what larger than that of the anthropoid apes of to-day, but the evidence of the Sterkfontein fossils evidently does not permit a firm statement on this point. On the other hand, the more recent discoveries by Dr. Broom of larger Australopithecine skulls at Swartkrans (photographs of which were also exhibited at the International Anatomical Congress) have raised anew the possibility that the size of the brain extended its range beyond that recorded for the gorilla and chimpanzee, and perhaps even came within the range of primitive hominids of the *Pithecanthropus* group.

W. E. Le Gros Clark

QUALITY IN GRASSLAND

A DISCUSSION on "Quality in Grassland" in Section M (Agriculture) of the British Association, held on August 31 during the Birmingham meeting of the Association, was opened by Dr. William Davies, director of the Grassland Research Station, Stratford-on-Avon. His remarks were followed by a short paper presented by Dr. D. H. Curnow, of the Courtauld Institute of Biochemistry, London, who dealt with œstrogens in grassland.

Dr. Davies suggested that rather than speak of quality in the singular, we should speak in the plural and discuss the 'qualities' of grass much as we speak of 'qualities' in man. Although most people have a working knowledge of what is meant by quality or qualities, it is, however, extremely difficult to provide a clear and concise definition of either quality or qualities. Among the qualities of grass and of grassland which were discussed were, first, the production of nutrients spread over as long a season of the year as possible; and the point was made that we here deal with quality as it is affected by high production of freely available nutrients. Because of the concentration of digestible nutrients in the leaf, it is clear that one of the first qualities of good grassland is that it is leafy as well as being at high production over a prolonged season of the year. Young actively growing leaf is of better quality than leafage of slower growth, while it may be shown that leaf tip is of better quality than leaf base. Actively growing leafage is usually of better quality than old and mature leafage. Leaf lamina has qualities that are superior to leaf sheath (in the grasses) or petiole. Stem even when immature is of lower quality than leaf.

Evidence from current researches being conducted at the Grassland Research Station and elsewhere in Great Britain shows that herbage can be produced for consumption *in situ*, even in the middle of winter. It is becoming clear, however, that winter grass has qualities which are distinctly different from those of spring-grown grass. These differences may be associated with the high fibre content of winter grass and with a lower energy-value than similar grass grown in spring. The nitrogen content of leaf lamina in winter is frequently higher than in summer. The feeding of pasturage *in situ* during the winter, therefore, may mean that, in the case of the high-production animal, in any event, carbohydrate of low fibre and of high energy-value might well be the sensible supplement. Indeed, there is some evidence to suggest that a carbohydrate supplement might be sensible, even at the height of spring flush.

Grass, using the term as embracing the legume and the herb, as well as the true grasses, is the cheapest and probably the healthiest form of animal feeding-stuff, particularly when grazed *in situ* by the animal itself. The farmer, therefore, is intensely interested in any technique which is practicable and will extend his grazing season. Grazing out of doors during the wet and inclement weather of winter clearly creates new problems for the farmer, but none of these seems to be insoluble. The work of the grassland technician is to examine critically the practical problems associated with the utilization of grass grazed *in situ* during the winter to provide the practising farmer with a technique both of production and of utilization of winter grass.

It is by no means certain that fibre content, energy value and nitrogen-level in the dry matter are the only distinctive differences between summer and winter grasses. Future investigation may indicate other differences, such as, for example, in œstrogen content or in the content of vitamin precursors, mineral value, and so on. There is here a wide and largely uncharted field of study, not only for the agronomist and animal husbandryman, but also for the biochemist and veterinarian.

It is a fairly simple observation that as grass, in its widest context, matures, so its quality deteriorates. Every herbaceous plant goes through a period of maturation from the time it starts growth in spring to the time when it has produced flower and seed. During this period the plant increases in dry weight but decreases in quality as measured by its nitrogen content (which gets lower) and its fibre content (which gets progressively higher). The farmer attempts to prevent this maturation taking its normal course when he grazes his grassland and maintains it in a leafy condition for as long as possible.

The ruminant animal is the largest aggregate consumer of the grass crop. It is abundantly clear that the animal at high production demands grass of high quality. Grass, however, may not be the perfect food for animals at a high level of production, for it may well show deficiencies such as those to be associated with straightforward lack of energy-value. The ruminant animal, however, can deal efficiently with leafage which may have a fibre content of 17 per cent or more. The non-ruminant, on the other hand, such as the pig and the hen, may well be found to show ability to utilize the grass crop. To do this effectively, and for grass to be a major element in its diet, we must provide herbage not only of high nitrogen content and of high energy-value but also especially herbage of low fibre-content. Here we must set the problem not only to the agronomist but to the plant breeder also. It should be possible for the plant breeder to select herbages in which the fibre content of the leaf lamina is as low as 10 per cent of the dry matter, and we should aim at material of even lower fibre content.

Another aspect of quality in the grass crop is that relating to mineral content. We know from the pioneer work of Prof. T. W. Fagan and others that many of the herbs of our pastures are extremely rich in minerals, especially calcium, phosphoric acid and potash. There may be other good attributes in the herbs when compared with the more normal grasses and clovers of Britain. For example, many of the herbs are sought after by the grazing animal, and further, what is true of the major elements mentioned may also be true of the trace elements. In this field, however, there is a great lack of critical evidence in so far as it relates to British herbage plants.

