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International Council for  
the Exploration of the Sea



C.M. 1975/J: 14  
Pelagic Fish (Southern)  
Committee  
Ref: Hydrography Cttee

Chub mackerel fishery in the fishing grounds of  
NW-Africa and longterm temperature conditions

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1. Introduction

In the pelagic chub mackerel fishery on the N.W.African fishing grounds GDR and foreign factory trawlers obtained high unit catches up to 40-60 tons per day. However, in spite of the excellent condition of the chub mackerel stock up to 1970 considerable differences in catches from year to year and in the beginning and duration of the fishing season were found in commercial fishing leading to serious uncertainties in fishing strategy.

On the other hand since 1970 some changes took place in the fishery of this area. Thus, besides of obvious stock reductions in chub mackerel and sardinella and decreases of the catches in pelagic fishes since 1971 alterations in the ichthyological structure of the region 20-26°N could be observed leading to the suggestion that temporal changes in environment conditions were of importance in this situation. Pilchard hitherto only found north of 24°N advanced south and occurred in enormous quantities up to 20°N. Other fishes such as *Macrorhamphosus* were registered southerly and divergences of the concentration type in pelagic fishes were stated.

In this report we'll try to discuss environmental conditions in the fishing period up to 1972 by classifying the years by means of their temperature level and to confront them with the stock conditions in chub mackerel.

2. Material

The investigations were done on the fishing grounds off the african coast between 12-26°N.

The fishing data are derived from the operations of the GDR factory trawlers of the fishing period 1967-1972. Every year the ships had been engaged in a "season" fishery in the area off Cape Blanco and Cape Barbas from June-November and in some years in the period from December to April off Cape Blanco and Cape Verde (south).

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The ships carried but a specialized chub mackerel/horse mackerel fishery continuously reaching chub mackerel shares of 60-80 % followed by horse mackerel.

Additionally fishing data of the soviet flett from 1958-1966 (1) were used.

Owing to the high developed and uniform catch technics there is a basis material for the chub mackerel stock which permits a first comparison of the stock composition with the character of environmental conditions.

To classify temperature conditions following data were used:

- Water temperatures

Surface temperatures in the region 12-26°N from 1968-1970 according to the observations of merchant ships. Surface temperatures at the station M'bour (Senegal) 1958-1971 (2).

- Air temperatures

Daily weather observations by the weather station Villa Cisneros (Rio de Oro) 1964-1975. Weather observations of the air port Dakar-Yoff 1967-1971.

The chub mackerel stock data were computed by virtual population analysis.

The material used includes a total of 51683 analysed fishes.

3. Differences in the strength of year classes in chub mackerel population

The figures refer to chub mackerel concentrations in the region between 12-23°N.

Fig. 1 shows the age composition of the chub mackerel catches of GDR factory trawlers in the period from 1968-1972. According to it the basis of the catches is formed by 4-5 years old fishes. At first sight some outstanding year classes running through a period of several years can be distinguished.

In Fig. 2 the variations between age groups of different year classes are demonstrated more detailed. From this picture well developed year classes up to 1967 followed by the poor year classes 1967 and 1968 and the good one of 1969 are seen.

The same trend results from the analysis of the age composition of the chub mackerel stock. In the table the number of fishes per year class computed by virtual population analysis is given.

Stock composition ( $\times 10^6$ )

Year/Age	1	2	3	4	5	6
1968	360	417	449	294	126	56
1969	351	292	309	298	201	78
1970	418	286	227	209	151	84
1971	877 <sup>1)</sup>	340 <sup>1)</sup>	225 <sup>1)</sup>	159 <sup>1)</sup>	106 <sup>1)</sup>	52 <sup>1)</sup>
1972	3344 <sup>1)</sup>	715 <sup>1)</sup>	257 <sup>1)</sup>	141 <sup>1)</sup>	74 <sup>1)</sup>	28 <sup>1)</sup>

1) estimated values

Fig 3 shows the relative strength of different age groups according to the calculations by the virtual population analysis. The same features as in fig. 2 can be seen.

By comparing the year classes in the two figures one can discern obvious differences in their abundance.

Year class state

1969	very well
1968	weak
1967	weak
1966	good
1965	excellent
1964	good
1963	moderate
1962	uncertain

To give a better illustration of the differences in year classes in fig. 4 a and 4 b the relative importance of different year classes during the reported fishing period from 1968-1972 is indicated.

Through all fishing years the excellent state of the year classes 1965 and 1966 can be recognized whereas the curves for the year classes 1967 and 1968 are far below the other ones.

It is interesting to notice that inspite of heavy fishing the year class 1969 following after the bad ones of 1967/1968 obviously exceeds those in the age of 2 years.

4. Long-time temperature situation on the fishing grounds

To characterize the temperature level of a year available mean monthly temperatures of the water surface and the air were used for the two most important regions, the area of Cape Blanco ( $20-21^{\circ}\text{N}$ ) and the area of Cape Verde ( $12-15^{\circ}\text{N}$ ). In fig. 5 is shown the mean monthly water surface temperature of the main fishing ground Cape Blanco based on ships' observations. From these curves can be distinguished very low temperatures in winter 1967/1968 and a warm period since 1969. The same situation is met south of Dakar in this period as shown in fig. 6.

In fig. 7 is given a chronological picture of the surface temperatures for the mentioned period. The outlined temperature differences especially in the spawning time in winter can be spotted.

Very valuable informations about long-time temperature variations follow from the water temperature data taken at the station M'bour/Senegal which comprehend a period of 13 years. The mean monthly water surface temperature at this station is given in fig. 8.

According to it in autumn and spring 1959/1960 there are quite cool temperatures. Since 1962 can be discerned a permanent rise of the temperature level both in summer/autumn and winter season reaching its peak in 1966 with a slight interruption in 1964. This situation is followed by a striking negative temperature anomaly in winter 1967 up to 1968. After this warm temperatures are found in spring, summer and autumn 1969 and since the winter 1971 cool temperatures prevail.

Fig. 9 demonstrates the temperature conditions at M'bour in a chronological way and indicates the spawning time when the fishes occur in the observation area. This picture emphasizes quite well the temperature anomalies especially in the cool period from 1967-1968.

For better comparability the area covered by the temperature curves in fig. 9 was gauged separately for the spawning and feeding time. The results are given in the following table.

Station M'bour      Area covered by the temperature curves (cm<sup>2</sup>)

Year	Spawning time (Dec.-April)	Feeding time (Mai-November)
1964	3.0	19.5
1965	4.1	22.4
1966	5.3	22.2
1967	5.8	17.8
1968	1.0	20.7
1969	6.1	24.6
1970	6.0	23.8
1971	5.1	-

The temperature differences are evident. To give an illustration of the temperature situation in anomalous years in fig. 12 the annual course of the mean surface temperatures of the two fishing grounds Cape Blanco and Cape Verde (south) in three years are confronted. In particular in winter the temperature deviations can be revealed.

To give a more precise information about the temperature conditions and their variations on the fishing grounds observations of the air

temperatures were added. In fig. 10 the course of the mean monthly air temperatures of the air port Dakar-Yoff are demonstrated. High temperatures rising from a low level in 1968 are seen in 1969. After a warm period up to 1970 the temperatures drop abruptly in 1971.

