Illustration and Description of Virgin Spinedace Larvae and Early Juveniles — Contribution to a Guide to Larval Fishes of the Virgin River

Final Report

VRRMRP Project Number VII.12.03

Prepared for

Virgin River Resource Management and Recovery Program
1594 W. North Temple, Suite 3310
Salt lake City, Utah 84116-5610

via

Steven M. Meismer
Local Coordinator, VRRMRP
533 E Waterworks Drive
St. George, Utah 84770

30 March 2013

by

Darrel E. Snyder, Sean C. Seal, and C. Lynn Bjork

LARVAL FISH LABORATORY
Department of Fish, Wildlife, & Conservation Biology
Colorado State University
1474 Campus Delivery
Fort Collins, Colorado 80523-1474

Telephone: (970) 491-5295, Fax: (970) 491-5091
E-mail: Darrel.Snyder@ColoState.edu

Larval Fish Laboratory
Contribution
178

Colorado State University
Knowledge to Go Places

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Project Duration:

01 February 2012 through 31 March 2013.

Relationship to Recovery Action Plan:

Objective 6: Determine ecological factors limiting abundance of native species.
Objective 7: Monitor habitat conditions and populations of native species.
Also monitoring or assessment of fish responses to other recovery activities.

Project Background Information:

Successful research on, and monitoring of, fish reproduction and early life history often depends on accurate identification of their collected larvae and early juveniles. Collections of these early life stages can help define spawning grounds, seasons, and requirements, as well as assess larval and juvenile fish production, survival, transport, migration, habitat use, and susceptibility to entrainment in water diversions and other impacts.

Of the six fishes native to the Virgin River, two remained undescribed as larvae-the Virgin River chub, federally endangered, and the Virgin spinedace, a Utah state conservation species. Description of the woundfin was funded in December 2009 by the Virgin River Program and completed in March 2011. The other native and all non-native species have been, or are being, described and included in guides for other waters. However, the current description of desert sucker in our 2005 guide to native cypriniform fishes of the Gila River Basin could be made more complete with illustrations for an additional three developmental stages-recently hatched protolarva, recently transformed metalarva, and recently transformed juvenile.

Description of Virgin River fish larvae and preparation of a guide for their identification was originally proposed to the Bureau of Land Management, a Program partner, in 1993 at the agency's request (via Mike Herder). In recent years, prospects for that work have been discussed informally with the Local Program Coordinator (Steven Meismer), and pre-proposals have been submitted for illustrating the larvae pending the successful culture and assemblage of preserved developmental series of needed species via Dexter National Fish Hatchery and Technology Center (DNFHTC), and the guide itself pending near completion of our work on other guides (currently a guide to cyprinid larvae of the Upper Colorado River Basin, completion of which has been delayed until spring 2013, and a guide to cypriniform larvae of the Middle Rio Grande to be completed in late 2013). Developmental study series of woundfin and Virgin chub were reared, preserved, and assembled for the Larval Fish Laboratory (LFL) in 2006 and 2007, and finally Virgin spinedace in 2011. We had suggested that needed illustrations be prepared as soon as possible in advance of the guide because the longer-term availability of LFL's fine illustrator, C. Lynn Bjork, could be assured.

With the successful rearing and preservation of developmental study series by DNFMTC, the local coordinator for the Virgin River Program requested a proposal (Scope of Work, SOW) for illustrating Virgin spinedace and acquiring associated morphometric, meristic, and size-relative-to-developmental-state data for their further description and eventual inclusion in a guide and computer-interactive key. As for recently completed work for the woundfin, those illustrations were to be assembled and the descriptive data summarized for immediate use in our standard 6-page descriptive species account format. The project was to be conducted with preserved specimens at the Larval Fish Laboratory, Colorado State University, Fort Collins, Colorado.

Goal and Objective:

The goal of this project is to facilitate researcher identification of collected Virgin spinedace larvae by documenting morphological development from recently hatched protolarvae through early juveniles with a set of eight detailed, dorsal-, lateral-, and ventral-view drawings and selected morphometric, meristic, and size-relative-to-developmental-state data. The objective is to continue documenting the early morphological development of Virgin River fish with illustrations and descriptive data prepared for immediate use and, if funded in the future, eventual inclusion with other descriptive accounts in a guide and key to at least the cypriniform fish larvae and early juveniles of the Virgin River.

Results and End Products:

The results of this project are summarized in the appended species account describing Virgin spinedace larvae and early juveniles. The end products of the project are a set of high-resolution digital scans of the drawings, an Excel spreadsheet of recorded individual specimen and summarized descriptive data, and the appended descriptive species account in LFL's standard 6-page format, supplemented with methodological diagrams, a list of literature cited in the account, and acknowledgments (content that would be included elsewhere in a guide). Digital files of the scanned illustrations and spreadsheet data will be submitted to the Virgin River Resources Management and Recovery Program with or shortly after this final report.

Species Account – *Lepidomeda mollispinis* (Virgin spinedace)

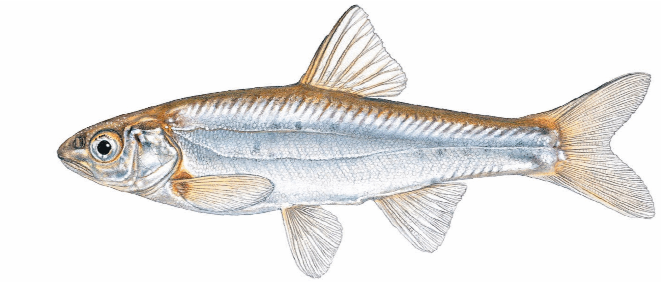

Fig. 1. *Lepidomeda mollispinis* adult (© Joseph R. Tomelleri).

Adult description: Up to 15 cm TL, rarely >10 cm. Snout and head conically rounded; head ≥2/3 as deep at nape. Terminal mouth moderately large; no barbels. Gut s-shaped. Body anteriorly rounded, somewhat laterally compressed, and covered with fine scales; lateral line complete. Dorsal fin begins behind pelvic origin with two nearly adjacent and fused, hardened (spinous) rays–a long modified first principal ray, retaining its unbranched soft tip, and a modified rudimentary ray little more than half its length. Anterior margins of pectoral, pelvic, and anal fins also thickened and somewhat spine like, as are basal portions of branched pelvic rays. Inner margins of pelvic fins partially adnate to body. Body silvery with brassy sheen and sooty blotches on sides; upper outer margin of opercle to preopercle darkly pigmented. Orange-red breeding colors at bases of paired fins in both sexes, and as a basal anal-fin band and sometimes a spot at upper gill slit in males. Peritoneum sparsely to moderately speckled.. See table of meristics below.

