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Identification of Avian and Mammalian Species Used in the Manufacture of Bone Whistles Recovered from a San Francisco Bay Area Archaeological Site

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THE identification of bone artifacts as to species of bird or mammal is often neglected by archaeologists. In this paper we identify bird and mammal species and their skeletal elements as employed in the manufacture of bone whistles associated with early California aboriginal burials. Evidence is presented that the species and bone elements used greatly influenced the whistle-maker in establishing the position of the whistle stop or sound orifice, and that the position of the sound orifice (on center or off center with reference to whistle length) need not have chronological significance in cultural development as formerly believed.

Previous studies (Brooks 1975; Howard 1929) of unmodified avian bones recovered from two San Francisco Bay area sites (CA-ALA-307, CA-ALA-309) resulted in the identification of 50 species representing 12 orders of birds. Two other studies attempted to identify artifacts manufactured from bird bone as to family or genera used (Davis and Treganza 1959; Hammel 1956). For the San Francisco Bay area this is the first study of species and osseous elements used to manufacture bone whistles based solely on a large collection of bone whistles recovered from the Filoli site (CA-SMA-125).

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MATERIAL AND METHODS

Two hundred and thirty-five bone whistles, whistle fragments, and bones recovered from the Filoli site (Fig. 1) were examined. The majority of the whistles were manufactured from bird bone (type FF in Gifford [1940]) and the remainder from mammal bones (Table 1). Complete whistles range in length from 40 to 222 mm. All the whistles show similar construction. An asphaltum bridge, or traces of one is found in the sound orifice (whistle stop) and an asphaltum plug or the remnants of one is found at the end opposite the sound orifice on most whistles. Several modified bird bones lacking a stop were also examined. Because these bones were modified at both the proximal and distal ends we believe they represent unfinished whistles. Identification of skeletal elements used for each whistle was based upon comparison with reference collections of the Museum of Birds and Mammals, San Jose State University, and the Museum of Vertebrate Zoology, University of California, Berkeley.

In many instances identification of bone whistles was relatively easily accomplished by a direct comparison of the whistle specimens with entire bones of the suspected species. At other times, fragments of bones lacked adequate diagnostic characteristics, and comparisons had to be made with bones of many

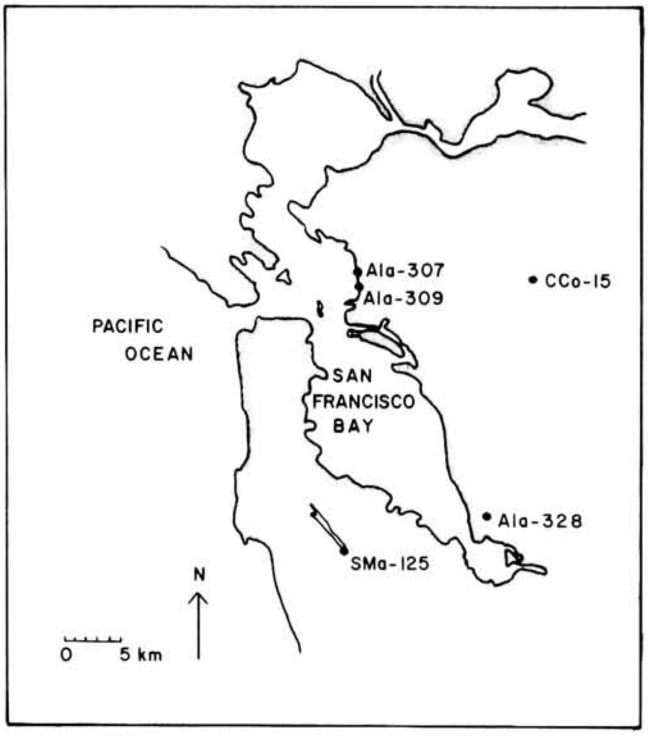

Fig. 1. Location of archaeological sites.

species before identification was possible. Furthermore, there is considerable variation in the size of skeletal materials between individuals of a given species. Morphological characteristics of osseous elements vary not only between individuals of similar age, but also between individuals of different age categories and often between sexes. Skeletons encompassing all of these variables were not available at the two museums for comparison with the bone whistles. Many closely related species differed only in size, and identifications could then be made based only on this difference. Because ulnae were the skeletal elements with the highest frequency of occurrence, and they were also representative of most species, several criteria were established to assist in their identification to species (Fig. 2).

