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Fishing methods, catches composition and exploited biomass in the Aby lagoon (Adiaké, Côte d'Ivoire)

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ABSTRACT

Ivorian lagoon water bodies contribute to the fight against food insecurity through fisheries. They provide fresh and competitive products to the local population. Thereby, strategies for their rational and sustainable exploitation must be put in place. This study aimed at contributing to the improvement of fishing activities in the Aby lagoon. It is the result of three months of surveys (from January to March 2020) with the fishermen and the fisheries administration. It appears that fishing is practiced by indigenous peoples. The most represented were aged over 45 years old (71.30%). Gillnets (65.59%) and nailed plank canoes (67%) were the most used. However, Aly nets (5.63% of fishing gears types) remain the most productive providing 80% of catches. The main fish species recorded were *Ethmalosa fimbriata* (Clupeidae), *Elops lacerta* (Elopidae) and *Sarotherodon melanotheron* (Cichlidae). However, the effective management of the water body still remains a major concern. Indeed, constraints were mainly: the non-submission of individual fishermen to the fisheries administration, the struggle for space reserved for fishing between individual and collective fishermen, the use of non-selective gears such as the Aly net. Thus, it seems necessary to train and sensitize the actors on the concept of sustainable development and to apply the management rules for a rational exploitation of this fishery.

Keywords: Fishing gears, Fish species, Production, Adiate, Ivory Coast.

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INTRODUCTION

According to FAO (2012), small-scale fishery employs more than 90% of people engaged in fishing catches in the world, and increasingly, there is recognition that it plays a major role for food security and for poverty reduction and prevention. Fishery resources represent the main sources of animal protein accessible to many populations. In 2017, for example, on a global scale, the average fish consumption, estimated per person, was around 20.5 kg (FAO, 2018). However, the lack of institutional capacities and the non-integration of this activity into national and regional development policies hinder the effective potential contribution of that sector.

In Côte d'Ivoire, the economy and food security highly remain dependent on the primary sector and therefore dependent on the difficulties linked to international markets. In the Ivorian continental waters (Aboua et al., 2010; N'dri, 2019; Kouassi et al., 2020; N'dri et al., 2020) as well as in lagoon area (Anoh, 2010; Diaby et al., 2012a et 2012b; Kouassi et al., 2012; Koulaï, 2012 et 2014), many studies have already been carried out. In the South Comoé region, jobs creation and the economy in terms of wealth creation are mainly dominated by fishing in the Aby lagoon (MIRAH, 2019). For Koulaï (2014), the development of this artisanal fishing in recent years has led administrative authorities, fishing stakeholders and researchers to become aware of the vitality of this sector activity sector. However, the numerous problems of exploitation and management contribute in making it vulnerable. Today, because of the influx of foreign communities who settle there and the high pressure of the fishery practiced there, the typology of gears and the level of fish productions exploited remain poorly controlled. This study aimed at contributing to the improvement of fishing activities in the Aby lagoon.

MATERIALS AND METHODS

Study area

This study was carried out in the Aby part of the Aby-Tendo-Ehy lagoon complex with an area of 425 km² (Figure 1). The site concerned has a length of 50 km and is covered by the Division of Adiaké, located between 5°30' North latitude and 3°15' West longitude. The relief is generally flat but dominated by plateaus. The climate is of the Attiean type with average rainfall of 1568.82 mm over the past five years (MIRAH, 2019).

Data collection

The data have been collected while a period from January to March 2020. The methodology is based on surveys carried out among fishermen working in the Aby part and agents of the Ministry of Animal and Fishery Resources who have a role in controlling and monitoring fishing activities.

Three techniques were used for sampling:

- a questionnaire was administered to 80 individual fishermen (quota survey method) using individual gears (gillnets, cast nets, traps, longlines and lines) and to all of the 28 fishermen using purse seines. The 108 fishermen surveyed came from the villages of Eplemlan, Erokouan, Mauricekro and Akpagne;
- an interview with the fisheries administration in order to get information about the type of fishermen, the fishing techniques, the level of exploited biomass, the management system and the difficulties encountered;
- the visits carried out in the landing stages, as for them, made it possible to follow the usual practices and to check the materials used.