Reproduction: Assumed to be non-guarding, open-substrate lithophil with demersal, adhesive eggs. Spawn April to early June, sometimes in March or July, at 13-17 °C; peaks correlated with peak discharges. Males congregate near lower ends of pools and converge on single females over spawning substrate. Eggs 1.8-2.0 mm.

Young: Hatch in 3 days at 23°C.

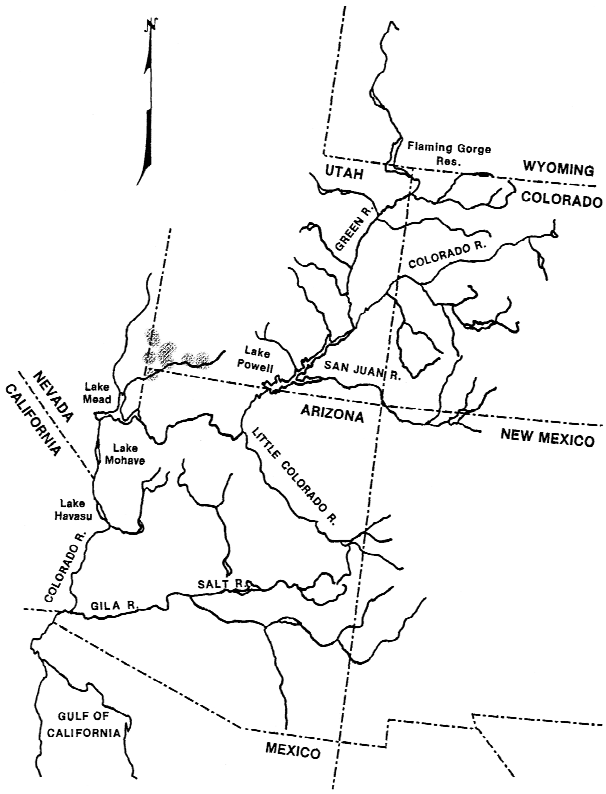

Fig. 2. Recent distribution of *Lepidomeda mollispinis* in the Colorado River Basin (endemic to Virgin River basin).

Table 1. Selected juvenile and adult meristics for *Lepidomeda mollispinis*. (P = principal rays; R = rudimentary rays; D = dorsal; V = ventral. Scales are lateral series or line when complete. Four added to vertebral count for Weberian complex. Pharyngeal teeth given as left outer row, inner row/right inner row, outer row. Mean or modal values underlined if known and noteworthy; rare values in parentheses.)

Character	Observed	Literature	Character	Observed	Literature
Dorsal-fin rays - P	8 [a]	8 [a]	Dorsal-fin rays - R	(1)2 [b]	–
Anal-fin rays - P	(8)9	8-9(10)	Anal-fin rays - R	2(3)	–
Caudal-fin rays - P	19	–	Caudal-fin rays - RD	(10)11-12-13(14)	–
Pectoral-fin rays	14-15 (16)	–	Caudal-fin rays - RV	10-11-12	–
Pelvic-fin rays	7(8)	(6)7	Lateral scales	(78-)84-87	(77-)82-88(-91)
Vertebrae	–	42-43-44	Pharyngeal teeth	–	2(3),(4)5/4(5),2

[a] Includes second spinous ray which develops from unbranched first principal ray; with rudimentary-based spine, fin formula would be II,7.
[b] Includes first spinous ray which develops from an unbranched rudimentary ray, often closely preceded by a very tiny first rudimentary ray.

Table 2. Size at onset of selected developmental events for *Lepidomeda mollispinis*. (As apparent under low-power magnification. P = principal rays; R = rudimentary/secondary rays. Rare values in parentheses.)

Event or structure	Onset or formation mm SL	mm TL	Fin rays or scales	First formed mm SL	mm TL	Last formed mm SL	mm TL
Hatched	(6)7	(6)7	Dorsal - P	(10)11	11-12	11-12	12-13
Eyes pigmented	* or 6	* or 6(7)	Anal - P	11-12	12-13	13-14	15-16
Yolk assimilated	(9)10	10-11	Caudal - P	9	(9)10	10(11)	11
Finfold absorbed	21(22)	(26)27	Caudal - R	11-12	12-13	(12)13-14(-16)	(14-)16-18(-20)
Pectoral-fin buds	*	*	Pectoral	(10)11	11-12	(17-)19-20	(21-)24
Pelvic-fin buds	(10)11	11-12	Pelvic	14(15)	16-17	15	18-19
* before hatching			Scales	21-22	26-27	23-26	29-32

References: Arizona Game and Fish Department 2001 & 2004, Balon 1975 and 1981, Fridell and Wagner (undated brochure), Fridell et al. 2012, La Rivers 1962, Lentsch et al. 2002, Miller and Hubbs 1960, Minckley 1973, Moore 1968, Page and Burr 1991, Rinne 1971, Sigler and Miller 1963, Sigler and Sigler 1996,

SPECIES ACCOUNT prepared by D. E. Snyder, S. C. Seal, and C. L. Bjork, Colorado State University Larval Fish Laboratory, Fort Collins, Colorado, for the Virgin River Resource Management and Recovery Program, Salt lake City, Utah (30 March 2013).

Table 3. Size at developmental interval (left) and gut phase (right) transitions for *Lepidomeda mollispinis*. (See Fig. 11 for phases of gut folding. Rare values in parentheses.)

Transition to	mm SL	mm TL	Transition to	mm SL	mm TL
Flexion mesolarva	9	(9)10	2 - 90° bend	12-13	14-15
Postflexion mesolarva	10(11)	11	3 - Full loop	21-22(-26)	26-27(-32)
Metalarva	13-14	15-16	4 - Partial crossover	not applicable	
Juvenile	21(22)	26(27)	5 - Full	not applicable	

Table 4. Summary of morphometrics and myomere counts by developmental phase for *Lepidomeda mollispinis*. (See Figure 12 for abbreviations and methods of measurement and counting. Protolarvae with unpigmented eyes excluded. Standard deviation (SD) of 0 represents a value <0.5.)

