Economy of Symbols

THE following observations may contain suggestions useful to research workers or others who would like to find systems of classification and/or enumeration requiring as small a number of symbols as possible.

1. The number of weeks in the year, 52, is exactly double the number of letters in the English alphabet. By choosing capital or lower-case letters we can denote in one symbol any week in the year. If we let *A* represent the first week in January, *a* the second week, *B* the third, and so on, the actual error possible through a confusion of caps with lower case becomes certainly small and probably negligible. For example, the birth date of an animal, *f*51, would signify the week of March 19, 1951. In many instances merely *f*1 would serve, where Mar 19 '51, with five unnecessary symbols, has been commonly in use.

2. Using only two letters of the alphabet permits us to give identity and ordinate rank to 702 different objects and yet do so with only two symbols. If one or two numbers are used, the limit is 110. With one, two, or three letters of the alphabet, 18,278 different objects can be denoted, as contrasted with 1,110 if one to three numbers are used. The economy becomes impressive when four letters are used—475,254 items, as compared with 11,110 when every combination of four numbers is employed.

3. Employing all the letters of the alphabet except *Q*, and also all the digits except 1 and 0 (because they are so easily confused with the letters *l* and *o*), we have 33 entirely familiar symbols that permit giving identity and ordinate rank to 1,122 different objects (*cf.* 702 in ¶ 2) by means of only one or two letters and numbers.

4. Omitting *Q*, we have in the English alphabet 20 consonants and 5 vowels. Using a consonant and a vowel, we can denominate 100 objects, either in 5 or less general categories of up to 20 subclasses each (*AB, AC, AD* . . ; *EB, EC,* etc.), or up to 20 categories with not more than 5 subclasses in each (*BA, BE, BI, BO, BU*; *CA,* etc.).

Three or four consonant-vowel combinations can be combined as syllables into a uniformly pronounceable word, such as *SADOTO*, with *S* pronounced *SH* and *C* pronounced as *S* to avoid variant pronunciations of *C* that would be confused with *S* or *K*. There are 1,000,000 different combinations in this three-syllable and easily pronounceable combination. Such a symbol is shorter to speak than, for example, "seven hundred and nineteen thousand two hundred and forty-two," or even "seven one nine two four two." With two such three-syllable names, every human being in the world for at least the past hundred years could have had a distinctive and pronounceable name. But the use of syllables to convey classifications and categories provides more interesting possibilities.

As an example, let us assume that to classify draftees the following information is pertinent and the number of categories is appropriate:

1. Year of birth: 100 categories, beginning 1900 as *AB*, 1901 *AC*, 1919 *AZ*, 1920 *EB*, and so on; e.g., *EH*.
2. State, territory, or subdivision where draft records are kept: Up to 100 categories, by means of two letters; e.g., *OS*.
3. Month of the present classification: 100 categories, covering an 8-year period; e.g., *IP*.
4. Single, married, children, etc.: 5 categories, using one vowel each; e.g., *A*.
5. Training or skill: 500 categories, using three letters; e.g., *DEV*.
6. Experience or stage of training: 5 categories, using one vowel each; e.g., *O*.
7. Months of military service to date: 100 categories, using two letters each; e.g., *DU*.
8. Any other rating: Up to 20 categories, by means of one final consonant; e.g., *R*.

Splitting the above sequence of letters up into two convenient words, we have: *EHOSIPA DEVODUR*.

The information conveyed by *EHOSIPA DEVODUR* according to the above classificatory designations is: Born in 1925, draft record in Kansas office, this classification made in May 1951, single, medical training, graduate and in intern stage of training, has already had 13 months of military service—the final consonant being available for any other desirable classification, such as branch of service, priority rating, etc.

These classificatory words differ in number of syllables. The first begins and ends with vowels, the second begins and ends with consonants. The words are therefore not easy to confuse with each other. Reference to a whole category of persons born in, say, 1925 could be made thus: *EH---/*; or to all those with 13 months of military training as */--DU-*. Statements relating to any whole category or categories can thus be made explicit and precise.

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Determination of Carbonyl Groups by Reaction with Radioactive Cyanide, and a Simple Means for Estimation of Molecular Weight in Polysaccharides[1]

POLYSACCHARIDE molecules have end groups of two kinds, corresponding to the beginning and ending of the polymer chain. In most polysaccharides, one end group consists of a reducing monosaccharide unit, and there is usually one, and only one such group in the molecule. The other kind of end group is found at the opposite end or ends of the molecule and is nonreducing. Attempts have been made to discover the average molecular weight by determination of the number of reducing end groups. The ratio of the reducing and nonreducing end groups has also been used to estimate the extent of branching in the molecule. Because of the relatively small number of reducing end groups, however, their accurate estimation in large molecules has been difficult.

