream area of the basin where it measures 20 m km^{-1}. The river is influenced by two distinct climates due to its geographic location. The Northern basin (near the springs), experiences a tropical trend of alternative dry and rainy seasons and highly varying temperature (10-40°C). From November to March, rains can be rare or turbulent. Furthermore, the harmattan wind which blows from November to April, accentuates the thermic and hygrometric amplitudes. The rainy season extends from May to September. The Southern basin is characterized by a sub-equatorial climate with two rainy and dry seasons. The great rainy season occurs from April to July with the greatest amount of precipitation in June. The second rainy season occurs in September. The magnitude of variations of the temperature is much lower than in the North and ranges from 18-35°C. Fish sampling took place on four stations (Fig. 1). The first sampling station which is situated at Beterou (09°11'N-02°16'E), on the Oueme river is located along a coarse, rocky zone with swift water currents. The second sampling station at Atchakpa (08°04'N-02°22'E) on the Oueme river is located in a rocky zone. Toue (07°12'N-02°17'E) is the third sampling station on the Zou tributary which marks the transition between the zones of swift water and the delta. The forth station at Agonlin Lowe's village (06°39N-02°28E) is situated within the Oueme delta.

Fish sample and data analysis: Monthly samples of *Labeo senegalensis* were obtained from artisanal fishermen between April, 2005 and March, 2006. The Total Length (TL) of each specimen was measured to the nearest 0.1 cm while weight was measured to the nearest 0.1 g. The Fish Stock Assessment Tool (FiSAT) software (Gayanilo *et al*., 2002) was used to analyse the monthly length-frequency data (Table 1). The ELEFAN procedure in FiSAT was used to sequentially arrange and restructure the monthly length-frequency data from which a preliminary $L\infty$ value was seeded. The procedure was then used to fit the Von Bertalanffy Growth Function (VBGF) using the equation proposed by Pauly and Gaschutz (1979):

$$L_t = L\infty[1- \exp\text{-}K(t\text{-}t_0)]$$

Where:

L_t = Length at age t (in years)
$L\infty$ = Asymptotic length (cm)
K = The von Bertalanffy growth coefficient (year)
t_0 = Age of the fish at zero length

The growth performance index was calculated as $\varnothing' = \log K + 2\log L\infty$ (Pauly and Munro, 1984). The empirical model of Pauly (1980) was used to estimate the natural mortality M:

$$\text{Log}M = -0.0066-0.279 \log L\infty + 0.6543 \log K + 0.4634 \log T$$

Where, T is the water temperature (the mean annual surface temperature in the basin). In the case, we set the temperature to a value of T = 28°C. For estimation of total

Table 1: Monthly length frequency data of Labeo senegalensis from the Oueme river

ML/Date	J	F	M	A	M	J	J	A	S	O	N	D
6	-	-	-	-	-	-	-	-	-	-	4	9
8	5	-	-	-	-	-	-	5	33	5	25	29
10	36	-	-	-	-	-	-	6	95	64	60	28
12	59	-	1	7	-	-	-	9	4	47	42	41
14	34	-	-	1	7	-	-	7	12	13	18	49
16	8	4	5	-	12	-	1	7	5	8	24	52
18	7	20	9	2	11	3	1	6	1	6	18	30
20	7	23	8	-	2	2	3	1	5	1	7	9
22	5	10	10	4	6	3	12	-	1	4	14	3
24	6	8	4	12	11	1	7	2	-	12	7	4
26	3	3	3	19	14	2	3	2	2	10	6	3
28	4	3	6	11	8	2	4	3	2	7	9	3
30	2	2	-	1	4	2	7	4	2	4	9	4
32	-	2	1	1	2	-	4	2	-	2	2	5
34	3	2	-	-	-	-	1	1	-	-	1	1
36	3	-	-	-	-	-	-	-	2	-	-	-
38	5	1	1	-	2	-	-	-	-	-	-	-
40	1	-	-	1	-	-	-	-	-	-	-	-
42	-	-	-	-	1	1	-	-	-	-	-	-
44	1	-	1	-	2	1	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-	-
48	-	-	-	-	-	-	-	-	-	-	-	-
50	-	-	-	-	-	-	-	-	-	-	-	-
52	-	-	-	-	-	-	-	1	-	-	-	-
Total	189	78	49	59	82	17	43	56	164	183	246	270

