

attention to the frequent presence in the throat and mouth of a perfectly harmless Gram-positive bacillus of irregular breadth which might easily be mistaken for the true diphtheria bacillus. Loeffler in his original communications had noted the existence of these harmless forms. For years this was regarded as an attenuated strain of the virulent germ, and as such spoken of as *B. pseudo-diphthericus*. With the discovery that this form was incapable of fermenting dextrose and other sugars, and was therefore quite distinct from the Klebs-Loeffler organism, the first name was seen to be inappropriate, and now this form is more generally known as *B. hofmanni*. Slowly, but at an increasing rate, other non-diphtherial organisms have been detected in the air, in water, and in the human body and its passages, often becoming regarded as the cause of one or other condition of disease, e.g., Hodgkin's disease, general paralysis, &c., until it came to be recognized as urgent that the group should be carefully studied, and the members classified.

The first notable attempt at such a classification on any considerable scale was made by Hoag* of Boston in 1907. He made an analysis of the properties of 199 pure cultures of members of the group, including among these 146 growths of what he termed provisionally "organism X" (a diphtheroid which he had isolated more particularly from the insane patients at the Danver Insane Hospital), seventeen strains of the Klebs-Loeffler bacillus, four of Hofmann's bacillus, &c. A still more thorough analysis was made in 1912 by Miss Morse of Chicago.† Her study of 295 different strains following the biometric methods of Theobald Smith and Winslow was so thorough and analytical that even if we are on the eve of a revolution in the method of determining the acidity and alkalinity of media, her results must remain as the basis of the scientific classification of this group. A year later Hine‡ in Great Britain published an article based upon his unpublished thesis of 1906, in which, basing himself upon the study of the biochemistry of seventy-one different cultures of various diphtheroids, he arrived at conclusions very similar to those of Miss Morse.§

Miss Morse recognized six groups (two groups or sub-groups of *B. diphtheria* distinguished by fixed morphological differences, the one less virulent than the other, *B. hofmanni*, *B. xerosis*, *B. hoagii*, and *B. flavidus*); Hine recognized five main groups (*B. diphtheria*, *B. hofmanni*, *B. coryzae segmentosus* (Cautley), a group of skin diphtheroids, and another of urethral diphtheroids).

Last year Mellon|| of Harvard Medical School, published the results of another exhaustive study of the group. Employing as many as ten different saccharides, he makes out no less than seven sub-groups of the diphtheroids, or, including *B. diphtheria*, eight. Experience must show whether he is justified in making this extensive subdivision. This is not the place to enter fully into the vexed matter of the specific value of fermentation tests. In connection with this diphtheroid group, as with other groups of pathogenic bacteria, those who have made the fullest and most exact studies are most willing to admit the wide variations that occur even in the fermentative activities of strains about whose allocation there can be no reasonable doubt. Thus, for example, Graham Smith has recorded an epidemic of diphtheria in which many of the cultures isolated fermented saccharose vigorously. On the other hand, it has to be admitted that with regard to specific sugars well defined groups in general show a striking constancy in their action. It is, for example, a perfectly sound rule to lay down that a diphtheroid which ferments dextrose, lactose and dextrine, and fails to produce acid with saccharose, is either *B. diphtheria*, or what we would term *B. quasi-diphthericus*, the differentiation between the two being made by the inoculation

test. However, the converse does not obtain that all diphtheria bacilli ferment these sugars. In an article just published, Smith of Glasgow throws doubt upon the fermentation of lactose by *B. diphtheria*.* Only two out of six of his strains, proved by inoculation to be the Klebs-Loeffler organisms, fermented this sugar. Either Glasgow has a special strain of bacilli, or this laboratory an inactive brand of lactose.

