APPENDIX II

Glossary

GLOSSARY

This glossary is a supplemented combination of most glossary terms and definitions listed by Hardy et al. (1978, including volume 1 by Jones et al. 1978), Auer (1982), and Simon and Wallus (2004; mostly from Wallus et al. 1990) as indicated by superscript numbers 1, 2, and 3, respectively. Terms and definitions from other sources end with a corresponding citation. Author modifications, definitions, and comments on usage in this guide are enclosed in brackets. Many terms included in this glossary are not used in this guide, but are provided for more general reference. For developmental-interval terminology used herein, see discussion and definitions provided in the introduction. For a review of other developmental-interval terminologies, including terms not included in this glossary, see Snyder (1976b). Terms for many anatomical features, methods and abbreviations for morphometrics and fin-ray and myomere counts, and definitions for phases of gut coil development are illustrated in Figures 2-5.

A – Abbreviation for anal fin.[1]

Abbreviate heterocercal – Tail in which the vertebral axis is prominently flexed upward, only partly invading upper lobe of caudal fin; fin fairly symmetrical externally.[1,3]

Actinotrichia – Fin supports which are precursors of fin rays or spines; also [mistakenly] called lepidotrichia.[2,3] Spiny fin rays; horny rays in the form of spines, which develop, embryonically at least, in all bony fish fins, and may persist as the spines in the spiny-rayed fishes (Acanthopterygii) [or are replaced by, or transformed into, scaly or soft rays called lepidotrichia in soft-rayed fishes (Malacopterygii) or the soft-rayed fins or parts of fins of spiny-rayed fishes] (Lagler et al. 1962, pp. 59 and 186).

Adherent – Attached or joined together, at least at one point.[1,3]

Adhesive egg – An egg which adheres on contact to substrate material or other eggs; adhesiveness of entire egg capsule may or may not persist after attachment.[1,3]

Adipose fin – A fleshy rayless median dorsal structure, located behind the true dorsal fin.[1,3]

Adnate – Congenitally united; conjoined.[1,3] Joined to; grown together.[2] Keel-like.[3]

Adnexed – Flaglike.[3]

Adult – Sexually mature as indicated by production of gametes.[1,3]

Air bladder – See gas bladder; swim bladder.

Alevin – A term applied to juvenile catfish, trout, and salmon after yolk absorption; exhibiting no post yolk-sac larval phase.[3] [However, if loss of finfold and acquisition of the minimum adult count of rays in all fins, including rudimentary rays, are required for transition to the juvenile period, most, if not all, of these fish do indeed have a post yolk-sac larval phase and the term is no longer useful as defined.]

Allopatric – Having separate and mutually exclusive areas of geographical distribution.[3]

Anadromous – Fishes which ascend rivers from the sea to spawn.[1,3]

Anal – Pertaining to the anus or vent.[1,3]

Anal fin – Unpaired median fin immediately behind anus or vent.[1,3]

Anal fin origin – Anterior-most point at which the anal fin attaches to the body.[1]

Anlage – Rudimentary form of an anatomical structure;[1,2,3] primordium.[1,3] Incipient.[3]

Antero-hyal – Anterior bone to which branchiostegal rays attach; formerly ceratohyal.[2,3]

Anus – External orifice of the intestine; vent [when opening also includes the end of the urogenital duct].[1,3]

Auditory vesicle – Sensory anlage from which the ear develops; clearly visible during early development.[1,3]

Axillary process – Enlarged accessory scale attached to the upper or anterior base of pectoral or pelvic fins.[1,3]

Barbel – Tactile process arising from the head of various fishes.[1,3]

Basibranchials – Three median bones on the floor of the gill chamber, joined to the ventral ends of the five gill arches.[2,3]

Bicuspid – Having or ending in two points; a tooth with two points.[2]

BL – Abbreviation for body length.[1]

Blastocoel – Cavity of the blastula; segmentation cavity.[1]

Blastoderm – *Sensu strictu,* early embryonic tissue composed of blastomeres; more generally, embryonic tissue prior to formation of embryonic axis.[1]

Blastodisc – Embryo-forming area of egg prior to cleavage.[1]

Blastomeres – Individual cells formed during cleavage.[1]

Blastopore – Opening formed by and bordered by the germ ring as it extends over the yolk.[1]

Blastula – Stage in embryonic development which represents the final product of cleavage stages, characterized by formation of the blastocoel.[1] A hollow ball of cells formed early in embryonic development.[3]

Body depth at anus – Vertical depth of body at anus,[2,3] not including finfolds.[3]

Body length – A specialized method of measuring, generally applied only to billfishes, and defined by Rivas (1956) as the distance from the tip of the mandible (with jaws closed) to the middle point on the posterior margin of the middle caudal rays.[1]

Branched ray – Soft ray with two or more branches distally.[1,3]

Branchial arches – Bony or cartilaginous structures supporting the gills, filaments, and rakers.[1,3] gill arches.[3]

