OCCURRENCE OF JELLYFISH AT THE BLACK SEA - MARMARA JUNCTIONS OF THE BOSPHORUS

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ABSTRACT

Jellyfish (*Aurelia*) populations have increased in significant proportions in the entire Black Sea in all seasons. This increase is considered "an ecological event of great importance" (Gomoyu, 1981) and leads to significant fluctuations in jellyfish biomass at the Bosphorus region. The results emerging from the present study on this aspect of the biology of the region can be summarized as follows:

-Most jellyfish species consist of *Aurelia aurita*.

-The jellyfish biomass over the water column varies both in space and in time.

-The mean biomass decreased between December and March and then increased between March and July.

-The mean jellyfish concentration in the study period is 10.65g wet weight per cubic metre. This value is in excellent agreement with the mean jellyfish concentration for the entire Black Sea.

-Comparison of visual observations made in 1985 and 1986 indicate that jellyfish surface concentrations appear to be declining on an interannual basis.

1. INTRODUCTION

A noticeable increase in the concentration of jellyfish has been observed in recent years in the Mediterranean generally and in the Black Sea particularly. The most striking population explosion of jellyfish was reported by Shushkina and Musayeva (1983) for the Black Sea region. These authors indicate that the main mass of jellyfish is concentrated at depths of 0-50m over the entire Black Sea and that the most abundant individuals are of the genus *Aurelia*.

In the Black Sea, the population of *Aurelia* consumes daily about 15% of the biomass of zooplankton in the fall, and up to 25% of the production of non-predatory zooplankton. In a year, *Aurelia* consumes on the average 10% of the production of the whole non-predatory zooplankton per square metre in every 24 hours, about 30% of the production of the non-predatory crustaceans. *Aurelia* is slightly susceptible to the pollution of its environment (Shushkina and Musayeva, 1983). Similar characteristics and impact on the marine life of *Aurelia* are reported for various other oceans of the world, e.g. the Baltic Sea (Möller, 1980, 1984).

There are several biomass estimates of the jellyfish in the Black Sea, the most reliable being 350-450 million tons by Gomoyu and Kupriyanov (1980). This is much greater than the biomass of anchovy in the Black Sea. The mean biomass of the jellyfish *Aurelia* in the Black Sea, between 1950 and 1962, is 1.4g wet weight per cubic metre (Mironov, 1971). The observations carried out from 1978 to 1981 showed that in the period May-June the mean biomass wet weight) amounts to 25g of jellyfish in a cubic metre, the corresponding figure in summer-fall being 1g (Gomoyu & Kupriyanov, 1980; Shushkina *et al.*, 1980 (cited in

Shushkina and Musayeva, 1983)). Taking these two jellyfish concentrations as first order averages for the periods during which they were measured, an annual mean value of 13g wet weight in a cubic metre can be inferred.

The considerable jellyfish biomass of the Black Sea, the predatory capacity of the jellyfish on the eggs and larvae of economically important plankton-eating pelagic fish, their ability to occupy the ecological niches and their inability to swim against sufficiently strong currents, call for a time series investigation in places of sufficiently strong currents, for example the Marmara and Black Sea junctions of the Bosphorus. Jellyfish carried out with currents to places where water masses are more or less stagnant will influence the organic matter input significantly and contribute to the deficiency of the dissolved oxygen content in deeper layers especially the sea bed. In fact, the two generations of *A. aurita* (winter generation from December to May and spring generation from April to August) introduced in succession to the basin may easily constitute a natural source of a smaller organic input to the Marmara Sea.

Within the ISKI (Department of Water and Sewage Administration, Municipality of Istanbul) project, IMS-METU (Institute of Marine Sciences; Middle East Technical University) has been carrying out a jellyfish monitoring study since December 1985. The preliminary results obtained in conjunction with this aspect of the monitoring programmes at large are presented in the following chapters.

