
Reports

1983

Dorsal and anal pterygiophore interdigitation patterns in four species of Morone (Teleostei, Percichthyidae) : an aid to larval identification

John E. Olney
Virginia Institute of Marine Science

George C. Grant
Virginia Institute of Marine Science

Fred E. Schultz

C. Laurence Cooper

John Hageman

Follow this and additional works at: <https://scholarworks.wm.edu/reports>



Part of the [Aquaculture and Fisheries Commons](#), [Marine Biology Commons](#), and the [Zoology Commons](#)

Recommended Citation

Olney, J. E., Grant, G. C., Schultz, F. E., Cooper, C., & Hageman, J. (1983) Dorsal and anal pterygiophore interdigitation patterns in four species of Morone (Teleostei, Percichthyidae) : an aid to larval identification. Virginia Institute of Marine Science, William & Mary. <https://doi.org/10.21220/V50X7B>

This Report is brought to you for free and open access by W&M ScholarWorks. It has been accepted for inclusion in Reports by an authorized administrator of W&M ScholarWorks. For more information, please contact scholarworks@wm.edu.

Dorsal and anal pterygiophore interdigitation patterns
in four species of Morone (Teleostei, Percichthyidae) -
An aid to larval identification^{1,2}

John E. Olney

George C. Grant

Virginia Institute of Marine Science
and School of Marine Science
College of William and Mary
Gloucester Point, Virginia 23062

Fred E. Schultz

Steimle and Associates, Inc.

P.O. Box 865

Metairie, Louisiana 70004

and

C. Lawrence Cooper

John Hageman

Center for Lake Erie Research
The Ohio State University
Columbus, Ohio 43210

ABSTRACT

The diagnostic potential of dorsal and anal pterygiophore interdigitation patterns was examined in larval stages of Morone saxatilis, M. chrysops, M. americana and M. mississippiensis. The number and position of pterygiophores relative to interneural spaces 1-6 and 10-13 and interhaemal spaces 12-15 as well as total number of dorsal and anal pterygiophores are characters useful in delimiting larvae of American Morone species. Interdigitation patterns useful in separating M. mississippiensis and M. americana larvae were not found, however these two species may not co-occur.

The genus Morone Mitchill comprises four American species (Robins et al. 1980; Setzler et al. 1980): M. americana (Gmelin), white perch; M. saxatilis (Walbaum), striped bass; M. chrysops (Rafinesque), white bass; and M. mississippiensis Jordan and Eigenmann, yellow bass. Representatives of the genus can be found in both freshwater and marine habitats where species pairs are sympatric throughout much of the range. Morone mississippiensis and M. chrysops naturally co-occur along the Mississippi River drainage, Texas and Oklahoma with M. chrysops also inhabiting the Great Lakes (Hubbs and Lagler 1964). Morone americana and M. saxatilis inhabit the Atlantic coastline (Hildebrand and Schroeder 1928; Bigelow and Schroeder 1953; Scott and Crossman 1973; Lee et al. 1978) and M. saxatilis has been introduced along the Pacific coast (Setzler et al. 1980). Recent evidence indicates that M. americana and M. chrysops now are sympatric in the Great Lakes region (Scott and Christie 1963; Scott and Crossman 1973; Lee et al. 1978).

Difficulty in identifying larvae of the various Morone species has prompted extensive efforts to describe diagnostic external characters (Fish 1932; Yellayi and Kilambi 1969; Dorsa and Fritzsche 1979; Schultz 1980; Mansueti 1958; Doroshev 1970; Hardy 1978; Drewry 1981; and others). However, genetic, environmental and preservative induced character variability may be responsible for continued identification error. Recently, Fritzsche and Johnson (1980) described osteological characters useful in the identification of two of the four American Morone species. Based primarily on cultured material, Fritzsche and Johnson (1980) relied on the morphology and

position of rostral and predorsal cartilages and anterior anal and dorsal fin pterygiophores to separate larval white perch and striped bass. Since the arrangement of pterygiophores, spines and rays has been shown to be useful in delimiting various teleostean fishes (Matsui 1967; Potthoff 1974, 1975, 1980; Houde and Potthoff 1976), we have examined the position of pterygiophores in relation to vertebrae in the larvae of M. saxatilis, M. chrysops, M. americana and M. mississippiensis in a search for diagnostic patterns. Our purpose was to confirm the observations of Fritzche and Johnson (1980) using wild material, quantify the natural variability in this suite of characters and expand the analysis to include all American Morone species.

