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«Астраханский государственный технический университет»

Адрес редакции:
414056, Астрахань, Татищева, 16,
Астраханский государственный технический университет.
Тел.: (8512) 61-42-98
Факс: (8512) 61-43-66
E-mail: vestnik_astu@astu.org
http://vestnik.astu.org/Pages/Show/1

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Editors address:
Astrakhan State Technical University
16 Tatishcheva Street, Astrakhan,
414056, Russia.
Tel.: (8512) 61-42-98
Fax: (8512) 61-43-66
E-mail: vestnik_astu@astu.org
http://vestnik.astu.org/Pages/Show/1

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Zacharie Sohou, Yacouba Sankare, Roger Djiman

PELAGIC FISH RESOURCES STOCKS ASSESSMENT IN SOUTH PART GULF OF GUINEA: BENIN CONTINENTAL SHELF[1]

Abstract. The global objectives of this campaign were to assess biomass and map the distribution of stocks of small coastal pelagic fish from Côte d'Ivoire, Ghana, Togo and Benin. The study was carried out with the help of hydroacoustic method. Besides, one of the other objectives was to describe the hydrographic conditions in the area during 3 days in 2012. It was found that the fish density was rather less in comparison with Nansen's survey (2002–2006). However, it should be noted that both researches were made during different time periods. The analysis of the obtained data has shown that *Ilisha africana* is the most important pelagic fish. This species was caught by most of the fishermen using non-motorized boats. The main pelagic species biomass is 3490 tons, including biomass of *Ilisha africana* that equals 310 tons, while the other species of pelagic fish are 3180 tons. Apart from *Ilisha africana*, there were other pelagic fish such as horse mackerel, mackerel and barracuda. Some bottom fishes were inaccessible. This study should promote more effective control of fishery at the continental shelf.

Key words: continental shelf, pelagic fish, hydroacoustic methods, *Ilisha africana*.

Introduction

Within the framework of the Agricultural Policy WAMU (PAU), the triennial program for the development of the fisheries sector in the West African Monetary Union (WAMU) was adopted in Dakar in March 2003, its objective is to establish a process of coordination and harmonization of the management of the shared fishery resources for a sustainable management of these resources and contribute to food security and poverty reduction in the WAMU. This program includes, among others, the definition of a joint development of fisheries and aquaculture management plan with WAMU; for that it's necessary to have knowledge of the state of fishery resources in the WAMU's countries.

It is in this context that the WAMU Commission has launched a call for surveys of pelagic resources in Côte d'Ivoire, Ghana, Togo and Benin and Senegal vessel N/O Itaf Déme CRODT was selected following a request.

Objectives of the mission

The global objectives of this campaign were to assess biomass and map the distribution of stocks of small coastal pelagics from Côte d' Ivoire, Ghana, Togo and Benin using a hydroacoustic method and describe the hydrographic conditions in the area during the survey period.

The specific objectives were:

– to map the distribution and estimate the biomass of the main small coastal pelagic target species: Madeiran sardine (*Sardinella maderensis*), Round sardinella (*Sardinella aurita*), Horse mackerel (*T. trecae, D. rhonchus, D. macarellus, D. punctatus*), Anchovy (*Engraulis encrasicolus*);

– to identify and describe the distribution of population sizes encountered by sampling pelagic and demersal layers;

– to collect biological data of the target species (*S. maderensis, S. aurita, T. trecae*);

– to conduct a hydrographic sampling and mapping radial profiles of temperature and salinity.

The campaign took place from 20 to 22 March 2012 under the effective leadership of the team leader. Collaboration between scientists and all members of the crew was very friendly.

Methodology

Equipment

Research Vessel

[1] The campaign was financed and organized by WAMU, which is a first in the sub-region of West Africa, except FAO survey. We would like to take this opportunity to extend our sincere thanks to the WAEMU, the Department of Animal Resources and especially its Director Mrs. Maria Luiza FEREIRA, who spared no effort for the success of this campaign. Our thanks also go to Director CRODT, and responsible for the task M. Abdoulaye SAARE and Responsible of study, Roche International.

Oceanographic vessels (N/O) ITAF DEME of Senegal:

Scientific Equipment and *Fishing gear* (Pelagic trawl nine (Norwegian-type), 2 bottom trawls.

