THE OCCURRENCE OF ZOOPLANKTON OFF TEMA DURING THE PERIOD 1969 - 1992

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Abstract :

Displacement volumes of zooplankton samples collected with the ICITA net at four stations along an oceanographic transect off Tema at approximately weekly intervals over the period, 1969 - 1992, are analysed. The pattern of inter-annual variations in zooplankton biomass over the entire 24-year period is the same though absolute values vary monthly and yearly. Underlying the fluctuations is a general trend in decline in zooplankton abundance.

Résumé :

Les volumes mesurés par déplacement de zooplancton collectés avec un filet ICITA sur quatre stations le long d'une radiale au large de Tema, approximativement à des intervalles hebdomadaires, sur la période 1969-1992 sont analysés.

La structure apparente des variations interannuelles de biomasse zooplanctonique est constante, bien que les valeurs absolues varient entre mois et années. Au dela de ces fluctuations, il semble exister une tendance à la décroissance de l'abondance du zooplancton.

1. Introduction :

As part of the studies to understand the impact of the marine environment on the sardinella stocks in particular and other fish stocks in Ghanaian coastal waters in general, the Fishery Research Unit (now the Research and Utilization Branch of the Fisheries Department) mounted a zooplankton sampling scheme in the late 1960s. It was intended to study the availability of zooplankton to the feeding of the sardinellas. Kwei(1964) showed that the sardinella was a zooplankton feeder. The results of this sampling scheme on the occurrence of zooplankton over specific periods of time have been published in several reports by Mensah (1962, 1968, 1972, 1974 etc.); Houghton and Mensah(1978). Most of these reports discussed among others, the monthly fluctuations in zooplankton abundance in relation to changes in sea surface temperatures and sardinella catches. These papers showed that zooplankton abundance was inversely related to the fall in sea surface temperatures and positively related to sardinella catches.

For example, Mensah (1974) examined the relationship between the seasonal upwelling and the appearance and life-history of the copepod *Calaniodes carinatus* (Kroyer) on the Ghanaian continental shelf.

The present paper seeks to examine the cycles of zooplankton production over the entire 24-year period (1969 - 1992) and considers if the patterns of availability of the zooplankton might have adversely affected the feeding and hence the availability of the sardinellas.

2. Method of Sampling at Sea :

An oceanographic transect off Tema and approximately perpendicular to the coast was worked, as much as possible, once a week. The transect consisted of four stations (A1, A2, B and C; Figures 1 and 2). An ICITA net was used to sample zooplankton at all the four oceanographic stations on the transect.

The mouth diameter of the net is 1 metre and the filtering section, 2.4 metres long; the mesh size is 330 um and the net is rigged with a Tsurumi-Seiki Kosakusho (T.S.K.) flow-meter.

The net was towed step-obliquely at five steps. 10-metre length of wire was paid out at each step so that a total of 50m length of wire was paid out on each occasion. The wire angle was also measured.

3. Method of Analysis in the Laboratory :

Displacement volumes of all the samples were measured. The volume of sea water filtered by the net was obtained by multiplying the flow-meter's constant factor by the number of revolutions.

The displacement volumes were standardised by correcting the volumes to what would have been present in 1,000 litres of sea water filtered.

In order to obtain the true depth of each haul, the length of wire paid out for a particular column of water was multiplied by the cosine of the wire angle.

The true depth that the ICITA net filtered varied mainly between 13 and 25m; occasionally it filtered down to 29m.

Monthly means of all the standardised displacement volumes obtained at the four stations (A1, A2, B and C) were calculated and used to draw the graphs for the period, 1969 - 1992, in figures 3, 4 and 5.

4. Results :

The highest abundance of zooplankton occurs during the three-month period of July, August and September which is also the period of the major upwelling in Ghanaian coastal waters. (Figures 3 and 5). For the rest of the year including the period of minor upwelling (January/February or March), zooplankton abundance is minimal.

Though this pattern of occurrence is similar each year for the 24-year period, absolute values both monthly and yearly vary (Figures 3 and 4). The same pattern is displayed in figure 5 where data for the whole 24-year period are averaged over months.

Both figures 3 and 4 show that there is a general trend in decline in zooplankton abundance after 1972; the decline was most noticeable during the period 1978 to 1987 and during the biennium 1991-1992.