METHODS

Specimens (N=185) utilized for this study were obtained from a variety of sources. All specimens, with the exception of two larval yellow bass (M. mississippiensis; 11, 18 mm SL) which were raised from eggs under laboratory conditions, were collected by plankton net. Institutional abbreviations used are: VIMS - Virginia Institute of Marine Science; CBL - Chesapeake Biological Laboratory, Solomons, Maryland; CLEAR - Center for Lake Erie Research; SAI - Steimle and Associates, Inc. In the following list, we record species name, number of larvae examined (N), institutional source, collection locale, date of collection, and length range of specimens examined (measured with an ocular micrometer and reported in mm SL): Morone saxatilis, N = 20, VIMS, York R., Virginia, spring, 1980, 11.3 - 17.1; Morone saxatilis, N = 20, CBL, Potomac R., Maryland, spring, 1980,

10.4 - 14.5; Morone americana, N = 50, VIMS, York R., Virginia, spring 1980, 10.8 - 20.0; Morone mississippiensis, N = 28, SAI, river systems in southern Louisiana, spring 1976-1979, 10.0 -16.1; Morone chrysops, N = 25, SAI, river systems in the southern Louisiana, spring 1976-1979, 9.9 - 19.4; Morone chrysops, N = 40, CLEAR, Lake Erie, spring 1974, 11.6 - 19.6.

Larvae were cleared and stained following the methods of Dingerkus and Uhler (1977) and examined in 50% glycerin under a binocular microscope. Predorsal bone (or cartilage) and dorsal or anal pterygiophore interdigitation were determined following the methods of Potthoff (1975, 1980) and Houde and Potthoff (1976). The number and position of these elements relative to interneural or interhaemal spaces (Fig. 1) were recorded for each specimen and digit sequences were later analysed using computer pattern recognition. Occasionally, the proximal tip of an anal or dorsal pterygiophore would coincide closely with the distal tip of its associated neural or haemal spine. In these instances, the position of the fin element was difficult to determine but recorded in the anterior-most interneural or interhaemal space.

RESULTS

Dorsal Fin Pterygiophores

The position of the first dorsal-spine bearing pterygiophore and the presence or absence of a pterygiophore in interneural space 10 or 11 (INS 10 or INS 11) are characters which delimit the larvae of Morone saxatilis, M. chrysops, M. americana, and M. mississippiensis

(Fig. 1). In larvae of M. saxatilis, the first dorsal pterygiophore is most frequently positioned in INS 4, posterior to the third neural spine (Fig. 1; Fritzsche and Johnson 1980). This element is anterior to the third neural spine in larvae of M. americana, M. chrysops and M. mississippiensis, and most frequently occupies INS 3 together with the third (or most posterior) predorsal bone (or cartilage). In our sample of 185 specimens, 12 patterns of predorsal and pterygiophore interdigitation were observed within interneural spaces 1-6 (Table 1). Of the four patterns observed in larvae of M. saxatilis, three were characteristic of striped bass only and occurred in 87.5% (35/40) of the sample. Only one pattern (of 9 observed) was common in larvae of M. chrysops, M. americana and M. mississippiensis (Table 1), occurring in percent frequencies of 78%, 84% and 77%, respectively.

