Technical Papers

Use of Factors for Converting Carbon or Nitrogen to Total Sedimentary Organics

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A very common method for calculating the organic content of marine sediments is to convert previously determined carbon or nitrogen data by use of conversion factors. The application of such factors requires a basic assumption that the carbon and/or nitrogen content of the organic debris is everywhere constant.

Boysen-Jensen (*1*) considered that carbon represented one-half of the organic constituents of marine plants and animals. On this basis, it was proposed that the carbon content of the sediments be multiplied by 2 in order to calculate the total sedimentary organics. The reasoning associated with this conversion factor requires a second assumption, namely, there is no change in the ratio of the various chemical compounds of the living population as it dies and settles to the bottom. In other words, bacterial decomposition does not occur in, or has little effect on, the settling organics. Differential decomposition between organics, which contain varying amounts of carbon and nitrogen, has been shown by Waksman (*2*). This fact, plus the known activity of bacteria in sea water, makes the second premise untenable.

Waksman (*3*), in pointing out some of the erroneous conceptions of Boysen-Jensen, proposed a more likely factor. On the basis of the carbon content of the organics obtained from a single marine sediment sample via extraction, and so forth, he suggested that total sedimentary organics be calculated by multiplying the carbon content by 1.887. To use this factor, it is necessary to assume that the ratio of different organic compounds is the same in all marine sediments. In other words, the various compounds are supplied to all sediments in the same ratio, and varying depositional environments have little or no effect on that ratio. Waksman realized that this may hold for limited areas of deposition but that widespread horizontal and vertical extrapolation was impossible.

A factor of 1.7, from the original 1.724 proposed and used by soil scientists, is commonly used for marine sediments. Trask (*4*) was probably the first to use this factor. Grippenberg (*5, 6*), Revelle and Shepard (*7*), Correns (*8*), Emery *et al.* (*9*), and Emery and Rittenberg (*10*) make use of this conversion factor. In addition to the previously discussed suppositions, this factor depends on sedimentary organics being similar to soil humus.

Trask (*11*) discussed and proposed a factor of 1.6 as being least objectionable. This figure is based on the oxygen content of organic matter. The oxygen content of marine organics was considered to be 23 percent; the sum of the carbon, hydrogen, nitrogen, and others is thus 77 percent. Approximate calculations show that hydrogen and nitrogen represent 20 percent of the carbon content. The carbon content of the organic matter is thus 64 percent. Carbon × 1.56 (or roughly 1.6) converts carbon to total sedimentary organics. The assumptions previously stated and the approximations involved in this calculation cause the same general objections to its use.

It has also been suggested, but not as seriously, that by determining the nitrogen content of the sediments and applying a factor, the total organics may be computed. Trask (*12*) and Trask *et al.* (*13*) suggest a rough factor of N × 18. This is based on an average calculated sedimentary nitrogen content of 5.5 percent. Trask states that the nitrogen may range from 3 to 10 percent and introduce errors up to 50 percent. Revelle and Shepard (*7*) suggest a factor of N × 14 with probable errors of 15 to 20 percent.

In the investigation of the composition of marine organics (*14*), I have found that the carbon and nitrogen content of sedimentary organics from 40 surface sediment samples taken from the Gulf of Maine ranges from 40.0 to 67.2 percent and 2.0 to 19.0 percent, respectively. The total organic content was determined by a summation of the extractable and hydrolyzable organics.

The organic material in all samples was extracted by means of a Soxhlet apparatus, using anhydrous ether and acetone. This was followed by reflux distillation using 95 percent ethyl alcohol and distilled water. The inorganic portions of these fractions were deducted from the total extract. The sediments were then hydrolyzed by refluxing in 5 percent hydrochloric acid and the hemicelluloses were determined. This was followed by treating the sample with 72 percent sulfuric acid at 8°C. The sulfuric acid was diluted to 8 percent and autoclaved, thus putting cellulose into solution. The remaining organics, of a lignin and lignoprotein complex, were determined by a carbon analysis. The entire process followed a careful time schedule and vacuum filtration separated the soluble materials.

The sum of the proximate parts was used as the total organic content of the sediments. From this information it was found that in order to convert the organic carbon to total organics, conversion factors ranging from 2.50 to 1.49 must be applied, the mean being C × 1.94. The standard deviation from this mean is 0.22 with a coefficient of variation of 11 percent. The nitrogen conversion factors range from 50.0 to 5.2 with a mean of 20.5. The standard deviation is 9.17, and the coefficient of variation is 45 percent.

