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PREDATION OF OYSTER LARVAE BY *AURELIA AURITA* IN A NORWEGIAN OYSTER POND

by

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ABSTRACT

In the norwegian oyster spatting ponds several factors may influence the spat production. During a basic, general study in a pond in 1983-84, *Aurelia aurita* was demonstrated to be a heavy predator on pelagic oyster larvae, reducing the spat production to zero. The medusae occurred at a density of up to 125 ind. pr. m^3. Body areas of individual medusae (x) and the number of oyster larvae in a medusa (y), followed the linear relationship y = 0.08X-0,01. The size of oyster larvae in plankton, in the digestive system of the medusae, or in sediment traps never exceeded 200 µm, suggesting that the larvae lived for maximum 3 days before they were eaten.

INTRODUCTION

Spat production of the oyster, Ostrea edulis, in Norway takes place in warmwater ponds. The channel which connects the pond with the fjord outside is closed in the spring. There is a sufficiently large drainage area surrounding the pond so that freshwater runoff creates a layer of brackish water on the top of the salt pond water. This stabilizes the watercolumn and the saltwater is rapidly heated. A temperature of 25 - 30 ^{0}C is normally reached during July/August. Under these conditions oysters will spawn readily. A thorough discription of the norwegian oyster ponds and the way they are operated is given by GAARDER og BJERKAN (1934).

In such extensive systems the production will be affected by several unmanagable factors. Meteorological conditions like the amount of rain, and sun radiation affects the temperature and primary production which again affects the timing and intensity in the oyster spawning and the feeding conditions. Further, investigations performed in 1983-84 in a pond near Bergen, Western Norway, indicated that low concentrations of nutrients, low O_2 values in the deeper parts of the pond, and predation of swarming oyster larvae by jellyfish act as limiting factors (AASE 1986).

The present paper deals with the predation on oyster larvae by A. aurita in the 1984 season.

MATERIALS AND METHODS

The investigation took place in Strønopollen, ca. 30 km south of Bergen. The pond has an area of 19 400 m and a maximum depth of 6.8 m (Fig. 1A). The volume of the pond is 53 000 m^3 which is distributed on the different depths as shown in Fig. 1B. The drainage area to the pond is 414 000 m and mainly consists of heather and pinewood. The pond is separated from the fjord by 3 dams, 2 of which can be closed/opened.

In 1984 the pond was closed April 28. From the date of closure till Sept. 16 salinity, temperature and oxygen were registered weekly. In the period May 27 - Sept. 16 waterbottle samples were examined for density of swarming oyster larvae. All larvae were length measured. In the period July 10 - Sept. 12 the density and size composition of the Aurelia population was estimated on 5 different dates. On each occasion a number of vertical tows with a plankton sampler was performed, the number varying between 12 and 27. The location of the different tows were attempted evenly distributed over the pond surface regardless of depth. The plankton sampler had a 0.08 m^2 rectangular opening and a conical net. On the first sampling date the mesh size of the net was 300 µ m. Later this was changed to a 1500 µm meshsize net. The number of medusae in each tow was counted, and the bell diameter of a random sample of the medusae was measured to the nearest lower cm, lying on a flat substrate.

On 3 occasions a varying number of medusae were sampled and the oyster larvae in their digestive system were counted and length measured.

The sedimentation of oyster larvae was registered by simple sediment traps, consisting of a cylinder 50 cm long and 10 cm in diameter. The traps were suspended from a buoy at 2,4 or 6 m depth and for time intervals varying from 1 to 6 days. The traps were examined for the number of oyster larvae and the fraction of these with empty shells.

RESULTS - DISCUSSION

Hydrography

Fig. 2 shows the salinity isoplets. Due to very little rain, no layer of brackish water of significant thickness or duration was established. The salinity was fairly high and stable increasing with depth from 24-26 o/oo in the surface to 28-29 o/oo at the bottom. Fig. 3 shows the temperature isopleths. After the closure of the pond, the temperature was rose steadily to above 20 ^{0}C in the beginning of June. For the rest of the season the temperature varied between 17 and 20^{0} C. Because of the lack of the stabilizing brackish water no greenhous effect occurred and there was frequent vertical mixing of the water. Fig. 4 shows the oxygen isoplets. The O_2 content was high, corresponding to over 100 % saturation in all depths for most of the season. The highest recorded value, 11,5 ml/l (= 214 % saturation) was registered at 4 m depth on June 6. Vertical mixings supplied the deeper waters with oxygen season throughout the season.

