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# LATE PLEISTOCENE FISHES FROM THE SHELTON MASTODON SITE (OAKLAND COUNTY, MICHIGAN) AND THEIR ECOLOGICAL CONTEXT

by

JEHESKEL SHOSHANI<sup>1</sup> and GERALD R. SMITH<sup>2</sup>

*Abstract*—Twenty-five identifiable fish bones were collected in lacustrine deposits at the Shelton Mastodon site in Oakland County, Michigan, USA. These bones represent four genera and four families, *Esox* (Esocidae), *Ameiurus* (Ictaluridae), *Lepomis* (Centrarchidae), and *Perca* (Percidae). All genera live in the Great Lakes region today, but two genera (*Lepomis* and *Perca*) and four species (*Esox lucius*, *Ameiurus melas*, *Lepomis cyanellus*, and *Perca flavescens*) represent the first records for the late Pleistocene of Michigan. Assignment to the Twocreekan substage of the late Wisconsinan is based on stratigraphic analysis and on 14 radiocarbon dates on plant and bone samples collected in different places in a wall profile at the excavation site. Profiles at the SMS are composed of three strata: the lowest is clay, the middle is sandy with wood and rocks at its base, and the upper is black muck. The range of radiocarbon ages for the lower portion of the bone-bearing middle unit is  $12,320 \pm 110$  to  $11,740 \pm 175$  years before present (ybp), and the range for the base of the top unit is  $9,640 \pm 120$  and  $9,490 \pm 295$  ybp. The lower unit yielded diatoms and mollusks, the middle unit plants, mollusks, insects, fishes, amphibians, and mammals (including American mastodon *Mammot americanum*, and Scott's moose *Cervalces scotti*), and the top unit yielded plants, mammals, and three archaeological objects. Ecological inferences based on modern representatives of the fish assemblage support a variety of habitats from oligotrophic and eutrophic waters with slightly cooler summers than those of the present in southeastern Michigan. Data presented here support inferred paleoecology based on stratigraphy, tree stumps and logs, coniferous cones and needles, pollen grains, diatoms, mollusks, amphibians, and mammals. The evidence suggests spruce (*Picea*) forest with clearings, lakes, and ponds during the Twocreekan substage (about 12,300 to 11,750 ybp) followed by a shift to pine (*Pinus*) dominated habitat in early Holocene times (about 10,000 ybp).

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<sup>1</sup>Department of Biological Sciences, Wayne State University, Detroit, Michigan 48202; and Cranbrook Institute of Science, Box 801, 500 Lone Pine Road, Bloomfield Hills, Michigan 48303-0801.

<sup>2</sup>Museum of Paleontology and Museum of Zoology, The University of Michigan, Ann Arbor, Michigan 48109-1079.

TABLE 1—Summary of Pleistocene fish specimens collected at the Shelton Mastodon Site, Oakland County, Michigan.

Taxon	Museum no.	Field no.	Description	Collection date	Grid sq. <sup>1</sup>	Individuals <sup>2</sup>
<i>Esox lucius</i> (Esocidae)	UM 13554	V123/443	Two vertebrae	18 Aug. 1984	NSP <sup>3</sup>	1-2
	UM 13555	V181/849	Five vertebrae	15 July 1987	NSP <sup>3</sup>	1-5
	UM 13556	V186/854	One basioccipital	22 July 1987	NSP <sup>3</sup>	1
	UM 13557	V195/863	One tooth	6 Aug. 1987	NSP <sup>3</sup>	1
	UM 13558	V200/868	One small vertebra	11 Aug. 1987	NSP <sup>3</sup>	1
	UM 13559	V212/1002a	One dentary, right, and 4 vertebrae	17-31 July 1988	NSP <sup>3</sup>	1-5
					Subtotal	2-15
<i>Ameiurus melas</i> (Ictaluridae)	UM 13560	V188/856	One cleithrum, right	26 July 1987	C4	1
	UM 13561	V190/858	One Weberian apparatus	26 July 1987	C4	1
					Subtotal	1-2
<i>Lepomis cyanellus</i> (Centrarchidae)	UM 13562	V189/857	One operculum, right	26 July 1987	C4	1
					Subtotal	1-1
<i>Perca flavescens</i> (Percidae)	UM 13563	V058/163	One operculum, left	12 July 1983	D4	1
	UM 13564	V079/290	One operculum, left	27 July 1983	D1	1
	UM 13565	V081/296	One vertebra	28 July 1983	C4	1
	UM 13566	V204/872a	One maxilla, left	17 Aug. 1984	F4	1
	UM 13567	V204/872b	One preoperculum, left	17 Aug. 1984	F4	1
	UM 13568	V204/872c	One supracleithrum, right?	17 Aug. 1984	F4	1
	UM 13569	V204/872d	One atlas vertebra	17 Aug. 1984	F4	1
					Subtotal	3-7
					Total	7-25

<sup>1</sup>Letters designate square in the excavation grid system where specimen was found<sup>2</sup>Explanations for minimum and maximum number of individuals, with subtotals and total, are given in the text<sup>3</sup>These bones were found in clay or sandy sediment in material excavated from the north side of the pond

## INTRODUCTION

The Shelton Mastodon Site [SMS] is a late Pleistocene fossil locality and archaeological site. As the name implies, the site is best known because it yielded the partial skeleton of a mastodon, but many other aspects of the site have been or are being studied. This paper is one in a series of reports on floristic, faunistic, and cultural elements collected at the Shelton Mastodon Site: Stoermer et al. (1988) on diatoms, Shoshani (1989) on mastodons, Shoshani et al. (1989a,b, 1990) on projectile points, Shoshani and Newsom (1989) on wood anatomy, DeFauw and Shoshani (1991) on amphibians, Thurlow and Shoshani (1996) on mollusks, Morgan et al. (in preparation) on Coleoptera, Snyder and Shoshani (in preparation) on pollen, and Zawiskie and Shoshani (in preparation) on stratigraphy.

