ICES Journal of Marine Science, 56: 1033–1043. 1999
Article No. jmsc.1999.0553, available online at http://www.idealibrary.com on IDEAL®

Marine fisheries management in Cameroon: overview and perspectives for improvement of the survey system and data collection

O. Njifonjou, F. Laloë, C. Chaboud, and M. Simier

Njifonjou, O., Laloë, F., Chaboud, C., and Simier, M. 1999. Marine fisheries management in Cameroon: overview and perspectives for improvement of the survey system and data collection. – ICES Journal of Marine Science, 56: 1033–1043.

Since 1982, a data-collection system has been in place in Cameroon to obtain statistics for the small-scale marine fisheries sector. Surveys have been conducted in an attempt to determine the impact of fishing effort on the resources, and data collected refer mostly to catch and effort. Although such data may be used for analysis of resource dynamics, they are generally inappropriate for analysing fishing activity in terms of the dynamics of exploitation. The latter analysis is necessary in order to address questions on the developmental capacity of the fisheries sector. With such a collection system, the main sources of uncertainty come from a lack of knowledge of the socio-economic dynamics of fishing communities, including the dynamics of the fishing fleet and technology. Data on those factors are needed to evaluate the impact of resource state and of the socio-economics of the operation on the fishing mortality. More information is therefore needed and a more systemic approach to data collection has been taken. This new approach and its implementation are discussed, taking into consideration catch–effort data as well as the new surveys on fishing units and socio-economic dynamics. These last two include information on fishing strategies (through surveying a fixed set of fishing units), and processing and trade of the fisheries products (through a sample of processors). Some results obtained from these data are presented, and their usefulness for fisheries development and management is discussed.

Key words: economic analysis, *Ethmalosa fimbriata*, exploitation dynamics, population dynamics, spatial distribution.

Received 24 October 1994; accepted 26 May 1999.

O. Njifonjou: Institute for Agricultural Research for Development, IRAD-CRHOL, PMB 77 Limbe, Cameroon. F. Laloë, C. Chaboud and M. Simier: Centre ORSTOM, B.P. 5045, 34032 Montpellier Cedex, France. Correspondence to C. Chaboud. Tel: +33 467 636964; fax: +33 467 638778; e-mail: chaboud@mpl.ird.fr

Introduction

Since the 1960s, fisheries research in much of Africa has been devoted to analysis of the status and dynamics of harvested resources in order to maximize sustainable catches. However, as stressed by Couty (1996), basic research on fishery practices and on the dynamics of exploitation of the resources had been carried out for many years (Gruvel, 1913; Monod, 1928). Even if improved knowledge of the resources remains a priority, a more integrated analysis of the joint dynamics of the resources and exploitation practices is needed in order to provide better advice for management of fisheries systems (Hilborn, 1985; Allen and McGlade, 1986; McGlade, 1989; Laurec *et al.*, 1991; Laloë and Samba, 1991; Chaboud and Charles-Dominique, 1991; Laloë *et al.*, 1998).

In Cameroon, a data-collection system for the small-scale marine fisheries sector has been in place since 1982. Surveys have been undertaken to glean scientific knowledge of the impact of fishing effort on the resources. Data collected relate mostly to catch and effort. Although such data are useful in analysing resource dynamics in relation to mortality and production, they are insufficient to elucidate the dynamics of exploitation, i.e. the response of fishing activities to changes in the resource, an analysis that is also necessary to address questions on the development potential of a fisheries sector. With such a collection system, the main sources of uncertainty derive from a lack of knowledge of the

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socio-economic dynamics of fishing communities, including dynamics of the fishing fleet and technology. Data on those issues are needed to evaluate the impact of resource status and socio-economics on fishing mortality.

For the latter purpose, a more comprehensive data-collection system is necessary. This paper outlines the objectives and technical aspects of a more extensive information-collecting system that was initiated in 1994 for the small-scale fisheries. The system comprises a combination of five different surveys. Although some results have been published before (Njifonjou, 1998a, b), this paper centres only on the approach methodology and analysis.

Two analyses made from the combined data collected through these surveys are also briefly presented for illustrative purposes. The first example deals with an analysis of the length–frequency distribution of *Ethmalosa fimbriata*, a species caught by purse seine, along with an analysis of the spatial dynamics of its exploitation. The second example covers an economic study (costs and earnings) of the activity of purse-seine units (*awasha*), as well as the processing and marketing of the fisheries products, and is linked with a description of the social conditions in one of the landing sites studied.

Finally, it is necessary to discuss how such a global survey system is needed to better answer general questions in respect of fisheries development.

The survey system

This section focuses on the different types of survey, instruments, and data-collection procedures involved in the multifaceted study. There are five types of survey (Njifonjou, 1998b). The study was conducted at four landing sites, Limbe Dockyard, Idenau, Londji, and Kribi (Fig. 1), selected according to the number of fishers, the type of fleet, and the fishing technique utilized. They are among the main landing sites of the artisanal fisheries sector of Cameroon. The general study concerns four types of fishing unit: purse seine, bottom gillnet, surface drift net, and enclosing gillnet. However, because of logistic constraints, some analyses had to be restricted to a single species (*E. fimbriata*), to one type of fishing unit (purse seine or *awasha* fishing), or limited to one or two landing sites only.

