Characterization of the production factors of the fishing industry and specific diversity in the Aghien lagoon (Ivory Coast)

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Abstract

The study of fishing activity on the Aghien Lagoon (Ivory Coast, West Africa), conducted from April 2019 to May 2020 identified 402 fishermen. This population is composed of Ivorians (73.38%) and foreigners (26.62%). The fishing activity is controlled by two categories of fishermen: professionals who only fish (42.53%) and occasional fishermen with an accessory activity (57.47%). Ivorian fishermen are mostly farmer-fishermen. The fishing activity is dominated in this lagoon by adults between 30 and 45 years old (48.26%). These fishermen have a high literacy rate (73%). The fishing techniques used in this lagoon are pots, hawks, gillnets, longlines, be...
the actors in their different activities, allowed for the verification of the information collected from the questionnaires. The criteria for classifying fishermen, based on nationality and ethnicity, time spent fishing and the distribution of fishermen by age group are inspired \(^{[6-8]}\). The distribution of fishermen by level of education is done according to Boguhé et al. (2011) \(^{[9]}\). The data obtained were processed with Excel soft.

3. Results

3.1. Fishers

3.1.1. Nationalities
A total of 402 fishermen were counted on the Aghien Lagoon between April 2019 and May 2020. This workforce is made up of 295 Ivorians (73.38%) and 107 foreigners all Togolese (26.62%) (Figure 2).

3.1.2. Age range
The dominant age group in the population of fishermen surveyed is adults between the ages of 30 and 45 (48.26%). Older people (26.62%) outnumber younger people (25.12%) in this population (Figure 3).

3.1.3. Study level
The fishermen of the Aghien Lagoon who have a level of education (73%) are more numerous than the illiterate (27%). Figure 4 presents the distribution of literate fishermen according to the level of education. Fishermen with secondary education (49%) are more represented than those with primary education (24%).

3.1.4. Professional category
Two categories of fishermen have been identified throughout the Aghien Lagoon (Figure 5). These are: -professional fishermen who are the least numerous (42.53%). These are individuals who have only fishing as an activity and practice it all year round. -Occasional fishermen (57.47%), who fish to meet their food needs or to solve a specific financial problem, are the most present in this population. They combine fishing with other income-generating activities. They are mostly Ivorians. The majority of fishermen (88%) carry out their activity individually. Collective fishing accounts for 12% of this population.
3.1.5. Activities related to fishing

The activities related to fishing, carried out by the fishermen on the Aghien lagoon are summarized in Table 1. In general, fishermen associate agriculture with fishing (50.50%). They are divided between 49.25% Ivorians and 1.25% foreigners. Only the Ivorians associate fishing with trade (06.22%), fish farming (00.5%), agriculture and sewing (00.25%).

Table 1: Activities identified among fishing communities in Aghien Lagoon from April 2019 to March 2020.

| Activities                              | Ivorian | Percentage | Foreigners | Percentage |
|------------------------------------------|---------|------------|------------|------------|
| Fishing only                             | 69      | 17.16      | 102        | 25.37      |
| Fishing + Agriculture                    | 198     | 49.25      | 5          | 01.25      |
| Fishing + Trading                        | 25      | 6.22       | 0          | 0          |
| Fishing + Fish Farming                   | 2       | 0.5        | 0          | 0          |
| Fishing + Agriculture + Sewing           | 1       | 0.25       | 0          | 0          |
| Total                                    | 295     | 73.38      | 107        | 26.62      |

3.1.6. Fishing equipment

3.1.6.1. Inventory and utilization rates

Six types of fishing gear are used by fishermen (Table 2). These are long lines, pots, bamboo traps, gill nets, beach seines and hawksbills. It appears from this table that professional fishermen use more gill nets (51.46%), longlines (17.54%) and pots (16.34%). The occasional fishermen prefer, in decreasing order, gill nets (94.37%), bamboo traps (91.77%), longlines (89.61%) and pots (88.31%)

Table 2: Inventory of fishing gear used by artisanal fishers on the Aghien lagoon, from April 2004 to March 2006

| Fishing gear            | Professional fishers | Rate utilization (%) | Occasional fishers | Rate utilization (%) |
|-------------------------|----------------------|----------------------|--------------------|----------------------|
| Longlines               | 17.54                | 89.61                |                     |                      |
| Fishnets                | 16.34                | 88.31                |                     |                      |
| Bamboo trap             | 5.26                 | 91.77                |                     |                      |
| Fishnets                | 51.46                | 94.37                |                     |                      |
| Beach seines            | 1.75                 | 90.43                |                     |                      |
| Éperviers               | 5.26                 | 99.96                |                     |                      |

3.1.6.2. Sélectivité

The fishing gears used on the Aghien lagoon are in most cases, selective. Selective gear is defined as gear that catches essentially one or two types of fish, without excluding the others. This can be seen in Table 3.