ML: Mid-length of class interval; n = 1436 mortality (Z) using the length-converted catch curve method (Gayanilo *et al*., 2002), length-frequency data of all fishing methods were pooled together. Based on the estimated L∞ and K, the length-converted catch curve was built, the slope of which with the sign changed gave an estimate of Z. Having obtained Z and M, fishing mortality was derived by subtraction (F = Z-M). A relative yield-per-recruit analysis was performed incorporating probabilities of captures computed as suggested by Pauly and Soriano (1986) and Gayanilo *et al*. (2002). For this purpose in *L. senegalensis*, the ogive selection estimated by detailed analysis of the left ascending part of the length-converted catch curve was used. The potential longevity of the fish was estimated according to Pauly (1980), $T_{max} = 3/K$.

RESULTS AND DISCUSSION

The parameters of the von Bertalanffy growth equation were estimated as L∞ = 57 cm TL and K = 0.30 $year^{-1}$. The growth curve superimposed on the length frequency data is shown in Fig. 2. The growth performance index (⌀') was calculated as 2.99. The theoretical longevity T_{max} was 10 years. From the length-converted catch curve (Fig. 3), total mortality (Z) was estimated at 1.47 $year^{-1}$ and the instantaneous natural Mortality rate (M) was estimated at 0.68 $year^{-1}$. Fishing mortality rate (F) was calculated by subtraction at 0.79 $year^{-1}$. The level of Exploitation (E) has been assessed by computing the exploitation rate (Fig. 4) as 0.55. The recruitment pattern of *L. senegalensis* was plotted in relation to the percentage of recruitment versus (i.e., projecting a set of length-frequency backward onto a 1 year time axis) as shown in Fig. 5. The highest peak for recruitment was in June to September indicating recruitment of one cohort $year^{-1}$. This suggested a major maximum breeding activity from July to September during the beginning of the flooding pattern of

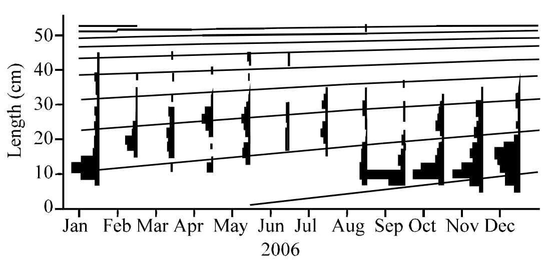

Fig. 2: Growth curves of *Labeo senegalensis*, super imposed over total length frequency data

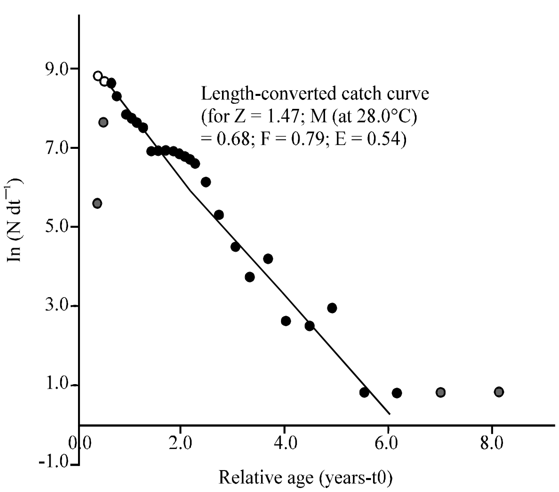

Fig. 3: Length-converted catch curve for estimating the total mortality (only black dots were considered for the computation of Z) of *Labeo senegalensis* in the Oueme river, Benin

