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PRELIMINARY RESULTS FROM POLUMAR III (April 13-18 1978) (SUROIT III) ATP, PRIMARY PRODUCTION AND RESPIRATION RATES IN SESTON ; RESPIRATION RATES IN ZOOPLANKTON

Complément à la Communication du Groupe Ecophysiologie du Centre Océanologique de Bretagne (SAMAIN et al.)

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R E S U M E

Des mesures de l'ATP, de la production primaire et des taux respiratoires du seston, des taux respiratoires du zooplancton ont été effectuées après le naufrage de l'"AMOCO CADIZ". La production primaire moyenne est du même ordre de grandeur que dans la situation normale. La vitesse de photosynthèse est inférieure à la station proche de l'"AMOCO CADIZ" comparativement à toutes les autres stations. Les taux respiratoires sont curieusement élevés en surface. La concentration en ATP est homogène sur la zone, les taux respiratoires du zooplancton concordent avec les observations effectuées dans l'upwelling péruvien ou sur des cultures de copépodes. Un traitement plus détaillé des données est nécessaire avant d'en déduire des conclusions.

A B S T R A C T

ATP, primary production and respiration rates in seston, respiration rates in zooplankton have been investigated after the spill by "AMOCO CADIZ". Gross primary production seems to be similar to the normal situation. The rate of photosynthesis is lower at the "AMOCO CADIZ" station than at any of the others. Respiration rates are surprisingly high at the surface. ATP concentration exhibit an homogeneous pattern, zooplankton respiration are similar to the data obtained in Peruvian upwelled waters or in zooplankton culture. A more detailed computation of data will be necessary before concluding.

M O T S - C L E S : Plancton, Taux respiratoires, ATP, Production primaire, Pollution, AMOCO CADIZ.

K E Y - W O R D S : Plankton, Respiration rates, ATP, Primary production, Pollution, AMOCO CADIZ.

INTRODUCTION

The effects of crude oil pollutants on plankton organisms are not well understood. Therefore different ecophysiological methods have been applied in order to gain information on the activity of plankton, as defined by primary production and respiration rates of phyto and zooplankton. It was supposed that ecological stress, if present, would become evident when important metabolic processes are regarded.

1. MATERIAL AND METHODS

During POLUMAR III filter samples from stations along the Brittany coast (including stations close to the "AMOCO CADIZ" locality as well as some far off) were taken from different depth. Zooplankton was taken at the same stations with vertical net tows.

ATP from 0,5 ℓ of water, filtered over Whatman GF/C discs, was extracted on board ship (HOLM-HANSEN & BOOTH, 1966) and stored frozen. The samples were then thawed and measured according to KARL & LA ROCK (1975) using firefly extracts by SERVA-Heidelberg, FRG in a SAR-ATP-Photometer 2000.

Primary production was measured according to STRICKLAND et al. (1965) in a simulated in situ incubator, corresponding to 100 %, 50 % and 33 % light intensity as calculated from the Secchi depth. Incubations lasted a full or a half true sun day. Geiger-Müller counts were obtained from the carbon 14 Centralen, Hørsholm, Denmark.

Respiration rates were calculated from ETS-activity-estimations as described by OWENS & KING (1975). A factor of R/ETS = 0,3 was used to convert ETS-activity into oxygen uptake (own estimation by a Winkler method) of seston and from this carbon respired was calculated by $C = O_2 \times 0,43$ (assuming an average RQ of 0,81 (MULLIN & BROOKS, 1970). Zooplankton respiration rates were expressed in $\mu l\ O_2\ hr^{-1}\ mg\ Protein^{-1}$, applying a factor of R/ETS = 0,5 (OWENS & KING, 1975). No attempt was made to apply different factors for different species within the mixed zooplankton populations. Protein was estimated in the lab in COB, Brest according to SAMAIN, DANIEL, LE COZ (1977).