The absence of a pterygiophore in INS 10 or INS 11 is a useful character identifying larval white perch and yellow bass (Fig. 1, Table 2). In our sample, eleven patterns of pterygiophore interdigitation were observed within interneural spaces 10-13 (Table 2). Patterns without blank interneural spaces characterized all larvae of M. saxatilis and M. chrysops and only 2.5% (2/80) of the combined sample of M. americana and M. mississippiensis larvae. The absence of a pterygiophore in INS 10 was the predominant pattern in larvae of white perch and yellow bass, occurring in 89% (71/80) of our combined sample (Table 2). Since pterygiophores of the soft dorsal fin first appear as cartilage (Fritzsche and Johnson 1980), the absence of a pterygiophore in INS 10 is diagnostic of Morone larvae in early stages of development (Fig. 2). Although incompletely

developed, M. saxatilis flexion larvae 8.5 - 9.0 mm SL/NL are recognizable since the ventral tips of the proximal radial (Fig. 2, PR2) supporting the second soft ray lies anterior to the vertical plane extended from the tip of the eleventh neural spine (Fig. 2), NS11). In addition, the distance between the ventral tips of PR1 and PR2 is greater than the distance between the tips of NS10 and NS11 in M. americana and less than that distance in M. saxatilis. Although not figured, these characters separate early larvae of M. chrysops and M. mississippiensis as well.

Excluding three predorsal elements, Morone larvae in our sample possessed 19-23 total dorsal pterygiophores (Table 3). As detailed by Fritzche and Johnson (1980), the anterior eight pterygiophores support 10 spines of varying lengths. The remaining elements support soft rays (Fig. 1). Although total counts overlapped among the four species, M. chrysops larvae possessed modal counts which exceeded those of all other species (Table 3).

Anal Fin Pterygiophores

The number and position of pterygiophores within interhaemal spaces 12-15 separate larvae of M. saxatilis and M. chrysops from M. americana and M. mississippiensis (Table 4, Fig. 1). In our sample of 185 larvae, 17 patterns of interdigitation were observed (Table 4) and, with the exception of five specimens, pattern overlap between the above-named species pairs did not occur. Six patterns within interhaemal spaces 12-15 occurred in larval striped bass and white bass and were characterized by the absence of the anterior

spine-bearing pterygiophore in interhaemal space 12 (IHS 12). This element was most frequently positioned together with the first soft ray-bearing pterygiophore in IHS 13. In larval white perch (as well as yellow bass), the first anal pterygiophore is notably longer and more massive than in striped bass and this relative difference becomes exaggerated with growth (Fritzsche and Johnson 1980). As a result, greater variability in interdigitation patterns was observed in M. americana larvae (Table 4) since the proximal tip of this stout element often extended into IHS 12.

In our sample, specimens possessed 9-14 total anal pterygiophores. The first anal element supports three spines with succeeding pterygiophores supporting soft rays (Fig. 1). Larvae of M. chrysops were distinguishable from those of M. americana and M. mississippiensis by virtue of total counts (Table 3). In addition, total anal element counts of striped bass exceeded those of yellow bass.

DISCUSSION

The diagnostic potential of pterygiophore interdigitation patterns in the genus Morone was first recognized by Woolcott (1957) in an examination of adult osteology. Although unable to detect useful anal pterygiophore patterns, Woolcott (1957) demonstrated differences in total dorsal pterygiophore counts and the location of certain elements in relation to neural spines. It is not surprising, therefore, that our results and those of Fritzsche and Johnson (1980) illustrate the utility of this suite of characters in identifying

young stages of American Morone species. Indeed, the number and position of anal and dorsal pterygiophores in relation to vertebrae are characters which have been successfully used to delimit larval scombrids (Matsui 1967; Potthoff 1974, 1975), larval sparids (Houde and Potthoff 1976) and larval coryphaenids (Potthoff 1980). An important consideration in these studies, however, is the extent to which natural variability affects character utility. Previous investigations (Matsui 1967; Potthoff 1974, 1975; Houde and Potthoff 1976) have emphasized variability (expressed as percent occurrence) of a particular pterygiophore number in a single interhaemal or interneural space. Our data indicate that patterns of interdigitation (ie, sequence of pterygiophore numbers in more than one space), when judiciously chosen, exhibit less variability and are more useful as diagnostic characters.

