OUTLINE FOR AN EDUCATIONAL ·EXHIBIT OF FISHES

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By FREDERIC A. LUCAS,

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An educational exhibit of fishes is one that will convey to the average visitor an idea of the distinctive characters and anatomical structure of this zoological group and its larger divisions, and also afford information as to the appearance, special modifications, and, so far as possible, habits of typical members of these subdivisions.

First of all should be shown examples of the lancelet, lampreys, ostracophores, sharks, and one of the bony fishes, to show the various classes of vertebrates embraced in the term "fishes." This part of the exhibit should include, so far as possible, skeletons of these forms, accompanied by diagrams and explanatory labels, to make clear the characters of the various groups represented and illustrate the meaning of Acrania, Craniota, and Gnathostomata.

Then should come specimens showing the resemblances and differences between Elasmobranchii and Teleostomi, as well as the peculiarities of their skeletal, nervous, circulatory, and digestive systems. These series should preferably be displayed side by side, and should include not only actual specimens but drawings and models, especially in cases where the natural objects are so small as not to be readily seen. Here should be shown dissections of the arterial and nervous systems, and enlarged, explanatory models of more important details. For example, a dissection would show the relation of the heart to the gills and a model the structure and peculiarities of the heart.

Emphasis should be laid on the more apparent and more important characters, since as this exhibit is for the general public it should not go too much into details or attempt to display and explain characters not readily comprehended; such matters are for books and for the student.

The exhibits just described are intended to serve as a preface or introduction to the systematic series of fishes and should stand by themselves in order to be the more readily understood.

The more evident characters of the subclasses and orders are to be shown in connection with these divisions or groups in the systematic exhibit; at the same time a good-sized chart or diagram illustrating the relations of fishes to

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other vertebrates and the primary divisions within the class, might well be introduced here.

The systematic series of fishes is to form the principal portion of the collection and is to include typical examples of the various subclasses and orders. It should not be too large and it should as a rule be confined to the more characteristic forms. The object of this series is to show the main divisions of fishes and give the observer an idea of their general appearance. To multiply forms and individuals would therefore be confusing and defeat the very object in view.

In selecting specimens to represent the various groups, preference should be given to the more characteristic and better-known species and, so far as possible, to species common in the vicinity[a] where the exhibit is to be displayed. The more common the species the more familiar is it to the observer, the more readily will he associate it with the fact illustrated, and the more forcibly will that fact be impressed upon him. The educational value of a specimen does not depend on its rarity but on the clearness with which it shows the fact it is intended to illustrate.

The larger extinct groups should be represented both by their fossil remains and by models or pictures, and important or readily obtainable fossil forms should be introduced in their proper places among existing species. In no way save by the use of fossils can a proper idea be given of the relationships of various groups and of their relative importance at the present time and during past geologic history.

As an adjunct to the systematic series there should be groups or pictures illustrating important or interesting points in the habits of fishes, such as the sargassum fish and stickleback with their "nests," the sunfish and its nest, the remora clinging to a shark, etc.

Small series or assemblages of fishes peculiar to certain localities or habitats could be introduced to advantage; thus a series of deep-sea forms would emphasize the peculiarities of the abyssal fauna and the remarkable modifications for life at great depths. Examples of deep-sea fishes should also be shown in their respective groups to illustrate the facts that the deep-sea fauna has been derived from that of the shallower seas and that resemblances that exist between them are largely due to adaptations toward one end—life in the depths of the sea.

One of these "supplementary series" might be devoted to the brilliant fishes of tropical waters, attention being called to the contrast they offer to the modest colored but important food fishes of temperate regions. In such "sup-

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[a] For example, a museum located near the Atlantic or Pacific coast should draw for its examples, so far as possible, upon the salt water fishes, while an inland museum should select as many examples as possible from the lakes and rivers. This naturally would be practicable only to a limited extent, owing to the fact that even the most scanty representation of the principal groups of fishes calls for many species.

plementary" displays might be illustrated the difference between the sluggish bottom-frequenting species, the active pelagic forms, and the highly modified species from the abyssal regions of the sea. Here it would be necessary to call in the aid of the artist to illustrate the adaptations to environment and show how the colors of some fishes blend in with the rocks and waving sea weeds.

