he has given equally strong reasons for discrediting the usual reckonings as to albuminoids and fats. He begins with the startling declaration that "chemists have at present no means for determining the quantity of albuminoids in any food," thus, in a line, impugning the trustworthiness of all the numerous prescriptions for feeding based on the supposed albuminoid ratio. He explains his announcement by pointing out that in all food analyses the quantities of albuminoids are supposed to be proportionate to the quantities of nitrogenous substance contained, and that this substance contains a certain percentage of nitrogen; whereas some of the nitrogenous substances in food are non albuminoid, and the percentage of nitrogen in different kinds of albuminoids varies considerably. When the general lines of food analyses were laid down, Mr. Warington further explains, analyses of albuminoids made up to that time showed a variation of only from 15.5 to 16.5 in the percentage of nitrogen; also that Mulder, then a high authority, taught that all the albuminoids of plants and animals were modifications of a single substance, which he called "protein", and that this contained 16 per cent. of nitrogen. This percentage was therefore adopted as representing the proportion of nitrogen in normal albuminoids, and the nitrogen in supposed albuminoid food was multiplied by 6.25 in order to get at the weight of albuminoids present. Modern investigation, however, has shown that this calculation rerely gives correct results, and that the errors are sometimes great. The percentages of nitrogen in different albuminoids vary considerably, particularly in those stored up in the seeds of plants, and as the case at issue is less complicated in relation to seeds than to other kinds of food, Mr. Warington first gives the results of recent researches in this direction.

An extended investigation carried out by Dr. T. B. Osborne, of the Connecticut Experiment Station, and still in progress, is referred to as throwing much light upon the question under consideration. The results show that it is rare to find a vegetable albuminoid containing as little as 16 per cent. of nitrogen, and several different kinds are mentioned in which the range of nitrogen percentage is from 15 68 to 19 30. It is clear, therefore, that the weight of albuminoids cannot be ascertained by multiplying the nitrogen in them by a single factor. Unfortunately, it is a difficult task to ascertain the quantity of albuminoids accurately, even in the simple case of a ripe seed. Before even approximate accuracy can be ensured, it will be neccessary to make numerous analyses of each kind of seed, in order to get an average result covering possible variations. In respect of some seeds Osborne's investigations have been sufficiently complete, Mr. Warington concludes, to allow of an approximately exact calculation. Five kinds of albuminoids are given for wheat, making together 11.5 per cent., and the percentage of nitrogen in the whole of the albuminoids is 17 6. The albuminoids in wheat are named Gliadin, Glutenin, Edestin, Leucosin, and Proteose, the first two making 10 out of the 11.5 per cent. of albuminoids found. According to the figures just given, the nitrogen in wheat should be multiplied by 5.68, instead of by 6.25 as at present, to get at the quantity of albuminoids. In the case of maize, there is less complication, as its albuminoid, Zein, occurs in greatly preponderating proportion, and the multiplying factor in this case is 6.10 Oil seeds contain albuminoids particularly rich in nitrogen, and the factor given for converting the nitrogen of linseed into albuminoids is 5 5 5. Investigations as to other oilseeds are not yet complete, but are expected to give results very close to those of linseed. Barley and oats, too, are still to be tested further, though Dr. Osborne expects to show that the multiplying factor of the former will be about 5.9, and that of the latter about 6

Considering that, even when Dr. Osborne's investigations have been completed, it would be rash to accept his results as accurate unless they are confirmed by other chemists, it is obvious that there is a very wide field for research in relation to the albuminoids of food But, accepting them provisionally, as at least more entitled to credit than those for which they are substituted, Mr. Warington gives an example of the extent of error for which the present method of reckoning albuminoids is responsible. In the case of a Western American linseed cake, he says, certified by the present method of analysis to contain 36 per cent. of albuminoids, the real proportion is only 31 9 per cent. Nor is this the only error, for as the carbo-hydrates are reckoned by difference in relation to the albuminoids, if the latter have been put 4 1 per cent. too high, the former must have been reckoned so much too low. The subject of food values, however, is not exhausted by considerations of the proportions of albuminoids and carbo-hydrates in food, and Mr. Warington proceeds to speculate upon the probable differences in the physiological value of albuminoids containing different proportions of nitrogen, suggesting feeding experiments to throw light upon the subject. Again, the subject is further complicated by the existence in some foods of various nitrogenous substances which are not albuminoids, and in such cases Mr. Warington suggests that, to avoid misleading statements, the term "nitrogenous substance" should be substituted for "albuminoids," the latter term being used only where all the nitrogenous constituents are albuminoids. Mr. Warington concludes his suggestive article by showing that research to determine the respective feeding values of different fats is as much needed as in the case of the albuminoids, and that the important problem of animal nutrition is in urgent need of the light which can only be thrown upon it by a large number of laboratory experiments.

ROTHAMSTED EXPERIMENTS.

(Continued)

Selection of pigs—Different foods—Increase—Respiration apparatus—Expts on cows, sheeps, &c.—Moscow and Vienna expts—Soxhlet's expts.—Recalculations.