Branchial region – In petromyzontids, area between the anterior margin of the first gill opening and the posterior margin of the last.[2] The pharyngeal region where branchial arches and gills develop.[3]

Branchiostegal rays, branchiostegals – Struts of bone inserting on the hyoid arch and supporting, in a fanwise fashion, the branchiostegal membrane.[1,3] Bony rays supporting the membranes which close the gill (branchial) cavity under the head.[2]

Buoyant egg – An egg which floats free within the water column; pelagic.[1,3]

C – Abbreviation for caudal fin.[1]

Caeca – Finger-like outpouchings at boundary of stomach and intestine.[1,3]

Calcareous – Composed of, containing, or characteristic of calcium carbonate.[3]

Cardiform – Brush-like; referring to teeth of uniform length in patches or bands.[2]

Catadromous – Fishes which go to sea from rivers to spawn.[1,3]

Caudal fin – Tail fin.[1,3]

Caudal peduncle – Area lying between posterior end of anal fin base and base of caudal fin.[1,3]

Cement glands – Discrete or diffuse structures which permit a larva to adhere to a substrate.[2,3]

Cephalic – Pertaining to the head.[2,3]

Ceratohyal – See antero-hyal.[3]

Cheek – Lateral surface of head between eye and opercle, usually excluding preopercle.[1,3]

Chevron-shaped – The earliest developmental form of myomeres in larvae; describing the angle formed by the epaxial and hypaxial portions of the myosepta.[2]

Choroid fissure – Line of juncture of invaginating borders of optic cup; apparent in young fish as a trough-like area below lens.[1,3] A cleft in outer layers of the eye visible in early larvae.[2]

Chorion – Outer covering of egg; egg capsule.[1,3] After water hardening, the outermost membrane of a fish egg.[2]

Chromatophores – Pigment-bearing cells;[1,2,3] frequently capable of expansions and contractions which change their size, shape, and color.[1,3]

Cirrus – Generally small, dermal, flap-like or tentacle-like process on the head or body.[1]

Cleavage stages – Initial stages in embryonic development where divisions of blastomeres are clearly marked; usually include 1st through 6th cleavages (2-64 cells).[1,3]

Cleithrum – Prominent bone of pectoral girdle, clearly visible in many fish larvae.[1,3] Large bone of support for the pectoral fins.[2]

Coelomic – Pertaining (belonging) to the body cavity.[2,3]

Confluent – Coming together to form one.[2,3]

Ctenoid scale – Scales with comb-like margin; bearing cteni.[1,3] Scales having small, needle-like projections on the posterior margin.[2]

Cycloid scale – Scales with evenly curved free border, without cteni.[1,3]

D – Abbreviation for dorsal fin.[1]

Deciduous – Referring to scales that are easily rubbed off and thus not firmly attached.[2]

Demersal – Refers to aquatic organisms living on or in close association with the substrate (bottom) (Bond 1996).

Demersal egg – An egg which remains on the bottom, either free or attached to substrate.[1,3] An egg which rests upon the substrate as a result of deposition or settling.[2] [An egg which sinks to the bottom in still water (negatively buoyant); in currents, unattached demersal eggs may be buoyed upward and carried down current.]

Dentary – Major bony element of the lower jaw, usually bearing teeth.[2,3]

Dorsal fins – Median, longitudinal, vertical fins located on the back.[1,3]

Dorsal fin origin – [Anterior-most] point where first dorsal ray or spine attaches to body.[1]

Early embryo – Stage in embryonic development characterized by formation of embryonic axis.[1,3]

Egg capsule – Outer-most encapsulating structure of the egg, consisting of one or more membranes; the protective shell.[1,3]

Egg diameter – In nearly spherical eggs, greatest diameter; in elliptical eggs given as two measurements, the greatest diameter or major axis and the least diameter or minor axis.[1,3]

Egg pit – The pit or pocket in a redd (nest) into which a trout female deposits one batch of eggs.[3]

Emarginate – Notched but not definitely forked, as in the shallowly notched caudal fin of some fishes.[1,3] Caudal fin possessing a slight notch or indentation.[2]

Embryonic axis – Primitive differentiation of the embryo; an elongate thickening of blastodermal tissue.[1]

Embryonic shield – Thickened shield-like area of the blastoderm at caudal edge of the germ ring.[1]

Emergence – The act of leaving the substrate and beginning to swim; swim-up.[2,3]

Epaxial – Portion of the body dorsal to the horizontal or median myoseptum.[2,3]

Epihyal – See postero-hyal.

Epurals – Modified vertebrae elements which lie above the vertebrae and support part of the caudal fin.[2,3]

Erythrophores – Red or orange chromatophores.[1,3]

Esophagus – Alimentary tract between pharynx and stomach.[1,3]

Eye diameter – Horizontal measurement (distance) of the iris of the eye.[2,3] [Horizontal diameter of the externally visible eye.]

