• DYNAMICS OF PLANKTON POPULATIONS IN UPWELLING AREAS

• Chlorophyll Measurements in Upwelling Areas by Remote Sensing (CURS)

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GENERAL

In connection with ground truth measurements for ERTS-1, two expeditions were undertaken by the principal investigator. Shiptime was provided from France and Spain on board the N. O. "Jean Charcot" and B. O. "Cornide de Saveedra".

On both ships continuous measurements were made to monitor the fluorescence as an indicator for chlorophyll. The fluorescence was calibrated with an extraction procedure in terms of $\mu g \cdot$ chlorophyll $\cdot 1^{-1}$. The extraction procedures applied differed slightly during the two missions. Both procedures are described in the attached forms. Also the cruise charts are included.

During the ERTS-1 meeting on September 29 at Goddard Space Flight Center, the first analysis of our data was presented with Dr. R. Curran, GSFC, as co-author. The paper was entitled "Chlorophyll Structure in the Ocean".

CHLOROPHYLL DETERMINATIONS

During the cruise with French R. V. "Jean Charcot", chlorophyll was determined when changes on the fluorometer occurred. Water was only collected when the readings were constant during the sampling procedure. The same input line for the fluorometer was used for sampling. The water was filtered over Gelman glass fiber filters type A, 0 47 mm. The filter was transferred to a tissue grinder and homogenized with 2 ml acetone. The homogenate was tranferred to a centrifuge tube and stored for at least one hour in the dark at 4°C.

The spectrophotometric determination of the chlorophyll was made with a Beckman grating spectrometer, model DB-G, reading the absorbance at wavelengths of 7500 and 6650 A.

On board the Spanish R. V. "Cornide de Saveedra" vertical profiles were taken with hydrobios water samplers. Normally, 4 l of seawater were filtered over GF/C, 4.35 cm glass fiber filters. Extraction was done with 4 ml 90% acetone during 24 hours at 0°C. Readings of the absorbance were done in a 1 cm cell using the DU - Spectrometer, Beckman at 7500 and 6650 A. According to T. R. Parsons (1966) the readings by a single reading measurement at 663 mu in 90% acetone, but corrected for the turbidity, the actual error is not more than 1 per cent. The specific absorption coefficient in 90% acetone was used to be 92 l/g cm.

Altogether on 24 stations chlorophyll and temperature were measured during the course with the French R. V. "Jean Charcot".

On the Spanish vessel samples were taken on 48 stations at depths of 1, 30, 60, 90, and 100 m. The sampling depth was modified at a few stations near the coast. Continuous measurements were done during the whole cruises including at the stations.

T. R. Parsons (1966), The determination of photosynthetic pigments in sea water. A Survey of methods 19-36. In: Determination of photosynthetic pigments in sea water, Monographs in oceanographic methodology, p. 69, UNESCO Paris.

RESULTS PRESENTED DURING THE ERTS-1 MEETING

Before we started our program we simulated an experiment with the spectral response of the 0.5 to 0.6 μm region of the MSS over oceanic regions with different chlorophyll concentrations. It showed a significant relationship between the obtained signal and the chlorophyll concentration in water. Our studies in upwelling areas with ERTS-1 make it necessary to estimate the chlorophyll concentration. Since sediments in near coastal areas respond in a similar way as chlorophyll within the spectral response of the MSS, it was intended to differentiate in a qualitative study between the effect of sediments suspended in water and chlorophyll on the different channels.

The target for a representative estuary with sediment discharge was the St. John's River in the south of the United States as shown in the color composit from channels 4, 5, and 7. Over cloud-free areas the river discharge is indicated by a higher reflected energy in the visible compared to the open ocean. Clouds are very easy to distinguish from sediment loaded water masses.

The black and white imagery of the channels 0.5-0.6, 0.6-0.7, 0.7-0.8, and 0.8-1.1 μm was color enhanced to display the reflective properties of seston and chlorophyll concentration. Channel 4 (0.5-0.6 μm) monitored the effect of chlorophyll was well as sediments and exhibits a diffuse structure in the response of the MSS. The next channel, located at 0.6-0.7 μm indicates a very pronounced gradient within the sediment plume. This is caused by the position of the

second absorption band of chlorophyll at 0.66 μm and the increased absorption of water which limit the photon penetration depth. The recordings in the near infrared (0.8-1.1 μm) gave a response only in the near coastal areas, thus indicating near surface parameters. The transport of sediments is limited to the coast and in agreement with the direction of near coastal currents and the Coriolis effect, is forced toward the south.

As a consequence, we may state that very high concentration of sediments and/or inorganic particulate matter are visible in all four bands of the MSS.

