

OCCASIONAL PAPERS OF THE MUSEUM OF
ZOOLOGY
UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN

FOUR NEW SPECIES OF FRESHWATER SCULPINS, GENUS
COTTUS, FROM WESTERN NORTH AMERICA

BY REEVE M. BAILEY AND CARL E. BOND¹

IN our studies of the freshwater cottid fishes of western North America we have encountered four unnamed species. Our systematic review is still incomplete, but it is expedient to publish descriptions of the new species at this time. Our investigations on these fishes dictate considerable modification of current ideas on relationships. These may be implemented in part by the recognition of several species groups.

THE *BAIRDI* SPECIES GROUP

The widest ranging of these, the *bairdi* group, includes the following presently recognized species: *Cottus bairdi* Girard, *C. bendirei* (Bean), *C. hubbsi* Bailey and Dimick, *C. baileyi* Robins, *C. cognatus* Richardson, *C. beldingi* Eigenmann and Eigenmann, *C. annae* Jordan and Starks, *C. tubulatus* Hubbs and Schultz, and *C. leiopomus* Gilbert and Evermann. Three additional forms have recently been synonymized with *Cottus cognatus* by McAllister and Lindsey (1961:75). In our review we shall further reduce the number of recognized species: *C. bendirei* and *C. hubbsi* will be treated as conspecific with *C. bairdi*; *C. annae* and *C. tubulatus* will be synonymized with *C. beldingi*.

The *bairdi* group, which in addition to the above includes three of the new species (*echinatus*, *extensus*, and *confusus*), may be characterized as follows: Palatine teeth present or absent; posterior nostril not tubular; preopercular spines various, from none to 4, the principal spine, if present, sharp; lachrymal not produced; suborbital stay without elevated bony ridge; pelvic interspace less than depth of caudal peduncle; pectoral and dorsal rays simple (one or a few

¹ Oregon State University, Corvallis, Oregon.

branched in occasional specimens); pelvic rays typically I,3 or I,4, simple; preoperculo-mandibular canals usually separate (rarely joined to form a median chin pore, except that in *bairdi* in the Potomac River drainage this is a common variation); postmaxillary pore present or not; dorsal fins usually separate at base, occasionally narrowly conjoined; spinous dorsal in adult male usually with a large dark blotch anteriorly and one posteriorly, these commonly confluent to form a submarginal band; males with developed genital papilla; body robust to slender; caudal peduncle thick or of moderate depth; head small to moderately large (2.9 to 4.0 in standard length); size moderate.

***Cottus echinatus*, new species**

Utah Lake Sculpin

(Figs. 1a, 2a, 4a)

Cottopsis semiscaber (misidentification). Jordan and Gilbert, 1881:459-60 (Utah L., Provo, Utah; characters).

Uranidea semiscabra (misidentification). Jordan and Gilbert, 1883:695 (in part, Utah Lake; description).

Cottus semiscaber (misidentifications). Jordan, 1891:35 (Provo R., Utah; description). Jordan and Evermann, 1898:1948-50 (in part, Provo R., Provo, Utah; description). Tanner, 1936:172 (in part, Utah L.).

Jordan and Gilbert (1881) and Jordan (1891:35) noted the prickly skin of this species and separated it from *Cottus bairdi*, but they employed Cope's name *semiscaber*, properly a specific synonym of *bairdi*.

TYPES.—The holotype, UMMZ² 177376, an adult female 64.5 mm. in standard length, was collected in Utah Lake at mouth of Provo River, Utah County, Utah, during April, 1928, by Vasco M. Tanner. Two paratypes, UMMZ 156794, 61.5 and 68.5 mm., were taken with the holotype. Other paratypes are: USNM 197681 (2), 69 and 92 mm., collected in Utah Lake, Utah, by Peter Madsen, part of lot originally entered on June 22, 1882, as USNM 30808, and USNM 27414 (2), 75 and 77 mm., taken in Utah Lake by David S. Jordan in 1880.

DIAGNOSIS.—A form of the *bairdi* species group with exposed palatine teeth in a band of moderate length and 2 or 3 rows wide; preopercle with 3 sharp spines and a blunt knob or with 4 sharp spines, the principal spine straight to notably curved upward, the one below directed downward and backward. Fin rays: Dorsal, VII or VIII, 16-18; anal, 13 or 14; pectoral, 16-18; pelvic, I,4. Body rather slender, depth 19.0

² Museum abbreviations are explained on page 25.

to 22.8 per cent of standard length, and depth of caudal peduncle 6.6 to 7.4 per cent of standard length; head of moderate length, 30.9 to 35.0 per cent of standard length (more than 32 per cent in 6 of 7 specimens); lateral line straight, incomplete, terminates below dorsal soft ray 16 to 18, with 26 to 29 pores; chin pores usually separate (a median pore in one of 7 specimens); postmaxillary pore present; prickles exceptionally numerous and widely distributed, present on all of body including caudal peduncle, breast and belly; body tan or brownish above, lighter below, with obscure darker markings on side and at caudal base; saddles obsolete; standard length to 92 mm. (total length 110 mm.).

Closely allied to *extensus* but distinguished by the prickles on breast and belly, larger head, and more robust body. Separable from *bairdi* by the heavy investment of prickles, the backward projection of the second preopercular spine, the uniform pigmentation, and the more numerous pectoral and anal rays.

ADDITIONAL CHARACTERS.—Counts and measurements of the holotype are given in Table 1. The mouth is slightly oblique and the jaws are straight; the maxilla extends to below center or rear of the pupil. The jaws are of approximately equal forward extension. In ventral aspect the mouth is deeply parabolic and the upper jaw is only narrowly visible. The interorbital space is of moderate width and is nearly flat. Palatine teeth are well developed and are exposed in all specimens.

The preopercle is strongly armed. Five specimens each have 3 well-formed, sharp spines plus a blunt knob; two have 4 sharp spines. The upper spine is straight or gently curved upward in 4 examples, and is abruptly upcurved in 2. In the latter, the spine simulates that of *C. ricei*. As in *extensus*, but unlike other American species of *Cottus*, the second preopercular spine is directed backward and downward instead of usually being hooked downward and forward.

The lateral line lies somewhat above the axial septum and is straight to its terminus without posterior, downward deflection. The cephalic pores are of moderate size, approximating the diameter of the anterior narial aperture. The preoperculomandibular series has 11–11 pores in five specimens, 12–11 in one, and 10–1–10 in one; all specimens have a postmaxillary pore on each side. There are 9 or 10 infraorbital pores.

Prickles extend from the occiput backward and cover the body densely to the posterior end of the dorsal fins. There are a few scattered prickles on the caudal peduncle. All specimens have prickles also on the breast and belly, a unique character of the species. Usually these are dense, but in one specimen there are few prickles on the

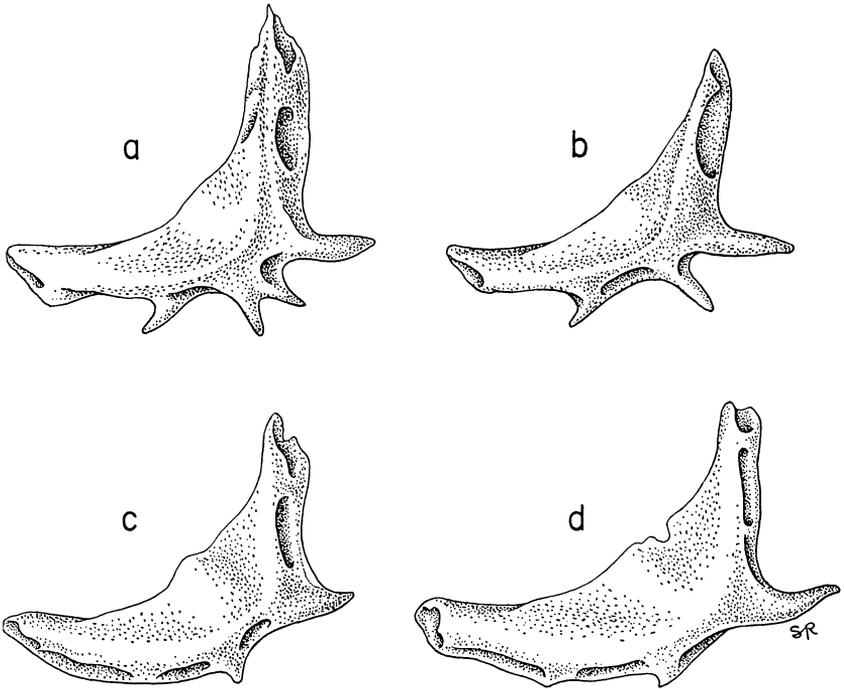


FIG. 1. Preopercles of four new species of *Cottus* in left lateral view. *a*, *Cottus echinatus*, UMMZ 156794, Utah Lake, Utah; standard length, 60 mm. (the double, posteroventral spine is atypical; there are only three spines on the right side in this specimen). *b*, *Cottus extensus*, UMMZ 141792, Bear Lake, Utah; s. l., 62 mm. *c*, *Cottus confusus*, UMMZ 161840, Salmon River, Idaho; s. l., 58 mm. *d*, *Cottus pitensis*, UMMZ 130646, Rush Creek, Modoc Co., California; s. l., 63 mm.

lower surface. Total vertebral counts, determined from skiagraphs, are 33 in 3 and 34 in 3.