Monthly follow-up survey of the fleet

This survey was conducted at all four landing sites. Initially, a frame survey was carried out, during which all active fishing units present at the landing sites were listed and numbered per category of fishing gear, and according to their mode of propulsion. The follow-up consisted of updating the lists every month. Active units were defined as those that had made at least one trip during the previous month. The survey was aimed at elucidating the overall dynamics at each site (variation in the potential fishing effort, migrations of fishers, etc.).

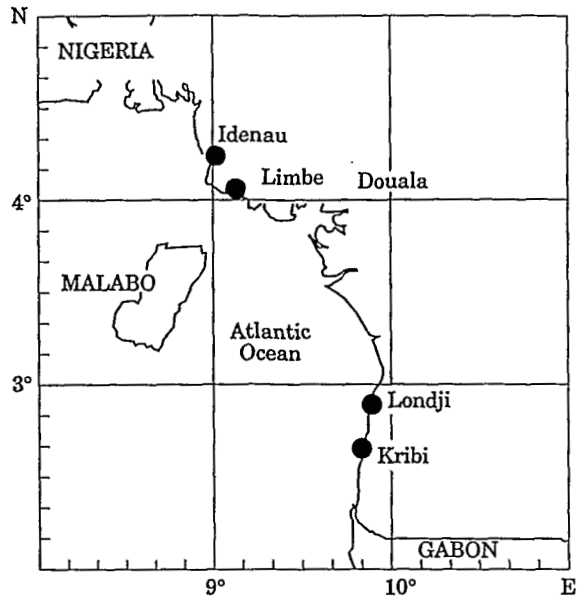

Figure 1. Cameroon coastal area: the survey landing sites.

Fishing trips, catch, and income survey

The survey was carried out according to a stratified scheme using a basic stratum that combined landing site, fishing unit, and month at two levels: the data collection day (6 days per month) and the observed units (trips made during the selected days). At each site, data were collected at the levels of day (number of fishing trips per month, weather conditions, etc.), and the individual fishing trips (fishing grounds visited, daily expenses, such as fuel and food, cost of repairs and maintenance, total catch per species or species group, market prices according to the different sale units, and income). The survey provided information (total catch per species, total expenses, total income, etc.) by extrapolation, at daily and monthly periods. Data collected from other socio-economic surveys were used to analyse economic profitability of specific fishing activities, and also to measure the performance of a sector in terms of creation of added value.

Permanent survey of a set of purse-seine fishing units (*awasha*)

The survey was conducted on a set of *awasha* for a period of more than a year (September 1995 to December 1996). Because there is no purse-seine fishery at Kribi and Londji, the survey was centred only on

Limbe Dockyard and at Idenau. The objective was to produce precise information on the patterns of exploitation through a study of economic organization within the *awasha*. It highlighted the structure of the sharing system used, generated quantitative information through an expenditure and revenue analysis of the *awasha* units, assessed their profitability, and highlighted some of their development constraints. To achieve these objectives, the information collected was categorized into general information, data on operational activities and expenses, and information on fish capture and revenues, the last two derived from the survey described in the previous section. General information included a description of the units' technical assets (boat, gear, engine, etc.) and also covered the fixed costs (initial purchase and replacement) of the assets, the mode of propulsion, the sources of funds, the crew size, the structure of sharing systems, interest rates, cost of labour, etc.

A questionnaire was designed to collect this information, but the fishers themselves (including fishing unit managers) were actively involved in data collection. They were used as complementary data collectors and were given notebooks to record the derived information.

Socio-economic surveys of fishing activities

The surveys generated information on market conditions and fish processing activities as well as on the social and economic context in which such activities take place. They were only carried out at Limbe Dockyard (Njifonjou, 1998b). Eventually, the information collected covered the overall organization of the sector. It describes the activities involved and allows economic analysis (cost and earnings) and indicators such as gross and net added value, monthly revenue of the fishing units, and the profitability rates for different activities in each sector.

Length–frequency analysis of fish samples

Samples were collected six times per month during the fishing trip, and the catch and income survey outlined above in Limbe Dockyard and at Idenau throughout a period of 29 months (May 1994 to November 1996). A sample of 100–200 fish was taken from one of the landings of the day and a total length–frequency distribution determined.

E. fimbriata length–frequency distribution and catch rate in the purse-seine fishery

Fish length–frequency data were pooled per month for a correspondence analysis applied to the length × month table (Badia and Do Chi, 1976). The table yielded 29 line-months and 22 × 1-cm length classes (14–35 cm). The analyses were conducted with ADE4 Software (Thioulouse *et al.*, 1997), and the results are shown in Figures 2 and 3. The projections of months and years with respect to the means on the 1st and 2nd factorial axes (Fig. 2c) give an idea of the organization of the different length classes in the catches.

Apparently, there is a prominent seasonal structure. However, although some months (October–January) show stable length classes from year to year, others (especially July) vary. The structure is clearer (Fig. 3) when the length–frequency distribution is rebuilt from the first four factorial axes (Persat and Chessel, 1989). The curves show the existence of two modal points, the first at 18–19 cm, the second at 25 cm. From these analyses, it appears that fish are generally bigger in the catches from October to January and smaller from March to June. For February and July–September, length frequency varies from year to year.

