FURTHER DISCOVERIES CONCERNING THE FLIGHTLESS "DIVING GEESE" OF THE GENUS CHENDYTES

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The exceptional preservation of skeletal elements of *Chendytes lawi* in a late Pleistocene marine terrace deposit on West Anacapa Island, Ventura County, California, was recorded by Miller, Mitchell, and Lipps (Los Angeles County Mus. Contr. Sci. No. 43, 1961:1–11). A cranium with associated cervical vertebrae was described, as well as a coracoid and portions of sterna, pelves, and a humerus.

Collecting has continued on the island over the past two years, and the assemblage of bones of the goose-sized, scoter-like *Chendytes* has been notably enhanced by the addition of a large portion of a sternum, several scapulae, the first ulnae, and the first complete humerus for the species *C. lawi* and the first carpometacarpus for the genus. A small fragment probably represents a portion of the furcula.

Important anatomical details are revealed by these elements. Additional specimens of humeri and coracoids provide indication of the range of variation in comparison with that of mainland representatives of the species. A total of more than 130 specimens of various skeletal elements of the species has been collected on the island to date.

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Illustrations are of photographs by George Brauer retouched by Pearl Hanback.

DESCRIPTION

Sternum (fig. 1*a*, *h*).—A badly fragmented sternum (LACM no. 2725) was repaired in the laboratory to form a relatively good specimen in which the left costal border is complete (with six costal processes) and the entire span of both coracoidal sulci and manubrium is intact. The specimen shows clearly the separation of the sulci noted by Miller, *et al.* (*op. cit.*) and provides an actual measurement of this separation, as well as of each individual sulcus. The manubrial area forms a broadly curved mass, heavy and smooth along its dorsal rim, and considerably depressed anteriorly between the sulci, where it blends directly into the anterior edge of the forward-protruding carina. This specimen shows that the "ventral labial prominence" mentioned by Miller *et al.* (*op. cit.*:8) is actually the anterior extension of the very low carina. The full anterior extension of the carina cannot be estimated; the broken portion protrudes about 13.5 mm. beyond the anterior border of the manubrium. A small, central foramen is situated anteriorly in the depressed area between the sulci and immediately ventral to the dorsal rim of the manubrium; the area above the manubrium, where a foramen occurs in the scoters, contains a small depression in *Chendytes* but no foramen.