Data analysis

The data collected were developed manually and then processed with the computer tool. The Microsoft Excel 365 software was used to make quantitative calculations.

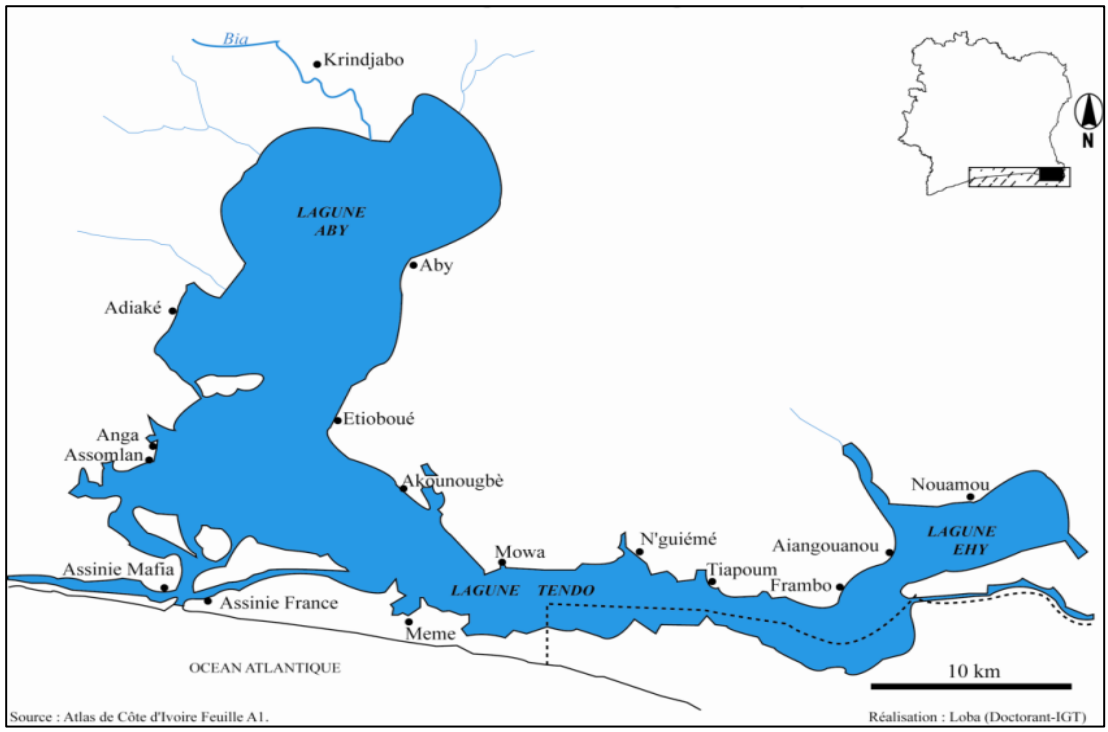

Figure 1 : Study area.

RESULTS

Typology of fishermen

Nationalities and ethnicities

All fishermen were Ivorian and indigenous. The only non-nationals were Ghanaians employed as fishermen's helpers in collective fishing crews. Their distribution by ethnic group gaved a majority proportion of Agni fishermen (53.70%), followed by the Ehotilé (29.63%) ones. The last place belongs to the Essouma with a frequency of 16.67%.

Socio-professional profile of fishermen

Three types of fishermen were identified. They were mostly professional (56.48%) and semi-professional (36.11%). The remaining 7.41% constituted the proportion of those said to be occasional ones. Among the actors, 79.63% were fishermen of origin or had fishermen parents and 87.04% were engaged exclusively in the fishing activity. Only 12.96% of them had an alternative activity which was only transportation by motorized canoes. Concerning the professional experience, the majority of actors (71.30%) had more than 10 years of fishing activity. Those with between 5 and 10 years of experience accounted for 28.70%. In addition to these actors, there were fishermen's helpers, encountered particularly at the level of collective fishing. They were entirely from Ghanaian origin. They usually go back home during the biological rest period of the fishery (from July to October) and return after the opening of the fishing season. In fact, the observation is that collective fishing is the responsibility of foreign fishermen employed as helpers by native fishermen.

