B with your isotope on the average β energy scale C.

6) Read the dose rate on scale D.

To read β dose rate only or in the case of pure β emitters use the nomogram as follows. Connect your isotope on scale C with the origin of B (at the intercept of B with the sphere's radius scale) and read dose rate on scale D. To read only the gamma dose rate, connect the intercept on B with the origin of C and read dose rate on D.

Further calculations may be made as follows, if desired.

1) To obtain the dose rate for *n* microcuries per kilogram, multiply by *n*, which may be any number larger or smaller than unity.

2) To obtain the "infinite dose," multiply by 1.44 *T* eff. (effective half-life).

$$T\ \text{eff.} = \frac{(\text{physical } T/2) \times (\text{biological } T/2)}{(\text{physical } T/2) + (\text{biological } T/2)}$$

3) To obtain the cumulative dose after time *t*, multiply the infinite dose by

$$1 - e^{-0.693\,t/T\,\text{eff.}}$$

Remarks

The assumptions made in constructing this nomogram should always be kept in mind, particularly in reference to β dosimetry: a highly energetic β ray (for example, K^{42}) will not be totally absorbed in a small volume (for example, a mouse). The unit of time for the dose rate should be chosen very much shorter than the effective half-life. The latter can be estimated with the above formula if the biological decay either follows a single exponential or is negligible as compared to the physical decay. If this is done, this nomogram will not only lead to saving of time and mental wear and tear but, if properly used, it will also minimize the chance of error.

Large working copies of this nomogram, which will be revised if so warranted by new data, are available.

References and Notes

1. This work was supported by the U.S. Atomic Energy Commission. We wish to acknowledge gratefully the constructive comments and suggestions of R. S. Benua, M. Berman, A. M. Brues, E. M. Chapman, V. P. Dole, D. D. Dziewiatkowski, G. Failla, L. E. Farr, R. J. Hasterlick, I. London, H. G. Parker, E. H. Quimby, J. E. Rall, and J. S. Robertson.
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Taxonomic Codification of Biological Entities

A system is proposed for taxonomic codification of biological entities adaptable to machine handling.

H. A. Denmark, H. V. Weems, Jr., Carlis Taylor

The vast accumulation of biological data presents the ever-increasing problem of filing these data in an easily accessible manner. Since efficient methods of coding quantitative and qualitative data and the use of machine methods have proved their value in business and in the medical profession, it is time that more workers in the biological fields realized the advantages of a well-organized coded system adaptable to machine sorting.

The need for a uniform taxonomic code is becoming more evident with the increasing importance of coordinating work. Some workers are attempting to solve the problem of coding in their fields of special interest. G. Congdon Wood (*1*) compiled an unpublished list of 24 such people in the United States, Canada, England, Italy, and Africa. Of the 24 listed, there are 14 people, representing as many organizations, using a coding system for sorting data. We believe that the code proposed in this article could serve the needs of all biological fields, including our own separate fields.

One of the primary purposes of coding biological information is to facilitate the sorting of mass data by a machine system. The increasing number of subjects to be filed has overtaxed filing systems that use a cross-filing index as the only means of extracting data. The coding of all biological entities would serve as a tool for extracting data and would not affect the present taxonomic nomenclature. A uniform code would permit the rapid exchange of information between organizations, and duplicate cards could be made available to workers interested in coded information. Mass statistical data could be extracted from these coded files by machine in a minimum period of time and with a high degree of accuracy.

Since quantitative and qualitative data can be coded, the first problem is to decide what coding system would best meet the needs of biological workers. A coding system permitting almost unlimited expansion within a category should be selected.

A central clearinghouse for the coding of all biological entities should be created and supported by those interested in such an undertaking. This would necessitate the employment of a full-time staff of specialists, which would include animal and plant taxonomists and trained specialists who would operate the machine system. For uniformity of coding, the proposed clearinghouse should assign all code numbers, and these numbers should be sent to those organizations working with the animals or plants, or both, that are being coded.

Open-Ended Code

The Entomology Department of the State Plant Board of Florida and the Statistical Laboratory of the University of Florida have adopted an open-ended code for the coding of all biological entities. This code may be described best as an "open-ended group classification code." The taxonomic coding of biolog-

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ical categories being coded by the State Plant Board of Florida are kingdom, phylum, class, order, family, genus, and species. Any number of categories may be included in this system of open-ended coding, but the categories and the number of digits for expansion must be determined in advance. In addition to the taxonomic coding of all biological entities, the location, scientific name of specimen, stage of specimen, host, date collected, collector, degree of infestation, weather, determiners of insects or other invertebrates and their hosts, treatment of specimen, and location of specimen, if preserved, also are coded by the Plant Board.

