Journal of Water Resource and Protection, 2025, 17(6), 339-358
https://www.scirp.org/journal/jwarp
ISSN Online: 1945-3108
ISSN Print: 1945-3094

Captures, Stocks, Ecological and Biological Aspects of Five Marine Economic Value Fish in Three West African Countries (Benin, Togo and Guinea): *Engraulis encrasicolus*, *Sardinella aurita*, *Brachydeuterus auritus*, *Pseudotolitus elongates* and *Ethmalosa fimbrita*

Richard Adande[1,2*], Lonsenigbe Camara[1], Temba Kinding Leno[3], Kolou Angèle Koïvogui[3], Moriba Alex Kolie[3], Lancei Koivogui[1]

[1]Department of Hydrology, Faculty of Technical Sciences (FST), University of N'zérékoré (UZ), N'Zérékoré, Guinea
[2]Department of Natural Resources Management, Faculty of Environmental Sciences (FSE), University of N'zérékoré (UZ), N'Zérékoré, Guinea
[3]Fédération des Piscirizilculteurs de la Guinée Forestière (FPGF), N'Zérékoré, Guinea
Email: *adanderich@gmail.com, *richard_adande@yahoo.fr, lonsenibgecamara@gmail.com, lenokinding@gmail.com, lanceikoivogui95@gmail.com, angelaangiek@gmail.com, moribaalexk@gmail.com

How to cite this paper: Adande, R., Camara, L., Leno, T.K., Koïvogui, K.A., Kolie, M.A. and Koivogui, L. (2025) Captures, Stocks, Ecological and Biological Aspects of Five Marine Economic Value Fish in Three West African Countries (Benin, Togo and Guinea): *Engraulis encrasicolus*, *Sardinella aurita*, *Brachydeuterus auritus*, *Pseudotolitus elongates* and *Ethmalosa fimbrita*. *Journal of Water Resource and Protection*, **17**, 339-358.
https://doi.org/10.4236/jwarp.2025.176017

Received: May 6, 2025
Accepted: June 6, 2025
Published: June 9, 2025

Abstract

Fish is the first cheap price protein source in developing countries. The current report aim is to value captures and stocks of five marine fish (*Engraulis encrasicolus*, *Sardinella aurita*, *Brachydeuterus auritus*, *Pseudotolitus elongates and Ethmalosa fimbrita*) in later years considering their biology and ecology especially taxonomic characteristics, morphology, distribution and habitat as economic value species by using available literature data for managing natural resources to meet human and environmental needs. Data were collected from FAO basis, fishing statistic of Guinea, fisheries directorate of Benin and ministry marine economy, fisheries and coastal protection of Togo. It results from data analysis that captures are high in Guinea especially *Ethmalosa fimbrita* (79795.66 ± 11438.88) followed by Benin *Sardinella aurita* (32,000 ± 2000) and Togo *Sardinella aurita* (31666.66 ± 3555.55) ($F_{(12, 18,812)}$ = 14.856, p = 0.00). These data confirm fishing pressure on these species using prohibited and industrial fishing gears. Regarding these conditions, a good knowledge of population structure must be assessed with new models adapted to each country by considering climate change effects for good management and resources

preservation. Besides, among species considered in the current review, some species like *Pseudotolitus elongates*, *Ethmalosa fimbrita* were recorded on the UICN red list.

Keywords

Engraulis encrasicolus, *Sardinella aurita*, *Brachydeuterus auritus*, *Pseudotolitus elongates*, *Ethmalosa fimbrita*

1. Introduction

Stocks of number of marine fish species are over-exploited with prohibited and industrial fishing gears due to high demand tied to galloping demography. Indeed, fish is the first protein source of major part of world population. Fish consumption is 20.2 kg per capita and 15% for the 4.3 billion of the other people [1]. According to [2], fish consumption is estimate to 165 million tons with double growing rate related to world population since 1961. In 2022, mean annual fish consumption per capita was 11 kg in West Africa and small pelagic represent 70% of fish consumed [3]. The abundance of marine animal species in West Africa is due to canary and Guinean water flow [4]-[6]. According to [7] and [8], fishers capture more than 1.6 million tons of pelagic fish either the two third of production with highest worldwide exploitation rate estimated to 50% of stock. These exploitations show the importance of fishing activities in West African region [9]. By the same way, evaluation of sardines and anchors stock in seven sub-regions of mediterranea revealed that most of stocks are highly exploited and 71% are over-exploited [10]. This exploitation rate of fish associated to increasing climate change effects is a challenge to be solved in order to ensure social, economic and environmental sustainability [11]. In Africa, the sadness of the situation is due to low evaluation models and limited resources for efficient management with illegal practices strengthened by corruption [6] [12] [13]. According to [14], bad management of fish stocks is due to bad cooperation among states. Some species like *E. fimbrita*, *P. elongates* were already recorded on the UICN red list acoording [15] and [16]. Considering the economic and ecological interest of some marine fish species, optimal and sustainable management of these resources is urgent [17]. Several works have been carried out on the biology of *E. encrasicolus*, *S. aurita*, *B. auritus*, *P. elongates* and *E. fimbrita* by different authors in the gulf of Guinea from Liberia, Côte d'Ivoire, Benin passing through Nigeria elsewhere [18]-[27]. The current review aims to estimate captures and stocks of five marine fish species also to assess their biology, ecology especially taxonomic, morphological characteristics, distribution and habitat. The aims of our study were to: 1) Estimating the different catches and the impact of exploitation by countries on the five commercially important marine species; and 2) Presenting the ecology and biology of these different species, in order to propose management strategies for these fish stocks in the

face of anthropogenic and environmental impacts.

2. Material and Methods

Data were collected from the literature and from the archives of the statistical databases of the various aquaculture structures in the three countries.

Statistical Analysis

Collected data were analyzed using STATISTICA software (Statsoft Inc., Tulsa, 131 OK, USA). The ANOVA was used to assess the effects of country pressures on different marine species. All significance levels were fixed at $p < 0.05$.