Age of fishermen

Fishermen over 45 years of age (older class) represented the majority (71.30%). Those with ages between 30 and 45 years (adult class) occupied the second place (28.70%). No fisherman under the age of 30 (youth class) was recorded.

Organization of fishing communities

There were two categories of fishermen in terms of organization.

Professionals, using purse seines (25.93%), were those who held fishing licenses and identification cards. They belonged to a legally constituted organization called ACEF (Anouanzê Cooperative of Eplemlan Fishermen). Created on August 29, 2008, its role is to defend the rights of fishermen with customary and administrative authorities. These actors paid taxes to the Town Hall and to the IFRAA (Interprofessional Fund for the Research and Agricultural Advice).

Semi-professionals and occasional workers were the most represented (74.07%). They were all individual fishermen and did not belong to any formal organization. Also, they refused to be identified and sometimes also refused to submit their catches to veterinary checks. They behaved like illegal immigrants. Unlike the semi-professionals, the fishermen's helpers were employed intermittently in the crews of the professionals.

Fishing techniques

Inventory of boats used

A total of 200 canoes were identified. The fishermen working at this lagoon mainly used canoes with ribs (134 canoes or 67%). Conversely, dugout canoes identified were in number of 66 (33%).

The fishermen, holders of Aly nets, generally used four canoes each:

- a large canoe (18 meters) which is used to transport the seine net and the fishermen's helpers;
- a medium canoe from 3 to 4 meters which has a role of scout, detects the school of fish;
- a canoe from 4 to 6 meters long used to transport the catch;
- a canoe of 4 meters long which allows the transportation of the fishermen's food.

Individual fishermen, on the other hand, generally used only 1 boat per fisherman. That boat as capacity can hold 2 people.

Fishing gears used and fishing period

Six gears types with a total number of four hundred and ninety-seven (497) were identified. They are divided into two large groups: collective gears (purse seines) and individual gears (gillnets, cast nets, traps, longlines and lines). Gillnets (length varying from 75 to 100m/unit) were dominant (65.59%). Their number per fisherman varied from 1 to 7 with an average of 4 nets/actor. The other individual gears accounted for 28.77% of the gears. Finally, came purse seines (5.63%) or Aly nets as they are called in the local language (Figure 2). They have a length ranging from 1200 to 1600m/unit. Each fisherman had only one seine net. Despite their small proportion, these non-selective collective gears exert strong pressure on fishery resources and remain the most productive ones. Indeed, the fisheries department has indicated that in 2019, these nets alone produced 80% of the catches.

Relative to the fishing period, the actors working with the purse seines mainly worked during the nights, between 5 p.m. and 3 a.m. Those using individual gear operated during the day and at night (70% of the actors) or during the day only for 30% of them. In addition, it is good to specify that there is a period of fishing closure which concerns only collective gears. During that period, collective fishermen converted themselves into individual fishermen for continuing fishing. Fishing is almost permanent.

Fishery statistics

Fisheries production exploited

The productions taken into account in this work only concern catches from purse seines and gillnets. The total biomass in 2019 evaluated at 1832.09 tons (Table 1) is considered lower than the actual quantity fished. However, the highest productions were obtained in March (194.24 tons), July (273 tons) and December (230 tons).

Fish species and families caught

The distribution of catches by family and species in the annual biomass according to the type of gears is given in Table 2. *Ethmalosa fimbriata* (Clupeidae) and *Elops lacerta* (Elopidae) are dominant in the catches made by purse seines with respectively 50% and 20%. At the level of gillnets, *Ethmalosa fimbriata* (Clupeidae) occupied the first place (60%)

followed by *Sarotherodon melanotheron* (Cichlidae) with a proportion of 20%.

Water body management system

Our study enabled to understand that the water body is managed by collaboration between the customary law established by the customary authority and the regulatory texts implemented by the prefectural authority and the fisheries administration.