The writer has found that the reducing end groups

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of polysaccharides can be combined with C^{14}-labeled sodium cyanide to give a cyanhydrin that on saponification yields a radioactive carbohydrate containing one carbon more than the parent polysaccharide. The reaction, which is the well-known cyanhydrin synthesis, converts a 6-carbon reducing end group to a 7-carbon unit containing a radioactive carboxyl. The presence of the carboxyl permits the separation and purification of the material by means of ion exchange resins. Thus absorption of the carboxyl derivative on a basic resin separates it from any unreacted polysaccharide, and elution of the absorbed material with aqueous ammonia provides a highly purified radioactive product. On account of the high sensitivity of radioactivity measurements, the combining proportion of the radioactive cyanide can be determined accurately. This is a measure of the average molecular weight of the reacting polysaccharide. The procedure provides not only a new tool for structural studies, but also a means for labeling carbohydrate material for biological and other investigations. Furthermore, it constitutes a sensitive method for ascertaining the number of carbonyl groups in a substance of known molecular weight. Reaction of polysaccharides with cold cyanide yields products that may have useful properties. The procedure is particularly suitable for the study of polysaccharides of relatively low molecular weight, and partially hydrolyzed products.

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Book Reviews

Crystal Growth. H. E. Buckley. New York: Wiley; London: Chapman & Hall, 1951. 571 pp. $9.00.

Anyone faced with the necessity of growing "perfect" crystals of any considerable size should first read this book. He will find it a bit slow going here and there, partly because of the author's weakness for long sentences (the first sentence on page 7 consists of 90 words), and partly because of his liberal use of "former" and "latter." If the reader is not disturbed by this he will find he has a very useful reference book.

The 12 chapters range from "The Artificial Preparation of Crystals" and "Theories of Crystal Growth" through "Modification of Crystal Habit by Impurities" to "Relationship of Substances during Crystallization." The thoroughness with which the author has covered his topics may be judged by the fact that he lists over 650 references to the literature, coming from the publications of more than 475 authors. The book contains 169 figures and 88 plates, all of high quality.

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Problems of Cytology and Evolution in the Pteridophyta. I. Manton. New York: Cambridge Univ. Press, 1950. 316 pp. $8.50.

Most recent books dealing with the synthetic approach to problems of evolution have discussed, primarily, general principles, with illustrations taken from various groups of animals and plants. These books have established certain principles and methods of attack on evolutionary problems, on which there is an ever-increasing amount of agreement. The logical sequel to these works is a series of many-sided attacks on problems of evolution in particular groups of animals and plants. One such attack is the volume by Dr. Manton on the Pteridophyta, and it is one which sets a very high standard.

Upon even a casual examination of the book, one is impressed by the amazing technique Dr. Manton has developed for studying the cytology of the Pteridophyta. Ferns and their allies have always been regarded as extremely difficult material for chromosomal studies. Their chromosome numbers are very high, and their somatic chromosomes are usually long, slender, and entangled among each other so that they are difficult to count. Furthermore, their cytoplasm often contains heavily staining inclusions, which tend to obscure the chromosomes. As a result, before Dr. Manton began her work, the numbers of few species were known with exactitude. But the present volume contains page after page of photographs and drawings of meiotic smear preparations in which gametic numbers which range from $n = 13$ (in *Hymenophyllum tunbridgense*) to $n = 108$ (in *Equisetum* spp.), and even $n = 256$, recorded in *Ophioglossum vulgatum* as the highest chromosome number known for any living organism, can be counted by the reader either exactly or with a reasonable degree of accuracy. Dr. Manton's techniques, which would require much patience and experience to reproduce successfully, are nevertheless well described in an appendix, so that anyone who desires to and has sufficient skill may follow in her footsteps.

The text may also be commended for its readability. Dr. Manton has achieved a fine balance between scientific precision and a personal narrative style. While learning a multitude of hitherto unrecorded facts about the interrelationships among the fern species of northern Europe, the reader accompanies her on field trips to the native habitats of many of them, on explorations through the rich literature on their systematics and morphology, and in her contests with them as refractory cytological objects. For instance, she writes as follows about the well-known boreal and