Fish Larvae—Ecologically Distinct Organisms[1]

by

Darrel E. Snyder

Larval Fish Laboratory
Colorado State University
Fort Collins, Colorado 80523

The behaviors and habitat requirements of larvae of most warmwater stream fishes are distinctly different from those of their juvenile and adult counterparts (Braum 1978; Marcy et al. 1980; Snyder 1983, 1985; Floyd et al. 1984; Faber 1985). The larval period—the interval of fish development from hatching or birth to loss of finfolds and development of adult complement of fin spines and rays—entails many and often dramatic changes in morphology and physiology. Also, it usually covers a number of short-term shifts in lifestyle and habitat. Indeed, a fish larva is often ecologically distinct not only from its juvenile and adult counterparts but from itself during certain intervals within the larval period.

The initial habitat of most fish larvae is the spawning ground. For warmwater stream fishes and anadromous species, there is much diversity in the earliest habitat requirements and behavior of larvae. Initial larval habitats, associated environmental requirements, and behaviors are considered in a classification of reproductive guilds by Balon (1981, 1984). The 22 families and over 260 species (Swift et al. 1986) of freshwater and anadromous fishes in the southeastern United States represent at least 17 of Balon's reproductive guilds (Table).

Some fishes remain on or near the spawning grounds throughout much or all of their early development, and some may use the same habitat throughout their life cycle. However, for most stream fishes, the initial habitat rapidly becomes inadequate, and the larvae either drift or actively migrate to more suitable nursery grounds, sometimes hundreds of kilometers downstream. The larvae and early juveniles of most stream fishes tend to use nearshore areas with relatively slow-moving water near cover, vegetation, or sharp vertical relief.

Larval fish size largely dictates the characteristics of suitable nursery habitat and the role larvae play in the aquatic system. In southeastern fresh waters, fish larvae may be as small as 2 mm in total length (TL) at hatching (e.g., white crappie [*Pomoxis annularis*]) and early larvae of some (e.g., striped bass [*Morone saxatilis*], freshwater drum [*Aplodinotus grunniens*], and emerald shiner [*Notropis atherinoides*]) inhabit pelagic waters and constitute a part of the planktonic community. These early pelagic larvae may be food for predatory copepods, whereas later larvae of these fishes may reverse the roles and prey on the copepods. Most fish larvae feed on rotifers and other small zooplankton; however, some are piscivorous and may consume other fish larvae nearly as long as themselves. Clark and Pearson (1979) observed fish larvae in the stomachs of over 25% of small (4–5 mm standard length [SL]) freshwater drum larvae. For this species, piscivory decreased with size and was not observed in larvae or early juveniles over 9 mm SL.

For most stream fishes, extremely high mortality during the embryonic and larval period is normal and accommodated by their reproductive strategy. Environmental effects that substantially add to, or reduce, natural larval fish mortality can have a corresponding effect on the eventual size of the adult population. The effects of changes in habitat and community structure on fish larvae can be quite different from those on juveniles and adults. The most common effect is loss or alteration of larval fish habitat. Fish larvae can be particularly sensitive to physical and chemical water pollution. Biotic alterations that might not be expected to have an adverse effect on native fishes, such as the introduction of exotic forage species, might indeed affect native populations by excess predation on, or competition with, their larvae. Fish larvae of many species are especially vulnerable to entrainment in water withdrawal systems for irrigation, domestic and industrial water supplies, and power plant cooling.

---

[1]Contribution 42 of the Larval Fish Laboratory, Colorado State University.

