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# REPORT AND PRELIMINARY RESULTS OF THE TAGGING PROGRAMME OF NATURAL DRIFT LOGS IN THE TUNA PURSE SEINE FISHERY AREA OF THE WESTERN INDIAN OCEAN

by

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## ABSTRACT

A tagging programme of natural drifting logs in the Western Indian Ocean was initiated by the "Association Thonière" (Indian Ocean Commission). The tagging operations of 109 logs and the survey of these logs are described and discussed. The 139 recorded fishing operations indicate a mean species composition (yellowfin: 19.8%; skipjack: 65.0%, bigeye: 10.1%, others 5.1%) which highlight a fair percentage of bigeye. This species composition, which diverge from previous data, can be explained by the depth of the nets used by the different purse seiners fleets reporting the catches.

The drift and fishing sequences of 64 logs are discussed and support the hypothesis of a 15 days period necessary to renew the exploitable concentration of tunas around logs. Due to the effects (species composition, size of the fishes) of logs in the concentration of tunas, further experiments are recommended to investigate the impact of a possible growing use of logs in the assessment of tuna stocks.

The survey of tagged natural drifting logs in the Western Indian Ocean has provided qualitative and quantitative information on the surface circulation. These first observations are quite consistent with the major patterns already described in the literature. In the future, such deployments should be pursued with a more intensive sampling effort in order to identify possible long range movements, especially between the Mozambique Channel and the Somali basin. These findings would bring valuable information for a better knowledge on tuna movements, as some observations (tuna tagging experiment) already support the idea of a northwards migratory flow between those two active fishing areas.

## RESUME

Un programme de marquage d'épaves naturelles a été lancé en 1988 dans l'Océan Indien ouest par l'Association Thonière (Commission de l'Océan Indien). Le marquage et le suivi de 109 épaves marquées sont décrits. Les 139 opérations de pêche enregistrées à ce jour sur ces épaves indiquent une composition spécifique des captures (albacore: 19,8%; listao 65,0%; patudo: 10,1%; divers: 5,1%) d'ù ressort une forte proportion de patudo. Ce résultat qui diffère de ceux rapportés jusqu'à présent pour les flotilles française et espagnole peut s'expliquer par la profondeur des sennes utilisées par les différentes flotilles.

Les séquences de dérive et d'opération de pêche de 64 épaves sont analysées. Cette analyse permet de formuler l'hypothèse selon laquelle une période de 15 jours environ serait nécessaire à la restauration des concentrations de thons exploitables autour des épaves. En raison des divers effets des épaves sur la nature des concentrations (composition spécifique, taille des poissons), il est recommandé de continuer l'expérience de marquage d'épave afin de disposer d'éléments permettant d'estimer l'impact potentiel d'un accroissement probable de cette méthode d'exploitation ( à l'aide d'épave) sur la dynamique des ressources thonières.

Le suivi des épaves naturelles dérivantes dans l'Océan Indien Ouest donne d'intéressantes informations qualitatives et quantitatives sur la circulation océanique de surface. Ces premiers résultats concordent bien avec les schémas généraux de circulation déjà décrits. L'expérience de marquage et de suivi d'épaves devrait être poursuivie et intensifiée pour permettre une meilleure description des mouvements à plus grande échelle, tout particulièrement des mouvements existants entre le Canal de Mozambique et le bassin de Somalie. Ces résultats devraient fournir matière à une meilleure connaissance des déplacements des thons entre ces deux importantes zones de pêche, déplacements déjà indiqués par d'autres méthodes (marquage).

## 1. INTRODUCTION

Natural drifting logs and floating objects of any kind are commonly used by industrial purse seiners to harvest tropical tunas : yellowfin (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*), bigeye (*Thunnus obesus*), in the Indian Ocean (HALLIER, 1985; STEQUERT and MARSAC, 1986) as well as in other oceans (STRETTA and SLEPOUKHA, 1986).

The C.O.I. ("Commission de l'Océan Indien"), with its Regional Tuna Project conducted within the frame of the "Association Thonière" a tagging program of natural drifting logs encountered in the open ocean, in order to get a more precise knowledge on this particular way of exploiting tunas as well as on the movements of these natural drifting logs in the South Western part of the Indian Ocean.

This method should also allow to get new insights into the mecanisms of concentration of the different species of tuna in the neighbourhood of these floating logs. This Paper gives informations on the present status of this research activity (which is still going on) and reports on the results obtained during the years 1988 and 1989.

## 2. MATERIALS AND METHOD

PVC pannels measuring 30 x 30 cm were used as tags. Each pannel is painted with bright colours (yellow and orange) resistant to the sea water corosion. A number and some identification words about the institution responsible for the tagging programme, are printed on each tag. All the surface of the tag is protected against ultraviolet agression by a special varnish. A small (12 x 20 cm) additional pannel to be fixed on the log by the tag itself, gives short informations in 3 languages (English, French and Spanish) to the fishermen about the observations to be noted when they encounter a tagged log at sea. Tags and additional pannels are securely fixed to the logs with long rustproof nails.

A large publicity was made to inform the fishermen about the tagging programme and its goals. Specially painted logbooks were distributed to captains of the purse seiners. These logbooks are designed to note informations about the date, position, number of the observed tags and precise description of the fishing operations.

The tagging operations reported here were performed by the vessel ("MASCAROI") chartered by the Regional Tuna Project, and by some kindly cooperating captains of French, spanish and Japanese purse seiners. Observations of tagged logs were reported by captains of the purse seiners (French, Spanish and Japanese) and namely by scientific observers of the Seychelles Fishing Authority (SFA) aboard purse seiners as well as by the Japanse purse seiner ("NIPPON MARU") chartered by JAMARC (Japan Marine Fishery Resource Research Centre). All the observation reported on logbooks were carefully collected and checked by ORSTOM and SFA in a cooperative action at the main landing place of the purse seiners fleet in Victoria harbour (Seychelles).

