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Remains of Tiny Fish from a Late Prehistoric Pomo Site Near Clear Lake, California

KENNETH W. GOBALET, Dept. of Biology, California State Univ., Bakersfield, CA 93311.

IN the analysis of the ichthyofauna recovered during the excavation of archaeological sites, materials obtained by fine-meshed screening provide information on small fishes. These remains complete a broad-spectrum picture of the fishes used in prehistory and prevent bias that results from the exclusive use of large-mesh screens (Fitch 1969; Casteel 1972a:385, 1976a:194). In instances where microscopic analysis of materials from California coastal middens has been undertaken (e.g., Fitch 1969, 1972; Johnson 1982; Gobalet 1988), the results have come from labor-intensive efforts not generally undertaken because of time and resource limitations.

An Asian market or Mexican grocery in the United States typically will have small, often tiny, dried fish for sale. Sardines, anchovies and herring are available in most American markets. Thus, even in some of the world's most affluent nations, small fishes are utilized. In archaeological studies in the United States and Canada, failure to conduct microanalysis overlooks potentially abundantly available resources. This is because most members of the largest family of North American freshwater fishes, the Cyprinidae (minnows), which were commonly used in prehistory, are under 100 mm. in standard length as adults (Lee et al. 1980:140-336). Native California minnows, however, tend to be larger.

Clear Lake, located in Lake County, California, is the largest natural freshwater lake wholly within the boundaries of the state. The introduction of 17 species of fishes over the past 100 years (Moyle 1976:6-13), has dramatically altered the species composition of the Clear Lake basin from prehistoric times when 14 native species were present (Hopkirk 1974:18). The thicktail chub (*Gila crassicauda*) and Clear Lake splittail (*Pogonichthys ciscoides*) are extinct fishes and can now be studied only indirectly through such sources as archaeological sites. A lamprey (*Lampetra* sp.) may have been extirpated and subsequently reintroduced to the basin (Taylor et al. 1982:191). The threespine stickleback (*Gasterosteus aculeatus*) and Sacramento perch (*Archoplites interruptus*) currently are rare in Clear Lake (Moyle 1976:8-11).

All fishes are small during their early developmental stages. The California roach (*Hesperoleucas symmetricus*) and threespine stickleback are tiny as adults and are smaller than 90 mm. standard length. Objectives of this study have been to recover and interpret the remains of tiny fishes from archaeological site CA-LAK-386 and to determine the season of occupation.

METHODS

Prior to the construction of Cache Creek Dam, archaeological site LAK-386 was located along a section of Cache Creek where it meandered through a low-gradient marsh near the community of Lower Lake, California (Fig. 1). It is situated approximately 2.5 km. upstream from the current outlet of Clear Lake at the Cache Creek Dam. This site,

Fig. 1. Location of archaeological site LAK-386.

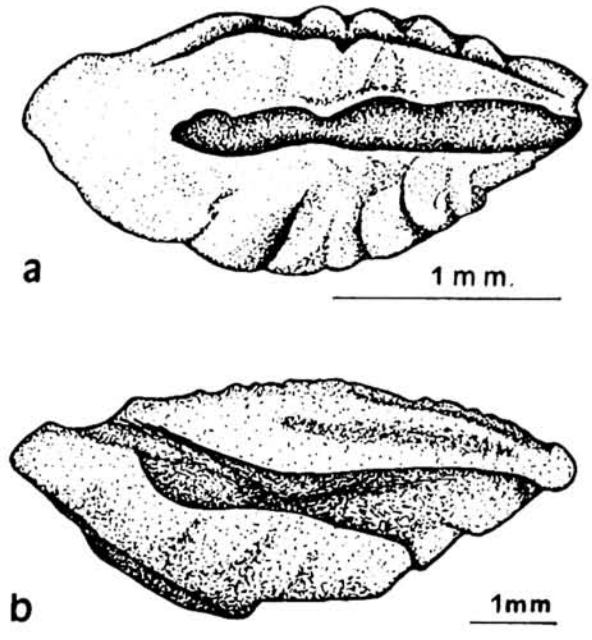

Fig. 2. Otoliths from prickly sculpin. a, right sagitta (length 2.4 mm.) from LAK-386, Unit 1, 50-60 cm. depth; b, right sagitta (length 6.9 mm.) from prickly sculpin 121 mm. in standard length.

within ethnographic Clear Lake Pomo territory, was occupied during the late prehistoric period (R. I. Orlins, personal communication 1989). This site was sampled in winter to spring 1988-1989 by California Archaeological Consultants, Woodland, California, under contract to the Sacramento District, U.S. Army Corps of Engineers, for a proposed channel modification project. Some of the analyzed materials were previously screened through 1/4-in. mesh. Materials from a pit feature were obtained by screening with 1/16-in.-mesh screens.