1) Captures and stock progression of some marine fish species

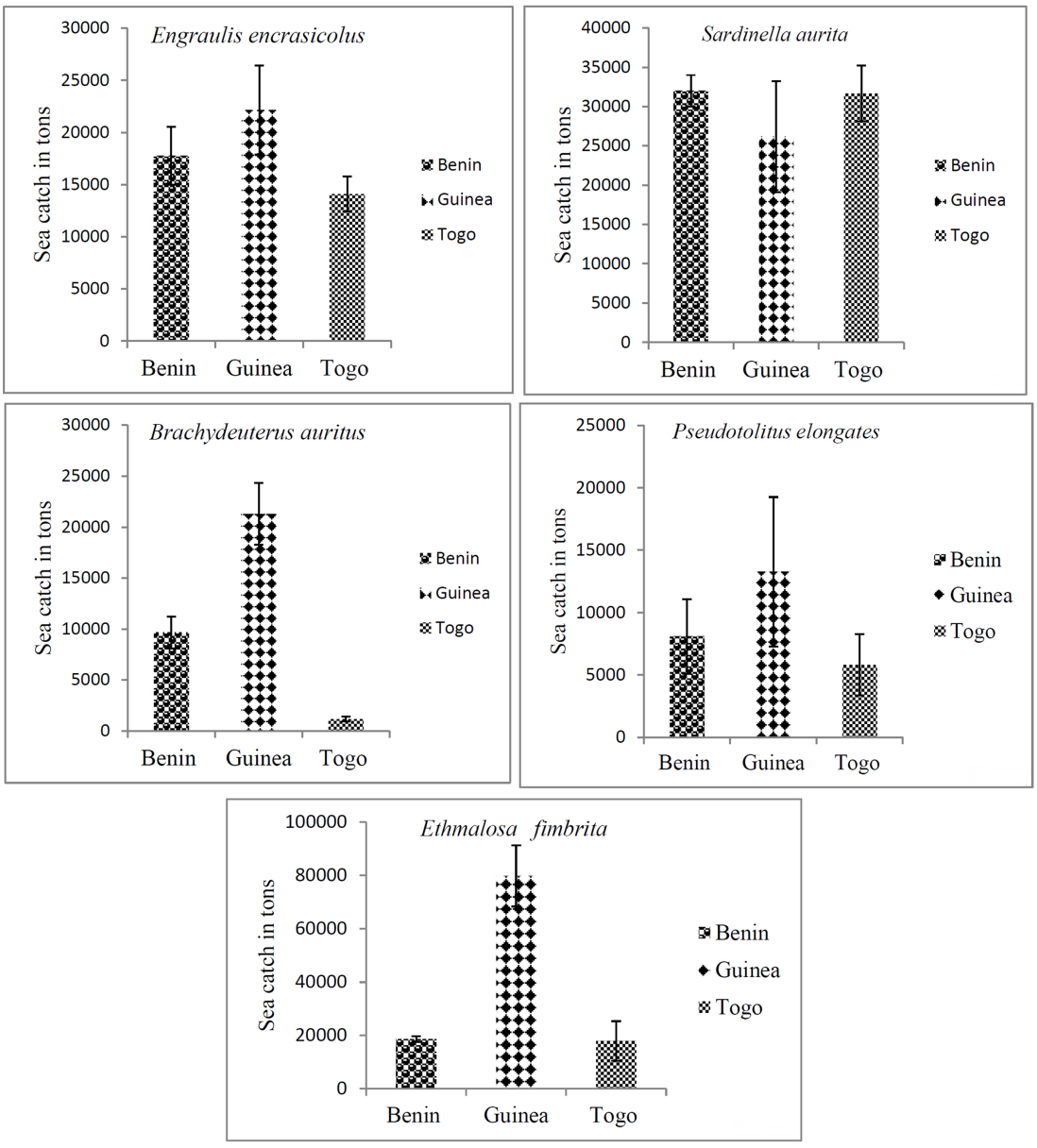
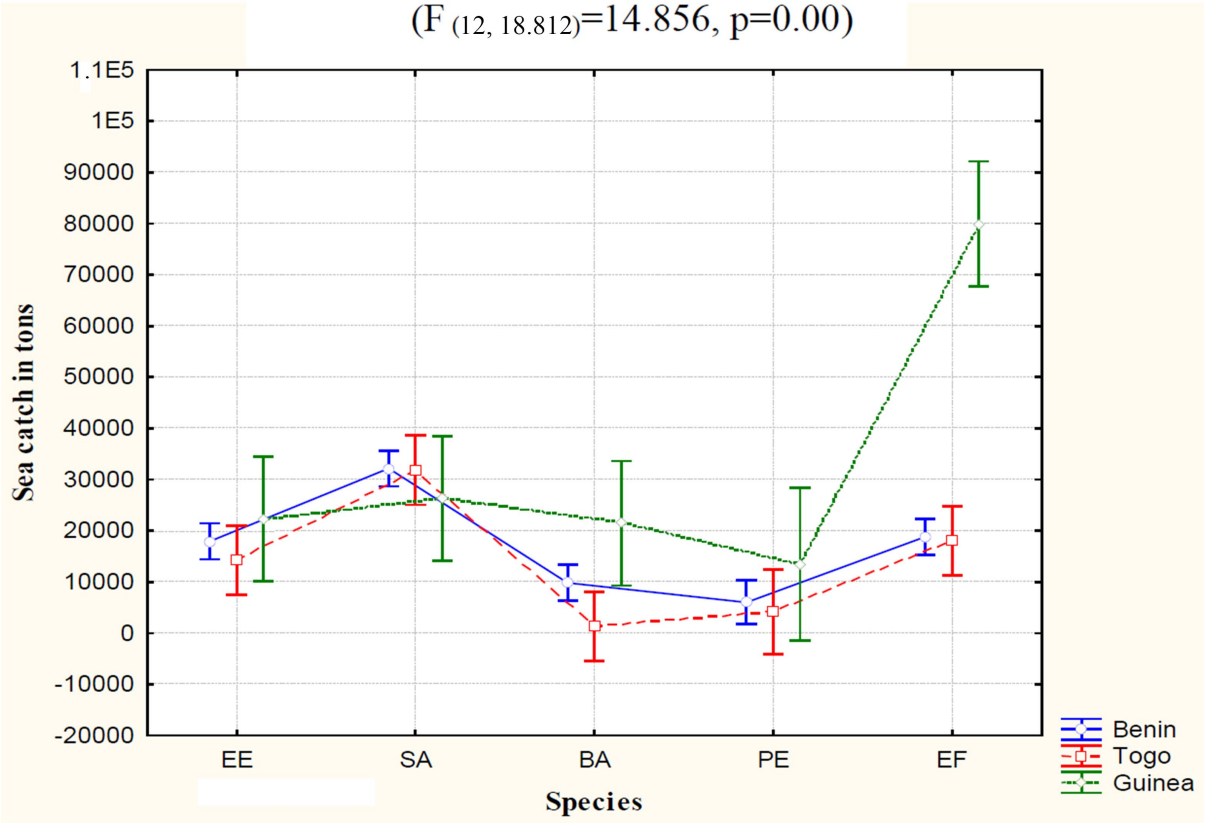


Figure 1. Different captures of five marine fish species in three West African countries (Sources: [1] [11] [27]-[32]).



EE: *Engraulis encrasicolus*, SA: *Sardinella aurita*, BA: *Brachydeuterus auritus*, PE: *Pseudotolitus elongates*, EF: *Ethmalosa fimbrita*.

Figure 2. Total captures of different fish species by country.

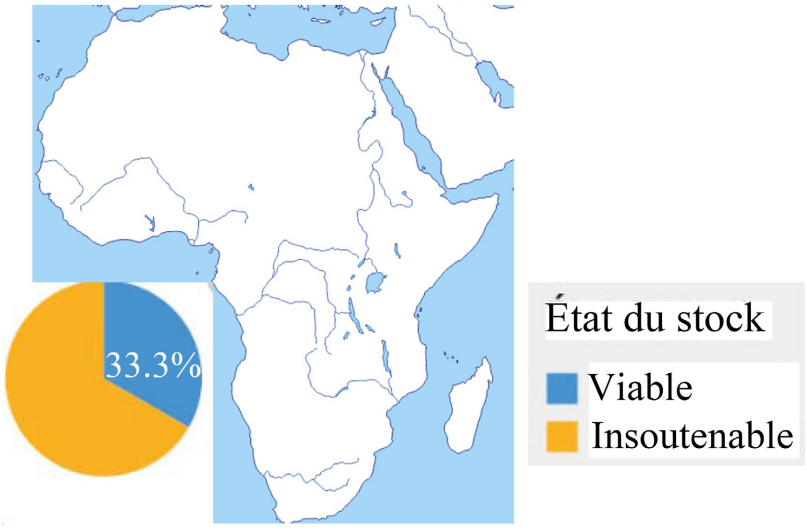


Figure 3. Stock estimation of pelagic fish in Africa (Source: [33]).

It results from estimations analysis (**Figure 1** and **Figure 2**), that Guinea exerts more pressure on marine fish particulary on *Ethmalosa fimbrita* followed by Benin and Togo on *Sardinella aurita* with ($F_{(12, 18,812)}$ = 14.856, p = 0.00). It is due to

the fact fish farming development is slowing down in Guinea. According to [34] and [35], fish farming started in Guinea by years 2000 s with average 3000 fish farmers for annual production of 4106 tons. However, the need is estimated to more than 134,000 tons. High capture could be justified by this deficit contrary to other countries where fish farming is meanly developed.

Even though data assessment regarding stock estimation is difficult with new models, some FAO data and other international organizations enabled us to have an insight on stock progression in Africa (**Figure 3**). It results from these analyses that 66.3% of fish stocks are threatened in Africa (**Figure 3**).

3. Ecological and Biological Aspects

Several work were carried out on the ecology and biology of *E. encrasicolus*, *S. aurita*, *B. auritus*, *Pseudotolitus elongates* and *Ethmalosa fimbrita* by different authors in the West African region of the gulf of Guinea from Liberia, Ivory Coast, Benin passing through Nigeria and elsewhere [20]-[27] [35]-[37]. Aspects of ecology such as taxonomic characteristics, morphology, distribution and habitat and biological aspects especially reproduction and growth were considered in the current assessment of these economic value fish in Benin, Guinea and Togo.

3.1. *Engraulis encrasicolus* (Linnaeus, 1758)

3.1.1. Taxonomic Caracteristics

Engraulis encrasicolus, pelagic fish is the only species of its family encountrered in Togo water system [24] [38]-[41]. It constitutes only one stock in the sub-region distributed among Benin, Ivory Coast, Ghana and Togo (**Figure 4** and **Table 1**) [42].