The dorsum is tan and in our material has no obvious saddles or blotches. There are 2 or 3 small dark marks at the caudal base, but the side has only faint traces of blotches. The ventral surface is light; it may be dusted with melanophores but is immaculate. The lower lip, though darker, is also uniformly shaded. The spinous dorsal fin in males shows the characteristic pigmentation of the species group, dark pigment anteriorly and posteriorly. The dorsal fins are narrowly conjoined in 3 individuals, separate to the base in 4. Except for the caudal, all fin rays are simple. The soft dorsal and caudal are boldly cross banded, and the pelvic and anal are faintly marked in males, immaculate in females.

TABLE I

COUNTS AND MEASUREMENTS OF HOLOTYPE OF FOUR NEW SPECIES OF *Cottus*
 Proportional measurements are expressed as thousandths of the standard length

Character	<i>echinatus</i>	<i>extensus</i>	<i>confusus</i>	<i>pitensis</i>
Fin rays:				
Dorsal spines	7	7	8	8
Dorsal soft rays	17	18	17	18
Caudal rays, principal	11	11	11	11
Anal rays	13	13	12	14
Pectoral rays	16-16	16-15	13-14	14-14
Pelvic rays	I,4-I,4	I,4-I,4	I,4-I,4	I,4-I,4
Vertebrae	34	33	33	33
Pores:				
Lateral line	27	27	34	34
Infraorbital canal	9-9	9-9	9-9	9-9
Preoperculomandibular canal	11-11	11-11	11-11	10-11
Standard length (mm).	64.0	88.5	72.5	83.2
Head length (including				
opercular membrane)	356	324	317	351
Greatest depth	217	180	214	230
Least depth	70	68	88	84
Body width (behind				
pectoral fin)	188	160	179	188
Predorsal length	367	343	353	373
Caudal peduncle length	172	136	157	125
Anus to base of caudal	498	494	458	463
Prepelvic length	297	282	291	297
Snout tip to anal origin	546	568	571	559
Highest dorsal spine	94	110	80	93
Spinous dorsal base	195	180	241	185
Highest dorsal soft ray	170	153	149	154
Soft dorsal base	406	444	401	409
Caudal length	273	226	234	228
Highest anal ray	134	129	159	141
Anal base	291	322	273	303
Longest pectoral ray	291	261	290	280
Pelvic fin length	184	189	207	190
Interpelvic width	31	27	39	25

TABLE 1 (continued)

COUNTS AND MEASUREMENTS OF HOLOTYPES OF FOUR NEW SPECIES OF *Cottus*
 Proportional measurements are expressed as thousandths of the standard length

Character	<i>echinatus</i>	<i>extensus</i>	<i>confusus</i>	<i>pitensis</i>
Head width	316	258	294	347
Head depth	189	164	194	196
Snout length	94	89	102	113
Orbit length	84	72	69	72
Postorbital length of head.....	186	169	165	175
Bony interorbital width	31	31	33	43
Upper jaw length	156	147	153	160
Mouth width	172	172	201	238
Isthmus width	63	46	76	78
Length of preopercular spine (from upper angle of base)	30	27	11	24
Tip of snout to tip of preopercular spine	294	259	255	286

RANGE.—So far as known *Cottus echinatus* is restricted to Utah Lake, Utah. Whether the species survived the low lake levels of the mid-1930's (Tanner, 1936:167) has not been ascertained. Jordan (1891:35) reported prickly sculpins from the Provo River, but National Museum specimens collected by him are labeled Utah Lake.

ETYMOLOGY.—The name *echinatus* (Latin, prickly) has reference to the most distinctive feature of the species, the heavy investment of prickles on the body, including the ventral surface.

RELATIONSHIP.—*Cottus echinatus* seems most closely related to *C. extensus* of Bear Lake, also in the Bonneville basin. The two species have presumably differentiated in isolation in their lacustrine habitats. Both are perhaps descended from a common ancestor that lived in Pleistocene Lake Bonneville. This ancestral form was probably a lacustrine derivative from *Cottus bairdi* or a *bairdi*-like stock.

The distinctive features of *extensus* and *echinatus* are interpreted as adaptations to lacustrine existence. These include a slender body and peduncle, well-prickled body, rather large cephalic pores, and a uniform coloration. Most of these characters have been independently acquired also in *Cottus princeps* of Klamath Lake and *C. asper*, a species that usually inhabits large rivers and low gradient waters that approach lacustrine conditions. In *asper*, however, the cephalic pores

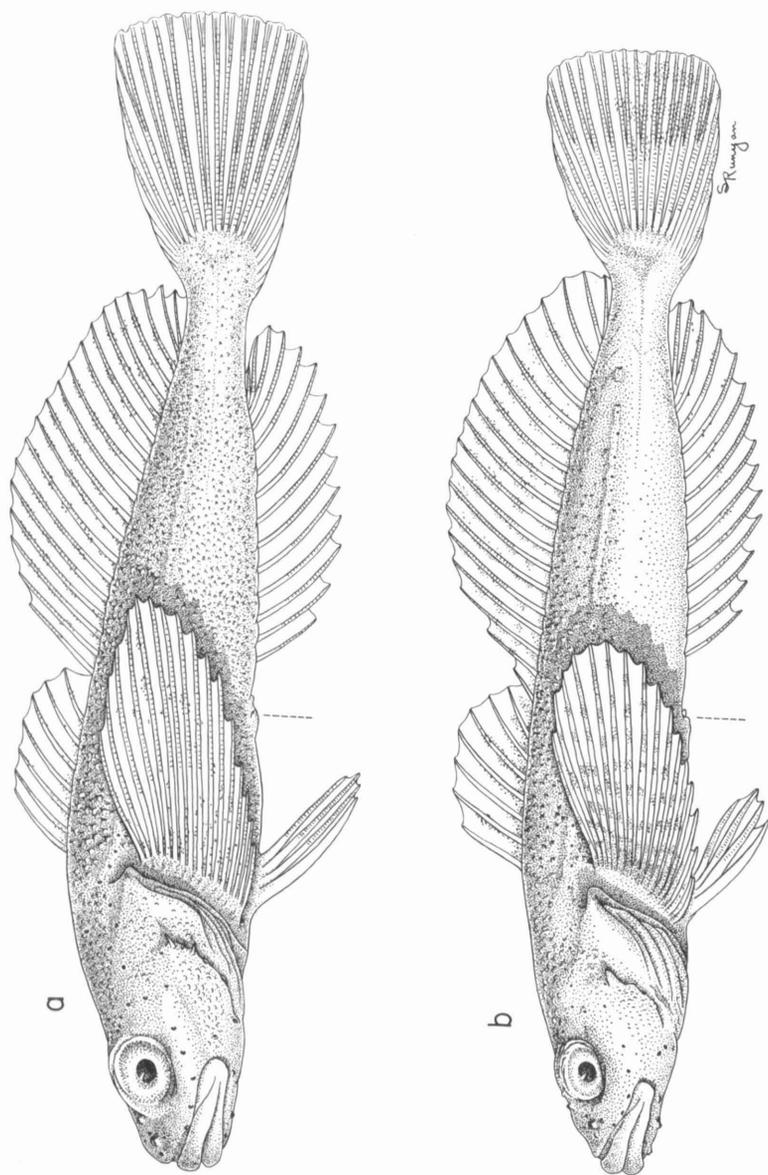


FIG. 2. a, *Cottus echinatus*, new species; the holotype. b, *Cottus extensus*, new species; the holotype.

are not enlarged. The posteriorly-directed second preopercular spine, shared by *extensus* and *echinatus*, points to genetic kinship of these forms, but its functional significance is not apparent. It may be noted that this same character is found in *Cottus* (*Mesocottus*) *haitej* Dybowski and *Trachidermus* (or *Cottus*) *fasciatus* Heckel from eastern Asia, but it is unlikely that close relationship is indicated.

Cottus extensus, new species

Bear Lake Sculpin

(Figs. 1b, 2b, 4b)

Cottus semiscaber (misidentifications). Snyder, 1919:4 (Bear L.). Tanner, 1936:172 (in part, Bear L.).

Cottus sp. McConnell, Clark, and Sigler, 1957:50-51, 74, fig. 19 (Bear L.; life history).

The existence of an undescribed sculpin in Bear Lake, Idaho and Utah, was first recognized by Carl L. Hubbs and L. E. Perry about 1941, while Perry was studying the Bonneville cisco. The sculpin, together with the three whitefishes described by Snyder (1919), brings to four the number of endemic species of fishes in Bear Lake, the most in any North American lake. We are indebted to Dr. Hubbs who suggested the name *extensus*.

TYPES.—The holotype, UMMZ 141840, an adult female 89 mm. in standard length, was collected along the east shore of Bear Lake, south of the South Eden Delta, Rich Co., Utah, on September 25, 1941, by L. E. Perry and L. B. Crookston. Fifteen paratypes, UMMZ 141841 (15), 23 to 81 mm., were taken with the holotype. At this station the bottom is composed of coarse gravel and large rubble. The collection was made near shore to a depth of 2 feet from 6:30 to 9:30 P.M., with a ten-foot minnow seine. The water was clear and cool (60°F.).