Interpretation of these results can be improved by analysing the data collected in the fishing trip catch and income survey. A correspondence analysis can be performed from tables containing the number of visits per fishing ground, plotted per month-year period. For the two landing sites considered (Limbe Dockyard and Idenau), the table yields 20 fishing grounds, from which the 11 most frequently visited (rate >5%) are considered for the analyses (Fig. 4). As in the previous case, projection of the fishing grounds on the 1st factorial plane (53%) separates southern and northern fishing grounds on the second axis (Fig. 4b). Projecting the monthly means in the same plane also associates the first axis (fishing grounds) with the fishing season (Fig. 4d).

A further correspondence analysis was made on the table containing the frequencies of appearance of species in the landings. The target species are *Sardinella maderensis* and three exploitation phases of *E. fimbriata*, as distinguished by fishermen. These are *mololo* or young immature fish (total length $TL<18$ cm), *dololo* or young mature fish ($18<TL<23$ cm), and *bonga* or adult mature fish ($TL>23$ cm). The results (Fig. 5) show that *bonga* are caught mainly from October to January each year. As shown by the results of other analyses, the fishing grounds then mostly visited are Njagassa, Atabong, and Eyenge. It also appears that the medium-size fish (the *dololo*) are found mainly from June to August, their fishing grounds being Cap Cameroon, Kange, and Man a War Bay.

All these analyses may be summarized on an annual exploitation cycle, in which months, fishing grounds, and species are combined, as shown in Figure 6. It shows that *bonga* are mostly captured in the northern part of the fishing area (Fig. 6b), particularly on those grounds farthest from the landing sites (Atabong, Njagassa).