	Protolarvae (N=6)			Flexion mesolarvae (N=7)			Postflexion mesolarvae (N=8)			Metalarvae (N=10)			Juveniles (N=11)		
	$\bar{x}$	±SD	Range	$\bar{x}$	±SD	Range	$\bar{x}$	±SD	Range	$\bar{x}$	±SD	Range	$\bar{x}$	±SD	Range
SL, mm	8	1	7 - 9	10	1	9 - 10	12	1	10 - 14	18	3	13 - 22	29	6	21 - 40
TL, mm	8	1	7 - 10	10	1	9 - 11	14	2	11 - 16	21	4	15 - 27	36	8	27 - 50
Lengths %SL															
AS to AE	3	0	2 - 3	4	1	2 - 5	5	0	5 - 5	6	1	5 - 8	6	1	5 - 7
PE	9	1	8 - 10	11	1	9 - 12	13	1	12 - 14	14	1	13 - 15	15	1	13 - 16
OP1	17	1	17 - 19	21	1	19 - 22	24	1	22 - 26	26	1	24 - 28	27	1	25 - 29
OP2							47	1[b]	46 - 47	48	1	47 - 49	47	1	46 - 49
PY	68	3	62 - 72	58	5[a]	52 - 64									
OPAF	47	13	25 - 61	28	1	26 - 29	32	1	29 - 33	46	11	32 - 60			
ODF	46	3	42 - 51	44	4	37 - 49	49	2[a]	45 - 50						
OD							50	1[b]	49 - 51	50	1	48 - 51	51	1	49 - 53
ID							63	1[c]	63 - 64	64	1	63 - 65	65	1	63 - 67
PV	70	2	65 - 73	67	1	65 - 68	69	1	67 - 70	67	2	64 - 69	66	1	64 - 68
OA							67	1[a]	66 - 68	66	1	64 - 68	65	1	64 - 68
IA										77	1	74 - 78	77	1	75 - 79
AFC							110	2	107 - 112	114	1	112 - 115	114	1	113 - 116
PC	104	1	103 - 105	106	1	105 - 107	113	4	107 - 116	121	2	118 - 124	125	1	122 - 126
Y	52	6	43 - 60	16	19	0 - 42									
P1	6	3	2 - 11	12	1	11 - 13	13	1	13 - 14	17	2	15 - 19	20	1	18 - 22
P2							3	1	0 - 4	10	5	3 - 15	17	1	15 - 18
D										22	2	19 - 24	24	1	22 - 25
A										16	2	13 - 18	18	1	18 - 19
Depths %SL															
at BPE	11	1	10 - 12	13	0	12 - 13	14	1	13 - 15	17	1	15 - 19	17	1	17 - 19
OP1	15	3	12 - 19	13	1	12 - 14	17	1	15 - 18	20	1	18 - 22	22	1	21 - 24
OD	14	2	10 - 16	10	1	10 - 11	13	1	12 - 15	19	3	14 - 23	24	1	22 - 26
BPV	6	1	5 - 7	7	0	7 - 8	10	1	8 - 11	14	2	11 - 16	17	1	16 - 20
AMPM	3	1	2 - 4	4	0	4 - 5	6	1	5 - 8	9	1	7 - 10	11	0	10 - 11
Max. yolk	10	4	5 - 15	2	3	0 - 7									
Widths %SL															
at BPE	10	1	8 - 12	13	1	12 - 14	15	1	14 - 16	16	1	15 - 18	17	1	15 - 18
OP1	11	3	9 - 16	11	1	10 - 12	14	1	12 - 15	16	1	14 - 18	18	1	16 - 20
OD	9	2	6 - 11	7	0	6 - 7	8	1	7 - 9	12	2	9 - 14	15	1	13 - 17
BPV	4	1	4 - 5	5	0	5 - 6	6	1	6 - 7	9	1	7 - 10	11	1	10 - 12
AMPM	2	0	2 - 3	3	0	2 - 3	3	0	3 - 4	4	0	3 - 5	5	1	4 - 7
Max. yolk	12	3	8 - 17	3	3	0 - 8									
Myomeres															
to PY	28	1	27 - 29	24	4[a]	20 - 28									
OPAF	19	6	7 - 26	7	0	6 - 7	7	1	6 - 8	14	6	7 - 23			
OP2							17	1[b]	16 - 17	16	1	15 - 17	15	0[b]	15 - 16
ODF	17	2	14 - 19	16	3	11 - 18	18	1[a]	17 - 20						
OD							19	1[b]	18 - 20	17	1	16 - 18	17	1[b]	16 - 18
PV	29	1	29 - 30	29	1	28 - 30	30	1	29 - 30	27	1	25 - 29	27	1[b]	26 - 28
Total	43	1	41 - 44	43	1	42 - 44	43	1	42 - 44	42	1	41 - 44	42	1[b]	41 - 43
After PV	14	1	12 - 15	14	1	13 - 15	13	0	13 - 14	15	1	14 - 16	15	1	14 - 16

[a] N = 5. [b] N = 7. [c] N = 4.

