Patterson, G. and O. Kachinjika. 1995. Limnology and phytoplankton ecology, p. 1-68. *In* A. Menz (ed.) The fishery potential and productivity of the pelagic zone of Lake Malaŵi/Niassa. Natural Resources Institute, Chatham, UK. 386 p.

Pauly, D. 1986. A simple method for estimating the food consumption of fish populations from growth data and food conversion experiments. U.S. Fish. Bull. 84(4):827-840.

Pauly, D. 1989. Food consumption by tropical and temperate fish populations: some generalizations. J. Fish Biol. 35 (Suppl. A):11-20.

Pauly, D. and I. Tsukayama, Editors. 1987. The Peruvian anchoveta and its upwelling ecosystem: three decades of change. ICLARM Stud. Rev. 15, 351 p.

Peters, D.S. and W.E. Schaaf. 1991. Empirical model of the trophic basis for fishery yield in coastal waters of the Eastern USA. Trans. Am. Fish. Soc. 120:459-473.

Sainsbury, K.J. 1986. Estimation of food consumption from field observations of fish feeding cycles. J. Fish Biol. 29:23-36.

Thompson, A.B., E.H. Allison and B.P. Ngatunga. Distribution and breeding biology of offshore pelagic cichlids in Lake Malaŵi/Niassa. Env. Biol. Fish (In press, a).

Thompson, A.B., E.H. Allison and B.P. Ngatunga. Distribution and breeding biology of offshore pelagic cyprinids and catfish in Lake Malaŵi/Niassa. Env. Biol. Fish (In press, b).

Turner, J.L. 1982. Lake flies, water fleas and sardines. *In* FAO Biological studies on the pelagic ecosystem of Lake Malaŵi. FI:DP/MLW/75/019, Tech. Rep. 1:165-182.

Walczak, P.S. 1982. Feeding habits and daily food consumption rates of the major pelagic fish species of Lake Malaŵi. Supplement to: FAO Biological Studies on the Pelagic Ecosystem of Lake Malaŵi. FI:DP/MLW/75/019, Tech. Rep. 1, Field Doc. 25, 19 p.

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Comparative Growth Performance for Species of the Family Clupeidae of Sierra Leone

Croissance comparée des espèces de la famille des Clupéidés en Sierra Leone

P.A.T. Showers

Abstract

Using length-frequency samples from the local fisheries and length-age data from otolith readings, von Bertalanffy growth parameters were estimated for the four species representing the Clupeidae family in Sierra Leone, *Sardinella aurita*, *S. maderensis*, *Ethmalosa fimbriata* and *Ilisha africana*. *E. fimbriata* and *I. africana* showed the highest and lowest values of ϕ', respectively, while *Sardinella* spp. were found to occupy the central position.

Résumé

Des données de fréquences de taille obtenues de pêcheries locales et des données sur l'âge par rapport à la longueur relevées par lecture des otolithes ont permis de calculer les paramètres de croissance de von Bertalanffy pour les quatre espèces constituant la famille des Clupéidés en Sierra Leone, Sardinella aurita, S. maderensis, Ethmalosa fimbriata *et* Ilisha africana. E. fimbriata *et* I. africana *ont respectivement donné les valeurs de ϕ' les plus élevées et les plus faibles alors que Sardinella spp. occupait la position centrale.*

Introduction

The Clupeidae constitutes one of the most abundant teleost families on the Sierra Leone shelf, and is represented by four species in three genera: *Sardinella aurita*, *S. maderensis*, *Ethmalosa fimbriata* and *Ilisha africana*. The species are pelagic and have extensive ranges in the East Central Atlantic. Maximum sizes are 30 cm for *S. maderensis* and *E. fimbriata* and 31 cm for *S. aurita* (Fischer et al. 1981).

In Sierra Leone, *S. aurita* occurs mainly in the northern part of the shelf, above latitude 8°N. *S. maderensis*, *E. fimbriata* and *I. africana*, which are less migratory, are found closer to shore (Domanevski et al. 1985) and are well represented in the north and in the south.