The bulk of this analysis is based on seven 1,000-cm.[3] column samples taken from the upper 60 cm. of excavation Unit 1. Each sample was washed through screens of 6 and 20 meshes per inch. Additionally, three levels were screened with sieves of 40 meshes per inch. Each sample was wet screened, dried, and examined under a dissecting microscope. Particular attention was directed toward the recovery of otoliths, which have been found in abundance in southern California middens when microanalysis is undertaken (e.g., Fitch 1969, 1972; Huddleston and Barker 1978).

Standard lengths of the fish from which these remains came were estimated by comparison with fish of known standard length in osteological collections. For the cyprinids, a regression curve was generated based on the width of the vertebral centra of skeletons of all available minnows of known standard length. Casteel (1974:Fig. 4) combined all suckers in much the same way.

The identification of the otolith (Fig. 2a) from the prickly sculpin (*Cottus asper*) is based on the 2.2-mm.-long right sagitta taken from an individual 46 mm. in standard length.

Fish names follow Robins et al. (1980) except that the spelling of the specific name for the tule perch, *Hysterocarpus traskii*, has priority (W. I. Follett, personal communication 1989) and *Oncorhynchus mykiss* is now the accepted name for the rainbow trout. The taxonomic status of the Clear Lake splittail and Clear Lake minnow (*Endemichthys* [*Hesperoleucas*] *grandipinnis*) is controversial (Hopkirk 1974:57; Hubbs 1974:809; Miller and Smith 1984; Hopkirk 1988:185). Presently available materials are insufficient to help resolve the debate.

SEASONALITY DETERMINATION

Since all freshwater fishes of temperate climates are ectotherms, their seasonal growth rate is variable. In northern temperate waters the slow-growth period occurs during cold weather, from November to February (Rojo 1987:220-221). Most rapid growth occurs in mature fish from June to September (Chilton and Beamish 1982:10). As a consequence, the rate of growth of skeletal parts and scales varies throughout the year and leaves rings that can be used to determine the age of fish and approximate season of death (Casteel 1976b:78-83; Caillet et al. 1986:144-157). Dark annuli are observable in the centra of fish vertebrae corresponding to the time of slowed-down growth; an opaque zone between the annuli corresponds to a time of more rapid growth (Chilton and Beamish 1982:10).

In California, annulus formation apparently results from spawning stress during March to June (Casteel 1972b:406). With experience it is possible to estimate the comparative development of the opaque region and determine whether the fish died during early or late summer. Reading these growth rings is, however, subjective, and is part science, art, and metaphysics (Caillet et al. 1986:145). Follett (1967:99) read the circuli of the scales recovered from a coprolite from Lovelock Cave, Nevada, and concluded the fish died during late summer or early autumn. Casteel

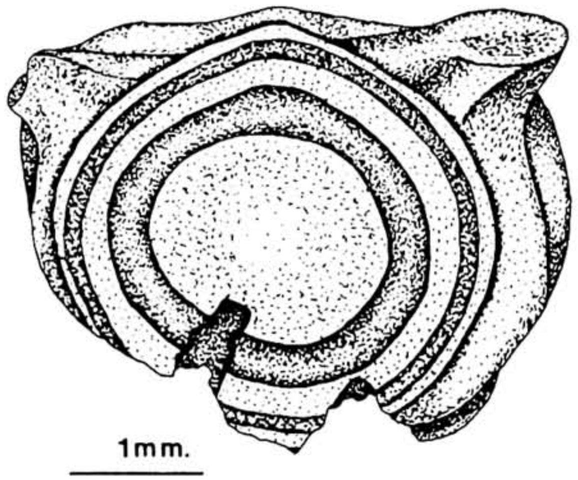

Fig. 3. First vertebra from a blackfish from LAK-386, 20-30 cm. depth.