5. Discussion and Conclusion :

The pattern of variations in the zooplankton biomass over the entire 24-year period has been shown to be the same as what has been observed during parts of this period (Mensah, 1962, 1968, 1972, 1974 and Houghton and Mensah, 1978). This is important to the sardinella fishery which is seasonal. The period of abundant availability and reproduction of the sardinella is synchronised with the upwelling occurrence and zooplankton abundance (Houghton and Mensah, 1978). Since the sardinella is a zooplankton feeder (Kwei,1964), and builds up its highest fat content during the upwelling season (Kwei,1966) a change in the pattern of abundance of the zooplankton biomass as has been described would adversely affect the feeding and consequently the reproductive cycles and occurrence of the sardinella, and hence its fishery. Such an adverse change in pattern of abundance has not been observed during the 24-year period.

In other words, if there had been any adverse or unusual changes in the abundance or biology of the sardinella during the period under review, these changes could not be attributed to changes in the cycles of occurrence of the zooplankton. However, diminution in zooplankton biomass over the Ghanaian and Ivoirian continental shelves between approximately 1971 and 1978 was observed by Binet (1982). In this work, Binet examined the correlation between sardinella landings, river flows, upwelling indices and zooplankton biomass over the period 1963 - 1980. He noted that this change in the ecosystem coincided with the Sahelian drought and expressed the hope that the ecosystem would revert to normal with a favourable change in the drought situation in the future.

However, the present paper shows that this reversion to normal zooplankton volumes has not yet occurred beyond the period Binet examined - the period of decline in zooplankton abundance has continued from 1973 till 1992, the period when data are available.

A fundamental question still remains to be answered and that is whether or not despite the decline, the levels of zooplankton biomass are sufficient as food for the sardinella population.

Pieces of documentary evidence available as follows, indicate that the levels of zooplankton abundance had not adversely affected the feeding of the *S. aurita* during the period under review :

(i) Though there was a near collapse of the *S. aurita* fishery beginning from 1973 to 1976, this was factually attributed to the overfishing of the adult *S. aurita* during the major upwelling season in 1972 (FRU/ORSTOM,1976; Binet 1982)

(ii) Furthermore, during the gradual recovery of the *S. aurita* stock reaching the peak in 1978, the zooplankton biomass continued to show its decline (Figures 3, 4 , and so one would assume that the levels of zooplankton biomass were adequate for the sustenance of the *S. aurita* stock.

In addition, since 1978, the *S. aurita* fishery has continued to fluctuate in yields with an upward trend and an exceptionally high catch in 1992 , though the fluctuations in zooplankton abundance with an underlying decline continued, especially during the biennium, 1991 - 1992 (Figure 4).

Thus, during the 24-year period under review, zooplankton abundance was adequate for the survival of the *S. aurita* stock.

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CAPTION OF TABLES AND FIGURES

Table 1: Monthly mean displacement volumes of zooplankton per 1000 m3 of sea water. A 1969 - 1980 ; B 1981 - 1992

Figure 1: The coastline and continental shelf off Tema, showing the position of the transect and the four stations A1, A2, B and C. (Culled from Mensah, 1974).

Figure 2 : Tema transect showing the stations (A1, A2, B and C) and layers of water sampled at each station. (Culled from Mensah, 1974).

Figure 3 : Monthly mean displacement volumes of zooplankton per 1000 litres of sea water, off Tema 1969-1992

Figure 4 : Yearly mean displacement volumes of zooplankton per 1000 litres of sea water. 1969-1992

Figure 5 : Monthly mean displacement volumes of zooplankton ml/1000 litres of sea water.

Table 1: Monthly mean displacement volumes of zooplankton per 1000 m3 of sea water. A 1969 - 1980

