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Cottus immaculatus, a new species of sculpin (Cottidae) from the Ozark Highlands of Arkansas and Missouri, USA

ANDREW P. KINZIGER[1] & ROBERT M. WOOD[2]

[1]*Department of Fisheries Biology, Humboldt State University, One Harpst Street, Arcata, CA 95521. E-mail: Andrew.Kinziger@Humboldt.edu*

[2]*Department of Biology, Saint Louis University, 3507 Laclede Avenue, St. Louis, MO 63103–2010, USA. E-mail: wood2@slu.edu*

Abstract

Cottus immaculatus, new species, is described from the Current, Eleven Point, Spring and White river systems of the White River drainage, in the Ozark Highlands of Arkansas and Missouri, USA. *Cottus immaculatus* is a member of the Uranidea clade and distinguishable from all members of the genus *Cottus* using genetic and morphological characters. *Cottus immaculatus* possesses a previously unreported but possibly widespread character in the genus *Cottus*, enlargement of the tips of the dorsal-fin spines of males. The description of *Cottus immaculatus* brings the total number of species recognized within the genus *Cottus* to 68.

Key words: sculpin, Cottidae, *Cottus*, *Cottus immaculatus*, *Cottus hypselurus*, *Cottus bairdii*, Missouri, Arkansas, Ozark Highlands, fin knobs

Introduction

Cottus hypselurus, the Ozark Sculpin, is a relatively small (< 80 mm SL) freshwater sculpin endemic to cool to cold streams of the Ozark Highlands in Missouri and Arkansas (Robins & Robison, 1985; Pflieger, 1997). Molecular phylogenetic analyses of the genus *Cottus* have resolved *C. hypselurus* as a member of the Uranidea clade (Kinziger *et al.*, 2005). Intraspecific molecular phylogenetic studies have revealed that *C. hypselurus* is a polytypic species composed of two monophyletic groups, one from the Osage, Gasconade and Black river drainages (Osage-Black clade), and another from the Current, Eleven Point and White River drainages (Current-White clade, Kinziger & Wood 2003). Counts of dorsal-fin rays are consistent with the recognition of two clades, the Osage-Black clade usually with 5–7 dorsal-fin rays and the Current-White clade usually with 8–9 dorsal-fin rays (Robins & Robison, 1985; Kinziger & Wood, 2003). These data indicate that *C. hypselurus* is composed of two species (Kinziger & Wood, 2003). Because *C. hypselurus* was originally described from Bennett Springs, Missouri (Osage drainage), the Osage-Black clade is properly named *C. hypselurus*, and the Current-White clade is in need of a formal name. Herein we describe the Current-White clade as a new species.

Methods

Institutional abbreviations are as in Leviton *et al.* (1985) and Leviton and Gibbs (1988). Type material of the *Cottus* species described herein are deposited in the National Museum of Natural History (USNM). Morphological data were collected directly from specimens, and color data were taken from live specimens in the field. Photographs of type materials were taken in the field. Trait data were recorded as described by Robins and Miller (1957), and traits not described by these authors follow Jenkins and Burkhead (1994). Morphometrics follow Freyhof *et al.* (2005). The condition of the caudal base band was scored as in Kinziger

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et al. (2000). Prickles (modified scales) which occur posterior to the pectoral fin insertion (postpectoral prickling) was scored as weakly prickled (0–10 prickles) or moderately to strongly prickled (>10 prickles). Pigmentation of the ventral surface of the peritoneum was examined after opening the abdominal cavity by cutting along both flanks and transversely posterior to the pelvic-fin insertion, forming a flap. Incisions along the flanks extended from a point even with the pectoral-fin insertion and extended posteriorly to a point even with the anus. The flap was peeled back and the pigmentation on the internal side of this flap was recorded as: 1) weakly pigmented (0–100 melanophores), or 2) moderately to strongly pigmented (> 100 melanophores). Melanophores present in blood vessels were not included in the assessment. Melanophores were consistently present throughout other interior portions of abdominal cavity; however, pigmentation of the ventral flap was found to vary among taxa and thus used in this study. To evaluate the utility of body depth for differentiating the new species, *C. hypselurus* and *C. bairdii* (see Robins & Robison, 1985), two body depth measurements were recorded from throughout the Ozark Highlands range of these species: (1) landmark body depth, the distance between the insertion of first anal-fin ray to insertion of the first dorsal-fin ray, and (2) caudal peduncle depth. Landmark body depth is uninfluenced by the degree to which the stomach is full and distended. All measurements were made using digital calipers to 0.1 mm.

***Cottus immaculatus*, new species**
Knobfin Sculpin
Figure 1

Holotype. USNM 396996, male, 63 mm SL, Current River at Baptist Camp Access, 2.7 air km east of Montauk State Park (37° 26.111' N; 91° 39.447' W), Dent County, Missouri, 25 April 2001.

Paratypes. Missouri, Dent County. USNM 396997, (10, 40–70 mm SL), INHS 102783, (10, 30–69 mm SL), UW 118923, (5, 49–64 mm SL), all taken with holotype.

Additional materials (nontypes). Arkansas: Fulton County: KU 16099 (15, 43–62 mm SL) Spring River at Many Islands Camp, 12 March 1975. KU 16109 (25, 42-57) Mill Pond Branch at Saddle, 12 March 2000. **Izard/Stone County:** HSU 3489 (25, 51-85) White River at Chessman Access, W Calico Rock, 6 March 2000. **Independence County:** INHS 53919 (12, 48-89) White River 5 mi. N Oil Trough, 11 November 1999. **Randolph County:** HSU 3480 (25, 43-70) Eleven Point River at Hwy 93, Dalton, 5 March 2000.

Missouri: Barry County: KU 16762 (16, 43-83) Little Flat Creek at McDowell, 11 August 1972. **Christian County:** KU 6516 (5, 41-47) Finley River at Highway 125, Linden, 29 August 1960. **Dent County:** HSU 3491 (45, 44-87) Current River at Highway 199, N Montauk, 26 November 1999. **Douglas County:** HSU 3478 (20, 41-73) Bryant Creek at Highway 14, 3 km E Gentryville, 7 March 2000. **Green County:** HSU 3483 (20, 42-63) Pearson Creek at County Road YY, 3 mi. E Springfield, 4 March 2001. **Oregon County:** KU 11026 (4, 59-72) Eleven Point River, 6.5 mi. N Alton, 3 July 1963. KU 11017 (12, 41-86) Eleven Point River, 9 mi. NE Alton, 30 June 1963. INHS 79424 (10, 50-71) Eleven Point River, Riverton, 26 April 1978. **Ozark County:** HSU 3494 (15, 44-74) North Fork White River at County Road CC, 10 mi. W West Plains, 7 March 2000. **Ripley County:** HSU 3476 (15, 42-74) Current River at Highway 160, W Doniphan, 4 March 2000. **Shannon County:** HSU 3473 (20, 52-88) Current River at County Road KK, Akers Ferry, 19 April 2000. **Taney County:** INHS 75487 (7, 48-64) Beaver Creek, 1 mi. NE Brownbranch, 4 September 1976.