ADDITIONAL MATERIAL (ALL FROM BEAR LAKE).—*Bear Lake County, Idaho*: UMMZ 141790 (7), 28-41 mm., east shore near North Eden Delta, T. 169 N, R. 44 E, sec. 36, summer, 1939, Perry. UMMZ 141807, 89 mm., 2 mi. N and 1 mi. E of Fish Haven, depth 40-45 ft., July 7, 1941, Perry. UMMZ 141812, 85 mm., 4 mi. E of Fish Haven, 120 ft., July 31, 1941, Perry. UMMZ 141818, 78 mm., Fish Haven beach, July 25, 1941, Perry. UMMZ 141810, 78 mm., 2 mi. E of Fish Haven, 40-50 ft., July 12, 1941, Perry. UMMZ 161786 (7), 26-39 mm., beach 5.5 mi. E of St. Charles, June 24, 1950, E. C. Raney and R. M. Bailey. UMMZ 177554, 109 mm., N end Bear Lake, 70 ft., July, 1952, W. J. McConnell. UMMZ 141797, 87 mm., location unknown, perhaps in Utah, 1941, Perry.

Rich County, Utah: UMMZ 141792 (51), 31-66 mm., east shore, 1 mi. S North Eden Delta, T. 14 N, R. 6 E, sec. 4 or 9, June 13, 1940, L. B. Crookston. UMMZ

141798 (2), 44 and 46 mm., Rock Gulch, east side, about 2 mi. S North Eden Delta, 15 ft., July, 1941, Perry. UMMZ 141814 (3), 74–100.5 mm., east shore midway between North and South Eden deltas, about Aug. 2, 1941, Perry. UMMZ 156792 (6), 38–43 mm., Sept. 5, 1930, Vasco M. Tanner. UMMZ 161796 (17), 28–62 mm., mouth of Swan Cr., 3 mi. N of Garden City, June 26, 1950, Marian and R. M. Bailey. OS 595, 32 mm., west shore, 3 mi. N of Garden City, Aug. 25, 1960, C. E. Bond. OS 1277 (124), 29–75 mm., east shore near south end, May 24, 1961, Gar Workman.

DIAGNOSIS.—A species of the *bairdi* species group with exposed palatine teeth in a band of moderate length and 2 to 4 rows wide; preopercle with 3 sharp spines and an obtusely pointed or blunt knob, the principal spine almost straight and directed backward and slightly upward, the one below directed downward and backward. Fin rays: Dorsal (VI) VII or VIII, 16–19; anal 13–15 (16); pectoral 15–17 (18); pelvic I,4 (occasionally I,3). Body very slender, greatest depth 15.4 to 21.1 per cent of standard length and depth of caudal peduncle (6.1) 6.5 to 7.5 (8.1) per cent of standard length; head rather short (27.4) 29 to 32 (33.3) per cent of standard length; lateral line straight, incomplete, typically terminates below dorsal soft ray 13 to 18, with 22 to 31 pores; no median chin pore; postmaxillary pore present; prickles well developed on dorsum and side, often as far back as caudal peduncle; breast and belly naked; body almost uniform tan or brownish above, lighter below, a few large blotches sometimes visible on side, dorsal saddles obsolete; standard length to 109 mm. (total length 130 mm.).

Distinguishable from *echinatus* by the naked breast and belly, smaller head, and more slender body. Separable from *bairdi* by the more slender body, smaller head, plain coloration, the more general distribution of prickles, the backward projection of the second preopercular spine, and the more numerous vertebrae, pectoral rays and anal rays.

ADDITIONAL CHARACTERS.—Counts and measurements of the holotype are given in Table 1. The mouth is large, nearly horizontal; the maxilla extends to below middle of pupil; the lower lip hides the upper as viewed from below; the exposed part of the maxilla is slender. The interorbital space is narrow and slightly concave; the head is broadest just behind the preopercle, tapering forward to the rounded snout. The eyes are placed in the anterior half of head, and there is a median concavity posterior to the orbits. The top of the head is rough. Palatine teeth are consistently well developed and exposed.

Preoperculomandibular pores number 11–11; infraorbital pores variable, from 8–9 to 10–10. The dorsal fins are usually narrowly separated but are often slightly conjoined, rather broadly so in the holotype. Depressed pectoral fin reaching at least to origin of anal; pelvic

reaching more than two-thirds way from origin to anus, sometimes reaching anus in juveniles. Caudal vertebrae, counted from dissected specimens, are 22 in 1, 23 in 5. Total vertebrae, counted from skiagraphs, are 33 in 4, 34 in 23. Pyloric caeca 3 in 8 specimens, 4 in one.

The pigmentation is almost uniform, the overall tone light to medium brown with underparts light. In adults there is usually no concentration of melanophores to form dorsal or lateral blotches, although one to three small, diffuse blotches may be present at the caudal base. In small juveniles, from four to six faintly defined dorsal saddles may be discerned, and there may be one or two series of diffuse lateral spots, those on the ventrolateral surface being most evident since they contrast with the lighter background. The melanophores of the upperparts are reduced more or less gradually on the ventrolateral surface and the lower surface is devoid of pigment except that the lower jaw is uniformly dusky and the rest of the lower surface of the head may be dusted with melanophores. The base of the first dorsal is dusky and there are some melanophores along the rays; usually there are no pronounced dark markings, but loose aggregations of melanophores form diffuse anterior and posterior blotches in breeding males. The soft dorsal and pectoral fins have clumps of melanophores that are aligned to form vague, weak bands. The caudal sometimes has similar faint cross bands, and it has several dusky spots on the simple and procurrent rays, both above and below. The pelvic and anal are clear, with only a few scattered melanophores.

RANGE AND HABITAT.—*Cottus extensus* is known only from Bear Lake, Utah and Idaho, where it is an abundant benthic animal, living from the shore zone to a depth of at least 175 feet (McConnell, Clark, and Sigler, 1957:50–51) and probably to the deepest part of the lake (208 feet). Bear Lake sculpins are reported to spawn around rocks near shore, apparently in April and May, after which most descend to water greater than 50 feet deep. OS 1277, collected on May 24, includes gravid and spent females and some males that appear to be ripe, others that seem to be spent. These sculpins are numerous and constitute an important food item of trout in Bear Lake (McConnell, *et al.*, 1957).

ETYMOLOGY.—The name *extensus* (a participle, from the Latin verb *extendo*) refers to the slender form of this species.

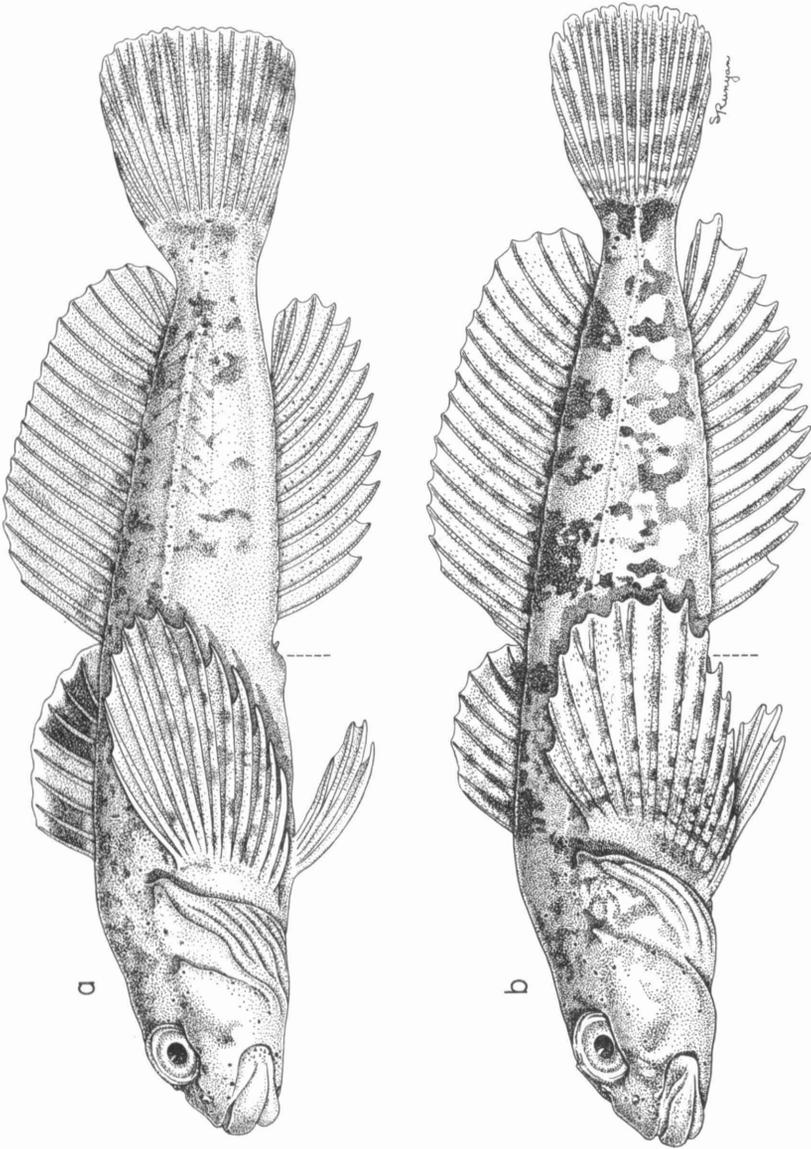


FIG. 3. *a*, *Cottus confusus*, new species; the holotype. *b*, *Cottus pitensis*, new species; the holotype.