TABLE 1 MONTHLY MEAN DISPLACEMENT VOLUMES OF ZOOPLANKTON PER 1000m^3 OF SEA WATER. 1969-1992.												
	1969	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**
J	30.3	139.3		248.5	154.4	155.8	119.3	78.8	210.9	153.6	62.0	55.1
F		127.3	14.8	171.6	107.9	112.7		90.5		58.8	80.6	119.5
M	262.9	109.8	129.1	170.3	165.7				63.9	64.5	77.9	82.8
A	204.8	153.7	107.7	209.8	88.5	68.0	104.1		78.8	65.6		172.0
M	133.1	133.0	198.0	175.3	125.9	58.8	56.9	144.3	107.8	52.4		77.5
J	211.4	144.3	215.6	162.8	160.2	102.0	161.1	198.3	147.6			92.1
J	349.8	287.5	399.6	257.6	229.9	99.4	154.0	607.4	201.2			213.6
A	747.4	1348.8	640.9	1088.3	346.5	476.4	365.2		475.0			336.9
S	1205.8	307.4	809.0	541.2		338.5	587.7	463.3	590.5			110.7
O	482.0	303.7	397.6	226.2	286.0	338.3	201.0	345.2			92.3	158.2
N	101.8	149.6	238.5	191.8	195.3	152.2	84.6	262.9		154.1	94.0	
D	169.6	202.0	245.7	170.6	343.4	118.9	121.8	180.7	173.2	187.0	58.3	
Me	**177.2**	**148.1**	**154.4**	**157.1**	**100.2**	**91.9**	**93.1**	**118.6**	**102.4**	**40.9**	**27.4**	**67.5**

Table 1: Monthly mean displacement volumes of zooplankton per 1000 m3 of sea water. B 1981 - 1992

1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean
	55.4	39.5	40.4	102.3	72.3		64.8	104.2		51.0	82.2	101.0
76.3	66.2	76.2			58.8			60.4	85.0	110.0		88.5
81.4	50.8	38.4	42.2	25.2	31.5		119.0	83.3		101.4	81.0	93.7
66.7	54.4		17.0	36.3	90.3		115.0	74.5		94.8	86.2	99.4
91.4	53.5			12.0	86.1		129.0	84.0	127.9	92.7	110.2	102.5
82.8	82.3	121.3		75.3	129.9		134.0	119.1	108.6	87.6	182.0	135.9
257.8	120.1	243.9	162.2	204.0	187.4	191.1	250.3	159.0	236.7		154.1	236.5
363.5	383.3		210.5	515.4		230.6	556.2	578.3	488.5		134.2	515.9
136.5	528.6	249.3	112.0	225.5	306.3		266.7	403.9	299.4		217.6	405.3
112.9	108.7	100.9	103.3	68.7		93.1		185.3	164.3	195.4	113.7	203.8
73.9	95.8	135.5		59.4		92.0	287.4	127.2	91.1	77.2	65.0	136.5
64.0	146.7	153.1	93.0			112.4	182.1	124.8	153.8	167.7		158.4
64.0	**75.9**	**57.9**	**41.1**	**63.1**	**50.7**	**45.0**	**100.2**	**91.5**	**87.8**	**48.9**	**58.4**	

