Culture potentials of *Macrobrachium sp. in* Cameroon

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ABSTRACT

This paper examines the status of the giant African river prawn from two sites along Cameroon's coastal zone viz; the Lobe river, at about 8km South of Kribi 56'E 9^0 and 2^0 54.74'N) and the Mungo and Ombe rivers, on the West Coast between 1990/91 and 1996/97 respectively. There was a gradual increase observed in the level of exploitation reflecting the interest in this species as a source of protein. Using the ELEFAN method, growth and mortality parameters estimates, based on length frequency distribution were $L\infty$ = 18.33 TL and 16.02cm TL, K = 1.91 and. 3.16/year, F = 0.07 and 0.41/year for the lobe and Ombe rivers respectively. The distribution of length indicated no definite spawning. Comparative studies indicated the species has much potential for culture. This was supported from estimates of culture indices (CI' using asymptotic length and CI using asymptotic *size)* which had values of 8.06 and 4.64 for the lobe and 11.72 and 6 48 respectively for the Ombe/Mungo rivers. When considered with other environmental factors, there is need to encourage intensive cultures of *Macrobrachium sp* along/within the coastal rivers/marsh-lands of Cameroon This will augment the protein needs, economic and cultural status of the dependent culturists, fishermen and population.

Key words : Giant African river prawn, coastal zone, growth/mortality, culture indice and aquaculture potential

RESUME

Une étude à été fait sur la croissance du géant crevette Africaine le long de la côte Camerounaise. Deux sites ont été choisi : le fleuve de la Lobe, situe à 8km vers le sud de Kribi (9°56'E et 2° 54.74'N) et les fleuves de Ombe et Mungo dans la Province du Sud-Ouest dans les années 1990/91 et 1996/97 respectivement. Les resultats ont montré une augmentation progressif sur le niveau d'exploitation donc l'importance de cette espèce comme source de proteine dans la zone. La methode ELEFAN a été utilisé pour estimer les paramètres de croissance et la mortalite, sur une base de distribution taille-fréquences. Les valeurs obtenues été $L\infty$ = 18.33 TL et 16.02 TL, K = 1.91 et 3.16 /an, F = 0.07 et 0.41/an pour les fleures de Lobe et Ombe / Mungo respectivement. La distribution des tailles n'a pas indiqué une perioide definitif pour la ponte. Des études comparative ont indiquer que cette espéce a beaucoup de potentielité pour l'aquaculture; confirmé par les estimations des indices de culture (CI' et CI utilisant la longeur et le poid asymptotiques) avec valeurs de 8.06 et 4.64 pour le fleuve Lobe et 11.72 et 6.84 pour les fleuves Ombe/Mungo respectivement. Compte tenue des autres facteurs du milieu naturel, il ya a le besoin d'encourager l'aquaculture intensif du *Macrobrachium spp* le long de/à l'intérieur des fleuves/ marécages du Cameroun. Ceci augmenterait les besoins de proteine, le statut economique et culturel des aquaculteurs, pêcheurs et la population.

Mots clés: Géant crevette Africaine, zone côtières, croissance/mortalité, indice d'aquaculture et potentiel d'aquaculture.

1. Introduction

The giant African river prawn, *Macrobrachium völlenhovenii* (Herklots) and the similar smaller species, *Macrobrachium macrobrachion* (Herklots) (both locally called in Cameroon as mucossa) of the family Palaemonidae are widely distributed in tropical fresh, brackish and sometimes saltwater. Within the Eastern Atlantic along the African coast, they are found in the commercial fisheries in the offshore Islands of Cape Verde, Fernando Po, Sao Tome and Principe and from Senegal south along the West/Central African coast to Angola.

Holthius (1980) and Sagua (1980) noted that *M. vollenhovenii* attained maximum total length of 182mm, does not seem to occur in large quantities in fishermen's catches and has excellent taste. Further to this, the exploitation has been motivated by its high demand as food, the use of sun-dried smaller individuals as condiments for flavoring food and its source as a foreign exchange earner. Due mainly to its fast growth rate, there is also considerable interest in the potential for aquaculture of the giant African river prawn.