Throughout our examination, we could not find interdigitation patterns which would delimit the larvae of white perch and yellow bass and total element overlap was great. Woolcott (1957) was unable to separate M. mississippiensis and M. americana adults using a variety of osteological characters but Whitehead and Wheeler (1966) delimit the species based on dorsal spine length and adult pigmentation. The extent to which these nominal species are sympatric is unknown, however current distributional data (Lee et al. 1978) do not indicate geographic overlap.

ACKNOWLEDGMENTS

During independent studies on development and ecology of larval Morone, we participated in a Morone identification workshop held in

Solomons, Maryland at The Sixth Annual Larval Fish Conference of The American Fisheries Society - Early Life History Section. We extend our appreciation to Dr. Douglas Martin (CBL) who organized these meetings, loaned larval material and encouraged the completion of this report. Special thanks to Robert W. Middleton (VIMS) for assistance with computer analysis.

REFERENCES

- Bigelow, H. B. and W. C. Schroeder. 1953. Fishes of the Gulf of Maine. Fishery Bulletin of the Fish and Wildlife Service 74(53):389-407.
- Dingerkus, G. and L. Uhler. 1977. Enzyme clearing of alcian blue stained small vertebrates for demonstration of cartilage Stain Technology 52:229-232.
- Doroshev, S. I. 1970. Biological features of the eggs, larvae and young of the striped bass (Roccus saxatilis Walbaum) in connection with the problem of its acclimatization in the USSR. Journal of Ichthyology 10:235-248.
- Dorsa, W. J. and R. A. Fritzche. 1979. Characters of newly hatched larvae of Morone chrysops (Pisces, Percichthyidae), from Yocona River, Mississippi. Journal of the Mississippi Academy of Science 24:37-41.
- Drewry, G. E. 1981. Externally visible features useful for seperating young striped bass (Morone saxatilis from those of white perch (Morone americana) in the Chesapeake Bay region. Rapports et Proces - Verbaux des Reunions Conseil International pour l'Exploration de la Mer 178:590-592.
- Fish, M. P. 1932. Contribution to the early histories of sixty-two species of fishes from Lake Erie and its tributary waters. Bulletin of the United States Bureau of Fisheries 47(10):293-398.

- Fritzsche, R. A. and G. D. Johnson. 1980. Early osteological development of white perch and striped bass with emphasis on identification of their larvae. Transactions of the American Fisheries Society 109(4):387-406.
- Hardy, J. D. Jr. 1978. Development of fishes of the Mid-Atlantic Bight: An atlas of the egg, larval and juvenile stages. Vol. III. Aphredoderidae through Rachycentridae. United States Fish and Wildlife Service, Biological Services Program, FWS/OBS-78/12.
- Hildebrand, S. F. and W. C. Schroeder. 1928. Fishes of Chesapeake Bay. Bulletin of the United States Bureau of Fisheries, Part 1, Vol. XLIII.
- Houde, E. D. and T. Potthoff. 1976. Egg and larval development of the sea bream Archosargus rhomboidalis (Linnaeus): Pisces, Sparidae. Bulletin of Marine Science 26(4):506-529.
- Hubbs, C. A. and K. F. Lagler. 1964. Fishes of the Great Lakes Region. The University of Michigan Press, Ann Arbor, Michigan.
- Lee, D. S., C. R. Gilbert, C. H. Hocutt, R. E. Jenkins, D. E. McAllister and J. R. Stauffer, Jr. 1978. Atlas of North American Freshwater Fishes. North Carolina State Museum of Natural History, Raleigh, North Carolina. 854 pp.
- Mansueti, R. 1958. Eggs, larvae and young of the striped bass, Roccus saxatilis. Maryland Department of Research and Education, Chesapeake Biological Laboratory, Contribution No. 112.

