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HADROPTERUS NOTOGRAMMUS, A NEW PERCID
FISH FROM MARYLAND, VIRGINIA, AND
WEST VIRGINIA¹

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IN recent years only 1 species of the percid genus *Hadropterus*, namely the shielded darter, *Hadropterus peltatus*, has been recognized as an inhabitant of the Atlantic coastal drainage basins between the James and the Hudson river systems. Another darter of this area, originally named *Hadropterus sellaris* (Radcliffe and Welsh, 1913: 31-32, Pl. 18), has been referred by Hubbs and Black (1940: 3) to the genus *Poecilichthys*. This species, known only from 2 type specimens taken in Swan Creek near Havre de Grace, Maryland, shows none of the enlarged spiny scales along the mid-ventral line or between the pelvic fins, which, in part, characterize *Hadropterus*. Recent efforts to obtain more specimens by seining in Swan Creek have proved fruitless.

Studies of all available specimens of *Hadropterus* from the Atlantic drainage now prove that a second species, herein named *Hadropterus notogrammus*, is present in tributaries of Chesapeake Bay from the Patuxent River system of Maryland south to the James River system of Virginia and West Virginia

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(Map 1). It has been confused with *Hadropterus peltatus*, a very similar species that occurs in the same stream systems as well as in others farther north and farther south. At 3 places the species have been collected together. These 2 darters are closely related to the blackside darter, *Hadropterus maculatus* (Girard), a fish of widespread distribution west of the Appalachian Mountains.

The cotypes of *Hadropterus maculatus* (Girard, 1859b: 100), in the United States National Museum (No. 1157), upon re-examination prove to be the species herein described as new. The name, however, is preoccupied by that of the western species *Alvordius maculatus* Girard (1859a: 67-68), which, following Hubbs (1926: 59-60), has been identified with the species previously called *Hadropterus aspro* (Cope and Jordan). The label with the cotypes of *Hadropterus maculatus* and the catalogue entry bear the data, Patuxent, Maryland. This locality we regard as probably correct, even though Girard (1859b: 100) gave as the type locality "an eastern tributary of the Potomac River, in Anne Arundel, Md." The Patuxent River drains Anne Arundel County, and *Hadropterus notogrammus* is still common there. This darter has been recognized as a valid species by few subsequent ichthyologists (see synonymy).

The pertinent material has been studied with the kind permission and co-operation of the curators in charge of the several collections. The specimens in the University of Michigan Museum of Zoology (U.M.M.Z.) were made available by Reeve M. Bailey. Those in the United States National Museum (U.S.N.M.) were loaned by Leonard P. Schultz. In addition, numerous specimens were seined in the Potomac River system by Robert R. Miller. The example in the American Museum of Natural History (A.M.N.H.) was kindly sent by Charles M. Breder, Jr. Other material was obtained from the Museum of Comparative Zoology through the kindness of William C. Schroeder. When we visited the Academy of Natural Sciences of Philadelphia, Henry W. Fowler made certain specimens available for examination. We are particularly grateful to

Lincoln C. Pettit, now of the Biology Department, St. Lawrence University, who made a special effort to collect the holotype and a series of paratypes in the James River system, Virginia. Funds supplied by the Trustee-Faculty Committee on Research, Cornell University (C.U.), made possible the collection of many of the specimens taken by E. C. Raney and assistants.

STRIPEBACK DARTER

Hadropterus notogrammus, new species

(Pl. I, Figs. 1-2; Pl. II, Figs. 1-2; Map 1)

Hadropterus maculatus (preoccupied by *Alvordius maculatus* Girard, 1859a: 67-68, also a species of *Hadropterus*).—Girard, 1859b: 100 (original description; "an eastern tributary of the Potomac River" [properly a tributary of the Patuxent River], Anne Arundel County, Maryland). Putnam, 1863: 4 (*Alvordius maculatus* Girard, 1859a: 67, considered a synonym).

Etheostoma maculatum.—Cope, 1869a: 401 (characters). Cope, 1870a: 261-62 (characters; misidentification); 1870b: 449 (misidentification). Jordan and Copeland, 1876: 135, 164 (misidentification, in part; range, Pennsylvania to North Carolina, in part).

Alvordius maculatus.—Jordan, 1877: 14 (Pennsylvania to North Carolina); 1878: 220 (range and synonymy, in part). Pratt, 1935: 118 (range in part, including James River).

Etheostoma blennioides (misidentifications).—Cope, 1869b: 211 (confused; record, headwaters of the James). Jordan, 1876: 222 (range and synonymy, in part).

Alvordius aspro (misidentification).—Jordan, 1880: 220, and 1884: 220 (range and synonymy, in part).

Etheostoma aspro (misidentification).—Jordan, 1890: 112 (characters; James River at Lick Run).

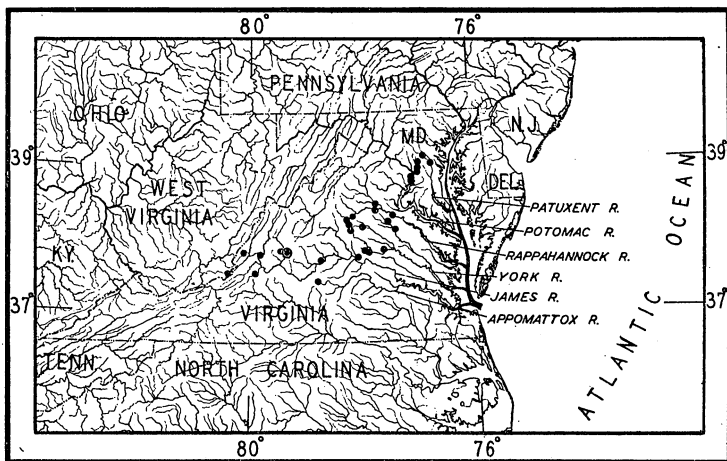
Hadropterus aspro (misidentification).—Pratt, 1923: 125 (range in part, including James River).

Alvordius nevisensis (misidentification).—Jordan and Gilbert, 1883: 502 (Maryland).

Etheostoma peltatum (misidentification).—Jordan, 1890: 113 (*H. maculatus* considered a synonym of *E. peltatum*).

Hadropterus peltatus (misidentifications).—Jordan, 1885: 867 (synonymy in footnote; confused). Jordan and Evermann, 1896:

1034 (considered a synonym of *H. maculatus*). Smith and Bean, 1899: 186 (Anne Arundel County, Maryland, and the upper Patuxent River). Radcliffe and Welsh, 1913: 32 (*H. peltatus* and *H. notogrammus* both used in preparation of table). Fowler, 1923: 10 (comparison). Truitt, Bean, and Fowler, 1929: 80-81 (Maryland records; two species confused). *Alvordius peltatus* (misidentification).—Jordan, Evermann, and Clark, 1930: 283 (*H. maculatus* considered a synonym). *Hadropterus peltatus crassus* (misidentification).—Fowler, 1945: 37, 136 (in synonymy; James River system?; species confused).