Table 1

SCIENTIFIC AND COMMON NAMES OF BIRD SPECIES RECOVERED FROM THE FILOLI SITE

BIRDS:	
Ciconiiformes	
Ardea herodias	– great blue heron
Strigiformes	
Bubo virginianus	– great horned owl
Tyto alba	– barn owl
Procellariiformes	
Diomedea albatrus	– short-tailed albatross
Diomedea nigripes	– black-footed albatross
Pelecaniformes	
Pelecanus erythrorhynchus	– white pelican
Pelecanus occidentalis	– brown pelican
Phalacrocorax auritus	– double-crested commorant
Anseriformes	
Anser albifrons	– white-fronted goose
Branta canadensis	– Canadian goose
Branta canadensis minima	– lesser Canadian goose
Chen caerulescens	– snow goose
Olor columbianus	– whistling swan
Falconiformes	
Cathartes aura	– turkey vulture
Gymnogyps californianus	– California condor
Aquila chrysaetos	– golden eagle
Haliaeetus leucocephalus	– bald eagle
Gruiformes	
Grus canadensis tabida	– large sandhill crane
MAMMALS:	
Carnivora	
Lynx rufus	– bobcat
Felis concolor	– mountain lion
Eumetopias jubatus	– Steller sea lion
Artiodactyla	
Odocoileus hemionus	– black-tailed deer

CRITERIA FOR SPECIES IDENTIFICATION

Ciconiiformes and Strigiformes

Bones of herons and owls in the Orders Ciconiiformes and Strigiformes, respectively, posed no problems to identification, because they were either intact (unworked) or the modified specimens were easily distinguished from other closely related species, based on size or obvious generic differences.

Procellariiformes

In the Order Procellariiformes, only two species of albatrosses (*Diomedea*) were represented by ulnae and humeri. These ulnae were distinctive among all other ulnae in the collection. All are nearly straight and appear to have a circular cross section. The major and

