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THE COLOR GRADING OF HONEY<sup>1</sup>

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CONTENTS

Requisites of a standard grader-----	Page 2	Instructions for grading-----	Page 6
Description of grader-----	4	Future development of graders-----	6

Extracted honey is commonly sold on the basis of its color and the plant source from which it is derived, as white orange honey, or light-amber clover honey. To persons familiar with the various honeys on the market, the naming of the plant source indicates the flavor of the honey, this being the only method by which the flavor may be indicated. As a rule, the honeys of light color bring a somewhat better price than the darker grades, and therefore the practice of designating the color has become general. Certain names for colors of honeys have come into common use in the trade, but these colors have never been accurately defined or otherwise designated.

It has been definitely established in the trade that not less than 12 pounds per gallon is the standard weight for honey; in grading honey, therefore, the density, or "body," need be given no further consideration.

With the flavor indicated by the plant source of the honey, and the body fixed at not less than 12 pounds per gallon, the next step is to establish color grades. As an aid to uniformity in grading, several color graders for extracted honey have been devised and placed upon the market. An examination of the colors of honeys collected from all parts of the United States, and of the colors of the materials used for comparison in these graders, reveals the fact that the colors of the graders are not the same as those usually found in honeys of similar degrees of darkness. A more serious difficulty arises because the color graders on the market do not have the same colors for grades of similar designation, so that a buyer using one grader

<sup>1</sup>Besides the work of the regular members of the staff of the Bee Culture Laboratory of the Bureau of Entomology, assistance in the research here described has been given by Dr. A. H. Pfund, of Johns Hopkins University; H. Wales, of the Color Laboratory of the Bureau of Chemistry, Department of Agriculture; and by B. Kurrelmeyer and E. W. Tschudi.

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and a seller using another might find themselves engaged in a dispute as to the proper color grade for a certain lot of honey.

It has seemed best to make a careful study of the colors found in a large collection of honeys, and then to devise a grader which may be used universally, in strict conformity with the colors found. This work was taken up in cooperation with the Bureau of Agricultural Economics, and has resulted in devising a type of grader whose outstanding feature is its extreme simplicity of operation.

In order that the development of this grader may be understood, the present circular necessarily must briefly discuss, with some attention to technical and scientific detail, the incidental studies and preliminary work connected with deciding on standard grades and perfecting a grader. A knowledge or understanding of all this is not in any way necessary to satisfactory operation of the grader. Its operation is so simple that, in order to grade honey accurately, only an understanding of the few paragraphs of instruction given on page 6 is necessary.

By way of preparation for a study of honey colors and for the construction of a satisfactory grader, the Bee Culture Laboratory, under E. F. Phillips, enlisted the cooperation in 1922 and 1923 of a large number of beekeepers in all parts of the country, and obtained a collection of over 450 samples of honeys such as appear on the American market. Studies of these honeys, and of the problems encountered in preparing a satisfactory honey grader, were at once begun and have been carried on as time permitted. In 1924 and 1925, under James I. Hambleton, the work was continued until the grader described in this circular was completed.

The transmission of light of various colors (wave lengths) through these honeys was determined by the use of the spectrophotometer. These samples were also on various occasions exhibited to beekeepers and those familiar with the common practices in the honey trade, and in conformity with information obtained in that connection the color limits of the several commonly accepted grades have been established. An effort was made to adopt the commonly accepted names and limits, rather than to attempt to mark off new boundaries or to adopt new and strange names.

#### REQUISITES OF A STANDARD GRADER

As is well known, the turbidity of honey varies considerably, not only for different honeys but for honey of the same grade coming from different sources and locations. The eye is affected primarily by the color in honey, and but little by the turbidity, whereas a reading given by the spectrophotometer is affected by both these factors. For example, a very turbid honey of the white grade may be classed as belonging in the light amber grade, or even in the amber, when classified only by the spectrophotometer readings. Furthermore, a given sample of honey undergoes a change in turbidity on standing for a time, so that it is impossible to limit the grades of honey solely on the basis of their transmission of light as measured by the usual spectrophotometer. Since honeys of the same color differ in turbidity, they can not be distinguished solely by their light transmission. In the making of a color grader it is

not satisfactory to use merely colored materials for comparison, but the instrument must be so constructed that the varying turbidity of honeys of a given grade does not lead to false determinations of their color grade. This has proved to be the most difficult problem in the making of a satisfactory grader, and the one which baffled all who worked on this research until a grader of the character here presented was devised.