2. MATERIALS AND METHODS

Jellyfish were collected during the cruises of the R/V BILIM along the Bosphorus as well as in the regions surrounding the junctions of the straits with the Black Sea and the Sea of Marmara. The monitoring stations are shown in Fig. 1. The dates of the cruises and the stations visited are summarized in Table I.

Fig. 1. Location of jellyfish sampling stations

Table 1. Jellyfish biomass from various stations (December 1985-July 1986).

Date of Cruise	Station code	Water filtered in m^3	Amount of jellyfish g/m^3	Species Identifed
20.12.85	M 2	49.3		
20.12.85	M 7	11.8		
20.12.85	M 6	912.3	1.21	Aurelia
20.12.85	M 14	456.1	0.02	Aurelia
20.12.85	M 16	532.2	0.28	Aurelia
20.12.85	C 45	532.2	1.88	Aurelia
21.12.85	M 5	532.2	1.32	Aurelia Rhizostoma
21.12.85	A 20	380.1	6.18	Aurelia
21.12.85	M 12	608.2	1.50	Aurelia
21.12.85	M 20	608.2	4.04	Aurelia
21.12.85	M 10	608.2	0.58	Aurelia
21.12.85	B 4	304.1	149.13	Aurelia
21.12.85	B 14	608.2	1.64	Aurelia
21.01.86	M 2	1064.3	0.33	Aurelia
21.01.86	M 6	881.9	5.33	Aurelia
22.01.86	M 14	790.7	0.25	Aurelia
22.01.86	M 8	532.2	0.38	Aurelia
22.01.86	M 20	881.9	0.28	Aurelia
23.01.86	M 10	425.7	0.23	Aurelia
23.01.86	M 5	760.2		
27.01.86	K 13	49.3	23.33	Aurelia
27.01.86	K 16	49.3	13.18	Aurelia
27.01.86	K 14	49.3	17.24	Aurelia
27.01.86	K 17	49.3	7.10	Aurelia
27.01.86	K 19	49.3	9.74	Aurelia
28.01.86	K 20	49.3	1.01	Aurelia
28.01.86	K 21	49.3	11.16	Aurelia
28.01.86	K 21*	49.3	128.80	Aurelia
13.03.86	B 4	29.6		
13.03.86	K 0	49.3		
13.03.86	K 2	49.3		
13.03.86	M 2	49.3		
13.03.86	M 3	49.3		
14.03.86	M 14	49.3		
14.03.86	M 16	49.3	0.20	Aurelia
14.03.86	M 18	49.3		
14.03.86	M 20	49.3		
06.05.86	M 3	19.7	20.30	Aurelia
06.05.86	M 2	33.5		
06.05.86	M 14	49.3	4.06	Aurelia
06.05.86	M 16	49.3	0.41	Aurelia
06.05.86	M 5	14.8		
07.05.86	M 18	49.3		
07.05.86	M 20	49.3		
20.05.86	B 4	19.7	5.08	Aurelia
20.05.86	B 10	19.7	17.77	Aurelia
20.05.86	K 0	49.3		
24.05.86	M 2	21.4	46.30	Aurelia
24.05.86	M 14	26.3		
24.05.86	M 16	19.7		
24.05.86	M 17	19.7	35.50	Aurelia
25.05.86	M 19	19.7		
25.05.86	M 20	19.7	0.25	Aurelia
14.07.86	B 4	9.9	20.20	Aurelia
14.07.86	B 14	9.9	2.02	Aurelia
17.07.86	M 3	11.5	115.65	Aurelia
18.07.86	M 14	9.9		
18.07.86	M 15	9.9		
18.07.86	M 5	12.8		
18.07.86	M 18	19.7		
18.07.86	M 20	26.3		

* Two tows within 10 minutes

The jellyfish net constructed at IMS-METU (Bingel *et al.*, 1987), was operated from the crane of the vessel. To increase the area covered, extra tows (mostly vertical and horizontal) were carried out. Jellyfish was weighted on board. When it was possible, species were identified and their wet weights recorded.

