

## Movements of Skipjack in the Eastern Atlantic, from Results of Tagging by Japan

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Japan, as a member country of ICCAT, tagged skipjack for the International Skipjack Year Program in the eastern Atlantic during 1980 and 1981. Migration of skipjack was analyzed mainly based on Japanese tagging results. The movement of tagged skipjack could be traced for more than a year and a half through the commercial skipjack fisheries. The skipjack tagged and released in the third quarter of the year in the Gulf of Guinea were recovered from a broad area in the eastern Atlantic, and showed two apparent movements towards the southeast and northwest. Movement to the southeast occurred just after release, while that to the northwest began at the fourth quarter of the same year and continued during the next year. Judging from the number of recoveries, movement to the northwest seems more extensive than that to the southeast.

En tant que pays membre de l'ICCAT, le Japon a effectué du marquage de listao dans l'atlantique est en 1980 et 1981, dans le cadre du programme d'Année Internationale du Listao. L'analyse des migrations de l'espèce se base surtout sur les résultats du marquage japonais. Les déplacements des listaos marqués ont pu être suivis pendant plus de dix-huit mois à travers la pêcherie commerciale de cette espèce. Les listaos relâchés après marquage au cours du troisième trimestre dans le golfe de Guinée ont été récupérés dans une ample zone de l'Atlantique est, et montrent deux axes apparents de déplacement, vers le sud-est et vers le nord-ouest. Les déplacements vers le sud-est se produisaient juste après le marquage, alors que les déplacements inverses débutaient pendant le quatrième trimestre et se poursuivaient tout au long de l'année suivante. A en juger d'après le nombre de récupérations, les déplacements semblent plus importants vers le nord-ouest que vers le sud-est.

Durante 1980 y 1981, Japón, como país miembro de ICCAT, llevó a cabo actividades de marcado de listado, en el Atlántico Este, para el Programa Año Internacional del Listado. Se analizó la migración de esta especie tomando como base principal los resultados japoneses obtenidos del estudio de esta actividad. Se pudo seguir el movimiento de los listados portadores de marcas durante más de un año y medio, a través de pesquerías comerciales que perseguían esta especie. Los listados marcados y liberados en el tercer trimestre del año en el Golfo de Guinea fueron recuperados en una amplia zona del Atlántico Este, y mostraron dos movimientos aparentes hacia el Sudeste y Noroeste. Los movimientos hacia el Sudeste tuvieron lugar justamente después de ser liberados, mientras que los desplazamientos hacia el Noroeste dieron comienzo en el cuarto trimestre del mismo año y continuaron durante el año siguiente. A juzgar por el número de recuperaciones, el movimiento dirigido hacia el Noroeste parece ser más importante que el encaminado hacia el Sudeste.

### 1. Introduction

ICCAT's International Skipjack Year Program was established in 1979 to evaluate the feasibility of further development of commercial skipjack fisheries and to improve assessments of the stocks in the Atlantic Ocean (ICCAT 1980a). One of the primary activities of the Program was tagging, because tagging provides information on biology (growth and migration), stock structure and population parameters such as mortality rates, availability and mixing rates. Because of this importance, twelve of thirteen participating countries tagged skipjack, most of them in the eastern Atlantic Ocean (ICCAT 1981, 1982b).

Migration of skipjack has not yet been comprehensively studied, except for a preliminary analysis of Bard et al. (1983). However, general features of skipjack distribution related to fisheries were reported in various papers.

The purpose of this paper is to study skipjack migration in the eastern Atlantic Ocean using tagging

results obtained during the International Skipjack Year Program.

### 2. Tagging Method and Data Used in the Analysis

Japanese skipjack tagging during the Skipjack Program is described in detail by Kume (1981) and Yamaguchi and Kikawa (1982). Using a chartered baitboat based at Tema, Ghana, a total of 12,976 skipjack

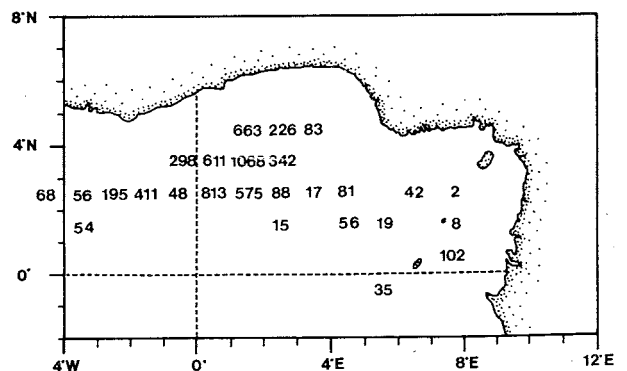


Figure 1. Number of skipjack released in 1980 by 1° square.