For the fishing ground of Cape Blanco air temperature data of the weather station Villa Cisneros are given in fig. 11. The trends mentioned in the analysis of the water temperatures are evident. Low temperatures in 1967/68, a warm period from 1969-1970 and low temperatures in the two years 1971-1972 can be traced out. As a summary of the results of the analysis of long-term temperature structure one can make some interesting statements.

In the period from 1958-1972 in the region of the N.W. African fishing grounds can be pointed out negative and positive temperature anomalies which utter not only in mean monthly water surface temperatures but also in air temperatures.

These particularities are found both in the northern region of Cape Blanco and south of Dakar.

5. Stock composition in chub mackerel and temperature conditions on the fishing grounds

The characterization of the peculiarities in the age composition in chub mackerel and the description of the temperature development in the last 14 years suggest a relation between the results.

Fig. 13 compares the temperature features of the period from 1964-1970 with the state of homologous age groups in the correspond time. A striking coincidence can be seen. In the "warm years" 1965-1966 good year classes are found whereas the distinctly weak year classes 1967/68 are in relation with the negative temperature anomaly in these years. After this good year classes appear during a period of warm years.

In fig. 14 another confrontation of the state of the year classes with the temperature conditions based on the measured area of the temperature curves in fig. 9 is given. The same trend is evident. Weak year classes can be seen in the time of temperature disorder in 1967/68 whereas before and after this time good year classes and warm years are found.

Considering the significance of the temperature level for the development of the year classes mainly the temperature level in winter seems to be of importance, however recalling to the mind the situation shown in the figures 7 and 9 also the temperature situation in the remaining feeding time plays a certain role.

The reported results show that it is possibly to establish relations between the actual state of the stocks of the pelagic chub mackerel and long-term the level of the temperature conditions on the N.W. African fishing grounds.

In this report we have to restrict to these facts and to refrain from a further discussion of possible reasons and consequences of these findings.

Literature

1. Promyslovij atlas 1958-1966 Kaliningrad 1968
2. Champagnat et al. 1969  
Observations oceanographiques dans la region de Dakar  
Dakar-Thiaroye, ORSTOM