In this paper we describe the fish specimens collected at the Shelton Mastodon Site and discuss their ecological significance. All fish collected at the SMS are native to Michigan today (Hubbs and Lagler, 1958; Bailey and Smith, 1981). The SMS osteichthian assemblage, though small (Table 1), provides evidence of the status of the freshwater fish community in southern Michigan between 12 and 9.5 thousand years ago. The significance of these finds for Pleistocene ecological reconstruction is enhanced by their well-documented association with other plant and animal fossils. Recent reports on Pleistocene fish remains from Michigan and the Great Lakes region are by Holman et al. (1986) and Steadman (1988); older papers are discussed in the text.

## GEOLOGICAL SETTING AND LOCALITY INFORMATION

The post-glacial history of the Great Lakes region in general and of Michigan in particular is well documented (Bay, 1938; Dorr and Eschman, 1970; Eschman and Mickelson, 1986; Evanson et al., 1976; Farrand and Eschman, 1974; and Kelley and Farrand, 1967). Oakland County is covered by a complex blanket of upper Wisconsinan sediments derived, in part, from the retreat of the Saginaw and Huron ice lobes. The topography is dominated by two northeast-southwest oriented moraine systems, in the northern and southern parts of the county. These moraines are separated by outwash plains, and an extensive glacial lacustrine plain is present in the southeastern portion of the county (Farrand and Eschman, 1974). During the early time, represented by deposits at the SMS site, the southern edge of the ice sheet was fluctuating over the northern lower peninsula of Michigan and the northern lakes Michigan and Huron. During the later part of SMS deposition, the glacial front receded north of Lake Superior (Prest, 1970).

The Shelton Mastodon Site was discovered in October of 1977 when Mr. K. Harold Shelton was dredging a pond along the course of an existing seasonal stream in a low marshy habitat. The SMS is located in Brandon Township (SE¼, SE¼, Section 26, T5N, R9E, Oakland County, Michigan), at an elevation of 317 m (1040 ft.), longitude approximately 82° 20' W, and latitude approximately 42° 50' N (Fig. 1). Because cultural remains were found at the site (two Early Archaic projectile points and one slightly modified flake), the SMS was assigned Michigan Archaeological Site number 20-OK394; details are given in Shoshani et al. (1989b). Field work at the SMS was carried out during the summer months of 1983-1987, using standard techniques described by Joukowsky (1980), Kummel and Raup (1965), and Rixon (1976).

A typical stratigraphic cross-section at the site reveals three distinctive units above glacial deposits (Fig. 2). Figure 2 also shows 10 of the 14 radiocarbon dates obtained from wood and bones collected at SMS. The forest floor, located at the bottom of the middle unit (Unit II), is on top of the clay of the lower unit (Unit I), and is evidenced by a laterally-continuous bed of spruce needles, cones, horizontal logs, charcoaled wood, in situ spruce tree stumps, rocks, cobbles, and boulders (Fig. 2). The latter (mostly cobbles and boulders) are of glacial origin,

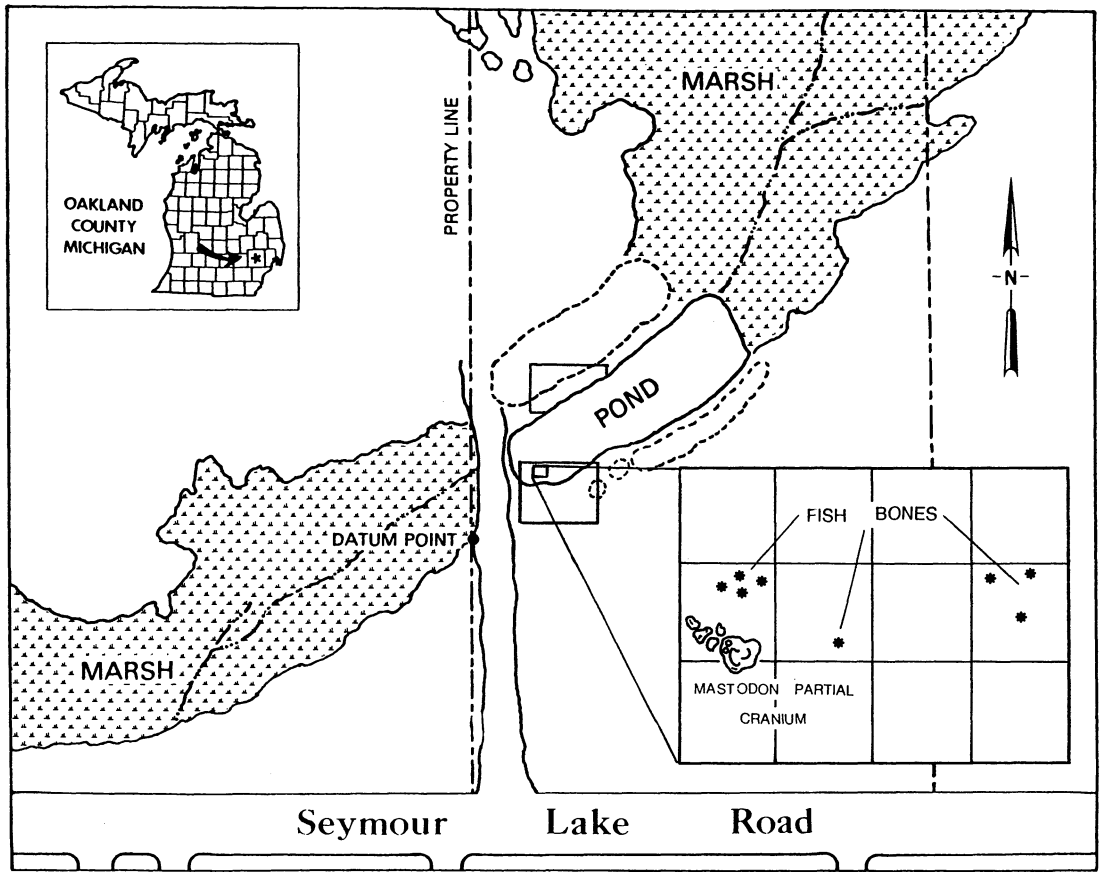


FIG. 1—Map of the Shelton Mastodon Site (1 cm in the figure  $\approx$  9 m on the ground). Top inset: map of Michigan with arrow pointing to Oakland County, location of the Shelton Site. Bottom inset: area where fish bones were found (modified after Shoshani et al., 1989b, p. 398; illustrated by Jann S. Grimes).