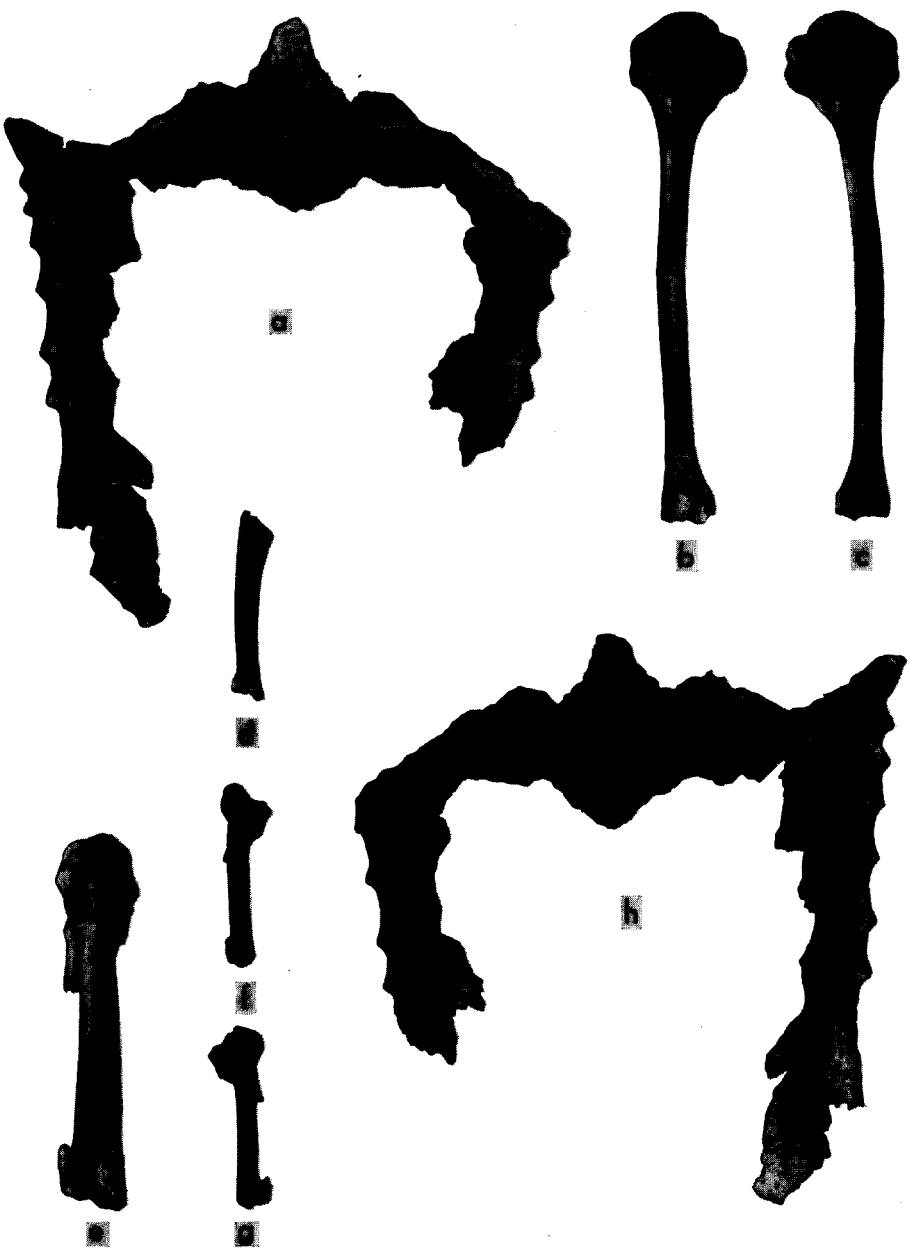

Fig. 1. *Chendytes lawi* from the late Pleistocene of West Anacapa Island, California. *a, h,* sternum, LACM no. 2725, dorsal and ventral views; *b, c,* humerus, LACM no. 4868, palmar and anconal views; *d,* ulna, LACM no. 2736, internal view; *e, f, g,* carpometacarpus, LACM no. 5536, posterior, external, and internal views. All natural size, except *e,* which is x 2.

The sternum of *Chendytes* bears superficial resemblance to that of the Galágapos Flightless Cormorant (*Nannopterum harrisi*) in the separation of the sulci. But, although the elements are nearly equal in overall size, the separation of the sulci is greater in *Chendytes,* and the carina projects farther anteriorly.

Measurements of sternum no. 2725: breadth across sternum at level of third costal process, 69.5 mm.; breadth across sulci, 57.5 mm.; extent of single sulcus, 20.0; space between right and left sulci, 26.8 mm.; length of costal border, 33.8 mm.; dorsoventral depth from midpoint of dorsal border of manubrium through carina, 9.9 mm.

Furcula.—A small fragment (LACM no. 2744) may represent a portion of the left clavicle of this species. It has somewhat similar curvature to that of the clavicle of the White-winged Scoter (*Melanitta deglandi*) but is thicker and less bladelike than in the existing species. A comparable thickening of the clavicle of *Nannopterum harrisi* is noted in comparison with the same element of flying cormorants such as the Brandt Cormorant (*Phalacrocorax penicillatus*).

Coracoid.—A nearly complete coracoid (LACM no. 2697) was described by Miller *et al.* (*op. cit.*:9). One of the other four coracoids now available (LACM no. 2730) is also nearly complete and provides indication of range in size and proportions. The two available coracoids of *Chendytes* from marine deposits of the southern California mainland are not sufficiently complete to provide accurate measurements but appear to agree with the island bones in size.

