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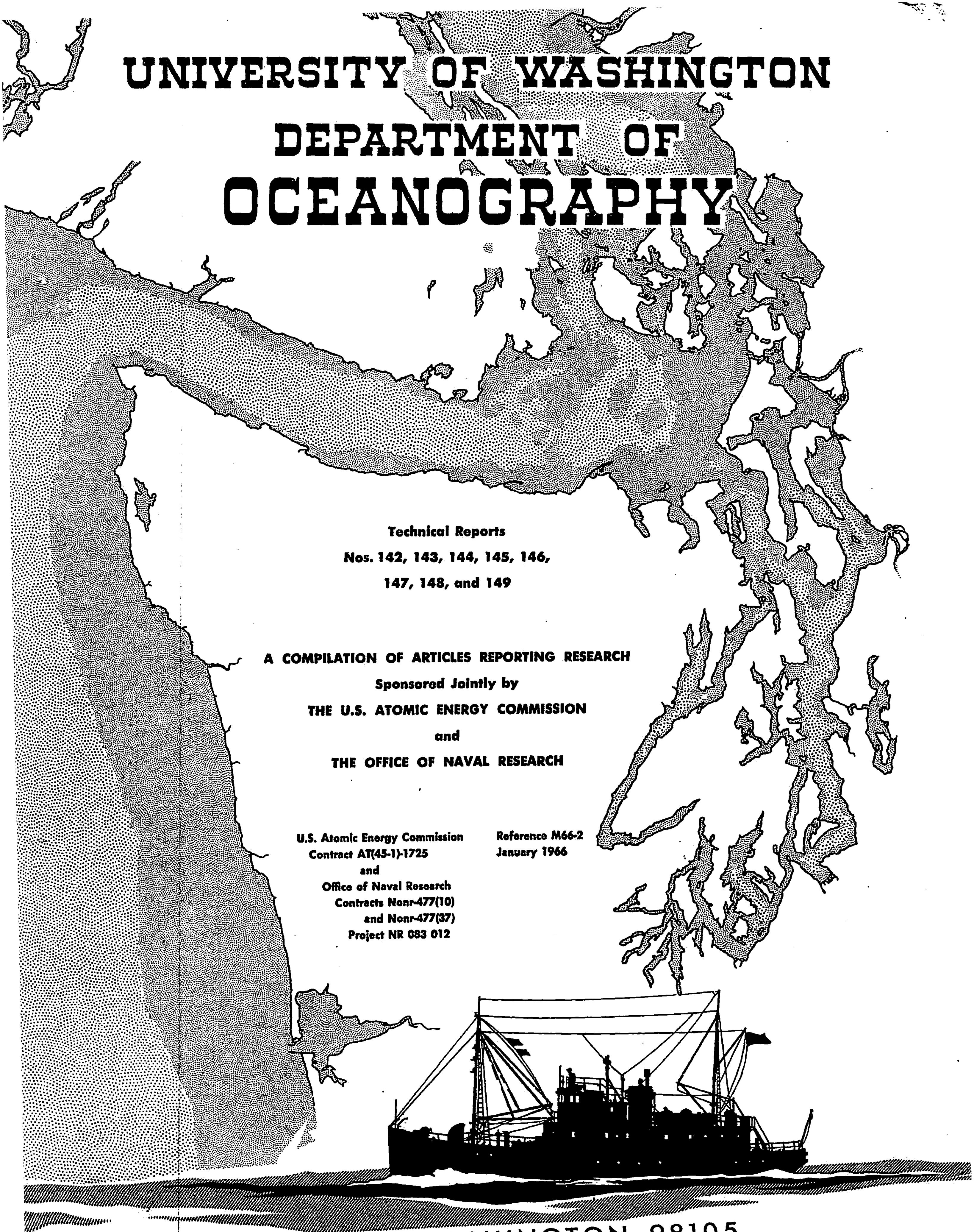

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RICHARD H. FLEMING
Chairman

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CLIFFORD A. BARNES
Principal Investigator

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Technical Report No. 142

BIO-LITHOLOGY OF NORTHEAST PACIFIC SURFACE SEDIMENTS, by Y. R. Nayudu and B. J. Enbysk. Marine Geology, *2*(4):310-342. 1964. (AEC: RLO-1725-42)

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CHLOROPHYLLS IN MARINE PHYTOPLANKTON: CORRELATION WITH CARBON UPTAKE, by G. C Anderson and K. Banse. Deep-Sea Research, *12*(4):531-533. 1965. (AEC: RLO-1725-47)

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Chlorophylls in marine phytoplankton : Correlation with carbon uptake*

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(*Received* 22 *February* 1965)

Abstract—Correlation coefficients between C^{14} uptake and light absorbance at 665 mμ of pigment extracts of natural marine phytoplankton populations were as high as between C^{14} uptake and chlorophyll *a* content from trichromatic determination, and higher than between C^{14} uptake and total chlorophyll content. In marine productivity studies, determination of chlorophyll *a* among the plant pigments may often be adequate.