probably from the adjacent morainal highland. Mastodon (*Mammut americanum*), Scott's moose (*Cervalces scotti*), fish bones, and other fauna occur at this level (Unit II), which were buried during episodic sedimentation events, probably following fires that periodically denuded the morainal highlands. Faunistic and floristic data from SMS support a marginal lacustrine environment between 12,300 to 11,750 ybp.

The boundary between Unit II and Unit III is marked by a gradational shift from sandy sediments to interbedded dark brown to black muck and peat; we refer to this boundary as the transition zone (Fig. 2). At this time, the ice sheet had retreated from the Great Lakes basins (Prest, 1970). The black mucks in this part of Michigan are known as Houghton and Adrian mucks (United States Department of Agriculture Soil Conservation Service, 1982). Cone and wood samples and associated pollen grains show that most of the organic detritus from Unit III was derived from a pine forest that surrounded ponded areas and low-lying bog habitats (Fig. 2). These ponds and bogs may have developed as by-products of beaver dams. Tree logs (birch, genus *Betula*) with bark on them rested on the top of sand and muck of the transition zone, and were covered by the muck of Unit III. Strata of Unit III varied in thickness from zero uphill from the modern stream to about 60 cm (sometimes thicker) adjacent to the same

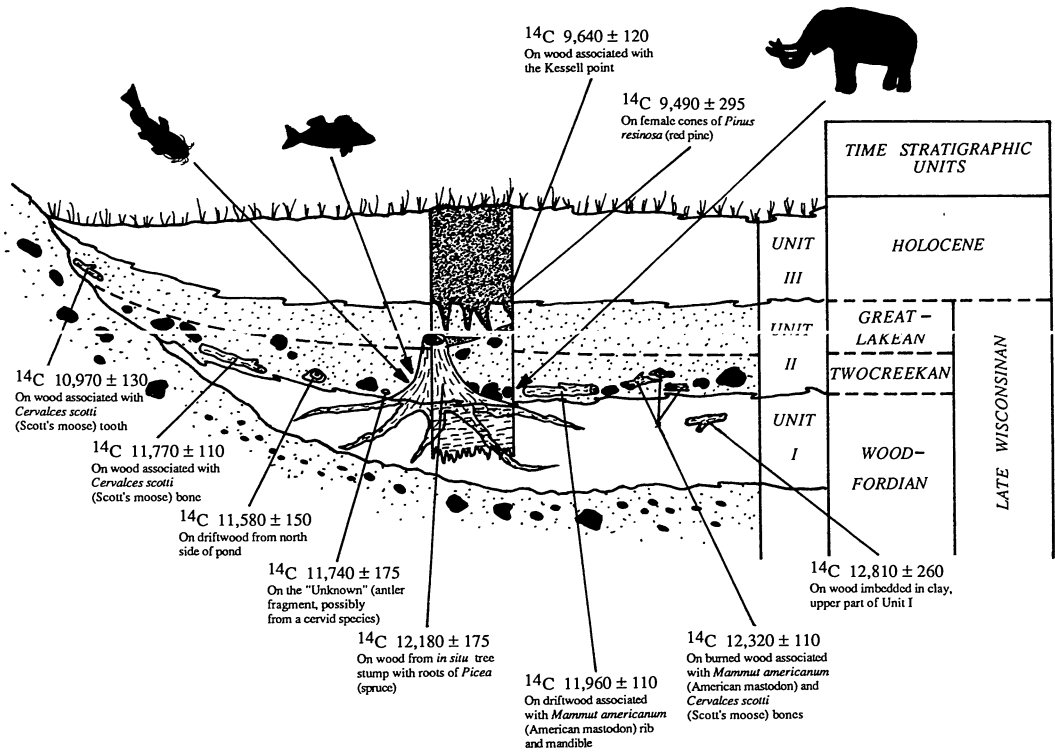


FIG. 2.—Composite, generalized stratigraphic cross section (south toward left) of the Shelton Mastodon Site, with associated radiocarbon dates and locations where fish bones were found (modified after Shoshani et al., 1989b, p. 403; illustrated by Jann S. Grimes).

water course. Sediments of this Unit were coarser, looser, and darker in color than those of Unit II. A system of complete orthogonal cracks in the middle of unit III descended as wedges into the lower layers of Unit II, and measured 5-20 cm wide at the top and 30-60 cm vertically (similar cracks were depicted by Beld, 1986:161).

Unit I, the blue-gray clay, is interpreted as having been deposited in an open lacustrine setting. This is corroborated by presence of many aquatic gastropods, unionids, and diatoms in this unit suggesting nutrient-rich, well oxygenated water. Unit I is overlaid by a complex sequence of interbedded sand, silt, and clay (Unit II), which is inferred to have been deposited over a long period of time in an oscillating marginal lacustrine environment. The lower part of unit II contains a spruce forest floor that developed on the lacustrine sediments following a drop in lake level. Occasional charcoaled wood in this zone attests to forest fire(s) in the surrounding area. Following the fire(s), binding and baffling capacity of the vegetation may had been temporarily reduced, allowing pebbles and cobbles to erode from the adjacent moraines toward the base of what we define as Unit II. Subsequent episodic sedimentation may have been responsible for the burial and preservation of the faunule, including the fish and the mastodon. Eventually, sandy sediments buried the entire forest zone as the lake expanded and contracted, and ultimately, the lake was filled in by clastics, and a network of prominent polygonal fissures developed on the exposed surface (Shoshani et al., 1989b).