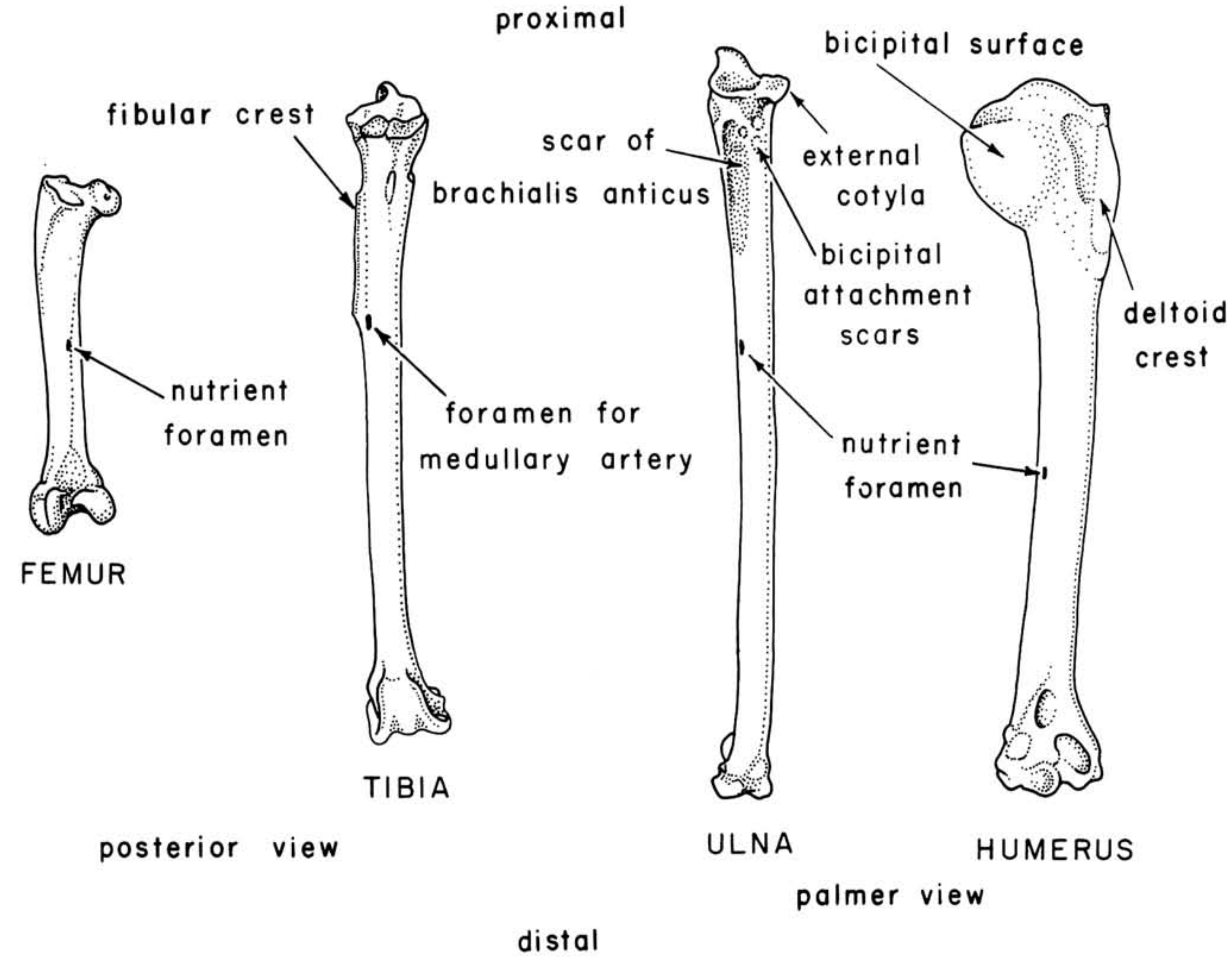

Fig. 2. The most common avian bones used in making tubes or whistles. The positions of the foramina show the most frequently chosen sites for initiating an opening (sound orifice) into the bones. The femur, tibia, and humerus are of a goose (*Chen caerulescens*); and the ulna is of a golden eagle (*Aquila chrysaetos*).

minor papillary attachments to secondary feather quills are discernible only by a slight difference in bone color, and almost no palpable raised nodes as found in many other avian orders are evident. At a glance the nodes appear to have been highly worked and polished (Fig. 3), yet this is their natural appearance. The number of major papillae is approximately 23. Nine of the ten humeri in this collection were from the short-tailed albatross *D. albatrus*, which have humeri considerably larger than their smaller relative, the black-footed albatross (*D. nigripes*).

Pelecaniformes

Two closely related species represented the Order Pelecaniformes, the brown and white pelican, *Pelecanus occidentalis* and *P. erythrorhynchus.* The ulnae are slightly curved in lateral view, and in cross section the posterior edge is slightly keeled; the dorsal side at mid-shaft is flat. Both species of pelicans have ulnae with 22 major papillae that are well developed as osseous, round knobs (Fig. 3). An ulna of a commorant, *Phalacrocorax auritus,* was also identified.