MAP 1. Distribution of *Hadropterus notogrammus*, with all known record stations, all based on specimens examined. The type locality is ringed. Shown also are the river systems inhabited and the former downstream courses of these rivers as tributaries of the Pleistocene extension of the Susquehanna River, now dismembered by the late Quaternary rise in sea level. The stations were plotted by E. C. Raney and the map drafted by Norman J. Wilimovsky, on a part of the drainage map of the United States (July, 1940) that was prepared under the direction of Carl L. Hubbs, chiefly from the base map of the United States Geological Survey.

MATERIAL

Of this species, we have examined 7 type series and 31 non-type sets, listed below by stream systems. The collecting stations are indicated as dots on Map 1.

Upper James River System

The holotype, a male, 67 mm. in standard length, was collected by Lincoln C. Pettit on May 17, 1941, in South River, a tributary of North River, James River system, 5 miles east of Lexington, Rockbridge County, Lexington quadrangle, Virginia. U.M.M.Z., No. 144696. The dot for the type locality on Map 1 is ringed.

All paratypes are also from the upper, montane part of the James River system, and all are from Virginia, except for one lot from West Virginia. They bear the following data:

U.S.N.M., No. 40242: 1 female, 53.5 mm. long, obtained by D. S. Jordan on September 8, 1888, in James River at Lick Run, near the Alleghany-Botetourt county line, Virginia.

C.U., No. 8324: 4 adults, 47 to 58 mm. long, collected by E. C. Raney and E. A. Lachner on March 31, 1940, in Catawba Creek, 2 miles north of Fincastle, Botetourt County, Virginia.

C.U., No. 9708 and U.M.M.Z., No. 144697: 10 adults, 46 to 56 mm. long, collected by L. C. Pettit on May 17, 1941, in North River, Rockbridge County, Virginia.

C.U., No. 10138: 1 female, 55 mm. long, secured by Pettit on October 27, 1940, in North River, Rockbridge County, Virginia.

C.U., No. 4909: 2 adults, 53 and 54 mm. long, taken by A. H. Wright on July 28, 1931, in Potts Creek, Monroe County, West Virginia.

U.M.M.Z., No. 95194: 1 female, 42 mm. long, seined by Carl L. and Laura C. Hubbs on September 10, 1928, in Dunlap Creek at Callaghan, west of Covington, Alleghany County, Virginia.

Additional specimens, with data as follows, have been examined from other river systems. These are not designated as paratypes.

Middle James and Appomattox River Systems

U.S.N.M., No. 107497: 1 juvenile, 39 mm. long, collected by L. P. Schultz and E. D. Reid on October 11, 1938, in Byrd Creek east of Columbia, Goochland County, Virginia.

A.M.N.H., No. 8023: 1 male, 40 mm. long, collected by E. R. Dunn at Midway Mills, Nelson County, Virginia.

U.S.N.M., No. 100190: 2 males, 55 and 69 mm. long, taken by Stuart Abraham on April 22, 1935, in Appomattox River between Appomattox Court House and Vera, Appomattox County, Virginia.

York River System

C.U., No. 10528: 3 adults, 41 to 55 mm. long, collected by Raney, Lachner, and R. D. Ross on June 19, 1946, in Cub Creek, a tributary of South Anna River, 2.5 miles north of Gum Springs, Louisa County, Virginia.

U.S.N.M., No. 107746: 15 adults, 51 to 60 mm. long, collected by Schultz and Reid on September 29, 1938, in New Found River, a tributary of South Anna River, 3.5 miles above its mouth, Hanover County, Virginia.

U.S.N.M., No. 107715: 3 juvenile to adult specimens, 33 to 52 mm. long, taken by Schultz and Reid on September 29, 1938, in North Anna River, 8 miles north of Louisa, Louisa County, Virginia.

U.S.N.M., No. 107705: 1 juvenile, 36 mm. long, obtained by Schultz and Reid on September 28, 1938, in South Anna River, 3.5 miles south of Gordonsville, Louisa County, Virginia.

U.S.N.M., No. 100227: 1 female, 42 mm. long, collected by Abraham on April 24, 1935, in South Anna River at U. S. Highway 15 crossing south of Orange, Orange County, Virginia.

U.S.N.M., No. 119842: 3 adults, 39 to 53 mm. long, secured by M. C. Marsh on September 27, 1897, in Mattaponi River at Milford, Caroline County, Virginia.

U.S.N.M., No. 119850: 10 adults, 38 to 60 mm. long, taken by Schultz and Reid on September 29, 1938, in Cub Creek, 1 mile above mouth and 5 miles north of Gum Springs, Louisa County, Virginia.

U.M.M.Z., No. 102326: 14 adults, 46 to 60 mm. long, taken by Hubbs and group on May 6, 1934, in Ni River about 10 miles south of Fredericksburg on U. S. Highway 1, Spotsylvania County, Virginia.

Rappahannock River System

U.S.N.M., No. 107478: 8 juvenile to adult specimens, 36 to 59 mm. long, collected by Schultz and Reid on October 12, 1938, in Blue Run, 6 miles west of Orange, Orange County, Virginia.

U.S.N.M., No. 88651: 1 adult female, 38 mm. long, collected by Reid on October 7, 1927, at the mouth of Wilderness Run, Orange County, Virginia.

C.U., No. 10193: 4 adults, 41 to 64 mm. long, collected by Raney, Lachner, and R. A. Pfeiffer on March 28, 1941, in the Rappahannock River at Fredericksburg, Stafford County, Virginia.

C.U., No. 10527: 3 adults, 48 to 65 mm. long, collected by Raney, Lachner, and Ross on June 19, 1946, in Rapidan River at Madison Mills, Madison County, Virginia.

C.U., No. 10999: 3 adults, 50 to 60 mm. long, secured by Raney, Ross, and R. D. Suttkus on April 13, 1947, in a tributary of Rappahannock River, one-half mile east of Remington, Fauquier County, Virginia.

Potomac River System

U.S.N.M., No. 100643: 2 juveniles, 32 and 45 mm. long, taken by Abraham on May 30, 1935, in Middle Run, 15 miles south of Alexandria, Fairfax County, Virginia.

U.S.N.M., No. 100709: 1 male, 45 mm. long, collected by Abraham on May 27, 1935, in Cameron Run, one-half mile south of Alexandria, Fairfax County, Virginia.

U.S.N.M., No. 131784: 3 adults, 41 to 52 mm. long, seined by Robert R. Miller and C. C. Swears on August 27, 1944, in Point Branch, a tributary of Anacostia River, 1.5 miles above Old Powder Factory Road on the boundary of Montgomery and Prince Georges counties, Maryland.

U.S.N.M., No. 131798: 1 male, 58 mm. long, obtained by Miller and James Schultz on September 3, 1944, in Little Paint Branch, tributary to Anacostia River, between Beltsville and College Park, Prince Georges County, Maryland.

U.S.N.M., No. 74225: 7 adults, 41 to 68 mm. long, seined by Alfred C. Weed and Ernest B. Marshall on July 20, 1912, in Indian Creek at Beltsville, Prince Georges County, Maryland.