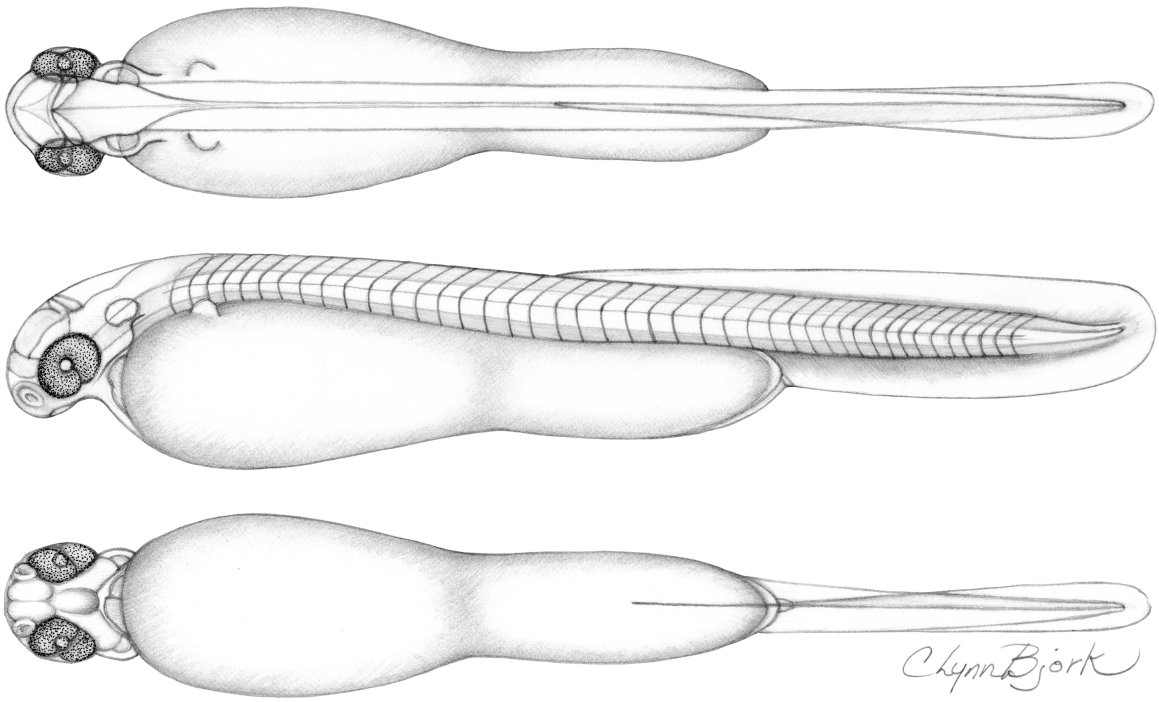

Fig. 3. *Lepidomeda mollispinis* protolarva with yolk, recently hatched, 6.6 mm SL, 6.8 mm TL. (Cultured in 2011 at Dexter National Fish Hatchery and Technology Center, New Mexico, with stock from the Virgin River, Utah; LFL# 121490.)

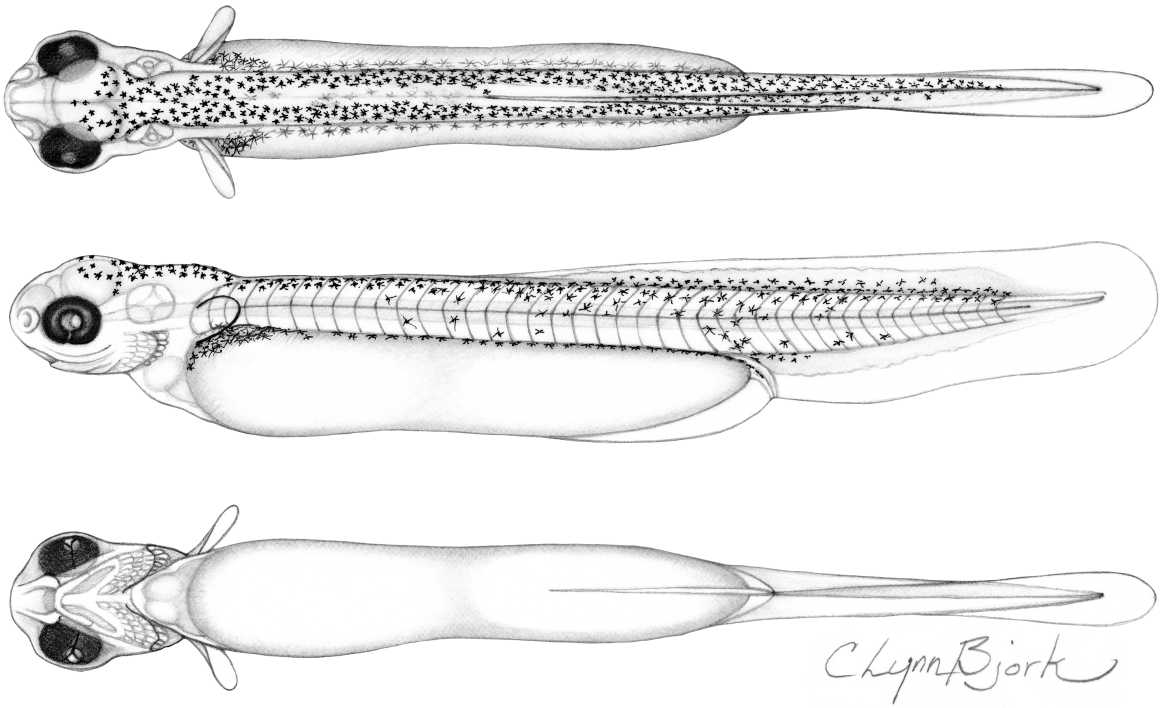

Fig. 4. *Lepidomeda mollispinis* protolarva with yolk, 2 d posthatch, 7.6 mm SL, 8.0 mm TL. (Cultured in 2011 at Dexter National Fish Hatchery and Technology Center, New Mexico, with stock from the Virgin River, Utah; LFL# 121493.)

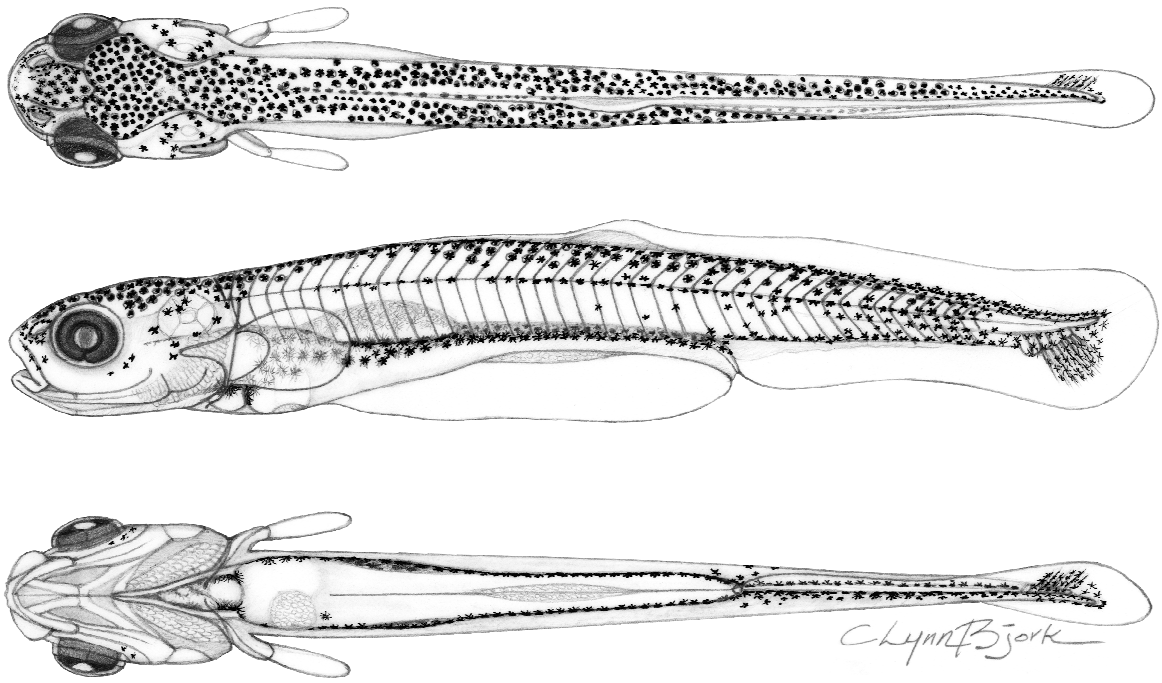

Fig. 5. *Lepidomeda mollispinis* flexion mesolarva with yolk, 6-7 d posthatch, 10.0 mm SL, 10.6 mm TL. (Cultured in 2011 at Dexter National Fish Hatchery and Technology Center, New Mexico, with stock from the Virgin River, Utah; LFL# 121496.)

