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From BULLETIN OF THE BUREAU OF FISHERIES, Volume XXVIII, 1908

Proceedings of the Fourth International Fishery Congress : : Washington, 1908



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A PLAN FOR AN EDUCATIONAL EXHIBIT OF FISHES



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Assistant Curator, American Museum of Natural History



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A PLAN FOR AN EDUCATIONAL EXHIBIT OF FISHES.



By ROY W. MINER,

Assistant Curator, American Museum of Natural History.



An exhibit to be educational must be attractive as well as instructive; that is, its features must be so arranged as to stimulate attention, and when that is accomplished, to offer instruction that will be appreciated not only by the casually interested observer, but also by those who have come for the express purpose of learning, namely, the pupils and teachers of the public schools, university students, and others specially interested. Its lessons therefore must be simple, direct, and systematically arranged.

But when we endeavor to accomplish this end with an exhibition of fishes, certain special problems are involved. In the first place, the material is refractory and difficult to prepare effectively for exhibition; in the second place, the very monotony of the fish form makes the study of arrangement a matter of special concern. The consideration of these questions will be taken up as follows: (1) The nature of the material available for exhibition will be discussed; (2) various methods for arranging and labeling the exhibit will be brought forward; (3) supplementary suggestions will be offered for rendering the exhibit instructive and attractive, and (4) the paper will close with a provisional list of fishes to be exhibited.

The writer does not pretend that he has solved the question of fish exhibition, but offers these suggestions partly as the result of his attempts in this direction and partly as tentative schemes which may aid in meeting some of the difficulties.

NATURE OF THE MATERIAL TO BE EXHIBITED.

The material for exhibit may be (1) alcoholic specimens, (2) mounted and painted skins, (3) casts, (4) models, (5) skeletons, (6) colored plates and photographs, (7) groups.

(1) *Alcoholic specimens* should be used but sparingly, as for the most part they have little exhibition value because of distortion, shrinkage, and loss of color. A few good anatomical preparations might be used to show certain

peculiarities of structure (pl. cxxvii), or certain kinds of accessory material, such as sharks' and skates' eggs, for example, may add to the value of the exhibit.

A rare and interesting form like the goblin shark (*Mitsukurina owstoni*) might be shown, especially if placed beside a model of the living fish; but on the whole alcoholic specimens decidedly detract from the interest of the exhibit.

(2) *Mounted and painted skins* are sometimes effective for exhibit, especially with fish like the gar-pike (*Lepisosteus osseus*), the enameled scales of which are very successfully treated in this way. (Pl. cxxviii.) In fact, this method may be used with many forms that have close-set, substantial scales (see yellow perch, pl. cxxix), and is especially effective in a fish of either gaudy or dark colors (e. g., the angel-fish, or the groupers). It does not, however, effectually reproduce the smooth, gleaming, iridescent body of other fishes, as the shrinkage and hardening of the drying skin and the paint that is applied obscure the original quality of the surface. Hence, painting a skin practically amounts to nothing more than painting on an inferior surface.

(3) *Casts*, however, though but a reproduction, are faithful, if well executed, and furnish a surface much better adapted for coloring. Transparent colors over a metallic silver paint may be made to give the effects of iridescence, especially with such fish as the mackerels, pompanos, and the lookdown. But even the plaster cast, no matter how well painted, nevertheless does not perfectly succeed in giving the surface bloom of the living fish.

(4) *Models*.—Some fishes, especially the rarer forms, are hard to procure except as distorted alcoholic specimens, yet it may be desirable to represent them in the exhibit. In such cases, if sufficient data can be procured, a model may be constructed giving a restoration of the original and it may be well to exhibit the alcoholic specimen beside the model.

(5) *Skeletons*.—The exhibit may be varied and its value greatly increased by the use of mounted skeletons of typical forms. These may be correlated by appropriate labeling so as to bring out their chief differences.

(6) *Colored plates* taken from published works will add to the attractiveness of the exhibit and may be used to represent rare species which could not otherwise be shown. Many of these plates possess artistic beauty and represent the living fish better than any known method of artificial preparation. At the same time they portray the extraordinary variety of color and form possessed by the fishes of tropical seas. Some of these plates are shown in plate cxxx.

(7) *Groups*.—It is the pictorial group, however, that calls forth the greatest display of interest on the part of the visitor. Groups are the attractive feature, the drawing card of an exhibit. In bird and mammal collections they have been employed with great success. There are, however, comparatively few fish groups, and in these the mistake is often made of producing an aquarium

effect without a central point of interest. A fish or school of fish swimming among seaweed and rocks is not sufficient excuse for the time and expense incurred in producing a fish group. There must be a central idea or theme, such as the life history of some interesting species, an instance of peculiar breeding habits, or an illustration of some biological phenomenon, like adaptation, protective coloration, symbiosis, or sexual dimorphism, which can be emphasized in a descriptive label for the benefit of the visitor. Instead of being merely a spectacle, the group now has educational value; while it is the pictorial effect which at first arrests the attention of the observer, the lesson it has to teach is impressed on the mind more vividly than by any other method. (See appendix, p. 1340, for specific suggestions for these groups.)

The nature of a fish exhibit is such that no one kind of material should be used to the exclusion of the rest. To show to the best advantage it should be so arranged that casts are interspersed with mounted skins, skeletons, and colored plates, while the monotony of single specimens is broken by groups at judicious intervals.

METHODS OF ARRANGEMENT.

In general, the synoptic or systematic arrangement is the best to follow. This is most readily effected by using single specimens in the bulk of the exhibit, which should, however, be varied with groups and accessory exhibits of a faunistic, commercial, and biological character. The synoptic series has great teaching value for the student of elementary zoology, since the orderly grouping of fishes carries with it an orderly grouping of facts readily retained by the mind. It is true that many casual visitors may not appreciate the advantages of the system, but when well arranged it sets forth, rather than obscures, the attractive and striking forms. For the benefit of such visitors the individual labels are made clear, simple, and interesting, while those placed with the groups are particularly adapted to their requirements. The student, however, needs a classification that is more in line with his studies, and this is furnished by the synoptic method of arrangement.

The classification to be followed will vary of course according to individual judgment. The writer has found that a combination of the American system of Jordan and Evermann with the English system of Boulenger is best adapted for purposes of exhibition. Valuable help in this connection has been derived from W. K. Gregory's article on "The Orders of Teleostomous Fishes."^a The scheme of classification will be given later in connection with the provisional list of fishes already referred to.

Three methods of arranging the exhibit in the hall are offered in the present paper, as follows: (1) the corridor arrangement; (2) the alcove arrangement; (3) the gallery arrangement.

^a *Annals New York Academy of Sciences*, vol. xvii, part II, no. 3, p. 437-508, pl. xxix-xxx.

(1) *The corridor arrangement.*—This method is in use in the American Museum of Natural History, where the fish exhibit is at present placed in an

L-shaped corridor (text fig. 1) connecting two wings of the museum. Here the cases are placed in end-to-end series along the walls on both sides, an arrangement well adapted for this style of hall. The cases for the synoptic series are of similar size and shape, of the variety shown in plate CXXVI. The two doors in front open outward. The back is solid and covered with a fabric (in this instance a blue denim), which sets off well the varied colors of the fishes. The specimens are attached directly to the back of the case and are removable. Nineteen cases are used at present for the synoptic series.

The main features of the arrangement and classification may be readily seen in the accompanying plates. The class Pisces is defined in a general label (pl. CXXXI) to be found at the entrance of the hall and also at intervals throughout the exhibit. Its subdivision into three subclasses is indicated at the bottom of the label. The parts of the hall devoted to the individual subclasses are shown by the large signs suspended from the ceiling (pl. CXXXII), while the orders are identified by

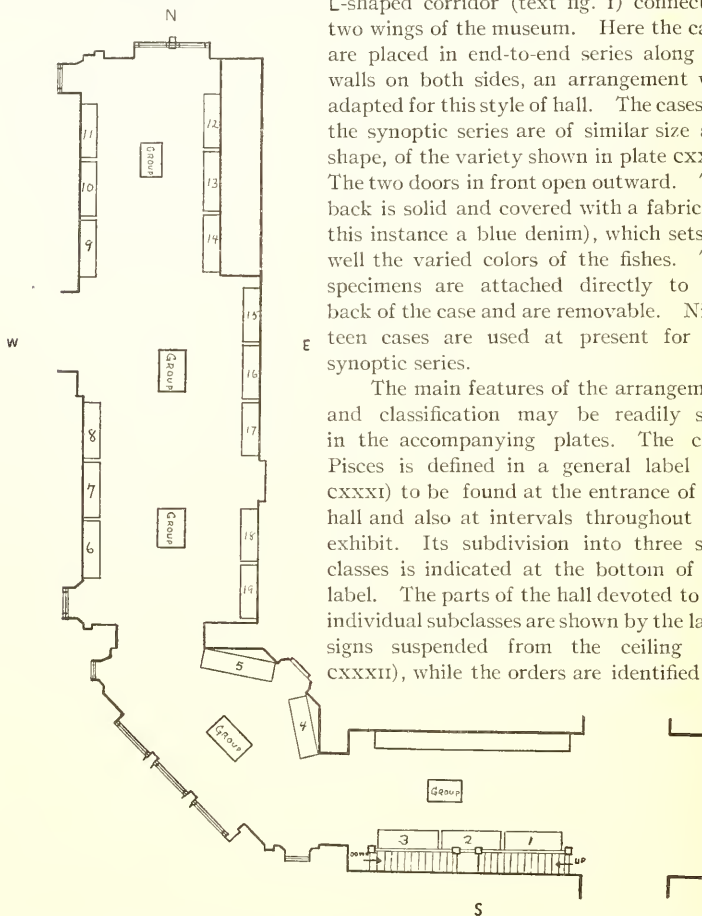


FIG. 1.—Plan of fish hall in the American Museum of Natural History, illustrating the "corridor method" of arranging the cases. The synoptic cases are numbered 1 to 19. The illustrative group cases are represented in the middle of the corridor.