Table 1. Classification of *Engraulis encrasicolus.*

Regnum:	Animal	Sub-phylum:	Gnathos-tomata	Sub-class:	Actinopte-rygiens	Family:	Engraulididae
Sub-regnum:	Metazoary	Super-class:	Fish	Super-order:	Teleosts	Genus:	*Engraulis*
Phylum:	Vertebrates	Class:	Osteichts	Order:	Clupeiforms	Species:	*encrasicolus*

3.1.2. Morphology of *Engraulis encrasicolus*

It is a small fish of maximum 20 centimeters length characterized by round and fusiform body (**Figure 4**). The snout is elongated, pointed with roster above the large oblique mouth. The maxillary passes the posterior border of eye. The dorsal fin, short is situated in the mid of the body; the origin of the anal fin is behind the basis of the dorsal. The caudal fin is forked with two modified scales, symmetric in the basis of rays. Scales are easily removable. The back is blue-green to clear-grey colored. In the presence of scales, faces are silver banded with dark-grey line. Along the West-African coast, *Engraulis encrasicolus* presents two kinds of size: a small form generally encountered at the limits of gulf of Guinea (11˚N to l˚S) where hydrological conditions are stable, and a big form localized in the Northern and Southern zones seasonally subject to trade wind [43].

Figure 4. Photo de *Engraulis encrasicolus*. http://eol.org/pages/223061/details

3.1.3. Distribution Area, Habitat and Reproduction of *E. encrasicolus*

E. encrasicolus divided by [44] in several local races with low migration rate, is distributed in the whole Eastern Atlantic, from Norway coasts to South Africa. It is also spread over the Mediterranean basin including the black sea and Azov sea and the Manche. It is significantly present on West African coasts from Ivory Coast to Benin (**Figure 5**) [43].

With gregarious life style, it live in coastal low depth waters till 150 m and sometimes 400 m [45] and also frequent estuaries from surface to bottom. [46] reports the presence of the species from Liberia to Benin coasts, more in surface water at night than at day time. The anchor appreciates diluted water and ponds more than salt waters ranging from 5‰ to 41‰.

3.1.4. Biology

In Togo water bodies, the first maturity height ranges from 5 to 7 cm [24]. [21] reported that in Ghana, the first maturity height is 5.7 cm (FL) corresponding to average 6.4 cm (TL) by considering the TL and FL relationship established by [47]. According to [25], the L50 is 8.4 cm in male and 8.8 cm in female. In other side, it is from 12 to 13 cm (Fage, 1911); 11 to 12 cm [48]; 11.8 cm [49]; 11.0 cm [50]. For smallest individuals, the sexual maturity height is 8.2 cm [51] and 8.6 cm and 9.7 cm respectively for males and females [52].

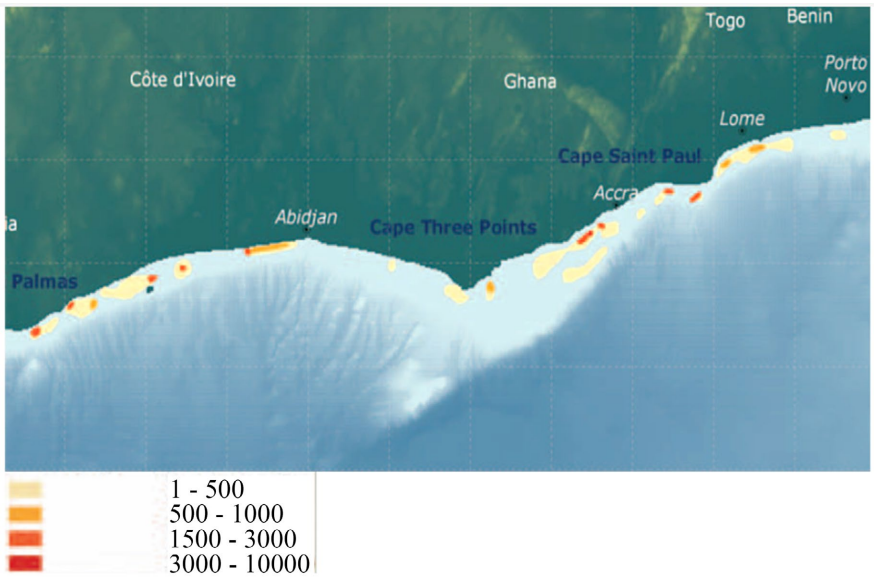


Figure 5. Distribution of *Engraulis encrasicolus* in coastal area from Ivory Coast to Benin [42].

[53] reports in his research work in Mauritania that reproduction depends mainly on temperature which depends on salinity and then trophic richness of the species habitat. He also confirms results of [54] and [55]. According to [53], the species reproduce in water with 14˚C temperature. It is sexual reproduction mode. [56] reported that a female weighing 25 g can spawn meanly 275,000 eggs per season hatching by the 2 to 4 next days after spawning [46]. According to [25], maturation in *E. encrasicolus* starts in Ivorian waters from November-December to March. It grows rapidly and its life duration is 3 years.

It fed on small planktonic crustaceans, eggs and pelagic fish fries. According to [57], natural mortality in larval stage depends on cannibalism exerted by adults. *E. encrasicolus* is harvested using pelagic trawl and fishing nets; but in Togo, Benin and Guinea, it is harvested using turning fishing nets in the beach (**Figure 5**).

3.2. *Sardinella aurita* (Valenciennes 1847)

3.2.1. Taxonomic Characteristics

The zoological classification of *Sardinella aurita* is shown in **Table 2**.

Table 2. Classification of *Sardinella aurita* (According to [58]).

Regnum:	Animal	Sub-Phylum:	Gnathos-tomata	Sub-class:	Actinopte-rygians	Family:	Clupeidae
Sub-regnum:	Metazoaire	Super-class	Fish	Super-order:	Teleosts	Genus:	Sardinella
Embran-chement:	Vertebrated	Class:	Ostéich-tyens	Order:	Clupéi-formes	Species:	*S. aurita*

3.2.2. Morphology of *Sardinella aurita*

According to [58], *Sardinella aurita* has elongated, round and most compressed body (**Figure 6**). The operculum is slightly prolonged, mean eyes; the skull top is striated (7 - 14) on parietal fronts, terminal muzzle, and rounded upper jaw, a second supra-maxillary with sub-equal upper and lower borders. Thin numerous gills spines. The dorsal fin origin is near the body's midst. The anal fin is in the basis of the dorsal. The two late rays are longer than those preceding. Pelvic fins are under dorsal and have 9 rays. The back is blue-green colored; flanks are silver with golden line and golden spot behind the operculum. There is a distinct dark spot on the posterior border of the operculum and yellow dorsal fin with black anterior rays.

Figure 6. Photo de *Sardinella aurita.* http://eol.org/pages/223061/details

3.2.3. Distribution Area, Habitat and Reproduction of *Sardinella aurita*

Sardinella aurita in Eastern Atlantic is spread over West African coasts, Mediterranean and the black sea coasts and in Western it is found in Cape Code in Argentina. It is also found in western Pacific from Japan to Philippines. It is present in the Western part of gulf of Guinea (Figure 7).

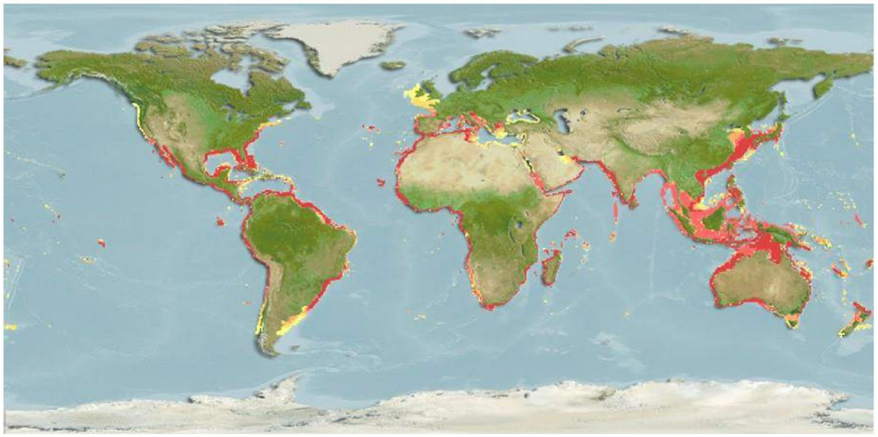


Figure 7. Geographical distribution of *Sardinella aurita*. Distribution area colors indicate adaptation level of the habitat (AquaMaps Search Page, 4/04/2025).