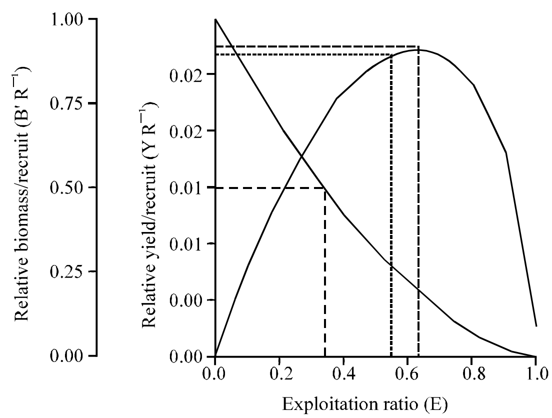

Fig. 4: Relative yield per recruit and relative biomass per recruit of *Labeo senegalensis* in the Oueme river, Benin

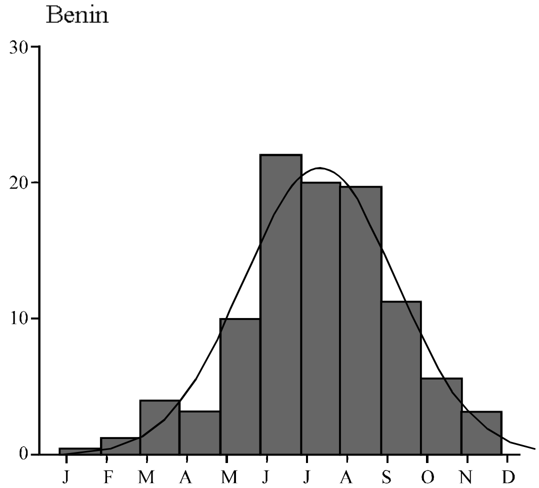

Fig. 5: Recruitment patterns of *Labeo senegalensis* in the Oueme river, Benin

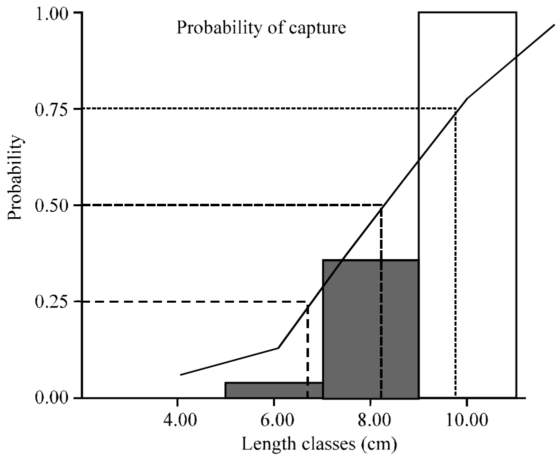

Fig. 6: Probability of capture analysis

Table 2: Estimates of growth parameters from this study and the values from previous studies

Locality	Parameters L_∞ (TL, cm)	K (year^{-1})	⌀'	References
Oueme river, Benin	57.0	0.30	2.99	This study
Lake Kainji, Nigeria	39.5	0.26	2.61	Moreau *et al.* (1995)
Niger-Benoue, Niger	45.6	0.63	3.12	de Merona *et al.* (1988)
Senegal river, Senegal	55.0	0.19	2.76	Moreau *et al.* (1995)

the river. The size at the 1st capture L_C (length at 50% capture) of *L. senegalensis* estimated by backward extrapolation of the straight portion of the right descending part (Fig. 6) of the catch curve was 8.2 cm TL. Effective management and conservation of any fishery resource requires considerable knowledge regarding population parameters such as growth, age, recruitment pattern, mortalities and exploitation level of the stock (Abohweyer and Falaye, 2008). Population parameters of *L. senegalensis* were not studied either in Benin. For the 1st time, a length frequency analysis was performed on *L. senegalensis* population of Oueme river.

The estimates of the growth parameters (L_∞ and K) in the present study for *Labeo senegalensis* are near those (Table 2) documented by Moreau *et al.* (1995) in the Senegal river in Senegal. On the other hand in Lake Kainji (Nigeria) and Niger-Benoue river (Niger), the values of growth parameters (Table 2) for the same species reported in previous studies (de Merona *et al.*, 1988; Moreau *et al.*, 1995) are different from those obtained in the present study.