TABLE 1
MEASUREMENTS OF CORACOIDS OF CHENDYTES FROM WEST ANACAPA ISLAND

	LACM no. 2697	LACM no. 2730
Length from head to sternocoracoidal angle	47.5 mm.	42.7 mm.
Distance from lower border of scapular facet to head	14.7	13.3
Breadth from greatest flare of scapular facet to ventral border below head	8.6	8.1
Dorsoventral dimension through shaft below procoracoid	4.0	4.0
Distance across scapular facet to procoracoid	6.1	5.5

Scapula.—The four specimens of scapula available from West Anacapa Island resemble the single mainland specimen assigned to *Chendytes lawi* (Howard, Condor, 57, 1955:135–143) in the poor development of the coracoidal articulation and the roughened surface of the glenoid facet (Howard, *op. cit.*:136). The position of the facet varies; in island specimen LACM no. 2733, as in that from the mainland, it is quite dorsal in position, but in LACM no. 2713 it faces laterally; in the other two (LACM nos. 2733a and 5538) the position of the facet is intermediate. About 4 to 5 mm. posterior to the facet, a marked swelling broadens and thickens the blade of the island scapulae for a distance of 9 to 10 mm.; posterior to the swelling the bone narrows. The blade is thickened in the mainland scapula but not broadened.

The scapulae from West Anacapa Island exceed in size those of the geologically earlier *C. milleri* from San Nicolas Island and are further distinguished by lesser development of the acromium and coracoidal articulation. The measurement of the breadth of the shaft posterior to the glenoid facet is the only one unaffected by eroded contours of the bones. In *C. milleri* this breadth of shaft is 3.9 to 4.0 mm.; in the West Anacapa Island specimens, 4.0 to 4.8 mm.; in the mainland bone assigned to *C. lawi,* 3.4 mm.

Humerus (fig. 1*b, c*).—Miller *et al.* (*op. cit.*:10), commenting on LACM humerus no. 2698 from West Anacapa Island, noted that it appeared heavier of shaft than that of *C. lawi* previously figured (LACM no. 2455) from the mainland coast at Newport Bay by Howard (*op. cit.*:141). They called attention to a swelling on the island humerus and suggested that this might be an abnormality. Three of the other four humeri now

available from the island include this area of the shaft. Two (LACM nos. 2729 and 5337) very closely resemble no. 2698 in breadth of shaft and presence of the swelling; on close scrutiny, this swelling is found to be an excrescence that occurs external to the distal portion of the deltoid crest and likely represents the attachment for the latissimus dorsi anterioris muscle. Humerus LACM no. 4868 lacks the excrescence but bears, in the same general position, a distinct line, approximately 7 mm. in length. Perhaps in older individuals, development of the muscle changed the aspect of its attachment from a line to an excrescence. In the Newport Bay humerus no. 2455, the line of the latissimus dorsi anterioris muscle is present but indistinct. Another specimen from Newport Bay (LACM no. 2030) is so smoothly worn that there is no evidence of a line.

Some variability is observable among the island humeri, particularly in the region of the pneumatic fossa. LACM no. 2729 resembles Newport no. 2455 in having a narrow, constricted fossa; in the other island bones, the fossa is wider. The attachment of the supraspinatus muscle below the pneumatic fossa is faint in four Anacapa specimens and both Newport bones but is very marked in the one complete island specimen (LACM no. 4868). This complete humerus also shows clearly the lack of excavation of the brachial impression above the distal condyles suggested by the other nearly complete bones as well as LACM no. 2030 from Newport Bay. This area is flat and smooth and is in marked contrast to the condition found in the type humerus of *C. milleri,* in which the brachial impression is deeply excavated along the internal edge of the palmar face of the bone.

Measurements of the complete Anacapa Island humerus are as follows: length, 68.2 mm.; breadth of distal end, 7.8 mm.; breadth of shaft just below the distal tip of the deltoid crest, 3.8 mm.; proximal breadth from external tuberosity through the bicipital crest, 15.5 mm.