Individuals  
per catch

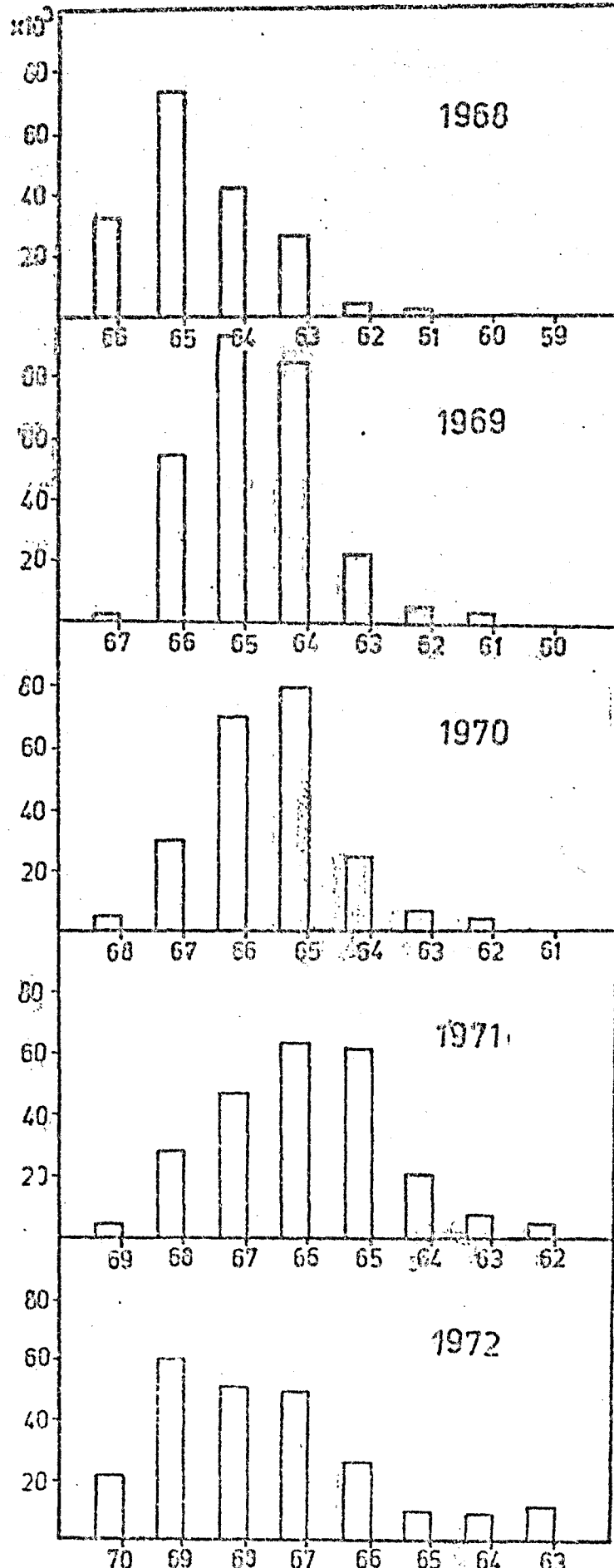


Fig. 1  
Age composition of the  
catches 1968-1972  
GDR

Individuals  
per catch  
 $\times 10^3$

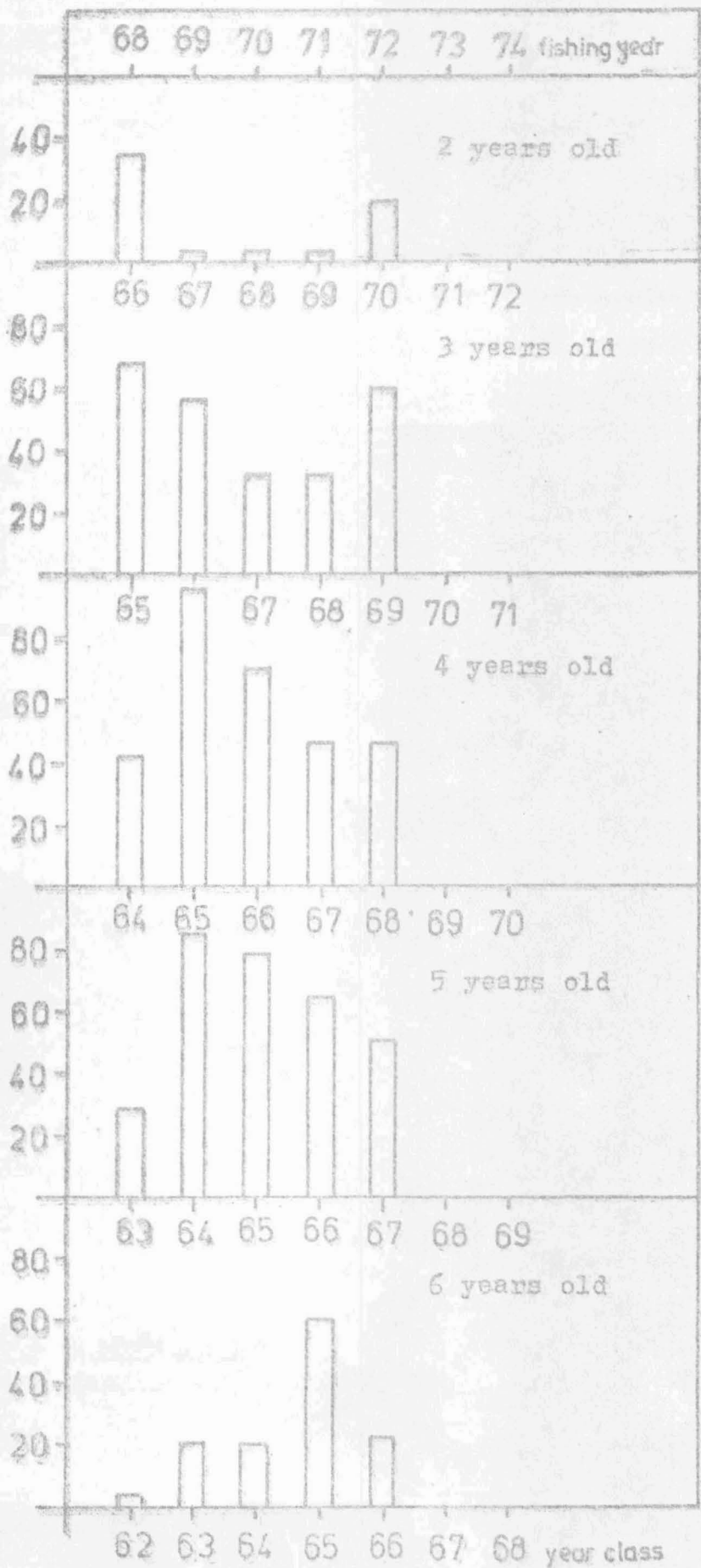


Fig. 2 Strength of different year classes according to individuals in catches



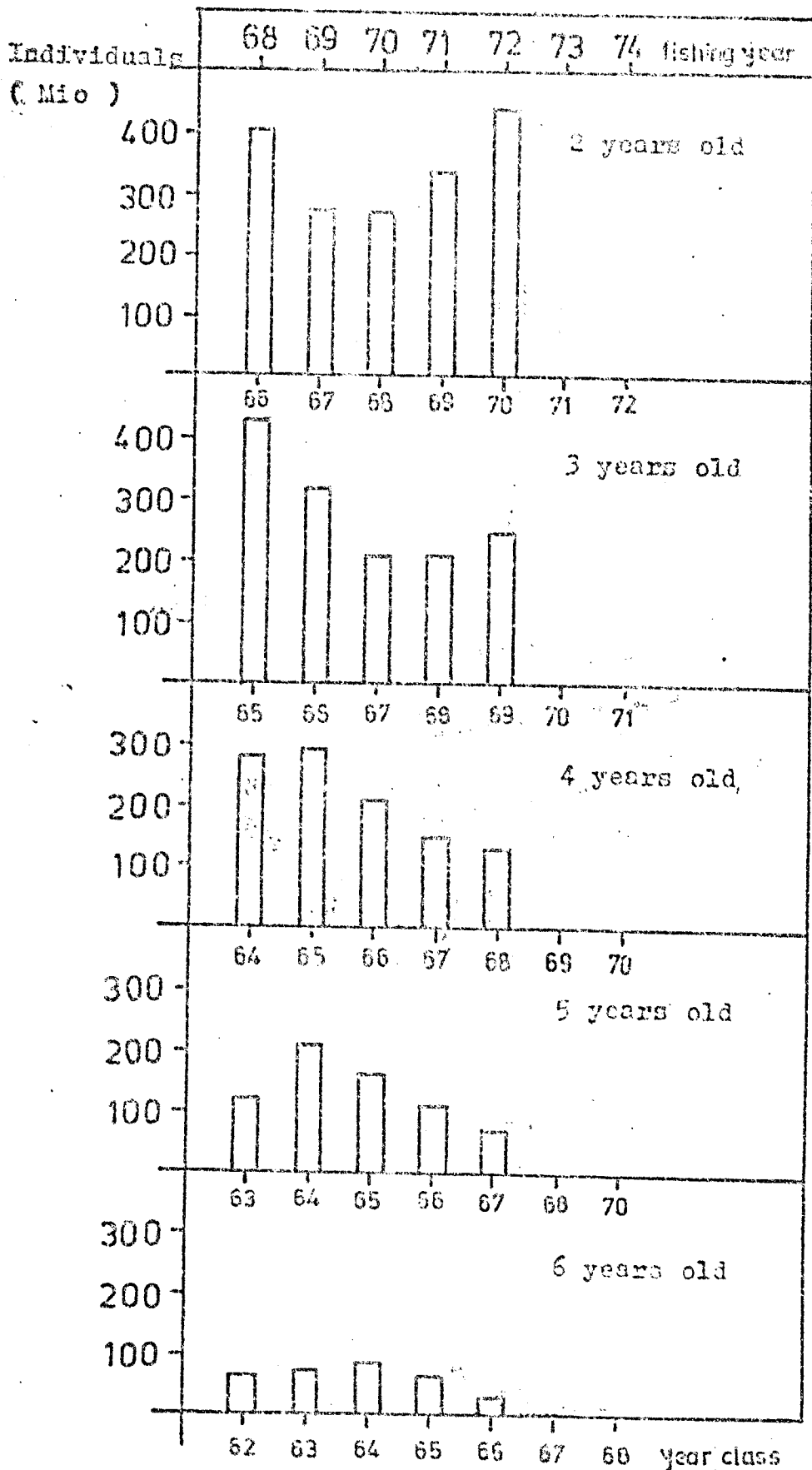


Fig. 3 Strength of different year classes according to virtual population analysis

Fig. 4 Relative strength of different year classes in the fishery according to virtual population analysis (a) and age composition of catches (b)