Falcate – Deeply concave as a fin with middle rays much shorter than anterior and posterior rays.[1,3] Scythe-shaped; referring to an anal fin.[2]

Fin insertion – [As used herein,] posterior-most point at which the fin attaches to the body.[3] [More generally refers to entire margin of fin attachment to the body, the fin base.]

Fin origin – Anterior-most point at which the fin attaches to the body.[3]

Finfold – Median fold of integument which extends along body of developing fishes and from which median fins arise.[1,3]

FL – Abbreviation for fork length.[1]

Flexion larva – Phase between hatching and upward flexing of the tip of the notochord [or appearance of first caudal fin rays] (Ahlstrom et al. 1976).

Flexion mesolarva – Among fishes with homocercal tails, subphase of mesolarval development characterized by an incomplete adult complement of principal caudal-fin rays (posterior portion of notochord flexes upward and standard length measured to end of notochord) (Snyder and Muth 1988, 1990, 2004; see discussion on developmental interval terminology in introduction; presence of yolk indicated by an appropriate modifier).

Focal point – Location of a fish maintaining a stationary position on or off the substrate for at least a 10-second period.[3]

Fontanelle – A gap or space between bones in the roof of the skull covered only by a membrane.[2]

Foramen – An opening through a bone.[2]

Fork length – Distance measured from the anterior-most point of the head to the end of the central caudal rays.[1,3] Distance from the most anterior point on the snout to the end of the shortest central caudal fin ray.[2]

Frenum – A fold of skin that limits movement of the upper jaw.[2,3] [Bridge of tissue tightly connecting anterior portion of upper lip to fleshy portion of snout above (rather than being fully separated by a crease or groove between) and making premaxillaries non-protractile (upper lip not protrusible).]

Ganoid scales – Diamond- or rhombic-shaped scales consisting of bone covered with enamel.[1,3]

Gape – The border of the mouth.[2] Distance between the tips of the open jaws of vertebrates (Pennak 1964). Width of gape is the greatest transverse distance across the opening of the mouth (Hubbs and Lagler 1958).

Gas bladder – Membranous, gas-filled organ located between the kidneys and alimentary canal in teleosts; air bladder or swim bladder.[1,3]

Gastrula – Stage in embryonic development between blastula and embryonic axis.[1,3]

Germ ring – The thickened rim of the blastoderm evident during late blastula and gastrula stages.[1]

Germinal disc – The blastodisc.[1]

Gill arches – See branchial arches.[1,3]

Gill rakers – Variously-shaped bony projections on anterior edge of the gill arches.[1,3] Unless otherwise stated, counts are for all rakers on the first arch [external row] (Hubbs and Lagler 1958).

Glossohyal – A median bone of the tongue.[2]

Granular yolk – Yolk consisting of discrete units of finely to coarsely granular material.[1,3]

Greatest body depth – Greatest vertical depth of the body excluding fins and finfolds.[2,3]

Guanophores – White chromatophores; characterized by presence of iridescent crystals of guanine.[1,3] [= iridophores.]

Gular fold – Transverse membrane across throat.[1,3]

Gular plate – Ventral bony plate between anterior third of lower jaws, as in *Amia calva*.[1] Ventral bony plate on throat, as in *Amia calva.*[3] Median ventral bony plate or plates located behind the chin and between the sides of the lower jaw.[2]

Gular region – Throat.[3]

Haemal – Relating to or situated on the side of the spinal cord where the heart and chief blood vessels are placed.[3]

Head length – Distance from anterior-most tip of head to posterior-most part of opercular membrane, excluding spine; prior to development of operculum, measured to posterior end of auditory vesicle.[1,3] Distance from the most anterior point on the snout [including mouth] to the posterior edge of the auditory vesicle, cleithrum or opercle as each develop.[2] [As used herein, measured instead to the origin of the pectoral fin, or prior to formation of the pectoral fin buds, to the cleithrum.]

Head width – Greatest dimension between opercles.[2,3] [Unless measured, as herein, at other specified locations such as middle of eye or just behind posterior margin of eye.]

Heterocercal – Tail in which the vertebral axis is flexed upward and extends nearly to tip of upper lobe of caudal fin; fin typically asymmetrical externally, upper lobe much longer than lower.[1,3]

HL – Abbreviation for head length.[1]

Holoblastic – Type of cleavage in which the entire egg, including the yolk, undergoes division.[1]

Homocercal – Tail in which the vertebral axis terminates in a penultimate vertebra followed by a urostyle (the fusion product of several vertebral elements); fin perfectly symmetrical externally.[1,3]

Horizontal myoseptum – Connective tissue dividing epaxial and hypaxial regions of the body;[2,3] median myoseptum.[3]

Hypaxial – That portion of the body ventral to the horizontal myoseptum.[2,3]

Hypochord – A transitional rod of cells which develops under the notochord in the trunk region of some embryos.[1,3]

Hypochordal – Below the notochord; referring to the lower lobe of the caudal fin.[2,3]

Hypurals – Expanded, fused, haemal spines of last few vertebrae which support the caudal fin.[1,3] The expanded hemal spines of the posterior vertebrae which support most of the caudal fin.[2]

Incipient – Becoming apparent.[2,3]

Incubation period – Time from fertilization of egg to hatching.[1,3]

Inferior mouth – Snout projecting beyond the lower jaw.[2,3] [As used herein, mouth that is horizontal (or nearly so) and distinctly on underside of head with lips well behind anterior margin of snout.]