were tagged and released in the Gulf of Guinea during July, August and September in 1980, and July and August in 1981. Tagging was concentrated in the northern part of the Gulf of Guinea, mostly off Tema, and releases were recorded by 1° square (Fig. 1 and 2 for 1980 and 1981, respectively). In 1980 tagging was more widely scattered than in 1981. The size distribution of skipjack tagged in 1980 is bimodal, while that of 1981 is unimodal (Fig. 3). However, the majority of tagged fish ranged between 35 and 50 cm in fork length.

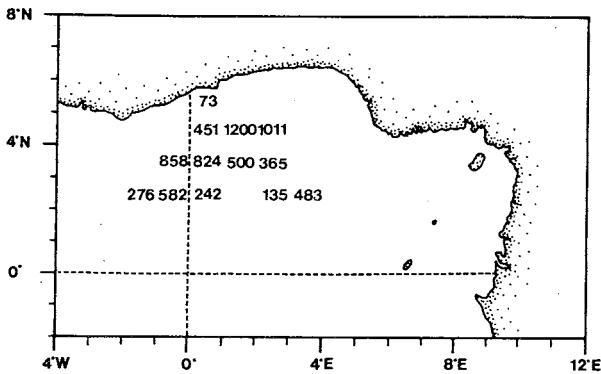


Figure 2. Number of skipjack released in 1981 by 1° square.

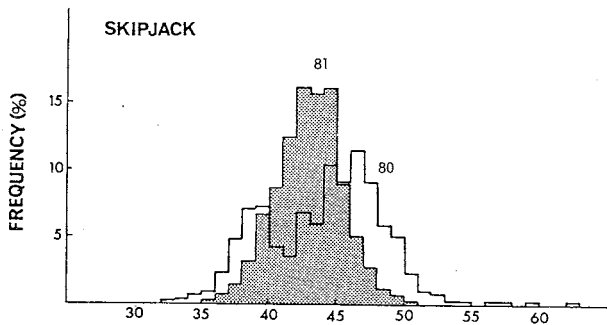


Figure 3. Length frequency distribution of tagged skipjack. The histogram for fish tagged in 1981 is shaded.

Two kinds of dart tags were used. One was yellow and made of vinyl tubing. The other was white and made of polyurethane.

As soon as the fish was hooked and swung aboard, it was laid on the tagging cradle to measure fork length. After the tag was inserted at the base of the second dorsal fin, the fish was quickly returned to the water. Usually these procedures took less than ten seconds. Damaged or badly tagged fish were not released.

This paper analyzes mainly the recovery data from the Japanese tagging program. Results obtained by

Senegal, the Republic of Cape Verde (Cayré et al. this volume) and other countries (Bard et al. 1983) are referred to for confirmation of the patterns of migration found in the Eastern Atlantic. From the total recoveries of the Japanese tagging program, almost one third were excluded because the area or date of recapture was unavailable.

### 3. Results

#### 3.1 AREA OF RECOVERY

Recoveries were reported from a broad area extending from 14°S to 27°N in latitude, and from 24°W to 13°E in longitude (Figs. 4 and 5). However, the majority were reported from the area 4°S–15°N and 20°W–10°E, being concentrated in the area from 0°–5°N and 6°W–3°E. The area of recapture closely coincides with the general skipjack fishing grounds as shown in the Introduction to this volume.

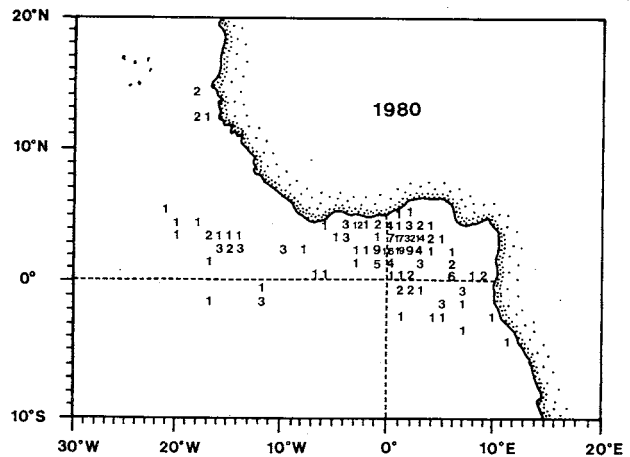


Figure 4. Distribution of the recoveries for tagged skipjack in 1980. Numerals show the number of recoveries by 1° square.