Pelagic oyster larvae

Table 1 gives the density of swarming oyster larvae in different depths at the different sampling dates. The highest density was found in the beginning of July and the beginning of August with a maximum of 53 larvae pr. l. found July 2 in 3 m depth. The estimated total population of oyster larvae on Aug. 3 was 102 mill. larvae, and on July 2 correspondingly 60 mill. larvae. For the rest of the season oyster larvae were unusually scarce compared to a year of normal or good spat production (GAARDER og BJERKAN 1934, AASE 1986). The lengths of the swarming larvae were small, varying between 160 and 200 µm. This indicates either that the larvae suffered from starvation and showed poor growth or that they died and fell out of the system for some reason or other.

The Aurelia population

Table 2 gives the results from the vertical net tows on the different dates and on the different stations. The results are presented as numbers of medusae per m^2. Comparison of the means and the variance of the means showed that on all 5 sampling dates, the medusae population were strongly patchy distributed horisontally (Fig. 5). On the first sampling date July 10 the mesh size of the plankton net was 300 µm. This probably led to avoidance by the medusae and a too low estimate of the population compared to the other dates when 1500 µm was used. Fig. 6 shows the estimates of the abundance on the last 4 dates. Because of the great individual differences between tows, the abundance curve was log transformed.

On July 16 the average density was estimated at 575 medusae pr. m^2. On the following dates the estimates were steadily declined to 88 medusae pr. m^2 on Sept. 12. By combining the content in the different tows with the depth from which the tows were pulled, the density of the medusae population by volume was calculated. With the assumption of an even distribution the corresponding total population was estimated. The results are given in Tabel 3.

The average bell-diameter of the medusae (shown in Tab. 3) was small, increasing from 2,05 cm on July 16 to 3,56 cm on Sept. 12. Based on the measurements of 60 medusae, the relationship between length and volume is shown in Fig. 7. The curve of best fit (r^2 = 0,86) is given by $V= 0,08\ D^{2,47}$ where V= volume in ml and D= bell-diameter in cm.

On Aug. 14 and 15 efforts were made to reduce the number of medusae in the pond. Six landnet hauls were performed, covering different areas of the pond. The catch was estimated at 1000 l of medusae. Based on the relationship between length and volume of the medusae, the catch in numbers was estimated to 640 000 medusae which was 25 % of the total population. This method therefore seems effective in taking out medusae from ponds, given that it is performed over a short time interval and gives good area coverage. However it requires much manpower.

<u>Stomach content of the medusae</u>

On July 12 and 30 and Aug. 21 a random sample of 50,52 and 60 medusae respectively were length measured and analysed for stomach content. Tab. 4 gives the results. On July 30 oyster larvae were found in 71 % of the medusae. The highest recorded was 14 oyster larvae in one medusa. Fig. 8 shows the capture efficiency related to the area of the medusae. Spearman's rank correlation shows that the number of oyster larvae in the medusae is strongly correlated to the area of the medusae (rs=0.53, p=0.0000, n=162). The number of oyster larvae per medusa (y) and individual medusa area (x) were linearly related by the line y= 0.08x - 0.01. There was a correspondingly strong correlation between the area of the medusae and their stomack content of other bivalve larvae and copepods.

Whenever the oyster larvae were correctly positioned in the medusae, they were length measured. The lengths were all in the interval of 180 - 200 μm. This corresponds well with the size of the pelagic oyster larvae.

When combining the average number of oyster larvae pr. medusa on sampling date July 30 with the estimated total medusapopulation on the same date, we find that 14 mill. oyster larvae were in the guts of medusae at the sampling moment. Although this figure is uncertain it strongly indicates that the medusae act as very heavy predators on the swarming oyster larvae. The actual predation rate depends on the rate of digestion.

Sedimentation of oyster larvae

Tab. 5 gives the results from the sediment trap investigations. The average daily sedimentation in the traps placed at 6 m depth were 20 larvae per trap, corresponding to 2400 larvae per m^2. The area of the 6 m contour is 930 m^2. This suggests a daily average sedimentation of 2.2 mill. larvae to this depth.