small white-lettered boards at the top of each case (pl. CXXXIII). A case may contain as many as four or five suborders, or if many forms are shown, as in the Perciformes (pl. CXXX), or if the specimens are large, as in the Selaclii (pl. CXXXV), two cases may be devoted to a single suborder. The location of each suborder is indicated by black lettering on the glass doors of the cases (pl. CXXXVI), and a definition of the group, together with a list of such of its included families as are represented in the exhibit, are found in descriptive case-labels hung on the doors of the cases (see pls. CXXXVI, CXXXVIII, and fig. 4, p. 1324).

The families are separated from each other by narrow bands of adhesive tape (pl. CXXXVII), harmonizing in color with the background, and are identified by small family-labels (text fig. 2) giving both the popular and scientific names and fastened to the back of the case in each family group. Under each specimen is a special descriptive label (text fig. 3) which gives the popular name

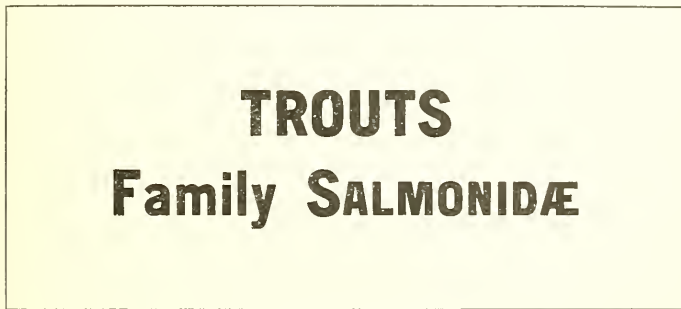


FIG. 2.—Example of family label.

in prominent type, while the scientific name is printed in smaller italic characters below. The name is followed by a brief popular description of the fish's habits, peculiarities, economic value, and geographical distribution. No effort, however, has been made to exhibit anything like a complete fish fauna, as the exhibit is entirely synoptic in character, only the principal families being shown and the typical and most interesting species in each family. Geographical distribution maps are being provided for the typical forms. Through the center of the hall will be placed groups illustrating life habits and other biological features. These will be of the general style shown in plate CXXXII. None are completed as yet, but in their places a few reptile groups have been installed temporarily.

The arrangement of the fish plates may be seen in plates CXXX, CXXXIII, CXXXIV, CXXXVI, and CXXXVII. They are mounted in passe-partout style and are hung to the backs of the cases in their proper synoptic position.

Very large and striking specimens are grouped in panels or friezes extending the length of the hall in the space between the ceiling and the tops of the cases (pl. CXXXVIII).

The labeling in this hall is based on the principle that since the exhibit has a double aim, being intended for both the general public and the students and instructors of the city schools and colleges, there should be a double system of labeling to meet the needs of the two classes. To this end the method of utilizing the exhibit by each class has been studied.

RAINBOW TROUT

Salmo irideus Gibbons

The so-called Rainbow Trout comprise several closely related species, and are noted for their gameness, dash, and beauty. They are found in mountain streams of the Pacific States and on the slopes of the Sierra Nevada Mountains. The typical Rainbow Trout (*Salmo irideus*) is found only in small brooks of the Californian Coast Ranges, and considering its size is perhaps the gamest of the series. It takes the fly with great readiness, even leaping from the water to meet it, and the struggle that follows is sure to be a long and keen one.

The weight of the Rainbow Trout varies from a half to 5 or 6 pounds, though the latter weight is exceptional.

FIG. 3.—Example of popular label for individual specimens.

The average person who enters the hall simply to see the exhibit is attracted first by the group cases. Then he passes before the synoptic cases, stopping here and there as his eye is attracted by some specimen. That is, it is the pictorial effect of the groups, or the striking features of some specimen, that draws his attention. In either case, if his interest is sufficiently aroused, he reads more or less of the accompanying label. Therefore the pictorial group labels and those with the individual specimens should be popular in character to meet his requirements (see fig. 3, p. 1322).

The elementary student of fishes, on the other hand, requires a systematic presentation of the subject, which will supplement and illustrate his studies.

To him the exhibit should appeal somewhat as an enlarged text-book, with object lessons for illustrations. It is to the elementary student, therefore, that the systematic arrangement is primarily directed—though it doubtless has its unconscious effect of orderliness upon the casual visitor as well—and the labels which bring out this classificatory side are aimed more directly at the student's understanding. Such are the labels indicating the larger groups, and especially the descriptive case labels defining the orders and suborders (see fig. 4, p. 1324). As these are based on anatomical features, especially those of the skeleton, they are necessarily more technical. An attempt, however, has been made to simplify them as much as possible, and to eliminate or explain technical terms. These labels also endeavor to bring out the phylogenetic relationship of the larger groups.

Accessory labels are freely used (fig. 5, p. 1325) to illustrate special features of biological interest.

(2) *The alcove arrangement.*—This is really an adaptation of the preceding method to a museum hall lighted by many windows from the side, thus permitting the cases to be placed alcove fashion with their ends to the windows, as in figure 6, page 1326. With this arrangement, instead of having a solid back, the cases are provided with glass on both sides, while a solid partition is constructed midway between, thus making it possible to utilize both sides of the case, in two adjoining alcoves.

The partition is covered with a colored fabric, e. g., blue denim, as in the preceding arrangement, and is framed in at top, bottom, and sides by light boards (fig. 7, p. 1327) inclined at an angle of about 45 degrees and wide enough to slant from the partition to the front edge of the case area, thus giving a beveled or countersunk effect. These inclined surfaces are covered with the same material as the partition and may be utilized for accessory labels, diagrams, etc. The bottom incline may also be utilized for such specimens as flatfishes, which would appear out of place when hung on a vertical surface.

THE TROUT-LIKE FISHES

Order MALACOPTERYGII

Suborder Isospondyli

Families

<i>Elopidæ</i>	<i>Clupeidæ</i>
<i>Albulidæ</i>	<i>Salmonidæ</i>
<i>Mormyridæ</i>	<i>Thymallidæ</i>

The fishes of this group include many of the most important food and game fishes, such as Tarpons, Trouts and Salmons, and the Herrings and Sardines. They are distinguished from the Ostariophysii (Case 6) by having the four anterior vertebræ of the spinal column unaltered and separate, and from the Eels (Apodes—Case 9) by the complete and well-developed skull. These characters, together with the soft-rayed dorsal fin and the cycloid scales—rounded in form and with smooth edges—also distinguish them from the Spiny-Rayed Fishes (Order Acanthopterygii—Case 9-14), most of which have ctenoid scales (i. e., scales rounded but with finely toothed edges) and fins partly supported by spines.

Like the Ostariophysii (Case 9) and the Pikes (Case 11) the Trouts have their ventral fins well separated from the pectorals and placed far back on the abdomen. This is a primitive arrangement and may be seen in all the lower fishes (e. g., the Sharks, Lungfishes, and Ganoids) and contrasts with the more specialized Acanthopterygian condition, in which the ventrals are attached close to the pectorals.

FIG. 4.—Example of descriptive case-label defining a suborder.

The fish in this case illustrate the natural phenomenon of degeneration, or rather specialization to an inactive life. The five suborders represented form a graded series of steps leading from fishes adapted to an extremely active existence down to relatively inactive, sluggish forms, incapable of rapid motion, but protected from their enemies by coats-of-mail or by the poisonous alkaloids in their flesh.

In the left-hand section may be seen the large, active wrasse-fishes and parrot-fishes (**Suborder PHARYNGOGNATHI**) well furnished with means of locomotion (i. e., fins), and with large gill-openings which permit the rapid oxygenation of the blood necessary to swiftly moving animals. The large cycloid scales are evenly distributed over the body and allow the greatest flexibility of movement. The teeth are adapted for seizing, and indicate carnivorous habits. Everything seems adapted to an extremely active life. On the other hand, there is a significant tendency toward fusion in certain bones of the skull, and (e. g., the parrot-fishes) in the teeth as well. This tendency is still more evident in the Scaly-Fin group (**Suborder SQUAMIPINNES**), where it appears in the fusion of the upper jaw elements, and in the gradual reduction of the gill-slits and the ventral fins. The body becomes laterally compressed and the transition to the type found in the next suborder (**SCLERODERMI**) is very clear. This suborder is represented in the upper right-hand section of this case by the trigger-fishes and file-fishes. Here the same flattened form is seen, and the reduction of the spinous dorsal and ventral fins to a few stiff spines is very evident. The bones of the skull have further fused, the gill-opening is a mere slit, and the upper jaw-teeth are compressed or even completely united, while the scales are reduced till, in the file-fishes, they become mere prickles. With the trunk-fishes (**Suborder OSTRACODERMI**) an immovable box-like armor takes the place of scales; the bones of the skull are almost completely joined; the gill-slit is extremely small; while the ribs and other skeletal elements have been practically reduced to a mere bony axis bracing the weak, soft dorsal, anal, and caudal fins. The spinous dorsal and the ventral fins have disappeared.

