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The Abundance, Condition Factor and Length-Weight Relationship of *Sardinella madernensis* (Jenyns, 1842) from Nkoro River Niger Delta, Nigeria

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Abstract: The abundance, condition factor and length – weight relationship of *Sardinella madernensis* from Nkoro River in the Niger Delta area of Nigeria was studied from January – December 2008. The fishery of *Sardinella madernensis* is highly commercial and marketed canned, fresh, smoked or dried. Apart from being a cheap source of highly nutritive protein, it also contains other essential nutrients required by the body. As a food, sardines are rich in minerals. They can be consumed in a variety of ways-grilled, pickled, or smoked, to name three-though canned sardines are most popular worldwide. Sardines are rich in omega-3 fatty acids, which can help maintain a healthy heart. Recent studies suggest that regular consumption of omega-3 fatty acids reduces the likelihood of developing Alzheimer's disease. These fatty acids can also help control blood sugar level. Not only are sardines high in omega-3 fatty acids, but they are also a good source of vitamin D, calcium, B12, and protein. Sardines are extremely low in contaminants such as mercury. No work has been done on the length – weight relationship of *Sardinella madernensis* from the Nkoro River. A study of the abundance, condition factor and length – weight relationship of *Sardinella madernensis* from the Nkoro River adds more information on the family, Clupeidae to complement the existing data in the management and culture of the species in the Nkoro River, Niger Delta. This is essential for formulation of development plan in the fishing industry. Nkoro River is economically important and rich in biodiversity. Numerous activities such as oil exploration and production and agricultural activities go on in the region. Most of Nigeria's oil and gas reserves and production, which account for over 80% federal government's revenue, are located within the Niger Delta region. The highest catch was recorded in December (6.80), followed by November(4.10), February (3.40), April (1.60), March (1.10), October(0.64), January and September(0.12). May, June, July and August recorded no catch during the study. The highest catch per unit effort (6.42) was recorded in station 1, followed by station 2 (6.34), station 4(3.42) and 3(1.26). From a sample size of 1800 specimens, K value was 1.00 and the exponential equation was $Wt = 0.0478\ (TL)^{3.580}$, indicating an allometric growth pattern. The highest condition factor value (0.95) was recorded in March and November the lowest (0.8) in June. *Sardinella madernensis* in Nkoro river is in a stable environment and was more abundant in the dry season months of November, December and February.

Key words: *Sardinella madernensis,* abundance, condition factor, length – weight relationship, Nkoro River, Nigeria

INTRODUCTION

Sardinella madernensis belongs to the family Clupeidae. This is the family of the herrings, shads, sardines, hilsa and menhadens. It includes many of the most important food fishes in the world. Clupeids are mostly marine forage fish, although a few species are found in freshwater. No species has scales on the head, and some are entirely scale less. The lateral line is short or absent, and the teeth are unusually small where they are present at all. Clupeids typically feeds on plankton, and range from 2centimeters (0.79in) to 75centimeters (30in) in length. They spawn huge numbers of eggs (up to 200,000 in some species) near the surface of the water. After hatching, the larvae live among the plankton until they develop a swim bladder and transform into adults. The adults typically live in large bodies. Forms schools in coastal waters, preferring waters of 24ºC. Feeds on a variety of small plank tonic invertebrates, fish larvae and phytoplankton. Breeds during the warm season (July-September). Juveniles and adults show clear north-south migrations in the Gabon-Congo-Angola sector of their range and also in the Sierra Leone-Mauritania sector, each area having nurseries. The movements are correlated with the seasonal upwelling. Marketed fresh, frozen or salted. Apart from being a cheap source of highly nutritive protein, it also contains other essential nutrients required by the body (Sikoki and Otobotekere, 1999).

As a food, sardines are rich in minerals. They can be consumed in a variety of ways-grilled, pickled, or smoked, to name three-though canned sardines are most popular worldwide Sardines are rich in omega-3 fatty acids, which can help maintain a healthy heart. Recent studies suggest that regular consumption of omega-3 fatty acids reduces the likelihood of developing Alzheimer's disease. These fatty acids can also help control blood sugar level. Not only are sardines high in omega-3 fatty acids, but they are also a good source of vitamin D, calcium, B12, and protein. Sardines are extremely low in contaminants such as mercury.

Canned sardines in supermarkets may actually be sprats (such as the "brisling sardine") or round herrings. The actual sizes of the fish canned vary by species. Good quality sardines should have the head and gills removed before packing. They may also be eviscerated before packing (typically the larger varieties), or not; if not eviscerated they should be free of undigested or partially digested food or feces (accomplished by holding the live fish in a tank for long enough that their digestive systems empty themselves). They may be packed in oil, water, or some sort of sauce.