The fraction of the larvae with empthy shells were high, even in the trap exposed for 1 day only. Microbial breakdown of the tissue in the oyster larvae is assumed to take more than 1 day. It is therefore probable that a significant part of the sedimented oyster larvae had been caught and digested by medusae before sinking to the bottom.

The lengths of the oyster larvae in the traps varied between 180 and 200 μm, which was the same as for oyster larvae in plankton and in the medusae.

The sizes of the pelagic oyster larvae, the larvae found in the medusae and in the sediment traps suggest that oyster larvae lived for a maximum of 3 days before they were eaten by medusae and that no spat settlement took place.

Normally Aurelia are very scarce in an oyster spatting pond. The conditions for reproduction of Aurelia were obviously very favourable in Strønopollen in 1984. This might be due to the unusually low temperature, and that Aurelia will not thrive or will die at temperatures of 25 - 30 ^{0}C.

REFERANCES

GAARDER, T. og P. BJERKAN 1934. Østers og østerskultur i Norge. A.S. John Griegs Boktrykkeri, Bergen. 96 pp.

AASE, H. 1986. Grunnleggende undersøkelser og praktiske tiltak rettet mot en bedre utnyttelse av østersyngelpoller. Sluttrapport. Avd. for Akvakultur L. nr. 9/86. 69 pp.

Table 1. Density of swarming oyster larvae in the different depths, at the different sampling dates.

Depth in meter / Date	0	1	2	3	4	5
27.5.	0	1	0	4	0	2
30.5.	0	0	0	0	0	0
6.6.	0	0	0	0	0	0
13.6.	0	0	0	0	0	0
20.6.	0	0	0	0	0	0
27.6.	0	0	0	0	0	0
2.7.	1	1	2	53	17	4
4.7.	4	3	3	12	12	0
6.7.	3	5	2	3	1	-
9.7.	0	3	0	0	1	-
12.7.	1	1	1	0	1	0
15.7.	1	0	5	1	0	0
18.7.	0	0	1	0	0	1
20.7.	0	3	1	4	0	0
23.7.	1	1	3	0	0	0
25.7.	0	0	3	5	2	0
1.8.	0	0	0	0	0	0
3.8.	40	5	23	0	1	0
17.8.	0	1	0	1	0	0
22.8.	1	1	0	-	-	-
29.8.	0	1	0	0	0	0
8.9.	0	0	0	0	0	0
16.9.	0	0	0	0	0	0

Table 2. Abundance of medusae in different samplings in numbers per m^2.

Station Number \ Date	10.7.	16.7.	30.7.	14.8.	12.9.
1	94	513	188	75	63
2	245	1750	150	113	100
3	94	263	113	100	13
4	137	325	188	75	163
5	94	275	150	88	63
6	36	188	88	163	88
7	151	225	213	75	100
8	224	38	138	150	50
9	51	425	400	238	150
10	58	50	313	100	150
11	100	88	238	150	50
12	51	2238	525	300	88
13	-	513	475	225	63
14	-	975	188	88	88
15	-	1000	413	213	63
16	-	488	488	163	113
17	-	425	188	-	-
18	-	-	175	-	-
19	-	-	100	-	-
20	-	-	500	-	-
21	-	-	300	-	-
22	-	-	175	-	-
23	-	-	538	-	-
24	-	-	250	-	-
25	-	-	375	-	-
26	-	-	525	-	-
Average abundance:	111.3	575.2	284.4	144.8	87.8
Standard deviation:	67.2	605.7	151.3	68.6	41.0

Table 3. Abundance of medusae in numbers per m^3, estimated corresponding total populations, and average bell diameter of the medusae.

Date	Number of medusae per m^3	Total population in mill.	Average bell diameter in cm.
16.6.	125.4	6.69	2.05
30.7.	86.3	4.61	3.01
14.8.	46.5	2.49	3.10
12.9.	31.6.	1.69	3.56

Table 4. Stomach content of the medusae at the different sampling dates.