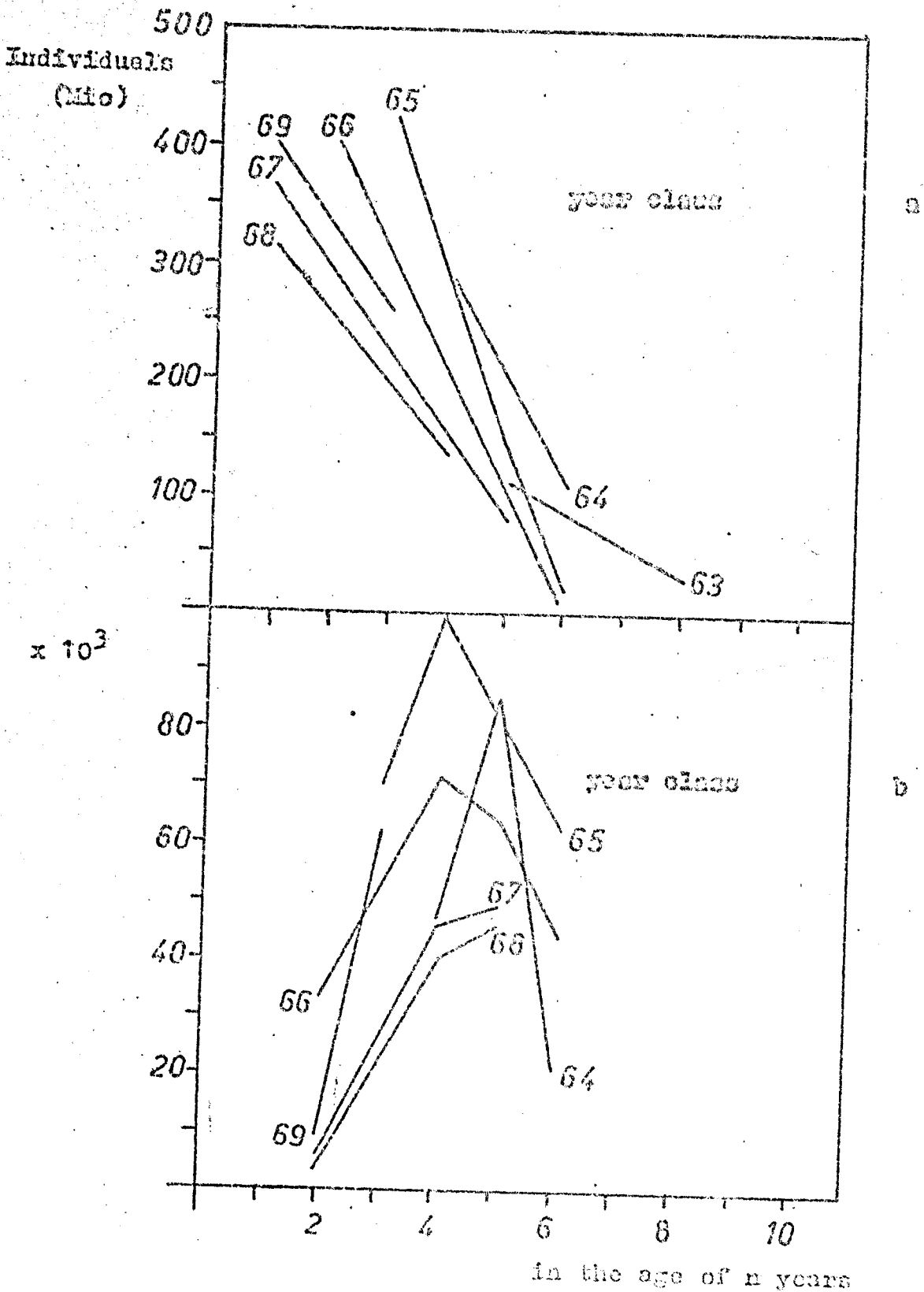
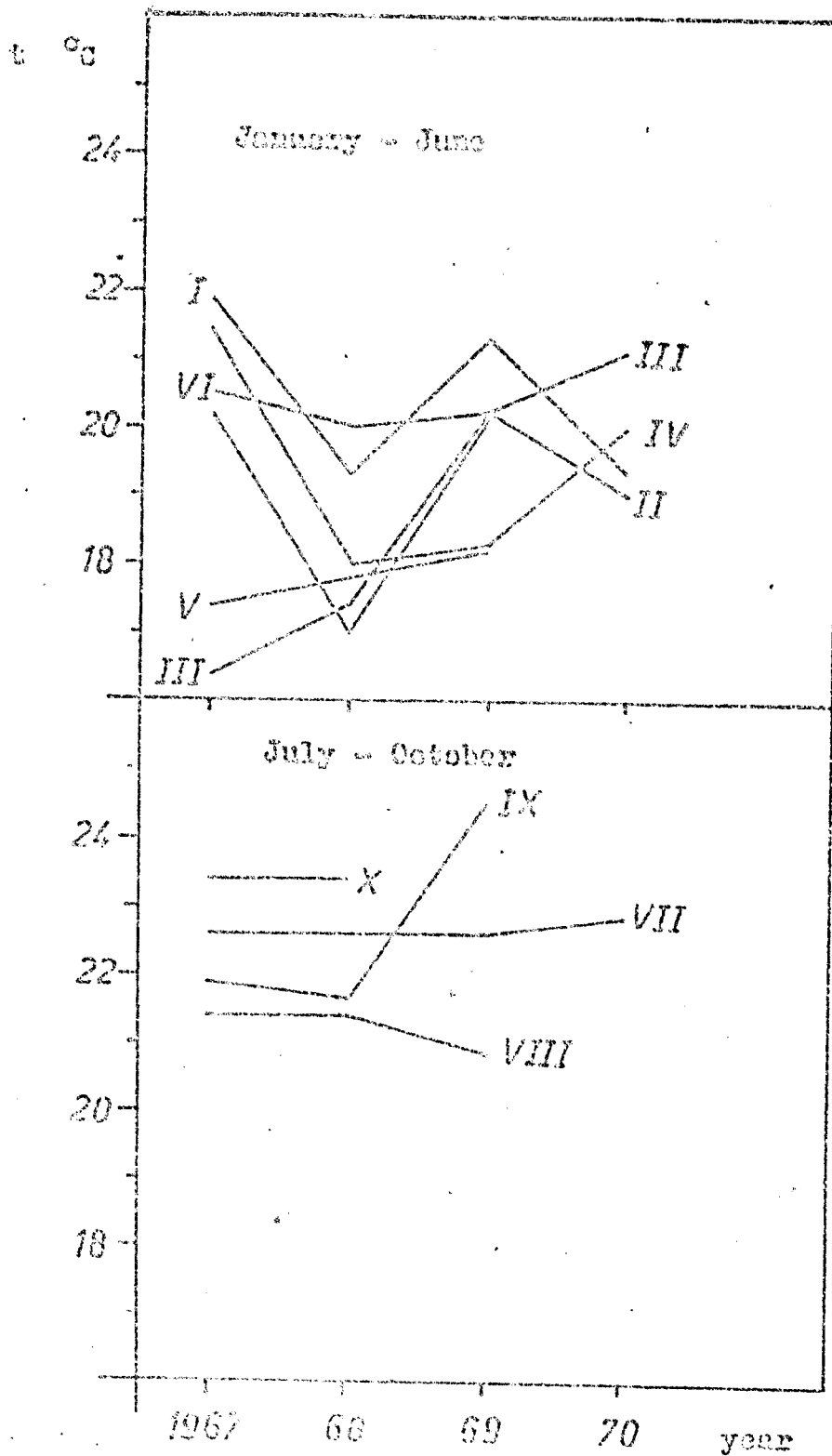


Fig. 5 Level of the monthly mean surface water temperatures 1967 - 1970  
 Position 20-21°N  
 Ships' observations