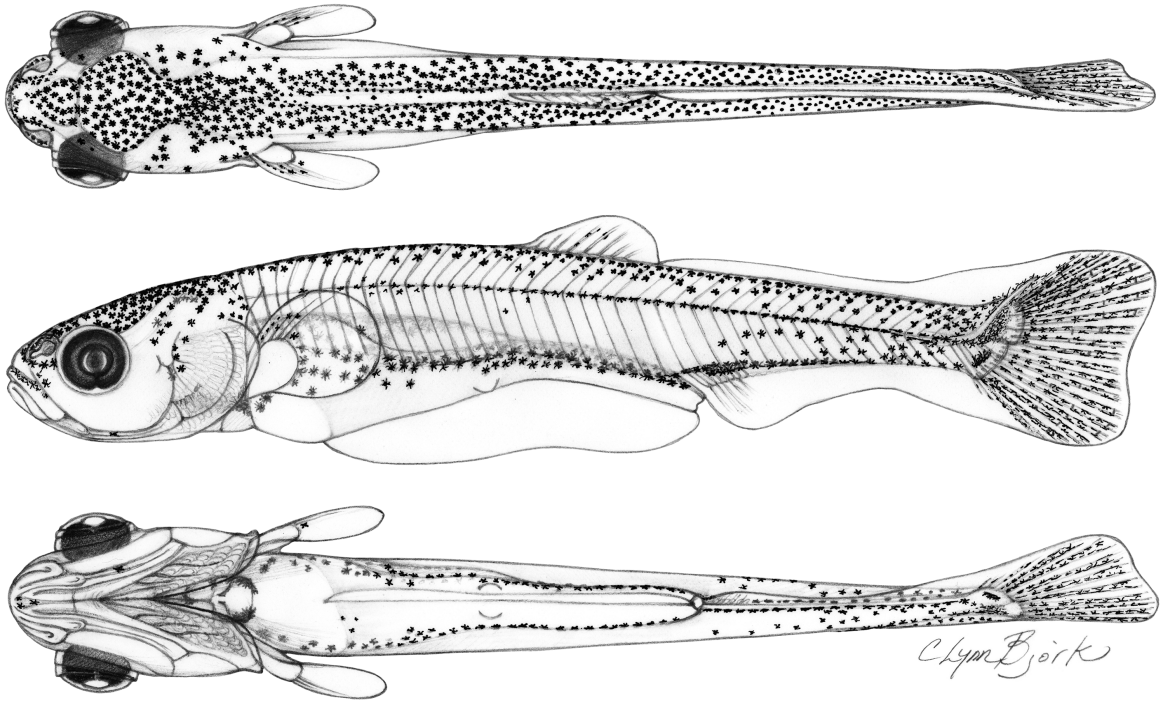

Fig. 6. *Lepidomeda mollispinis* postflexion mesolarva, 11-12 d posthatch, 11.7 mm SL, 13.2 mm TL. (Cultured in 2011 at Dexter National Fish Hatchery and Technology Center, New Mexico, with stock from the Virgin River, Utah; LFL# 121499.)

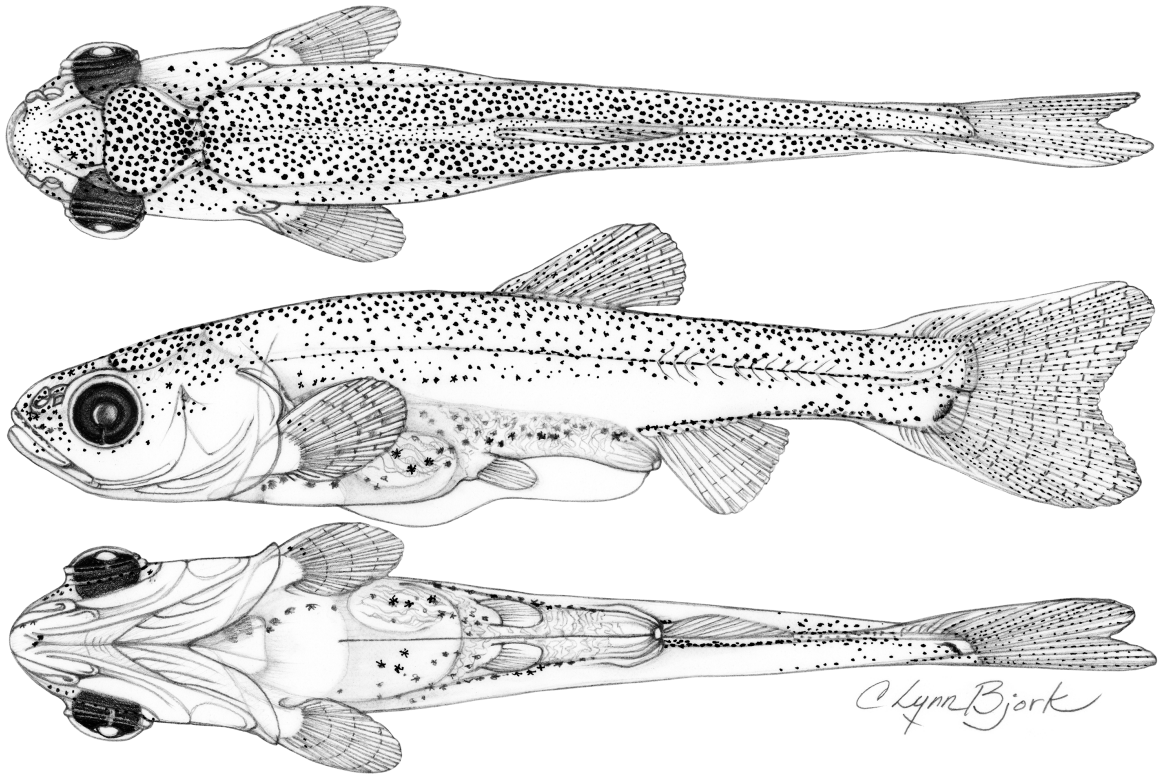

Fig. 7. *Lepidomeda mollispinis* metalarva, recently transformed, 15.3 mm SL, 18.1 mm TL. (Cultured in 2011 at Dexter National Fish Hatchery and Technology Center, New Mexico, with stock from the Virgin River, Utah; LFL# 121502.)