## 3. RESULTS

### 3.1. Tagging operations

Most part of the 109 taggings of natural logs was done during 1989, as well as the subsequent fishing and drift observations made on the tagged logs (Table 1).

| | Number of tagged logs | Number of observations made after tagging | Number of fishing operations recorded on tagged logs | TOTAL REPORTED CATCHES (metric tons) YF | SJ | BE | OTH | TOTAL | Mean catch per set (tons) |
|---|---|---|---|---|---|---|---|---|---|
| 1988 | 8 | | | | | | | | |
| 1989 | 101 | 237 | 139 | 619.2 (19.8%) | 2031.4 (65.0%) | 314.6 (10.1%) | 159.0 (5.1%) | 3124.2 | 22.5 |

YF = Yellowfin; SJ = Skipjack; BE = Big eye; OTH = Undetermined and other species

TABLE 1 : Summary results of the tagging operation of natural drift logs and of the fishing operations made on previously tagged logs.

### 3.2. Drift of the tagged logs

The results of this tagging operation were analysed according to 4 periods that are relevant to different hydrological seasons in the Western Indian Ocean. From December to March, the north-east monsoon prevails. The wind flux is moderate; it blows from the north-east in the northern hemisphere, and shifts to the north-west south of equator. The second monsoon, which is active from June to September, generates winds blowing strongly from the south-east in the southern hemisphere, and from the south-west north of equator. The periods between these two events are called intermonsoons with westerlies blowing along the equator.

The effect on the ocean results in a wind-driven seasonal circulation in the whole basin, very well described in oceanographic atlas (WYRTKI, 1971; HASTENRATH and LAMB, 1979) and summarized in figure 2. The observed drifts of the natural logs highlight the main features of this circulation.

From December to March-April (fig. 3a), the eastward drift is the South Equatorial Counter Current (SECC), which is typically a seasonal current observed during the north-east monsoon. It stretches between 2°S and 9°S, which are the limits of two other currents flowing westwards, the North Equatorial Current (NEC) and the South Equatorial Current (SEC). The northern boundary is a convergence area while the southern boundary is a divergence with a shallow thermocline (20 m depth). The average velocity of the SECC ranges from 1 to 1.5 knots. PITON and MAGNIER (1975) estimated the water transport to 1 million cubic metres per second (≈ 1 Sverdrup). In the present experiment, the logs were drifting in a northestward direction, since the water mass moves towards the convergence.

Few data were gathered during the April-May intermonsoon (fig. 3b). The eastward drift between 3°S and 5°S is an indication of the remaining SECC. In the northern Mozambique Channel, we have a slight evidence of the anticyclonic gyre. As described by PITON et al. (1981) and SAETRE (1984), the circulation is strongly influenced by the basin's shape and the seabed topography (especially the narrowness of the channel central part). The SEC rounds the northern tip of Madagascar and continues west to reach the Mozambique coast between 10°S and 12°S, then partly shifts to the south and feeds an eastward flow, south of Comoros islands, that crosses the Channel thus far the north-west coast of Madagascar.

During the boreal summer monsoon (June-September), tagging was carried out in the Somali basin, north (2°N) of equator (fig. 3c), the logs drift clearly to the east. From 0° to 2° N, some return drifts to the west are observed. The general eastwards drift is the result of the Southwest Monsoon Current, but little eddies that were observed by PITON (1976) along the equator could explain the return drifts of some logs.

The drifts observed during the October-November intermonsoon (fig. 3d) are in fully accordance with the strong equatorial jet well documented by WYRTKI (1973) and KNOX (1976). Due to its eastwards direction, this current is trapped on the equator, within a 500 km width belt, and the velocity can reach as much as 3 knots. Drifting buoys launched during this period in 1979, 1980 and 1981 (fig. 4) show a straight drift to the east as far as 80°E, with an average speed of 1.5 knot (1980) and 2 knots (1981). The average drifting speed : 1.4 knots calculated from 11 important apparently straight Eastwards drifts of tagged logs observed during this period (figure 3d), is quite consistent with the previous observations.

### 3.3. Recorded catches around tagged logs

As a whole 237 observations including date, position and fishing data were made on previously tagged logs (Table 1); among these observations 139 fishing operations (i.e. purse seine sets) were recorded : Table 1. As one can understand several observations can proceed from the same log when this tagged log was successively harvested or spotted during its drift at sea. Thus 93 tagged logs were observed at least one time after tagging; the different observations made log by log were grouped into 93 sequences. The longest sequence as recorded by now, last 97 days with 11 observations (7 with successful fishing operation) made during this 97 days sequence (figure 5).

Moreover 64 of these 93 sequences include at least one fishing operation and provide opportunities to be analysed.

4. DISCUSSION

- **Species composition of the catches**

Skipjack tuna represents the most important proportion (65%) of the total catch made around tagged logs (Table 2) but bigeye tuna is fairly well represented as well (10.1%). This fair proportion of bigeye tuna has to be compared with the species composition of the catches made around natural logs by the French and Spanish purse seiners. As reported by HALLIER (1990) for the fishing year 1989 using the most recent method of estimation the species composition of the catches of the French and Spanish fleet is: yellowfin, 33.9%; skipjack, 60.0%; bigeye, 6.1%.

| PURSE SEINER FLAG | YF | SJ | BE | OTH | TOTAL |
|---|---|---|---|---|---|
| JAPAN | 425.6<br>(20.7%) | 1321.9<br>(64.4%) | 272.6<br>(13.3%) | 32.0<br>( 1.6%) | 2052.1 |
| FRENCH + SPANISH | 193.6<br>(19.8%) | 709.5<br>(65.0%) | 42.0<br>( 3.9%) | 127.0<br>(11.8%) | 1072.1 |
| TOTAL | 619.2<br>(19.8%) | 2031.4<br>(65.0%) | 314.6<br>(10.1%) | 159.0<br>( 5.1%) | 3124.2 |

TABLE 2 : Species composition of catches (MT) made by 2 types of purse seiners around the tagged logs (YF = Yellowfin; SJ = Skipjack; BE = Big eye; OTH = Undetermined and other species)

The discrepancy observed between these 2 results, mainly in the bigeye tuna proportion (10.1% v.s. 6.1%), could be explained by the depth of the net used in the different fishing fleets. Fishing data we report proceed mainly (65.7% of the total catch) from Japanese purse seiners (Table 2) which nets are much deeper (≃ 250 m) than the other fleets ones (180-230 m). As indicated in Table 2 the species composition of the catches made by the only French and Spanish fleet is much more similar with the results updated by HALLIER (1990) specially if we look at the small proportion of bigeye (3.9%). Moreover the high proportion of bigeye (13.3%) in the Japanese catches is similar to the one observed in the Mauritian purse seiners (CAYRE et al., 1990) which are operated in a Mauritius - Japan joint venture: yellowfin, 19.5%; skipjack, 65.0%; bigeye, 15.0%. So far, the depth of the net seems to have a significant impact on the species composition of the catch. As the use of logs (natural or man made ones) tends to increase, the depth of the nets should be carefully taken into account in the future analysis of the exploitation of tuna.