Cottus confusus, new species

Shorthead Sculpin

(Figs. 1c, 3a, 4c)

- Cottus beldingii* (misidentifications). Jordan and Starks, in Jordan, 1896:223 (Birch Cr., Ida.). Jordan and Evermann, 1898:1961 (Birch Cr., Ida.).
- Cottus punctulatus* (misidentifications). Evermann and Meek, 1898:83 (Alturas Lake, Ida.). Schultz, 1941:35-39 (in part; Middle Fork Flathead R., Trout Lk., Mont., and perhaps other localities).
- Cottus bairdi punctulatus* (misidentification, in part). Weisel, 1957:69-70 (North Fork Flathead R., Mont.).
- Cottus bairdii* ssp. (misidentification). Bailey and Dimick, 1949:17 (Alturas Lake Cr., Ida.).
- Cottus* sp. Hubbs and Miller, 1948:76 (in part; Snake R. Lava Plain; five endemic subspecies or races). Carl, Clemens, and Lindsey, 1959:169 (Flathead R., B. C., Salmon R. dr., Ida., northeastern Ore., eastern Wash.). McAllister and Lindsey, 1961:84 (description; Flathead R., B. C.). Bond, 1961:37 (Columbia dr.; characters).

As indicated above, specimens of this species have been available to a number of workers, but it has not been recognized as a distinct species except by Carl, Clemens, and Lindsey (1959), McAllister and Lindsey (1961), and Bond (1961). Hubbs and Miller (1948) believed that the populations of *Cottus* (including both *C. confusus* and *C. beldingi*) in the several streams of the Snake River Plain were relicts of the old Snake River fauna. Bailey and Dimick (1949) noted that in the Salmon River drainage *confusus* (as "*bairdii*") lives sympatrically with the form described by them as *Cottus hubbsi*. Our continuing investigations indicate, however, that it is *hubbsi* that is the allopatric representative of the eastern *C. bairdi*. Thus, despite close similarity to *bairdi*, the present form appears to be an undescribed species that is sympatric with *bairdi* in parts of the Columbia basin.

TYPES.—The holotype, UMMZ 177377, an adult male, 75 mm. in standard length, was collected in the Salmon River, tributary to Snake River, 25 miles northwest of Ketchum, T. 7 N, R. 14 E, sec. 36, Blaine County, Idaho, on July 4, 1950, by Marian K., Douglas M., and Reeve M. Bailey. Thirty-nine paratypes, UMMZ 161840, 20 to 73 mm., were taken with the holotype. At the type locality the Salmon River is from 15 to 30 feet wide, is not over 3 feet deep, has a swift to torrential current, and when seined was clear and cold (47°F. when the air temperature was 72°F.). The bottom is composed of rubble and gravel with some silt. Shorthead sculpins were taken from beneath stones and in emergent grass along the shore. The only fish associates were *Salmo clarki* and *Salvelinus fontinalis*, both of which were uncommon.

ADDITIONAL MATERIAL.—*Puget Sound Drainage, Washington:* UMMZ 180366 (27), 21–71 mm., S. Fk. Snoqualmie R., at U.S. hwy. 10 crossing, 4.5 mi. W Snoqualmie Pass, below Rockdale, King Co. UMMZ 180375, 52 mm., Raging R. at mouth in Snoqualmie R., Fall City, King Co. UMMZ 180379 (5), 55–82 mm., White R., 6.5 mi. N of NE entrance Mt. Rainier Natl. Park, Pierce Co. OS 813 (6), 32–67 mm., and UMMZ 179633 (5), 34–57 mm., White R., 8.3 mi. above Mud Mountain Dam near Buckley, T. 19 N, R. 8 E, sec. 3, King Co. UMMZ 180378 (4), 42–81 mm., White R., Buckley, King and Pierce cos. UW 14267 (33), 22–63 mm., Spring Cr., trib. to Minter Cr., Pierce Co. OS 1285, 57 mm., Minter Cr. at Hatchery, Pierce Co. UW 15879, 51 mm., S. Fk. Skokomish R., Mason Co.

Columbia River Drainage, Oregon: OS 849, 44 mm., Big Cr., trib. Columbia R. above first concrete bridge upstream from Oregon Fish Commission Hatchery, T. 7 N, R. 7 W, Clatsop Co. OS 1290 (3), 44–56 mm., N. Fk. Santiam R., Marion Forks, T. 11 S, R. 7 E, sec. 21, Linn Co. OS 806 (6), 62–81 mm., Hackleman Cr., hwy. 20, about 1.5 mi. above Fish L., T. 14 S, R. 6 E, sec. 22, Linn Co. OS 1292 (5), 31–50 mm., S. Fk. McKenzie R. at French Pete Cr., T. 7 S, R. 5 E, sec. 32, Lane Co. OS 1291 (5), 22–72 mm., N. Fk. Willamette R., 13 mi. above Westfir, T. 19 S, R. 4 E, sec. 28, Lane Co. OS 833 (6), 15–49 mm., Salt Cr., hwy. 58, 9.5 mi. below Salt Cr. Falls, T. 22 S, R. 5 E, sec. 8, Lane Co. OS 799 (2), 41 and 42 mm., Salt Cr. along hwy. 58, 5 mi. downstream from Salt Cr. Falls, T. 22 S, R. 5 E, sec. 22, Lane Co. OS 544 (13), 37–93 mm., Middle Fk. Willamette R. near mouth of Staley Cr., Secret Forest Camp, T. 24 S, R. 4 E, sec. 18, Lane Co. OS 528 (85), 31–95 mm., Middle Fk. Willamette R., 0.5 mi. below Rigdon Guard Station, T. 24 S, R. 4 E, sec. 16, Lane Co. OS 508 (3), 42–65 mm., Zig Zag R., trib. to Sandy R., Rhododendron, T. 3 S, R. 7 E, sec. 2, Clackamas Co. OS 489 and UMMZ 180458 (13), 39–72 mm., Camp Cr., trib. to Zig Zag R., trib. to Sandy R., 3 mi. SE Rhododendron, T. 3 S, R. 7 E, sec. 13, Clackamas Co. OS 492, 78 mm., Columbia R., Bonneville Dam, Multnomah Co. OS 844 (4), 37–74 mm., West Fk. Hood R., Mohr Park, T. 1 N, R. 9 E, sec. 22, Hood River Co. OS 1284 (2), 44, 66 mm., E. Fk. Hood R., T. 1 S, R. 10 E, sec. 4, Hood River Co. OS 846 (3), 36–70 mm., Gate Cr., trib. Rock Cr., trib. White R., T. 4 S, R. 11 E, sec. 21, Wasco Co. OS 848 (5), 30–47 mm., Warm Springs R., Hehe Butte, T. 7 S, R. 11 E, sec. 18, Wasco Co. OS 847 (5), 32–39 mm., Beaver Cr., trib. Warm Springs R., about 4 mi. N of Hehe Butte, T. 6 S, R. 10 E, sec. 36, Wasco Co. OS 845 (4), 22–64 mm., Beaver Cr., trib. Warm Springs R., near N. boundary of Warm Springs Indian Res., T. 5 S, R. 10 E, sec. 20, Wasco Co. UMMZ 157226, 104 mm., Wizard Cr., trib. to Metolius R., trib. to Deschutes R., near Camp Sherman, Jefferson Co. OS 495 (6), 18–60 mm., spring at Wizard Falls State Fish Hatchery, trib. to Metolius R., near Camp Sherman, Jefferson Co. OS 399 (3), 27–42 mm., Metolius R., trib. to Deschutes R. OS 1278, 36 mm., Strawberry Cr., Prairie City, Grant Co.

Snake River Drainage, Oregon: UMMZ 98743 (2), 71 and 100 mm., Lostine R., trib. to Grande Ronde R., 2 mi. below Lostine, Wallowa Co. OS 509 (5), 34–76 mm., Lostine R., Lostine, Wallowa Co. UMMZ 105304 (16), 21–71 mm., Lick Cr., trib. to Big Sheep Cr., trib. to Imnaha R., T. 5 S, R. 46 E, sec. 2, Wallowa Co. OS 491 (2), 27 and 68 mm., Grouse Cr., at mouth in Imnaha R., Wallowa Co. OS 510 (8), 25–70 mm., Imnaha R. at Coverdale, Wallowa Co. OS 490 (68), 37–78 mm., East Pine Cr., trib. to Pine Cr., T. 7 S, R. 46 E, Baker Co. OS 494 (4), 69–86 mm., East Pine Cr., near Halfway, T. 7 S, R. 46 E, Baker Co. OS 485 (16), 29–67 mm., Clear Cr., trib. to Pine Cr., near Halfway, T. 8 S, R. 46 E, sec. 9, Baker Co. OS 487 (13), 42–86 mm., Pine Cr., at Halfway, T. 8 S, R. 46 E, sec. 8, Baker Co. OS 488 (7),

40-71 mm., Eagle Cr., trib. to Powder R., T. 9 S, R. 45 E, Baker Co. OS 496 (27), 33-82 mm., Little Malheur Cr. at mouth of Camp Cr., trib. to N. Fk. Malheur R., T. 15 S, R. 36 E, sec. 23, Grant Co. OS 486 (15), 31-67 mm., N. Fk. Malheur R., 1 mi. below Forest Guard Station, T. 16 S, R. 35 E, sec. 2, Grant Co. UMMZ 180455 (11), 28-70 mm., N. Fk. Malheur R. at mouth of Bear Cr., Grant Co. OS 484 (18), 37-81 mm., Elk Cr. at mouth in N. Fk. Malheur R., T. 15 S, R. 35 E, sec. 27, and Big Cr., trib. to Middle Fk. Malheur R., T. 16 S, R. 34 E, sec. 14 and 23, Grant Co. OS 493 (51), 17-73 mm., Wolf Cr., trib. to Calamity Cr., trib. to N. Fk. Malheur R., T. 17 S, R. 33 E, sec. 35, Grant Co.

