versity of London attached to the Imperial College of Science and Technology.

DUE to the absence of Dean Vaughan in war service, a reorganization of the administration staff of the University of Michigan Medical School has been necessary. The present officers are as follows: dean, Victor C. Vaughan, M.D., LL.D., Colonel, M. C., N. A. (absent on leave); assistant dean, Charles W. Edmunds, A.B., M.D.; acting secretary, Rollo E. McCotter, M.D., and assistant secretary, Ethel Bradley Flick.

THE following new appointments have been made in the various departments of Western Reserve University. In Adelbert College, Webster Godman Simon, A.M., as instructor in mathematics. In the School of Medicine, Carl J. Wiggers, M.D., as professor of physiology. The following promotions have been made in the Dental School: Harold Newton Cole, Ph.D., M.D., assistant professor of dermatology and syphilology; Gaius Elijah Harmon, M.D., C.P.H., assistant professor of hygiene and bacteriology (now senior instructor in hygiene); Bradley Merrill Patten, A.M., Ph.D., assistant professor of sistology and embryology.

IN the Georgetown University Medical School Dr. Clarence R. Dufour, who resigned as clinical professor of diseases of eye and ear, has been appointed emeritus professor; Dr. Isaac S. Stone, professor of gynecology, who resigned after twenty-six years of service, has been succeeded by Dr. J. Thomas Kelly, and Drs. James M. Moser and John A. Foote have been appointed assistant professor of pediatrics.

DR. R. O. CROMWELL, formerly assistant plant pathologist at the experiment station at West Raleigh, North Carolina, has been appointed extension plant pathologist at the Iowa State College of Agriculture and Mechanic Arts, at Ames Iowa.

DR. SAMUEL T. DARLING, of the International Health Board, has been appointed professor of hygiene and director of laboratories in the School of Medicine and Surgery in São Paulo, Brazil.

DISCUSSION AND CORRESPONDENCE

THE CRITERION OF SUBSPECIFIC INTERGRADATION IN VERTEBRATE ZOOLOGY

INTERGRADATION is now generally accepted, both in codes of nomenclature and in practise, as the criterion of zoological subspecies. A second means of determining subspecific relationship, the degree of difference, so strongly advocated by Dr. C. Hart Merriam[1] and others, has been found unsatisfactory; still more so a third, the natural outgrowth of the latter, that of general resemblance, which makes the species practically equal to a subgeneric group. Dr. Ernst Hartert and a few others have employed this last method, but it leads to such evident inaccuracies as treating the American cedar waxwing, *Bombycilla cedrorum*, as a subspecies of the Bohemian waxwing, *Bombycilla garrula*.

What constitutes subspecific intergradation, however, seems still to be debatable, if the diversity of usage among current authors is to be taken as evidence. Briefly stated, there are three ways in which intergradation takes place: (1) By a gradual change over contiguous geographic areas; (2) by an abrupt change in an intermediate area; and (3) by individual variation, whether or not the ranges of the two forms adjoin. The first of these is the kind of intergradation so commonly seen on continental areas where one form passes insensibly into another in the intermediate territory, and is so well-known as not to need illustration. The second is much less common and often results in the presence at certain localities of typical examples of both forms, together with all shades of intermediates; but the only question likely to arise in treating a case of this kind is the allocation of the individuals which occur in such places,—whether they shall be treated all as the one form to which they collectively most approach, or whether the more or less typical examples of each shall be referred to their respective races. The third kind of intergradation, that of individual variation, is of almost as frequent occurrence as

[1] SCIENCE, N. S., V., No. 124, May 14, 1897, pp. 753–758.

the first, and is the sort so often seen on islands, on mountain peaks or other isolated continental areas; and it is this that seems to be at present the debatable kind of intergradation. Shall this be considered equivalent to uninterrupted continental intergradation, or shall it be ignored entirely as intergradation, and the forms so limited be considered distinct species, although some of their individuals may not be distinguishable from those of some other form?

The recent remarks of Mr. H. S. Swarth on the subspecific relationships of certain jays of the genus *Aphelocoma*[2] again brings up this question. A statement of this particular case, which the present writer has already briefly explained,[3] may be of interest in the present connection, since it is typical of the third kind of intergradation. *Aphelocoma californica californica, Aphelocoma californica immanis,* and *Aphelocoma californica hypoleuca* are three jays occurring on the Pacific coast from Oregon to southern Lower California, the first two with continuous ranges, the third supposedly isolated. Adjoining *Aphelocoma californica immanis* on the eastern side of the Sierra Nevada, and living sometimes at the same localities, where apparently specifically distinct, is *Aphelocoma californica woodhouseii.* The last, however, ranges eastward to Texas, where it intergrades with *Aphelocoma californica texana,* and through other Mexican subspecies with *Aphelocoma californica sumichrasti* of southern Mexico, the range of which is entirely separate and far removed from any of the races of California or Lower California. Some individuals of *Aphelocoma californica sumichrasti,* however, are difficult, if not impossible, certainly to distinguish from *Aphelocoma californica immanis* or *Aphelocoma californica hypoleuca.*

Mr. Swarth would consider that the individual variation of *Aphelocoma californica sumichrasti* from southern Mexico, which bridges the difference between *Aphelocoma californica immanis* and *Aphelocoma californica hypoleuca,* is not intergradation in a subspecific sense; furthermore, he regards *Aphelocoma californica hypoleuca* from southern Lower California as a distinct species (although he admits that certain examples of *Aphelocoma californica immanis* found in northern California are indistinguishable from this Lower California form) because of the interposition of a darker form of *Aphelocoma californica,* the range of which he considers widely removed, and with which he supposes *Aphelocoma californica hypoleuca* does not geographically intergrade.[4] In such cases the intervening form has the same biological effect as a land or water barrier. Thus the particular point brought out is that intergradation by individual variation is not intergradation in a subspecific sense, and that, therefore, a form to be a subspecies must have a continuous range and merge geographically. With this as the only criterion, all island and isolated alpine forms must be considered distinct species, however slightly and inconstantly they may be differentiated, a view by no means held by zoologists generally.

