Victor E. Shelford presented an illustrated paper of which an abstract is given below.

ECOLOGICAL SUCCESSSION OF FISH AND ITS BEARING ON FISH CULTURE.

The investigation with which my paper deals is not yet completed. The results are too extensive for reading before the Academy. Accordingly, only an abstract of the chief facts and conclusions is given here. The completed work will be published elsewhere later.

I. Definition. Ecological succession differs from geological succession or the succession of species, in that species may be ignored, except as names are necessary, and only the *habits* of the forms taken into consideration.

II. Area studied. The area studied is at the head of Lake Michigan where deposition of sand and the recession of the lake have caused the formation of a series of long sloughs parallel with the shore. Attention has been concentrated on the first, fifth, seventh, and fourteenth of these, as counted from the lake. The first is youngest. The fifth may be considered as at least five times as old as the first; the seventh, seven times as old; and the fourteenth, fourteen times as old.

III. Succession. Slough XIV was once in the same stage as slough I, and was then occupied by fish ecologically similar to those in slough I at present. The vegetation grew and humus accumulated, making it impossible for the ecological types of slough I to continue, and these were succeeded by the ecological types such as we now find in slough V; in due time these gave way to the ecological types in slough VII, and these likewise to those of slough XIV.

IV. Causes. This includes causes of succession of fish, and the factors governing the distribution of fish with reference to the disappearance of the food fishes (large mouthed black bass, the green sunfish, and bluegill) from the sloughs as they grow older or in other words their absence from all but slough I when they colud have gotten into the other until recently, when certain railroad culverts were discontinued and filled.

1. *Size and depth.* It is not due to their selecting the largest and deepest bodies of water. These fishes are found in the shallowest and smallest of the ponds (slough I).

2. *Chemistry of water.* An analysis has shown difference too slight to be recognized by fish.

3. *Food.* The fish are not where the food supply is greatest.

a. Food has been shown to be greatest in the sloughs which do not contain these fish.

b. The fish food consumed in each slough is about the same, but the consumers in the older sloughs are different and undesirable fishes.

c. The fish food supply is greatest in the older members of another series of ponds studied for comparison. In these fishes are numerous in the older ponds, and fish are almost absent from the youngest which is artificial. The greatest food supply in the older sloughs is not, due therefore, to the absent of the fish in question, but to *other causes*.

4. *Living place of the fish*. The fish are not in the situations which they are known to frequent in large bodies of water, as these situations are not present in slough I, but are present in the others.

5. *Breeding place*. These fish are known to breed chiefly on bare bottom. The vegetation and humus which come with age *destroy bare bottom and hence fish breeding places*. Slough I is the only one having extensive bare bottom. The fish in question are in the pond containing suitable breeding places, to the neglect of other factors.

V. CONCLUSIONS. 1. *Scientific*. The breeding habits and distribution of suitable breeding places are the first factors in the distribution and succession of fish, as has been shown for certain beetles and is held for birds. This is crucial to ecological study.

2. *Economic*. a. These data indicate clearly that the prooduction of food fishes of a given area depends upon the availability of suitable breeding places.

b. Economic effort should be directed toward: (1) The study of the behavior of fish, especially during the breeding season. (2) The cultivation, preservation, and protection by legislation of the breeding places of food and game fishes.