Table. *Reproductive guilds[a] by family for fishes in fresh waters of the southeastern United States.*

		Nonguarders								Guarders						Bearers		
	Number of guilds	Open substrate						Brood hiders		Substrate choosers		Nesters				External	Internal	
Family		A11	A12	A13	A14	A15	A16	A23	A24	B13	B14	B22	B23	B25	B27	C14	C22	C24
Acipenseridae (sturgeons)	2		X[b]	X														
Polyodontidae (paddlefish)	1		X[b]															
Lepisosteidae (gars)	1					X												
Amiidae (bowfin)	1													X				
Clupeidae (herrings)	3	X	X		X													
Hiodontidae (mooneyes)	1		X															
Salmonidae (trouts)	1							X										
Umbridae (mudminnows)	1													X				
Esocidae (pikes)	1					X												
Cyprinidae (minnows)	9	X		X	X	X	X	X	X				X		X			
Catostomidae (suckers)	3			X		X	X											
Ictaluridae (catfishes)	2												X		X			
Amblyopsidae (cavefishes)	1															X		
Aphredoderidae (pirate perch)	1											?				?		
Cyprinodontidae (killifishes)	3				X	X					X							
Poeciliidae (livebearers)	2																X	X
Atherinidae (silversides)	1				X													
Percichthyidae (temperate basses)	2	X			X													
Centrarchidae (sunfishes)	4									X		X	X	X				
Percidae (perches)	7		X		X	X	X	X						X	X			
Sciaenidae (drum)	1	X																
Cottidae (sculpins)	1														X			
Number of families		4	5	3	6	6	3	3	1	1	1	1(2)	3	4	4	1(2)	1	1

[a]Guild codes: A11 = pelagic spawners; A12 = rock and gravel spawners with pelagic larvae; A13 = rock and gravel spawners with benthic larvae; A14 = nonobligatory plant spawners; A15 = obligatory plant spawners; A16 = sand spawner; A23 = rock and gravel hiders; A24 = cavity hiders; B13 = rock and gravel tenders; B14 = plant tenders; B22 = miscellaneous substrate nesters; B23 = rock and gravel nesters; B25 = plant material nesters; B27 = hole nesters; C14 = gill-chamber brooders; C22 = obligate lecithotrophic livebearers; C24 = viviparous trophoderms (see Balon 1975, 1981, 1984 for detailed descriptions of these and other guilds).

[b]Between A12 and A13—recently hatched larvae drift near bottom (epibenthic drifters?).

In our attempt to evaluate environmental impacts and aquatic management programs, we often turn to models, habitat-quality indices, and related tools. Unfortunately, these models or tools can be no better than the data on which they are based, and for most species of fish, reproductive and early life history data are often lacking, inadequate, or questionable. For southeastern fishes and aquatic systems, there is much basic research that needs to be done to fill the immense void in our knowledge, including such basic tasks as determining what the larvae of many fishes look like. In the Southeast, we have only four limited manuals for larval fish identification (Hogue et al. 1976; McGowan 1984; Conrow and Zale 1985), although some species are covered in taxonomic manuals for other parts of the country (Auer 1982; see lists in Snyder 1983 or Simon 1986 for others). The importance of accurate identification of specimens cannot be overemphasized because critical resource management decisions are sometimes based on species-specific field data. Before we can effectively proceed with field studies on fish larvae in the Southeast, we must be able to accurately identify specimens.

The early life stages of fishes must be an important concern in the development of management plans and impact assessment methods. Aquatic ecologists and fishery biologists are often too preoccupied with the needs of adult fishes to recognize the differing requirements of earlier life stages. It is simpler and less costly to concentrate on one life stage of a target species than on a whole series of ecologically distinct stages; however, fish populations depend on adequate survival of their embryos, larvae, and early juveniles.

Information Sources

Auer, N. A. 1982. Identification of larval fishes of the Great Lakes Basin with emphasis on the Lake Michigan drainage. Great Lakes Fishery Commission, Ann Arbor, Mich. Spec. Publ. 82-3. 744 pp.

Balon, E. K. 1975. Reproductive guilds of fishes: a proposal and definition. J. Fish. Res. Board Can. 32:821-864.

Balon, E. K. 1981. Additions and amendments to the classification of reproductive styles in fishes. Environ. Biol. Fishes 6:377-389.

Balon, E. K. 1984. Patterns in the evolution of reproductive styles in fishes. Pages 35-53 *in* G. W. Potts and R. J. Wootton, eds. Fish reproduction, strategies and tactics. Academic Press, Inc., New York. 410 pp.