The available data on the light transmission of the grades in terms of readings with the spectrophotometer are here tabulated in order to present the characteristics of the several grades with accuracy. Readings with Lovibund glasses are also included for comparison. These figures are given because of their bearing on the development of the color grader and on the standard grades which have been selected. All honey transmitting less light than the amber grade is classed as dark and for this no readings are given. A knowledge of these figures is not essential to the operation of the grader, but will be of use in the construction of other graders of different types.

	Percentage of light transmitted, as measured by the spectrophotometer.			Lovibund readings		
	Blue (480 $\mu$ )	Yellow (580 $\mu$ )	Red (680 $\mu$ )	Blue	Yellow	Red
Water-white.....	64.0	77.0	81.5	0.54	1.05	0.52
Extra white.....	60.0	76.0	80.5	0.58	1.40	0.66
White.....	50.0	71.0	78.0	1.15	3.00	1.33
Extra-light amber.....	48.0	70.0	77.0	1.70	3.28	1.95
Light amber.....	34.5	63.0	73.0	1.80	5.14	2.10
Amber.....	15.0	49.0	63.0	2.00	13.00	4.00

As previously stated, these readings for light transmission depend in part upon the degree of turbidity of the honeys, a fact which must be taken into account in comparisons of such readings with determinations made by the use of the honey grader.

It might at first thought be supposed that standard samples of honey could be chosen, and that these would serve as standards for the honeys of similar grades. This, however, is not the case, for several reasons, chief among them being the tendency of honey to change color and appearance with age. At first, the turbidity may decrease, making the honey clearer; then the color deepens, the darkening becoming quite perceptible at the end of two years, and in some honeys much earlier, until, after 15 or 20 years, most of the light honeys become quite amber in color.

Many attempts were made to produce solutions with color and turbidity representing the average turbidity found in honey, and thus to represent the boundaries between the various grades, but all these attempts failed, either through lack of permanency of the solutions themselves, lack of permanency in color, failure to retain the necessary turbidity, or other reasons that often could not be known until after considerable time had elapsed. All these trials delayed the completion of the work.

It seemed important to devise a type of grader in which no consideration need be given to turbidity, as must be done in the use

of the spectrophotometer, so that all honeys falling within the range of the grader could be classed accurately, and it is believed that the grader herein illustrated and described meets all the conditions imposed by the peculiar composition and character of honey.

