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> 1960. Style manual for biological journals.
> Amer. Inst. Biol. Sci., Washington. 92 p.

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THE TERNS OF THE DRY TORTUGAS

WILLIAM B. ROBERTSON, JR.[1]

SYNOPSIS: New information from unpublished sources and from published records hitherto overlooked permit a re-evaluation of the history of the Dry Tortugas and of the terns that inhabit them. The geography and ecology of the 11 keys that have variously comprised the group since it was first mapped in the 1770's are described and their major changes traced. The recorded occurrences of the seven species of terns reported nesting on the keys are analyzed in detail. The Sooty Tern colony has fluctuated from a low of about 5,000 adults in 1903 to a reported peak of 190,000 in 1950; for the past four years it has remained steady at about 100,000. The Brown Noddy population, which reached a peak of 35,000 in 1919, was reduced by rats to about 400 adults in 1938; it is in the neighborhood of 2,000 today. A colony of 150 to 450 Roseate Terns has nested in most years from 1917 to the present. About 500 Least Terns nested regularly from 1916 to 1932, then unaccountably dwindled to a few pairs by 1937 and shortly afterward disappeared. Royal and Sandwich Terns nested abundantly in the mid-19th century, and a colony of Royals may have existed as late as 1890. Both species are believed to have been extirpated from the Tortugas by egging. No verifiable evidence exists for the nesting of the Common Tern, which has been reported several times. The Black Noddy, first reported for the continental United States at Dry Tortugas in 1960, has been found there each summer since.

[1] The author is Park Biologist at Everglades National Park and Fort Jefferson National Monument, Homestead, Florida. Manuscript submitted 10 October 1963.—ED.

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Introduction

The tern colonies of the Dry Tortugas, in particular the great breeding aggregations of the Sooty Tern, *Sterna fuscata* Linnaeus, and the Brown Noddy, *Anous stolidus* (Linnaeus), have been of interest to ornithologists since Audubon visited them in 1832. Although the area is remote and difficult of access even today, few bird colonies in North America can boast so long a record of observations or so extensive a literature.

During the early years of the Carnegie Institution of Washington's Tortugas Laboratory, John B. Watson and his co-workers made extended observations on Sooty Terns and Brown Noddies (Watson, 1907, 1908, 1910; Watson and Lashley, 1915; Lashley, 1915). Their work provided nearly all of the detailed life history data available for these species until recently. It also included pioneer experimental studies of behavior, homing, and orientation, as well as an early instance of the use of metal leg bands to mark birds.

Excepting the work of Watson and his associates, the literature consists almost entirely of descriptions of the ternery as observed during brief visits. Many accounts since 1900 include estimates of the number of Sooty Terns, Brown Noddies, and other breeding spe-

cies. Lengthier studies by National Park Service personnel in 1937 and 1938 (Beard, 1939) were concerned particularly with predation upon Sooty Tern chicks by Magnificent Frigate-birds, *Fregata magnificens* Mathews. Parts of the historical record were summarized by Bartsch (1919), Vinten (1943), Sprunt (1948*b*), and Moore and Dilley (1953).

Modern banding at the Dry Tortugas began with the activities of Jack C. Russell in 1936 and was continued annually through 1941, principally on outings sponsored by the Florida Audubon Society. About 13,300 Sooty Terns and 246 Brown Noddies were banded. The bandings were reported separately by eight or more individuals and no analysis of the data was undertaken until recently (Austin, 1962 MS.).

In June 1959, the National Park Service, Florida State Museum, and Florida Audubon Society began a cooperative mass-banding study of the movements and demography of the Sooty Tern population. At the end of the 1963 season new bandings of Sooty Terns by project cooperators totalled approximately 32,300 adults and 41,900 juveniles. In the course of this work it became evident that a number of the widely scattered published reports and much unpublished information had not been taken into account by previous compilers. Because of this, several apparent misinterpretations of the history of the colony had gained wide currency. The present summary resulted.

The names of birds are those of the *Check-List of North American Birds,* American Ornithologists' Union, 1957, except for the changes resulting from the recent discovery of *Anous tenuirostris* (Temminck) at the Dry Tortugas (Robertson *et al.,* 1961).

ACKNOWLEDGMENTS

It is possible to mention here only a few of the people who helped me to assemble the data this paper summarizes. The cooperation of those named and many others contributed greatly to this review.

I am particularly indebted to Joseph C. Moore for permission to refer to the unpublished reports of tern censuses he made in 1953, 1954, and 1955. C. Russell Mason also made extensive field notes available to me. Others who contributed unpublished data or photographs included Robert P. Allen, H. G. Deignan, John R. DeWeese, Willard E. Dilley, Theodore R. Greer, David O. Hill, James B. Meade, Dennis R. Paulson, Roger T. Peterson, Chandler S. Robbins, Alexander Sprunt IV, and Louis A. Stimson.

Albert Manucy provided a wealth of information from his research on the history of Dry Tortugas and useful advice on historical sources. Of those who helped me to obtain copies of rare publications, maps, and material from archives, I must thank in particular Luis R. Arana, Charles M. Brookfield, C. Gordon Fredine, Lowell Sumner, and C. R. Vinten. Charles I. Park, Julius F. Stone, Jr., and C. C. Von Paulsen gave me their recollections of Dry Tortugas in the late 1920's and early 1930's, a period for which little written record exists.

Recent work at Dry Tortugas has depended greatly upon the cooperation of National Park Service personnel in the area particularly District Manager and Mrs. Wallace B. Elms, District Manager James A. Olson, and Park Rangers Roy Evenson, Carl S. Christensen, and James E. Markette.

Finally, I am grateful to Oliver L. Austin, Jr. for assistance in locating references, friendly encouragement, and many helpful comments on the manuscript.

Location and Physiography

The Dry Tortugas, the westernmost outliers of the Florida Keys, are an area of shoals with several small, low islands located about 70 miles west by slightly north of Key West (figure 1). The shoals have the shape of a roughly elliptical atoll with its long axis northeast-southwest. They enclose a lagoon about 10 miles in greatest diameter, its center lying at approximately 24°40'N, 82°52'W. The 10-fathom line closely approaches the outer perimeter of the shoals. Depths within the lagoon are mostly 5 to 10 fathoms. According to Vaughan (1914) the shape and alignment of the shoals were determined primarily by currents and antedate the present luxuriant growth of reef corals. The nearest land is the Marquesas Keys, about 50 miles east.

The islands of the Dry Tortugas (Vaughan, 1914; Davis, 1942) are made up of coarse, unconsolidated calcareous sand and larger detrital fragments, chiefly the remains of lime-secreting marine organisms. Skeletons of corals predominate. Because of the strong currents and heavy wave action during storms, little fine sediment accumulates and the shorelines of the islands change frequently. Highest elevations on most of the present Tortugan islets do not exceed 3 or 4 feet above normal high tides. Except for Garden Key and Loggerhead Key, all are subject to some overflow by storm tides.

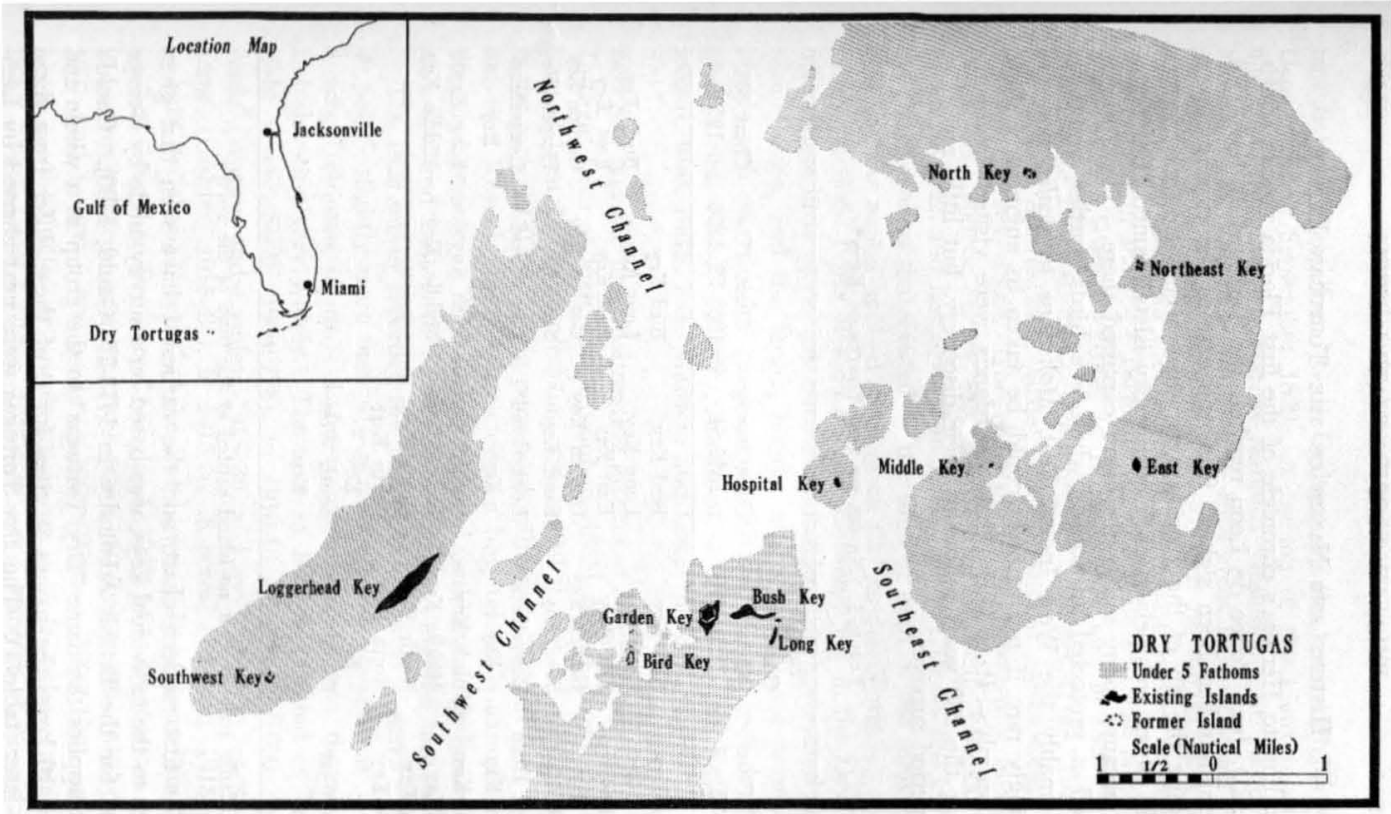

FIGURE 1. Dry Tortugas, showing shoal areas and the location of existing and former islands. Based on Coast and Geodetic Survey 585 "Dry Tortugas." Location of former islands from U. S. Coast and Geodetic Survey 471a "Tortugas Harbor and Approaches."

History and Names of the Tortugan Keys

According to Herrera's chronicle of the first Florida voyage (Davis, 1935: 21), Juan Ponce de Leon reached the Tortugas 21 June 1513. The islands had been sighted from the east as the expedition was rounding the tip of the Florida Keys some weeks earlier. Herrera speaks of an archipelago of "eleven rocky islets" named "Las Tortugas" because many sea turtles were captured there. The Tortugas offered a protected anchorage where sea birds, turtles, and seals (presumably the West Indian Seal, *Monachus tropicalis,* now exceedingly rare if not extinct) could be taken to augment a ship's food supply. It is likely that the islands were visited frequently during the 250 years following their discovery, but little record of this period survives.

Table 1. Names of the Tortugan Keys*

Gauld Chart 1773-75	Tatnall Gednery Chart 1829	Coast Survey 1853-54	Chart 471a 1868-75, 1896	Chart 585 1958
Booby Kay	Bird Key	Bird Key	Bird Key	
	Long Key	Long Key	Long Key	Bush Key
East Kay	East Key	East Key	East Key	East Key
Bush Kay	Garden Key	Garden Key	Garden Key	Garden Key
Middle Kay	Sand Key	Sand Key	Sand Key	Hospital Key
Logger Head	Loggerhead	Loggerhead	Loggerhead	Loggerhead
Turtle Kay	Key	Key	Key	Key
Rocky Kay	Bush Key	Bush Key	Bush Key	Long Key
Bird Kay	Middle Key	Middle Key	Middle Key	Middle Key
North Kay	North Key	North Key		
Sandy Kay	North East Key	North East Key		
South West Kay	South West Key	South West Key		

* Blanks indicate that no island existed at the time of the survey.

The first modern chart, and the earliest I have seen that gives names to the individual keys, was based on a survey made by George Gauld for the British Admiralty in 1773-75 (Gauld, 1790). Gauld's chart applies the name "Dry Tortugas" to the group as a whole and shows 10 keys; the names it gives for 6 of these differ from those used later (table 1). The Dry Tortugas were next charted by Lieu-

tenants Josiah Tatnall and G. R. Gednery for the United States Navy Department in September 1829. A tracing of this chart is in the files of Castillo de San Marcos National Monument, St. Augustine, Florida (C. R. Vinten, *in litt.*). The 1829 chart has particular value because it gives areas and elevations for 6 of the 11 keys then emerged. Parties from the United States Coast Survey worked at the Tortugas in 1853-54 ("Tortugas Island", Scale 1:31,680; and "Section No. VI", Scale 1:400,000, in Bache, 1858), and in 1868-75 ("T-1410", Scale 1:10,000, in Coast Survey, 1878; Chart 471a, "Tortugas Harbor and Approaches", Scale 1:40,000, United States Coast and Geodetic Survey, 1896). The chart of the area presently in use is Coast and Geodetic Survey 585, "Dry Tortugas", Scale 1:30,000, first issued in 1922 and last revised in 1958. Table 1 shows the keys of the Dry Tortugas that existed at the time of each of the above surveys and the names applied to them on the various charts.

Two general types of keys may be distinguished in the Dry Tortugas, those little more than barren sandbanks slightly elevated above normal tides, and the larger, higher, and usually more permanent islands with considerable plant cover. The first group includes Hospital, Long, Middle, North, Northeast, and Southwest Keys; the second, Bird, Bush, East, Garden, and Loggerhead Keys.

Bird Key was the principal nesting ground of Sooty Terns at the Dry Tortugas from at least 1832 (Audubon, 1835) and of Brown Noddies from at least 1857 (Wurdemann, 1861) until the island washed away in the early 1930's. During periods of military activity at Fort Jefferson, Bird Key also served at times as a hospital site, quarantine station, and cemetery. The former hospital buildings later housed the Audubon and Biological Survey wardens guarding the tern colony.

The 1829 survey recorded the area of Bird Key as "4 acres 2 roods 20 poles", slightly more than 4½ acres, and the elevation as "3 feet 8 inches" (Vinten, *in litt.*). Later comments on its area, dimensions, and elevation vary widely. The area in 1890 was stated as "about eight acres" (Scott, 1904: 278), in 1910-13 as "about 6,000 square yards" (Watson and Lashley, 1915: 35) and as "somewhat less than 5 acres" (Lashley, 1915: 61), in 1915 as "8 acres" (Pearson, 1915: 412), in 1918 as "about 6 acres" (Ashe and Lowe, 1918 MS.), and in about 1926 as "less than five acres" (England, 1928: 14). Dimensions given in various publications range from 500 x 250 feet in 1904 (Millspaugh, 1907: 233) to 400 x 300 yards in 1907 (Watson, 1908: 191), and the key is credited with various elevations up to "6 feet above mean tide level" (Watson and Lashley, 1915). A comparison of the representa-

tions of Bird Key on the charts of different periods suggests that much of the reported variation existed mainly in the eye of the observer.

It is commonly stated that Bird Key was destroyed by a hurricane in 1935, the Labor Day hurricane that devastated the Florida Keys often being specified (Stevenson, 1938; Davis, 1942; Vinten, 1943; Sprunt, 1946*b*, 1948*b*). Other authors cite the "hurricane of 1933" (Robinson, 1940: 3; Peterson, 1950: 318) and "the big hurricane of 1938" (Peterson and Fisher, 1955: 142) as the storm responsible. Many accounts suggest that the key was destroyed suddenly. Dilley (1950: 67) wrote: "At times changes may be very sudden, as illustrated by the complete disappearance of Bird Key during the hurricane of 1935." Stevenson (1938) noted that Bird Key had been eroding gradually for some time before the 1935 storm, and Robinson (1940), Peterson (1950), and Peterson and Fisher (1955) state that it began to "sink" in 1928.

The disappearance of Bird Key appears to have been an extended process following destruction of the vegetation, and without immediate relation to any of the storms mentioned. In 1832 the key had a thick cover of bushes (Audubon, 1835), and in 1857 Wurdemann (1861: 426) described it as "covered with bay cedar *[Suriana maritima]* bushes seven or eight feet in height interspersed here and there with the cactus." Later descriptions of the vegetation up to 1910 are almost identical to Wurdemann's. As early as 1904, however, some erosion had begun. Millspaugh (1907: 233) noted from Lansing's observations: "Wave action from the northwest appears to be rapidly eroding the western beach, the vegetation on the shore plainly showing the enchroachment."

The severe hurricane of 15-17 October 1910 (Tannehill, 1950: 175-176) was the first important event in the destruction of Bird Key. Of its effects Lashley (1915: 62-63) wrote: "The Key was formerly overgrown thickly with bay cedars, but the greater number of these were killed by the hurricane of 1910 and only a few living cedars remain." In 1915-16 the effects of the 1910 storm were still evident. Bird Key then had only scattered patches of bay cedar bushes (Bowman, 1918: 124). On 10-11 September 1919, another severe hurricane passed directly over Dry Tortugas (Tannehill, 1950: 186-187). In his assessment of the damage done on Bird Key, Warden T. J. Ashe (1919 MS.) wrote: "All vegetation on island destroyed."

Accounts of visits to Bird Key after 1919 (Bartsch, 1923, 1931, 1932; England, 1928) trace the rapid erosion of the denuded island. The later stages are indicated in the following comments by Charles I. Park (*in litt.*): "When I went there in 1929, Bird Key had already

started to wash away. The house which the former warden had occupied was considered unsafe so I lived on Garden Key and commuted by boat to the other keys. . . . Each year erosion on Bird Key progressed until in 1934 there was very little of the island above water level." As of June 1935, Longstreet (1936*a*: 37) stated: "the remains of Bird Key [are] now eroded to a negligible sandbar."

FIGURE 2. Aerial view looking west, Dry Tortugas, January 1945. Long Key in foreground, Bush Key and Garden Key next rear, and Loggerhead Key in background. The white spot on the shoal to the left of Garden Key and slightly above it is a sand bar at the former location of Bird Key. (Official photograph, U. S. Navy.)

The 1935 Labor Day hurricane was a storm of extreme intensity but small diameter that struck the central Florida Keys (Tannehill, 1950). In reply to questions about this storm and the one of 4-6 November, which was the only other hurricane in the area in 1935, Gordon E. Dunn of the United States Weather Bureau, Miami, wrote me (*in litt.*): "Neither of these storms passed very close to Dry Tortugas or to Bird Key, and it is doubtful that either of these storms should have primary responsibility for the disappearance of Bird Key. I would expect that their effect on Bird Key would have been relatively minor." After storms in January 1940 (Felton, 1940 MS.), a 40-foot sandbar elevated 2 feet above high water emerged at the former location of Bird Key. Other intermittent reappearances have occurred more recently (figure 2).

Bush Key, where most of the Sooty Terns and Brown Noddies have nested in recent years, has an involved history complicated by confusion of names. The names Bush Key and Long Key have been

applied at various times to each of the two adjacent islands on the shoal east of Fort Jefferson (table 1, figures 2 and 3). The names in current use were established with the first edition of Chart 585 (1922), but the confusion persisted somewhat longer (*viz.*, Coast Pilot, 1936: 78).

FIGURE 3. Aerial view looking east. Garden Key and Fort Jefferson in foreground. Bush Key, the east spit, and the northernmost sand ridge of Long Key at upper right. Large trees in the parade of Fort Jefferson are mainly buttonwoods (*Conocarpus erectus*), possibly remnants of the original stand. Pilings at the north and south extremities of Garden Key formerly supported the coaling docks. The center of Bush Key is a thicket of bay cedar (*Suriana maritima*) enclosing several mangrove-fringed ponds. Brown Noddies nest at the edges of this area. The Sooty Tern colony occupies open areas between the bay cedars and the shore. (Official photograph, U. S. Navy, by U. S. Naval Air Station, Key West, 1959.)

Now the second largest of the Tortugan islets, Bush Key has undergone several cycles of building and erosion. Gauld's chart shows no land in the area. The 1829 survey reported (as "Long Key") an island with an area of "5 acres 3 roods 22 poles" and an elevation of "2 feet 4 inches" (Arana, *in litt.*). By 1832 this island (or possibly Long

Key) was thickly covered with bushes and low trees, and Audubon (1835) referred to it as "Noddy Key" because most of the population of Brown Noddies was nesting there. Maps of 1853-54 (Bache, 1858) show a sizable island at the present location of Bush Key. During the military occupation of Fort Jefferson in the 1860's, the island served as a pasture and slaughter grounds for cattle and hogs brought in as food for the garrison (Holder, 1868: 262; Manucy, 1943: 321). Shortly after this time, Bush Key and Long Key are said to have been, "almost entirely obliterated by a hurricane" (Holder, 1892: 77). About 1889 Bush Key was a barren sandbank (Coast Pilot, 1889: 40) and Chart 471a of 1896 shows only a small area above high water. Scott's (1890) detailed account of Tortugan geography as of the spring of 1890 mentions no land at this location.

The history of Bush Key after 1900 is thoroughly bedevilled by confusion of names. Significant observations on Tortugan geography in this period were made by Lansing in 1904 (Millspaugh, 1907), Bowman in 1915-16 (Bowman, 1918), and Bartsch in 1917 (Bartsch, 1919). Millspaugh does not mention Bush Key. Bowman (1918: 128-129) describes a large, irregular island that had shrubs about 12 years old. Bartsch (1919: 469, 482) refers to Bush Key as "an elevated coral reef" with the statement "all the vegetation, in fact, most everything shiftable above the sea, has long since been swept away by the waves."

These records appear to show that Bush Key did not exist in 1904, built up rapidly until 1915-16, and then was suddenly reduced and devegetated (presumably by storms) to produce the conditions Bartsch found in 1917. Davis (1942: 187-189) and Sprunt (1948*b*: 5-6) adopt approximately this interpretation of its history. Davis also points out that Lansing may have overlooked a small island in 1904 because a considerable quantity of sand was removed from the area in 1901-05 for use as fill during the construction of coaling sheds and piers on Garden Key (figure 3).

The record is open to the alternative interpretation that Bush Key had a history of steady growth from before 1900. Close examination of the accounts of Millspaugh (1907) and Bartsch (1919) strongly suggest that these authors, following the nomenclature of the charts then current, referred to the present Bush Key as Long Key and vice versa. Bartsch (1919: 469), for example, wrote of Long Key: "the northern end consists of a barren rim of coral boulders that curves eastward and southward, to join with the reef fringe of Bush Key." This is a fairly accurate description of present geography with the names of the keys reversed. Bowman (1918) discussed

Bush and Long Keys together but appears to have followed present usage in his application of the names. "Long Key" is described in Millspaugh's (1907: 225) account as, "so low as to be awash during heavy weather" and "void of vegetation." Bartsch (1919) indicated that the southern part of "Long Key" supported a sparse vegetation of grass and bushes in 1917.

The probable history of Bush Key may be summarized as follows. After having existed as a well-vegetated island for 40 or 50 years, it was destroyed by a hurricane around 1870. Sandbars soon reappeared at the site, but as late as 1904 they were small and had no permanent vegetation. During the next decade some plants became established and a series of ridges and bars developed as shown in Bowman's (1918) sketch. By 1915 (Bowman, 1918) or 1919 (Davis, 1942) several of the sandbars had grown together to cut off ponds from the ocean. Most of the area between the coalesced bars gradually filled and a long sandspit built up from the east end to give the key approximately its present shape (Davis, 1942; figure 3). Bush Key continued to build up during the 1930's and 1940's and contained an estimated 110,000 square yards in 1946 (Sprunt, 1946*b*: 5). More recently some of the shores have eroded, but the island seems to be more or less stabilized at about 20 acres.

East Key appears on all maps of the area and, unique among the present islands of the Dry Tortugas, it has borne the same name throughout its history. Although more stable than many Tortugan islets, East Key has undergone substantial changes in size and vegetation. Gauld's chart shows it as the second largest island of the group. This is corroborated by the 1829 survey which recorded an elevation of more than 4 feet and an area of about 12 acres, second in size only to Loggerhead Key. During the late 1800's and early 1900's, East Key may have suffered several periods of devegetation and erosion. About 1860 (Holder, 1892) it was covered with a dense stand of bay cedar bushes and numerous mangroves. In 1875 it was reported to be "partly covered with a growth of cedar" (Coast Survey, 1878) and later (Coast Pilot, 1889) was said to have "a few bushes on it." At almost the same time, Scott (1890: 302) wrote of East Key: "It is a low, sandy, coral island, covered in parts with stunted bushes, and contains an area of perhaps eighteen acres." By 1904 little but herbaceous growth persisted and Millspaugh (1907: 224-225) described East Key as "little more than a mere sand bank 280 x 50 feet in area." He may, however, have been misinformed about its size. In 1915-16 (Bowman, 1918: 131-132) the island was said to be "almost entirely

covered with vegetation" including "large, well-grown bushes," but no bay cedar. Its dimensions were given as about one-third mile long and less than one-sixth mile wide. Davis (1942: 191) found a thicket of bay cedar on the highest sand ridge and reported the island's dimensions to be about 1200 x 600 feet. He stated that East Key "has probably grown in size and become more stabilized in the past half-century." Sprunt (1948*b*: 17) wrote of East Key: "It comprises about 85,000 square yards," indicating continued growth. At present sizable bushes of bay cedar, sea lavender (*Tournefortia gnaphalodes*), and *Scaevola plumieri* are well distributed over East Key.

It has often been said that Sooty Terns and Brown Noddies were not known to have nested on East Key and several authors have remarked upon the failure of the terns to use so suitable a nesting area. These comments overlook various records of the 19th century. Large breeding colonies of both species occupied East Key in the 1850's (Wurdemann, 1861; Bryant, 1859*a*). Sooties, at least, still nested there as late as 1890 (Scott, 1890). Continual persecution by eggers, mentioned by every early writer, may finally have driven the terns from East Key. Though a warden was in residence at Bird Key each nesting season from 1903 on, his surveillance is not likely to have extended to the outlying islands. It is of interest that no terns have bred on East Key during the past 28 years of strict protection.

Garden Key adjoins the best protected anchorage in Tortugan waters and has long been the center of human activity in the area (Manucy, 1943). Most of the key is occupied by the immense ruin of Fort Jefferson (figures 2 and 3). A lighthouse was built on Garden Key as early as 1825. Construction of the fort began in December 1846 and was discontinued about 20 years later with the work still far from complete. After use chiefly as a military prison, the post was abandoned in the 1870's. It was reoccupied during and after the Spanish-American War and World War I, first as a coaling station, later as a seaplane base and wireless station.

Gauld's chart shows Garden Key with an irregular shoreline and the 1829 survey reported its area as about 7½ acres. An interesting map in the files of the U.S. Corps of Engineers (Bache, 1845 MS.) is a detailed topographic survey of Garden Key as it was immediately before the construction of Fort Jefferson began. The shape is roughly elliptical, highest land elevations are just over 5 feet above mean low water, and the center of the island is shown as low and evidently swampy. The exact scale of the map is uncertain. Calculations (by

William M. Alexander, Assistant Park Engineer, Everglades National Park) based upon the scale taken from a superimposed outline drawing of the Fort, laid out on the original map presumably by Major Bache, give a land area of 8.8 acres above high tide line. The size of Garden Key was increased by filling when the Fort was being built and again about 1900 when the coaling structures were built. Davis (1942: 185) gave the area as 16 acres, of which 5 acres lay outside the walls of the Fort.

No terns are known to have nested on Garden Key until relatively recent years. Detail shown on the 1845 map suggests that the interior of the island may originally have been too heavily vegetated to attract nesting Sooties, although much of it was apparently suitable for Brown Noddies. Any that may have nested there undoubtedly were displaced soon after 1845. A few pairs of Brown Noddies have nested on pilings and in the ruins of the north coaling dock in a number of years since at least 1932 (Bartsch, 1932). In 1937 (Longstreet, 1937), 1938 (Beard, 1938), and 1947 (Sprunt, 1947*a*) large numbers of Sooty Terns nested along the east side of Garden Key. A substantial part of the Brown Noddy population also nested there in 1937 and 1938, but not in 1947 (Sprunt, 1948*a*).

Hospital Key, although always a small, shifting sandbar with little vegetation, has existed since the earliest surveys of the Dry Tortugas. The present name, which was used as early as 1875 (Coast Survey, 1878) stems from the isolation hospital for yellow fever patients built there in the 1860's. Sand Key, an earlier name, remained in common use until the 1940's. Various plants have been recorded from Hospital Key, but the island is so often awash in rough weather that no permanent plant cover has become established.

Least Terns nested on Hospital Key in 1907 (Watson, 1907) and 1937 (C. R. Mason, *in litt.*) and a colony of Roseate Terns has occupied the key in a number of recent years since 1937 (Mason, *in litt.*). Sprunt (1948*b*: 17) suggested that Sooty Terns might find Hospital Key a suitable nesting area, a prediction fulfilled when a few Sooties nested there in 1957 and 1959.

Loggerhead Key is the largest, highest, and most heavily vegetated of the Tortugas and the site of the 150-foot Loggerhead Light (figure 4) built in 1856-60. The size and shape of the key have been remarkably constant. It had an area of about 30 acres in 1829 and is approximately the same size at present, erosion of the west shore

having been balanced by the growth of sandspits at the northeast and southwest ends. Loggerhead Key has been credited with an elevation of 9 feet above mean tide (Millspaugh, 1907: 235; Davis, 1942: 179) but it seems likely that this estimate is excessive. The 1829 survey gave the elevation as "4 feet 4 inches."

Least Terns nested on the Loggerhead Key sandspits intermittently from before 1900 to 1936 (Russell, 1938 MS.: 4). No other tern is known to have nested on the island.

FIGURE 4. Loggerhead Key about 1945, looking southwest from the north tip. In the foreground is the former site of the Tortugas Laboratory, Carnegie Institution of Washington. In the center of the island, Loggerhead Light. (Official photograph, U. S. Navy, by U. S. Naval Air Station, Key West.)