The underlying outwash and morainal till (beneath Unit I) in the area are part of the Defiance morainal system and were built during the Port Bruce Stade (ca. 14,500 ybp; Eschman and Mickelson, 1986). The geochronology at the SMS has been established on the

TABLE 2—Radiocarbon dates for fourteen samples from the Shelton Mastodon Site, Oakland County, Michigan (modified from Shoshani et al., 1989b, p. 402). Stratigraphic units are shown in Figure 2.

Sample number	Laboratory <sup>1</sup> number	Material	Radiocarbon <sup>2</sup> age	Notes
<b>A. Holocene strata, Unit III</b>				
V159/560	GX-14037-G	Bone gelatin	35 <sup>3</sup> ± 130	Sample 1, small sample of artiodactyl bone previously cast in epoxy.
—	GX-13505	Bone fragments	535 ± 220	Collected on north side of pond in dump pile of 1977 material; 15 bone fragments of a squid.
—	GX-13682	Red pine cones (5)	9,490 ± 295	Collected 3 August 1987 45-50 cm below surface in square V10; <i>Pinus resinosa</i> (weight 10.1 g).
P221/435	B-10302	Wood	9,640 ± 120	Collected 8 August 1984; fragments in lowest level of square AA1 associated with the Kessell projectile point.
<b>B. Pleistocene strata, Unit II</b>				
P224/441	B-13212	Wood	10,020 ± 80	Collected 10 July 1985 in square F4 <sup>4</sup> from in situ tree stump with roots.
—	GX-13099	<i>Mammut</i> bone	10,875 ± 155	Collected from the surface in 1983; 18 samples totaling 87 cranial fragments.
P223/437	B-10303	Wood	10,970 ± 130	Collected 17 August 1984 in the upper level of square J2, in close proximity to <i>Cervalces scotti</i> tooth fragments.
P336/639	GX-13681	Wood	11,580 ± 150	Collected 18-21 August 1987 on north side of pond.
V161/562	AA-2315 <sup>5</sup>	"Unknown"	11,740 ± 175	Collected 12 August 1986 in the lower level of square L10 (see Shoshani et al., 1989b).
P229/482	B-14266	Wood	11,770 ± 110	Collected 3 August 1985 in the lower level of square g2; associated with <i>C. scotti</i> dentary fragments and teeth.
P165/323	B-9083	Wood	11,960 ± 110	Collected 30 July 1983 in the lower level of square d1; associated with <i>Mammut americanum</i> rib and mandible.
P314/617	GX-13098	Wood	12,180 ± 175	Collected 18 August 1986 in square DD4 from in situ tree stump with roots.
P148/303	B-9084	Charcoaled wood	12,320 ± 110	Collected 11, 13, 22 and 27 July 1983 from squares D1, D2, D3, and D4 <sup>4</sup> ; fragments associated with <i>C. scotti</i> and <i>M. americanum</i>
<b>C. Pleistocene strata, Unit I</b>				
—	GX-14038	Wood	12,810 ± 260	Collected in square V10 imbedded in clay.

<sup>1</sup>B: Beta Analytic Inc., Coral Gables, Florida. GX: Geochron Laboratories Division, Cambridge, Massachusetts.<sup>2</sup>Ages are radiocarbon years before 1950 A.D.<sup>3</sup>Bone gelatin yield was good for a small sample, and appeared to be of good quality; thus it seems unlikely that the modern result can be attributed to the epoxy casting contamination.<sup>4</sup>Excavation squares where fish specimens were found, when known, are given in Table 1.<sup>5</sup>Age obtained from the University of Arizona, Tucson, using an electron acceleration technique; all other ages were determined using conventional methods.



basis of 14 radiocarbon dates (Table 2) as follows: one for the upper portion of Unit I ( $12,810 \pm 260$  ybp), eight for the lower portion of Unit II (range =  $12,320 \pm 110$  to  $11,740 \pm 175$  ybp for the south side of pond), one for the upper portion of Unit II ( $10,970 \pm 130$  ybp), two for the lowest portion of Unit III ( $9,640 \pm 120$  and  $9,490 \pm 295$  ybp), and two for the uppermost portion of Unit III ( $535 \pm 220$  and  $35 \pm 130$ ; the latter determined on domestic mammals). Based on detailed stratigraphic analysis and  $^{14}\text{C}$  data, Shoshani et al. (1989b) designated the lower stratum of Unit II as the Twocreekan substage of the late Wisconsinan. The date of  $9,490 \pm 295$  ybp (Shoshani, 1990), for female cones of the red pine (*Pinus resinosa*) collected in Unit III, close to the Holocene (Unit III)/Pleistocene (Unit II) boundary at the SMS, is a date which fits well within the geochronology of the SMS. The lowest part of Unit III is clearly of Holocene age ( $9,640 \pm 120$  ybp). Moreover Early Archaic projectile points (identified by Henry T. Wright as a Kessel point and a LeCroy point) from the bottom of Unit III are considered to be between 8,500 and 10,000 years old (Broyles, 1971; Fitting, 1975; Fitting et al., undated; Shoshani et al., 1989a, 1990).

### SYSTEMATIC DESCRIPTION OF FISHES

Here follows a brief account of the fish material found in Unit II at the SMS. Identifications of bones were confirmed using the osteological collection of the Division of Fishes, University of Michigan Museum of Zoology. All specimens are in the collections of the University of Michigan Museum of Paleontology [UM], Ann Arbor, Michigan. A summary of Pleistocene fish specimens collected at the Shelton Mastodon site is given in Table 1, and a general illustration with locations of bones on the skull and skeleton are given in Figure 3; specific bones are detailed in Figures 4-6.