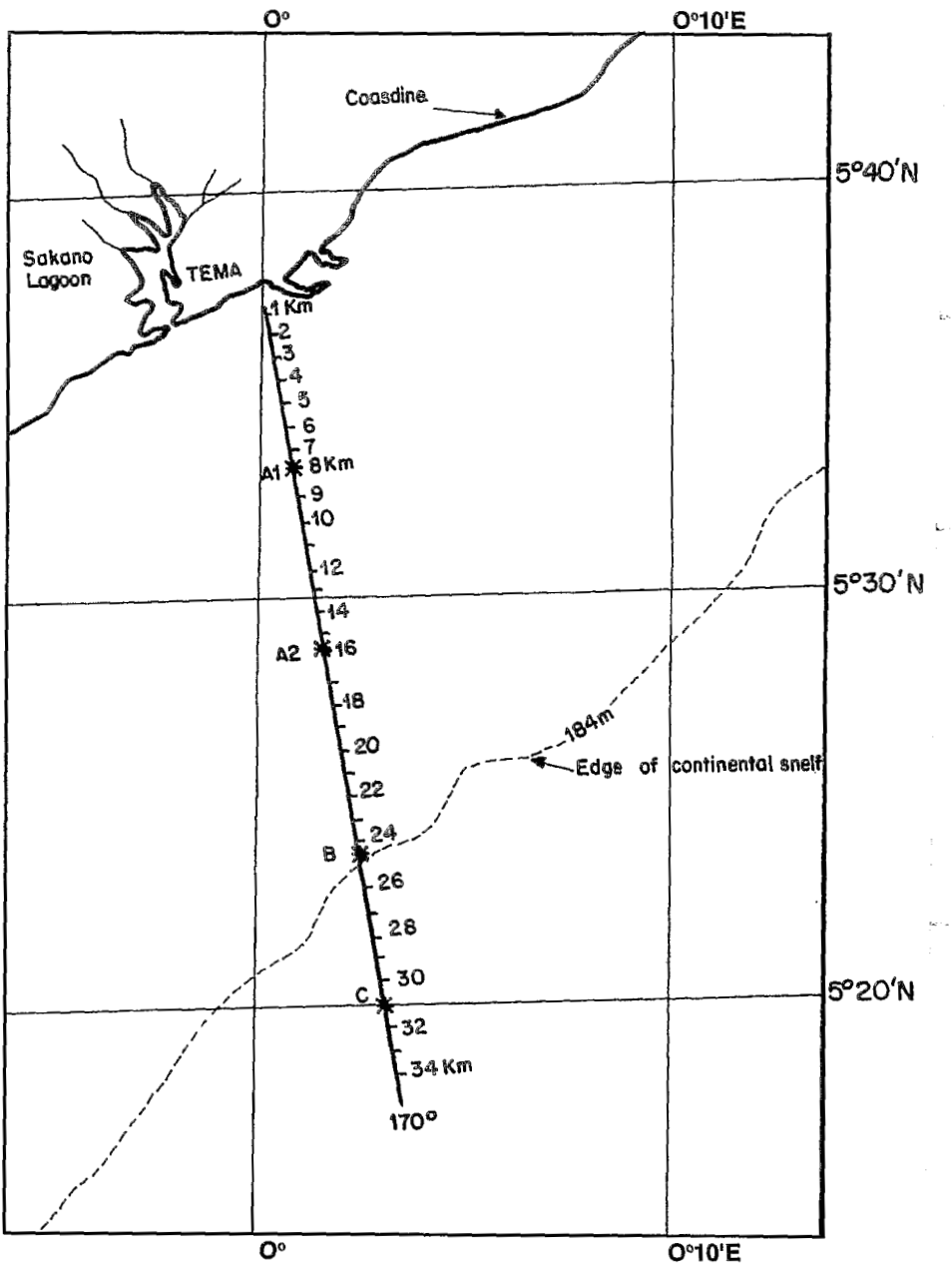

Figure 1 : The coastline and continental shelf off Tema, showing the position of the transect and the four stations A1, A2, B and C. (Culled from Mensah, 1974).