The family owes its high commercial significance to its overwhelming abundance in the local industrial and artisanal fisheries, thereby contributing a large proportion to the total annual fish landings. *S. aurita* dominates the industrial fisheries through its high pelagic component exploited by purse seines, whereas *E. fimbriata* and *S. maderensis* are predominant in the artisanal catches (Brainerd 1978, 1980; Vakily 1992). Earlier studies pertaining to the biology and ecology of the family in Sierra Leone waters include Turay (1982), Bockarie (1984), Ibrahim (1987) and Anyangwa (1988, 1991), while Vakily and Pauly (1995) recently reviewed the migratory patterns of *S. aurita* and *S. maderensis* of Sierra Leone.

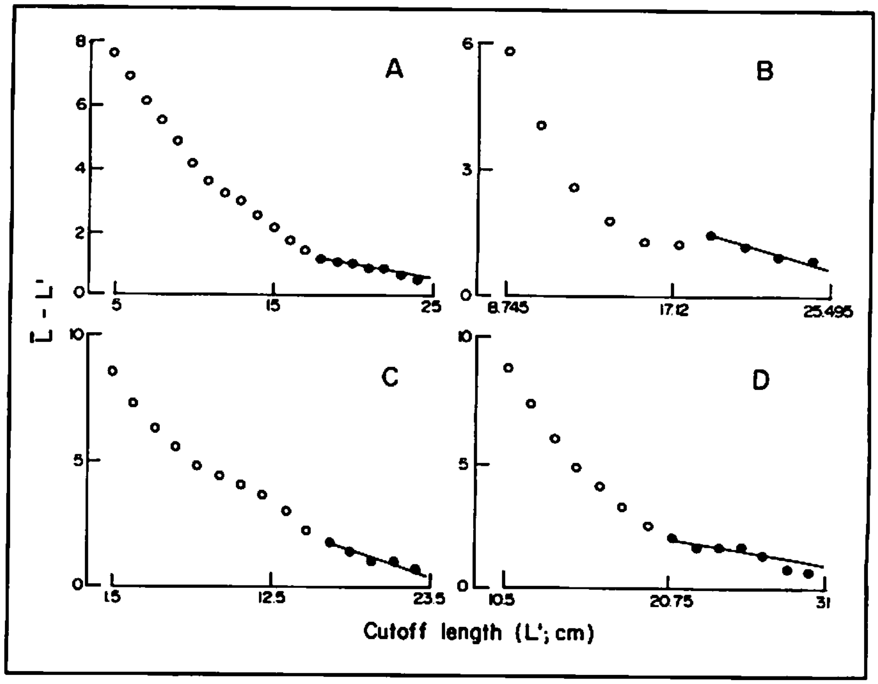

Fig. 1. Powell-Wetherall plots for four clupeids in Sierra Leone: A: Sardinella aurita *(FL_∞ = 30.25 cm; Z/K = 9.24)*; B: S. maderensis *(FL_∞ = 28.72 cm; Z/K = 5.32)*; C: Ilisha africana *(FL_∞ = 24.5 cm; Z/K = 3.59)*; D: Ethmalosa fimbriata *(FL_∞ = 39.29 cm; Z/K = 8.28)*.

Materials and Methods

The monthly length-frequency samples used for this study were obtained from the artisanal and industrial fisheries of Sierra Leone during 1988-89, while the lengths at age were derived from otolith readings of specimens taken from the Sierra Leone shelf during research surveys (FAO 1985).

All analyses were carried out using the analytical routines incorporated in FiSAT (Gayanilo et al. 1996). Preliminary estimates of L_∞ were obtained through the Powell-Wetherall plot (Pauly 1986; Wetherall 1986).

The growth performances of the species were compared using the f' index of Pauly and Munro (1984):

$$\phi' = \log_{10} K + 2\log_{10} L_\infty$$

where L_∞ represents the asymptotic length (FL, in cm) and K is the rate at which L_∞ is approached (per year).

Results and Discussion

The Powell-Wetherall plots are shown in Fig. 1. For all four species investigated, the preliminary values from the plots came very close to those subsequently obtained through the ELEFAN routines (Fig. 2) The final estimates of growth showed some seasonality in all four cases.

