cation being its application to the statistical discussion of the distributions of stars—many peculiar objects are also illustrated and briefly discussed. Thus the entire array of prints is well selected to cover the great majority of problems and obstacles that the student of stellar classification is apt to encounter.

In general the criteria adopted by the authors are qualitatively in accord with the criteria Miss Annie J. Cannon employed for the massive Henry Draper Catalogue. Often the actual lines used in the two instances differ, while the elements represented are the same. There are, however, some marked discrepancies, the most conspicuous being in the utilization of the K-line of ionized calcium, which played a heavy role in all Miss Cannon's work but is not employed at all in Morgan, Keenan and Kellman's Atlas. Stars (mainly of the A and early F-types) classified on the new system will consequently show conspicuous systematic deviations from the Henry Draper system. This problem of the classification of the A- and F-type stars has arisen often before in this field of investigation. The criteria used for these classes at Mount Wilson and at Harvard, for example, have been conspicuously discordant, the Mount Wilson observers preferring to base their estimates on comparatively faint metallic lines rather than on the strong calcium line. The problem arose in the first place apparently because the K-line was ill placed at the weak violet extremity of the Mount Wilson spectra, whereas the fainter lines used at Mount Wilson do not show up well on the extremely small dispersion employed for the bulk of the Henry Draper Catalogue. Morgan's Yerkes spectra appear to represent a spectral purity in between the other two, and hence have the practical advantage of effecting a compromise between the faint apparent magnitudes accessible with the Harvard small dispersion objective prism spectra, and the detail and accuracy obtainable from the Mount Wilson equipment.

The descriptions of the various peculiar groups of A–F stars will unquestionably be helpful to other investigators. These stars can be arranged not only according to the temperature and luminosity classes; but numerous sub-groups exist which, from the abnormal intensities of certain lines, have been called silicon, strontium, manganese or metallic-line stars. To the last group, particularly, belong the problematic stars that are assigned to appreciably different classes when different criteria are employed. During work in progress by the reviewer, on the sub-classification of bright stars, two spectral classes are now being recorded for such stars. In extreme cases the discrepancy may amount to a whole spectral class. Although the proportion of stars with ambiguous spectral classes is small, the actual number is evidently too great to be ignored in problems of classification. Earlier work by Dr. Morgan paid much attention to the A stars, and his judgment on which criteria are most suitable, *i.e.*, best correlated with temperature, should be given high weight.

The authors stress the fact that the Atlas has been constructed from slit spectra having a dispersion of about 125 Ångstroms per millimeter. (The reproductions have been enlarged to about 8Å/mm). Just which criteria are most desirable and adequate for the determination of systematically accurate spectral classes depends very appreciably on the dispersion and purity of the spectrograms obtained. Very many of the criteria adopted at Victoria or Mount Wilson, for example, are unsuited to the small dispersion Yerkes spectrograms. Several of the spectral lines included among the Yerkes criteria, on the other hand, are too weak for the smaller dispersion objective prism spectra that Miss Cannon had used. Many of the Yerkes criteria outlined and illustrated appear admirable for the much larger-dispersion objective prism spectra (45Å/mm) used in similar work by the reviewer. Others of the Yerkes criteria, however, are not suited to these larger-scale photographs, because the pairs of lines easily compared in small dispersion are too far separated or situated where background differences in photographic density make intercomparisons awkward. Numerous instruments throughout the country (including those at Harvard) are, however, equipped to yield spectra for which the criteria given in the Atlas are admirably suited.

It is a pleasure to know that this much-needed guide to two-dimensional spectral classification is now available, and to recommend it not only to those who will use it as a research tool, but likewise to teachers who frequently need first-rate illustrations of typical spectra and of absolute magnitude effects. Moreover, the Atlas should go far toward bringing about a desirable greater uniformity in stellar classification in the future.

DORRIT HOFFLEIT

SPECIAL ARTICLES

OBSERVATIONS ON THE NATURE AND PROPERTIES OF THE FLUORESCENT FACTOR F_2[1]

THE accompanying publication of Huff and Perlzweig[2,3] prompts us to make the present report.

[1] From the Department of Pediatrics of the Johns Hopkins University and the Harriet Lane Home of the Johns Hopkins Hospital, Baltimore, Maryland.

[2] J. W. Huff and W. A. Perlzweig, SCIENCE, 97: 538, 1943.

Purified preparations of F_2 more than 100 times as potent in fluorescent units as the original permutit eluates[4] have been obtained from human urine by procedures to be published shortly. The final product is a waxy yellowish brown solid which has been crystallized. It is free from niacin, as judged by a negative immediate cyanogen bromide reaction, but possesses biological properties similar to niacin. One hamster rendered moribund on a niacin-free diet was restored to normal behavior within two hours after oral administration of purified F_2. Purified F_2 is a powerful bacterial growth catalyst for *E. coli* and *H. influenzae*.[5] F_2 occurs in the urine of animals that do not require niacin in their diet (pigs; rats); it occurs in many rat tissues, notably in the liver.