3. RESULTS AND DISCUSSION

During the December 1985-July 1986 period, an average jellyfish biomass of 10.6g wet weight m^{-3} was measured. This value is in excellent agreement with the jellyfish biomass reported for the Black Sea and is indicative of strong biological interactions betweeen the Sea of Marmara and the Black Sea, anticipated earlier. Seasonal averages of the jellyfish biomass were found to be as follows:

TIME PERIOD	BIOMASS - WET WEIGHT g per cubic metre
Winter 1985-1986	6.94
Spring 1985-1986	4.08
Summer 1985-1986	17.20

Mean jellyfish biomass for different regions and time periods are summarized in Table 2.

Shushkina and Musayeva (1983) suggest that two generations of *Aurelia* occupy the Black Sea. The first generation is observed during a 6-month period between December and May and the second from April to August. The largest individuals of these generations are found in May and September respectively. These decreases and increases in jellyfish biomass correlate well with the changes in plankton biomass (Figs. 2 and 3).

The time series plot of the mean wet weight of the jellyfish biomasses for the Istanbul region indicates that probably both generations were caught during the investigation period (Fig. 3). The decrease in the mean biomasses from December to March corroborated Shushkina and Musayeva's (1983) observations,

Table 2. Mean jellyfish biomass at different times in the junction of the Bosphorus.

Months	Region	Wet weight (g/m^3)
December 1985	Bosphorus	75.385
December 1985	Marmara junction	1.546
January 1986	Black Sea	26.450
January 1986	Marmara junction	0.971
March 1986	Black Sea junction	0.000
March 1986	Bosphorus	0.000
March 1986	Marmara junction	0.033
May 1986 *	Marmara junction	3.539
May 1986 +	Black Sea junction	0.000
May 1986	Bosphorus junction	11.425
May 1986	Marmara junction	19.275
(*) In the first half and (+) in the second half		

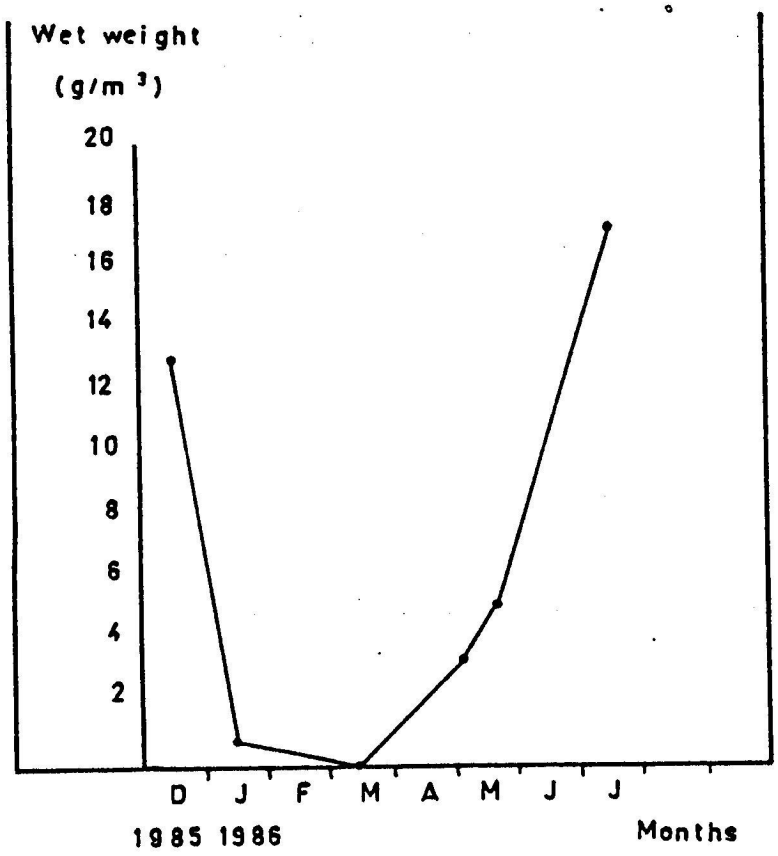

Fig. 2. Monthly variations in the mean wet weights of jellyfish at the Black Sea-Marmara junctions of the Bosphorus.

