CC/NUMBERS 52-53
DECEMBER 24-31, 1990

This Week's Citation Classic®

Parsons T R & Strickland J D H. Discussion of spectrophotometric determination of marine-plant pigments, with revised equations for ascertaining chlorophylls and carotenoids. *J. Mar. Res.* 21:155-63, 1963.
[Fisheries Research Board of Canada, Pacific Oceanographic Group, Nanaimo, British Columbia, Canada]

Improved spectrophotometric equations for the determination of chlorophylls and carotenoids in seawater were formulated based on the isolation of pigments by column chromatography. [The *SCI*® indicates that this paper has been cited in more than 255 publications.]

How Much Phytoplankton in the Oceans?

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This paper was an attempt to improve the coefficients used in equations for the determination of marine algal pigments as originally described in 1952 by F.A. Richards with T.G. Thompson.[1] The frequent citing of the paper does not indicate any great advance in science, but rather it represents an improvement in a very popular technique for determining the standing stock of phytoplankton in the sea through chlorophyll analysis.

Subsequently, the method was further improved by a special working group of the Scientific Committee on Oceanic Research (SCOR).[2] At about the same time, a new technique in pigment analyses resulted from the use of a fluorometer, which is about 10 times more sensitive than the spectrophotometric technique.[3] Finally, the use of reverse-phase high-performance liquid chromatography[4] probably represents the best present-day method for algal pigment analysis, since in this method individual pigments are separated out, which is not the case in the earlier spectrophotometric and fluorometric methods.

With so many modifications in methodology occurring within a relatively short time span, one has to ask why our paper has been cited so often. I believe the answer to this lies in the fact that it is the method given in *A Practical Handbook of Seawater Analysis*,[5] which is a frequently cited text. Although this book also gives the Richards with Thompson equations and the SCOR/UNESCO equations for pigment analysis, the former are considered inaccurate and the latter require the more difficult setting of a spectrophotometer at 663 nm. The former wavelength is generally not marked as a calibration on spectrophotometers and has to be guessed to be between 660 and 665 nm. (Thus a small gain in the sensitivity of this method results in some loss of accuracy.)

1. **Richards F A & Thompson T G.** The estimation and characterization of plankton populations by pigment analyses. A spectrophotometric method for the estimation of plankton pigments. *J. Mar. Res.* 11:156-72, 1952. (Cited 290 times.)
2. **UNESCO.** *Monograph on oceanographic methodology. 1. Determination of photosynthetic pigments in sea-water.* Paris: UNESCO Publications, 1966. 69 p. (Cited 20 times.)
3. **Lorenzen C J.** A method for the continuous measurement of *in vivo* chlorophyll concentration. *Deep-Sea Res.* 13:223-7, 1966. (Cited 345 times.)
4. **Mantoura R F C & Llewellyn C A.** The rapid determination of algal chlorophyll and carotenoid pigments and their breakdown products in natural waters by reverse-phase high-performance liquid chromatography. *Anal. Chim. Acta* 151:297-314, 1983. (Cited 100 times.)
5. **Strickland J D H & Parsons T R.** *A practical handbook of seawater analysis.* Fisheries Research Board of Canada, Bulletin 167, 1972. p. 185-92. (Cited 15 times.)

*Received September 6, 1990

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