Patuxent River System

U.S.N.M., No. 106584: 2 females, 53 and 54 mm. long, taken by E. B. Marshall on April 18, 1937, in a tributary of Patuxent River at Laurel, Prince Georges County, Maryland.

U.S.N.M., No. 73322: 1 female, 53 mm. long, collected by E. B. Marshall on April 15, 1912, in Crow Branch near Laurel, Maryland.

U.S.N.M., No. 82612: 1 female, 59 mm. long, taken by George Marshall on July 15, 1918, in Fair Branch near Laurel, Maryland.

U.S.N.M., No. 74441: 1 male, 51 mm. long, collected by E. B. Marshall on June 14, 1912, at Laurel, Maryland.

U.S.N.M., No. 67433: 1 female, 52 mm. long, obtained by E. B. Marshall, in July, 1902, at Laurel, Maryland.

U.M.M.Z., No. 105519: 2 adults, 46 to 54 mm. long, taken by E. B. Marshall in 1938, in tributaries of Patuxent River, near Laurel, Maryland.

U.S.N.M., No. 1157: 2 males, 58 and 69 mm. long, secured by J. H. Clark at Patuxent, Maryland (cotypes of *Hadropterus maculatus* Girard, 1859b: 100).

U.S.N.M., No. 1303: 1 male, 58 mm. long, taken by S. F. Baird in a tributary of the Patuxent River in Anne Arundel County, Maryland.

U.M.M.Z., No. 144698: 2 specimens, 36 to 51 mm. long, collected by William H. Stickel on September 29, 1941, in Patuxent River at Telegraph Road, Patuxent Research Refuge, Anne Arundel County, Maryland.

U.M.M.Z., No. 138225: 1 female, 51 mm. long, secured by Ford Wilke and Robert E. Stewart on April 28, 1941, in Patuxent River at Patuxent Research Refuge, Prince Georges County, Maryland.

TABLE I
COMPARISON OF *Hadropterus notogrammus* WITH *Hadropterus peltatus*

Character	<i>H. notogrammus</i>	<i>H. peltatus</i>
Color markings along mid-line of back	Oval tan blotches (either disconnected or connected) are separated from the tan stripe along the upper side by a continuous pale streak.	Blackish saddles are interconnected, before and behind, by oblique extensions, so as to enclose oval light areas and to form a zigzag tan line along the upper back.
Dark nuchal blotch	Does not enclose a light oval area in the center and is separated from the origin of the dorsal fin by a light area.	Encloses near its center a light oval spot that, in turn, often has a small dark spot in its center; the blotch extends to the origin of the dorsal fin and there meets a light oval spot.
First dorsal fin	Rather uniformly dark (particularly in males) on the lower half of the membranes, especially on the anterior part of the fin.	Has a row of discrete black crescents, which form a conspicuous dark band just below the middle of the fin.
Dark caudal spot	Median	Lies below the middle of the tail base.
Dark blotches along sides	Mostly oval	Basically quadrate.
Lower side of head	Lacks the dark stripe behind the chin, although scattered melanophores may occur.	Has a dark stripe behind the chin.
Pigmentation on premaxillary	Dense on the sides, as well as in front.	Dense only on the front part.
Body	Slimmer, more pointed fore and aft when viewed from above, and more nearly oval in cross section.	Heavier, especially in the pectoral region; the head has a wider entering angle and is bluntish; the sides of the body are more nearly vertical.
Caudal fin	Has, when extended, a nearly straight posterior edge.	Emarginate.
Squamation on side of head	Cheek has some scales; opercle is completely scaled; subopercle is usually scaled.	Cheek is scaleless, or very nearly so; opercle is scaleless, or sparsely scaled dorsally; subopercle is scaleless.
Ventral scutes of males	Oval, armed with moderate spines.	Much longer than wide, armed with large spines.

RELATIONSHIPS

Although it has been confused for many years with *Hadropterus peltatus*, the only other species of the genus that is found within its range, *H. notogrammus* proves to be easily separable from that species. Table I as well as Plates I and II will facilitate their identification.

In addition to the more obvious distinctions enumerated in Table I, *H. notogrammus* differs from *H. peltatus* in many ways. The eye is longer than deep rather than about as long as deep. The eyes are more superolateral. The preorbital is narrower. The procurent caudal rays are better developed. The ctenii on the scales are smaller. The mid-line of the belly in nearly all females is scaled just in front of anus, whereas in *peltatus* this region is scaleless. The general pigmentation of the body is more intense. The head is longer and less deep. The mouth is more oblique.

From *Hadropterus maculatus* (Girard), the species that is wide-ranging west of the Appalachian Mountains, *H. notogrammus* differs markedly in dorsal body pattern. In this respect *maculatus* is much like *peltatus* (Pls. I-II). The species *notogrammus* and *maculatus* are similar and they both differ from *peltatus* in the size and shape of the enlarged ventral scutes of the male, in the coloration of the spinous dorsal fin, in lacking a strong stripe of melanophores on the underside of the head behind the chin, and in the greater extension of melanophores onto the side of the premaxillary. Although in some parts of its range it is subject to considerable variation in these respects, *maculatus* contrasts with *notogrammus* in having finer scales, a longer and slenderer caudal peduncle, and the origin of the dorsal fin farther forward. From the robust *H. roanoka*, *notogrammus* is clearly differentiated on the basis of scale count (39 to 51, usually about 43 to 45, in *roanoka*) and by the distinctive coloration, as well as by the slenderer body. For a summary of the characters of other species of *Hadropterus*, none of which is closely related to *notogrammus*, see Bailey (1940: 530).

TABLE II
COMPARISON BY RIVER SYSTEMS OF SCALE COUNTS OF
Hadropterus notogrammus

In the body of the table the figures in the first line for each rubric are the observed range and, in parentheses, the mean; those in the second line are the number of specimens and, in parentheses, the percentage separable above (+) or below (-) the arbitrary line of separation that is indicated in parentheses in the column heading. The frequency distributions are detailed in the Appendix.

River System	Number of Scales or Scale Rows				
	Lateral Line (60-61)	Above Lat. Line(7-8)	Below Lat. Line(9-10)	Around C. Ped.(21-22)	Along Midventral Line(8-9)
Patuxent	54-61 (57.2) 13 (92;-)	6-8 (6.9) 14 (93;-)	8-10 (9.1) 14 (71;-)	20-21 (20.9) 14 (100;-)	7-10 (8.5) 4 (50;+)
Potomac	51-59 (54.8) 15 (100;-)	6-8 (7.2) 15 (67;-)	9-11 (9.7) 15 (60;+)	20-23 (21.1) 15 (67;-)	9-11 (10.1) 8 (100;+)
Rappahannock	55-62 (58.8) 16 (75;-)	6-8 (6.9) 16 (87;-)	9-12 (9.8) 16 (63;+)	20-23 (21.2) 16 (75;-)	7-10 (8.4) 8 (63;+)
York	50-60 (54.5) 50 (100;-)	6-8 (6.7) 47 (94;-)	8-11 (9.2) 47 (72;-)	18-23 (20.5) 46 (85;-)	5-13 (7.8) 31 (68;-)
Upper James	57-65 (61.5) 20 (75;+)	6-8 (7.7) 20 (70;+)	8-11 (9.9) 20 (55;+)	20-24 (22.1) 20 (75;+)	8-13 (8.4) 13 (62;+)
Middle James and Appomattox	56-60 (58.3) 4 (100;-)	6-8 (7.0) 4 (75;+)	8-11 (9.7) 4 (75;+)	21-22 (21.7) 4 (75;+)
Total	50-65 (56.8) 118	6-8 (7.0) 116	8-12 (9.5) 116	18-24 (21.0) 115	5-13 (8.6) 64