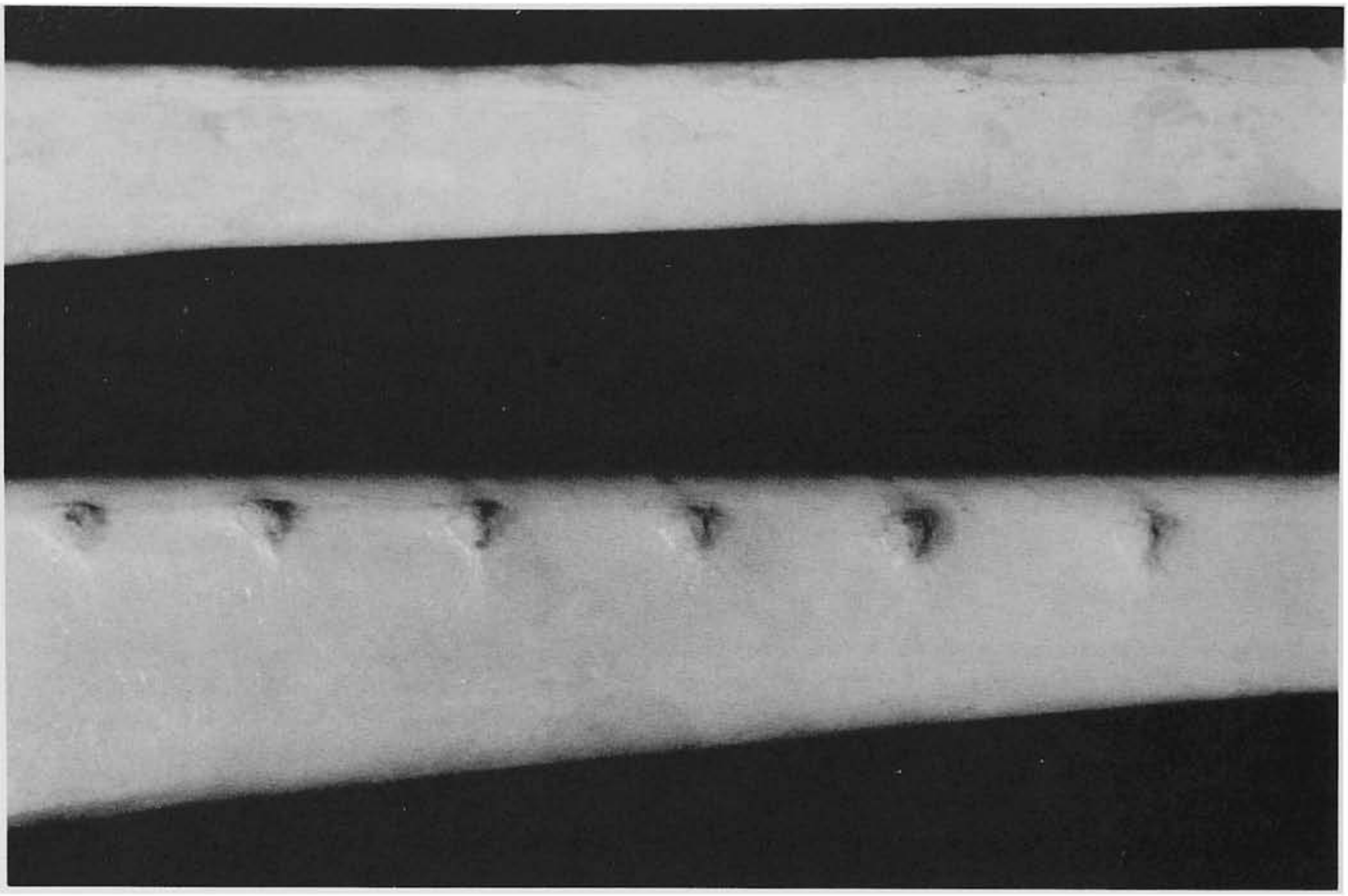

Fig. 3. Photographic comparisons of mid-sections of intact ulnae removed from carcasses of the black-footed albatross *Diomedea nigripes* (above), and the brown pelican *Pelecanus occidentalis* (below). The tubercle-like papillary nodes that serve as attachment points for the secondary flight feathers are well developed in the pelicans, but not in the albatrosses. In the latter the secondary feather attachment points are barely palpable and can be recognized as slightly discolored areas of bone. In bone whistles made from albatross ulnae these areas appear to have been highly polished but in fact were not.

Anseriformes

Among the species of the Order Anseriformes, the ulnae of geese and swans are very similar and ulnar differences are largely a matter of size. The secondary papillae are well developed and ellipsoidal in shape with their long axis in line with the longitudinal axis of the bone; they number about 11 to 12 among the genera *Branta, Anser,* and *Chen.* Four tibiae are assignable to the white-fronted goose, *Anser albifrons,* based on close size conformity with reference specimens. The swan, *Olor,* has 15 poorly elevated papillae. In cross section the bone of *Olor* is nearly circular and in the mid-shaft region has no dorsal flat area above the major papillae as is typically seen in the pelican.

Falconiformes

The largest bones in the collection represent four species of the Order Falconiformes (Table 2). The largest bones are those of the California condor, *Gymnogyps californianus.* Two whistles were made from ulnae of turkey vulture, *Cathartes aura.* Other ulnae represented include those of the bald eagle, *Haliaeetus leucocephalus,* and of one possible golden eagle, *Aquila chrysaetos.* The ulna of these species is curved and has well developed papillary nodes. The bone is circular in cross section. Identification of bald