Sardines are typically tightly packed in a small can which is scored for easy opening either with a pull tab (similar to how a can is opened), or a church key, attached to the side of the can. Thus, it has the virtues of being an easily portable, non-perishable, self-contained source of food, and often such things as sewing kits or survival kits are packed in a similar container. The close packing of sardines in the can has led to their being used metaphorically for any situation where people or objects are crowded together; for instance, in a bus or subway car. It has also been used as the name of a children's game where one child hides and each successive child who finds the hidden one packs into the space until there is only one left out, who becomes the next one to hide.

Catch Per Unit Effort (CPUE) is a useful index in the assessment of abundance of fish species (Gulland, 1975). It is essential in the determination of maximum sustainable yield (MSY) and potential yield. Tobor (1992) reported that the inshore waters of most parts of the West African coast are rich in fish resources in quantities that can support commercial exploitation on a sustainable basis. However, later developments in fisheries studies have pointed to the depletion of the fish stocks (Okpanefe, 1977).

Condition factor compares the wellbeing of a fish and is based on the hypothesis that heavier fish of a given length are in better condition (Bagenal and Tesch, 1978). Condition factor has been used as an index of growth and feeding intensity (Fagade, 1979). Condition factor decrease with increase in length (Bakare, 1970, Fagade 1979); and also influences the reproductive cycle in fish (Welcome, 1979). Condition factors of different species of cichlid fishes have been reported by Siddique, 1977; Fagade, 1978; 1979; 1983; Dodzie and Wangila, 1980; Arawomo, 1982 and Oni *et al.*, 1983. Some condition factors reported for other fish species include; Alfred – Ockiya (2000), *Chana chana* in fresh water swamps of Niger Delta and Hart (1997), *Mugil cephalus* in Bonny estuary, Hart and Abowei (2007), ten fish species from the lower Nun River, and Abowei and Davies (2009), *Clarotes lateceps* from the fresh water reaches of the lower Nun river.

The length-weight relationship of fish is an important fishery management tool. Its importance is pronounced in estimating the average weight at a given length group (Beyer, 1987) and in assessing the relative well being of a fish population (Bolger and Connoly, 1989). Consequently, length-weight studies on fish are extensive. Notable among these are the reports Shenouda *et. al* (1994), for *Chrysichthys spp* from the Southernmost part of the River Nile (Egypt), Alfred-Ockiya and Njoku (1985) for mullet in New Calabar River, Ahmed and Saha (1996) for carps in Lake Kapital, Bangladash, King (1996) for Nigeria fresh water fishes, Hart (1997) for Mugil cephalus in Bonny Estuary; Diri (2002) Tilapia guineensis in Elechi creek.

Unfortunately, no work has been done on the length – weight relationship of *S maderensis* from the Nkoro River. A study of the abundance, condition factor and length – weight relationship of *S maderensis* from the Nkoro River adds more information on the family, Cluipeidae to complement the existing data in the management and culture of the species in the Nkoro River, Niger Delta.

Accurate fisheries statistics in the river; and its adjourning flood plains is vital for the formulation of a sound fisheries management programme in the Nkoro River and similar water bodies. But, this is completely lacking. A part from Scott, 1966; Reed *et al.*, 1967; Otobo, 1981; FAO, 1994; Otobo, 1993, Ita and Medahili, 1997; Sikoki and Otobotekere, 1999; Ezekiel *et al.*, 2002; Abowei and Ezekiel 2003; Abowei *et al.*, 2007; Abowei and Hart 2007; Abowei *et al.*, 2008, Abowei and Hart 2008, Abowei and Hart, 2009 and Abowei and Davies 2009, from different water bodies, there are no reliable data on the abundance of *S. madernenses* from Nkoro River. This is essential for formulation of development plan in the fishing industry. This paper therefore provides information to fill that gap in Nkoro River fisheries.

MATERIALS AND METHODS

Study Area: The Nkoro River is a distributory of the Andoni River in the Niger Delta area of Nigeria. The Nkoro River lies between latitudes 4º 28' to 4º 45' N and longitudes 7º 45'E. The Niger Delta is one of the world largest wetlands covering an area of approximately 70,000 km^2. The area is economical important and rich in biodiversity. Numerous activities such as oil exploration and production and agricultural activities go on in the region. Most of Nigeria's oil and gas reserves and production, which account for over 80% federal government's revenue, is located within the Niger Delta region. The Red and white mangroves (*Rhizonhora* and *Avicenia* spp) mangrove swamps and flood plains border

Table 1: Monthly catch per unit effort for *S maderensis* in Nkoro River

Jan.	Feb.	Mar.	Apr.	May	Jun	.Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
0.38	3.40	1.10	1.60	0.00	0.00	0.00	0.00	0.20	0.04	4.10	6.80

the river and its numerous creeks; and these are well exposed at low tides.

