21 • Some aspects of the sardinella fishery in Ghana

KWAME ABU KORANTENG
Fisheries Department, Research and Utilization Branch, Tema, Ghana

ABSTRACT

Two main species of sardinellas, namely *Sardinella aurita* and *S. maderensis*, are found in the Western Gulf of Guinea especially off Ghana and Ivory Coast. The fishery has a long history in Ghana and is extremely important both socially and economically. Early investigations have shown that the fishery, which is mainly artisanal, especially in Ghana, is influenced by climatic and oceanographic conditions. After unusually high catch, especially of the *S.aurita*, in 1972, yields from the sardinella fishery have been very variable and highly unpredictable. This has been of great concern to fishermen and fisheries scientists and is now clearly evident that research effort needs to be stepped up especially as regards the stock-environment relationship and possibly to be able to predict the future availability of the fish.

RÉSUMÉ

Les deux principales espèces de sardinelles, Sardinella aurita et Sardinella maderensis, sont localisées à l'ouest du golfe de Guinée particulièrement au large du Ghana et de la Côte-d'Ivoire. Leur pêche qui a une longue histoire au Ghana est socio-économiquement très importante. Des enquêtes historiques ont indiqué que la pêche, qui est principalement artisanale au Ghana, est influencée par les conditions climatiques et océanographiques. Après une très importante prise de S. aurita lors de l'année 1972, les apports de la pêche de sardinelles ont été très variables et non prédictibles. Cette situation a été d'un grand impact pour les pêcheurs. L'effort de recherche pour cette pêcherie en terme de relations stock-environnement doit être soutenu afin de pouvoir éventuellement faire des prédictions sur le devenir de ces stocks.

INTRODUCTION

The round sardinella, *Sardinella aurita* and the flat sardinella, *Sardinella maderensis* are the two main species of sardinellas found in the Western Gulf of Guinea statistical division of the Fishery Committee for the Eastern Central Atlantic (CECAF). This division which encompasses Ivory Coast, Ghana, Togo and Benin has one stock of *S. aurita* (FRU/ORSTOM, 1976). The sardinella fishery is seasonal. *S. aurita*, for example, is most abundant during the period of the major coastal upwelling (July-September) although the juveniles are fished throughout the year, mainly by beach seiners and, to some extent, by poli operators. The adults are fished during the two fishing seasons, i.e. July to September (main) and for about three weeks only in January/February (minor). *S. maderensis* on the other hand, being more tolerant to changes in salinity and temperature than *S. aurita*, (Muta, 1964; Oren and Ofori-

Adu, 1973) is around for most months of the year.
In this paper, a brief history of the sardinella fishery in Ghana is given. Also the gears employed in the fishery are described, and the evolution of catches, efforts and CPUE (Catch Per Unit of Effort) examined.

A BRIEF HISTORY OF THE FISHERY IN GHANA

Sardinella fishery in Ghana has a long history. Before the introduction of the purse seine gear and motorized fishing in Ghana, the sardinella fishery in Ghana which was localized in waters off Accra and Sekondi-Takoradi (Lawson and Kwei, 1974) was dominated by the use of beach seines. The beach seine and the ali nets were the traditional fishing gears for catching sardinellas. Ali fishing dates as far back as about 1850 (Lawson and Kwei, 1974).
Kwei (1964) noted that *Sardinella aurita*, accounting for over 50 % of yearly landings of marine fish, was the most exploited fish in Ghanaian marine waters in the sixties. Sardinellas, especially the *S. aurita*, form the socio-economic resource base for many rural fishing communities (Kwei, 1988).
In the early 1970s, sardinella stocks were thought to be the greatest potential resources in the whole of the Gulf of Guinea (Ansa-Emmim, 1973). Between 1963 and 1971, production from the fishery varied between 3 900 and 36 000 metric tons per annum providing the Ghanaian population with some 20 000 tons (average) of fish annually. This was consumed locally, and the sardinella fishery was regarded to be a very potential and consistent source of input for the new fish cannery at the Tema Food Complex Corporation. Even before this period the Fisheries Department, soon after it was established in 1946, had set up a pilot cannery and fishmeal plant (Ocran, 1973). The aim of the pilot cannery, according to the above author, was to conduct trials into the canning of sardinella and mackerel. A similar attempt was made at Tema by the Russians in 1961.
Then came 1972 fishing season when Ghana alone harvested over 90 000 tons of both species of sardinellas. After this unusually high catch, especially of the *S. aurita*, this species virtually vanished from the catches in 1973. In recent years, catches of these species, especially of the round sardinella, have been highly variable and most unpredictable. The resources appear to have dwindled and showed signs of complete collapse in some years.