Regarding the regulatory texts, provisions have been made for a good selectivity of the gears and to regulate the exploitation and management of the lagoon water body. For example, a second reserve (Abiaty reserve) has been created after the one of Aby and which are exploited by fishermen during biological rest. That put an end to the recurring conflicts between fishermen from Aby and those from Abiaty when there was only one reserve. The Fisheries Department also checks the compliance of gears and checks if fishermen comply with the regulations in effect. Also, it manages the fisheries production statistics.

At the level of customary management, it is the prescriptions of the local deities that dominate. For example, fishing is prohibited throughout the entire lagoon every Wednesday, which is, according to custom an adoration day of the spirit Assemlan (Koulaï, 2005). As other prohibitions, women in their menstrual period do not have access to the lagoon. Any violation of these prohibitions is a source of curse according to the respondents.

Moreover, in case of conflicts related to the fishing activity, the settlement is done in collaboration with the chieftaincy and the fisheries administration. Unfortunately, there is a perpetual conflict between fishermen. In fact, individual fishermen accuse the actors of collective fishing of practing excessive fishing. This leads to the struggle for the space reserved for fishing between individual and collective fishermen.

Figure 2 : Purse seines counted at the fishermen's camp.

Table 1 : Fisheries production exploited.

Month	Productions (in tons)	Total	Monthly average	Standard deviation
January	103,139			
February	138,8			
March.	194,24			
April	150,51			
May	103,32	**1832,09**	**152,67**	**54,52**
June	132,51			
July	273			
August	166,6			
September	103,918			
October	111,3			
November	126,2			
December	230			

Source: Annual activities report, DD MIRAH Adiaké (2019)

Table 2 : Species and families of fish caught in the Aby lagoon.

Type of gear	Family	Species	Percentage (%)	Commercial name
Collective fishing gears (all species combined)				
Purse seine (Aly nets)	Clupeidae	*Ethmalosa fimbriata*	50	Aoube
	Elopidae	*Elops lacerta*	20	Elops
	Claroteidae	Chrysichthys *nigrodigitatus*	15	Mâchoiron
	Cichlidae	*Oreochromis niloticus*	10	Tilapia
		Sarotherodon melanotheron	05	Carp
Individual fishing gears				
Ethmalosa Gillnets	Clupeidae	*Ethmalosa fimbriata*	60	Aoube
Mullet Gillnets	Mugilidae	*Mugil curema*	10	Mullet
Lich gillnets	Carangidae	*Lichia glauca*	10	Lich
Carp Gillnets	Cichlidae	*Sarotherodon melanotheron*	20	Carp

Source: Annual activities report, DD MIRAH Adiaké (2019)

DISCUSSION

Surveys have shown that in the fishery, indigenous nationals have the monopoly on fishing activity and are the only ones entitled to own machinery. This massive presence of local fishermen can be explained by the fact that they have a fishing tradition and they consider fishing as a main activity. The absence of foreign fishermen would be linked to the fact that the natives accused them to practice of excessive fishing with a high fishing effort, the use of non-regulatory gears and the practice of fishing with toxic products. Indeed, natives still remember such a practice which has already had as disadvantage the decrease of stocks in 1980 and 1981, leading to a drop of catches and consequently of turnover. Thus, the banning of foreigners from owning fishing gears or being titular fishermen is still the rule in the Aby lagoon. Non-natives can only be helpers or apprentices fishermen without any decision-making power. This exclusive control of fishing by nationals corroborates the results of N'dri et al. (2020) at Songori Lake. For Koulaï (2014), this enthusiasm of local actors for fishing in the Aby lagoon could be justified by the lack of diversity of activities. Our results are contrary to the work of Anoh (2010), on lagoons of Fresco, Grand-Lahou and Ébrié, which showed that indigenous fishermen have gradually given up fishing in favor of new speculations (rubber tree cultivation for example) deemed more economically profitable. This absence of foreign fishermen is not in congruence with the observations of N'dri (2019) at Lake Bolondo with 61.54% Malian fishermen. Da Costa and Dietoa (2007) at Lake Faé with 88.77% of foreign fishermen of Malian origin, Boguhe et al. (2011) at the Bandama River, in the locality of Pacobo with 78% of Malian fishermen and Anoh and Kakou (2014) with 87% of the Bozo ethnic group at the Comoé River and its tributaries in the sub-prefecture of Aniassue.