Long Key is a bar or shoal of reef debris with several dune-like elevations of broken coral (figure 2). Davis (1942: 189) estimated that more than one-third of the key was flooded by normal high tides and that the sparse vegetation of herbaceous halophytes and scattered small mangroves covered less than one-third of the area above high tide. If allowance is made for apparent confusion of names in the past (see Bush Key), it appears that Long Key has never been greatly different. Gauld's chart of 1773-75 which shows a small island at the north end of the bar and below it the notation "Ridge of rocks almost dry and very steep", closely approximates present conditions.

A few Least Terns occasionally nested on the higher sandbanks at the north end of Long Key as late as 1948 (Sprunt, 1948c). Roseate Terns have nested there from time to time, most recently in 1962 (Robertson, 1962). Some Sooties and Brown Noddies probably nested there in 1932 and 1933 (Bartsch, 1932, 1933). In 1943 (Budlong, 1944 MS.), 1952 (Moore and Dilley, 1953), 1956 (Robertson, 1956 MS.), and perhaps in other years, many Sooties have tried to nest in rocky spots between the dunes and farther south on Long Key, but because even moderate storm waves wash over this section, the attempts are believed to have been largely unproductive.

Middle Key is shown on Gauld's chart as a fair-sized island, and the map symbols indicate that it supported some vegetation at that time. In 1875 (Coast Survey, 1878) Middle Key was still considerably larger than it is now but without established vegetation. More recently the key has existed only intermittently as a low strip of bare sand with few or no plants.

Several pairs of Least Terns may have nested on Middle Key in 1947 (Sprunt, 1948*a*), and a small colony of Roseates nested there in 1953 (DeWeese, 1953 MS.), and possibly also in 1960. Gauld's name for the island, "Bird Kay," suggests that it was once a more important nesting locality.

North Key, Northeast Key, and *Southwest Key* all were barren sand islands that had washed away by 1875 (Coast Survey, 1878). They have shown no tendency to reappear, but the former location of Southwest Key is marked on present charts as bare at low water. No plants are recorded from any of these keys and no terns are known to have nested on Southwest Key, which may never have been much more than a high place in the reef. Northeast Key harbored a large colony of Royal and Sandwich Terns in the late 1850's (Bryant, 1859*a*). The only definite reference to nesting on North Key seems to be Holder's (1892: 155) mention of "a solitary gull's egg" (from the context possibly a Sooty Tern egg) found on the bare summit of a sand ridge. In addition, Bartsch (1919: 492-493) believed that the island—about 8 miles northeast of Tortugas Lighthouse—"a small sand-bar a few acres in extent, called Booby Island"—where Audubon found large numbers of some species of Booby, was probably North Key.

Sooty Tern

Appearance and behavior combine to make the Sooty Tern a conspicuous bird, and it has usually been the most abundant species in the Tortugas terneries. Little wonder, then, that the crowded and noisy breeding colonies of Sooties have claimed most of the attention of observers who visited the Dry Tortugas.

Perhaps inevitably, much of the comment on the Sooty Tern at the Dry Tortugas has centered on the question, how many? Early ornithologists contented themselves with word pictures that suggest merely large numbers of birds, but few 20th century authors have failed to attempt a numerical reckoning of the size of the colony. Their figures range in quality from guesses made after brief observation to estimates calculated from measurements of colony area and density of nests. Table 2 shows what I consider the soundest figures available for numbers of adult Sooties in each year of record from 1903 to 1956. Population figures for several of the years have had an eventful history in the hands of compilers, and quantitative data were found for a number of years previously thought to be gaps in the record. With these corrections and additions the broad outline of the history of the colony seems clear, though many details remain obscure.

The Dry Tortugas ternery has been called "The Oldest Bird Colony" (Peterson, 1950) on the assumption that its known history reaches back to the discovery of the area in 1513. It is reasonable to suppose that the "other birds" of Herrrera's statement (Davis, 1935), ". . . there were killed many pelicans and other birds that amounted to five thousand . . . ", included Sooty Terns. The accounts of other early visitors, such as John Hawkins (Longstreet, 1936*a*), and much later ones, such as George Gauld (1796), contain similar imprecise allusions to the abundance of sea-fowl at the Dry Tortugas. No certain record of any tern is known for the area, however, prior to Audubon's visit in May 1832.

Record of Nesting

1832. Audubon (1835: 263-269) reported Sooties breeding in great numbers on Bird Key and Noddies breeding on Bush Key. His account shows that both colonies were then being heavily exploited as a source of food. Besides several references to the killing of adult birds and the gathering of eggs it includes the following:

"At Bird Key we found a party of Spanish Eggers from Havannah. They had already laid in a cargo of about eight tons of the eggs of

TABLE 2. BREEDING POPULATIONS OF SOOTY TERNS AT THE DRY TORTUGAS

Year	Number of Adults	Method	Reference
1903	5000	Estimate	Burton (in Dutcher, 1904)
1907	18,858	Area x Density	Watson (1908)
1909	40,000	Estimate	Peacon (1909 ms.)
1911	48,000	Estimate	Peacon (1911 ms.)
1912	48,000	Estimate	Peacon (1912 ms.)
1913	30,000	Estimate	Peacon (1913 ms.)
1914	97,500	Estimate	Peacon (1914 ms.)
1915	102,000	Estimate	Ashe and Bethel (1915 ms.)
1916	60,000	Estimate	Bethel (1916 ms.)
1917	80,000	Estimate	Ashe (in Pearson, 1917)
1918	100,000	Estimate	Ashe (in Pearson, 1918)
1919	110,000	Estimate	Ashe (1919 ms.)
1929	80,000	Estimate	Park (ms. notes)
1935	30,000	Estimate	Mason (1936)
1936	40,000	Estimate	Doe and Russell (1936)
1937	72,000	Area x Density	Longstreet (1937)
1938	64,057	Area x Density Direct Count	Beard (1938)
1939	70,000	Estimate	Robinson (1939)
1940	100,000	Estimate	Robinson (1940)
1941	100,000	Estimate	Peterson (1950)
1942	65,000	Estimate	Budlong (in Vinten, 1943)
1943	100,000	Estimate	Budlong (1943 ms.)
1944	130,000	Estimate	Vinten (*in litt.*)
1945	109,000	Area x Density	Sprunt (1946a)
1946	97,200	Area x Density	Sprunt (1946b)
1947	64,270	Area x Density Direct Count	Sprunt (1947a)
1948	104,000	Area x Density	Sprunt (1948c)
1949	120,220	Area x Density	Dilley (1950)
1950	190,876	Area x Density	Moore and Dilley (1953)
1951	167,770	Area x Density	Moore and Dilley (1953)
1952	76,326	Area x Density	Moore and Dilley (1953)
1953	84,569	Area x Density	Moore (1954 ms.)
1954	88,776	Area x Density	Moore (1954 ms.)
1955	71,102	Area x Density	Moore (1955 ms.)
1956	90,452	Area x Density Direct Count	Robertson (1956 ms.)

this Tern and the Noddy. On asking them how many they supposed they had, they answered that they never counted them, even while selling them, but disposed of them at seventy-five cents per gallon; and that one turn to market sometimes produced upwards of two hundred dollars, while it took only a week to sail backwards and forwards and collect their cargo. Some eggers, who now and then come from Key West, sell their eggs at twelve and a half cents the dozen; but wherever these eggs are carried, they must soon be disposed of and eaten, for they become putrid in a few weeks."

Sprunt (1948*b*:8) points out that Audubon's account contains nothing definite about the number of terns. Despite this, later writers almost without exception have supposed that Audubon found Sooty Terns in far greater numbers than were ever seen again at the Dry Tortugas. The statement, "both species were on their respective breeding-grounds by millions," has been cited both as evidence of former abundance and as typical of Audubon's bent for extravagant language. Although attributed to Audubon, in fact it is only reported by him as the remark of an officer of the *Marion,* made as the ship approached Dry Tortugas and before Audubon had seen the tern colony.

Peterson (1950: 318) used one of the statistics of the Cuban egg trade cited above to obtain an estimate of the number of terns in the colony in 1832. He wrote: "A sooty's egg weighs about thirty grams, or about fifteen eggs to the pound. Eight tons would come to about 240,000 eggs. As sooties and noddies normally lay but one egg this shows irrefutably that the concentration was far larger than it is now." A repetition of the exercise (Peterson and Fisher, 1955: 142) arrived at an estimate of about 250,000.

Had Audubon mentioned no other statistics, this ingenious reasoning might indeed be difficult to dispute. The eggers who spoke of an eight-ton cargo, however, also told Audubon that they sometimes realized "upwards of two hundred dollars" per trip to market. If this is interpreted to have been as much as $250, the 250,000-egg cargo was sold at ten for a penny. This seems too good a bargain in eggs even for 1832, especially as the price in Key West is given as "twelve and a half cents the dozen."

The Sooty Tern population can also be estimated on the basis of a return of $250 per successful trip and the stated Havana price of "seventy-five cents per gallon," if the latter is taken to mean fluid egg contents. Worth (1940: 56) calculated the volume of a Sooty Tern egg as 1.95 cubic inches or about 118 eggs to the standard gallon.

At 75 cents per gallon a $250 cargo would amount to about 334 gallons, therefore equalling about 39,412 eggs.

Some or all of Audubon's statistical information about egging evidently is inexact. Attempts to derive a population estimate from any of the details he gives seem unwarranted.

The question of the size of the colony in 1832 can be approached by considering the number of nests Bird Key could accommodate. Although Sooty Terns nest in dense aggregations, a limit of colony compressibility exists. Watson (1908: 200) wrote of Sooties nesting on Bird Key in 1907: "Each pair . . . defended a circular territory roughly 14 inches to two feet in diameter." If the smaller figure is taken to represent maximum density of nesting observed by Watson, then the minimum area of the territory of a nesting Sooty was 154 square inches and the maximum density of nesting about 8.4 nests per square yard.

Detailed observations of the density of nesting of Sooty Terns on Bush Key were made in 1953-56 on 20 to 30 plots each of 8 square yards distributed throughout the parts of the island judged suitable for nesting. The largest number of eggs laid on a plot was 56 (7.00 square yard) on one plot in 1954. Field maps show four instances in which 10 eggs occurred in areas of one square yard within the larger plots. In each case, however, some were located at the edges, and no one square yard area appears to contain 10 entire territories. The average number of eggs per square yard for all occupied plots and the number of plots that contained one or more eggs were: *1953*—3.00 per square yard (14 plots), *1954*—3.12 (21), *1955*—2.1 (26) (Moore 1954 ms., 1955 ms.); and *1956*—2.53 (20) (Robertson, 1956 ms.).

Measured nesting densities reported for other Sooty Tern colonies are mostly similar to or lower than those found on Bush Key. Data for two breeding seasons on Ascension Island (Ashmole, 1963*a*: 309), for example, show maximum densities (on plots of 25 square yards area) of 5.28 and 5.00 eggs per square yard; average densities for all plots occupied of 1.95 and 2.00 eggs per square yard.

The 1953-56 data from Bush Key suggest that 10 nests per square yard is about the maximum density breeding Sooties will tolerate. Few colonies are this crowded, except locally, because vegetation or terrain limit the number of acceptable nest sites. Nesting Sooties ordinarily avoid areas with dense shrubbery or heavy herbaceous ground cover. Ashmole (1963*a*) found that nests also were fewer on featureless bare ground deficient in the local clues that enable

a bird to return to the proper egg. The Tortugas ternery, however, lacks extensive bare areas.

From the Tatnall-Gednery survey Bird Key is known to have had an area of about 4½ acres (21,780 square yards) in 1829. Assuming for the moment that the Sooty Tern colony occupied its entire surface, an average density of 11.5 nests per square yard would be necessary to accommodate 250,000 nests. Parts of Bird Key, however, were thickly covered with bay cedar bushes in the 19th century. Photographs taken much later, after the hurricane of 1910 had greatly reduced the amount of plant cover (*e.g.*, Bartsch, 1919: Plate 13), show large areas still not available to nesting Sooties because of the dense bush growth. Therefore, I think it unlikely that the maximum breeding population of Sooty Terns on Bird Key much exceeded 50,000 pairs.

Audubon's manner of reference to his visit to Bird Key suggests that he saw tremendous numbers of Sooty Terns. A large subjective element, however, seemingly must be allowed in verbal descriptions of first visits to Sooty Tern colonies. When Herbert K. Job saw the Bird Key ternery at its lowest ebb in 1903 he wrote (1905: 87) of the Sooties: "There are such clouds of them that accurately to estimate their numbers was impossible . . . " This language also could be taken to indicate great abundance were it not for the rest of the Reverend Job's sentence which reads: " . . . but my guess of six or eight thousand I think cannot be far out of the way."

It seems characteristic of moderns to suppose that Audubon saw all bird concentrations in their pristine glory. However true this may have been of many places he visited, it does not apply in the case of the Dry Tortugas. Bird Key was adjacent to a fine anchorage, itself adjacent to a major shipping lane that had been used for more than three centuries. That there were no accurate charts before Gauld's survey of the 1770's can scarcely have deterred mariners from using Tortugas harbor. Audubon was told that the terns had frequented Tortugas "since the oldest wrecker on that coast can recollect." It is altogether likely that the ternery was first disturbed on the day of its discovery, and as often thereafter as ships put in to Tortugas in appropriate season. The most that can be assumed is that exploitation up to about 1832 had been infrequent enough to permit the Sooties to rear young in most years.

1840-1902. Although much of this period was marked by intensive human activity at the Dry Tortugas, the record of the tern colonies in the 19th century after Audubon's visit is limited to observations

by Bryant (1859*a*), Wurdemann (1861), Maynard (1881), and Scott (1890). Comments by the first three of these authors are brief. Scott discusses the Dry Tortugas in greater detail, but most of his information about terns is hearsay, because the colonies were not active at the dates of his visit, 19 March to 10 April 1890.

Data accompanying bird specimens from the Dry Tortugas in several collections show that other ornithologists may have visited the tern colonies during this period, but left little or no published record of their observations. One such visit was by A. L. Heermann and John Krider, probably in May 1848. Howell (1932: 13) mentions this expedition but does not include the Dry Tortugas among the places visited. Heermann (1853: 34), however, lists eggs of the Sooty Tern and Brown Noddy from "Tortugas Islands" presented by him to the oological collection of the Academy of Natural Sciences of Philadelphia. At least a part of this material (ANSP Catalogue Nos. 32055, 32060, and 32061) is still in the collection (Henry M. Stevenson, *in litt.*) The specimens bear no date, but Heermann is known to have visited Florida only once. In the book in which John Krider summarized his career, including "only those species of birds of the United States that I have myself collected and mounted", he refers to the Sooty Tern as follows (1879: 81) : "Common on the Keys of Florida and the Tortugas, where it breeds in large numbers. I have two specimens in my collection."

The two main items to be gleaned from the later 19th century papers are: Sooties and Noddies then nested on East Key as well as Bird Key, and the colonies were under increasing pressure from eggers.

Dr. Henry Bryant traveled and collected extensively in Florida in the decade 1850-1860, but his obituary in the *Annual Report* of the Boston Society of Natural History for 1867 gives no details of his work in Florida, and little seems to be recorded elsewhere. All that has been known of his visit to Dry Tortugas is that he was there on 8 May. Data on bird specimens he collected now in the Museum of Comparative Zoology (David O. Hill, *in litt.*) suggest that the year was 1850. Two Sooty Terns (MCZ Catalogue Nos. 42097 and 42099) carry the dates 10 May and 11 May, respectively, with no year; a Great White Heron (MCZ No. 42534) he collected at Sand Key off Key West, however, places Bryant near the Tortugas on 16 April 1850. His visit there can have occurred no later than the 1853 nesting season, because on 19 April 1854 he donated his collection of birds' eggs from Florida, including eggs of the Sooty and Noddy to the Boston Society of Natural History. His own account of his visit

(1859*a*: 19-21) states merely that he found Sooties and Noddies nesting principally on East Key and "in as great numbers as at the time of Audubon," and that Royal and Sandwich Terns were breeding "in great numbers" on Northeast Key. In a paper on Bahaman birds (1859b: 134) he remarks that Sooties and Noddies occur there "in immense numbers, as at the Tortugas."

Gustavus Wurdemann (1861: 426) described his visit to the Tortugas the last week of June 1857 in a letter that accompanied a shipment of bird specimens to the Smithsonian, published two years after his death in 1859. "At the Tortugas are two keys or islands, East Key and Bird Key, which serve as places of resort to the noddies and laying gulls to deposit their eggs and raise their young. They are watched closely at East Key by boatmen, who gather the eggs to carry them to Key West for sale. But at Bird Key the birds are under special protection of Captain D. P. Woodbury, the officer in charge of construction of the fortifications. . . . The keys are covered with Bay cedar bushes seven or eight feet in height, interspersed here and there with the cactus, among which some young laying gulls sought refuge. Their eggs are laid on the sand, whilst the noddies lay in nests built from two to six feet from the ground of dried sticks or twigs. Only one egg was found in each noddie's nest, and about two in the laying gull's. Their eggs are said to have been taken some time previous to our visit, and that they lay usually two or three. I picked up several female laying gulls with my hands, and might have caught noddies if I had not been encumbered with the gun, birds, and eggs. No young noddies were seen at this time, which was the last week of June. . . . " Other specimens in the National Museum (Deignan, *in litt.*) and a Sooty Tern in the Museum of Comparative Zoology he took there 10 June 1858 (Hill, *in litt.*) show Wurdemann also visited the Tortugas the next year.

C. J. Maynard never visited the Dry Tortugas in person. As Howell (1932: 16) notes "In 1874 he worked at Cedar Keys from January 26 to March 1. From there, in a small yacht he went down the coast as far as Clearwater, but from that point he was obliged to return home on account of illness, leaving his assistants to complete the trip, which took them as far as the Tortugas." This may partly explain the several geographical and historical inaccuracies in his account (1881: 480): "The Sooty Terns are now only found in any numbers on the small islands which lie to the southward [sic] of Key West and which are known as the Dry Tortugas. Here they breed on Bird Key which is about four miles [sic] from Fort Jefferson, depositing their eggs early in May. The birds are extremely

tame when nesting, insomuch so, that they may be killed with sticks or even caught with the hand, and they deposit the eggs on the naked sand. There were thousands of these birds on this little key in 1874, but as the soldiers of Fort Jefferson had been in the habit of taking the eggs regularly every other day, but few or no young were raised. The officer who had command of the fort, prohibited shooting the birds on the island, but the continual robbing of the eggs must ultimately drive the Sooty Terns from this breeding ground."

The actual date of Maynard's assistants' visit is indicated by a Sooty Tern in the Museum of Comparative Zoology (No. 204310, Hill, *in litt.*) taken there 25 May 1874, though no collector is named. The account contains no first-hand comment on the Noddy, nor does it mention East Key, which lay approximately 4 miles from Fort Jefferson. Regarding the comments on egging by soldiers in the area, the Fort Jefferson garrison had been withdrawn 11 January 1874, leaving only a small detail to guard ordnance stores and a much reduced construction crew engaged mainly in closing down the operation (Manucy, 1961 MS.). In addition, Captain Woodbury, the only commanding officer known to have shown an interest in protecting the tern colony, had left the Dry Tortugas in 1860 and died in Key West of yellow fever 15 August 1864 (Cullum, 1891: 496-497; Manucy, 1961 MS.). It seems likely that the report Maynard received from his assistants in 1874 blended considerable hearsay with their actual observations.

Most of W. E. D. Scott's information about nesting terns was sent to him after his return from the Dry Tortugas by Dr. F. S. Goodman, who was stationed at the Quarantine Station on Garden Key. Scott reports (1890: 307) Sooties nesting on East Key and Bird Key, and Noddies "mainly confined" to Bird Key, but his comments on egging are of greatest interest: "All of the Gulls and Terns that breed at the Dry Tortugas have been much diminished in numbers in the past ten years. It has always been the custom for some of the boats engaged in fishing and sponging about Key West to resort to these islands during the breeding season, and lately their depredations have really made a very appreciable difference in the birds that resort to this breeding ground. I am told that the eggs have a commercial value as an article of food in the markets of Key West, where barrels of birds' eggs from the Tortugas are brought every season of late years."

Vinten (1943: 54) suggests that search of the records of government agencies that had maintained operations at the Dry Tortugas might reveal additional data about the tern population during this

period. Though most of the search of the voluminous Army archives of Fort Jefferson remains to be accomplished, the studies of historians show these archives do indeed contain information pertinent to the history of the ternery. Albert Manucy (*in litt.*) advises me that among records he examined he recalls having seen correspondence relating to the visit of Louis Agassiz to the Dry Tortugas in 1858, and that the Fort Jefferson Letter Books include such items as a letter from Mordecai and Co. to Woodbury on 3 May 1859 concerning shipment of Woodbury's bird specimens to the Smithsonian Institution.

The historical records Manucy (1961 MS.) studied suggest Bird Key suffered even more disturbance than the authors of ornithological works on the Dry Tortugas have appreciated. Shortly after war began in 1861, for instance, concern for the safety of Fort Jefferson, still unfinished and weakly armed, led to the appropriation early in 1862 of $200,000 to fortify Bird Key. The preliminary survey, including extensive borings to determine subsoil structure, was delayed by personnel changes and slow delivery of materials, and was not completed until the spring of 1864. The project then seems to have lapsed, but it can hardly have failed to disrupt the terns attempting to nest during the survey.

Manucy also cites a letter of 18 July 1865 to the Post Commandant from Edward Frost, Assistant Engineer in Charge, complaining of the removal of a number of hogs "from their ranging ground on Long Key to Bird Key" which contained "the scattered graves of many Union Soldiers who have died at this Post during the war." Whether or not the hogs were returned to Long Key seems to be unrecorded. Most probably the Sooty Terns failed to rear young at the Dry Tortugas in most of the years from 1860 to the early 1870's when Fort Jefferson was heavily garrisoned. This loss of annual recruitment plus an undoubtedly heavy mortality of adults must have reduced the population rapidly.

Little definite information about the ternery exists for the years 1890-1903. It may be presumed that the colony was raided regularly by eggers, and that some time in this period Sooty Terns nested for the last time on East Key. J. W. Atkins, a well-known resident collector of Key West, collected specimens now in the Museum of Comparative Zoology at the Dry Tortugas in May 1896, but no other record of his trip is known. A. G. Mayer visited Bird Key in 1898, but the only datum published (in Dutcher, 1906) is his impression that Sooties were then about one-third as numerous as at his next visit in 1906.

With the outbreak of the Spanish-American War, Fort Jefferson was garrisoned once more from 1898 until about 1906. In 1900 the Dry Tortugas were transferred to the Navy Department and construction of a coaling depot at Garden Key began.

Sprunt (1948*b*: 9) suggests that the renewed military activity at Fort Jefferson probably put additional pressure on the tern colony. The Navy at the command level was aware of the need to protect Bird Key, for a letter from Captain T. C. Treadwell quoted by Dutcher (1903: 120-121) states Treadwell ordered egging stopped soon after he assumed command of the U. S. Naval Station, Key West, in June 1901. Unfortunately orders from Key West were not altogether effective at the Dry Tortugas, for according to Thompson (1903: 77-78) the terns "suffered very seriously" from eggers in 1902. Thompson adds, presumably with reference to the recent past and to both Sooties and Noddies: "There have been years when not a single individual was raised, every egg having been taken shortly after it was laid."

Thanks to William Dutcher's untiring efforts sterner measures to protect Bird Key followed in 1903. The Secretary of the Navy issued an order on 24 April prohibiting the taking of eggs or disturbing of terns at Dry Tortugas, and in May W. R. Burton was detailed there as a special warden representing the American Ornithologists' Union with the permission and logistical support of the Navy (Dutcher, 1904). Burton arrived at Bird Key accompanied by H. K. Job 19 May 1903. The modern history of the ternery can fairly be said to begin on that date.

1903. Four estimates of the Sooty Tern population in 1903 are available from the published comments of the original observers. They are: "3600" by Job and Burton made before Job returned to Key West on 22 May; "at least 5000" by Burton in a letter to Dutcher dated 15 July 1903, the increase accounted for by birds that began nesting after Job's departure; "five to six thousand" by Job in a letter to Dutcher (all three figures published in Dutcher, 1904); and, "six or eight thousand" (Job, 1905: 87). The context of the accounts suggests that the figures refer to number of adult Sooties rather than number of nests, but nowhere is this clearly stated. Compilers have given the 1903 population as 3600 (Longstreet, 1936*a*; Vinten, 1943; Sprunt, 1947*b*; Peterson 1950), 6-8000 (Sprunt, 1948b), and "about 7000 nests" (Fisher and Lockley, 1954: 60; Peterson and Fisher, 1955: 142). The figures, where identified, are in all cases credited to Job. I consider the warden's figure of 5,000, based upon observation of the

colony through the entire nesting season, to be the soundest estimate available.

I have found no record of the condition of the colony in 1904 and no estimates of the population for the seasons of 1904 through 1906. Charles Russell, the warden in 1905, reported "a very successful season" (Dutcher, 1905). After visiting the colony in 1906 A. G. Mayer informed Dutcher (Dutcher, 1906) that the Sooties appeared to be three times as numerous as they were in 1898.

1907. John B. Watson began his studies of the tern colony in 1907 and also served as the warden of the National Association of Audubon Societies for that season. In addition to his other work Watson made a careful estimate of the nesting population of Sooties. He divided the colony into 10 sections presumably distinguished by conspicuous features of vegetation or terrain. By determining the area and sampling the density of distribution of nests within each section, he arrived at an estimated 9,429 nests or 18,858 breeding adults (Watson, 1908: 198).

1908. Most summaries of the changes in size of the Tortugas Sooty Tern population include an estimate of 20,000 (or 10,000 nests) as the population in 1908. All authors who cite an authority credit this figure to Watson who, according to the Carnegie annual reports, was not at the Dry Tortugas in 1908 or 1909. The earliest reference I find to it is Lashley's (1915: 61) statement that Sooty Tern nests totalled "more than 10,000 in 1908," with no mention of the source of his information. I have omitted the figure from table 2 because I can find no authority for it.

1909-1916. On 6 April 1908 Executive Order No. 779 of President Theodore Roosevelt established the Tortugas Keys Reservation for protection of birds nesting in the area. The order specified that use as a bird reservation was not to interfere with military uses (under President Polk's Executive Order of 17 September 1845 establishing the Dry Tortugas Military Reservation) except that military use of Bird Key was prohibited. Protection of the Tortugas Keys Reservation became the responsibility of the Bureau of Biological Survey.

After 1908 warden protection at the Dry Tortugas was supported jointly by the Biological Survey and the National Association of Audubon Societies. T. J. Ashe of Key West, who was in general charge of bird protection activities in the Florida Keys during most of the ensuing decade, hired and supervised the men stationed at Bird Key.

These were John Peacon (1909-1914), Ludwig Bethel (1915-1916), and William E. Lowe (1917-1919). Warden's reports on the condition and size of the tern colony were made annually to both supporting organizations. From the annual reports to the Biological Survey I have seen only the data entered in the bird distribution file now at Patuxent Wildlife Research Center of the Bureau of Sport Fisheries and Wildlife.

The annual reports to the National Association of Audubon Societies for this period are still in the files of that organization. Some were prepared by Ashe and submitted in his name; others seem to have been prepared by his wardens at Bird Key. They include estimates of the population of Sooties in all the years 1909 through 1916 except 1910. Watson apparently prepared the 1910 report for *Bird-Lore*, but it was not published and has been lost. This is unfortunate because comments in a later report (Watson, 1912 MS.) indicate he made the 1910 count of Sooties by the same method he used in 1907.

Previous summaries of the colony include no mention of Sooty Terns in these years, but skip directly from the questionable 1908 figure to 1917. In addition to the annual warden's reports, several published comments for this period have been generally overlooked. Of the population in 1913 Watson and Lashley (1915: 38) wrote: "There are probably more than 18,000 (possibly 30,000) sooties on Bird Key." On 28 May 1915 Herbert K. Job and H. R. Mills visited Bird Key to take motion pictures for the National Association of Audubon Societies. A brief excerpt published from Job's report (Pearson, 1915) gives the number of Sooties as "possibly 75,000." Pearson also prepared a longer article about this trip (1915 MS.), evidently copy for *Bird-Lore* that wasn't used, which quotes more extensively from Job. It reveals that the 75,000 population figure was based on area-density calculations by Mills. Because these calculations contain obvious inaccuracies impossible to resolve today, I have used the 1915 population estimate from the warden's report in table 2.

1917. According to Warden T. J. Ashe's annual report (Pearson, 1917: 398) " . . . there were probably 80,000 of these birds [Sooty Terns] nesting on the island." This figure has been overlooked by compilers, who instead have misquoted the 1917 population of Sooties from Bartsch as "18,000" (Longstreet, 1936*a*; Fisher and Lockley, 1954) or "25,000" (Vinten, 1943; Sprunt, 1947*b*, 1948*b*). Bartsch's list of the birds seen at the Dry Tortugas 19-31 July 1917 (1919: 471) includes under Sooty Tern "adult [1]18,000 young [2]7,200." The figures are keyed to footnotes that read: "[1]Based upon Doctor Watson's cen-

sus of 1908.", and "[2]An estimate admitting two-fifths as many offspring as we had parents." Bartsch also (1919: 473) wrote of the Sooties: " . . . probably more than 25,000 are present on Bird Key at the close of the breeding season." Apparently Bartsch made no independent estimate of the Sooty Tern population in 1917; the figure 18,000 is an approximation of Watson's total for 1907 (not 1908) and the "more than 25,000" is merely 18,000 adults plus Bartsch's arbitrary figure for young of the year.

1918-1934. None of the earlier compilations mentions these years. I have seen warden's reports only for 1918 and 1919. A Federal law effective 1 July 1919 ended the National Association of Audubon Societies' participation in the protection of Bird Key (Pearson, 1919). The Biological Survey continued to employ a warden at the Dry Tortugas during the summer at least through 1930, but no wardens' reports can be located in the files now stored at Patuxent Wildlife Research Center (Robbins, *in litt.*), and the distribution files contain only the warden's estimate of the Sooty Tern population in 1929 (Park, MS. notes).

Several popular articles published in the 1920's refer in passing to the number of terns at the Dry Tortugas. England (1928: 86) mentions a population of 50,000, and a photograph in an article by Longley (1927: 66) is captioned: "The west shore of Bird Key showing some of the 33,000 birds that breed here annually." These figures are not considered *bona fide* population estimates. Neither can be associated with a definite year, and the 33,000 is suspiciously near Bartsch's (1919: 471) total of 32,810 for all the birds (19 species) he identified at the Dry Tortugas in July 1917.