(1972b:407-409) used the annuli of fish vertebrae to determine the season of two burials at French Camp, San Joaquin County, California. Figure 3 is an illustration of unusually clear growth rings in the vertebra of a blackfish (*Orthodon microlepidotus*) from LAK-386.

RESULTS AND DISCUSSION

All of the fishes found in this investigation are natives of California (Table 1). In fact, remains of all but four of the 14 fishes listed by Moyle (1976:6-13) as native to Clear Lake were found. Only 29 identifiable bones were obtained by field screening with 1/4-in.-mesh screen and laboratory screening the column sample with screen of 6 meshes/inch (Table 2). Field screening Feature 1 with 1/16-in.-screen by California Archaeological Consultants and microscopic examination of fine-screened column samples yielded 124 elements. Three species (hitch [*Lavinia exilicauda*], prickly sculpin, and threespine stickleback) were identified only from the 1/16-in.-mesh and finer screenings. Data are highly biased in favor of large individuals when only large screens are employed, findings consistent with those of Casteel

Table 1
SPECIES IDENTIFIED FROM LAK-386

Scientific Name	Common Name	Maximum Standard Length in mm.[a]
Family Cyprinidae		
Orthodon microlepidotus	Sacramento blackfish	450
Mylopharodon conocephalus	Hardhead	800
Lavinia exilicauda	Hitch	260
Ptychocheilus grandis	Sacramento squawfish	1150
Pogonichthys ciscoides	Clear Lake splittail	262[b]
Family Catostomidae		
Catostomus occidentalis	Sacramento sucker	500
Family Gasterosteidae		
Gasterosteus aculeatus	Threespine stickleback	50
Family Centrarchidae		
Archoplites interruptus	Sacramento perch	480
Family Embiotocidae		
Hysterocarpus traskii	Tule perch	160
Family Cottidae		
Cottus asper	Prickly sculpin	200

[a] Based on Moyle (1976:passim).
[b] Based on Hopkirk (1973:30).

(1976a:194). Typically, the fish indicated while using the screens 6 meshes/inch and larger are a minimum of 170 mm. in standard length, while those recovered with use of screens 1/16 in. and smaller may have standard lengths even smaller than 50 mm. The detailed provenience information on the recovered elements can be found elsewhere (Gobalet 1989).

The greatest number of identifiable remains are from the Sacramento perch and tule perch (Table 2). Most of the Sacramento perch remains are from fish under 80 mm. standard length. Young Sacramento perch inhabit areas with beds of rooted and emergent aquatic vegetation of lakes, sloughs, and sluggish rivers (Moyle 1976:294). Tule perch in Clear Lake school in large numbers and are associated with emergent aquatic plants or overhanging banks (Moyle 1976:337-338). Sticklebacks also are sluggish-water fish that live in weedy pools, over sand or mud, or among emergent plants at stream edges (Moyle 1976:280). Prior to modern-day habitat alteration, the Sacramento perch and tule perch were found in association with other fish (hitch, blackfish, and thicktail chub) that prefer slow-moving water (Schulz and Simons 1973:110). These clues from the natural history of these fish clearly suggest that the fishing emphasis at LAK-386 was among the vegetation of the slow-moving marshy waters, conditions that still exist in the area.

The absence of California roach from these remains further suggests that the tule marshes were the primary objective of the fishermen because California roach are found associated with Sacramento suckers (*Catostomus occidentalis*) and Sacramento squawfish (*Ptychocheilus grandis*) in streams (Moyle and