#### Family ESOCIDAE

##### *Esox lucius* Linnaeus [northern pike] Fig. 4A-D

**Material.**—UM 13554, 13555, 13556, 13557, 13558, and 13559 (Fig. 4A-D): 13 vertebrae (UM 13554, 13555, 13556, 13558, and 13559), a nearly complete right dentary (UM 13559) and one tooth (UM 13557). The dentary measures 88.5 mm long, 8.7 mm wide at the anterior end, 31.0 mm wide at the posterior end, and varies in thickness from 1.2 mm to 6.3 mm. The tooth measures 12 mm long, 4.8 mm wide at its base, and 2.2 mm thick at the same point. There are one basioccipital vertebra and 12 body vertebrae; the former measures 17.0 mm long, 14.4 mm wide, and 12.5 mm thick.

**Remarks.**—Minimum and maximum number of individual fish represented by these bones are two and 15, respectively. Based on the size and shape of the tooth of one fish, it is estimated that the fish was about 60-70 cm long. The dentary of another fish has five sensory pores, diagnostic of *Esox lucius*. It and the vertebrae represent a fish about 50 cm long. In comparing the SMS pike vertebrae with those of recent pike, we find 6-7 year-old fish reaching a total length of about 50 cm. This growth is slower than present local pike growth, and compares to that of Alberta and Saskatchewan pike today (Scott and Crossman, 1973, p. 358-359).

**Distribution and habitat.**—The pike inhabits clear, slow, vegetated rivers and weedy bays of lakes (Scott and Crossman, 1973). Its distribution is circumpolar, in North America from Alaska south to Missouri and Nebraska, east of the Rocky Mountains and west of the Appalachians (Scott and Crossman, 1973). Spawning occurs in the spring at  $4^{\circ}$  -  $11^{\circ}$  C. Hatching occurs at  $18^{\circ}$  -  $20^{\circ}$  C.

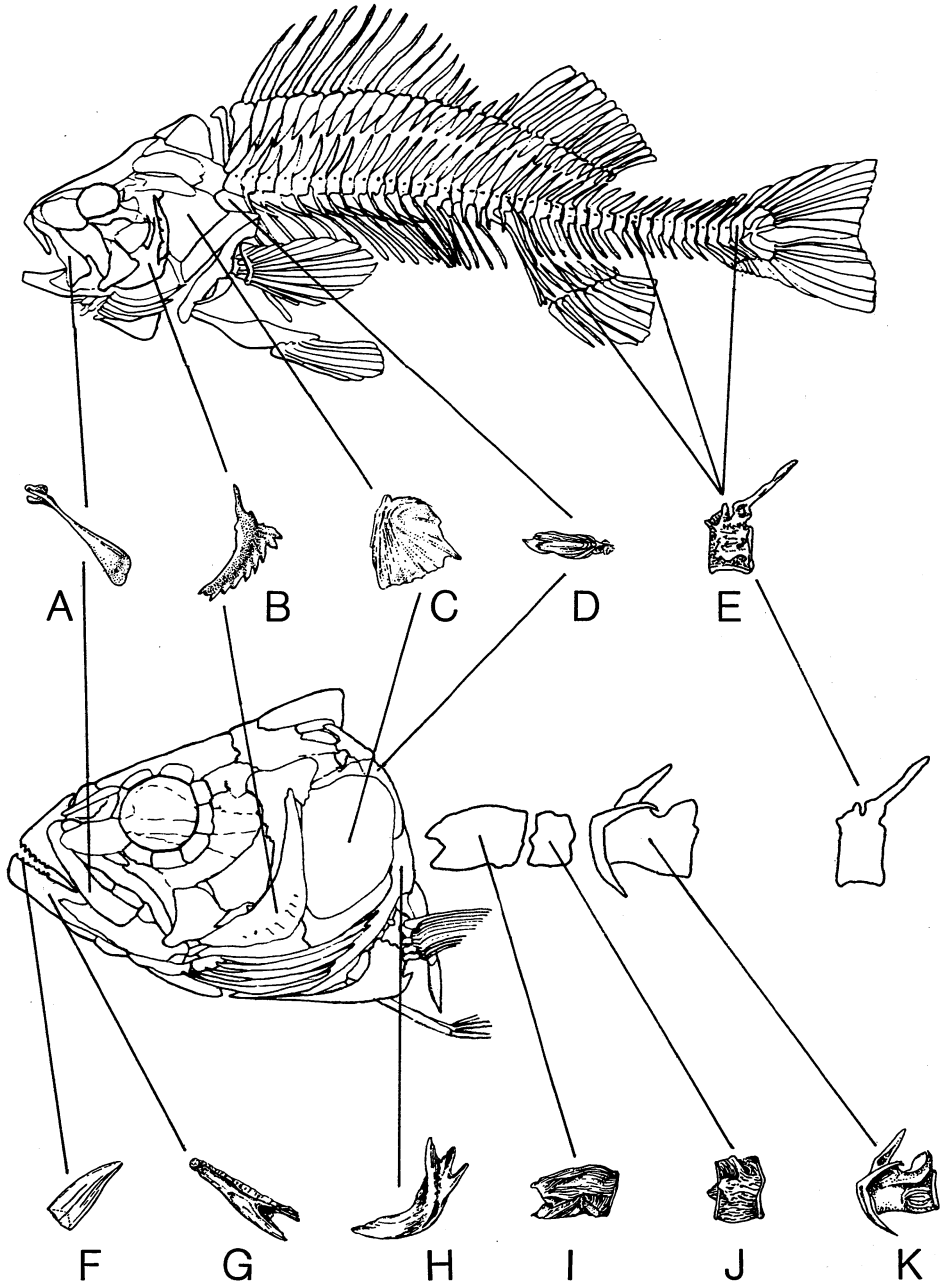


FIG. 3—Diagrams of a skeleton of *Perca flavescens* (top, modified after Dean, 1895) and a composite syncranium of a teleost fish (bottom, modified after Gregory, 1959) depicting locations of bones that were found at the Shelton Mastodon Site. Individual bones (A-E) were identified as belonging to *P. flavescens*; all other others (F-K) were identified as belonging to other fish species (see Figs. 4, 5, and 6 for details). Key: a, maxilla; b, preoperculum; c, operculum; d, supracleithrum; e, vertebra (thoracic or caudal); f, tooth; g, dentary; h, cleithrum; i, basioccipital; j, atlas vertebra; k, Weberian apparatus (illustrated by Trina J. Fennell and Jann S. Grimes).