- **Successive catches made around logs**

As a whole the mean catch by successful set made around tagged logs (22.5 t) is quite similar with the one reported by MONTAUDOUIN and HALLIER (1990) from observers data (19.8 t for 1989).

If we combine all the data of the 64 "fishing sequences" observed on tagged logs (each sequence can include both successful sets and simple observations of the absence of tunas around spotted log) it is of interest to note that the mean catch by visit of the log seems to grow with the time at sea of the log (figure 6a). But it is important to note the sharp corresponding decrease in the number of observations (figure 6b) which make questionable the significance of this apparent growing catch specially for the data gathered over 50 days (figure 6b).

More interesting is the apparent modal distribution of the catches in regards with the time. Three modes appear centered at 2, 17 and 37 days. This observation tends to support the hypothesis stating that a mean time of 15 days is necessary to renew the amount of tunas aggregated around the logs in a sufficient volume to be exploited by purse seiners.

As noted by HALLIER (1990) it is rare that more than 3 consecutive sets (one day apart) are made on the same log; our present data confirm this observation.

## CONCLUSION

The tagging of natural logs seems quite a valuable method to investigate the movements of the drifting logs, and thus precise oceanographical features of the Indian Ocean circulation, as well as the pattern of the concentration of tunas around logs and the exploitation of these aggregated fishes.

The analysis of the data gathered by now, yields results which are consistent with previous analysis. The period of turnover of the harvested concentrations of tunas around log (15 days hypothesis) and the evolution of the nature (species and sizes of the fishes) of the concentration has still to be carefully investigated. The experiment has to be carried on in order to evaluate the possible impact a growing use of logs could have on the management of tuna resources.

The drifting patterns evidenced by this experiment are similar to those described during oceanographic cruises. Additional deployments are recommended and should be focused to the identification of long range movements. This kind of experiment would also allow to estimate the residence time of the logs in the so called "great whirl", located between 5°N and 9°N in the Somali basin. As a matter of fact, it seems possible that logs found in the Northern Mozambique Channel in the first quarter of the year could travel north within the East African Coast Current that feeds into the Somali Current during the south-west monsoon, and therefore be found in the anticyclonic gyre off Somalia. A better knowledge of the drifting patterns in this area is recommended due to the high level of catch recorded by purse seiners targetting on logs from August to October and due to the indication of a northwards migratory flow of tunas exploited in this area, as recently showed by some tagging experiments (CAYRE and RAMCHARRUN, 1990).

# REFERENCES


Cayré P., D. Norungee, C. Bègue, 1990. Catches and landings of tuna in Mauritius from 1987 to 1989 and descriptions of the 1989 Mauritian purse seine fishery: distribution and size composition of the catches. Indo Pacific Tuna Development Programme, Expert Consultation on Stock Assessment of Tunas in the Indian Ocean, 2-6 July 1990, Bangkok, Thailand; **Doc. TWS/90/60**, 10 p.

Cayré P., B. Ramcharrun 1990. Results of the tagging operations conducted within the Regional Tuna Project (Indian Ocean Commission) in 1988 and 1989. Indo Pacific Tuna Development Programme, Expert Consultation on Stock Assessment of Tunas in the Indian Ocean, 2-6 July 1990, Bangkok, Thailand; **Doc. TWS/90/61**, 10 p.

Fieux M., A. Kartavtseff, 1985. Campagne" SINODE" à bord du MARION DUFRESNE. Vol. 1. Routines 1980-1983. Publ. Mission Rech. Terres Aust. Antart. Fr., **(85-02)**: 126 p.

Hallier J. P., 1985. Purse seining on debris-associated schools in the Western Indian Ocean. IPTP Collective Volume of documents, **TWS/85/30**, 150-156.

Hallier J. P., 1990. Tuna fishing on log associated schools in the Western Indian Ocean : an aggregation behaviour. Indo Pacific Tuna Development Programme, Expert Consultation on Stock Assessment of Tunas in the Indian Ocean, 2-6 July 1990, Bangkok, Thailand; **Doc. TWS/90/66**, 35 p.

Hastenrath S., P. J. Lamb 1979. Climatic atlas of the Indian Ocean. Part 1 : surface climate and atmospheric circulation. Madison, Wisconsin, University of Wisconsin Press : 97 p

Knox R. A. 1976. On a long series of measurements of Indian Ocean equatorial currents near Addu Atoll. Deep Sea Res., **23 (3)** : 211-221.

Montaudouin (de) X., J.P. Hallier 1990. Purse seine net durations and their incidence on the purse seine searching efforts in the Western Indian Ocean. IPTP, TWS/90/49

Piton B., Y. Magnier 1975. Remarques sur la circulation et les caractéristiques hydrologiques de la couche superficielle entre Madagascar et l'équatuer. Cah. ORSTOM (Sér. Océanogr.), **13 (2)** : 117-132.

Piton B., 1976. Particularités météorologiques et océanographiques des parages du banc des Seychelles (Océan Indien). Cah. ORSTOM (Sér. Océanogr.), **14 (4)** : 289-299.

Piton B., J. H. Pointeau, J. S. Ngoumbi 1981. Atlas hydrologique du canal de Mozambique (Océan Indien). Trav. Doc. ORSTOM, Paris, **(132)** : 41 p.

Saetre R., A.J. Da Silva, 1984. The circulation of the Mozambique Channel, Deep Sea Res. (An Oceanogr. Res. Pap.) **18 (1)** : 1-22.

Stequert B., F. Marsac, 1986. La pêche de surface des thonidés tropicaux dans l'Océan Indien. FAO. Doc. Tech. Pêches, **282**: 213 p.