DESCRIPTION OF THE CURRENT FISHERY

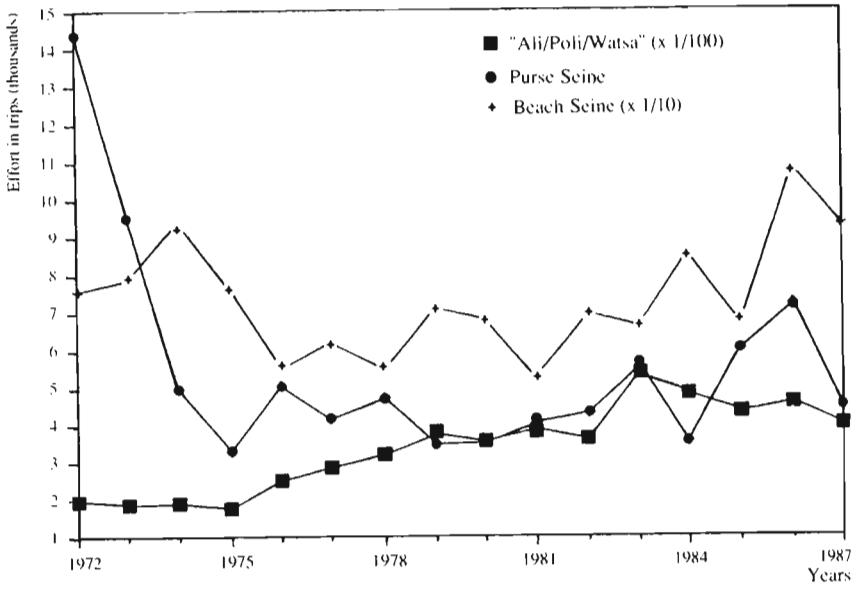
Gears used in the fishery

The sardinella fishery in Ghana today is characterized by the use of various types of gears. The main gears used are "poli", "ali", "watsa", and beach seine in the artisanal sector, and purse seine and, to a very limited extent, trawl in the industrial and semi-industrial fleets.
In the artisanal sector, the traditional fishing craft is the dug-out canoe and the fishing gears in use are the beach seine, poli, ali and watsa. Doyi (1984), gives elaborate descriptions and operations of these gears.
Usually, the beach seine net used in Ghana has a bunt which forms a bag during operation. The gear is operated during daylight hours only and almost all year round.
The poli and watsa are purse seine nets which are operated from large dug-out canoes. The poli net is used throughout the year, to catch sardinellas during the sardinella season and anchovies (*Engraulis encrasicolus*) and other pelagic species after the sardinella season. The ali net on the other hand, is a drifting gill net. It is also used throughout the year, but most especially before the onset and towards the end of the sardinella season when the fish are not shoaling. The ali net is used mainly during the night to catch both *S. aurita* and *S. maderensis*. The sizes of the meshes in these gears are as follows: beach seine, 10-20 mm in the bunt; poli, 10 mm; watsa, 50-60 mm (originally; smaller meshes are now in use) and ali, 40-50 mm.
The inshore or semi-industrial fleet which is made up of trawler/purse seiners, also exploits sardinellas using purse seine nets. These vessels are built locally and measure between 8 and 37 m long. The purse seine net used on these vessels is similar in construction to the poli gear used on the canoes; however, it has larger twines and larger meshes of around 25 mm. When sea surface temperatures are not sufficiently low (26°C and below), the sardinellas remain close to the bottom of the sea where they become more vulnerable to the trawling gear (Kwei, 1988).
The industrial fleet of very large vessels, are mainly trawlers and thus catch only small quantities of sardinellas in Ghanaian waters. The artisanal fleet is, by far, the largest exploiter of sardinellas in Ghanaian waters. The poli, for example, which is the main gear used in the artisanal sector for catching sardinellas, contributed about 70 % of all sardinellas caught in Ghanaian waters in the last five years.
Figure 1 shows the evolution of efforts, since 1972, of each of the main gears used in the sardinella fishery. In Ghanaian statistics, catch and effort for the poli, ali and watsa gears are considered together because they are operated from the same type of canoe. The canoe is the primary sampling unit in Ghanaian catch assessment surveys.