*Fossil occurrence.*—The genus is known from the Paleocene and the species from the late Pleistocene to Holocene in North America (Wilson, 1984; Smith, 1981, p. 165). In Michigan, the genus, not the species, was documented in Pleistocene deposits (Wilson, 1967, p. 201; Dorr and Eschman, 1970, p. 401). Late Pleistocene *Esox lucius* was reported from the southern end of Lake Michigan (Teller and Bardack, 1975).

#### Family ICTALURIDAE

*Ameiurus melas* (Rafinesque) [black bullhead]

Figs. 4E, 5

*Material.*—UM 13560 and 13561 (Fig. 4E): one nearly complete right cleithrum (UM 13560) and one nearly complete Weberian apparatus (UM 13561; Fig. 5). The cleithrum measures 27.5 mm from the anterior edge to posterior tip of the ventral spine, and 9.0 mm between the tips of the dorsal and ventral spines and is 2.2 mm thick. The Weberian apparatus is 19.0 mm wide, 12.1 mm long, and 13.5 mm high.

*Remarks.*—Minimum and maximum number of individual fish represented by these bones are one and two. The species is recognized by the shape and texture of the plural ribs of the Weberian apparatus and the shape and texture of the spines of the cleithrum. (The Weberian apparatus is composed of five anterior vertebrae and associated ribs, and transmitted vibrations from the swim bladder to the inner ear.) Based on the sizes of these bones, the fish were about 15 cm in total length.

*Distribution and habitat.*—The black bullhead occurs in low-gradient streams, oxbows, and ponds of the Mississippi and Gulf of Mexico drainages, north to the Great Lakes drainages and southern Canada (Trautman, 1981).

*Fossil occurrence.*—The genus is known from the Miocene to Recent (Lundberg, 1975). *Ameiurus melas* was reported from Wisconsin by Teller-Marshall and Bardack (1978).

#### Family CENTRARCHIDAE

*Lepomis cyanellus* Rafinesque [green sunfish]

Fig. 4F

*Material.*—UM 13562; one right operculum (Fig. 4F). This bone measures 11.0 mm long, 10.0 mm high, and 1.1 mm thick.

*Remarks.*—Based on the size of this operculum, it is estimated that the fish was 8 cm long. The green sunfish was identified by the characteristic shape and serration of the operculum.

*Distribution and habitat.*—The native distribution of the green sunfish is from the lower Great Lakes drainages, south through the Mississippi drainage and southwest to the Rio Grande.

*Fossil occurrence.*—The genus is known from the Miocene to late Pleistocene and Holocene (Smith, 1981, p. 167). *Lepomis cyanellus* was reported for Wisconsin (Teller-Marshall and Bardack, 1978).

