a small fraction of the coming demand. If, as has been urged, the exhaustless stores of the atmosphere are not available to plants, the outlook is dark enough; but if the farmer may use his crops to gather it, without money and without price, we may dismiss our solicitude. With the assurance that plants obtain nitrogen from the air, the fear of starvation for the over-populated earth of the future may be ignored. That research is bringing the brighter answer to this problem, there seems to be most excellent ground to hope.

WARM AND COLD WATER FOR MILCH COWS IN WINTER.

WHETHER or not it is desirable in Wisconsin to warm water for domestic animals, has been experimented upon by F. H. King at the Agricultural Experiment Station at Madison.

On the night of Jan. 21, 1889, six cows were placed in stanchions side by side, in two groups of three each, upon a daily ration of five pounds of bran mixed with two pounds of ground oats and six pounds of hay, together with what dry cut corn-fodder they would eat up clean; and this ration was not changed until after the close of the experiment, March 25. During this time the cows were fed twice and watered once daily. They were allowed the freedom of the barnyard during the middle of each pleasant day, and in every way received similar treatment, except that, when one group of cows was getting water at 32° F., the other group took it at 70° F. The time of the experiment was divided into three periods of sixteen days each, having intervals between them. At the close of the first and second periods the temperatures of the water were reversed for each of the cows in order to eliminate, so far as might be, the individual differences of the two groups.

In plan this experiment contemplated as its chief object ascertaining whether it is true, as many farmers believe, that warm water for milch cows produces a measurable increase in the yield of milk over that of cold water, and, if so, whether this increase affected the volume simply, or the weight of the solids contained, to an extent which would make it remunerative in general practice to warm the water for cows.

The discussion of the results obtained has shown for these six cows, while under experiment, the following facts: —

1. While on warm water, they gave, on the average, 1.002 pounds of milk per cow per day more than while on cold water, or 6.23 per cent of the general average daily yield of 16.06 pounds.

2. They drank on the average, daily, while on cold water, 63 pounds; but while on warm, 73 pounds, or 10 pounds per cow more.

3. They ate more while on warm water than while on cold, and at the rate of .74 of a pound of corn-fodder per cow per day.

4. An increase in the amount of water drank was coincident with an increase in the quantity of milk given; and this was true irrespective of whether the water was warm or cold, an increase of 10 pounds in every 100 pounds of water drank being accompanied by an increase of 1 pound in every 100 pounds of milk given, nearly.

5. They consumed solid food, while on warm water, at the rate of 1.44 pounds for each pound of milk produced; and while on cold water, at the rate of 1.54 pounds for each pound of milk given.

6. An increase in the amount of water drank, when the temperature of the water remained the same, was associated with an increase in the amount of water in the milk without a notable increase in the total solids contained.

7. An increase in the temperature of the water drank, rather than an increase in the quantity of it, was associated with an increase in the total amount of solids produced.

8. There was a daily fluctuation in the percentage of water in the milk associated with a fluctuation in the amount of water drank.

9. Five cows manifested a strong preference for water at 70° over that of 32°, but one of the cows showed an even stronger liking for the iced water.

10. With but one exception, the cows, while they ate less and drank less during the cold-water periods, weighed more at their close, and, with but three exceptions, they weighed less at the close of the warm-water periods.

11. With butter at 20 cents per pound, skimmed milk at 25 cents per hundredweight, corn-fodder at $5 per ton, and the cost of warming water for forty cows 120 days at $15, the results obtained from the cows on the experiment indicate that a net gain of $21.36 would be realized on a herd of forty cows averaging sixteen pounds of milk per cow per day, and at least $10 on a herd of twenty, and $5 on a herd of ten cows. Counting corn-fodder at $10 per ton, the net gain on a herd of forty cows would still be $12.48.

THE ETHNOLOGICAL SIGNIFICANCE OF THE BEECH.

THE new science of linguistic paleontology has thrown a flood of light on several obscure problems of ethnology. It has, for instance, been proved that the names of the ass and the camel in Aryan languages are not primitive, but merely loan-words from the Semitic. This fact by itself goes far to disprove the hypothesis which placed the cradle of the Aryans in Central Asia, a region of which these animals are natives.

According to an article on the above subject by Canon Isaac Taylor, published in a recent number of *Knowledge*, in no case have more valuable results been obtained than in the case of the beech. This tree, which flourishes only in temperate climates, and is a lover of chalk subsoils, is confined to a definite and restricted area. It grows in the extreme south of Norway and Sweden, but is not found east of a line which strikes across Europe from the Frische Haff on the Baltic coast, near Königsberg, through Poland to the Crimea, ending finally in the Caucasus.