Bartsch visited Bird Key several times during the 1920's and in August of 1931, 1932, and 1933. Existing records of his trips contain no reference to the total numbers of Sooty Terns. The brief published accounts of the later visits (Bartsch, 1931, 1932, 1933) have great interest because Bird Key was then eroding rapidly. In 1932 Bartsch noted that a few Sooties were nesting on Bush [Long] Key. The following year he reported (1933: 267) that more than half the population had left Bird Key and "It is beginning to look as if the major portion would eventually establish itself on Long [Bush] Key." C. C. Von Paulsen of Homestead, Florida, then an officer of the U. S. Coast Guard, visited the Dry Tortugas frequently in the years 1932-1934. As he remembers it (personal communication) a substantial part of the Sooties nested on Bird Key in 1933 and smaller numbers remained there in 1934.

From the scant information available it appears that the tern colony may have been without warden protection in the early 1930's. Charles I. Park, the last Bird Key warden and now a resident of Key West, wrote me in a letter 14 December 1959: "As well as I can remember, I served as warden in the Tortugas area from 1929 through the summer of 1934, a total of six years." As G. A. England (1928: 14) refers to Charles Park as the Bird Key warden during his visit there the summer of 1926 or 1927, apparently Mr. Park began his six years of service two or three years earlier than he recollects. Others who knew the Dry Tortugas in the early 1930's do not recall a warden in the area during those years (Julius F. Stone, Jr., Charles M. Brookfield, and C. C. Von Paulsen, personal communications).

Absence of warden protection would explain the apparently well-founded rumors that the early depression years saw a vigorous renewal of egging at the Dry Tortugas. It seems likely that protection of the ternery at least was less vigilant in the nesting seasons of 1931 through 1934, although Sooties are known to have succeeded in rearing many young in some of these years (Bartsch, 1932).

The National Park Service assumed administrative responsibility for the Dry Tortugas early in 1935. Mason (1936: 18) mentions that the Custodian of Fort Jefferson turned away many boat parties from Key West that came to gather eggs on Bush Key in the spring of 1935. Correspondence in National Park Service files suggests that the colony was raided late in the 1935 season and a number of young birds taken. Protection of the colony by the National Park Service probably was not fully effective until the nesting season of 1936.

From 1935 through 1941 one or two groups of observers visited the Dry Tortugas each June on trips sponsored by the Florida Audubon Society. The visits were brief, each group spending from two to five days at the Tortugas. Adult and young terns were banded in 1937 through 1941, and the published accounts of all the trips, except that of 1941, include estimates of the number of Sooty Terns. In 1937 and 1938 many Sooties nested along the east side of Garden Key (figures 5 and 6) as well as on Bush Key.

1935. The population figure in table 2 is an average of estimates by members of the party (Mason, 1936). Some thought as many as 50,000 Sooties were present.

1936. Doe and Russell (1936: 6-7) state of the published population estimate: "It was the general opinion of those who had been on the

trip in 1935 that the tern colony had increased one-third." Mason (MS. notes) entered an estimate of 48,000 in his field notes with the comment that he considered it "very conservative" because the nesting colony of Sooties covered a much larger area on Bush Key than it had in 1935.

FIGURE 5. Portion of the Sooty Tern colony on the east side of Garden Key in 1937: (top) June; and, (bottom) August, showing many well-grown juveniles. (National Park Service photographs by Philip C. Puderer.)

1937. The colony was said to occupy an area of 8000 square yards on Garden Key and 4000 square yards on Bush Key. From this area and a nesting density of "about six sooties to the square yard," determined from one sample plot of 9 square yards in "a typical section" of the Garden Key colony, Longstreet (1937: 8) calculated a total of "72,000 [adult Sooties] actually present at one time." Though 72,000 birds present at one time would represent a total of 144,000 breeding adults by the usual methods of reckoning, Longstreet (1937: 8) continued: "It would seem not far wrong to calculate the number of adult sooty terns at the Tortugas in June 1937, as approximating 100,000. This would be a tremendous increase over any previous estimates, and for that reason may be seriously in error. But, at any rate, it is an estimate based on actual count of birds in a given area, multiplied by the number of times that area is found in the total area occupied by the birds." All summaries of the history of the Tortugas Sooty Tern population have cited the 1937 population as 100,000 from this source. Russell (1938 MS.) also "estimated the number of Sooties to exceed 100,000."

Other observers appear to have considered this estimate too high. Young and Dickinson (1937) believed that Bush Key had no more than 20,000 Sooties, and Mason (MS. notes) recorded an estimate of 75,000 for the total adult population. Longstreet (1937: 7) includes a photograph, taken from the terreplein of Fort Jefferson, of the sample plot on which the figure for density of nesting was based. The picture shows most of the Sooties are either incubating or brooding small young, and hence distributed one adult per territory. Because of the angle it is not possible to tell exactly how many Sooties are on nests within the 9 square yard plot, but the number is 20 to 30, certainly not 54. Thus, Longstreet's figure of 6 birds per square yard is apparently based on a nesting density of about 3 nests per square yard with allowance for the absent member of each pair. Accordingly, 72,000 is considered the soundest estimate of the breeding population of adult Sooties in 1937.

1938. This year Sooty Terns again nested on both Garden (figure 6) and Bush Keys, but the colony divided more equally between the two. Considerable effort was devoted to careful measurements of areas occupied and nest densities on both keys, and the resulting estimate (Beard, 1938) is undoubtedly one of the more accurate of the population figures for adult Sooties in the Tortugas ternery. Direct counts of nests on the coaling docks (figure 6a) and in small, irregular patches of dense vegetation on Garden Key totalled 3950.

FIGURE 6. Sooty Tern colony on Garden Key in 1938: (top) Sooties nesting on the north coaling dock; (bottom) another section of the colony early in the season. Bush Key in the background in both photos. (National Park Service photographs by Daniel B. Beard.)

The main open nesting areas occupied 5442 square yards on Garden Key and 11,097 square yards on Bush Key; a measured sample of 276 square yards on Garden Key yielded an average nesting density of 1.8 nests per square yard, which was taken as typical for both keys. Nesting density in the more heavily vegetated parts of the Bush Key colony was determined as 1.25 nests per square yard. Beard's (1938) calculations contain a slight error in addition, and the correct total is 64,057, not 64,058.

1939. The entire colony of Sooties nested on Bush Key this season. O. B. Taylor (1939 MS.) was told by the Custodian that part of the birds first settled on Garden Key in early May, but soon moved across to Bush Key. Robinson (1939: 7) thought they abandoned Garden Key because "most of the cover around the fort had been cut down prior to the arrival of the terns this season." Though he speaks of counting birds on "sample areas," Robinson probably arrived at his population figure by calculating from approximations of the colony area and nesting density. As it is not certain that any areas were measured, this and his 1940 figure are considered simple estimates. Vinten (1943) credits another estimate, also of 70,000 and perhaps taken from Robinson, to James B. Felton, then Custodian of the fort. Taylor (1939 MS.) recorded an independent estimate of 65,000 adult Sooties from his observations later in June 1939.

1940. A sketch of the colony (Robinson, 1940) shows that Sooties occupied most of Bush Key except the eastern sandspit, as they had in 1939. The accompanying text reads: "At first it did not seem that there were quite as many sooty terns as last year, but a complete tour of the key revealed that there were more than we expected. The same method was employed to estimate the number of birds as last year, and our figures show that there were 100,000 sooty terns in the colony." Just how this was calculated he does not say.

1941. The published report of the trip (Rea, Kyle, and Stimson, 1941) included no estimate of the number of Sooties, but R. T. Peterson, who accompanied the second of the two parties, wrote (1950: 318): "On our visit in 1941 we hardly dared estimate the number exactly, but it was well over the 100,000 mark."

1942-1944. Information for these years comes from the official reports of Custodian Robert R. Budlong. As he was unable to spend much time observing the colony, his comments on numbers and popu-

lation trends must be viewed as impressions rather than careful estimates. Military aircraft were active in the Dry Tortugas area during this period. Budlong (1942 MS.) comments that the tern colony was frequently disturbed by low-flying planes in 1942. The report of the A.O.U. Committee on Bird Protection for 1943 (Allen, 1944: 629) states: "Unauthorized use of Bird Key [sic], Fort Jefferson National Monument, as a bombing target by unidentified aircraft late in 1942 resulted in a fire that burned all vegetation. This and several less injurious acts of similar nature have been the subject of protests to the several military and naval establishments. Fortunately, the fire occurred outside the nesting season, but the island will not be usable by the Sooty and Noddy Terns until it is revegetated." The comments presumably apply to Bush Key. Burning of the vegetation is not likely to have discouraged Sooty Tern nesting but it may well have affected the Noddies.

In 1942 Budlong (1942 MS.) stated the colony had decreased about one-third and estimated the number of Sooties at 60-70,000, all on Bush Key. Vinten's (1943) statement of the figure as 65,000 has been followed. In 1943 Budlong (1943 MS.) considered the population to have shown a 50 per cent increase to "about 100,000." In 1944 the Sooties abandoned Long Key, the east spit of Bush Key, and several large areas on Bush Key proper, all used heavily in 1943, but Budlong (1944 MS.) believed there were "as many or more Sooties in the colony" as in 1943. At the end of the season Vinten (*in litt.* to Regional Director, U. S. Fish and Wildlife Service, Atlanta, Ga.) commented: "About 130,000 birds nested there during the past summer."

1945-1948. Data for these years are quoted from the reports of Alexander Sprunt, Jr., who made annual trips to the colony in June and determined the size of the adult Sooty population each year by an area $\times$ density method. While he paid careful attention to the space the colony occupied, just how he measured the average nesting densities isn't always clear. In 1945 he appears to have used those determined by Beard (1938), about 1.8 nests per square yard in open areas and 1.25 in more heavily vegetated sections. The other years he determined separate nesting densities for each section of the colony that appeared to differ materially, but he gives sizes of the areas sampled and counts of nests in each only for Bush Key in 1946 (1946*b*: 5).

Sprunt also described the remarkable spread of vegetation on Bush Key in this period and its effect on the location and density of the nesting Sooties. He records the space the colony occupied on Bush

Key in 1945 as 34,000 square yards (1946*a*), in 1946 as 27,200 square yards (1946*b*), and in 1947 as about 7,000 square yards (1947*a*). In 1947 some of the colony nested on Garden Key again as they did in 1937 and 1938. In 1948 the entire colony again located on Bush Key; the vegetation was still luxuriant, but the Sooties dispersed more thinly over an area of 52,000 square yards (1948*c*).

1949-1956. Population estimates for these years were made by personnel of Everglades National Park. Willard E. Dilley, then Chief Park Naturalist, worked at the Dry Tortugas in 1949 and 1950, and he and Joseph C. Moore, then Park Biologist, worked together there in 1951. Moore continued the annual surveys through 1955. I made the population estimate of 1956 following procedures established by Moore. Results of the surveys of 1949 through 1952 have been published; data for 1953 through 1956 are from typed reports in the Everglades National Park files.

All population estimates were obtained by the usual area $\times$ density methods. Those of 1949 through 1951 were based upon separate determinations of area and density of nesting in a number of sub-areas where the pattern of occupation by nesting Sooties seemed to differ noticeably, essentially the same procedure folllowed by Sprunt, Beard, and others back to Watson in 1907. The number of sub-areas distinguished and measured separately was: 1949, 7; 1950, 22; and, 1951, 15. In 1952 Moore established 20 marked plots each of 8 square yards distributed throughout the parts of Bush Key considered to be available to nesting Sooties. Data on density of nesting used in calculating the Sooty Tern populations of 1952 and 1953 were taken from these plots, and data for 1954 through 1956 were taken from these plots plus 10 additional plots Moore established in 1954.

In 1951, 1952, and 1956 numbers of Sooties nested among rough coral rubble at low sites on Long Key. Moore and Dilley (Moore, MS. notes) estimated 455 adult Sooties nesting on Long Key in 1951, and in 1952 Moore (Moore and Dilley, 1953: 76) believed about 2000 present, although few yet had eggs. On 26-27 May 1956, David O. Karraker, my wife, and I counted 2880 Sooty Tern nests with eggs in place on Long Key, and saw about 700 scattered eggs from nests that had been flooded (Robertson, 1956 MS.). All the Long Key nestings were behind the schedule of the main colony and produced few or no young.

In reporting Sooty Tern observations from a visit to the Dry Tortugas in May 1953, Fisher (in Peterson and Fisher, 1955: 143) commented: "My own estimate of the number of occupied nests—

80,000—was not far off. A census based on sample plot counts which was made two weeks later by the Park Service came up with a figure of 84,569 sooty nests." The figure mentioned was in fact an estimate of the number of breeding adults (Moore, 1954 MS.); the number of nests actually amounted to but few more than half Fisher's estimate.

1957-1963. In 1957 Sooty Terns were first recorded nesting on Hospital Key. Mr. and Mrs. John R. DeWeese found about 200 nests there in June but were not certain that any young were reared (*in litt.*). None nested on Hospital Key in 1958 (Richard Ward, *in litt.*), but on 15 June 1959 O. L. Austin, Jr., C. R. Mason, and I found about 50 adult Sooties among the colony of Roseate Terns there and located about 10 Sooty Tern nests with eggs. In the main ternery of Sooties on Bush Key hatching was at least 90 percent complete at this time and the larger young were about half-grown. In the nesting seasons of 1960-1962 no Sooties were observed at Hospital Key, but in July 1963 about 8 adults appeared to be settled there, again associated with nesting Roseates. No search was made for nests, but the behavior of the Sooties suggested that they were nesting. It is of interest that all occurrences of Sooties on Hospital Key were in years when Roseates also nested there, none having been noted in the years when the Roseate Terns located elsewhere.

Work at the Tortugas in 1959-1963 consisted chiefly of banding adult and young Sooty Terns in large numbers, and no direct estimates of the size of the colony were attempted. My impression is that in 1959-1963 the population was in the range of 70,000 to 100,000 breeding adult Sooties and varied relatively little from year to year. Approximately 6,500 to 11,000 young Sooties were banded each year in 1960-1963 and the recorded mortality of eggs and small young accounted for an additional 2,000 to 6,500 nesting efforts annually. Counts of living young and of young found dead made each year after banding was completed have shown consistently that from one-third to one-quarter of the birds of the year were banded.

Each year since 1960 a sample of from 7,000 to 8,200 adult Sooties has been captured in mist nets set at the perimeter of the colony (figure 7). It should be possible to estimate the number of adults accurately from the proportion of banded individuals occurring in samples taken later the same breeding season. But calculations from May-banded adults in samples of adults netted the following July yield population estimates considered three to five times too high. Two characteristics of the Tortugas Sooty Tern population, strong localization of individuals within the colony and straggling arrival

and departure, hamper use of mark-recapture data for estimating total numbers. Banded adults do not become randomly distributed throughout the colony, and the sampled population changes in composition from week to week during the breeding season.

FIGURE 7. Members of the Florida field excursion, 13th International Ornithological Congress, mist-netting adult Sooty Terns on the west beach of Bush Key. In foreground from the left, Josias Cunningham (U.K.) and Staffen Ulfstrand (Sweden). The matted ground cover is sea purslane (*Sesuvium portulacastrum*). (Photograph by A. Schifferli, 13 June 1962.)

DISCUSSION

Only a limited interpretation of the record of the population of Sooty Terns at the Dry Tortugas (table 2) can be undertaken now. The present discussion aims merely to review the estimates in the light of the species' behavioral characteristics and the Tortugan environmental factors that may have influenced them over the years. Some of the local limiting factors and the difficulties of accurate censusing were recognized and discussed by earlier writers. The preliminary results of work now in progress include some additional pertinent information. Comments are limited to the population records from 1903 to date.

The fact that all adults in the colony do not begin to nest at about the same time has plagued Sooty Tern counters at Dry Tortugas from

the beginning. The varying population reports of 1903 (Dutcher, 1904) resulted in part from the arrival of many Sooties after Job and Burton had made their first estimate. Watson (1908: 318) specified that his 1907 count was made "late in the brooding season, after all the eggs had been laid." Later observations, particularly by Moore in the early 1950's, make it clear that simply to delay the count until all the birds arrive is not a satisfactory solution. It may be useful to review what is known of the arrival and landing of Sooty Terns at the Dry Tortugas.

A period of nocturnal swarming over the breeding grounds before actual nesting begins is characteristic of the species (*cf.* Ashmole, 1963*a*). The Brown Noddy also exhibits this behavior at the Dry Tortugas, and it may be part of the pre-breeding activity of all pelagic terns, although observations on species other than the Sooty are few. The occurrence of Sooty Terns on regular nocturnal visits in late winter was not reported at the Dry Tortugas until rather recently (Vinten, 1944; Baker, 1944). Our knowledge of the phenomenon coincides closely with the period of Sooty Tern occupancy of Bush Key and National Park Service occupancy of adjoining Garden Key.

Park Service personnel stationed on Garden Key have kept a complete record of the dates the Sooties were first heard over the area at night and first seen to land on Bush Key by day annually since 1943. The two events are the outstanding phenological phenomena of the, for some, rather humdrum year at the Dry Tortugas, and one suspects they have often been recorded as welcome evidence of the passage of time. Dates of the first night occurrence of the Sooties range from 8 February (1943 and 1956) to 7 March (1950) with an average date over the 20-year period of 20 February. The average date of the first daytime landing is almost exactly 2 months later, 21 April.

Typically the number of birds, as judged by the amount of noise, begins to increase nightly soon after the first report, but for a month to six weeks no Sooties are to be seen in the vicinity by day. Their daytime whereabouts during this period is regarded locally as something of a mystery, but my records of 24-26 February 1964 suggest that the birds frequent the Gulf of Mexico probably at no great distance. I heard Sooties calling as early as 2030 hours (all times EST) and as late as 0615 hours, both 25 February. They seemed to approach from the northwest and the last birds over Garden Key near dawn seemed to depart in that direction.

Activity on the night of 25-26 February 1964 centered about one mile north-northwest of Bush Key. Observation from a boat in this

area disclosed several separate flocks, each apparently of many thousands, milling about in rapid flight within a few feet of the surface of the water. No appreciable movement toward the colony site on Bush Key occurred from 2100 to 0130 hours. At least a month before the first daytime landing, however, Sooties have been reported landing on Bush Key at night, and occasional precocious females lay eggs during nocturnal visits as much as three weeks before nesting begins (Robert and Stevenson, 1951). The night landings presumably correspond to the gatherings on Ascension termed "night clubs" by Ashmole (1963a: 301 ff.), but no detailed observations are available from the Tortugas.

A few days to a fortnight before the definitive landing a few Sooties often remain on Bush Key well past daybreak, and scattered birds and occasional large flocks are seen at sea nearby. Soon after these first daytime sightings Sooties either land at night and remain on the island or begin landing by day, usually in early morning. The number that land the first day reportedly varies from a few hundred to many thousands. Elms (personal communication) estimated 40,000 the first day in 1963. Laying begins at once. Commonly hundreds of birds are incubating by the afternoon of the day of landing.

New flocks arrive nightly for at least several weeks. Moore and Dilley (1953) noted that the spread of hatching dates indicated the period of arrival was greatly more prolonged in some years. The larger the colony becomes, the more difficult are new arrivals to detect, except as they occupy entirely new ground.

In the usual pattern of landing, successive flocks settle immediately contiguous to the ground already occupied. Almost invariably the first Sooties land on the west side of Bush Key. From this nucleus the colony builds eastward along both shores, the last birds to come in landing on the east spit or (occasionally) Long Key. Felton (1941 MS.) suggested that thus the Sooties first settle on the oldest part of Bush Key, an intriguing idea impossible to verify. In at least two of the years when Sooties nested on Garden Key (Beard, 1938; Gibbs, 1947 MS.) the first birds landed on the north coaling docks (figure 6). In 1938 new flocks built southward from that point until all of Garden Key east of the fort was occupied before any landed on the west side of Bush Key.

Over the past 20 seasons first landings of Sooties at the Dry Tortugas have become consistently earlier. The average date of first landings for 1943-52 was 27 April, for 1953-62 it was 14 April. The landings of 7 April 1961, 6 April 1962, 3 April 1963, and 28 March 1964 are the earliest of reliable record. No similar trend can be seen

in the record of first nocturnal visits. These are less likely to be recorded accurately, because they apparently are brief high overflights by a few birds in the middle of the night. On the night of 19-20 January 1964, about 3 weeks before the then earliest report, I heard Sooties calling over Garden Key four times between 2345 and 0200 hours. Each time one or two birds flew over rapidly and fairly high, the passage marked by three to five unmistakable "wideawake" calls. The following night it was colder with high winds, and I listened from 2200 to 0200 hours without hearing any Sooties. On my next visit in late February 1964 large numbers were visiting the area nightly.

Brief observations of Sooties as they first landed in April and May 1963 revealed several interesting characteristics of appearance and behavior in the newly-arrived birds. Despite the fact that they presumably have been on the wing almost continuously for a period of several months or longer, most individuals are fat and appear to be in peak physical condition. Sooties appear to be heavier at first landing than at any other time in the breeding season; a number of birds at this time weighed 190 to 210 grams, whereas weights exceeding 180 grams are unusual later. Ashmole (1963a: 340 ff.) reported that most Ascension Sooties had completed molt by the time they began to assemble in the colony at night and the same probably is true of the Tortugas population. In the hand the plumage of newly-arrived birds is conspicuously fresh and unworn. The attenuate tips of the outer pair of rectrices extend as much as 80 mm beyond the adjacent pair in delicate streamers that are soon lost apparently by abrasion on land. In June and July the outer rectrices are only 15-20 mm longer than the next pair.

Tightly packed roosting in the colony is a characteristic group behavior for several days immediately after the landing. All the birds settle at once and form a nearly continuous cover over the ground. The colony then appears much more densely tenanted than it does after incubation begins, when only one member of the pair is usually present at the nest.

Also typical of this period are flights, presumably part of the pair formation ritual, in which two individuals stay very close together. In these flights two birds leave the ternery, circle to an altitude of several hundred feet, then change to an exaggeratedly deep and slow wingbeat, meanwhile giving a call that apparently is peculiar to the occasion. The flights may occur over the colony or remote from it. They vary in duration from a few seconds to about a minute and may consist of one ritualized flight or of several alternated with intervals of normal flight. Flights usually end abruptly with the two terns

making a headlong descent checked a few feet above the water, and then flying rapidly back to the colony. Occasional two-bird flights occur throughout the breeding season, but they are more frequent and protracted among Sooties that have recently landed, when dozens of flights may be in progress simultaneously.

Brown Noddies on Bush Key perform ritualized two-bird flights that closely resemble those just described for the Sooty Tern, and I have occasionally seen similar flights by Royal Terns wintering at the Tortugas. In all three species a distinct call is associated with the flights and often drew my attention to the birds engaged in them. Warham's (1956: 89-90) description of a "Butterfly Flight" of Brown Noddies and Black Noddies on Pelsart Island, Western Australia, seems to apply equally well to flights observed at the Tortugas, and presumably all represent the "High Flight" aerial display that has been described for many terns.

Sprunt (1948*b*: 18) and several other observers suspected that the date of sampling in a given year might affect the estimate of population, but no means of quantifying the suspicion existed until Moore established marked plots on Bush Key in 1952. In 1953 the first Sooties landed 14 April and the first hatching was noted 23 May. Moore's nest counts that year (1954 MS.) showed 64,724 adults present 14 May, 81,210 on 23 May, and 84,569 on 28 May. From these figures he calculated that an average of 1832 new birds entered the ternery daily from 14 to 23 May, and the rate dropped to 672 daily from 23 to 28 May. No later checks were made that season, but general observations of the colony suggest that Sooties continue to arrive and start nesting through much of June in some years.

Moore (1954 MS.) suggested that, to assure comparable population estimates from year to year, density of nesting data should be based on counts of nests made one week after first hatching. This perhaps is the most practical solution possible, but the way Sooty Terns arrive to nest clearly makes it difficult to estimate the size of a colony accurately except from repeated counts spaced to sample the entire season. Population estimates based on nesting densities made either much before or much after hatching begins are likely to be too low.

From the known pattern in the Common Tern it appeared likely that late-arriving Sooties include the young adults returning to the colony for the first time, and that age at first return is 3 or 4 years. Several returns recorded in 1937-41, however, seemed to show Sooties banded as young of the year back in the ternery the first or second year after banding. We now believe these reports resulted from mistakes in reading or reporting band numbers.

No returns of the 5500 juveniles banded in June 1959 were recorded in handling a total of 19,327 adult Sooties (927 returns) in May and July 1960 and 1961 and in May 1962 (4513, 426 returns), but the 198 returns provided by a sample of 4190 adults taken 8-15 July 1962 included 11 of the 1959 cohort. Samples of adults mist-netted at the colony in 1963 on 8-11 April (1125, 140 returns), 15-19 May (4021, 685 returns), and 9-14 July (3807, 362 returns) contained 0, 6, and 50 respectively of the 1959 juveniles. The July 1963 sample also included 3 returns from the cohort of 10,127 juveniles banded in July 1960. It thus appears that Sooties first return to the natal colony late in their third year and first return in force late in their fourth year. Our data show that although 0.2 per cent of the 1959 cohort of young Sooties returned to Bush Key in their third year, only 0.03 per cent of the 1960 cohort did so. This is of interest in view of the recovery record of the two cohorts since leaving the colony. For the young of 1959 not a single recovery has been reported; for the 1960 group we have 13 recoveries, 6 of which were birds found dead along the storm track of hurricane Donna of September 1960. This suggests that the 1960 cohort suffered much heavier mortality during its extra-Tortugan years.

Late-arriving adults apparently often pioneer in the changes of colony site. Bartsch (1932: 281) in reporting the first move of Sooties from the ancestral Bird Key location observed that 30 pairs nesting on Bush [Long] Key still had eggs or small young on 10-21 August 1932 while most of the young in the main colony were already on the wing. All of the recorded nestings on Hospital Key and Long Key were well behind the usual schedule and presumably were initiated by birds that arrived late and failed to find space in the parent colony.

Late-nesting Sooty Terns at the Tortugas seldom succeed in rearing young, in part because they so often nest in unsuitable places such as the easily flooded sites on Long Key, and in part because isolated nesting groups are especially subject to predation. In 1963, for example, we detected no significant loss from predation in the main colony, but predators (both rats and Cattle Egrets suspected) destroyed the eggs of an estimated 1500 pairs of Sooties that settled on the east spit of Bush Key (figure 3) late in the season. No Sooties had landed on the east spit 24 April but on 15-19 May it was fully occupied by incubating birds and others that had not yet laid eggs. Attack by predators must have occurred soon after, because no Sooties remained there on 5 July, and broken eggs that ranged from slightly incubated to about ready to hatch were scattered over the ground.

In 1963 most of the 3 and 4-year-old adults apparently arrived during late May and June and sought space in the main colony rather than at its edges or at outlying sites. About 95 per cent of the returns for the juvenile cohorts of 1959 and 1960 were localized in the southwestern one-quarter of Bush Key, the same area in which chicks were banded most heavily in those years. Large samples of adults taken farther east on Bush Key (including a sample of 329 from birds then landing on the east spit, 16 May) included few or no returns of juveniles banded in 1959 and 1960. Thus the young adults returning for the first time seemed to center their activities near the natal nest location, even though that part of the colony already was densely occupied. Although strong site tenacity in terns (Austin, 1949) undoubtedly serves to maintain the established colony, it must also weigh heavily against the likelihood of successful breeding by younger adults. We have no clear evidence that any Tortugas Sooties nested in their third or fourth years. We suspect that inexperience, late arrival, and site tenacity combine to make successful breeding by young adults a rare occurrence, at least in colonies where adult mortality is low and space relatively limited.

Straggling departure is as characteristic of the Tortugas Sooties as straggling arrival, but this aspect of seasonal change in the population has seldom been mentioned. Early writers believed the terns left in one body or within a few days. Thompson's (1903: 82) statement that the Noddies leave "in great flocks and at night. . . . The entire exodus consumes but two or three days" is typical of comments for both species. Later, Bartsch (1919: 473) quoted reports of the Bird Key wardens to show that noticeable mass departures occurred over a period of 2 to 6 weeks. More recent observations confirm this and do not extend the extreme dates Bartsch mentions, 9 August and 25 September. Although a decrease in the size of the colony is seldom obvious before mid-August, several lines of evidence suggest departures begin much earlier.

Birds that do not renest after failing in their first breeding attempt probably begin to leave the ternery in May. Egg removal experiments by Ridley and Percy (1958) on Desnoeufs Island, Seychelles, and by Ashmole (1963a) on Ascension show that Sooties are far less persistent layers than has been supposed. No more than 50 per cent of those whose first eggs were removed laid a replacement, and renesting seldom occurred after loss of well-incubated eggs or newly hatched chicks. The few observations at the Tortugas seem to agree with these findings, and suggest in addition that the likelihood of renesting begins to decline sharply at a relatively early date in the

breeding season. Birds whose first eggs were destroyed by predators on the east spit of Bush Key in late May or June 1963 laid no replacements there. We found nothing in July to suggest that they had renested elsewhere on Bush Key, nor did there seem to be any substantial number of unemployed adults around the colony. Apparently Tortugas Sooties whose first breeding effort ends in failure after about mid-May tend to leave the colony soon afterward without renesting.

The earliest departure for which definite evidence exists is that of an adult banded on Bush Key in May 1960 and found dead at Ruskin, Hillsborough County, Florida, about 215 miles north by a little east of the Tortugas, on 25 July 1960. Other banding data, however, suggest that many adult Sooties leave the colony between late May and early July. Large samples of adults were taken in mist nets in both May and July, 1960 through 1963. Extreme dates of the sampling periods were 15-31 May and 8-17 July, and the location and method of capture were virtually the same for all samples. The 14,884 adults handled in July 1960-1963 included 160 (1.08 per cent) banded in May of the same year, whereas 12,100 handled in May 1961-1963 included 412 (3.4 per cent) banded in May of the previous year. The range in the various samples was: May to July repeats, 0.65-1.6 per cent; May to May returns, 2.8-3.9 per cent. May-banded adults thus occurred three times more frequently in samples of the following May than in samples taken 5 to 6 weeks later in the year of banding. The simplest explanation is that many adults present in May leave before the second week of July. These presumably include both frustrated breeders whose ties to the colony are relaxed by loss of eggs or young and early breeders whose young have fledged.