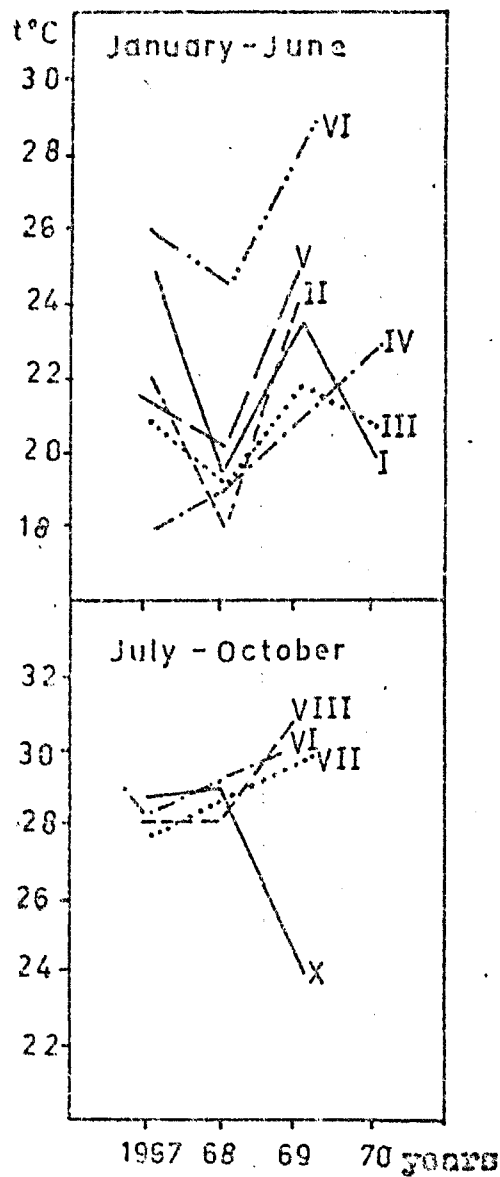


Fig. 6 Level of the monthly mean surface water temperatures 1957 - 1970 Position 13-14°N Ships' observations

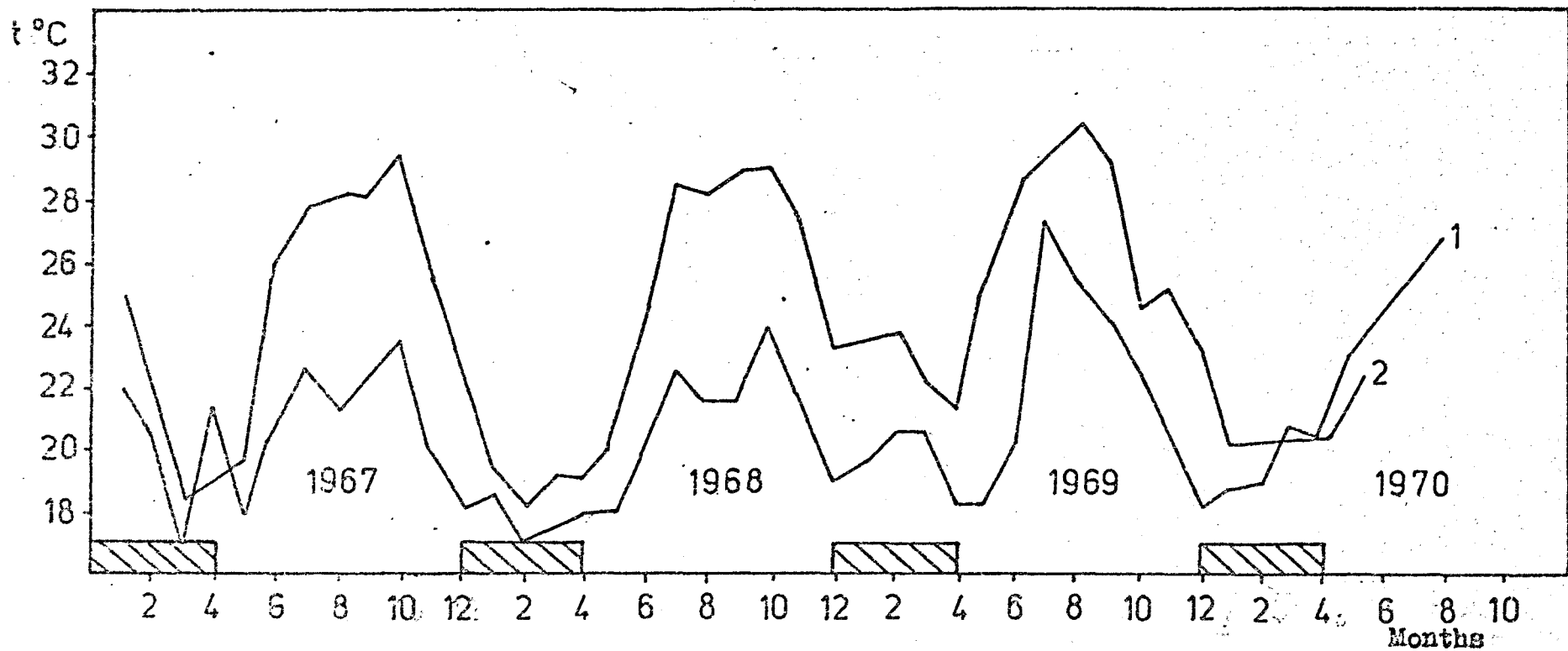


Fig. 7 Annual course of mean surface water temperatures from 1967-1970  
 Ships' observations  
 1 20 - 21 °C  
 2 13 - 14 °C  
 ▨ Spawning time