INTRODUCTION

THE present paper attempts to assess the significance of chlorophyll *a* estimates by the trichromatic approach in regard to photosynthesis of natural marine phytoplankton. In the trichromatic method (RICHARDS with THOMPSON, 1952; PARSONS and STRICKLAND, 1963), values for chlorophylls *a*, *b* and *c* are obtained simultaneously from spectrophotometer readings at the peaks of absorption of the three pigments resulting in corrections for interference from each pigment on the measurement of the other. Recent tentative recommendations of a standard method by SCOR-UNESCO Working Group no. 17 on Determination of Photosynthetic Pigments (1964) have endorsed this approach. However, the chlorophyll *a* results from the trichromatic method depend mainly upon the reading at 665 mμ and proportionality factors for converting measurements at 665 mμ into chlorophyll *a* concentrations without other corrections have been given (ODUM, MCCONNELL and ABBOTT, 1958; TALLING and DRIVER, 1963). Many workers deal only with chlorophyll *a* since it alone is believed to convert light energy into chemical energy, although light energy absorbed by other chlorophylls can be transferred to chlorophyll *a* (FOGG, 1953). The latter pigment is often used for plankton mass estimates as well as for estimating production from chlorophyll and light measurements. Conversely, the sum of chlorophylls *a*, *b* and *c* have also been correlated with photosynthesis of marine phytoplankton to estimate production from chlorophyll and light measurements. It has also been suggested that gross evaluations could be made of the taxonomic composition, or of the physiological state of the population from pigment ratios, including carotenoid measurements (STRICKLAND, 1960).

METHODS

Data were obtained from an investigation of the effects of Columbia River effluent on biological features in the northeast Pacific Ocean. Pigment extracts were prepared and their optical density determined (RICHARDS with THOMPSON,

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1952; CREITZ and RICHARDS, 1955). Readings at 750 mμ were subtracted from those made at 665, 645 and 630 mμ, to correct for turbidity of the extract. From 10 cruises of the R.V. *Brown Bear*, January 1961 to June 1962, 568 surface water measurements of chlorophyll and photosynthesis measured by C^{14} uptake in a fluorescent (" Cool-White ") light incubator at 9150 lux were utilized. These data appeared in an earlier paper where seasonal changes in ratios of C^{14} uptake : chlorophyll *a* and detrital chlorophyll were discussed (ANDERSON, 1964). Subsurface measurements were not used because a paper in preparation shows that shade adapted populations occur beneath the mixed layer which have different C^{14} uptake/chlorophyll ratios than those found in surface waters.

RESULTS AND DISCUSSION

Correlation and regression coefficients were calculated between C^{14} uptake and chlorophyll *a*, C^{14} uptake and total chlorophyll (sum of chlorophyll *a*, *b* and *c*), and C^{14} uptake and absorbance at 665 mμ corrected for turbidity (Table 1). All coefficients of correlation are significant at the 1% level except that between C^{14} uptake and total chlorophyll during cruise 280 which is not significant at the 5% level. The correlation coefficients of C^{14} uptake and chlorophyll *a* are very similar to those of C^{14} uptake and absorbance at 665 mμ, the maximum difference being 0·024. However, the differences of coefficients of correlation of C^{14} and total chlorophyll from either the chlorophyll *a* or absorbance at 655 mμ are in most cases much greater. In fact,

Table 1. Coefficients of correlation and equations of regression for C^{14} uptake (Y) vs. estimates of chlorophyll (X) in surface waters off the Washington-Oregon coasts.