According to [59], *Sardinella aurita*, along the West African coast shows two populations in term of size. A small with sexual maturity height varying from 12 to 104 cm is generally encountered in the limits of the gulf of Guinea (11˚N to 1˚S) where hydrologic conditions are stable. The big form is located in North and south in zones exposed to trade wind, can be found in Mauritania, Senegal, Gabon, Congo and Angola with 19 - 20 cm maturity height. The most evident character is reduction of maximum and mean length in maturity height measurements. This character shows dwarfish in *S. aurita* and at least three dwarf populations were identified: Guinea-Liberia, Ivory Coast-Ghana, Gabon. But, on Ghanaian coasts we also find the big size population [59]. [46] [60] [61] estimated that *S. aurita* prefers deeper waters than coasts. It could frequent 70 - 100 m depth where surface waters are hot and comes to surface during upwelling. Most of *S. aurita* are found in the East of Cap the Three Points. Marking carried out in Ghana by [62] showed that their migration during cold season (July-September) is followed by movement toward East till Togo. They return to West from October to December but at high depth before coming to the original habitat. It could be more abundant in isobaths from 40 to 200 m. Spawning happens mainly in coastal waters during upwelling season. During low salt water period, *S. aurita* is not found in water with salinity lower than 35%. It also fears coasts influenced by terrestrial runoff [63]. Fries spend more time in nursery with low movements on the coast contrary to adults. *S. aurita* feeds mainly on plankton. It is able to retain small particles [64]. It is possible that unavailability of zooplankton could affect growth, fecundity, stock height or behavior of the species [65]. Besides, low zooplankton biomass will correspond to high predation of eggs and larvae [66]. Adults have be-

havior that could be influenced by zooplankton scarcity. Indeed, plankton concentrations near the coast are higher than the bottom [67]. Some research works indicate that height (FL) is 16.7 cm in male and 17.1 cm in female [68].

3.3. *Brachydeuterus auritus* (Valenciennes, 1831)

3.3.1. Taxonomic Characteristics of *Brachydeuterus auritus*

Brachydeuterus auritus belongs to Haemulidae family with 11 genus and its zoological position is mentioned in Table 3 below.

Table 3. Classification of *Brachydeuterus auritus* (Valenciennes, 1831).

Regum:	Animal	Sub-Phylum:	Gnathos-tomata	Sub-class:	Actinopte-rygians	Family:	Haemulidae
Sub-regnum:	Metazoaire	Super-class:	Fish	Super-order:	Teleosts	Genus:	Brachydeuterus
Phylum:	Vertebrates	Class:	Osteichts	Order:	Perciforms	Species:	*B. auritus*

3.3.2. Morphology of *Brachydeuterus auritus*

According [69], *Brachydeuterus auritus* is characterized alongated and compressed body with height 2.6 to 3 times standard length. It has big eyes and large protractile mouth. The snout is smallest than eyes diameter. The dorsal fin possesses 12 moderated spines and 11 to 13 soft rays. The third and sometimes the forth spine is longest than others. The anal fin has 3 spines with 9 to 10 soft rays. The caudal fin is deeply inserted. The lateral line is made of 48 to 52 scales with 4 to 5 under ranks. The back is olive colored, flanks and belly are silver colored. On the top of the operculum, there is a black spot. Some small black spots are also viewable on the basis of the dorsal fin (Figure 8).

Figure 8. Photo de *Brachydeuterus auritus* (Source, [70]).

3.3.3. Distribution Area, Habitats and Reproduction of *Brachydeuterus auritus*

Brachydeuterus auritus is of species which biology is little assessed. Important

research work carried out in Ivory Coast, Ghana, Nigeria, Togo and Congo focused mainly on the distribution of the species [37] [71]). *B. auritus* is semi-pelagic species eurybenthic. It is subject to tropical and sub-tropical distribution and is found along coastal areas from Mauritania to Angola at depth 10 to 100 m [72] and in Togo on sand bottom from 0 to 100 m depth [24] [37] [39] [73]. According to [74] and [75], *B. auritus* is abundant in Ghana at 55 to 90 m depth. [76] reported that the species moves in group and is located around the thermocline. Young specimens are found only in the coastal round though adults dwell in large but come progressively in the coastal area during spawning period.

The multiple feeding behaviors of *B. auritus* are limited to microscopic zooplankton, shrimps, fish juveniles, cephalopods, benthic crustaceans and sometimes polychetes [77] Planktonic crustaceans constitute the major part of food diet especially big copepods that are abundant near coastal areas. *B. auritus* fed near the bottom in day time and in intermediary water body at night. [77] reported that feeding could be important during the rainy season where zooplankton is abundant. Food diet could vary between the long rainy season and the long dry season. The short rainy season food diet is not significantly different from dry seasons. If planktonic crustaceans are less abundant (during the summer), the species changes its diet. [78] and [79] confirmed the works of [77] and revealed that the species prefers polychetes and fish. The works of [37] are the only focused on the biology of *B. auritus* in Togo water bodies and assessed growth and first sexual maturity height. In Congo, the first sexual maturity height is 12 cm (FL) for female [80]; in Ivory Coast 13.8 cm and 14.5 cm (TL) [77] and then 12.25 and 11.96 cm (FL) [81]. In Ghana 14.8 for male and 15.1 cm for female [82]; in Senegal 14.4 and 14.8 cm [72].

3.4. *Pseudotolitus elongates* (Bowdich, 1825)

3.4.1. Taxonomic Characteristics of *Pseudotolitus elongates*

Pseudotolitus elongates belongs to Sciaenidae family and constitutes the most important fish community of gulf of Guinea [83]. The Sciaenidae family counts 270 species distributed in 70 average genus according to [84] and [85] with main representatives that belong to the *Pseudotolithus* genus (**Table 4**). There are eight genus distributed in sixteen species known from West African coasts. Among these species, we only retain three belonging to *Pseudotolithus* genus often found in brackish water [86]. They are mainly *Pseudotolithus elongatus*, *Pseudotolithus senegalensis* and *Pseudotolithus typus*.

Table 4. Classification of *Pseudotolithus elongates.*

Regnum:	Animal	Sub-Phylum:	Gnathostomata	Sub-class:	Actinopté-rygiens	Family:	Sciaenidae
Sub-regnum:	Metazoaire	Super-class:	Fish	Super-order:	Téléos-téens	Genus:	*Pseudotolithus*
Phylum:	Vertebrates	Class:	Teleosts	Order:	Eupercaria incertae sedis	Species:	*P. elongatus*

3.4.2. Morphology of *Pseudotolithus elongatus*

Pseudotolithus elongatus is a fusiform fish, alongated and laterally compressed with long dorsal fin deeply inserted according to [69]. It has 11 dorsal spines and between 29 and 35 dorsal soft rays with short head and large oblique snout. Its identification is difficult due to allometry. It has villiform teeth arranged in shrink bands in both jaws. In addition, *P. elongatus* has average 19 to 2 branchiospines on the first gill arch. Scales are ctenoid on the body and cycloid on the chest and head. It is gray silver colored with reddish aspect. The dorsal and caudal fins are gray and the back is olive colored (**Figure 9**).

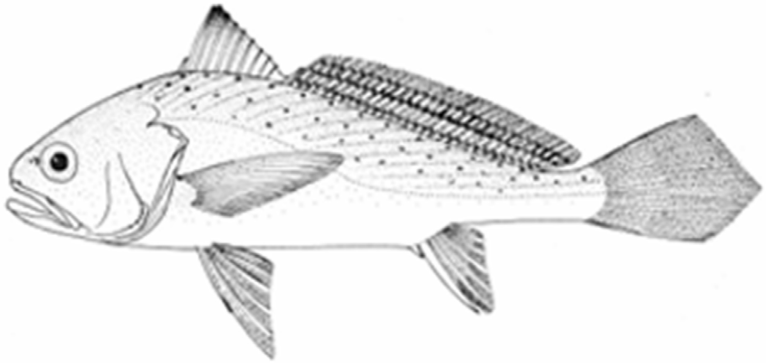


Figure 9. Photo of *Pseudotolithus elongatus* (Source: [15]).

3.4.3. Distribution Area, Habitats and Reproduction of *P. elongatus*

Distribution area of *P. elongatus* in Eastern Atlantic mainly spread from Southern Senegal till Angola (**Figure 10**). The species is considerate as native of the gulf of Guinea ranging from Southern Bissau Guinea till Congo where it appears highly. Highest captures come from Guinean coasts [15] [87]. However, according to [88] *P. elongtaus* is scarces in Ivory Coast where water conditions (upwelling) don't fit this species ecology.

