middle of glenoid facet, shaft becoming angular at antero-external edge, and area below glenoid and scapular facets flattened; glenoid facet slightly depressed, blending into shaft without flare, and blending below into scapular facet; scapular facet flat, not cup-shaped; coracohumeral surface rising almost vertically above glenoid facet, broad, centrally depressed, irregular in shape, but more oval than crescentic; procoracoid thick and apparently short (tip broken).

Measurements: Distance from scapular facet to tip of head, 22.0 mm; breadth below head across triosseal canal, 7.4 mm; greatest depth from triosseal canal through glenoid facet, 8.0 mm.

DISCUSSION

The swelling of the lower part of the triosseal canal in the fossil coracoid, the narrowness and thickness of the bone in this area and through the neck, and the anterior overhang of the head are characters found in marine birds such as the penguins and alcids. Although taxonomically unrelated, these two groups of birds are alike in the modification of the wing bones toward a flipper-like condition adapted to under water "flight." Even in those alcids still capable of aerial flight, the coracoid has similar characters. The swelling of the lower triosseal region tends to narrow and deepen the passageway for the pectoral tendon, and presumably afforded support to the tendon so as to strengthen the upstroke of the wing in swimming. The channel is even more constricted and deeper in the alcids and penguins than in *Plotopterum*, suggesting that the fossil bird may not have been the equal of these other birds as a swimmer.

It is difficult to determine from this incomplete coracoid whether or not the extinct bird had completely lost the power of aerial flight. The modifications of the bone are entirely different from those found in the coracoid of the flightless cormorant, *Nannopterum*. In *Nannopterum* the modifying process has been one of degeneration, whereas the evidence indicates that in *Plotopterum* the wing had assumed a secondary function as a strong swimming organ. The fact that the modifications of the coracoid parallel those of the coracoid of penguins and auks suggests that the wing elements were shorter and more flattened in the fossil than in the cormorants and anhingas. Obviously *Plotopterum* represents a trend in aquatic adaptation sufficiently distinct from either of these two existing groups to warrant the designation of a separate family, to be known as the Plotopteridae.

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REDISCOVERY OF THE NESTING GROUNDS OF NEWELL'S MANX SHEARWATER (*PUFFINUS PUFFINUS NEWELLI*), WITH INITIAL OBSERVATIONS

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Newell's Shearwater or Ao (*Puffinus puffinus newelli* Henshaw), sometimes considered a race of the Manx Shearwater, is one of the most poorly known of the seabirds of Hawaii. In recent years no nesting sites have been known. Henshaw (1902) stated, "This bird was first obtained by Mr. M. Newell on the island of Maui in the spring of 1894, several of them having been taken from their burrows by the natives and brought to Mr. Newell alive." Munro (1941) mentioned that Mr. Alanson Bryan found skins of the Ao in about 1900 in the Gay and Robinson collections from Kauai. Bryan (1908) reported hearing the call of what he thought was the Ao in the valleys of Molokai. Munro (1944) expressed the opinion that the mongoose had no doubt killed all of them that nested on Hawaii, Maui, and Molokai. He further stated, "It may still nest in remote valleys on the north side of Kauai or perhaps Niihau. By some it is thought to be extinct and if so there are only about seven specimens in existence." Kauai, as the only major island without the mongoose, has frequently been suggested as the primary nesting area of the Ao. King and Gould (1967) concluded that Kauai is now the primary and possibly the only breeding locality of Newell's Shearwater. They estimated its population on Kauai to be in the low thousands. Locally, the annual autumnal misfortune of the Ao "falling" out of the sky onto lighted highways, parks, football fields, and buildings was well known to residents on the eastern side of Kauai. Swedberg sent about 40 of these "downed" birds to the Smithsonian Institution in 1966.

Specific information leading to the discovery of the nesting grounds came from Mr. Eddie Goo. While searching for his dogs after a pig hunt in the Moloaa Forest Reserve on Kauai in early July 1967, he found the dogs atop a 457-m ridge with black and white feathers in their mouths.

On 25 July 1967 a helicopter dropped us on this ridge at 22° 10′ N and 159° 21′ 50″ W, overlooking Moloaa Bay which was 4 km away to the northeast. From this precipitous, knife-like ridge of the Makaleha Mountains we could see the bridge on State Route 56 that crosses Moloaa Stream. There was a moderately dense tree canopy on portions of the ridge and almost everywhere there were dense, impenetrable stands of uluhe or false staghorn fern (*Dicranopteris linearis*). A landing was not possible in the dense uluhe, which in places was 3 m tall, so we jumped to the ground. We cut a trail southeasterly along the wet, earthen ridge toward Puu Ehu for approximately 0.5 km. As we proceeded along the ridge we noticed a shearwater skull, white feathers, hog feces containing feathers, and a rotten egg below a burrow. The egg was a light beige color and measured 36 mm by 61 mm. At 10:40 we heard a sudden chorus of shearwaters calling from their burrows about 90 m ahead of us.