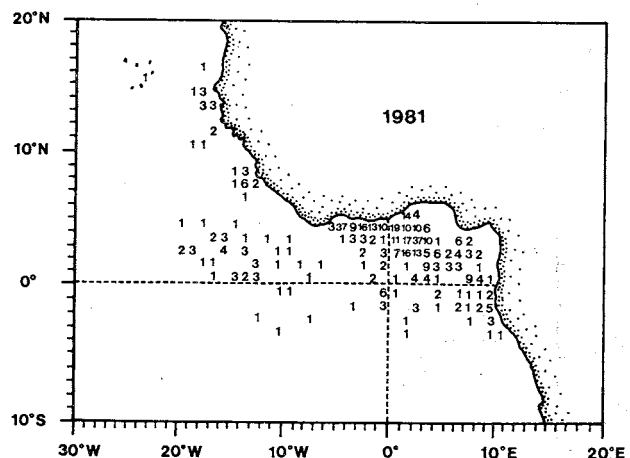


Figure 5. Distribution of the recoveries for tagged skipjack in 1981. Numerals show the number of recoveries by 1° square. Three recoveries were reported from outside this figure at 27°N, 15°W; 14°S, 10°E; and 13°S, 12°E.

3.2 RECOVERY BY FISHING GEAR

Tagged skipjack were mainly recaptured by purse seine and by pole-and-line from bait-boats (Table 1). In 1981, most recoveries (68%) were by purse seine. Recoveries by pole-and-line were chiefly from inside the Gulf of Guinea (Figs. 6 and 8). On the contrary, many of the recoveries by purse seine were from the area north of the equator between 10°W and 20°W, that is, west of the Gulf, or off Dakar north of 10°N (Figs. 7 and 9). This difference reflected the differing use of gear on the two fishing grounds.

Table 1. Number of recoveries by year for tagged skipjack released in 1980 and 1981.

YEAR	Baitboat	Purse Seine	Unknown	Other	TOTAL
1980	167	173	115	1	456
1981	154	501	86	0	741

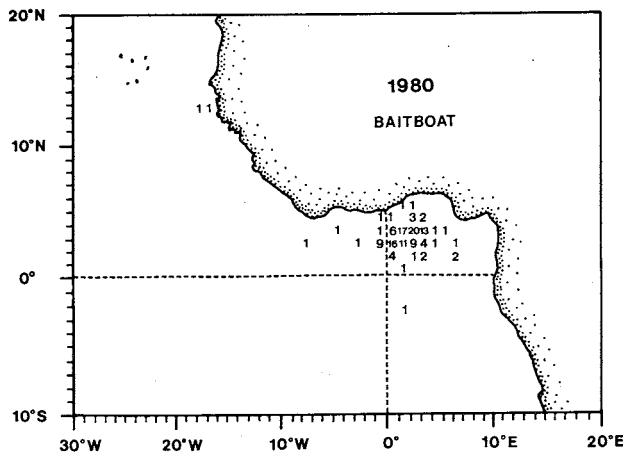


Figure 6. Distribution of recoveries by baitboat fishery, for skipjack tagged in 1980.

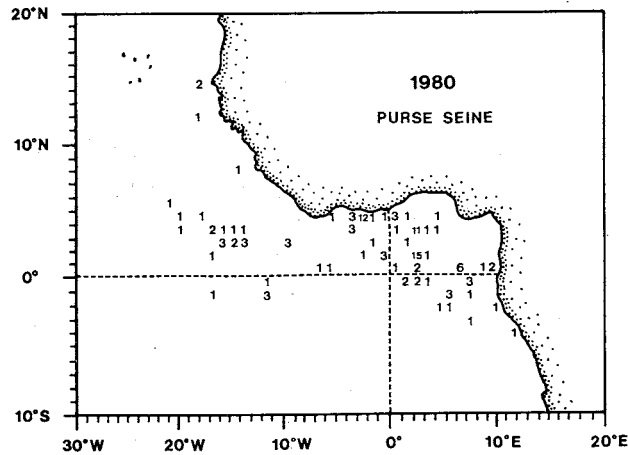


Figure 7. Distribution of recoveries by purse-seine fishery, for skipjack tagged in 1980.