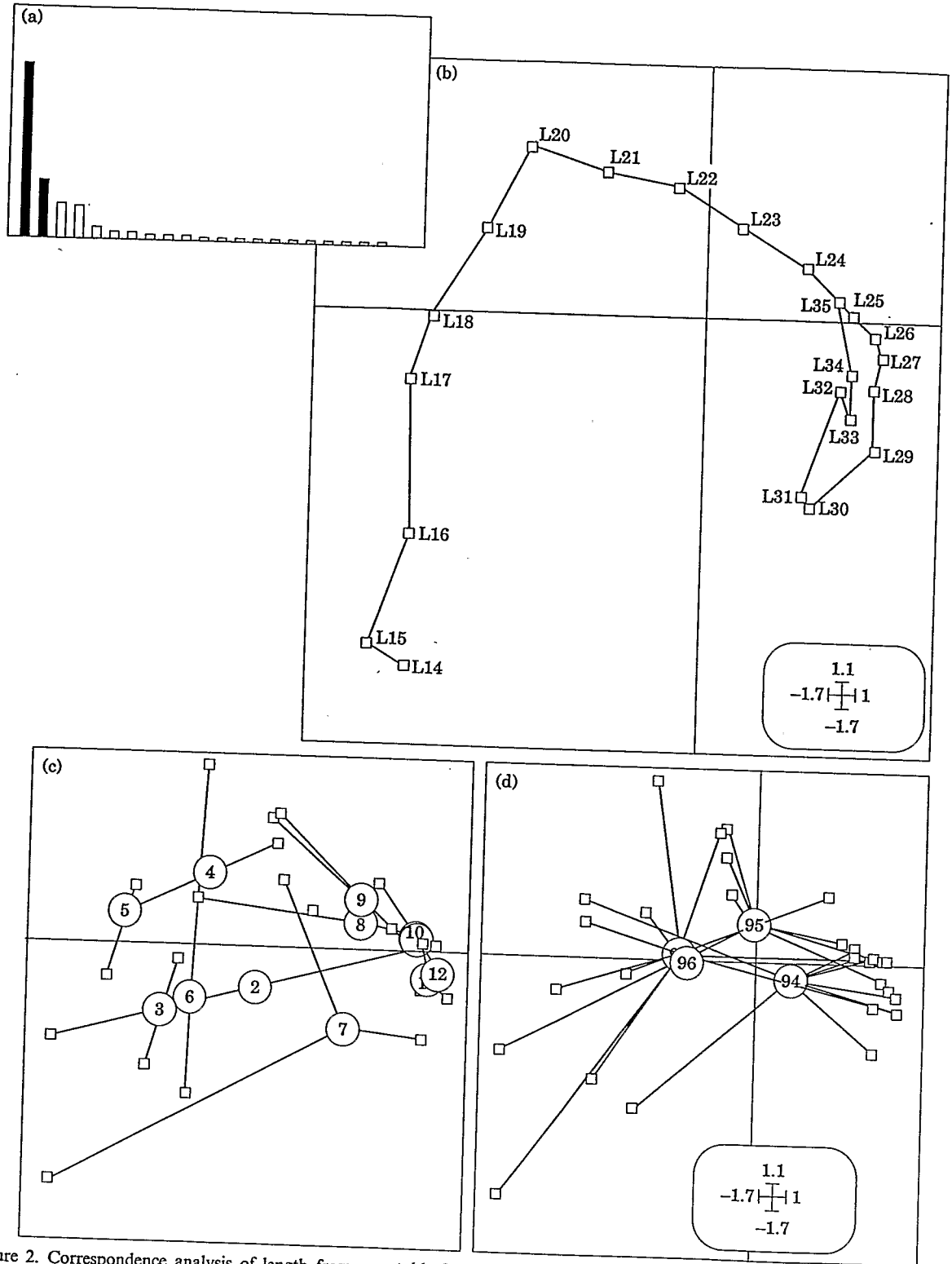

Figure 2. Correspondence analysis of length–frequency table for *E. fimbriata*. (a) Eigenvalues diagram. (b) Projection of the columns (22 length classes, 14–35 cm) on the first two axes (69% of variability), (c) and (d) Projection of the rows on the same axes (small squares). Average points by month (c) and by year (d) are superimposed.

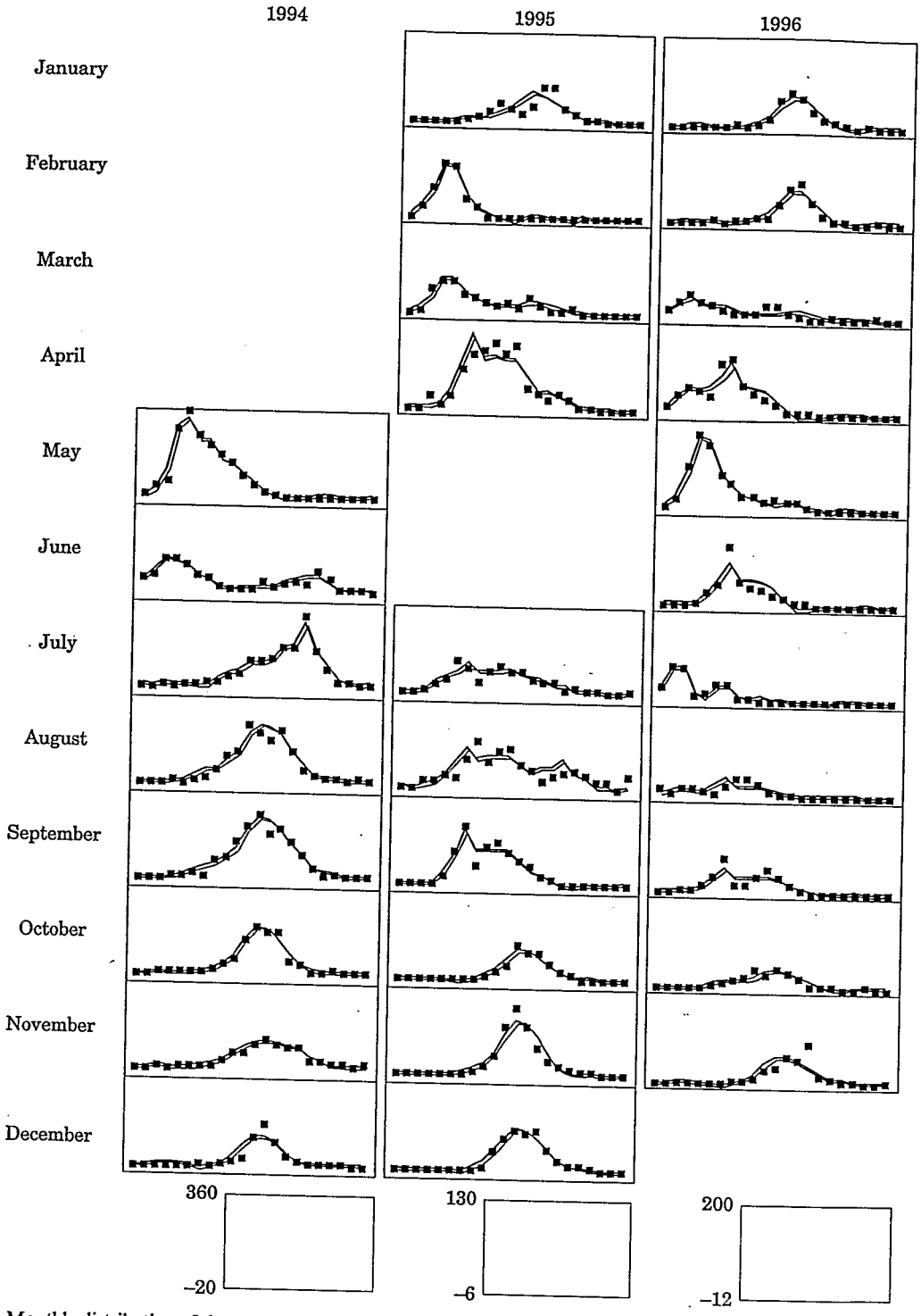

Figure 3. Monthly distribution of the 22 length classes (abscissa). Minimum and maximum frequency values (ordinates in number of individuals) are given at the bottom for each year. Smooth curves (lines), reconstituted from the first four factorial axes of the correspondence analysis (88% of variability), are superimposed on observed data (dots).