The coastal waters (Figure 1) of Cameroon are made up of about 10.000km^2 of continental shelf, 2.700km^2 of mangroves, a dense river network with many estuaries, natural reservoirs and lakes (Folack *et al,* 1999). These are of much potential for fish culture and biodiversity conservation. Climatic studies within Cameroon's coastal zone by GEF/UNEP (1998) indicated M*acrohrachium spp* to fall within the favorable culture zone with average temperatures between 20 and *25°C.* There was also an abundance of phytoplankton (Folack, 1988, 1989) with growth studies indicating favorable culture indices (Gabche and Hockey, 1995). Other factors favorable to culture within Cameroon' coastal waters include good soil types and water quality parameters. Some of these are the hydromorphic soils, Dissolved Oxygen (5-8mg/l), pH (7-9), conductivity (200-300ms), low salinity (less than 25psu). Availability of agro-industrial by-products (Table 1), rich in protein, carbohydrates and other nutrients with some preliminary infrastructure gives much hope for culture in the coastal zone. Two operational structures are responsible for fish culture and these include: the specialized Research Station

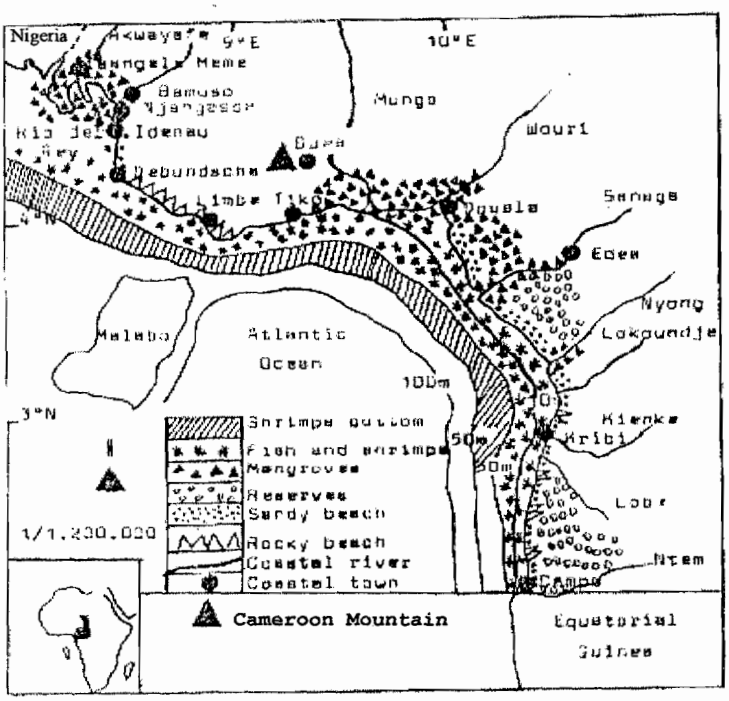

Figure 1. Characteristics of Cameroon' s dense river network with *M voilenhovenii* predominant in most of them.

for Fisheries and Marine Sciences in Limbe and the sub-units of the Ministry of Livestock, Fisheries and Animal Industries

A major incentive for the culture of M. *vollenhovenii,* within central and other West African coastal zones comes from the availability of cheap sources of feed within its natural habitats. For example, palm oil factories in the Cameroonian and Nigerian coastal zones produce wastes with significant amounts of oil. These can be used, amongst other agro-industrial wastes such as palm kernel press cake, cassava peels and leaves, and fishmeal, as important sources of local feed. There also exists a potential local market with the increased tourism around the coasts. There is the need to improve on the living standards of Cameroon's coastal population and also compensate for the continuous decrease observed in the maritime capture fishery

The aim of this study was to determine the population parameters of M. *vollenhovenii,* within Cameroonian rivers, their exploitation rates and aquaculture potential. Other considerations in terms of a rational management and development of the culture of this pelagic species are discussed