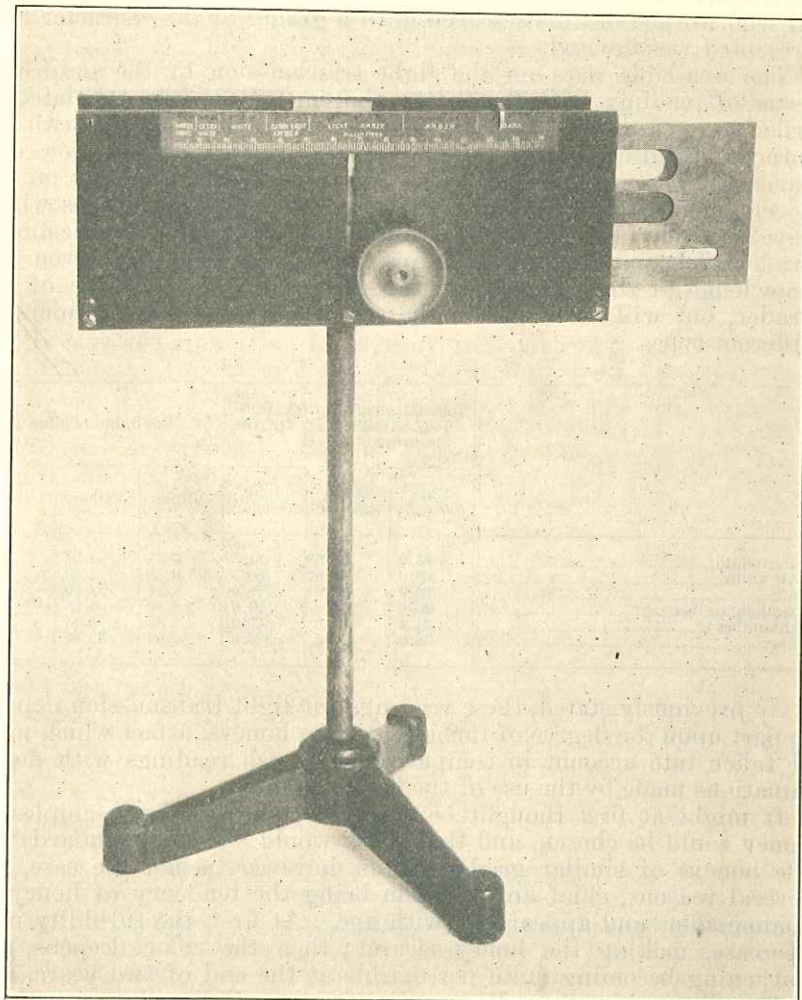


FIG. 1.—The grader devised and officially adopted by the Office of Bee Culture Investigation and the Bureau of Agricultural Economics for the color grading of honey

#### DESCRIPTION OF GRADER

The grader (fig. 1) is composed primarily of a wedge-shaped prism of glass, of the proper thickness, angle, and color, mounted with a correspondingly designed wedge-shaped glass trough in which the sample of honey to be graded is placed. By means of a rack and pinion the plate on which the prism and the honey trough are mounted is moved to right or left, while the honey and the prism

are viewed through properly designed openings in the front and rear plates of the case of the instrument. A pointer is fixed on the movable plate. When the appearance of the honey in the trough and that of the glass prism below it are exactly alike as seen through the narrow slot in the front of the case, the position of the pointer on the movable plate, in respect to the graduations on the scale, determines the grade of the honey.

Besides the divisions marking the limits of the various grades of honey, the scale is also provided with centimeter and millimeter graduations which may be used if it is desired to make an exact reference to the position of the pointer on the scale.

Numerous tests have shown that different persons, when grading the same sample of honey on a grader of this character, can determine the proper grading so accurately that the personal factor is practically eliminated and that the grading is more accurate than is possible where a sample of honey in a vial is compared with a similar color sample. The method of construction of this grader appears to nullify the confusing effects of the various colors and shades of color, and the varying turbidities of honeys, so that a close approach to perfect grading can be accomplished.

Green trees or other varicolored backgrounds also materially affect the appearance of a sample of honey. If clear blue sky were always available little trouble would be experienced with light from this source, but in practice graders would ordinarily be used in houses where window frames, trees, or other obstructions would modify light conditions sufficiently to cause errors in grading. It has been found that with the grader described this matter of variation in the background can be taken care of satisfactorily by the use of a sheet of ground glass in the slot through the back of the case.

Although the type of grader illustrated is more expensive than the graders heretofore in use, no satisfactory, permanent, and accurate grader that can be sold at a low price has yet been devised. The Bureau of Agricultural Economics has therefore decided that the standard grades of honey shall be those determined by the Bee Culture Laboratory in accordance with its investigations, and that it will use a grader of the type described for the determination of these grades.