Among the special series, or series illustrating modification for offense and defense, for capturing food, or escaping devourers, come phosphorescent and electrical fishes. Another of these special series might well be an exhibit of game fishes, and this should be mounted as artistically as possible, with specially designed backgrounds and surroundings. Such an exhibit could be made very attractive without being in the least garish. These various series should be kept by themselves. The object of the systematic part of the exhibit is to display as plainly as possible the orders and higher groups of the class of fishes, and these distinctions should be made as clear as possible for the sake of the general visitor, for whose benefit the exhibition part of a museum is provided. The number of specimens, also, should be carefully kept down in order not to tire the visitor and confuse him with a multiplicity of forms; but there should be no hesitancy in using several specimens of the same fish if needed to illustrate more than one fact.[a] It may even be questioned if such repetition may not be advisable in order to drive home and clinch the fact that a common species is none the less a typical one and that mere rarity does not in itself mean anything.

The questions of whose classification to adopt and how it may best be illustrated are not easy to answer, because no two systematists are agreed as to the relative importance and exact position of certain groups. In the outline here presented the classification employed by Doctor Jordan in his Guide to the Study of Fishes has been followed, partly as a matter of convenience and partly on account of the amount of information contained in the book. Practical difficulties in the way of displaying any group of animals are met with in the limitations and disposition of space available for such exhibits. In many ways it seems best to indicate the divisions adopted and arrangement followed on a large label, number the orders, and repeat these numbers on the labels.

One of the physical difficulties encountered in arranging exhibits is that animals of very different sizes may be zoologically related,[b] rendering it difficult to place the specimens at once in their proper order and to permit the smaller specimens to be seen. To preserve a balance by exhibiting small examples of such species as reach a large size is to give a wrong impression to the beholder,

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[a] Burt Wilder notes this in his "Educational Museums of Vertebrates," showing how the same species may be used for several purposes.

[b] Such an instance among mammals is the relationship of rhinoceros, hyrax, and elephant.

and it is a difficult matter to correct by information on a label the effect produced by the specimens themselves. By adopting the method suggested of numbering the orders or families in accordance with a given scheme of classification the smaller animals may be placed where they may be readily seen.

If small examples of fishes that reach a large size are undesirable because they give a wrong impression to the beholder, unusually large individuals are to be ruled out for the same reason—that they give an exaggerated and incorrect idea of the species illustrated. Such specimens may, however, be shown by themselves or where they will have a decorative value, the fact that they are of exceptional size being plainly noted on the label.

It is to be constantly borne in mind that exhibits are for the public; that the average visitor is not given to studying exhibits; and that every effort should be made to have the objects shown illustrate and press home the meaning of the ideas they are intended to convey. Such being the case, the specimens chosen for display should be typical of the group or fact they are intended to illustrate. Rare or unfamiliar species should be eschewed so far as possible, for their very rarity is a drawback and militates against their teaching power.

No provision has been made in this plan for exhibiting fishery products, or methods of capturing fish, though much information in regard to such matters might be noted on the labels. There is a temptation to extend in these directions, but such exhibits should properly be kept apart, if for no other reason than the large amount of room demanded and the difficulty of telling just where to stop. Technological and commercial exhibits are capable of almost indefinite extension, and to deal with the subject of fisheries alone calls for a large museum.

No hard and fast line can be drawn as to the character of the material used for display; alcoholic specimens, casts, mounted fishes, plates, all have their uses and in some one particular each has its superiority to the others. As a rule the writer believes thoroughly good casts of fishes to be superior to other preparations for exhibition purposes, and this is particularly true of large or smooth-skinned species. For small species alcoholics, mounted in flat jars, are to be preferred, and wherever enlarged models are shown they should, if possible, be accompanied by alcoholics. The public always likes to see "the real thing" and know on what foundation a restoration or an enlargement is constructed. The preferable mode of arrangement is believed to be the alcove system with cases 9 feet high on three sides and a table or other low case in the center. An ideal method would be to have the systematic series on one side of a broad aisle, and the supplementary or special series on the other with any groups of fishes in a dark corridor close by, but the arrangement must of necessity conform to the limitations placed upon it by the plan of the building in which it is displayed.

