Reports

Taxonomic "Descriptions"

Abstract. Original descriptions of organisms are often difficult to visualize, due to the fact that authors attempt to include the variability of the species in the description. Since the scientific name remains associated permanently with the holotype, it is suggested that the description of the holotype (which is a concrete thing) be segregated from the characterization of the species (which is conceptual).

My observations regarding the functions and objectivity of taxonomic "descriptions" result from experiences of the past 20 years in trying to visualize described organisms. I offer them in the hope that they may stimulate a discussion of methods which will result in less ambiguity in descriptions and, consequently, in greater ease of recognizing named forms.

Obviously the first questions to be answered are: What is a description? What is its purpose? *Webster's New Collegiate Dictionary* (ed. 5) defines *description* in the following terms: "Discourse, or an example of it, designed to describe a scene, person, emotion, etc." Since Webster utilizes *describe* to define *description,* it is necessary to refer to the former, for which the first part of the definition reads: "To represent by words." Webster gives as synonyms of *describe*: "represent, relate, recount, narrate, express, explain; depict, picture, delineate, characterize." The purpose of a description is to convey a concept of the object under scrutiny as clearly as possible by means of words, pictures, or diagrams.

But what are we describing? In the past, we have commonly stated that we are describing a "new species" or a "new genus." The result, in general, has been that the greater the amount of material the author had before him, the vaguer and less useful for identification his "description" became. Descriptions based upon long series become loaded with *more or less, usually, generally, about, a litte longer,* and comparable terms, with the result that a person trying to visualize the organism, or to match a specimen with the description, finds it extremely difficult to do so. Though such phrases or words are used deliberately because they are indefinite and ambiguous, they make it difficult for the reader to learn what the described specimens look like. Descriptions based upon uniques are usually more easily visualized than are those based upon series.

Are we, however, actually describing species or genera? At best we are describing only a very small segment of a variable and varying population which is represented by preserved specimens. It follows that any description or characterization of a "species" is necessarily imperfect, because no person knows the full extent of variability in any species. Furthermore, since no two specimens are exactly alike, the association of specimens must always be somewhat subjective.

Because of the impediments encountered in connection with verbal descriptions, the system of types was developed, the "holotype" being a single specimen selected by the author to represent the species permanently and to serve as a point of referral for authoritative information in case questions arise. Consequently, the closer the description comes to fitting the holotype exactly, the better the picture one can obtain of the typical specimen of the species.

Under such circumstances, would it not be best to follow the ensuing procedure in describing new species?

1) Describe the holotype exactly and in detail, giving comparative measurements in concrete terms or ratios. Selection of the holotype from the specimens available becomes the first step in "describing," if such a process is used. Since only a single specimen is involved, there can hardly be an excuse for ambiguity or vagueness in the description. Data regarding place and time of capture, collector, host, other pertinent information, and location of the holotype should be given. (A few authors do follow the procedure of describing the holotype at present.)

2) If it is available, describe the allotype and record data associated with it.

3) Attempt to characterize the species —that is, discuss the probable limits, variability, and geographical and host ranges of the species and the characters by which the species can be most easily recognized. Compare the remainder of the series—that is, the paratypes—with the holotype and explain your conception of the species.

4) Differentiate the species from others which have been described.

To a certain extent, a comparable *modus operandi* might be adopted for the higher categories, since each has its "type," but the descriptions of course become more and more inclusive.

Following such a procedure in describing new species would enable one to segregate the tangible (the holotype) from the intangible (the conception which the author has of the species) and would go far toward making the original description more useful to the person who has to refer to it. The procedure also makes justifiable the description of "species" upon the basis of uniques or small series (although this is not recommended unless a group is being revised or monographed).

The use of such a system would be one means of placing taxonomy on a more objective basis. It would certainly be of help in the future, as neotypes are designated to replace our present holotypes (which inevitably will be destroyed as the ages pass).

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Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

Bomb Carbon-14 in Human Beings

Abstract. The concentration of bomb-produced radiocarbon in human beings will lag behind the rising concentration in average atmospheric CO_2. Measurements on human materials suggest a lag of about 1 year for both breath CO_2 and blood, with the suggestion of a somewhat higher value for lung tissue. These results are in reasonable agreement with predictions based on independent evidence.

In evaluating the hazard to man of bomb-produced radiocarbon, one of the factors which must be considered is the time relationship between the C^{14} concentration in the carbon of the human body and that in the carbon of atmospheric CO_2. Several investigators (*1–3*) have published data on the atmospheric

radiocarbon increase resulting from nuclear tests. To our knowledge, no comparable information has been published for the human body.

To date three measurements of contemporary body radiocarbon have been made in our laboratory. The results given in Table 1 are expressed as permillage difference from the C^{14} concentration of a standard sample (*3*). In order to eliminate differences resulting from isotopic fractionation, C^{13}/C^{12} ratios were determined for each sample, allowing the radiocarbon results to be normalized to a common C^{13}/C^{12} ratio (see last column, Table 1).

The results are plotted in Fig. 1 along with the curve published by Broecker and Walton (*3*) for the C^{14} concentration in atmospheric CO_2 as a function of time. Since all the results are normalized to the same δC^{13} value, displacements from the curve reflect only a lag between the human materials and the average atmosphere. For blood and breath CO_2, this lag is 1.1 years; for lung tissue, 1.8 years.

Ideally, only two factors should contribute to this time lag: (i) the time between photosynthesis of food and consumption by human beings and (ii) the residence time of carbon in human tissue. However, if the curve of Fig. 1 does not represent the atmosphere in which foods eaten by the sample subjects were grown, this fact will also influence the lag times. As is discussed below, the true lag times are probably less than the values obtained from Fig. 1.