Physical Sampling:

Environmental data collection was performed using a CTD sensor ALEC, AST 1000 model. The measures concerned a total of 9 stations on the 4 radial of the area covered. Hydrographic profiles of temperature and salinity were taken on 10, 50 and 100 meters.

Biological Sampling:

Fishing operations were performed using a pelagic trawl and very often with a demersal trawl used in the pelagic maintained in surface via big balloons. These operations were carried out according to the importance of fish concentrations encountered. Thus, 7 trawls were totally operating, including 2 with pelagic trawl and 5 with the bottom trawl. At each station, a representative sample was taken to determine the composition, weight and number by species, size frequency for the target species.

The length-weight relationship for the estimation of biomass is:

$$W = L^3 \cdot \text{cond} \ / \ 100.$$

Where a condition factor 0.94 was used for the round sardinella, 0.97 for madeiran sardinella and horse mackerel and 0.96 to 0.88 for Carangidae, Clupeidae and associated with an average size of 23 cm was used for the evaluation biomass.

Estimation of Biomass

The estimation of the biomass using the acoustic method is based on the integration technique based on the measurements of SA values corresponding to the total surface reflecting fish for a unit of water surface through the acoustic wave (m²/min²). The analysis and allocation of these values in the standard group are based on echo-grams provided by the integrator Bergen [1] and species compositions capture.

– Sardinella (*Sardinella maderensis*);

– Anchovy (*Engraulis encrasicolus*);

– PEL1 (*Ilisha africana*);

– PEL2 (Carangidae, Scombridae, Sphyraenidae and others).

The conversion of SA values in number of individuals per nm^2 is performed using the *TS* (target strength) function recommended by Foote (1987) for Clupeidae:

$$TS = 20 \cdot \log L - 72 \ Db,$$

which can be expressed on the surface in the form [2]:

$$C_{Fi} = 1.26 \cdot 10^6 \cdot L^{-2}.$$

Where L is the total length in cm and C_{Fi} conversion factor of individual i.

The density in number of individual per class size and per nm^2 is obtained by applying the formula:

$$\rho_i = S_A \frac{p_i}{\sum_{i=1}^{n} \frac{p_i}{C_{F_1}}}.$$

Where, ρ_i = density of fish in size class I, S_A = average value of integration and p_i = the percentage of size class i in the sample.

The equation above shows that the conversion of integration values S_A in biomass depends on size distribution in the area. As a result, a frequency representative size of the area has been deducted whenever possible and when the composition between adults and juveniles is fairly homogeneous. The actual size class is obtained by applying the formula [3]:

$$N_i = A \cdot S_A \cdot p_i / (\sum_{i=1}^{n} \frac{p_i}{C_{F_i}}).$$

With, N_i = abundance of fish in size class i; S_A = index acoustic integration; p_i = the percentage of size class i in the sample; A = Area MN fish concentration estimated using a planimeter; n = number of length classes; C_{Fi} = conversion factor fish length L_i; The abundance N was obtained by adding the number N_i of each size class using the formula:

$$N = \sum_{i=1}^{n} N_i .$$

The size distribution of the given species in the area is obtained by a simple addition of size frequencies observed in each haul. In case of co-occurrence of the target species, the S_A values are separated by taking into account the distribution of size and number in the capture rate. Biomass in the size class i was estimated by multiplying its workforce by the average weight W_i of an individual in this class. If weight is not available, it is replaced by the weights calculated from the condition factor (height-weight relationship):

$$W_i = \frac{\text{cond}}{100} L_i^3 .$$

In the species belonging to the group PEL2, an average size of 23 cm was applied to evaluate the biomass. Total biomass in a zone B is obtained by adding biomass B_i of each size class of the formula:

$$N = \sum_{i=1}^{n} B_i = \sum_{i=1}^{n} N_i \bar{W}_i .$$

The abundance and biomass at the Beninese continental shelf are obtained by adding the values of areas.

Results

During the campaign, the surface temperature was recorded continuously. The minimum temperature 15.37 °C is recorded in 204 meters depth, while the maximum temperature is 29.48 °C at the surface.

Surface water temperatures are higher on the eastern part than in the western part of the continental shelf. Fig. 1 shows the vertical distribution of the temperature from 15 °C at 200 m deep to 29 °C on the surface.