Diagnosis. *Cottus immaculatus* is diagnosed from all other described members of the genus *Cottus*, except *C. hypselurus* and *C. caeruleomentum*, by the blue chin and belly on spawning males. *Cottus immaculatus* is distinguished from *C. hypselurus* by dorsal fin spines 8–9 in 96% of specimens versus 6–7 in 96% of specimens; pectoral fin rays 16–17 in 84% of specimens versus 13–15 in 78% of specimens; pigmentation of the ventral surface of the peritoneum weak in 91% of specimens versus moderate to strong in 85% of specimens; dorsal-fin union moderate to wide versus slight to moderate. *Cottus immaculatus* is distinguished from *C. caeruleomentum* by caudal base band notched versus non-notched; dorsal fins moderately to widely connected versus slightly connected; pectoral fin rays 16–17 in 84% of specimens versus 12–15 in 94% of specimens; ventral surface of peritoneum weakly pigmented versus moderately to strongly pigmented.

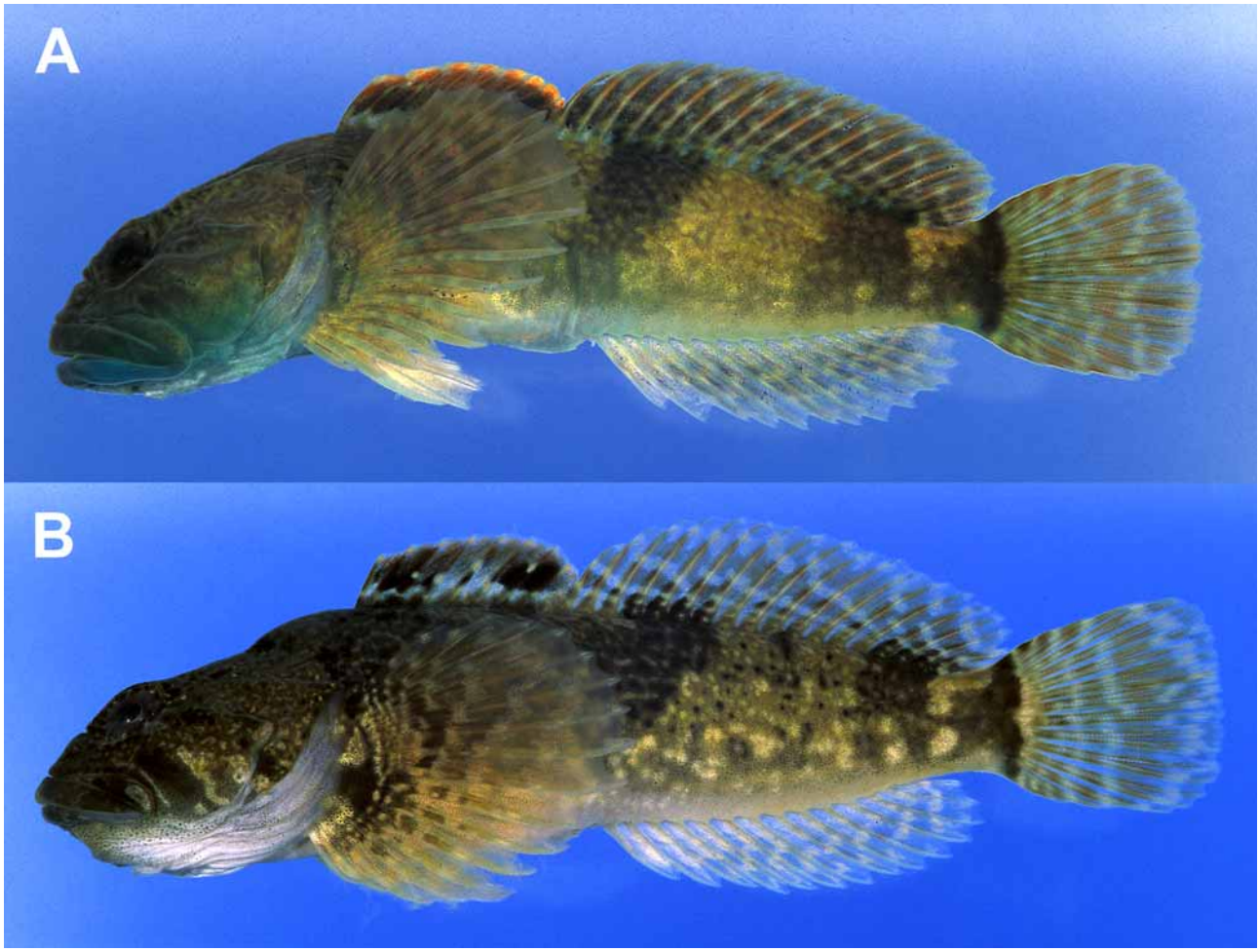

FIGURE 1. *Cottus immaculatus* (A) male 63 mm SL, holotype, USNM 396996, and (B) male, 60.44 mm SL. Photographs by J.F. Switzer.

Description. *Cottus immaculatus* is a moderate-sized species of the genus *Cottus*; the largest specimen examined is 90 mm SL. Typical body shape is illustrated in Figure 1, degree of peritoneum pigmentation is shown in Figure 2, and fin knobs are shown in Figure 3. Frequency distributions of spines, fins and lateral-line pores are given in Tables 1–5. Degree of connection between dorsal fins is given in Table 6. Extent of post-pectoral prickling and peritoneum pigmentation are given in Tables 7 and 8. Variation in the condition of the caudal-base band is given in Table 9.

Anal-fin rays 13, rarely 12 or 14; dorsal-fin spines 8, rarely 7 or 9; dorsal-fin rays 15–19, usually 17–18; pectoral-fin rays 13–17, usually 16; pelvic-fin rays 4, rarely 3; pelvic fin spines 1; branchiostegal rays 6; lateral-line pores 19–29, usually 21–25; lateral pores 5, rarely 3, 4 or 6; infraorbital pores 9, rarely 8 or 10; supraorbital pores 3; coronal pores 1, rarely absent; supratemporal pores 3, rarely 4; preopercular mandibular pores 11, rarely 10 or 12, post-maxillary pore present; median chin pores 2, rarely 1.