Table 2

BIRD SPECIES IDENTIFIED FROM BONE ELEMENTS ASSOCIATED WITH BURIALS AT THE FILOLI SITE

SPECIES	ULNAE	RADII	HUMERI	FEMORA	TIBIAE	TARSI	TOTAL	PERCENT
Ardea herodias	1				3		4	3
Bubo virginianus	2					2	4	3
Tyto alba						2	2	1
Diomedea albatrus	32	2	9		3		46	31
Diomedea nigripes	1						1	1
Pelecanus erythrorhynchus			1				1	1
Pelecanus occidentalis	11						11	7
Phalacrocorax auritus	1						1	1
Anser albifrons	24				4		28	19
Chen caerulescens	10						10	7
Branta canadensis	1						1	1
Branta canadensis minima	8						8	5
Olor columbianus	8						8	5
Cathartes aura	2						2	1
Gymnogyps californianus	1	2			1		4	3
Aquila chrysaetos					1		1	1
Haliaeetus leucocephalus	6			3	1		10	7
Grus canadensis tabida					4		4	3

eagle, as opposed to golden eagle, is based on the following characteristics of the ulna: in palmer view of the proximal end the external cotyla (Fig. 2) is smoothly supported beneath in the golden eagle, while in the bald eagle the external cotyla is sharply angled underneath. In similar view (Fig. 2), the bicipital attachment consists of three tendinal scars in *Aquila* and in the same region there is one large tendinal scar in *Haliaeetus.* One bone whistle tibia in the collection is from the golden eagle. It is distinguished from the bald eagle by a longer fibular crest, and by the terminal scar of attachment of the fibular spine that is relatively much higher in the golden eagle than in the bald eagle. The internal articular surface on the proximal end of the bone of the golden eagle has a pronounced medial excavation beneath it, which is lacking in the bald eagle.

Gruiformes

Of particular interest are four bone whistles (1-1775A, 1-1775B, 1-1625, 1-1627) made from tibiae of cranes (Order Gruiformes). They were found in pairs and represent right and left tibiae from perhaps the same individual crane. The only area on the bone whistles that could serve as a landmark for similar comparative measurements on intact tibiae of other crane specimens, is the greatest transverse width of the tibia taken at the most distal point of former fusion of the fibula to the lateral edge of the tibia. The specific identification of these bones, on the basis of measurements alone, suggests affinity with the larger race of sandhill crane, *Grus canadensis tabida* or the now nearly extinct whooping crane, *G. americana* (Table 3). Sight records of the whooping crane were reported during the 1800s in Colusa and Sutter counties, California (Bent 1926), when they commonly appeared throughout most of the midwestern states during their annual migrations. The larger sandhill crane does not occur in California today, yet Howard (1929) recorded its presence at the Emeryville site (CA-ALA-309).

In both the sandhill and whooping cranes, the foramen of the medullary artery is located on the posterolateral edge of the tibiae. In four whistles the sound orifices are located in the area of this foramen, since it is absent proximally and distally on the whistles. View-

Table 3
A SUMMARY OF TIBIAL WIDTHS OF THREE SPECIES OF CRANES COMPARED TO THREE BONE WHISTLES MADE OF CRANE TIBIAE

Tibiae Sample	Sex	N	X Width	S.D.	Range in Width (mm.)	Collection Localities
Grus canadensis canadensis	M, F	18	9.4	,47	8.3-10.0	Alaska, California (Fresno, Merced, Modoc, and Butte counties)
Grus canadensis tabida	M, F	3	11.8	.92	10.8-12.6	Nevada
Grus americana	?	1	11.8			Illinois
Grus (whistles)	?	3*	11.8	.26	11.5-12.0	California (San Mateo County)

*There were four whistles, but one (1-1627) was badly crushed and misshapen and thus not measurable.

ing the whistle's approximated cross-sectional shape through the sound orifice, the posterolateral edge is sharp and in section would form an acute angle (less than 90°). This angle continues distally to the distal fusion of the fibula in *G. canadensis*. In *G. americana* the angle is not as acute distally and gives the exterior lateral edge a more rounded appearance than in *G. canadensis*. The somewhat flat tendinal grooves that course along the posterodistal end of the tibia on the anterolateral side of the distal fusion of the fibula are larger in *G. americana* than in the largest *G. canadensis*. The difference in the acute angle of the posterolateral edge of the tibia near the foramen of the medullary artery, coupled with the larger size of the tendinal grooves on the anterior and posterior sides of the tibia near the distal end of the fibular fusion, aside from measurements, rule out the whooping crane as the species to which these tibiae belonged.