Insertion (of fin) – See fin insertion.

Integument – An enveloping layer or membrane.[3] Coating or external skin (Pennak 1964).

Internarial – Area between the nares on one side of the head or the other.[2]

Interorbital – Space between eyes over top of head.[1,3]

Interorbital width – Least distance between the orbits across dorsum of head.[2]

Interradial – Area between the fin rays.[2,3]

Interspaces – Spaces between parr marks of salmonids.[2,3]

Iridocytes – Crystals of guanine having reflective and iridescent qualities.[1,3]

Iridophores – See guanophores.

Isocercal – Tail in which vertebral axis terminates in median line of fin, as in Gadiformes,[1,2,3] caudal fin rays arising symmetrically from it.[2]

Isthmus – The narrow area of flesh in the jugular region between gill openings.[1,3] Fleshy space beneath the head and between the gill openings.[2]

Jugular – Pertaining to the throat.[1,3] Gular.[3]

Juvenile – Young fish after attainment of minimum adult fin-ray counts and before sexual maturation.[1] Young fish after attainment of minimum adult fin-ray counts and complete absorption of the median finfold and before sexual maturation.[3] [Latter definition used herein–see discussion on developmental interval terminology in introduction].

Keeled – With a ridge or ridges.[1,3]

Kupffer's vesicle – A small, vesicular, ventro-caudal pocketing which forms as blastopore narrows.[1]

Lanceolate – Slightly broad at the base and tapering to a point.[2]

Larva – Young fish between time of hatching and attainment of minimum adult fin ray counts.[1] Young fish between time of hatching and attainment of juvenile characteristics.[3] Encompasses both yolk-sac and post yolk-sac phases of development (Wallus et al. 1990). As used herein, period of fish development between hatching or birth and (1) acquisition of adult complement of fin spines and rays (principal and rudimentary) in all fins, and (2) loss beyond recognition of all finfold not retained by the adult (Snyder and Muth 1988, 1990, 2004; see discussion on developmental interval terminology in introduction; presence of yolk indicated by an appropriate modifier).

Late embryo – Stage prior to hatching in which the embryo has developed external characteristics of its hatching stage.[1,3]

Lateral line – Series of sensory pores and/or tubes extending backward from head along sides.[1,3]

Lateral-line scales – Pored or notched scales associated with the lateral line.[1,3] Count of pores in the lateral line, or the number of scales along the line in the position which would normally be occupied by a typical lateral line from the shoulder girdle to the structural base of the caudal fin (scales wholly on the caudal fin base not included in the count,

even when well developed and pored) (Hubbs and Lagler 1958). [Second definition: lateral-series scales.]

Lateral-series scales – [Number of rows of scales crossing the midlateral surface or lateral line if complete; see second definition by Hubbs and Lagler (1958) for lateral-line scales.

Lateral teeth – In petromyzontids, teeth of oral disc lateral to esophageal opening.[2]

Lepidotrichia – Replacements of actinotrichia; soft fin rays or spines.[2] See actinotrichia.[3] Scaly or soft fin rays [typically branched and jointed or segmented, always biserial (laterally divided or paired)]; replacements of [embryonic or larval] actinotrichia in the soft-rayed fishes or the soft-rayed fins or parts of fins of spiny-rayed fishes (Lagler et al. 1962, pp. 59 and 186).

Low-terminal mouth – [As used herein, mouth that is slightly oblique to horizontal with anterior end of upper lip at or below bottom-of-eye level and either even with or the most anterior margin of snout.]

Mandible – Lower jaw, comprised of three bones: dentary, angular and articular.[1,3]

Maxilla – The posterior, lateral bones of the upper jaw.[2]

Maxillary – The dorsal-most of the two bones in the upper jaw.[1,3]

Meckel's cartilage – Embryonic cartilaginous axis of the lower jaw in bony fishes,[1,3] forms the area of jaw articulation in adults.[3]

Melanophores – Black chromatophores.[1,3] [Also brown.] Melanin-bearing pigment cell.[2]

Mental – Pertaining to the chin.[1,3]

Meroblastic – Type of cleavage in which only the blastodisc undergoes division.[1]

Mesencephalon – Midbrain; serves optic functions.[2]

Mesolarva – Phase of larval development characterized by presence of at least one dorsal, anal, or caudal-fin spine or ray but either lacking the adult complement of principal soft rays in at least one median (dorsal, anal, or caudal) fin or lacking pelvic-fin buds or pelvic fins (if present in adult) (Snyder and Muth 1988, 1990, 2004; see discussion on developmental interval terminology in introduction; presence of yolk indicated by an appropriate modifier; standard length measured to end of notochord or, when sufficiently developed, axial skeleton).

