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A Photographical Method of Studying Morphological Variation.

By

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With 1 plate.

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In connexion with certain investigations concerning *Lymnaea* I had to study the shell-variation in *Lymnaea limosa* (L.) It proved to be particularly important to define the degree of variation within each population studied, and this was performed by applying the morphometric method. Certain measures served as a starting-point whereupon certain indices could be calculated. The means of these indices as well as their standard deviation have been made out. The percentage of the standard deviation expresses the extent of variation within a population. However, for two reasons I did not content myself with merely this expression for the variation in question. On the one hand I thought it desirable to achieve a concrete graphic representation of the degree of variation in a population, and on the other many characters in the form of the shell are difficult if not impossible to ascertain by merely a morphometric investigation. For these reasons the morphometrical method needs supplementing, also as to quality.

Once or twice, in literature, I have noticed a photographical curiosity meant to give a sort of photographical average: A number of human faces had been exposed on the same plate, all of them in exactly the same place of the plate, wherewith the time for each exposure was abbreviated. The method I am going to deal with in the following lines — I propose to call it mean-photographing — is based on the same proceeding.

Mean-photographing of, for instance, a population of shells is performed as follows: A number of specimens of equal size are chosen and one of them is photographed in the usual way in order to control the arrangement of light and to find out the right time of exposure. When taking the very mean-photograph the time for each separate exposure is found by dividing the time which the above-mentioned photo had required, by the number of objects intended for the mean-photograph. In order to give the mean-photograph its intended character, it is absolutely necessary to put the projection of the shells exactly in the same place on the plate. So it is extremely difficult to fit in the objects for mean-photographing. In order to avoid any further increase of these difficulties, a moderate enlargement is preferable. Further enlargements may be executed later on when taking copies. It has proved practical in mean-photographing to place the camera vertically. The object can then be fixed on a loose slab of glass by means of wax, plasticine or the like. The slab is then put before the objective, its right position is demarcated in some way and the outline of the object is drawn on the screen. If there should be a distinctly marked outline in the centre of the projection, it should also be drawn on the screen. Now the first object can be photographed, whereupon the screen is put in again. The next object is fixed on the glass-slab in the place of the first and the slab is minutely adjusted so as to make the picture of the new object coincide exactly with the drawing on the screen of the camera, whereupon also this object is exposed. In case the two objects should differ somewhat in size, it is most advisable, when fitting them in, to apply as much as possible to their central portions by which the difference in size is spread out equally over the whole outline of the object. The objects are easier fitted in when a lookingglass is fastened above the screen or the object is placed on a movable slab manoeuvred from the region of the screen of the camera.

On Plate I some mean-photos of *Lymnaea limosa* are reproduced. Fig. 1 shows a specimen photographed in the usual way, and Fig. 2 is a mean-photo of 20 specimens of the same population. The somewhat diffuse, yet fully visible outline indicates the mean outline of the shells. In this population the shell-variation is slight. The orientation of the shells has not been the best possible one. Fig. 3 shows a mean-photo of a population with heterogeneous shell-form. Figs. 4—7 gives mean-photos of different populations, 5, 7, 10 and 20 specimens respectively being comprised by one picture. If there are only few objects (Fig. 4 and 5), and if the variation between the objects is considerable (Fig. 6), it is possible to discern the

outline of each specimen and to compare it to that of the others. A greater number of specimens, especially if they vary but slightly from each other, leads to a fusion of the single pictures so as to produce one congruent and fairly distinct picture (Fig. 7). Fig. 8 is composed of 7 specimens and gives an uncommonly distinct picture, the enlargement being not more than 1.5.

Mean-photographing may prove useful in many departments. In the first place it is applicable to objects of equal size and fixed shape, the form-differences of which can be made obvious by a projection in one plane. Mean-photographing, on the one hand, allows to achieve a detailed morphological characterization as to outline of a population and, on the other hand, it gives a direct graphic parallel to the standard deviation — be it merely an approximate one.