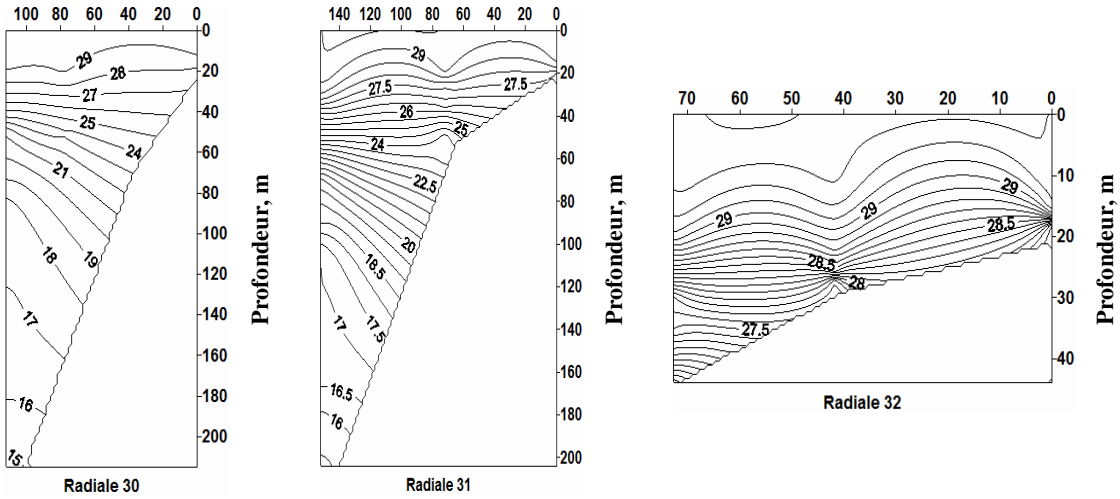

Fig. 1. Hydrographic temperature profiles

The point of the thermocline is observed around 50 m depth; Fig. 2 shows that the salinity varies from 34.5 ‰ at the surface to 35.6 ‰ in depth.

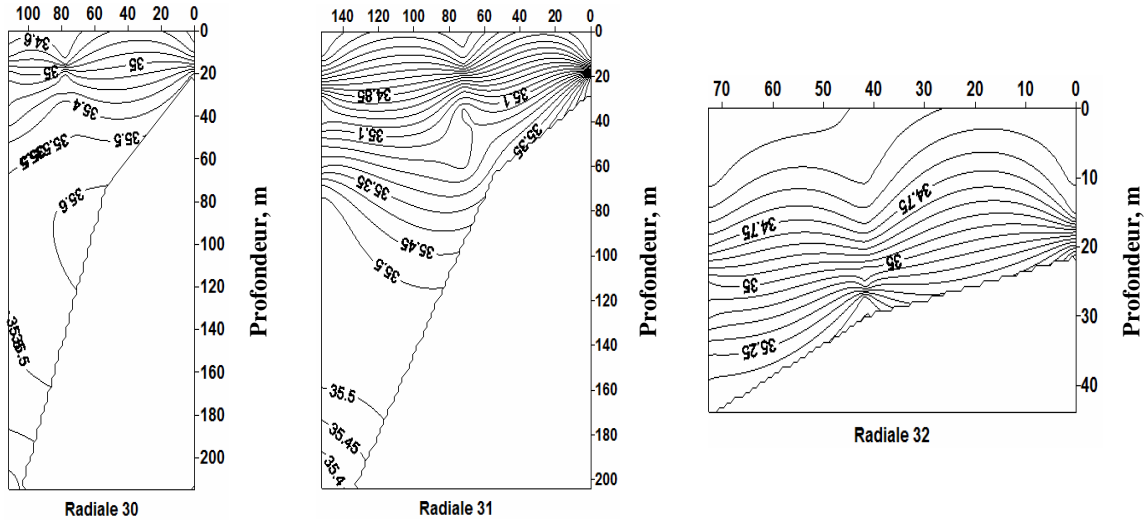

Fig. 2. Hydrographic salinity profiles

In Fig. 3, we observe a decrease of temperature from West to East 29.3 to 29.5 °C, with a central core at Cotonou vertical.

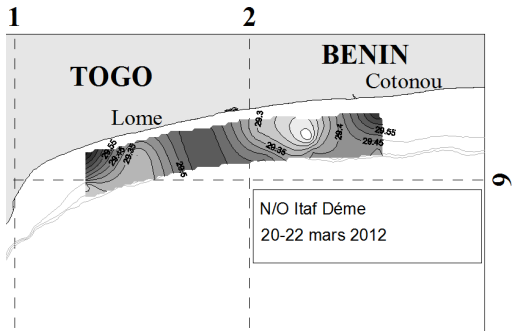

Fig. 3. Surface temperature distribution

The sardinella was not found in the area during this campaign.