Morphometrics of holotype (63 mm SL, male) and 4 paratypes (49.3–68.6 mm SL, 2 males, 1 female, 1 unsexed) as percent of SL (mean and range): lateral head length 34.8, 33.6–36.0; dorsal head length 27.6, 25.7–31.1; pre first-dorsal fin distance 38.7, 37.8–39.7; pre second-dorsal fin distance (58.7, 57.3–60.2); base of first dorsal fin 18.1, 17.4–19.1; pre-anal length 58.5, 57.7–59.6; body depth at first dorsal-fin origin 24.3, 23.2–26.6; body depth at second dorsal-fin origin 22.1, 19.6–23.6; caudal peduncle depth 10.4, 9.5–11.3; caudal peduncle length 9.2, 6.2–10.7; head width at gill openings 30.1, 28.3–31.8. As percent of lateral head length (mean and range): eye diameter 24.4, 21.2–26.7; interorbital width 14.8, 12.4– 18.2; snout length 30.0, 28.7–32.7; caudal peduncle depth 29.8, 26.3–32.6; caudal peduncle length 26.4, 17.7–31.3; body width 36.0, 32.9–40.4.

TABLE 1. Frequency distribution of anal-fin rays in *Cottus hypselurus* and *Cottus immaculatus*.

	No. rays					
Species, System	12	13	14	15	N	Mean
C. hypselurus						
Black	4	69	10		83	13.07
Osage	1	20			21	12.95
Gasconade	11	87	17	1	116	13.07
Total	16	176	27	1	220	13.00
C. immaculatus						
Current	5	66	20		91	13.16
Eleven Point		37	14		51	13.27
Spring	4	28	8		40	13.1
White	3	95	22		120	13.16
Total	12	226	64		302	13.17

TABLE 2. Frequency distribution of dorsal-fin spines in *Cottus hypselurus* and *Cottus immaculatus*.

	No. spines					
Species, System	6	7	8	9	N	Mean
C. hypselurus						
Black	2	78	3		83	7.01
Osage		18	3		21	7.14
Gasconade	8	105	3		116	6.96
Total	10	201	9		220	6.99
C. immaculatus						
Current		5	83	3	91	7.98
Eleven Point		3	46	2	51	7.98
Spring		1	38	1	40	8.00
White		4	110	6	120	8.02
Total		13	277	12	302	7.99

Pectoral fins large, extending to at least second anal-fin ray when pressed against body. Pelvic fins well short of anus when pressed against body. Caudal fin subtruncate. Dorsal fins moderately to widely connected. Last anal-fin ray and dorsal-fin ray branched, caudal-fin rays branched; rays of all other fins unbranched. First pelvic-fin spine and ray combined into single element. Palatine tooth patch moderately developed. Postpectoral prickling weak (<10 prickles) in White River system and moderate to strong (>10 prickles) in Current, Eleven Point and Spring river systems. Preopercular armature: spine one moderately developed; spine two moderately to weakly developed; spine three weakly developed or absent. Lateral line incomplete and rarely interrupted. Gill membrane attached to isthmus. Dorsal surface of head and rarely nape with papillae (Kinziger, 2003).

Body overall dusky and mottled, background color brown to olive. Horizontal row of 3–5 square blotches on light background or several pale dots (1–2 mm diameter) on dark background present posteroventrad. Black spots on sides and head (0.3 mm diameter). Chin uniformly dusky or rarely slightly mottled. Dark blotch usually present at pectoral-fin base. Two faint suborbital bars usually present: bar one extending ventrally to maxilla; bar two extending posteriorly to uppermost preopercular spine. Pigmentation of the ventral surface of the peritoneum weak.

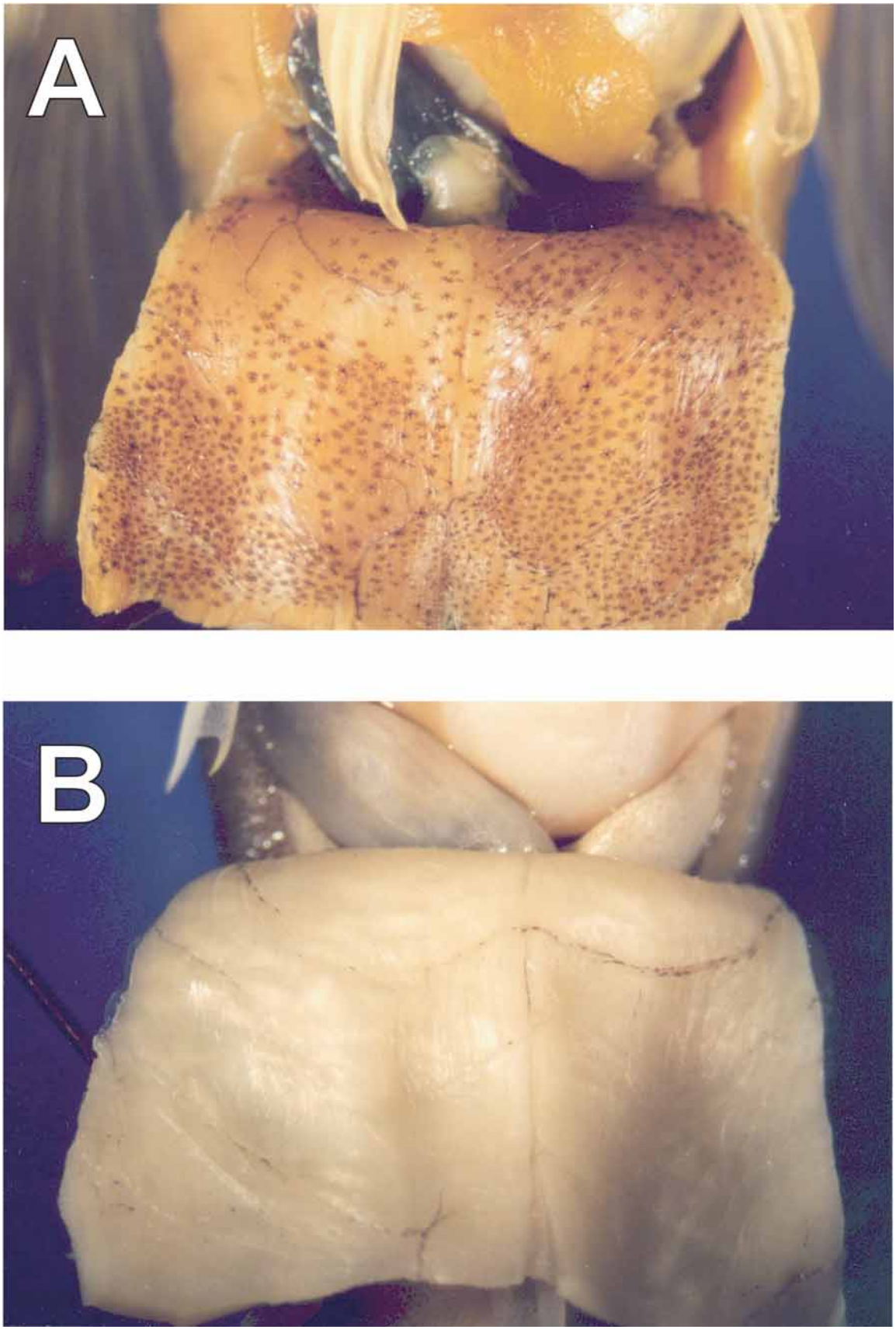

FIGURE 2. Pigmentation of the ventral surface of the peritoneum in: (A) *Cottus bairdii* (HSU 3506, 59.9 mm SL) with moderate to strong peritoneum pigmentation, and (B) *Cottus immaculatus* (HSU 3489, 80.0 mm SL) with weak peritoneum pigmentation.