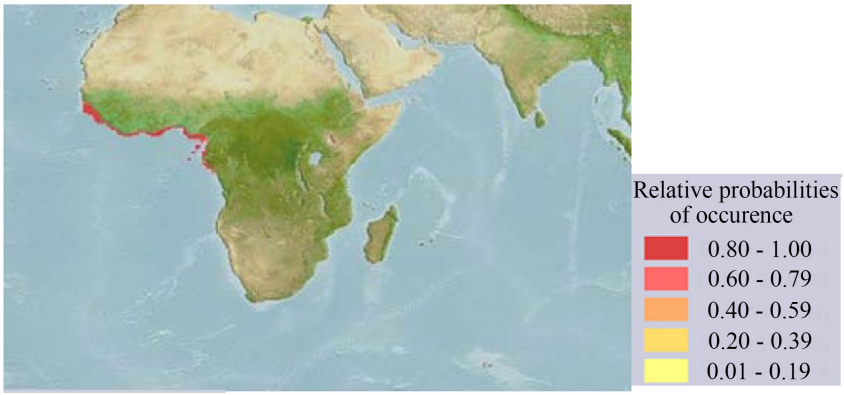


Figure 10. Distribution map of *Pseudotolithus elongatus* (Source: http://www.aquamaps.org/).

P. elongatus dwells in the moody bottom of coastal water bodies. According to [87] and [89], it can also be found in coastal lagoons and estuaries that represent

spawning media. During rainy season, it spawns in large water (average 100 m). *P. elongatus* fed on shrimps, fish juveniles and other crustaceans. Both of oocytes don't reach maturity at same time in *P. elongatus*. It is characterized by continuous gametogenesis and spawn along the year [87] [89] [90].

3.5. *Ethmalosa fimbrita* (Bowdich, 1825)

3.5.1. Taxonomic Characteristics of *E. fimbrita*

Ethmalosa fimbrita spends its first year in brackish water where it spawns and migrates to sea water in the second year [91] (**Table 5**).

Table 5. Classification of *Ethmalosa fimbrita.*

Regnum:	Animal	Sub-Phylum:	Gnathos-tomata	Sub-class:	Actinopte-rygians	Family:	Clupeidae
Sub-regnum:	Metazoaire	Super-clas:	Fish	Super-order:	Teleosts	Genus:	Ethmalosa
Phylum:	Vertebrates	Class:	Actinopterygi	Order:	Clupeiformes	Species:	*E. fimbriata*

3.5.2. Morphology of *Ethmalosa fimbrita*

Its height is average 35 cm standard length, but it is most commonly comprised between 20 and 25 cm. in Ghanaian water bodies, this species reaches its sexual maturity at 22 cm [92]. The same study reported fecundity ranging from 16000 for 21.2 cm fish weighing 88 g to 51750 cm for 30.4 cm specimen weighing 242.7 g. The sex ratio (male/female) was 0.88. Fisheries data from delta Niger revealed mean annual mortality rate estimated to 1.2 per year [93]. According to [69], *E. frimbrita* doesn't have dorsal spine but soft dorsal rays comprised between 16 and 19 and anal soft rays between 19 and 25 (**Figure 11**). The compressed body has scales on the belly due to vertebra comprised between 40 and 44. Long inferior branchiospines, thin and numerous and three times longer than gill filaments. It also possess superior branchiospines highly curved in form of V. By the same way, *E. frimbrita* has a black spot behind operculum followed by other spots. The dorsal fin is black and the caudal is yellow.

Figure 11. Photo of *Ethmalosa fimbrita* (Source: Adande, 2025, This work).

3.5.3. Distribution AREA, Habitats and Reproduction of *Ethmalosa fimbrita*

Ethmalosa fimbrita is present in coastal area, estuaries and often in Dakhla River of occidental Sahara till Lobito in Angola corresponding to Northern limits and

extreme South of 25˚C isotherms the year round. According to [16], few small specimens are present in Lake Nokoué in Benin. The same author reported that remarks made by [94] in Cap-Vert regarding location are not verified.

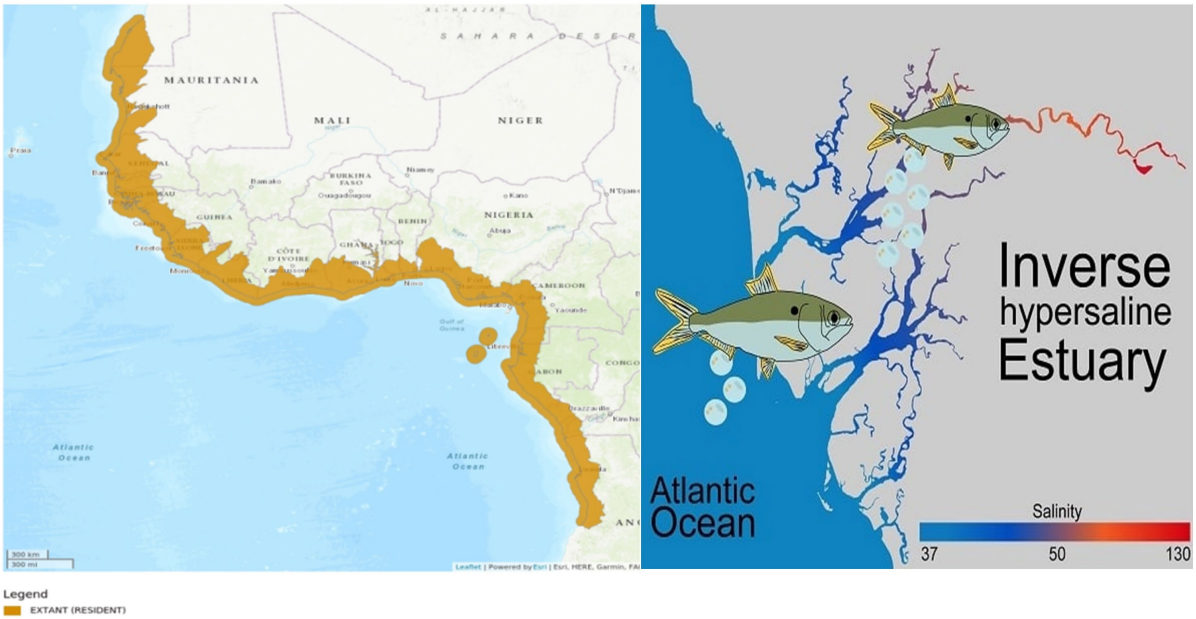


Figure 12. Distribution map and migration tied to salinity of *Ethmalosa fimbrita* (Source: distribution of *E. fimbrita* according to [95].

Ethmalosa fimbrita is euryhaline and brackish migrator (**Figure 12**). It lives in low depth coastal water, lagoons and estuaries and often in fresh water at more than 300 km offstream (Gambie River). The most abundant populations are found in lagoons and estuaries [96]. Generally, 12 cm specimens of *E. fimbrita* prefer more than 5 ppt salinity. *E. fimbrita* practices spring migration to coastal area for spawning (reproduction in sea water, lagoons and estuaries with salinity comprised between 3.5 and 38 ppt) followed by autumn migration to the large. The species lives average 4 to 5 years and the first spawning happens at 1 year age [97]. It mainly fed on phytoplankton.

4. Conclusions

Species *E. encrasicolus*, *S. aurita*, *Brachydeuterus auritus*, *Pseudotolitus elongates and Ethmalosa fimbrita* are highly exploited in West African countries. These species worldwide larges captures. Variation tied to regions, periods and height lead to studies of reproduction and growth that constitute two important aspects of the biology of the species. High pressure exerted of some species (*Pseudotolitus elongatus and Ethmalosa fimbrita*) justify their enrollment on the UICN red list. It is important to adopt preservation strategies, stock management by using new modeling methods regarding each country considering climate change effects. To safeguard these species, governments in different countries will need to:

Implement country-specific modeling systems for each species to ensure accurate stock information for proper management.

- Promote fish farming and domestication of these fish.
- Train aquaculture experts.
- Facilitate the import of aquaculture equipment.
- Fight corrupt practices.

Funding

We are supported by the Ministry of Higher Education and Scientific Research and Innovation of Guinea.

Data and Material Availability

All data related to the study are available from the first author and the horn author responding and they could be provided as soon as possible.

Declarations

The methodology and statistical analyses were approved by all authors and co-authors.

All authors consented to participate in the publication process of the document.

Consent for Publication

All the authors consented to publish the findings of the study.

Conflicts of Interest

The authors declare no competing interests.

References

[1] Food and Agriculture Organization (2022) La Situation mondiale des pêches et de l'aquaculture. Vers une Transformation Bleue. FAO. https://doi.org/10.4060/cc0461fr

[2] Food and Agriculture Organization (2024) La Situation mondiale des pêches et de l'aquaculture. La Transformation Bleue en Action. FAO. https://doi.org/10.4060/cd0683fr

[3] Van Hecke, É. and Vanderleenen, F. (2023) Poisson et nutrition en Afrique. *Belgeo*, **2**, 1-11.