2 -Materials and methods

2.1 -The fishery

The commercial fishery for M. *vollenhovenii* in Cameroon

Table 1: Agro-industrial by products for fish culture in the Cameroon's coastal zone (Folack *et al* 1999)

Agro-industry	Location	By product	Yearly average production (tons)
S.C.M	Douala	Wheat bran flour	205.8
		Wheat bran pellets	219 1
		Pellets	*566.9*
C.C.C.	Douala	Palm kernel cake	*5,725*
Brasseries du Cameroun	Douala	Brewery waste	3,400
UCB	Douala	Brewery waste	250
Guinness	Douala	Brewery waste	1,800
Fishing companies	Along the coast	Fish waste	–
		Shell powder	–
Slaughter house	Main coastal towns	Blood meal	–
Slaughter house	coastal towns	Burnt bone powder	–

SCM =Societe Camerounaise de Minoterie
CCC = Complexe Chimique du Cameroun
UCB = Union Camerounaise des Brasseries

is based within the coastal zone which extends for about 420 km long (Sayer et al., 1992) (Latitudes $2^0 20^1$N at the Equatorial Guinea borders to 40 40'N at the Nigerian borders) (Fig. I). The dense river network made up mainly of the Lobe (about 8km south of Kribi ($9^0 56'$E and $2^0 54.74'$), Sanaga, Mungo and Ombe rivers (on the west coast) and their estuaries form dominant sites for fishing of *M. vollenhovenii.* Along these rivers and their estuaries are several landing sites for both indigenous and foreign artisanal or small-scale fishermen. They fish for prawn, shrimps and other pelagic fish species (e. g. *Sardinella maderensis* and *Ethmalosa fimbriata)* both on a part-time and permanent basis.

Dugout canoes are used and range in lengths between 6 to 8m with 2-3 hand paddles and 2-3 fishermen per fishing trip. Basket traps (4-9cm-mesh size) of length 40-100cm and diameter of 14.2-14.5cm, made from wide strips peeled from the hard outer layer of a palm frond stem were used in catching the species. The strips are tightly interlaced into a fusiform trap with reduction in diameter towards the end These traps are similar in structure to those described in Liberia by Miller (1971) and in Lake Barombi Mbo in Kumba (Trewavas *et al,* 1972).

The bait used is made up of fresh palm nuts or chaff from palm mills and white cassava root or leaves. At the estuarine zone, the basket traps are set at low tide within the inter-tidal zone and removed during the next low tide. Within the rivers, basket traps are set for about 8 hours (2-10 am); within the rocky shores with vegetation cover and defense territories (zones used by most prawn species to hide away from predators). The traps are emptied, the prawns sorted, with the smaller ones removed for fishermen's consumption and the larger ones are sold.

Sales from catches within the Mungo and Ombe rivers take place at the Tuesday and Friday markets, whereas those from the Lobe are sold in Lobe or the municipal market in Kribi on a daily basis. Some fishermen keep their prawns in holding traps within the rivers awaiting reasonable quantities for the market.

2.2- Methods and measurements.

A total of 598 prawns were randomly collected from fishermen twice a month between October, 1990 and September 1991 from the Lobe River. This was followed by the collection of 1365 random samples from fishermen weekly between March 1996 and February 1997 from the Mungo and Ombe rivers on the West Coast of Cameroon. The total length (TL) and carapace length (CL) (to the centimeter (cm) below) of each individual were measured while the total weights (W) were obtained by the use of a sensitive top loading Mettler balance with a precision of 0.01. The length-frequency distribution was analysed by first pooling on a quarterly basis (Pauly, 1983). The computer package Length Frequency Distribution Analysis (LFDA) was used for length frequency data analysis using Shepherds Length Composition Analysis (SLCA) and Electronic Length Frequency Analysis (ELEFAN These methods were used to estimate the von Bertalanffy parameters of the growth equation:

$$L_t = L\infty\ (1 - e^{-k(t-t_0)}) \quad \ldots\ldots(1)$$

with parameters
K = growth rate or curvature parameter,
L = asymptotic length and
t_o = time at which length equals zero.
Log transformations of the length weight relationships were derived from the following equation:

$$W = a.\ TL^b \quad \ldots\ldots(2)$$

Where:
W = Weight (gm)
TL = Total length (cm) and
a and b = constants.
The growth performance index (Φ) (Pauly and Munro (1984) was determined as:

$$(\Phi) = Log_{10}\ (K) + 2\ Log_{10}\ (L\infty) \quad \ldots\ldots(3)$$

with parameters as defined above. The growth performance index, (Φ), is an indication of the well being of an aquatic species relative to its external milieu. Pauly and Munro (1984) assumed that whenever the same units are used, the quantity, (Φ), is normally distributed within different populations of a given species.

The culture potential of *M. vollenhovenli* was determined from two culture indices (CI and CI') used in choosing fish for culture (Matthew's and Samuel 1990 and 1992). They are:

$$CI = \Phi^* P \quad \ldots\ldots(4)$$

where Φ* is the growth performance index based on weight (with W∞ = asymptotic size as defined in Moreau *et al* 1986) i.e:

$$\Phi^* = Log_{10}\ K + 2/3\ Log_{10}\ W\infty \quad \ldots\ldots(5)$$

with parameters defined above.

$$CI' = \Phi^{**} P \quad \ldots\ldots(6)$$

where Φ** is the growth performance index (Φ *) developed by Pauly and Munro (1984) using asymptot. body length (L∞)

P as used in both cases is the mean annual price (wholesale or retail) in US dollars per kilogram of fresh total weight, used as standard. The culture indices (CI) determined using weight instead of length is of more interest to aquaculturists. The instantaneous rate of total mortality *(Z)* was determined using the Beverton and Holt (1956) and Powell—Wetherall (Wetherall *et al,* 1987) methods.

The instantaneous rates of natural mortality (M) was estimated from Pauly's (1980) empirical length growth equation using 28°C as mean water temperature. The instantaneous rate of fishing mortality (F) was calculated from the equation.