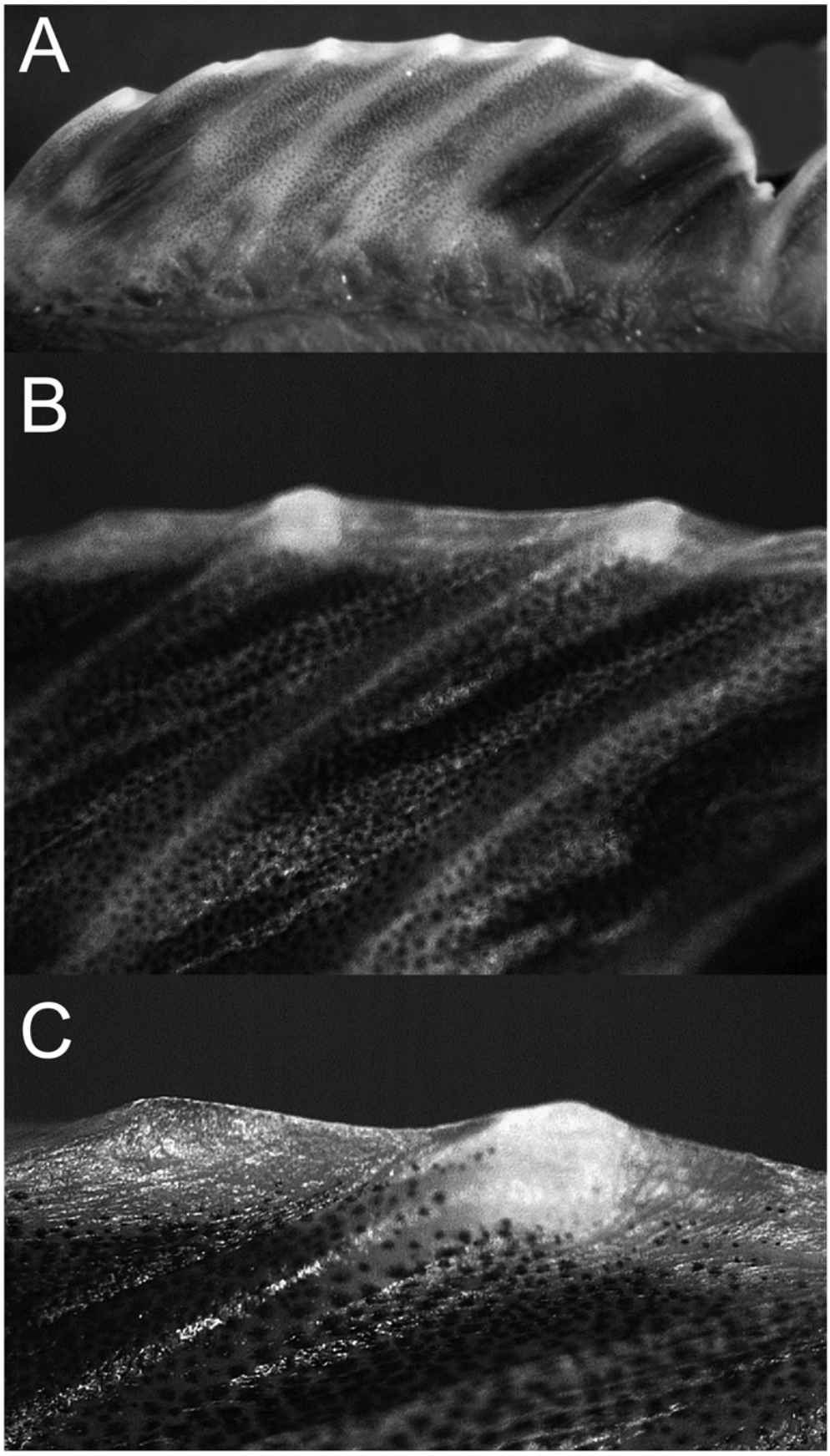

FIGURE 3. Enlargement of the tips of dorsal-fin spines (fin-knobs) of male *Cottus immaculatus* (79 mm SL, HSU 3489). A) first dorsal-fin, B) third and fourth dorsal-fin spines, and C) tip of third dorsal-fin spine.

TABLE 3. Frequency distribution of dorsal-fin rays in *Cottus hypselurus* and *Cottus immaculatus*.

	No. rays						
Species, System	15	16	17	18	19	N	Mean
C. hypselurus							
Black		1	23	54	5	83	17.76
Osage		0	3	17	1	21	17.9
Gasconade		1	39	76		116	17.64
Total		2	65	147	6	220	17.77
C. immaculatus							
Current			28	60	3	91	17.72
Eleven Point			4	39	8	51	18.08
Spring		1	17	21	1	40	17.55
White	1		45	69	5	120	17.64
Total	1	1	94	189	17	302	17.75

TABLE 4. Frequency distribution of pectoral-fin rays in *Cottus hypselurus* and *Cottus immaculatus*. Includes both left and right fins.

	No. rays						
Species, System	13	14	15	16	17	N	Mean
C. hypselurus							
Black	2	7	114	43		166	15.19
Osage		2	19	21		42	15.45
Gasconade		16	181	35		232	15.08
Total	2	25	314	99		440	15.15
C. immaculatus							
Current	1	1	22	143	15	182	15.93
Eleven Point		1	8	78	15	102	16.05
Spring		2	19	49	10	80	15.83
White			40	172	28	240	15.95
Total	1	4	89	442	68	604	15.95

TABLE 5. Frequency distribution of lateral-line pores in *Cottus hypselurus* and *Cottus immaculatus*.

