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Identification of Fish Eggs

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A wide variety of egg types exists among teleost fishes in both freshwater and marine environments. Eggs may be pelagic and nonadhesive or demersal and either adhesive or not. They may possess a variety of specialized structures aiding in flotation or attachment. Depending on egg type and associated reproductive ecology, many characters are useful in identification. These characters have been reviewed for pelagic marine eggs by Rass (1973), Robertson (1975a), Russell (1976), and Ahlstrom and Moser (1980); we have liberally and extensively drawn from the latter. Important characters for other egg types have been discussed in part by Balon (1975a, 1981a), Hardy (1978a, b), Jones et al. (1978), and Snyder (1981). Characters such as size and possession of oil globules are important for all types; however, perivitelline space and chorion sculpturing are more important in pelagic eggs, while in demersal eggs special coatings, chorion thickness, or nature of egg deposition may be more useful.

A wealth of potential characters useful in egg identification exists; however, it is still difficult to identify eggs of most species with certainty. Except for late stages, few may be recognized at the species level. Some characters are useful at a family level, but presently it is not productive to speculate on the systematic significance of any characters (see Kendall et al., this volume). Presently, the main goal of taxonomy with respect to fish eggs is identification.

Regardless of egg type or reproductive ecology, a summary of identification characters useful to an egg taxonomist is presented. Additionally, we recommend using available literature for reference and encourage the building of local fish egg collections. We follow Ahlstrom and Ball (1954) in subdividing