This is probably owing to fishing pressure. According to Welcomme (1999), the strong tendency of fish length to decrease as fishing pressure increases means that length-linked changes occur in several demographic parameters. The value of the index of overall growth performance ⌀' obtained in the present study is in the range (2.65-3.32) recorded by Baijot *et al.* (1997) for the Western African fishes. These researchers consider that values in range (2.65-3.32) express a fast growth performance and potential. This result was in concordance with the results of de Merona *et al.* (1988) for the Niger-Benoue river, Moreau *et al.* (1995) for the Lake Kainji and Senegal river. This fast growth in the Oueme river population of *L. senegalensis* could allow for the attainment of fish large enough to migrate in the floodplains during the annual spawning migration as well as to maximise individual reproductive capacity.

In additional according to Welcomme (2001), the fish growth in a population reflects their ability to fulfil their own nutritional requirements and to adapt to the abiotic conditions of the environment. The fast growth (⌀' = 2.99) of *L. senegalensis* population in the Oueme river can principally be attributed to food availability, the nutritional value of the food ingested.

Concerning mortality, natural Mortality (M) estimates, apart from showing the proportion of death caused by all factors except fishing were lower than the total mortality Z and Fishing mortality (F). The high mortality rates can therefore be attributed to high fishing mortality. This indicates that exist a fishing pressure on *L. senegalensis* stock in the Oueme river. The predominant small fish in certain sampling stations such as Agonlin-Lowe may therefore explain partly the high fishing mortality.

The exploitation rate (0.55) is also slightly higher than the expected optimal exploitation level. This indicates that the *L. senegalensis* stock is on the verge being overfished and confirms the observations reported for the same species by Montchowui *et al.* (2008) in the Oueme river Delta. High fishing pressure on several fish stocks in Oueme river and others Beninese water bodies was previously indicated by Laleye *et al.* (2003, 2005) and Montchowui *et al.* (2008).

Those researchers indicated the fishing captures were currently dominated by the small size fishes. By consequent, the big size fishes such as *Heterobranchus longifilis*, *Gymnarchus niloticus*, *Parachanna obscura*, *Chrysichthys nigrodigitatus*, *Labeo senegalensis*, etc., became rare in fish captures in the Oueme river.

In the present study, the size at the first capture L_C (length at 50% capture) of *L. senegalensis* estimated by backward extrapolation of the straight portion of the right descending part (Fig. 6) of the catch curve was 8.2 cm TL.

This value is widely lower than the length at the first sexual maturity reported for *L. senegalensis* (29 cm TL for the females, 25.7 cm TL for the males) by Montchowui *et al.* (2010) in the Oueme river. Moreover, comparing the length-frequency distributions of captured

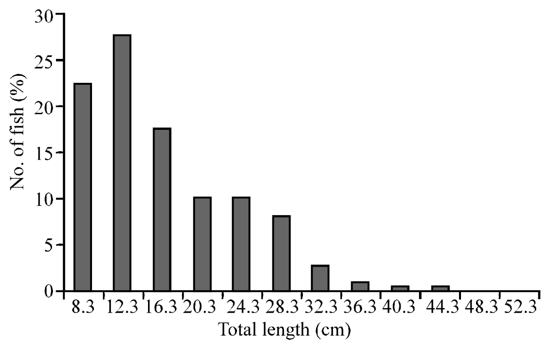

Fig. 7: Length frequency distributions of *Labeo senegalensis* caught from the Oueme river

fishes (Fig. 7) to the length of the sexual maturity, it comes out that for the examined sample about 87.5% of the caught fishes are <29 cm TL (L50 of females). It means that many individuals of *L. senegalensis* are captured before their first reproduction. It can then be considered that the population is heavily overfished and juveniles are the most captured in the Oueme river basin. It is therefore, necessary to ban certain fishing gears. Indeed, Montchowui *et al*. (2008) recently reported the negative impact of some fishing gears on *L. senegalensis* population in the low Oueme river valley. These gears are the small seine (Akpelou in local language) and bow-nets (Adja in local language) which catch all sizes. From the management point of view, this situation calls for a management strategy that will allow the escape of such sizes from the gear used in the resource exploitation. The L_C is very vital parameter that should be considered in the management of fisheries resource when used along with length at first maturity as it's indication of the health status of the resource.