Table 2
SUMMARY OF RESULTS OF ANALYSIS OF LAK-386

	Unit 1 Column Sample Sieve 40/in.		Unit 1 Column Sample Sieve 20/in.		Unit 2 Feature 1 1/16-in.-mesh and flotation		Units 1 and 2 1/4 in. and 6 mesh/in. Screening combined	
Species	**Number of Elements**	**Estimated S.L. in mm.**	**Number of Elements**	**Estimated S.L. in mm.**	**Number of Elements**	**Estimated S.L. in mm.**	**Number of Elements**	**Estimated S.L. in mm.**
Sacramento blackfish	2	Very small	1	150	–	–	4	300-450 (MNI = 3)
Hardhead	–	–	6	< 70-135 (MNI = 4)	1	200	1	250
Hitch	–	–	1	< 70	7	150-270 (MNI = 3)	–	–
Prickly sculpin	–	–	1	50	–	–	–	–
Sacramento perch	1	80	12	< 80	14	< 100	1	?
Sacramento sucker	–	–	1	100	3	300	9	170-500[a] (MNI = 8)
Clear Lake splittail	–	–	1	135	–	–	2	170,300 (MNI = 2)
Sacramento squawfish	–	–	–	–	–	–	1	300
Threespine stickleback	4	50	7	50	3	50		
Tule perch	4	< 70	36	< 60-100 (MNI = 5)	6	60, 100	3	< 100-130 (MNI = 3)
Cyprinidae	4	< 50	4	60-180 (MNI = 4)	5	150-325 (MNI = 3)	8	180, 250, 325

[a] Eight are over 300.

Nichols 1973:484), not with the fauna of sluggish waters. California roach may also be associated with rainbow trout in streams (Taylor et al. 1982). Neither fish was found here. The squawfish, Sacramento sucker, and hardhead (*Mylopharodon conocephalus*) remains identified here include the largest individual fish caught. Since these fish generally prefer more open areas or streams (Schulz and Simons 1973:110; Moyle 1976:214) it is suggested that these larger fish were taken from the main stream by a technique that excluded the tiny roach. The fish dams and drags, traps, weirs, and harpoons used by the Dry Creek Pomo in streams as described by Theodoratus et al. (1975:108-128) probably would have excluded small fish. The scarcity of hitch is surprising considering their popularity among the Pomo (Moss 1989:13). Hopkirk (1988:185-186), has determined that the Clear Lake splittail and not *Lavinia exilicauda*, which now bears the common name "hitch," is actually the "hitch" of the Eastern Pomo. The spawning streams which were the points of capture of both Clear Lake splittail and hitch (e.g., Kelsey Creek) are a considerable distance from this site. Prior to 1940, Clear Lake splittail was the most abundant species in the lake (Hopkirk 1988:185).

Small fish probably were captured using poison (Theodoratus et al. 1975:128-129), baskets, dip nets, and fine seines in the marshy backwaters where smaller fishes tend to congregate. Without the attention to microscopic remains, the 1/4-in. field screening would have indicated only a fishing emphasis for larger fish in moving streams or more open water.

Small fish are consumed today even in developed countries like the United States, Japan, and Mexico. The tiniest fish are eaten in curries in India. Such consumption of small fish certainly could have been likely by the Pomo. Follett (1982:193) cited anecdotal evidence for the use of the tiny speckled dace (*Rhinichthys osculus*) and Lahontan redside (*Richardsonius egregius*) by the Northern Paiute, and reported the recovery of small tui chub (*Gila bicolor*) and speckled dace remains from coprolites at Lovelock Cave, Nevada (Follett 1967:95-96). Fingerling bonytail (*Gila elegans*) were found in coprolites of the ancestral Cahuilla Indians of the northern Salton Basin (Wilke 1978:82). Dried fish apparently were not ground before consumption as was done in parts of the Great Basin by Native Americans (Fowler and Bath 1981:185); this would have pulverized virtually everything.

Sticklebacks are heavily armored and have dorsal and pelvic spines (Fig. 4) that are deterrents to predators (Hoogland et al. 1956: 205-236). These features also make sticklebacks unappetizing to humans. The possibility thus exists that the sticklebacks and all the small fish were incidentally tossed aside as garbage, or are present as the discarded stomach contents of predators (squawfish, thicktail chub, birds, etc.) that were obtained by the Pomo. Though Casteel (1976b:40) noted that remains of sticklebacks are common when archaeological and paleontological deposits are examined microscopically, I have only been able to find a single record by Salls et al. (1989) of sticklebacks from an archaeological site in California. This undoubtedly is because midden materials are not commonly examined microscopically. Cultural resource management reports, in which such information might be found, however, are poorly circulated and fail to reach a large audience.