Independent Drainages, Upper Snake River Basin, Idaho: UMMZ 157011 (32), 16-89 mm., Beaver Cr., Spencer, Clark Co. UMMZ 127586 (278), 16-98 mm., Beaver Cr., 4 mi. above Spencer, T. 13 N, R. 36 E, Clark Co. UMMZ 127589-90 (59), 13-101 mm., Medicine Lodge Cr., Patetzick Ranch, 13 mi. by road above Small P. O., T. 12 N, R. 33 E, Clark Co. UMMZ 157016 (7), 75-95 mm., Medicine Lodge Cr., at hwy. 22, Clark Co. UMMZ 127602 (9), 23-61 mm., Birch Cr., T. 9 N, R. 30 E, Clark Co. USNM 43733, 65 mm., Birch Cr. UMMZ 158921 (32), 32-92 mm., Summit Cr., mouth to head, trib. to Little Lost R., Custer Co. UMMZ 127611 (12), 15-52 mm., Little Lost R., T. 10 N, R. 26 E, Butte Co. UMMZ 158920 (3), 80-105 mm., upper Little Lost R., Butte Co. UMMZ 127614 (10), 34-58 mm., Wet Cr., Lost River Mts., 1 mi. above junction with Big Cr., trib. to Little Lost R., near corner of T. 8 and 9 N, R. 25 and 26 E, Custer Co. UMMZ 127609, 22 mm., Little Lost R., between Badger and Wet creeks, T. 9 N, R. 27 E, Butte Co. UMMZ 127606 (91), 18-88 mm., Big Spring Cr., near source, trib. to Little Lost R., T. 8 N, R. 27 E, 21 mi. from Howe, Butte Co. UMMZ 127622 (274), 25-72 mm., Big Lost R., T. 8 N, R. 22 E, Custer Co.

Boise River Drainage, Snake River Basin, Idaho: UMMZ 144816 (8), 20-77 mm., Moores Cr., Idaho City, Boise Co.

Salmon River Drainage, Snake River Basin, Idaho: UMMZ 157039 (4), 34-66 mm., Warm Lake outlet creek, just below lake, trib. to S. Fk. Salmon R., T. 15 N, R. 6 E, Valley Co. UW 14261 (23), 30-69 mm., Elk Cr., trib. to Middle Fk. Salmon R., Valley Co. UMMZ 117871 (4), 18-61 mm., Challis Cr., Mosquito Flat, Custer Co. UMMZ 161853, 32 mm., Challis Cr., near mouth in Salmon R., 5 mi. NNE Challis, at U.S. 93, T. 14 N, R. 19 E, sec. 2, Custer Co. USNM 73697 (2), 19 and 54 mm., Alturas L. UMMZ 118103 (4), 15-73 mm., Alturas Lake Cr., below Alturas L., 21 mi. S Stanley, Blaine Co. UMMZ 118077 (9), 28-60 mm., Alturas Lake Cr., at bridge to Pettit L., Blaine Co. UMMZ 161858 (3), 42-48 mm., Pahsimeroi R., 3 mi. SE of mouth in Salmon R., 3 mi. SE Ellis, T. 15 N, R. 21 E, sec. 6, Lemhi and Custer cos. UMMZ 158922 (10), 32-81 mm., Goldburg Cr. near head, trib. to Pahsimeroi R., Custer Co. UMMZ 161860, 57 mm., N. Fk. Salmon R., Gibbonsville, T. 26 N, R. 19 W, sec. 36, Lemhi Co.

Clearwater River Drainage, Snake River Basin, Idaho: OS 1282 (2), 66 and 75 mm., Silver Cr., trib. Orogrande Cr., Clearwater R. dr., T. 38 N, R. 7 E, sec. 36, Clearwater Co.

Columbia River Drainage, Washington: UMMZ 180383 (31), 30-83 mm., Hall Cr., just above mouth in Cowlitz R., 2 mi. SW Packwood, Lewis Co. OS 1288, 57 mm., Tyee Cr., Wind R. dr., near Carson, Skamania Co. UMMZ 180365, 44 mm., Coal Cr., Hyak, just above head Keechelus L., Yakima R. system, Kittitas Co. OS 1289 (11), 22-63 mm., White R., trib. to L. Wenatchee, above jct. with N. Fk., Chelan Co. UMMZ 180353 (16), 32-79 mm., Nason Cr., 1/4 mi. above mouth in

Wenatchee R., Chelan Co. UMMZ 98636-37 (13), 30-70 mm., Nason Cr., trib. to Wenatchee R., 1 mi. above Merritt, Chelan Co.

Spokane River Drainage, Columbia River Basin, Idaho: UMMZ 157034, 45 mm., St. Maries R., trib. to Cour d'Alene R., near mouth of Olson Cr., Benewah Co. OS 1279 (2), 57 and 67 mm., Thorn Cr., St. Maries R. dr., T. 46 N, R. 2 W, sec. 36, Benewah Co. OS 1281 (2), 35 and 57 mm., Rochat Cr., trib. St. Joe R., T. 46 N, R. 1 W, Benewah Co. OS 1283 (2), 71 and 83 mm., Trout Cr., St. Joe R. dr., T. 46 N, R. 2 E, sec. 31, Shoshone Co. OS 1286 (3), 35-65 mm., Gold Cr., trib. to St. Joe R., T. 44 N, R. 9 E, sec. 7, Shoshone Co., OS 1280 (2), 68 and 76 mm., Simmons Cr., trib. St. Joe R., T. 44 N, R. 9 E, sec. 2A, Shoshone Co. OS 1287 (2), 42 and 92 mm., St. Joe R., T. 43 N, R. 9 E, sec. 6, Shoshone Co.

Flathead River Drainage, Montana: MSU (4), 50-62 mm., Moose Cr., trib. to N. Fk., Flathead Co. MSU (2), 46 and 67 mm., Coal Cr., trib. to N. Fk., Flathead Co. MSU (2), 41 and 74 mm., Ford Cr., trib. to N. Fk., Flathead Co. MSU (4), 85-122 mm., Hallowatt Cr. at confluence with Big Cr., trib. to N. Fk., Flathead Co. UW 3261 (14), 32-51 mm., mouth of inlet (Camas Cr.) to Trout L., trib. to N. Fk., Glacier National Park. UW 3260 (10), 25-69 mm., Middle Fk. Flathead R., Nyack, Glacier National Park.

North Fork Flathead River Drainage, British Columbia: BC 56-557 (4), 36-52 mm., Flathead R. near U.S. border. BC 55-278, 86 mm., Howell Cr. BC 55-276, N. Fk. Flathead R., Kootenays.

DIAGNOSIS.—A species of the *bairdi* species group with palatine teeth present but in a short, narrow row that is often visible only by dissection; preopercular spines usually 2. Fin rays: Dorsal, VII-IX (X), (15) 16-18 (19); anal (10) 12-14; pectoral (11) 13-14 (15); pelvic I,4 (I,3 or I,5 in less than 1 per cent of specimens). Body moderately slender, depth of caudal peduncle 7.5 to 9.5 per cent of standard length; head short (26.3) 29 to 31 (33.8) per cent of standard length; lateral line never complete, typically terminates or interrupted below ray 10 to 16 of soft dorsal, often with short posterior section (s); pores (21) 22-33 (37); median chin pore typically lacking (present in 4 per cent); postmaxillary pore variable, present in about 60 per cent of specimens counted; prickles variable, most often present as a patch mesial to pectoral fin, sometimes reduced or absent; body clouded or mottled with dark, saddles and cross bands poorly defined; standard length to 122 mm. (total length 147 mm.).

Distinguishable from *bairdi* by the smaller head, reduced preopercular armature, fewer pectoral rays, and, in the area of geographic overlap, by the shorter lateral line and weaker palatine dentition. Separable from *beldingi* and *leiopomus* by the presence of palatine teeth, better preopercular armature, and usually by the well-developed patch of prickles mesial to the pectoral fin.

ADDITIONAL CHARACTERS.—Counts and measurements of the holotype are given in Table 1. The mouth is almost horizontal and of

moderate size, the maxilla extends to below front to middle of pupil; as viewed from below, the mouth is semicircular and the upper lip is hidden by the lower. The interorbital space is narrow and slightly depressed.

Palatine teeth are present in all except one of the 233 specimens examined; usually the individual teeth are well developed but they are few in number and the tooth patch is only 1 or 2 teeth wide and is short. Commonly these teeth are largely obscured by fleshy epithelium.

The preopercular armature is intermediate in development between that of *C. bairdi* and those of *C. beldingi* and *C. leiopomus*. Of 233 specimens examined, 2 sharp spines, 2 sharp spines and a blunt lobe, or 1 sharp spine and a blunt lobe occur in 82 per cent. The others have 1 or 3 sharp spines. There is considerable variation among samples, but no consistent geographic trend is discernible. There is no clear indication of allometric change.