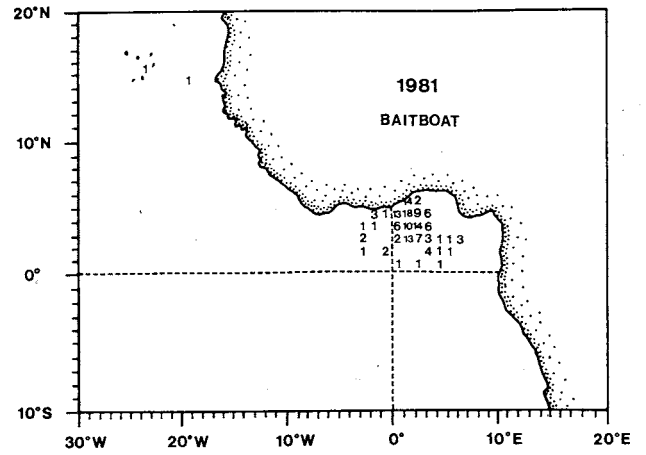


Figure 8. Distribution of recoveries by baitboat fishery, for skipjack tagged in 1981.

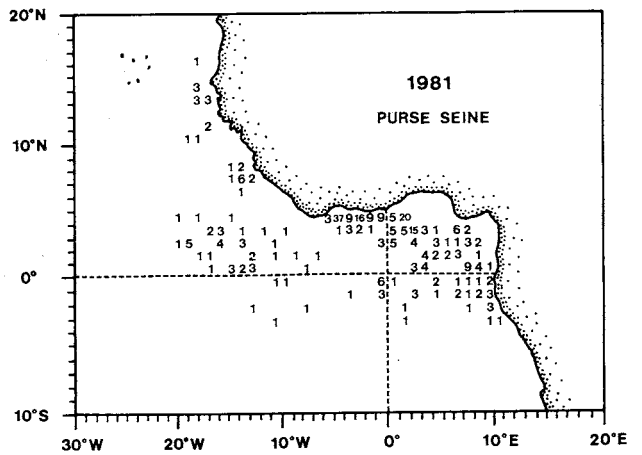


Figure 9. Distribution of recoveries by purse-seine fishery, for skipjack tagged in 1981. One recovery came from outside this figure, off Angola (13°S, 12°E).

3.3 NUMBER OF RECOVERIES BY MONTH

By the end of May 1983, a total of 1,197 recoveries were reported, of which 784 were accompanied with known date and location (Table 2). Recoveries peaked in September, and remained high until Febru-

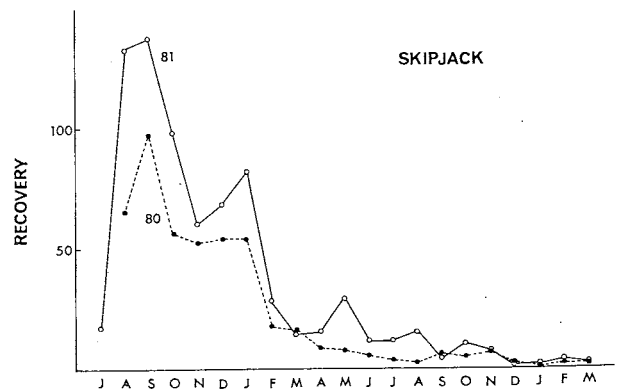


Figure 10. Recoveries by month of skipjack tagged and released in 1980 (broken line) and 1981 (solid line).

ary when they suddenly dropped (Fig. 10). After the following summer, few recoveries were reported. The latest reported recovery from the 1980 tagging was in March 1982, and likewise the latest from 1981 tagging was in March 1983.

Table 2. Total recoveries and recoveries with known recovery locations (in parentheses) for releases in 1980 and 1981.