Finally, in the puffers (**Suborder GYMNODONTES**) we have the last stage of degeneration or specialization to a sluggish existence. Scales, spinous dorsal fin, and distinct teeth are gone. Pelvis, ribs, and caudal vertebrae are degenerate and, in extreme forms, even absent. The remaining fins, like those of the trunk-fish, are weak, and the body incapable of rapid motion, while the leathery skin, power of inflation, and poisonous flesh act as protective factors. The largest example of the group, the head-fish or mola, sluggishly floats on the surface of the sea, leading an inactive and lazy existence.

FIG. 5.—An accessory label to illustrate a biological phenomenon.

Each alcove should be devoted to one or two related subdivisions of fishes, arranged synoptically, as already described, and in the center of the alcove may

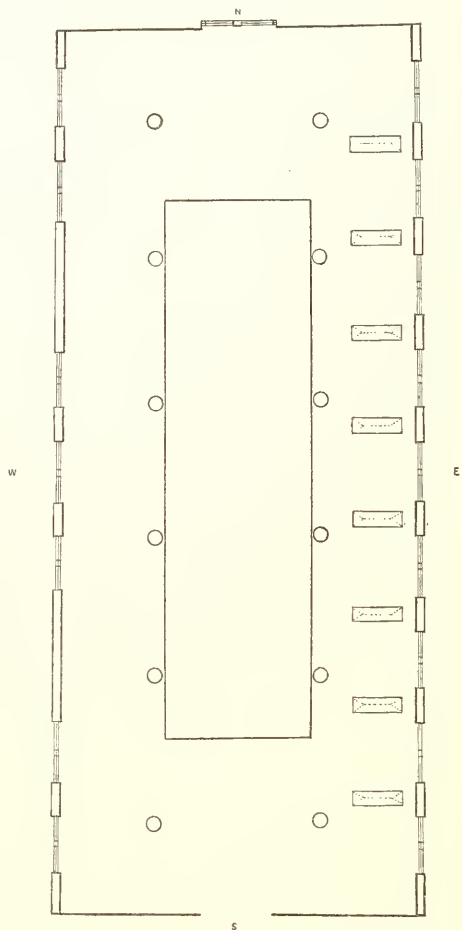


FIG. 6.—Plan showing hall adapted to the "alcove arrangement" of cases.

be placed a group case illustrating some features connected with one or more of the species in the surrounding cases.

(3) *The gallery arrangement.*—The idea for this somewhat more elaborate method was suggested by the gallery of habitat bird groups in the American Museum, but differs from it in that it combines a synoptic with a group exhibit. It is adapted for a gallery surrounding a hall occupying the space of two stories, such as occurs in most museums. At the side of the gallery farthest from the windows is a continuous screen to cut off all light from other parts of the hall (fig. 8, p. 1328), while the window side is entirely taken up with a series of exhibits, framed in by a casing, which, while it shuts off the light from the gallery, yet diverts it so as to illuminate the exhibit from within.

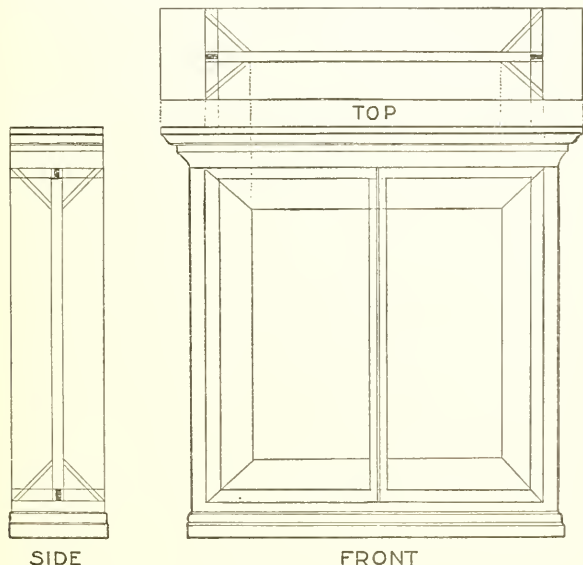


FIG. 7.—Diagram of fish case to be used in hall with "alcove arrangement," showing central partition with countersunk effect.

The adaptation of this method to a fish exhibit is shown in figure 9, page 1329. Through the opening (A) is seen a pictorial fish group representing some interesting feature. In the sketch an exhibit of fish life in the vicinity of a coral reef in tropical waters has been indicated in outline. This group is the central feature of that portion of the synoptic exhibit containing the suborders Pharyngognathi, Squamipinnes, Sclerodermi, and Gymnodontes, which contain so many of the brilliantly colored tropical species.

The panels *B* and *C* are devoted to the synoptic portion of the exhibit and contain representative species of the typical families included in the above-mentioned suborders. These specimens are fastened to a cloth-covered backing

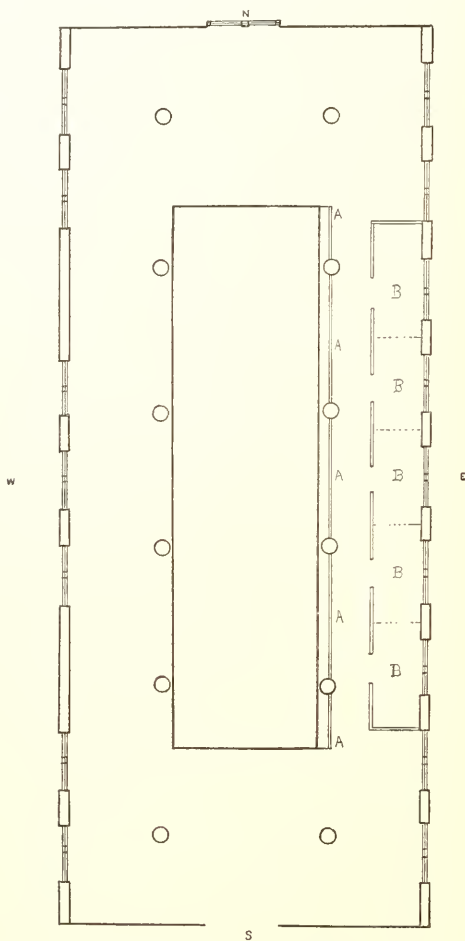


FIG. 8.—Plan illustrating the "gallery arrangement" of fish exhibits, showing screen (A) and row of group exhibits (B) of the kind shown in figure 9, page 1329.

placed just far enough behind the glass to comfortably accommodate the fish and show them off well. Small labels identify each specimen. The names of the suborders are lettered in black on the glass. The panels are lighted electric-

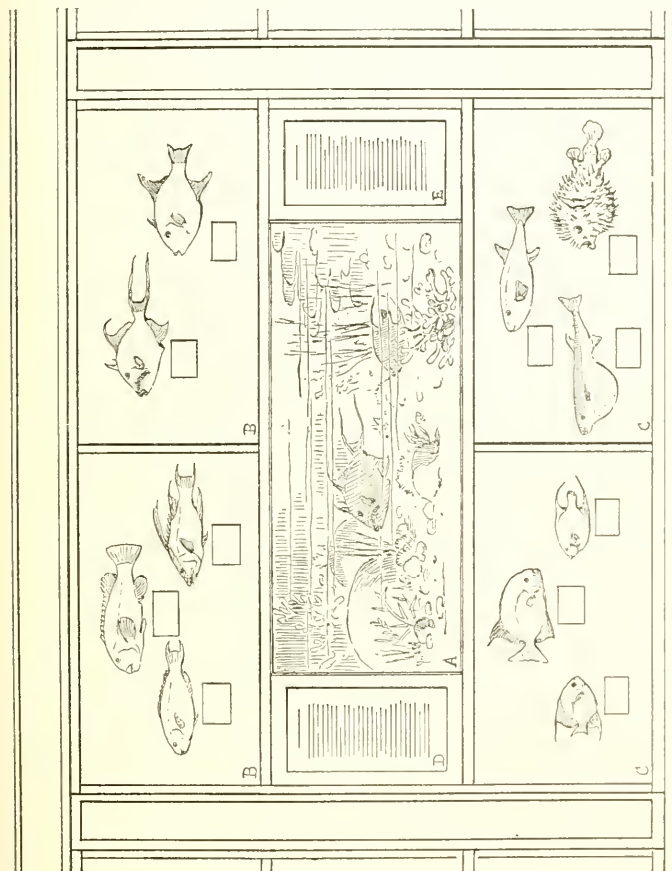


FIG. 9.—Sketch illustrating combination of pictorial fish groups with synoptic method of exhibition. (A) Group illuminated from within. (B, C) Panels devoted to synoptic portions of the exhibit. (D, E) Illuminated ground glass descriptive labels.

ally from above and below. At D and E are placed illuminated ground glass descriptive labels defining the synoptic divisions and describing the interesting features of the central group (A). The light from the windows behind may

be utilized to a large extent during the daytime for illuminating these exhibits with the help of properly arranged reflectors. Colored plates and photographs may be used to good effect on the walls of the hall at the ends of the gallery. (The two latter methods are offered as tentative suggestions for adapting to other museum conditions some of the ideas contained in method no. 1.)