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Table 1 : Station No.	Depth m	ATP ng ℓ^{-1}	Prim. Prod. mg C $m^{-3} d^{-1}$	Photos Rate mgC/ mg Chl a/hr	Resp. Rate %Prim. Prod.	Zooplankton spec. Resp $\mu l\ O_2\ hr^{-1} mgProt^{-1}$
18	0	105	3,7		190	17,5
19	0	61				14,7
	20	86				
	75	83				
21	0	105	21,5		24	20,0
	4	100	29,7	1,38	18	
	7	144	37,7	1,75	14	
	20	110				
	45	51				
22	0	329				44,7
	20	203				
	35	70				
23	0	313				
	10	335				
	20	350				
24	0	164				13,1
	20	145				
	55	197				
28	0	110				21,6
29	0	110				
30	0	114	5,7		54	18,1
	4	126	40,5	2,50	8	
	7	102	31,0	1,48	12	
	20	115				
	55	149				
31	0	326	25,0		20	
	20	280				
	40	129				
32	0	71				20,4
	20	56				
	55	22				
34	0	161				
	16	62				
	32	74				
35	0	32				
36	0	51				28,7
	35	45				
40	0	118				18,2
	55	32				
43	0	157	13,7		40	11,8
	4	183	15,3	1,42	32	
	7	243	20,2	2,40	32	
	75	130				
45	0	104	10,7		82	24,6
	4	254	25,8	0,80	28	
	7	206	31,9	0,91	38	
	20	595				
	33	221				
47	0	101				
	20	116				
	33	30				

2. RESULTS

Preliminary results are presented in table 1. Primary production was measured only on a few stations because of lack of time. Secchi depth values were very similar on all stations, close to 11 m. From this the euphotic depth may be calculated, reaching down to about 25 m. Therefore primary production may also be expressed in mgC m^{-2} day^{-1}, assuming that the integrated value between 0 and 7 m stands for half the value which could potentially be obtained from the total euphotic layer (which would definetly be the upper limit of gross primary production). Thus gross primary production is computed to be 415 $mgCm^{-2}day^{-1}$ off Roscoff (st. 21), 360 mgC $m^{-2}d^{-1}$ in the Bay of Lannion (st. 30), 230 $mgCm^{-2}d^{-1}$ in the middle of the English (st. 43) Channel, and 320 mgC $m^{-2}d^{-1}$ in the vicinity of the "AMOCO CADIZ" (st. 45). The rate of photosynthesis is lower at the "AMOCO CADIZ" station than at any of the others (0,85 mgC/mg Chl *a* /hr.). However, here Chl *a* reaches maximum values of 2,8 mg Chl *a* m^{-3}. Since there is no indication from the ATP-data that the high Chl *a* values coincide with high concentrations of ATP, it may be assumed that there should be a high yield of dead pigment and not necessarily an inhibited photosynthetic rate. Microscopical analyses will reveal more about this question. Respiration rates are surprisingly high at the surface and it would be intrigueing to see if there exists a correlation to hydrocarbon concentrations. High respiration rates on stations 43 and 45 may also be due to illumination (cloudy sky).

ATP concentrations are low in the Bay of St.Brieuc and further east (sts. 32-40) ranging generally below 100 ng ℓ^{-1} ATP. With few exceptions ATP-concentrations exhibit a homogeneous pattern within the euphotic zone without distinct stratifications.

Zooplankton respiration rates are in the same range found in Peruvian upwelled waters (HENDRIKSON, unpublished) and in zooplankton cultures (OWENS & KING, 1975) with copepods, reaching values between 11,8 and 28,7 µl O_2 hr^{-1} mg $protein^{-1}$. Only one value (st. 22) is much higher than the others (44,7 µl O_2 hr^{-1} mg $protein^{-1}$).

3. DISCUSSION

Although physiological parameters offer opportunities to detect subtle differences of metabolic activity, these data generally lack sufficient material for comparison. Referring to gross primary production for example, the values found are well in agreement with the results of GRALL (1966) who worked in the region of Roscoff. No comparison however is possible for the other parameters. Metabolic rates on their own on the other side generally show a wide natural range of variation depending on environmental or biogeneous factors, the influence of pollution being one factor among many.

Thus in this case no such drastic values occurred which would correspond to the effect of pollution with certainity. Nor did the comparison between a non-polluted station (43) and a polluted station (45) reveal any distinct differences. The only hints which may be gathered from these data which are likely to indicate pollution derive from high respiration rates at the surface which correlate with high values of ATP / primary production ratios. These ratios indicate the amount of living biomass which is necessary to produce one mg C m^{-3} day^{-1}. Probably these ratios yield more information than the low photosynthetic rates at st. 45, since there is no difference between st. 43 (non polluted) and other polluted sts. such as 21 and 30. Further information however must be gained from microscopic observations since only these enable us to compare definite populations or to decide if there were any comparable populations present at all. In future more attention should be drawn to bio-assay-arrangements, which would consist titute definite populations.

Beside the difficulties mentioned the history of the populations found was unknown to us with respect to water exchanges and advection of new plankton populations from unpolluted areas.

Further there is little information of long term effects of crude oil pollution and even if no apparent damage of plankton populations could be detected by the means of the physiological methods applied, nothing can be deducted from this for long term effects.

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