[4] Ba, A. (2002) Surexploitation des ressources halieutiques: Des experts sonnent l'alerte. Le Soleil (Dakar), 2 p.

[5] Brochier, T., Auger, P., Pecquerie, L., Machu, E., Capet, X., Thiaw, M., *et al.* (2018) Complex Small Pelagic Fish Population Patterns Arising from Individual Behavioral Responses to Their Environment. *Progress in Oceanography*, **164**, 12-27. https://doi.org/10.1016/j.pocean.2018.03.011

[6] Failler, P., Pan, H. and Akbari, N. (2022) Integrated Social-Economic-Ecological Modeling for Fisheries: The ECOST Model. *Frontiers in Marine Science*, **8**, Article 704371. https://doi.org/10.3389/fmars.2021.704371

[7] Jönsson, J.H. (2019) Overfishing, Social Problems, and Ecosocial Sustainability in

Senegalese Fishing Communities. *Journal of Community Practice*, **27**, 213-230. https://doi.org/10.1080/10705422.2019.1660290

[8] Dème, E.h.B., Failler, P., Fall, A.D., Dème, M., Diedhiou, I., Touron-Gardic, G., *et al.* (2023) Contribution of Small-Scale Migrant Fishing to the Emergence of the Fishmeal Industry in West Africa: Cases of Mauritania, Senegal and the Gambia. *Frontiers in Marine Science*, **10**, Article 871911. https://doi.org/10.3389/fmars.2023.871911

[9] Deme, E.H.B., Deme, M. and Failler, P. (2022) Small Pelagic Fish in Senegal: A Multi-Usage Resource. *Marine Policy*, **141**, Article 105083. https://doi.org/10.1016/j.marpol.2022.105083

[10] Commission Européenne (2014) 2014/156/UE: Décision d'exécution de la Commission du 19 mars 2014 établissant un programme spécifique de contrôle et d'inspection applicable aux pêcheries exploitant les stocks de thon rouge dans l'atlantique est et la méditerranée, d'espadon dans la méditerranée et aux pêcheries exploitant les stocks de sardine et d'anchois dans l'Adriatique Nord.

[11] Food and Agriculture Organization (2024) Regional review of capacity requirements for fisheries data collection and fisheries data management in Member Nations of the Fisheries Committee for the West Central Gulf of Guinea. https://doi.org/10.4060/cd3151en

[12] Gascuel, D. (2016) L'évaluation et la gestion des stocks de poissons l'Institut océanographique sur. 16. http://www.institut-ocean.org/

[13] Dème, M. and Thiao, D. (2021) Politiques de pêche et innovations adaptatives des pêcheries artisanales sénégalaises. *Natures Sciences Sociétés*, **29**, 174-184. https://doi.org/10.1051/nss/2021039

[14] March, A. and Failler, P. (2022) Small-Scale Fisheries Development in Africa: Lessons Learned and Best Practices for Enhancing Food Security and Livelihoods. *Marine Policy*, **136**, Article 104925. https://doi.org/10.1016/j.marpol.2021.104925

[15] Sidibe, A. (2010) Evaluation-Test sur l'utilisation de la Liste Rouge de l'UICN comme outil de suivi des risques de perte de biodiversité : Application aux espèces de poissons démersaux côtiers exploités en Afrique du Nord-Ouest. 67. Microsoft Word—Rapport-Etude-Liste Rouge de l'UICN et Poissons démersaux en AO_Sidibé-Final.

[16] Lalèyè, P., *et al.* (2020) *Ethmalosa fimbriata*. The IUCN Red List of Threatened Species.

[17] Sharif, J. (2014) Étude de la structure des populations et du régime alimentaire de l'anchois eu ropéen (*Engraulis encrasicolus*) et de la sardine européenne (*Sardina pilchardus*): Relations avec l'environnement. Biodiversité et Ecologie. Université du Littoral Côte d'Opale.

[18] Raitt, D.S.F. and Sagua, V.O. (1972) Preliminary Investigations on the Biology of *Brachydeuterus auritus* (Val. 1831), in Nigerian Waters. In: *Proceedings of the Symposium on the Oceanography and Fisheries Resources of the Tropical* Atlantic, UNESCO, 397-401.

[19] Beck, V.U. (1974) Bstandskundliche untersuchungen an einigen fischarten der grundschleppnetz fischerei auf dem schelf vor Togo (West africa). Universität Hamburg, 126. [Stock Assessment of Some Fish Species Caught by the Bottom Trawl Fishery on the Shelf of Togo. Master's Thesis, Hamburg University].

[20] Beck, V.U. (1976) Die Zuammentzung der Eträge aus der küstenfischerei Togos. Institut fur Hydrobiologie und Fischerei Wissenschaft der Universität Hamburg, 37-45.

[21] Koranteng, K.A. (1993) Size at First Maturity of *Engraulis encrasicolus* in Ghanaian

Waters and Suggestions for Appropriate Mesh Size in Its Fishery. *Naga*, **16**, 29-30.

[22] Samba, O., Diouf, K., Fall, M., Ndiaye, P. and Panfili, J. (2021) Long Term Changes in Life History Traits and Catches of the Round Sardinella, *Sardinella aurita* (Clupeidae), along the Senegal Coast, West Africa. *Regional Studies in Marine Science*, **42**, Article No. 101621. https://doi.org/10.1016/j.rsma.2021.101621

[23] Abbey, L.D., Glover-Amengor, M., Atikpo, M.O. and Howell, N.K. (2017) Proximate and Biochemical Characterization of Burrito (*Bachydeuterus auritus*) and Flying Gurnard (*Dactylopterus volitans*). *Food Science and Nutrition*, **5**, 369-373. https://doi.org/10.1002/fsn3.401

[24] Mehl, S., Olsen, M. and Bannerman, P. (2006) Surveys of the Fish Resources of the Western Gulf of Guinea (Benin, Togo, Ghana & Côte d'Ivoire). Survey of the Pelagic and Demersal Resources. FAO/NORAD-EAF-NANSEN Project//GCLME. Cruise Dr Fridtjof Nansen, 1999, 2000, 2002, 2004, 2005 et 2006," Reports.

[25] Ouattara, S., Fantodji, A. and Ouattara, M. (2008) Quelques aspects reproductifs de l'anchois (*Engraulis encrasicolus*) de la pêche artisanale du littoral est ivoirien.

[26] Konan, K.J., Joanny, T.G.T., Sylla, S., Lianthuam, L. and Kumar, K.L. (2015) Stock Assessment of the Bigeye Grunt *Brachydeuterus auritus* (Valenciennes, 1832) in the Coastal Water of Ivory Coast, *International Journal of Agricultural Policy and Research*, **3**, 222-230.

[27] Nunoo, F.K.E. and Azumah, D.Y.M. (2015) Selectivity Studies on Beach Seine Deployed in Nearshore Waters Near Accra, Ghana. University of Ghana, 17 p.

[28] CNSHB (Centre National des Sciences Halieutiques de Boussoura) (2022) Bulletin statistique des pêches, ministère des pêches et de l'economie maritime (MPEM).

[29] CNSHB (Centre National des Sciences Halieutiques de Boussoura) (2023) Bulletin statistique des pêches, ministère des pêches et de l'economie maritime (MPEM).

[30] DPHB (Direction des Pêches Halieutiques du Bénin) (2024) Evolution de la production halieutique de 2018 à 2023.

[31] Togo (2023) Des statistiques des pêches du ministère de l'economie maritime, de la pêche et de la protection côtière.

[32] Sedzro, K.M., Fiogbe, E.D., Guerra, E.B. and Stamatopoulos, C. (2016) Analyse de la fiabilité des statistiques des pêcheries maritimes artisanales togolaises générées par la méthode ARTFISH de la FAO. *Journal of Applied Biosciences*, **97**, 9227-9239. https://doi.org/10.4314/jab.v97i1.8

[33] Food and Agriculture Organization (2024) La Situation mondiale des pêches et de l'aquaculture-La transformation bleue en action. https://doi.org/10.4060/cd0683fr

[34] Palliere, A. and Rangé, C. (2016) Les projets de développement favorisentils la construction de nouveaux communs autour des savoirs locaux ? Le cas de la pisciriziculture en Guinée Forestière. 12ème conférence internationale sur le développement de l'AFD« Communs et Développement.

[35] APDRA (2017) Pisciculture paysanne projet de développement de la rizipisciculture de guinée forestière.