DIAGNOSIS

Hadropterus notogrammus differs strikingly from its near relatives, *H. maculatus* and *H. peltatus*, in the color pattern of the back (Pl. II). A conspicuous pale streak on the dorso-lateral body surface continues forward to set off the longitudinal dark nuchal blotch (or blotches). A pale cross band usually surrounds the front of the dorsal fin. Irregular oval dark blotches on the mid-line of the back sometimes touch each other but only rarely reach laterally to contact the continuous pale streak. Most of the 6 to 8 dark oval blotches along the side of the body are connected by a narrow median lateral stripe. Between the pale stripe and the dark lateral blotches lies a continuous zigzag tan stripe, which is edged below by a pale streak where it is not in direct contact with one of the black blotches. Black pigment on the spinous dorsal of a highly colored male is most pronounced on the lower half of the first 4 to 6 interradial membranes, but is also evident on the other membranes. This pigment becomes most intense near the base of the membranes, but does not form definite black crescents as it does in *Hadropterus peltatus*. The subocular and preocular dark bars are well developed. The scales, of moderate size, number 50 to 65 along the lateral line, 6 to 8 above the lateral line, 8 to 12 below the lateral line, and 18 to 24 around the caudal peduncle (Table II). From 5 to 13, usually 7 to 10, enlarged scales (Table II), each with spines of moderate length, lie along the mid-line of the belly of males (females lack these large scutes, but have a few small scales along the mid-line posteriorly). The cheek is partly scaled, usually bearing only a few small, more or less embedded scales on the upper third. The opercle is covered with scales of normal size. There is usually one row of scales on the subopercle, occasionally 2 rows. The nape is either naked or partly scaled; usually it bears only a scattering of small embedded scales; when normal scales are included they usually lie close to the origin of the dorsal fin. Dorsal rays, XII to XVI—11 to 14 (total, 23 to 29); anal rays, II, 8 to 10;

TABLE III

COMPARISON BY RIVER SYSTEMS OF FIN-RAY COUNTS AND MERISTIC INDEX OF *Hadropterus notogrammus*
For explanation see sublegend of Table II.

River System	Number of Rays and Meristic Index					
	Dorsal Spines (14-15)	D Soft Rays(11-12)	Total D Rays(26-27)	Anal Soft Rays(8-9)	Pectoral Rays (13-14)*	Meristic Index (67-68) †
Patuxent	12-14(13.4) 14(100;-)	11-13(12.0) 14(79;+)	24-27(25.4) 14(86;-)	8-10(9.0) 14(86;+)	13-14(13.8) 28(82;+)	59-67(64.1) 14(100;-)
Potomac	12-15(13.1) 15(93;-)	11-13(11.8) 15(73;+)	24-26(24.9) 15(100;-)	8-10(8.9) 15(80;+)	13-15(13.9) 32(81;+)	58-66(61.6) 15(100;-)
Rappahannock	13-15(13.9) 16(93;-)	11-13(12.0) 16(87;+)	24-27(25.9) 16(81;-)	8-10(9.1) 16(81;+)	13-15(13.9) 32(75;+)	61-71(66.1) 16(75;-)
York	12-15(13.5) 47(96;-)	11-13(11.6) 47(57;+)	23-27(25.1) 47(96;-)	8-10(8.7) 47(66;+)	13-15(14.2) 92(99;+)	55-65(60.0) 44(100;-)
Upper James	14-16(14.7) 20(65;+)	11-14(12.3) 20(80;+)	25-29(27.1) 20(65;+)	9-10(9.4) 20(100;+)	13-15(13.8) 42(69;+)	66-74(70.1) 20(90;+)
Middle James and Ap- pomattox	14-15(14.7) 4(75;+)	11-12(11.7) 4(75;+)	26-27(26.5) 4(50;±)	9-9(9.0) 4(100;+)	13-15(13.9) 8(75;+)	64-68(66.0) 4(75;-)
Total	12-16(13.7) 116	11-14(11.9) 116	23-29(25.6) 116	8-10(8.9) 116	13-15(14.0) 234	55-74(63.6) 113

* Each side tabulated.

† Computed for each specimen by subtracting the total number of pectoral rays from the sum of the lateral line scales, the dorsal spines and soft rays, and the anal soft rays.

pectoral rays, 13 to 15. The edge of the preopercle is smooth. The gill membranes are separate. The distance from the insertion of the pelvic fin to the union of the gill membranes goes 0.5 to 0.8 times into the distance from the tip of the mandible to the union of the gill membranes. Branchiostegal rays, 6. The head is relatively broad and the snout is rather short. The air bladder is present but small.

FURTHER DESCRIPTION

Many of the additional characters, such as those of body form and color pattern, are illustrated in Figures 1 and 2 on each of the plates. The scale counts are detailed by drainage system in Table II and the fin-ray counts in Table III. Counts for the holotype are: scales, 7—65—11 (the lateral line count is extreme for the species); scale rows around caudal peduncle, 22; dorsal rays, XV—12; anal rays, II, 9; pectoral rays, 13—13. The spinous and soft dorsal fins are slightly to moderately separated. Following the format employed by Hubbs and Raney (1939: 5-6) various body and fin measurements, including those for the holotype, are expressed as proportions in Table IV. Counts and measurements were made in accordance with the recommendations by Hubbs and Lagler (1941: 12-20; 1947: 8-15). Other descriptive items, based on the holotype and paratypes (from the upper parts of the James River system), follow.

HEAD CHARACTERS

The vertical arm of the preopercle is slightly longer than the horizontal arm. The width of the premaxillary frenum equals the distance between the anterior and posterior nostrils, enters the length of the eye 2.5 times, and is slightly greater than the width of the fleshy anterior tip of the upper lip. In the holotype the width of the mandibular frenum goes 1.5 times into the width of the premaxillary frenum and the lower jaw is included within the somewhat bluntly rounded snout. Some small paratypes, in contrast, have the snout sharper. In lateral view, the lower edge of the upper lip

TABLE IV

MEASUREMENTS OF 34 SPECIMENS OF *Hadropterus notogrammus*

The measurements were taken with dividers and stepped into the part indicated. Averages are in parentheses.