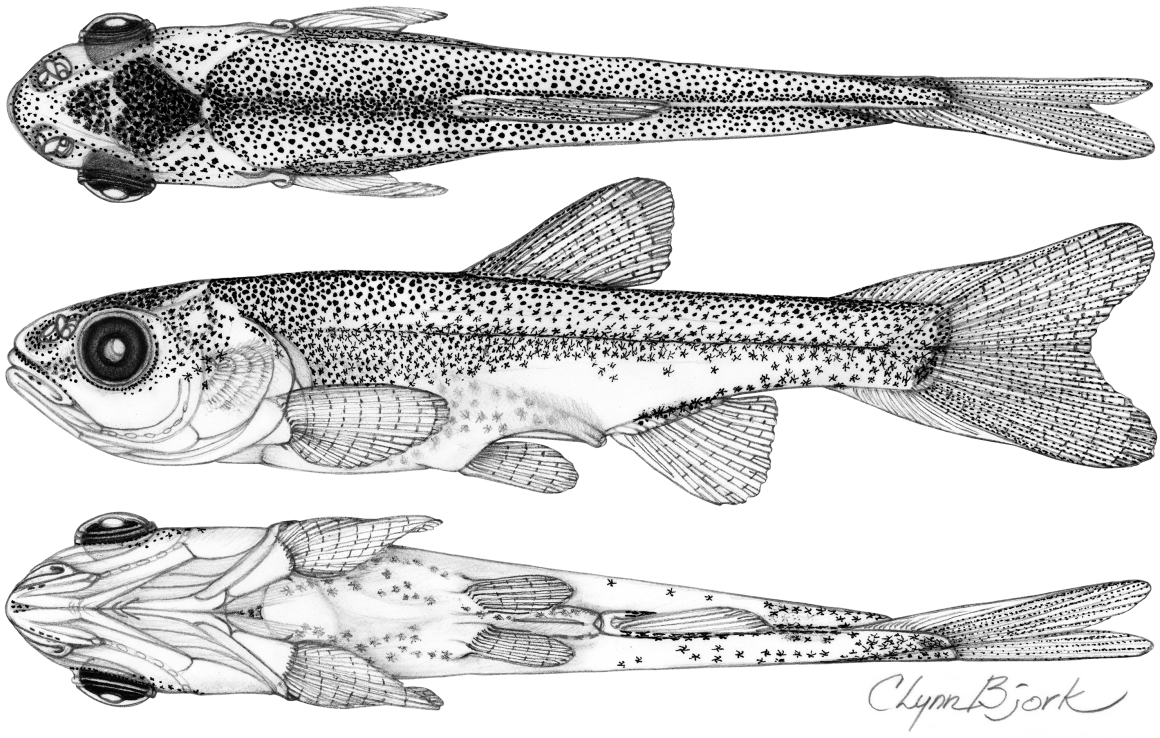

Fig. 8. *Lepidomeda mollispinis* metalarva, 19.5 mm SL, 23.8 mm TL. (Cultured in 2011 at Dexter National Fish Hatchery and Technology Center, New Mexico, with stock from the Virgin River, Utah; LFL# 121505.)

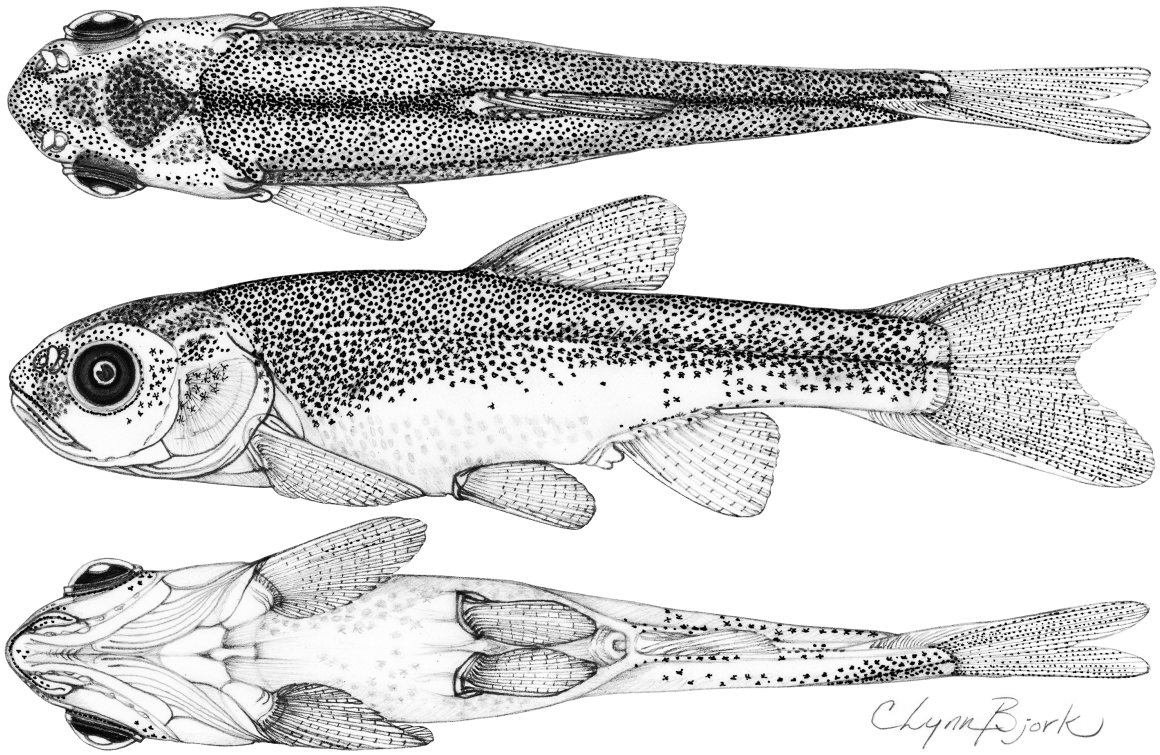

Fig. 9. *Lepidomeda mollispinis* juvenile, recently transformed, 24.8 mm SL, 30.3 mm TL. (Cultured in 2011 at Dexter National Fish Hatchery and Technology Center, New Mexico, with stock from the Virgin River, Utah; LFL# 121508.)