Relative to the age of fishermen, the activity is dominated by people over 45 years old. The absence of young people could be explained by their schooling, rural exodus or the lack of financial means for the purchase of fishing materials (equipments). Also, they are often afraid of drownings because of their inexperience. Our result is different from those of Tah et al. (2009) and Vanga (2011) who showed at Lake Ayamé that the dominant age class was that of young people, with respective proportions of 51% and 64%.

There is no formal professional organization among individual fishermen. This would be justified by the fact that they remain hostile to the fisheries administration and against the payment of taxes. Another argument related to this state of affairs is that individual fishermen would accuse the actors of collective fishing to practice excessive fishing with the destruction of their gillnets. For them, the space intended for fishing is mainly exploited or occupied by the collective gears, thus leading to a decrease in their catches. This lack of formal organization was also noted by the work of N'dri (2019) and Da Costa and Dietoa (2007). On the other hand, our data are not congruent with those of Boguhe et al. (2011) who observed the existence of a cooperative-type association among Ivorian fishermen in Taabo.

With regard to fishing equipment, the dominance of canoes with ribs is due to the fact that they are much larger and more suitable for collective fishing compared to dugout canoes. These same results were obtained by Vanga (2001) at Lake Buyo and N'dri (2019). According to the first quoted, these boats would resist much more to the prevailing winds and to the contact with waves. For the second author, that would be linked to the fact that the wood was difficult to find in the northern part of the country. Contrary to our data, there are other fishing sites that recorded a significant share of dugout canoes. This is for example the case of Lake Songori with 83.33% dugout canoes (N'dri et al., 2020).

Gillnets were mostly used. This situation would be linked to the easy conditions of acquisition and to their mastery by the fishermen. This result is comparable to those of N'dri (2018) at Songori and Bolondo lakes. These data are contrary to those of Vanga (2011) where the bamboo trap (54%) was the most used gear.

Indent low use of Aly nets would be due to the fact that Ivorian fishermen do not master them and to their high cost (10,000,000 to 25,000,000 CFA francs). The other reason would be the lack of an experienced crew. Indeed, their efficient use is the responsibility of non-nationals (Ghanaian fishermen for the Aby lagoon). However, for the fact that those non-nationals fishermen cannot be titular fishermen or owners of gears, they are employed as fishermen's helpers in collective fishing by nationals. The last reason is that the population would have liked the limitation of this type of gear because of its pressure on fishery resources.

The total biomass in 2019 estimated at 1832.09 tons is underestimated. This situation would be justified by the fact that the collection of statistics remains a difficult activity to carry out. Indeed, individual fishermen remain hostile to the fisheries administration and refuse to submit their catches to veterinary control. This negatively impacts the statistics. For them, the control activity aims to subject them to the payment of taxes. The low production recorded would also be linked to the fact that the statistics did not take into account the catches of other individual gears.

Conclusion

Fishing in the Aby lagoon is permanent throughout the year. Nationals hold exclusive control of the activity. Fishermen over 45 years of age are dominant. Gillnets and nailed plank canoes were the most commonly used fishing gears. However, the Aly net remains the most productive gear despite its low proportion. The main species recorded are *Ethmalosa fimbriata* (Clupeidae), *Elops lacerta* (Elopidae) and *Sarotherodon melanotheron* (Cichlidae). The non-submission of individual fishermen to the fisheries administration, the struggle for the space reserved for fishing between individual and collective fishermen, the use of non-selective gears such as the Aly net were the difficulties noted. As this activity is important, the administrative and customary authorities should monitor the rational exploitation of these resources.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

KMN and GKGB carried out the data collection on the field. KMN, KDK and GKGB contributed to the writing of the article. KY supervised the work.

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