- Matsui, T. 1967. Review of the mackerel genera Scomber and Rastrelliger with description of a new species of Rastrelliger.
Copeia 1967: 71-83.
- Potthoff, T. 1974. Osteological development and variation in young tunas, genus Thunnus (Pisces, Scombridae), from the Atlantic Ocean. *Fishery Bulletin* 72:563-588.
- Potthoff, T. 1975. Development and structure of the caudal complex, the vertebral column, and the pterygiophores in the blackfin tuna (Thunnus atlanticus, Pisces, Scombridae). *Bulletin of Marine Science* 25(2):205-231.
- Potthoff, T. 1980. Development and structure of fins and fin supports in dolphin fishes Coryphaena hippurus and Coryphaena equiselis (Coryphaenidae). *Fishery Bulletin* 78(2):277-312.
- Robins, C. R., R. M. Bailey, C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea and W. B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada. American Fisheries Society, Special Publication No. 12.
- Schultz, F. E. 1980. Reproduction and early life history of Morone mississippiensis (Percichthyidae) with comparisons to three other Morone species. Masters Thesis, University of Mississippi, University, Mississippi, USA. 105 pp.
- Scott, N. B. and W. J. Christie. 1963. The invasion of the lower Great Lakes by the white perch, Roccus americanus (Gmelin). *Journal of the Fisheries Research Board of Canada* 20(5):1189-1195.

- Scott, W. B. and E. J. Crossman. 1973. *Freshwater Fishes of Canada*.
Fisheries Research Board of Canada, Bulletin 184. 966 pp.
- Setzler, E. M., W. R. Boynton, K. V. Wood, H. H. Zoin, L. Lubbers,
N. K. Mountford, P. Frere, L. Tucker, and J. A. Mihursky. 1980.
Synopsis of biological data on striped bass, Morone saxatilis
(Walbaum). NOAA Technical Report NMFS Circular 433.
- Whitehead, P. J. P., and A. C. Wheeler. 1966. The generic names
used for sea basses of Europe and North America (Pisces:
Serranidae). *Annals' del Musco Civico di Storia Naturale*
Giacomo Doria, Genova 76:23-41.
- Woolcott, W. S. 1957. Comparative osteology of serranid fishes
of the genus Roccus (Mitchill). *Copeia* 1957:1-10.
- Yellayi, R. R. and R. V. Kilambi. 1969. Observations on early
development of white bass, Roccus chrysops (Rafinesque).
Proceedings of the Annual Conference Southeastern Association
of Game and Fish Commissioners 23:261-265.

FOOTNOTES

- ¹ Contribution number 0000 of the Virginia Institute of Marine Science and number 000 of the Center for Lake Erie Research.
- ² This research was supported in part by the National Marine Fisheries Service, Grant No. NA81FAD VA5B and by the U. S. Fish and Wildlife Service, Contract No. 14-16-0009-81-032.

Table 1. Patterns of predorsal and pterygiophore interdigitation within interneural spaces 1-6 in a sample of 185

Morone larvae. Abbreviations used are: P - predorsal bone (or cartilage), MS - M. saxatilis, MC - M. chrysops, MA - M. americana, MM - M. mississippiensis.

INTERNEURAL SPACE						PATTERN FREQUENCY			
1	2	3	4	5	6	MS	MC	MA	MM
P	P	P	2	1	2	19			
P	P	P	2	2	1	15			
P	P	P	1	2	2	1			
P	P	P+1	1	2	1	5	51	42	23
P	P	P+1	2	1	1		5	4	4
P	P	P+2	1	2	1		5		
P	P	P+2	2	1	1		2		
P	P	P+1	1	1	2		1		
P	O	PP+1	1	2	1		1		
P	PP	1	1	2	1			3	2
P	PP	1	2	1	1			1	
P	P	P+1	3	1	1				1
TOTAL						40	65	50	30

Table 2. Patterns of pterygiophore interdigitation within inter-neural spaces 10-13 in a sample of 185 Morone larvae. Abbreviations used are MS - M. saxatilis, MC - M. chrysops, MA - M. americana, MM - M. mississippiensis.

