**Supplemental Table 2. Characters taken without modification directly from Harold and Weitzman (1996) except that character 67, which was removed. Reproduced here to aid with the use of these features given the necessary renumbering caused by removal of character 67.**

1. Interfrontal joint. 0, separate; 1, fused anteriorly.

2. Dorsal frontal surface. 0, smooth; 1, pitted.

3. Longitudinal frontal fossa. 0, separate; 1, joined anteriorly.

4. Longitudinal frontal fossa. 0, shallow; 1, deep.

5. Frontal crest. 0, present; 1, absent anteriorly.

6. Frontal crest. 0, low or absent; 1, prominent.

7. Interorbital space. 0, broad; 1, narrow.

8. Parietal surface. 0, smooth; 1, pitted.

9. Parietal-sphenotic relationship. 0, no contact; 1, contact.

10 Parietal-pterotic relationship. 0, contact; 1, no contact.

11. Parietal-intercalar relationship. 0, no contact; 1, contact.

12. Parietals. 0, not separated by supraoccipital; 1, separated.

13. Parietal crest. 0, absent; 1, present.

14. Parasphenoid shape. 0, straight to slightly convex; 1, strongly convex.

15. Parasphenoid glossopharyngeal tunnel. 0, absent; 1, present.

16. Parasphenoid lateral wing. 0, moderately welld eveloped; 1, posterior process and wings form a cap.

17. Basisphenoid. 0, present; 1, absent.

18. Posterior myodome. 0, large; 1, small; 2, moderate size; 3, dorsally elongate.

19. Posterior myodome. 0, horizontal; 1, vertical.

20. Sphenotic size. 0, small; 1, moderate to large.

21. Posttemporal fossa bounded by frontal. 0, yes; 1, no.

22. Neural arch attachment. 0, some free; 1, all fused.

23. Posttemporal fossa bounded by sphenotic. 0, none; 1, small to large amount.

24. Posttemporal fossa bounded by pterotic. 0, large amount; 1, moderate amount.

25. Posttemporal fossa bounded by epioccipital. 0, large amount; 1, moderate amount; 2, small amount.

26. Posttemporal fossa bounded by parietal. 0, large amount; 1, moderate amount; 2, small amount; 3, reduced and specialized.

27. Posttemporal fossa bounded by intercalar. 0, none; 1, small amount.

28. Posttemporal fossa bounded by exoccipital. 0, none; 1, varying amounts.

29. Otic bullae. 0, well-developed, large; 1, not visible.

30. Exoccipital pedicles. 0, moderately well-developed; 1, enlarged.

31. Basioccipital. 0, as deep or deeper than exoccipital, in posterior view; 1, not as deep as exoccipital.

32. Exoccipital plates dorsal to foramen magnum. 0, in contact; 1, no contact.

33. Centrum-like face of basioccipital. 0, moderate size; 1, shallow or small.

34. Epioccipital process. 0, small to prominent; 1, prominent posterodorsal process; 2, slender spine-like process.

35. Palatine teeth. 0, one row present; 1, absent.

36. Palatine posterior process. 0, present; 1, absent.

37. Palatine shape. 0, double-headed; 1, posterior head lost; 2, cartilaginous bar with tooth plate ventrally.

38. Mesopterygoid teeth. 0, present; 1, absent.

39. Mesopterygoid shape. 0, short; 1, long.

40. Mesopterygoid fenestra. 0, absent; 1, present.

41. Ectopterygoid shape. 0, broad, elongate, moderate size; 1, slender, elongate; 2, triangular to quadrangular, large.

42. Symplectic shape, overall. 0, elongate slender; 1, very elongate.

43. Symplectic shape, terminations. 0, dorsal end enlarged, not club-shaped; 1, both ends equal; 2, club-shaped.

44. Articulation of dorsal border of quadrate. 0, with metapterygoid; 1, ectopterygoid and/or mesopterygoid plus metapterygoid.

45. Position of lower jaw adductor pocket. 0, posterior 1/3 or 1/4 of mandible; 1, middle or anterior of mandible.

46. Mandible shape. 0, elongate, posterior portion 2-3 times depth of anterior; 1, deep, 3-4 times depth of anterior.

47. Mandible tooth line and coronoid platform. 0, platform absent; 1, platform present.

48. Mandibulohyoid ligament system. 0, mandible to epihyal and to interopercle; 1, separate to interopercle and epihyal to interopercle; 2, no fibers to interopercle.