One digit is provided for kingdom, two digits are provided for phylum, two digits for class, two digits for order, three digits for family, three digits for genus, and three digits for species. Up to 9 different items can be coded for each unit, 99 for two units, 999 items for three units, and so on. For example, the three units allotted for species will permit the coding of up to 999 species in any one genus; this allows for greater numbers of items in any one of these categories than would ever be needed.

Taxonomic entities are being coded at random rather than phylogenetically or alphabetically because of the simplicity of adding names to a coded list. Random assignment of code numbers does not cause entities to become regimented, nor does it necessitate the reassignment of code numbers when names are added, as would be the case if the names were coded alphabetically or phylogenetically. The code number remains with a scientific name, even though the name is placed in synonymy. If the synonym should prove to be a valid species it will have a code number. Thus, for example, in order to select all filed data on a particular species of insect, one would machine-sort all cards for the code number of that species and also for the code numbers of all synonyms under which data have been filed at any time. This, of course, requires the maintenance of species files, including synonyms, as in any other system of filing data relating to plants or animals. To put it more simply, code numbers are merely substituted for words so that data can be filed compactly and sorted by machine.

Clearinghouse

Coding should be done by the proposed clearinghouse and should not be the responsibility of the separate organizations. This would require the close cooperation of all taxonomic workers, with each sending all proposed name changes to this central clearinghouse for coding once the names have been approved, or a literature abstracting organization could relay names of newly described species to the clearinghouse for coding.

The State Plant Board is the clearinghouse for the State Plant Pest Survey, which is a state and federal cooperative project. Several thousand insect indentifications are made each year. Weekly and annual summaries of the insect conditions are being compiled. The laborious task of hand-sorting these data would require hundreds of hours of secretarial time, and errors are often introduced in the course of transcribing. Data coded for machine-sorting reduce the time required to extract information and reduce the possibility of errors to a minimum. The files of detail cards have been arranged alphabetically by class, order, family, genus, and species. Two cards have been developed for filing data. One card is designed to handle all in-state reports and is red-striped along the top margin; a second card is designed for all out-of-state and foreign reports and is blue-striped along the top margin for ease of visually separating the two types of cards. The change by the Plant Board from a three-way file (specimen, host, and accession number) on 3- by 9-inch cards to a one-card file on an I.B.M. card has reduced the necessary filing space by several dozens of linear feet.

Machine Installation

The Plant Board, as a matter of convenience, is using the services of an I.B.M. punched-card system that is located on the campus of the University of Florida. Many organizations may not have sufficient work to justify a machine installation. The Plant Board does not have machines at this time but plans to install a key-punch machine and a sorting machine. If an organization should consider the use of some or all of the necessary equipment, it would be advisable to adopt coding for as many phases of its work as possible to defray the operating expenses of these machines. The Plant Board is presently coding a Plant Pest Survey, a Citrus Tree Count Survey, and all the invertebrates collected by the Quarantine Department of the State Plant Board at the ports of entry. The machine may be used, also, for inventories and payrolls.

An organization need not be located near a machine installation. A small organization can keep a detail card file in its office and send coded information to a machine installation that will contract to punch, sort, and summarize data periodically. As an example, the information received from the State Plant Board field inspectors and from Florida Agricultural Experiment Stations, Florida Agricultural Extension Service, commercial companies, and private citizens is coded by the Plant Board. Once the reporting form has been received and the determination of the specimen has been made, the form is rechecked for the correct scientific names. All information is coded on an 80-column code sheet and sent to the University of Florida Statistical Laboratory. A detail card is filed in the office of the Entomology Department for a ready reference of individual reports. Longer reports are summarized by the Statistical Laboratory.

The Plant Board has coded data assembled over a period of 4½ years at the time of writing of this article.

Some of the special features of handling coded data are as follows:

1) If an insect has been positively coded to genus and doubtfully to species, it is possible to indicate the doubtful determination in coded data by overpunching at the point that is doubtful.

2) The disposition code indicates that a specimen has been discarded or pinned, placed in a preservative, stored in an envelope, mounted on a slide, embedded in plastic, photographed, or whatever the case may be. The collection in which the specimen is located may be indicated, also.

3) Parentheses around an author's name are indicated by an ampersand before and after the name, since some machines are not equipped with parenthesis keys.

An example of an insect and its code, selected from the Plant Board's coded data to show the function of the code, is given in Table 1.

Table 1. Coded data compiled by the State Plant Board of Florida.