$$Z = F + M \text{ (Ricker, 1975)} \qquad 7$$

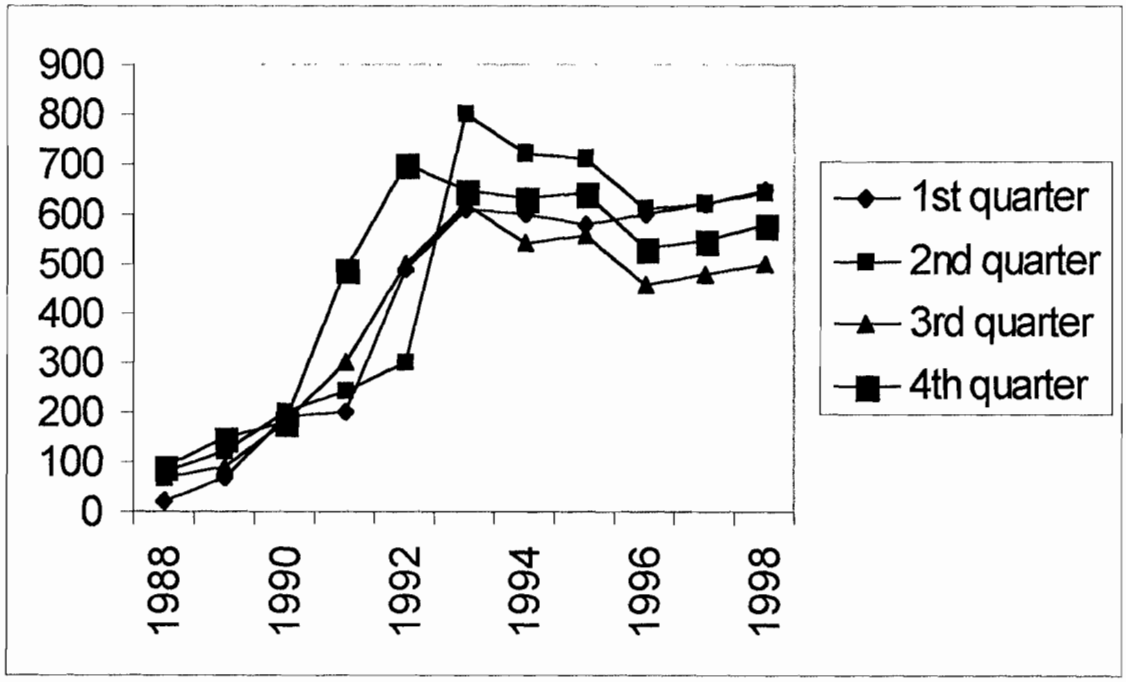

Figure 2. Catch statistics for *M. vollenhovenii* from Ombe/Mungo river (1988 – 1998)

This was followed by the estimation of the exploitation ratio (F), given as F/Z.

Results

The catch statistics for *M vollenhovenii* in the Ombe/Mungo rivers for 1988-1990 showed fluctuations with increases for the different quarters as the years progressed (Fig. 2). The mean length of *M. vollenhovenii* from the Lobe was 8.31cm with carapace length ranging between 1.3– 6.4cm and a mean of 3.2cm. Those for the Mungo and Ombe rivers had a mean length of 8.42 and carapace length of 1.2-7.1cm with a mean of 3.48cm. The total length histograms (Fig. 3 for the Lobe and Fig. 4 for Mungo/Ombe) showed several modes indicating that there was no definite spawning period within the year.

The length-weight relationship for M *vollenhovenni* in the different sites were as follows:

Lobe river:
Males
$Log_{10}W = -4.419 + 2.876 Log_{10}(TL)$ (n–299, r = 0.953)

Females
$Log_{10}W = -4.736 + 2.920 Log_{10}(TL)$ (n=295, r= 0.915)

Combined sexes
$Log_{10}W = -1.520 \pm 2.720 Log_{10}(TL)$ (n=598, r=0.850)

Ombe/Mungo
Males
$Log_{10}W = -4.500 + 2.912 Log_{10}(TL)$ (n=454, r = 0.946)
Females
$Log_{10}W = -4.923 + 2.967 Log_{10}(TL)$ (n=710,r=0.932)

Combined sexes
$Log_{10}W = -1.734 + 2.812\ Log_{10}(TL)$ (n=1,164, r= 0.872

All the above equations indicate that the species exhibit isometric growth in the rivers. The von Bertalanffy parameters determined from the ELEFAN method with the calculated growth performance indices are given in Table 2. The equations determined from ELEFAN parameters with the highest score were:

Lobe: $L_t = 18.33\ \{1\text{-exp. } [1.91\ (t+0.29)]\}$ cmTL

Table 2: Growth parameter estimates and performance indices obtained for M. *vollenhovenji in the* lobe and Ombe/Mungo rivers using the ELEFAN method.

Site	Growth Parameters K	L∞(cm)	To (years)	Score	Growth Performance (ϕ)
Lobe	1.91	18.33	-0.290	0.255	2.69
	1.89	18.11	0.288	0.245	2.79
Ombe/Mungo	1.51	16.02	0.450	0.361	1.38
	1.50	16.00	0.440	0.360	0.58