Carnivora and Artiodactyla

Four species of mammals were used to manufacture bone whistles. Three species in the Order Carnivora are represented in the Filoli site collection. Eight whistles were made from femora of the bobcat, *Lynx rufus*. Other identifiable whistles were made from the bones of juvenile carnivores: the left tibia of the Steller sea lion, *Eumetopias jubatus*, and the right humerus of the mountain lion, *Felis concolor*. The Order Artiodactyla is represented by a left tibia of a juvenile black-tailed deer, *Odocoileus hemionus*.

RESULTS

From a collection of 235 bones examined we have identified 18 avian species representing seven orders, and four mammalian species of two orders. From a total of 211 avian bones or bone fragments used as whistles, 157 were identified to species, 25 were identified to genera or family, and 29 were unidentifiable (Table 4). Eleven bones of four mammalian species were also employed in whistle manufacture. Other identifiable remains include a digit I phalanx of a great horned owl, *Bubo virginianus*, and four unmodified tarsometarsi of a great horned owl and a barn owl, *Tyto alba*. An unmodified tarsus of a bald eagle was also identified. Ulnae represented 82% of all bird bone. Humeri and tibiae followed at 15%, tarsi and femora at 2% and radii at 1% (Table 2).

DISCUSSION

Whistles were made from bones of at least 18 avian species. Most species are present-day,

Table 4

AVIAN AND MAMMALIAN SPECIES IDENTIFIED FROM BONE WHISTLES WHICH WERE ASSOCIATED WITH BURIALS AT THE FILOLI SITE

SPECIES	BURIAL				
Avian	#3	#7	#12	#18	#19
Ardea herodias	4				
Bubo virginianus	2				
Diomedea albatrus	41	2	1		2
Diomedea nigripes	1				
Pelecanus erythrorhynchus	1				
Pelecanus occidentalis	8	2	1		
Phalacrocorax auritus				1	
Anser albifrons	28				
Chen caerulescens	10				
Branta canadensis	1				
Branta canadensis minima	8				
Olor columbianus	7	1			
Anserine indeterminate	16				
Cathartes aura	2				
Gymnogyps californianus	1	1	2		
Aquila chrysaetos	1				
Haliaeetus leucocephalus	4	2	4		
Aquila/Haliaeetus	2		1		
Grus canadensis tabida	2		2		
Indeterminate	20			1	
Mammalian					
Lynx rufus	8				
Felis concolor	1				
Eumetopias jubatus	1				
Odocoileus hemionus	1				

year-round residents or seasonal migrants. The exceptions include two nearly extinct species, the California condor and the short-tailed albatross. A third species with dangerously low population numbers is the bald eagle. The larger race of sandhill crane does not occur in California today, but specimens were identified at the Emeryville site by Howard (1929). With the exception of the albatrosses, at least 18 species of birds may well have been hunted in the south San Francisco Bay region or environs. The two albatross species could have been captured along the Pacific coast. Ample evidence of their occurrence at some coastal sites in the area is discussed elsewhere (Morejohn 1976).

Without knowledge of the species from which the bones were derived, Davis and Treganza (1959) studied single-holed bird-bone whistles which they segregated into two types based on their relative size and degree of finish. The shorter, averaging 7.6 cm. in length, has its sound orifice located on the flat or convex surface near the middle of the bone. The other is longer, averaging 14.6 cm. in length, with the sound orifice located on the concave surface of the bone, at approximately one third the length of the bone from the end. In contrast, our analysis of whistles from CA-SMA-125 indicates that the shape, concave or convex, or flatness of a side of a bone is often diagnostic for a given bone element of a particular species. The side on which the sound orifice is made on the ulna is generally directly related to the position in the intact bone of a nutrient foramen. This foramen serves as the initial hole into the bone which is expanded by the whistle maker to produce the sound orifice (Fig. 4).

With reference to which side of bones the holes for whistle stops were made, Hammel (1956: 48) stated "whistle maker's criterion evidently was the curve in the long axis of the bone rather than in the cross-section." Many avian ulnae are curved; however, the ulnae of the black-footed and short-tailed altabrosses are nearly straight, but the nutrient foramen is still on the rounded anterior face which in other species may be rounded or flat in cross section with curved ulnae. Irrespective of the shape, for the CA-SMA-125 sample, the nutrient foramen is always on the anterior face of avian ulnae used as whistles. The location of the nutrient foramen was the whistle maker's criterion for positioning the hole for the sound orifice, not the curve in the long axis of the bone.