A few dozen to several hundred Sooties usually remain on Bush Key after the rest are gone. Most are juveniles and most are sick, injured, or deformed. Only rarely do any survive the fall flights of accipiters and falcons in late September and October. Tortugas Sooties seldom abandon healthy young, although reports suggest this may have happened once or twice when departure was hurried by severe storms in late August or early September. On 8-11 September 1962 about 50 young birds remained on Bush Key during the day. Most were obviously infirm and several died every day. Each evening 200-300 adults and about 100 strong-flying young returned to the colony. All the young were still being fed by adults and the relative numbers of young and adults suggested that both members of most pairs were present.

The early departure of some adults probably has not been a major source of error in population estimates (table 2). The critical event for estimates based on nest counts is departure of hatchlings from the nest site, which becomes important even earlier. Nest density data used in calculating populations in 1945-1948 were recorded after mid-June and thus may considerably underestimate actual numbers. Nest counts of 1951-1956 were made in late May and in several of these years large numbers of adults were thought to have arrived and nested after the counts. The knowledge that young Sooties do not return in force until their fourth year makes the reported increases of 1903 to 1907, 1913 to 1914, 1939 to 1940, 1942 to 1943, and 1949 to 1950 highly improbable from Tortugan recruitment alone. Those of 1938 to 1939, 1943 to 1944, 1947 to 1948, and 1955 to 1956 seem unlikely in that they leave little room for mortality in the intervening years.

The reported populations of 1950 and 1951 stand out as much above other estimates. I have reviewed the field records for these years and the errors, if any, are in the data, not in the calculations. Moore and Dilley (1953: 79) suggested that the unprecedentedly high populations of 1950 and 1951 "may be attributable to several years being unusually favorable for weather and food." However, evidence that the relevant years, 1946 and 1947, were marked by especially successful reproduction is wanting.

In spite of the questions raised above, the reports since 1903 probably represent the actual trends of population with fair accuracy. In general, the Bird Key colony of Sooty Terns increased under protection to about 80,000 to 100,000 breeding adults by around 1917. The severe hurricanes of 1910, 1915, and 1919 that ultimately caused a great reduction in the number of preferred nest sites available to Brown Noddies on Bird Key probably made enough more area available to Sooties to compensate for the area lost by erosion. In any event the Sooty Tern population apparently maintained about the same level from *c.* 1917 to *c.* 1930. Disturbance resulting from renewed egging in the early 1930's, and probably also from the enforced movement of the colony from Bird Key, seems adequate to account for the reported decrease to about 30,000 adults in 1935. Within a relatively few years after 1935 the colony, now on Bush Key, again attained approximately the same upper level that it had on Bird Key. The view that 60,000 to 100,000 adults represents the normal Sooty Tern population of Dry Tortugas under protection (Moore and Dilley, 1953) probably is close to the mark. Fluctuation within these limits doubtless results in large part from varying success

in rearing young because of year to year variations in weather, food supply, and predation, and from varying mortality during the population's pelagic phases. Predation is seldom important at Dry Tortugas, although Magnificent Frigate-birds take fair numbers of young Sooties in some seasons (Beard, 1939; Dilley, 1949 MS.) and instances of predation by rats, cats (Russell, 1938 MS.), Laughing Gulls, *Larus atricilla* Linnaeus (Watson and Lashley, 1915: 38), and a Great White Heron, *Ardea occidentalis* Audubon (Robertson, 1962), have been reported.

It is not clear what factors act to set the upper limit attainable by the Tortugas Sooty Tern population, nor how they act, but I suggest tentatively that the limits may be determined as much by the species' behavior pattern as by such environmental factors as food and territory. The question of whether or not Sooties are ever crowded on Bush Key has been debated by authors to no conclusion. It is clearly a strong departure from normal behavior, however, for Sooties to nest elsewhere than at the colony site of the previous year or at the edge of a mass of Sooties already nesting. That Tortugas Sooties rather frequently have settled at new locations suggests that Bush Key has been overcrowded at times, however it may have appeared to human observers.

The obvious question then is, why hasn't the colony spread to nearby islands that seem fully as suitable as Bush Key? The reason appears to be that the earlier and more successful breeders tend strongly to settle at the colony site of the previous year. Present data indicate that when the progeny of these birds return to nest, they seek nesting space near the location where they were reared. Such a pattern tends to maintain a strong nucleus at the expense of possible colony expansion. The individuals that colonize peripheral or outlying locations are those compelled to do so, principally because they arrive late at the colony. As a group these may tend to be chronic unsuccessful breeders that have lost site tenacity. The new locations they occupy are commonly much more exposed to weather and predators, and late arrival reduces the likelihood of renesting after disturbance. Thus, the pioneering that might lead to establishment at new locations and an increase in the local population is almost always foredoomed to fail.

The successful shift of the colony site from Bird Key to Bush Key in the early 1930's was probably facilitated, once the area of Bird Key was reduced to a certain point, by landings on Bush Key early enough in the season by large enough numbers of birds for successful breeding. The behavior of the colony in 1937, 1938, and 1947 when the

first Sooties that arrived settled on Garden Key is less easily explained. In these cases, however, unusual conditions apparently existed on Bush Key at the time nocturnal swarming began, an infestation of rats in the 1930's (Russell, 1938 MS.; Beard, 1938) and unusually luxuriant vegetation in the 1940's (Sprunt, 1948*b*). Perhaps these disturbances were sufficient to produce atypical behavior.

It was formerly believed (Murphy, 1936: 1125-1127) that all Sooty Terns deserted their nesting areas for a period of time between breeding seasons. More complete information, however, shows that Sooties are present in the neighborhood of some colonies throughout the year. Ashmole (1963a: 301) states " . . . there was no month in which Wideawakes could not be seen or heard from Ascension." The same appears true of colonies off Oahu, Hawaii, studied by Richardson and Fisher (1950), and of those at Willis Island (Hogan, 1925) and Raine Island (Warham, 1961), northeastern Australia. Ashmole and others have drawn a contrast between the colonies where Sooties are continually present and latitudinally more peripheral colonies, such as the Dry Tortugas, where they are absent for several months of the year, but the supposed difference may disappear with more study. Excepting birds carried north by hurricanes, all recoveries (through 1963) of Sooty Terns banded as adults at the Dry Tortugas have been within the Gulf of Mexico, indicating that the breeding population does not disperse widely. The January records cited above leave November and December as the only months in which Sooties have not been reported at the Dry Tortugas. The possibility that some individuals remain within commuting distance and make occasional night flights over the colony throughout the off-season cannot at present be excluded.

The Sooty Terns of the Tortugas have often been cited as typical of the populations that have a 12-month cycle and begin breeding at about the same time every year. This appears true of records from the time of Audubon to the early 1940's, all of which indicate that laying began in late April or early May. Over the past two decades, however, first eggs have been laid at consistently earlier dates. The cycle remains essentially annual, but nesting now begins a full month earlier than it did in the 1940's. The significance of this slow advance of breeding date and the factors that might account for it are unknown at present. No relationship to a particular moon phase (Chapin and Wing, 1959; Ashmole, 1963a: 349) is apparent. The date of landing and first eggs in 1964 coincided with the full moon, but the landings of 1961-1963 occurred 23, 14, and 6 days respectively before the full moon. The earlier breeding of Sooty Terns in the

Tortugas may be merely another phenomenon of the sort that is commonly attributed to a supposed trend toward warmer climate. Another possibility is that earlier breeding is associated with an increase in the size of the colony, although clear proof of an increase is lacking. Fisher and Lockley (1954) cite instances for many species of seabirds showing that larger colonies tend to become active earlier in the season.

Richardson and Fisher (1950) reported that Sooty Terns on two small islands located about 10 miles apart off the windward coast of Oahu had distinctly different breeding seasons, the colony on Moku Manu beginning to nest in November while that on Manana began in April. They suggested that Manana might have been colonized by birds from Midway Island or some other distant population which breeds in the northern hemisphere spring. The possibility that Sooties nesting on Manana are the overflow from the larger colony on Moku Manu, however, does not appear to be excluded by the information so far published about these populations. Egg-laying on Moku Manu began in November and extended through March, while the season on Manana is shown as April through June (Richardson and Fisher, 1950: 304, table 4). Thus the season on Manana merely continued that of Moku Manu, rather than being distinct from it. This characteristic, the fact that the population on Manana varied greatly in the two breeding seasons observed and that few young were reared in either season, and the fact that the Moku Manu colony was reportedly overcrowded all suggest pioneering of a new site by birds that arrived late, such as has been observed several times at the Tortugas.

Ashmole (1963a) recently published a highly informative account of two breeding seasons of the Sooty Terns of Ascension Island. From his observations of Sooties and other species that breed there he advanced (Ashmole, 1963b) the hypothesis that competition for available food within foraging range of the nesting colony was the principal factor regulating the numbers of tropical seabirds. No single study as intensive as Ashmole's has been made at the Dry Tortugas, but, because of the long record of observations available, the Tortugas colony ranks as perhaps the best-known Sooty Tern population after Ascension. A comparison (table 3) shows striking differences between the two populations in mortality factors and breeding success. Although it is of the order of one-tenth the size of the Ascension population, the Tortugas population appears to have reared a substantially larger number of young in some years.

Ashmole (1963a) describes heavy mortality of Sooty Tern chicks, apparently from starvation, and presents other evidence indicating that adults had great difficulty obtaining adequate food for young, especially in the second season he observed. He cites (1963b: 465) records similarly consistent with his hypothesis of population control from other Sooty Tern colonies and for other species of tropical seabirds. Feeding conditions apparently are so much more favorable for Sooty Terns in the neighborhood of the Dry Tortugas that the likelihood of their numbers being limited by competition for available food seems improbable. Recent observations at the Tortugas support Watson's (1908: 192-195) statements that the terns do most of their feeding within a radius of about 15 miles from the colony. Although much of the feeding occurs outside the Tortugas lagoon, flocks of Sooties often fish within sight of the colony. Fish and squids regurgitated by adults returning from feeding commonly are intact, as if taken but a few minutes before. By contrast Ashmole (1963a: 333) found that feeding adults were absent for extended periods; he saw no Sooties fishing near Ascension; and the food remains regurgitated by the birds were seldom recognizeable. From his studies of the development of young on Ascension, Ashmole concluded (1963a: 320): "The capacity of young Wideawakes to survive for long periods on relatively little food, while growing hardly at all, but to accept large quantities of food when it is available, is clearly an adaptation to an environment in which the food supply is precarious." While few detailed data are available on the development of young Sooties at the Tortugas, general observations indicate that their growth is regular and rapid and that the ability to fly short distances is attained at 5 to 6 weeks of age, in contrast to the fledging period of 8 weeks or longer recorded for Ascension (Ashmole, 1963a: 321). No incidents of mass starvation of young Sooties have been reported at the Tortugas.

Acknowledging the need for additional critical data, it appears that no shortage of food available to Sooty Terns exists in the vicinity of the Dry Tortugas colony; and, therefore, that competition for food during the breeding season cannot be the factor that checks the increase of the population short of the limits of available nesting terrain. As suggested above, social factors—in particular, site tenacity in young adults, and the tendency of late arrivals to choose insecure nest sites near the colony rather than more secure sites at a little distance—appear to operate in a density-dependent manner to limit growth of population. Ashmole (1963b) is surely correct in pointing out that competition for nesting space could not regulate total species popu-

lations of seabirds effectively because individuals that fail to find space in one colony could go elsewhere. How much movement of this sort actually occurs in the Sooty Tern is a moot point at present. It seems likely that asynchrony of breeding cycles would inhibit exchange of birds between some colonies. Whatever the factors are that ultimately control the total number of Sooty Terns, however, observations at the Tortugas strongly suggest that social forces can effectively regulate numbers at the level of the individual colony.

TABLE 3. SOME CHARACTERISTICS OF THE SOOTY TERN POPULATIONS OF ASCENSION ISLAND (FROM ASHMOLE, 1963a) AND THE DRY TORTUGAS

	Ascension Island	Dry Tortugas
Estimated number of Breeding adults	*c.* 750,000	*c.* 80,000
Nesting space available	Relatively unlimited	Limited on Bush Key, several other habitable islands nearby.
Mortality of adults at the colony	Estimated 1 to 3% killed by feral cats; predation proportionally heavier on the earlier breeders.	Insignificant, virtually all losses result from birds becoming entangled in vegetation.
Mortality of eggs and young caused by predation	Heavy (cats and frigatebirds)	Usually minor (mainly rats), except in outlying nesting areas.
Mortality of eggs and young caused by weather	No information	Occasionally heavy at low sites and when hurricanes occur during the breeding season.
Mortality resulting from attacks upon stray chicks by adult Sooties	Considerable	Probably the major cause of mortality of chicks.
Mortality of young from starvation	Frequent, much heavier in some breeding seasons.	Never reported.
Over-all breeding success - (young fledged as a % of eggs laid)	Low, estimated at *c.* 10-20% and perhaps not over 2% in two successive breeding periods.	Probably seldom below 70% in years with no summer hurricanes.
Interval from start of one breeding period to start of the next.	*c.* 9.7 months	*c.* 12 months

Brown Noddy

Record of Nesting

19th Century. Accounts by naturalists who visited the Dry Tortugas in this period suggest that Brown Noddies were numerous and identify the keys on which they nested at different times, but beyond that contribute relatively little to the history of the Tortugan population. In 1832 all the Noddies were nesting on Bush Key, but "several thousand" nests not in use were seen on Bird Key as well, leading Audubon (1835) to suppose that Sooty Terns had driven the Noddies from the latter island not long before. Bartsch seems to have thought that Noddies persisted in nesting apart from the Sooties until Bush Key was washed away around 1870. He writes (1919: 482): "Since then [1832] the colony has been forced to make a complete shift and the choice between Bird and Loggerhead Key has fallen to the former. . . . " Wurdemann (1861) and Bryant (1859*a*), however, reported both species nesting on Bird and East Key in the 1850's. The separation of the nesting areas of Sooties and Noddies observed by Audubon may well have been temporary, for his report seems to be the only record that Noddies nested on Bush Key during its 19th century emergence. In 1890 (Scott, 1890) most of the Noddies were nesting on Bird Key.

Several of the early reports suggest that Noddies and Sooties were then about equally abundant at the Tortugas. Audubon (1835: 268) wrote of the Noddies: "They nearly equal in number the Sooty Terns. . . . " Scott (1890) was informed that Noddies were more common than Sooties, and Holder's (1892: 194ff.) account of an egging sortie to Bird Key about 1860 suggests the same.

Later writers have taken such comments to indicate that the Noddy population of the Dry Tortugas suffered particularly severe reduction. Job, for example, remarked (1905: 87-88) of his observations in 1903: "Of the Noddies there are hardly a thousand, which is a great decrease from the numbers that were once here." It appears to me that the reports of near parity in numbers of Sooties and Brown Noddies are more likely evidence that the population of Sooties had been much reduced. The Brown Noddy at the Dry Tortugas has always nested mainly in bushes. No report suggests otherwise. More specifically, its nesting is confined largely to the edges of clumps or thickets of bay cedar. Few nests are placed within dense shrubbery. From what is known of the vegetation of keys where the ternery has been located, it seems certain that the Sooties, nesting in dense masses on the ground, would always have been able to reach much greater

numbers than the Noddies before their increase was limited by scarcity of nest sites.

It seems likely also that, in a ternery such as the Dry Tortugas, the Noddy population might be expected to decline more slowly than the Sooties under the pressure of sustained egging. Eggers preferred Sooty Tern eggs to those of other terns. Many writers mention this, Audubon, for example, informing us that eggs of the Sooty are "delicious, in whatever way cooked. . . . " Because Sooties nest closer together and are much more strongly territorial than Noddies, repeated disturbance of a mixed ternery would almost certainly result in disproportionately high mortality of Sooty Tern chicks. The fact that Noddy nests are more scattered and placed in heavier cover would make it much more difficult for eggers to gather an entire laying. Finally, the usual nesting season of Noddies at the Dry Tortugas is considerably more extended than that of the Sooties which, again, would make loss of an entire season's production less likely.

1902. Thompson (1903) presented an excellent and well-illustrated life history study of the Brown Noddy as observed on Bird Key in 1902. His account includes the earliest clearly stated estimate of the size of the population: "As nearly as can be judged it [the Noddy colony] contains about three thousand individuals."

1903. As with the Sooty Tern, several estimates of the number of Noddies are available from 1903 observations by Burton and Job. They are "about 400" and "at least . . . 600" (Burton in Dutcher, 1904), and "hardly a thousand" (Job, 1905). All summaries of the history of the population cite the number in 1903 as 400 and credit it to Job. The warden's end-of-season figure of 600, however, seems the best estimate available.

The warden on Bird Key (in Dutcher, 1905) said that the terns had a successful season in 1905, and Mayer (in Dutcher, 1906) reported in 1906 that Noddies on Bird Key had increased since 1898 but not so much as the Sooties. Nothing else is known about the colony of Noddies for the period 1903-1907.

1907. As part of his remarkably varied investigations on Bird Key the summer of 1907, Watson made the first known estimate of the Tortugas population of Brown Noddies based on a direct count of their nests. He published two explicit descriptions of his method and results (Watson, 1907: 311, 1908: 197). The latter reads: "By means of a mechanical counting device it was found possible actually

to count the total number of (active) Noddy nests. The count gave 603 nests. In some places, where the bay-cedar bushes are very dense and the area has to be covered 'dog-fashion' (or at times even still more primitively), and in others where the cactus growth is very luxuriant, error in counting was easily possibly. On account of these possibilities of error, I believe that 700 nests is a more representative number. Since two birds occupy one nest, we have a total of 1,400 adult noddies on the island."

Despite Watson's abundantly clear exposition all later references except Bent (1921: 303) and Longstreet (1936*b*, but not 1936*a*) give the 1907 population as "4000". Many, in addition, cite "1400" as the population in 1908, crediting this figure also to Watson, and the apparent decrease has drawn comment: *e. g.*, "The noddy population took an unexplained drop from 4,000 in 1907 to 1,400 in 1908" (Sprunt, 1947b: 215).

Two errors are involved here. They seem to stem respectively from a mistake in Bartsch's (1919) account of Watson's observations, and from misreading of Bartsch, who gives two figures for the number of adult Noddies on Bird Key. The first (1919: 471) occurs in a table and reads: "Noddy tern, estimated, adult[1] 4,000." The numeral "1" refers to a footnote on the same page that reads: "Based upon Doctor Watson's census of 1908". The figure, "4,000," appears to be a *lapsus* and, as pointed out under Sooty Tern, Watson apparently did not work at the Dry Tortugas in 1908. The second reference (Bartsch, 1919: 482) gives the correct figure but attributes it to the wrong year: " . . . Watson estimated the presence of 1,400 adult birds in 1908."

Three points seem clear from the tangle of mistaken citations: 1. Watson's estimate of the population in 1907 was 1400 adults. 2. No estimate of the population of Noddies in 1908 exists. 3. Compilers have often cited Watson from Bartsch or from one another rather than from Watson.

Watson touches upon a problem that has plagued many later observers of Noddies at the Dry Tortugas in his comment (1907: 311): " . . . one feels that there is a vastly greater number [than 1400] present." He concluded that many of the Noddies at Bird Key were non-breeders.

1909-1929. The reports of wardens stationed on Bird Key to the National Association of Audubon Societies (through 1919) and to the Biological Survey include estimates of the number of adult Noddies for all years of the period 1909-1919, and for 1929 (table 4). The

estimate for 1910 is based upon another count of Noddy nests by Watson. The warden's estimate for 1918 was published (in Pearson, 1918). Howell (1932: 272) summarizes all the reports, presumably from the files of the Biological Survey, mentioning specifically the population figures of 1910, 1916, and 1929. Stevenson (1938: 307) also refers to the 1929 figure. Other summaries jump from 1908 to 1917 to 1935. All who include 1917 (Vinten, 1943: 57; Fisher and Lockley, 1954: 60; *et al.*) give the population that year as "4,000" citing the figure from Bartsch (1919). Bartsch, however, made no independent estimate of the population in 1917. Curiously, this estimate of "4,000" is the same as that credited (mistakenly) to Watson in both 1907 and 1908.

TABLE 4. BREEDING POPULATIONS OF BROWN NODDIES AT DRY TORTUGAS

Year	Number of Adults*	Method	Reference
1902	3000	Estimate	Thompson (1903)
1903	600	Estimate	Burton (in Dutcher, 1904)
1907	1206 (1400)	Nest Count	Watson (1908a)
1909	5000	Estimate	Peacon (1909 ms.)
1910	1710	Nest Count	Ashe (ms. notes)
1911	2000	Estimate	Peacon (1911 ms.)
1912	1500	Estimate	Peacon (1912 ms.)
1913	600	Estimate	Peacon (1913 ms.)
1914	2500	Estimate	Peacon (1914 ms.)
1915	5000	Estimate	Ashe (ms. notes)
1916	6000	Estimate	Bethel (1916 ms.)
1917	10,000	Estimate	Lowe (1917 ms.)
1918	15,000	Estimate	Ashe (in Pearson, 1918)
1919	35,000	Estimate	Ashe (1919 ms.)
1922	1600	Estimate	Bartsch (ms. notes)
1929	3000	Estimate	Park (ms. notes)
1935	3000	Estimate	Mason (1936)
1936	4000	Estimate	Doe and Russell (1936)
1937	2000	Estimate	Longstreet (1937)
1938	392 (413)	Nest Count	Beard (1938)
1939	380	Nest Count	Robinson (1939)
1939	454	Nest Count	Taylor (1939 ms.)
1940	180	Estimate	Robinson (1940)

(continued)

TABLE 4 (continued)

Year	Number of Adults	Method	Reference
1940	750	Estimate	Felton (1940 ms.)
1941	400	Estimate	Stimson (*in litt.*)
1941	1000	Estimate	Peterson (in Vinten, 1943)
1942	450	Estimate	Budlong (in Vinten, 1943)
1945	625	Estimate	Sprunt (1946a)
1946	492 (550)	Nest Count	Sprunt (1946b)
1947	202 (250)	Nest Count	Sprunt (1948a)
1948	282 (300)	Nest Count	Sprunt (1948c)
1949	566 (622)	Nest Count	Dilley (1950)
1950	490 (538)	Nest Count	Moore and Dilley (1953)
1951	518 (570)	Nest Count	Moore and Dilley (1953)
1952	890 (978)	Nest Count	Moore and Dilley (1953)
1953	842 (926)	Nest Count	Moore (1954 ms.)
1954	970 (1066)	Nest Count	Moore (1954 ms.)
1955	1108 (1218)	Nest Count	Moore (1955 ms.)
1962	2130	Nest Count	W. B. and Betty Robertson

* In many years when the breeding population of Brown Noddies was determined by counting nests, observers added an arbitrary figure (commonly 10 per cent) to account for nests not found. Population estimates that include such additions are placed in parentheses beneath the figure based on the actual nest count.

Figures for 1915-1919 quoted from the warden's reports (table 4) contradict all previous comments regarding peak populations of Noddies at the Dry Tortugas. Even if the figures are substantially discounted to allow for overenthusiastic interpretation by the individuals directly responsible, it appears likely that the Tortugan Noddy colony reached by far its highest population during this period.

1930-1934. The only references to the colony in these years that I have seen are by Bartsch (see Sooty Tern) and his comments include

no estimate of population. In 1931 Bartsch (1931: 373) noted: "This change of vegetation [destruction of bay cedar on Bird Key by storms] has forced the noddy terns to change from a tree-nesting to a sand-nesting habit." The following year (Bartsch, 1932: 281) most of the Noddies still nested on Bird Key, but about 70 nests were found in dense mats of sea purslane (*Sesuvium portulacastsum*) on "Bush [Long] Key," 32 nests in bay cedar bushes on "Long [Bush] Key," and a few nests on pilings around the coaling docks on Garden Key, where apparently few young were reared because most of them fell off into the water. Presumably Bartsch's (1933: 267) statement that "more than half" the colony had left Bird Key in 1933 referred to Noddies as well as Sooties.

1935-1962. The population figures (table 4) require little comment. Data for most of the years were obtained by direct counts of nests. In the years for which independent estimates are available, observers were in close agreement except in 1939, 1940, and 1941. Having no basis for a decision between the two figures available for each of these years, I have included both. The entire colony of Noddies

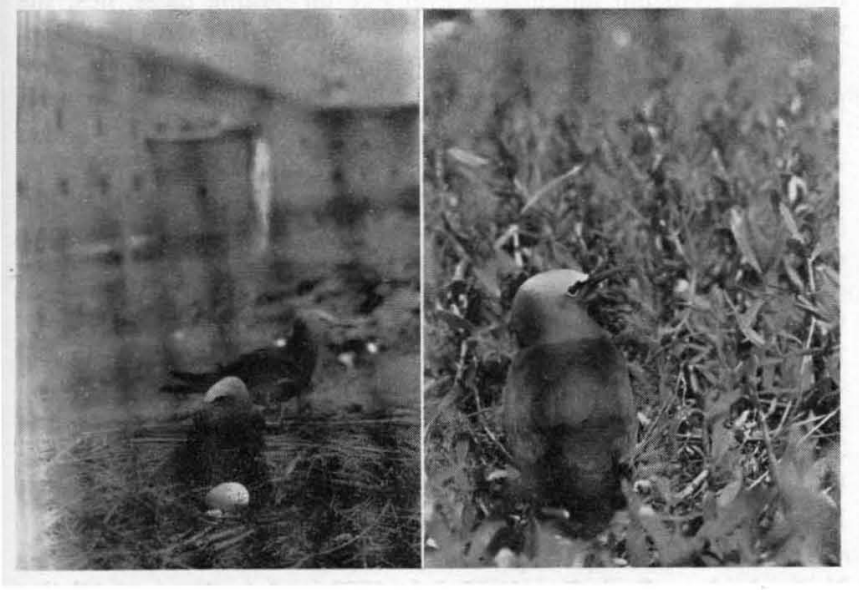

FIGURE 8. Brown Noddies nesting on Garden Key, 1938: (a.) pair at nest on a pile of sea oats (*Uniola paniculata*) cut and raked before the terns landed; (b.) adult incubating egg laid on bare ground amid sea purslane. (National Park Service photographs by Daniel B. Beard.)

nested on Bush Key in most years of this period. Departures from this pattern, all involving nesting on Garden Key, were reported as follows: *1936*, 6 pairs nested on docks and pilings (Doe and Russell, 1936); *1937*, most of the population nested on Garden Key (Young and Dickinson, 1937; Longstreet, 1937; Russell, 1938 MS.); *1938*, nesting was divided about equally between Garden Key (figure 8) and Bush Key (Beard, 1938); *1939*, about the same division as in 1938 (Robinson, 1939; Taylor, 1939 MS.); *1947*, 9 nests on Garden Key (Sprunt, 1948*a*); and, *1948*, 1 unsuccessful nest on Garden Key (Sprunt, 1948*c*).

Discussion

Brown Noddies have been banded and recaptured at the Dry Tortugas in much smaller numbers than the Sooty Terns, and banding data contribute little to an analysis of past population records. It seems likely, for example, that Brown Noddies do not return to breed for the first time until they reach three or four years of age, but no proof is available. Reasons for believing that a Brown Noddy population is likely to decrease more slowly than a Sooty Tern population under the pressure of egging and disturbance are given above. Similar reasoning from the information available on nesting dates, nest site preferences, and mortality of Brown Noddies at Dry Tortugas helps to explain parts of the population record (table 3), but the fit is a good bit poorer than for the Sooty.

The main difficulty in estimating populations of Brown Noddies seems to arise less from the obvious influx of new birds than from long-delayed nesting starts by birds already in the colony. This has vexed nest counters more than those who undertook to estimate the number of adults in the area. As mentioned above, Watson doubted that his count of nests in 1907 recorded the entire Brown Noddy population. Some later observers also have felt that the number of nests found failed to account for the adults on hand. Observations at the Dry Tortugas in 1960-1963 suggest that it is usual for nesting starts by Brown Noddies to be distributed over a period of at least 10 weeks from April to early July. It may be that the loafing birds Watson and others considered to be non-breeders were merely late breeders.

To illustrate, 39 (13.1 per cent) of 298 Brown Noddy nests that I examined on Bush Key 11-15 July 1962 contained eggs. All that were marked for later checking contained eggs or small young on 2 August, and young that were not more than half-grown on 8-11 September. I have no reason to think that any of these nests repre-

sented renesting after failure of earlier attempts, but the possibility cannot be excluded.

Dates of Watson's 1907 count of nests are not recorded, but estimates of the Brown Noddy population in 1939, 1945, 1946, and 1948 through 1955 are based on counts of nests during or before the third week of June. It is to be suspected that these underestimate the breeding population. Nest counts near the end of the season present no difficulty because with few exceptions recently used nests are easily distinguished from any nest remnants that may persist from the year before.

The unproductiveness characteristic of late nesting by the Sooty Tern at the Dry Tortugas seems untrue of late nests of the Brown Noddy. No decline in the attentiveness of adult Brown Noddies with young in the nest in early September 1962 was apparent. Barring accidents of weather or predation, the young seemed likely to fledge successfully. Such accidents, of course, become more likely as the season of hurricanes and hawk migration advances at the Dry Tortugas.

Factors other than human predation believed to have affected the Brown Noddies in the Tortugas colony at various times are predation by rats, mortality caused by storms during the breeding season, and storm damage to bay cedar bushes. The population record since 1900 reflects to some extent the recorded occurrences of rat infestations and severe storms. Information below on hurricane occurrence is taken from contemporary reports and from Dunn and Miller (1960) and Tannehill (1950).

The years from 1900 through 1910 had one bad summer storm, 16 June 1906, and an infestation of rats on Bird Key is said to have been eliminated by 1908 (Dutcher, 1908*b*; Mayer, 1908). I suspect that Thompson's (1903) estimate for 1902 was near the mark, and that the 1903 Job-Burton estimate was much too low. Except for the 1903 figure, agreement between the population record and the record of disturbance is reasonably good. The colony appears at first to have increased slowly; then to have declined slightly, and then once more to have increased slowly to the end of the period.

I have seen no record that rats were present on Bird Key in appreciable numbers after 1908. In the decade 1910-1919 Bird Key was repeatedly battered by hurricanes. The first of importance, 15-17 October 1910, did great damage to the bushy vegetation (see p. 8). Early hurricanes of great severity occurred on 13-15 August and 3 and 28 September 1915, and 4 July 1916. In 1919 the Dry Tortugas

were hit squarely by a hurricane of extreme intensity on 10-11 September.