The lateral line extends backward well above the axial line to near its termination, usually just anterior to the posterior end of the soft-dorsal fin. Here it (or its visible remnant) is deflected abruptly downward to the axial line. Commonly the line is interrupted and one or more short sections of the canal are present in front of the caudal base. The pores of the preoperculomandibular series are quite variable, ranging from 8-1-8 to 10-12. Of 208 specimens examined 7 (3 per cent) have a median chin pore, and 128 (61 per cent) and 135 (65 per cent) have a postmaxillary pore on a branch of the left and right preoperculomandibular canal, respectively. Prickles, if present, are restricted to that part of the side covered by the appressed pectoral fin; the head, posterior part of the body, area near the dorsal fin, and the breast and belly are naked. Caudal vertebrae, counted from 8 dissected or cleared specimens, number 22 in 3, 23 in 3, and 24 in 2. Total vertebral counts of three X-rayed specimens are 33, 33, and 35.

There is no sharp contrast of dark and light pigment on the body in *confusus*. The top of the head and nape may be peppered with dark flecks but have no cross bars or blotches. Six dorsal saddles are usually discernible, two below the spinous dorsal, three beneath the soft dorsal and one at the base of the caudal. These are usually faint and give way on the side to clouded and irregular specks and blotches. Contrasting markings are best defined in juveniles. The lower surface of head and body is light, uniformly dusted with micromelanophores. The lower lip is scarcely or not at all darker than the lightly pigmented mandibular ramus. The spinous dorsal in adults has a con-

centration of dark pigment on the posterior part and on the anterior two membranes, with the fin margin light (reddish brown in life)—typical of members of the *bairdi* species group. The second dorsal, caudal, and pectoral fins are indistinctly and irregularly marked by cross bands, and the pelvic and anal fins are dusted with melanophores.

GEOGRAPHIC VARIATION.—Throughout the lower Columbia, Snake, and Salmon rivers, *C. confusus* is highly consistent in having a moderate to well-developed patch of prickles on the side mesial to the appressed pectoral fin. The patch of prickles commonly extends somewhat above the lateral line. In a group of small, independent streams flowing into sinks of the upper Snake River Plain, however, the shorthead sculpin is naked or poorly prickled. Of 57 specimens examined, 39 lack prickles altogether and 18 have only a few, usually fewer than five on one side. In none of these specimens is the patch extensive. The striking difference in prickle development in these areas would seem to justify recognition of subspecies, but there is a parallel and probably independent reduction in prickles in the Flathead River of Montana and British Columbia, a drainage remote from the Snake River Plain. Of 17 specimens, 10 lack prickles and 7 have 1 or a few on one side. None has a well-developed patch. We have no ready explanation for the reduced prickle development in these areas, but a correlation may be noted. In the lower Columbia, *confusus* is commonly associated with *C. bairdi*, which in this area typically has a similar and coextensive patch of axillary prickles. The only other species of *Cottus* in the streams tributary to the Snake River Plain is the naked *beldingi*, which has been taken in Pass Creek of the Big Lost River system. In the Flathead River the only associated species of *Cottus* is *cognatus*, in which the prickles are usually few, varying from none to a sparsely-covered but rather large axillary patch. In *C. confusus* from the Flathead drainage and from the streams tributary to the Snake River Plain the pectoral and anal-fin counts average slightly higher than in the rest of the range.

A postmaxillary pore is usually present in specimens of *C. confusus* from most of the Columbia basin, one is commonly present in those from the isolated streams of the Snake River Plain, but it is only rarely present in fish from the Flathead River drainage. The frequencies of occurrence are as follows: General range in Columbia basin, 124 specimens, postmaxillary pore on left side in 99 (79.8 per cent), on right side in 105 (84.7 per cent); Snake River Plain, 67 specimens, pore on left in 28 (41.8 per cent), on right in 30 (44.8 per cent); Flat-

head River, 17 specimens, present on left in 1 (5.9 per cent) and on right in 1.

RANGE.—*Cottus confusus* is restricted to the Puget Sound and Columbia River basins. It is found as far downstream in the Columbia as Big Creek, Clatsop County, Oregon, upstream in the Snake River to the Malheur River, through much of the Salmon and Clearwater river drainages, and in the Flathead River of Montana to extreme southeastern British Columbia. In addition, it inhabits several small independent drainages of the upper Snake River Plain, southern

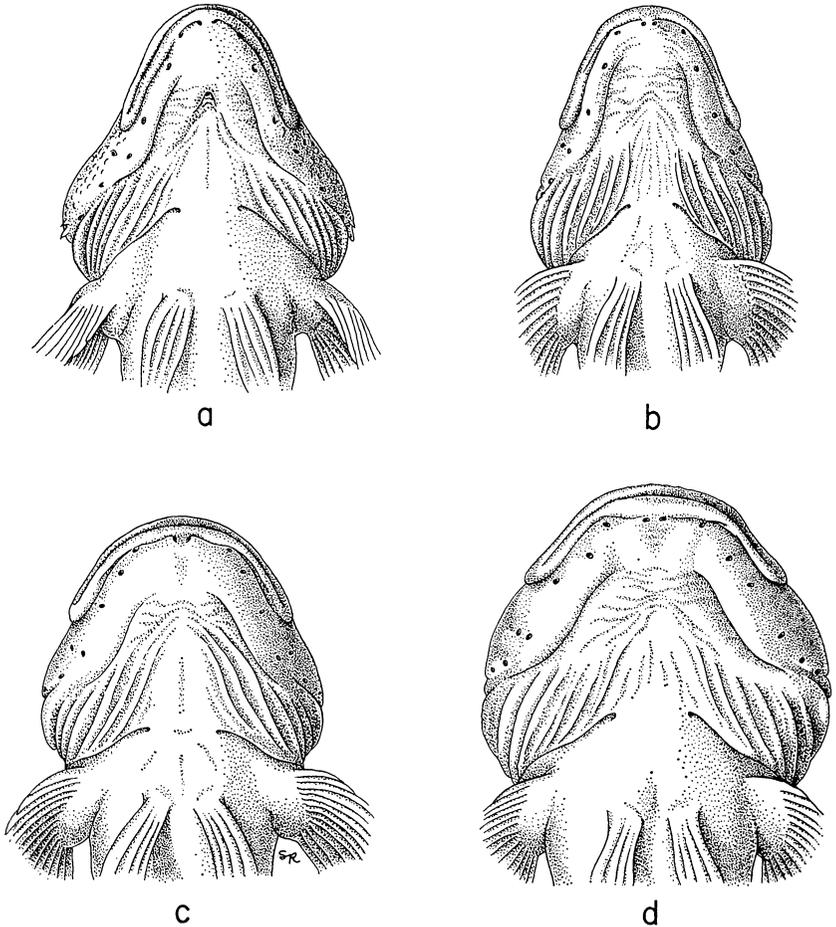


FIG. 4. Lower surface of head and breast in the holotypes of four new species of *Cottus*. a, *Cottus echinatus*; b, *Cottus extensus*; c, *Cottus confusus*; d, *Cottus pitensis*.

Idaho. Otherwise *confusus* is unknown from the upper Snake River drainage. It seems likely, therefore, that the isolated population in these independent drainages flowing to the southeast gained access to the area by stream transfer involving headwaters of the Salmon River, a number of which flow to the northwest out of the same valleys. That of the Pahsimeroi and Little Lost rivers provides an especially suggestive avenue of past dispersal.

Cottus confusus is the only species of the genus known from above the high falls of the Snoqualmie River in the Puget Sound drainage. It occurs within a short distance of Snoqualmie Pass on both slopes of the Cascades—in the South Fork of the Snoqualmie and in Coal Creek of the Yakima drainage. These streams closely approach the rather broad flat pass from each side, and it appears that this has provided an access route for *confusus* to enter the Puget Sound drainage. *C. confusus* is the dominant, and in many places the only, species of *Cottus* in the high mountain streams of the Cascades in Washington.

HABITAT.—*Cottus confusus* lives chiefly in riffles of small cold streams, usually farther upstream than other species of the genus, but has been taken in large rivers including the Columbia. The species commonly occurs in the same streams with *C. bairdi*, for example in the Salmon River drainage, and is sympatric with *C. cognatus* in the Flathead River. It is found in many stream systems with *C. beldingi*, including the Big Lost River, Willamette River and others, but the two species are seldom taken at the same stations. *C. confusus* is sometimes found living with *C. rhotheus*, with *C. asper*, and with *C. aleuticus*. These four species were all taken in a collection from the Snoqualmie River at Fall City, Washington, in the Puget Sound drainage.

ETYMOLOGY.—The name *confusus* (Latin, clouded) refers to the irregular and indistinct body pigmentation.