On the posterior margin of avian ulnae, there are osseous papillae (nodes) for ligamentous attachment of quill bases of the secondary flight feathers. As noted earlier, some avian families exhibit well-developed nodes, in other families these nodes are poorly developed. Assuming no intentional modification,

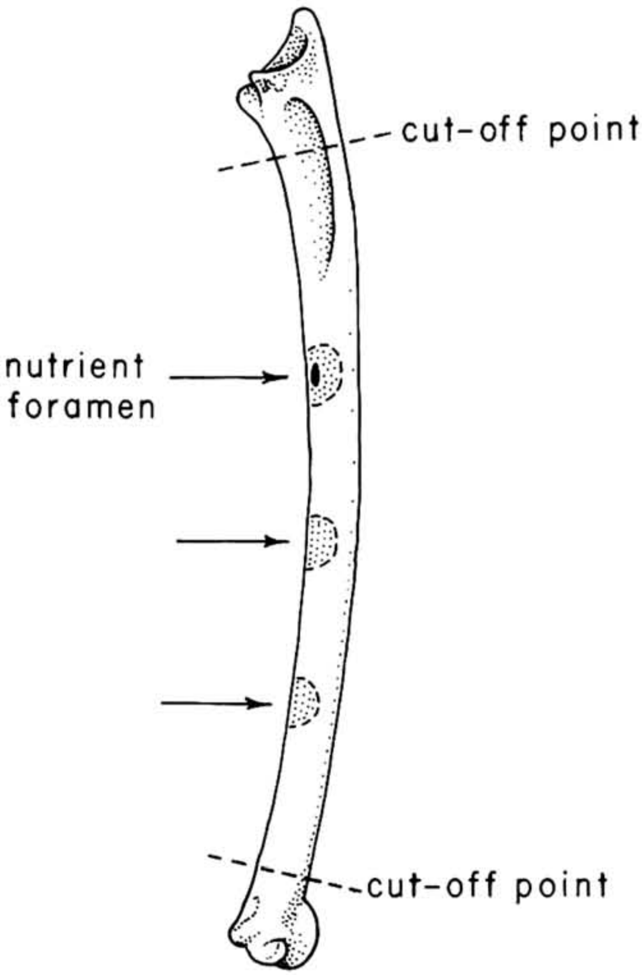

Fig. 4. The ulna of a hypothetical goose showing the major cutoff points and potential sites of sound orifices. The upper arrow shows the nutrient foramen where most sound orifices are initiated. The lower two arrows show the less frequently occurring sites for making sound orifices.

the degree of "finish" on the ulnae is dependent upon the presence or absence of palpable nodes.

Tubular bird-bone whistles first appear in the Middle Horizon of central California (Lillard, Heizer, and Fenenga 1939) and continue into the Late Horizon. Studying whistles recovered from Middle and Late Horizon sites, Beardsley (1954) noted the position of whistle stops (sound orifice) advanced from off-center to a central position, therefore representing a typological change. Although we have not looked at the collections studied by Beardsley, the present analysis of bone whistles from the Late Horizon Filoli site (Galloway 1976) leads us to a different interpretation. The species of bird and bone element used for whistles, humeri, ulnae, tibiae and femora (Table 2), largely determines whether the whistle stop is centered or off-centered. Thus, the availability of a particular avian species will influence the occurrence of on-centered versus off-centered whistle stops. A chronological pattern characterizing the position of the whistle stop in bird-bone whistles, therefore, may not be valid. Rather, excluding the effect of trade, it is a function of which avian species were more readily available in the locality.

For the San Francisco Bay area there are only two published reports describing large collections of unmodified avian bones recovered from archaeological sites. Fifty avian species representing 12 orders of birds were identified among 4,155 osseous remains from the Emeryville site (Howard 1929). In a considerably smaller collection from a west Berkeley site (CA-ALA-307), Brooks (1975) identified 17 species and nine orders of birds. Eighty percent of 482 identifiable bones were waterfowl (Anseriformes) in origin, but most were not identified because of the striking similarity among species. Species identification of the large number of waterfowl bones encountered at the Emeryville site was not attempted. Of the 84 anseriform bone whistles studied, 75% were identifiable to species.