River system	Patuxent	Potomac	Rappahannock	York	Upper James		Total Range and Average
	6	6	6	6	9 Paratypes	Holotype	
No. of specimens	6	6	6	6	9 Paratypes	Holotype	34
Standard length, mm.	52-58 (53.5)	44-66 (53.8)	48-63 (56.7)	53-57 (55.3)	44-56 (51.6)	67	44-66 (53.8)
In standard length:							
Depth of body	4.7-5.4 (5.1)	5.1-5.5 (5.3)	4.8-5.1 (5.0)	4.7-5.0 (4.9)	4.7-5.6 (5.2)	5.5	4.7-5.6 (5.1)
Length of head, including opercular membrane	3.2-3.5 (3.4)	3.3-3.5 (3.4)	3.3-3.4 (3.4)	3.2-3.4 (3.3)	3.3-3.6 (3.4)	3.4	3.2-3.6 (3.4)
In length of head:							
Depth of caudal peduncle	2.9-3.2 (3.0)	3.0-3.1 (3.0)	2.9-3.0 (3.0)	2.9-3.1 (3.0)	2.9-3.0 (3.0)	3.1	2.9-3.2 (3.0)
Highest dorsal spine	2.2-2.7 (2.5)	2.2-2.8 (2.5)	2.1-2.9 (2.4)	2.3-2.6 (2.4)	2.2-2.8 (2.5)	2.6	2.1-2.9 (2.5)
Highest dorsal soft ray	1.9-2.1 (2.0)	2.0-2.2 (2.1)	1.9-2.0 (2.0)	1.9-2.0 (2.0)	1.9-2.3 (2.1)	2.1	1.9-2.3 (2.0)
Highest anal ray	1.9-2.0 (1.9)	1.8-1.9 (1.9)	1.7-2.1 (1.9)	1.7-2.0 (1.9)	1.8-2.1 (1.9)	2.0	1.7-2.1 (1.9)
Longest caudal ray	1.3-1.6 (1.4)	1.3-1.4 (1.4)	1.3-1.5 (1.4)	1.3-1.5 (1.4)	1.2-1.7 (1.4)	1.7	1.2-1.7 (1.4)

TABLE IV—(Cont.)

River system	Patuxent	Potomac	Rappahannock	York	Upper James		Total Range and Average
					Paratypes	Holotype	
Length of pectoral fin	1.2 (1.2)	1.1-1.2 (1.1)	1.1-1.2 (1.1)	1.1-1.2 (1.1)	1.0-1.1 (1.1)	1.1	1.0-1.2 (1.1)
Length of pelvic fin	1.3-1.4 (1.3)	1.3-1.4 (1.3)	1.3-1.5 (1.4)	1.3-1.4 (1.4)	1.2-1.5 (1.4)	1.4	1.2-1.5- (1.4)
Depth of head	1.7-1.9 (1.8)	1.8-1.9 (1.8)	1.7-1.8 (1.8)	1.8-1.9 (1.9)	1.8-2.0 (1.8)	1.8	1.7-2.0 (1.8)
Width of head	1.8-2.0 (1.9)	1.7-1.9 (1.9)	1.7-1.9 (1.8)	1.8-2.0 (1.9)	1.7-2.0 (1.9)	1.7	1.7-2.0 (1.9)
Length of eye	3.7-4.2 (4.1)	3.8-4.3 (4.1)	3.9-4.4 (4.1)	4.1-4.5 (4.2)	3.7-4.1 (4.0)	4.3	3.7-4.5 (4.1)
Length of snout	3.8-4.1 (3.9)	3.9-4.2 (4.0)	4.0-4.1 (4.0)	4.0-4.4 (4.2)	3.9-4.2 (4.0)	4.3	3.8-4.4 (4.0)
Length of upper jaw	3.4-3.6 (3.5)	3.1-3.4 (3.2)	3.1-3.3 (3.1)	3.1-3.5 (3.3)	3.1-3.3 (3.2)	3.1	3.1-3.6 (3.3)
In length of snout:							
Length of eye	0.9-1.0 (1.0)	0.9-1.1 (1.0)	0.9-1.1 (1.0)	0.9-1.1 (1.0)	0.9-1.0 (1.0)	1.0	0.9-1.1 (1.0)

TABLE IV—(Cont.)

River system	Patuxent	Potomac	Rappahannock	York	Upper James		Total Range and Average
					Paratypes	Holotype	
In length of eye:							
Least fleshy interorbital width	1.3-1.7 (1.5)	1.5-1.8 (1.6)	1.5-1.8 (1.6)	1.2-1.6 (1.4)	1.5-1.8 (1.6)	1.9	1.2-1.9 (1.6)
Least bony interorbital width	2.0-2.3 (2.1)	2.0-2.4 (2.2)	2.1-2.4 (2.2)	2.0-2.1 (2.1)	2.0-2.2 (2.1)	2.3	2.0-2.4 (2.1)
In distance from tip of mandible to union of gill membranes:							
Distance from insertion of pelvic fin to union of gill membranes	0.6-0.8 (0.7)	0.6-0.8 (0.7)	0.6-0.8 (0.7)	0.6-0.7 (0.6)	0.6-0.8 (0.7)	0.5	0.5-0.8 (0.7)

is curved gently downward near the anterior tip. The upper lip rises almost to the level of the center of the eye. The mandibles are gently curved. The vomer bears a small triangular patch of teeth; each palatine, an interior row of rather small depressible teeth and an outer row of minute teeth. In the jaws rather strong teeth are aligned in the outer row and smaller interior teeth form a narrow, scarcely more than biserial, band. The gill rakers number 2+13 in the holotype. The 2 on the upper arm and the uppermost 9 on the lower arm are large. The longest, the first on the lower arm, when depressed extends only slightly beyond the base of the first raker below.

LATERAL LINE STRUCTURES

The lateral canal of the head, as is usual in darters, has 5 pores. The anterior nasal pore opens in front of and above the anterior nostril, and it connects with the canal by a short posteriorly extending tube. The posterior nasal pore opens just above the posterior nostril and enters the canal by a slender tube that extends mesad and forward from the pore. The interorbital pore opens at a point above the front border of the pupil and connects with the canal by a tube that extends forward and mesad. The single coronal pore is located at the end of a slender, slightly curved tube which extends backward from the canal. The postorbital pore opens immediately anterior to the canal and joins it by a short tube. The 8-pored infraorbital canal is complete. The operculo-mandibular canal has 10 pores. The median pore of the complete supratemporal commissure is at the end of a backward extending canal. (See Hubbs and Cannon, 1935, Pl. 2, for explanation of terms.) The lateral line is straight and complete.

GENITAL PAPILLA

The genital papilla of the male, located just posterior to the anus, is a flattened fleshy flap that is rounded behind and extends backward almost to the base of the first anal ray.

The posterior edge is slightly notched in the center in some males, and in the holotype there is an extra flap on the left side that presumably is a regenerated piece, since the papilla appears to have been injured. In the female the papilla is a larger semirectangular flap that is somewhat fimbriate on the posterior border, where the longitudinal creases and folds on the ventral side of the flap converge.

SPECIALIZED VENTRAL SCALES

Each of the 5 to 13 enlarged scales along the mid-line of the belly of the adult males is almost circular, with a rather straight anterior border. There is some variation in the length of the spines, but the largest are about one-fifth the largest diameter of the scute. These spines usually vary from 3 to 6 and are deflected backward and downward. Occasionally, 1 of the enlarged median scales is flanked by a smaller, somewhat specialized scale.