Yearly fluctuation in abundance, catch and CPUE

Sardinella resources in the Western Gulf of Guinea, like most pelagic resources, experience large fluctuations in abundance. The amount of sardinellas, especially, *S. aurita* available to the fisherman appears to determine the annual production (catch) from the fishery. The amount of available fish (abundance), on the other hand, depends on a number of factors, the most important of these being the coastal upwelling (Pople and Mensah, 1971; FRU/ORSTOM, 1976; Ofori-Adu, 1978; Cury and Roy, 1987), rainfall (Oren and Ofori-Adu, 1973; Binet, 1982) and recruitment (FRU/ORSTOM, 1976).

Fig. 1
Evolution of fishing efforts of sardinella fleets between 1972 and 1987.



There are corresponding yearly fluctuations in catch and catch per unit of effort (CPUE). It is believed, however, that in Ghanaian waters, fluctuations in CPUE depict the fluctuations in abundance (CECAF, 1988).
In table 1 and figure 2 are presented annual catches of the two sardinella species in Ghana. Due to technical problems of species identification (Zei, 1969) data for *S. aurita* before 1971, include *S. maderensis*.
Presented in tables 2 and 3 are annual CPUE values (1972-1987) for *S. aurita* and *S. maderensis* respectively for the three main categories of gears used in the sardinella fishery. The annual CPUE values were calculated from :

$$\text{annual CPUE} = \frac{\sum_{1}^{12} \text{monthly CPUE}}{12}$$

where effort is the number of operations (or trips) made in the month and catch is in tonnes.
In view of the importance of beach seine catches with regard to recruitment, monthly CPUE values for both *S. aurita* and *S. maderensis*, for the period 1972-1987, were obtained and the mean value for each month, over the 16 years period was computed. These values were plotted against months in figure 3.
Beach seine annual CPUE for the two species, also for the period 1972 to 1987 are shown in figure 4. Also shown in this figure, is a graph of upwelling index. This index is obtained by multiplying the number of fortnights with sea surface temperatures (SST) less than 26°C by the difference between 26°C and the mean SST during these periods (FRU/ORSTOM, 1976). The index, thus takes into consideration the period and intensity of the upwelling.

RESEARCH

Research into the biology and fishery of sardinellas, especially the *S. aurita*, has been of primary concern in Ghana. Work in this direction, eventually, led to the establishment of the Fishery Research Unit at Tema in 1962. After a brief period of inactive work, research in this area has been re-activated.

Biomass

The biomass has been an important aspect of the work on the species. The potential yield of the resource was estimated to be not exceeding 49 000 tons annually (FRU/ORSTOM, 1976).
Recent acoustic surveys by *RV Dr Fridtjof Nansen* (Stromme, 1983) and *RV Cornide de Saavedra* (Oliver *et al.*, 1986), quote a combined biomass of the two sardinellas and anchovy (*Engraulis encrasicolus*) in Ghanaian waters as 40 000 and 74 000 tons respectively.

Fig. 2
Trend in landings of sardinellas (1963-1987).

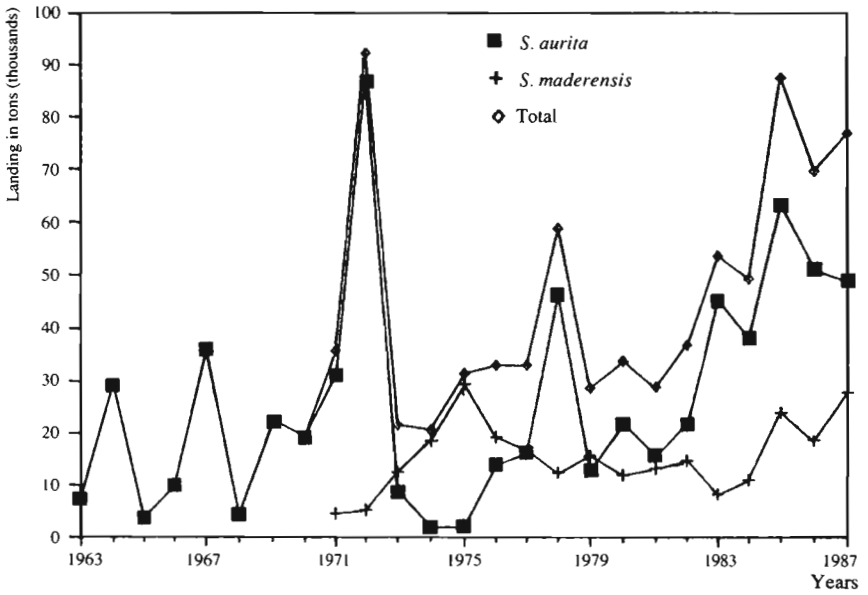


Fig. 3
Monthly CPUE of the sardinellas in the beach seine
(1972-1987 average).