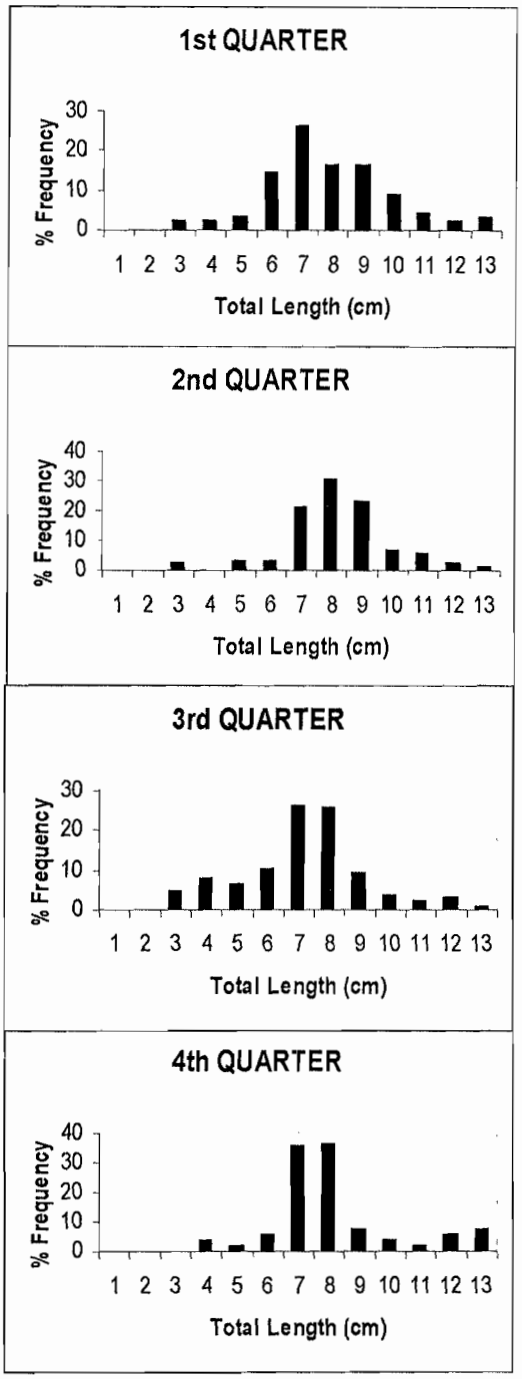

Figure 3: Length – Frequency distribution *of M vollenhovenii* (n = 1365 caught in Ombe/Mungo river (March, 1996 – February, 1997).

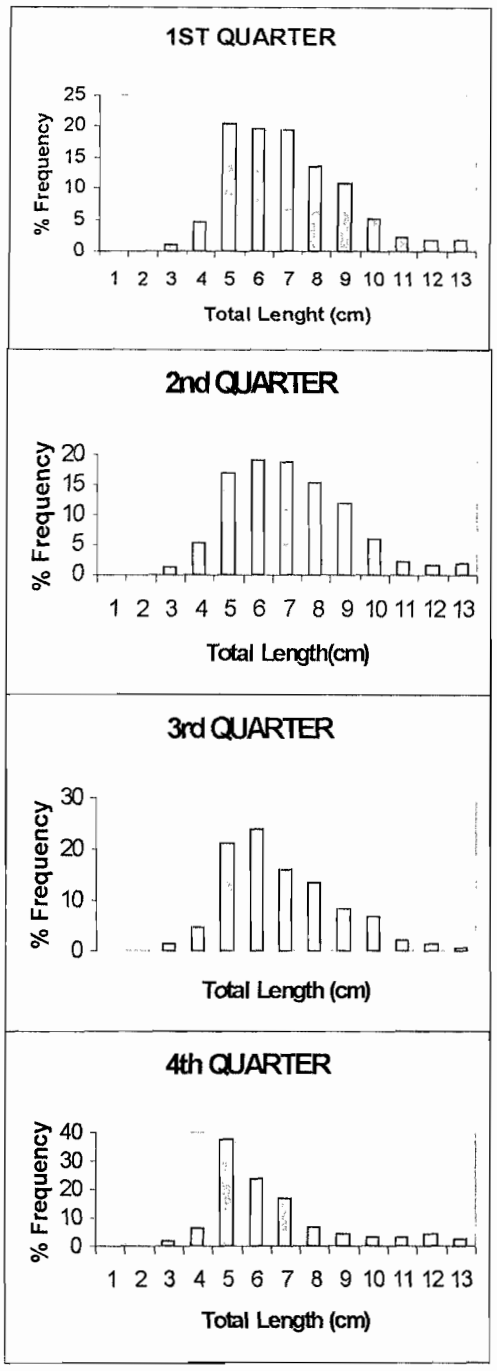

Figure 4. Length frequency distribution of *M. vollenhovenii* (n~598) caught in Lobe river Kribi October, 1990 – September, 1991)