At 11:00 we located an occupied burrow and dug out a nestling Ao. Based on later observations we estimated that it was about eight days old. The burrow was semicircular in shape, about 1.5 m long, and had two entrances. It was 12 m below the crest of the ridge on a 65-degree slope that made climbing difficult. The soil was a reddish-brown clay. Uluhe

fern was the dominant ground cover and Ohia-ha (*Eugenia* sp.) and Ohia-lehua (*Metrosideros collina*) were the dominant tree canopy. A downy Ao found in a second burrow on the crest of the ridge was left undisturbed. With the first nestling found, we made our way back to meet the helicopter and cleared a place for landing.

We returned to the area by helicopter the following day and at 17:30 found a burrow containing an adult Ao and a nestling about four days old. We camped overnight and listened to the calling behavior of the Ao as they arrived at the nesting grounds in the evening and departed for the sea in the morning. The first arrivals from the sea were at 20:00, a few minutes after dark. This is in contrast to the findings of Lockley (1942) with the Manx Shearwater, which arrived two hours after sunset. The birds called almost continuously as they flew in circles over the area. The nasal calling was loud and sounded like a combination of jackass braying and crow calling. At a later date Sincock heard this calling at a distance of 1.6 km while he was in the fields below the ridge. Calling subsided noticeably at 22:30, but continued intermittently throughout the night, which was rainy. Calling increased at 03:40 and continued until 05:25 when it abruptly ceased just before dawn.

Some of the Ao reached the ground in an astounding manner. After calling and circling the area they crashed into the tree tops and tumbled pell-mell through the branches into the dense understory of uluhe. Many tunnels were hollowed out of the base of the fern through which the birds had crawled to enter their burrows. After landing, most birds seemed to require 10 to 30 minutes to locate their burrows. Light from a two-cell flashlight confused most of the birds on the ground and light from an electronic flash generally caused them to remain immobile for 30 minutes to two hours.

Further observations and banding were conducted in the area during the periods 1–4 August and 28–29 August 1967. Six nestlings and 14 adults were banded. The evening calling of the first arrivals commenced at 19:45 during the latter period, corresponding to the first few minutes of darkness. Calling and flight activity continued almost without interruption on cloudy, rainy nights, but subsided on clear nights by about 22:30. Calling from the ground was occasionally heard a few minutes before the arrival of the birds from the sea, and intermittently thereafter. This calling was sporadic and infrequent and did not seem to be a form of communication with the flying birds.

The calling of the flying birds reached such a crescendo that it was not possible to estimate accurately the number of birds by sound, but there may have been more than 500. The dense vegetation and hazardous terrain made it difficult to search out the burrows to estimate numbers.

Only two of about 30 burrows observed had more than one entrance. All burrows were close to trees and none was found in open expanses of uluhe where there was no tree canopy. The burrows were dug horizontally into clay banks, generally with a turn 4.6 to 6.1 cm from the entrance. They averaged 1.1 m in depth near the crest of the hill, but those further down the steep slope averaged about 2.1 m in depth. Measurements of the burrow entrances were consistent; of six measured the range in width was 13.3 cm to 16.5 cm, and the range in height was 7.6 cm to 8.3 cm.

Adults caught shortly after returning from the sea frequently regurgitated their stomach contents. Squid was the most common content, but small silver-sided fish were noted on two occasions.

Based on a dozen observations of eggs and nestlings we presume most hatching occurred between mid-July and the first week in August. At Skokholm Island, Wales, Lockley (1942) found the peak of the hatching of the Manx Shearwater was in the latter part of June.

There had been some speculation about the manner in which the adults took flight once they were on the ground. Those that had crashed to ground in lighted areas of the island at lower elevations seemed unable to fly, particularly when there was little wind. At the nesting site on the ridge a strong east wind normally swept up the mountain slope about an hour before dawn, undoubtedly aiding the birds in taking flight. One moonlit night at 05:00 Sincock saw indistinctly the silhouette of an Ao as it took off through the dense uluhe fern; about three flaps of its wings cleared the Ao from the fern and it flew steeply up through the tree canopy.

Except for the presence of feathers in hog feces, one burrow that had been dug out by an unknown animal, and the dogs that made the discovery possible, there was no further evidence of predation. One bird was found hanging by its neck in the crotch of a tree, no doubt a victim of a crash landing.

In mid-October the Ao was once again landing on roads and lighted areas on the eastern side of Kauai. Mr. R. Doepping, security guard at the Kauai Surf Hotel in Lihue, picked up 125 Ao on the hotel grounds between 22 October and 3 November 1967, and released them each following day. Between 4 November and 11 November he picked up 75 more which we banded and released. None of the 200 Ao handled by Mr. Doepping wore bands, although Sincock had banded 20 on the nesting grounds.

There are other sites on Kauai that resemble the nesting area that we discovered, and further exploration and listening from vantage points may reveal more areas used by the Ao.