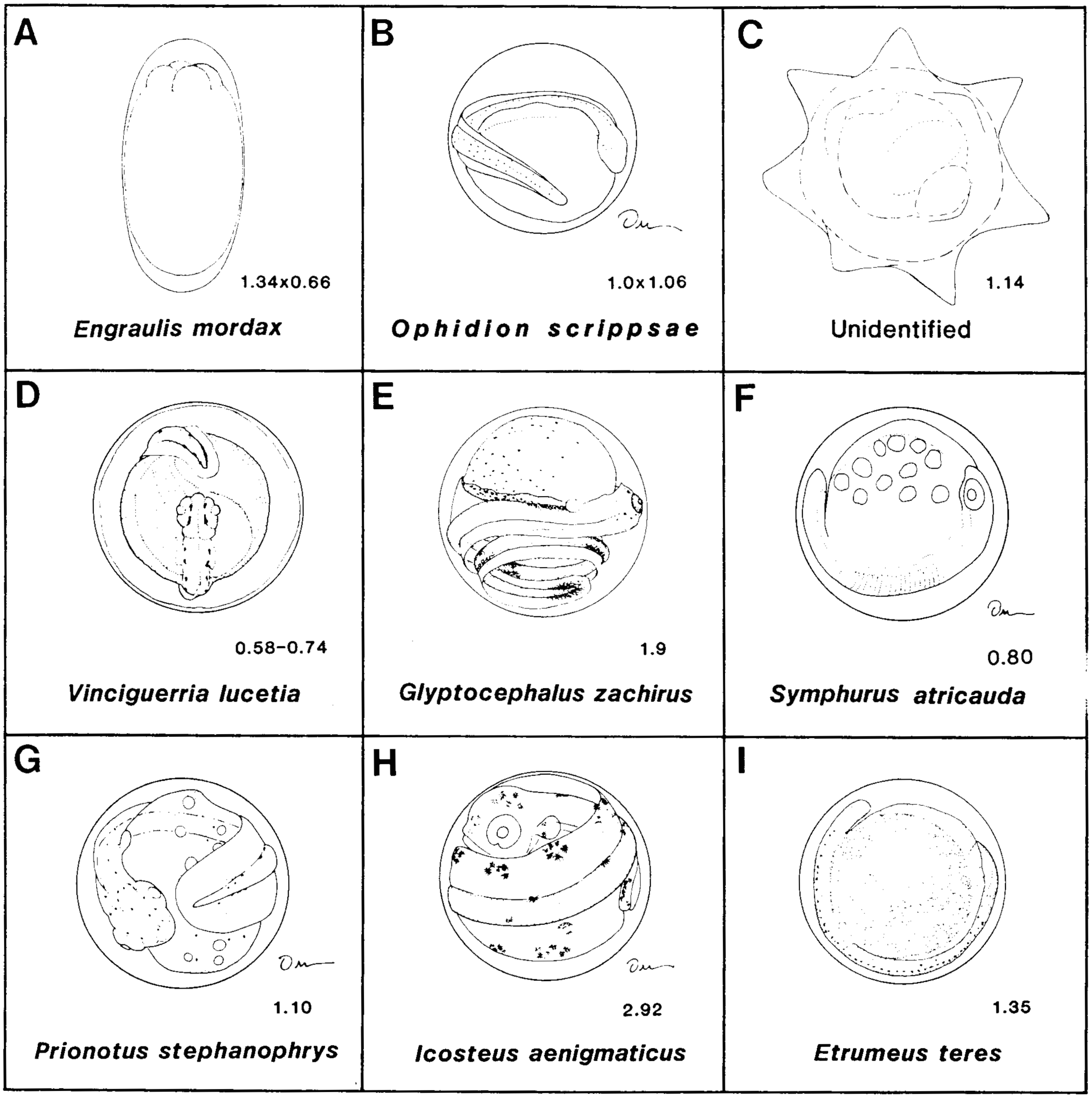

Fig. 13. Fish eggs. Captions under each illustration indicate the species and the diameter or dimensions of the egg in millimeters. A. *Engraulis mordax*, original; B. *Ophidion scrippsae*, original; C. Unidentified, original; D. *Vinciguerria lucetia*, from Ahlstrom and Counts (1958); E. *Glyptocephalus zachirus*, from Ahlstrom and Moser (1980); F. *Symphurus atricauda*, original; G. *Prionotus stephanophrys*, original; H. *Icosteus aenigmaticus*, original; and I. *Etrumeus teres*, original.

egg development as follows: Early—from fertilization to closure of blastopore, Middle—from closure of blastopore to tail bud lifting off yolk, and Late—from tail bud lifting off yolk to time of hatching.

Identification Characters

Shape.—The vast majority of all egg types are spherical. Exceptions include ellipsoidal eggs as found in anchovies, *Engraulis* and *Anchoa,* and slightly flattened or ovoid eggs as seen in members of the families Gobiidae, Scaridae, and Ophidiidae (Fig. 13A, B). A number of demersal eggs have somewhat irregular shapes, especially those associated with large egg masses. The perciform family Congrogadidae has cruciform shaped eggs (Herwig and Dewey, 1982). An unidentified, star-shaped egg is encountered infrequently in the Alaska region (Fig. 13C).

Size.—The average marine and freshwater fish egg size is about 1.0 mm. According to Ahlstrom and Moser (1980), pelagic fish eggs range from 0.5 mm [*Vinciguerria* (Fig. 13D)] to about 5.5 mm (Muraenidae). Demersal eggs may range higher in size (up to 7.0–8.0 mm), e.g., members of the families Salmonidae, Anarhichadidae, and Zoarcidae. Mouth brooders, e.g., in the catfish family Ariidae, have among the largest eggs with sizes from 14 mm to 26 mm.

Oil globules.—The oil globule provides useful characters in fish egg identification; these include presence or absence, number, size, position, color, and pigmentation. Among both pelagic and demersal eggs, the most common form contains a single oil globule. Eggs may lack an oil globule as in most gadines and pleuronectids (*Glyptocephalus*), contain only one (*Icosteus*), or have multiple oil globules as in the cynoglossids and triglids (*Symphurus* and *Prionotus*) (Fig. 13E, F, G, and H). In pelagic eggs with a single oil globule, the size ranges from <0.10 mm to >1.0 mm (Ahlstrom and Moser, 1980). The position of the oil globule within the yolk sac is usually posterior, but several groups contain species that have an anterior placement (e.g., labrids and carangids) and others have an intermediate placement (argentinids). In some fishes, oil globules migrate during embryonic development. Some members of the family Bathylagidae initially possess multiple oil globules that eventually coalesce into a single globule (Ahlstrom, 1969). Although not a totally reliable character, the oil globule color can be useful, especially in the identification of freshly taken demersal eggs. Lastly, many species have oil globules with melanistic pigment, *Icosteus* (Fig. 13H) and *Icichthys.*