The foregoing data indicate that, in order to be consistent with the accuracy of carbon and nitrogen determinations, it is best to report the elemental analysis and not use conversion factors. If for any reason the use of a conversion factor is insisted upon, then carbon, not nitrogen, should be used as an indicator.

The amount of carbon or nitrogen present in the organic matter of sediments is dependent upon numerous factors. Some of the more obvious are (i) the carbon or nitrogen content of the original supply of organic detritus, (ii) the ratio of the various organic compounds or groups, (iii) the carbon or nitrogen content of the various organic compounds or groups present in the sediments, (iv) the amount and type of decomposition that has affected the organic matter during and following deposition, and (v) the degree of resistance that various organic compounds or groups display. All of these factors will vary according to the environmental conditions existing or preexistent in the area sampled. It is thus quite possible that *n* number of investigations, undertaken to determine a single constant for converting organic carbon or nitrogen to total sedimentary organics, will produce approximately *n* number of constants.

References and Notes

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Effect of 2,4-D on Respiration and on Destruction of IAA in Oat and Sunflower Tissues*

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It has been established that the naturally occurring hormone or auxin, indolacetic acid (IAA), and 2,4-dichlorophenoxyacetic acid (2,4-D) stimulate certain general respiratory responses in *in vitro* experiments with plants (*1, 2*). Miller and Burris (*2*) showed in addition that for pea sections, concomitant with the increase of respiration caused by the presence of IAA, there occurred a gradual disappearance of IAA from the medium, which was accompanied by an equivalent decline in respiratory rate. Later, Miller and Henderson (*3*), reported the identical situation for oat coleoptile sections. The disappearance of IAA finds credence in the work of Tang and Bonner (*4*) and Wagenknecht and Burris (*5*).

Experiments with Avena *coleoptile sections.* By use of the direct method of Warburg, results with varying concentrations of 2,4-D and IAA indicate that both substances increase proportionately the oxygen uptake of *Avena* coleoptile sections, but that in the case of IAA there is a sharp decline in the rate after the fourth or fifth hour (Fig. 1); the same response does not occur with 2,4-D. Figure 1 represents a typical determination in which oxygen uptake of *Avena* sections was measured in the presence of IAA and 2,4-D, singly and combined. The broken curve shows the theoretical additive oxygen uptake that should be expected by combination of the two substances. It is easy to observe that this is not the case. Indeed, after 6 hr the oxygen uptake for the two combined (upper solid curve; 100 ppm IAA and 500 ppm 2,4-D) showed a continued rise at a very rapid rate, thus revealing a "synergistic effect." At this time the oxygen uptake by IAA alone had dropped to the endogenous rate.

Figure 2 shows the effects of varying concentrations

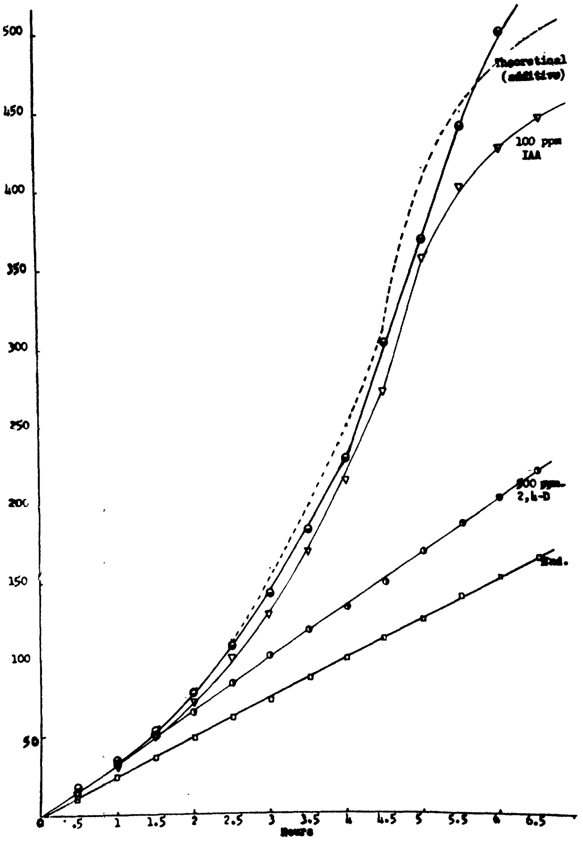

Fig. 1. Respiration of oat sections with IAA and 2,4-D. Abscissa: time in hours. Ordinate: μlit O_2 uptake. The three lower solid curves represent: endogenous; 500 ppm 2,4-D; and 100 ppm IAA, from bottom to top, respectively.