	No. Pores														
Species, System	17	18	19	20	21	22	23	24	25	26	27	28	29	N	Mean
C. hypselurus															
Black			1	2	4	22	22	12	11	7		1	1	83	23.31
Osage		2			2	3	7	4	2	1				21	22.71
Gasconade	1			5	20	29	31	14	8	6	2			116	22.71
Total	1	2	1	7	26	54	60	30	21	14	2	1	1	220	22.91
C. immaculatus															
Current					5	17	19	25	16	5	2	1		90	23.64
Eleven Point				1	4	8	19	11	5	2	1			51	23.23
Spring							2	17	10	11				40	24.75
White			2	3	6	20	28	37	14	7	2		1	120	23.42
Total			2	4	15	45	68	90	45	25	5	1	1	301	23.76

TABLE 6. Frequency distribution of dorsal-fin union in *Cottus hypselurus* and *Cottus immaculatus* scored as in Jenkins and Burkhead (1994).

	Dorsal-fin union							
Species, System	Separate	Very Slight	Slight	Slight-Moderate	Moderate	Moderate-Wide	Wide	N
Cottus hypselurus								
Black		2	30	24	23	1	3	83
Osage			3	4	9	4	1	21
Gasconade	1	5	40	35	27	4	4	116
Total	1	5	73	63	59	9	8	218
Cottus immaculatus								
Current				4	12	16	59	91
Eleven Point			2	4	18	16	11	51
Spring			2	5	24	4	5	40
White			1	3	27	36	52	119
Total			5	16	81	72	127	301

TABLE 7. Frequency distribution of the development of postpectoral prickling in *Cottus hypselurus* and *Cottus immaculatus*. Weak (0–10 prickles), moderate to strong (>10 prickles).

	Prickling		
Species, System	Weak	Moderate-Strong	N
C. hypselurus			
Black	82	1	83
Osage	6	15	21
Gasconade	4	112	116
Total	92	128	220
C. immaculatus			
Current		91	91
Eleven Point	3	48	51
Spring	0	40	40
White	111	9	120
Total	114	188	302

Three to five narrow to wide saddles (numbered from anterior to posterior). Saddle one under dorsal-fin spines 1–3 and saddle two under dorsal fin spines 6–8. Saddles one and two rarely extending to lateral line and often diffuse, narrow or absent. Saddle three under dorsal fin rays 5–8 extending anteroventrad to venter and wide. Saddle four under dorsal fin rays 10–12, never extending to lateral line and narrow, diffuse, or absent. Saddle five under dorsal fin rays 15–18 extending anteroventrad to venter and wide. Saddles three and five rarely extend dorsally onto dorsal fin rays. The caudal base band encircles caudal fin base and extends anteriorly forming triangular blotch or sometimes connecting with saddle five. Caudal base band notched.

Caudal fin banded or tessellated. Anal-fin rays unpigmented or tessellated, membranes uniformly dusky. First dorsal-fin membranes and spines black anteriorly between elements one and three and posteriorly between the last three to four spines (two-spotted, Figure 1B) or uniformly dusky and pale margined. Males with tips of first dorsal spines thickened into small fleshy knobs, 0.3–0.5 mm diameter. Second dorsal fin marbled or uniformly dusky. Pectoral-fin banded, tessellated, or uniformly dusky. Pelvic-fin rays lacking pigmentation, rarely a few melanophores on membranes. Juvenile (≤40 mm SL) sometimes with jet black bodies except copper color at base of pectoral-fins, U-shaped mark on nape, and dorsal surface of caudal peduncle.

TABLE 8. Frequency distribution of the pigmentation pattern on the ventral surface of the peritoneum in *Cottus hypselurus* and *Cottus immaculatus* and 18 other *Cottus* taxa. Weak (0–100 melanophores), and moderate to strong (> 100 melanophores).

	Peritoneum Pigmentation		
Species, System	Weak	Moderate to Strong	
C. hypselurus			
Black	29	52	81
Osage		19	19
Gasconade	2	110	112
Total	31	181	212
C. immaculatus			
Current	73	2	75
Eleven Point	43	6	49
Spring	39		39
White	102	17	119
Total	257	25	282
C. bairdii	15	35	50
C. paulus		10	10
C. caeruleomentum	2	18	20
C. girardi		10	10
C. sp. cf. cognatus (checkered sculpin)	1	9	10
C. hubbsi	1	1	2
C. carolinae	18	4	22
C. rhotheus	5	15	20
C. cognatus	3	6	9
C. extensus	3		3
C. leiopomus		10	10
C. confusus		10	10
C. greenei		10	10
C. pitensis	10	4	14
C. aleuticus	2	8	10
C. asper	10		10
C. klamathensis	13	7	20
C. perplexus	4	4	8

Nuptial male body dark grayish black, not jet black. Blue-green or aqua on inside of mouth, mandible, chin, branchiostegal membrane, gular region, and belly to anal-fin ray insertion. Pelvic fin blue or dusky black, first dorsal-fin distal margin orange or red, all other fins black.

Comparisons. *Cottus immaculatus* and *C. hypselurus* were considered to be conspecific (Robins & Robison, 1985), but are distinguished by several characters. In addition to the characters in the diagnosis, *C. immaculatus* is distinguished from *C. hypselurus* by caudal-base band notched versus caudal-base band notched or non-notched; lateral line pores modally 24 versus 23. *Cottus immaculatus* and *C. hypselurus* have allopatric distributions; *C. immaculatus* occurs in the Current, Eleven Point, Spring and White river systems of the White River drainage, and *C. hypselurus* occurs in the Osage, Black, and Gasconade drainages (Figure 4; Kinziger & Wood, 2003).

TABLE 9. Frequency distribution of caudal-base band condition in *Cottus hypselurus* and *Cottus immaculatus* scored as in Kinziger *et al.* (2000).

	Caudal-base band			
Species, System	Notched	Intermediate	Unnotched	N
C. hypselurus				
Black	23	40	18	81
Osage	9	7	4	20
Gasconade	50	32	32	114
Total	82	79	54	215
C. immaculatus				
Current	87	4	0	91
Eleven Point	44	5	2	51
Spring	39	0	1	40
White	112	7	1	120
Total	282	16	4	302

Cottus immaculatus and *C. bairdii* occur allopatrically in the Ozark Highlands. *Cottus immaculatus* is in the Current, Eleven Point, Spring, and White river systems of the White River drainage, and *C. bairdii* is in the Osage, Gasconade, and Meramec drainages and smaller tributaries to the Mississippi and Missouri rivers in the eastern and northern Ozark Highlands (Figure 4; Kinziger & Wood, 2003; Pflieger, 1997; Robison & Buchanan, 1988). *Cottus bairdii* also occurs in the Little Black River, a tributary to the Current River, a drainage where *C. immaculatus* is broadly distributed; however, *C. immaculatus* has never been collected in the Little Black River (Pflieger, 1997; personal data). *Cottus immaculatus* is distinguished from Ozark Highland populations of *C. bairdii* by spawning males with blue chin and belly versus black; pigmentation of the ventral surface of the peritoneum weakly pigmented in 91% of specimens versus weakly to strongly pigmented (Table 8); mean least caudal-peduncle depth 9.3% SL versus 8.1% SL; mean landmark body depth 22.1% SL versus 19.7% SL (Figure 5); chin uniformly pigmented versus chin mottled; dorsal fins moderately to widely connected versus very slightly to moderately connected (Table 6).