Pure phytoplankton populations should cuase a response principally in channel 4. This response is the result of increased reflectivity at short wavelengths and the compensation of reflection by absorbtion in channel 5.

A second test site along the Northwest Coast of Africa was analyzed. Figure 3 shows the color enhanced imagery obtained from channel 4 (o.5-0.6 μm), where the white area represents the Coast near Cape Blanc.

Our ground truth measurements indicated chlorophyll concentration up to 20 $\mu g \cdot l^{-1}$. The visibility measured with the secchi disc is only several meters, which shows that the topography does not affect the signal obtained with ERTS-1. Since channel five showed no visible structure, and also sediment transport by river discharge is absent we can conclude that the structure visible in channel 4 is due to the

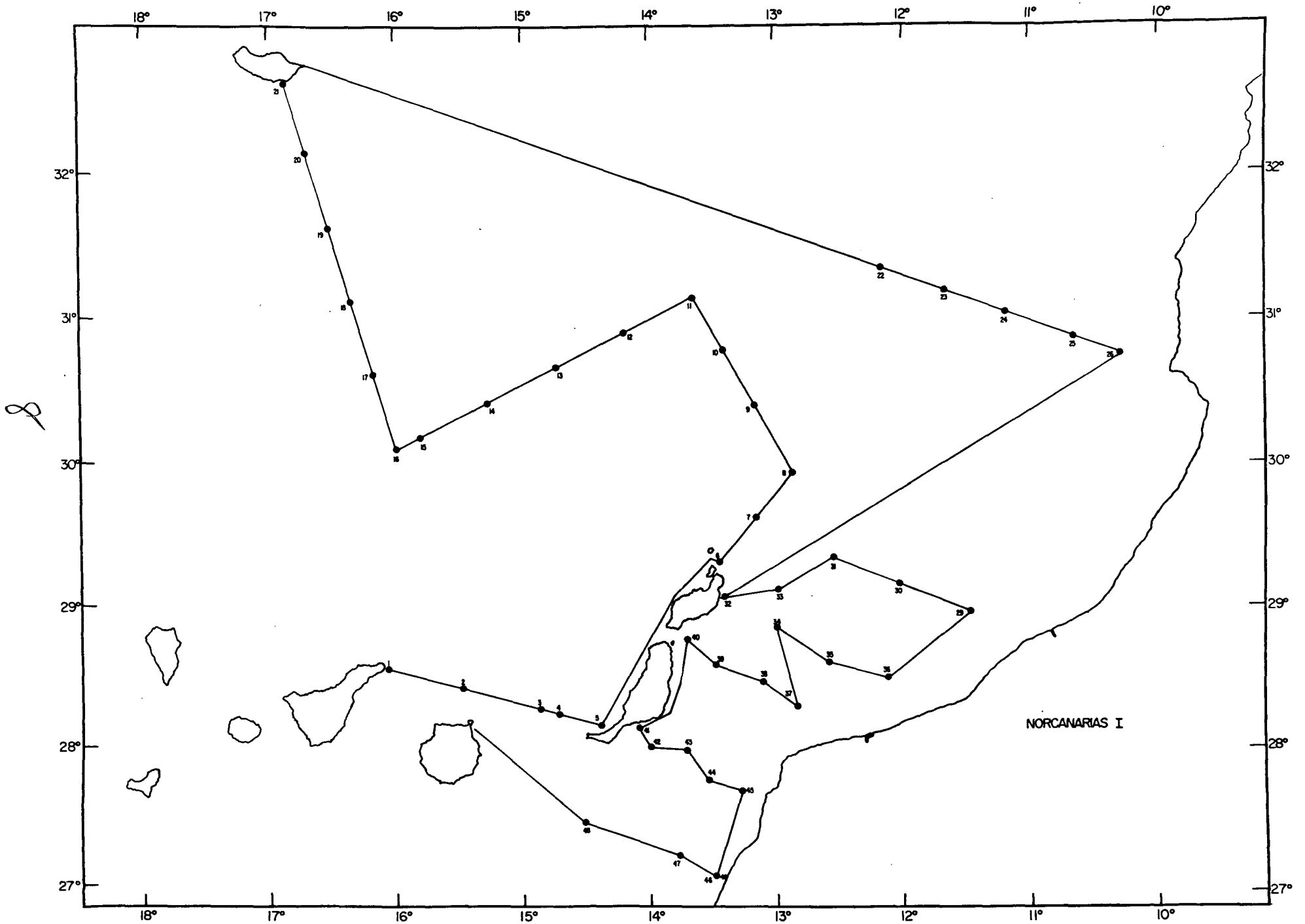
distribution of chlorophyll.