Anteriorly the belly is naked in both sexes. As is usual in the genus, there is an enlarged scale just back of the pelvic fin base and another near the middle of the breast. Most females have small scales on the posterior one-third to one-half of the belly. Although normally these scales are not specialized, some are slightly enlarged and have small spines on the posterior border.

In the holotype, five embedded scales lie immediately behind the enlarged breast scale. Just anterior to the anus, on either side of the mid-line, in this specimen and in some others, are two scutes of moderate size. The large scales on the mid-line of the holotype number 11. Most paratypes also have some small scales on the breast, but some specimens are naked in this area.

COLORATION

The life colors of a female taken by Carl L. and Laura C. Hubbs on September 10, 1928, in Dunlap Creek, at Callaghan, Alleghany County, Virginia, follow: the dark lateral oval blotches are blue-black; the light areas of the cheeks, the

light bars on the spinous dorsal fin, the dorsolateral stripe of the body, and the areas around the dark lateral blotches are golden; other light areas on the sides and back and between the mandibles are amber; the mandibles are bright metallic blue.

In alcohol the oval blotches (usually 7) are black and the darker areas on the back are tan. The dark blotches along the mid-side contrast with the light lower sides and belly. The dark spot at the base of the caudal fin is median and on a level with the dark lateral stripe that connects the lateral blotches (in *H. peltatus* the spot lies below the lateral stripe). In some specimens this caudal spot is expanded vertically to form a bar. The ventral surface of the body is light, with an even scattering of melanophores, which are most conspicuous anteriorly and become most pronounced in the breeding males. Along the mid-line of the back, under the dorsal fin, are 7 small oval tan blotches, which may or may not be connected. Just laterad is a more or less uninterrupted light line that continues forward on either side of the semiquadrate nuchal blotch (or blotches), around the front of which it usually crosses the body to meet its fellow of the opposite side. Another light streak crosses the back just in front of the dorsal fin. Between the conspicuous light stripe and the lateral dark blotches is a tan stripe with irregular edges. It starts above the opercle and continues somewhat irregularly backward to below the second dorsal fin, where it tends to break up into oval blotches. Ventrally it sometimes fuses with the dark lateral blotches just below it on the side of the body, but seldom extends dorsally to touch the tan blotches on the dorsal mid-line.

On the top of the head are 2 light lines that run laterally backward behind the eye and connect with another somewhat fainter light line that lies just above the opercle. The top of the snout is rather evenly and heavily pigmented in breeding males and is spotted with tan in other specimens. A dark stripe begins on the snout, crosses the eye, and continues backward across the dorsal part of the cheek and then across

the opercle, on which it is somewhat expanded ventrally. Its posterior extension on the body is more or less continuous with the dark lateral stripe. A dark subocular bar reaches ventrally to the lower limit of the cheek. In the breeding male there is much black in the membranes of the spinous dorsal fin. This black color is nearly solid on the ventral part of the first 5 or 6 interradiial membranes; posteriorly, it is more limited to the center of the basal part of each membrane and is less intense; on the last few membranes, the intensity is slightly regained. On the soft dorsal, also, the dark pigment is concentrated on the interradiial membranes, so as to give this fin a weakly banded appearance. The caudal has 3 or 4 rather faint vertical dark bands. In addition, the first few principal ventral and dorsal rays of the caudal are dusky near the base. The anal and pelvic fins are usually covered with small melanophores. The pectorals are somewhat less dusky. In nonbreeding males and in females the black is less intense on the fins, all of which tend to be somewhat barred.

INTRASPECIFIC VARIATION

Although its range (Map 1) is limited to the streams that flow from the west into the southern half of Chesapeake Bay and although these streams were undoubtedly tributaries of a great river that flowed through the shallow depression of this bay during the late Pleistocene lowering of sea level (Veatch and Smith, 1939: 44; Atwood, 1940: 36), *Hadrop-terus notogrammus* is by no means uniform in its characters. The samples from the several river systems differ rather markedly in certain meristic features (Tables II-III and Appendix). Some of the differences may be attributed to the isolation of populations since the connecting river was drowned by the formation of Chesapeake Bay, as a result of the rising sea levels that accompanied the recession of the Wisconsin icecap. *H. notogrammus* is a riffle species that avoids the base-level parts of the streams as well as the brackish waters of the arms of Chesapeake Bay.

The most marked variation, however, appears to have an ecological basis, which may have antedated the Wisconsin epoch of glaciation. The populations of the upper part of the Coastal Plain and of the Piedmont have on the average fewer scales and fewer fin rays than do those inhabiting the mountains. By far the highest counts characterize the samples from the upper part of the James River system—the only series that represent real montane habitats (compare Map 1 with Plate II in Fenneman's monograph, 1938). The next highest averages are exhibited by the series from the Rappahannock drainage system, which in the mountains abuts the James River system. Most of the Rappahannock samples, however, are from Piedmont streams. The specimens from the York system—from both the Mattaponi and the Pamunkey branches—have the lowest averages, and this system is cut off from the higher mountains by the branches of the Rappahannock and the James rivers. Farther north, perhaps because of a preference for relatively warm waters, this species seems to have been confined to the lowlands and for this reason did not follow *H. peltatus* in the Postglacial reinvasion of the Susquehanna, Delaware, and Hudson watersheds. In the Potomac system it seems to be confined to streams close to the head of tide-water, below the falls. The Patuxent is not a mountain stream. In correlation with the relatively low elevations, the counts are rather low for the most northern systems. The 4 fish from the middle part of the James system and from the short Appomattox River, which enters the James River near the head of its estuary, agree better with the specimens from the other systems than with those from the upper James (Tables II-III).

It is probable that the population of the upper montane part of the James River system will prove subspecifically distinct because of the higher counts. On the basis of the available data, differentiation on the subspecific level is definitely indicated. Using a meristic index, computed to maximize approximately the differences in the counts, it is possible to set a line (between indices 67 and 68) that will allow the

separation of 90 per cent of the upper James specimens from 75 to 100 per cent of the specimens of other stocks (last column, Table III). By using the lateral line scale counts, with the division set between 60 and 61, it is possible to separate 75 per cent of the upper James fish from 75 to 100 per cent of those from other waters. Separability approaching that expected for subspecies is obtained for the counts of scales above the lateral line, of scale rows around the caudal peduncle, of the dorsal spines, and of total dorsal rays (though for the 3 latter tallies the 4 fish from the middle James and the Appomattox happen to agree best with those from the upper James).

Because of the limited amount of material available from the James it is deemed inexpedient at the moment to separate *Hadropterus notogrammus* into 2 subspecies. Should the study of further collections confirm the consistency of the high counts now shown only by material from the upper montane parts of the James River system, a new subspecies should be recognized for the populations that inhabit the other waters.

HABITAT

Small and medium streams appear to provide the optimum habitat for *Hadropterus notogrammus*. Small brooks are avoided except during the spring spawning migration. On one occasion *H. notogrammus* was taken in a river, the Rappahannock at Fredericksburg, Virginia, along with *H. peltatus*. Here both species were found among the boulders in the riffles below the falls under the U. S. Highway 1 bridge. During spring both species occur in moderate-sized streams, in and near riffles. At this time of year scuffing stones and kicking out weedbeds seem to be the most productive methods of collecting these darters. In the summer they are more common in the pools near riffles. They avoid strictly sand-bottomed streams.