Records of the Brown Noddy population for this period, all from warden reports, show a decline through the season of 1913, then a meteoric rise to the 1919 figure, the highest ever reported for the colony. This record does not tally satisfactorily with the record of disturbance, if one assumes that the Tortugas colony is a discrete population all of whose surviving adults return to breed annually. The 1910 hurricane was too late in the season to have caused much direct mortality, and its damage to vegetation cannot have affected breeding success before the season of 1911. Available information (Peacon, 1911 MS.; Ashe, MS. notes) suggests that nesting in 1911 was normal. For 1912 and 1913 the reports indicate abnormal behavior and great decreases in the number of adults which the observers attributed to scarcity of nest sites. Ashe (MS. notes) reported that Noddies were seen on Bird Key on 20 March 1912, an unusually early date, but by 22 May only an estimated 400 had appeared, although the population later increased to about 1500 (Peacon, 1912 MS.). In another report on the 1912 season Watson (1912 MS.) advises planting bay cedar bushes on Bird Key "in large quantities." The report for 1913 (Peacon, 1913 MS.) lists only 600 adult Noddies and comments on the great decrease of the species. If the population data are considered at all reliable, the decreases of 1912 and 1913 must have resulted from the failure of adults to return to the colony. The decline seems too early and too abrupt to result from less successful breeding after 1910.

Interpretation of the population trend for the years 1914-1919 presents even greater difficulty. It is known (Bowman, 1918) that shrubby growth on Bird Key had recovered to a considerable extent by 1915-1916. The 1910 storm may have greatly increased the amount of thicket edge, and hence the number of available nest sites, by breaking up formerly solid stands of bay cedar. If so, conditions favorable to a rapid increase of Noddies may have existed by 1914 or 1915. The year-to-year increase, however, is much too large to be accounted for entirely by the successful breeding of a discrete Tortugas population. Moreover, the summer storms of 1915 reportedly caused heavy mortality of adult and young Noddies on Bird Key (Ashe and Bethel, 1915 MS.) and the same is almost surely true of the hurricane of 4 July 1916.

The 1919 storm stripped Bird Key of vegetation and also killed "many" terns (Ashe, 1919 MS.). This storm greatly reduced the number of suitable nest sites and no record of recovery of the bay cedar

growth exists. Unless the 1919 storm killed most of the adults, however, the decrease from 35,000 in 1919 to 1600 in 1922 can be explained only by the failure of many adults to return to the Dry Tortugas. The records indicate no decline in numbers over the years of the enforced movement of the colony from Bird Key to Bush Key.

The more recent record shows low points in the late 1930's and the late 1940's. The first was attributable to rat predation. The causes of the second downturn are more obscure, but records suggest that rats may again have been a factor. None of the reports for 1936 mentions the presence of rats, but Russell (1938 MS.) who spent the summers of 1936 and 1937 at the Dry Tortugas, states that rats became common around the fort in the fall of 1936 and that some apparently swam the channel to Bush Key. By the summer of 1937 rats were so numerous on Bush Key that they could be seen commonly by day and "by thousands" at night. Russell believed the Brown Noddy nesting season of 1937 a nearly complete failure, with more than 90 percent of the eggs and young lost to rats. Other authors give substantially the same account. I have seen nothing to indicate that the rats killed adult Brown Noddies in any numbers, yet only some 400 adults were in the colony the following year. As the population figures for these two years are open to little question, either the adult population suffered extra-Tortugan mortality of a catastrophic nature or most of the population either bred elsewhere or not at all. Practically no information is as yet available on colony fidelity in this species and the factors that may modify it.

Whatever its mortality in the extra-Tortugan phases of its annual cycle, the mortality of Brown Noddies at the ternery is low, certainly much lower than in the Sooty Tern. On 11-15 July and 8-9 September 1962 James B. Meade (in July), my wife, and I counted and buried all of the dead terns and unhatched eggs that we could find on Bush Key and counted and examined all the nests of Brown Noddies. The total observed mortality of Brown Noddies was 2 downy chicks and 11 larger juveniles, a remarkably low 1.23 percent. Although some of the young still unfledged in early September may not have matured, this suggests that under favorable conditions—no predators and no summer storms—Brown Noddy populations can closely approach their maximum possible rate of increase for the egg to fledging stage. The Tortugas colony has been largely free of disturbance by rats or severe summer storms since the early 1950's, and the increase of Brown Noddies in the past decade may approximate that possible for a colony of its size performing as a discrete reproductive unit.

As in the Sooty Tern, the question of factors limiting the popu-

lation of Brown Noddies is debatable. In 1936 when the colony last reached the level of about 4000 adults, unusual numbers were found nesting on the ground. Several authors (Doe and Russell, 1936; Allen, 1936; Dickinson, 1941) suggested that this behavior resulted from the scarcity of nest sites in bushes, but Beard (1938: 10) disagreed stating: "There are more available nesting locations for both species of birds [on Bush Key] than were ever present on Bird Key." In 1955 Moore (1955 MS.) reported the highest total of Noddies since 1937 and commented: " . . . it was amply evident afield that Bush Key has suitable *Suriana* thicket-edge for the nesting of twice this present population."

TABLE 5. BROWN NODDY NEST SITES ON THE WEST HALF OF BUSH KEY OUTSIDE THE MAIN BAY CEDAR THICKETS

Nest Site	Number of Nests 1962	1963
Dead Bushes (mostly *Suriana*)	68	76
Sea Rocket (*Cakile lanceolata*)	15	27
Bay Cedar (*Suriana martima*)	20	13
Bare Ground	10	10
Spurge (*Euphorbia buxifolia*)	10	2
Prickly Pear Cactus (*Opuntia* sp.)	5	7
Sea Lavender (*Tournefortia gnaphalodes*)	5	
Sea Oats (*Uniola paniculata*)		1
Sea Purslane (*Sesuvium portulacastrum*)	1	
Total	134	136

Close study of records of the vegetation of Bird Key suggest that, although it was a much smaller island, it may well have had more brushy edge at times than Bush Key does now, particularly if the surmise that hurricanes fragmented formerly solid thickets is correct. As of 1962, the point of doubled population to which Moore referred had been reached. Brown Noddies in recent years have used a wide range of nest sites in addition to the typical bay cedar fringes. Table 5 shows nest sites used by Noddies in 1962 and 1963 in the area between the shore of the western half of Bush Key and the outer edges of the large bay cedar thicket in the center of the island where most of the Noddies nest (see figure 3). Nests in isolated living bay cedar bushes and some of those in dead bushes were built in a typical manner and within the usual range of heights above

ground, roughly 3 to 10 feet. Most other Noddy nests in this section were no more than 18 inches from the ground, rudimentary in form, and intimately surrounded by nesting Sooties. Parent Noddies at nests of this sort tended to participate in the panics that affected nearby parts of the Sooty Tern colony, and the young seemed to begin leaving the nest earlier than they ordinarily do nests in bay cedar, often as downy chicks.

In both years a large proportion of the Brown Noddy nests placed at low sites within the Sooty Tern colony probably failed. Observed pre-fledging mortality of Noddies was strongly concentrated in this part of the colony, particularly near ground nests and those placed on low herbaceous plants such as sea rocket, spurge, and cactus. In July of both years evidence of nest success in the form of adults attending young birds was conspicuously absent from the vicinity of many such nests in addition to those where unhatched eggs or dead young were found. Mortality recorded at the western outlying nests in 1963 (3 eggs and 16 chicks) cannot be related to total mortality because I did not examine all of the Brown Noddy nests in the central thicket. In 1962, however, 77 percent of the observed mortality (10 of 13 chicks) was associated with nests outside the main thicket in the western half of Bush Key, which comprised only 13 percent (134 of 1065) of the total nests of Brown Noddies.

When the Brown Noddy population on Bush Key is high, use by Noddies of nest sites not typical for this colony apparently increases, and such nests are much more likely to fail than are those placed in live bay cedar bushes. Shortage of secure nest sites in the immediate vicinity of the established colony thus may tend to set an upper limit of population size. Ashmole (1936*b*: 458-459) argues that competition for nest sites seldom regulates population size in tropical sea birds because individuals that fail to get nesting space in one colony can usually emigrate to less crowded colonies or found new colonies. Acknowledging that successful emigration must have occurred many times in the history of every wide-spread colonial species, it is clear that attraction to the known breeding place is a potent countering factor in some sea birds. Potential emigrants seem far more likely to expend their reproductive effort at less secure sites in or near the existing colony. At least four times the presumed overflow population of Brown Noddies at the Tortugas has used atypical sites on the island the colony was occupying rather than moving into vacant bay cedar thickets on other islands near by—on Bird Key after the hurricane of 1910 and in the early 1930's; on Bush Key at times of peak numbers in 1936 and at present.

Indeed, Ashmole's (1962) account of the Black Noddies of Boatswain Bird Island, Ascension, suggests they behave similarly when faced by a shortage of preferred nest sites. Crowding there reportedly led them to use unsuitable ledges rather than colonize new cliffs. Strong attraction to the traditional breeding place seems often to inhibit the emigration of surplus birds and to determine a sequence of events that effectively regulates colony size.

Except for Audubon's fanciful account, the effects of a concentration of Sooty Terns upon the behavior, and perhaps the numbers, of Brown Noddies nesting in the same area has scarcely been considered. Nest sites of most of the Noddies on Bush Key are ringed by nesting Sooties. Disturbance by the Sooties may figure at least indirectly in the poor success of low nests of Noddies within the Sooty Tern colony. At other times presence of the Sooties seems to have favored the Noddies. Russell (1938 MS.) noted that almost the only Noddies whose young survived the rat plague of 1937 were those nesting in bushes surrounded by dense concentrations of nesting Sooties. Contacts between Noddies and Sooties are infrequent in the Tortugas colony. Of a similar aggregation on Pelsart Island, Western Australia, Warham (1956: 89) stated: " . . . there seemed to be no friction between the two species." Nevertheless, the behavior of Brown Noddies at the Dry Tortugas differs considerably in the absence of the Sooties. Where Sooties are present in numbers, Brown Noddies entering and leaving the ternery tend to fly fairly high and relatively few are taken in mist nets set on the open beaches. In September 1962 with most of the Sooties gone, Brown Noddies swooped from perches on the bush tops and left the island in low, rapid flight. This difference in their behavior is reflected in the mist-net catches of 9-10 September when Brown Noddies were taken at an average rate (8 per net hour) that far exceeded any previous results for nets set in the open.

Roseate Tern

Audubon reported Roseate Terns, *Sterna dougallii* Montagu, nesting in the Florida Keys (Howell, 1932: 264), but he and other early observers apparently saw none at the Dry Tortugas. The first were reported by Bartsch (1919) who located a breeding colony of about 100 pairs on Bush Key or Long Key in July 1917. Most reports of visitors to the area since 1917 have included some mention of Roseate Terns. Three partial summaries of the records have been published (Sprunt, 1948*a*, 1949, 1951), the last carrying the local history of the

species through the breeding season of 1949. Table 6 shows the record of breeding occurrence of the Roseate Tern at Dry Tortugas, 1917-1963. The reports for a number of the years in this span deserve comment.

1917. In initial remarks on his observations of the summer of 1917, Bartsch (1918: 171) wrote: " . . . probably 200 common terns formed a rookery on the rough coral shore of the eastern end of the island [Bush Key]. Their young birds of various ages could be seen at all times." The later, more detailed report of the 1917 breeding season (Bartsch, 1919) does not mention the Common Tern in text, but discusses (p. 489) a colony of "about 100 pairs" of Roseate Terns breeding "on the rough coral and shellstrewn northeastern end of Long Key." The legends to Plates 27-32 in the 1919 publication, a series of photographs of the colony site and of young birds, state that the pictures show Common Terns, but a footnote (p. 500) corrects this to read Roseate Tern. The downy chick shown in one of the photographs (Bartsch, 1919: Plate 28a) is clearly a Roseate. It appears certain that these reports refer to a single colony. A Roseate Tern specimen in the U. S. National Museum Bartsch collected on Bush Key 17 May 1919 doubtless served to establish the correct identity.

In his writings on the Tortugas, Bartsch appears on some occasions to have followed the nomenclature of older charts on which application of the names Long Key and Bush Key is reversed from present usage. For this reason it is impossible to determine conclusively whether the Roseate Tern colonies of 1917, 1921, 1922, and 1932 were located on the eastern sandspit of Bush Key or on one of the ricks of coral fragments that comprise the island now known as Long Key. This uncertainty is of little importance, because the sites are similar and not more than a few hundred yards apart.

1921. Nests with 1, 2, and 3 eggs were seen (Bartsch, MS. notes).

1922-1925. According to Bartsch (MS. notes), the terns were assembled at the colony site 14 May 1922, but had not begun to nest. For 7 June 1924 he noted, "some seen, but colony not breeding." He also observed numbers of Roseate Terns feeding in the Tortugas area on 5 September 1923 and 12-18 August 1925.

1935. The total shown in table 6 is a synthesis of the estimates by members of the Audubon party. Some of the observers thought that no more than 100 pairs of Roseates were in the colony (Russell, 1938

MS.). Mason (1936 and *in litt.*) reports young 3 or 4 days old and many eggs not yet hatched.

1936. The published account (Doe and Russell, 1936: 7) states: "There were probably about the same number of roseate terns as last year . . . , " but Doe (MS. notes) recorded that the Roseate Tern colony numbered "about 400 nests." Nesting was apparently just beginning, for Mason (MS. notes) wrote "96 nests located, all with 1 or 2 eggs. None yet hatched."

1937. Reports of the trip (Young and Dickinson, 1937; Longstreet, 1937) give no estimate of the number of Roseate Terns seen. This omission misled Sprunt (1949, 1951) to state that none bred at the Dry Tortugas in 1937. Young and Dickinson, however, mention (pp. 3-4) that they visited a key where Roseate Terns were nesting and they include (p.6) a photograph with the legend, "Roseate Tern banded by C. R. Mason on Sand Key." Banding schedules show that Mason banded three adult Roseates on Sand (Hospital) Key on 25 June 1937 and he advises (*in litt.*) that as he recalls it the colony nesting there was slightly smaller than the ones observed on Bush Key in 1935 and 1936.

1938. Mason (1938: 1) noted the nesting colony included "better than 300 birds." His MS. notes record that 157 nests with eggs were counted, and that the location of the ternery, not mentioned in the published report, was the eastern sandspit of Bush Key.

1940. Nesting was just beginning. The observers found 5 nests each containing a single egg. In addition, the Fort Jefferson Custodian told Robinson (1940: 3) that "quite a number" of Roseate Terns were believed to be nesting on Bird Key, then re-emerging as a sandbar.

1941. The brief report of the two parties of observers who visited the Dry Tortugas in June 1941 (Rea, Kyle, and Stimson, 1941) mentions only that Roseate Terns were nesting on Bush Key. Louis A. Stimson (*in litt.*) writes me that the first group saw but one Roseate Tern, in flight over Fort Jefferson. Roger T. Peterson, who accompanied the second group, writes me (*in litt.*) that he saw no Roseates, but that the Custodian of the fort told him there was a nesting colony on the east end of Bush Key. Individuals who had seen the colony in both years told R. R. Budlong (1942 MS.) that it was about the same size in 1941 and in 1942. As with the 1937 report, lack of a definite popula-

tion figure has resulted in the statement that the species was absent from Dry Tortugas in 1941 (Sprunt, 1949).

1942. The colony was located "on the reef between Bush and Long Keys." The total shown seems to have been only a rough estimate, the author commenting that he was able to visit the area but once, on 2 July, and found "numerous eggs and young birds."

1943. No population figure is given in the report which merely states "The Roseate Tern colony seems to contain about the same number of birds as last year."

1947. Sprunt (1948*a*: 29) counted 67 nests on Long Key, 54 on Bush Key, and 21 on Hospital Key. In addition, about 12 young (not included in the total) survived from an earlier nesting on Long Key disrupted by high tides.

1948. Sprunt (1948*c*: 14) counted a total of 216 nests with hatching "about 50% complete." He adds: "It is virtually certain that a few were missed, despite care. A total of 225 is very likely."

1949. Dilley (1950: 68) located 44 active nests on Bush Key and 7 on Long Key. An additional 17 nests on Hospital Key (not included in total) are said to have been abandoned.

1950-1952. Nest locations in the three years were: *1950,* 55 on Bush Key and 7 on Hospital Key; *1951,* 35 on Hospital Key and 33 on Long Key; *1952,* 136 on Long Key and 58 on Bush Key. From observations later in the summer of 1950, John R. De Weese (*in litt.* to Dilley) reported storm tides flooded all the Roseate Tern nests so that no young were reared that year.

1953. An earlier group of 9 nests on Middle Key, the only Roseate Tern nests present in the area on 26 May (Moore, 1954 MS.), was destroyed by high tides during a storm 28-30 May. The later nesting included 79 nests on Hospital Key, 26 on Middle Key, and 15 on Bush Key.

1956. When counted, many of the nests (88 on Long Key and 14 on Bush Key) had incomplete clutches and a number of fresh nest scrapes without eggs were present. Two weeks earlier Margaret H. Hundley had estimated 150 Roseate Terns in the Tortugas area (Stevenson, 1956: 327).

1957-1958. The record for these years is almost certainly incomplete. No 1957 observations later than mid-May are available, and in 1958 no particular effort was made to locate the colony. Possibly colonies of more normal size developed each year.

1959. A hasty count located approximately 225 nests in a dense mat of *Sesuvium* on the highest ridge of Hospital Key. Hatching was about half completed with the largest chicks about one week old. The party banded 80 chicks.

1960. Observers who visited the Dry Tortugas in early May saw some Roseate Terns around the east end of Bush Key, but the colony apparently had not begun nesting (I. Joel Abramson, *in litt.*). Banders working there 27-31 May frequently saw a few Roseates fishing in the bight between Bush Key and Long Key, but found no nests. Severe squalls prevented visits to any of the outlying keys by either party in May. On 11 July members of a second group of banders landed on all the keys. No Roseates were nesting at that date, but a densely massed assemblage of terns and gulls on Middle Key included about 100 individuals of some species of white *Sterna*, many of which were birds of the year. The behavior and unsteady flight of these youngsters indicated that they had been reared at Dry Tortugas, although not necessarily on Middle Key. Opportunity to study the adults was brief, and the observers, aware of the uncertainty surrounding reports of southern nestings of the Common Tern concluded that the birds were Roseates. The single juvenile netted and banded on Middle Key was so reported.

1961. Oliver L. Austin, Jr., and William G. Atwater banded 20 well-grown juveniles on the east spit of Bush Key 16 July.

1962. The Roseate Terns first located on several elongate heaps of rough coral fragments near the south end of Long Key. A member of the banding party, Theodore R. Greer, devoted several days to photographing (figure 9) and observing the colony from a blind. On 27 May he counted 118 nests, 34 containing single eggs and 84 with two-egg clutches. On 13 June a field excursion group of the 13th International Ornithological Congress (Robertson, 1962) found the colony site deserted and broken egg shells remaining in the nest depressions. Slight vascularization of the inner shell membranes indicated that predation had occurred early in incubation, and the way the shells were broken suggested the work of an avian predator. The

most likely suspects were the some 20 cattle Egrets, *Bubulcus ibis*, then frequenting Bush and Garden Keys. Cattle Egrets at the Dry Tortugas have formed some unusual feeding habits. In May and June 1962 and May 1963 they were frequently seen to stalk and kill injured or exhausted spring migrant passerines (mainly Parulids) and to feed upon small birds already dead.

FIGURE 9. Roseate Tern incubating, south end of Long Key, 26 May 1962. The colony occupied several dune-like elevations of coral rubble. The bird pictured had a darker bill than most of the adults in the colony, but note that lower mandible is lighter (reddish) at the base. (Photograph by Theodore R. Greer.)

Some of the Roseates appear to have renested on Hospital Key in July. C. R. Mason and others found about 50 nests, all with one egg, there on 16 July. Park Ranger Carl S. Christensen (*in litt.*) visited the colony 10 days later and reported that hatching had begun. At that time none of the nests contained more than one egg, apparently the normal clutch for second nestings of Roseates at the Dry Tortugas.

1963. On 17 and 18 May members of the banding party counted 73 nests, each containing one or two eggs, and banded 32 adult Roseates on Hospital Key. On 7 July large young from the May nesting were congregated on the beaches and an estimated 150 additional adults had arrived and begun nesting.

Discussion

Comments on the nesting of the Roseate Tern at the Dry Tortugas have stressed the isolation of the colony and its erratic fluctuations in size from year to year. Sprunt (1951*a*: 14), for example, writes: "The marked fluctuation of this tern at Tortugas seems without explanation as, indeed, does the very fact of its being there!" Analysis of the longer record of population now available suggests that much of the supposed fluctuation results from incomplete data.

The Tortugan Roseate colony has shifted frequently between the Bush Key-Long Key area opposite Fort Jefferson and the area of Hospital and Middle Keys, several miles northeast of the Fort. In some years the entire breeding population has been concentrated on one key; in other years two or three separate colonies existed (table 6). Observers are not likely to have overlooked Roseate Terns nesting on Bush Key or Long Key, but Hospital and Middle Keys are less easily accessible and neither was visited by the observers who reported for 1935, 1936, 1939, 1940, 1941, and 1956, nor probably for 1938, 1942, 1943, and 1945.

Table 6. Breeding Records of Roseate Terns at the Dry Tortugas

Date	Location of Ternery	Number of Adults	Source
19-31 July 1917	"Long Key"	200	Bartsch (1919)
9 June 1921	"Bush Key"	200	Bartsch (ms. notes)
14 May 1922	"Bush Key"	200	Bartsch (ms. notes)
August, 1932	"in the quarters previously occupied"	"the usual . . . colony"	Bartsch (1932)
19-20 June 1935	Bush Key	400	Mason (1936) Longstreet (1936a, 1936b)
17-19 June 1936	Bush Key	400	Doe & Russell (1936)
23-25 June 1937	Hospital Key	250–300	Mason (ms. notes)
20-25 June 1938	Bush Key	314	Mason (ms. notes)
21 June 1939	Bush Key	214	Taylor (1939 ms.)
about 3 June 1940	Bush Key	20	Robinson (1940)

(continued)

TABLE 6 (continued)

Date	Location of Ternery	Number of Adults	Source
early June, 1941	Bush Key	?	See comments
2 July 1942	Long Key	*c.* 150	Budlong (1942 ms.)
1943	Bush Key	*c.* 150	Budlong (1943 ms.)
18-20 June 1945	Bush Key	170	Sprunt (1946a)
23-25 June 1947	Long Key Bush Key Hospital Key	284	Sprunt (1948a)
15-18 June 1948	Long Key	450	Sprunt (1948c)
13 June 1949	Bush Key Long Key (Hospital Key)	102	Dilley (1950)
1-5 June 1950	Bush Key Hospital Key	124	Moore & Dilley (1953)
31 May-4 June 1951	Hospital Key Long Key	136	Moore & Dilley (1953)
27 May 1952	Long Key Bush Key	388	Moore & Dilley (1953)
1 July 1953	Hospital Key Middle Key Bush Key	240	DeWeese (1953 ms.)
27 May 1954	Hospital Key	370	Moore (1954 ms.)
3 June 1955	Bush Key	436	Moore (1955 ms.)
26 May 1956	Long Key Bush Key	204	Robertson (1956 ms.)
19 May 1957	Hospital Key	30	DeWeese (1957 ms.)
June 1958	Bush Key	15	Ward (*in litt.*)
13 June 1959	Hospital Key	450	O. L. Austin, Jr. *et al.*
7-8 May 1960	(Bush Key) Middle Key?	100–125	Abramson (*in litt.*)
7-17 July 1961	Bush Key	120	Robertson (1961)
25-28 May 1962	Long Key	236	Greer (*in litt.*)
May and July 1963	Hospital Key	c. 300	C. R. Mason, W. B. Robertson, *et al.*

In addition to low counts resulting from incomplete coverage, some counts made while the colony was forming surely underestimate the actual breeding population. Roseate Terns at the Dry Tortugas are often well behind the Sooties in their breeding schedule, and nesting dates have varied considerably from year to year. In some years the full complement of breeding adults assembles by mid-May and laying begins during the first week of June. In other years many first nests still have incomplete clutches the last week of June.

The relation between the date and the size of the population recorded is well illustrated by the records for 1939 when on 9 June Robinson (1939: 9) estimated about 80 Roseate Terns on the east end of Bush Key and found 13 nests with eggs. On 21 June in the same colony Taylor (1939 MS.) counted 107 nests with eggs. Moore, in 1952 (Moore and Dilley, 1953: 78), counted 93 nests on Bush and Long Keys 24 May and 194 nests there on 27 May. In late May 1953 Moore (1954 MS.) was able to locate only 9 Roseate Tern nests at the Dry Tortugas, but by July (DeWeese, 1953 MS.) 120 nests were present on three keys. Checks of this sort are not available for other years, but the earlier counts clearly have tended to be lower. The low Roseate Tern populations recorded in 1940, 1950, 1951, and 1957 all derive from counts made in May or the first week of June.

In 1946 a search of all of the Tortugan keys 16-20 June revealed no Roseate Terns (Sprunt, 1946*a*: 1,7). The Custodian of Fort Jefferson, however, had reported a few Roseate Terns in the area during May (Gibbs, 1946 MS.). Perhaps none nested at the Dry Tortugas in 1946, but it may also be that formation of the colony was unusually retarded that season, or that an early nesting was destroyed by spring tides or predators. Excepting only 1946, all complete surveys of the known nesting keys made after mid-June have located breeding aggregations of approximately 150 to 450 adult Roseate Terns. Thus the Tortugan Roseate colony appears neither particularly erratic in its breeding nor to undergo numerical fluctuations of unusual magnitude.

The difficulties of season and location mentioned above may possibly account for the failure of 19th century ornithologists to find Roseate Terns at the Tortugas. While it seems likely that Audubon and others would have investigated all the keys, it is not certain that any of them did. Scott, and probably also Audubon, Bryant, and Maynard's assistants were at Dry Tortugas too early in the spring to find Roseate Terns, assuming that the colony existed and followed its present seasonal schedule. In addition Bryant's testimony is rendered equivocal by the possiblity that he confused Roseate and Com-

mon Terns. His statement that he saw no Roseate Terns follows his comment (1859*a*: 21): "I found the Little Tern and Wilson's Tern breeding at different localities among the keys and along the shore of the mainland."

As for the Tortugan colony's reputed isolation, while it is indeed remote from the remainder of the Roseate Tern's breeding range in the United States, it is at the periphery of the species' extensive Antillean-Caribbean range. In terms of the species' world range, it is rather the North Atlantic colonies that are unusual. Most other Roseate Terns nest within about 30 degrees of the equator (Voous, 1960: 151, map 196). The colonies that breed from Virginia to Nova Scotia and from Britanny to Jutland may be relict as Fisher and Lockley (1954: 87) suggest, but local extirpation cannot be disregarded as a possible cause of present breeding range discontinuities. In Florida, for example, no Roseate Tern nesting colonies have been known since the mid-19th century, except the one at the Dry Tortugas. Many summer sight records of Roseate Terns in the central Florida Keys and the recent report of a small colony "on the Vaca Keys" in which 3 chicks were banded and several nests with single eggs seen on 11 June 1962 (Pace, 1962) suggest the possible recolonizing of former breeding range. This colony of about 30 adults was again active in the summer of 1963 (Christine A. Bonney, personal communication).

Least Tern

The egg collection catalogue of the U. S. National Museum lists eggs of the Least Tern, *Sterna albifrons* Pallas, taken at Dry Tortugas in 1859 and 1861 (Robbins, *in litt.*). Little else is known of its nesting there prior to 1900. Scott (1890: 306) was informed that it occurred commonly, but saw none during his visit in March-April 1890. By 1900 the Tortugan population of Least Terns had declined greatly. Thompson (1903: 83-84) found a colony of 30 pairs on Long Key in 1902 and reported that formerly populous colonies on Loggerhead Key had been dispersed by eggers. Watson (1907: 315-316) reported 50 pairs attempted to nest first on Loggerhead Key and then on Hospital Key, but predation and disturbance prevented both colonies from producing young and he considered the species "nearing extinction" at the Dry Tortugas.

With the establishment of the Carnegie Tortugas Laboratory, A. G. Mayer, the first director, undertook to stop the gathering of tern eggs and to control the rats that infested several of the keys. In 1908 he wrote that the success of these efforts could be seen in

the thriving colonies of Least Terns on both ends of Loggerhead Key and on Bush Key, the latter said to number about 1000 birds (Dutcher, 1908*b*; Mayer 1908). The revival of the colonies on Loggerhead Key was short-lived. In 1917 Bartsch (1919: 487) observed that "the persistent efforts of eggers" had finally driven the birds away from the island. Small nestings were reported on Loggerhead Key in 1932 (Bartsch, 1932: 287) and in 1935-1936 (Russell, 1938 MS.), but there has been no subsequent indication that the Least Tern might recolonize its original Tortugan breeding ground. Its failure to do so at Loggerhead may be explained in part by the fact that dogs and cats kept by the lighthouse personnel often have had free range of the island.

In contrast to the checkered history of the Loggerhead colonies, Least Terns nesting in the Bush Key-Long Key area maintained a fairly constant population for many years. Bartsch (1916, 1917, 1919) reported a colony of 200 on Bush Key in 1915, 500 there in 1916, and 500 on Long Key in 1917. On 9 June 1921 there were 400-500 birds on Long Key and Bartsch noted on 3 June 1924 (MS. notes) that "several colonies" were breeding in the Tortugas. Warden Charles I. Park (MS. notes) estimated 500 Least Terns nesting on Long and Bush Keys in July 1929, and 700 nesting on Bush Key in 1930. Bartsch (1932: 281) found "the usual breeding colonies" active in August 1932.

The first Florida Audubon Society Tortugas trip in 1935 reported 200 Least Terns nesting on the east spit of Bush Key (Mason 1936: 18), which suggests the population was somewhat reduced from that present a few years earlier. The following year Doe and Russell (1936: 7) estimated this colony to number only 100 birds. In 1937 there were no Least Terns on Bush Key, but about 25 pairs nested in the Roseate Tern colony on Hospital Key (Russell, 1938 MS.)

In the next four years Least Terns were reported on the east spit of Bush Key and adjacent parts of Long Key as follows: In 1938 Mason (1938: 4) found 11 nests. In 1939 Robinson (1939: 9) reported 25 adults, and the following year (1940: 3) "Not more than a dozen Least Terns in the colony." In 1941 Stimson (*in litt.*) reported "a few Least Terns nesting."