Stretta J. M., M. Slepoukha, 1986. Analyse des facteurs biotiques et abiotiques associés aux bancs de thons Comptes-rendus de la conférence ICCAT sur le programme de l'année internationale du listao: 161-169.

Wyrtki K., 1971. Oceanographic atlas of the International Indian Ocean Expedition. Washington, D.C., National Science Foundation, 531 p.

Wyrtki K., 1973. An equatorial jet in the Indian Ocean. Science, Wash., **181** : 262-264.

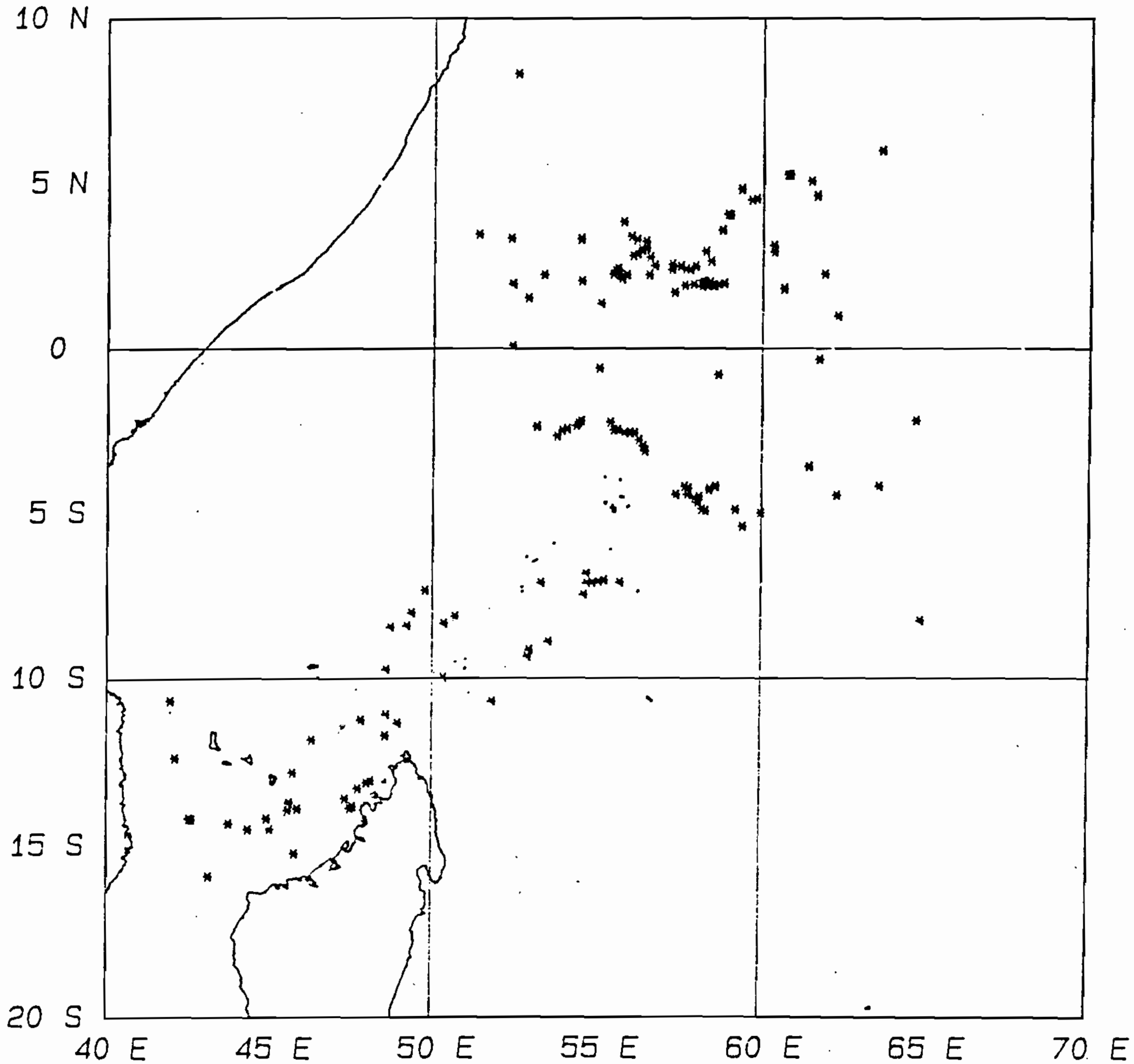



Figure 1: Location of the tagging operations of natural drift logs performed during 1988 and 1989