CONCLUSION

The recruitment pattern suggests that seasonal recruitment consists of one peak seasonal pulse between June and September. There are no published reports on *L. senegalensis* recruitment in Benin. However, it has been reported that the *L. senegalensis* spawn mainly during June-September (Albaret, 1982; Montchowui *et al*., 2010). Major spawning was observed in August in the Oueme river, Benin. The major recruitment peak (June-September) detected in this study correspond to the major spawning season. The kind of study could assist in correlating the spawning and recruitment cycles in the Oueme river. This is typical feature of many African fishes studied so far (Baijot *et al*., 1997; Rabour *et al*., 2003; King and Etim, 2004; Montchowui *et al*., 2009).

ACKNOWLEDGEMENTS

This research was supported by the Belgian Technical Cooperation (BTC) and the University Agency of Francophonie (AUF). Researchers wish to thank to Joslain Daguegue for his assistance. Researchers are grateful to the anonymous referees for their constructive review of this manuscript.

REFERENCES

Abohweyer, P.O. and E.A. Falaye, 2008. Population parameters of *Macrobrachium vollenhovenii* in the lagos-lekki lagoon system, Nigeria. J. Fisheries Int., 3: 27-33.

Albaret, J.J., 1982. Reproduction and fecundity of freshwater fish in Ivory Coast. Rev. Hydrobiol. Trop., 15: 347-371.

Baijot, E., J. Moreau, I. Barry and S. Bouda, 1997. Biology and Demography of the main Fish Species of Reservoirs in Burkina Faso. In: Hydrobiological Aspects of Fisheries in Small Reservoirs in the Sahel Region, Baijot, E., J. Moreau and S. Bouda (Eds.). Technical Centre for Agricultural and Rural Cooperation, Wagenigen, Netherlands, ISBN: 929081138 2, pp: 140-141.

De Merona, B., T. Hecht and J. Moreau, 1988. Growth of the African Freshwater Fish. In: Biology and Ecology of the African Freshwater Fish, Leveque, C., M.N. Bruton and G.W. Ssentongo (Eds.). ORSTOM, French, pp: 191-219.

Delaney, L.M., M.J. Daniel and C.E. Campbell, 2007. Abundance and distribution of fish in the lower Mnembo River, Malawi-Mozambique. Afr. J. Ecol., 45: 390-397.

Gayanilo, F.C., P. Sparre and D. Pauly, 2002. The FAO-ICLARM Stock Assessment Tools (FISAT-II) User's Guide. Computerized Information Series, FAO, Rome, Italy.

Hilborn, R. and C.J. Walters, 1992. Quantitative Fisheries Stock Assessment, Choice, Dynamics and Uncertainty. Chapman and Hall, London, Pages: 570.

Issac, V.J., 1990. The Accuracy of Some Length-Based Methods for Fish Population Studies. ICLARM, Manila, Philippines, ISBN: 971-1022-86-9, Pages: 81.

King, R.P. and L. Etim, 2004. Reproduction, growth, mortality and yield of *Tilapia mariae* Boulenger 1899 (Cichlidae) in a Nigerian rainforest wetland stream. J. Appl. Ichthyol., 20: 502-510.

Laleye, P., A. Chikou, J.C. Philippart, G.G. Teugels and P. Vandewalle, 2004. Study of the ichthyological diversity of the Oueme River basin in Benin (West Africa). Cybium, 28: 329-339.

Laleye, P., O. Salako, A. Chikou and J.C. Philippart, 2005. Artisanal gill-net fishery catches of the catfish, *Schilbe intermedius* (Teleostei: Schilbeidae), in two tributaries of the Oueme River, Benin, West Africa. Afr. J. Aquat. Sci., 30: 163-166.

Laleye, P., C. Niyonkuru, J. Moreau and G.G. Teugels, 2003. Spatial and seasonal distribution on the ichthyofauna of Lake Nokoue, Benin, West Africa. Afr. J. Aquat. Sci., 28: 151-161.