Ombe/Mungo:

$L_t = 16.02\ (1 - \exp.\ [-3.16\ (t + 0.863)]\}$cm TL

The estimated values of $L\infty = 18.33$ and 16.02 for the Lobe and Ombe/Mungo rivers, when substituted in the log transformed data ($p<0.001$) of the length-weight relationship for combined sexes of *M.vollenhovenii* gave asymptotic sizes of 82.4g and 45.0g (Table 3) respectively The longevity (t_{max}) of *M. vollenhovenii* estimated from its maximum observed lengths (L_{max} =13.5cm TL) for the Lobe and (L_{max} = 13.1cm TL) for the Ombe/Mungo rivers and the equation, $t_{max} = 3/k$ Pauly (1983) approximated 1.57 and 0.95 years respectively. Both indicated the short life span of *M. vollenhovenii.*

For the Lobe river, values of k= 1.91 and $TL\infty = 18.33$ were used in the Pauly and Munro's (1984) equation to give a growth performance index of 2.69. The same equation when applied to K = 1.51 and $L\infty = 16.02$ for the Ombe/Mungo, gave a growth performance index of 1.38. These values indicated that the species had suitable environmental conditions in both milieu (though better in the Lobe).

Table 3: Estimates of culture indices (CI' using asymptotic length and CI using asymptotic size) for Lobe and Ombe/Mungo rivers.

Site	(ϕ)	W∞	(ϕ)	P(USD) kg^{-1}	CI'	CI
Lobe	1.50	82.4	1.12	2.75	4.29	3.08
Ombe/Mungo	1.28	*45.0*	0.98	4.00	5.12	3.92

The culture indices CI' were 4.29 and 5.12 and CI = 3.08 and 3.92 respectively for the Lobe and Ombe/Mungo rivers (Table 3). The mean annual prices (wholesale or retail) used were US $ 2.75 and US $4 per kilogram for the Lobe and Ombe/Mungo respectively.

Estimates by Gabche and Hockey (1995) of total mortality (Z) in the Lobe were 2.85 ± 0.426 (Beverton and Holt) and 3.966 ± *2.54* (Powell and Wetherall) per year. For the Ombe/Mungo, the total mortality (Z) estimate were 2.82 ± *0396* year $^{-}$ (Beverton and Hok) and 3.854± 2.48 year (Powell and Wetherall). The annual mean temperature of 28^{0}C observed for Cameroonian coastal waters when substituted in Pauly' s (1980) multiple regression equation, gave instantaneous rates of natural mortality (M) of 3.61 year^{-1} with Z = 3.966 year^{-1} for the Lobe, and M = 2.28 year^{-1} with Z= 3.85 for the Ombe/Mungo rivers. The instantaneous rates of fishing mortality (F) of 0,258 and *1.57* for the Limbe/Mungo gave exploitation ratios (E= F/Z) of 0.07 and 0.41 respectively, indicating low fishing intensity. These values do not exceed the optimum rate of 0.5 (Gulland, 1971 and, Pauly 1983) estimated to give the highest yield for recruit of a population.

Discussion and conclusions

There was a gradual increase observed in the level of exploitation of *M. vollenhovenii* in the Ombe/Mungo rivers as the years progressed, from 1988 onwards. This reflects the interest in this species as a source of protein. Much is being put in by fishermen (approximately 942 and 4908) around the Lobe and Ombe/Mungo (Njifoniou *et al* 1993) rivers respectively) involved in part time fishing of *M. vollenhovenii,* to meet up with the needs of mostly Cameroon's approximately 2.5 million coastal population. The several modes observed in the length-frequency distribution were an indication of multiple spawning. This is a characteristic of tropical aquatic fish populations in, which there are no extremes in temperature as seen in temperate zones. There is need to further study every staging and quantification of buried females to strengthen this conclusion. The observed maximum sizes of 13.5 and 13.1cm in this study were lower than the estimated asymptotic lengths of 16.41, 16.32 and 18.17 obtained by Holthius (1980) and Powell (1982). This further confirms that *M. vollenhovenii is* the largest growing prawn in Western Africa. It also brings into sharp focus the need for culture of this species. Intensive culture should improve on the growth performance and economic value of the stock.