INTERNEURAL SPACE				PATTERN FREQUENCY			
10	11	12	13	MS	MC	MA	MM
1	1	1	2	34	52	2	
1	1	2	1	3			
1	1	1	3	1	11		
1	1	2	2	2	1		
2	1	1	2		1		
1	0	2	2			17	2
1	0	1	2			16	6
1	0	2	1			14	15
0	1	1	2			1	3
0	1	2	1				3
1	0	1	3				1
TOTAL				40	65	50	30

Table 3. Frequency of total dorsal and anal pterygiophores in a sample of 185 Morone larvae. Total dorsal element counts exclude predorsal bones.

Total Pterygiophores	ANAL FIN						DORSAL FIN				
	9	10	11	12	13	14	19	20	21	22	23
<u>M. saxatilis</u>			3	37			6	32	2		
<u>M. chrysops</u>				10	52	2		3	45	15	2
<u>M. americana</u>		33	17				5	45			
<u>M. mississippiensis</u>	3	27					69	11			

Table 4. Patterns of pterygiophore interdigitation within interhaemal spaces 12-15 in a sample of 185 Morone larvae. Abbreviations used are MS - M. saxatilis, MC - M. chrysops, MA - M. americana, MM - M. mississippiensis.

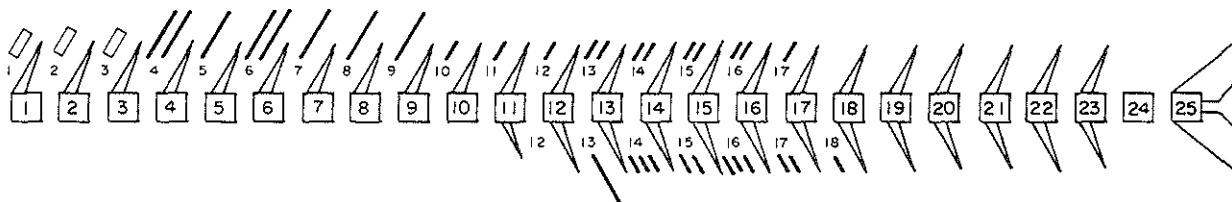
INTERHAEMAL SPACE				PATTERN FREQUENCY			
12	13	14	15	MS	MC	MA	MM
0	1	3	2	16	1	1	2
0	2	2	3	12	32		
0	2	2	2	8	31		
0	1	3	3	2			
0	2	3	2		1		
0	1	2	3	2		6	7
0	1	2	2			28	17
1	0	2	2			7	
1	1	1	3			1	2
1	1	2	2			1	1
0	1	1	3				1
0	1	0	3			1	
0	1	1	2			1	
1	0	2	3			1	
1	0	3	2			1	
1	1	1	2			1	
0	2	1	2			1	
TOTAL				40	65	50	30

FIGURE CAPTIONS

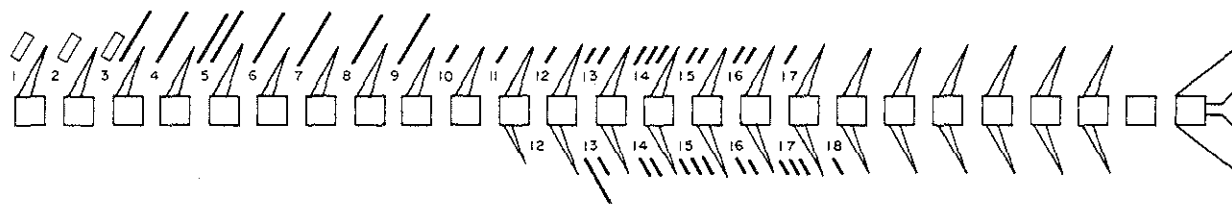
Figure 1. Diagrammatic representation of the most frequently observed patterns of predorsal, dorsal and anal pterygiophore interdigitation in four species of Morone. Larger numerals indicate vertebral number. Smaller numerals indicate interneural or interhaemal space designation.