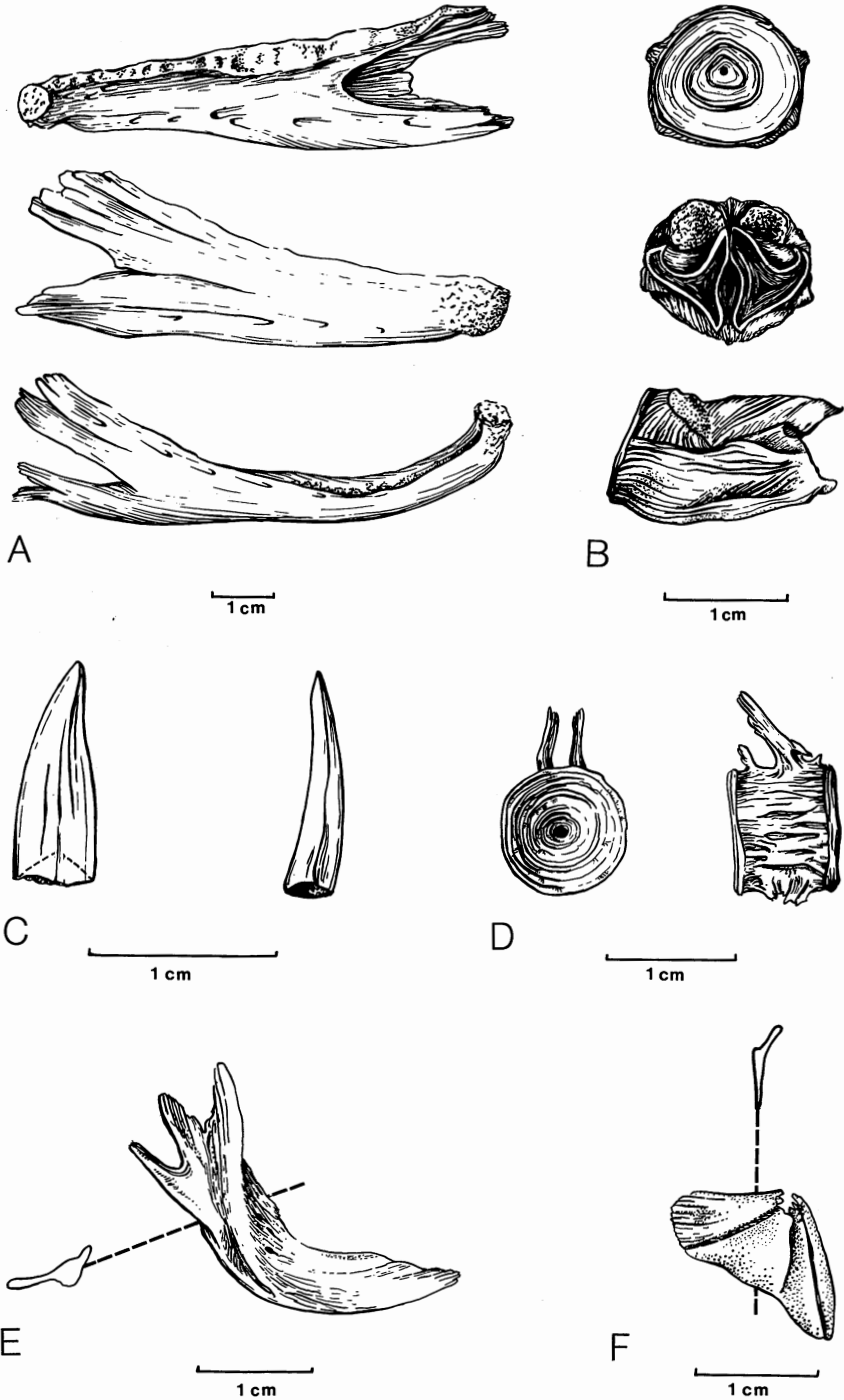


FIG. 4—Fishes from the Shelton Mastodon Site: *Esox lucius* (A-D, northern pike, family Esocidae), *Ameiurus melas* (E, black bullhead, family Ictaluridae), and *Lepomis cyanellus* (F, green sunfish, family Centrarchidae). A, *Esox lucius*, UM 13559, right dentary in medial, lateral, and dorsal views. B, *Esox lucius*, UM 13556, basioccipital in posterior, anterior, and lateral views. C, *Esox lucius*, →

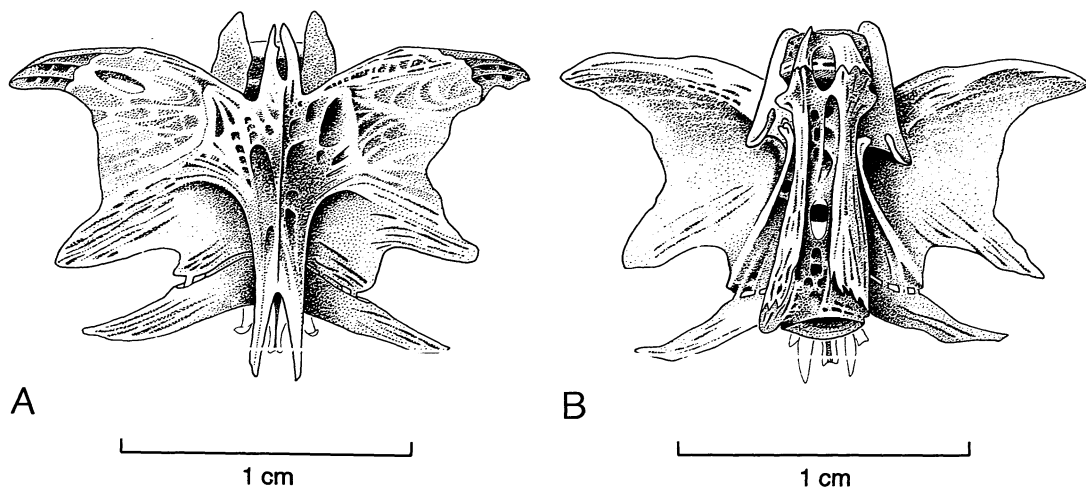


FIG. 5—*Ameiurus melas* (black bullhead, family Ictaluridae) Weberian apparatus found at the Shelton Mastodon Site, UM 13561, in dorsal (A) and ventral views (B). Anterior is toward the top of the page. Illustrated by B. Miljour.

#### Family PERCIDAE

##### *Perca flavescens* (Mitchill) [yellow perch]

##### Fig. 6

**Material.**—UM 13563, 13564, 13565, 13566, 13567, 13568, and 13569 (Fig. 6): two left opercula (UM 13563 and 13564), one left maxilla (UM 13566), one left preoperculum (UM 13567), one right supracleithrum (UM 13568), one atlas vertebra (UM 13569), and one vertebra (UM 13565). One of the opercula (UM 13563) measures 21 mm long, 17.5 mm wide, and 3.6 mm thick, the other (UM 13564) measures 13.3 mm long, 11.5 mm wide, and 1.0 mm thick (UM 13564 measurements were estimated). The left maxilla is 8.9 mm long, 2.6 mm wide, and 2.0 mm thick, and the preoperculum measures 2.9 mm long and 2.8 mm wide, and 0.5 mm thick. The supracleithrum measures 9.8 mm long, 3.3 mm wide, and 1.0 mm thick.

**Remarks.**—Minimum and maximum number of individual fish represented by these bones are three and seven, respectively. Based on the size of the bones, it is estimated that the fishes were small, 8-13 cm long. Jawbones of the yellow perch are identified by their distinctive shapes; the preopercle has distinctive serrations; the opercle has distinctive spines.

**Distribution and habitat.**—The yellow perch is native from Great Slave Lake to Nova Scotia and south to Kansas and South Carolina. It inhabits lakes, ponds, and low-gradient rivers (Scott and Crossman, 1973).

**Fossil occurrence.**—The genus is known from the Pleistocene to Holocene of North America (Smith, 1981, p. 167).

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UM 13557, tooth. D, *Esox lucius*, UM 13554, thoracic vertebra in posterior and lateral views; anterior is at the right. E, *Ameiurus melas*, UM 13560, right cleithrum in lateral view. F, *Lepomis cyanellus*, UM 13562, right operculum in lateral view. Illustrated by Trina J. Fennell.