49. Antorbital. 0, present; 1, absent.

50. Supraorbital. 0, present; 1, absent.

51. Infraorbital series. 0, six bones, excluding antorbital; 1, reduced to four or fewer.

52. Opercle shape, notch in dorsal border. 0, present but altered or reduced relative to outgroups; 1, modified.

53. Opercular spine. 0, present; 1, developed into a lateral ridge; 2, strong lateral spiny process.

54. Opercle shape. 0, roughly rectangular or quadrangular; 1, elongate rectangular.

55. Subopercle shape. 0, rectangular to half rectangular; 1, triangular; 2, dorsoventrally elongate.

56. Relative size of interopercle and subopercle. 0, interopercle length about equal to that of subopercle; 1, interopercle much longer than subopercle.

57. Interopercle shape. 0, short dorsal process; 1, elongate dorsal process; 2, highly elongate, narrow dorsal process.

58. Subopercle ossification. 0, complete; 1, incomplete.

59. Preopercular angle. 0, gradual, up to right angle; 1, abrupt right angle.

60. Preopercular spines. 0, absent; 1, present.

61. Relative size of preopercular limbs. 0, dorsal and ventral limbs about equal; 1, dorsal limb much longer than ventral.

62. Interpremaxillary ligament. 0, strong; 1, weak.

63. Premaxillary-proethmoid (rostrodermethmoid lateral process) crossed ligament. 0, present; 1, absent.

64. Premaxillary-proethmoid (rostrodermethmoid lateral process) uncrossed ligament. 0, present; 1, absent.

65. Palatopremaxillary ligament. 0, separate maxillary head-palatine and maxillary-premaxillary ligament; 1, continuous palatopremaxillary ligament; ?, absent.

66. Palatomaxillary ligament. 0, short; 1, long; 2, moderate length; 3, very short.

67. Suspensory palatine ligament. 0, long; 1, short.

68. Premaxillary ascending process. 0, short to moderately long; 1, elongate; 2, almost none.

69. Maxillary angle. 0, not angulate; 1, angulate.

70. Maxillary width. 0, slender; 1, posteriorly expanded.

71. Maxillary toothed border. 0, convex; 1, concave.

72. Anterior supramaxilla. 0, present; 1, absent.

73. Hyomandibular length. 0, moderately long, about half of cranial length; 1, very long, about three-quarters of cranial length.

74. Hyomandibular spine. 0, present; 1, absent.

75. Posterior ceratohyal length. 0, short, less than length of anterior ceratohyal; 1, elongate, greater than half of anterior ceratohyal length.

76. Anterior ceratohyal shape. 0, moderately constricted in middle; 1, greatly constricted; 2, not greatly constricted.

77. Largest end of anterior ceratohyal. 0, posterior or both ends about equal; 1, anterior.

78. Total number of branchiostegal rays. 0, 12 to 22, rarely 11 in *Ichthyococcus*; 1, 10 or fewer.

79. Urohyal shape. 0, incised posterior margin; 1, not incised.

80. Basihyal. 0, present; 1, absent.

81. Supraethmoid relative position to frontals. 0, ventral; 1, dorsal; ?, supraethmoid absent.

82. Length of posterior supraethmoid process. 0, long; 1, process absent; 2, short; ?, supraethmoid absent.

83. Relative size of supraethmoid. 0, large; 1, small to moderate; ?, supraethmoid absent.

84. Proethmoids (lateral processes of rostrodermethmoid). 0, present; 1, absent.

85. Capsular ethmoids. 0, present, well-developed; 1, absent; 2, fused together; 3, fused to supraethmoid.

86. Ventral ethmoid. 0, present; 1, absent.

87. Myodome bone. 0, well-developed, separate; 1, absent.

88. Lateral ethmoid. 0, well-developed; 1, small to moderate size; 2, absent.

89. Lateral vomerine teeth. 0, present; 1, absent.

90. Median vomerine teeth. 0, absent; 1, present.

91. Vomer. 0, present; 1, absent.

92. Vomer, anterodorsal extension. 0, not reaching supraethmoid; 1, reaching supraethmoid; 2, special process dorsal to supraethmoid; 2, extends dorsally, ventral to supraethmoid.

93. Ethmoid cornu. 0, absent or weakly developed; 1, moderately to well-developed.

94. Ethmoid prenasal process. 0, absent; 1, present.

95. Ethmoid cartilage. 0, broad; 1, narrow; 2, broad, modified.

96. Rib-bearing vertebrae. 0, first rib associated with vertebra 2; 1, first rib associated with vertebra 3.

97. Enlarged ribs. 0, absent; 1, present.

98. Ribs directly supporting pelvic girdle. 0, absent; 1, present.

99. Epipleurals. 0, present; 1, absent.

100. Epineurals. 0, present; 1, absent.

101. Expanded neural and haemal spines. 0, absent; 1, present.

102. Specialized supraneurals (dorsal blade). 0, absent; 1, present.

103. Epurals. 0, three separate elements; 1, two separate elements; 2, one element; 3, epurals absent; ?, fused to uroneural