Pflieger (1997) indicated the presence of both *C. bairdii* and *C. hypselurus* in tributaries to Stockton Reservior (Osage drainage); however, examination of specimens from this region (HSU 3516, HSU 3542, HSU 3527) indicates that *C. bairdii* occurs in these tributaries to the exclusion of *C. hypselurus*.

Cottus carolinae is the only *Cottus* species known to occur sympatrically with *C. immaculatus*, and is found throughout much of the geographic range of *C. immaculatus* (Robison & Buchanan, 1988; Pflieger, 1997; Kinziger & Wood, 2003; Figure 4). *Cottus immaculatus* and *C. carolinae* are members of the Uranidea clade but distantly related to one another (Kinziger *et al.*, 2005). *Cottus immaculatus* is distinguished from *C. carolinae* by lateral line incomplete versus lateral line complete; lateral line with 19–29, usually 21–25 pores versus lateral line with 28–35, usually 31–34 pores; caudal-base band notched versus non-notched (Table 9); caudal-base band narrow versus broad and angling anteroventrally; dorsal saddle three wide versus narrow; chin uniformly pigmented versus mottled (Robins, 1954; Jenkins & Burkhead, 1994; Pflieger, 1997).

Distribution. *Cottus immaculatus* is distributed in the Current, Eleven Point, Spring and White river systems of the White River drainage in the Ozark Highlands of Missouri and Arkansas (Figure 4). *Cottus immaculatus* occurs in cool to cold spring-fed creeks and rivers with cobble bottoms. In the Current River, *C. immaculatus* is the only species of *Cottus* present upstream of Akers Ferry; however, downstream of Akers Ferry, *C. immaculatus* is sympatric with *C. carolinae* (pers. obs.). *Cottus immaculatus* has not been found in the lower reaches of the Black River between the confluences of the Current, Eleven Point, Spring and White river systems presumably because unsuitable habitat exists in this lowland faunal region.

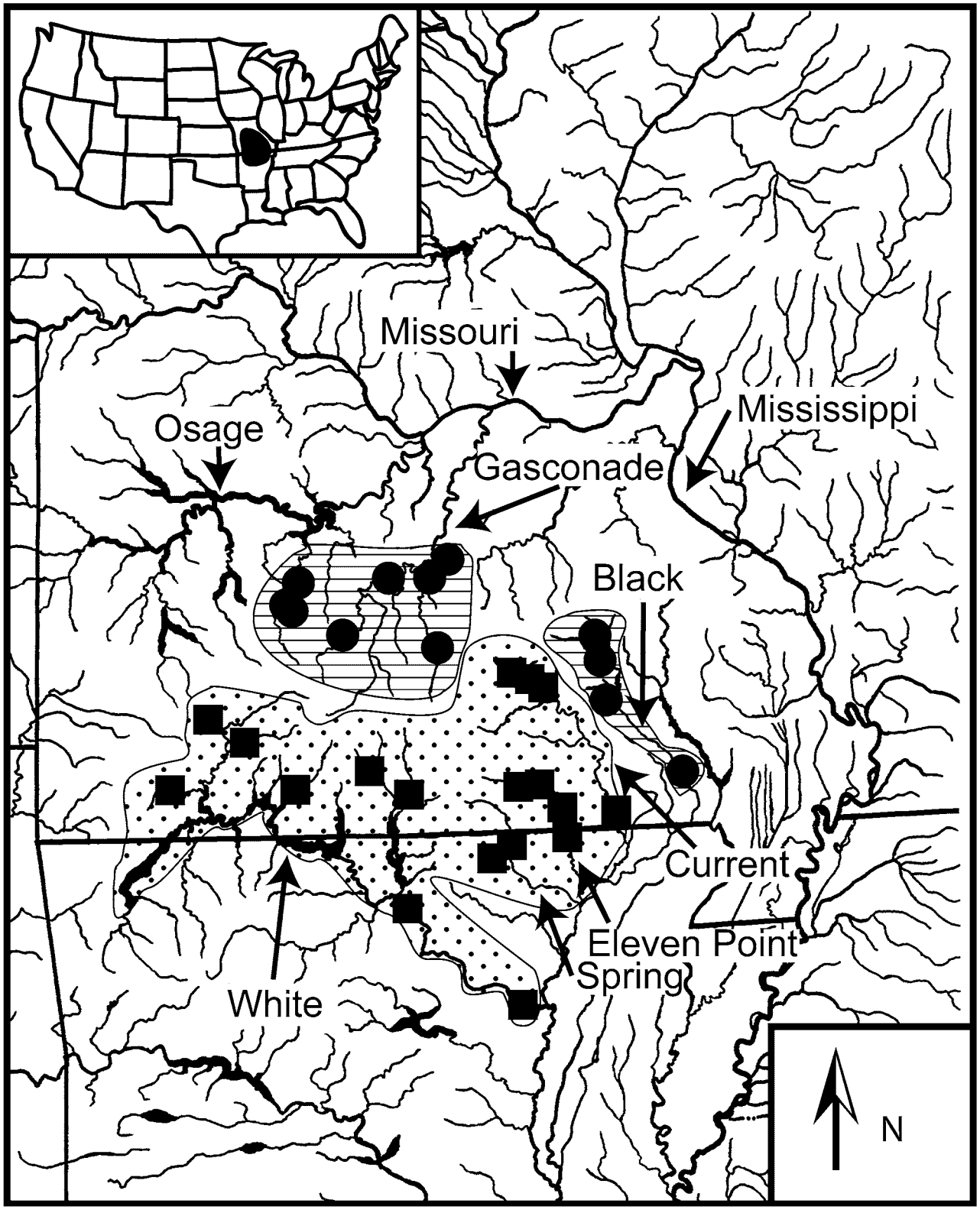

FIGURE 4. Distribution of *Cottus immaculatus* (stippling) and *C. hypselurus* (horizontal lines) in the Ozark Highlands of Missouri and Arkansas (after Robison and Buchanan, 1988; Pflieger, 1997). Material examined of *Cottus immaculatus* (squares) and comparative material of *Cottus hypselurus* (circles). Inset is combined range of *Cottus immaculatus* and *Cottus hypselurus*.

Reproduction. *Cottus immaculatus* most likely spawns in cavities; egg masses of this species have been found attached to the undersides of rocks (Pflieger, 1997; unpubl. data). Egg masses have been collected from

the White River on 6 March 2000 (unpubl. data), and gravid females and nuptial males are in collections from 4 March to 26 April from the Current, Eleven Point, Spring and White systems (HSU 3476, HSU 3473, HSU 3480, INHS 79424, KU 16099, KU 16109, HSU 3494, HSU 3478, HSU 3489, HSU 3483). These data suggest spawning happens in March and April. However, Pflieger (1997) found an egg mass on 2 January 1986 in the White River system presumably belonging to *C. immaculatus,* which suggests spawning may begin in December.

