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DIRECT BACTERIA COUNTING IN THE BANDA SEA

by

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ABSTRACT

Bacteria counting in the Banda sea were carried out in two seasons during Snellius II Expedition. In August 1984, representing the southeast monsoon where upwelling is expected, bacteria counts were higher than in February 1985, representing the northwest monsoon where downwelling is expected. Some biological parameters of the Banda Sea were in support of the bacteria numbers in the expected upwelling region.

ABSTRACT

Perhitungan bakteri di laut Banda telah dilakukan dalam dua musim selama Ekspedisi Snellius II berlangsung. Penelitian pada bulan Agustus 1984, mewakili musim tenggara, yang diharapkan adanya proses upwelling, jumlah bakteri lebih tinggi dari pada hasil penelitian bulan Februari 1985, mewakili musim barat laut yang diharapkan adanya proses downwelling. Beberapa parameter biologi Laut Banda menyokong hasil perhitungan bakteri di daerah yang diharapkan proses upwelling terjadi.

INTRODUCTION

WYRTKI (1961) stated that upwelling in the Banda Sea occur during the southeast monsoon and downwelling during the northwest monsoon. The statement of WYRTKI made the Banda Sea attractive for many oceanographers and biologists The last expedition which took part in the investigation of the Banda sea was the Snellius II Expedition (July 1984 - July 1985). This Expedition was a combined study of oceanography and biology with the aim to prove WYRTKI'S statement. Many Indonesian and Dutch scientists with different sciencetific backgrounds were involved in the expedition.

Upwelling is a process in which colder water, rich in nutrients, rises to the surface. In areas where upwelling occur the productivity will increase, high primary production and consequently high concentrations of herbivores and other organisms of the food chain. So upwelling, beside being a physical phenomena, could also be applied for biological research.

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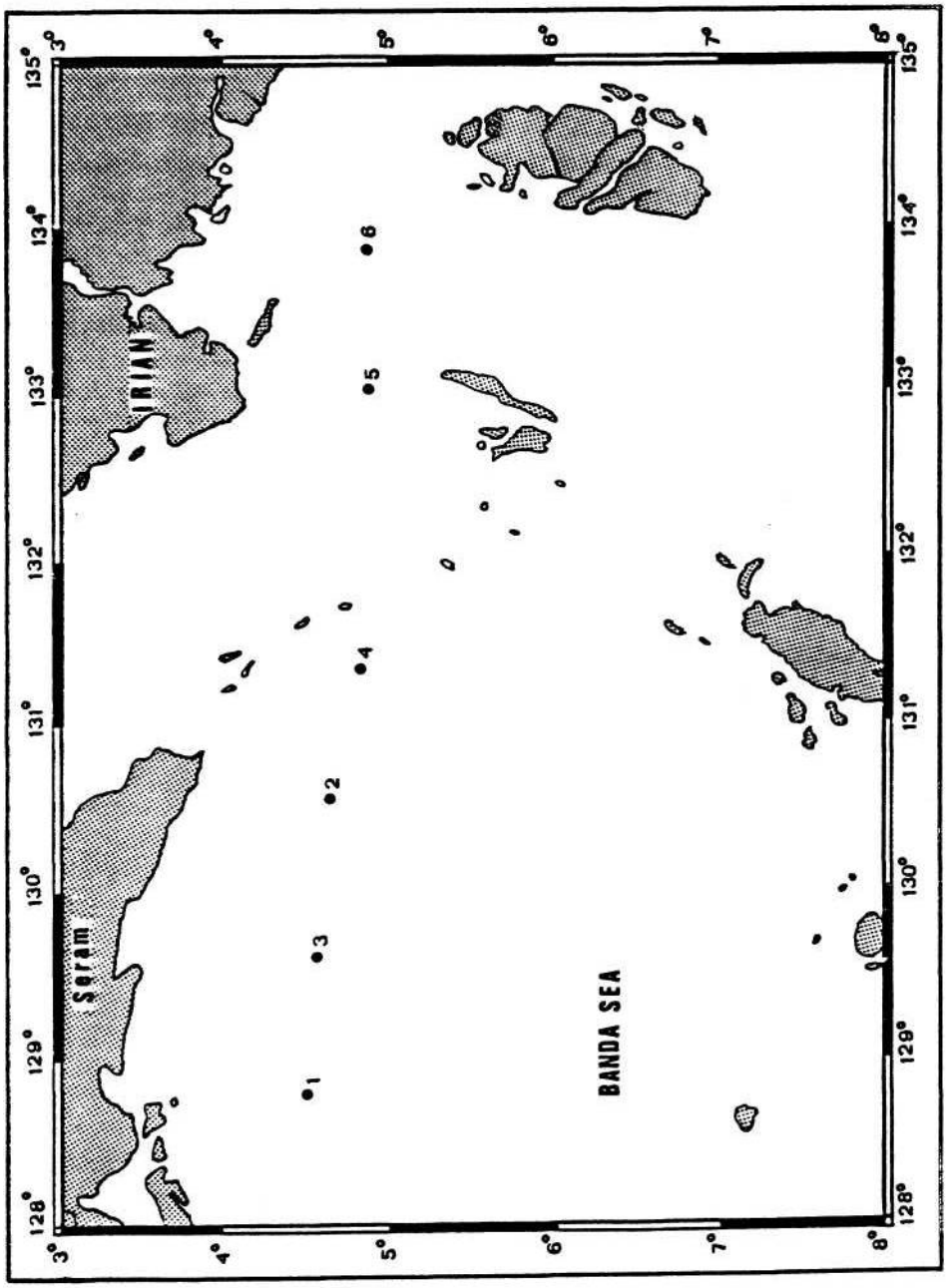