Table 3: Gear selectivity

| Species                        | Longlines | Fishnets | Bamboo trap | Fishnets | Beach seines | Éperviers |
|--------------------------------|-----------|----------|-------------|----------|--------------|-----------|
| Chrysichthys mauro           | X         | X        | X           |          |              |           |
| Chrysichthys nigrodigitatus  | X         | X        | X           |          |              |           |
| Pomadaïss jubelini           | X         | X        | X           |          |              |           |
| Polydactylus quadrifilis     | X         | X        | X           |          |              |           |
| Sarotherodon melanotheron    | X         | X        | X           |          |              |           |
| Tilapia guineensis           | X         | X        | X           |          |              |           |
| Tylochromis jentinki jentinki| X         | X        | X           |          |              |           |

Sm = small mesh; Mm = Medium mesh; Lm = Large mesh
The small mesh nets (10 mm to 30 mm) catch all small fish. Those of medium mesh (30 mm to 50 mm) catch mainly *Tilapia guineensis* and *Sarotherodon melanotheron*. Those of large mesh (50 mm and more) catch essentially *Polydactylus quadrifilis* and *Chrysichthys maurs*. For the hawksbills, the gears are made for *Tylochromis jentinki jintinki* and *Tilapia guineensis*. Concerning the longlines, the targeted species are *Chrysichthys maurs* and *Pomadasys jubelini*. The predominant species caught by the creels are *Chrysichthys nigrodigitatus* and *Chrysichthys maurus*. The bamboo traps catch exclusively *Chrysichthys maurs* and *Chrysichthys nigrodigitatus*. The beach seine captures all species regardless of size.

3.1.7. Captures

3.1.7.1. Specific richness

The present study identified 45 species in 25 families and 8 orders (Table 4).

### Table 4: Orders, families, and species of fish sampled in Aghien Lagoon from April 2019 to March 2020.

| Order            | Family         | Species                        |
|------------------|----------------|--------------------------------|
| Osteoglossiformes| Notopteridae   | *Papyrocranus afer*            |
|                  | Mormyridae     | *Marcusenius furcidens*        |
|                  |                | *Marcusenius asheri*           |
|                  |                | *Petrocephalus bovei*          |
| Elopiformes      | Elopidae       | *Elops lacerta*                |
| Clupeiformes     | Clupeidae      | *Ethmalosa fimbriata*          |
|                  |                | *Pellonula leonensis*          |
| Characiformes    | Distichodontidae| *Distichodus rostratus* |
|                  | Alestidae      | *Brycinus longipinnis*         |
|                  |                | *Brycinus nurse*               |
|                  | Hepsetidae     | *Hepsetus odoe*               |
| Siluriformes     | Schilbeidae    | *Parailia pellucida*           |
|                  |                | *Schilbe mystus*               |
|                  | Claridae       | *Clarias ebriensis*            |
|                  |                | *Clarias gariepinus*           |
|                  |                | *Heterobranchus isopterus*     |
|                  |                | *Heterobranchus longifilis*    |
|                  | Claroteidae    | *Chrysichthys auratus*         |
|                  |                | *Chrysichthys maurs*           |
|                  |                | *Chrysichthys nigrodigitatus*  |
| Mochokidae       |                | *Synodontis bastiani*          |
| Beloniformes     | Hemirampphidae | *Hemiramus balao*              |
| Perciformes      | Carangidae     | *Caranx hippos*                |
|                  |                | *Trachinotus tereai*           |
| Gerreidae        |                | *Eucinostomus melanopterus*    |
| Haemulidae       |                | *Pomadasys jubelini*           |
|                  |                | *Pomadasys rogerii*            |
| Sciaenidae       |                | *Pseudotolithus elongatus*     |
|                  |                | *Pseudotolithus senegalensis*  |

Table 5: continuation and end

| Ordres            | Familles         | Espèces                        |
|-------------------|------------------|--------------------------------|
| Polynemidae       | *Polydactylus quadrifilis* |
| Monodactylidae    | *Monodactylus sebae* |
| Mugilidae         | *Liza falcipinnis*  |
|                   | *Mugil cephalus*   |
|                   | *Mugil curena*     |
| Cichlidae         | *Chromidotilapia gantheri* |
|                   | *Hemichromis fasciatus* |
| Sarotherodon melanotheron | *Tilapia guineensis* |
|                   | *Tilapia mariae*   |
|                   | *Tylochromis jentinki* |
| Gobiidae          | *Bathygobius soporator* |
| Sphyraenidae      | *Sphyraena afra*   |
| Channidae         | *Parachanna obscura* |
| Pleuronectiformes  | *Paralichthysidae* |
|                   | *Citharichthys stampfii* |
| Cynoglossidae     | *Cynoglossus senegalensis* |