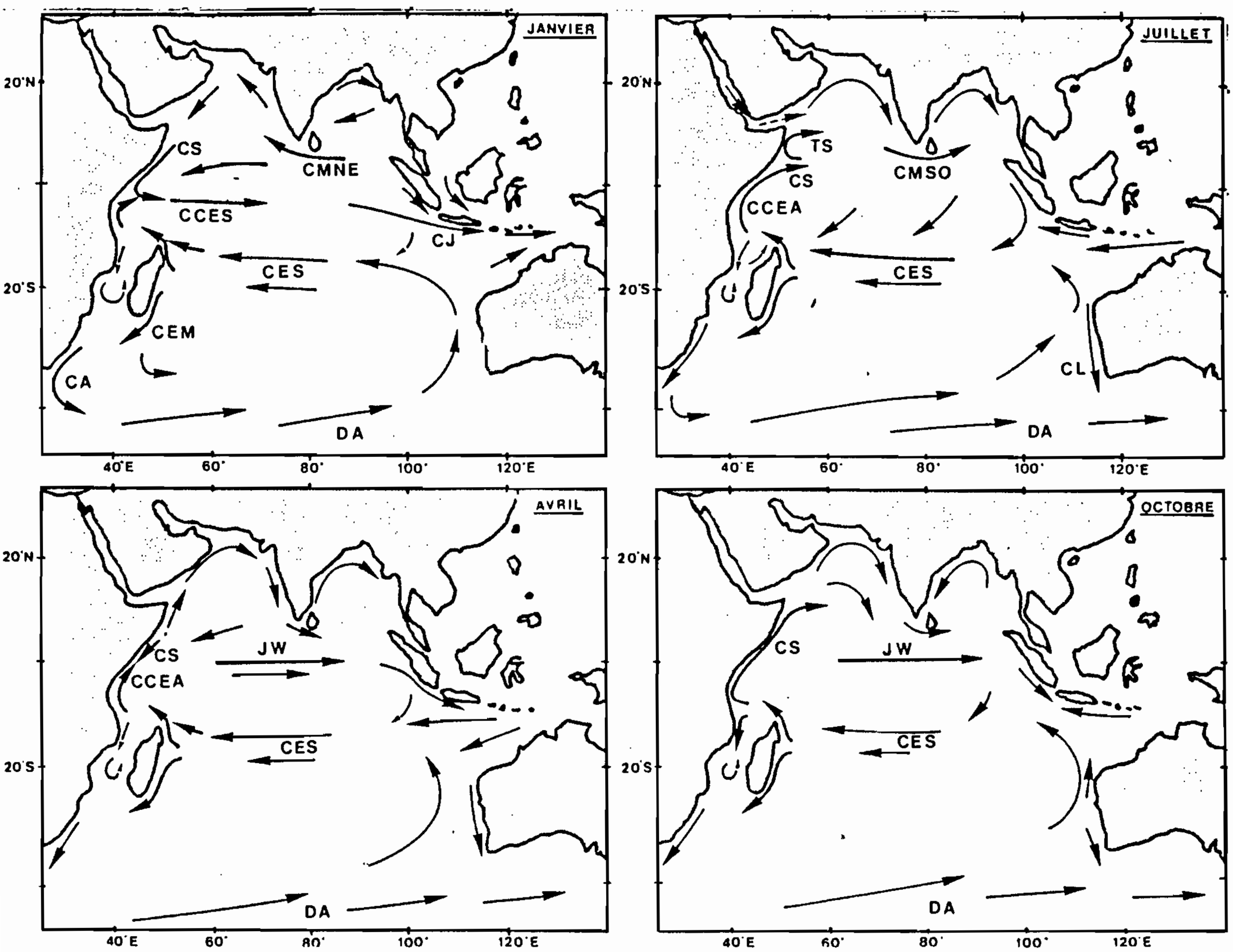
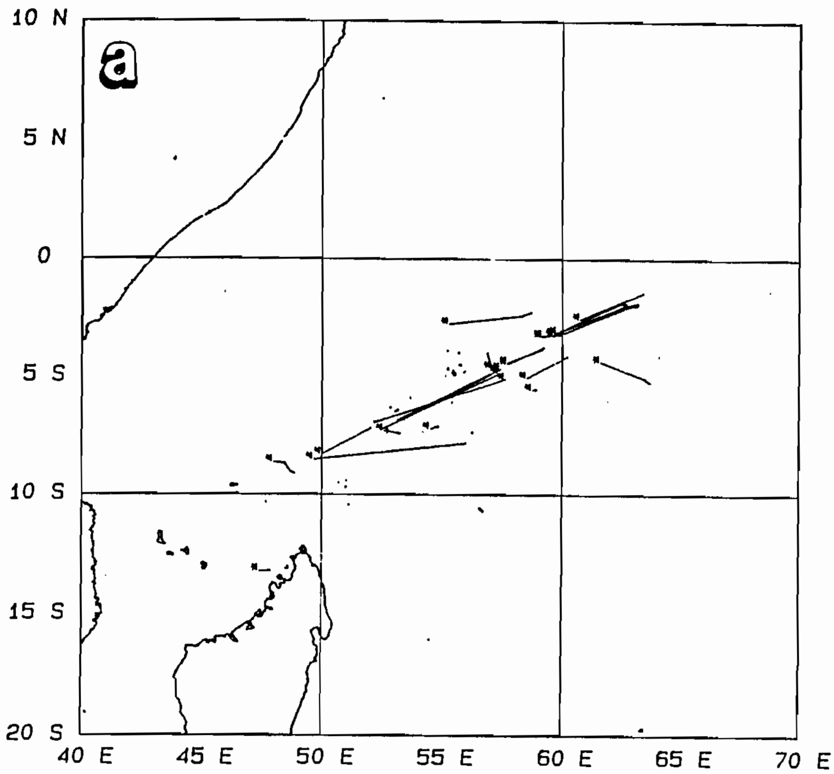



**Figure 2 :** Surface currents in January, April, July and October (from Fieux, 1985; in Stequert and Marsac 1986)

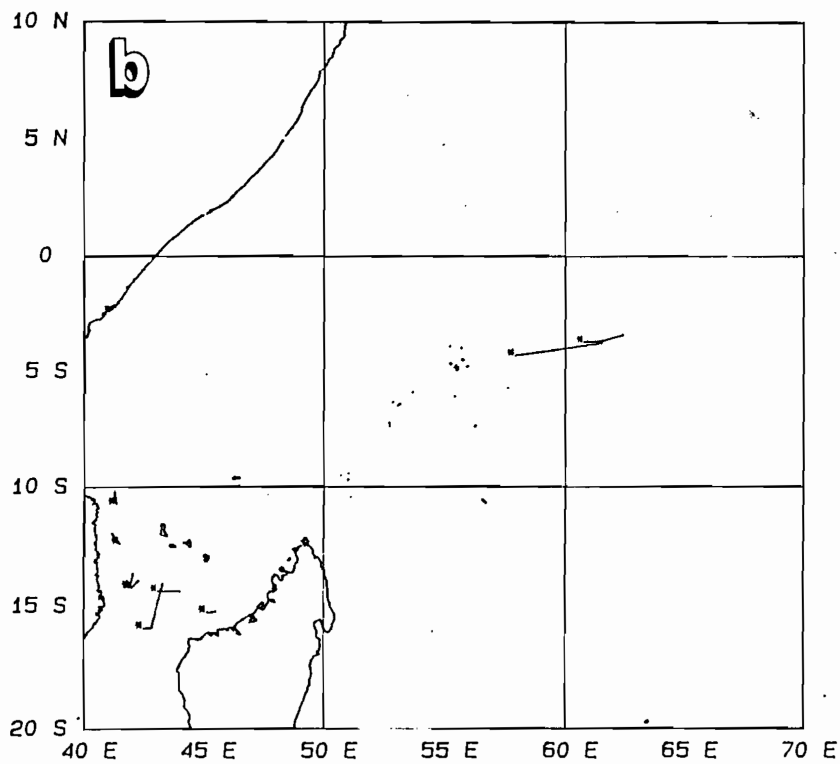
**LEGEND :**

| | | |
|---|---|---|
| CS | : | Somalia Current |
| TS | : | Somalia Vortex |
| CMNE | : | Drift current of the north-east monsoon |
| CMSO | : | Drift current of the south-west monsoon |
| CCES | : | South equatorial counter current |
| CCEA | : | East African coastal current |
| CES | : | South Equatorial current (SEC) |
| JW | : | Equatorial Wyrtki jet |
| CJ | : | Java current |
| CEM | : | Current of East Madagascar |
| CA | : | Aiguilles current |
| CL | : | Leuwin current |
| DA | : | Antartic drift |