Figure 1. Location sampling stations during Snellius II Expedition August 1984 and February 1985 in the Banda Sea.

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Opposite of the upwelling process is the downwelling or sinking of water masses. Dynamically it is as important as upwelling, but it did not get so much attention as the productive upwelling.

In the Snellius II Expedition the biological ecosystems were studied, one of these was bacteria population which could support the statement of WYRTKI.

MATERIAL AND METHOD

Water samples were collected by using Rosette Sampler from surface to about 300 m depth in August 1984 and February 1985, representing the southeast and north-west monsoons respectively (Fig.l). About 25 ml subsamples were immediately transferred to sterile screw cap bottles and fixed with formaldehyde to a final concentration of 2% and stored at 4°C. Bacteria counting analyses were done in the laboratory of microbiology at NIOZ, the Netherland. In principle the procedure to analyze bacteria biomass was as described by PARSON *et al* (1984). A cellulose membrane filter (0.8 um porosize) is placed on the filtering apparatus as backing filter. On this bancking filter a polycarbonate membrane filter (0.2 um porosize) that was stained by Sudan Black is placed, 5 ml subsample, already fixed by formaldehyde is pipetted on the filter and Acridine Orange stain solution is added to a final concentration of 0.016 %. After 3 minutes coloring, a subsample is drawn by suction through the filter. The polycarbonate nuclepore filter, removed from the filtering apparatus, is placed over a drop of cargille type A immersion oil on microscope slide, another drop is put on the filter and a glass cover slip is placed to cover it. Immediately the bacteria are counted under the epifluorescence microscope. At least 200 bacteria are counted on at least 10 fields observation under the microscope.

RESULT AND DISCUSSION

The results indicate that vertical distribution of bacteria in the water column has the same pattern in all stations. This mean that in August as well as in February the highest numbers were always found in the upper 600 m water colums (Fig. 2). FUKAMI *et al* (1983) stated that the density of bacteria generally show a maximum value at the surface or near the surface and decreases with increasing depth. FERGUSON and PALUMBE (1979 quoted by FUKAMI *et al*.,1983) stated that the maximum values seem to be reached in or above the thermocline SUWARTANA (1985) found that the thermocline in the Banda Sea is between 20 m and 450 m depth. In this upper layer we found the highest concentration of bacteria. In August 1984 the highest value was found at the surface of station 5 (9.7 x 10 bacteria per ml) and the lowest at 300 m depth of station 1 (0.4 x 10^5 bacteria per ml) (Fig. 2). In February 1985 the highest bacteria numbers were found at the surface of station