In only three previous studies were attempts made to identify artifacts manufactured from bird bone as to family or genus or species used. In describing bone whistles from CA-ALA-328, Davis and Treganza (1959: 21) stated "The most common bones are duck ulnae and humeri, and crane (or heron) and condor are also represented." For the Emeryville site Howard (1929: 372) stated "In a random sample of artifacts, the writer finds a distal end of the humerus of a pelican cut squarely across showing knife marks; tubes and whistles of the ulna of eagles, hawks and geese; and an awl of the radius of the Great Blue Heron." From a Contra Costa site (CA-CCO-15), Hammel (1956) found five complete bird-bone whistles and 16 fragments of others interred with burial #1. Avian species identified from partial ulnae constituting these whistles were golden eagle (6), bald eagle (1), and brown pelican (2).

Of the 222 whistles recovered from the Filoli site, 190 (90%) were found with burials (Table 4). Five out of 21 burials had whistles interred as grave goods. Burial #18 had one whistle made from the ulna of a commorant, *Phalacrocorax auritus,* and one unidentifiable bone whistle; Burial #19 had two whistles made from the ulnae of *Diomedea albatrus.* All except four of the 19 whistles interred with burials #7 and #12 were made from ulnae representing a minimum of six species (Table 4). Burial #12 also had two whistles made from the radius of California condor and a pair of whistles made from the tibia of *G. canadensis tabida.*

It is common to find bone whistles interred with burials, but it is unusual to find a large number of bone whistles associated with a single burial. Interred with burial #3 were 167 bone whistles. Based on the large collection of whistles and other associated artifacts, Galloway (1976) suggested burial #3 "may" represent the possible remains of a shaman burial. Data presented here show that at least 17 species of birds and one mammalian species were used to manufacture these whistles. Eight whistles were made from the femora of the bobcat. A minimum of 16 species of birds, Ciconiiformes (1), Strigiformes (1), Procellariiformes (2), Pelecaniformes (2), Anseriformes (5), Falconiformes (4), and Gruiformes (1), were identified (Table 4).

CA-SMA-125 is located within territory ethnographically occupied by the Penutian-speaking Costanoans, as recorded in the ethnohistoric literature. Ethnographic data on Costanoan shamanism are almost non-existent as described by Kroeber:

> Costanoan shamanism has passed away with scarcely a trace. We know that the doctor sang, and sucked material objects out of the body of the sick, and that sometimes he was believed to exercise control of the weather and of the natural crops. His relation to his spirits, the precise manner in which disease was caused, the actions attending his entrance into the profession, the probable belief in bear shamans, are all matters on which the evidence is lost [Kroeber 1925: 472].

Many different types of shamans are found in California, with weather, dancing, bear, and sucking shamans being noted as present in the Bay area (Harrington 1942).

A shaman's natural powers were usually obtained through a totemic animal. Gayton (1930: 388) gives the following description of a Yokut's totemic animal and its relationship to shamanism:

> In their mythology Owl appears as the prehistoric shaman whose duty was, upon the creation of man, to sponsor and aid those human beings who took up the profession of doctoring.

Only burial #3 had modified and unmodified owl remains. Recovered were two unmodified tarsometarsi, two whistles, a right and left ulna, and a digit I phalanx of a great horned owl, plus two unmodified tarsometarsi of a barn owl. The unmodified owl tarsometarsi "may" represent totemic animals interred with burial #3. Yet, as discussed by Elsasser (1961), the problem of identifying a shaman burial based on associated artifacts is extremely difficult. Until bone whistles associated with burials from other archaeological sites are assigned to the avian or mammalian species used, any interpretation regarding the possible ceremonial significance of burial #3 is tentative at best.

SUMMARY

A collection of 235 bone whistles, whistle fragments, and bones from a California archaeological site (CA-SMA-125), known also as the Filoli site, was studied. Ninety-four percent of osseous material was made into whistles; six percent was intact or slightly modified. Eighteen avian and four mammalian species were represented among the bone whistles. Bird bone comprised approximately 95% of the whistles. The ulna was the most frequently used bone. Criteria for osteological distinction between two species of eagles and two species of cranes are presented. The position of the sound orifice of these whistles is primarily determined by the location of a nutrient foramen near the center or off-center on the shaft of the bone. This opening is worked into a larger hole to produce a sound orifice. The position of the sound orifice does not necessarily have chronological significance in cultural development.

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