Table 1. Consonant sounds and corresponding numbers.

Numbers	Sounds
1	T and D
2	N
3	M
4	R
5	L
6	J, CH, SH, soft C, and soft G
7	K, hard C, and hard G
8	F and V
9	P and B
10	S and Z

monosyllabic word, and the first letter-number set, "S-1," is derived as usual while the second consonant and the number of letters in the word gives the second coding set, "T-6." Authors' names are punched by the method outlined by Casey *et al.* (*4*).

One example of the flexibility of the system described here is its ability to code any information (for example, dates, journals, empirical formulas) consisting of letters and numbers. For example, an empirical formula such as $C_{12}H_{24}O_2$, could be coded as C-2, H-4, O-2, in the outer row and C-1, H-2 in the inner row where the outer and inner rows are equivalent to units and tens, respectively.

Assuming that the letters and the consonant sounds occur randomly in the English language, it is possible to estimate the selectivity of the system (*1*, chap. 21). This is equivalent to calculating the probability that a card (false retrieval) would respond to a random sorting operation when w words are coded two times per card in f fields when each field can be punched n different ways. The probability is approximately $(w/nf)^2$, and when the card format shown in Fig. 1 is used, the chance of a false retrieval is calculated to be about 0.1 percent if five words are coded per card.

Experience with the method indicates that it is possible to code at the rate of 2 to 4 words per minute, while retrieval requires approximately 2 to 3 minutes per word per deck of 1000 cards.

In general, punching key words has proved satisfactory. For example, a paper entitled "Properties of bovine *pancreatic ribonuclease* in ethylene *glycol* solutions" would be coded with the italicized words. Since the article is concerned with "structure," this key word would also be punched. This card would be retrieved in a search for the effects of solvents on the structure of ribonuclease by needling for either or both "ribonuclease" and "structure." Because of the specialization in science, it is our experience that the number of false retrievals caused by synonyms or multiplicity of word meanings is a very small percentage of the selected cards and is more than compensated for by the speed and ease of operation of the new method.

The scheme becomes increasingly cumbersome, as do all hand-operated methods, as the information deck exceeds 5000 cards. However, in our hands, it has proved exceptionally versatile for small decks, for example, those accumulated for writing a review or book or which have been subdivided on a yearly basis. The greatest advantage of the system presented here is its speed, achieved by storing the index in the memory (*5*).

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5. This is contribution No. 1050 from the Chemical Laboratories of Indiana University. This work was supported by grants from Corn Industries Research Foundation and USPHS (RG 8500). I am most grateful to Dr. Sherman Dickman, for without his valuable suggestions and encouragement this report would not have been published.

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Goethite in Radular Teeth of Recent Marine Gastropods

Abstract. The x-ray diffraction patterns of the denticle material from several species show that the material consists of the mineral goethite. This is the first indication that goethite is precipitated by marine invertebrates. The mineralogy of the denticle caps has biologic and geologic implications.

The denticles of the radular teeth from marine chitons (*Polyplacophora*) consist of black opaque material, have a high iron content, and acquire through magnetization an appreciable magnetic moment (*1*). X-ray defraction patterns of the denticle material from some chiton species correspond with those of the mineral magnetite (Fe_3O_4) in both spacing and intensity of lines, whereas those from other chiton species show that this material contains some unidentified minerals plus magnetite (*2*).

Iron is also known to occur in the radular teeth of certain marine gastropods in the order Archaeogastropods (*3, 4*). A quantitative analysis performed on the ash of the radular teeth from *Patella athletica* showed an iron content equivalent to 54 percent Fe_2O_3 (*5*). There is a question whether the iron in the radular teeth of gastropods is similar to that in the chitons (present as a crystalline inorganic compound) or bound up in an organic compound. A survey of the physical and crystal chemical structure of the radular teeth from the Archaeogastropods was undertaken.

Species of *Scissurella, Perotrochus, Haliotis, Acmaea, Patella, Nomaeopelta, Lottia, Fissurella, Diadora, Nerita, Tegula*, and *Littorina* were selected for study. The radular teeth were dissected from specimens preserved in alcohol and examined under a binocular microscope. The teeth of species from the genera *Patella, Acmaea, Nomaeopelta*, and *Lottia* were found to be capped with a black-brown to yellow-brown opaque material, whereas those of the species from the other genera listed were colorless and transparent (*6*).

Laboratory tests showed that the capping material of the teeth from *Acmaea, Patella, Nomaeopelta*, and *Lottia* species scratch fluorite and apatite (weakly), whereas the transparent teeth of *Littorina* and *Fissurella* scratch gypsum but not calcite. This places the hardness of the denticle material in species of *Acmaea, Patella, Nomaeopelta*, and *Lottia* close to 5 and that of the teeth in *Littorina* and *Fissurella* between 2 and 3 on the Mohs hardness scale.

Denticle caps of *Acmaea mitra, Lottia gigantea, Nomaeopelta dalliana*, and *Patella vulgata* and the teeth of *Fissurella barbadensis, Diadora* sp., and *Littorina planaxis* were mechanically separated, and the samples were investigated by x-ray diffraction (Norelco instrument) with a Debye-Sherrer camera using Fe filtered Co radiation. A sample of pure goethite ($\alpha\ Fe_2O_3 \cdot H_2O$) from Michigan was included for comparison. The transparent teeth of the *Fissurella, Diadora*, and *Littorina* species gave no discernible x-ray diffraction pattern. The x-ray diffraction patterns of the capping material for the teeth of

Patella vulgata, Nomaeopelta dalliana, Lottia gigantea (Fig. 1*B*), and *Acmaea mitra* (Fig. 1*C*) check those of the goethite sample (Fig. 1*A*) in both spacing and intensity of lines.