One of the qualities of the grass/legume sward is that it seems to improve soil condition and is acknowledged to increase the fertility of the soil, or at least to promote some benefit whereby arable crops in the rotation become more thrifty and more productive. Here again there seems to be an extraordinary lack of sound experimental evidence. We can infer, however, with some degree of confidence that the farmer who has been able to introduce the long ley into his farming system achieves a soil which works easier and better, and he raises the general level of his crop yields. One of the good qualities to be looked for in the grass crop, therefore, is abundant root development, which in turn fosters an improvement in soil condition and in level of crop production. Much work is urgently required in this connexion, not only in the agronomic field but also in associated fields of scientific endeavour. We need to know, for example, the influence not only of different grasses, legumes and herbs upon soil fertility, but also the influence of different systems of management of the grass crop and the part they play in building up the soil. Similarly, what is the long-term influence of different mineral products upon the soil, as well as upon the crops that are grown ?

No discussion on quality in grassland would be complete without reference to the qualities of the accepted fattening grassland of the Midlands and elsewhere in Great Britain. What is the fundamental difference between the so-called fattening and non-fattening land ? Clearly, any land is capable of fattening a bullock if that bullock can be maintained at a uniform level and reasonably high plane of nutrition throughout its fattening period. In the case of fattening land, the accepted practice is to turn the cattle beast out to grass in April and, without any purposeful management, that animal may be expected to be fat soon after midsummer almost irrespective of weather or season. In the case of non-fattening land, however, to achieve the same result in the fattened animal, one needs to plan the grazing in such a way that the animal is moved from pasture to pasture and assured of an abundance of high-quality feed which will maintain the animal at a high level of nutrition. From the scientific point of view, therefore, the distinction between fattening and non-fattening land is not a fundamental one and is in no way absolute. If the fattening animal is kept at a constant high plane of nutrition during the whole of its fattening period, then it should be possible to fatten on any land in Great Britain.

Dr. Curnow's paper on the œstrogens of grass was extremely informative. There is here clearly an important field of study which may have wide practical consequences. The technique of isolating the various œstrogenic compounds, and of relating each of them to the animal and its nutrition, remains to be worked out in detail. The observed facts are that, in Western Australia for example, excessive œstrogen occurring in a diet largely based on subterranean clover produced serious ill-effects in sheep of both sexes. Investigations in progress have shown that œstrogenic compounds are commonly found in a range of the native herbage of Great Britain, although normally not to the extent found in Western Australia. So far, little or no ill-effects have been observed in Britain, but work at the Courtauld Institute in London and at the National Institute for Research in Dairying at Reading is clearly important and aims in part at determining the role of the œstrogens in animal nutrition.

In the lively discussion which took place after the opening papers, Sir James Scott Watson indicated the practical difficulties of breeding in both the cow and the ewe so as to make use of the greater production which we can now expect from the grasslands of the world. This is a point of enormous importance, as it refers not only to our potential in lowland districts, but also to the problem of hill and marginal land. Dr. Norman Wright indicated, however, that the need for more production from grassland in Britain is immediate, if only to reduce our annual requirements of imported feeding stuffs. If properly utilized, grasslands in Britain can provide the bulk, if not the whole, of our protein requirements for cattle foods ; although we might have to import a certain proportion of low-fibre carbohydrates. Colonel J. A. Symon raised the important question of winter grass, and indicated that the problem on the farm is always to balance any extra summer carrying-capacity by an adequacy of good winter feed. Dr. R. E. Slade suggested that our level of manuring in general practice is not nearly high enough, and that with an improvement in our manurial practice and an increase in the amount of plant foods applied to the soil our grasslands would produce not only more dry matter per acre, but also more leaf, and leaf of better quality. He drew the important distinction between leaf protein and seed protein. Prof. H. D. Kay (president of Section M) closed the discussion by indicating that the animal protein factor might still prove a very important one, although speakers had suggested that a factor biologically equivalent to the animal protein factor may well be present in the leaf of high-quality herbage. WILLIAM DAVIES

PLANETARY ATMOSPHERES

A GEOPHYSICAL Discussion was held under the auspices of the Royal Astronomical Society during its recent visit to Dublin. Prof. L. W. Pollak, of the Dublin Institute for Advanced Studies, presided, and the general subject considered was "Planetary Atmospheres", although, as will be seen, no very strict limitation to the problems discussed was really observed. Prof. Pollak, in his opening remarks, directed attention to the fact that the occasion was perhaps a historic one, since it was, so far as he knew, the first time a meeting of this nature had been held in Dublin.

As a preliminary to the main discussion, Mr. R. Naismith, of the Radio Research Station, Slough, showed a research film entitled "The Ionosphere". The film illustrated the short-period changes in the heights and degrees of ionization of the various ionospheric layers, and showed clearly the great advantage of this method of presentation of scientific data in giving a coherent picture of comparatively slowly fluctuating phenomena.

The discussion proper was opened by Prof. J. H. J. Poole, who spoke on the origin of free oxygen in the earth's atmosphere. Prior to 1924, Jeffreys suggested that the constituents of the primitive atmosphere, including all the water of the hydrosphere, were originally held in solution in the once liquid earth, and only emitted to form an atmosphere during the