Figure 2. The arrangement of neural spines and dorsal pterygiophores in Morone americana (A-8.5 mm SL; B-11.2 mm SL) and M. saxatilis (C-8.5 mm SL; D-11.1 mm SL). Abbreviations used are NS9-neural spine of ninth vertebra; NS12 - neural spine of 12th vertebra; PR1 - proximal radial supporting the first soft ray of the second dorsal fin; PR2- proximal radial supporting the second soft ray of the second dorsal fin; numerals indicate respective interneural space designations. Stippling indicates positive stain reactions (Alcian Blue or Alizarin Red).

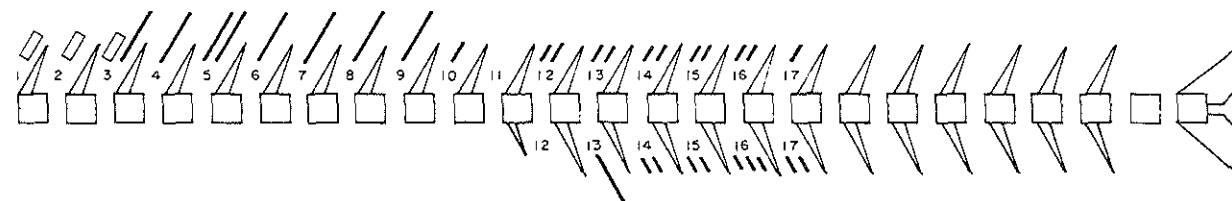
saxatilis



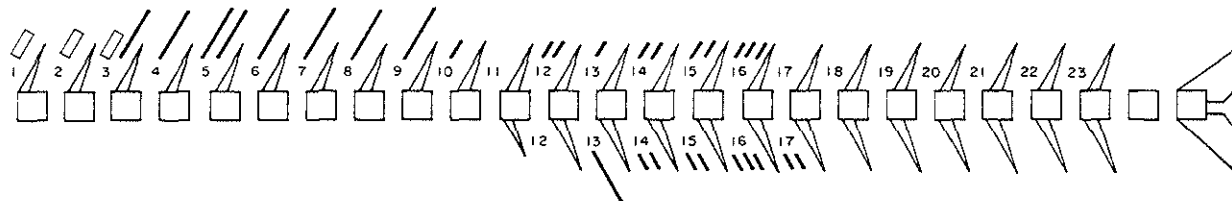
chrysops




americana




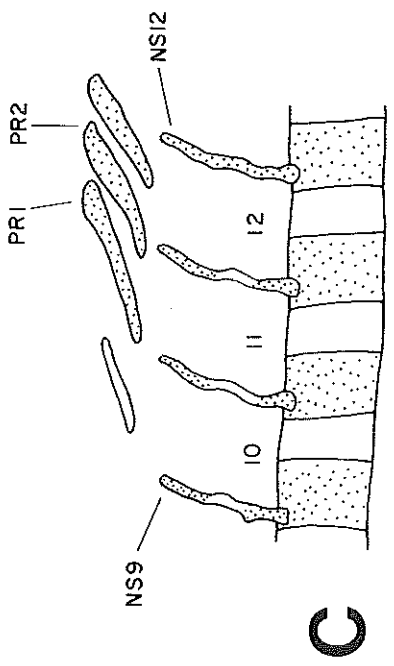
mississippiensis



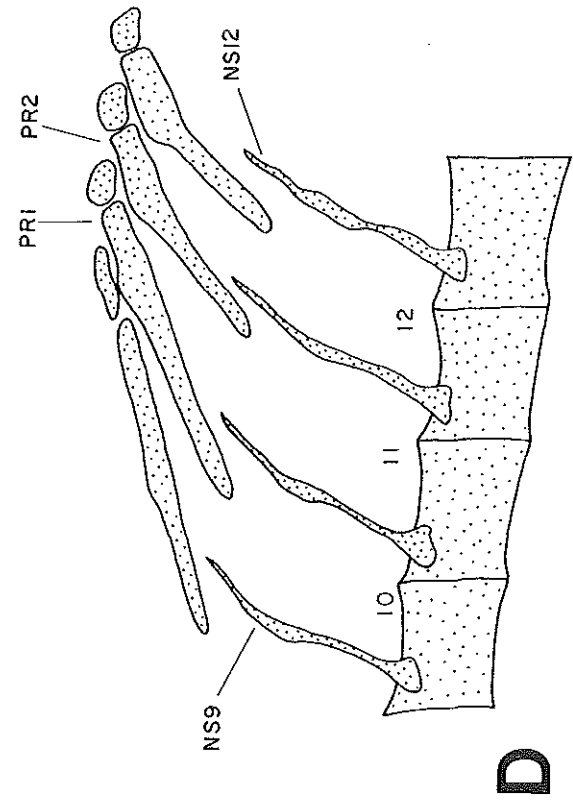
 = PREDORSAL BONE

 = SPINE BEARING PTERYGIOPHORE

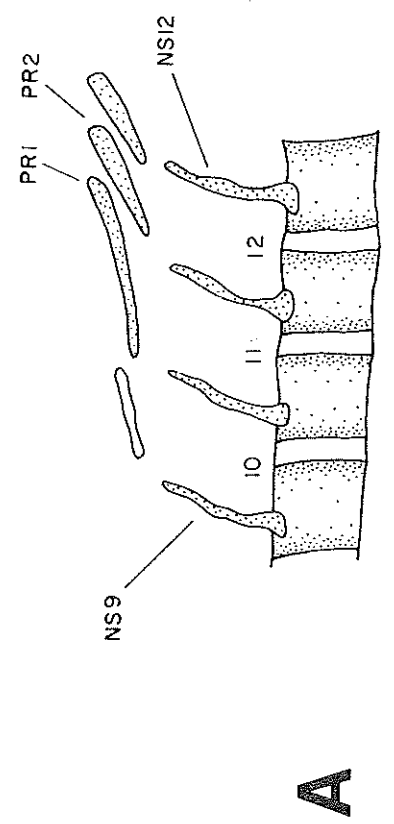
 = RAY BEARING PTERYGIOPHORE



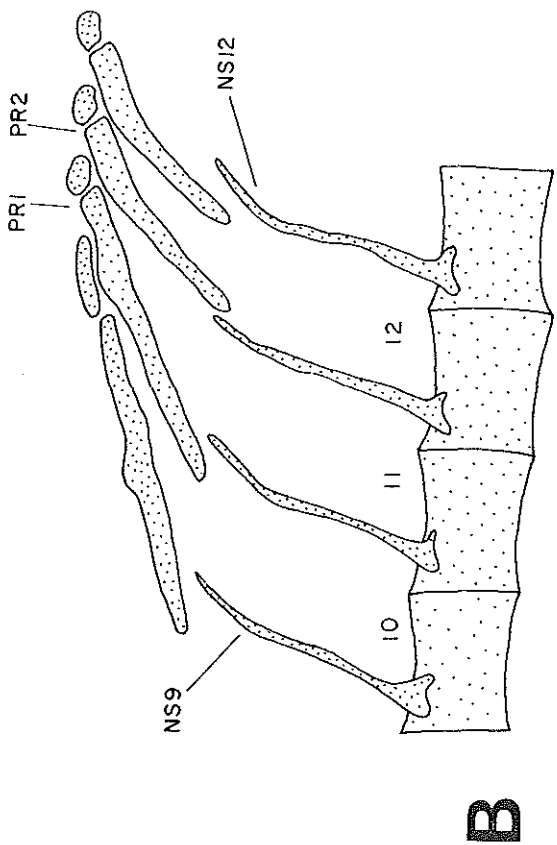
C



D



A



B