The oscillation of chlorophyll boundaries as well as the separated zones with high chlorophyll concentrations as seen with ERTS-1 was also recognized by continuous chlorophyll measurements carried out with a fluorescence technique aboard a research vessel in the same area.

CRUISE TRACK CHART OF B. O. "CORNIDE DE SAVEEDRA"

IN CONNECTION WITH THE ERTS-I GROUND TRUTH PROGRAM

1972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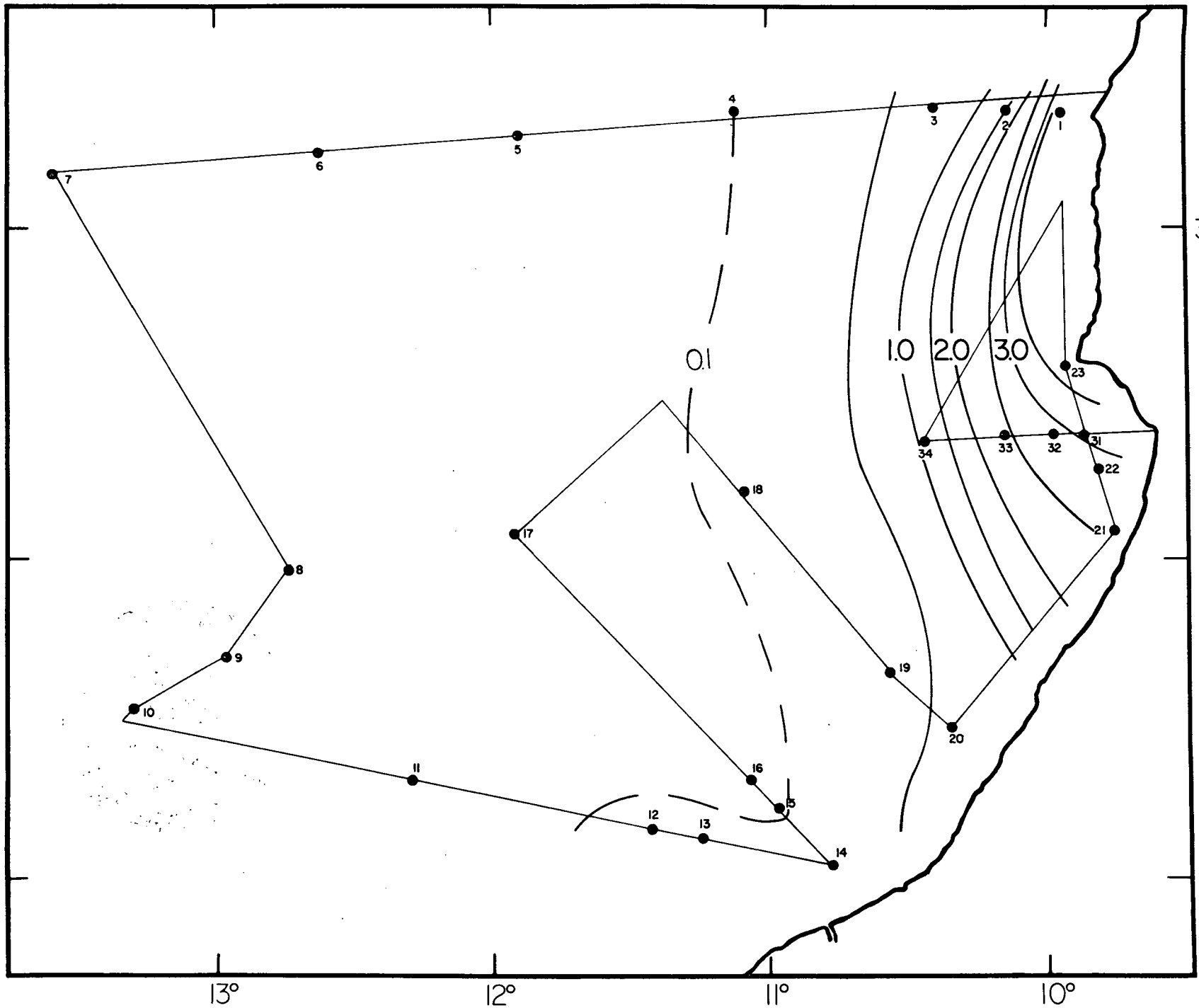
CRUISE TRACK CHART OF N. O. "JEAN CHARCOT" IN CONNECTION WITH THE ERTS-1 GROUND TRUTH PROGRAM 1972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