Preliminary studies suggest that the growth performance of *Sardinella* spp. (Fig. 3) off Sierra Leone is less than off Sénégal, where a strong upwelling occurs (see, e.g., Postel 1955; Pham-Thuoc and Szypula 1975; Boëly et al. 1982; Samb 1988).

A global comparison of growth performance in this genus thus appears warranted, and may lead to identification of environmental factors acting on what appears a very variable group of species, and leading to locally variable growth parameters.

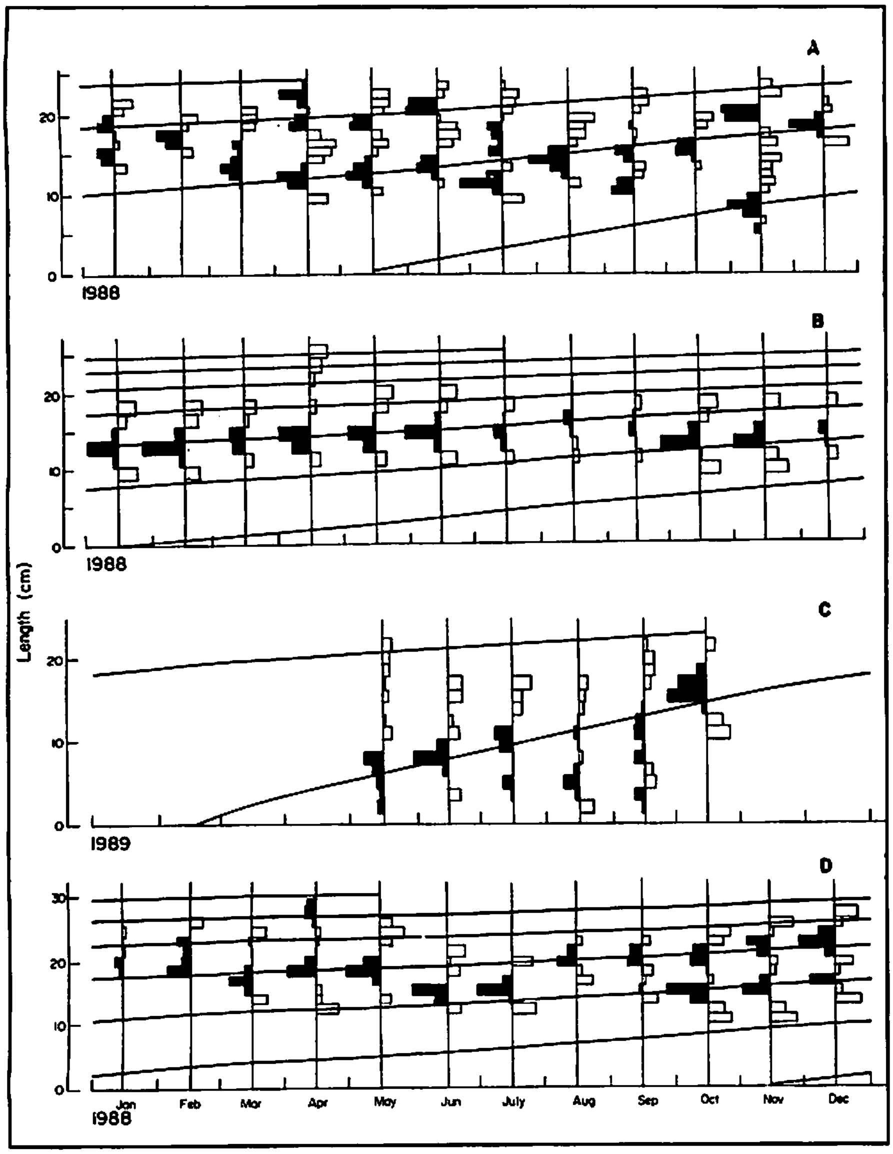

Fig. 2. Restructured length-frequency data with growth curves superimposed by ELEFAN I: **A: Sardinella aurita** *(FL_{∞} = 32.0 cm; K = 0.48 $year^{-1}$; C = 0.35; WP = 0.20);* **B: S. maderensis** *(FL_{∞} = 29.6 cm; K = 0.30 $year^{-1}$; C = 0.25; WP = 0.10);* **C: Ilisha africana** *(FL_{∞} = 25.9 cm; K = 1.37 $year^{-1}$; C = 0.25; WP = 0.30);* **D: Ethmalosa fimbriata** *(FL_{∞} = 40.8 cm; K = 0.25 $year^{-1}$; C = 0.25; WP = 0.35).*