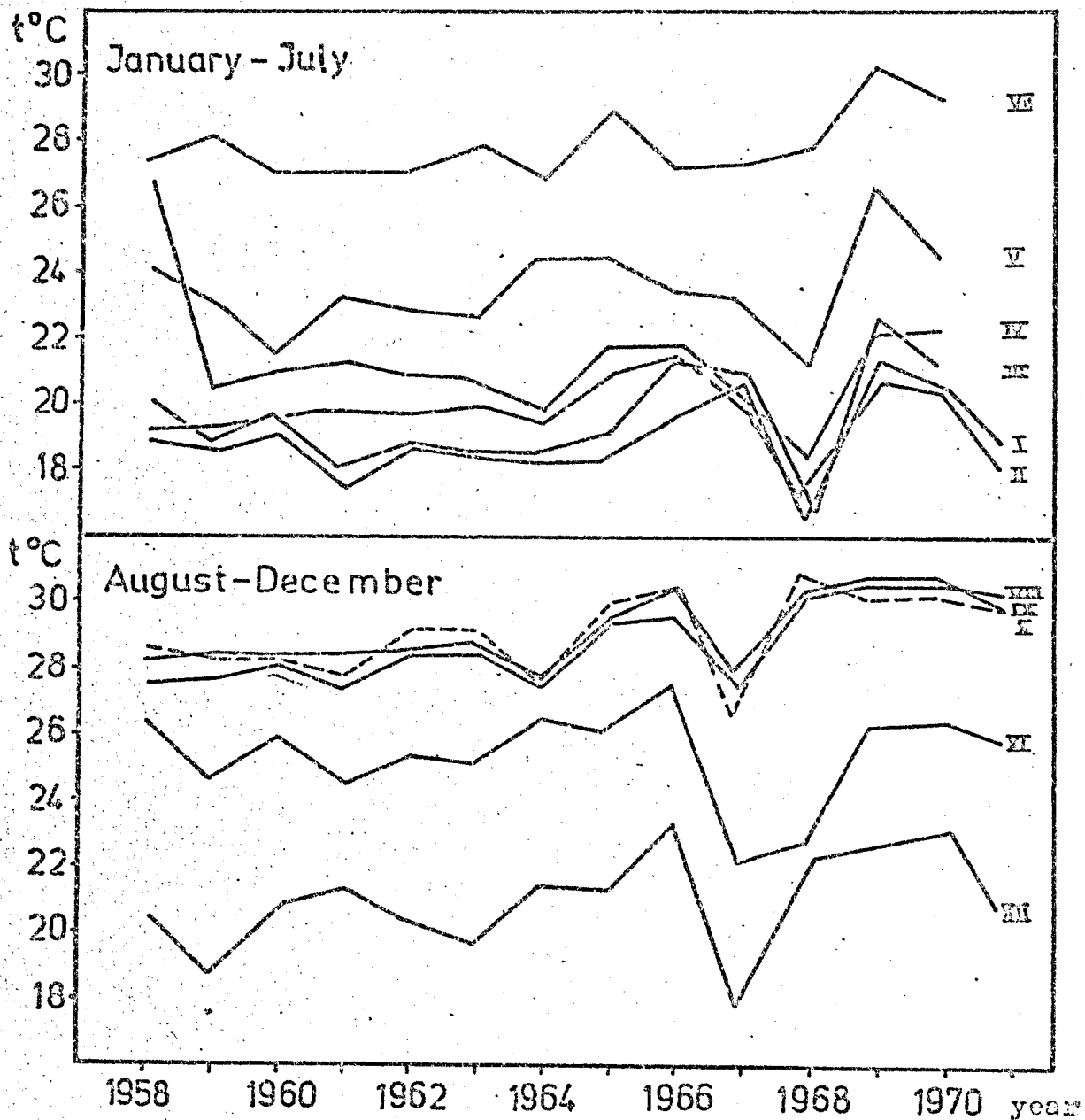


Fig. 6 level of the monthly mean temperatures of the water surface from 1958-1970  
Station N'bour

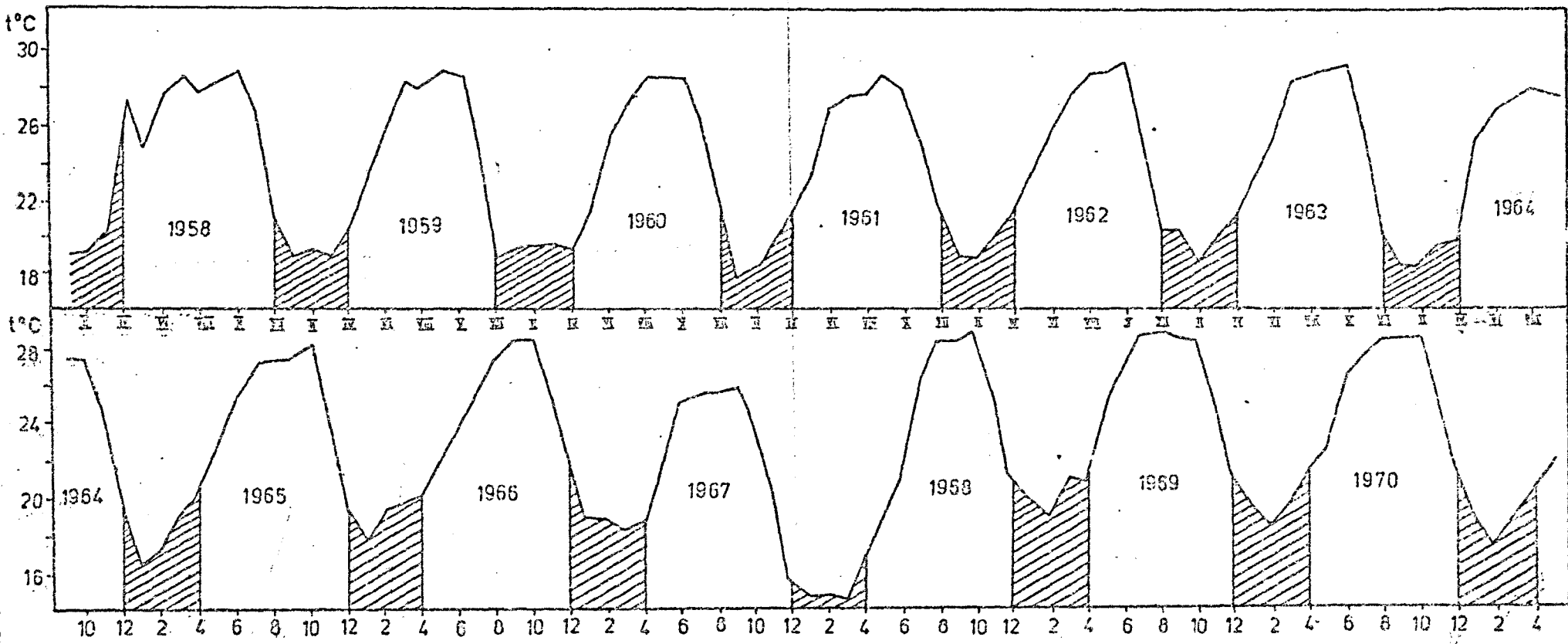


Fig. 9 annual course of the mean monthly surface water temperatures from 1958 - 1971 Station H'bour spawning time Month