Date	Number of medusae with oyster larvae	Total number of oyster larvae	Total number of other bivalv larvae	Total number of copepods
12.7.	8	13	87	5
30.7.	37	159	792	30
21.8.	21	39	215	15

Tab. 5 Sedimentation of oyster larvae

Date	Depth of trap in m	Number of oyster larvae in trap	Number of emptyshelled larvae	Number of larvae with tissue	Sedimentation rate number of larvae/ m^2 /day
18.7.-20.7.	2	1	-	1	60
16.8.-21.8.	2	20	19	1	480
06.7.-12.7.	4	33	-	-	660
16.8.-21.8.	4	30	28	2	720
18.7.-20.7.	4	24	24	-	1440
06.7.-09.7.	6	78	-	-	3120
06.7.-12.7.	6	106	105	1	2120
15.7.-16.7.	6	19	11	8	2280
16.7.-18.7.	6	38	32	6	2280
16.7.-18.7.	6	50	48	2	3000
18.7.-20.7.	6	41	29	12	2460
25.7.-27.7.	6	43	40	3	2580
16.8.-21.8.	6	67	64	3	1608

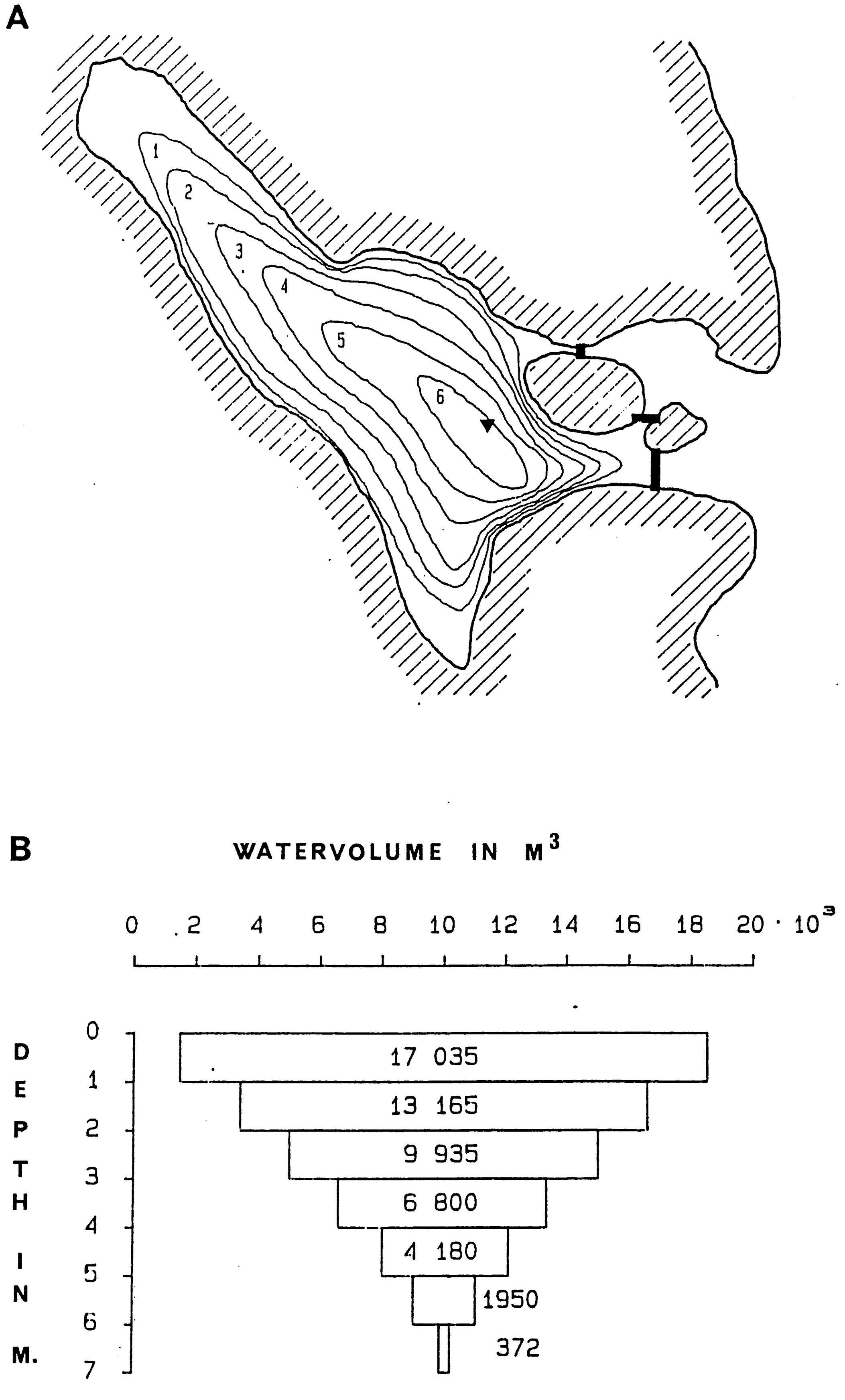

Fig. 1 A. Strønopollen with depth contours.
B. The watervolume in the different depth intervals.