Swedberg found dead Ao near the Pali tunnel on Oahu on 4 August, 9 September, and 19, 25, and 27 November 1967. Possibly a nesting ground also exists in the mountains of Oahu.

The nestling that we found on 25 July 1967 was kept in captivity to record plumage development until 28 August 1967, when it died from enteritis resulting from puncture of its gizzard by a squid beak. The captive bird ate about one-half pound of squid per day.

Description of the collected specimen on 25 July 1967, when it was estimated to be 8 days old, was as follows: The eye color was black. The bill color was slate gray. The downy plumage of the bird was a medium gray color on the rump, back and head. The chin, gular region and jugulum were a soft downy white. The breast was whitish to very pale gray. The abdomen and anal region were white. The inner surface of the leg was pink and the outer surface was gray. The webs of the feet were pink. The inside toe was pink; the middle toe was pink on the inner side and gray on the outer side; the outer toe was gray.

Primary feather development was first noted on the captive bird when it was estimated to be about 21 days old. At an estimated age of 28 days, the down on the dorsal surface of the wing was being dropped and the primaries were encased pin feathers about 12 mm long. On 20 August, when the nestling was estimated as 34 days old, the tips of the encased

primaries were exposed. The following day they averaged 25.4 mm in length and were one-half exposed. A nestling that hatched on 2 August on the breeding ground had encased primaries about 6 mm long on 29 August.

The captive shearwater at death on 28 August was estimated as 42 days old; its primaries ranged from 25.4 mm to 50.8 mm in length and the primary and secondary wing converts had replaced most of the down. The white feathers of the ventral tract had developed although they were obscured by dense down. The black feathers of the humeral tract, the interscapular region and the upper dorsal region were exposed and free of down. There was little evidence of feather development in the capital tract or the cervical apterium. Pin feathers were just beginning to show in the pelvic region and in the caudal tract.

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FOWL POX IN CASSIN'S SPARROW, *AIMOPHILA CASSINII*

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Fowl pox, a disease caused by various members of the fowl pox virus complex, has been recorded as naturally occurring in an increasing number of native North American birds (Bleitz 1958; Kirmse 1966), since first reported by Gallagher (1916). The occurrence in another native species, Cassin's Sparrow (*Aimophila cassinii*), is reported herein.

An adult male Cassin's Sparrow (R.O.M. no. 97965) was observed exhibiting normal behavior in song and flight prior to its collection by J. A. Dick on 18 June 1966 in a sagebrush (*Artemisia* sp.)-covered pasture on the Conover Ranch in Seward County, Kansas. Subsequent examination showed the lores and base of the upper bill to be occupied by a large, brown, hard, irregular mass (fig. 1), 15 × 12 × 9 mm, in size, appearing to arise from the loral skin, and extending into and filling both nares. Sagittal section of the mass demonstrated it to be of solid consistency, with an outer, dark-brown, horny portion containing faint radiating darker brown lines, and a white basal portion. Adjacent eye, skull, and oral structures were unaffected, and no lesions were found in the viscera or on the legs or wings.

FIGURE 1. Cassin's Sparrow, adult male R.O.M. no. 97965, showing fowl pox lesion of head (×1½).

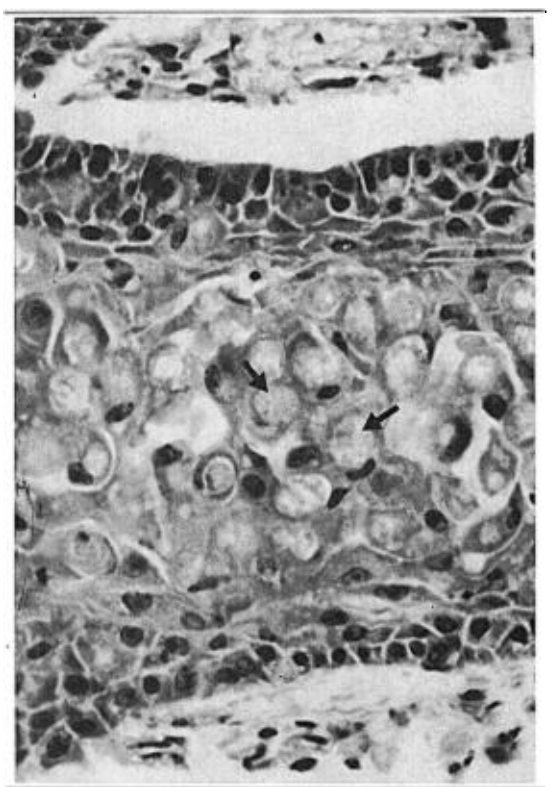

FIGURE 2. Portion of an epidermal rete peg of fowl pox lesion of Cassin's Sparrow. Arrows indicate Bollinger bodies. Hematoxylin and eosin stain (×460).

Histological examination of the lesion showed great epidermal hyperplasia, with many epithelial cells containing cytoplasmic granular inclusion bodies, identifiable as the Bollinger bodies of fowl pox (fig. 2).