The microscopic search yielded three otoliths, the 4.5-mm.-long sagitta from a blackfish, the 1.2-mm.-long sagitta of an undetermined minnow (Cyprinidae) and the

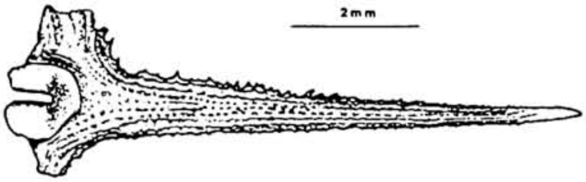

Fig. 4. Pelvic spine from the threespine stickleback from LAK-386, Unit 2, Feature 1.

2.4-mm.-long sagitta from a prickly sculpin. This sagitta was the only element recovered from the prickly sculpin (Fig. 2a). A potential difficulty of faunal identification is ontogenetic change in certain elements. The sagittae of adult prickly sculpin (Fig. 2b) are different in shape from those of juveniles (compare Fig. 2a and 2b). Investigators undertaking faunal analysis need to have a wide range of sizes of comparative materials to be able to confidently confirm their identifications.

The attention to microscopic analysis of these midden remains places us in a position of being able to consider the utilization of these individually small, but in combination, potentially substantial, resources. Casteel (1976a:195) found that the concentration of effort on the microscopic analysis of column samples was more thorough and far less time-consuming than the analysis of field-sorted faunas.

Table 3 lists the results of the analysis of the growth rings of 27 vertebrae and one scale from LAK-386. Seventeen elements indicate death in summer to fall, eleven in the winter to spring. The inescapable conclusion is that the fish found here died throughout the year and thus suggest year-round fishing activity. Seven of the eight vertebrae analyzed from Feature 1 indicate summer occupation. This feature may have resulted from a summer activity.

SUMMARY

The labor-intensive fine-screening and microanalysis of materials from archaeological

Table 3
AGE AND SEASON OF DEATH OF FISH FROM LAK-386

Level in cm.	Taxon	Vertebral Annuli[a]	Probable Season of Death
Unit 1			
10-20	Tule perch	2+	Summer to fall
20-30	Blackfish	3	Winter to spring
	Splittail	3+	Summer to fall
	Sacramento sucker	5+ or 6+	Summer to fall
30-40	Hardhead	2+	Summer to fall
	Tule perch	2++ (almost 3)	Fall
	Cyprinidae	2	Winter to spring
		2+	Summer to fall
40-50	Tule perch	1+	Summer to fall
	Cyprinidae	2	Winter to spring
	Sacramento sucker	4	Winter to spring
	Bony fish	3+ or 4+	Summer to fall
50-60	Cyprinidae	2 or 3	Winter to spring
Unit 2			
30-40	Tule perch	2	Summer to fall
40-50	Sacramento sucker	4+ (only bit of new growth)	Late spring, early summer
50-60	Sacramento sucker	2	Summer to fall
		4	Summer to fall
	Splittail	3 (like one that died March 18)	Late winter to spring
	Cyprinidae	3	Winter to spring
Feature 1	Hitch	3++ (almost 4)	Late fall
		1+	Summer to fall
	Tule perch	2	Winter to spring
		2+	Summer to fall
		3+ (scale)	Summer to fall
	Cyprinidae	2+	Summer to fall
		2+	Summer to fall
		3+	Summer to fall
		3+	Summer to fall

[a] Numbers indicate yearly annuli; "+" indicates opaque material corresponding to rapid growth. For example, an element designated "2+" indicates death in the rapid growth phase (summer) of the third year.

site LAK-386 has yielded the remains of 10 of the 14 species of native fishes of Clear Lake, including numerous young or small Sacramento perch, tule perch, threespine stickleback, prickly sculpin, and undetermined minnows. These small fishes tend to live in sluggish waters among aquatic vegetation. These remains thus suggest the exploitation of this habitat by the local Clear Lake Pomo. Sampling methods utilizing screens larger than 1/16-in.-mesh would have missed these small fishes entirely and left the impression that only large fishes were captured. The only identified element from a prickly sculpin was a tiny otolith. Since this element differs in form in adults of the species, it is evident that a wide range of sizes of comparative specimens is needed to insure accurate identification. Evaluation of the growth rings of vertebral centra suggests that these fishes were exploited throughout the year.

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