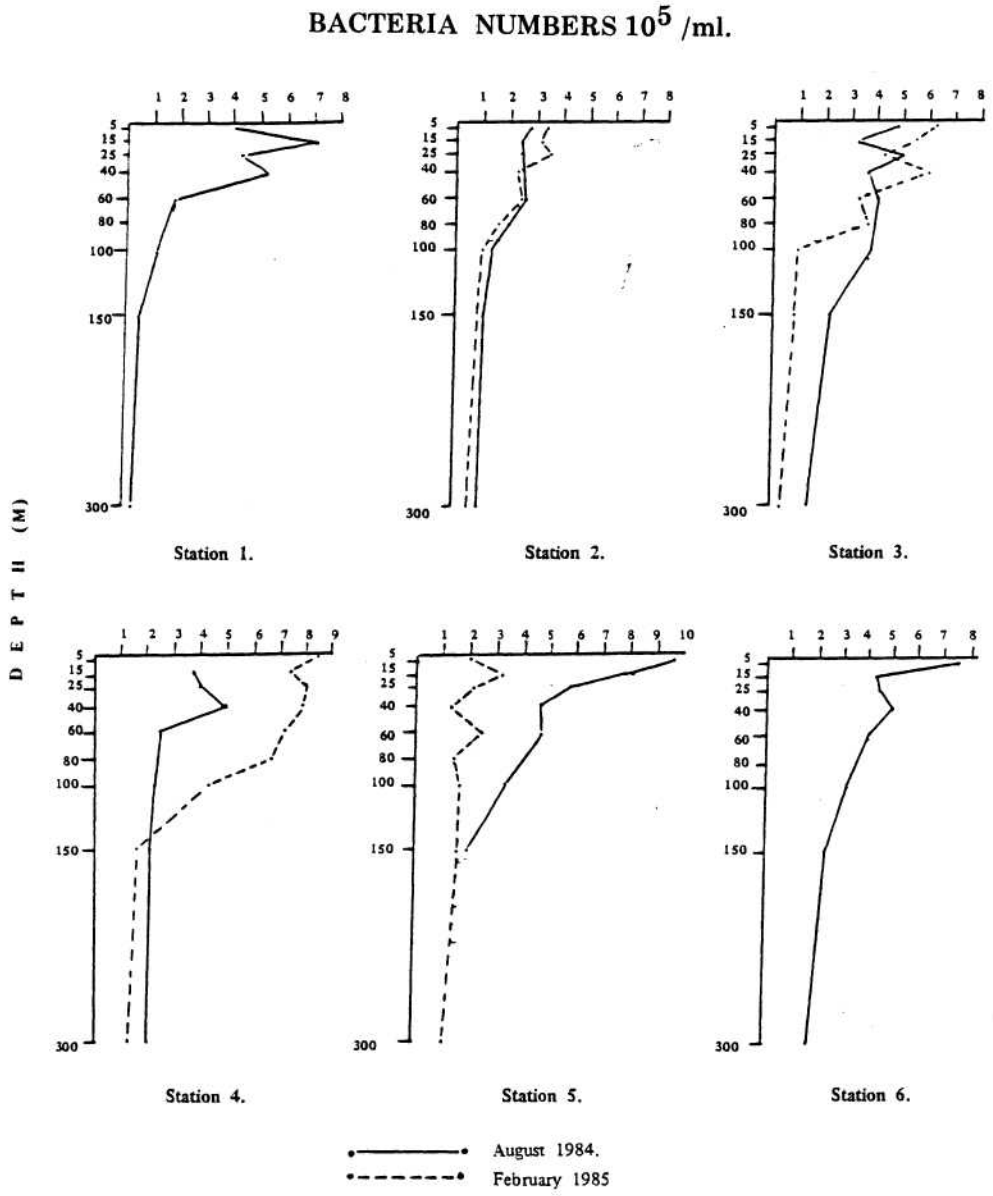

Figure 2. Vertical distribution of bacteria numbers during southeast monsoon (August 1984) and nortnwest monsoon (February 1985) in the Banda Sea.