In 1946 Sprunt (1951: 15) saw empty nest scrapes on both Bush and Hospital Keys, but does not mention how many birds were present. In 1947 he reported (1948*a*: 30) "less than a dozen" adults on Bush and several scrapes without eggs on Middle or Hospital Key. In 1948 he reported (1948*c*: 13-14) 12 birds on Bush Key, where the following year Dilley (1950: 68) found a single nest with eggs. In

1951 Moore and Dilley (1953: 78) saw two birds but found no nest. Thereafter no Leasts were reported at the Tortugas during the breeding season until July 1963, when about five adults were seen for several days around Garden and Long Keys.

As mentioned under Roseate Tern, Hospital Key was not visited in some years, and some of the visits after 1935 may have been too early in the season to record Least Terns nesting. The record is doubtless incomplete, but certainly the species no longer breeds regularly at the Dry Tortugas.

No clear explanation of the rapid disappearance of the Least as a breeding species at the Dry Tortugas can be advanced. Between 1932 and 1937 a stable and long-established population of approximately 500 breeding adults on Bush Key—Long Key decreased to a few birds, with no evidence that the colony suffered disturbance of any sort. The decline of the Least Terns during the years when the colony of Sooty Terns was becoming established and increasing on Bush Key suggests the possibility of some relationship between the two events. Also of possible significance is the great increase of Least Tern colonies along the adjacent coasts of southern Florida since the early 1930's. Dredging along the Inland Waterway and for coastal real-estate developments has created innumerable small, sheltered islets and bars which provide ideal nesting sites, perhaps preferable to more exposed islands like the Tortugas.

Common Tern

Until Hallman (1961) reported two nests found "in the midst of the colony of Least Terns" on a spoil island in St. Joseph's Bay, Gulf County, in June 1961, observations at Dry Tortugas provided the only generally accepted evidence of the nesting of the Common Tern in Florida (Howell, 1932: 263). In fact, the Tortugan colony has been considered the only one in the entire Gulf of Mexico region (Lowery and Newman, 1954: 530), although the A.O.U. Check-List (1957: 235) mentions breeding colonies on the coast of Texas, and Stewart (1962: 485) recently reported a possible nesting on the Gulf coast of Mississippi.

The few records of breeding at the Tortugas are not altogether satisfactory. They are documented neither by specimens nor photographs, and a strong possibility of confusion with the Roseate Tern exists. As has been noted, the first report of nesting Common Terns in the area (Bartsch, 1918) proved to be based on a misidentification

of Roseate Terns and was later corrected (Bartsch, 1919). The other reports are summarized below.

Bartsch (MS. notes) reported a colony of 75 pairs of Common Terns on Bush Key 3 June 1924 and noted that the nests contained "1-4 eggs or newly hatched young." On 13 August 1925 he reported "quite a colony present" at Bush and Long Keys, and in 1932 (Bartsch, 1932: 281) "the usual breeding colonies" were said to be active. I have been unable to learn anything more about these observations. It is to be noted, however, that Bartsch also reported Roseate Terns at Dry Tortugas on about the same dates in 1924 and 1925.

The remaining records date from the breeding seasons of 1935, 1936, and 1937. In each case Common Terns were reported nesting with a larger group of Roseate Terns on the east spit of Bush Key in 1935 and 1936 and on Hospital Key in 1937. Available information suggests some uncertainty in the minds of the observers concerning identification of the birds as Common Terns and the number of presumed Common Terns present. The number in 1935 was reported variously as 50 birds (Mason, 1936: 18; Longstreet, 1936*a*: 33) "about 75 pair" (Longstreet, 1936*b*: 99), and "100 pair" (Doe, MS. notes). Longstreet (1936*a*: 42) commented: "Mr. Mason and I believe that we found the common tern breeding on Bush Key. However, we did not collect any birds or eggs."

The report of the Florida Audubon Society's Tortugas trip of 1936 (Doe and Russell, 1936: 7) states: " . . . the common terns showed a marked decrease, only a few pairs being noted." Mason advised me (*in litt.*) that only four birds were seen on Bush Key in 1936 and that no nests were located. Russell (1938 MS.), however, wrote elsewhere: " . . . in 1935 and 1936 I estimated the same colony to contain about 200 birds." The latter statement could pertain to observations made later in the summer.

Published accounts of the 1937 trip (Longstreet, 1937; Young and Dickinson, 1937) do not mention the Common Tern, but Mason (*in litt.*) saw a few adults that he believed were Common Terns among the Roseates on Hospital Key. Russell (1938 MS.) states that Common Terns nested on Hospital Key in 1937 without indicating how large the colony was. Since 1937, the only reported occurrence at the Dry Tortugas during the breeding season appears to be two seen on Middle Key by Mr. and Mrs. John R. DeWeese, 29 May 1955 (Moore, 1955 MS.).

It seems necessary to conclude from the above that breeding of the Common Tern at the Dry Tortugas is not proved. The downy young of the Common and Roseate Terns are easily distinguishable

by anyone familiar with them. Chicks of the presumed Common Terns at Tortugas were seen in 1924 and probably also in 1935 (Mason, *in litt.*), but no record that they were compared critically with Roseate Tern chicks exists. In addition, some of the identifications of adult Common Terns apparently were based upon the bill color, which often is unreliable for separating Commons and Roseates. Greer (*in litt.*) advised me that no more than 15 or 20 of the adults in the colony of Roseates on Long Key in May 1962 had entirely dark bills, the others having at least the basal third of the bill orange-red. The latter is considered to be the "variant" condition by Peterson (1947: plate 37), while Pough (1951: 288) states: "Its bill is black except for a little red at the base (occasionally more)."

The Common Tern has been reported to nest at a number of New World localities south of its regular breeding range. Considerable uncertainty surrounds most of these records, however, because of the similarity between Common and Roseate Terns, and because banding evidence shows subadult Common Terns often summer in the tropics. As Voous (1957: 139) notes: "Its nesting in the West Indian region has been almost as frequently stated as it has been rejected . . . " Bond (1956: 58) gave full credence to none of the numerous reports of breeding in the Bahamas and elsewhere in the West Indies. Similar doubt attaches in some degree to most or all of the alleged nestings on the South Atlantic and Gulf coasts of the United States, including those at the Dry Tortugas.

Voous (1957: 137-140; 1963) has recently published unquestionable proof of the Common Tern nesting at Curaçao, Aruba, and Bonaire in the southern Caribbean. Records that he assembled suggest that the species has a long history there as an irregular breeder in solitary pairs or small colonies of fewer than 20 adults. It is also said to breed in the nearby Venezuelan islands of Los Roques and Las Aves (Phelps and Phelps, 1958: 111). As Bond (1958: 5) states, this proof of southern nesting compels a re-examination of the earlier reports.

The significance of the proved and reported southern nestings of the Common Tern is not clear, but most of the records seem to conform to a pattern—small numbers of birds nesting sporadically, often in association with larger colonies of other terns, especially Roseates and Leasts. Band recoveries show that many 1-, 2-, and 3-year-old Common Terns summer in the Caribbean and elsewhere south of the species' usual breeding range. I suggest as a provisional explanation that some individuals in these normally subadult age groups reach sexual maturity in southern latitudes and are occasiona-

ally stimulated to nest when they become associated with terneries of other species.

Voous (1960: 128) has commented: "The few recorded breeding places in the tropics, very limited in extent and altogether isolated from one another, must be regarded as recent colonizations by birds left behind after wintering . . . " As presently known, however, southern nestings of the Common Tern seem to fit more closely the hypothesis that they are anomalous, impermanent, and perhaps related to the age of the individuals. It is doubtful that they have significance as extensions of the species' breeding range.

Royal and Sandwich Terns

Audubon found the Royal Tern, *Thalasseus maximus* (Boddaert), nesting abundantly at the Dry Tortugas in May 1832. John Krider (1879: 80), presumably from observations made in the spring of 1848, writes of it: "Very abundant on Tortugas Island, Florida, and breeds on the Keys of Florida." In May, probably of 1850, Bryant (1859a: 20-21) visited Northeast Key, Dry Tortugas, where he observed this species and the Sandwich Tern, *Thalasseus sandvicensis* (Latham), breeding "in great numbers." The U. S. National Museum contains eggs of the Royal Tern collected at Dry Tortugas by Gustavus Wurdemann in 1858, and eggs of both species collected by Dr. D. W. Whitehurst and Captain D. P. Woodbury in 1859 (H. G. Deignan, *in litt.*). Scott (1890) does not mention the Sandwich Tern, but he saw sizable flocks of Royal Terns at the Dry Tortugas in early April 1890, and was told that many remained there to breed.

These brief comments span the entire record of breeding by these species at the Tortugas, except that a single Royal Tern egg was found on Middle Key in May 1952 with no further evidence of nesting (DeWeese, 1952 MS.) In Sprunt's (1962: 84) report of my 7 November 1961 observation of Royal Terns " . . . there appeared to be several times this number nesting on the south end of Long Key," nesting is a typographical error for resting. Royal Terns still visit the Tortugas regularly, sometimes in large numbers. For the Sandwich Tern a number of observations exist from the neighborhood of Key West, including several in summer, but three sight records, two of them recent, are the only known occurrences at the Dry Tortugas in this century (Sprunt, 1962: 84).

Northeast Key, mentioned as the site of the nesting colony of Royal and Sandwich Terns, had washed away by 1875. The narrative of a survey made in that year states (Coast Survey, 1878): "North

Key, Northeast Key, and Southwest Key, as represented on old maps, have no existence now, not being bare even at low water." Other islands nearby, such as East Key, had areas apparently suitable for the species, and it seems doubtful that loss of one key could have caused loss of the colony. A more likely explanation is that the increasingly persistent egging after about 1880 (Scott, 1890) eventually extirpated the ternery. Both *Thalasseus* species nested commonly at a number of southern Florida localities in the 1800's, but no breeding colony of either species is known to exist in the area today.

Black Noddy

The Black Noddy, *Anous tenuirostris* (Temminck) was first recorded in the continental United States at Bush Key, Dry Tortugas, 13 July 1960 (Robertson *et al.*, 1961), when one was collected and a second individual seen. During the summers of 1961, 1962, and 1963 the species was seen repeatedly on Bush Key. With one exception the observations have been of single birds, usually perched with Brown Noddies in the dead tree at the south shore of Bush Key from which the 1960 specimen was collected. To date at least five different individuals have been seen, and the species apparently is of more than casual occurrence there.

The Black Noddy is slightly smaller and darker than the Brown Noddy, its bill is thinner, and its crown patch is whiter, more sharply defined, and extends farther back on the nape. Yet the two species are so similar in general appearance and behavior that one could easily be overlooked in a congregation of the other unless the observer were expecting or watching for it. Sutherland (1961) describes how he first spotted the Black Noddy in 1960, while making prolonged observations on a group of Brown Noddies in the "noddy tree" on Bush Key to record their calls. Otherwise the species might easily have gone undetected, and it is indeed possible that a few birds may have frequented the Tortugas ternery unnoticed for many years.

In 1961 the first party of banders saw a Black Noddy daily in the noddy tree 26-31 May. The bird is clearly recognizable in 16-mm color movies B. G. Hubbard took 27 May (figure 10). The second banding group also found one Black Noddy on station in the tree 7, 10, 11, and 15 July. The bird seen in May had an indistinct slash of lighter brown across the left middle coverts, apparently caused by worn feathers it had not molted. The bird seen in July lacked this mark and may have been a different individual. Repeated attempts

by both groups of banders to capture the bird failed. It showed the extreme tameness characteristic of noddies and tolerated approach to within a few feet, but was much more agile on the wing than the Brown Noddies and easily avoided both mist and hand nets.

In 1962 four parties with a combined total of more than 50 observers searched Bush Key for Black Noddies without success 5-6 May, 11-14 May, 25-28 May, and 13 June. The second banding party found one at the usual roost on 7 and 11 July, and on 13 July caught it in a hand net. It was banded (683-12000 on right leg, unnumbered red plastic on left), weighed (103 grams), measured (wing arc 218 mm, exposed culmen 42 mm), photographed (figure 12) and released. Its mouth lining, by Palmer and Reilly's (1956) color standards, was approximately "scarlet-orange", strikingly different from the "orange-yellow" of the Brown Noddy's mouth. This individual has not been reported since. The party saw no more Black Noddies through 15 July, and I could find none on 2 August. On the evening of 9 September, however, my wife and I caught a second Black Noddy in a mist net on the west beach and banded it (683-11999).

The first 1963 banding party saw one Black Noddy near Hospital Key 17 May, but could find none on Bush Key. On 6 July the second party found one unbanded bird perched among Brown Noddies at the north coaling dock on Garden Key and photographed it from a distance of a few feet. On 9 July two Black Noddies, neither banded, roosted for several hours at the same place. One of these differed from all others seen at the Tortugas in having the back of the pileum dusky rather than white. Presumably it was a younger individual. A number of interspecific squabbles for roosting space were observed, in which the larger Brown Noddy was usually dominant.

Thus one or more of at least five individual Black Noddies have been present at the Tortugas ternery during four successive summers. Their known extreme dates of occurrence, 17 May-9 September, span virtually the entire breeding period of terns in the area. Since 1960 we have devoted considerable time, perhaps 50 or more man-hours, to searching for a possible Black Noddy nest. So far no Black Noddy has been seen at a nest, and no nests, eggs, or young have been found that appeared to differ from those of the Brown Noddy.

The Black Noddy of July 1962 was several times observed to leave its perch in the noddy tree and fly directly into an area of dense brush near the west end of the key. This behavior was suspiciously like that of the off-duty member of an incubating or brooding pair, but minute search of the area—several acres of tightly interwoven

FIGURE 10. Black Noddy (left) and Brown Noddy, Bush Key, 27 May 1961. (Photograph enlarged from 16 mm movie by B. G. Hubbard.)

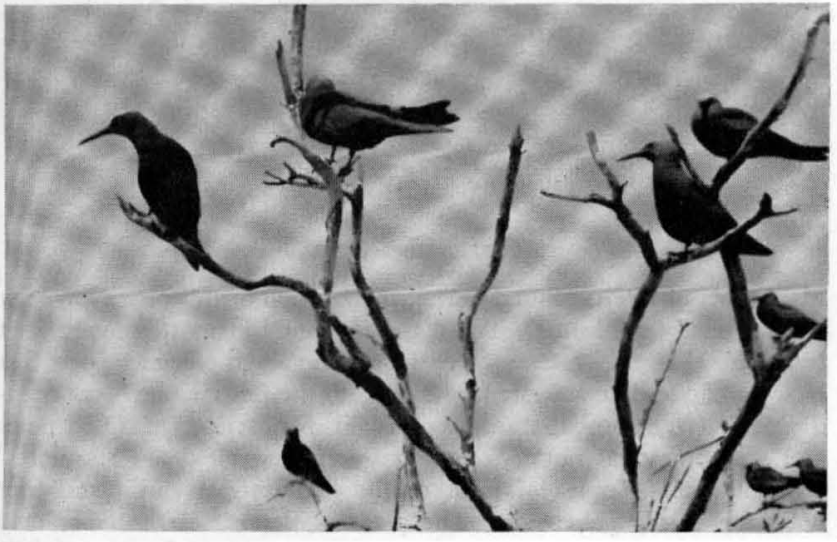

FIGURE 11. Black Noddy (upper left) and Brown Noddies, Bush Key, Dry Tortugas, 7 July 1962. (Photograph by Nagahisa Kuroda.)

old bay cedars growing amid thick beds of *Opuntia* cactus—was impossible in the time available.

The bird we banded some 7 weeks later in September we netted on the shore near the same area. The bird was coming into the ternery, and while being handled disgorged a rounded food mass about 40 mm in diameter, the compacted remains of a large number of tiny minnows. The Brown Noddies at the time were still feeding a few large young in or near the nests.

Therefore while we strongly suspect and would like to believe that the Black Noddy has been nesting at Dry Tortugas, we have not as yet been able to prove it.

FIGURE 12. Close-up of the head of the first Black Noddy banded at Dry Tortugas, Bush Key, 13 July 1962. (Photograph by James B. Meade.)

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Doe, Charles E.

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1911 MS. Warden's annual report, Bird Key, Dry Tortugas. National Audubon Society files, New York.

1912 MS. Warden's annual report, Bird Key Dry Tortugas. National Audubon Society files, New York.

1913 MS. Warden's annual report, Bird Key, Dry Tortugas, National Audubon Society files, New York.

1914 MS. Warden's annual report, Bird Key, Dry Tortugas. National Audubon Society files, New York. [All information about the reports of John Peacon is from notes made for me by Robert P. Allen. I have seen none of the original reports.]

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mate the population of Sooties. Ashe reported that terns suffered heavy mortality as a result of the hurricanes of 13 August and 5 September 1915. This ms. appears to be copy prepared by Pearson for publication in Bird-Lore, but only a brief excerpt from it was published.]

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1940. 1940 Tortugas expedition. Florida Naturalist, 14: 1-6.

Russell, Jack C.

1938 MS. Narrative report on wildlife of Fort Jefferson National Monument. National Park Service files. Typewritten, 39 pp. [Dated 24 February 1938. Report of observations made during the author's employment as a student wildlife technician, 10 June-15 September 1937, with notes from earlier visits in 1935 and 1936. The first 24 pages deal chiefly with birds; the remainder with marine life, principally mollusks. Discusses all nesting terns in detail.]

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1948*b*. The tern colonies of the Dry Tortugas Keys. Auk, 65: 1-19.

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Stevenson, James O.

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Vinten, C. R.

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1908. The behavior of Noddy and Sooty Terns. Carnegie Inst. Washington, Papers from the Tortugas Laboratory, 2: 187-255.

1910. Further data on the homing sense of Noddy and Sooty Terns. Science, 32 (n.s.): 470-473.

1912 MS. Special report Tortugas Reservation. National Audubon Society files, New York. [States that he visited Bird Key too late in the season to make accurate population estimates (Carnegie Inst. Washington, Yearbook for 1912 (No. 11): 125, however, gives the dates of Watson's 1912 work in the area as 6 June-12 July). Recommends planting of "large quantities" of bay cedar on Bird Key to repair damage done to vegetation by the hurricane of 1910. From notes by Robert P. Allen. I have not seen the original.]

Watson, John B., and K. S. Lashley

1915. An historical and experimental study of homing. Carnegie Inst. Washington, Papers from the Tortugas Laboratory, 7: 7-60.

Worth, C. Brooke

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CATALOGUE OF FOSSIL BIRDS

Part 1 (Archaeopterygiformes through Ardeiformes)

PIERCE BRODKORB[1]

SYNOPSIS: The first installment of a catalogue of the fossil birds of the world covers 49 families in 15 orders of birds, or nearly half of the orders and about one-fourth of the families known. The species treated number 374, of which 273 are extinct, and 101 represent living species recorded from fossil or prehistoric sites. For the paleospecies the data include citation of the original description, synonyms, nature and repository of types, reference to pertinent revisionary papers, and detailed geological and geographic ranges, with bibliographic reference to their occurrence.

Major taxonomic changes include recognition of three subclasses, Sauriurae for *Archaeopteryx*, Odontoholcae for the Hesperornithidae, and Ornithurae for the remaining birds. Three infraclasses of Ornithurae are recognized, Dromaeognathae (for the Tinamidae), Ratitae, and Carinatae.

Changes in position include transfer of the family Opisthodactylidae to the Rheiformes, Enaliornithidae to the Gaviiformes, and Baptornithidae to the Podicipediformes.

On priority the ordinal name Ciconiiformes yields to Ardeiformes. Prior family names adopted include Emeidae for Anomalopterygidae, Oceanitidae for Hydrobatidae, and Plataleidae for Threskiornithidae.

New taxa proposed are Colymboidinae (new subfamily, Gaviidae), *Cayetanornis* (new genus, Tinamidae), and *Palaeeudyptes marplesi* (new species, Spheniscidae). The misprinted name Pelagodornithidae is emended to Plegadornithidae, to conform with the spelling of the type-genus.

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[1]The author is Professor of Biological Sciences at the University of Florida, Gainesville. Manuscript received 28 January 1963.—ED.

TABLE OF CONTENTS

INTRODUCTION

Our knowledge of fossil birds has increased greatly during the thirty-year interval since the publication of Lambrecht's *Handbuch der Palaeornithologie* in 1933. Re-evaluation of the classical forms and the discovery of new Mesozoic material afford an entirely different perspective of the earliest birds: We now believe that the theory of the toothed birds was mostly fictitious; we realize that a number of modern orders existed during the Age of Reptiles; and we may even hint at a possible polyphyletic origin of the class Aves. Discovery of more than a dozen new families gives greater breadth and depth to our understanding of the evolution of birds. New collecting techniques have resulted in an increase of the known fossil species by more than a third and the filling in of the fossil record of many living species. It therefore seems time to bring the list of fossil birds of the world up to date.

The classification adopted here is, with modifications, that of Wetmore (1960, Smithsonian misc. Coll., vol. 139, no. 11, pp. 1-37), which has many advantages over the several other recent attempts to classify birds. Its many editions have benefited from the author's rich experience with both living and fossil birds, whereas for some strange reason other systems totally ignore the fossil record. The use of uniform endings for order-group taxa and their formation from valid generic names are useful mnemonics, unfortunately abandoned by certain other authors. And the recognition of intermediate, non-mandatory taxa is helpful in suggesting relationships.

In matters of nomenclature I attempt to follow the International Code of Zoological Nomenclature adopted by the XV International Congress of Zoology (London, 1961), not without certain misgivings, however. The new edition of the Code for the first time sets up rules to cover family-group names, but unfortunately these do not all quite follow the same principles that govern genus-group and species-group names. Exercise of the Commission's plenary powers in suspending the rules at its discretion, the establishment of different effective dates for an increasing number of rules, and the numerous lists of "nomina conservanda" impose a seemingly greater bibliographic and legalistic chore than would the rigid application of the law of priority.

Abbreviation of serial publications follows Romer, Wright, Edinger, and Van Frank (1962, Bibliography of fossil vertebrates exclusive of North America, 1509-1927, Geological Society of America, Memoir 87). Sources not listed in Romer *et al.* are given in full when first cited and abbreviated thereafter.

The catalogue includes all higher taxa of birds. Families with no fossil record are included with appropriate notation, to emphasize gaps in our knowledge. Bibliographic reference is given to the apparent first valid publication of names employed for order-group and family-group taxa; such data are not otherwise summarized in ornithological works of the last hundred years. Complete principal synonymies are included only where necessary to substantiate change from current usage. Above the level of the species, daggers in the headings differentiate paleotaxa from neotaxa. Insofar as compatible with phylogenetic considerations, the arrangement of taxa follows geological sequence.

The catalogue admits paleospecies when validly described on diagnostic parts of the skeleton. Unless later corroborated by identifiable bones, species founded upon indeterminate elements, eggshells, feather impressions, footprints, or other unsatisfactory evidence are relegated to the category of Incertae Sedis. These will be listed at the end of the catalogue, as will nomina nuda and non-avian forms originally described as birds.

The coverage under the fossil species includes reference to the original description, synonyms, nature of holotypes and museum where preserved, and reference to certain revisionary work. Distributional data include details of the geological horizon and geographic range, with bibliographic references to such occurrences. Paleospecies are numbered consecutively within a family.

Each family concludes with a list of its living species known as fossils, with bibliographic citation to their geographic occurrence as fossils. Localities from prehistoric deposits (marked with asterisks) are incorporated insofar as they have come to my attention, although a thorough search of the anthropological literature was not made. Neospecies are numbered separately within each family.

Much difference of opinion exists regarding the boundaries of geological time units. For this reason I have stressed formations or other rock units, rather than so-called provincial faunal ages. Upon completion of the catalogue a correlation chart is planned.

The National Science Foundation aided preparation of the catalogue through grant number G19595. Hildegarde Howard of Los Angeles was good enough to read the bulk of the manuscript, and Elliot W. Dawson of Wellington, New Zealand, kindly criticized the section on the moas. Throughout this work I have benefited greatly through repeated discussion with Alexander Wetmore of the United States National Museum. Extensive correspondence with James Fisher of London has proved most useful. Others who have been helpful in

providing specimens or information include Oscar Arredondo, Habana, Cuba; Walter Auffenberg, Boulder, Colorado; Oliver L. Austin, Jr., Gainesville, Florida; Ripley P. Bullen, Gainesville; William A. Clemens, Jr., Lawrence, Kansas; Walter W. Dalquest, Wichita Falls, Texas; Georges Dementiev, Moscow, USSR; J. C. Dickinson, Jr., Gainesville; A. Gordon Edmund, Toronto, Canada; J. S. Erskine, Wolfville, Nova Scotia; Richard Estes, Boston, Massachusetts; W. D. Frankforter, Grand Rapids, Michigan; Joseph T. Gregory, Berkeley, California; J. Hill Hamon, Terre Haute, Indiana; Claude W. Hibbard, Ann Arbor, Michigan; J. Alan Holman, Normal, Illinois; Marie L. Hopkins, Pocatello, Idaho; Philip S. Humphrey, Washington, D. C.; H. G. Kugler, Basel, Switzerland; John F. Lance, Tucson, Arizona; John J. McCoy, Jacksonville, Florida; Alden H. Miller, Berkeley; Loye Miller, Davis, California; Rachel H. Nichols, New York, New York; Stanley J. Olsen, Tallahassee, Florida; Bryan Patterson, Cambridge, Massachusetts; Clayton E. Ray, Gainesville; Donald E. Savage, Berkeley; J. Arnold Shotwell, Eugene, Oregon; Elwyn L. Simons, New Haven, Connecticut; George Gaylord Simpson, Cambridge, Massachusetts; Bob H. Slaughter, Dallas, Texas; R. A. Stirton, Berkeley; Robert W. Storer, Ann Arbor; Dwight W. Taylor, Washington; Richard H. Tedford, Riverside, California; Harrison B. Tordoff, Ann Arbor; William D. Turnbull, Chicago, Illinois; Robert D. Weigel, Normal; Druid Wilson, Washington; John A. Wilson, Austin, Texas; Robert W. Wilson, Rapid City, South Dakota; Elizabeth S. Wing, Gainesville; and David B. Wingate, Hamilton, Bermuda.

The present installment covers the orders Archaeopterygiformes through Ardeiformes, exclusive of the Ichthyornithiformes, which will be treated later. The two or three further installments needed to complete the work will, it is hoped, appear at frequent intervals. The literature of avian paleontology is so scattered that it is difficult to avoid overlooking important papers. Therefore authors are urged to send additions and corrections for inclusion in a supplement to be published on conclusion of the work.

Class AVES Linnaeus

Aves Linnaeus, Systema Naturae, ed. 10, vol. 1, pp. 12, 78 (classis).

Subclass †SAURIURAE Haeckel

Sauriurae Haeckel, 1866, Generelle Morphologie der Organismen, vol. 2, p. cxxxix (Subklasse).—*Saururi* Vogt, 1879, Rev. sci. (Paris), vol. 17, p. 247.—*Saururae* Stejneger, 1885, Stand. nat. Hist., vol. 4, p. 21 (sub-class).—*Saurura* Steinmann, 1907, Einführung in die Paläontologie, ed. 2, p. 460 (Unterklasse).

Archaeornithes Gadow, 1893, Bronn Klass. Ordn., Vögel, pt. 2, pp. 86, 299 (Unterclasse).

Order †ARCHAEOPTERYGIFORMES Fürbringer

Saururae Huxley, 1867, Proc. zool. Soc. London, p. 418 (order, ex subclass *Sauriurae* Haeckel; not based on generic name).—Cope, 1889, Amer. Natural., vol. 23, p. 869 (superorder).—*Saurura* Steinmann and Döderlein, 1890, Elemente der Paläontologie, p. 668 (Ordnung).

Ornithopappi Stejneger, 1885, Stand. nat. Hist., vol. 4, p. 21 (order; not based on generic name).

Archornithes Fürbringer, 1888, Untersuchungen zur Morphologie und Systematik der Vögel, vol. 2, p. 1565 (ordo; not based on generic name).—*Archornithiformes* Shufeldt, 1903, Amer. Natural., vol. 37, no. 433, p. 34 (supersuborder).

Archaeopterygiformes Fürbringer, 1888, op. cit., p. 1565 (subordo; type *Archaeopteryx* Meyer).—*Archaeopteryges* Fürbringer, 1888, op. cit., p. 1565 ("gens," between suborder and superfamily).—Sharpe, 1891, Review of Recent Attempts to Classify Birds, p. 67 (order).—*Archaeopterygomorphi* Hay, 1930, Publ. Carnegie Instn. Washington, no. 390, vol. 2, p. 276 (order).

Saurornithes Beddard, 1898, Structure and Classification of Birds, p. 529 (order; not based on generic name).

Family †ARCHAEOPTERYGIDAE Huxley

Archaeopterygidae Huxley, 1872, Manual of the Anatomy of Vertebrated Animals, p. 233 (type *Archaeopteryx* Meyer).—*Archaeopteridae* Shufeldt, 1903, Amer. Natural., vol. 37, no. 433, p. 34.

Archornithidae Carus, 1875, Handbuch der Zoologie, vol. 1, p. 368 (not based on generic name).

Archaeornithidae Petronievics, 1925, Geol. An. balkan. Poluos., vol. 18, p. 67 (type *Archaeornis* Petronievics).

Genus †*Archaeopteryx* Meyer

Archaeopteryx H. von Meyer, 1861 (after Sept. 30), Neues Jahrb. Min. Geol. Pal., p. 679 (type by monotypy *Archaeopteryx lithographica* Meyer).

Archaeopterix Anonymous, 1861, Neues Jahrb. Min. Geol. Pal., p. v (lapsus or emendation).

Archeopteryx Owen, 1864, Philos. Trans. Roy. Soc. London for 1863, vol. 153, p. 33 footnote (emendation or lapsus).

Griphosaurus A. Wagner, 1861 (after Nov. 9), Sitz.-Ber. bayer. Akad. Wiss., vol. 2, p. 153 (type by monotypy *Griphosaurus problematicus* Wagner).

Gryphosaurus "A. Wagner," Marschall, 1873, Nomenclator Zoologicus, p. 49 (lapsus).

Griphornis "Owen, 1862, Rev. Nat. Hist., p. 313," H. Woodward, 1962 (Dec.), Intellectual Observer, vol. 2, no. 5, p. 317 (new name for *Griphosaurus*).

Gryphornis "Owen, 1862, p. 313," Lambrecht, 1933, Handbuch der Palaeornithologie, p. 80 (lapsus).

Archaeornis Petronievics, 1917 (Apr. 20), Proc. zool. Soc. London, pt. 1, p. 5 footnote (type by monotypy *Archaeopteryx siemensii* Dames).