The five standard grades of color are as follows: Water-white, white, light amber, amber, and dark. These are the terms at present commonly used in the sale of honeys. In response to the demand from western beekeepers for further subdivisions of the lighter grades, two additional grades are established as subdivisions of the white and light-amber grades, these to be designated as extra-white and extra-light amber. These terms are also used occasionally in the trade at present. In establishing the limits of these extra grades, it has seemed best not to divide a grade into two equal parts, but to place the color limits so that approximately 30 per cent of the honeys in the white or the amber grade shall be included in the "extra" grade. This division results in the choicest honeys in either grade, so far as color is concerned, falling into the corresponding "extra" grade.

## INSTRUCTIONS FOR GRADING

In using a grader of the type described, the sample of honey to be graded is placed in the wedge-shaped trough, the movable plate of the instrument being then shifted to right or left, by means of the rack and pinion, until the sample as viewed through the slot is of exactly the same shade as the glass below it. The pointer then indicates the grade.

A sample of honey the reading of which falls between the lines bounding any grade is to be considered as of that grade. If, however, in reading any given sample the pointer falls exactly on the line dividing two grades, the sample is to be considered as being in the higher grade.

Any sample of honey which falls in the water-white grade or which is lighter than any honey that can be matched on the grader, is, of course, to be classed as water-white. In like manner, any sample of dark honey which falls below the limits available for dark honey on the grader scale will still be classed as dark honey.

In grading any sample, if it is desired to give a closer description of the color than is afforded by the standard grades, the millimeter scale may be used; for instance, if the sample grades as light amber, but falls in the lighter part of the scale, the seller may wish to state that his honey graded light amber, with a reading of, for instance, 5.1, or, if it falls in the darker portion of the grade, he might say that the sample was light amber, with a reading of, for instance, 8.2. The use of this millimeter scale is not, however, to be considered as a necessary part of the grading, nor would it, except in special cases, be desirable or necessary to use other designation than the standard grade as indicated on the upper half of the scale.

In using the grader it is well to place it at a window opening toward the sky with most of the light excluded except that falling on the grader. It is advisable to make two or three successive readings of the same sample so as to avoid any chance of error. After taking the readings for any sample of honey the trough should be carefully washed and dried before another sample is placed in it. Nothing but water should be used in washing the trough. Hot water should not be used.

## FUTURE DEVELOPMENT OF GRADERS

As has been stated, because of the tendency of honeys to darken and change in other characteristics than color, it is impossible to use them as permanent standards for comparison. It may be possible, however, to use honey or some comparable color solution in a grader that will be satisfactory for one or two seasons. It may also be found that most beekeepers will not require a grader that will cover the whole series of grades from water-white to amber, but that two or three grades will be sufficient for the personal use of the majority of beekeepers. If such is found to be the case, as well may happen, the grader herein described may then be used for standardizing such temporary or small and less expensive graders as might be desired for use in regions producing only a few grades of market honey.

## The Color Grading of Honey

In the work which has been done on grading honey by comparison between a standard color in a bottle and a similar-sized sample of the honey to be graded, some things have been demonstrated which may well be included in this discussion of honey grading.

In graders previously used in this country the materials are placed in narrow bottles, but with too narrow a bottle the finer gradations in color are not easily distinguished. It is therefore recommended that round bottles having a diameter approximately of  $1\frac{1}{8}$  inches be used. Whatever the size of the bottle, bottles of the same size should be used to contain the samples to be graded. Any variation in the sizes of the bottles used for the samples of honey will lead to errors in the grading.

In making a holder for sample bottles, it is recommended that a wooden framework be used, painted or stained a dull black, as any color in the framework reflects light both to the standard liquids and to the samples of honey. Under usual circumstances a frame holding four samples would be sufficient. The face of the grader should be made of some thin material, presumably metal, having slits cut to permit the middle of the grader bottles and the middle of the sample bottles to be viewed, but so as to cut off the edges of both types of bottles. Where the edges of round bottles are visible there is so great confusion due to variation in thickness of the materials as to make grading uncertain. It is further advised that the back of the framework be fitted with a sheet of ground glass to insure the passage of diffused light through both grader and honey bottles, this being, as previously stated, necessary to accurate grading.

20

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8

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