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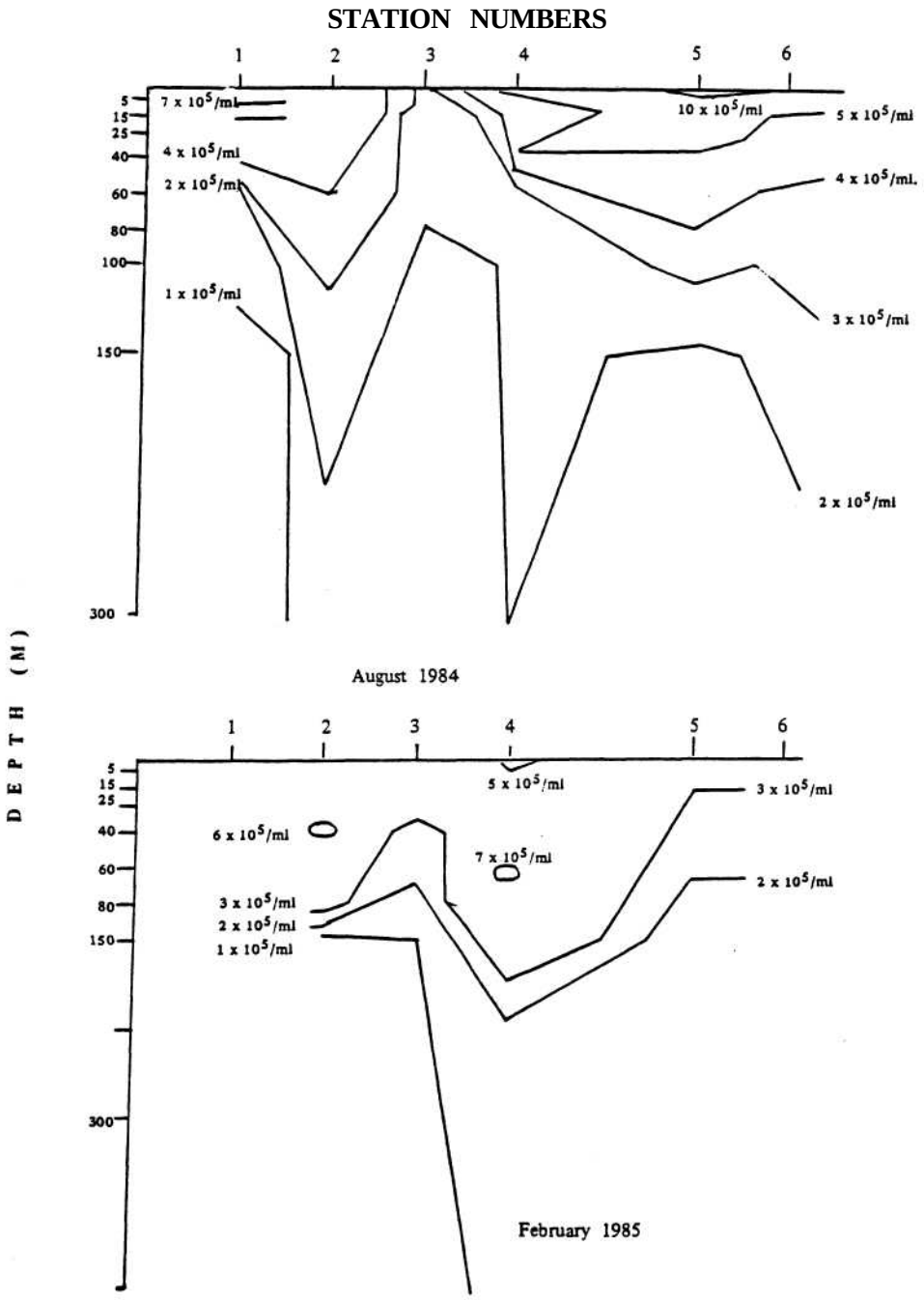

Figure 3. Horizontal distribution of bacteria numbers during southeast monsoon (August 1984), above and northwest monsoon (February 1985), below in the Banda Sea.