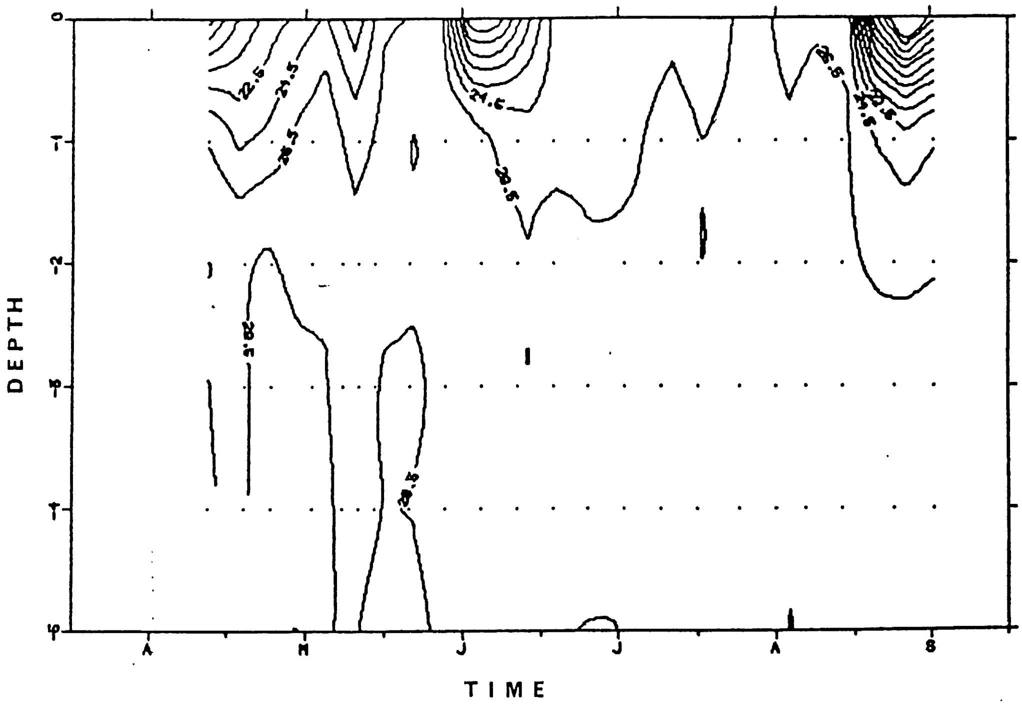

Fig. 2 Salinity isoplets in Strønopollen in 1984.