The name *notogrammus*, derived from *νωτος*, "back" and *γραμμή*, "a line," refers to the prominent light color streak along the back.

APPENDIX

SCALE AND FIN-RAY COUNTS OF HADROPTERUS NOTOGRAMMUS BY RIVER SYSTEMS

The number of specimens for each count is recorded in parentheses. The data are analyzed in Tables II and III.

LATERAL LINE SCALES.—*Patuxent*: 54(1), 55(2), 56(3), 58(4), 59(1), 60(1), 61(1). *Potomac*: 51(1), 52(3), 53(2), 54(3), 56(2), 58(1), 59(3). *Rappahannock*: 55(1), 57(4), 58(3), 59(2), 60(2), 61(2), 62(2). *York*: 50(2), 51(6), 52(3), 53(4), 54(10), 55(8), 56(6), 57(5), 58(3), 59(2), 60(1). *Upper James*: 57(1), 59(1), 60(2), 61(7), 62(5), 63(1), 64(1), 65(2). *Middle James and Appomattox*: 56(1), 57(1), 60(2).

SCALES ABOVE LATERAL LINE.—*Patuxent*: 6(2), 7(11), 8(1). *Potomac*: 6(2), 7(8), 8(5). *Rappahannock*: 6(4), 7(10), 8(2). *York*: 6(19), 7(25), 8(3). *Upper James*: 6(1), 7(5), 8(14). *Middle James and Appomattox*: 6(1), 7(2), 8(1).

SCALES BELOW LATERAL LINE.—*Patuxent*: 8(2), 9(8), 10(4). *Potomac*: 9(6), 10(8), 11(1). *Rappahannock*: 9(6), 10(8), 11(1), 12(1). *York*: 8(9), 9(25), 10(9), 11(4). *Upper James*: 8(1), 9(8), 10(4), 11(7). *Middle James and Appomattox*: 8(1), 10(2), 11(1).

SCALE ROWS AROUND CAUDAL PEDUNCLE.—*Patuxent*: 20(2), 21(12). *Potomac*: 20(6), 21(4), 22(3), 23(2). *Rappahannock*: 20(4), 21(8), 22(1), 23(3). *York*: 18(1), 19(4), 20(18), 21(16), 22(6), 23(1). *Upper James*: 20(1), 21(4), 22(9), 23(5), 24(1). *Middle James and Appomattox*: 21(1), 22(3).

ENLARGED SCALES ON MID-LINE OF BELLY OF MALE.—*Patuxent*: 7(1), 8(1), 9(1), 10(1). *Potomac*: 9(3), 10(1), 11(4). *Rappahannock*: 7(1), 8(2), 9(3), 10(2). *York*: 5(3), 6(3), 7(11), 8(4), 9(4), 10(4), 12(1), 13(1). *Upper James*: 8(5), 9(4), 10(1), 11(1), 12(1), 13(1).

DORSAL SPINES.—*Patuxent*: 12(1), 13(6), 14(7). *Potomac*: 12(5), 13(5), 14(4), 15(1). *Rappahannock*: 13(3), 14(12), 15(1). *York*: 12(4), 13(18), 14(23), 15(2). *Upper James*: 14(7), 15(11), 16(2). *Middle James and Appomattox*: 14(1), 15(3).

DORSAL SOFT RAYS.—*Patuxent*: 11(3), 12(8), 13(3). *Potomac*: 11(4), 12(10), 13(1). *Rappahannock*: 11(2), 12(12), 13(2). *York*: 11(20), 12(24), 13(3). *Upper James*: 11(4), 12(8), 13(7), 14(1). *Middle James and Appomattox*: 11(1), 12(3).

TOTAL DORSAL RAYS.—*Patuxent*: 24(2), 25(6), 26(4), 27(2). *Potomac*: 24(5), 25(7), 28(3). *Rappahannock*: 24(1), 25(3), 26(9), 27(3). *York*: 23(2), 24(7), 25(23), 26(13), 27(2). *Upper James*: 25(1), 26(6), 27(8), 28(3), 29(2). *Middle James and Appomattox*: 26(2), 27(2).

ANAL SOFT RAYS.—*Patuxent*: 8(2), 9(10), 10(2). *Potomac*: 8(3),

9(10), 10(2). *Rappahannock*: 8(3), 9(9), 10(4). *York*: 8(16), 9(30), 10(1). *Upper James*: 9(16), 10(4). *Middle James and Appomattox*: 9(4).

PECTORAL RAYS (each side tabulated).—*Patuxent*: 13(5), 14(23). *Potomac*: 13(6), 14(24), 15(2). *Rappahannock*: 13(8), 14(20), 15(4). *York*: 13(1), 14(70), 15(21). *Upper James*: 13(13), 14(26), 15(3). *Middle James and Appomattox*: 13(2), 14(5), 15(1).

MERISTIC INDEX (computed for each specimen by subtracting the total number of pectoral rays from the sum of the lateral line scales, the dorsal spines and soft rays, and the anal soft rays).—*Patuxent*: 59(1), 61(1), 62(1), 63(2), 64(1), 65(4), 66(2), 67(2). *Potomac*: 58(3), 59(3), 60(2), 62(1), 65(5), 66(1). *Rappahannock*: 61(1), 62(1), 63(1), 64(2), 65(1), 66(2), 67(4), 68(1), 69(1), 70(1), 71(1). *York*: 55(1), 56(6), 58(8), 59(2), 60(10), 61(4), 62(3), 63(5), 64(3), 65(2). *Upper James*: 66(2), 68(3), 69(3), 70(2), 71(4), 72(3), 73(2), 74(1). *Middle James and Appomattox*: 64(1), 66(2), 68(1).

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Raney and Hubbs

PLATE I

FIG. 1. *Hadropterus notogrammus*: side view of a paratype, an adult female 58 mm. in standard length, C.U., No. 8324 (for data see p. 5).

FIG. 2. *Hadropterus notogrammus*: side view of holotype, an adult male (for data see p. 5).

FIG. 3. *Hadropterus peltatus*: side view of an adult male, 65 mm. long, collected by E. C. Raney on May 14, 1938, in outlet of Spencer Lake, Susquehanna River system, 2 miles north of Spencer, Tioga County, New York.

FIG. 4. *Hadropterus maculatus*: side view of an adult male, 47 mm. long, collected by Raney and E. A. Lachner on April 2, 1940, in South Fork of New River, Kanawha River system, 1 mile southwest of Fleetwood, Ashe County, North Carolina.

All photographs by Art Smith.