SUPPLEMENTARY SUGGESTIONS.

(1) *Small fishes*.—Some species which should be represented in a synoptic series are so small that they would appear lost if placed directly against the case background. A good setting for such forms is shown in plate cxl. Here two specimens of *Hippocampus hudsonius* are mounted against a colored plaster panel, modeled in relief to give a suggestion of seaweed.

(2) *Small balanced aquaria* of living fishes may be used with good effect at or near the windows of the exhibition hall (pl. cxxxii). They may be either fresh water or marine, and forms may be exhibited from time to time that will be objects of interest in themselves. In such instances, small descriptive labels may be placed near the aquaria to bring out the interesting features. These labels should have removable backs to permit the insertion of new descriptive material as the fish exhibited are changed.

(3) *Colored plates* like those used in the synoptic series may be arranged in panels as wall decorations, as in plate cxxxii. These panels should harmonize with the general color scheme of the exhibit setting and may be devoted to the fauna of specific regions.

(4) *Photographs* of living fish, or illustrating the commercial fisheries, etc., may be used to add interest and attractiveness to the halls.

(5) A *plan* of the hall should be placed at the entrance to aid the visitor in orienting himself and in finding groups of which he may be in search.

(6) Many of the descriptive labels may be effectively illustrated either by indexed outline drawings for the sake of added clearness (pl. cxxxii) or by water-color sketches illustrating interesting habits (pl. cxxxix).

(7) A *special exhibit* of the fishes most abundant locally could be made an attractive feature, or this could be arranged as a seasonal exhibit by changing the fishes to correspond with their seasonal abundance in local waters.

(8) Single specimens may sometimes be artistically mounted on a pedestal, with just a suggestion of accessory setting, as in plate cxli.

PROVISIONAL LIST OF FISHES FOR A SYNOPTIC EXHIBIT.

In the following list selection has been made from species which would fall under the five following classes: (1) Typical forms; (2) commercial forms; (3) peculiar and striking forms; (4) forms with interesting life-habits; (5) forms valuable for illustrating biological phenomena like protective coloration, symbi-

osis, adaptation, etc. Only a tentative selection is given, and many of the species named could be replaced by other forms.

The classification used in the list, as above mentioned, is a combination of the English and American systems, adapted for exhibition purposes.

It is natural that particular emphasis should be laid on North American fishes, and these are chosen to represent the families where possible. More room is also given to commercial fishes than to others.

CLASS PISCES.

SUBCLASS ELASMOBRANCHII.

ORDER PLAGIOTOMI.

Suborder Selachii.

Family Notidanidæ.

Notidanus (Hexanchus) griseus (cow shark).

Family Scylliidæ.

Ginglymostoma cirratum (nurse shark).

Family Galeidæ.

Mustelus canis (dog shark).

Carcharinus lamia (cub shark).

Family Carchariidæ.

Carcharias littoralis (sand shark).

Prionace glauca (great blue shark).

Scoliodon terra-novæ (sharp-nosed shark).

Family Sphyrnidæ.

Sphyrna zygena (hammer-head shark).

Sphyrna tiburo (bonnet-head shark).

Family Alopiidæ.

Alopias vulpes (thresher shark).

Family Lamnidæ.

Carcharodon carcharias (man-eater shark).

Lamna cornubica (porbeagle).

Family Cetorhinidæ.

Cetorhinus maximus (basking shark).

Family Squalidæ.

Squalus acanthias (dogfish).

Family Rhinidæ.

Rhina squatina (angel shark).

Suborder Batoidei.

Family Pristidæ.

Pristis pectinatus (common sawfish).

Family Rhinobatidæ.

Rhinobatus lentiginosus (guitar-fish).

Family Raiidæ.

Raia crinacea (common skate).

Raia levis (barndoor skate).

Family Torpedinidæ.

Tetronarce occidentalis (torpedo).

Family Dasyatidæ.

Dasyatis centrura (sting ray).

Family Myliobatidæ.

Myliobatis freminvillei (eagle ray).

Manta birostris (sea devil).

ORDER HOLOCEPHALI.

Suborder Chimæroidei.

Family Chimæridæ.

- Chimæra monstrosa* (chimæra).
Chimæra collicii (ratfish).
Chimæra purpurascens (purple chimæra).

SUBCLASS DIPNEUSTI.

ORDER MONOPNEUMONA.

Family Ceratodontidæ.

- Neoceratodus forsteri* (Australian lungfish).

ORDER DIPLOPNEUMONA.

Family Lepidosirenidæ.

- Protopterus dolloi* (African lungfish).
Protopterus annectens (African lungfish).
Protopterus athiopicus (African lungfish).
Lepidosiren paradoxa (South American lungfish).

SUBCLASS TELEOSTOMI.

ORDER CROSSOPTERYGII.

Suborder Cladistia.

Family Polypteridæ.

- Polypterus bichir* (bichir).

ORDER CHONDROSTEI.

Family Polyodontidæ.

- Polyodon spathula* (paddlefish).

Family Acipenseridæ.

- Acipenser sturio* (common sturgeon).
Acipenser rubicundus (lake sturgeon).
Scaphirhynchus platyrhynchus (shovel-nose sturgeon).

ORDER HOLOSTEI.

Suborder Rhomboganoidea.

Family Lepisosteidæ.

- Lepisosteus ossæus* (long-nose gar).
Lepisosteus platostomus (short-nose gar).
Lepisosteus tristachus (alligator gar).

Suborder Cycloganoidea.

Family Amiidæ.

- Amia calva* (bowfin).

ORDER OSTARIOPHYSI.

Suborder Nematognathi.

Family Siluridæ.

- Ameiurus catus* (white cat).
Felichthys marinus (gaff-topsail).
Ictalurus punctatus (channel cat).
Ameiurus nebulosus (common bullhead).
Schilbeodes insignis (mad tom).

Suborder Eventognathi.

Family Catostomidæ.

- Catostomus commersonii* (common sucker).

Family Cyprinidæ.

- Moxostoma valenciænum* (common redhorse).
Ictiobus cyprinella (red-mouth buffalo-fish).

ORDER OSTARIOPHYSI—continued.

Suborder Eventognathi—Continued.

Family Cyprinidæ—Continued.

- Cyprinus carpio* (golden carp).
- Campostoma onomalum* (stone roller).
- Semotilus atromaculatus* (horned dace).
- Notropis* sp. (shiner).
- Rhinichthys atronasus* (black-nose dace).

Suborder Heterognathi.

Family Erythrinidæ.

- Macrodon microlepis* (traliira).

Family Characinidæ.

- Brycon dentex* (characin).
- Hydrocyon goliath* (characin).
- Tetragonopterus argentatus* (sardina blanca).

Suborder Gymnnoti.

Family Gymnotidæ.

- Giton fasciatus* (carapo).
- Gymnotus electricus* (electric eel).

ORDER APODES.

Suborder Colocephali.

Family Muraenidæ.

- Lycodontis moringa* (common spotted moray).
- Lycodontis ocellatus* (spotted moray).
- Lycodontis funebris* (black moray).
- Muræna rictifera* (moray).
- Echidna nebulosa* (moray).

Suborder Enchelycephali.

Family Anguillidæ.

- Anguilla chryssypa* (American eel).

Family Leptocephalidæ.

- Leptocephalus conger* (conger eel).

Family Nemichthyidæ.

- Nemichthys scolopæus* (snipe eel).

Family Myridæ.

- Myrophis punctatus* (worm eel).

Family Ophichthyidæ.

- Ophichthys gomesii* (sea serpent).

ORDER MALACOPTERYGII.

Suborder Isospondyli.

Family Elopidae.

- Tarpon atlanticus* (tarpon).
- Elops saurus* (ten-pounder).

Family Albulidæ.

- Albula vulpes* (ladyfish).

Family Hiodontidæ.

- Hiodon tergisus* (moon-eye).

Family Clupeidæ.

- Clupea harengus* (common herring).
- Alosa sapidissima* (American shad).
- Pomolobus pseudoharengus* (alewife).
- Brevoortia tyrannus* (menhaden).

ORDER MALACOPTERYGII—continued.

Suborder Isospondyli—Continued.

Family Salmonidae.

- Coregonus clupeiformis* (common whitefish).
Oncorhynchus tshawytscha (quinnat salmon).
Salmo irideus (rainbow trout).
Salmo sebago (landlocked salmon).
Salmo salar (common Atlantic salmon).
Salvelinus fontinalis (brook trout).
Cristivomer namaycush (Mackinaw trout).

Family Thymallidae.

- Thymallus ontariensis* (Michigan grayling).

Family Argentinidae.

- Osmerus mordax* (American smelt).

ORDER MESICHTHYES.