Mesopterygoid – Middle of three dermal bones of the upper jaw.[2]

Metalarva – Phase of larval development characterized by presence of (1) adult complement of principal soft rays in all median fins and (2) pelvic-fin buds or pelvic fins (if present in adult) (Snyder and Muth 1988, 1990, 2004; see discussion on developmental interval terminology in introduction; presence of yolk indicated by an appropriate modifier; standard length measured to posterior end of axial skeleton, hypural elements or plates in fishes with homocercal tails).

Metencephalon – Portion of the brain immediately behind the mesencephalon.[2] [Hind brain.]

Micropyle – Opening in egg capsule through which spermatozoa enter.[1] Principle path of sperm entry through the chorion (vitelline membrane) of an egg.[2]

Molariform – Referring to a tooth with a flat grinding surface.[2]

Morula – Stage in development of egg in which blastomeres form a mulberry-like cluster.[1]

Myomeres – Serial muscle bundles of the body.[1,3] [Total myomere count is sum of preanal (to posterior margin of vent) and postanal (post vent) counts and should approximate the number of vertebrae (including Weberian vertebrae in ostariophysian fishes such as cyprinids, catostomids, and ictalurids).]

Myoseptum(a) – Connective tissue partition(s) separating myomeres.[1,3] Thin partition of connective tissue which joins myomeres.[2]

Nape – Area immediately posterior to occipital region.[1]

Nares – Nostrils, openings leading to the olfactory organs.[2,3]

Narial – Pertaining to the nares.[2,3]

Nasal – Pertaining to region of the nostrils, or to the specific bone in that region.[1,3]

NL – Abbreviation of notochord length.[1]

Notochord – Longitudinal supporting axis of body which is eventually replaced by the vertebral column in teleostean fishes.[1]

Notochord length – Straight-line distance from anterior-most part of head to posterior tip of notochord; used [as standard length] prior to and during notochord flexion.[1,3]

Obtuse – With a blunt or rounded end; an angle greater than 90 degrees.[2,3]

Occipital region – Area on dorsal surface of head, beginning above or immediately behind eyes and extending backwards to end of head;[1,3] occiput.[3]

Oil globule(s) – Discrete sphere(s) of fatty material with-in the yolk.[1,3]

Olfactory buds – Incipient olfactory organs.[1,3]

Ontogeny – Developmental history of an organism from zygote to maturity (Pennak 1964).

Opercle – Large posterior bone of the operculum.[3]

Operculum – Gill cover.[3]

Optic vesicles – Embryonic vesicular structures which give rise to the eyes.[1,3]

Origin (or fin) – See fin origin.

Otoliths – Small, calcareous, secreted bodies within the inner ear.[1,3]

Over yearling – Fish having spent at least one winter in a stream; applies to trout and salmon.[3]

P [or P1] – Abbreviation for pectoral fin.[1]

P2 [or V] – [Abbreviation for the ventral or pelvic fin.]

Palatine teeth – Teeth on the paired palatine bones in the roof of the mouth of some fishes.[1,3]

Palatines – Paired bones on the roof of the mouth, often bearing teeth.[2]

Parapatric – Distribution of species or other taxa that meet in a very narrow zone of overlap.[3]

Paravertebral – Along the same plane as the spinal column.[2]

Parietal – Paired bones of the roof of the skull.[2]

Pectoral [fin] bud – Swelling at site of future pectoral fin; anlage of pectoral fin.[1]

Pectoral fin length – Distance from base to farthest tip of fin.[2]

Pectoral fins – Paired fins behind head, articulating with pectoral girdle.[1,3]

Peduncle – Portion of body between anal and caudal fins.[2,3] [Caudal peduncle.]

Pelagic – Floating free in water column; not necessarily near the surface.[1,3] Living in the open water habitat, as opposed to bottom living or inshore inhabitants.[2]

Pelvic bud – Swelling at site of future pelvic (ventral) fins; anlage of pelvic fin.[1,3]

Pelvic fins – Paired fins articulating with pelvic girdle; ventral fins.[1,3]

Periblast – A layer of tissue between the yolk and cells of blastoderm which is observed as a thin border around blastula.[1]

Pericardium – Cavity in which the heart lies.[2,3]

Peritoneum – Membranous lining of abdominal cavity.[1,2,3]

Perivitelline space – Fluid-filled space between egg proper and egg capsule.[1,3] Fluid-filled space between the chorion and yolk material.[2]

Pharyngeal teeth – Teeth on the pharyngeal bones of the branchial skeleton.[1,3] Bony tooth-like projections derived from the fifth (pharyngeal) gill arch.[2] In cyprinids, both left and right arches bear 1-3 rows of teeth; counts for each row and arch are given in a formula in order from left to right [rows separated by commas, arches by a dash] (Hubbs and Lagler 1958).