Further, it was maintained that, in the case of pigs fattening rapidly on their most appropriate fattening food, the amount of fat stored up in proportion to the amount of fat and nitrogenous substance consumed was so large that the question of whether or not the carbohydrates contribute to fat formation might be conclusively settled by a properly conducted feeding experiment with those animals, without any analysis of the faeces or the urine, or any determination of the products of respiration. I stated that it was only necessary to select two animals of a breed of good fattening quality and as nearly alike as possible in character and in weight, a convenient size and weight being, say, about 90 pounds per head. Each should then be fed with ground barley of good quality, giving it by degrees, until both weighed about 100 pounds. Then, slaughter one and determine its total amount of nitrogenous substance and of fat. Continue to feed the other with barley meal (and water) exclusively, as much as it will consume, until it reaches a weight of about 200 pounds; then slaughter and analyze it as the first. The quantity and composition of the food must, of course, also be determined. Such an animal would probably consume about 500 pounds of barley and increase in live weight from 100 to 200 pounds in from eight to ten weeks, more or less, according to the quality of the animal, the quality of the food, and other conditions. It was desirable that the animals selected should have been feeding on fairly good food previously, so that the transition to full fattening food should not be too sudden. It was also, of course, desirable that the experiments should be made in duplicate if possible.

In the discussion which followed Professor Henneberg, who was, I believe, the first to have a Pettenkofer respiration apparatus constructed for experimenting with the larger animals of the farm, and had, perhaps, at that time conducted more experiments on feeding than any other agricultural chemist in Germany, said "he did not doubt the formation of fat from carbohydrates in the case of pigs." He added that probably sooner or later the carbohydrates would be restored to their former position so far as fat formation in other animals was concerned, for already some experiments had shown that such formation was quite close upon the limits of the amount possibly derivable from the fat and albuminoid matters of the food. Prof. Emil von Wolff also spoke in the same sense, so far as pigs were concerned.

Since that time, experiments have been made on the subject in Germany with various animals; but, even in those with pigs, the conditions above indicated as desirable, with a view to obtaining decisive results the most easily, were not followed.

Experiments were made with cows, by Voit at Munich, (1) by Wolff at Hohenheim, (2) and by G. Kühn at Mockern. (3) In those at Munich and at Hohenheim, the amount of fat in the food and that possibly derivable from the albumin consumed very nearly corresponded with the amount of fat in the milk. In the experiment at Möckern, however, a small excess of milk fat was produced. None of those experiments, therefore, afforded evidence of the formation of fat from the carbohydrates.

In experiments made by Kern and Wattenberg, at Göttingen, (4) with sheep of various ages, in ten cases the fat stored up fell short by 24 to 64 per cent of that which could have been derived from the fatty matter and nitrogenous substance consumed. In one experiment, however, one animal was killed and the initial composition determined, and the other was fed for ten weeks, and the composition and digestibility of the food were determined. The results showed that 29.4 per cent of the fat stored up must have been derived from other sources than the fat and the albumin of the food; and, even making all allowance for possible error, "it was concluded that fat must have been derived from the carbohydrates consumed."

In other experiments at Göttingen, by T. Pfeiffer and Lehmann, (1) a similar result was obtained with a sheep fed with a considerable quantity of sugar.

In an experiment made by Wolff, at Hohenheim, (2) a young pig was fed for one hundred and eight days with barley and maize meal, with the addition of pure starch. The constituents digested were determined. Referring to the results, Wolff says that, having regard simply to the amounts of constituents consumed, and of increase produced, it is scarcely possible to suppose that the quantity of fat which must have been stored up could have been formed without the cooperation of the carbohydrates. He points out that fat equal to only 29 per cent of the increase in live weight could have been produced from the fat and the albumin of the food, and in this calculation he takes the whole of the albumin as available, without reckoning any to have been stored up. He adds that, according to the percentage of fat in increase in the Rothamsted experiment No. 1, there must have been 60 per cent or more. According to our own calculation of Wolff's results it seems probable that about 60 per cent of the total fat in the increase must have been derived from carbohydrates. It is particularly to be observed that, in the case of this experiment, Wolff concluded that the formation of fat from the carbohydrates might be considered established, not only without any respiration apparatus, but even without any direct determination of fat in the animal.

Wolff quotes the results of experiments with pigs at Moscow, by Tschirwinsky, in 1880-81 and in 1881-82. (3) It was estimated that in the one case 61.6 per cent, and in the other 76.9 per cent, of the fat of the increase must have had its source in the carbohydrates of the food.

In an experiment made with a pig at Vienna by Meissl and Strohmer, (4) it was estimated that 82.2 per cent of the stored-up fat must have been derived from the carbohydrates consumed.

At Broskau, Weiske and B. Schulze, (5) made experiments with geese; and they concluded that in one case 13 per cent and in the other 17.6 per cent of the stored-up fat must have been derived from carbohydrates.

At Peterhof, near Riga, Chaniewski, (5) experimented with geese; and from the results concluded that in one case 71.1 per cent, in another 78.6 per cent, and in a third 86.7 per cent of the

(1) Ztschr. Biol., 1869, p. 113.

(2) Die Versuchs-Stationen Hohenheim, Berlin, 1870, p. 50; also M. Fleischer in Virchow's Arch. Path. Anat., Band 51, 1870.

(3) Versuchs-Stationen, 1869, vol. 12. p. 451.

(4) Jour. Landw., Jahrg. 26, p. 549.

(1) Jour. Landw., 1885, vol. 23, p. 337; also, 1886, vol. 34, p. 83.

(2) Die rationelle Fütterung der landwirtschaftlichen Nutztiere, 5te Aufl., 1888, p. 48.

(3) Versuchs-Stationen, 1883, Band 29. p. 317.

(4) Ber. Acad. Wissensch. Wien, 1883, Band 88, Part III.

(5) Die rationelle Fütterung der landwirtschaftlichen Nutztiere, 5te Aufl., 1888, p. 50.

(5) Die rationelle Fütterung der landwirtschaftlichen Nutztiere, 5te Aufl., 1888, p. 50.