In former times the limit was more narrowly restricted. In Cæsar's time the beech had not reached Britain or Holland, while at the close of the bronze age, or the beginning of the iron age, it was only just beginning to replace the oak in Denmark. Early in the neolithic age its range was probably confined to France, northern Italy, and northern Greece; while in Germany, as Dr. Schrader believes, it did not extend north of the Thuringian forest. It flourishes in Macedonia, and clothes the north-eastern slopes of the Thessalian coast chain, while in the south of Epirus the ilex or evergreen oak replaces it as the characteristic forest-tree.

Within these ancient limits of the beech we must place the cradle of four Aryan languages, — German, Latin, Celtic, and Greek. We draw this conclusion from the following philological facts: the word for beech is, in Gothoic, *boka;* in Latin, *fagus;* in Celtic, *faidhbhile;* while the corresponding word, φηγός, denotes the oak in Greek.

With regard to other members of the Aryan family, the names for the beech — *buky* in old Slavonic, *bukas* in Lithuanian, and *buk* in Russian — are manifestly loan-words from the German. This would go to prove that the Slavs, in the prehistoric period, must have dwelt east of the beech line, though they have since advanced within it. Johannes Schmidt has shown reason for believing in the unbroken geographical continuity of the European Aryans, previous to the linguistic separation: hence they must be placed astride, so to speak, of the beech line, — the Slavs and Lithuanians in European Russia; and the Celts, Latins, Hellenes, and Teutons, farther to the west.

We have now to account for the fact that the word denoting the beech in Latin, German, and Celtic, has come in Greek to denote, not the beech, but the oak. A well-known explanation of the difficulty has been offered by Professor Max Müller in the second series of his lectures. He contends that the word originally denoted the oak, but that it was transferred to the beech at the time when the oak-forests of Jutland were replaced by beech-forests. But this does not account for the fact that the Latin word *fagus* means the beech, for Helbig has shown that the Umbrians had already reached Italy before the commencement of the age of bronze. The bronze age began in Italy earlier than in Denmark, and in the bronze age the oak was still the prevailing tree in Denmark, and was quite unknown in the neolithic age, when the Umbrians, whose language was a dialect of Latin, were already settled in Italy. The word *fagus*, therefore, must have denoted the beech in Latin at a period prior to the change in the forest-growth to

which Professor Max Müller attributes the alteration in the meaning of the word.

Moreover, a great change in the vegetation of a country, such as the replacement of the Danish oak-forests by forests of beech, must have occupied many centuries. At what moment, then, was the name transferred from one tree to the other? Were the people of Denmark content to have no name for the beech when it first appeared, and what did they call the oak after having deprived it of its original title, in the prolonged period during which the two trees must have been growing side by side?

Another hypothesis, less beset with difficulties, has been advanced by Geiger and Fick, who suppose that the word originally signified the beech, and received among the Greeks the changed signification of the oak. If the Greeks had migrated from a land of beeches to a land of oaks, there is no difficulty in understanding that they may have transferred the name of one tree to the other. The word meaning the food-tree (*φαγ ἴν*, "to eat") would be as applicable to the evergreen oak, with its acorns, as to the beech, the mast of which was the staple food for their swine. The beech, as has been said, is not found south of Dodona, which lies in the centre of Epirus. It is noticeable that the most ancient Greek legends are connected with Dodona, where the Greeks made their first halt in their progress to the south, and where the earliest prophetic utterances were obtained from the rustling of the leaves of the sacred tree, — the *φηγὸς*. Hence we may believe that the Greeks entered the peninsula, not from Asia Minor, but from the northwest, through the valleys of Epirus. This route would explain how the old Aryan word denoting the beech came to be applied by the immigrants to designate the tree which flourished on the hillslopes of their new territory. In modern times we have similar instances of transferred names in the United States, where such English names as "the robin," "the hemlock," and "the maple" are used to denote wholly different species.

But with regard to the Greeks, it may be urged that before they entered the peninsula they must have been already acquainted with the deciduous oak which flourishes in the region whence they emigrated. This objection is met by the fact that the Greeks had a second name for the oak, *δρῦς*, which corresponds to the old Irish *daur* oak, as well as to the Gothic *triu*, and the Sanscrit *dru*, which mean simply a tree. Both of the Greek words for the oak are used by Sophocles in speaking of the sacred oak at Dodona.

The Greek word for the deciduous oak agrees with the Celtic word, while the Greek word for the evergreen oak was the word which in their former home had denoted the beech.

The question as to whether the original Aryan word denoted the beech or the oak is not unimportant, as from it may be drawn an inference as to the primitive seat of the Aryan race.