Physoclistic – Having no connection between the esophagus and the pneumatic duct [of the swim (air or gas) bladder]; typical of perciform fishes.[3]

Physostomus – Having the swim bladder connected to the esophagus by the pneumatic duct;[2,3] typical of cypriniform fishes.[3]

Plicae – Wrinkle-like folds found on the lips of some catostomids.[2,3]

Post yolk-sac larva – Phase beginning with complete absorption of the yolk and ending when a minimum adult complement of rays is present in all fins and the median finfold is completely absorbed (Wallus et al. 1990).

Postanal length – Distance from posterior margin of anus [or vent] to the tip of the caudal fin,[2,3] or median finfold.[2]

Postanal myomeres – The number of myomeres between posterior margin of anus and the most posterior myoseptums.[1] Number of whole myomeres posterior to an imaginary vertical line at the most posterior point of the anus [vent],[2,3] including one urostylar element; the first postanal myomere is the first myomere behind and not touched by the imaginary line.[3] [The last myomere lies immediately anterior to the most posterior complete myoseptum.]

Postero-hyal – Posterior bone to which branchiostegal rays attach, formerly epihyal.[2,3]

Postflexion larva – Phase following upward flexion of the tip of the notochord [more precisely considered to begin with formation of all principal caudal fin rays] (Ahlstrom et al. 1976).

Postflexion mesolarva – Among fishes with homocercal tails, subphase of mesolarval development characterized by adult complement of principal caudal-fin rays (notochord flexion essentially complete and standard length measured to posterior-most margin of hypural elements or plates) (Snyder and Muth 1988, 1990, 2004; see discussion on developmental interval terminology in introduction; presence of yolk indicated by an appropriate modifier).

Postorbital length – Distance from posterior margin of eye to posterior edge of opercular membrane.[2,3] [Or to origin of pectoral fin, depending on criteria for head length.]

Preanal length – Method of measuring often not stated, assumed to be about equivalent to snout to vent length in larvae.[1] Distance from anterior-most part of head to posterior margin of anus.[2,3] [Snout-to-vent length, herein measured to posterior margin of vent.]

Preanal myomeres – The number of myomeres between the anterior-most myoseptum[1,3] and the posterior margin of anus[1] or an imaginary vertical line drawn at the posterior margin of anus, including any bisected by the line.[3] Number of myomeres from the nape to, and including any myomeres bisected by an imaginary vertical line at the most posterior point of the anus.[2] [As used herein, the most anterior myomere, which is mostly an epaxial unit, is located immediately behind the occiput and often deltoid in shape (somewhat wider at the top), and the last is the most posterior myomere transected by a vertical line from the posterior margin of the vent.]

Prebranchial length – In petromyzontids, distance between the tip of the snout and the anterior margin of the first gill opening.[2]

Predorsal length – Distance from the most anterior point on the snout to the anterior margin of the base [origin] of the first dorsal fin ray when formed.[2]

Predorsal myomeres – Number of myomeres from nape to dorsal origin of median finfold.[2] [Or, to origin of the dorsal fin once anterior-most pterygiophores or fin rays are formed.]

Predorsal scales – Scales along dorsal ridge from occiput to origin of dorsal fin.[1,3]

Preflexion larva – Phase between hatching and upward flexing of the tip of the notochord [or appearance of first caudal fin rays] (Ahlstrom et al. 1976).

Preflexion mesolarva – Among fishes with homocercal tails, subphase of mesolarval development characterized by absence of caudal-fin rays (posterior portion of notochord remains essentially straight and standard length measured to end of notochord; when first median-fin ray is a caudal ray, as in most fishes, larva progresses directly from protolarva to flexion mesolarva) (Snyder and Muth 1988, 1990, 2004; see discussion on developmental interval terminology in introduction; presence of yolk indicated by an appropriate modifier).

Prejuvenile – Developmental stage [phase] immediately following acquisition of minimum fin ray complement of adult and before assumption of adult-like body form; used only where strikingly different from juvenile[1,3] (*cf.* Hubbs, 1958; *Tholichthys* stage of butterflyfishes, querimana stage of mullets, etc.).[1] [Transitional phase.]

Premaxilla, premaxillary – The ventral-most of the two bones included in the upper jaw.[1,3] Primary bone of the upper jaw in most fish, usually bearing teeth.[2]

Preorbital – Large bone anterior to the eye.[2]

Primordium – Rudimentary form of an anatomical structure; anlage.[1,3]

Principal anal- and dorsal-fin rays – In certain fishes, particularly the Cyprinidae and Catostomidae,. . . the principal rays include the branched rays plus one unbranched ray [the anteriorly adjacent, usually longest, unbranched ray]; . . . the last two bases [branched rays, both of which articulate with the most posterior pterygiophore] are counted as one ray (Hubbs and Lagler 1958). [In traditional fin-ray count formulas, represented by Arabic numerals.]