The distribution of the main pelagic species found during the campaign in Benin is illustrated in Fig. 4. It demonstrates pelagic clupeids and their morphology close to sardinella's (P1) represented here by razor shad.

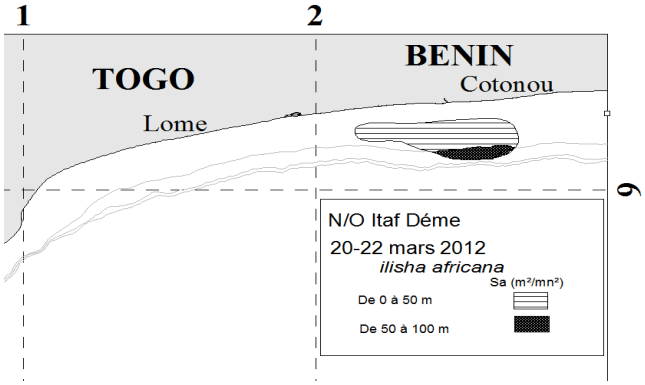

Fig. 4. *Ilisha africana* distribution

All other pelagic (P2) different from sardinella and *Ilisha africana* are mainly composed of *Chloroscombrus chrysurus, Alectis alexandrinus, Selene dorsalis Boops boops, Brachydeuterus auritus, Trichiurus lepturus* and *Scomberomorus tritor* presented as P2 on Fig. 5.

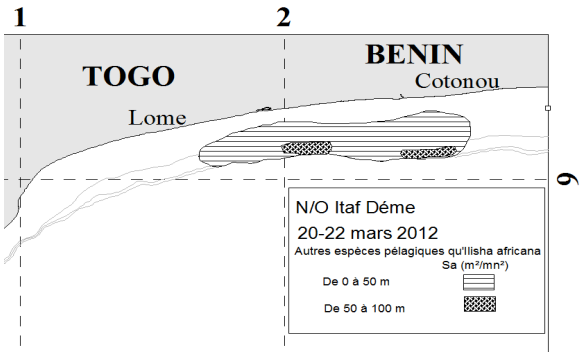

Fig. 5. Carangidae and other associated species distribution

Species density P2 according to the strata varies from 0 to 50 m²/min² and from 50 to 100 m²/min².

On Fig. 4 we see that razor shad (*Ilisha africana*) was captured in the West and in front of Cotonou with a biomass 340 tons. Only these species contribute to 9.7 % of the total catch.

On Fig. 5, we note that the highest densities of other pelagic P2 group are found in the west of Cotonou following the deep strata with a biomass 3180 tons (Tabl.). These species contribute to 90.3 % of the total catch.

Biomass Estimation of principal species by region

Species	Biomass, ton
P1 *Ilisha africana*	340
P2 *Chloroscombrus chrysurus, Alectis alexandrinus, Selene dorsalis Boops boops, Brachydeuterus auritus, Trichiurus lepturus* and *Scomberomorus tritor*	3 180

On the Fig. 6, *Ilisha africana* distribution, which is the most important pelagic fish caught during survey period, is represented.

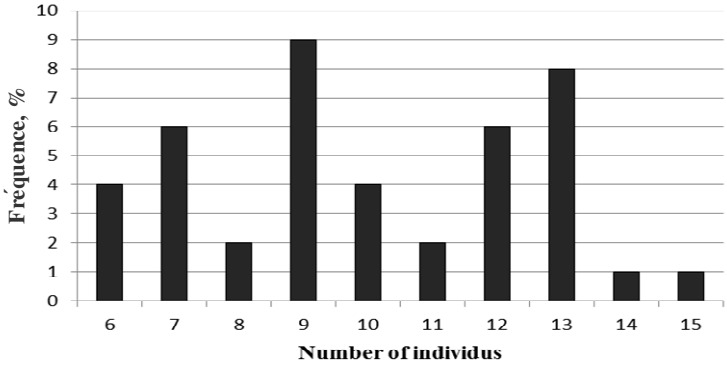

Fig. 6. *Ilisha africana* Frequency size

On the figure above (Fig. 6), we note two modes, most of the fish number around 9 % and following 8 %. This population is bimodal.