Month of recovery	Year of release		
	1980	1981	ALL
July	0 (0)	17 (17)	17 (17)
Aug.	65 (46)	132 (43)	197 (89)
Sep.	97 (74)	137 (98)	234 (172)
Oct.	56 (40)	97 (80)	153 (120)
Nov.	52 (38)	60 (47)	112 (85)
Dec.	54 (28)	68 (51)	122 (79)
Jan.	54 (15)	81 (68)	135 (83)
Feb.	17 (6)	28 (16)	45 (22)
Mar.	16 (3)	14 (12)	30 (15)
Apr.	8 (5)	15 (11)	23 (16)
May	7 (5)	29 (21)	36 (26)
June	5 (1)	11 (7)	16 (8)
July	3 (0)	11 (8)	14 (8)
Aug.	2 (0)	15 (12)	17 (12)
Sep.	6 (3)	4 (2)	10 (5)
Oct.	4 (1)	10 (9)	14 (10)
Nov.	6 (2)	6 (6)	12 (8)
Dec.	2 (1)	1 (1)	3 (2)
Jan.	0 (0)	1 (1)	1 (1)
Feb.	1 (1)	3 (3)	4 (4)
Mar.	1 (1)	1 (1)	2 (2)
TOTAL	456 (270)	741 (514)	1197 (784)

### 3.4 THE COURSE OF RECOVERY THROUGH TIME

The trends in the monthly rates of recovery are similar between 1980 and 1981 (Fig. 10). This similarity suggests the behaviour and/or mortality of skipjack were the same in the two years, justifying the combination of data in further analyses.

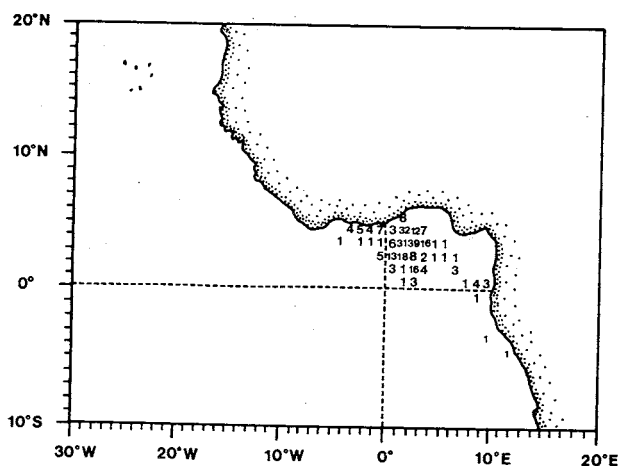


Figure 11. Location, by 1° square, of recoveries in the third quarter of fish released in 1980 and 1981. Two recoveries were reported from outside this figure, (14°S, 10°E) and (13°S, 12°E).

The distribution of recoveries of the tagged fish by quarter year can be summarized as follows:

3rd quarter (release year): Most of the recoveries were reported from the tagging area, but some were from near Point Noire, indicating a southeasterly movement of the fish. The most southerly recovery was reported from off Angola (Fig. 11).

4th quarter: More than 10% of the recoveries in this quarter came from west of 10°W and between 0°–5°N. Most of the tagged fish still remained in the tagging area (Fig. 12).

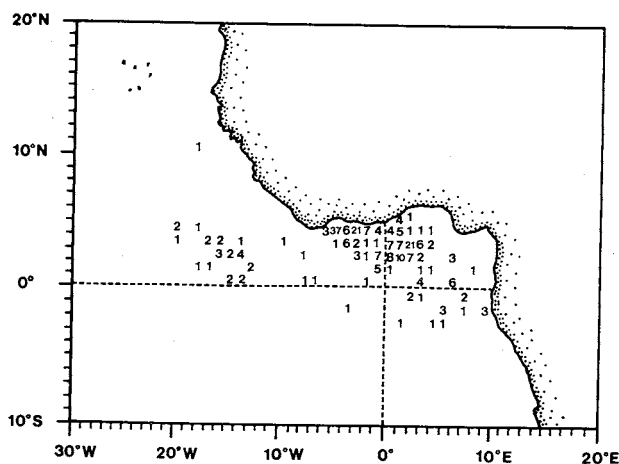


Figure 12. As in 11, but for recoveries in the fourth quarter.

1st quarter (2nd year): As a whole, the area of recoveries shifted to the south by two or three degrees in latitude. Recovery points dispersed to offshore especially in the eastern Gulf of Guinea (Fig. 13). The number of recoveries decreased significantly in February (Fig. 10).