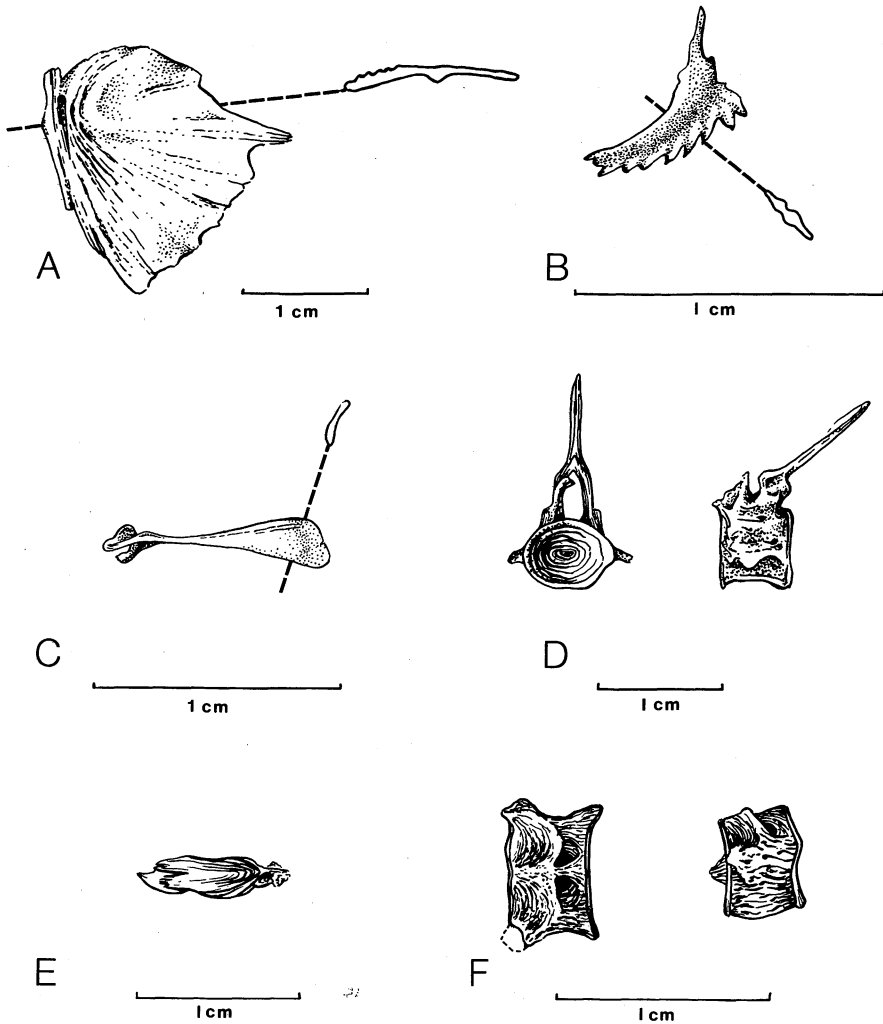


FIG. 6—*Perca flavescens* (yellow perch, family Percidae) skeletal elements found at the Shelton Mastodon Site. All bones are from the left side and viewed laterally except as noted. A, UM 13563, operculum. B, UM 13567, preoperculum. C, UM 13566, maxilla. D, UM 13565, thoracic vertebra in anterior (left) and lateral views (right, with anterior toward the left). E, UM 13568, right supracleithrum. F, UM 13569, atlas vertebra in dorsal (left) and lateral views (right, with anterior toward left). Illustrated by Trina J. Fennell.

#### ECOLOGICAL INFERENCES

*Esox lucius*, the northern pike (family Esocidae), is the largest of the fish species found at the SMS, followed by the yellow perch, black bullhead, and green sunfish. *Esox* is a large predator that feeds mostly on fish, but occasionally on frogs and other small animals. It inhabits open waters of lakes, ponds, and streams and indicates the presence of a large body of water. It winters in deep waters but spawns in the spring in shallow water and flooded marshes. Perch (*Perca*) and green sunfish (*Lepomis*) feed on zooplankton, insects, and smaller fishes. They inhabit vegetated lakes and quiet parts of streams.

The bullhead (*Ameiurus*) and sunfish (*Lepomis*) indicate warm waters and a long growing season. The pike (*Esox*) and perch (*Perca*) indicate cool waters, with the normal average summer temperature of the warmest month not exceeding 27° C. These four species presently coexist in the Great Lakes and upper Mississippi drainages. Comparing our specimens to museum fish skeletons of known age and size indicates slow growth in the SMS habitat; the pikes were 6-8 years old and measured 50-70 cm long. The two yellow perch were 4 years old and measured 8-13 cm long. Both *E. lucius* and *P. flavescens*, according to Scott and Crossman (1973), are fish of open waters; both spawn in the spring, in water temperature of 4° C, for *Esox* and 9-12° C, for *Perca* (Scott and Crossman, 1973, pp. 358, 757).

The presence of green sunfish and black bullheads indicates SMS spring and summer temperatures and length of growing season similar to those of Michigan today. Summers could not have been cooler than the present temperatures in the northern Great Lakes region. We speculate, therefore, that the area was not more than 3° C cooler in mean annual temperature, with April temperatures generally above freezing, and an average frost-free season of at least 120 days. These estimates are based on the correlations between the northern limits of the range of black bullhead and green sunfish today with climatic isopleths given by the U.S. Department of Commerce (1968).

A mean July land temperature of 14° to 16° C was estimated by Morgan and Morgan (1979) from analysis of terrestrial beetles at the Twocreekan stratotype at Two Creeks, Wisconsin (44° N latitude, which is 1.5° N of the SMS), suggesting analogy with conditions in the southern part of the modern boreal forest. Thus, these authors estimated that the Twocreekan July temperature was up to 10° C cooler than at present at this latitude. The paleoecology of the fish assemblage at the SMS is not consistent with Morgan and Morgan's (1979) hypothesis for Wisconsin, given the growth rate of the pike and the long growing seasons required by the sunfish and bullhead at SMS. The fish evidence suggests a frost-free growing season of at least 120 days, similar to central Minnesota at present (as compared to about 160 days at the SMS now).

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