1. *Archaeopteryx lithographica* Meyer

Archaeopteryx lithographica H. von Meyer, 1861 (after Sept. 30), Neues Jahrb. Min. Geol. Pal., p. 679 (type from Kohler's cut, feather impression in Berlin Mus., reverse in Munich Mus.).

Griphosaurus problematicus A. Wagner, 1861 (after Nov. 9), Sitz.-Ber. bayer. Akad. Wiss., vol. 2, p. 146 (type skeleton from Ottman's cut, Brit. Mus. no. 37001).

Griphosaurus longicaudatus Owen, 1862, Rev. Nat. Hist., p. 313 (new name for *Griphosaurus problematicus* Wagner).

Archeopteryx macrura Owen, 1864, Philos. Trans. Roy. Soc. London for 1863, vol. 153, p. 33 note, pl. 1-4 (new name for *Griphornis longicaudatus* Owen).

Archaeopteryx macroura Kleinschmidt, 1951, Proc. X. internat. orn. Congress, p. 631 (emendation or lapsus).

Archaeopteryx oweni Petronievics, 1917, Proc. zool. Soc. London, p. 5 (new name for *Archeopteryx macrura* Owen).

UPPER JURASSIC, PORTLANDIAN (Solnhofener Plattenkalk). BAVARIA: Kohler's cut in community quarry at Solnhofen (Meyer, 1861); Ottman's cut (Wagner, 1861) and Opitsch's quarry (Heller, 1959, Erlanger geologische Abhandlungen, vol. 31, p. 9) at Langenaltheimer Haardt near Pappenheim.

2. *Archaeopteryx siemensii* Dames

Archaeopteryx siemensii Dames, 1897 (Aug. 9), Sitz.-Ber. Akad. Wiss. Berlin, vol. 38, p. 829 [p. 12 of separate], fig. 1-2 (type skeleton from Dorr cut, Berlin Mus.).

UPPER JURASSIC, PORTLANDIAN (Solnhofener Plattenkalk). BAVARIA: Dorr cut at Blumberg near Eichstatt.[1]

[1]As pointed out by Wetmore (1960, Smithsonian misc. Coll., vol. 139, no. 11. pp. 1-3), the arguments for specific identity with *A. lithographica* are not wholly convincing.

Subclass †ODONTOHOLCAE Stejneger

Odontoholcae Stejneger, 1885, Stand. nat. Hist., vol. 4, p. 27 (subclass, ex order *Odontolcae* Marsh; type *Hesperornis* Marsh).

Order †HESPERORNITHIFORMES (Fürbringer)

Odontolcae Marsh, 1875, Amer. Jour. Sci., ser. 3, vol. 10, p. 407 (order; type *Hesperornis* Marsh).

Odontolgae Forbes, 1884, Ibis, ser. 5, vol. 2, no. 5, p. 119 (order).

Odontornithes Forbes, 1884, Ibis, ser. 5, vol. 2, no. 5, p. 119 (superorder for *Archaeopteryx*, *Hesperornis*, and *Ichthyornis*).

Dromaeopappi Stejneger, 1885, Stand. nat. Hist., vol. 4, p. 27 (order; type *Hesperornis* Marsh).

Hesperornithes Fürbringer, 1888, Untersuch. Morph. Syst. Vögel, vol. 2, pp. 1165, 1438, 1541 ("gens;" type *Hesperornis* Marsh).—*Hesperornithiformes* Sharpe, 1899, Hand-list of the Genera and Species of Birds, vol. 1, p. 116 (order).—*Hesperornithomorphi* Hay, 1930, Publ. Carnegie Instn. Washington, no. 390, vol. 2, p. 277 (order).

Odontognathae Wetmore, 1930, Proc. U. S. nat. Mus., vol. 76, art. 24, p. 1 (superorder for Hesperornithiformes and Ichthyornithiformes).

Family †HESPERORNITHIDAE Marsh

Hesperornidae Marsh, 1872, Amer. Jour. Sci., ser. 3, vol. 3, p. 363 (type *Hesperornis* Marsh).—*Hesperornithidae* Marsh, 1876, Amer. Jour. Sci., ser. 3, vol. 11, p. 509.—*Hesperornithoidea* Shufeldt, Amer. Natural., vol. 37, no. 433, p. 59 (superfamily).

Genus †*Hesperornis* Marsh

Hesperornis Marsh, 1872, Amer. Jour. Sci., ser. 3, vol. 3, p. 57 (nomen nudum); p. 360 (type by monotypy *Hesperornis regalis* Marsh).

Lestornis Marsh, 1876, Amer. Jour. Sci., ser. 3, vol. 11, p. 509 (type by monotypy *Lestornis crassipes* Marsh).

Hargeria Lucas, 1903, Proc. U. S. nat. Mus., vol. 26, p. 552 (type by monotypy *Hesperornis gracilis* Marsh).

1. *Hesperornis regalis* Marsh

Hesperornis regalis Marsh, 1872, Amer. Jour. Sci., ser. 3, vol. 3, p. 57 (nomen nudum); p. 360 (lectotype from 20 miles east of Wallace, partial skeleton, Yale Peabody Mus. no. 1200, designated by Marsh, 1880).

UPPER CRETACEOUS, CONIACIAN (Niobrara formation, Smoky Hill chalk member). KANSAS: Logan County: south bank of Smoky Hill River, 20 miles east of Wallace (Marsh, 1872, l.c.); Smoky Hill River, 12 miles east of Wallace (Marsh, 1880, Odontornithes, p. 195); Two Mile Creek (Wetmore, 1940, Smiths. Misc. Coll., vol. 99, no. 4, p. 3).

2. *Hesperornis crassipes* (Marsh)

Lestornis crassipes Marsh, 1876, Amer. Jour. Sci., vol. 11, p. 509 (type from western Kansas, incomplete postcranial skeleton, Yale Peabody Mus. no. 1474).

UPPER CRETACEOUS, CONIACIAN (Niobrara formation, Smoky Hill chalk member). KANSAS: probably from Smoky Hill River in Wallace County, as the type was collected by G. P. Cooper in April 1876.

3. *Hesperornis gracilis* Marsh

Hesperornis gracilis Marsh, 1876, Amer. Jour. Sci., ser. 3, vol. 11, p. 510 (type left tarsometatarsus, Yale Peabody Mus. no. 1478).

UPPER CRETACEOUS, CONIACIAN (Niobrara formation, Smoky Hill chalk member). KANSAS: Smoky Hill River (probably in Wallace County, as the type was collected by G. P. Cooper in April 1876).

Genus †*Coniornis* Marsh

Coniornis Marsh, 1893 (Jan.), Amer. Jour. Sci., ser. 3, vol. 45, no. 265, p. 82. (type by monotypy *Coniornis altus* Marsh).

4. *Coniornis altus* Marsh

Coniornis altus Marsh, 1893 (Jan.), Amer. Jour. Sci., ser. 3, vol. 45, no. 265, p. 82, fig. 1-3 (type distal half of right tibiotarsus, Yale Peabody Mus. no. 515).
Hesperornis montana Shufeldt, 1915 (June), Auk, vol. 32, no. 3, p. 293, pl. 18, fig. 4, 6, 8, 10, 12 (type 23d vertebra, U. S. Nat. Mus. no. 8199).[1]

UPPER CRETACEOUS, CAMPANIAN (upper part of Claggett formation). MONTANA: Fergus County: 1 mile above mouth of Dog Creek, near mouth of Judith River.

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[1]The two names are based on elements of comparable size from the same horizon and locality. The supposition that the type locality of *C. altus* lay near the base of the fresh-water Judith River formation rather than in the underlying marine Claggett formation resulted in part from early usage of the term "Judith River beds" in a general sense to include all the later-named Cretaceous formations in the area. Marsh stated that the type was collected with marine fossils.

Subclass ORNITHURAE Haeckel

Ornithurae Haeckel, 1866, Generelle Morphologie der Organismen, vol. 2, p. 139 (Subklasse).

Odontornithes Marsh, 1873, Amer. Jour. Sci., ser. 3, vol. 5, pp. 161, 162 (subclass; type *Ichthyornis* Marsh).

Odontormae Stejneger, 1885, Stand. nat. Hist., vol. 4, p. 23 (sub-class for *Ichthyornis*).—*Odontotormae* Menzbier, 1887, Bull. Soc. Natural. Moscou, no. 2, p. 63 (Unterclasse, ex order *Odontotormae* Marsh).

Neornithes Gadow, 1893, Bronn Klass. Ordn., Vögel, pt. 2, pp. 90, 299 (Unterclasse).[1]

Infraclass DROMAEOGNATHAE Huxley[2]

Dromaeognathae Huxley, 1867, Proc. zool. Soc. London, p. 456 (suborder; not based on generic name).

Order TINAMIFORMES (Huxley)

Tinamomorphae Huxley, 1872, Manual Anatomy Vertebrated Animals, p. 234 (suborder?; type *Tinamus* Hermann).

Crypturi Sclater and Salvin, 1872, Nomenclator Avium Neotropicalium, p. 152 (type *Crypturus* Illiger, a junior synonym of *Tinamus* Hermann).

Family TINAMIDAE Gray

Crypturidae Bonaparte, 1831, Saggio di una Distribuzione Metodica degli Animali Vertebrati, p. 53 (type *Crypturus* Illiger, a junior synonym of *Tinamus* Hermann).

Tinamidae G. R. Gray, 1840, List Genera Birds, p. 63 (type *Tinamus* Hermann).

Genus †*Tinamisornis* Rovereto

Tinamisornis Rovereto, 1914, An. Mus. nac. Buenos Aires, vol. 25, p. 161 (type *Tinamisornis intermedius* Rovereto, designated by Richmond, 1927, Proc. U. S. nat. Mus., vol. 70, no. 2664, p. 35; *Tinamisornis parvulus* Rovereto was designated by Brodkorb, 1961, Auk, vol. 78, p. 257, in oversight of Richmond's action).

Roveretornis Brodkorb, 1961, Auk, vol. 78, no. 2, p. 257 (type by original designation *Tinamisornis intermedius* Rovereto).

1. *Tinamisornis intermedius* Rovereto

Tinamisornis intermedius Rovereto, 1914, An. Mus. nac. Buenos Aires, vol. 25, pp. 161, 162, pl. 25, fig. 2-2c only (lectotype from Monte Hermoso, left humerus, Buenos Aires Mus., designated by Brodkorb, 1961).

UPPER PLIOCENE (Monte Hermoso formation). ARGENTINA: Prov. Buenos Aires: Monte Hermoso.

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[1]About 36 other subclass names have been proposed for various groups of living birds.

[2]New rank.

Genus †*Cayetanornis* Brodkorb[1]

2. *Cayetanornis parvulus* (Rovereto)

Tinamisornis parvulus Rovereto, An. Mus. nac. Buenos Aires, vol. 25, pp. 161-162, pl. 25, fig. 3-3c (lectotype right humerus, Buenos Aires Mus., designated by Brodkorb, 1961).

UPPER PLIOCENE (Monte Hermoso formation). ARGENTINA: Prov. Buenos Aires: Monte Hermoso.

Genus †*Querandiornis* Rusconi

Querandiornis Rusconi, 1958, Rev. Mus. Hist. nat. Mendoza, vol. 11, nos. 1-4, p. 157 (type by monotypy *Querandiornis romani* Rusconi).

3. *Querandiornis romani* Rusconi

Querandiornis romani Rusconi, 1958, Rev. Mus. Hist. nat. Mendoza, vol. 11, nos. 1-4, p. 157.

UPPER PLIOCENE (Monte Hermoso formation). ARGENTINA: Prov. Buenos Aires: Monte Hermoso.

Genus *Nothura* Wagler

Nothura Wagler, 1827, Systema avium, vol. 1, folio 19 (type *Tinamus boraquira* Spix).

4. *Nothura paludosa* Mercerat

Nothura paludosa Mercerat, 1897, An. Soc. cien. argentina, vol. 43, p. 239 (type femur, La Plata Mus.).

UPPER PLEISTOCENE (Pampas formation). ARGENTINA: Prov. Buenos Aires: Arrecifes.

Neospecies of Tinamidae from Pleistocene sites:

1. *Tinamus major* (Gmelin). BRAZIL: Minas Geraes: Lapa da Escrivania near Lagoa Santa (O. Winge, 1887, E Mus. Lund., vol. 1, no. 2, p. 16).
2. *Crypturellus obsoletus* (Temminck). BRAZIL: Minas Geraes: Lapa do Bahu, Lapa do Capão Secco, Lapa da Escrivania, Lapa do Marinho, and Lapa do Taquaral (Winge, op. cit., p. 16).
3. *Crypturellus noctivagus* (Wied). BRAZIL: Lapa da Escrivania (Winge, op. cit., p. 16).
4. *Crypturellus parvirostris* (Wagler). BRAZIL: Lapa da Escrivania (Winge, op. cit., p. 17).
5. *Crypturellus tataupa* (Temminck). BRAZIL: Lapa da Escrivania, Lapa do Marinho, and Lapa do Capão Secco (Winge, op. cit., p. 16).

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[1]New genus. Type *Tinamisornis parvulus* Rovereto. For characters see Brodkorb (1961, Auk, vol. 78, p. 257). Named for Cayetano Rovereto.

6. *Rhynchotus rufescens* (Temminck). BRAZIL: Lapa da Escrivania and Lapa da Lagoa do Sumidouro (Winge, op. cit., p. 18).

7. *Nothoprocta cinerascens* (Burmeister). ARGENTINA: Buenos Aires: Luján (Ameghino, 1891, Rev. argentina Hist. nat., vol. 1, p. 446).

8. *Nothura maculosa* (Temminck). BRAZIL: Lapa da Escrivania and Lapa da Lagoa do Sumidouro (Winge, op. cit., p. 17). ARGENTINA: Luján (Ameghino, op. cit., p. 446).

9. *Nothura minor* (Spix). BRAZIL: Lapa da Escrivania (Winge, op. cit., p. 17).

10. *Taoniscus nanus* (Temminck). BRAZIL: Lapa da Escrivania (Winge, op. cit., p. 17).

Infraclass RATITAE Merrem[1]

Aves Ratitae Merrem, 1813, Abh. Akad. Wiss. Berlin, p. 259.
Palaeognathae Pycraft, Trans. zool. Soc. London, vol. 15, p. 149.—*Palaegnathae* Wetmore, 1930, Proc. U. S. nat. Mus., vol. 76, art. 24, p. 2 (superorder).

Order STRUTHIONIFORMES (Latham)

Struthiones Latham, 1790, Index ornitholgicus, pp. xv, 662 (type *Struthio* Linnaeus).—*Struthioniformes* Fürbringer, 1888, Untersuch. Morph. Syst. Vögel, vol. 2, pp. 1540, 1565 (subordo).

Family †ELEUTHERORNITHIDAE Wetmore

Eleutherornithidae Wetmore, 1951 (Nov. 1), Smithsonian misc. Coll., vol. 117, no. 4, pp. 3, 14 (type *Eleutherornis* Schaub).

Genus †*Eleutherornis* Schaub

Eleutherornis Schaub, 1940, Eclogae geol. Helvetiae, vol. 33, no. 2, p. 283 (type by monotypy *Eleutherornis helveticus* Schaub).

1. *Eleutherornis helveticus* Schaub

Eleutherornis helveticus Schaub, 1940, Eclogae geol. Helvetiae, vol. 33, no. 2, p. 283, fig. 1-4 (type pelvis from Bohnerz, Basel Mus. no. Eh 781).

LOWER MIDDLE EOCENE (Egerkingen gamma). SWITZERLAND: Bohnerz.

Family STRUTHIONIDAE Vigors

Struthionidae Vigors, 1825, Trans. Linn. Soc. London, vol. 14, pp. 478, 480 (type *Struthio* Linnaeus).

Genus *Struthio* Linnaeus

Struthio Linnaeus, 1758, Syst. Nat., ed. 10, vol. 1, p. 155 (type *Struthio camelus* Linnaeus, Recent).
Struthiolithus Brandt, 1873, Bull. Acad. Sci. St. Petersburg, vol. 18, p. 158 (type by monotypy *Struthiolithus chersonensis* Brandt).
Megaloscelornis Lydekker, 1879, Rec. geol. Surv. India, vol. 12, p. 53 (type by monotypy *Megaloscelornis sivalensis* Lydekker).
Palaeostruthio Burchak-Abramovich, 1953, Akad. Nauk Azerbaidzhanskoi S.S.R., p. 81 (type by original designation *Palaeostruthio sternatus* Burchak-Abramovich).
Pachystruthio Kretzoi, 1953, Acta geologica, vol. 2, pp. 231-242 (subgenus; type by monotypy *Struthio* (*Pachystruthio*) *pannonicus* Kretzoi).

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[1]New rank. Whether the ratites form a natural group is still a far from settled question, and it is likely to remain unanswered until their origins can be traced in the fossil record. Both ratites and carinates could have arisen from a tinamou-like stock.

1. *Struthio asiaticus* Milne-Edwards

Struthio palaeindica Falconer, 1868, Palaeontological Memoirs, vol. 1, pp. xxi, 554 (nomen nudum; 15 elements from Siwalik Hills listed, with Brit. Mus. cat. nos., from unpublished Plate R).

Struthio asiaticus Milne-Edwards, 1871, Oiseaux Foss. France, vol. 2, sheet 74, p. 587 (brief description; type tarsometatarsus from Siwalik Hills, Brit. Mus.).

Megaloscelornis sivalensis Lydekker, 1879, Rec. geol. Surv. India, vol. 12, p. 56, part (types from Siwalik Hills, tibiotarsus and fibula, Indian Mus., Calcutta, casts in Brit. Mus.).

Struthio indicus Bidwell, 1904, Ibis, ser. 9, vol. 4, p. 760, fig. 7 (types from Nullas, 7 eggshell fragments, Brit. Mus., Tring Mus., and Calcutta Mus.).

LOWER PLIOCENE (Siwalik series). INDIA: UNITED PROVINCES: Siwalik Hills, probably near Hardwar (Falconer, 1868); Nullas on Ken River in Banda district (Bidwell, 1904).

2. *Struthio chersonensis* (Brandt)[1]

Struthiolithus chersonensis Brandt, 1873, Bull. Acad. Sci. St. Petersburg, vol. 18, p. 158 (type egg from Malinovka destroyed, cast said to be in St. Petersburg Acad. Sci.).

Struthio karatheodoris Forsyth Major, 1888, C. R. Acad. Sci. Paris, vol. 107, p. 1178 (type from Samos, femur, Barbey coll., Valleyres).

Struthio novorossicus Alexejew, 1916, Animaux fossiles du village Novo-Elisavetovka, p. 388, fig. 55-56 (types from Novo-Elisavetovka, distal portions of 3 tarsometatarsi, Novorossyisk Univ. nos. 1559-1561).

Struthio brachydactylus Burchak-Abramovich, 1939, Priroda, no. 5, p. 95; redescribed 1949, Doklady Akad. Nauk SSSR, vol. 67, no. 1, p. 14, fig. 1-4 (type from Grebeniki, skeleton lacking sternum, wings, and sacrum, Acad. Sci. Moscow).

Palaeostruthio sternatus Burchak-Abramovich, 1953, Akad. Nauk Azerbaidzhanskoi SSSR, p. 81, pl. 18, fig. 1 (type from Grebeniki, sternum, Acad. Sci. Moscow no. 408/367).

LOWER PLIOCENE (Pannonian). GREECE: Samos Island (Forsyth-Major, 1888). UKRAINE: Malinovka near Kherson (Brandt, 1873); Kuyalnik estuary near Odessa, Vyshiva (Novo-Pokrovsk), and Novo-Elisavetovka (Alexejew, 1916); Grebeniki (Burchak-Abramovich, 1939). KAZAKSTAN: Pavlodar (Howard, 1939, Fortschr. Pal. vol. 2, p. 313). Probably referable here are specifically undetermined records from Maragheh in Iran and from Garet-el-Muluk, Egypt (Lambrecht, 1933, Handb. Palaeorn., pp. 103-104).

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[1]That more than one species of ostrich existed during the early Pliocene has not been proved.

3. *Struthio wimani* Lowe

Struthio wimani Lowe, 1931, Pal. sinica, ser. C, vol. 6, fasc. 4, p. 18, pl. 1, fig. 1; pl. 2, fig. 2; pl. 3; pl. 4, fig. 1, 4 (type from Locality 30, T'ai Chia Kou, pelvis, Palaeont. Mus., Upsala).

Struthio mongolicus Lowe, 1931, Pal. sinica, ser. C, vol. 6, fasc. 4, p. 34, pl. 4, fig. 5 (types eggshell fragments, Upsala Mus.; locality of type not stated, but figured specimen is from Olan Chorea).

LOWER PLIOCENE (*Hipparion* red clays). CHINA: Prov. Shansi: T'ai Chia Kou in Pao-te Hsien (Lowe, 1931); Hsiang-ning Hsien (Lambrecht, 1933, Handb. Palaeorn., p. 106). Prov. Kansu: Ching Yang Fu (Lambrecht, 1933).

LOWER PLIOCENE (Ertemte stage). MONGOLIA: Ertemte, Olan Chorea, Tjelgol-Tabool, and Doshen (Lowe, 1931); Choei Tong K'eou, Sjara Osso Gol, Hong-Tcheng, Shabarakh Ussu, Djadochta, and Hung Kurek (Lambrecht, 1933).

4. *Struthio pannonicus* Kretzoi

Struthio (*Pachystruthio*) *pannonicus* Kretzoi, 1953, Acta geologica, vol. 2, pp. 231-242, pl. 1-3 (type from Kisláng, right pedal phalanx 1 of digit III).

LOWER PLEISTOCENE (upper Calabrian). HUNGARY: Transdanubia: Kisláng.

5. *Struthio oldawayi* Lowe

Struthio oldawayi Lowe, 1933, Ibis, ser. 13, vol. 3, no. 4, pp. 652, 654 (type from Oldaway, pelvis and sacrum, apparently in Brit. Mus.).

LOWER PLEISTOCENE (Olduvai series, bed 1). TANGANYIKA: Olduvai (Oldaway).

6. *Struthio anderssoni* Lowe

Struthio anderssoni Lowe, 1931, Pal. sinica, ser. C, vol. 6, fasc. 4, p. 26, fig. 2 (type complete eggshell from Honan, Brit. Mus. no. A.1308; femora later recorded by Boule and Teilhard de Chardin, 1928; Howard, 1939).

UPPER PLEISTOCENE (Sanmen series, Fenho stage). CHINA: Prov. Hopeh: Yao Kuan Chuang; Ching Hsing coal mine; K'ou-An; Chou-k'ou-tien. Prov. Shantung: Sha-Wa-Tsun. Prov. Shansi: Tang-T'ai-Chuang; Liang-Chia T'an. Prov. Honan: K'iho on Wei River; Wu-An Hsien; Chengchow Hsien; Han Wanh Cheng in Ho Yin Hsien; SSu-shui Hsien; Chao Kon in Kung Hsien; Ts'ai Chia Chuang, Hsia Juo Yü, and Tung Huang Nü Yüan in Hsi An Honein; Feng Ming P'o, Kuo Yü Kou, and Yang Shao Tsun in Mien Chih Hsien (Lambrecht, 1933, Handb. Palaeorn., p. 104).

Neospecies of Struthionidae from Pleistocene and *prehistoric sites:

1. *Struthio camelus* Linnaeus. ALGERIA: Hassi-el Ratmaia in the Grand Erg and Mouilah-Maatalah (Lambrecht, 1933, Handb. Palaeorn., p. 108). ARABIA: Tuwairifa, 'Ain Sala, Umm al Qurun, Umm Tina, Qa'amiyat, Abu Sabbau, *Summan Mahadir, and *Bani Ma'aridh (Lowe, 1933, Ibis, p. 658). BURYAT-MONGOL REPUBLIC: Troitzkosavask, Selenga River, and Chorenchoi (Lambrecht, 1933, p. 107). OUTER MONGOLIA: Shabarakh Ussu and Djadochta (Lambrecht, 1933, p. 108).

Order RHEIFORMES (Forbes)

Rheae Forbes, 1884 (Jan.), Ibis, ser. 5, vol. 2, no. 5. p. 119 (type *Rhea* Brisson).—*Rheiformes* Fürbringer, 1888, Untersuch. Morph. Syst. Vögel, vol. 2, pp. 1540, 1565 (subordo).

Family †Opisthodactylidae Ameghino

Opisthodactylidae Ameghino, 1895, Bol. Inst. geog. argentino, vol. 15, p. 81 (type *Opisthodactylus* Ameghino).

Genus †*Opisthodactylus* Ameghino[1]

Opisthodactylus Ameghino, 1891 (Dec.), Rev. argentina Hist. nat., vol. 1, p. 453 (type by monotypy *Opisthodactylus patagonicus* Ameghino).

1. *Opisthodactylus patagonicus* Ameghino

Opisthodactylus patagonicus Ameghino, 1891 (Dec.), Rev. argentina Hist. nat., vol. 1, p. 453 (type distal portion of tarsometatarsus, Brit. Mus.).

Lower Eocene (Casamayor formation). Argentina: southern Patagonia.

Family Rheidae (Bonaparte)

Rheinae Bonaparte, 1853, C. R. Acad. Sci. Paris, vol. 37, no. 18, p. 646 (sous-famille; type *Rhea* Brisson).

Genus †*Heterorhea* Rovereto

Heterorhea Rovereto, 1914, An. Mus. nac. Buenos Aires, vol. 25, p. 160 (type by monotypy *Heterorhea dabbenei* Rovereto).

1. *Heterorhea dabbenei* Rovereto

Heterorhea dabbenei Rovereto, 1914, An. Mus. nac. Buenos Aires, vol. 25, p. 160, pl. 25, fig. 1 (type tarsometatarsus, Buenos Aires Mus.).

Upper Pliocene (Monte Hermoso formation). Argentina: Prov. Buenos Aires: Monte Hermoso.

Genus *Rhea* Brisson

Rhea Brisson, 1760, Ornithologia, vol. 1, p. 46 (type *Struthio americanus* Linnaeus, Recent).

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[1]Transferred from the Phororhacoidea to the rheas by Patterson and Kraglievich (1960, Publ. Mus. municipal Cien. nat. y trad. Mar del Plata, vol. 1, no. 1, p. 11) without any supporting evidence. The characters of the distal end of the tarsometatarsus mentioned by Ameghino, namely the concavity of the plantar surface above the trochleae and the facet for a hind toe, would preclude its reference to the Rheidae as currently understood.

2. *Rhea anchorenensis* C. Ameghino and Rusconi

Rhea americana anchorenense C. Ameghino and Rusconi, 1932, An. Soc. cien. argentina, vol. 114, p. 38, fig. 1 (type distal half of tarsometatarsus, Museo La Plata).

LOWER PLEISTOCENE (basal Enseñadan). ARGENTINA: Prov. Buenos Aires: Anchorena.

Genus *Pterocnemia* Gray

Pterocnemia Gray, 1871, Hand-list Birds Brit. Mus., vol. 3, p. 2 (type *Rhea pennata* d'Orbigny, Recent).

3. *Pterocnemia fossilis* (Ameghino)

Rhea fossilis F. Ameghino, 1882, Catalogue spécial de la Section anthropologique et paléontologique de la Républic Argentine, Exposition universelle de 1878, Group second, Classe huitème, p. 42 (type from Olivera, incomplete skeleton, Museo La Plata nos. 200-228).

Rhea pampeana Moreno and Mercerat, 1891, An. Mus. La Plata, Pal. arg., vol. 1, pp. 27, 70, pl. 19, fig. 1, 3-10, 13; pl. 20, fig. 1-4; pl. 21, fig. 1-4 (same type as *R. fossilis* Ameghino).

[?]*Rhea nana* Lydekker, 1894, Knowledge (London), vol. 17, p. 265 (type a runt egg of unknown age and locality).

UPPER PLEISTOCENE (Pampas formation, upper level). ARGENTINA: Prov. Buenos Aires: Olivera.

Neospecies of Rheidae from Pleistocene sites:

1. *Rhea americana* (Linnaeus). BRAZIL: Minas Geraes: Lapa de Anna Felicia, Lapa da Anta no. 1, and Lapa da Escrivania no. 1 (O. Winge, 1887, E Mus. Lund., vol. 1, no. 2, p. 18). ARGENTINA: Prov. Buenos Aires: Luján (Ameghino, 1891, Rev. arg. Hist. nat., vol. 1, p. 448); Mar del Plata (*Rhea fossilis* Moreno and Mercerat, 1891; see below).

Fossil synonyms of this species (fide Ameghino, 1891) include: *Rhea fossilis* Moreno and Mercerat, 1891, An. Mus. La Plata, Pal. arg., vol. 1, pp. 28, 71, pl. 19, fig. 2, 11, 16; pl. 20, fig. 2; pl. 21, fig. 6 (types from Mar del Plata, fragmentary right tibiotarsus, fragmentary right and left tarsometatarsi, Mus. La Plata nos. 229-233); *Rhea subpampeana* Moreno and Mercerat, 1891, op. cit., pp. 27, 70, pl. 20, fig. 22 (type right outer digital trochlea, Mus. La Plata no. 199, said to be from Laguna de Vitél, but both locality and age erroneous according to Ameghino).

Order CASUARIIFORMES (Sclater)

Casuarii Sclater, 1880, Ibis, ser. 4, vol. 4, no. 16, pp. 410, 411 (order; type *Casuarius* Linnaeus).—Casuariiformes Fürbringer, 1888, Untersuch. Morph. Syst. Vögel, vol. 2, pp. 1541, 1565 (subordo).

Family CASUARIIDAE Kaup

Casuariidae Kaup, 1847, fide Gray, 1870, Hand-list Gen. Sp. Birds, pt. 3, p. 2 (type *Casuarius* Linnaeus).

Genus *Casuarius* Brisson

Casuarius Brisson, 1760, Ornithologia, vol. 1, p. 46 (type *Struthio casuarius* Linnaeus, Recent).

1. *Casuarius lydekkeri* Rothschild

Casuarius lydekkeri Rothschild, 1911, Verh. V. internat. ornith. Kongr. Berlin 1910, pp. 151, 162 (type from Wellington Valley, distal part of right tibiotarsus, Australian Mus. no. MF 1268; cast Brit. Mus. no. A.158 = B.10394; see A. H. Miller, 1962, Rec. Austral. Mus., vol. 25, p. 235).

UPPER PLEISTOCENE (cave deposit). NEW SOUTH WALES: Wellington Valley.

Family DROMICEIIDAE Richmond

Dromaiinae Gray, 1870, Hand-list Gen. Sp. Birds, pt. 3, pp. v, 2 (subfamily; type *Dromaius* Vieillot, 1818, a junior synonym of *Dromiceius* Vieillot).