PLATE I

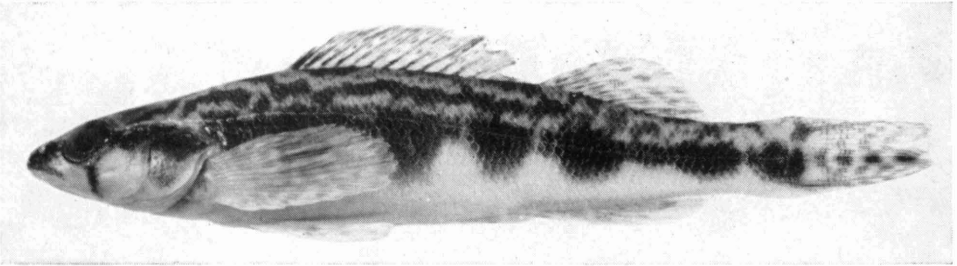


FIG. 1

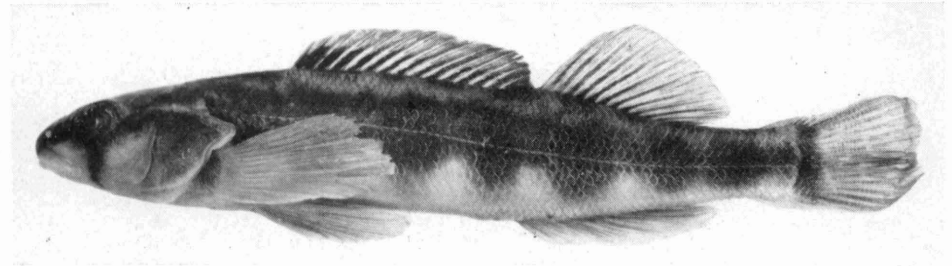


FIG. 2

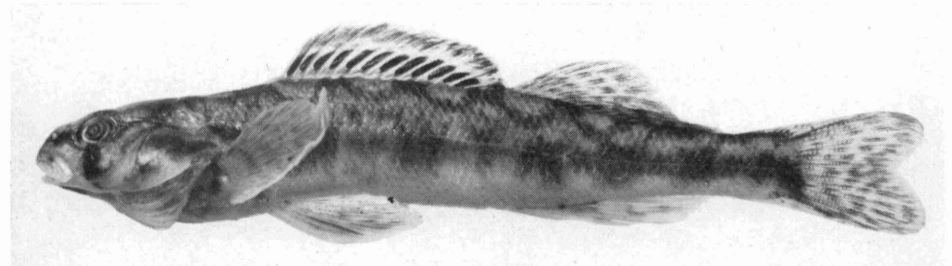


FIG. 3

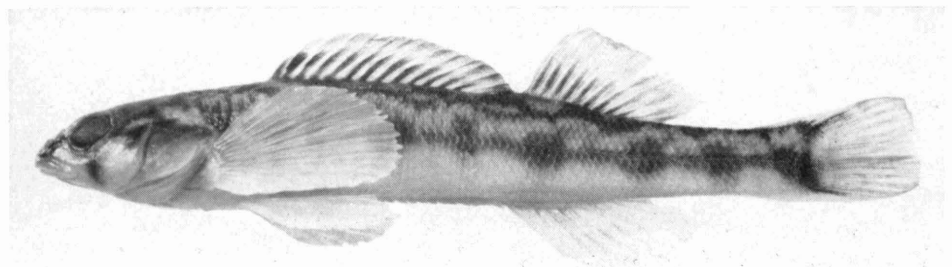


FIG. 4

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PLATE II

FIG. 1. *Hadropterus notogrammus*: dorsal view of female specimen shown on Plate I, Fig. 1.

FIG. 2. *Hadropterus notogrammus*: dorsal view of holotype, an adult male.

FIG. 3. *Hadropterus peltatus*: dorsal view of adult male shown on Plate I, Fig. 3.

FIG. 4. *Hadropterus maculatus*: dorsal view of adult male shown on Plate I, Fig. 4.

All photographs by Art Smith.

PLATE II

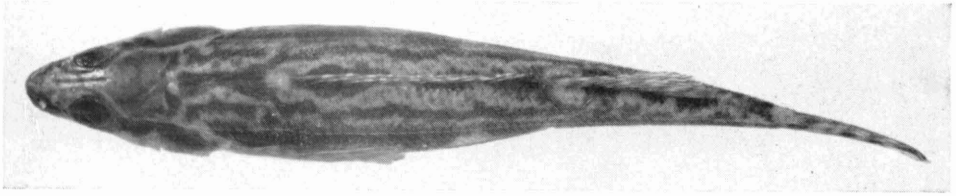


FIG. 1

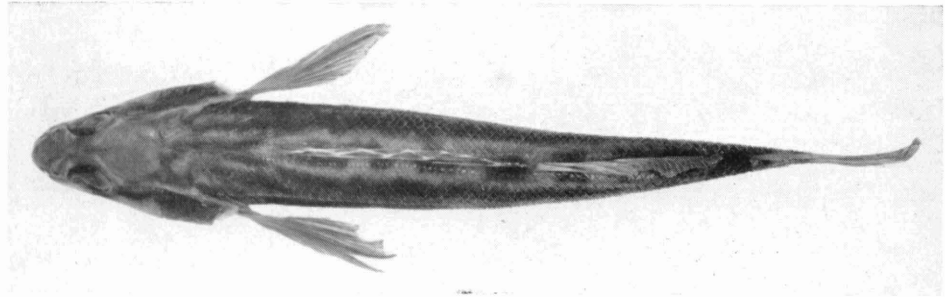


FIG. 2

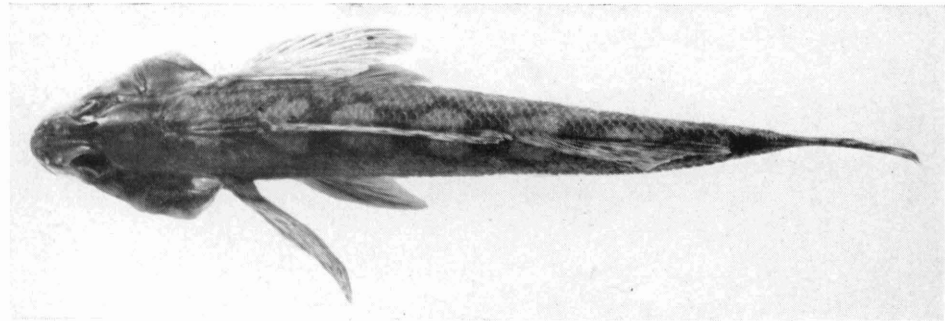


FIG. 3

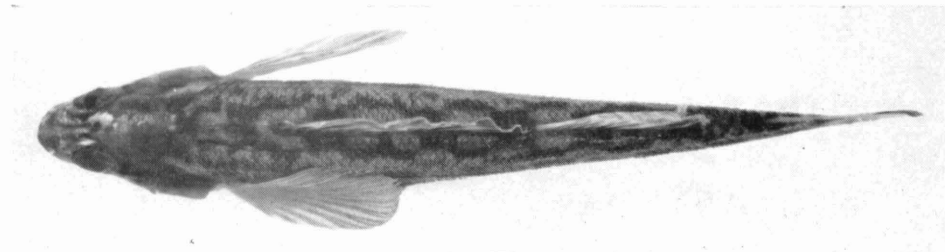


FIG. 4