104. Caudal radials, other than epurals. 0, present; 1, absent.

105. Uroneurals. 0, two present; 1, one present (second uroneural absent).

106. Parhypural. 0, free from preural centrum 1 and hypural 1; 1, fused to preural centrum 1 and/or hypural 1.

107. Hypurals 1 and 2. 0, autogenous; 1, fused.

108. Hypurals 3, 4, and 5. 0, autogenous; 1, fused (3–5 or 3–6 fused).

109. Ural centrum 2. 0, not fused to PUl + Ul; 1, fused to PUl + Ul.

110. Sagitta: post-caudal trough. 0, present; 1, absent.

111. Sagitta: crista superior. 0, present; 1, absent.

112. Sagitta: crista inferior. 0, present; 1, absent.

113. Sagitta: rostrum. 0, well-developed, prominent; 1, very short; 2, absent or low eminence.

114. Sagitta: lateral surface. 0, convex; 1, flat.

115. Sagitta: lateral profile. 0, longer than deep (height about 1.3 to 2.0 times in length; 1, deeper than long (height about 0.4 to 0.9 times in length).

116. Sagitta: length relative to cranial length. 0, large (4.7 to 7.0 times in length of cranium); 1, small (15 to 50 times in length of cranium).

117. Photophore development. 0, in situ formation through white phase; 1, budding (photophores in clusters).

118. Adipose fin shape. 0, short-based; 1, long-based.

119. Number of pelvic radials. 0, three; 1, six; 2, one.

120. Body shape. 0, highly elongate with shallow head; 1, deep body and head.

121. Photophores ventrally on caudal peduncle. 0, singly or in clusters of 2; 1, clusters of 4 or more.

122. Position of anal-fin origin. 0, posterior to dorsal-fin origin; 1, anterior to dorsal-fin origin. Highly variable in the Gonostomatidae, hence coded "?" for that outgroup.

123. Anal-fin hiatus. 0, absent; 1, present.

124. Attachment of pterygiophores immediately anterior and posterior to anal-fin hiatus. 0, non-ligamentous; 1, ligamentous.

125. Anterior portion of pelvic girdle ischial process. 0, present; 1, absent.

126. Pelvic girdle orientation. 0, horizontal; 1, approximately vertical.

127. Abdominal keel-like structure. 0, absent; 1, present.

128. Body depth. 0, 3.7 to 7.7 percent of standard length; 1, 0.8 to 2.0 percent of standard length.

129. Iliac spines. 0, absent; 1, present.

130. Photophores: posterior inferior OP size. 0, about equal to other OP; 1, greatly enlarged.

131. Photophores: SO. 0, present; 1, absent.

132. Photophores: OA. 0, more than 1; none or 1.

133. Posterior infraorbitals. 0, posterior infraorbitals, behind eye, present; 1, posterior part of series, those posterior to eye, absent (equivalent to infraorbitals 5 and 6 and possibly 4).

134. Number of anterior infraorbitals. 0, three or four present; 1, entire series represented by two anterior elements (probably equivalent to numbers 1 and 2 in other taxa).

135. NPU2 shape. 0, narrow; 1, broad and flat.

136. Palatopremaxillary ligament. 0, single slip; 1, ligament originating on palatine and subdivided into branches to premaxilla, maxilla, and supraethmoid.

137. Posttemporal. 0, short and weak, not well-ossified; 1, elongate and strong, well-ossified.

138. Cleithrum ventral lateral wing. 0, no posterior notch; 1, posterior notch through which fin rays pass.

139. Cleithrum shape. 0, ventral anterior portion smoothly curved; 1, ventral anterior portion highly angular.

140. Pectoral radial articulation. 0, radial II articulating with scapula and coracoid; 1, radial II articulating only with scapula.

141. Photophores: L (lateral). 0, absent; 1, present.

142. Posttemporal and supracleithrum relationship. 0, free; 1, fused.

143. Distal pterygiophore perichondral ossifications. 0, present; 1, absent.

144. Urohyal size. 0, moderate to large; 1, small.

145. Number of hypobranchial 1 gill rakers. 0, more than three; 1, three or fewer.

146. Hypobranchial 1 middorsal tabular process. 0, absent; 1, present.

147. Pubic process relationship to posterior pleural rib. 0, not parallel or bound together; 1, shaft of pubic process tightly bound and parallel to distal end of last pleural rib.

148. Hypobranchial 1 shape. 0, approximately straight; 1, curved dorsally in an arc.

149. Photophores: PV number. 0, more than 10; 1, 10.