[36] Bannerman, P.O. and Cowx, I.G. (2002) Stock Assessment of the Big-Eye Grunt (*Brachydeuterus auritus*, Val.) Fishery in Ghanaian Coastal Waters. *Fisheries Research*, **59**, 197-207. https://doi.org/10.1016/s0165-7836(01)00404-0

[37] Beck, V.U. (1974) Bstandskundliche Untersuchungen an einigen fischarten der Grundschleppnetz Fischerei auf dem schelf vor Togo (West africa). Universität Hamburg, 126. [Stock Assessment of Some Fish Species Caught by the Bottom Trawl Fishery

on the Shelf of Togo. Master's Thesis, Hamburg University].

[38] Midinoudewa, H.E.C. (2012) Biodiversité et écologie des espèces de requins pêchées sur les côtes du Bénin: mémoire. 81 p. https://www.researchgate.net/publication/320244834

[39] Lhomme, F. (1985) Estimation par chalutage des ressources halieutiques du plateau continental togolais. ORSTOM.

[40] Oliver, P., Miquel, J. and Bruno, J. (1987) Preliminary Report of the Survey Carried Out by the R/V CORNIDE DE SAAVEDRA in Liberia, Côte d'Ivoire and Togo, May-June 1987. Instituto Espanol de Ocenaografia.

[41] Ali, D., Tcharie, K., Banguina, K. and Sedzro, K.M. (2012) Evaluation des stocks pélagiques de la Côte d'Ivoire, du Ghana, du Togo et du Bénin-Mars 2012. Projet régional d'évaluation des stocks halieutiques, UEMOA. Rapport Scientifique de la Campagne pélagique 2012. Bateau Itaf Deme.

[42] Gbaguidi, A., Sedzro, K.M., Quaatey, S.N.K., Bannermann, P., Joanny, T., Mehl, S., Alvheim, O., Caramelo, M.A. and Tandstad, M. (2008) Distribution and Abundance of the Main Pelagic Fish Stocks in the Western Gulf of Guinea (Benin, Togo, Ghana and Côte d'Ivoire). Summary of Results from the R/V Dr. Fridtjof Nansen Surveys 1981-2006. Global Information System on Fishes. http://www.fishbase.org

[43] Amalatchy, J.Y.N., Deme, E.B., Atsé, A.B.N., Aka, S.K., Koudou, D., Koudou, D., *et al.* (2023) Dynamiques transfrontalières dans la pêche à petite échelle: Le rôle des pêcheurs migrants ghanéens dans la pêcherie de petits pélagiques en Côte d'Ivoire, Belgeo. http://journals.openedition.org/belgeo/63248

[44] Fage, L. (1911) Recherches sur la biologie de l'anchois, *Engraulis encrasicolus* (Linnaeus, 1766): Races, âge-migration. *Annales de l' Institut océanographique*, **2**, 140.

[45] Schneider, W. (1992) Fiches FAO d'identification des espèces pour les besoins de la pêche. Guide de terrain des ressources marines commerciales du golfe de Guinée. Préparé et publié avec la collaboration du Bureau régional de la FAO pour l'Afrique. FAO, 268 p.

[46] Marchal, E. (1966) Œufs, larves et post-larvaires de l'anchois du golfe de guinée, *Anchoviella guineensis* (Blache et Rossignol). *Documents Scientifiques Provisoires ORSTOM*, 5, 15.

[47] Gaamour, A., Ben Abdallah, L., Khemiri, S. and Mili, S. (2004) Etudes de la biologie et de l'exploitation des petits pélagiques en Tunisie.

[48] Furnestin, J. (1945) Note préliminaire sur 1'Anchois (*Engraulis encrasicolus*) du Golf e de Gascogne. *Revue des Travaux de l'Office Scientifique et Technique des Pêches*, **13**, 197-209.

[49] Bas, C. and Morales, E. (1954) Algunos datos para el estudio de la biologia de la anchoa *Engraulis encrasicolus L.* de la Costa Brava. Instituto de Biología APL.

[50] Arrignon, J. (1966) L'anchois (*Engraulis encrasicolus*) des côtes d'Oranie. Revue des Travaux de l'Institut.

[51] Navaz, J.M. and Lozano Cabo, F. (1966) Données sur la taille, l'âge et la croissance de l'E. encrasicolus.

[52] Sinovcic, G. (1978) On the Ecology of Anchovy, *Engraulis encrasicolus* (L.)., in the Central Adriatic. *Acta Adriatica*, **19**, 3-32.

[53] Ba, I.S. (1988) Biologie et dynamique des populations d'anchois (*Engraulis encrasicolus*) des côtes mauritaniennes. Thèse de Doctorat de 3ème Cycle, Université de Bretagne Occidentale, 131 p.

[54] Furnestin, J. and Furnestin, M.L. (1959) La reproduction de la sardine et de l'anchois

des côtes Atlantiques du Maroc (Saisons et aires de ponte). *Revue des Travaux de l'Institut des Pêches Maritimes*, **23**, 79-102.

[55] Sobral, M.C. (1975) Contribution à l'étude du plancton et de la reproduction de la sardine et de l'anchois dans la côte portuguaise. Conseil International pour l'Exploration de la Mer, Comité Maritime, 1975/J, 11.

[56] Pecquerie, L. (2007) Modélisation bioénergétique de la croissance du développement et de la reproduction d'un petit pélagique: L'anchois du golfe de Gascogne. Thèse de doctorat en Halieutique, Université de Rennes, 250.
http://www.theses.fr/2007NSARH072

[57] Hunter, J.R. and Kimbell, C.A. (1980) Egg Cannibalism in the Northern Anchovy, *Engraulis mordax. Fisheries Bulletin*, **78**, 811-816.

[58] Fischer, W., Bauchot, M.-L. and Schneider, M. (1987) Fiches FAO d'identification des espèces pour les besoins de la pêche. (Révision 1). Méditerranée et mer Noire. Zone de pêche 37. Volume II. Vertébrés. Publication préparée par la FAO, résultat d'un accord entre la FAO et la Commission des Communautés Européennes (Projet GCP/INT/422/EEC) financée conjointement par ces deux organisations. FAO, Vo1.2, 1061.

[59] Marchal, E. (1993) Biologie et écologie des poissons pélagiques côtiers du littoral ivoirien. In: *Environnement et ressources aquatiques de Côte d'ivoire*, Office de la Recherche Scientifique et Technique Outre-Mer, 277-286.

[60] Ben-Tuvia, A. (1960) Fluctuations in the Stock of *Sardinella aurita* and Its Dependence on Temperature and Raine. *Proceedings World Scientific Meeting on the Biology of Sardines and Related Species*, 1193-1203.

[61] Cury, P. and Fontana, A. (1988) Compétition et stratégies démographiques comparées de deux espèces de sardinelles (*Sardinella aurita* et *Sardinella maderensis*) des côtes ouest-africaines. *Aquatic Living Resources*, **1**, 165-180.
https://doi.org/10.1051/alr:1988018

[62] ORSTOLI/FRU (1976) Rapport du groupe de travail sur la sardinelle (*S. aurita*) des côtes ivoiro-ghanéennes. Fisheries Research Unit Tema, Cent. Rech. Océanogr, Abidjan, Orstom, 62.

[63] Postel, E. (1955) Résumé des connaissances acquiesce sur les clupéidés de l'Ouest Africain-*Rapp. Cons. Explor.*, 137, 14-17. In: Ayoub Baali, Hajar Bourassi, Samira Falah, Wahbi Abderrazik, Khalid Manchih, Khadija Amenzoui and Ahmed Yahyaoui, 2017. Reproductive Biology of *Sardinella* sp. (*Sardinella aurita* and *Sardinella maderensis*) in the South of Morocco. *Pakistan Journal of Biological Sciences* **20**, 165-178.

[64] Dia, A.E.K. (1972) Étude de la nutrition de certains clupéides de Côte d'Ivoire. Rapport Scientifique UNDP/SP/288/IV C6, Abidjan, RS/11/72.

[65] Conand, C. (1977) Contributions à l'étude du cycle sexuel el de la fécondité de la sardinelle ronde, *Sardinella aurila*: Pêche sardinière dakaroise en 1975 et premier semestre 1976. *Cahiers ORSTOM*, *Série Océanographie*, **15**, 301-312.

[66] Lasker, R. (1975) Field Criteria for Survival of Anchovy Larvae: The Relation between Inshore Chlorophyll Maximum Layers and Successful First Feeding. *Fishery Bulletin*, **73**, 453-462.