Balon, E. K. 1985. The theory of saltatory ontogeny and life history models revisited. Pages 13-30 *in* E. K. Balon, ed. Early life histories of fishes; new developmental, ecological and evolutionary perspectives. W. Junk Publishers, Dordrecht, The Netherlands. 280 pp.

Balon, E. K., W. T. Momot, and H. A. Regier. 1977. Reproductive guilds of percids: results of the paleogeographic history and ecological succession. J. Fish. Res. Board Can. 34:1910-1921.

Bennett, D. H., and R. W. McFarlane. 1983. The fishes of the Savannah River Plant: National Environmental Park. U.S. Department of Energy, National Environmental Research Park, Savannah River Ecology Laboratory, Aiken, S.C. 152 pp.

Blaxter, J. H. S. 1969. Development: eggs and larvae. Pages 177-252 *in* W. S. Hoar and D. J. Randall, eds. Fish physiology. Volume 3: reproduction and growth, bioluminescence, pigments and poisons. Academic Press, Inc., New York. 485 pp.

Blaxter, J. H. S. 1986. Development of sense organs and behavior of teleost larvae with special reference to feeding and predator avoidance. Trans. Am. Fish. Soc. 115:98-114.

Braum, E. 1978. Ecological aspects of the survival of fish eggs, embryos and larvae. Pages 102-134 *in* S. D. Gerking, ed. Ecology of freshwater fish production. John Wiley & Sons, New York. 520 pp.

Clark, A. L., and W. D. Pearson. 1979. Early piscivory in larvae of the freshwater drum, *Aplodinotus grunniens*. Pages 31-59 *in* R. Wallus and C. W. Voigtlander, eds. Proceedings of a workshop on freshwater larval fishes. Tennessee Valley Authority, Norris, Tenn. 241 pp. [There are some size-related and species identification errors in this paper, including the smallest specimen drawn and photographed: the specimen shown in Figs. 3 and 7, labeled a 3.4-mm freshwater drum, was actually a percid, probably *Stizostedion*, at least 8 mm.]

Conrow, R., and A. V. Zale. 1985. Early life history stages of fishes of Orange Lake, Florida: an illustrated identification manual. Fla. Coop. Fish Wildl. Res. Unit Tech. Rep. 15, University of Florida, Gainesville. 45 pp.

Faber, D. J. 1985. Water babies: larval fishes of Ottawa and vicinity. National Museum of Natural Sciences, Ottawa, Ontario. 25 pp.

Floyd, K. B., R. D. Hoyt, and S. Timbrook. 1984. Chronology of appearance and habitat partitioning by stream larval fishes. Trans. Am. Fish. Soc. 113:217-223.

Hardy, J. D., Jr., G. E. Drewry, R. A. Fritzsche, G. D. Johnson, P. W. Jones, and F. D. Martin. 1978. Development of fishes of the Mid-Atlantic Bight, an atlas of egg, larval and juvenile stages. U.S. Fish. Wildl. Serv., FWS/OBS-78/12. 6 volumes.

Hoar, W. S., and D. J. Randall, editors. 1988. Fish physiology. Volume 11: the physiology of developing fish. Academic Press, Inc., New York. Part A, 546 pp.; Part B, 436 pp.

Hogue, J. J., Jr., R. Wallus, and L. K. Kay. 1976. Preliminary guide to the identification of larval fishes in the Tennessee River. Tennessee Valley Authority, Technical Note B19, Knoxville, Tenn. 66 pp.

Holland, L. E., and M. L. Huston. 1983. A compilation of available literature on the larvae of fishes common to the upper Mississippi River. U.S. Fish and Wildlife Service, National Fishery Research Laboratory, La Cross, Wis. 364 pp.

Kindschi, G. A., R. D. Hoyt, and G. J. Overmann. 1979. Some aspects of the ecology of larval fishes in Rough River Lake, Kentucky. Pages 139-166 *in* R. D. Hoyt, ed. Proceedings of the third symposium on larval fish. Western Kentucky University, Department of Biology, Bowling Green. 236 pp.