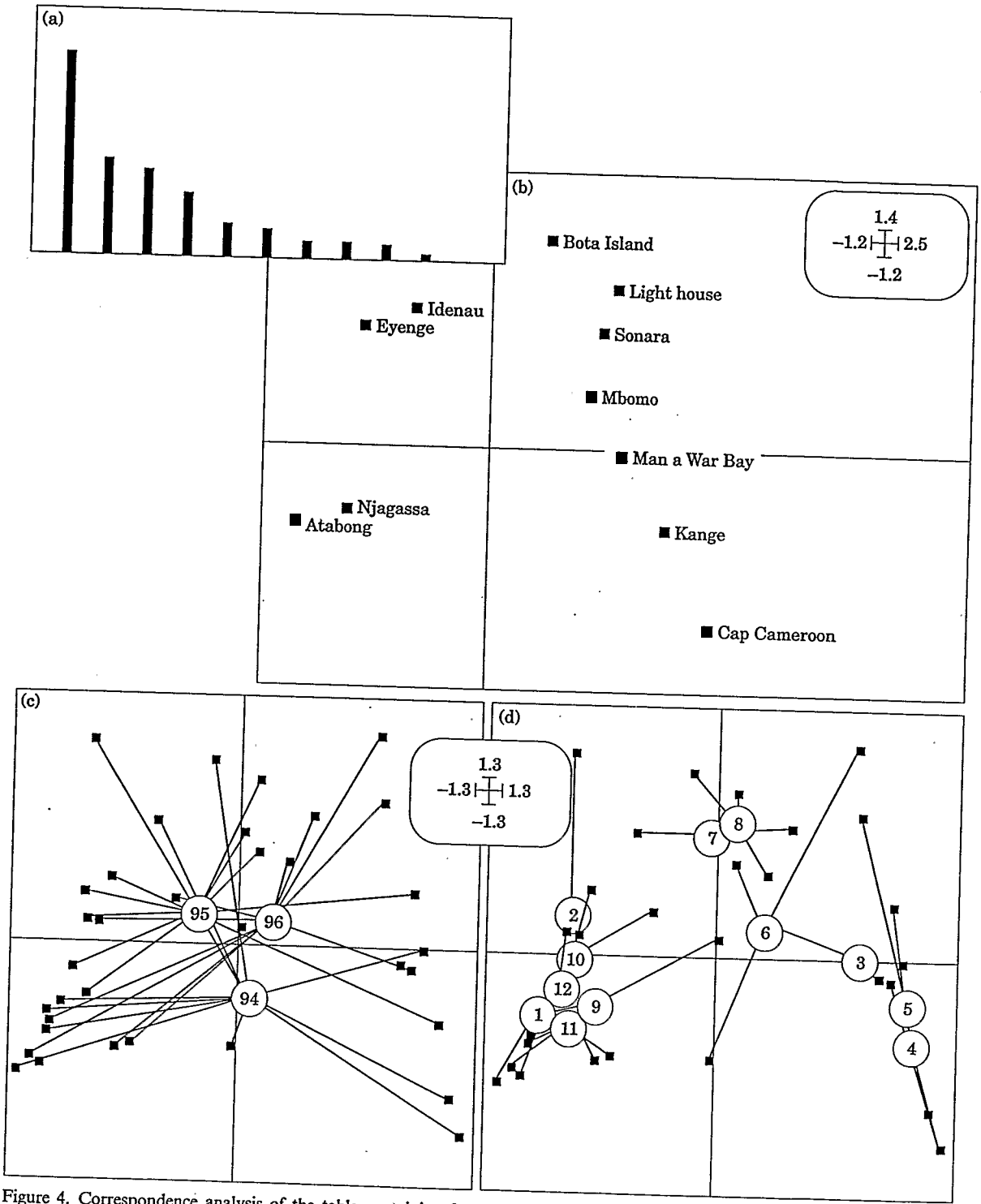

Figure 4. Correspondence analysis of the table containing frequencies of visits per fishing site (columns) and per month-year (rows). (a) Eigenvalues diagram. (b) Projection of the fishing sites on the first two axes. (c) and (d) Projection of the rows on the same axes (black squares). Average points by year (c) and by month (d) are superimposed.