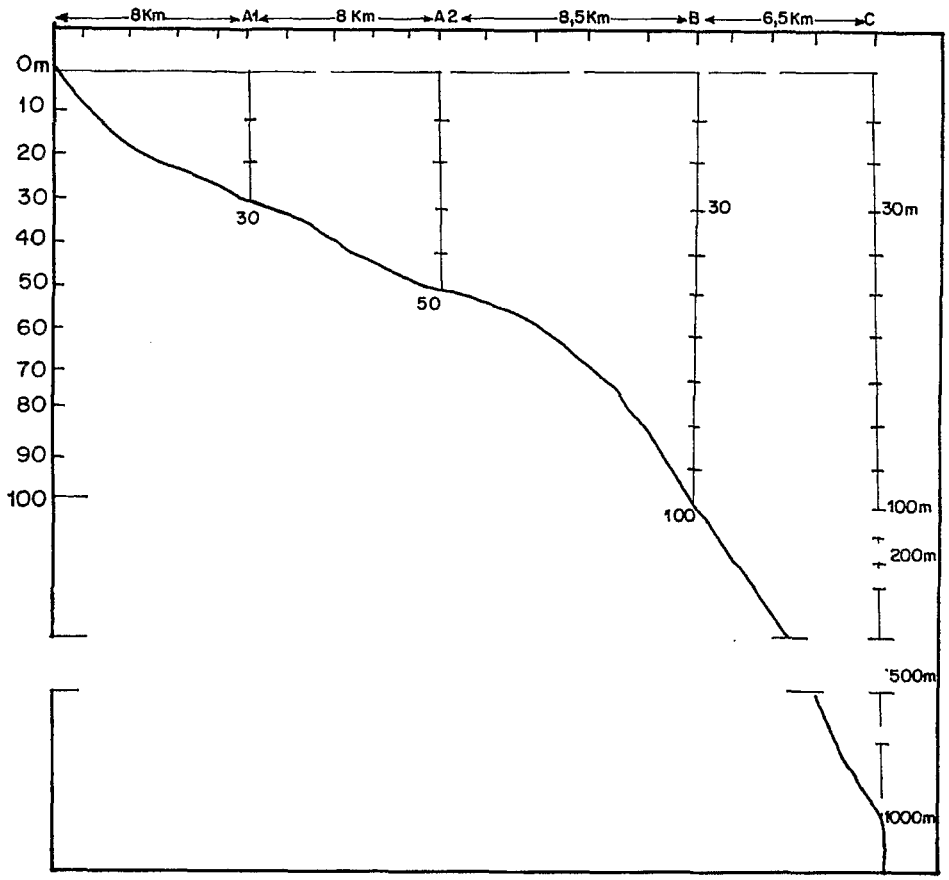

Figure 2 : Tema transect showing the stations (A1, A2, B and C) and layers of water sampled at each station. (Culled from Mensah, 1974).

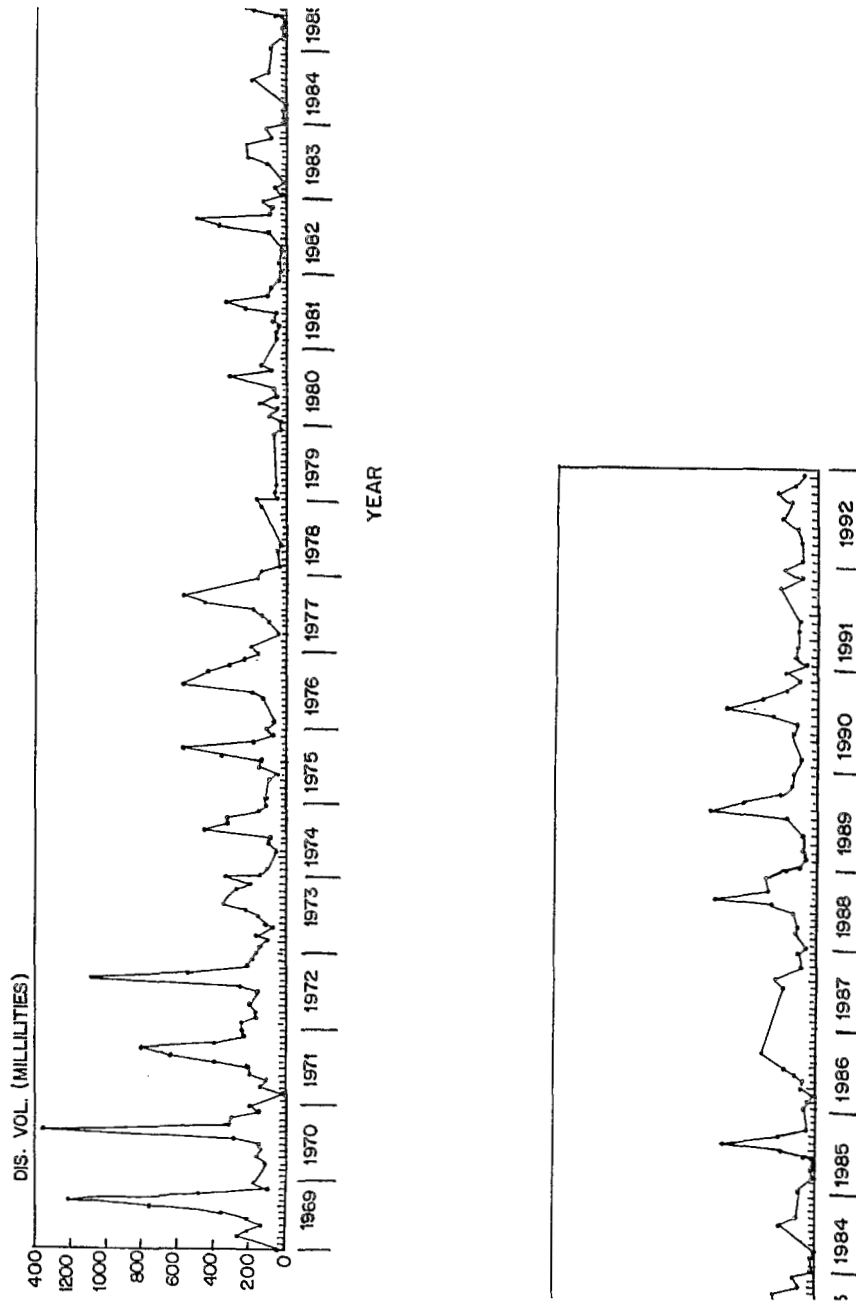

Figure 3: Monthly mean displacement volumes of zooplankton per 1000 litres of sea water, off Tema 1969-1992