The longevity of 1.57 and 0.95 years for *M. vollenhovenii* showed the species to be short lived as compared to other tropical shrimps e.g. *Peneus merguiensis, P. indicus, P. subtilis, Metapeiieus affinis* and *M. palmensis* (Venema *et al* 1988). This is an indication of high culture potentials for *M. vollenhovenii* since fish farmers will spend a shorter time to realize their products after cropping. *M. vollenhovenii* shows a better growth performance than others in the marine/estuarine ecosystems (Gabche and Hockey, 1995). The culture indices of 4.29 and 5.12 for the Lobe and 3.08 and 3.92 for the Ombe/Mungo all fall within the ranges of 5.71-20.5 and 1.81-12.41 required for commercially important populations (*Acanthopagrus curvieri,* CI = 12.41, CI' 20.5; *Parapanacopsis stylifera* CI = 1.84, CI'= 5.71 and *Panaeus simisulcatus* CI = 3.95, CI' = 8.61 in Kuwait waters (Matthews and Samuel, 1992).

The culture potential from growth performance is only one of several factors relevant to choosing crustaceans for culture. Other factors to be considered besides growths are:

- The value of the fish and its popularity;
- Biological characteristics such as tendency to be cannibalistic or sensitive to handling
- Availability of feed (this is possible for most Western African coastal states);
- Low tendency of pollution of aquatic milieu;
- The presence of the dense mangrove and coastal forest which reduce access to potential culture sites; construction of ponds needs cutting down of forest trees which is relatively expensive.
- Lack of technical know-how and culture biotechnology with respect to stocking, fingerling production and pond management.
- Availability of seeds to meet up with demand from farmers and sustainable production to meet up with demand and product economic returns.
- Difficult access to credits by aquaculturists, due to the in experience of the local banking system on the fish and shrimp sector.
- Competition on land use in the coastal zone since there is presently low use of land for aquaculture with most for agriculture.
- Administrative constraints in obtaining a licence for aquaculture.

The general appeal and popular taste can only be estimated by scrutinizing fish prices, the biological and environmental characteristics can be determined experimentally while other socio-economic and technological factors can be assessed using rapid participatory diagnosis and appraisal techniques. There is so much encouragement that is needed from the public sector towards potential aquaculturists. These include:

- Improvement on credit facilities to aquaculturists in the coastal zone.

- Participation and involvement of the private sector in aquaculture.
- Improvement on national, regional and international co-operation in aquaculture.
- Exploit and develop the potentials of national and international research scientists interested in aquaculture.

The justification from this study is quite short of all these but it shows that there exists much potential for *M. vollenhovenii* as a cultivable species. The total mortality of *M vollenhovenii* is largely due to fishing activities and predation from birds and reptiles. The high values (M = 3.61 year^{-1} and 2.28 year^{-1}) for the Lobe and Ombe/Mungo respectively resulted from the presence of piscivorous fishes and adverse environmental conditions. These should be avoided during intensive culture. To meet up with the protein and economic needs of the population and tourists, it is recommended that intensive culture should be practiced. Although exploitation rates of 0.07 and 0.41 indicate under-exploitation, these values are most likely to increase with time. This will be due to the high inflation rate that the local human population is presently facing. The increase will probably be more than the optimum value of 0.5 (Gulland, 1971; Pauly, 1983) which gives the highest yield per recruit for the fish population. Intensive culture can be the only reliable conservation measure that will result in reduction of pressure on the species in the wild. The end result will be an improvement on the protein needs social, economic and cultural status of the fishermen and dependants.

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