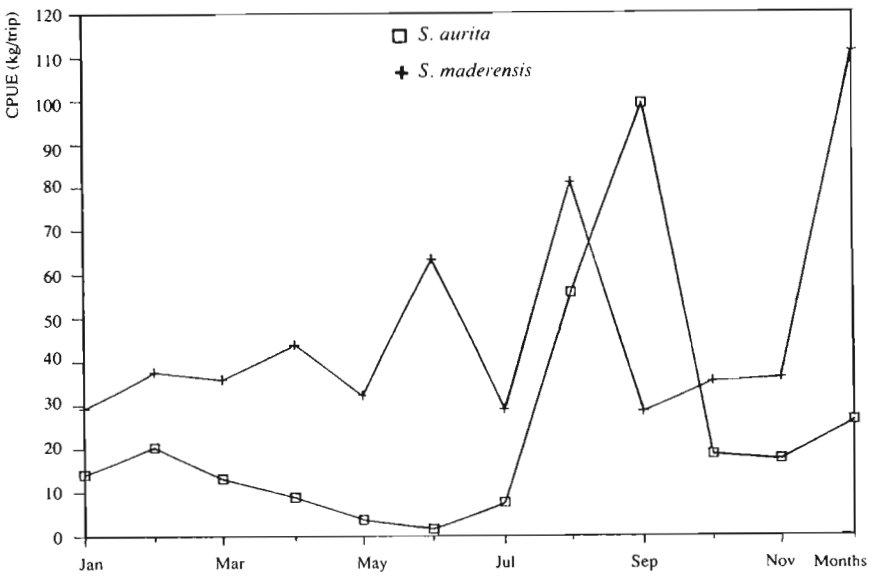
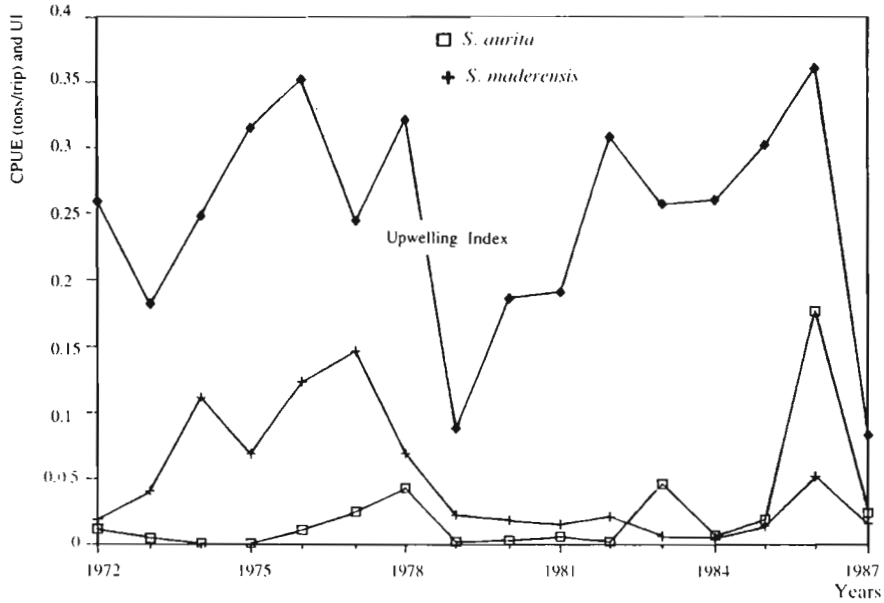


Fig. 4

CPUE of the two sardinellas in beach seines and upwelling index (U.I.).



Recruitment

The problem of recruitment has not yet been satisfactorily solved. Stock-recruitment relationship in the context of the coastal upwelling, has been examined (Oren and Ofori-Adu, 1973; FRU/ORSTOM, 1976; Binet, 1982; Cury and Roy, 1987), however there have not been any conclusive results from the work done so far.