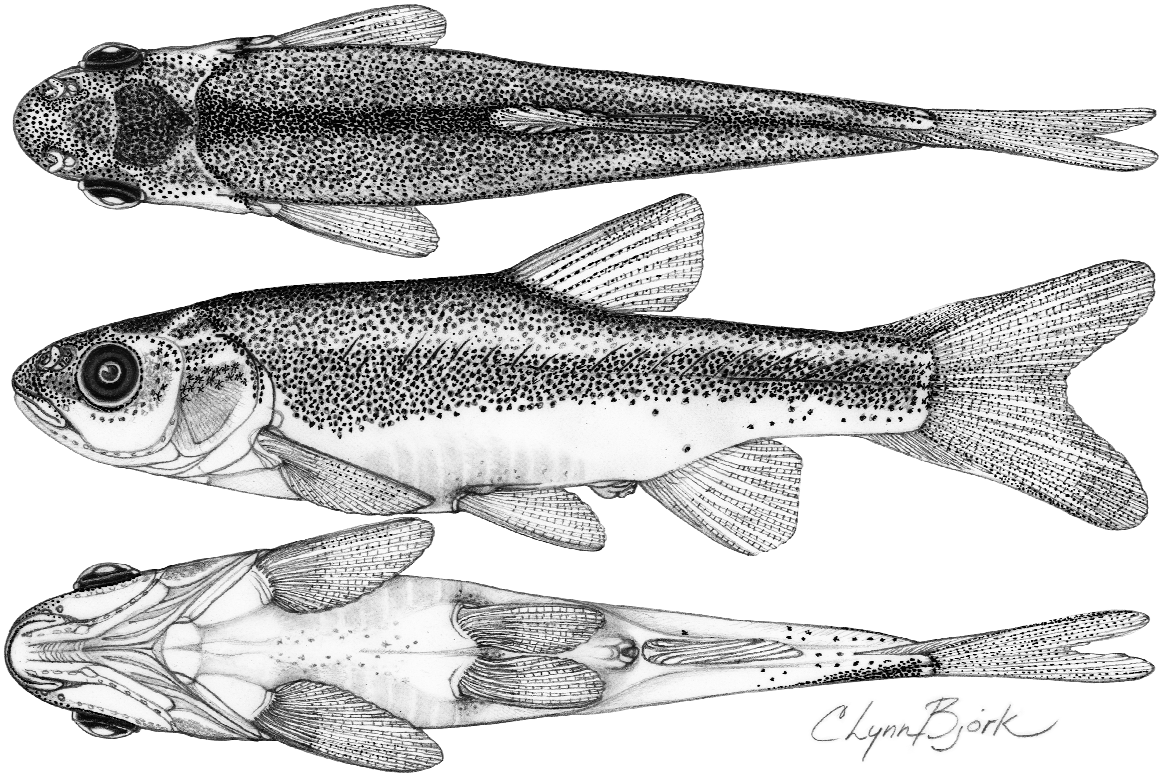

Fig. 10. *Lepidomeda mollispinis* juvenile, 35.4 mm SL, 43.9 mm TL. (Cultured in 2011 at Dexter National Fish Hatchery and Technology Center, New Mexico, with stock from the Virgin River, Utah; LFL# 121511.)

