

off at one or other of the bars, showing these to be places of weakness.

The extent of the barring varies much on different birds and according to locality and season. Sometimes all the wing, tail, and covert feathers are affected, while in others only a few plumes exhibit the imperfection. Again, the number of bars on different feathers varies greatly; frequently they occur at fairly regular intervals along the entire length of the feather, or only a few are present and the rest of the feather is perfect. Where the barring is close, a single barb will be irregular at five or six places along its length. The deficiency can be overcome to a large degree by juxtaposition in the process of "dressing" before the feathers are retailed, but buyers estimate that, as a result of the presence of the bars, the value of the feather to the farmer is frequently diminished from 20 per cent. to 50 per cent., probably an average of about 25 per cent. As the trouble is very general over all the ostrich-farming districts in South Africa, it is manifest that the subject is one which calls for thorough scientific investigation.

The development of the ostrich feather has not yet been

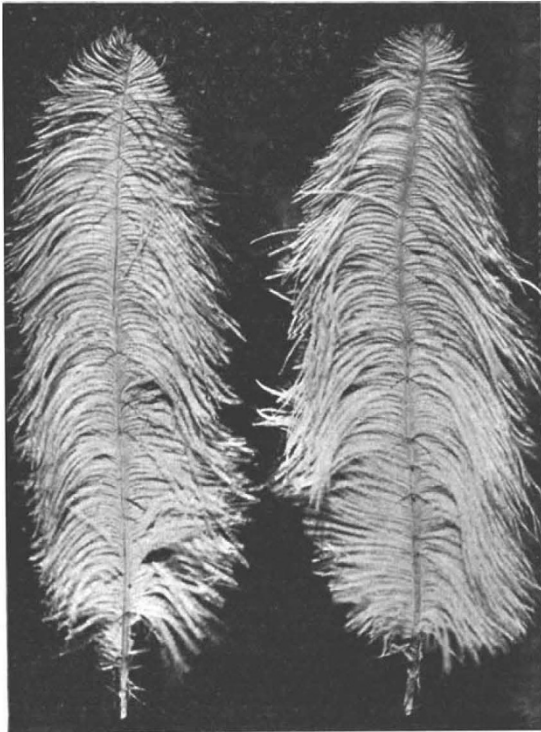


FIG. 1.—Ostrich feathers showing barring.

worked out, but from our knowledge of that of feathers generally there can be no question that the barring represents some interference with the normal growth of the plume at an early stage, an interference which prevents the proper differentiation later of the feather into rachis, barbs, and barbules; moreover, these must recur from time to time during the growth of the feather. As to the cause, the evidence mainly points to impaired nutrition of the feather germ during its early stages. Farmers universally acknowledge that an insufficiency of food during the time the feathers are forming, as from a drought, will result in a plucking full of barrings, breakages, and other malformations. In a general way it is recognised that the better fed the bird the less likely are its feathers to show any defects. Furthermore, from correspondence with Dr. R. M. Strong, of the University of Chicago, who has been engaged upon a study of the development of feathers for years, I learn that experiments have been conducted by Prof. C. O. Whitman and himself upon malformations in other birds exactly similar to those of the ostrich. Ring-

doves, after hatching, were alternately starved and fed for some days at a time when the feather was in process of formation, with very remarkable results. On the feathers developing, similar bars were produced in very striking fashion and in great profusion. The results of the experiments were such as to leave no doubt that the barring in this case was due to malnutrition or some disturbance in the metabolism of the bird.

The ostrich farmer, however, is convinced that insufficiency of food is not the only factor involved. Frequently bars appear on the feathers of birds which apparently have been well fed all the time. A general opinion prevails that the ostrich fly, *Hippobosca struthionis*, is often responsible for the trouble, and also the ostrich mite, *Pterolichus bicaudatus*, both of which sometimes infest the birds in large numbers. It is difficult to see how these external parasites can act directly upon the feather germ, but it is undoubtedly that the progressive farmer who dips or sprays his birds against the pests produces a plumage much less subject to imperfections, and consequently of higher value. Whether the fly or mite can affect the feather directly or only indirectly by lowering the general condition of health of the bird is a subject for investigation, as is also the influence of the tape-worms and thread-worms (*Strongylus douglassi*) which frequently infest the animals. The influence of in-breeding and heredity will also have to be considered. It is significant to find that a similar barring occurs on the ostrich farms in Pasadena, California, among birds which have been ill fed, and the trouble is general on the ostrich farms in Florida, where conditions are not so favourable for birds. A much rarer defect is where the parts of a feather have failed to differentiate along one or more vertical lines extending the whole length of the vane. This irregularity is in all probability the result of some permanent injury to the feather germ or its socket, and occurs independently of the nutritive condition of the bird.

The production of these irregularities in the growth of feathers as epidermal derivatives is of much zoological interest in connection with pathological conditions of epidermal structures generally. As is well known, the enamel of the teeth of children is frequently grooved or pitted in transverse rows, a condition which can usually be traced to some error in feeding, congenital disease, or ailments affecting the general nutrition of the body during the time the teeth were forming; the finger nails are often transversely grooved after an illness or injury, pointing to a response to malnutrition; hair frequently breaks, falls off, or changes in character after an illness from the same cause; the horns of cattle and antelopes occasionally show one or more narrow constrictions representing a diminution in the amount of horny material. All these defects can be correlated with some low condition of health of the animal at the time, and serve to establish that the imperfections in the feathers of ostriches are not an isolated phenomenon, but, *mutatis mutandis*, can be compared with imperfections in the epidermal products of other vertebrates.

While it may be rash to predict before the experiments in hand are completed, yet from the facts already known there seems good reason for expecting that the trouble will be found to rest very largely with the farmer, and that the remedy will be mainly a question of a proper and regular supply of food—not an easy matter in time of droughts. Without question there exists an extremely sensitive relationship between the production of a perfect feather and the proper nutrition of the bird; artificial selection in breeding may also assist towards the production of a strain in which the feathers are less influenced by constitutional changes in the bird. J. E. DUERDEN.

Rhodes University College, Grahamstown,  
Cape Colony.

#### Origin of the Term "Metabatic."

My attention has been directed to the word *metabatic* as relating to the transfer of energy. I should be much obliged if anyone could give me information as to the author of the term, the date of its introduction, or any scientific paper in which it occurs in such form as to betoken its exact meaning.

ROBERT E. BAYNES.

Christ Church, Oxford.