And studying carefully the excellent tables compiled by Hoag, Morse and Mellon, we find ourselves justified in selecting for this group, the four sugars employed in this investigation. Had we, that is, employed ten, we cannot see that, judged by the experiences of the above-noted observers, we should have at all materially altered our findings. As it is, the permutations and combinations afforded by four variables, or more truly (including virulence) five, are quite sufficient for all reasonable and practical purposes. Species are not so precisely limited. It is well to bear in mind that the separation of forms of life into genera and species is in its essence at most a convention, a convention instituted for the sake of utility, in order to permit the orderly classification of the forms under review. Among these lower forms of life sharply defined species as such do not exist. When, therefore, a classification becomes so minute that in place of being useful it becomes tiresome, the primary object of the convention is defeated. It is contrary to good sense and good practice to elevate a single variation in the fermentation tests into a specific difference. Within the limits of this group the four sugars selected, together with the results of inoculation, or virulence, afford all the particulars necessary for a sound classification. Even these four, in our opinion, are at most helpful, not definitive. Diagnosis, that is, cannot be based upon fermentation tests alone.

Employing these and utilizing the data afforded by the investigations above-mentioned, we recognize the following members of the group:—

CLASSIFICATION OF THE MEMBERS OF THE DIPHTHERIA GROUP, BASED UPON CULTURAL CHARACTERS, FERMENTATION TESTS AND PRODUCTION OF ECTOTOXINS.

	Dextrose	Lactose	Saccharose	Dextrine	Ectotoxins
<i>B. enzymicus</i> (Mellon, 1917) ...	+	+	+	+	—
<i>B. diphtheria</i> (Klebs-Loeffler, 1887) ..	+	+	—	+	+
<i>B. quasi-diphthericus</i> (the authors) ...	+	+	—	+	—
<i>B. hoagii</i> (Morse, 1912) ...	+	±	±	±	—
<i>B. xerosis</i> (Kuschbert and Neisser, 1884)...	+	—	+	—	—
<i>B. flavidus</i> (Morse, 1912) ...	+	—	—	—	—
<i>B. ruedigeri</i> (Mellon, 1917) ...	—	—	—	—	+
<i>B. hofmanni</i> (? Park and Beebe, 1895) ...	—	—	—	—	—

Morphologically all the organisms here noted have the peculiar features of the diphtheria bacillus, and may on first sight be mistaken for it. There are a few forms on record which may be mistaken for *B. diphtheria*, but ferment sugars with the production of gas. These we do not regard as diphtheroids, but as members of the proteus group, nearly allied. The characteristics of the various sub-groups or species are as follows:—

B. enzymicus.—So-called from the strong tendency exhibited to ferment sugars with the production of acid. All the members of the group ferment at least six of the saccharides employed commonly in bacteriological research; some ferment as many as ten. Growth poor when first isolated; individuals vary greatly in size and appearance.

Included in this group are the strains (*B. hodgkini*) isolated by Bunting and others from cases of Hodgkin's disease.

B. diphtheria, cultures greyish white, with no pigment production, slightly moist; characteristics so well known that they need not here be recapitulated.

B. quasi-diphthericus.—The separation off of this sub-group is necessitated by the consideration that bacilli which

* *Boston Med. and Surg. Journ.*, 1907, x, 197.

† *Journ. of Inf. Diseases*, 1912, xi, 253.

‡ *Journ. of Pathology and Bacteriology*, 1913, xviii, 75.

§ In 1906 (*Journ. of Hygiene*, 1906, vi, 286), and later in 1908, in the well-known volume by Nuttall and himself, ("Bacteriology of Diphtheria," p. 161), Graham Smith described and named a considerable number of diphtheroids. He did not, however, make a study of the fermentative activities on a sufficiently extensive scale, so that, willing as we are to credit his pioneer work, it is difficult to place precisely his various species or sub-species. Add to this, by the laws of botanical nomenclature, several of his designations, being trinomial, are inadmissible.

|| *Journ. of Bacteriology*, 1917, ii, 269.

* *Applied Bacteriology*, edited by C. H. Browning, M.D. London, 1918, p. 60.