Fish Sampling: Fish specimens were procured from artisanal fishers and middlemen at their landing site for the study. Sampling of landed catches was done twice in a month for a period of twelve months The fishers used a wide range of fishing gear such as hook and line, long line, cast nets, gill nets and traps. From the catches, fish specimen were collected randomly and identified using keys and descriptions by Holden and Reed (1972), Loveque *et al*., (1991) and Reed *et al*., (1967). Specimens were stored in coolers containing ice and transported to the laboratory for further analysis.

Abundance was estimated from the weight (kg) of the total catch of each station for each species over the period of this study and compared for difference using Analysis of variance (ANOVA) to test for difference between the stations. Catch per unit effort was calculated by dividing the total monthly catch by the effort (number of fishers per boat) and finally dividing by the number of hours of fishing giving:

CPUE= Total catch/No of fishers/fishing hours
CPUE = Kg/man/hr (King, 1991).

The figures for catch per unit effort were tested for variation on monthly and station basis using ANOVA.

The Total Length (TL) of the fish was measured from the tip of the anterior or part of the month to the caudal fin using meter rule calibrated in centimeters. Fish were measured to the nearest centimeter. Fish weight was measured after blot drying with a piece of clean hand towel. Weighing was done with a tabletop weighing balance, to the nearest gram. The length measurements were converted into length frequencies with constant class intervals of 2cm. The mean lengths and weights of the classes were used for data analysis, the format accepted by FISAT (Gayanilo and Pauly, 1997).

The relationship between the length (L) and weight (W) of fish was expressed by equation (Pauly, 1983):

$$W=aL^{b} \qquad (1)$$

Where

W=Weight of fish in(g)
L=Total Length (TL) of fish in(cm)
a=Constant (intercept)
b=The Length exponent (slope)

The "a" and "b" values were obtained from a linear regression of the length and weight of fish. The correlation (r^2), that is the degree of association between the length and weight was computed from the linear regression analysis:

$$R = r^2 \qquad (2)$$

The condition factor (k) of the experimental fish was estimated from the relationship:

$$K = \frac{100\ W}{L^3} \qquad (3)$$

WhereK= condition factor,W= weight of fish, L= length of fish (cm)

RESULTS

The monthly catch per unit effort for *S maderensis* in Nkoro River is presented in Table 1. The highest catch was recorded in December (6.80), followed by November(4.10), February (3.40), April (1.60), March (1.10), October(0.64) and September(0.12). May, June, July and August recorded no catch during the study.

The catch per unit effort of *S maderensis* at each station in Nkoro River is presented in Table 2. The highest catch per unit effort (6.42) was recorded in station 1, followed by station 2 (6.34), station 4(3.42) and 3(1.26).

Table 3 expresses the condition factor and the exponential equation from the length weight relationship of *S maderensis* in Nkoro River. From a sample size of 1324 specimens, K value was 0.947 and the exponential equation was $Wt = 0.0478\ (TL)^{3.580}$, indicating an allometric growth pattern.

Fig. 1 illustrates the monthly condition factor for in Nkoro River. The highest condition factor value (0.95) was recorded in March and November the lowest (0.8) in June.

Table 2: Catch per unit effort of *S maderensis* at each station in Nkoro River

Station 1	Station 2	Station 3	Station 4
6.42	6.34	1.26	3.42

Table 3: Condition factor and exponential equation of *S maderensis* in Nkoro River

N	K	Exponential Equation
1324	0.947	$Wt = 0.0478(TL)^{3.580}$

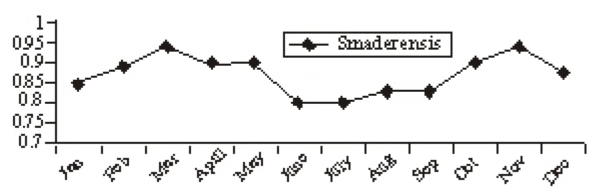

Fig. 1: Monthly condition factor for *S maderensis*

DISCUSSION

The catch per unit effort values range are: *S maderensis,* 0.00 (May, June, July and August to 6.80 (December)] from this study varied from the results obtained from other studies. Scott (1966) reported that, rivers, lakes and swamps of the Niger Delta produced about 2,000 tonnes of fish per year. Moses (1981) estimated a mean annual catch of 4,791 tonnes from the cross river over a period of twelve years. Sikoki and Hart (1999) in the Brass river, estimated the total biomass of 160.20 of fish per boat, total catch of 254,554kg, annual production of 610.93 tonnes, estimated mean catch per boat of 384.90kg and a standing stock of 1.19km^{-2}.

