DISCUSSION

A FORGOTTEN CONTRIBUTION TO NUTRITION BY MAGENDIE

McCAY[1] has called attention to the hitherto little recognized feeding experiments of Magendie in 1816, in which that noted physiologist tried to demonstrate the importance of nitrogenous foods in the diet. The criticism applied to some of Magendie's work has been its lack of completeness. It is of interest, therefore, to note that the distinguished teacher of Claude Bernard performed further nutrition investigations that supplement and extend the knowledge derived from his early failures to maintain dogs on rations of isolated materials. These additional and practically forgotten experiments in some respects exceed in value the later and more celebrated contributions of the gelatine commission, of which Magendie was chairman. Although, strangely enough, this work is not quoted in the gelatine report it is described in all but the first editions of the "Précis Elémentaire de Physiologie." The experiments are also discussed by Londe[2] and Johannes Müller.[3] The story may be retold as it could have been read nearly a hundred years ago in the American edition of Magendie's text-book.[4]

Since the publication of these facts (the experiments of 1816), in the first edition of this work, I have observed others not less important, which show how limited our knowledge still is on the subject of nutrition.

A dog was allowed to eat pure wheaten bread and drink common water at will. He died within fifty days, with all the signs of marasmus in the highest degree.

Another dog ate exclusively *military* or *munition* bread; his health continued perfectly good.

Rabbits or Guinea-pigs fed with a single substance, as wheat, barley, oats, cabbage, carrots, etc., will die, apparently from inanition, within a fortnight, and sometimes much sooner. But if the same substances be given together, or after short intervals, the animals live, and do well.

I fed an ass on dry rice, and afterward boiled it in water, because he refused the first; the animal lived only fifteen days. The last days he constantly refused to eat the rice. A cock was fed on boiled rice for several months, and preserved its health.

Dogs fed exclusively with cheese, and others with hard eggs, lived for a long time, but became weak and emaciated; lost their hair, showing imperfect nutrition. . . . The most general and important consequence deducible from these facts, and which ought to be followed up and examined, is, that diversity and multiplicity of aliments is a very important hygienic rule. This is indicated by our instincts, and the variations that the seasons bring in the nature and kind of aliments.

While the precise duplication of Magendie's experiments might prove difficult and while failure to eat in some instances masked the effects produced by the diets, yet in general, the qualitative results are such as might be expected from the standpoint of our modern knowledge. Magendie's interpretations are particularly skilful. The author indicates a rational solution to the practical problems of nutrition and yet recognizes that the field is just being opened. From the historical aspect we may credit Magendie as being one of the first physiologists to use rodents for nutritional investigations. The plan of the experiments described shows that he must have realized that the nutritive requirements of different species may vary. Finally, in view of our present data on the phenomena of dietary deficiencies in animals, his observation, that prolonged consumption of poor diets might result in loss of fur and in general emaciation, is peculiarly significant. One is almost tempted to say that Magendie observed, thereby, some of the signs of vitamin G deficiency in his dogs fed on eggs or cheese alone.

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[1] C. M. McCay, "Was Magendie the First Student of Vitamins?" SCIENCE, 71: 315, 1930.

[2] C. Londe, "Note sur les Alimens," *Arch. gén. de Méd.*, 10: 51–66, 1826.

[3] J. Müller, "Elements of Physiology," transl. by W. Baly, American ed. by J. Bell, Philadelphia, p. 333, 1843.

[4] F. Magendie, "An Elementary Treatise on Human Physiology," transl. by J. Revere, New York, p. 485, 1845.

A PROPOSED CLASSIFICATION OF DISEASE TRANSMISSIONS BY ARTHROPODS

THE diseases which are transmitted by insects and other arthropods often are classified according to the causative organism, and sometimes according to the transmitting agent. Each classification serves definite purposes. I should like to propose a classification based upon the type of transmission which occurs, not with the idea of attempting to supplant either of the systems of classification already established, but rather with the hope that this one will supplement and probably clarify the others.