It is believed that such an exhibit as that outlined in this paper is quite within the reach of a museum, even of moderate size. Naturally it could not be brought together all at once, but it might be assembled gradually, taking for immediate display such species as were available and waiting for the others to be acquired. Where vacancies occurred, due to the lack of species needed for the representation of important groups, this might be noted on a label, or in many instances a figure of the fish might be shown. This would call attention to the needs of the collection and might lead to securing desirable specimens.

The systematic series calls for about 175 specimens, including fossils, 44 skeletons and other anatomical pieces, and 13 figures in cases where species are rare or small; a total of 230 specimens. This may seem a small number to represent a group containing over 13,000 living species, but it would be an easy matter to add systematically to such a collection, while, on the other hand, it is believed to present a fairly good idea of the extent and principal modifications of the group.

SYNOPSIS OF ARRANGEMENT AND LIST OF PRINCIPAL SPECIMENS TO BE SHOWN.

INTRODUCTORY DISPLAY.

Fishes and fish-like vertebrates, showing the forms popularly known as fishes—the lancelet, lamprey, ostracophore, and dogfish, and the bass or other acanthopterygian. To be accompanied by skeletons and figures to make clear the meaning of such terms as Acrania, Craniota, and Gnathostomata.

THE CLASSES ELASMOBRANCHII AND TELEOSTOMI COMPARED AND CONTRASTED.

Skull of shark showing that the cranium is a mass of calcified cartilage and not composed of separate bones, and showing the manner in which the jaw is connected with the cranium. Specimen showing the separate gill openings.

Skull of bony fish, cast or specimen showing single gill opening and flap.

ANATOMY OF FISHES.

Cast showing the external topography of a fish with the name of the principal parts or regions.

Skeleton; dermal bones to be removed from one side of the skull.

Cranium of fish compared with that of mammal, the corresponding bones similarly colored. To illustrate great differences between the two groups.

Model showing the general anatomy of a teleost fish.

Dissections, accompanied by models, showing nervous and circulatory systems.

Specimens and models showing the development of a fish.

SYSTEMATIC SERIES OF FISHES.

Comprising characteristic examples of the various orders and suborders of the classes popularly known as fishes, and including specimens showing the more important or apparent characters of these groups. To consist of alcoholic and mounted fishes, casts, and anatomical specimens.

A detailed list is subjoined.

SPECIAL OR SUPPLEMENTARY EXHIBITS.

Fishes of tropical waters, showing their brilliant coloring. To be shown in a group.

Fishes of temperate seas.

Deep-sea fishes, showing their modifications for life at great depths.

Fishes of shallow waters, illustrating modifications in form and color for concealment. To be shown in one or several groups.

Electrical fishes.

Phosphorescent fishes.

Exhibit of game fishes.

Small groups, illustrating nesting habits of such fishes as *Amia*, sunfish, stickleback, chub, etc. Rarer examples may be added where obtainable.

DETAILED LIST OF FISHES FOR EXHIBIT.

Class ELASMOBRANCHII.
    Order PLEUROPTERYGII.   Extinct.
        Cladoselache, model.
    Order ACANTHODII.   Extinct.
        Acanthodes, figure.
        Diplacanthus, figure.
    Order ICHTHYOTOMI.   Extinct.
        Pleuracanthus, figure.
        Pleuracanthus, teeth and spines.
    Order NOTIDANI.
        Notidanus, cast.
        Notidanus, jaw or teeth.
    Order ASTEROSPONDYLI.
        Section of vertebra showing structure.
        Lamna, cast and teeth.
        Carcharodon, cast and jaws or teeth.
        Carcharodon, teeth of extinct *C. megalodon*.
        Cestracion philippi, cast or mounted specimen; skeleton, or at least teeth.