Yolk.—The degree of yolk segmentation is an important identification character. Yolk is usually segmented in primitive forms, e.g., *Etrumeus* (Fig. 13I), and homogeneous in higher forms (Rass, 1973; Ahlstrom and Moser, 1980). The opaqueness of yolk found in catfishes, salmonids, and gars can be diagnostic.[1] Pigment, which may also be diagnostic, can be present during various developmental stages from middle to late. Yolk color is often important especially in demersal eggs. Among demersal eggs vitelline circulation patterns within the yolk sac are useful in identification.[1]

Chorion.—A number of characteristics associated with the chorion or egg envelope can be useful in identifying fish eggs and have been shown to be highly adapted to the environmental conditions under which an embryo develops (Ivankov and Kurdyayeva, 1973; Stehr and Hawkes, 1979; Laale, 1980; Stehr, 1982). The most important character of the chorion is whether it is smooth, as is in most fishes, or sculptured. Among fish eggs with patterns, the size and texture (e.g., raised hexagons, pustules) of the design are diagnostic. Raised polygonal surfaces are found in several unrelated species (Stehr, 1982), e.g., *Synodus* and *Pleuronichthys* (Sumida et al., 1979), and pustules occur among some bathylagids and argentinids. *Mugil cephalus* eggs (Fig. 14A), previously considered to have a smooth chorion, have a raised patterned surface visible by scanning electron microscope (Boehlert, this volume). In many groups of fishes, the chorion has various degrees of ornamentation consisting of projections, threads, filaments, or stalks which may aid in flotation (pelagic) or attachment (demersal). In some scomberesocids, e.g., *Cololabis* (Fig. 14B), some exocoetids and atherinids, pelagic eggs are attached to each other or to a substrate by filaments. Spines are found in some myctophiforms and exocoetids, and stalks occur in some demersal egg groups, e.g., blenniids and *Osmerus mordax.* In ostraciid eggs, a patch of pustules is present near the micropyle (Fig. 14C).

Recently, thickness of the chorion has been of diagnostic value (Ivankov and Kurdyayeva, 1973; Boehlert, this volume). Stehr and Hawkes (1979), using scanning electron microscopy, found that most marine teleosts with pelagic eggs have thin chorions in relation to egg diameter whereas demersal eggs tend to develop much thicker chorions. Color of the chorion is an important diagnostic character, especially for freshly taken demersal eggs in the marine intertidal environment (Matarese and Marliave, 1982). A number of freshwater demersal fishes have eggs that possess a special coating associated with the chorion which can be either gelatinous or adhesive, e.g., *Perca, Ictalurus,* and *Notropis* (Snyder, 1981).

Perivitelline space.—Most fish eggs have a narrow- to medium-width perivitelline space, but wide spaces are common in some groups, especially among the more primitive fishes that have a segmented yolk, e.g., Clupeiformes (*Sardinops,* Fig. 14D), Anguilliformes, and Salmoniformes (*Chauliodus,* Fig. 14E) (Ahlstrom and Moser, 1980). Large perivitelline spaces are also found among some unrelated higher forms, such as cyprinids (*Notropis*), percichthyids (*Morone saxatilis*), or pleuronectids (*Hippoglossoides*).

Embryonic characters.—Characters associated with the developing embryo are extremely useful in egg identification, particularly in the middle and late stages of development. Many eggs not identifiable in the early stages are easily recognizable using embryonic characters such as pigment on embryo or finfold and morphology. In some fishes, embryonic pigment in the late stages has already undergone sufficient migration and rearrangement to the point where it resembles the yolk-sac larva; this is common in several groups including gadiformes, e.g., *Merluccius* (Fig. 14F), *Gadus,* and *Theragra,* and heavily pigmented flatfishes like *Pleuronichthys* and *Hypsopsetta.* Characteristic late-stage pigment bands appear in *Glyptocephalus* (Fig. 13E). In most freshwater species, pigment is not present prior to pigment cell migration but appears sometime after the cells have mi-

[1] F. Douglas Martin, Chesapeake Biological Laboratory, P.O. Box 38, Solomons, Maryland 20688. Personal communication, October 1982.