Principal caudal [-fin] rays – Caudal rays inserting on hypural elements; the number of principal rays is generally defined as the number of branched rays plus two [adjacent unbranched rays, one above and one below the branched rays].[1,3] [In traditional fin-ray count formulas, represented by Arabic numerals.]

Procurrent caudal rays – A series of much shorter rays anterior to the principal caudal rays, dorsally and ventrally, not typically included in the margin of the caudal fin.[1,3] [Rudimentary or secondary rays of the caudal-fin; in traditional fin-ray count formulas, represented by lower case Roman numerals (dorsal before and ventral after principal ray count, separated by commas.]

Pronephric ducts – Ducts of pronephric kidney of early developmental stages.[1,3]

Protolarva – Phase of larval development characterized by absence of dorsal-, anal-, and caudal-fin spines and rays (Snyder and Muth 1988, 1990, 2004; see discussion on developmental interval terminology in introduction; presence of yolk indicated by an appropriate modifier; standard length measured to end of notochord).

Protractile – Describing premaxillae which can be extended.[2] [Protrusible.]

Pterygoid – Dermal bone of the upper jaw.[2]

Pterygiophores – Bones of the internal skeleton supporting the dorsal and anal fins.[2,3]

Redd – An excavated area or nest into which trout spawn.[3]

Retrorse – Pointing backward.[3]

Rostrum – Snout.[3]

Rudimentary fin rays – [In certain fishes, particularly the Cyprinidae and Catostomidae, size-graded series of shorter, unbranched soft rays anterior to the principal rays of the dorsal, anal, and caudal fins; also called secondary rays or, in the case of the caudal fin, procurrent rays; in traditional fin-ray count formulas, represented by lower case Roman numerals and separated from the principal ray count, in Arabic, by commas.]

Saddle markings – Pigment patterns which cover the dorsal and lateral aspects and give an overall appearance of a saddle.[2]

Secondary fin rays – See rudimentary fin rays, and with respect to the caudal fin, procurrent rays.

Scute – A modified, thickened scale, often spiny or keeled.[1,3]

Semibuoyant – Referring to eggs which neither float nor sink, but remain suspended in the water column.[2,3]

Sigmoid heart – The S-shaped heart which develops from the primitive heart tube.[1,3]

SL – Abbreviation for standard length.[1]

Snout – [Portion of head anterior to eyes and, as used herein, including the portion of the mouth anterior to the eyes (often used in reference only to the fleshy anterior extension of the head above the mouth including the nares).]

Snout-to-vent length – Distance from anterior-most part of head to posterior margin of anus [vent]; the precise method of measurement often not stated.[1] [See preanal length.]

Soft rays – Bilaterally paired, usually segmented, fin supports.[1,3] [See lepidotrichia; in traditional fin-ray count formulas, principal soft rays of median fins or all rays of paired fins represented by Arabic numerals.]

Somites – Primitive, segmented, mesodermal tissue along each side of notochord.[1] [Consists in part of future myomeres.]

Spatulate – Having a rounded apex and tapering to a base; spoon-shaped.[2]

Spines – Unpaired [uniserial, not bilaterally divided], unsegmented, unbranched fin supports, usually (but not always) stiff and pungent.[1,3] [In traditional fin-ray count formulas, represented by upper case Roman numerals, and if part of a fin with both spines and soft rays, separated from such by a comma, or if in a fully separated section of the fin (e.g., first dorsal fin of some perciform fishes), separated by a dash.]

Spinous rays – [In certain otherwise soft-rayed fish, soft rays that during embryonic or larval development are thickened, fused, and hardened into spine-like structures, sometimes with moderate to strong serrations or barbs along their posterior margins (e.g., spines at the anterior margins of the dorsal and pectoral fins in catfishes, order Siluriformes, dorsal and anal fins in goldfish *Carassius auratus* and carp *Cyprinus carpio*, and dorsal fins of the spiny-rayed cyprinids, tribe Plagopterini, for which the basal portions of certain other dorsal, pelvic, and pectoral fin rays also exhibit spine-like modifications–Hubbs and Lagler 1958, Lagler et al. 1962, and Miller and Hubbs 1960). In formulas for fin-ray counts, fully spinous rays may designated by Roman numerals like true spines.]

Squamation – Covering of scales.[2,3]

Standard length – In larvae, straight-line distance from anterior-most part of head to end of hypural elements; not applicable to larvae prior to [or during] notochord flexion (in juveniles and adults measured from most anterior point of snout or upper lip.)[1] In larvae, straight-line distance from anterior-most part of head to the most posterior point of the notochord or hypural complex.[2,3] [As used herein for fish with homocercal tails, includes notochord length prior to formation of all principal caudal fin rays which signals the end of notochord flexion.]