Table 4, 5 and 6 gives an intuitive deduction from a series of discussions held by Mrs Bard (of CRO, Abidjan) and Mensah and the author (of FRU, Tema) on the question of upwelling, recruitment and year-class abundance in the fishery. It was assumed here that:

- a good upwelling enhances spawning and increases the chances of good recruitment;
- length frequencies are indicative of year-class abundance.

Migration

The migration pattern of *S. aurita* has been studied in detail (Kwei, 1964; Knudsen, 1971; Ansa-Emmim, 1976). The model proposed by Ansa-Emmim and discussed in FRU/ORSTOM (1976) indicates that one stock of *S. aurita* exists off Ghana-Ivory Coast. The bulk of the stock rests off central Ghana and at the onset of the fishing season the fish migrate towards the shores of Ivory Coast and western Ghana. They turn eastwards as they hit the coast and continue in this direction to Togo and probably Benin. The fish that are not caught return to their resting grounds towards the end of the season.

This model still holds although recent evidence and discussions point to some departure from this pattern of migration as well as doubts as to whether one or more separate stocks of the round sardinella exist off Ivory Coast-Ghana. At the last Working Group on sardinellas and other pelagic species held in Abidjan in 1987, this issue was discussed at length.

Effective fishing effort and the problem of modelling

In view of the multiplicity of fishing gears used in the industry; and these have varied efficiencies, it has been very difficult to obtain an effective fishing effort which could be used for modelling.

DISCUSSION AND CONCLUSION

The sardinella fishery in Ghana, which has a very long history is quite obviously, a very important one. It is a target fishery both at the artisanal and semi-industrial levels. The perturbations in abundance and catch rates, however, adversely affect the livelihood of the fishermen.

The unusually high catch of *S. aurita* in 1972 was due primarily, to the fact that the fish was most available that year. The reason for the abundance that season is still not very well understood but the poor catches in the ensuing seasons have been attributed to over-fishing

Table 1

Total annual landings of *S. aurita* and *S. maderensis* in Ghana, 1962-1988.

Years	*S. aurita*	*S. maderensis*	Total *Sardinellas*
1963	7460		7460
1964	29430		29430
1965	3900		3900
1966	10000		10000
1967	36200		36200
1968	4300		4300
1969	22500		22500
1970	19500		19500
1971	31216	4626	35842
1972	87066	5263	92329
1973	8988	12582	21570
1974	2032	18622	20654
1975	2066	29472	31538
1976	13803	19209	33012
1977	16366	16732	33098
1978	46374	12368	58742
1979	12844	15857	28701
1980	21894	11955	33849
1981	15596	13304	28900
1982	21985	14877	36862
1983	45324	8279	53603
1984	38215	11110	49325
1985	63501	24060	87561
1986	50998	18721	69719
1987	48886	28025	76911
1988	65000	10000	75000

Note: 1988 is estimated from data already obtained from january to august. Until about 1971, the two species were combined in the statistics.

Table 2

CPUE (in tonnes/trip) of *S. aurita* obtained from the main gears used in the fishery.

	Ali/Poli/Watsa	Beach Seine	Purse Seine
1972	0.981	0.012	0.766
1973	0.017	0.005	0.072
1974	0.007	0.001	0.021
1975	0.003	0.001	0.026
1976	0.051	0.011	0.241
1977	0.021	0.025	0.263
1978	0.129	0.043	0.505
1979	0.025	0.002	0.334
1980	0.048	0.003	0.438
1981	0.021	0.006	0.325
1982	0.035	0.002	0.502
1983	0.059	0.046	0.534
1984	0.047	0.007	0.324
1985	0.139	0.019	0.622
1986	0.053	0.177	0.238
1987	0.109	0.024	0.305

Table 3

CPUE (in tonnes/trip) of *S. maderensis* obtained from the main gears used in the fishery.