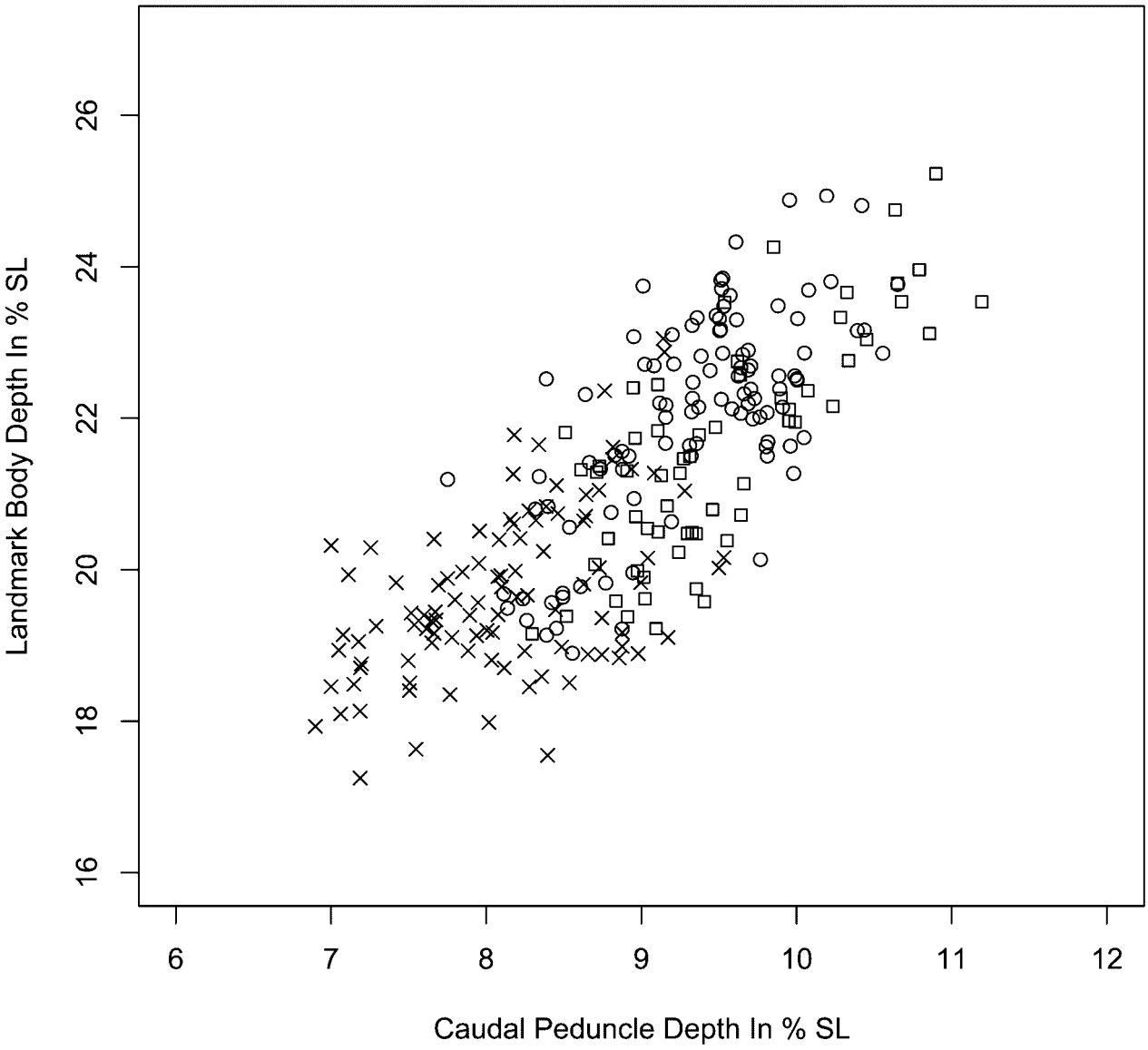

FIGURE 5. Plot of landmark body depth in percent standard length versus least caudal peduncle depth in percent standard length for *Cottus immaculatus* (circle), *Cottus hypselurus* (square) and *Cottus bairdii* (cross).

Conservation status. *Cottus immaculatus* is abundant within its range.

Etymology. The specific epithet *immaculatus* is Latin for immaculate in reference to the absence of melanophores on the ventral surface of the peritoneum. The common name, Knobfin Sculpin, is in reference to the fleshy knobs present at the tips of the dorsal fin spines of spawning males.

Remarks. *Cottus immaculatus* possesses a previously unreported character in the genus *Cottus*, enlargement of the tips of the dorsal-fin spines of males. Many members of the genus *Cottus* share the same cavity nesting spawning behavior (Pflieger, 1997; Jenkins and Burkhead, 1994), and other species may possess this morphological trait. Fleshy knobs at the tips of the dorsal-fin spines have also been reported from the percid subgenera *Boleosoma* and *Catonotus* of the genus *Etheostoma* (Page & Bart, 1989; Bart & Page,

1991). It is hypothesized that fin knobs may have an adaptive function related to cavity nesting in *Boleosoma* and *Catonotus*. In both subgenera, males establish territories under stones, and ripe females enter and lay eggs on the ceiling (Page & Bart, 1989). Fin knobs may protect eggs from puncture during nesting or may serve as egg-mimics that prompt mating because females prefer nests already containing eggs (Page & Swofford, 1984; Page & Bart, 1989; Bart & Page, 1991).

Preliminary data suggest that fin knobs in *C. immaculatus* may serve an egg-mimic function (Figure 3). First, *C. immaculatus* is most likely a territorial cavity-nesting species that attaches eggs to the ceiling of its nesting cavity, as do members of the subgenera *Boleosoma* and *Catonotus*. Second, the red to orange coloration of the knobs and distal margin of the first dorsal-fin are similar to the color of *C. immaculatus* eggs and help to distinguish the knobs from the rest of the darkly colored fin membrane. Third, experiments with a cavity-nesting *Cottus* species, *C. gobio*, reveal that males whose nests contain eggs are preferred by females (Marconato & Bisazza, 1986). However, the small size of the knobs (0.3–0.5 mm diameter) relative to the size of the eggs of this species (2–3 mm diameter) is not consistent with the egg-mimic hypothesis, and other possible functions such as prevention of egg puncture during nest guarding should not be discounted.