Purified F_2 is readily extracted by butyl alcohols only from alkaline solutions, which explains our observation[6] that alkalinization of urinary eluates was necessary before butyl alcohol extraction to obtain F_2 fluorescence. In acid, neutral or weakly alkaline solutions F_2 exhibits its characteristic fluorescence[7]; with strong alkali fluorescence becomes more greenish. This change is reversible on the addition of acid. On standing with alkali fluorescence gradually fades and a yellowish color develops, changes which are irreversible. F_2 oxidizes slowly in the air, more rapidly in the presence of alkali and $K_3Fe(CN)_6$; the characteristic blue fluorescence is lost and a violet fluorescence develops. This change is irreversible. Addition of acetone to alkaline F_2 solutions produces an intense yellow solution with a green fluorescence resembling that of uranium glass; this change is irreversible. Sulfanilic acid produces an orange red color with loss of fluorescence.

F_2 appears to be a pyridine compound. On alkaline hydrolysis a positive cyanogen bromide test[8] is obtained, not present originally. F_2 is destroyed rapidly by HNO_2.

Since our original communication[4] we have investigated various other pyridine derivatives and wish to report that none of the following can be identified with F_2: cozymase, dihydrocozymase, desaminocozymase, nicotinamide nucleoside and acetyl nicotinamide. We have for some time been familiar with the physical and chemical similarity between F_2 and the N-methyl reduction products of nicotinamide studied by Karrer *et al.*,[9] and had embarked on a program of preparing and testing these compounds when the communication of Huff and Perlzweig was sent to us. Our results to date indicate that one of the dihydro-N-methyl nicotinamides is indistinguishable from F_2 by its adsorption properties, solubility in eleven organic solvents and its reactions with alkali, $K_3Fe(CN)_6$, HNO_2, acetone and sulfanilic acid. We do not feel justified in identifying F_2 as an N-methyl dihydronicotinamide for three reasons: (1) because one of the N-ethyl isomers likewise possesses these identical properties; (2) because acetylation of F_2, of N-methyl and of N-ethyl dihydronicotinamide gives compounds with different fluorescent properties and solubilities; and (3) because the absorption spectrum of F_2 shows characteristic differences.[10]

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THE PROBABLE IDENTITY OF NAJJAR AND HOLT'S FLUORESCENT SUBSTANCE, F_2

THE following observations are presented to show the similarity in biological and chemical behavior of N-methyl nicotinamide and F_2, the substance described by Najjar and collaborators,[1,2] as appearing in the urine in small amounts normally, and in large amounts after the ingestion of nicotinic acid derivatives.

N-methyl nicotinamide chloride, Fig. 1, was prepared essentially by the simple method given by Karrer.[3] A concentrated solution of F_2 in 25 per cent. KCl solution was prepared from urine obtained from human subjects after large doses of nicotinamide, by the original methods[1,2] and slightly modified by us. A comparison of the biological and chemical behavior of the two substances follows:

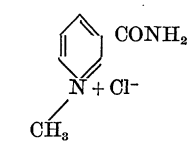

FIG. 1

Animal species which are known to methylate nicotinic acid, man, dog, rat, excreted F_2 in large amounts after doses of nicotinamide. In the rat, which synthesizes nicotinic acid and excretes it largely as tri-

[3] Kindly shown to us in manuscript.
[4] V. A. Najjar and R. W. Wood, *Proc. Soc. Exp. Biol. and Med.*, 44: 386, 1940.
[5] These observations were made in collaboration with J. H. Hill and H. D. Zepp.
[6] V. A. Najjar and L. E. Holt, Jr., SCIENCE, 93: 20, 1941.
[7] V. A. Najjar, H. J. Stein, L. E. Holt, Jr., and C. V. Kabler, *J. Clin. Invest.*, 21: 263, 1942.
[8] We are indebted to Dr. Harold J. Stein for these determinations.
[9] P. Karrer, G. Schwartzenbach, F. Benz and U. Sollmsen, *Helvet. Chim. Acta*, 19: 811, 1936.
[10] We are indebted to Dr. N. H. Coy for these measurements.
[1] V. A. Najjar and R. W. Wood, *Proc. Soc. Exp. Biol. and Med.*, 44: 386, 1940.
[2] V. A. Najjar and L. E. Holt, SCIENCE, 93: 20, 1941.
[3] P. Karrer, G. Schwartzenbach, F. Benz and U. Sollmsen, *Helv. Chim. Acta.*, 19: 826, 1936. See also O. Warburg and W. Christian, *Biochem. Zeits.*, 287: pp. 314 *ff*, 1936, for an important discussion of N-methyl nicotinamide as a model for the active component of the reversibly reducible pyridine coenzymes.