	Ali/Poli/Watsa	Beach Seine	Purse Seine
1972	0.015	0.019	0.047
1973	0.040	0.041	0.870
1974	0.028	0.112	0.206
1975	0.075	0.069	0.277
1976	0.042	0.124	0.274
1977	0.019	0.147	0.407
1978	0.022	0.069	0.273
1979	0.025	0.022	0.460
1980	0.028	0.018	0.174
1981	0.028	0.015	0.141
1982	0.035	0.021	0.164
1983	0.013	0.006	0.129
1984	0.019	0.005	0.265
1985	0.049	0.014	0.171
1986	0.026	0.052	0.173
1987	0.059	0.016	0.254

Table 4

CPUE (tonnes/trip) of *S.aurita* caught by Beach seines. 1972-1987.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1972	0.021	0	0.01	0.013	0	0	0.033	0.041	0.015	0.003	0.001	0.003
1973	0.001	0	0.001	0.002	0.003	0	0	0.004	0.012	0	0.001	0.031
1974	0.002	0.002	0	0	0	0.003	0.002	0	0	0	0.001	0
1975	0	0	0.005	0.004	0	0.001	0	0	0	0	0.001	0
1976	0	0	0	0.001	0	0	0	0	0	0.027	0	0.099
1977	0.02	0.014	0	0.001	0	0	0	0	0.001	0.16	0.072	0.037
1978	0.1	0.138	0.034	0.012	0	0	0.031	0.021	0.008	0	0.118	0.044
1979	0	0	0.007	0.007	0.005	0	0	0	0	0	0.006	0
1980	0.01	0.005	0.003	0	0.003	0	0	0.004	0.002	0.008	0	0
1981	0.001	0.019	0	0.014	0.025	0	0	0	0.012	0	0.002	0
1982	0.009	0.001	0.005	0.004	0.004	0	0	0.002	0.001	0.002	0.004	0
1983	0.001	0.032	0.001	0	0	0	0	0.33	0.1	0	0	0.091
1984	0.017	0	0	0	0	0	0	0	0	0.056	0.005	0
1985	0.001	0.037	0	0.049	0.014	0.001	0.029	0.065	0.016	0	0.019	0
1986	0.006	0.032	0.134	0.033	0	0	0.003	0.347	1.399	0.022	0.043	0.107
1987	0.036	0.046	0.011	0.004	0.006	0.02	0.025	0.081	0.025	0.019	0.007	0.01

Table 5

CPUE (tonnes/trip) of *S. maderensis* caught by Beach seines. 1972-1987.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1972	0.008	0.017	0.04	0.013	0	0.006	0.048	0.057	0.023	0.018	0.003	0
1973	0	0.004	0.047	0.031	0.056	0.065	0.042	0.044	0.017	0.028	0.083	0.069
1974	0.03	0.058	0.022	0.051	0.016	0.076	0.042	0.12	0.016	0.035	0.098	0.782
1975	0.023	0.071	0.051	0.034	0.037	0.112	0.027	0.04	0.037	0.135	0.156	0.107
1976	0.066	0.134	0.21	0.255	0.068	0.112	0.125	0.161	0.149	0.098	0.039	0.073
1977	0.125	0.133	0.061	0.111	0.034	0.497	0.034	0.157	0.185	0.124	0.084	0.223
1978	0.005	0.066	0.013	0.023	0.209	0.058	0	0.026	0.005	0.058	0	0.367
1979	0.02	0.033	0.02	0.049	0.009	0.004	0.016	0.01	0.005	0.018	0.002	0.077
1980	0.023	0.004	0.036	0.028	0.015	0.013	0.015	0.075	0	0	0	0.003
1981	0.039	0.004	0.007	0.012	0.01	0.01	0.001	0.031	0.01	0	0	0.055
1982	0.022	0.024	0.027	0.039	0.011	0.009	0.015	0.05	0.002	0.009	0.045	0.004
1983	0.039	0	0	0.006	0	0	0.005	0	0	0	0.016	0.011
1984	0.03	0	0.001	0.014	0.007	0.001	0.001	0	0	0.006	0.003	0
1985	0.003	0.021	0.02	0.005	0.019	0.013	0.023	0	0	0.016	0.041	0.006
1986	0.004	0.016	0	0.012	0.005	0.021	0.049	0.512	0.004	0.005	0	0.001
1987	0.033	0.018	0.019	0.02	0.019	0.017	0.021	0.015	0.003	0.016	0.011	0.005