Homoptera	Cicadellidae	*Hortensia*	*similis* (Walker)
04	004	010	001

The code indicates the 4th order, the 4th family within the 4th order, the 10th genus within the 4th family, and the 1st species within the 10th genus. The code is quite flexible, and, when proper expansion is provided for, the system will allow for coding of an almost infinite number of entities.

Conclusion

The State Plant Board of Florida has adopted an open-ended code for coding biological entities. The system permits the coding of quantitative and qualitative data and the sorting by machine of mass data with a high degree of accuracy. Although the form used by the Plant Board is designed primarily for surveys, the coding by other organizations of animals and plants should be made uniform to increase the usefulness of the code on a world-wide basis, regardless of the form used. Uniform coding can be accomplished best through a central clearinghouse.

On casual consideration this system may appear to be expensive and complicated. Actually, however, the coding procedure is relatively simple. Careful examination of the total cost of cataloging, extracting, and analyzing data and the comparative ease of performing the operations that are described in this article shows the system to be economical.

If the idea of standardizing is accepted by biologists, it might result in our being able to compare results better and in expediting the obtaining of information pertaining to such subjects as life histories, populations, and distribution.

Note

1. Dr. Wood is head of the Biology Group of the Chemical-Biological Coordination Center, Washington, D.C.

News of Science

Antarctic Research Program at U.S. Stations Resumes after Polar Winter

The onset of the antarctic spring signaled the resumption of a heavy schedule of International Geophysical Year scientific activities in Antarctica. After long months of polar darkness, the 70 scientists who wintered over at the seven United States IGY stations have accelerated work in a broad range of geophysical missions. Many of them have moved from winter quarters into the field.

Study Subjects

Antarctica's structure beneath its thick coating of ice, the frigid region's effect on world weather and climate, its influence on global communications, its geologic history and geophysical future, are among the subjects in the scientific study of this vast land area. The all-out scientific effort also includes accumulation of significant data on aurora and airglow, cosmic rays, geomagnetism, glaciology, gravity, ionospheric physics, meteorology, and seismology. Shipboard rocketry experiments and oceanographic research, as well as special station studies in botany, zoology, and microbiology, will be conducted.

Traverses

Much of the scientific information to be collected by U.S. scientists in the coming season as the IGY nears its end will be gathered on a series of major oversnow traverses (see map on page 993). The surface traverse parties, moving in tractors fitted with electronic apparatus for detection of crevasses, will conduct seismic, glaciological, and other geophysical studies. One traverse departed from Little America Station about 15 October in an attempt to cross the Ross Ice Shelf to the top of the Skelton Glacier and continue to Victoria Land Plateau. Another traverse will start 1 November from Byrd Station in Marie Byrd Land, covering the territory between the station and the Horlick Mountains, skirting the northern edge of the Horlick Mountain Range for a distance of 200 to 300 miles, and then returning to Byrd Station. A third traverse will pick up from Ellsworth Station, near the Weddell Sea coast, and continue on to Byrd Station. The traverse parties use seismic techniques to measure ice thickness and to determine the character of the subglacial floor and of exposed land areas.

Besides the oversnow treks, an airborne traverse is planned. This will follow a course running southward from Mount Waesche to the northern edge of the Horlick Mountains. The study group, traveling in ski-equipped planes, will land at 50-mile intervals for seismographic soundings probing the depth of the antarctic ice sheet. It will also engage in gravity observations and glaciological work.

Personnel

Scientific leaders at the U.S. IGY antarctic stations are: Little America Station, Albert P. Crary; Byrd Station, Stephen S. Barnes; Wilkes Station, Willis L. Tressler; Ellsworth Station, Matthew J. Brennan. At Hallett Station, a joint United States–New Zealand undertaking, the scientific leader is a New Zealander, K. J. Salmon. Recently, the study group which wintered over at the various stations was augmented by some 70 additional colleagues who were transported to Antarctica for summer-season research. Some of the newcomers will remain for the next winter, relieving current IGY personnel.

Past Work

IGY scientists in Antarctica have already collected much significant information:

Seismic measurements of ice thickness indicate that there is probably 40 percent more ice in Antarctica than was previously thought. Scientists from the Byrd Station, for example, measured ice 14,000 feet thick, resting on bedrock 8200 feet below sea level; this may be the thickest ice measured anywhere in the world.

The antarctic ice covering is estimated to have been, at one time, as much as 1000 feet thicker than it is now. Not yet known, however, is whether the total ice mass is presently increasing or decreasing.

A record low temperature of – 125.3 °F was reported by Soviet scientists at an IGY station near the center of Antarctica. At the South Pole itself, U.S. IGY radiation studies have shown that during the antarctic midsummer the pole receives more sunlight than any other