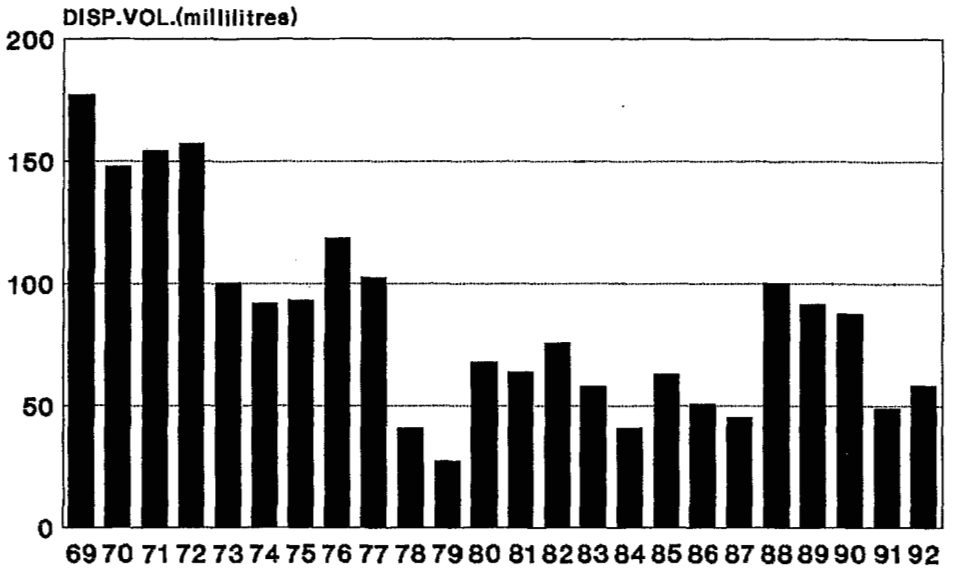

Figure 4 : Yearly mean displacement volumes of zooplankton per 1000 litres of sea water. 1969-1992

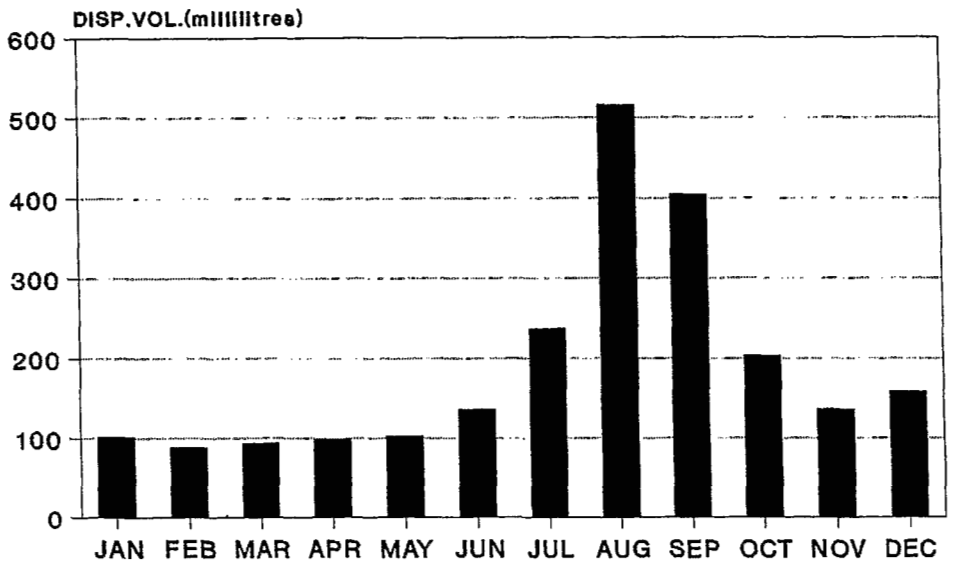

Figure 5 : Monthly mean displacement volumes of zooplankton ml/1000 litres of sea water.