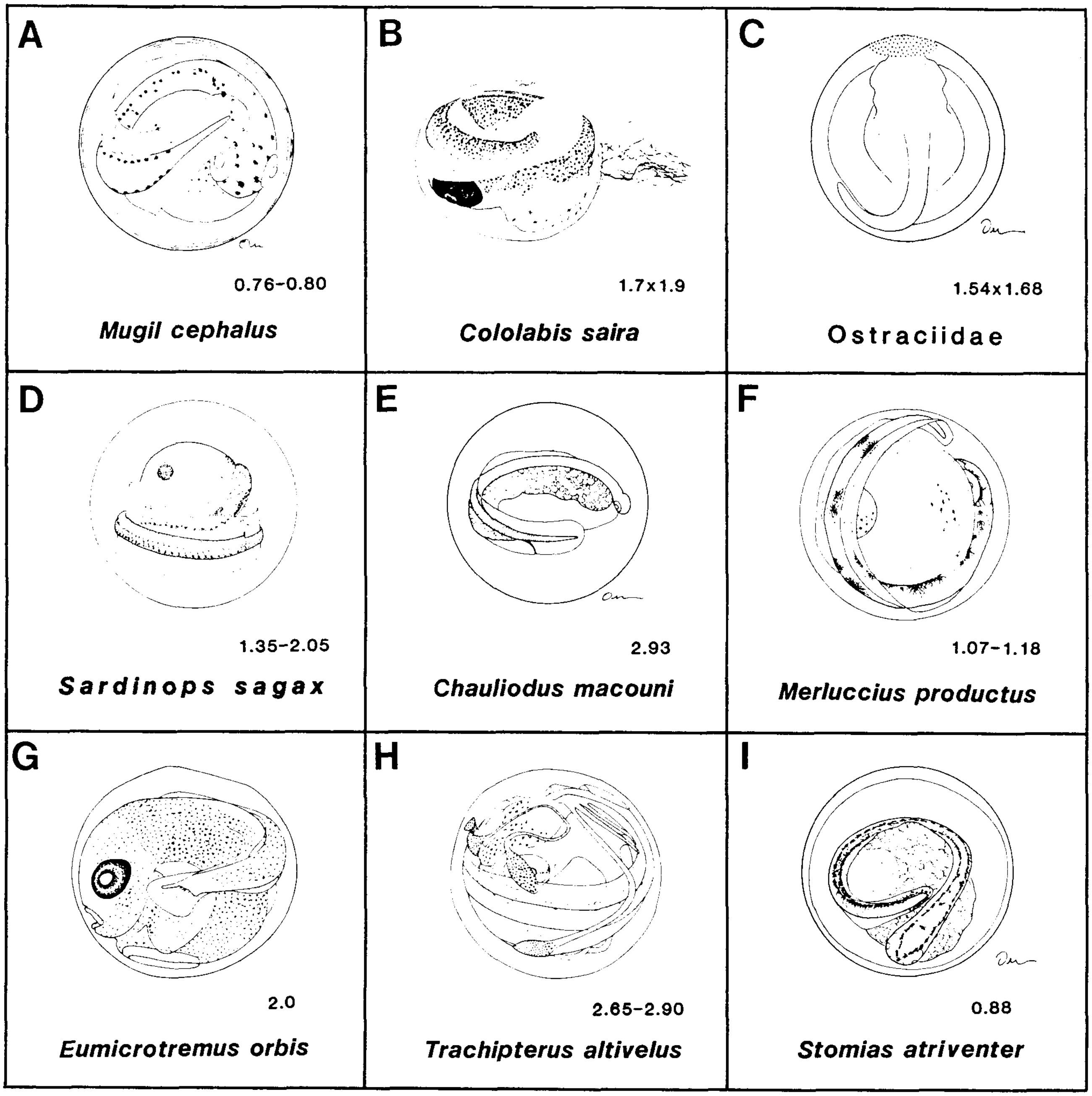

Fig. 14. Fish eggs. Captions under each illustration indicate the species and the diameter or dimensions of the egg in millimeters. A. *Mugil cephalus*, original; B. *Cololabis saira*, original; C. Ostraciidae, original; D. *Sardinops sagax*, original; E. *Chauliodus macouni*, original; F. *Merluccius productus*, from Ahlstrom and Counts (1955); G. *Eumicrotremus orbis*, from Matarese and Borton unpubl. MS; H. *Trachipterus altivelus*, original; and I. *Stomias atriventer*, original.

grated to their actual destinations (Snyder, 1981). As seen in the cyclopterid, *Eumicrotremus*, most late-stage demersal embryos resemble the newly hatched larva with respect to all characters (Fig. 14G). The morphology of the head, gut, and postanal body as well as the number of myomeres is used for identification within all fish egg groups. A number of specialized characters associated with the embryo are essential for identification when present, e.g., elongated fin rays—*Trachipterus* (Fig. 14H), precocious fin development (caudal—exocoetids and *Trichodon*; pelvic—*Trachinus*), and pelvic disc development in some cyclopterids (*Eumicrotremus*) (Fig. 14G).

Miscellaneous characters.—The presence of a secondary membrane inside the chorion occurs in some groups, although it is lacking in most fishes. *Stomias atriventer* eggs have a double membrane (Fig. 14I). These membranes occur in some of the more primitive fishes including members of the Anguilliformes, Clupeiformes, and Salmoniformes. In some species, like the freshwater cyprinid *Abbottina rivularis* (Nakamura, 1969), the secondary membrane is thick and gelatinous. The presence and size of the micropyle are diagnostic in other fishes, particularly freshwater demersal eggs (Laale, 1980; Riehl, 1980). Among freshwater fishes, the cleavage pattern is important for egg identification. In the more primitive families (Acipenseridae, Polyodontidae, Lepisosteidae, and Amiidae), cleavage pattern is typically semiholoblastic as opposed to the meroblastic pattern seen in the higher teleosts. Genetic studies have shown differences in LDH A zymograms to be a useful, diagnostic tool for the identification of *Gadus morhua* and *Melanogrammus aeglefinus* eggs (Mork et al., 1983).