Class ELASMOBRANCHII—Continued.
    Order TECTOSPONDYLI.
        Section of vertebra showing structure.
        Squalus.
        Pristiophorus.
        Squatina.
        Rhinobatus.   To be shown mainly by
        Raja.   casts.
        Torpedo.
        Myliobatis.
        Pristis.
        This number of specimens is desirable to show the transition from sharks to rays.
    Order HOLOCEPHALI.
        Chimæra.
        Chimræa, skeleton.
Class OSTRACOPHORI.
    Order HETEROSTRACI.
        Lanarkia, casts and figures.
        Pteraspis.

Class OSTRACOPHORI—Continued.
    Order OSTEOSTRACI.
        Cephalaspis, specimens, or casts, and models.
    Order ANTIARCHI.
        Pterichthys, specimens, or casts, and models.
        Bothriolepis.
    Order ANASPIDA.
        Birkenia, casts and drawings.
    Order ARTHRODIRA.
        Coccosteus, cast and model.
        Dinichthys (if possible).
Class TELEOSTOMI, true-mouthed fishes.
  Subclass CROSSOPTERYGII.
    Order HAPLISTIA. Extinct.
        Tarassius, figure.
    Order RHIPIDISTIA. Extinct.
        Holoptychius, cast.
        Gyroptychius, figure.
    Order ACTINISTIA. Extinct.
        Undina, good figure.
    Order CLADISTIA.
        Polypterus, and skeleton, large figure or model of fin.
  Subclass DIPNEUSTA.
    Order DIPNOI.
        Neoceratodus } and skeleton of one spe-
        Lepidosiren } cies.
  Subclass ACTINOPTERI.
    Order LYSOPTERI. Extinct.
        Catopterus redfieldius, specimens.
    Order CHONDROSTEI, sturgeons.
        Acipenser, and small skeleton.
        Scaphirhynchus.
    Order SELACHOSTOMI.
        Polyodon, and skeleton.
    Order PYCNODONTI. Extinct.
        Gyrodus, cast and figure.
    Order LEPISOSTEI.
        Lepisosteus, vertebrae to show the procœlous type.
        Lepisosteus, and skeleton.
    Order HALECOMORPHI.
        Amia, and skeleton.

Class TELEOSTOMI, true-mouthed fishes—Con.
  Subclass TELEOSTEI, true bony fishes.
    Order ISOSPONDYLI.
        Salmo; Diplomystus, fossil.
        Coregonus.
        Alosa.
        Tarpon.
        Albula.
        Osteoglossum.
        Stomias, Chauliodus, deep-sea forms.
    Suborder INIOMI.
        Synodus, Ipnops, Diaphas, Myctophum— deep-sea forms.
    Order APODES.
        Anguilla, skeleton or at least skull.
        Anguilla.
        Muræna, skull.
        Gymnothorax.
        Leptocephalus, figures showing development of eel.
    Suborder LYOMERI.
        Gastrostomus, deep-sea forms.
        Saccopharynx.
    Order HETEROMI.
        Notacanthus.
  Series OSTARIOPHYSI.
    Order HETEROGNATHI.
        Serrasalmo, the caribe.
    Order EVENTOGNATHI.
        Cyprinus, and skeleton.
        Notropis, or similar form.
        Semotilus.
        Abramis.
        Good large examples of pharyngeal teeth.
        Catostomus as typically American).
        Ictiobus.
    Order NEMATOGNATHI.
        Arius, spine of large species.
        Ictalurus, and skeleton.
        Ameiurus.
        Malapterurus.
        Schilbeodes.
        Clarias.
        Loricaria.
        Callichthys.
        Gymnotus.

Class TELEOSTOMI, true-mouthed fishes—Con.
  Series OSTARIOPHYSI—Continued.
    Order SCYPHOPHORI, African "elephant-fish."
      Mormyrus.
      Gymnarchus.
    Order HAPLOMI.
      Esox, and skeleton.
      Umbra.
      Anableps.
      Fundulus.
      Gambusia.
      Amblyopsis.
    Order XENOMI.
      Dallia.
    Order ACANTHOPTERYGII.
      Suborder SYNENTOGNATHI.
        Belone.
        Exocœtus, and skeleton.
        Hemirhamphus.
      Suborder PERCESOCES.
        Atherina
        Mullus
        Mugil.
        Sphyræna.
        Polynemus or *Polydactylus*, shoulder
          girdle to show structure.
    Order PHTHINOBRANCHII.
      Fistularia, skeleton.
      Gasterosteus, shoulder girdle and enlarged
        drawing.
      Syngnathus.
      Hippocampus.
      Pegasus.
      Suborder SALMOPERCES.
        Percopsis.
        Lampris (if possible).
        Semiophorus (or even cast).
        Zeus faber, and skeleton.
    Order BERYCOIDII.
      Beryx, cranium showing orbitosphenoid.
      Holocentrus.
      Monocentris.
    Order PERCOMORPHI.
      Scomber.
      Trichiurus.
      Xiphias.
      Carangus, and skeleton.
      Coryphæna.
      Gastronemus, fossil.
      Suborder PERCOMORPHI.
        Aphredoderus.
        Roccus, skeleton.