Suborder Haplomi.

Family Synodontidae.

- Synodus varius* (lizard-fish).
Synodus jayeni (lizard-fish).

Family Ipnopidae.

- Ipnops murrayi* (lantern-eye).

Family Dalliidæ.

- Dallia pectoralis* (Alaska blackfish).

Family Esocidae.

- Umbra pygmaea* (eastern mud minnow).
Esox masquinongy (muskallunge).
Esox reticulatus (pickereel).

Family Peciliidae.

- Fundulus heteroclitus* (common killifish).
Cyprinodon variegatus (sheepshead minnow).
Anableps dowii (four-eyed fish).
Heterandria formosa.

Family Amblyopsidae.

- Typhlichthys subterraneus* (small blindfish).
Amblyopsis spelæus (blindfish of Mammoth Cave).

Suborder Syntognathi.

Family Belonidae.

- Tylosurus caribbaeus* (needlefish).

Family Hemirhamphidae.

- Hyporhamphus roberti* (common half-beak).
Scombrosox saurus (saury).

Family Exocoetidae.

- Fodiator acutus* (sharp-nose flying-fish).
Exocatus volitans (flying-fish).

ORDER THORACOSTRACI.

Suborder Hemibranchii.

Family Gasterosteidae.

- Gasterosteus bispinosus* (common eastern stickleback).
Gasterosteus aculeatus (European stickleback).

Family Fistulariidae.

- Fistularia tabacaria* (trumpet-fish).

ORDER THORACOSTRACI—continued.

Suborder Lophobranchii.

Family Syngnathidæ.

- Siphostoma fuscum* (common pipefish).
- Hippocampus hudsonius* (common sea-horse).
- Hippocampus styliifer* (sea-horse).
- Hippocampus punctulatus* (caballete de mar).
- Hippocampus zostera* (sea-horse).

ORDER ACANTHOPTERYGII.

Suborder Percosoces.

Family Atherinidæ.

- Menidia gracilis* (silverside).

Family Mugilidæ.

- Mugil cephalus* (common mullet).
- Mugil curema* (white mullet).

Family Sphyranidæ.

- Sphyraena borcalis* (northern barracuda).

Family Mullidæ.

- Upeneus maculatus* (red goatfish).
- Upeneus martinicus* (yellow goatfish).

Family Holocentridæ.

- Holocentrus ascensionis* (squirrel-fish).

Family Ammodytidæ.

- Ammodytes americanus* (sand lance).

Suborder Scombriformes.

Family Scombridæ.

- Gymnosarda pflamisi* (oceanic bonito).
- Thunnus thynnus* (tunny).
- Scomber scombrus* (common mackerel).
- Sarda sarda* (bonito).
- Scomberomorus maculatus* (Spanish mackerel).

Family Trichiuridæ.

- Trichiurus lepturus* (cutlass-fish).

Family Istiophoridæ.

- Istiophorus nigricans* (sailfish).

Family Xiphiidæ.

- Xiphias gladius* (common swordfish).

Family Carangidæ.

- Oligoplites saurus* (leather-jacket).
- Caranx hippos* (crevallé).
- Caranx crysos* (runner).
- Vomer setipennis* (moonfish).
- Selene vomer* (lookdown).
- Trachinotus goodii* (great pompano).
- Trachinotus carolinus* (common pompano).

Family Pomatomidæ.

- Pomatomus saltatrix* (bluefish).

Family Coryphænidæ.

- Coryphæna hippurus* (common dolphin).

Family Stromateidæ.

- Poronotus triacanthus* (butterfish).

Family Rachycentridæ.

- Rachycentron canadum* (sergeant-fish).

ORDER ACANTHOPTERYGII—continued.

Suborder Perciformes.

Family Centrarchidæ.

Centrarchus macropterus (round sunfish).

Lepomis auritus (redbreast bream).

Lepomis pallidus (blue-gill).

Family Percidæ.

Stizostedion canadense (sauger).

Perca flavescens (yellow perch).

Ammocrypta pellucida (sand darter).

Family Serranidæ.

Roccus chrysops (white bass).

Roccus lineatus (striped bass).

Morone americana (white perch).

Bodianus fulvus punctatus (nigger-fish).

Epinephelus striatus (Nassau grouper).

Epinephelus adscensionis (rock hind).

Epinephelus guttatus (red hind).

Epinephelus morio (red grouper).

Garruba nigrita (black jewfish).

Centropristes striatus (black sea bass).

Family Priacanthidæ.

Priacanthus arenatus (catalufa).

Family Lutianidæ.

Neomænis griseus (gray snapper).

Neomænis guttatus (flamenco).

Neomænis jocu (dog snapper).

Neomænis apodus (schoolmaster).

Lutianus aya (red snapper).

Lutianus analis (mutton-fish).

Ocyurus chrysurus (yellow-tail).

Family Hæmulidæ.

Hæmulon album (margate-fish).

Hæmulon plumieri (common grunt).

Bathystoma rimator (red-mouth grunt).

Orthopristis chrysopterus (hogfish).

Family Sparidæ.

Calamus bajonado (jolt-head porgy).

Stenotomus chrysops (common scup).

Archosargus probatocephalus (sheepshead).

Archosargus unimaculatus (salema).

Family Gerridæ.

Gerys olisthostomus (Irish pompano).

Family Sciaenidæ.

Cynoscion regalis (common weakfish).

Cynoscion nebulosus (spotted weakfish).

Bairdiella chrysura (mademoiselle).

Sciaenops ocellatus (channel bass).

Micropogon undulatus (croaker).

Menticirrhus americanus (Carolina whiting).

Menticirrhus saxatilis (kingfish).

Pogonias cromis (drum).

Aplodinotus grunniens (freshwater drum).

ORDER ACANTHOPTERYGII—continued.

Suborder Perciformes—Continued.

Family Pomacentridæ.

Eupomacentrus leucostictus (Bean Gregory).*Eupomacentrus fuscus* (Maria Molle).*Abudefduf saxatilis* (cow pilot).

Suborder Pharyngognathi.

Family Labridæ.

Tautoglabrus adspersus (cunner).*Tautoga onitis* (tautog).*Lachnolaimus maximus* (hogfish).*Halichæres* sp.

Family Scaridæ.

Sparisoma abildgardi (red parrot-fish).*Callyodon caruleus* (blue parrot-fish).*Scarus vetula* (old wife).

Suborder Squamipinnes.

Family Ehippidæ.

Chaetodipterus faber (spade-fish).

Family Chaetodontidæ.

Megaprotodon trijascialis.*Pomacanthus arcuatus* (black angel).*Holacanthus tricolor* (rock beauty).*Holacanthus ciliaris* (blue angel-fish).*Chaetodon ocellatus* (isabelita).*Chaetodon capistratus* (parché).*Chaetodon striatus* (butterfly-fish).

Suborder Sclerodermi.

Family Balistidæ.

Balistes vetula (old wife).*Balistes carolinensis* (leather-jacket).*Balistapus rectangulus*.

Family Teuthididæ.

Teuthis caruleus (blue tang).*Teuthis hepatus* (common surgeon-fish).

Family Monacanthidæ.

Monacanthus hispidus (filefish).*Aluterus schæpfi* (orange filefish).

Suborder Ostracodermi.

Family Ostraciidæ.

Lactophrys trigonus (common trunkfish).*Lactophrys bicaudata* (spotted trunkfish).*Lactophrys triqueter* (rock shellfish).*Lactophrys tricornis* (cowfish).

Suborder Gymnodontes.

Family Tetraodontidæ.

Lagocephalus levigatus (smooth puffer).*Spheroides maculatus* (puffer).

Family Diodontidæ.

Diodon hystrix (porcupine-fish).*Chilomycterus schæpfi* (common burrfish).

Family Molidæ.

Mola mola (ocean sunfish).

ORDER ACANTHOPTERYGII—continued.

Suborder Scleroperci.

Family Scorpaenidae.

- Sebastes marinus* (rosefish).
Sebastes constellatus (spotted rockfish).
Sebastes rosaceus (corsair).

Family Cottidae.

- Cottus ictalops* (miller's-thumb).
Myoxocephalus octodecimspinosus (long-spined sculpin).
Hemitripterus americanus (sea-raven).

Family Triglidæ.

- Prionotus carolinus* (common gurnard).
Prionotus strigatus (northern striped gurnard).

Family Cephalacanthidae.

- Cephalacanthus volitans* (flying robin).

Family Cyclopteridæ.

- Cyclopterus lumpus* (lumpfish).

Family Liparididæ.

- Liparis liparis* (sea-snail).

Suborder Gobiiformes.

Family Gobiidae.

- Dormitator maculatus* (pañeca).
Gobius oceanicus (esmeralda).
Typhlogobius californiensis (blind goby).

Suborder Discocephali.

Family Echeineididæ.

- Echeinis naucrates* (shark-sucker).
Remora remora (remora).

Suborder Jugulares.

Family Malacanthidae.

- Malacanthus plumieri* (matajuelo blanco).
Caulolatilus princeps (blanquillo).
Lopholatilus chamaeleonticeps (tilefish).

Family Uranoscopidae.

- Astroscopus y-gracum* (electric stargazer).

Family Batrachoididae.

