

ural selection to eliminate either the original type or the new variety. It would, moreover, be illogical to presume that the same agent that has been instrumental in causing the disappearance of the pigment in the natural fish is the same agent, in the same locality, and under apparently the same conditions, that is instrumental in again producing pigment on the lower side.

A Precise Criterion of Species. C. B. DAVENPORT.

IN order to decide whether two allied groups are species or varieties it is necessary first to give an exact quantitative expression to the two best criteria of species—divergence and segregation—by the use of the modern mathematical method of studying individual variation. Divergence is the distance between the modes of the two groups in question expressed in units of the average deviation from the mean of the individuals of one of the groups. Segregation is inversely proportional to the number of intergrades, or it is the height of the lowest ordinate between the two modes expressed in units of the height of one of the modes.

An examination of the usage of systematists will tell us what least degree of divergence or segregation is usually expected in distinct species. Leaving the precise determination of this least degree still undecided, we may conclude: A group of allied individuals giving a dimorphic curve of a (differential) character consists of two species either when the minimum between the two groups is m [20] % or less, of the shorter mode, or when their modes diverge by n [10?] or more times the smaller average deviation of the two subgroups. Otherwise the dimorphic curve indicates two races.

Certain Results from a Study of the Variation of Littorina. H. C. BUMPUS.

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specimens of *Necturus* revealed the fact that those individuals which were abnormal so far as location of the pelvis was concerned were also abnormal in respect to many others, and only remotely related characters; that those individuals which were unstable in respect to one character tended towards instability in respect to all characters; that variation of one organ was an indication of probable variation of other, if not of all, organs. The examination of over 1,700 sparrows' eggs encouraged the belief that this principle of the general instability of variants might be of further application, and in a recent article by Havelock Ellis, on *Genius and Stature*, it is concluded, on anthropological data alone, that those variations of mind which have been instrumental in producing men of eminence are accompanied by striking and remote physical variations; that those who have attained distinction as warriors, statesmen, scientists or writers have generally been above or below the mean of stature.

The speaker then exhibited 1,000 shells of *Littorina littorea* which had been arranged in order, according to their shape, from extreme elongation to extreme ventricosity, and showed that those at the extremes tended toward excessive variation in weight. Both ventricose and elongated shells were far *heavier* and *lighter* than the species of more ordinary form.

Grafting Experiments on Tadpoles, with Special Reference to the Study of the Growth and Regeneration of the Tail. R. G. HARRISON.

THE method of grafting amphibian larvæ, as described by Born in his exceedingly original and suggestive paper [*Archiv f. Entwicklungsmechanik*, Bd. 4], may be applied to the study of the normal growth of the embryo. Thus, when portions of larvæ of *Rana virescens* and *R. palustris* are combined in various ways to form a complete normal organism, the sharp con-

trast in color between the tissues of the two species enables one to follow in the living specimen the exact development of each part. If the tail-bud of an embryo (ca. 4.5 mm. long) of one species be replaced by a similar portion taken from the other, it may be observed that, as the tail grows, the epidermis from the body moves out over the base of the tail until about the end of the sixth day it covers its proximal two-thirds. The underlying tissues (muscle plates, notochord and spinal cord) grow apically, and the place of union between the two portions remains very near to the base of the tail, although it does shift with respect to the anus through a distance equal to about three metameres. When several segments of the body are grafted along with the tail, a similar shifting of the epidermis takes place, though less in amount, and even when the two parts are united in the region of the pronephros there is a slight backward movement. This is brought about largely, if not entirely, by the pulling of the skin due to the enormous growth of the tail as compared with the body. The parallel between the direction and amount of movement of the epidermis during development, and the mode of distribution of the cutaneous nerves in the body and tail of full-grown tadpoles, indicates that each nerve supplies that region of the integument which, at an early stage, was nearest to it.

When, in place of a tail-bud which has been removed, a similar portion of another larva is grafted by its distal end, leaving the proximal end free, a tail-like structure is regenerated. In cases where the notochords of the two parts unite, the regenerated tail attains a degree of perfection but little inferior to those regenerated from the distal end. If the notochords do not unite, regeneration may take place from both pieces, resulting in a forked tail. When neither the notochords nor spinal cords unite, the tail stump of the stock regener-

ates, while the grafted piece remains as an insignificant lump on the side of the tail.

In all cases (six) where *virescens* tails were grafted to *palustris* larvæ, and in fifty per cent. (four) of the cases in which *palustris* were grafted to *virescens* larvæ, degeneration of the transplanted tissue took place, beginning sometimes as early as three weeks after operation. This was independent of metamorphosis, having begun before the appearance of the extremities. The tadpoles lived for weeks afterwards with withered tails, without undergoing further metamorphosis.

One specimen in which the two parts were united in the region of the pronephros passed successfully through its metamorphosis. Little or no blending of specific characters could be observed. The head of the frog had the markings of *R. virescens*, while the body and hind legs had those of *R. palustris*.

The Structure and Development of the Excretory Organs in Limulus. W. PATTEN.

THE brick-red gland or coxal gland of *Limulus* has long been regarded as a ductless gland of uncertain significance, but we are now able to demonstrate that it is provided with a duct several millimeters in diameter and three or four inches long.

Its development has also been carefully studied, but the structure described as the developing gland proves to be the developing duct; the embryonic gland was not seen at all.

Naturally, the conclusions as to the significance of this organ based on such foundations can have but little value.

The duct in the adult is so thin-walled that it is not readily seen and is very difficult to dissect. But it may be easily injected with either celloidin or asphalt, the mass filling the duct and penetrating all through the lobes of the gland. Isolation is then effected by corrosion with caustic potash.