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4, ($8.4xl0^5$ bacteria per ml) and the lowest population at a depth of 300 m of station 2, ($0.4xl0^5$ bacteria per ml). Table 1 gives the range of bacteria numbers, the highest and lowest bacteria numbers, from the surface to 300 m depth. When the distribution of bacteria numbers on the transect from west to east is plotted in isoline (Fig. 3), it showed that in August 1984 the surface bacteria numbers are 10×10^5 bacteria per ml and at 300 m depth less than 1×10^5 bacteria per ml.

Table 1. The highest and lowest bacteria numbers from the surface to 300 m depth, during August 1984 and February 1985 in the Banda Sea. Numbers in 10^5 per ml.

Stations no.	August 1984 Range	Mean	February 1985 Range	Mean
1.	0.4 – 7.2	3.1.	not determined	
2.	0.9 – 2.7	1.8	0.6 – 3.5	2.3
3.	1.4 – 4.9	3.7	0.4 – 6.3	3.8
4.	2.0 – 4.9	3.1	1.2 – 8.4	5.8
5.	1.9 – 9.7	5.4	1.1 –3.2	1.8
6.	1.7 – 7.9	4.0	not determined	

The highest population of bacteria are found in the east part and the lowest numbers in the middle part of the Banda Sea. Downward the value of low population of bacteria was shifting to the west. In February 1985 the population of bacteria in the surface was 8×10^5 bacteria per ml and at 300 m depth less than 1×10^5 bacteria per ml. The highest bacteria population was found in the middle part of the researched area and low bacteria population are found in the east of the Banda Sea. This is in contrast to the observation made in August. When the result is compared to the other result of regions, our result do not differ very much. FERGUSON & RUBLEE (1976) found that the distribution of bacteria in the Gulf Stream of North Carolina values between 10,000 - 100,000 bacteria per ml. HOBBIE *et al* (1977) found that bacterial populations in deeper water off Africa were 1.6×10^6 bacteria per ml at the surface and 3.4×10^3 bacteria per ml at depth of 4200 m. The maximum depth of the Band Sea is more than 7000 m, but only the upper 300 m was studied and over that water column a clear decrease in numbers was found. MITSKEVICH & KRISS (1982) found in water samples from equatorial areas in the Pacific and the Indian Oceans that the numbers of bacteria ranging between 1000 bacteria per ml to 2 x 10 bacteria per ml. The Banda Sea is located in the equatorial area and water is moving from the Pacific to the Indian Oceans.

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The influence of the seasons on the distribution of bacteria is not so clear while the distribution of the bacteria is different. During southeast monsoon in August, where the upwelling was expected, the highest bacteria numbers were found in the surface water of the northeastern part of Banda Sea. In this region, upwelling is expected and all other biological parameters measured in the ecosystem: phytoplankton, zooplankton, fish show highest values (ANONYMOUS N.D.). During the northeast monsoon in February downwelling was expected, the distribution pattern was quite different. The highest numbers of bacteria was found in the middle part of Banda Sea, so nutrients influence tlie primary production and this, in turn, provide food for the bacteria. JANNASCH (1958) stated that nutrients were the factor that determined the distribution of bacteria in natural waters. The northwest monsoon period showed lower numbers in bacteria than the southeast monsoon period. This could be caused by the effect of movement of water masses, upwelling or import of water from other regions. Based on the different *Pteropod* sp. composition, SCHALK (personal cummnication) showed that during southeast monsooninfluxof water masses coming from the Pacific enter to the Banda Sea, while during the northwest monsoon water should come from the Java Sea or Indian Ocean and fill the Banda Sea. So, suggestion by WYRTKI (1961) for upwelling occur during southeast monsoon and for downwelling occur during northwest monsoon from the point of view of bacteria counting was confirmed.

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