- Opsanus tau* (toadfish).
Porichthys notatus (singing-fish).

Family Gobiessocidae.

- Gobiesox virgatulus* (clingfish).

Family Blenniidae.

- Pholis gunnellus* (butterfish).
Lumpenus lampetraformis (snake blenny).
Labrisomus nuchipennis.

Family Anarhichadidae.

- Cryptacanthodes maculatus* (wry-mouth).
Anarhichas lupus (wolf-fish).

Family Zoarcidae.

- Zoarces anguillaris* (eel pout).

Family Fierasferidae.

- Fierasfer affinis* (pearlfish).

ORDER ACANTHOPTERYGII—continued.

Suborder Tæniosomi.

Family Regalecidae.

Regalecus glesne (oarfish).^a

Family Trachypteridae.

Trachypterus rex-salmonorum (king-of-the-salmon).^a

Suborder Anacanthini.

Family Merlucciidae.

Merluccius merluccius (European hake).*Merluccius bilinearis* (whiting).

Family Gadidae.

Gadus callarias (common cod).*Microgadus tomcod* (tomcod).*Pollachius virens* (pollock).*Melanogrammus aeglefinus* (haddock).*Lota maculosa* (burbot).*Molva molva* (ling).*Urophycis tenuis* (squirrel hake).*Enchelyopus cimbrius* (four-bearded rockling).*Brosme brosme* (cusk).

Family Macrouridae.

Macrourus bairdii (common rat-tail).

Suborder Heterosomata.

Family Pleuronectidae.

Hippoglossus hippoglossus (halibut).*Paralichthys dentatus* (summer flounder).*Paralichthys oblongus* (four-spotted flounder).*Limanda ferruginea* (rusty dab).*Pseudopleuronectes americanus* (winter flounder).*Hippoglossoides platessoides* (sand dab).*Lophopsetta maculata* (window-pane).

Family Soleidae.

Achirus fasciatus (American sole).*Symphurus plagusia* (tongue-fish).

ORDER PEDICULATI.

Family Lophiidae.

Lophius piscatorius (common angler).

Family Ceratiidae.

Cryptopsaras coucui (sea-devil).

Family Antennariidae.

Pterophryne histrio (sargassum-fish).*Antennarius occlatus* (frogfish).

Family Malthidae.

Ogcocephalus vespertilio (batfish).*Maltha maltha*.^a Rare. To be represented by colored plates or drawings.

APPENDIX.

SUGGESTIONS FOR SUBJECTS FOR ILLUSTRATIVE MUSEUM FISH GROUPS.

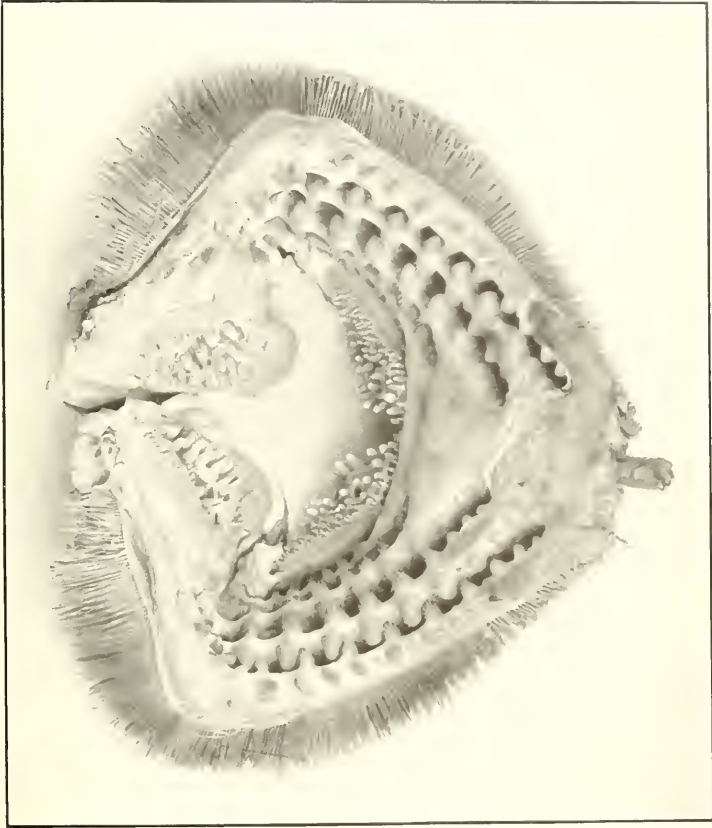
(See pages 1318-1319.)

- Order Plagiostomi: Cnb-shark with shark-sucker. (Commensalism.)
 Transitional forms—shark to skate. (Evolution and adaptation.)
- Order Holocephali: Life history of *Chimara collicii*. (Growth and development.)
- Subclass Dipnensi: Nesting and burrowing habits of *Protopterus*.
- Order Chondrostei: Feeding habits of *Polyodon spathula*. (Also adaptation.)
- Order Holostei: Nesting and feeding habits of *Amia calva*. (Instincts.)
- Order Ostariophysi: Land habits of *Doras*. (Possible evolution in progress.)
- Order Apodes: Life history of the common eel. (Metamorphosis.)
 Group of morays. (Adaptation.)
 Deep sea saccopharyngids. (Adaptation.)
- Order Malacopterygii: Humpbacked or hooknosed salmon. (Sexual dimorphism.)
 Salmon leaping. (Instincts.)
- Order Mesichthyes: Four-eyed fish (*Anableps dowii*). (Adaptation.)
 Blindfish—cave fauna. (Degeneration; adaptation.)
 Group of flying fishes. (Adaptation.)
- Order Thoracostraci: Breeding habits of stickleback. (Instincts.)
 Group of sea horses. (Specialization; protective resemblance.)
- Order Acanthopterygii:
 Suborder Percosoces: Habits and adaptations of *Anabas scandens*.
 Suborder Scombriformes: Life history of *Selene vomer*. (Metamorphosis.)
Nomeus gronovii and *Physalia arethusa*. (Symbiosis.)
 Suborder Perciformes: Nesting habits of the gourami (*Osphrromenus olfax*). (Instincts.)
 Suborders Perciformes, Pharyngognathi, Squamipinnes, Sclerodermi, and Gymnodontes: Tropical coloration and degeneration.
 Suborder Scleroparei: Group of toadfishes, sea-robins and sea-ravens to illustrate adaptation to bottom life and protective resemblance.
 Suborder Jugulares: Group of *Fierasjer acus* and holothurians to illustrate symbiosis.
 Suborder Heterosomata: Life history of flounder. (Metamorphosis, adaptation to bottom life, and protective resemblance.)
- Order Pediculati: Group of deep-sea fishes illustrating adaptation.

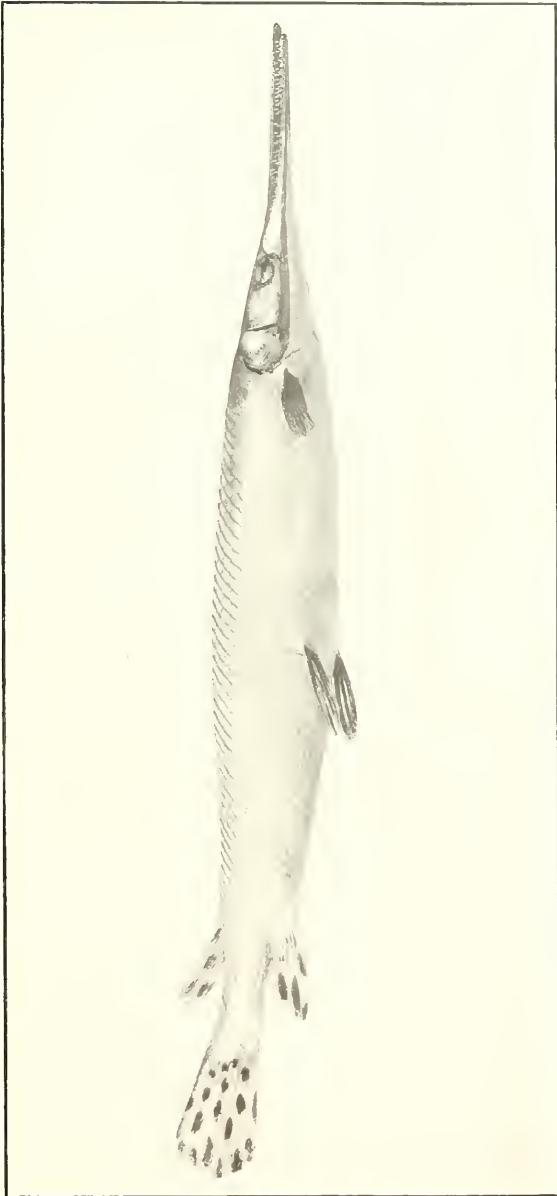
NOTE.—In several instances two or more of the above suggestions could be advantageously combined in a single group, illustrating several biological principles in one exhibit.