2nd quarter: The first recoveries in the area north of 5°N (i.e. off Freetown and Dakar) were reported in April (Fig. 14).

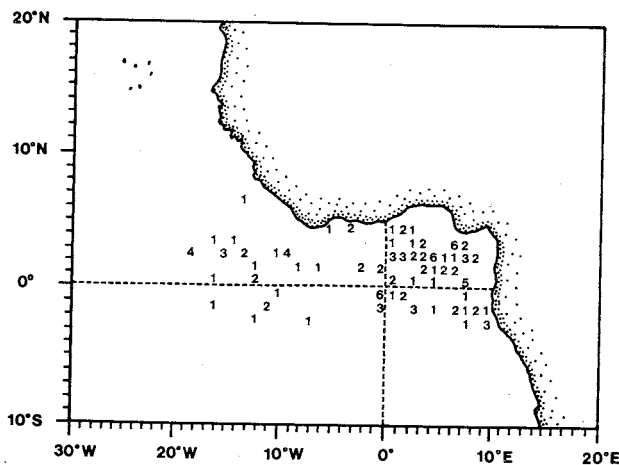


Figure 13. As in 11, but for the first quarter in the year after tagging.



First there is a southeasterly movement of skipjack from the center of the Gulf of Guinea in summer. Some fish may reach Angola in September, but judging from the small number of recoveries, this movement does not appear extensive. A later more extensive movement begins in October towards the west, the fish reaching the area of  $0^{\circ}$ – $5^{\circ}$ N and  $10^{\circ}$ – $20^{\circ}$ W in November. At least some of these fish migrate northwards during April, and by July or August reach areas off Dakar or even the Canary Islands. After September, recoveries again exhibit a gradual shifting to the south. Thereafter the fish do not show any particular movement, and only a small number of tagged fish were caught in offshore areas of the Gulf of Guinea. They apparently either move outside the area of the fishery or become invulnerable to the fishing gear. Cayré et al. (this volume) showed that skipjack off Cape Verde and Senegal move south to the western part of the Gulf of Guinea, but do not appear to make any further migration to the south or southeast of the Gulf.

Bard et al. (1983) made a preliminary analysis of skipjack movements in the eastern Atlantic from tagging by various countries during the Skipjack Program. The fish tagged off Dakar or Cape Verde moved southeastward, while those tagged off Point Noire moved northwestward. These facts suggest that skipjack in the Gulf of Guinea make seasonal southeast-northwestward and reverse migrations from the Gulf to Point Noire, and from the Gulf to an area off Dakar or Freetown, respectively. According to the present study, however, recoveries in the tagging area and around Cape Lopez were reported continuously for more than a year. This indicates that skipjack in the center of the Gulf of Guinea are a mixed population showing different migratory patterns.

The probability of recovery of a tagged fish depends not only upon the movement of the fish, but also on the fishing effort in the area to which it migrated. Since the recovery data comes only from

the commercial fishery in the eastern Atlantic, it is impossible to know of the existence of a tagged fish where there is no fishery. Current fisheries for skipjack do not cover the entire eastern Atlantic. Since the number of reported recoveries decreases considerably during the February following tagging, dispersion of the fish from the Gulf of Guinea to offshore or outside the fishery probably takes place at this time of the year, although a small percentage of the fish continue to remain in the Gulf.

Tagging during the skipjack program has greatly improved our understanding of the biology of skipjack in the eastern Atlantic. However, several questions still remain concerning migrations of younger and maturing fishes, the mixing rate of the fishes that make different migrations, and how dispersion occurs. A tagging program developed on a more or less continuous temporal spatial basis is desirable in the future. This will greatly improve the information on migratory pattern and stock structure of skipjack in the eastern Atlantic.

## 5. Conclusion

Migration of skipjack in the eastern Atlantic is analyzed based on tagging results during the International Skipjack Year Program. Results are as follows:

- 1) The skipjack which are concentrated in the Gulf of Guinea at the third quarter of the year make a wide ranging migration in the eastern Atlantic.
- 2) There are two apparent movements towards the northwest and southeast from the Gulf of Guinea.
- 3) The degree of migration varies greatly among individual skipjack.
- 4) It is suggested that a large dispersion of fish in the Gulf of Guinea occurs in February.