**Figure 3 :** Drift of the tagged logs observed during 4 periods:

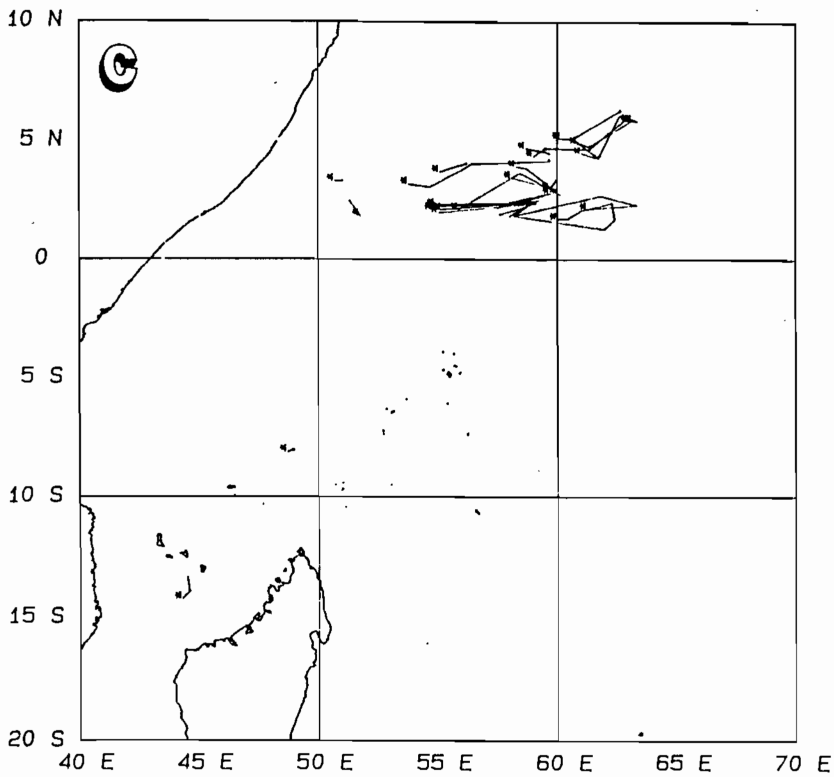



* A) 1st December - 31st March

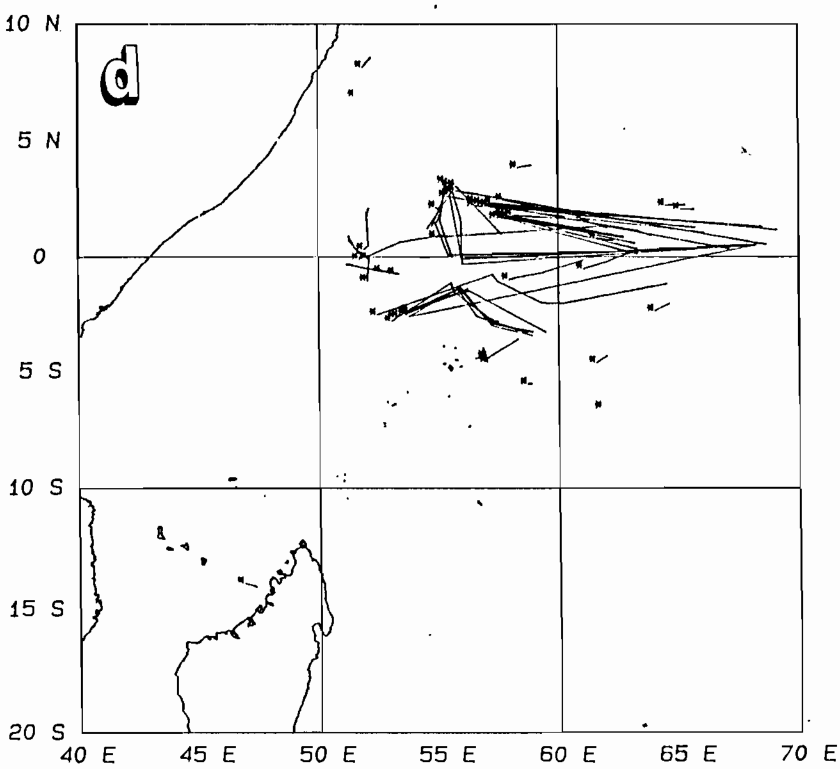



* B) 1st April - 31st May

**Figure 3 :** (Continued)




* C) 1st June - 30th September




* D) 1st October - 30th November

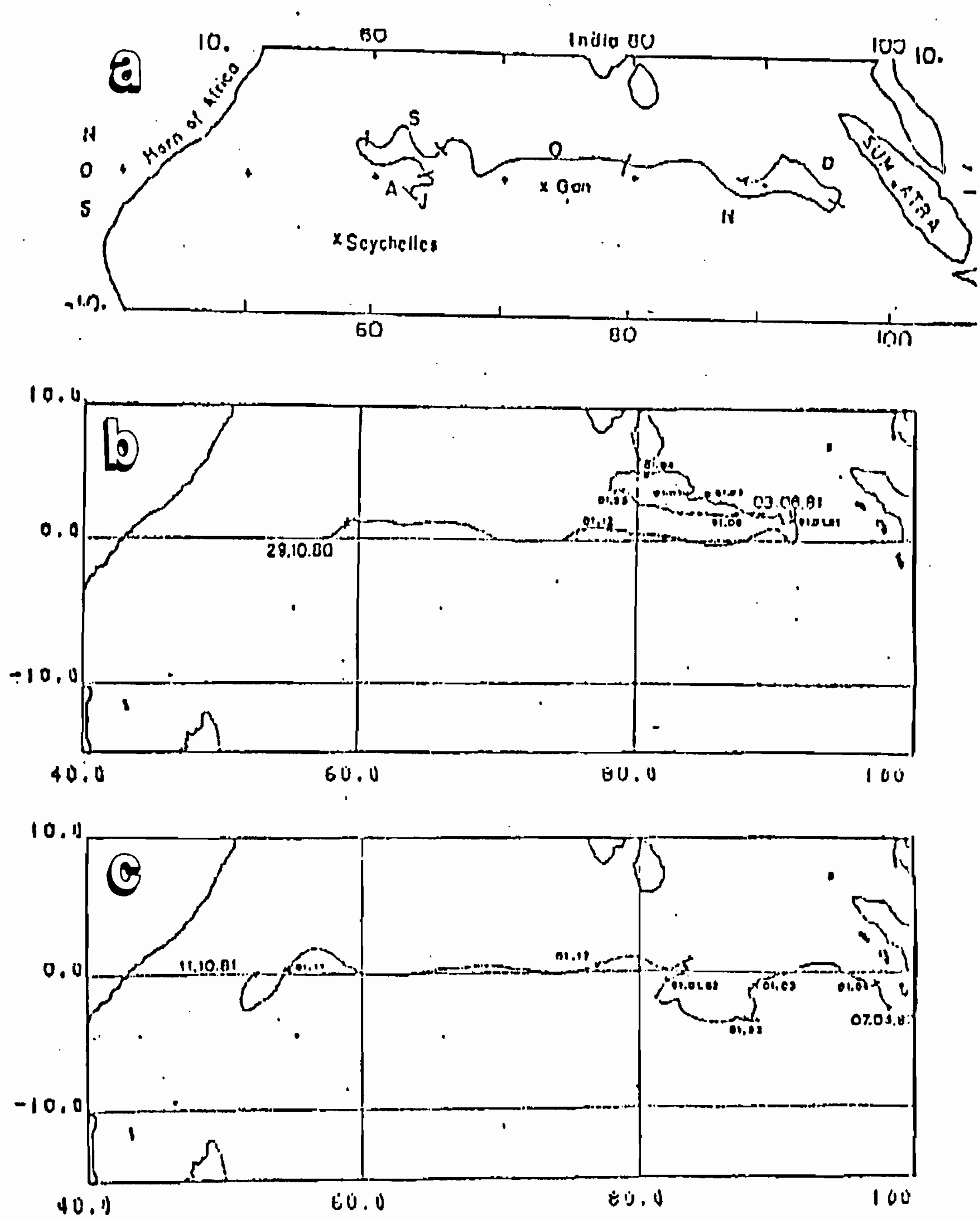



Figure 4 : Eastwards trajectories of experimental drift buoys in the equatorial currents observed in November (a: 1979, b: 1980, c: 1981)

Figure 5 : duration of the 93 observed drifts of tagged logs grouped by class of 10 days duration.