Date, cruise no. and no. of measurements		C^{14} uptake : Chlorophyll *a*	C^{14} uptake : D665 mμ	C^{14} uptake : Chlorophyll $a+b+c$
10–27 Jan. 1961		0·591	0·583	0·422
(275)	(60)	$Y = 2{\cdot}58\ X + 0{\cdot}228$	$Y = 42{\cdot}298\ X + 0{\cdot}097$	$Y = 0{\cdot}601\ X + 0{\cdot}604$
7–24 March 1961		0·659	0·643	0·180
(280)	(55)	$Y = 3{\cdot}644\ X + 0{\cdot}086$	$Y = 52{\cdot}082\ X + 0{\cdot}118$	$Y = 0{\cdot}330\ X + 1{\cdot}433$
8–24 May 1961		0·723	0·707	0·640
(287)	(69)	$Y = 7{\cdot}794\ X + 1{\cdot}894$	$Y = 115{\cdot}039\ X + 2{\cdot}046$	$Y = 4{\cdot}734\ X + 1{\cdot}573$
9–19 June 1961		0·669	0·678	0·570
(288)	(25)	$Y = 1{\cdot}371\ X + 0{\cdot}819$	$Y = 20{\cdot}555\ X + 0{\cdot}799$	$Y = 0{\cdot}746\ X + 1{\cdot}034$
6–25 July 1961		0·928	0·940	0·944
(290)	(56)	$Y = 3{\cdot}363\ X + 0{\cdot}136$	$Y = 51{\cdot}184\ X + 0{\cdot}155$	$Y = 2{\cdot}169\ X + 0{\cdot}015$
28 July–13 Aug. 1961		0·795	0·797	0·814
(291)	(59)	$Y = 2{\cdot}599\ X + 2{\cdot}825$	$Y = 38{\cdot}818\ X + 2{\cdot}753$	$Y = 1{\cdot}791\ X + 2{\cdot}330$
28 Nov.–18 Dec. 1961		0·693	0·689	0·590
(297)	(72)	$Y = 1{\cdot}637\ X + 0{\cdot}070$	$Y = 23{\cdot}731\ X + 0{\cdot}071$	$Y = 0{\cdot}667\ X + 0{\cdot}178$
23 Jan.–7 Feb. 1962		0·734	0·710	0·549
(299)	(58)	$Y = 1{\cdot}920\ X + 0{\cdot}051$	$Y = 27{\cdot}119\ X + 0{\cdot}087$	$Y = 0{\cdot}699\ X + 0{\cdot}304$
27 March–12 April 1962		0·715	0·715	0·639
(304)	(71)	$Y = 2{\cdot}144\ X + 0{\cdot}349$	$Y = 31{\cdot}799\ X + 0{\cdot}307$	$Y = 1{\cdot}129\ X + 0{\cdot}296$
7–19 June 1962		0·788	0·789	0·795
(308)	(43)	$Y = 1{\cdot}722\ X - 0{\cdot}104$	$Y = 25{\cdot}708\ X - 0{\cdot}123$	$Y = 1{\cdot}113\ X - 0{\cdot}139$

in 9 out of 12 cases the coefficients are smaller indicating a somewhat poorer relation to C^{14} uptake than the other estimates.

We interpret these results as suggesting that chlorophyll *a* calculated from trichromatic measurements and absorbance at 665 mμ are equally good for measurements of plant pigment relative to photosynthetic potential. In the 568 measurements made in the present study, the calculated chlorophyll *a* and absorbance at 665 mμ have a correlation coefficient of 0·999. The inclusion of estimates of chlorophylls *b* and *c* as measured here on the average reduces the degree of correlation.

Recently, revised trichromatic equations were proposed by PARSONS and STRICKLAND (1963) and by SCOR-UNESCO (1964) which are based on different absorption coefficients for chlorophylls *a*, *b* and *c*. We have not compared chlorophyll *a* calculations from the PARSONS and STRICKLAND equations with photosynthesis because the relation to the RICHARDS with THOMPSON (1952) equations is linear. Although it would have been very desirable to make the same comparison for the equations of SCOR-UNESCO, the necessary readings of absorbance at 663 mμ rather than 665 mμ are not available for the present data. If the result of such a comparison would be the same as that found for the original equations, routine plant pigment determinations in sea water in connection with C^{14} uptake measurements may be based on readings at the chlorophyll *a* peak only, with a suitable correction for turbidity. With chlorophyll *b* nearly absent in most oceanic waters, a narrow band filter instrument of a half band width of about 5–10 mμ is certainly suitable. This holds also for routine determinations in connection with estimates of biomass. The method chosen should be calibrated against a standard procedure such as that proposed by SCOR-UNESCO.

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