THE "ORIGINAL" SPECIFIC GRAVITY OF BEER.

THE December (1914) issue of the Journal of the Institute of Brewing is an important number of this publication, and of more than merely technical interest. It contains a series of reports and memoranda upon the subject of the determination of the "original" specific gravity of beer, and the results of the work described have now, by the Finance Act of 1914, been legalised as the basis for checking or determining the charge of duty upon this beverage. The main reports are contributed jointly by Sir Edward Thorpe and Dr. H. T. Brown, and the latter author supplements them by interesting studies of both the historical and the scientific aspect of the question.

Beer is taxed as being an alcoholic beverage, and it is popularly supposed to pay duty according to the amount of alcohol it contains. This, however, is not strictly the case. The basis of taxation is not the actual quantity of alcohol in the beer, but the specific gravity of the unfermented wort, which may be regarded as a measure of the quantity of alcohol potentially producible. Essentially, the wort of beer is a solution of various sugars—maltose, dextrose, cane sugar, and invert sugar—either arising from the malt and grain used, or directly added as such. The proportion of sugars varies considerably, according to the kind of product desired. In wort for producing strong ale, for instance, there may be twice as much sugar as in that destined for ordinary table beer. But, in the main, the proportion of sugar determines the specific gravity of the unfermented wort, and the specific gravity is therefore made the basis of the charge of duty levied on the beer. A brewer is thus left at liberty to ferment his wort as much or as little as he likes, and to produce a stronger or a weaker a heavier or a lighter beverage, as his fancy dictates or his customers prefer.

As soon as fermentation commences, the specific gravity of the wort begins to alter, and in general to decrease. This is so for two reasons. First, the destruction of sugar by fermentation removes solid matter from solution; and secondly, the alcohol produced is specifically lighter than the wort. Hence, unless the specific gravity is determined before fermentation has commenced it is useless as the basis for the correct assessment of duty. It is impracticable, however, to have a revenue officer in attendance in all cases to take the specific gravity of the wort before fermentation begins; moreover, it often happens that the "collection" of the wort extends over several hours, during which time the first portions may have been in contact with yeast, and fermented to an appreciable degree, before the last portions have been added. Even were this not so, other difficulties arise. A large quantity of beer is exported, and the exporter is entitled to a "drawback" or rebate equivalent to the duty originally charged upon the unfermented wort from which the beer was made. Hence it is necessary to devise a method whereby the original specific gravity of the unfermented wort can be ascertained by the analysis either of the partly-fermented wort or of the finished beer, as the case may be.

As a first approximation, such a method may be based upon the well-known equations of Gay-Lussac denoting the conversion of sugar into alcohol. With maltose, for example, it is readily calculable from the equation:—

$$\underset{\text{Maltose}}{C_{12}H_{22}O_{11}} + H_2O = 4\underset{\text{Alcohol}}{C_2H_6O} + 4CO_2,$$

that 100 parts of this sugar yield theoretically 53·8 parts of alcohol. Hence by determining the quantity of alcohol in a given specimen of wort or beer, we find the equivalent amount of sugar destroyed; and from the known density of solutions of maltose we can thus deduce the corresponding loss of specific gravity. Adding the number denoting this loss to the specific gravity of the residual wort or beer freed from alcohol, we can, theoretically, obtain the "original" specific gravity of the wort, *i.e.*, the gravity before fermentation had commenced.

In practice, however, this calculation is not sufficiently accurate. As Pasteur long ago showed in his studies of fermentation, a part of the sugar destroyed is not converted into alcohol. Moreover, different classes of sugars yield different percentages of alcohol. Again, the introduction of yeast complicates the matter, since part of the solid matter of the wort is used up in sustaining the growth of the yeast, and a sensible quantity of alcohol may be added as such with the yeast itself. These and other disturbing factors, small individually, together affect the result sufficiently to render the figures given by the simple theoretical method, as outlined above, only an approximation to what obtains in actual brewery operations.

We have, in fact, to fall back upon an empirical basis for the calculation of results sufficiently accurate to be used in practice. Starting with worts of known specific gravity, fermentations may be carried out, and from the examination of samples drawn as the process continues, it can be ascertained experimentally what is the actual loss of specific gravity consequent upon the production of known quantities of alcohol. Such experiments, in fact, have been made, and the results have been embodied in statutory tables for use in assessing the duty on beer.

Manifestly it is of much importance that these tables should be true and just. If inaccurate in one direction they are unfair to the public by reason of the loss of revenue entailed; if erroneous in the opposite sense they are unfair to the brewer.