Leveque, C. and J. Daget, 1984. Cyprinidae. In: In: Check-list of the Freshwater Fishes of Africa (CLOFFA), Daget, J., J.P. Gosse and D.F.E. Thys Van Den Audenaerde (Eds.). ORSTOM, Paris and MRAC, Tervuren, pp: 217-342.

Leveque, C., 2003. Cyprinidae. In: The Fresh and Brackish Water Fishes of West Africa, Paugy, D., C. Leveque and G.G. Teugels (Eds.). Coll. Tropical Fauna and Flora 40. IRD, MNHN and Royal Museum of Center Africa, France, pp: 322-436.

Montchowui, E., P. Laleye, J. Moreau, J.C. Philippart and P. Poncin, 2009. Population parameters of African carp, *Labeo parvus* Boulenger, 1902 (Pisces: Cyprinidae) in the Oueme River in Benin (West Africa). North West. J. Zool., 5: 26-33.

Montchowui, E., P. Laleye, P. Poncin and J.C. Philippart, 2010. Reproductive strategy of *Labeo senegalensis* Valenciennes, 1842 (Teleostei: Cyprinidae) in the Oueme basin, Benin. Afr. J. Aquat. Sci., 35: 81-85.

Montchowui, E., P. Tobada, A. Chikou and P. Laleye, 2008. Characteristics and fishing impact on exploitation of *Labeo senegalensis* Valenciennes 1842 in the lower Oueme River valley, Benin. Int. J. Biol. Chem. Sci., 2: 478-489.

Moreau, J., M.L.D. Palomares, F.S.B. Torres and D. Pauly, 1995. Demographic atlas of populations of the freshwater fish from Africa. ICLARM Technical Report, 45, Pages: 140.

Nassar, A.K.V., 1999. Length-weight relationships of tuna baitfish from the Lakshadweep Islands, India. Naga ICLARM Q., 22: 42-44.

Omoreigie, E., 2001. Utilization and nutrient digestibility of mango seeds and palm kernel meal by juvenile *Labeo senegalensis* (Antheriniformes: Cyprinidae). Aqua. Res., 32: 681-687.

Pauly, D. and G. Gaschutz, 1979. A simple method for fitting oscillating length growth data, with a program for pocket calculators. ICES Council Meeting Papers, pp: 24-26.

Pauly, D. and J.L. Munro, 1984. Once more on the comparison of growth in fish and invertebrates Fishbyte, 2: 21-21.

Pauly, D. and M.L. Soriano, 1986. Some Pratical Extensions to the Beverton and Holt's Relative Yield Per Recruit Model. In: The first Asian fisheries forum, Maclean, Maclean, J., L.B. Dizon and L.V. Hosillo, (Eds.). Asian Fisheries Society, Manila, pp: 491-496..

Pauly, D., 1980. On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 Fish stocks. J. Cons. Int. Explor. Mer., 39: 175-192.

Rabour, C.O., J. Gichuki and J. Moreau, 2003. Growth, mortality and recruitment of Nile perch *Lates niloticus* (L. Centropomidae) in the Nyanza Gulf of Lake Victoria: An evaluation update. NAGA, WorldFish Center Quarterly, 262: 8-12.

Skelton, P.H., D. Tweddle and P.B.N. Jackson, 1991. Cyprinids in Africa. In: Cyprinid Fishes: Systematics, Biology And Exploitation, Winfield, I.J. and J.S. Nelson, (Eds.) Chapman and Hall, London, pp: 211-239.

Welcomme, R.L., 1999. A review of a model for qualitative evaluation of exploitation levels in multispecies fisheries. Fish. Manage. Ecol., 6: 1-19.

Welcomme, R.L., 2001. Inland Fisheries. Ecology and Management. Food and Agriculture Organization of the United Nations. Blackwell Science Press, New York.

Weyl, O.L.F. and A.J. Booth, 1999. On the life-history of a cyprinid fish, *Labeo cylindricus*. Environ. Biol. Fish. 55: 215-225.