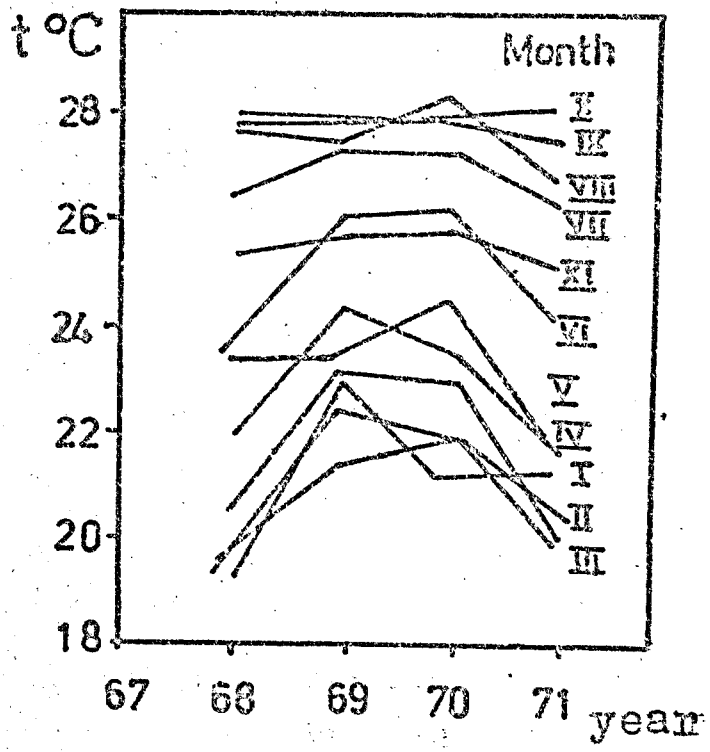


Fig. 10 Mean monthly air temperatures from 1967 - 1971  
 Airport Dakar - Yoff



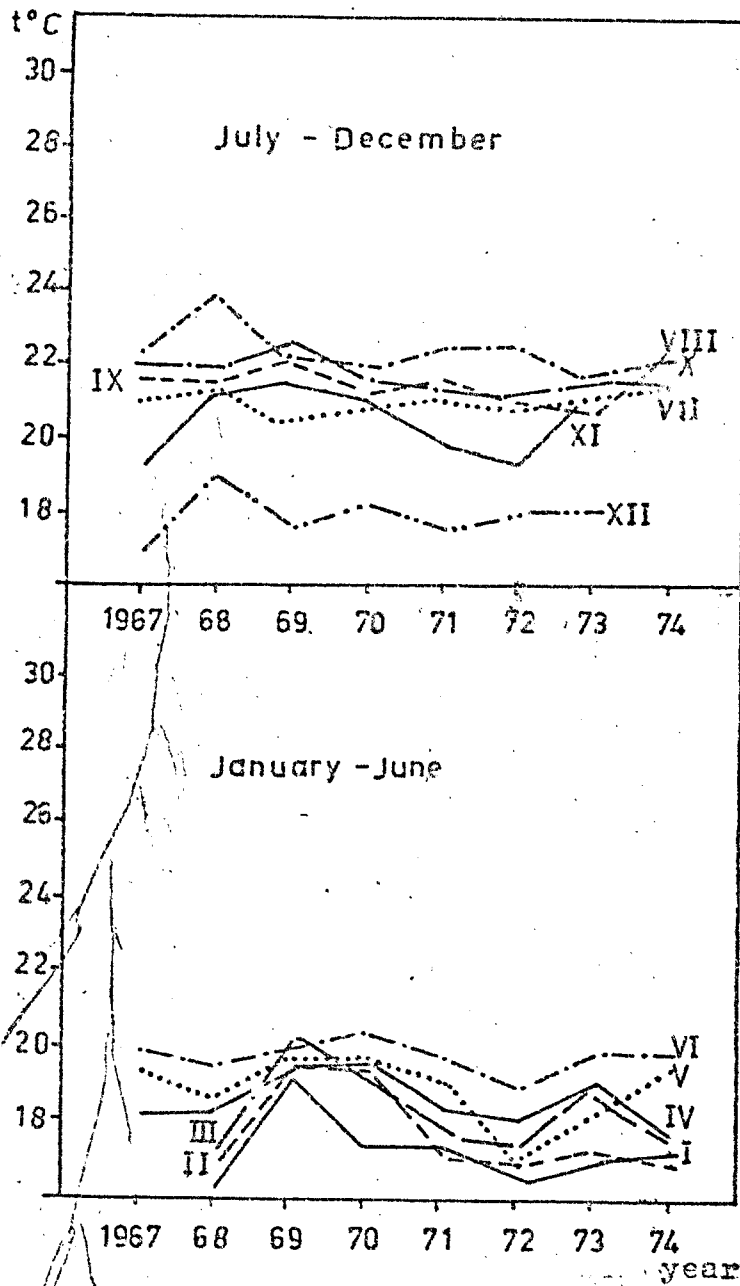


Fig. 11 Level of the monthly mean air temperature from 1967 - 1974  
Weather stations Villa Cisneros

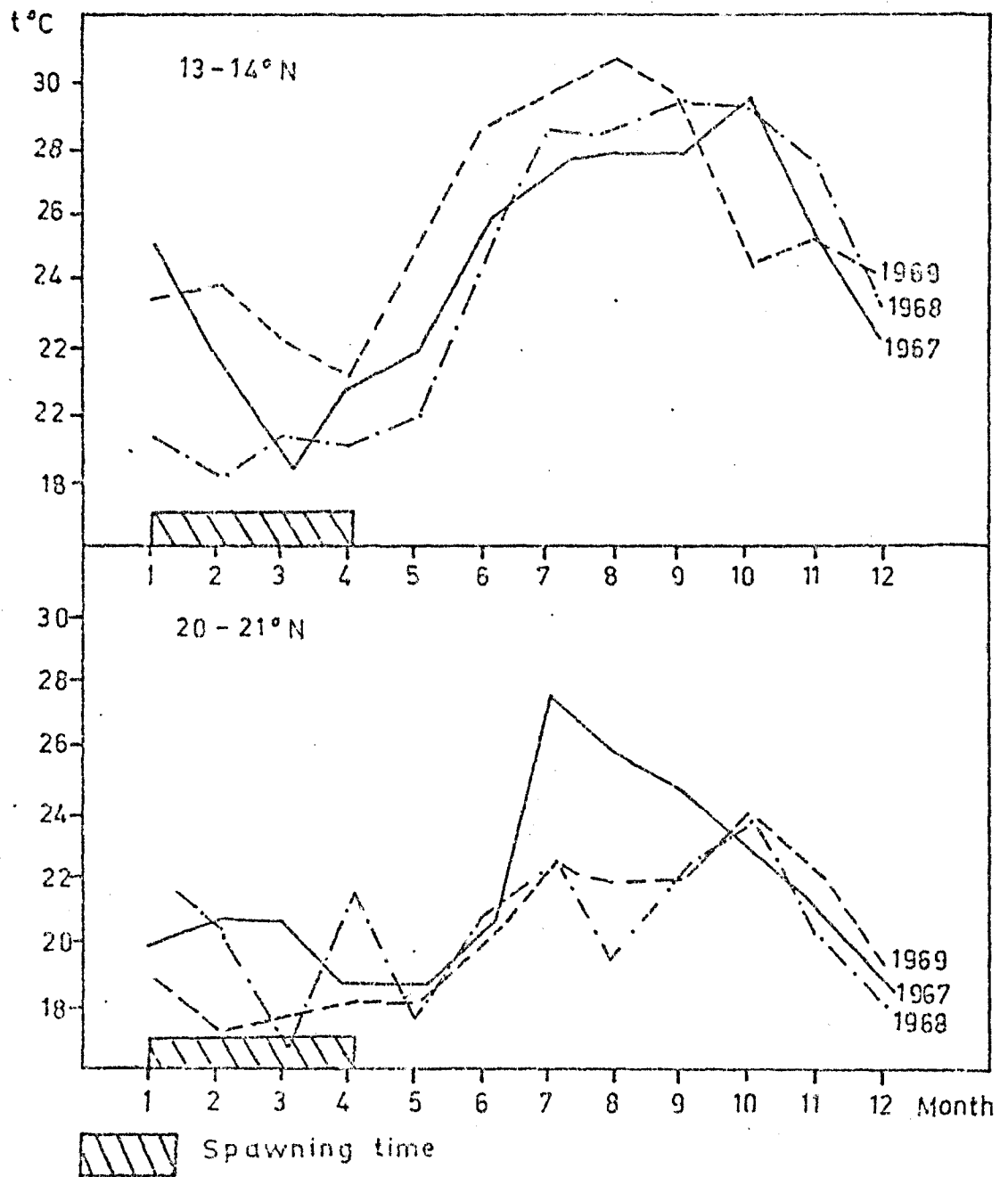


Fig. 12 Comparison of the general surface temperature level of three years in two regions  
Ships' observation