The nearest approach to such a classification is the well established use of the terms "biological" and "mechanical" in connection with transmission by arthropods. These words have served a purpose, but they are inadequate for clearness. It is also true that authors are not in agreement as to their exact meanings. The transmission of malarias by mosquitoes is certainly biological. The transmission of anthrax and surra in cattle by blood-sucking flies is mechanical. In many cases the classification of the transmission is not so easily made, and authors classify them in one group or another depending upon their conception mainly of what constitutes a biological transmission. Unfortunately, some writers have interpreted biological to mean cyclical, that is, that the parasite concerned undergoes morphological change in the transmitting arthropod. It seems obvious, however, that at least two biological events may occur in the life of a parasite during its sojourn in the invertebrate host. It may multiply, or it may undergo cyclical change. Other changes are conceivable, but as yet not demonstrated. The four combinations which may be made of these two biological events are given below, together with the names being proposed for the type of transmission represented by the combination.

	Multiplication of organism in vector	No multiplication of organism in vector
Cyclical change of organism in vector	I. Cyclo-propagative Example: Malaria by mosquitoes	II. Cyclo-developmental Example: Filaria by mosquitoes
No cyclical change of organism in vector	III. Propagative Typhus by lice	IV. Mechanical Typhoid by flies

It will be noted that the older term, biological, can still be retained as a collective term for types I, II and III in contrast to type IV, for which I have retained the old term, mechanical. The classification proposed is, then:

Diseases Classified According to Type of Transmission

A. Biological
- I. Cyclo-propagative—the organisms undergo cyclical change and multiply.
- II. Cyclo-developmental—the organisms undergo cyclical change but do not multiply.
- III. Propagative—the organisms undergo no cyclical change, but they multiply.

B. IV. Mechanical—the organisms undergo neither cyclical change nor multiplication.

It is, of course, difficult to classify all arthropod-borne diseases on such a scheme. The transmission of relapsing fever by ticks is very probably propagative, but since it is believed by some authors that the spirochaete undergoes a change in morphology in the tick, it is possible that this transmission may be cyclo-propagative. Also, some diseases may fall into two (or possibly more) classifications. The transmission of bubonic plague may be propagative, since we know that the causative organism can multiply in the fore-gut of the flea, and also possibly mechanical, by the direct passage of the organisms in the feces of a flea recently fed on an infected rat. However, it is believed that these cases do not lessen the value of the classification.

When the diseases of man are tabulated according to this scheme, certain facts stand out prominently which were previously obscure or unobserved. For example, it is found that a relatively small group of diseases is transmitted mechanically by arthropods. Also, when one looks for those diseases of greatest importance he finds them in groups I and III. The one characteristic, then, which they have in common is their ability to multiply within their arthropod hosts. The possible exception to this statement is the case of filariasis. However, the difficulty which this disease has in spreading is well known, and must certainly be attributed largely to the fact that the filarial organism does not multiply in its vector. The fact that the most important arthropod-borne diseases of man have one thing in common suggests that more emphasis should be placed upon investigating this common characteristic; that is, toward discovering what factors are concerned in determining whether a parasite can or can not multiply in its invertebrate host.

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GLAUCONITE AND FORAMINIFERAL SHELLS

IN the issue of SCIENCE for July 3d, A. L. Dryden, Jr., makes some statements relative to the occurrence of glauconite in fossil foraminiferal shells. The writer has been studying the mechanics of concretion development in fossil-bearing concretions from the Cook Mountain (Eocene) formation of Brazos County, Texas. This formation carries large amounts of glauconite, but the observations recorded below were made wholly on the glauconite found within the concretions. The figures are from counts made on

TABLE I

Type of occurrence	Number
Irregular, free, unpolished glauconite grains	126
Thoroughly rounded and polished, free glauconite grains	1911
Empty foraminiferal shells	21
Foraminiferal shells packed with glauconite	189
Foraminiferal shells packed with a mixture of glauconite and other mineral matter	57

TABLE II

Ratio of total free glauconite grains to total grains occupying foraminiferal shells	8.28 to 1
Ratio of foraminiferal shells packed with glauconite to shells packed with a mixture of glauconite and other mineral matter	3.33 to 1
Ratio of total packed foraminiferal shells to empty shells	11.10 to 1