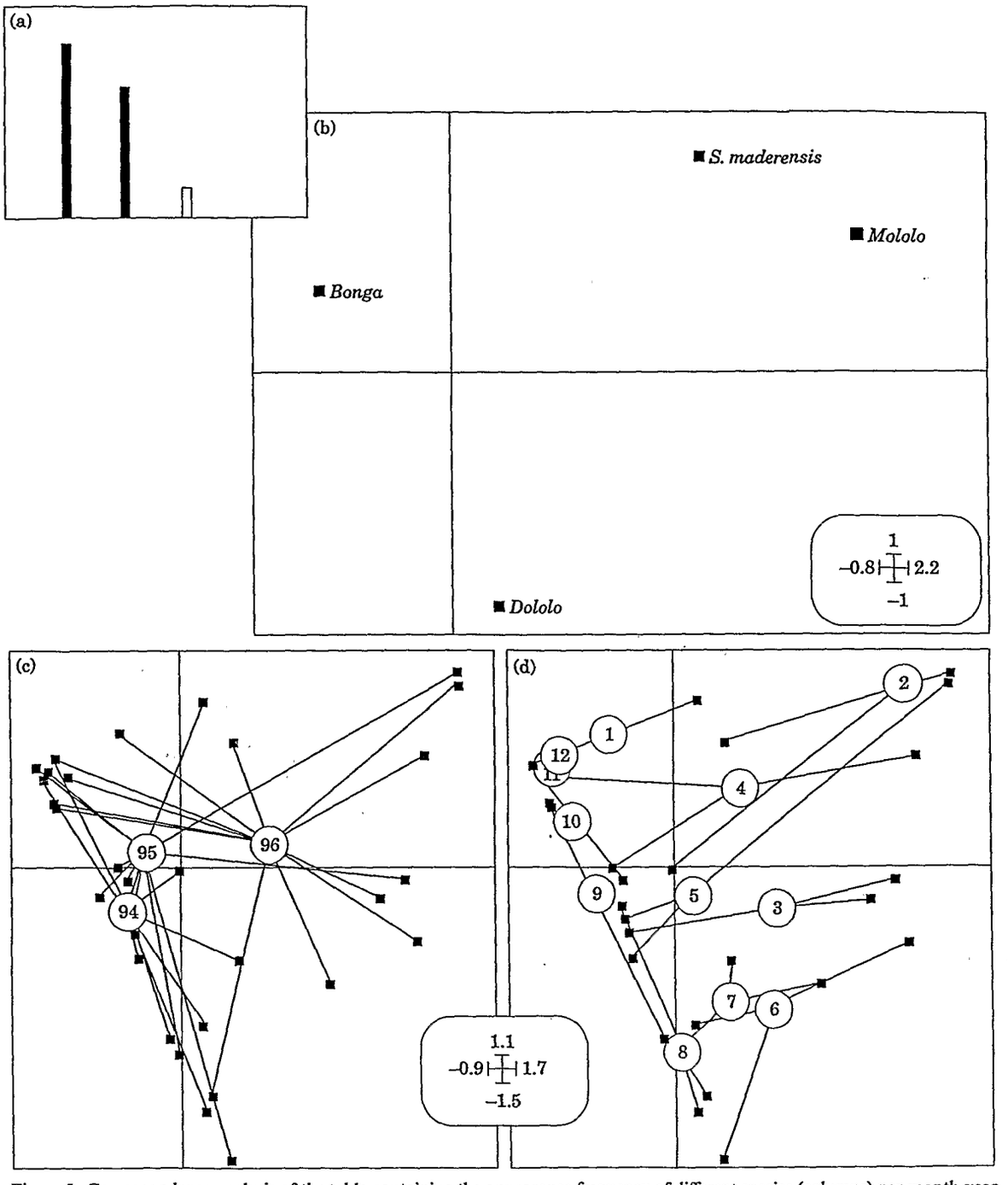

Figure 5. Correspondence analysis of the table containing the appearance frequency of different species (columns) per month-year (rows). (a) Eigenvalues diagram. (b) Projection of the species and life history stages on the first two axes. (c) and (d) Projection of the rows on the same axes (black squares). Average points by year (c) and by month (d) are superimposed.

From recent qualitative field reports, there was an increased proportion of *mololo* in the landings during the years 1997 and 1998. This confirms the decrease in individual fish size in July and August from 1994 to 1996 (Fig. 3) and raises the possibility that overfishing is taking place. However, given the spatial dynamics of the *awasha*, as interpreted above, there is another interpretation. The increase in proportions of immature fish in

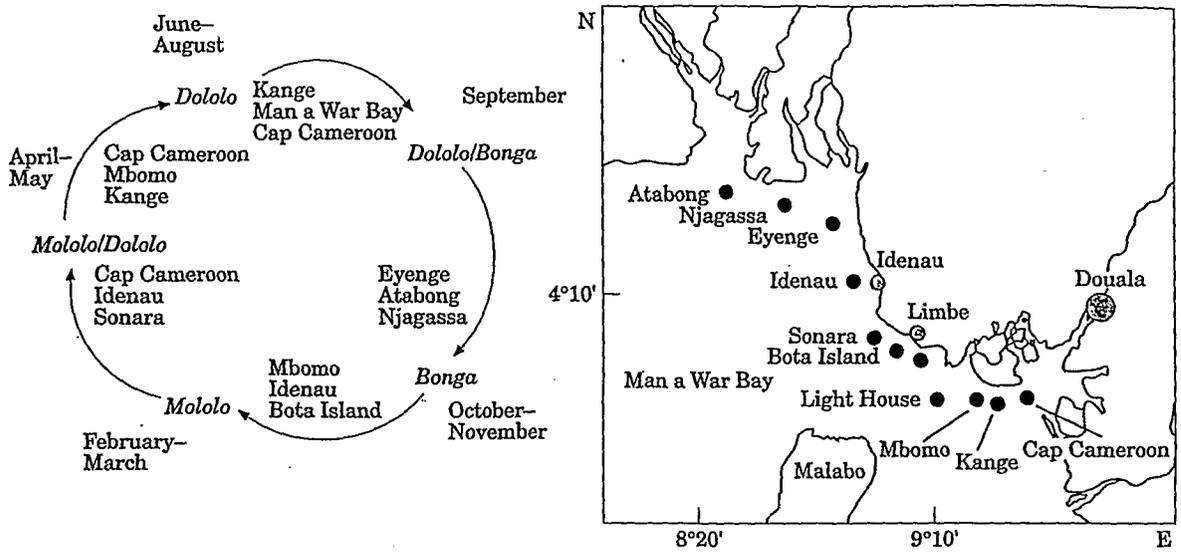

Figure 6. *Ethmalosa fimbriata* exploitation cycle and fishing grounds location map.