i.e. that the so-called first generation biomasses are much lower than those of the second (or spring) generation. Miranov's (1971) observations on the other hand are contrary to the findings of Shuskina and Musayeva (1983). The time series obtained in the present study is too short to allow us at this stage to draw any firm conclusion on the seasonal variations of jellyfish in the region monitored. It is however quite clear that significant variability in time and space of jellyfish exists and that this aspect of the monitoring programmes should be followed (and is) in order to obtain a better understanding of the biological cycles that are relevant to the programmes at large.

It is also worth pointing out that prior to the present quantitative sampling, visual observations indicated the presence of large amounts of jellyfish in the entire Turkish straits. In comparison, the visual observations made in the region during the recent cruises are indicative of a remarkable decrease in the occurrence of the surface concentrations of jellyfish. The reasons for this apparent decrease are not yet clear.

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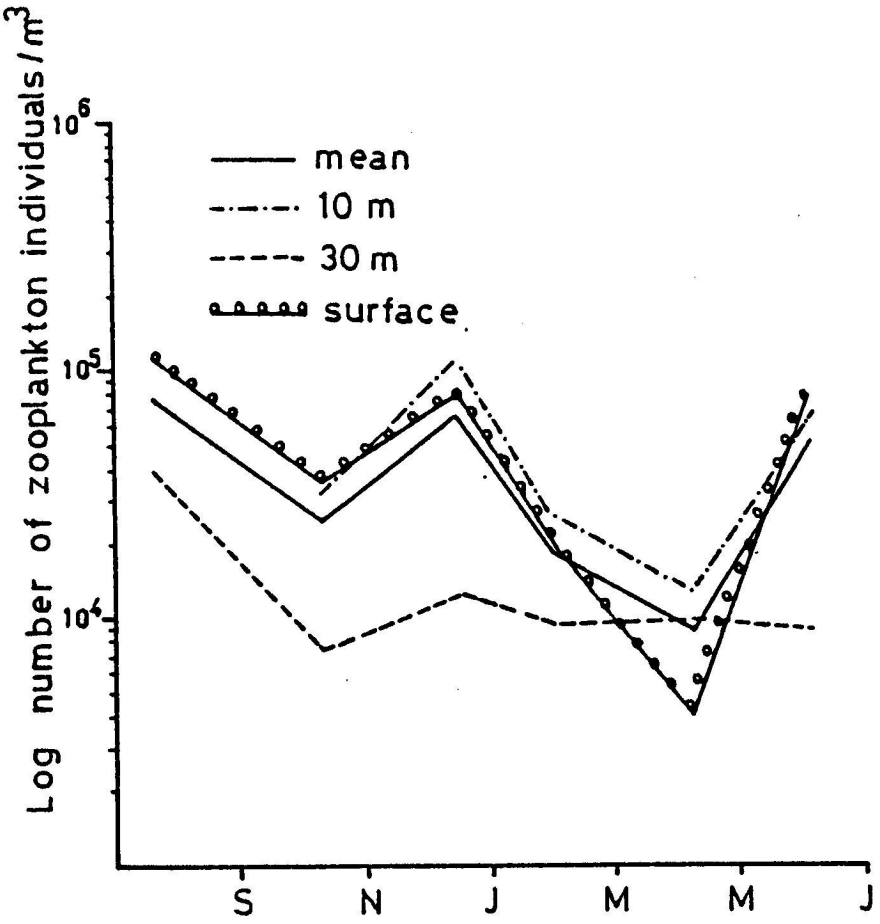

Fig. 3. Bimonthly distribution of zooplankton from September 1985 to July 1986 at the Marmara junction of the Bosphorus

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