As pointed out by Suess (*4*) and Fergusson (*5*), plants growing in industrial areas show a greater fossil CO_2 effect (that is, lower C^{14} concentration) than those growing in areas removed from industrial activity. In addition, Munnich and Vogel (*2*) have suggested that plants growing in zones of dense vegetation may incorporate CO_2 given off by decaying organic materials in soils. Both effects will tend to lengthen the lag times obtained in Fig. 1, the curve of which is based on samples collected in areas remote from both industrial activity and dense vegetation.

Table 1. C^{14}/C^{12} ratios for human materials.

Sample	δC^{14}	δC^{13}	ΔC^{14}
Lung tissue, with associated blood, from a New York City resident. (Sample L-371A, June 1958)	61 ± 10	−14.7	42 ± 10
Respiratory CO_2 from a resident of Rockland County, N.Y. (Sample L-505A, 1 Jan. 1959)	106 ± 8	−21.8	105 ± 8
Blood from same person as sample L-505A. (Sample L-505B, 1 Jan. 1959)	115 ± 8	−16.5	102 ± 8

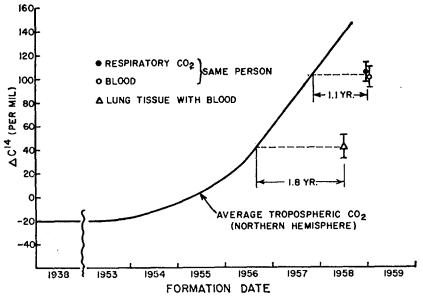

Fig. 1. Relationship between the normalized C^{14} concentration in human beings and the C^{14} concentration in tropospheric CO_2 of the Northern Hemisphere. Curve taken from Broecker and Walton (*3*).

Although it is not possible to predict how much too long the lag times might be, a few assumptions can give an idea about the magnitude. If the local "Suess effect" (dilution with industrial CO_2) were to be 1 percent greater than the world average value of 2 percent (*5*), the lag time as measured in Fig. 1 would be 0.2 year too long; this is based on the presently observed atmospheric increase of 5 percent per year. Furthermore, if plants were to photosynthesize a significant amount (say 10 percent) of decay CO_2 and if this CO_2 were derived mainly from organic material grown 3 years previously when the atmosphere was 15 percent lower in its C^{14} concentration, then an apparent lag of 0.3 year would be introduced. Thus it is evident that the lag times read from Fig. 1 are maximum values.

A crude estimate of the lag between photosynthesis and human consumption can be made by considering the average American diet. For fruits, vegetables and grains, the time is not likely to exceed 1 year, for the supply of these foods is almost completely replenished each growth season. Milk products should have a similar time lag, since the milk should closely reflect the animal diet (a cow produces its own body weight of milk in 3 months). An analogous situation exists for eggs. On the other hand, meat may show a longer lag, since the mean residence time of carbon in the animal must be taken into account. Since meat provides less than 20 percent of the carbon in the average diet, this effect is probably not sufficient to raise the average lag to more than 1 year.

To our knowledge, the biological half-life for carbon in the soft tissue and bone of man has not yet been determined. For soft tissue in rats the value is 35 days (*6*), but as was shown by Richmond and Langham (*7*), who have determined biological half-times of alkali metals in various mammals, the residence time for human beings may be considerably different from that for rats (for Cs^{137} it is 6.5 times longer). A lower limit for the turnover time can be obtained by dividing the carbon content of the body by the amount of carbon metabolized per day. The latter may be computed as food intake less fecal excretion or as respiratory CO_2 plus urinary carbon. In either case, the result is about 300 g of carbon. For a 150-lb person, therefore, the minimum turnover time for the body as a whole is about 40 days. This figure is also the length of time which respiratory CO_2 should lag behind ingested food.

From the foregoing information, these conclusions are warranted:

1) The interval between the fixation of carbon in average food and the consumption of that food is less than 1 year (that is, less than 1.1 years minus 40 days).

2) The maximum time which blood lags behind food is about 6 months; in other words, the mean residence time of a carbon atom in the blood is no more than 6 months. This is based on an upper limit (2 σ) for the difference between blood and respiratory CO_2 (20 per mill) converted to months through division by 4 per mill per month (equivalent to the slope of the atmospheric curve in Fig. 1) and supplemented by the 40-day lag between breath and food.

3) The carbon of lung tissue has a somewhat longer mean residence time than that of blood.

From this discussion it is evident that more measurements are needed. Among other things, further measurements should answer these three major questions: (i) To what extent does decay CO_2 enter growing plants? (ii) To what extent can variation in diet affect the lag time? (iii) What is the mean residence time of carbon in human soft tissue and in human bone? Answers to these questions will provide further data needed in assessing the hazard to man of bomb-produced radiocarbon (*8*).

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References and Notes

1. T. A. Rafter and G. J. Fergusson, *New Zealand J. Sci. Technol.* B38, 871 (1957); H. de Vries, *Science* 128, 250 (1958).
2. K. O. Munnich and J. C. Vogel, *Naturwissenschaften* 14, 327 (1958).
3. W. S. Broecker and A. Walton, *Science*, this issue.
4. H. E. Suess, *Science* 122, 415 (1955).
5. G. J. Fergusson, *Proc. Roy. Soc.*, in press.
6. J. Schubert and W. D. Armstrong, *J. Biol. Chem.* 177, 521 (1949).
7. C. R. Richmond and W. Langham, *Health Phys.* 1, 223 (1958).

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