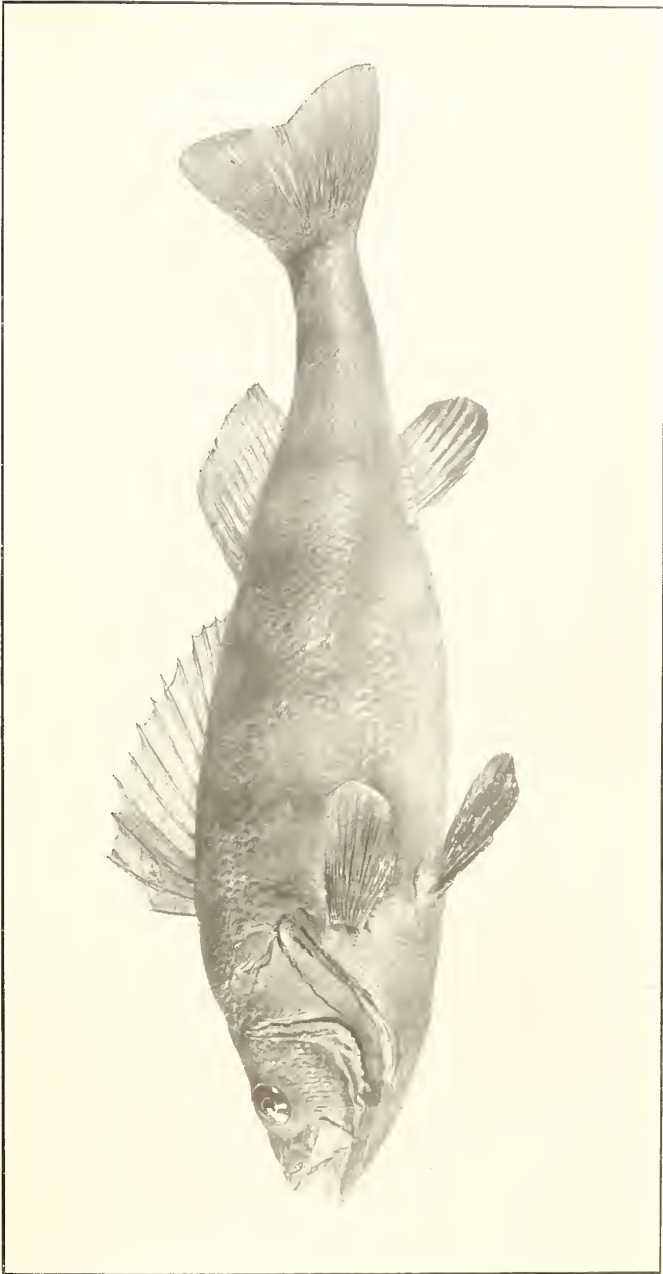
Typical synoptic case used in "corridor arrangement" for exhibition of fishes.



Section showing gill arches and pharyngeal teeth of the channel bass, *Sargocentrus*. This illustrates the kind of alveolar material to be used in necessary anatomical exhibits.



Mounted and painted skin of the long-nosed gar (*Lepisosteus osseus*), the hard-enameled scales of which may be advantageously treated in this way.



Mounted and painted skin of yellow perch, *Perca flavescens*.



One of the cases devoted to the perch group, showing methods of utilizing formal plates and frames.

THE FISHES

CLASS PISCES



A MACKEREL

Fishes may be defined as jaw-bearing, back-boned animals, adapted in shape, method of breathing, and method of locomotion for an aquatic life.

In shape, they are spindle-like, thus offering little resistance to the water when swimming.

They breathe by means of *gills*, organs adapted to purify the blood by the oxygen contained in the water. In most fishes the gills are protected by a gill-cover, the *operculum*.

The chief organ of locomotion is the powerful *tail*, which is aided more or less by the paired *pectoral* and *pelvic fins*, which correspond to the fore and hind limbs of land animals. The paired fins, however, act chiefly as balancers.

The median dorsal and anal fins act as keels and give stability to the fish.

Besides an internal cartilaginous or bony skeleton, fishes usually possess an outer *exoskeleton* of spines, denticles, scales or bony plates.

An *air-bladder* is frequently present, and serves as a float, except in the Dipneusti, where it acts as a lung and aids the gills in purifying the blood.

Fishes also possess highly organized eyes, paired *organs of hearing*, and a peculiar series of sense-organs arranged along the side to form the *lateral line*.

Fishes are divided into three subclasses as follows:

CLASS PISCES

(One Class)

Subclass Eurypteropteri
(Two or Three Classes)

Subclass Dipneusti
(One Class)

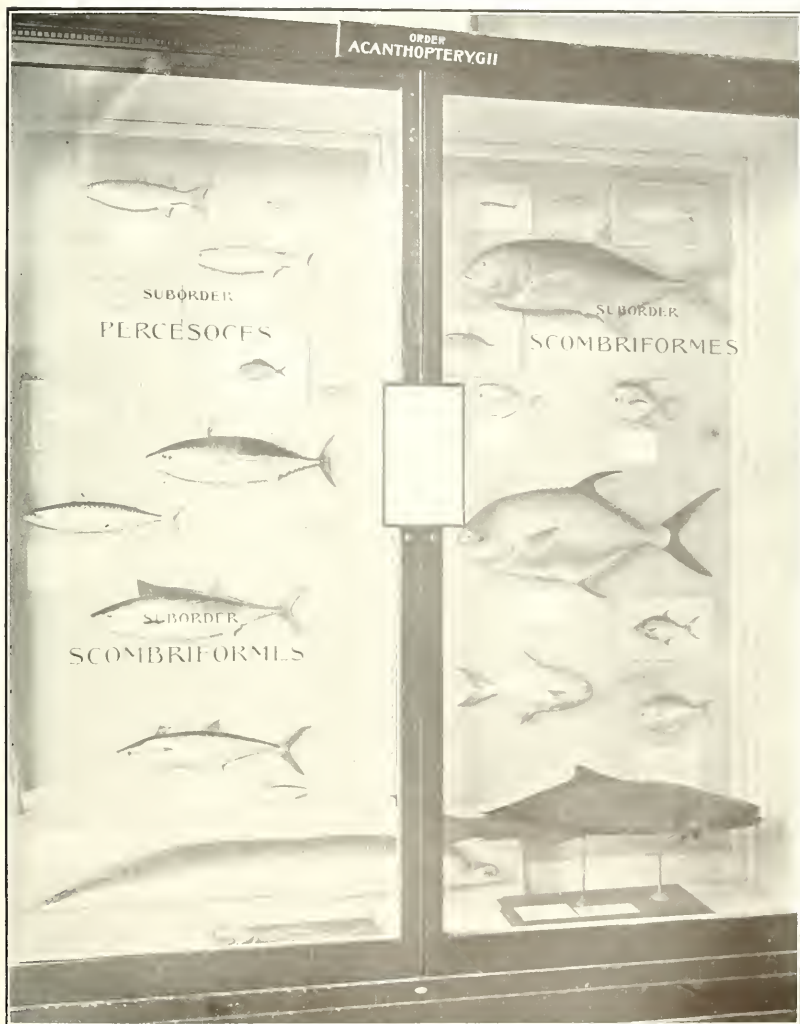
Subclass Teleostei
(One Class)

In the above all the subclasses are indicated by the long legs, excepted from the outline. For further subdivisions consult the case-labels.

General label defining class Pisces. Framed copies of this label are placed in various parts of the fish hall. The figure of the mackerel at the top is drawn in by hand. A different species is represented on every copy of the label, carrying with it a label in forms near which it is placed.



A corner in the fish corridor, showing the subclass signs suspended from the ceiling, the use of aquaria, and colored plates in panels for descriptive purposes.



A typical case illustrating the arrangement of specimens and the method of indicating classification.



A typical case with doors open, showing character of material used.