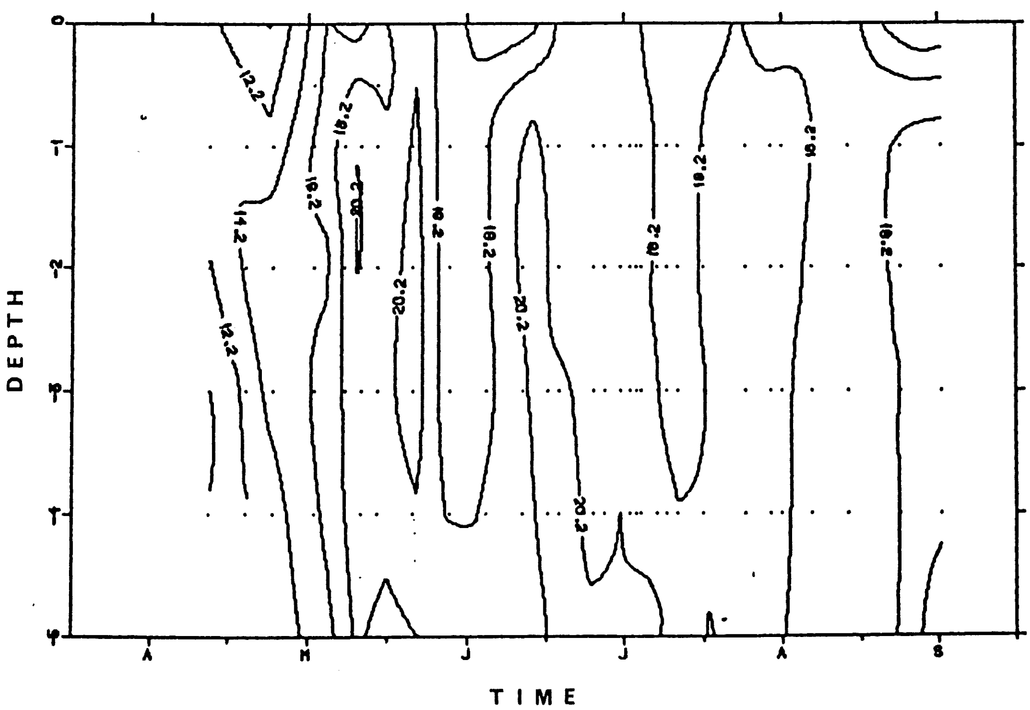

Fig. 3 Temperature isoplets in Strønopollen in 1984.

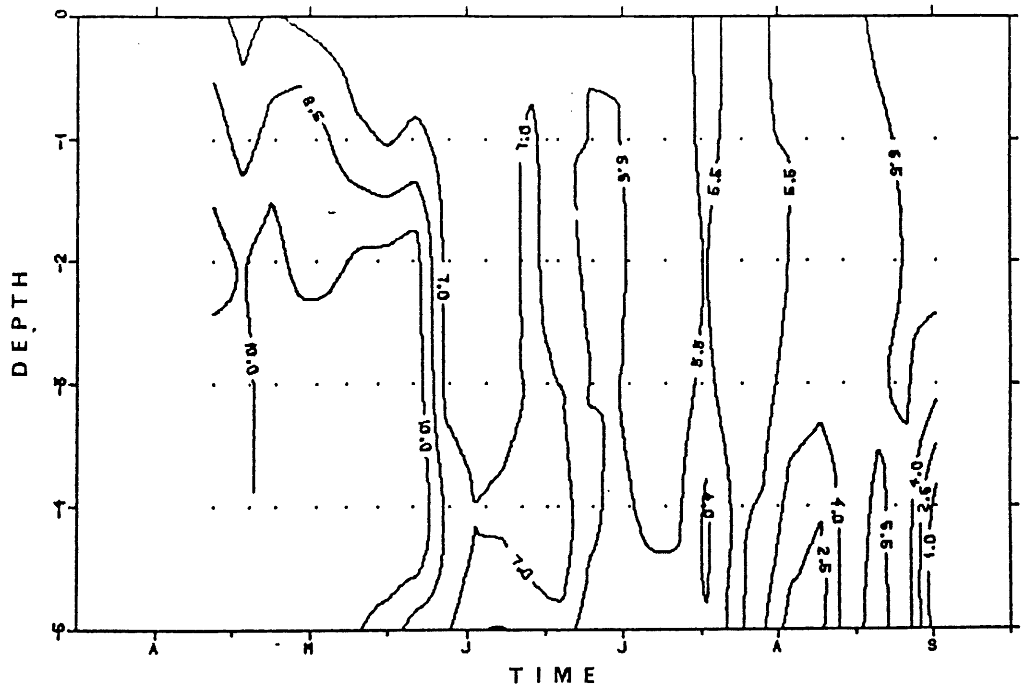

Fig. 4 Oxygen isoplets (ml pr. l) in Strønopollen in 1984.