The first original gravity tables were constructed in the year 1847 by Messrs. Dobson and Phillips, of the Inland Revenue Department. They were drawn up with considerable care; but some discussion having arisen, the whole matter was referred a few years later to Profs. Graham, Hofmann, and Redwood, whose report was pre-

sented to the authorities in 1852, and published the same year in the Journal of the Chemical Society. For some time past it has been known that the table supplied with this report is less accurate than is desirable—not, it appears, from any inherent errors, but from having been based upon fermentations which differed in some respects from those obtaining in ordinary brewery practice. About six years ago, therefore, the Commissioners of Customs and Excise gave instructions for a revision of the table to be made. This was undertaken by Sir Edward Thorpe, who was at that time principal chemist of the Government Laboratory, conjointly with Dr. H. T. Brown, nominated on behalf of the brewing trade by the Council of the Institute of Brewing. The necessary experiments, which altogether extended over a period of about two years, comprised not only brewings made under laboratory conditions, but an extensive series of observations at representative breweries, in order to obtain data which should correspond fairly with the actual working conditions met with in modern brewing practice. In the result a table has been constructed which there is every reason to believe is trustworthy, and which has now been legally established for use in place of the former statutory table of Profs. Graham, Hofmann, and Redwood. As compared with the older table, its general effect is somewhat to increase the amount of duty chargeable.

Dr. Brown's special contribution is a valuable study of the scientific principles underlying the empirical method of determining original specific gravity. He shows that a reasoned or "theoretical" process is quite possible—though not necessarily preferable—if the data have been properly established. C. SIMMONDS.

ROLL-CALL OF BRITISH BIRDS.[1]

WE have received from the British Ornithologists' Union the second and revised edition of its "List of British Birds." It is an authoritative compilation which does credit to the zeal and carefulness of the editorial committee. While the task was only accomplished by division of labour, the whole has been revised by the entire committee, who consider themselves jointly responsible, although many disputed points have been decided by the votes of the majority. The first edition, published in 1883, included 376 birds; the present edition has 475, quite apart from a long list of species the presence of which has been recorded, but not satisfactorily proved.

It is interesting to look into the composition of the list of 475 birds. In the first place, 188 are regular breeding birds, and 286 are non-breeding, and one (the great auk) is extinct. The list may be further sub-divided. Thus, there are 141 residents, including, of course, many that are partially migratory. In this category are included three introduced birds—the little owl, the pheasant, and the red-legged partridge, besides the capercaillie, which was indigenous, but became extinct about 1760–70, and was re-introduced from Sweden in 1837–8. A second set is made up of 47 summer visitors, including a few which occasionally leave representatives with us in winter. The third set consists of 46 winter visitors; the fourth of 30 birds of passage; the fifth of 61 occasional visitors which have occurred on more than twenty occasions.

The largest category in the classification is that of rare visitors, which have been recorded on fewer than twenty occasions. This group numbers 149, which shows how diligent the search for the occurrence of rare birds has been in the British Islands. Under each bird we find a few references, the etymology of the name, the distribution in the British Islands, and the general distribution. A long appendix is devoted to the birds which have been excluded because the evidence of their occurrence is not regarded by the committee as entirely satisfactory. Two others deal with questions of nomenclature. The members of the committee deserve the thanks of all ornithologists for the effectiveness with which they have done their work, which must have made heavy demands on their time and afforded abundant exercise for their judgment.

[1] "A List of British Birds." Compiled by a Committee of the British Ornithologists' Union. Second and Revised Edition. Pp. xxii+430. (London: W. Wesley and Son, 1915.) Price 7*s*. 6*d*.

NOTES.

WE learn with much regret of the sudden death on March 23, through heart-failure, of Prof. Otto N. Witt, professor of chemical technology in the Technical High School at Charlottenburg.

DR. F. TAYLOR, consulting physician to Guy's Hospital, has been elected president of the Royal College of Physicians in succession to Sir Thomas Barlow.

THE fifth annual award of the Willard Gibbs Medal, founded by Mr. W. A. Converse, of Chicago, has been made, says *Science*, to Prof. A. A. Noyes, director of the research laboratory of physical chemistry, Massachusetts Institute of Technology.

A STRONG after-shock of the Avezzano earthquake of January 13 was felt in Rome on April 5, at 7.20 a.m. (6.20 G.M.T.). According to a report issued by the geodynamic observatory at Rome, the epicentre of the after-shock appears to have been close to Avezzano.

THE American Philosophical Society will meet at Philadelphia on April 22–24 for the reading and discussion of papers. The programme includes papers on many subjects of recent research in physical and natural science, and also a symposium on the earth: its figure, dimensions, and the constitution of its interior.

DR. J. SCOTT KELTIE, who has been secretary of the Royal Geographical Society since 1892, vacated that office at the end of last month, and has been succeeded by Mr. A. R. Hinks, who has been assistant secretary of the society since 1913. Dr. Keltie will not, however, entirely sever his official connection with the society, for he has undertaken to act with Mr. Hinks as joint-editor of the *Geographical Journal* for the next two years.