### 3.1.7.2. Numerical Abundance

Perciformes dominate the fish catches on the Aghien Lagoon with a proportion of 52%. They are followed by Siluriformes (19%), Elopiformes (9%) and Clupeiformes (7%). The other orders account for 13% of this population (Figure 6). At the family level, the Cichlidae (32%) are the most represented in...
the catches. The Claroteidae (14%), Elopeidae (9%), Clupeidae (8%) and Polynemidae (7%) are next. The other families represent 30% of the fish population (Figure 7). At the species level, Tilapia guineensis is the most abundant species in the Aghien Lagoon with 12% of all fish caught. This species is followed by Elops Lacerta and Chrysichthys nigrodigitatus (9% each), Sarotherodon melanotheron (8%), Tylochromis jentinki and Polydactylus quadrifilis (7% each). The other species represent 48% of this total number (Figure 8).

Fig 6: Numerical percentage of major fish orders caught in Aghien Lagoon from April 2019 to March 2020.

Fig 7: Numerical percentage of major fish families caught in Aghien Lagoon from April 2019 to March 2020

Fig 8: Numerical percentage of major fish species caught in Aghien Lagoon from April 2019 to March 2020

3.1.7.3. Weight abundance

In the Aghien Lagoon, the best represented orders are the Perciformes with 48%. This is followed by the Siluriformes and Clupeiformes (19% each) and the Elopiformes (9%) of the total weight of the catches. The proportion by weight of the other orders is 5% (Figure 9).
The family Clupeidae is the best represented with 19% of the total catch. This family is followed by Claroteidae (18%), Cichlidae (14%), Elopeidae (9%) and Haemulidae (7%). The other families constitute 33% of the weight percentage (Figure 10).

At the species level, the dominant species are in order *Chrysichthys nigrodigitatus* (17%), *Ethmalosa fimbriata* (10%), *Elops lacerta* and *Pellonula leonensis* (9%), *Pomadasys jubelini* (7%) and *Polydactylus quadrifilis* (6%). The proportion of other species was 42% (Figure 11).

**Fig 9:** Weight percentage of major fish orders caught in Aghien Lagoon from April 2019 to March 2020

**Fig 10:** Weight percentage of major fish families caught in Aghien Lagoon from April 2019 to March 2020.
4. Discussion
In the Aghien lagoon, fishing is carried out by foreigners and Ivorians, the majority of whom are adults (48.26%) with a low participation of youth (25.12%). This result is consistent with those of several studies characterizing fishing communities in Ivory Coast [1,6,10]. The presence of foreign fishers could be explained by several reasons: (1) the proximity of their country of origin to Ivory Coast; (2) the ethnic and social characteristics of these fishermen are sometimes very similar to those encountered in Ivory Coast; (3) the high demand for fish, which is likely to guarantee an attractive price, is quite motivating for these foreign fishermen (Vanga, 2001) [6]; and (4) the existence in Ivorian legislation, of few binding provisions for foreign fishermen (Kien et al., 2015) [10]. The variable age would condition the professional conscience among fishermen. Indeed, the low enthusiasm of most young people can be explained by the fact that beyond their lack of experience in commercial fishing, they believe that the activity in question is not an asset that they can leave as an inheritance to their descendants. In this case, fishing constitutes a means of acquiring financial resources for the development of agricultural activities (Kien, 2016) [4]. The study of the selectivity of fishing gears shows that Chrysichthys nigrodigitatus is the only one caught by five gears out of the six. This result expresses the pressure on this species. This situation could threaten, in the long term, the qualitative availability of fishery resources, leading to an imbalance in the population to the benefit of tilapia (Vanga, 2001) [6]. It would therefore be important to consider sustainable management plans for the fishery resource on this body of water.

5. Conclusion
The exploitation of fishery resources on the Aghien lagoon is artisanal and individual. It is dominated by occasional, mostly literate, adult fishermen. Among the Ivorians, fishing is mainly a secondary activity. Gill nets are the most widely used engines in the Aghien lagoon. Chrysichthys nigrodigitatus is the most common species in the catches of various gears taken on this lagoon. Sustainable management of resources requires the authorities to carry out strict measures to prevent the collapse of the stock of this species and therefore an imbalance in this ecosystem. The conduct of any fisheries development policy must take into account the low level of education of certain actors.

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