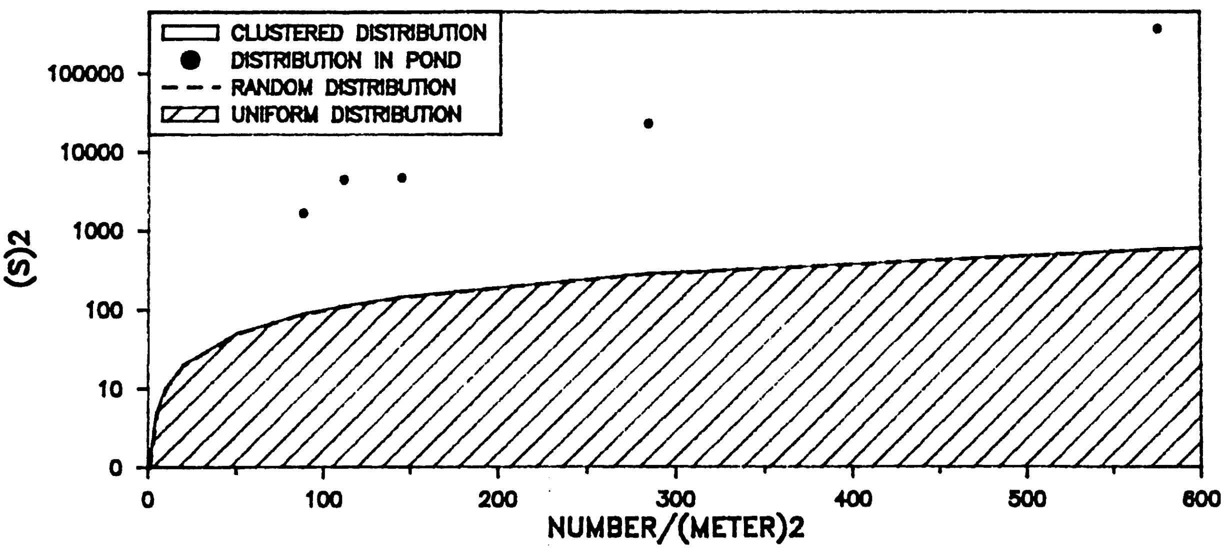

Fig. 5 Horisontal distribution of medusae in Strønopollen 1984.

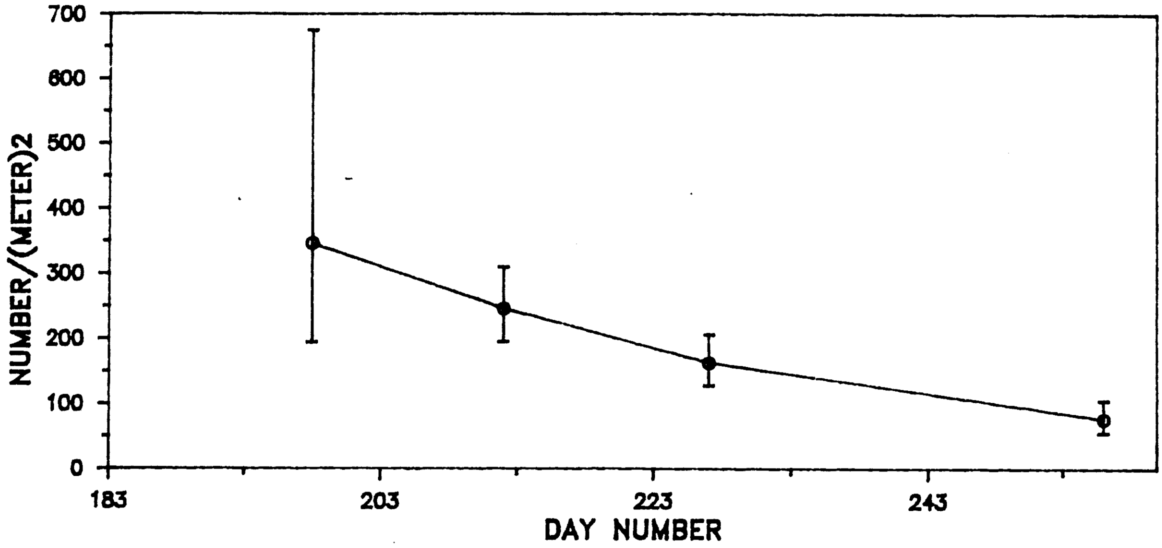

Fig. 6 Population density of medusae in Strønopollen 1984.