Discussion

Various studies in the regional context on board the Vessel Research F. Nansen have shown that the resources have reached the level of overexploitation, resulting in lower yields per unit of effort, a reduction in the size of fish caught. This is due to high population pressure reflected on the continental

shelf fisheries due to uncontrolled fishing effort, widespread use of non-selective fishing gear and practices especially in the absence of sustained political orientation of fishermen to unexploited or underexploited marine fisheries resources [4].

These campaigns took place during the great hydrological cold season from April to July, sometimes from August to September. It should be noted that no campaign has been carried out in the warm hydrological season on the boat Fridtjof Nansen.

In 1999, due to the narrowness and similar configuration of the continental shelves of Benin and Togo [5] the two countries were combined for analysis. The campaign results concern the two countries and deserve the same interpretation.

But next year, data from the two countries were considered separately and data from Benin and Togo were separated for analysis.

Acoustic surveys were usually done at night and were primarily pelagic species that were classified here into two groups:

– Pelagic I: Clupeidae;

– Pelagic II: Carangidae, Scombridae, Sphyraenidae, Trichiuridae.

Conclusions

All seven (07) stations were generally trawled. The Benin continental shelf offers a variety of hydrological faces; we can find different conditions of temperature and salinity from one depth to another and a radial to another one.

The main pelagic species biomass of 3490 tons are represented by Clupeidae (*Ilisha africana*) with a biomass of 310 tons. The other group consists of pelagic species other than *Ilisha africana* with a biomass of 3180 tons.

The period of the campaign in March, do not actually match the right period for pelagic and this is what explained the observed low output. According to the various previous works, pelagic fish are abundant in the latter half of the year. That is why it is recommended to carry out pelagic campaign in the period of its abundance.

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INFORMATION ABOUT THE AUTHORS

Sohou Zacharie – Republic of Benin; Benin Fisheries and Oceanological Research Institute; Candidate of Technical Sciences; Assistant Professor; director; zsohou@gmail.com.

Sankare Yacouba – Côte d'Ivoire, Abidjan; Oceanologic Research Centre – Ivory Coast; Candidate of Technical Sciences; Researcher; sankare811@yahoo.fr.

Djiman Roger – Republic of Benin; Benin Fisheries and Oceanological Research Institute; by; Research Engineer; rodjiman@yahoo.fr.

Захари Соху, Якуба Санькаре, Роже Джиман

ОЦЕНКА РАСПРЕДЕЛЕНИЯ ЗАПАСОВ ПЕЛАГИЧЕСКИХ РЫБ В ЮЖНОЙ ЧАСТИ ГВИНЕЙСКОГО ЗАЛИВА: КОНТИНЕНТАЛЬНЫЙ ШЕЛЬФ БЕНИНА

Проведена оценка и картирование распределения запасов пелагических рыб вблизи берегов Кот-д'Ивуара, Ганы, Того и Бенина. Исследование проводилось гидроакустическим методом. Помимо этого одной из целей исследования было описание гидрографического состояния указанной области в течение трех дней 2012 г. Количество рыбы оказалось значительно меньшим в сравнении с исследованием Нансена (2002–2006). Однако следует отметить, что оба исследования проводились в разные периоды времени. Анализ полученных данных показал, что *Ilisha africana* является наиболее значимым видом пелагических рыб. Этот вид стал уловом большинства рыбаков, использующих немоторизованные лодки. Биомасса основных пелагических видов составила 3490 т, в том числе биомасса *Ilisha africana* – 310 т, других видов пелагических рыб – 3180 т. Кроме *Ilisha africana* были представлены ставрида, скумбрия и барракуды. Некоторые донные рыбы были труднодоступны. Данное исследование должно способствовать более эффективному управлению рыболовством на континентальном шельфе.

Ключевые слова: континентальный шельф, пелагические рыбы, гидроакустические методы, *Ilisha africana.*

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Соху Захари – Республика Бенин; Бенинский исследовательский институт рыбного хозяйства и океанографии; канд. техн. наук, доцент; директор; zsohou@gmail.com.

Санькаре Якуба – Республика Кот-д'Ивуар, Абиджан; Океанографический научно-исследовательский центр; канд. техн. наук; исследователь; sankare811@yahoo.fr.

Джиман Роже – Республика Бенин; Бенинский исследовательский институт рыбного хозяйства и океанографии; инженер-исследователь; rodjiman@yahoo.fr.