[67] Binet, D. (1982) Influence des variations climatiques sur la pêcherie des *Sardinella aurita* ivoiro-ghanéennes: Relation sécheresse-surpêche. *Oceanologica Acta*, **5**, 443-452

[68] Quaatey, S.N.K. and Maravelias, C.D. (1999) Maturity and Spawning Pattern of Sardinella Aurita in Relation to Water Temperature and Zooplankton Abundance off

Ghana, West Africa. *Journal of Applied Ichthyology*, **15**, 63-69. https://doi.org/10.1046/j.1439-0426.1999.00111.x

[69] Froese, R. and Pauly, D. (2025) FishBase. World Register of Marines Species (WORMS), World Wide Web Electronic Publication. https://www.fishbase.org

[70] Sedzro, K.M., Sohou, Z., Santamaria, M.T.G., Jurado-ruzafa, A., Sossoukpe, E., Chikou, A., Fiogbe, E.D. and Guerra, E.B. (2018) Determination of the Age and Growth by Otolithometry of *Brachydeuterus auritus* off Togolese Waters Détermination par otolithométrie de l'âge et de la croissance de *Brachydeuterus auritus* des eaux togolaises. *Environment and Water Science-Human Territory International Journal*, 2. http://revues.imist.ma/?journal=ewash-ti/

[71] Williams, F. (1968) Report on the Guinean Trawling Survey. *Publication G-8 in the N.O.D.C. General Series*, **99**, 827.

[72] Samb, B. (2003) Biology of *Brachydeuterus auritus.* Fish Biodivity: Local Studies as Basis for Global Inferences. *ACP-EU Fisheries Research Report* N°14, ISS N 1025-3971.

[73] Corsnier, A., Berrit, G.R. and Marteau, J. (1966) Fonds de pêche le long des côtes des républiques du Dahomey et du Togo. Cah. ORSTOM, 1-144.

[74] Salzen, E.A. (1957) A Trawling Survey off the Gold Coast. *Journal of the Colonial Office Committee for Marine and Fisheries Research*, **23**, 72-82. https://doi.org/10.1093/icesjms/23.1.72

[75] Chrzan, F. (1961) Characteristics of the Stock Composition of Fish in West African Shallow Waters as Observed in 1961. ICES Conference Memorandum 1961/Atlantic Comm. Pap, 10.

[76] Longhurst, A.R. (1964) The Coastal Oceanography of Western Nigeria. *Bulletin de l'Institut Français d'Afrique Noire*, **26**, 337-402.

[77] Barro, M. (1976) Contribution à l'étude de la biologie et de la dynamique des populations de *Brachydeuterus auritus* (Val. 1831) (Téléostéens. *Pomadasyidae*) au large de la Côte d'Ivoire (Sous Presse).

[78] Longhurst, A.R. (1960) A Summary Survey of the Food of West African Demersal Fish. *Bulletin Institut Fondamental d' Afrique Noire*, **22**, 276-282.

[79] Adebiyi, F.A. (2013) Growth Pattern of the Big Eye Grunt *Brachydeuterus auritus* (Valenciennes, 1832) off Lagos, Nigeria. Department of Marine Sciences, Faculty of Science, University of Lagos, Akoka, Yaba, Lagos, Nigeria. *Indian Journal of Fish*, **60**, 9-12.

[80] Fontana, A. and Bouchereau, T.J. (1976) Croissance de *Brachydeuterus auritus* au Congo. Documents Scientifiques Office de la Recherche Scientifique et Technique Outre-Mer (Pointe Noire) Nouvelle Série, 47, 8.

[81] Zan-Bi, T.T. (2014) Biologie de reproduction et Dynamique d'exploitation du Pelon *Brachydeuterus auritus* (Valenciennes, 1831) à Grand-Bassam (Côte d'Ivoire). Mémoire de Master Recherche. Université Polytechnique de Bobo-Dioulasso, 63.

[82] Asabere-Ameyaw, A. (2001) Observations on the Reproductive Biology and Recruitment of the Big Eye Grunt *Brachydeuterus auritus* (Pisces: Haemulidae), in Ghana. *Journal of the Ghana Science Association*, **3**, 14-21. https://doi.org/10.4314/jgsa.v3i3.17760

[83] Teitelbaum, A. (1999) Ecologie des communautés de poissons en Guinée. Exemple de la communauté a Sciaenidae dans les îles de Loos. Rapport de Stage, Ecole Supérieure d'Agro-Economie International (ISTOM), IRD-CNSHB, 60.

[84] Chao, N.L., Bearez, P. and Robertson, D.R. (2001) A New Genus and New Species of Sciaenidae from the Gulf of Panama (Perciformes: Sciaenidae). *Revue de Biologie*

Tropicale, **49**, 81-88.

[85] Chao, N.L. (2003) Sciaenidae. In: Carpenter, K.E., Ed., *The Living Marine Resources of the Western Central Atlantic*, *Species Identification Guide for Fishery Purposes*, Vol. 3, Document FAO, 1583-1653. http://www.fao.org/3/y4162e/y4162e00.htm

[86] Albaret, J.J. (1994) Les poissons, biologie et peuplement. In: Durand, J.R., Dufour, P.H., Guiral, D. and Zabi, S.G.F., Eds. *Environnement et ressources aquatiques en Côte d'Ivoire*: *Les milieux lagunaires*, ORSTOM, 239-280. http://www.documentation.ird.fr/hor/fdi:40693

[87] Domain, F., Chavance, P. and Bah, A. (2000) Notes sur la reproduction des espèces démersales du peuplement côtier guinéen. In: François, D., Pierre,C. and Diallo, A., eds., *La Pêche Côtière en Guinée*: *Ressources et Exploitation*, IRD/CNSHB, 393. http://www.documentation.ird.fr/hor/fdi:010025015

[88] Caverivière, A. (1993) Some Methodological Considerations on Delta Distribution, Stratification and Tow Duration, for Trawl Surveys Carried Out in West Africa. *Fisheries Research*, **16**, 223-237. https://doi.org/10.1016/0165-7836(93)90095-o

[89] Kone, T., Amon, Y.N., Kouakou, I.K.F. and N'da, K. (2021) Caractéristiques morphologique et histologique des gonades de Pseudotolithus elongatus (Bowdich, 1825) de la lagune Ebrié en Côte d'Ivoire. *International Journal of Biological and Chemical Sciences*, **15**, 889-896. https://doi.org/10.4314/ijbcs.v15i3.4

[90] Ekanem, S.B., Achima, M.J. and Ekere, M.M. (2004) Studies on Some Reproductive Aspects of Pseudotolithus Elongatus in Cross River Estuary, Nigeria. *Scientia Marina*, **68**, 265-271. https://doi.org/10.3989/scimar.2004.68n2265

[91] Gerlotto, F. (1976) Biologie de *Ethmalosa fimbrita* en Côte d'ivoire, étude de la croissance en lagune par la méthode de Petersen. *Document Scientifique de centre de Recherche océanographie*, **2**, 1-27.

[92] Blay, J. and Eyeson, K.N. (1982) Feeding Activity and Food Habits of the Shad, *Ethmalosa fimbriata* (bowdich), in the Coastal Waters of Cape Coast, Ghana. *Journal of Fish Biology*, **21**, 403-410. https://doi.org/10.1111/j.1095-8649.1982.tb02845.x

[93] Moses, B.S. (1988) Growth, Mortality and Potential Yield of Bonga, *Ethmalosa fimbriata* (Bowdich 1825) of Nigerian Inshore Waters. *Fisheries Research*, **6**, 233-247. https://doi.org/10.1016/0165-7836(88)90016-1

[94] Munroe, T. (2016) Cluepidae: Herrings (Shads, Pilchards, Sprats, Sardinellas). In: Carpenter, K. and De Angelis, N., Eds., *The Living Marine Resources of the Eastern Central Atlantic*, *Volume* 3: *Bony fishes Part* 1 (*Elopiformes to Scorpaeniformes*), FAO Species Identification Guide for Fishery Purposes, Rome, FAO, 1511-2350.

[95] The IUCN (2020) Red List of Threatened Species: *Ethmalosa fimbriata*-Published in 2020. https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T182611A15541529.en

[96] Whitehead, P.J.P. (1985) FAO Species Catalogue. Vol. 7. Clupeoid Fishes of the World (Suborder Clupeoidei). An Annotated and Illustrated Catalogue of the Herrings, Sardines, Pilchards, Sprats, Shads, Anchovies and Wolf-Herrings. FAO Fish. Synop, 125(7/1), FAO, 1-303.

[97] Charles-Dominique, E. and Albaret, J-J. (2003) African Shads, with Emphasis on the West African Shad *Ethmalosa fimbriata*. *American Fisheries Society Symposium*, 7-48.