Variation in the total estimate values Nkoro River could be attributed to differences in fishing and industrial activities in the different rivers. The reason for the low estimates in the Nkoro River could be as a result of high mortality of both juveniles and brood stock of various fish species as a result of predatory activities, which is typical of the study area. A similar remark was made by, Ssentengo *et al.*, (1986). Satia, 1990 also noted the controversy surrounding fish production statistics. In the lower Nun River, much of the problem hampering the acquisition of reasonably accurate fisheries statistics and resource appraisal appear to stem mainly from lack of, or inadequate investment and lack of trained personnel to handle data collection.

Factors affecting fish distribution and abundance have already been reported by different workers. Availability of food, spawning rates, breeding grounds coupled with shelter, presence of current, vegetation, depth of water, breeding rabbits migration and low predation have been suggested as major limiting factors affecting the distribution and abundance of various fish families in Kainji Lake (Ita, 1978).

Angelescu *et al.*, *(*1958) reported fish catch varied with type of gear used, tidal condition and period of capture, diurnally and seasonally. From the work of King (1991), it is clear that most commercially and scientifically important fish species occurring in the Niger Delta waters can be landed all year round by artisanal fishers but there are months when they are more abundant.

The values obtained for the weight – length relationship showed that *S maderensis was* allometric in growth. Several authors have reported both isometric and allometric growth for different fish species from various water bodies. King 1991, reported allometric growth patterns for Tilapia species from Umuoseriche lake. King (1996) reported isometric growth for *Pseudotolithus elongatus* from Qua Iboe estuary. Ekeng (1990) also reported an isometric growth pattern for *Etmalosa fimbriata* from Cross River estuary in Cross River state. Marcus (1984), obtained an isometric growth patterns for *E. fimbriata* from coastal and brackish water of Akwa Ibom state. Shenouda *et al.*, (1994) also observed an isometric growth patterns for *Chysichthys auratus* from the southern most parts of River Nile and Egypt.

The transformed length fitted over weight gave linear growth indicating the three dimensional growth structures of most fish species (Lagler *et al.*, 1977). Values of the length exponent in the length-weight relationship being isometric implies that the fish species did not increase in weight faster than the cube of their total lengths. However, the weight of the rest species increased faster than the cube of their total lengths.

Length-weight relationships give information on the condition and growth patterns of fish (Bagenal and Tesch, 1978). Fish are said to exhibit isometric growth when length increases in equal proportions with body weight for constant specific gravity. The regression co-efficient for isometric growth is ‘3’ and values greater or lesser than ‘3’ indicate allometric growth (Gayanilo and Pauly 1997).

The mean condition factors 0.947 and monthly condition factor ranging from 0.8 – 0.95 obtained in this study varied slightly with the results from other studies. Ajayi (1982), reported K=0.77 – 0.81 for *Clarotes filamentosus* in lake Oguta; Nwadiaro and Okorie (1985) obtained K = 0.49-1.48 in Andoni river. The value obtained from the study showed that all species studied were in good condition. Gayanilo and Pauly (1997) reported that certain factors often affect the well - being of a fish. These include: data pulling, sorting into classes, sex, stages of maturity and state of the stomach.

The factor of condition factor (K) reflects, through its variations, information on the physiological state of the fish in relation to its welfare. From a nutritional point of view, there is the accumulation of fat and gonad development (Le Cren, 1951). From a reproductive point of view, the highest K values are reached in some species (Angelescu *et al.*, 1958). K also gives information when comparing two populations living in certain feeding, density, climate, and other conditions; when determining the period of gonad maturation; and when following up the degree of feeding activity of a species to verify whether it is making good use of its feeding source (Weatherley, 1972). From the above assertions we could conclude that the five species in this work reproduce between May to October since they recorded the lowest K at about this period.

Furthermore, Vazzoler (1996) confirmed that lowest K values during the more developed gonad stages might mean resource transfer to the gonads during the reproductive period. Braga (1986), through other authors, showed that values of the condition factor vary according to seasons and are influenced by environmental conditions. The same may be occurring in the environment under study since the floodplain is influenced by many biotic and abiotic factors, which favour the equilibrium of all the species in the ecosystem.

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