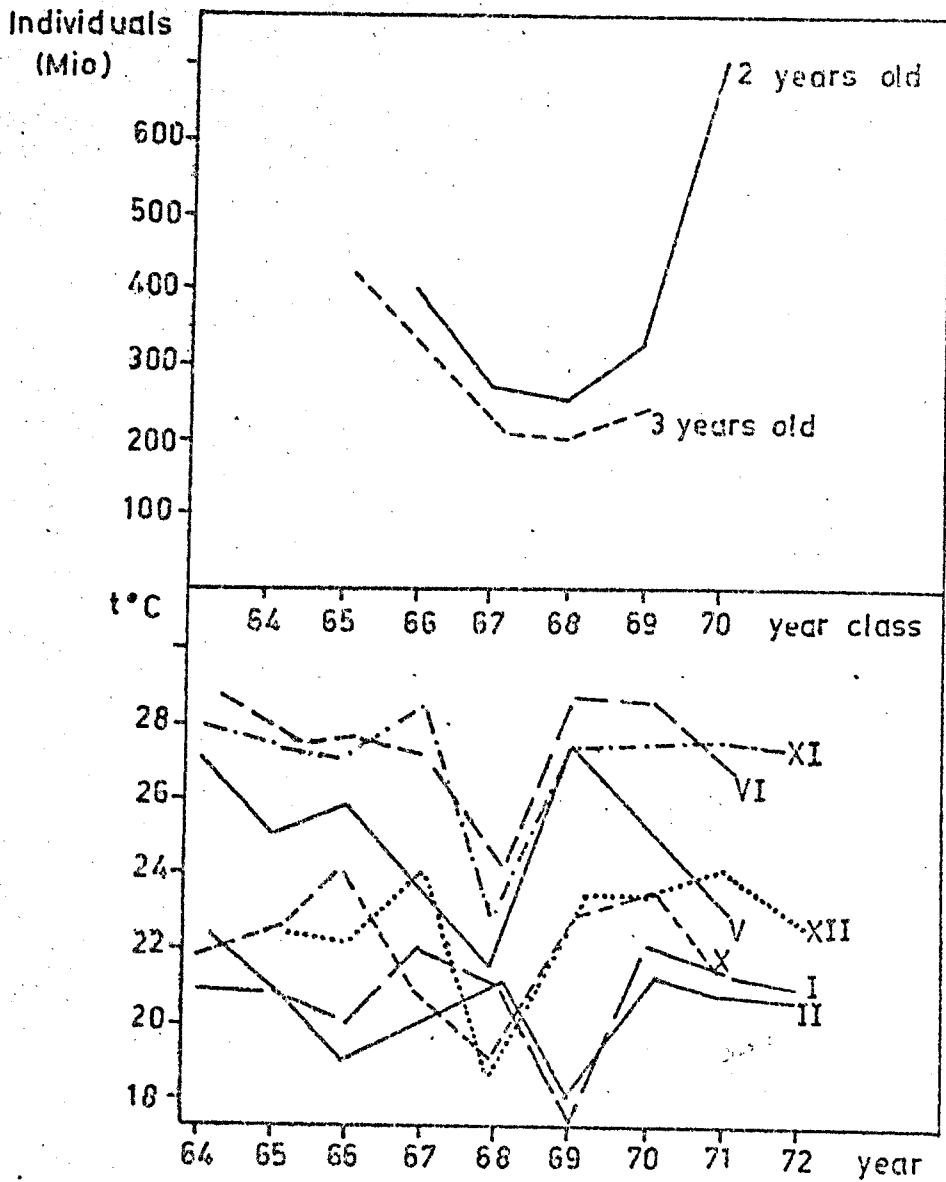


Fig. 13 Strength of various homologous age groups according to virtual population analysis compared with the temperature conditions  
Station M'bour

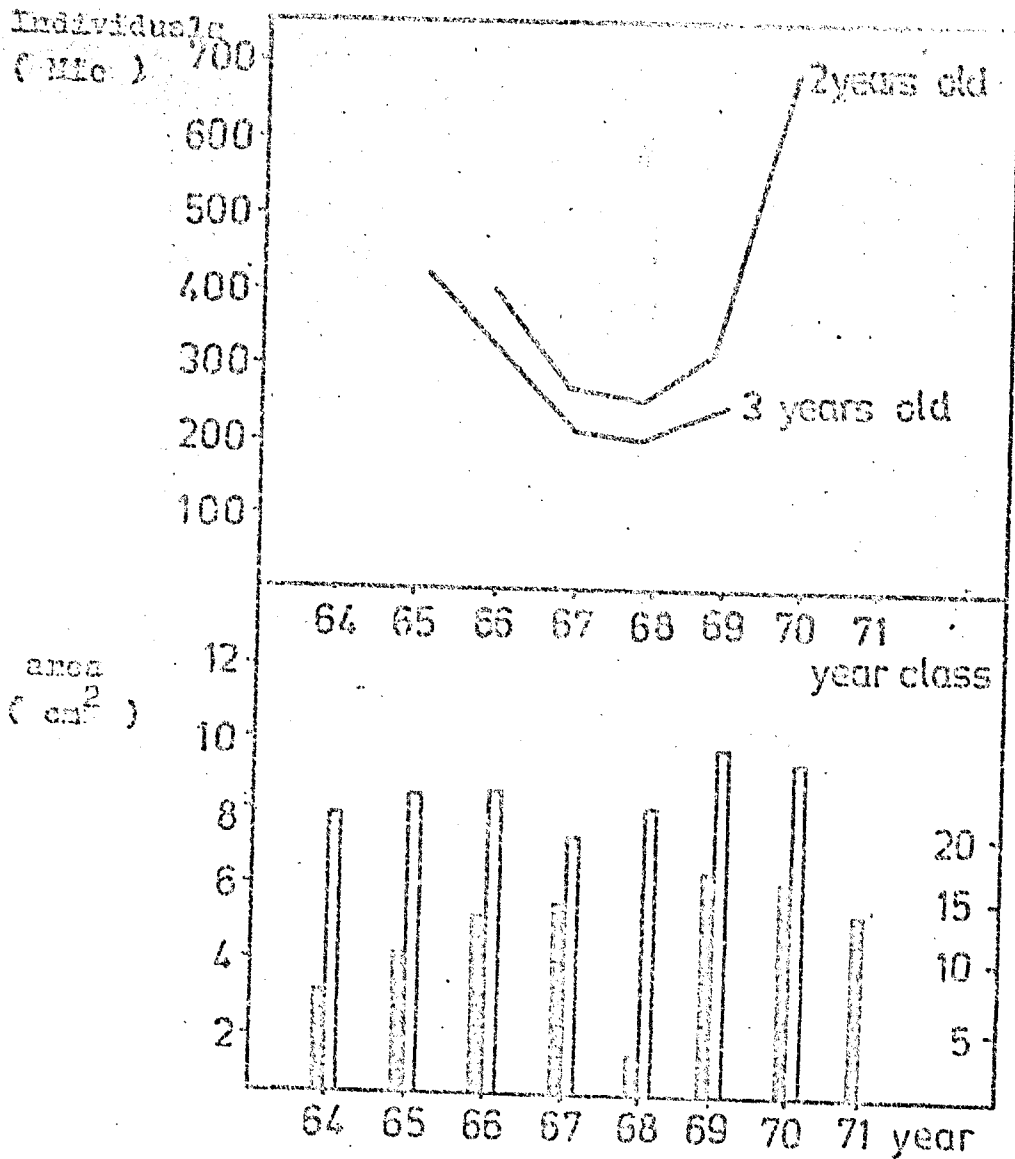


Fig. 14 Strength of various homologous age groups compared with the area covered by the temperature curves of fig 9 in spawning and feeding time

- feeding time
- ▨ spawning time