Laerm, J., and B. J. Freeman. 1986. Fishes of the Okefenokee Swamp. University of Georgia Press, Athens. 118 pp.

Lathrop, B. F., and D. E. Snyder. 1986. Bibliographies on fish reproduction and early life history. Am. Fish. Soc. Early Life Hist. Sect. Newsl. 7(2):29-36.

Marcy, B. C., V. R. Kranz, and R. P. Barr. 1980. Ecological and behavioral characteristics of fish eggs and young influencing their entrainment. Pages 29-74 *in* C. H. Hocutt, J. R. Stauffer, Jr., J. E. Edinger, L. W. Hall, Jr., and R. P. Morgan, II, eds. Power plants: effects on fish and shellfish behavior. Academic Press, Inc., New York. 346 pp.

McGowan, E. G. 1984. An identification guide for selected larval fishes from Robinson Impoundment, South Carolina. Carolina Power and Light Company, New Hill, N.C. 56 pp.

McGowan, E. G. 1988. An illustrated guide to larval fishes from three North Carolina piedmont impoundments. Carolina Power and Light Company, New Hill, N.C. 113 pp.

Moser, H. G., W. J. Richards, D. M. Cohen, M. P. Fahay, A. W. Kendall, Jr., and S. L. Richardson. 1984. Ontogeny and systematics of fishes. Am. Soc. Ichthyol. Herpetol. Spec. Publ. 1. 760 pp.

Muth, R. T., and J. C. Schmulbach. 1984. Downstream transport of fish larvae in a shallow prairie river. Trans. Am. Fish. Soc. 113:224-230.

Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Board Can. Bull. 184. 966 pp.

Simon, T. P. 1986. A listing of regional guides, keys, and selected comparative descriptions of freshwater and marine larval fishes. Am. Fish. Soc. Early Life Hist. Sect. Newsl. 7(1):10-15.

Snyder, D. E. 1976. Terminologies for intervals of larval fish development. Pages 41-60 *in* J. Boreman, ed. Great Lakes fish egg and larvae identification; proceedings of a workshop. U.S. Fish Wildl. Serv., FWS/OBS-76/23. 220 pp.

Snyder, D. E. 1981. Contributions to a guide to the cypriniform fish larvae of the Upper Colorado River system in Colorado. U.S. Bur. Land Manage., Biol. Sci. Ser. 3. 81 pp.

Snyder, D. E. 1983. Fish eggs and larvae. Pages 165-197 *in* L. Nielsen and D. Johnson, eds. Fishery techniques. American Fisheries Society, Bethesda, Md. 458 pp.

Snyder, D. E. 1985. Larval fish ecology: a critical management concern. U.S. Fish and Wildlife Service, Office of Information Transfer, Fort Collins, Colo. [videotape, 24 min.]

Swift, C. C., C. R. Gilbert, S. A. Bortone, G. H. Burgess, and R. W. Yerger. 1986. Zoogeography of the freshwater fishes of the southeastern United States: Savannah River to Lake Pontchartrain. Pages 213-265 *in* C. H. Hocutt and E. O. Wiley, eds. The zoogeography of North American freshwater fishes. John Wiley & Sons, New York. 866 pp.

Taber, C. A. 1969. The distribution and identification of larval fishes in the Buncombe Creek Arm of Lake Texoma with observations on spawning habits and relative abundance. Ph.D. dissertation, University of Oklahoma, Norman. 120 pp.

Wang, J. C. S., and R. J. Kernehan. 1979. Fishes of the Delaware estuaries, a guide to the early life histories. Ecological Analysts, Inc., Towson, Md. 410 pp.

Snyder, D. E. 1990. Fish Larvae--Ecologically Distinct Organisms. Pages 20-23 in M. B. Bains, editor. Ecology and assessment of warmwater streams: workshop synopsis. U.S. Fish and Wildlife Service Biological Report 90(5).