THE ASPER SPECIES GROUP

The fourth new species is allocated to the *asper* species group, an apparently natural aggregation that is definable morphologically only by a combination of characters. The most distinctive features of the *asper* group, the usual confluence of the dorsal fins, the presence of a dark blotch posteriorly in the first dorsal fin, and the frequent occurrence of branched pectoral rays, are not well marked in the new species. *C. pitensis* has apparently evolved characters through modifications that parallel their appearance in the *bairdi* group. Close simi-

larity of the new species to *gulosus* and *perplexus* in basic features of pigmentation lends support to the contention that the intimate relationships are with these forms rather than with members of the *bairdi* group. The American species of the *asper* group are *Cottus gulosus* (Girard), *Cottus pitensis*, n. sp., *C. perplexus* Gilbert and Evermann, *C. marginatus* (Bean), *C. klamathensis* Gilbert, *C. asper* Richardson, *C. greenei* (Gilbert and Culver), and *C. princeps* Gilbert. All live on the Pacific slope; in addition *C. asper* has recently entered the upper Mackenzie drainage.

***Cottus pitensis*, new species**

Pit Sculpin

(Figs. 1*d*, 3*b*, 4*d*)

Cottoptis gulosus (misidentifications). Girard, 1857:10-11 (Upper Pitt R.; characters). Girard, 1858:54 (Upper Pitt R., Ore.).

Uranidea gulosa (misidentification). Jordan and Henshaw, 1878: 199, 200 [S. Fk. Pitt R.] (Jesse's Valley, Modoc Co., Cal.).

Cottus gulosus (misidentifications, in part). Snyder, 1908*a*:78, 101 (Drew Cr., Lake Co., Ore. and Pitt R., Canby [Modoc Co., Cal.]; characters). Rutter, 1908:146 (S. Fk. Pitt R., S. Fk. Post-office; Pitt R., Canby; Rush Cr., Aden; Fall R., Fall R. Mills and Dana; Hat Cr., Cassel; Burney R., Burneyville; characters; synonymy).

Cottus [of *gulosus* type]. Hubbs and Miller, 1948:71 (Goose Lake drainage).

Cottus sp. (Pit River sculpin). Bond, 1961:38 (Goose Lake tribs., Ore.; characters).

This common species of the Pit River system has been obtained frequently by collectors but has been treated as *Cottus gulosus* except by Bond (1961).

TYPES.—The holotype, UMMZ 130558, an adult male 83.2 mm. in standard length, was collected in North Fork of Pit River, east of Alturas, T. 42 N, R. 13 E, Modoc County, California, on August 8, 1934, by Carl L. Hubbs and family. Six paratypes, UMMZ 130559, 55 to 76 mm. long, were taken with the holotype. When collected, the water at this station was moderately clear and stagnant but surprisingly cool; the depth was as great as 3 feet and the stream was dry to pools of up to 30 feet in width. The bottom was composed of sand, mud, gravel and some stones, vegetation was generally dense, and the shore had low banks and grassy slopes with some willows in the sagebrush flat between juniper-covered hills.

ADDITIONAL MATERIAL.—*Lake County, Oregon*: OS 817 (13), 37-43 mm. and OS 511 (9), 42-70 mm., Thomas Creek at second crossing of Dairy Cr. Road, T. 37 S, R. 18 E, sec. 27, July 15, 1954, J. M. Bali. OS 512 (4), 44-77 mm., Cottonwood Cr. (trib. to Goose Lake), T. 38 S, R. 19 E, Sept. 5, 1953, Bali. OS 513 (10), 59-70

mm. and UMMZ 180459 (3), 58–78 mm., Cottonwood Cr. (trib. to Goose Lake), below Cottonwood Res., T. 38 S, R. 19 E, sec. 29, Sept. 10, 1954, Bali.

California: CAS 25963 (37), 55–98 mm., Pit R., June 4, 1953, Wm. Rowley. UMMZ 141576 (5), 21–78 mm., S. Fk. Pit R., Likely, Modoc Co., July 7, 1942, C. L. Hubbs and family. UMMZ 179600 (3), 60–88 mm., Pit R. at road crossing just S Canby, Modoc Co., Aug. 13, 1961, Robert R. Miller and Teruya Uyeno. UMMZ 130646 (21), 47–91 mm., Rush Cr. (trib. to Ash Cr. to Pit R.), T. 40 N, R. 9 E, sec. 23 and 24, 0.5 mi. below upper crossing on Canby-Adin Road, 0.25 mi. below Indian Springs, about 6 mi. above Adin, Modoc Co., Aug. 16, 1934, Hubbs family. UMMZ 158415 (17), 61–113 mm., Baum Lake, Hat Cr. Reservoir No. 2, about 4 mi. above junction of creek with Pit R., T. 36 N, R. 4 E, sec. 20 and 29, Shasta Co., May 6, 1949, J. H. Wales and German. UMMZ 146647, 81 mm., Wagon Cr., water supply for Mt. Shasta Hatchery, Mt. Shasta (town) [Siskiyou Co.], March 20, 1938, California State Division of Fish and Game. OS 1293 (11), 43–ca. 80 mm., Sacramento R., near Mt. Shasta, Shasta Co., June 22, 1962, C. D. Becker and M. Katz.

DIAGNOSIS.—A species of the *asper* species group with no palatine teeth; preopercular spines usually 2, but often with a blunt elevation below the second. Fin rays: Dorsal (VI) VIII–IX (X), (16) 17–18 (19); anal (12) 13–15; pectoral (12) 14–15 (16); pelvic (I,3 in 7 per cent of counts), I,4, the fourth ray often reduced in length. Body moderately robust, depth of caudal peduncle 8.0 to 9.0 (10.0) per cent of standard length; head long, (30) 31 to 35 (36) per cent of standard length, with an allometric increase evident; lateral line complete or nearly so, pores (31) 33 to 37 (39); median chin pore most often absent (see p. 23); postmaxillary pore usually present, but variable in some populations; prickles present, in moderate-sized patch mesial to pectoral fin; dorsal surface of head in small specimens flat, contrasting with a prominent nuchal hump; body and head with mottling and vermiculations, with a tendency to form transverse bands across back; pigmentation of first dorsal fin variable, melanophores usually concentrated in a large blotch posteriorly, as in *asper* and *gulosus*, but flecks and blotches may form a dark submarginal band or both anterior and posterior blotches may be developed, as in members of the *bairdi* group; standard length to 113 mm. (total length 133).

Distinguished from *gulosus* by the consistent absence of palatine teeth, the usually better-developed lateral line, and the typical complement of two preopercular spines (Table 2); differs from *perplexus* by having 32 or more lateral-line pores, wider head, and, usually, separate dorsal fins.

ADDITIONAL CHARACTERS.—Counts and measurements of the holotype are given in Table 1. The mouth is almost horizontal and of moderate size, the maxilla extends to below front to middle of pupil; as viewed

TABLE 2
COMPARISON OF THREE SPECIES OF *Cottus*

Character	<i>gulosus</i>	<i>pitensis</i>	<i>perplexus</i>
Palatine teeth	Present	Absent	Absent
Preopercular spines	(2+) 3 or 3+ (4); usually 3	(1+) 2 to 3; usually 2	(1) 2 to 3 (4); usually 2 or 2+
Lateral line (specimens over 50 mm.):			
Percentage in which complete	23	87	36
Pores	(21) 22-36 (38)	(31) 33-37 (39)	(15) 22-32 (33)
Pectoral rays	(14) 15 or 16 (17)	(12) 13-15 (16)	(13) 14 or 15 (16)
Head length (per cent of standard length)	(30) 31-36 (39)	(30) 31-35 (36)	(23) 28-33 (38)
Mouth size:			
Maxilla extends to below	Posterior part of eye	Posterior part of eye	Anterior part of eye
Overall width	Equals or exceeds body width behind pectorals	Equals or exceeds body width behind pectorals	Less than body width behind pectorals
Dorsal fins	Conjoined or separate	Usually separate or nearly so	Usually conjoined, most often broadly so
Pigmentation	Usually with large irregular dark blotches on a lighter background	Similar to <i>perplexus</i>	Variable, usually of vermiculations and small blotches that do not have high contrast with background

from below, the mouth is a broad arc and the upper lip is narrowly visible. The interorbital space is narrow and flat or scarcely depressed.

No palatine teeth are present in any of the 101 specimens checked. The preopercular armature is comparable to that of *perplexus*, weaker than in *gulosus*. Of 86 specimens examined, 6 have a single spine and a blunt lobe, 49 have two sharp spines, 22 have two spines and a blunt projection, and 9 have three spines.

The lateral line lies somewhat above the axial line and is straight anteriorly; it is deflected downward below the posterior end of the second dorsal fin and continues uninterrupted to the caudal base. The pores of the preoperculomandibular series in 54 specimens from the Pit River system number 11–11 in 34, 10–11 in 4, 11–10 in 3, 10–10 in 5, 10–9 in 2, 8–9 in 1, 10–1–10 in 1, 10–1–9 in 1, 9–1–10 in 1, 9–1–9 in 1, and 2–6 in 1 (an obvious abnormality). Thus, 4 have a median chin pore. Eleven specimens from the upper Sacramento River near Mt. Shasta (OS 1293) differ notably in that all have a median chin pore (all of these lack palatine teeth and thus are distinct from *C. gulosus*). In 31 additional specimens from above the falls of Pit River, 5 have a median chin pore and 26 lack it. For the combined samples, 20 of 96 specimens (21 per cent) have a median chin pore. A postmaxillary pore is present on the left side in 42 and on the right side in 42 (76 per cent) of 55 specimens. Prickles occur consistently in a well-developed oval area mesial to the appressed pectoral fin; they may extend just above the lateral line, but the dorsum, nape, posterior part of body, belly, and breast are naked. Total vertebral counts are as follows: CAS 25963, 33 in 9, 34 in 1; UMMZ 130646, 33 in 7, 34 in 12; UMMZ 130558, 33 in 1 (the holotype).