(FRU/ORSTOM, 1976) and anomalous climatic conditions in 1973 (Mendelssohn and Cury, 1987).
It is very obvious from the unpredictable fluctuations in abundance, especially of the *S. aurita*, that the fishery is not as well understood as was once thought. For example, it may be inferred from table 4 that the minor upwelling appears to have assumed much greater importance in the fishery than previously thought.
The estimation of the biomass of the sardinellas has always been something of a problem. It is hard, for example, to reconcile the high total catches since 1983 (Mensah and Koranteng, 1988) with the low biomass recorded in both the *Dr Fridtjof Nansen* and *Cornide de Saavedra* surveys. One can only surmise that the timing of the surveys and the fact that the shallow water belt (0-10m) of the continental shelf not being covered in both surveys to be some of the possible reasons for this disparity.
At the moment it is extremely difficult to make any kind of meaningful prediction about the future of the fishery. On one hand one may be tempted to conjecture that the immediate future of the fishery appears to be gloomy. However, if one recalls some of the most difficult times of the fishery, for example in 1973 and 1974, then one is led to desist from making such a statement. Obviously, though, it appears that the level of research on the sardinella resources in the Gulf of Guinea must be raised.

Table 6

Upwelling strengh, recruitment and year-class abundance in the *S. aurita* fishery in Ghana and Côte-d'Ivoire. A very good upwelling, recruitment or year-class is indicated by three stars. For 1986, 1987 and 1988, the upper symbols are for the major upwelling and the lower ones are for the minor upwelling.

Curent year			Abundance in the Ghanaian fishery			Abundance in the Ivorian fishery		
Upwelling		Recruitment						
			0+	1+	2+	0+	1+	2+
1984	***	***	*	**	**		**	**
1985	***	***	*	**	**		**	**
1986	***	***	**					
	***	***	***	*	*		*	**
1987	***	*	*	**				
	0	0	*	**	**		*	**
1988	*	*	*	*	**	*?	*	*
	**	**	**	**?	**	?	?	?

DISCUSSION

DIAW: Y a-t-il une compétition entre les flottes artisanales et les flottes industrielles au Ghana ?

KORANTENG: Oui. Comme au Sénégal, il y a une compétition pour la ressource et le marché.

DIAW: Pourquoi certaines années la relation intensité de l'upwelling-taille du stock ne fonctionne-t-elle apparemment plus ?

KORANTENG: Nous pensons que lorsque le stock est effondré la réponse du stock aux fluctuations environnementales est d'une nature différente et peut être régie par d'autres facteurs que l'enrichissement trophique du milieu.

DIAW: Serait-il possible d'appliquer une répartition de l'effort de pêche entre les flottilles artisanales et industrielles sur le littoral ghanéen en tenant compte de l'espace ?

KORANTENG: Je ne pense pas. Le plateau continental est en effet réduit et permettrait difficilement son partage entre les différentes flottilles exploitant cette ressource.

BINET: A-t-on observé des changements dans la composition et l'abondance du plancton, parallèlement aux changements observés dans le rythme saisonnier des pluies ?

KORANTENG: Apparemment non. On a cependant constaté qu'il y avait moins de plancton lorsque les saisons sont anormales mais les variations saisonnières restent, semble-t-il, inchangées.

MARCHAL: Y a-t-il, au Ghana, un seul stock de sardinelles ?

KORANTENG: On ne peut pas, à l'heure actuelle, répondre à cette question. Certaines études (analyse spatiale des PUE, étude des biomasses par écho-intégration..) pourraient permettre de constater s'il existe une ségrégation spatiale.

MARCHAL: Concernant les estimations de biomasse réalisées par le N.O. *Fridjof Nansen*, il faut être prudent. En juillet-août les sardinelles sont en surface, les bancs sont alors mal échantillonnés par écho-intégration. Il serait préférable de planifier une campagne pendant une période où les sardinelles sont près du fond pour éviter ce genre de biais.

DIAW: A-t-on observé des migrations de pêcheurs simultanément à celles des sardinelles ?

KORANTENG: Les pêcheurs suivent les migrations

des sardinelles vers l'est, souvent jusqu'au Togo. A l'heure actuelle, ils se déplacent moins car l'utilisation des moteurs hors-bord leur permet d'atteindre des zones de pêche éloignées sans déplacer leur base à terre.

BINET: Y-a-t-il eu des changements dans les variations saisonnières de PUE ?

KORANTENG: On observe un décalage d'environ un mois dans le pic de PUE.

GARCIA: Etant donné qu'il y a pour chaque stock une ou deux générations par an, les variations saisonnières de PUE et les variations du rythme saisonnier d'une année sur l'autre sont difficiles à interpréter sans une connaissance de la démographie, de la composition en taille ou en âge (en particulier parce que les différents types de pêche peuvent changer de stratégie d'une année sur l'autre et même parfois d'un mois sur l'autre).

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