Ecological and behavioral considerations.—A number of considerations related to mode of reproduction and collection rather than the characters of the eggs themselves are essential when identifying any type of fish egg. In identifying demersal eggs one must consider where they were collected—on rocks, on plants, in masses, and if parental care is involved. Nest type, nature of egg deposition, and the presence of guarding parents can all be essential clues to proper identification. Also, for any egg type one must note spawning time (season), location depth, and gear used for collection. In addition, the rearing of unknown eggs to an identifiable larval stage is useful in species determination as shown by Stevens and Moser (1982) for the blenny, *Hypsoblennius*. Of course, a necessary prerequisite to accurate identification of eggs is a thorough knowledge of the species present in any given area and their breeding seasonality.

Summary of Characters

Characters most useful in identification of fish eggs are the following: (1) egg shape—spherical, ellipsoidal, irregular, or otherwise; (2) egg size—fish eggs range in size from 0.5 to 26.0 mm; (3) oil globules—presence or absence, number, size, color, position, and pigmentation; (4) yolk—segmented or homogeneous, nature of segmentation, color, pigmentation, and circulation pattern; (5) chorion—smooth or ornamented, type of ornamentation, thickness, color, and coatings; (6) perivitelline space—width; (7) embryonic characters—morphological features, pigment patterns, and special structures; (8) miscellaneous characters—inner or secondary membrane (presence or absence, location), cleavage pattern, micropyle (size), and biochemical analysis; and (9) ecological and behavioral considerations—collection (gear, location, season, etc.), and mode of reproduction (nests, parental care, etc.).

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