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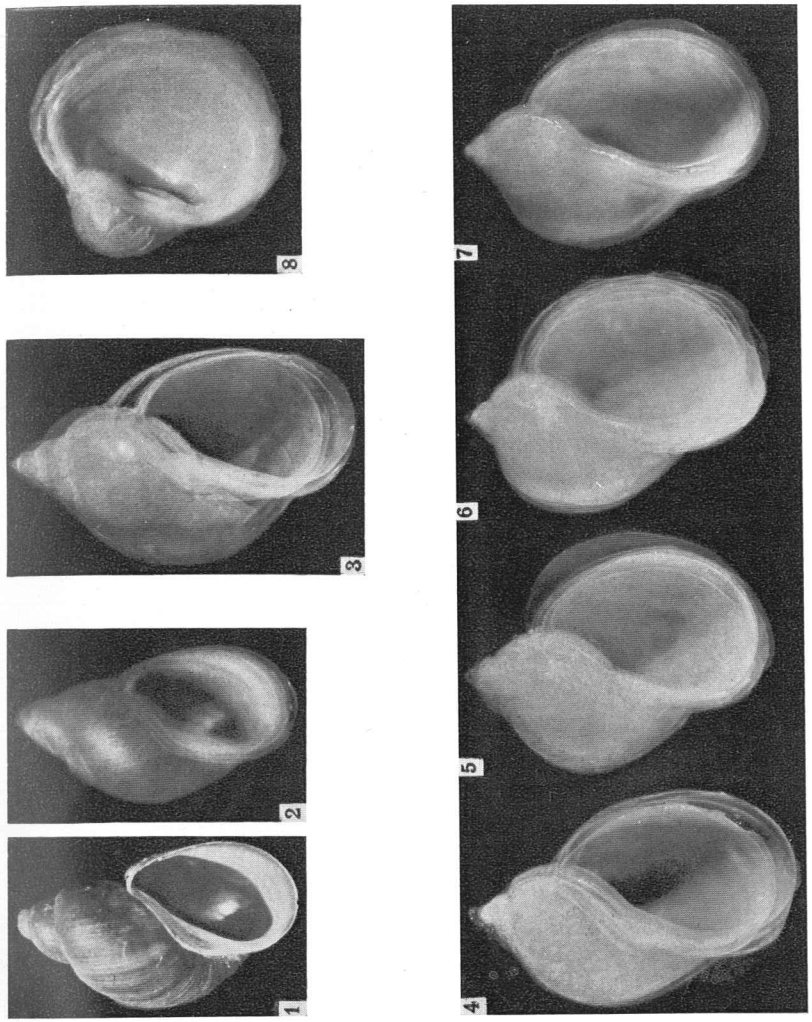

Plate I.

Mean-photographs of *Lymnaea limosa* (Linné) from Sweden.

Fig. 1, Norrtälje, Uppland, 1 specimen, 3 ×; Fig. 2, Norrtälje, Uppland, 20 specimens, 3 ×; Fig. 3. Karesuando, Lappland, 6 specimens, 2.5 ×; Fig. 4, Fittja, Södermanland, 5 specimens, 4 ×; Fig. 5, Runmarö, Archipelago of Stockholm, 7 specimens, 3 ×; Fig. 6, Lake Mälaren at Södertälje, 10 specimens, 2.5 ×; Fig. 7, Svartlögafjärden, Archipelago of Stockholm, 20 specimens, 3 ×; Fig, 8, Värna, Östergötland, 7 specimens, 1.5 ×. All photos by C. Swedén.

Gastropoda

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Hawaiian Lymnaeidae*

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INTRODUCTION

During the last three years I have been studying the family Lymnaeidae in order to produce a thorough systematic account of the group. For that purpose I have borrowed collections from various museums. Those from Bernice P. Bishop Museum, a comparatively rich material of shells and animals in alcohol, have proved the Hawaiian lymnaeid fauna to be the richest in the world in relation to its restricted geographical range. For that reason and because all Hawaiian species are endemic forms, this separate paper on the Hawaiian lymnaeid fauna has been prepared.

The systematic method used is based upon some general conclusions as to principles of variation and evolution within the group. I must confine this report to an account of the Hawaiian fauna, leaving general treatment of the group for my monographic survey of the family.

I wish to express my appreciation of the assistance received from the late Dr. C. Montague Cooke, Jr., of the helpfulness of Mr. Yoshio Kondo in connection with my studies of the Hawaiian material, and of the interest of Mr. W. J. Clench, who read the paper critically.

KEY TO SPECIES

A. Shell features.
Shell sinistral ..... **L. reticulata**
Shell dextral
Well-developed spire.
Whorls generally somewhat truncate. Suture very moderately sloping ..... **L. volutata**
Whorls not truncate. Suture ordinarily sloping ..... **L. rubella**

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