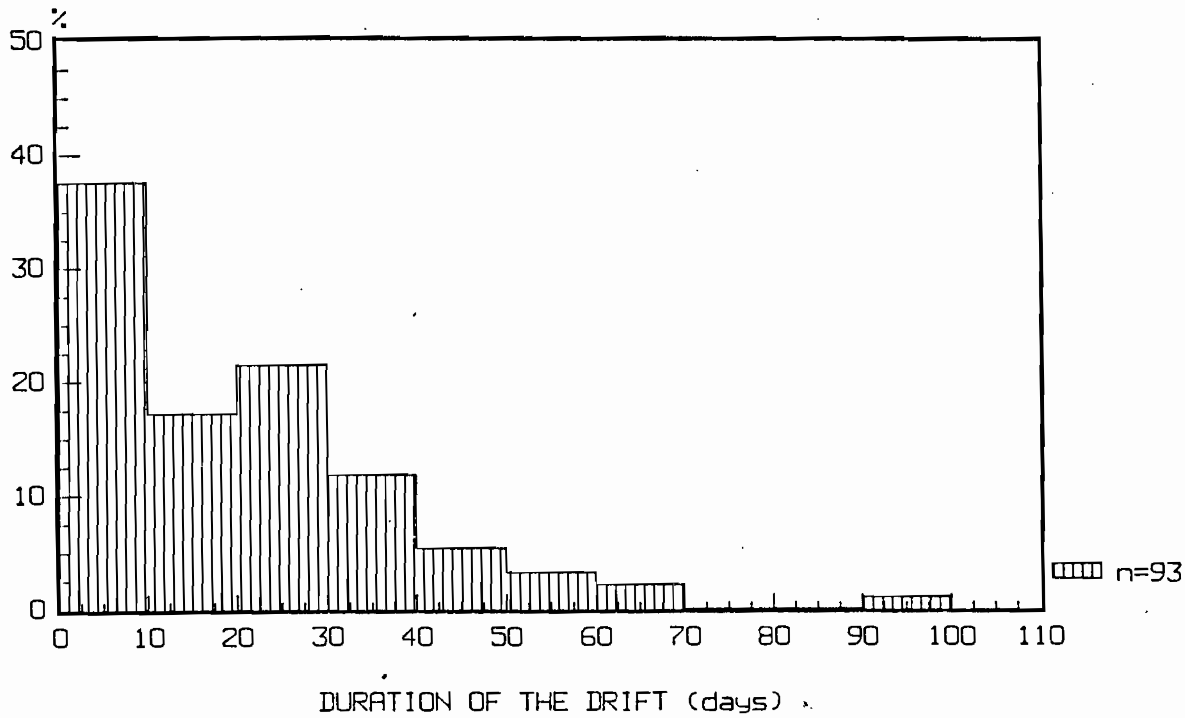
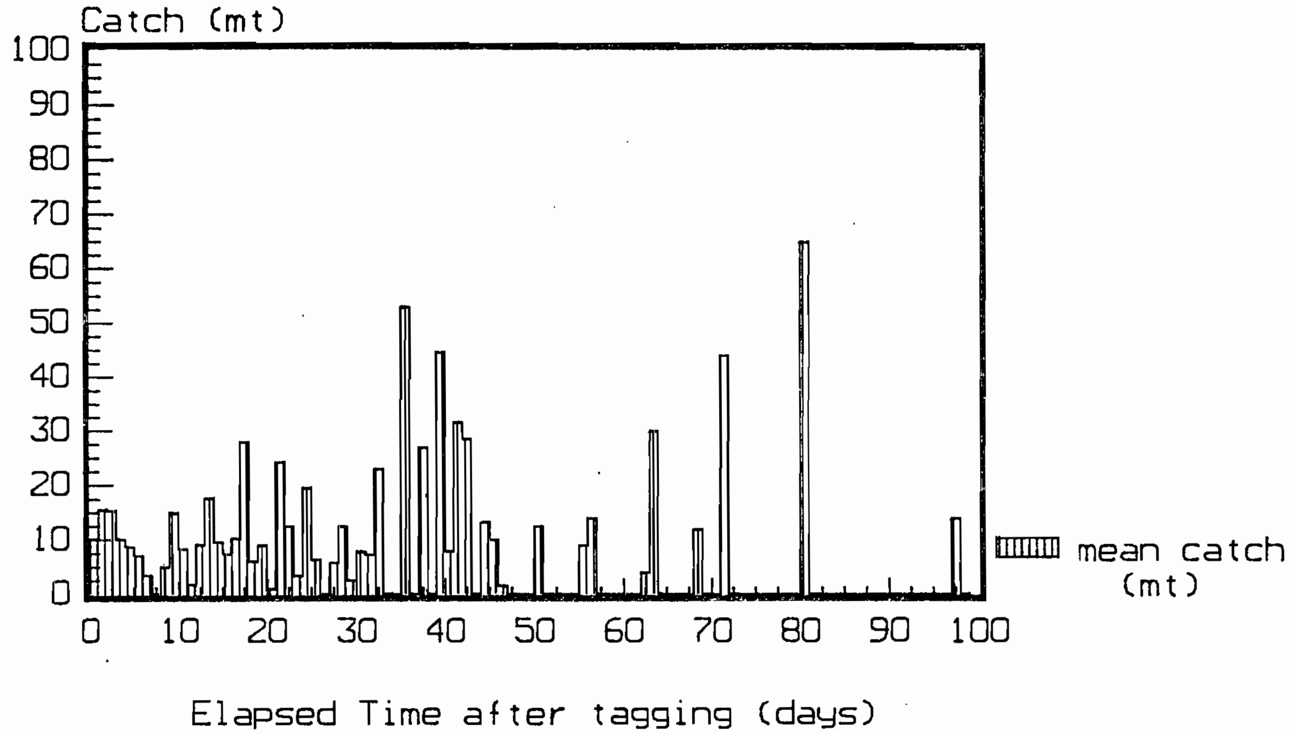
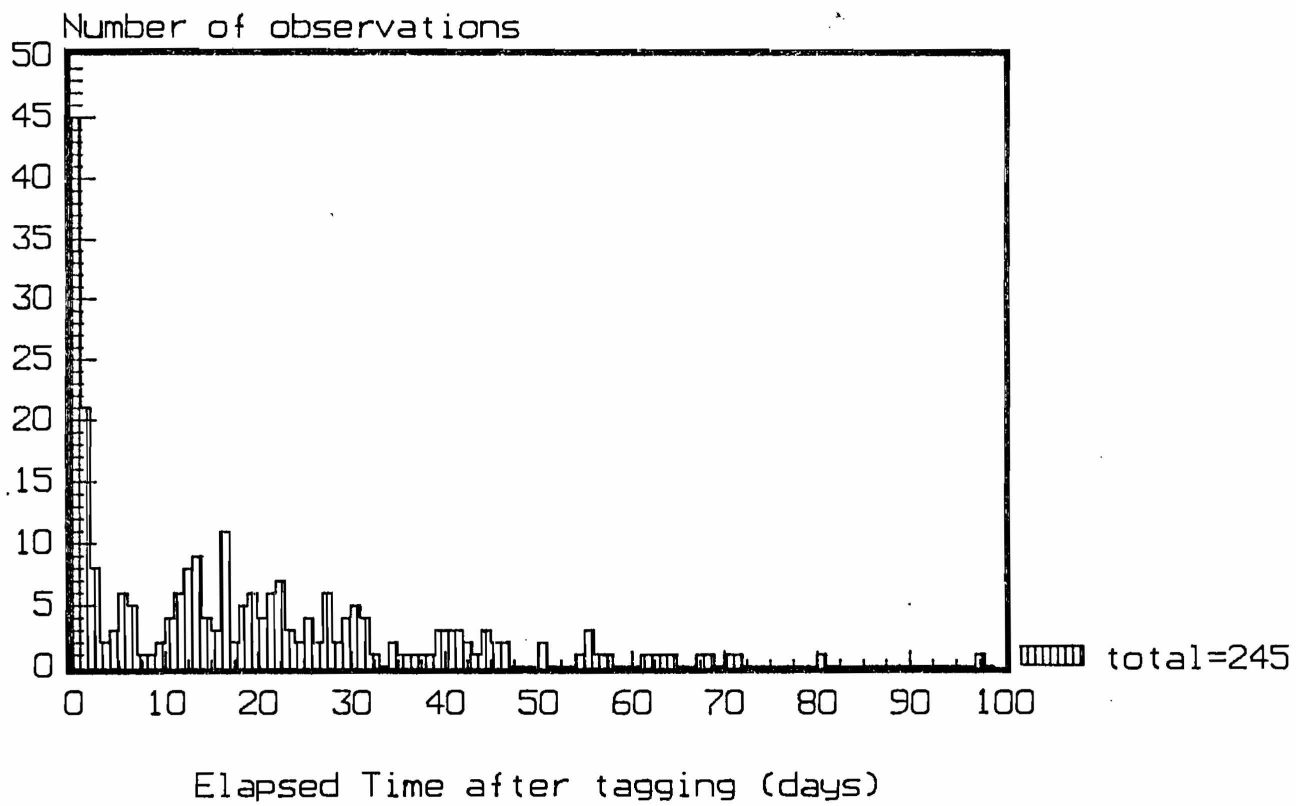


Figure 6: A) mean catch (tons) by visit made on the tagged logs v.s. time at sea after tagging.




B) corresponding number of observations (i.e. number of visits).



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