awasha catches may be attributable to their accessibility on the fishing grounds close to the fishers' landing sites. Therefore, fishers would have no need to search for *bonga* on the fishing grounds in the north. In such a case, the decrease in proportions of *bonga* in the landings would not necessarily be reflective of an absence in the population. However, at present it is not known which of these two theories is correct.

Economic and social aspects of the fishery system

The economic and social dimensions of fishery activities off Cameroon were assessed through two approaches. First, a quantitative study was designed to evaluate the economic performance of the fishery. Second, the importance of the fishery sector in the larger context of local economy and society was evaluated. The first study was done for the main fishing unit types: *awasha*, bottom gillnets, and surface drift nets. The *awasha* results are presented here. The second evaluation centred on fish processing and marketing activities and especially on a comprehensive study of Limbe Dockyard, a popular fishing village.

Why are such studies included in this work? Fishing is a market-oriented economic activity and, therefore, any observation system aimed at understanding the exploitation dynamics has to take this dimension into account. The exploitation dynamics are also explained by the social context of the fishing activities. The Limbe Dockyard study highlights how a social analysis can help to explain strategic choices of the fishers in order to maintain and develop their activities in the frame of multiple social networks.

Evaluation of economic performance of *awasha*

The typical *awasha* fishing unit consists of a traditional boat (wooden-plank canoe) 18–22 m long and 2–3 m wide, operating with 20–23 fishermen and propelled by a 40 hp outboard engine. The gear is a purse seine 600–1000 m long. The data on costs and earnings aim at providing business managers, planners, and administrators with a better understanding and assessment of the economic reality of fisherfolk and the capacity to plan development and management interventions more effectively. The information may also be useful for fishers themselves, providing them with a better insight on the returns on their investments and more control over decisions on economic resource allocations. It is clear that fishers' access to information is limited mainly because of the absence of accounts in their activity.

The cost analysis used different methodologies for estimation of fixed and variable costs. The fixed costs are mainly of depreciation costs, which were evaluated, for each unit, at the beginning of the survey. To estimate the total investment costs, the replacement costs of fishing equipment and material (canoe, engine, fishing gear, etc.) were used rather than the initial purchase price of the assets (Horemans, 1996; Turray and Verstralen, 1997).

As noted by Njifonjou (1998a), prices of *awasha* canoes range from US$3080 to US$4000 and engines cost some US$3500. The price of the complete set of gear encountered during the field study ranged from

Table 1. Cost and earning analysis of purse-seine fishing units in Limbe Dockyard and Idenau during the study period (November 1995 to October 1996).

Parameter		Value (US$)	
Output (total gross revenue)		70 000	
Inputs	Fuel and oil	8817	
	Maintenance and repairs	385	
	Food (during trips)	953	
	Accommodation	3000	
	Social charges	333	
Total input		13 458	
Gross Added Value (GAV)		56 575	%GAV
	Crew share	28 288	50%
	Boat-owner share	28 288	50%
	Licence and taxes	158	0.3%
	Recruitment of crew	2000	1.6%
	Staying document	3750	6.7%
	Capital depreciation	8067	14.3%
Net Added Value (NAV)		48 508	85%
Net boat-owner revenue		14 313	25.3%
Fisher annual revenue		1230	
Fisher monthly revenue		102	
Boat-owner monthly revenue		1193	
Boat-owner revenue per fishing trip		76	
Fisher revenue per fishing trip		7	

Source: Njifonjou (1998a).

US$13 400 to US$16 600, depending on the dimensions and types of material used. Therefore, the total investment cost for a typical *awasha* is estimated at US$23 000, giving an annual depreciation cost of about US$8000. Other fixed costs include taxes, fishing licences, and crew recruitment costs.

The variable costs refer to the operating costs involved in the fishing activities of an *awasha* unit. Estimated at an average of US$54 per trip, these costs depend mainly on the fishing effort and are generally summed on a daily trip basis. They include fuel expenses (87% of operating costs), food (9%), oil, ropes, repairs, and maintenance (4%).

The landings range between 3 and 28 t of pelagic fish per month, with an average of 13 t per *awasha* fishing unit. From these combined figures, the total monthly gross earnings were calculated. The highest gross monthly revenue is in August (US$13 078) and the lowest in February (US$1320). Among the fishing units studied, the total annual sales averaged US$70 000 per fishing unit, or a gross revenue of about US$5833 per month (Table 1).

The sharing system used in the *awasha* fishery leads to equal division of the net revenue (gross revenue minus common costs per trip) between crew and boat-owners. With an average of US$100 per month, the crew members' income is higher than that earned in the agricultural sector and equal to the average salary of public servants.