This is the first indication that goethite is precipitated by marine invertebrates. After death of the animals, the goethite of the denticles should be incorporated into the marine sediments. Whether goethite is stable in any of the sedimentary environments of the sea remains to be determined.

Of the gastropods investigated here, the species of *Acmaea, Patella, Nomaeopelta, Lottia, Fissurella, Diadora, Nerita, Tegula*, and *Littorina* live on rocky surfaces in the littoral zone and on rocks at shallow depth in the euphotic zone. These species feed on filamentous algae attached to rocks. It has been shown, particularly for limestones, that the filamentous algae enmesh the surfaces and commonly also bore into the rocks to a depth of a few millimeters (*7, 8*). The boring algae cause weakening and, frequently, disintegration of the rocks. Gastropods and chitons which feed on filamentous algae remove the filaments from the rocks by scraping

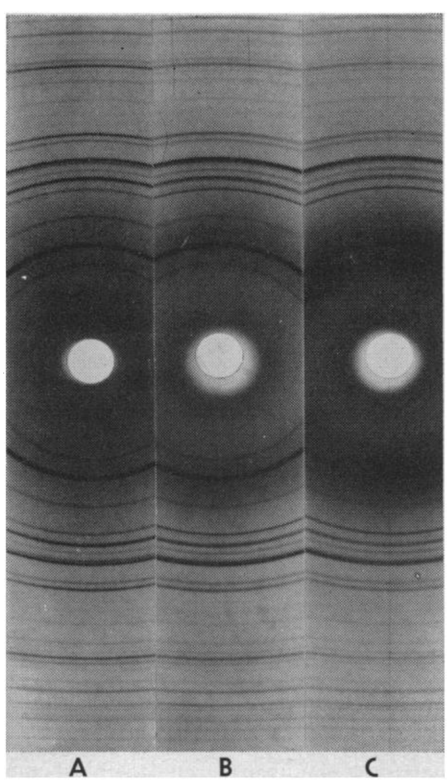

Fig. 1. X-ray diffraction photographs, Fe filtered Co radiation. *A*, reference goethite; *B*, single denticles of *Lottia gigantea*, Corona del Mar, California; *C*, single denticles of *Acmaea mitra*, Sitka, Alaska.

with their radular teeth. Some species of gastropods are reported to graze only on the filaments attached to the surface, whereas other gastropod species, such as the chitons, are able to feed also on embedded algae by penetrating the rocks with their radular teeth (*2, 7–9*). There is uncertainty whether some gastropods can remove boring algae when they are embedded in consolidated rocks or only when the rock particles are mechanically weakened by the boring algae (*8*), and it is important to know whether algae-feeding gastropods are capable of effective biomechanical erosion of rocks in the sea.

The teeth of the *Acmaea, Patella, Nomaeopelta*, and *Lottia* species investigated here were shown to be capped by goethite with a hardness close to 5. Hence these species are able to erode limestone and rocks with mineral grains in hardness close to that of their goethite denticles. The teeth of the species of *Fissurella, Diadora, Tegula*, and *Littorina* were shown to consist of organic compound with a hardness of less than 3. Therefore, these species are incapable of eroding limestone and most other rock types, except where mineral grains are already loosened by biochemical, physiochemical, or mechanical processes. These species must be grouped with the algal grazers. Large sediment volumes have been reported from the gut contents of species (*9*) which belong to this category. One source of the sediment particles has already been mentioned. Wave-transported sediment grains which are trapped by and agglutinated on the mucilagenous sheath of filamentous algae are another source of the ingested sediments.

More data are needed on the compounds which compose radular teeth in Mollusca. The sources of iron could be marine algae, which commonly enrich iron relative to sea water (*4*) and form a major part of the diet of chitons and the gastropods under consideration. The iron could also be derived from the dissolution of ingested sediment particles in their intestinal tract. It has been reported that hemocyanin is the oxygen-carrying transport pigment in the blood, and myoglobin occurs in the radular muscles of some of the chitons and gastropods under consideration (*10*). The localization of myoglobin in the radular muscles may have some bearing on the mechanisms of the precipitation of magnetite in the chiton denticles and of goethite in the denticles of the gastropods noted above. Clearly, there appears to be a fundamental biochemical problem involving iron-transport systems and the mechanisms for precipitation of goethite and magnetite by gastropods and chitons (*11, 12*).

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6. To remove the organic fractions, samples of teeth from all species were treated with a Clorox solution (5.3 percent aqueous solution of sodium hypochlorite). Of the teeth from species of the genera *Acmaea, Patella, Nomaeopelta*, and *Lottia*, only the opaque denticles remained intact. The transparent teeth of the species from the other genera listed were entirely digested in the solution, indicating that they are composed of organic compounds.

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Some Effects of Room Acoustics on Evoked Auditory Potentials

Abstract. Auditory potentials were recorded from bipolar electrodes chronically implanted in the cochlear nuclei of four cats. In a training box modified to reduce echoes these animals were exposed to clicks and tone pulses presented from an overhead speaker. Slight changes in the position of the animal in the resulting sound field produced marked changes in the potentials evoked from the cochlear nucleus. These phenomena were observed in the unanesthetized, unrestrained subjects as well as in those under Nembutal anesthesia. It is suggested that these acoustic effects complicate the analysis and interpretation of potentials evoked from the cochlear nucleus under conditions of habituation, shifts in attention, and learning.

When pulses of sound are introduced into a room or chamber a complex acoustic field is produced. Points of high and low sound pressure level result from the interaction of direct