According to Professor Max Müller, the Aryans migrated from Central Asia, where the beech is unknown. If this had been the case, it is extremely difficult to explain how the ancestors of the Latins, Celts, and Teutons, migrating, as Pictet maintains, at different times and by different routes, to lands where the beech abounds, should all have chanced to call it by the same primitive name, merely modified according to the fundamental phonetic laws of Latin and German. But, on the other hand, all such difficulties disappear if we assume that the cradle of the Aryans was in the original beech region; that is, roughly speaking, in the valleys of the Rhine, the Main, and the Danube; and that it was here that the differentiation of the Greek, Latin, Celtic, and German languages took place.

The name of the beech bears also on the solution of the question as to which of the neolithic races has the best claim to represent the primitive Aryans. The choice probably lies between the brachycephalic Celto-Latin race, some of whose earliest settlements may be discovered in the pile-dwellings of Bavaria, Switzerland, and northern Italy, and the dolichocephalic Scandinavian race, whose remains are found in the Danish kitchen-middens. That one of these races constituted the primitive Aryan race, and imposed its language on the other, is highly probable.

Now, as we have already seen, in the neolithic age the beech had not yet reached Denmark, the fir being at that time the predominant tree. In the bronze age the fir was succeeded by the oak, which gave place in the iron period to the beech: hence the beech region was at that time inhabited by the Celto-Latin people, while the Scandinavian race in all probability dwelt to the north of its limit.

The beech has therefore a threefold ethnological significance. 1. It proves that the Greeks entered Hellas from the north, probably through Epirus, and not, as has been contended, from Asia Minor. 2. It proves that the differentiation of the Aryan languages took place not in Asia, but in Central Europe, on either side of the beech line; the Slavs and Lithuanians being to the east of it, the Greeks, Celts, and Latins, farther to the west. 3. It makes it probable that the primitive Aryans belonged to the brachycephalic Celto-Latin race, and not the dolichocephalic Scandinavians.

ENGLAND'S COAL-RESOURCES.

A PAPER on this subject was read by Professor Edward Hull at the recent meeting of the British Association. To at once set at rest any alarm that may be felt as to Professor Hull unfurling the old banner of "Exhaustion of English Coal-Fields," *Engineering* states that he estimates there is enough coal in Northumberland and Durham to last, at the present rate of consumption, for three hundred years; supposing, of course, one goes deep enough for it. Before that period has elapsed, however, it is to be hoped, on behalf of posterity, that the petroleum-engine, the sun-motor, or some other force, will have promoted steam and gas engines to the serener atmosphere of the antiquarian museum.

Professor Hull is the director of the Geological Survey in Ireland, and he naturally turns to coal as a refreshing subject, which has not become hackneyed to him by his official labors. By a diagram shown on the walls, the output of coal since the beginning of the century was given. The figures have often been quoted, but may be given once again in brief. In the year 1800 the output of coal probably did not exceed 10,000,000 tons, a very large proportion of which was drawn from the Newcastle district. In the year 1830 the quantity raised in the British Islands was about 29,000,000 tons, it 1860 it had reached 80,042,698, and in 1888 the quantity had reached about 170,000,000 tons, as shown by the returns issued by the Board of Trade. There was reason for believing that between the beginning of the century and the year 1875 the output of coal had more than doubled itself for each successive quarter of a century. Since the year 1860, in which the author had estimated that sufficient coal existed to a limiting depth of 4,000 feet to last, at the rate of production for that year, for one thousand years, the available quantity of coal had been reduced by 3,650,000,000 tons; but this amount, great as it was, had not very materially affected the coal-resources. The production of the South Wales coal-field had doubled in the quarter of a century between 1854 and 1879, and in 1888 amounted to the enormous total of 27,355,000 tons, largely owing to the demand for steam-coal in the Cardiff district. The resources of this great basin are enormous, and render it capable of maintaining or increasing its present output for a long period of years. The Lancashire and Cheshire and the great Yorkshire and Nottingham coal-fields are highly progressive, as is also the Northumberland and Durham. This great northern coal-field, notwithstanding the long period over which it has been worked, shows no signs of falling off in its output. The discovery of the liassic ironstone of the Cleveland district, and the great exports from the northern ports, have given a vast impetus to northern coal-mining during the last quarter of a century; and the enormous drain upon this coal-field, the limits of which have been definitely determined, cannot fail to cause a serious falling-off in its output during the twentieth century, although there is sufficient to maintain the present rate of consumption for three hundred years. The relation between coal-production and the development of the iron trade since the discovery of the ironstone deposits of the North Riding of Yorkshire, and the richer hematites of North Lancashire and Cumberland, was then considered; and the different coal-fields of the British Isles were passed in review in order to show those which are in a progressive condition, and which are stationary or retrogressive. The author concluded his subject by expressing an opinion, that, while the enormous output of coal during the past few years had not actually crippled England's resources, a general rise in the value of coal must ensue in the near future, owing to