The profitability (yearly profit/investment) rate is 62%. This is far higher than the interest rate in the Cameroon banking system, and allows boat-owners to recover their investment costs within 2 years (21 months on average). However, because fishing is a highly risky and uncertain business as a result of institutional and moral hazards and of an uncertain natural and economic environment, this high profitability rate is misleading (Charles, 1992; Chaboud, 1995).

Another interesting point is the very high added value obtained from the activity. The net added value is about 69% of gross revenue. The *awasha* fishery can then be considered, despite its relatively minor importance in the national economy, as a very profitable sector, not just for private interests, but also in terms of regional and national economic development.

Fish processing and marketing

Most of the fish landed are processed by smoke-drying. This processing activity, clearly distinguished from the

fishing process itself, is under the control of women, mainly fishers' wives (Jallow, 1994). It is well organized and the surveys have yielded clear information on processing techniques, cost, and revenue.

Economic performance here is good. From a sample of 13 processing units involved during a 6-month study in Limbe Dockyard, precise economic indicators such as net added value per fishing unit (US$213 per month) were obtained. Also, return on fixed capital appears to be very high (>100%), probably as a result of technological developments in the sector. Another interesting feature is the local origin of the inputs (fish, wood, and small equipment). The processing sector therefore has a significant positive impact on informal employment and such other local economic activities as timber production and trade.

Marketing of fresh fish is not as important as that of smoked fish. When fish is to be consumed fresh, it is marketed by Cameroon fishmongers, and the development of this market is limited by the lack of infrastructure for preservation and transport of fresh fishery products. When marketing is orientated towards satisfying fish processing input needs (collection of fresh fish from the various landing sites and transport to the main processing centres), it is mainly under the control of migrant traders (Beninese, Ghaneans, Nigerians). The social relationships between producers, traders, and processors consequently have a direct impact on the economic organization of the fish marketing channels (Smith and Mines, 1986). Most traders buying products from migrant fishers are women of the same origin. Cameroonians are in charge of the hinterland distribution of fresh and smoked fish, taking advantage of the mobility constraints on migrant women. These features lead to an efficient division of labour, allowing more diffuse benefits from value added by fish production, processing, and marketing into the general economy.

Social context of fishing activities

The study of Limbe Dockyard highlighted the complex integration of migrant fishers into different social networks and the fact that the dynamics of the fishing activities cannot be explained solely by internal factors. The fishery is clearly a highly profitable activity that can generate many opportunities for informal employment, and informal and institutional income-generating activities. Migrant fishers are then obligated to negotiate with local social actors (local populations, traditional authorities, fish processors and traders, administration, etc.) to maintain and develop their activities. Such a situation and organization (Njifonjou, 1998b) has already been described in other countries of the region (Jul-Larsen, 1994).

The following example illustrates such institutional arrangements. Before 1989, some underemployed young men, the *bolo boys*, were employed preferentially by *awasha* fishing units to unload the boats and undertake other menial duties. They were also given fish by the fishers, who appreciated the cheap labour. In 1989, the situation changed radically because of a conflict between the fishers and the *bolo boys*. Fishers then stopped using the *bolo boys* and instead employed young women. This solution was accepted in Limbe Dockyard, but fishers agreed with the local administration to continue giving free fish to the *bolo boys*. The local fishery system continued to work, but with a greater complexity (formal recognition of the *bolo boys* system, and the arrival of more migrant women).

Discussion and conclusion

The results of each of the five surveys described was devoted to a specific aspect of fisheries exploitation, and was used to answer specific questions. For example, catch–effort data can lead to the estimation of parameters such as MSY and calculation of maximum fishing effort for some species. However, the cases studied show that the combined use of the surveys enhances overall knowledge of the fish exploitation system.

In Limbe Dockyard, for example, it turns out that understanding the *awasha* fishing activities is only achievable through analysis of catch rate, the economic profitability of the fishing unit, and the life and working conditions (family and institutional relationships) in the fishery. The last obviously includes the women's involvement in fish processing and the integration of these activities in the national economy through fresh and smoked fish marketing.

From the economic analysis, the important outcome so far is the financial health of the small-scale fisheries of Cameroon, particularly the *awasha* fishery. Boat-owners make considerable profits and, compared to government officials and farmers, boat-owners and fishers have similar or higher incomes. The sector is also very important in the provision of employment, protein, and income within rural coastal communities that have few other options. Another positive outcome of the study was the fact that fishers' participation in data collection provided them with useful information for managing their fishing units, and also promoted the practice of record-keeping.

The data-collection system constitutes an "observatory of fishing activity" and should be viewed as providing a global perspective of the whole sector. It will allow the answering of questions about how to develop new fisheries. Such questions are often asked in Africa, where similar fisheries can be categorized according to their characteristics and environment (e.g. Senegal, Ghana, South Africa, Cameroon, Mozambique). Fish-

eries in those countries should be viewed both as a resource and as a socio-economic need. So the challenge should be to provide a better model (Röling, 1994) for integrating fisheries knowledge that leads to sustainable management and development within the sector.

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