

Letters to the Editor.

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A Relation between the Radial Velocities of Spiral Nebulae and the Velocity of Dissolution of Matter.

ACCORDING to a fundamental formula of Einstein's cosmological theory of gravitation, the total mass of the universe, M , is connected with the radius of curvature of the universe, R , by the formula

$$(1) \quad M = \frac{c^2 \pi}{2f} R.$$

In this equation c denotes the velocity of light and f the constant of gravitation.

If we regard the size of the universe as variable, and if we denote by a the 'disintegration constant' of matter and by v that 'cosmic velocity' which represents the differential coefficient of R with respect to time, we obtain from equation (1):

$$(2) \quad M a = \frac{c^2 \pi}{2f} v.$$

As is well known, a is equal to the mass equivalent of 2 ergs per gram-second in the case of the sun. The average value for all fixed stars undoubtedly agrees in order of magnitude with that value. Hence, approximately,

$$(3) \quad v = \frac{4f}{\pi c^4} M = 1.1 \times 10^{-49} M.$$

If we insert for M , according to Hubble (*Astrophys. Jour.*, 64, p. 369; 1926), 1.8×10^{57} gm., equation (3) yields for v a value of about 2×10^8 cm. or 2000 km. per second. This value agrees well with the magnitude of the velocity with which the farthest spiral nebulae appear to recede from us.

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Animal Husbandry.

THE term 'animal husbandry' is gradually becoming more employed by both administrators and scientists concerned with the live stock industry. That it is differently employed by different speakers is the apology for what follows.

The aim of the science of animal husbandry is the efficient production of farm live stock: it deals with the application of those basic sciences which affect the production and maturation of our farm live stock. The principal sciences from which it derives are genetics, nutrition, animal health, economics, and physiology, both reproductive and nutritional. These basal sciences seek to discern fundamental principles by the formation of hypotheses, which as evidence accumulates become theories, and eventually on final proof take their place as laws. In their turn these sciences draw on others.

The science of animal husbandry does more than apply the sciences from which it derives: it coordinates them. The real function of the scientific animal husbandman consists, not in the direct application of new knowledge or the mere testing upon a

large scale of such hypotheses as its basal sciences may bring forth, but in the relation of new facts to existing circumstances. This implies that animal husbandry is not merely an applied science: it can evolve new techniques and can prosecute research.

Just as other sciences have various aspects, so has the science of animal husbandry. In a certain aspect one of its basal sciences may predominate. The science of animal husbandry in relation to a particular science applies that particular science to practice and at the same time takes into consideration the other basal sciences which affect the problem under consideration.

In Great Britain there is no school of scientific animal husbandry as such. Consequently this science has been largely developed by those institutes connected with agriculture which are concerned with research into the basal sciences, particularly genetics, nutrition, and physiology. Each kind of institute has, to a greater or less degree, developed animal husbandry. For example, there is the science of animal husbandry based upon the science of nutrition; the science of nutrition alone can make little contribution to the material welfare of mankind through live stock without taking into consideration the other basal sciences. Thus there are developed animal husbandmen who are primarily nutritionists but who also must have a sufficient understanding of the principles and findings of the other sciences to enable them to coordinate the work with which they are mainly identified. In the same way, there are animal husbandmen who are primarily either veterinarians or geneticists.

At the present time it is open to question whether the industry of agriculture can profit more from the new scientific discoveries which one may reasonably anticipate will be made by the research workers in the basal sciences or from an intelligent and coordinated application of that knowledge which is already available. Hitherto greater emphasis has been laid on the value of fundamental researches: and rightly so, since these are an absolute prerequisite to the proper functioning of the science of husbandry. It can, however, be fairly debated whether the time is not now ripe for an organised development of the science of husbandry. But whether this should be directed as a separate entity seems doubtful. Since its inspiration is drawn from the research institutes, separation would possibly sterilise it.

It would appear better were the science of animal husbandry to continue to be based on the various research institutes, but that the dissemination of results should be made, not through the existing county organisers (who have such a wide field to cover that they can be expert in no one subject without some sacrifice in another), but through advisory animal husbandmen, each operating in an area. These men would have no administrative duties. Their function would be to maintain contact with the various research institutes (they could, in fact, have their headquarters at one of these) and to apply the results of the animal husbandry sections of the various research institutes to the particular problems of their area. Such animal husbandmen would specialise in different aspects, such as pigs, horses, dairy cattle, etc. They would at the same time act as *rapporteurs* to the animal husbandry section of the research institute on which they are based. Undoubtedly there is a weak link in the chain which connects scientific research designed for the assistance of agriculture to the practice of farming. A recognition that animal husbandry exists as a science would do much to strengthen this link.

A precise definition cannot be confined to a few words. Briefly, animal husbandry may be defined as