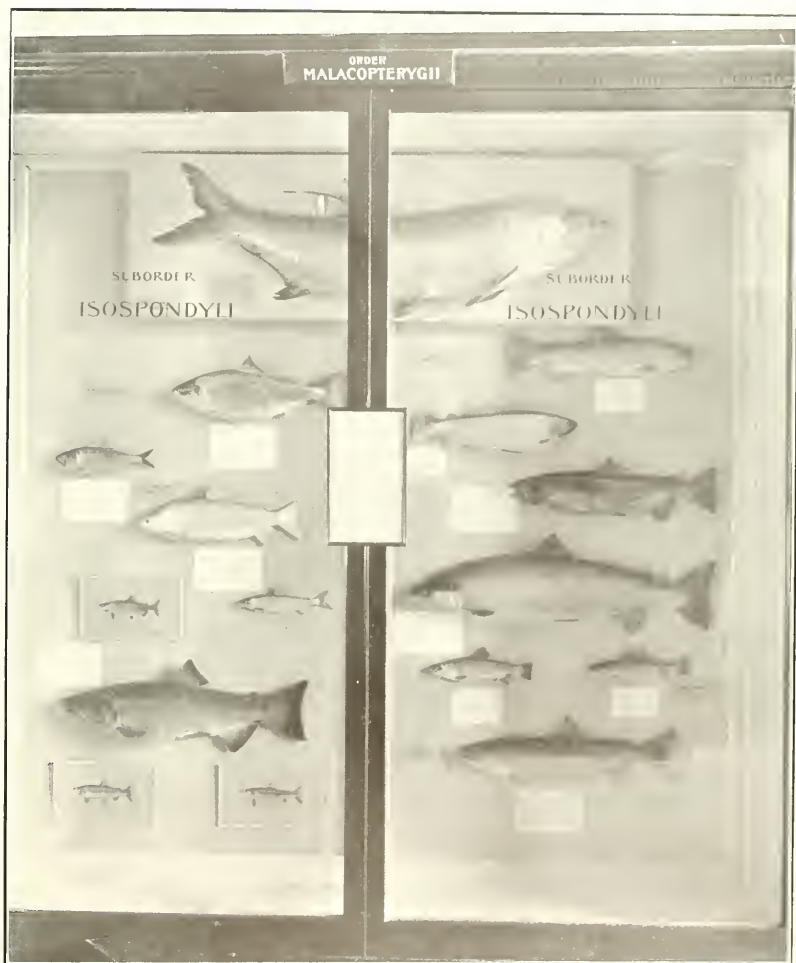
ORDER
PLAGIOSTOMI

SUBORDER
SELACHII

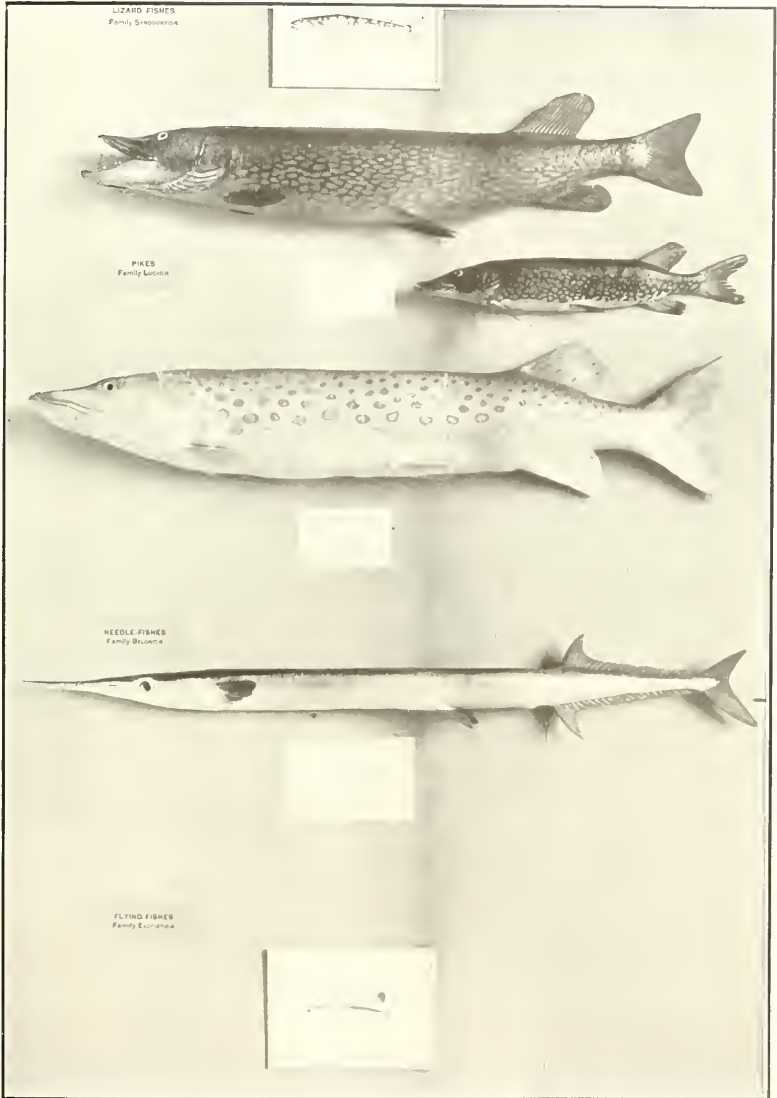
SUBORDER
SELACHII

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One of the shark cases.



Case devoted to the trout group. The method of indicating the suborder is well shown in this figure. The case label, hanging on the front of the case, contains a definition of the suborder.



A portion of the case devoted to the Haplomi, illustrating the use of family labels and the method of separating the families by means of strips of tape.



Method of treating large specimens to form friable preservation.

BURROWING HABIT OF THE AFRICAN LUNG-FISH

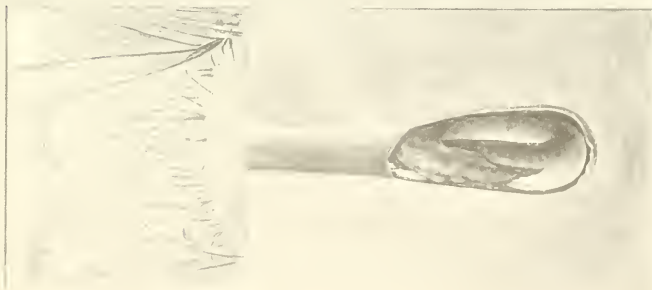
The accompanying illustration shows the manner in which the Lung-fish of the Nile and Congo (*Protopterus*) spends the dry season when the waters of those rivers have receded and left the mud-flats along the banks to bake in the sun.

As this curious creature possesses both lungs and gills, it is able to breathe either in water or air. During the time of flood it swims about the marshes along the bank searching for food and breathing by means of its gills like any ordinary fish. But in the dry season, as the waters recede, instead of seeking the river channel it burrows about 18 inches down into the mud, and coils up as shown in the figure.

It then secretes from its skin-glands a gelatinous substance which entirely covers its body, and hardens to form a cocoon-like envelope. A small opening, however, is left at the mouth of the fish, and a narrow tube is formed continuous with the envelope and connecting with the lung-cavity.

Thus the animal is enabled to pass the dry season in a dormant state, breathing air like the Amphibians, with the ancestors of which it is doubtless closely connected.

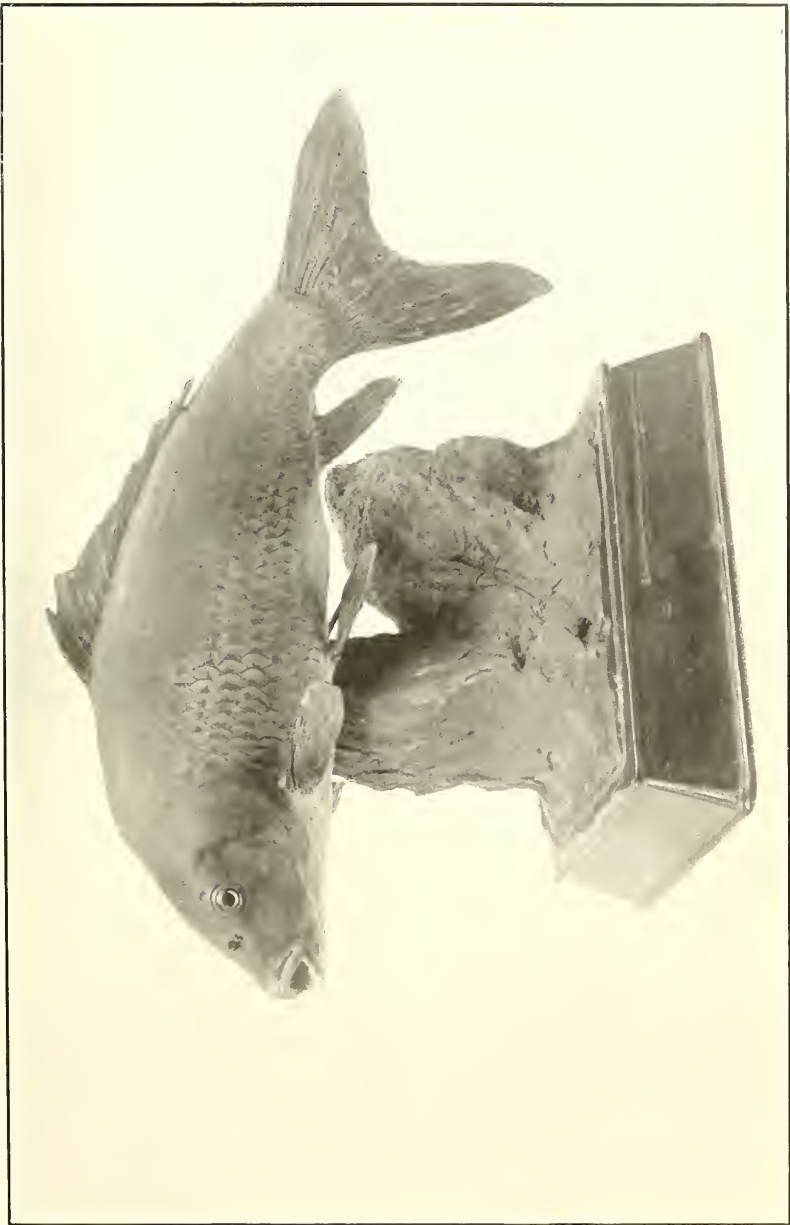
While the Lung-fish is in this condition, the mud in which it lies has often been cut into blocks and transported to England and America, and when placed in water in a warm room the fish emerges and resumes its active state, apparently as lively as ever.



Type of label describing a life-habit, illustrated by water-color sketch.



Method of treating small fishes. The photograph is actual size.



A method of mounting a single specimen.

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