Class TELEOSTOMI, true-mouthed fishes—Con.
  Series OSTARIOPHYSI—Continued.
    Order PERCOMORPHI—Continued.
      Suborder PERCOMORPHI—Continued.
        Eupomotis.
        Micropterus.
        Perca.
        Stizostedion.
        Etheostoma.
        Asineops, fossil.
        Promicrops.
        Epinephelus.
        Priacanthus.
        Lutianus.
        Hæmulon.
        Upeneus.
        Cynoscion.
        Chiasmodon.
        Lopholatilus.
      Suborder LABYRINTHINCI.
        Anabas scandens, if possible in climbing
          attitude.
      Suborder HOLCONOTI.
        Cymatogaster, with young
        Hypsurus.
        Embiotoca.
      Suborder CHROMIDES.
        Heros.
        Priscacara, fossil.
        Pomacentrus.
      Suborder PHARYNCOGNATHI.
        Tautoga, skull showing enlarged pharyn-
          geals.
        Ctenolabrus, cunner.
        Scarus, skull with pharyngeals, or allied
          form.
        Pseudoscarus.
        Sparisoma.
    Order SQUAMIPINNES.
      Chætodipterus, skeleton.
      Chætodon.
      Holacanthus.
      Acanthurus or *Teuthis.*
    Order PLECTOGNATHI.
      Balistes, skeleton.
      Balistes.
      Monacanthus.
      Lactophrys.
      Lactophrys, skeleton.
      Lagocephalus.
      Sphæroides.
      Diodon.
      Mola

Class TELEOSTOMI, true-mouthed fishes—Con.
  Series OSTARIOPHYSI—Continued.
    Order PAREIOPLITAE.
      Sebastes or *Sebastodes,* skeleton or skull.
      Sebastes.
      Scorpæna.
      Synanceia.
      Trigla.
      Cottus.
      Cottus, skeleton.
      Cyclopterus.
      Cephalacanthus.
    Suborder GOBIOIDEI.
      Gobius, specimen showing the ventrals joined to form a sucking disk.
      Periopthalmus on tree.
      Typhlogobius (if possible).
    Suborder DISCOCEPHALI.
      Echeneis.
      Echeneis, skeleton showing modified fin one showing top of head.
      Elacate.
    Suborder TÆNIOSOMI.
      Regalecus.
      Trachypterus.
    Order HETEROSOMATA.
      Skeleton of good-sized specimen.
      Platophrys.
      Lophopsetta.
      Hippoglossus.

Class TELEOSTOMI, true-mouthed fishes—Con.
  Series OSTARIOPHYSI—Continued.
    Order HETEROSOMATA—Continued.
      Paralichthys.
      Solea.
      Symphurus.
    Suborder JUGULARES.
      Uranoscopus or *Astroscopus.*
      Blennius.
      Anarichas, skull.
      Anarichas.
      Zoarces.
      Brotula.
      Opsanus tau.
    Order OPISTHOMI.
    Order ANACANTHINI.
      Gadus.
      Gadus, skeleton.
      Lota (as a fresh-water form).
      Cælorhynchus, grenadier.
      Albatrossia or *Steindachnerella,* deep-sea form.
    Order PEDICULATI.
      Lophius.
      Lophius, skeleton.
      Cryptosaras, deep sea.
      Ceratias, deep sea.
      Antennarius.
      Ogcocephalus, Malthe.