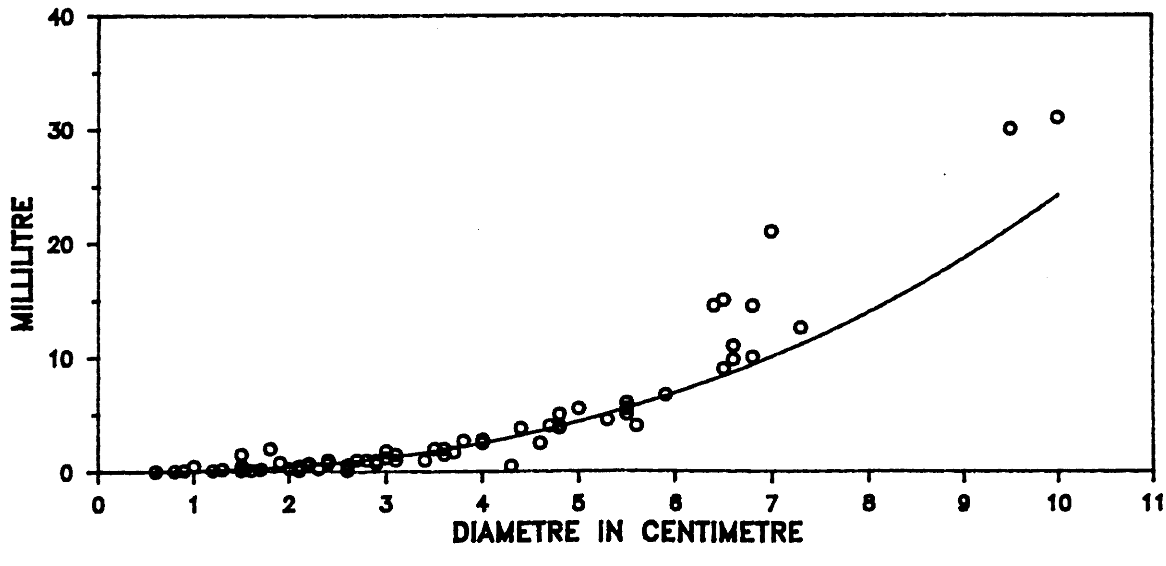

Fig. 7 The relationship betweeen individual volume and bell diameter of <u>Aurelia aurita</u> in Strønopollen 1984.

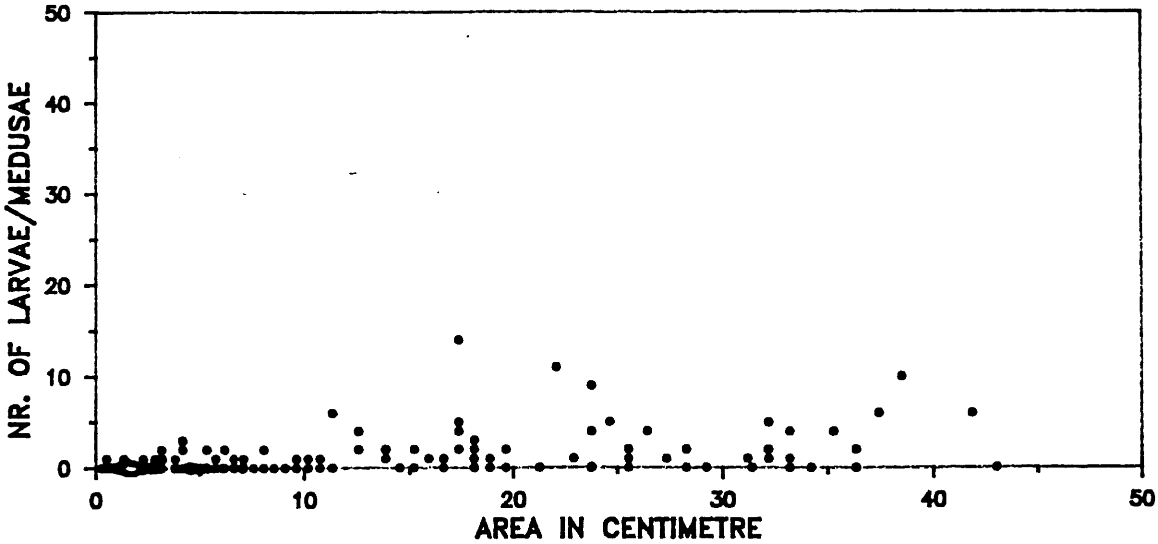

Fig. 8 The relationship between the area of the medusae and the number of oyster larvae caught.