Comparative material. *Cottus hypselurus*: Missouri: Dallas County: HSU 3488 (4, 41-52) Niangua River at Highway 64, 5 mi. NW Lebanon, 20 April 2000. HSU 3484 (12, 54-105). KU 11244 (5, 41-67) large spring W Niangua River near Highway 64, 10 July 1961. **Dallas/Laclede County:** Bennett Spring at Bennett Spring State Park, 5 mi NE Lebanon (type locality), 20 April 2000. **Laclede County:** HSU 3490 (20, 53-81) Osage Fork at County Road 5-650, 7 mi. S Lebanon, 2 April 2001. **Phelps County:** HSU 3482 (15,44-63) Spring Creek at County Road J, 1 mi. E Spring Creek, 28 May 2000. HSU 3599 (45, 48-71) Little Piney Creek at Lane Spring Recreational Area, Yancy Mills, 26 November 1999. **Pulaski County:** HSU 3479 (12, 40-76) Roubidoux River at Business 44, Waynesville, 3 March 2001. INHS 76691 (4, 45-63) Roubidoux River 2 mi. N Waynesville, 21 May 1977. **Reynolds County:** HSU 3474 (39, 43-79) unnamed spring at Highway 72/21, Centerville, 6 November 1999. KU 16568 (20, 45-62) Middle Fork Black River, 1.2 mi. SE Lesterville, 26 July 1976. KU 7696 (2, 60-62) Webb Creek, small tributary to Clearwater Reservoir, State Road HH, 8 April 1963. HSU 3475 (20, 47-75) Big Piney Creek at County Road BB, 8 mi. SE Licking, 20 April 2000. HSU 3493 (22, 48-76) Markham Spring at Markham Spring Recreational Area, N Browns Crossing, 17 October 2000.

Additional comparative material for peritoneum pigmentation analysis. *Cottus bairdii*: HSU 3504 (21) Little Piney Creek at Lane Spring, Yancy Mills, Phelps County, Missouri. HSU 3506 (29) Big Buffalo Creek at Buffalo Creek Conservation Area, 2 mi. SW Boylers Mill, Benton County, Missouri. ***Cottus paulus*:** USNM 241910 (10) Coldwater Spring and Creek, 5.7 mi. W Oxford, Calhoun County, Alabama. ***Cottus caeruleomentum*:** USNM 241935 (10) Licking Run at Route 416, Franklin County, Pennsylvania. USNM 230950 (10) Craig Creek at County Road 621, Craig County, Virginia. ***Cottus girardi*:** USNM 335038 (10) Brush Creek, Virginia. ***C. sp. cf. cognatus* (checkered sculpin)**: USNM 232186 (10) Muddy Run at Route 28004, Franklin County, Pennsylvania. ***Cottus hubbsi*:** USNM 142970 (2) Dragoon Cr, 5 miles S Deer Park, Washington. ***Cottus carolinae*:** HSU 3463 (8) Liberty Creek along Route 608, 3.5 air mi. SE Pounding Mill, Tazewell County, Virginia. HSU 3595 (4) Big Piney Creek at County Road BB, 5 mi. SE Licking, Texas County Missouri. HSU 3596 (10) James River at County Road O, 5 mi. W Highlandville, Stone County, Missouir. ***Cottus rhotheus*:** HSU 3741 (10) Greasy Creek at Grange Hall Road, WSW Philomath, Benton County, Oregon. HSU 1635 (10) Yakima River, Washington. ***Cottus cognatus*:** HSU 3541 (9) unnamed spring tributary to Citron Cr, Wisconsin. ***Cottus extensus*:** HSU 3538 (3) Bear Lake at Cisco Beach, 7 mi N Laketown, Rich County, Utah. ***Cottus leiopomus*:** HSU 3750 (10) Big Wood River along Highway 75, Hailey, Blaine County, Idaho. ***Cottus confusus*:** HSU 3747 (10) Salmon River at FR 194, S Sawtooth City, Blaine County, Idaho. ***Cottus greenei*:** HSU 3742 (10) Bickle Lake Springs at Hagerman National Fish Hatchery, 5 mi. S Hagerman, Gooding County, Idaho. ***Cottus pitensis*:** HSU 3748 (5) Hat Creek at end of unnamed road W State Route 299, 7 mi. NE Burney, Shasta County California. ***Cottus aleuticus*:** HSU 3746 (10) Smith River along State Route 197, Ruby Vanderventer County Park, Del Norte County, California. ***Cottus asper*:** HSU 3745 (10) Smith River along State Route 197, Ruby Vanderventer County Park, Del Norte County, California. ***Cottus klamathensis*:** HSU 3749 (10) Hat Creek at end of unnamed road W State Route 299, 7 mi.

NE Burney, Shasta County, California. HSU 3753 (10) Shasta River at unnamed crossing off State Route 263, 3 mi. NE Yreka, Siskiyou County, California. ***Cottus perplexus*****:** HSU 3546 (8) Greasy Creek at Grange Hall Road, 2.5 mi WSW Philomath, Benton Co., Oregon.

Material used in body depth analysis. *Cottus bairdii:* Missouri: Benton County: HSU 3506 (20, 26-71) Big Buffalo Creek at Buffalo Creek Conservation Area, 2 mi. SE Boylers Mill, 13 July 2000. **St. Louis County:** HSU 3505 (40, 34-83) Kiefer Creek along Kiefer Creek Road, SEllisville, 20 February 2000. **Marion County:** HSU 3507 (20, 31-77) Clear Creek at Clear Creek Road, 2 mi. N Hannibal, 28 November 1999. **Phelps County:** HSU 3504 (20, 45-65) Little Piney Creek at Lane Spring, Yancy Mills, 31 July 2001.

Cottus hypselurus**: Missouri: Dallas County:** HSU 3488 (8, 35-65) Niangua River at Highway 64, 5 mi. NW Lebanon, 20 April 2000. **Dallas/Laclede County:** HSU 3484 (12, 42-85) Bennett Spring at Bennett Spring State Park, 5 mi. NE Lebanon, 20 April 2000. **Phelps County:** HSU 3599 (10, 25-79) Little Piney Creek at Lane Spring, Yancy Mills, 26 November 1999. **Reynolds County:** HSU 3474 (20, 23-79) Unnamed Spring at Highway 72/21, Centerville, 6 November 1999.

Cottus immaculatus**: Arkansas: Izark/Stone County:** HSU 3489 (20, 34-85) White River at Chessman Access, W Calico Rock, 6 March 2000. **Randolph County:** HSU 3480 (20, 43-70) Eleven Point River at Highway 93, Dalton, 5 March 2000.

Missouri: Dent County: HSU 3491 (45, 33-87) Current River at Highway 119, N Montauk, 26 November 1999. **Ozark County:** HSU 3494 (20, 34-85) North Fork White River at County Road CC, 10 mi. W West Plains, 7 March 2000.

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