not being sent in in time. We hope there will be no excuses this year on the score of ignorance or otherwise, as the Board must necessarily deal strictly with dilatory societies, in justice to punctual ones.]

ON THE USE OF BONES IN AGRICULTURE.

FIRST ARTICLE.

The peopling of the world by two classes of antagonistic organisms—plants and animals—is one of the most beautiful arrangements in nature, and gives rise to some of the most important phenomena with which the philosopher has to deal. The distributions of plants and of animals over the globe follow nearly the same law; it is only in rare and exceptional cases where they are not associated together, for they not only both depend upon similar conditions of soil and climate, but they insensibly minister to each others wants. The animal in every breath exhales a gas—carbonic acid—not only unsuitable for being again taken into the lungs, but highly poisonous, so that the very act of life vitiates the atmosphere and tends to extinguish all animal life; the plant, animate but insensate thing, is ready with its thousand mouths on each of its thousand leaves to inhale the vitiated air, abstract the carbon for the building up of its own wooden frame work, and give back the (to it useless) oxygen to purify the atmosphere and render it wholesome to the animal creation. Could anything be more beautiful than this? each playing its harmonious part on the stage of organic life, so as to serve its own and its neighbour's ends.

When it is considered, says Liebig, that every constituent of the body of man and animals is derived from plants, and that not a single element is generated by the vital principle, it is evident that all the inorganic constituents of the animal organism must be regarded, in some respect or other, as manure. "During life the inorganic components of plants which are not required by the animal system, are disengaged from the organism in the form of excrements. After death the nitrogen and carbon pass into the atmosphere as ammonia and carbonic acid, the products of their putrefaction, and at last nothing remains except the phosphate of lime and other salts in their bones. Now this earthy residue of the putrefaction of animals must be considered, in a rational system of agriculture, as a powerful manure for plants, because that which has been abstracted from a soil for a series of years must be restored to it, if the land is to be kept in a permanent condition of fertility."* In practical agriculture the necessity of returning to the soil what is taken from it, and more, is fully recognized; and as farm produce is chiefly converted one way or other, into animal food, the matters are usually returned in the form of animal excreta or animal remains. The former, consisting of the matter not assimilated by the animal, is of course greatly inferior as plant-food to the latter, which consists of the substances actually acquired by animals from the plants eaten as food. The powerful nature of animal manures is known to every farmer. All animal substances may be turned to good account, hair, woolen rags, &c.; and the luxuriance of a potato or a turnip plant growing beside an old shoe, or a vine flourishing over a stray bone are familiar examples of the striking effects of this class of substances. The florist, in the culture of his geraniums, can find *no* substance more highly suitable for encouraging them to rapid growth than the parings of horses' hoofs.

These facts indicate in some measure the reason why bones, fossil and recent, and in many forms, have become of such extensive utility as manurial agents.—Bone forms the principal waste substance in animals whose flesh is used as food, and is that whose decomposition goes on most slowly; and it is thus conveniently obtainable in sufficient quantities to return to the soil the elements which were taken therefrom for its construction. "It is forty or fifty years," says Dr. Johnston, "since bones began to be introduced in large quantities into Britain from the Continent, and especially from the north of Europe. They have since been constantly growing in repute as a manure, and large tracts of our high lands have been almost dependent upon them for the means of profitable cultivation. The vast importations of guano have scarcely checked the demand for them, and there is no question, I think, that their use will hereafter receive a very large development."

Bones vary in chemical composition in different animals, at different ages of the same animal, and according to the part of the body from which they are taken. They consist of two, organic and inorganic, parts; when bones are burned, the gelatine or animal matter (which forms the organic part) disappears,—the ash consisting of white *bone earth*, which is the inorganic part alone remaining. Much discussion has taken place as to whether the organic part of bones gave them value as a manure, or whether it was not entirely by their inorganic parts that they acted; but it may now be fairly assumed that both have a share in the manurial action. The following table is given by Agassiz and Gould as indicating the chemical constitution of the inorganic constituents of bone in the four classes of animals:—

ANALYSES OF BONES.

	Hawk. (Bird.)	Man. (Mammal)	Tortoise. (Reptile.)	Cod. (Fish.)
Phos. of Lime with a trace of Fluate	64.39	59.63	52.66	57.29
Carbonate of Lime...	7 03	7.33	12.53	4.90
Phos. of Magnesia .	0.94	1.32	0.82	2.40
Sulphate and Carbon. of Soda, & Chloride of Sodium	0 92	0.69	0.90	1.10
Glutin and *Chondrin.*	25.73	29.70	31.75	32.31
Oil	0.99	1.33	1.34	2.00
	100.	100.	100.	100.

The following composition of the inorganic parts of the bones of the cow is given by Johnston as representing very nearly that of the bones which are usually applied to the land:—

Organic Animal matter (gelatine)....	33¼
Phosphate of Lime.....	55¼
Phosphate of Magnesia.....	3
Carbonate of Lime.....	3¼
Soda and Common Salt.....	3¼
Chloride of Calcium	1
	100

There is a striking analogy in composition between bones and guano, which is, for other reasons, interesting to the practical man, but is especially important in connection with the object of the present paper. The following table exhibits the composition of bones compared with the average composition of good guano, supposing both in the dry state. Bones, as they are applied to the land, contain about 18 per cent. of water, Ichaboe guano from 20 to 25 per cent.:

	Bones.	Guano.
Organic Animal Matter.....	33	56
Phos. of Lime and Magnesia.	59	26
Carbonate of Lime.....	4	6
Salts of Soda.....	4	10
Salts of Potash.....	trace	trace
Silicious Matter.....		2
	100	100

"If we compare these two columns, we see that bones and guano contain essentially the same things. There is an organic part in both; both contain a large per centage of phosphates; and there are salts of soda and a trace of potash in both. But they differ in the proportions in which these several constituents are present. Thus—

"*a* The organic matter is in larger proportion in the guano. It is to be observed, however, that this organic matter is in the guano in a very decomposed state. It consists of salts, (oxalates, carbonates, &c.) of ammonia mixed with dark-coloured matter, (humic acid,) and water of crystalliation. In the Ichaboe guano, the ammonia rarely exceeds six or eight per cent. of the whole weight. But this proportion of ammonia we have seen that the gelatine of the bones will produce when it undergoes complete decomposition. On the whole, therefore, I am inclined to think that the organic matter in a cwt. of bones is nearly of equal value

* Liebig, Organic Chemistry, pp. 174-5.