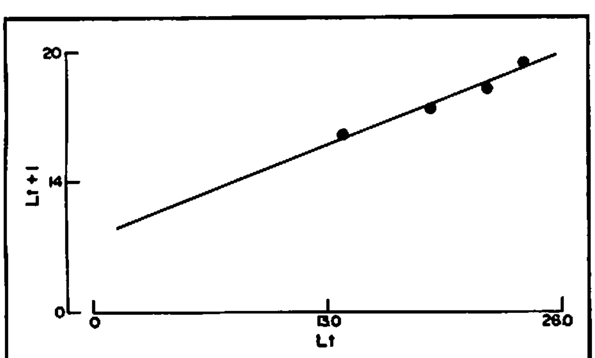

Fig. 3. Ford-Walford plot for **Sardinella aurita** *(a = 8.140; b = 0.747).*

References

Anyangwa, T.A. 1988. An investigation of age, growth and mortality of the herring *Sardinella eba*. Department of Zoology, University of Sierra Leone. B.Sc. dissertation.

Anyangwa, T.A. 1991. Aspects of the biology and ecology of the family Clupeidae in the coastal waters of Sierra Leone. Institute of Marine Biology and Oceanography, Fourah Bay College, University of Sierra Leone. 126 p. M.Sc. thesis.

Boëly, T., P. Freon and B. Stequert. 1982. La croissance de *Sardinella aurita* (Val. 1847) au Sénégal. Oceanogr. Trop. 17:103-119.

Bokarie, M. 1984. Studies on the population structure of *Sardinella eba*. Department of Zoology, Fourah Bay College, University of Sierra Leone. B.Sc. (Hons.) dissertation.

Brainerd, T.R. 1978. Some data on landings of pelagic fish by the artisanal fishermen near Freetown during January-December 1978. Bull. Mar. Biol. Oceanogr. (Fourah Bay College, Univ. of Sierra Leone) 3(1):12-26.

Brainerd, T.R. 1980. The demersal fisheries of Sierra Leone with notes on recent research surveys, p. 25. *In* Rapport du deuxième groupe de travail ad hoc sur les stocks démersaux côtiers du sud de la Mauritanie au Libéria. COPACE/PACE Ser. 80/23 (Fr.). FAO, Rome.

Domanevski, L.N., V.G. Kolesnikov, S.G. Krivospitchenko, M.E. Grudtsev, V.Z. Gaikov, Y.G. Sazonov, A.I. Kozhemyakin and V.A. Lopatko. 1985. Main results of joint USSR-Sierra Leone investigations of pelagic fishes. p. 16-23. *In* Report of the Second *Ad Hoc* Working Group on Pelagic Stocks of the Sherbro Statistical Division (34.3.3)CECAF/TECH/85/65. FAO, Rome..

FAO. 1985. Report of the second *Ad Hoc* Working Group on the Pelagic Stocks of the Sherbro Statistical Division (34.3.3). CECAF/TECH/85/65, 85 p. FAO, Rome.

Fischer, W., G. Bianchi and W.B. Scott, Editors. 1981. FAO species identification sheets for fishery purposes. Eastern Central Atlantic; fishing areas 34, 47 (in part). Canada Funds-in-Trust. Department of Fisheries and Oceans, Ottawa by arrangement with FAO, Rome. Vol. II.

Gayanilo, F.C., Jr., P. Sparre and D. Pauly. 1996. The FAO-ICLARM Stock Assessment Tools (FiSAT) user's guide. FAO Computerized Info. Ser. (Fish.) No. 7, 126 p.