The principle underlying the use of intergradation as an indication of subspecific relationship and sought to be expressed in nomenclature by a trinomial is that a subspecies is an imperfectly segregated species. Manifestly no form that is a geographic representative of a species is perfectly segregated if any of its normally adult individuals are practically indistinguishable from comparable individuals of another form. We should, therefore, make our nomenclature conform to the facts, not our facts to the nomenclature. In order to do this and satisfactorily to settle the specific status of a number of closely related forms that collectively cover a large geographic area, it is important that we take not only one or two contiguous, but all the forms and their

[2] *Univ. Calif. Publ. Zool.,* XVII., No. 13, February 23, 1918, pp. 406–413; 420–421.

[3] *Condor,* XIX., May, 1917, p. 94.

[4] That *Aphelocoma californica hypoleuca,* as we shall elsewhere explain, proves to have a range practically continuous with *Aphelocoma californica californica* and completely intergrades geographically with the latter, does not affect the principle at present involved.

relations, into consideration. It is evident to any zoologist who has studied large series of specimens of a wide-ranging and plastic species that it is, of course, easy to mistake false for true intergradation, as, for instance, if adults in comparable age and condition are not used in comparison. It is likewise easy to overlook evidence of intergradation, since the latter is sometimes obscured by other circumstances. For example, two forms may meet on the edges of their ranges and intermingle on common ground, remaining perfectly separate and be apparently distinct species, yet elsewhere directly or indirectly through other forms completely intergrade. This is exemplified in our case of *Aphelocoma* by *Aphelocoma californica woodhouseii,* which remains an apparently distinct species where its range meets that of *Aphelocoma californica immanis* at the foot of the Sierra Nevada, but which eastward passes directly by continuous geographic intergradation into *Aphelocoma californica texana,* and thence through forms in eastern Mexico into *Aphelocoma californica sumichrasti,* which in turn intergrades individually with *Aphelocoma californica hypoleuca* and *Aphelocoma californica immanis.* A parallel case is found in the mice of the genus *Peromyscus,* as shown by Mr. W. H. Osgood,[5] in *Peromyscus maniculatus austerus* (Baird) and *Peromyscus maniculatus oreas* Bangs; and also in *Peromyscus maniculatus gambelii* (Baird) and *Peromyscus maniculatus rubidus* Osgood. To consider them species, because at some point where their ranges meet they remain distinct while at another similar place they intergrade, would clearly not best represent the facts.

The use, therefore, of individual variation as one of the chief criterions of intergradation seems not only not illogical but necessary.

HARRY C. OBERHOLSER

COTTON AS A SEED CROP

UTILIZATION of cotton seed as a source of oil and other valuable products has brought forward two questions for cotton breeders; first, the possibility of increasing the oil-content in the seeds of lint-bearing varieties; and second, the breeding of a lintless cotton, to be grown strictly as a seed-crop. In asking the first question it is assumed that the oil might be increased without reducing the lint, while the second is prompted by the idea that lintless varieties could be harvested by machinery, thus avoiding the chief difficulty and expense in the production of fiber, the labor of picking the cotton by hand.

Increasing the oil in cotton seed was undertaken several years ago in connection with the breeding of the Trice variety. A large amount of careful work was done by Professor S. M. Bain, of the University of Tennessee, assisted by the late Mr. Albert T. Anders, formerly of the Bureau of Plant Industry, but without finding the definite differences that were sought as the basis of selection for oil-content. The fluctuations induced by conditions of growth or associated with various degrees of maturity attained by the seeds were so large as to conceal inherent differences of individual plants or progenies. As might be expected from the greater proportion of kernel to shell, the oil-content seems to be higher in varieties with large seeds, more than 24 per cent. of oil, or 64 gallons per ton of seed, being reported for the Meade cotton in Georgia, but large-seeded varieties are unpopular because they do not have the highest percentages of lint.

The breeding of lintless varieties might not prove difficult, since individual plants with entirely naked seeds have been found as chance variations in lint-bearing stocks. Degenerate "slick-seeded" plants with little or no fuzz on the seeds and only a sparse covering of lint are of rather common occurrence in the Southeastern States in ordinary short staple fields raised from "gin-run" seed. Some of the inferior "Hindi" variations of the Egyptian type of cotton have nearly naked seeds. Failure to eliminate the Hindi admixture in Egypt damages the crop to the extent of several million dollars every year. A lintless cotton would need to be excluded rigorously from any region where other varieties are grown. The seed must become much more valuable than

[5] *North Amer. Fauna,* No. 28, April 17, 1909, pp. 52, 53, 66, 69 and 70.