The pectoral rays are most often simple, but frequently one to four of the third to sixth upper rays are branched, as they commonly are in other members of the *asper* species group except for *C. asper* and *C. greenei*, in which they are only rarely branched. Among 89 large specimens examined, 69 (77.5 per cent) have all pectoral rays simple, 6 have a single pectoral ray branched on one side, 7 have two rays branched (one on each side or two on one side only), and 7 others have branched rays on each side (a total of 3 branched rays in one, 5 in two, 6 in two, 7 in one, and 8 in one). The holotype has 5 branched rays, the fourth and fifth on the left side and the third, fourth, and fifth on the right. In the holotype, the ninth anal ray is branched, and incipient branches are evident in some of the other anal rays and in some dorsal rays.

The body and head are mottled and vermiculated, but the top of

the head is darker than the nape or cheeks; there are 5 or 6 transverse bands or saddles, 2 below the spinous dorsal and 3 or 4 under the soft dorsal; the saddles usually do not reach below the lateral line before breaking up. Many specimens have a nearly complete dark band around the posterior part of the caudal peduncle. A dark subocular bar is usually present. The pectoral and caudal fins are banded, with moderate contrast. The soft dorsal has flecks that form indistinct or irregular bands; the ventral surface, including pelvic and anal fins, is light, with few melanophores. Usually there is a dark, crescent-shaped spot on the anterior face of the pectoral fin at the base of the middle rays.

ETYMOLOGY.—*Cottus pitensis* is named for the Pit River basin in southcentral Oregon and northeastern California.

REMARKS.—Characteristically *Cottus pitensis* is an inhabitant of the Pit River system both above and below the falls at Fall River Mills, from Lake County, Oregon, to Hat Creek, Shasta County, California. It seems likely that the species evolved above the falls from an isolated stock of *Cottus gulosus*. That species lives in two major disjunct areas: (1) the Sacramento system and nearby coastal streams north of San Francisco Bay as far as the Noyo River (Snyder, 1908b:160), and (2) coastal streams from the Coquille River, westcentral Oregon, to the Puget Sound drainage, Washington. It does not now occur in intervening waters, including the Rogue and Klamath basins. We assume that factors associated with the extensive recent volcanism of the area (e.g., ash falls and lava flows) are responsible both for the disjunct distribution of *gulosus* and for the isolation of the ancestral stock of *pitensis*. It is to be noted that disruption of ranges has also occurred in *Cottus klamathensis* and in the closely related forms *Cottus tenuis* and *C. asperrimus* (Robins and Miller, 1957). We may hypothesize that while the large separated stocks of *gulosus* underwent scant differentiation the small population above the Pit River falls evolved into *C. pitensis*. It then descended the falls and now lives there, apparently as a fully distinct species. We do not know of the association of *gulosus* and *pitensis*. However, *gulosus* occurs in McCloud River (whence it was described under the name *Cottus shasta* Jordan and Starks, in Jordan, 1896), an upper affluent to the Sacramento River basin, and *Cottus pitensis* lives in the upper Sacramento River, the next stream to the west of the McCloud River. Examination of additional specimens from the area may add to our understanding of the phyletic and ecologic relationships of these forms. The above hypothesis is based

on the assumption that *pitensis* is derived from *gulosus*. An alternative possibility is that it evolved from *Cottus perplexus* or an ancestral stock of that species. As may be seen from Table 2, *pitensis* shares characters with each of these species. We are studying the problem further.

ACKNOWLEDGMENTS

We sincerely appreciate the courtesy of those persons who are responsible for museum collections for making them available to us. The abbreviations used herein, the museums involved, and those who have loaned or granted access to specimens are as follows: BC, University of British Columbia (Norman J. Wilimovsky); CAS, California Academy of Sciences (W. I. Follett and Lillian J. Dempster); MSU, Montana State University (George F. Weisel); OS, Oregon State University; UMMZ, Museum of Zoology, The University of Michigan; USNM, United States National Museum (Leonard P. Schultz, Ernest A. Lachner, and William R. Taylor); UW, College of Fisheries, University of Washington (Arthur D. Welander and Richard B. Grinols). In addition to those listed in the text, many persons have participated in the collection of specimens; to them we express thanks. Miss Suzanne Runyan, staff artist of the Museum of Zoology, prepared the illustrations with her characteristic skill.

Part of this research was made possible through a National Science Foundation faculty fellowship to C. E. Bond. This assistance is appreciated.

LITERATURE CITED

- BAILEY, REEVE M., AND MARY FITZGIBBON DIMICK
 1949 *Cottus hubbsi*, a new cottid fish from the Columbia River system in Washington and Idaho. Occ. Papers Mus. Zool. Univ. Mich., 513:1-18.
- BOND, CARL E.
 1961 Keys to Oregon freshwater fishes. Tech. Bull. Agr. Expt. Sta., Oregon State Univ., 58:1-42.
- CARL, G. CLIFFORD, W. A. CLEMENS, AND C. C. LINDSEY
 1959 The fresh-water fishes of British Columbia. 3rd ed. Handbook British Columbia Provincial Mus., 5:1-192.
- EVERMANN, BARTON WARREN, AND SETH EUGENE MEEK
 1898 A report upon salmon investigations in the Columbia River basin and elsewhere on the Pacific Coast in 1896. Bull. U.S. Fish Comm., 17 (1897):15-84.
- GIRARD, CHARLES
 1857 Report upon fishes collected on the survey. U.S. Pacific R. R. Survey, 6 (4):9-34.
 1858 Fishes, Pp. 1-400. *In*: General report on the zoology of the several Pacific railroad routes. *Ibid.*, 10 (4).
- HUBBS, CARL L., AND ROBERT R. MILLER
 1948 The zoological evidence: Correlation between fish distribution and hydrographic history in the desert basins of western United States, Pp. 17-166. *In*: The Great Basin with emphasis on glacial and postglacial times. Bull. Univ. Utah, 38 (20).
- JORDAN, DAVID STARR
 1891 Report of explorations in Colorado and Utah during the summer of 1889, with an account of the fishes found in each of the river basins examined. Bull. U.S. Fish Comm., 9 (1889):1-40.
 1896 Notes on fishes, little known or new to science. Proc. California Acad. Sci., Ser. 2, 6:201-44.
- JORDAN, DAVID STARR, AND BARTON WARREN EVERMANN
 1898 The fishes of North and Middle America: A descriptive catalogue of the species of fish-like vertebrates found in the waters of North America, north of the Isthmus of Panama. Bull. U.S. Natl. Mus., 47 (3):v-xxiv, 2183a-3136.
- JORDAN, DAVID STARR, AND CHARLES H. GILBERT
 1881 Notes on a collection of fishes from Utah Lake. Proc. U.S. Natl. Mus., 3 (1880):459-465.
 1883 Synopsis of the fishes of North America. Bull. U.S. Natl. Mus., 16:lvi + 1018 pp.
- JORDAN, DAVID STARR, AND H. W. HENSHAW
 1878 Report upon the fishes collected during the years 1875, 1876, and 1877, in California and Nevada, Pp. 187-200. *In*: George M. Wheeler, Ann. Rept. U.S. Geog. Surveys West of the 100th Meridian. . . .

MCALLISTER, D. E., AND C. C. LINDSEY

- 1961 Systematics of the freshwater sculpins (*Cottus*) of British Columbia. Bull. Natl. Mus. Canada, 172 (Contrib. Zool., 1959):66-89.

MCCONNELL, WILLIAM J., WILLIAM J. CLARK, AND WILLIAM F. SIGLER

- 1957 Bear Lake: Its fish and fishing. Utah State Dept. Fish and Game, Idaho Dept. Fish and Game, and Wildl. Mgmt. Dept. Utah State Agr. Coll. 76 pp.

ROBINS, C. RICHARD, AND ROBERT RUSH MILLER

- 1957 Classification, variation, and distribution of the sculpins, genus *Cottus*, inhabiting Pacific slope waters in California and southern Oregon, with a key to the species. California Fish and Game, 43 (3):213-33.

RUTTER, CLOUDSLEY

- 1908 The fishes of the Sacramento-San Joaquin basin, with a study of their distribution and variation. Bull. U.S. Bur. Fisheries, 27 (1907):103-52.

SCHULTZ, LEONARD P.

- 1941 Fishes of Glacier National Park, Montana. Conserv. Bull. U.S. Natl. Park Serv., 22:1-42.

SNYDER, JOHN OTTERBEIN

- 1908a Relationships of the fish fauna of the lakes of southeastern Oregon. Bull. U.S. Bur. Fisheries, 27 (1907):69-102.
1908b The fishes of the coastal streams of Oregon and northern California. *Ibid.*:153-89.
1919 Three new whitefishes from Bear Lake, Idaho and Utah. *Ibid.*, 36 (1917-18):3-9.

TANNER, VASCO M.

- 1936 A study of the fishes of Utah. Utah Acad. Sci., Arts and Letters, 13:155-84.

WEISEL, GEORGE F.

- 1957 Fish guide for Intermountain Montana. Montana State Univ. Press, Missoula. 88 pp.

Accepted for publication September 26, 1963