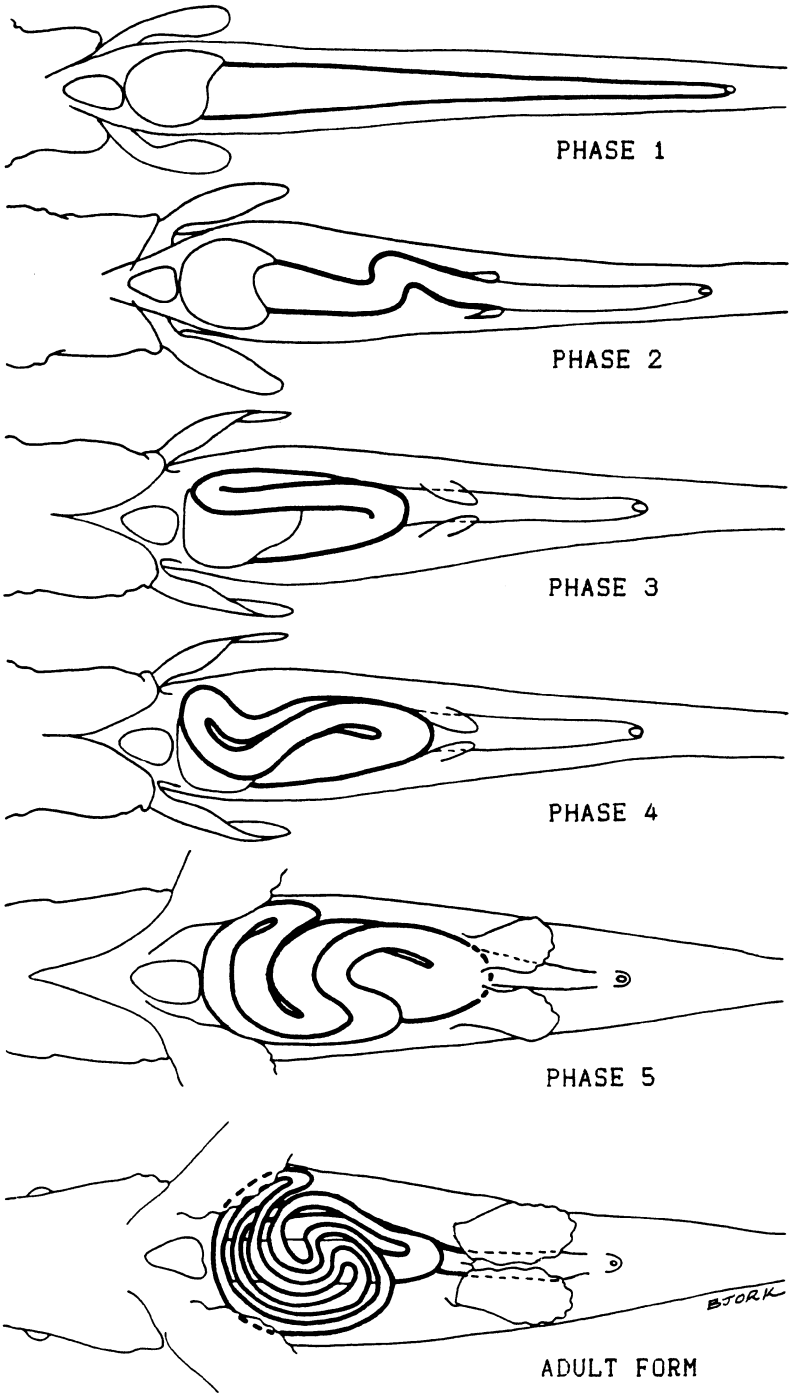

Fig. 11. Phases of gut coil development in catostomid fish larvae and early juveniles with comparison to adult form in *Catostomus commersonii* (latter modified from Stewart 1926). Phase 1 – essentially straight gut. Phase 2 – initial loop formation (usually on left side), begins with 90° bend. Phase 3 – full loop, begins with straight loop extending to near anterior end of visceral cavity. Phase 4 – partial fold and crossover, begins with crossing of first limb over ventral midline. Phase 5 – full fold and crossover, begins with both limbs of loop extending fully to opposite (usually right) side, four segments of gut cross nearly perpendicular to the body axis. Later in Phase 5 and in adult form, outer portions of gut folds or coils extend well up both sides of visceral cavity. (From Snyder and Muth 1988, Fig. 4, as reprinted in Snyder and Muth1990 and 2004, Fig. 5, and Snyder et al. 2005, Fig. 5.)

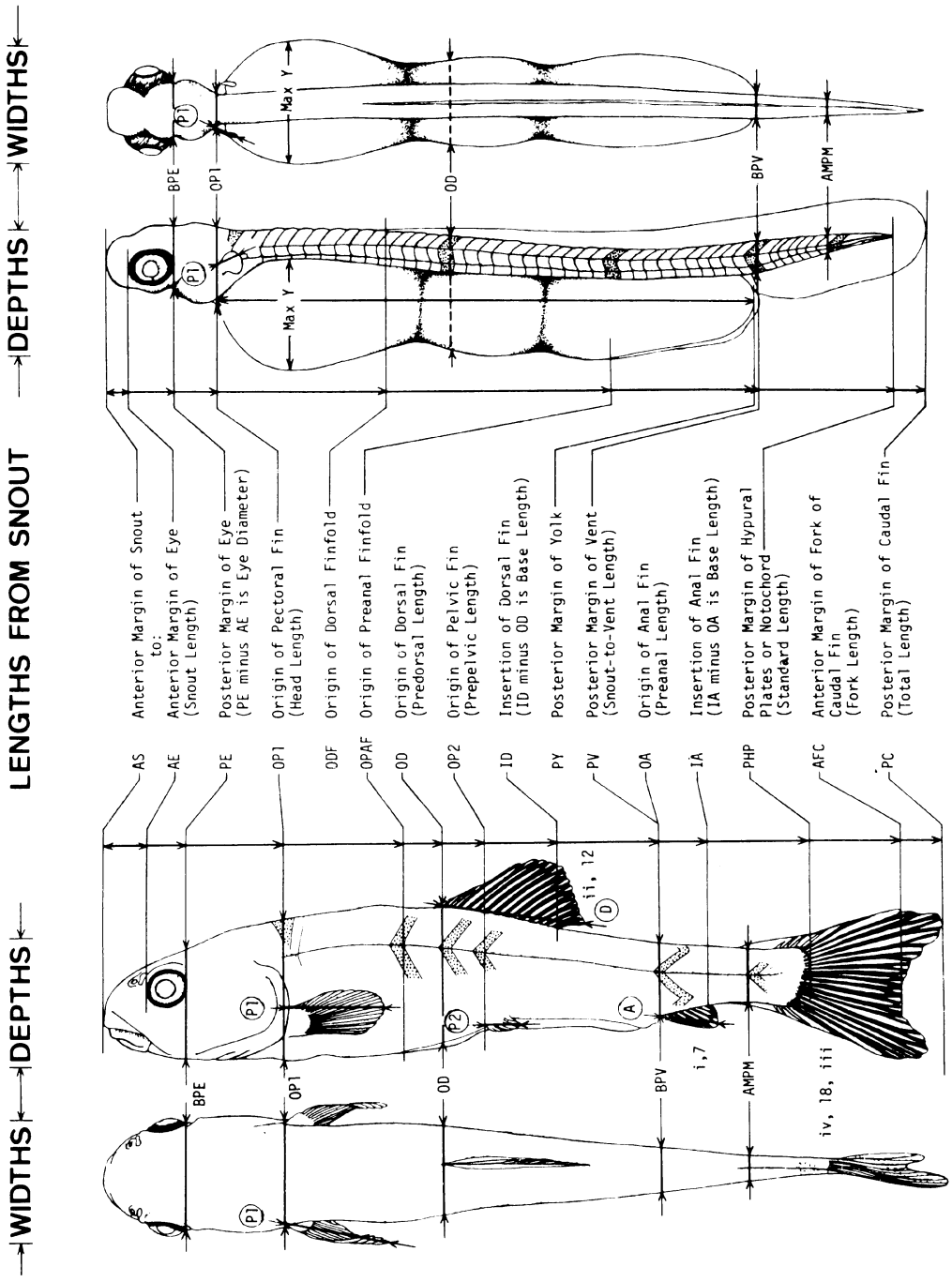

Fig. 12. Measures and counts for larval and early juvenile fishes. Yolk sac and pterygiophores are included in width and depth measures but fins and finfolds are not. "B" in BPE and BPV means immediately behind. AMPM is anterior margin of most posterior myomere. Location of width and depth measures at OD prior to D formation is approximated to that of later larvae. PHP is measured to end of notochord until adult complement of principal caudal-fin rays are observed. Fin lengths (D, A, P1, and P2, encircled) are measured along plane of fin from origin to most distal margin. When reported together, rudimentary median-fin rays (outlined above) are given in lower case Roman numerals, while principal median-fin rays (darkened above) are given in arabic numerals; rudimentary rays are not distinguished in paired fins. Most anterior, most posterior, and last myomeres in counts to specific points of reference are shaded above. (From Snyder 1981, Fig. 4, as reprinted in Snyder and Muth 1988, Fig 3, Snyder and Muth 1990 and 2004, Fig. 4, and Snyder et al. 2005, Fig. 4.)

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