Ulna (fig. *d*).—The discovery of two specimens of ulna in the West Anacapa Island assemblage provides the first opportunity for comparison of this element of *Chendytes lawi* with that of *C. milleri.* The ulnae from Anacapa are shorter and relatively stockier than those of the earlier species from San Nicolas Island. The impression of the brachial anticus muscle on the internal side of the shaft, proximally, is less excavated; distally, the external condyle has less proximal extent beyond the carpal tuberosity. Neither proximal nor distal articular end is completely preserved.

TABLE 2

MEASUREMENTS OF ULNAE OF CHENDYTES

	C. lawi W. Anacapa Island		*C. milleri* San Nicolas Island
	LACM 2764	LACM 2736	LACM 2387
Approximate length	24.9–25.7 mm.		31.4 mm.
Breadth shaft	2.5– 2.6		2.7
Depth shaft	3.2– 3.3		3.2

Carpometacarpus (fig. 1*e, f, g*).—The single carpometacarpus from West Anacapa Island (LACM no. 5536) is the first record of this element for the genus *Chendytes.* As anticipated, the element shows the marked signs of degeneration that accompany flightlessness. It is, however, approximately equal in length to the ulnar segment.

Compared with carpometacarpi of living scoters, a resemblance is observable in the relatively long process of metacarpal 1 (proximodistally) in the fossil *Chendytes* bone. All contours are less markedly delineated, however; the external articular surface of the trochlea ends near the proximal extremity; below this point the external surface slopes abruptly mediad to the internal crest, interrupted opposite the distal tip of the

internal crest by a small external papilla, which is apparently a remnant of the prominent lobe found in *Melanitta*.

Measurements of carpometacarpus no. 5536: length, 24.5 mm.; breadth of shaft of metacarpal 2 (middle), 2.8 mm.; distance from tip of process of metacarpal 1 to posterior edge of internal crest of trochlea, 7.5 mm.; proximodistal length of metacarpal 1, 5.5 mm.

With the three main elements of the wing now at hand, the relationship in size of the individual segments is for the first time evident. Apparently degeneration did not take place in proportion to the normal length of each segment, if we may use the scoters as an index. In the Surf Scoter (*Melanitta perspicillata*) and the White-winged Scoter (*M. deglandi*), for example, the ratio of humerus to ulna to carpometacarpus averages approximately 100:84:58, whereas in *C. lawi* the ratio of these elements approximates 100:36:36. The lesser degeneration of the wing of *C. milleri* is demonstrated in the ratio of humerus to ulna in that species, of 100:45. The carpometacarpus of *C. milleri* is yet to be found. Both species of *Chendytes* exceed the Galápagos Flightless Cormorant in the shortening of the distal segments relative to the humerus. In *Nannopterum* the ratio of humerus to ulna to carpometacarpus is approximately 100:77:41. Here, as in *Chendytes*, the carpometacarpus is apparently less affected than the ulna, when comparison is made with such cormorants of normal flying habits as *Phalacrocorax albociliatus* and *P. penicillatus*, in which the ratio of the wing segments averages 100:102:43.

SUMMARY AND CONCLUSIONS

The finding of the first carpometacarpus of *Chendytes*, of a furcula probably of the genus, and of the first ulna of the species *Chendytes lawi* are reported. These were obtained from the late Pleistocene of West Anacapa Island, California. Characteristics of these elements and heretofore undescribed parts of the sternum, scapula, and humerus are discussed.

As in the case of previously described pectoral elements of *Chendytes*, the newly discovered parts emphasize the marked degeneration of the flying mechanism of this bird.

Some variability in detail of contour is evident in pectoral elements where several specimens of each are available. This suggests either that actual hereditary differences tend to be tolerated where a limb has lost its function or that individual habits of manipulating the relatively useless wing brought about variation in development of muscles, the attachments of which influenced the contours of the bone as the individual aged. Basic characters sufficient to differentiate *C. lawi* from *C. milleri* are clearly apparent in all pectoral elements that can be compared in the two species.

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