Stellate – Referring to a melanophore [with pigment] which is expanded into a starlike shape.[2,3]

Stomodeum – Primitive invagination of the ectoderm which eventually gives rise to the mouth.[1,3] Primordial mouth; the anterior pitted portion of the embryonic gut.[2]

Submandibular – Beneath the lower jaw; along the edge of the lower jaw.[2]

Subterminal mouth – [As used herein, mouth that is slightly oblique to horizontal with anterior margin of upper lip at or below bottom-of-eye level and lips slightly to moderately preceded or overhung by anterior margin of snout; between low-terminal and inferior positions.]

Superior mouth – Condition when the lower jaw extends upward and the mouth opens dorsally.[2,3] [As used herein, mouth that is strongly oblique with anterior end of upper lip above middle-of-eye level and lower jaw usually the most anterior margin of snout.]

Supramaxilla – Small dermal bone attached posterior and dorsal to the maxilla.[2]

Supraoral – Above the mouth; referring to the teeth of the oral disc in lampreys which are anterior to the mouth opening.[2]

Supraoral tooth plate – In petromyzontids, tooth plate immediately anterior to esophageal opening.[2]

Swim bladder – See gas bladder.

Sympatric – Species inhabiting the same or overlapping geographic areas.[3]

Tail-bud stage – Stage of embryonic development characterized by a prominent caudal bulge and marked development of cephalic region.[1]

Tail-free stage – Stage of embryonic development characterized by separation of the tail from the yolk.[1]

Tail length – In petromyzontids, distance from cloacal slit to tip of caudal fin.[2]

Teleosts – Bony fishes.[3]

Terminal mouth – Condition when lower and upper jaws are equal in length and the mouth opens terminally.[2,3] [As used herein, mouth that is moderately oblique with anterior end of upper lip above bottom-of-eye to middle-of-eye level, lips usually even with or the most anterior margin of snout (sometimes slightly behind anterior margin of snout).]

Tessellated – Markings or colors arranged into squares.[2]

TL – Abbreviation for total length.[1]

Total length – Straight-line distance from anterior-most part of head to tip of tail.[1,3] Distance from the most anterior point on the snout to the most posterior point on the caudal fin or finfold.[2]

Truncate – Ending abruptly along a vertical line.[2] Terminate abruptly as if the end were cut off.[3]

Trunk length – In petromyzontids, distance between posterior margin of last gill opening and cloacal slit.[2]

Trunk myomeres – In petromyzontids, myomeres between the most posterior gill opening and the cloacal slit.[2]

Urostyle – Terminal vertebral element in higher teleosts, derived from the fusion and loss of several of the most posterior centra of the more primitive forms;[1,3] usually modified for caudal fin support.[3] Final vertebral segment usually modified for caudal fin support.[2]

V [or P2] – Abbreviation for the ventral or pelvic fin.[1]

Vent – Anus.[1,3] [Cloacal aperture, includes both anus and end of the uro-genital duct.]

Ventral fins – Paired fins articulating with the pelvic girdle; pelvic fins.[1]

Vermiculate – Having wormlike markings.[2,3]

Villiform – In the form of finger-like projections.[2]

Vitelline membrane – After water hardening, the membrane surrounding the egg proper (animal and vegetal material).[2]

Vitelline vessels – Arteries and veins of yolk region.[1,3]

Vomer – Anterior, median bone of the roof of the mouth (= prevomer).[2]

Water-hardening – Expansion and toughening of egg capsule due to absorption of water into the perivitelline space.[1,3] Process of membrane delamination and fluid formation which forms the perivitelline space bordered by the chorion and vitelline membrane.[2]

Weberian vertebrae – First four vertebrae in cyprinids, catostomids, and ictalurids which are modified to connect the swim bladder to the inner ear.[2]

Width of perivitelline space – Distance between yolk and egg capsule expressed either as direct measurement or a ratio of the egg diameter.[1] Distance between yolk and outer margin of egg capsule.[3] [Technically, measured instead to the inner surface of the chorion.]

Xanthophores – Yellow chromatophores.[1,2,3]

Yearling – A fish in its second year.[3]

Yolk – Food reserve of embryonic and early larval stages, usually seen as a yellowish sphere diminishing in size as development proceeds.[1,3]

Yolk diameter – Greatest diameter of yolk; more accurately measurable prior to embryo formation.[1,3]

Yolk plug – Yolk within the blastopore.[1]

Yolk sac – A bag-like ventral extension of the primitive gut containing the yolk.[1,3]

Yolk-sac larva – A larval fish characterized by the presence of a yolk-sac.[1,3] Phase of development from the moment of hatching to complete absorption of the yolk (Wallus et al. 1990).

Yolk-sac length – Horizontal distance from most anterior to most posterior margin of yolk sac.[2,3]

Yolk-sac depth – Vertical distance from dorsum to venter of yolk sac.[2]

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[Inside back cover]