Ibrahim, A. 1987. Studies on the biology of *Sardinella eba*. Fourah Bay College, University of Sierra Leone. B.Sc. dissertation.

Pauly, D. and J.L. Munro. 1984. Once more on the comparison of growth in fish and invertebrates. Fishbyte 2(1):21.

Pauly, D. 1986. A simple method for estimating the food consumption of fish populations from growth data and food conversion experiments. U.S. Fish Bull. 84(4): 827-842.

Pham-Thuoc and J. Szypula. 1975. Age and growth rate of gilt sardine (*Sardinella aurita* Cuv. & Val.) from North East African waters. ICES C.M. 1975/J:5. Pel. Fish (Southern) Committee.
Postel, E. 1955. Résumé des connaissances acquises sur les Clupéidés de l'Ouest Afrique. Rapp. P-V. Réun. CIEM 137:14-17.
Samb, B. 1988. Seasonal growth, mortality and recruitment pattern of *Sardinella maderensis* off Sénégal, p. 257-271. *In* S. Venema, J.M. Christensen and D. Pauly (eds.) Contributions to tropical fisheries biology: papers by the participants of FAO/DANIDA follow-up training courses. FAO Fish Rep. No. 389, 519 p.
Turay, L. 1982. Studies on the biology of the bonga *Ethmalosa fimbriata*. Fourah Bay College, University of Sierra Leone. B.Sc. dissertation.
Vakily, J.M. 1992. Assessing and managing the marine fish resources of Sierra Leone, West Africa. Naga, ICLARM Q. 15(1):31-35.
Vakily, J.M. and D. Pauly. 1995. Seasonal movements of sardinella off Sierra Leone, p. 426-436. *In* F.X. Bard and K.A. Koranteng (eds.) Dynamics and use of sardinella resources from upwelling off Ghana and Ivory Coast [Dynamique et usage des ressources en sardinelles de l'upwelling côtier du Ghana et de la Côte d'Ivoire]. Acts of DUSRU meeting, 5-8 October 1993, Accra, Ghana. ORSTOM Éditions, Paris. 438 p.
Wetherall, J.S. 1986. A method for estimating growth and mortality parameters from length-frequency data. Fishbyte 4(1):12-14.

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On Modeling and Management of Capture Fisheries: One View

Modélisation et aménagement des pêches de capture: une optique

U.I. Enin

Abstract

Sustainability of benefits from capture fisheries has been a concern of fisheries scientists for a long time. The development of fisheries management models reflects the historical debate (from maximum sustainable yield to maximum economic yield, and so on) of what benefits are valued and need to be sustained. Social and anthropological research needs an increased emphasis on bio-socioeconomic models to effectively determine directions for fisheries management.

Résumé

Assurer la continuité des bénéfices liés à la pêche de capture est un souci que partagent les halieutes depuis longtemps. La mise au point de modèles d'aménagement de la pêche reflète bien le débat qui fait déjà histoire (rendement potentiel des pêches, maximum de rendement économique, etc.) sur l'évaluation des bénéfices et le besoin d'assurer leur continuité. La recherche anthropologique et sociale doit davantage mettre l'accent sur les modèles bio-socioéconomiques afin que puissent être dégagées les grandes orientations de la gestion des pêches.

Introduction

The term 'sustainable development' is probably the most 'catchy' phrase today. It came into common usage after the Brundtland Commission Report (WCED 1987) was published. Fishery biologists will be remembered as among the earliest originators of the sustainability concept. After Petersen (1894, 1903) distinguished between growth and recruitment overfishing in a stock of plaice, and Garstang (1900-03) showed that fish abundance in the North Sea declined by half under heavy fishing pressure, Russel (1931) delineated the four elements of fish population dynamics (the popular Russel's axiom) and identified maximum sustainable yield (MSY) as the aim of rational exploitation.

Building on the legacies of Thompson and Bell (1934) and Graham (1935), Schaefer (1954, 1957) developed the surplus production model, which related catch to stock size and fishing effort. The model determined MSY and the level of exploitation to achieve it, thus laying the foundation for the scientific management of fisheries