Dromaeidae A. Newton, 1896, Dictionary of Birds, p. 213 (type *"Dromaeus"* Vieillot).

Dromiceiidae Richmond, 1908, Proc. U. S. nat. Mus., vol. 35, no. 1656, pp. 598, 651 (type *Dromiceius* Vieillot).

Genus *Dromiceius* Vieillot

Dromiceius Vieillot, 1816, Analyse nouv. orn. élém., p. 54 (type *Casuarius novaehollandiae* Latham, Recent).

1. *Dromiceius patricius* (DeVis)

Dromaius patricius DeVis, 1888, Proc. Linn. Soc. N. S. Wales, ser. 2, vol. 3, p. 1290, pl. 36, fig. 13a-c (types from King's Creek, proximal and distal ends of right tibiotarsus, left coracoid, probably in Queensland Mus.).

UPPER PLEISTOCENE (Chinchilla beds). QUEENSLAND: King's Creek.

UPPER PLEISTOCENE (Katipiri sands, Malkuni fauna). SOUTH AUSTRALIA: Wurdulumankula near Lake Eyre (DeVis, 1906, Ann. Queensland Mus., no. 6, p. 25).

UPPER PLEISTOCENE (cave deposits). NEW SOUTH WALES: Wellington Valley (Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 352).

2. *Dromiceius gracilipes* (DeVis)

Dromaius gracilipes DeVis, 1892, Proc. Linn. Soc. N. S. Wales, ser. 2, vol. 6, p. 445, pl. 23, fig. 7 (type tarsometatarsus).

UPPER PLEISTOCENE (Chinchilla beds). QUEENSLAND.

3. *Dromiceius minor* (Spencer)

Dromaeus minor Spencer, 1906, Victoria Naturalist, vol. 23, p. 140 (type partial skeleton).
Dromaeus bassi Legge, 1907, Emu, vol. 6, p. 119.
Dromiceius spenceri Mathews, 1912, Novit. zool. (London), vol. 18, p. 176 footnote.

QUATERNARY. AUSTRALIA: King Island in Bass Strait.

Recently extinct species of Dromiceiidae from the Pleistocene:

1. *Dromiceius diemenianus* (Jennings). AUSTRALIA: Kangaroo Island (Lambrecht, 1933, Handb. Palaeorn., p. 114).

Family †DROMORNITHIDAE Fürbringer

Dromornithidae Fürbringer, 1888, Untersuch. Morph. Syst. Vögel, vol. 2, pp. 1435, 1565 (type *Dromornis* Owen).

Genus †*Dromornis* Owen

Dromornis Owen, 1872, Proc. zool. Soc. London, p. 682 (type by monotypy *Dromornis australis* Owen).

1. *Dromornis australis* Owen

Dromornis australis Owen, 1872, Proc. zool. Soc. London, p. 682 (type from Peak Downs, right femur, Sydney Mus., cast in Brit. Mus.).
Dromaius australis Woods, 1883, Proc. Linn. Soc. N. S. Wales, vol. 7, p. 387 (types from Penola, 2 tibiae, 2 tarsometatarsi, coll. Rev. J. E. Tenison Woods, perhaps now in Penola Institute).
[?]*Dinornis queenslandiae* DeVis, 1884, Proc. Roy. Soc. Queensland, vol. 1, p. 23, pl. 3-4 (type from King's Creek, proximal end of femur, Queensland Mus.).

UPPER PLEISTOCENE (Chinchilla beds). QUEENSLAND: Peak Downs (Owen, 1872); King's Creek? (DeVis, 1884).

UPPER PLEISTOCENE. SOUTH AUSTRALIA: Penola in Gambier Range (Woods, 1883).

Genus †*Genyornis* Stirling and Zietz

Genyornis Stirling and Zietz, 1896, Trans. Roy. Soc. S. Australia, vol. 20, p. 182 (type by monotypy *Genyornis newtoni* Stirling and Zietz).

2. *Genyornis newtoni* Stirling and Zietz

Genyornis newtoni Stirling and Zietz, 1896, Trans. Roy. Soc. S. Australia, vol. 20, p. 182 (type from Lake Callabonna, skeleton, South Australian Mus. in Adelaide).

Upper Pleistocene. South Australia: Lake Callabonna (Stirling and Zietz, 1896); Normanville, Baldina Creek near Burra, Parroo River, and Mount Gambier (Lambrecht, 1933, Handb. Palaeorn., p. 117). New South Wales: Gorec and Canadian Gold Lead, near Mudgee (Lambrecht, 1933).

Order †AEPYORNITHIFORMES (Newton)

Aepyornithes A. Newton, 1884, Encyclop. brit., ed. 9, vol. 18, p. 44 (type *Aepyornis* Geoffroy).—*Aepiornithes* Stejneger, 1885, Stand. nat. Hist., vol. 4, p. 47.—*Aepyornithiformes* Fürbringer, 1888, Untersuch. Morph. Syst. Vögel, vol. 2, pp. 1541, 1565 (intermediäre subordo).—*Aepiornithiformes* Ridgway, 1901, Bull. U. S. nat. Mus., no. 50, pt. 1, p. 9.

Family †AEPYORNITHIDAE (Bonaparte)

Epyornithinae Bonaparte, 1853, C. R. Acad. Sci. Paris, vol. 37, no. 18, p. 643 (sous-famille; type "*Epyornis*" Geoffroy).—*Aepyornithidae* A. Newton, 1884, Encyclop. brit., ed. 9, vol. 18, p. 44.

Subfamily †EREMOPEZINAE Lambrecht

Eremopezinae Lambrecht, 1933, Handb. Palaeon., p. 216 (type *Eremopezus* Andrews).

Genus †*Eremopezus* Andrews

Eremopezus Andrews, 1904, Proc. zool. Soc. London, p. 163 (type by monotypy *Eremopezus eocaenus* Andrews).

[?]*Psammornis* Andrews, 1911, Verh. V internat. ornith. Kongr. Berlin 1910, p. 169 (type by monotypy *Psammornis rothschildi* Andrews).

1. *Eremopezus eocaenus* Andrews

Eremopezus eocaenus Andrews, 1904, Proc. zool. Soc. London, p. 163, pl. 5 (type from Birket-el-Qurun, distal end of tibiotarsus, Brit. Mus.).

[?]*Psammornis rothschildi* Andrews, 1911, Verh. V internat. ornith. Kongr. Berlin 1910, p. 169 (types from east of Touggourt, eggshell fragments, Brit. Mus. and Tring Mus.).

[?]*Psammornis lybicus* Moltoni, 1928, Ann. Mus. Storia nat. Giacomo Doria, vol. 52, p. 399, fig. (types from south of Hatiet el-Huedda and south of Giarabub, eggshell fragments).

UPPER EOCENE (Fayum formation, Birket-el-Qurun stage). EGYPT: Fayum: north of Birket-el-Qurun (Andrews, 1904).

EOCENE? LYBIA: 27 kilometers south of Hatiet el-Huedda and south of Giarabub? (Moltoni, 1928). ALGERIA: 12 miles east of Touggourt, Biskra, Ouargla, El Golea, and Temacine (Andrews, 1911). ARABIA: Shuqquat al Khalfat (Lowe, 1933, Ibis, p. 656).

Subfamily †AEPYORNITHINAE (Bonaparte)

Genus †*Stromeria* Lambrecht

Stromeria Lambrecht, 1929, Abh. bayer. Akad. Wiss., Math.-Naturw. Abt., F. 4, p. 1 (type by monotypy *Stromeria fajumensis* Lambrecht).

2. *Stromeria fajumensis* Lambrecht

Stromeria fajumensis Lambrecht, 1929, Abh. bayer. Akad. Wiss., Math.-Naturw. Abt., F. 4, p. 1, pl. 2 (type from Dimeh, distal third of right tarsometatarsus, Munich Mus.).

Stromeria fayumensis Lambrecht, 1933, Handb. Palaeorn., p. 193.

LOWER OLIGOCENE (Fayum formation, Qatram stage). EGYPT: Fayum: north of Dimeh.

Genus †*Mullerornis* Milne-Edwards and Grandidier

Mullerornis Milne-Edwards and Grandidier, 1894, C. R. Acad. Sci. Paris, vol. 118, p. 125 (type *Mullerornis betsilei*, designated by Richmond, 1902, Proc. U. S. Nat. Mus., vol. 24, p. 697).

Flacourtia Andrews, 1895, Novit. zool. (London), vol. 2, p. 23 (type *Mullerornis rudis* Milne-Edwards and Grandidier).

3. *Mullerornis betsilei* Milne-Edwards and Grandidier

Mullerornis betsilei Milne-Edwards and Grandidier, 1894, C. R. Acad. Sci. Paris, vol. 118, p. 125 (types tibia, tarsometatarsus, Paris Mus.).

QUATERNARY. MADAGASCAR: Antsirabé, in center of island.

4. *Mullerornis agilis* Milne-Edwards and Grandidier

Mullerornis agilis Milne-Edwards and Grandidier, 1894, C. R. Acad. Sci. Paris, vol. 118, p. 125 (type tibia, Paris Mus.).

QUATERNARY. MADAGASCAR: southwest coast near Mouroundava.

5. *Mullerornis rudis* Milne-Edwards and Grandidier

Mullerornis rudis Milne-Edwards and Grandidier, 1894, C. R. Acad. Sci. Paris, vol. 118, pl. 26 (types tibia, tarsometatarsus, Paris Mus.).

QUATERNARY. MADAGASCAR: west coast between Bélo and Mouroundava.

Genus †*Aepyornis* Geoffroy

Aepyornis I. Geoffroy-Saint-Hilaire, 1851 (after Jan. 27), C. R. Acad. Sci. Paris, vol. 32, no. 4, p. 104 (type by monotypy *Aepyornis maximus* Geoffroy).

Aepiornis Geoffroy, 1851, Rev. Mag. Zool. (Paris), ser. 2, vol. 3, p. 52 (emendation).

Epiornis Müller and Baldamus, 1851, Naumannia, vol. 1, no. 4, p. 48 (emendation).

Epyornis Bonaparte, 1854, Ann. Sci. nat. (Paris), ser. 4, vol. 1, fasc. 3, p. 139 (emendation; Épyornis used as a common name by Geoffroy, 1851, C. R., l.c.).

6. *Aepyornis maximus* Geoffroy

Aepyornis maximus I. Geoffroy-Saint-Hilaire, 1851 (after Jan. 27), C. R. Acad. Sci. Paris, vol. 32, no. 4, p. 104 (types from Masikoro, egg and lower end of left metatarsus, Paris Mus.).

Aepyornis modestus Milne-Edwards and Grandidier, 1869, Ann. Sci. nat. (Paris), ser. 5, vol. 7, p. 314 (type from Ambolisatra, Paris Mus.).

Aepyornis titan Andrews, 1894 (Jan. 12), Geol. Mag., no. 355 = n.s., decade 4, vol. 1, no. 1, p. 18 (type from Itampulu Vé, left tibiotarsus, Brit. Mus.).

Aepyornis ingens Milne-Edwards and Grandidier, 1894 (after Jan. 13), C. R. Acad. Sci. Paris, vol. 118, no. 3, p. 124 (types from west coast between Bélo and Mouroundava, femur, tibia, Paris Mus.).

QUATERNARY. MADAGASCAR: Ambolisatra or Amboulitsate (Milne-Edwards and Grandidier, 1869); Masikoro or Machicora (Milne-Edwards and Grandidier, 1894); Mouroundava, between Bélo and Mouroundava, and Itampulu Vé (Andrews, 1894); Lamboharana (Lambrecht, 1933, Handb. Palaeorn., p. 198).

7. *Aepyornis medius* Milne-Edwards and Grandidier

Aepyornis medius Milne-Edwards and Grandidier, 1866, Recherches sur la faune ornithologique éteinte des Îles Mascareignes et de Madagascar, p. 97, note 2 (type, Paris Mus.).

Aepyornis grandidieri Rowley, 1867, Proc. zool. Soc. London, p. 892 (type from Cape Sainte Marie, eggshell fragment, coll. Alfred Grandidier).

Aepyornis cursor Milne-Edwards and Grandidier, 1894 (after Jan. 15), C. R. Acad. Sci. Paris, vol. 118, no. 3, p. 124 (type tarsometatarsus, Paris Mus., locality not stated).

Aepyornis lentus Milne-Edwards and Grandidier, 1894 (after Jan. 15), C. R. Acad. Sci. Paris, vol. 118, no. 3, p. 124 (type tarsometatarsus, Paris Mus., locality not stated).

QUATERNARY. MADAGASCAR: Cape Sainte-Marie; probably between Bélo and Mouroundava (Milne-Edwards and Grandidier).

8. *Aepyornis hildebrandti* Burckhardt

Aepyornis hildebrandti Burckhardt, 1893, Pal. Abh., vol. 6, p. 127, pl. 13-16 (type tarsometatarsus, Berlin Mus.).

Aepyornis mulleri Milne-Edwards and Grandidier, 1894 (after Jan. 15), C. R. Acad. Sci. Paris, vol. 118, no. 3, p. 124 (type from Antsirabé, nearly complete skeleton, Paris Mus.).

QUATERNARY. MADAGASCAR: Antsirabe.

9. *Aepyornis gracilis* Monnier

Aepyornis gracilis Monnier, 1913, Ann. Pal. (Paris), vol. 8, p. 15, pl. 8, fig. 10 (type femur, Paris Mus.).

QUATERNARY. MADAGASCAR.

Order †DINORNITHIFORMES (Gadow)

Immanes A. Newton, 1884, Encyclop. brit., ed. 9, vol. 18, p. 44.

Dinornithes Gadow, 1893, Bronn Klass. Ordn., Vögel, pt. 2, pp. 105, 299 (type *Dinornis* Owen).—*Dinornithiformes* Ridgway, 1901, Bull. U. S. Nat. Mus., no. 50, pt. 1, p. 9.

Family †EMEIDAE (Bonaparte)

Emeinae Bonaparte, 1854, Ann. Sci. nat. (Paris), vol. 1, p. 48 (type *Emeus* Reichenbach).

Anomalopterygidae Oliver, 1930, New Zealand Birds, p. 28 (type *Anomalopteryx* Reichenbach).

Subfamily †ANOMALOPTERYGINAE (Oliver)

Anomalopteryginae Archey, 1941 (May 29), Bull. Auckland Inst. and Mus., no. 1, pp. 11, 77 (sub-family).

Genus †*Anomalopteryx* Reichenbach

Anomalopteryx Reichenbach, 1852, Avium Systema Naturale, p. xxx (type by monotypy *Dinornis didiformis* Owen).

Graya Bonaparte, 1856 (after Nov. 3), C. R. Acad. Sci. Paris, vol. 43, no. 18, p. 841 (type by present designation *Dinornis dromaeoides* Owen).

Anomalornis Hutton, 1897 (June), Trans. N. Zealand Inst., vol. 29, p. 543 (new name for *Anomalopteryx* Reichenbach).

1. *Anomalopteryx antiquus* Hutton

Anomalopteryx antiquus Hutton, 1892 (May), Trans. N. Zealand Inst., vol. 24, p. 124 (lectotype tibia, Canterbury Mus., designated by Archey, 1941, p. 29).

UPPER MIOCENE OR LOWER PLIOCENE. NEW ZEALAND: SOUTH ISLAND: Gleniti Valley near Timaru.

2. *Anomalopteryx didiformis* (Owen)

Dinornis didiformis Owen, 1844 (June 5), Trans. zool. Soc. London, vol. 3, pt. 3, p. 242, pl. 27, fig. 3-6 (type from Poverty Bay, metatarsus, Royal College of Surgeons; cast Brit. Mus. no. 18595).

Dinornis dromaeoides Owen, 1844 (June 5), Trans. zool. Soc. London, vol. 3, pt. 3, p. 253, pl. 22, fig. 1-2; pl. 23, fig. 1 (type from Poverty Bay, femur, Roy. Coll. Surg. no. f.16; cast Brit. Mus. no. 18598; cast Canterbury Mus.).

Dinornis dromioides Owen, 1846 (July), Proc. zool. Soc. London, pt. 14, pp. 46, 47 (emendation or lapsus).

Dinornis parvus Owen, 1883 (Jan.), Trans. zool. Soc. London, vol. 11, pt. 8, no. 1, p. 233, pl. 51-58 (type from Pokororo, skeleton, Brit. Mus. no. A.3).

Anomalopteryx fortis Hutton, 1893 (May), Trans. N. Zealand Inst., vol. 25, p. 9 (lectotype from Glenmark, Canterbury Mus., designated by Archey, 1941).

QUATERNARY. NEW ZEALAND: NORTH ISLAND: Poverty Bay (Owen, 1844); Waingongoro and Te Rangatapu (Lydekker, 1891, Cat. Foss.

Birds Brit. Mus., p. 666); Waipu, Akaitio, Karamu, Moawhango, Pataua, Martinborough, Rotorua, Opito, Te Aute, and Lyall Bay (Lambrecht, 1933, Handb. Palaeorn., p. 143); Nuhaka, Awamarino, Te Anga, Mangaotaki, and Waikaremoana (Archey, 1941, Bull. Auckland Inst. Mus., no. 1, p. 137); Tukituki River, Hangatiki, Tahora, Pohue, Coonoor, Makirikiri, Mangaone, Kaiiwi, Wanganui, Lake Kaitoke, and Levin (Oliver, 1955, N. Zealand Birds, ed. 2, p. 582); Gisborne, Whangarei, and Coromandel (Scarlett, 1957, Proc. N. Zealand ecol. Soc., no. 4, p. 17). SOUTH ISAND: Pokororo (Owen, 1883); 40 miles north of Nelson, Waikouaiti, Ruamoa near Oamaru, and Otago (Lydekker, 1891, pp. 278, 666); Glenmark (Hutton, 1893); Takaka Hill, Hamilton Swamp, Waiau, Cheviot, Aorere River, and Kapua (Lambrecht, 1933, p. 144); Castle Rocks, Collingwood, and Mount Arthur (Archey, 1941); Shag River, Broken River, and Papatowai (Oliver, 1955). Although birds from the South Island average slightly smaller, the differences are too slight to permit subspecific separation.

Genus †*Megalapteryx* Haast

Megalapteryx Haast, 1886 (Dec.), Trans. zool. Soc. London, vol. 12, pt. 5, p. 161 (type by monotypy *Megalapteryx hectori* Haast).

Palaeocasuarius Forbes, 1892 (May), Trans. N. Zealand Inst., vol. 24, p. 189 (nomen nudum).—Forbes, 1893 (July), Ibis, ser. 6, vol. 5, no. 19, p. 450 (generic characters; included species *P. haasti* and *P. velox*, both nomina nuda at this point).—Rothschild, 1907 (Nov. 12), Extinct Birds, p. 219 (type by original designation *Palaeocasuarius haasti* "Forbes").

3. *Megalapteryx didinus* (Owen)

Dinornis didinus Owen, 1883 (Jan.), Trans. zool. Soc. London, vol. 11, pt. 8, p. 257, pl. 59-61 (type from Queenstown, incomplete skeleton, Brit. Mus. no. A.16).

Megalapteryx hectori Haast, 1886 (Dec.), Trans. zool. Soc. London, vol. 12, pt. 5, p. 161, pl. 30 (type from Takaka, leg bones, Nelson Mus.).

Megalapteryx tenuipes Lydekker, 1891 (Apr. 25), Cat. Fossil Birds Brit. Mus., p. 251, fig. 69a (type from Lake Wakatipu, right tibiotarsus, Brit. Mus. no. 49990).

Palaeocasuarius haasti Forbes, 1893 (July), Ibis, ser. 6, vol. 5, no. 19, p. 451 (nomen nudum).—Rothschild, 1907 (Nov. 12), Extinct Birds, p. 220 (type from Manitoto, femur, Liverpool Mus.).

Palaeocasuarius velox Forbes, 1893 (July), Ibis, ser. 6, vol. 5, no. 19, p. 451 (nomen nudum).—Rothschild, 1907 (Nov. 12), Extinct Birds, p. 220 (type from Manitoto, femur, Liverpool Mus.).

Palaeocasuarius elegans Rothschild, 1907 (Nov. 12), Extinct Birds, p. 220 (type from Manitoto, femur, Liverpool Mus.).

Megalapteryx hamiltoni Rothschild, 1907 (Nov. 12), Extinct Birds, p. 197 (type from Waingongoro, left femur, Brit. Mus. no. 32145).

QUATERNARY. NEW ZEALAND: SOUTH ISLAND: Queenstown near Lake Wakatipu (Owen, 1883); Takaka (Haast, 1886); Maniototo (Rothschild, 1907); Buller River, Kapua, and Nelson (Lambrecht, 1933, Handb. Palaeorn., p. 142); Mount Arthur, Inangahua, Old Man Range, and Aniseed Valley (Archey, 1941, Bull. Auckland Inst. Mus., no. 1, pp. 31, 33, 138); D'Urville Island, Pokororo, Glenmark, Cromwell, Manuherikia, Kingston, Papatowai, and Te Anau (Oliver, 1955, N. Zealand Birds, ed. 2, p. 583); Inangahua Junction (Scarlett, 1957; Proc. N. Zealand ecol. Soc., no. 4, p. 17). NORTH ISLAND: Waingongoro (Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 251; doubtful, fide Oliver); Makirikiri (Archey, 1941, p. 35).

4. *Megalapteryx benhami* Archey

Megalapteryx benhami Archey, 1941 (May 29), Bull. Auckland Inst. Mus., no. 1, pp. 35, 138 (type from Mount Arthur, femur, Auckland Mus.).

QUATERNARY. NEW ZEALAND: SOUTH ISLAND: Mount Arthur (Archey, 1941); Wairangi (Oliver, 1955, N. Zealand Birds, ed. 2, p. 585).

Genus †*Pachyornis* Lydekker

Pachyornis Lydekker, 1891 (Apr. 25), Cat. Fossil Birds Brit. Mus., p. 316 (type *Dinornis elephantopus* Owen, by original designation).

5. *Pachyornis elephantopus* (Owen)

Dinornis elephantopus Owen, 1856 (July 30), Proc. zool. Soc. London, pt. 24, p. 54 (lectotype from Awamoa, left metatarsus, Brit. Mus. designated by Archey, 1941, Bull. Auckland Inst. Mus., no. 1, p. 36).

Dinornis crassus var. *major* Hutton, 1875 (July), Trans. N. Zealand Inst., vol. 7, pp. 276-278 (lectotype from Hamilton Swamp, metatarsus, designated by Archey, 1941, p. 38).

Pachyornis immanis Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 343, fig. 66B (type from South Island, left tarsometatarsus, Brit. Mus. no. A.168).

Euryapteryx ponderosus Hutton, 1891 (Nov.), N. Zealand Jour. Sci., new issue, vol. 1, no. 6, p. 249 (lectotype from Hamilton Swamp, metatarsus, Otago Mus., designated by Archey, 1941, p. 36).

Pachyornis rothschildi Lydekker, 1892 (Apr.), Proc. zool. Soc. London for 1891, no. 33, p. 479 (types from unknown locality, associated right femur, tibiae, metatarsi, Tring Mus.).

Pachyornis inhabilis Hutton, 1893 (May), Trans. N. Zealand Inst., vol. 25, p. 11 (type from "probably somewhere in Canterbury," incomplete skeleton, Canterbury Mus. no. 9.2.23).

Pachyornis valgus Hutton, 1893 (May), Trans. N. Zealand Inst., vol. 25, p. 12 (types from Enfield, right and left tibiae, Canterbury Mus.).

QUATERNARY. NEW ZEALAND: SOUTH ISLAND: Awamoa (Owen, 1856); Hamilton Swamp (Hutton, 1875); Ruamoa and Glenmark Swamp (Lydekker, 1891, Cat., p. 321); Kapua, Waitaki River, and

Stewart Island (Oliver, 1930, N. Zealand Birds, p. 51); Waikouaiti, Broken River, Motunau, Riverton Beach, Takaka Hill, and Shag Point (Lambrecht, 1933, Handb., pp. 150-151); Enfield (Hutton, 1893); Pyramid Valley (Archey, 1941, p. 138); Tarakohe, Herbert, and Papatowai (Oliver, 1955, N. Zealand Birds, ed. 2, p. 576).

6. *Pachyornis pygmaeus* (Hutton)

Euryapteryx pygmaeus Hutton, 1891 (Nov.), N. Zealand Jour. Sci., new issue, vol. 1, no. 6, p. 249 (lectotypes from Takaka, right and left metatarsi, Nelson Mus., designated by Hutton, 1892, Trans. N. Zealand Inst., vol. 24, p. 139).

QUATERNARY. NEW ZEALAND: SOUTH ISLAND: Takaka tableland.

7. *Pachyornis mappini* Archey

Pachyornis mappini Archey, 1941 (May 29), Bull. Auckland Inst. Mus., no. 1, p. 41, pl. 4, fig. 4; pl. 5, fig. 4; pl. 7, fig. 3; pl. 9, fig. 4; pl. 10, fig. 4; pl. 11, fig. 4; pl. 12, fig. 5; pl. 15, fig. 1a-c (type from Mangaotaki, skeleton, Auckland Mus. no. 124).

QUATERNARY. NEW ZEALAND: NORTH ISLAND: Mangaotaki, Waikaremoana, Doubtless Bay, Coromandel, Makirikiri, Karamu, and Amodeo Bay (Archey, 1941); Waipu, Gisborne, Mangaone, Nuhaka, Te Aute, Coonoor, Martinborough, and Eketahuna (Oliver, 1955, N. Zealand Birds, ed. 2, p. 574).

8. *Pachyornis oweni* (Haast)

Dinornis oweni Haast, 1885, Proc. zool. Soc. London for 1885, no. 31, p. 482 (nomen nudum).—Haast, 1886 (Dec.), Trans. zool. Soc. London, vol. 12, pt. 5, p. 171, pl. 31-32 (type from Pataua near Whangarei, skeleton, Auckland Mus. no. A.M. 384).

QUATERNARY. NEW ZEALAND: NORTH ISLAND: Pataua (Haast, 1886); Tom Bolling Bay, Doubtless Bay, Waikawau, and Westmere near Auckland (Archey, 1941, Bull. Auckland Inst. Mus., no. 1, p. 44); Lake Ohia, Te Aute, Martinborough, and Makirikiri (Oliver, 1955, N. Zealand Birds, ed. 2, p. 582).

9. *Pachyornis septentrionalis* Oliver

Pachyornis septentrionalis Oliver, 1949, Moas N. Zealand Australia, p. 61 (type from Pohue, incomplete skeleton, Dominion Mus. at Wellington).

QUATERNARY. NEW ZEALAND: NORTH ISLAND: Pohue (Oliver, 1949); Doubtless Bay, Whangarei, Bay of Plenty, Waikaremoana, Te Aute, and Martinborough (Oliver, 1955, N. Zealand Birds, ed. 2, p. 574); Coonoor and Wanganui (Scarlett, 1957, Proc. N. Zealand ecol. Soc., no. 4, p. 17).

10. *Pachyornis murihiku* Oliver

Pachyornis murihiku Oliver, 1949, Moas N. Zealand Australia, p. 67 (type from Greenhills, skeleton, Southland Mus.).

QUATERNARY. NEW ZEALAND: SOUTH ISLAND: Greenhills near Bluff.

11. *Pachyornis australis* Oliver

Pachyornis australis Oliver, 1949, Moas N. Zealand Australia, p. 70 (type from Salisbury tableland, skull and neck vertebrae, Dominion Mus.).

QUATERNARY. NEW ZEALAND: SOUTH ISLAND: Salisbury tableland at headwaters of Takaka River (Oliver, 1949); Southland and Nelson (Oliver, 1955, N. Zealand Birds, ed. 2, p. 575).

Subfamily †EMEINAE Bonaparte

Emeinae Bonaparte, 1854, Ann. Sci. nat. (Paris), vol. 1, p. 48 (type *Emeus* Reichenbach).

Genus †*Emeus* Reichenbach

Emeus Reichenbach, 1852, Avium Systema Naturale, p. xxx (type by monotypy *Dinornis crassus* Owen).

Syornis Reichenbach, 1852, Avium Systema Naturale, p. xxx (type *Dinornis casuarinus* Owen).

Meionornis Haast, 1874 (June), Trans. N. Zealand Inst., vol. 6, p. 426 (type *Dinornis casuarinus* Owen, designated by Archey, 1941, Bull. Auckland Inst. Mus., no. 1, p. 45).

Mesopteryx Hutton, 1891 (Nov.), N. Zealand Jour. Sci., new issue, vol. 1, no. 6, p. 248 (type by monotypy *Dinornis huttonii* Owen).

12. *Emeus crassus* (Owen)

Dinornis crassus Owen, 1846 (July), Proc. zool. Soc. London, pt. 14, p. 46 (lectotype from Waikouaiti, now lost, designated by Lydekker, 1891, Cat., p. 307; casts, Brit. Mus. no. A.186, Auckland Mus. no. A.M. 298).

Dinornis casuarinus Owen, 1846 (July), Proc. zool. Soc. London, pt. 14, p. 47 (lectotype from Waikouaiti, now lost, designated by Lydekker, 1891, p. 257).

[?]*Dinornis rheides* Owen, 1851 (Jan. 1), Trans. zool. Soc. London, vol. 4, pt. 1, p. 8 (indeterminate?).

QUATERNARY. NEW ZEALAND: SOUTH ISLAND: Waikouaiti (Owen, 1846); Glenmark (Lydekker, 1891, Cat., p. 257); Enfield, Kapua, Hamilton Swamp, Awamoa, Dunedin, and Earnscleugh Cave (Lambrecht, 1933, Handb., p. 147); Pyramid Valley and Kia Ora (Archey, 1941, pp. 51, 149); Waitaki, Shag River, Ohai, Papatowai, Greenhills, Riverton, and Wakapatu (Oliver, 1955, N. Zealand Birds, ed. 2, p. 577). NORTH ISLAND: Martinborough and Te Aute (according to Archey, 1941, p. 51, these are the only valid records from the North Island). Recorded from Stewart Island by Lambrecht, but not confirmed by subsequent authors.

13. *Emeus huttonii* (Owen)

Dinornis huttonii Owen, 1879, Extinct Birds N. Zealand, p. 430 (lectotype from Hamilton Swamp, right metatarsus, Otago Mus., designated by Archey, 1941, p. 52).

Euryapteryx compacta Hutton, 1893 (May), Trans. N. Zealand Inst., vol. 25, p. 11 (type from Enfield, tibia, Canterbury Mus.).

QUATERNARY. NEW ZEALAND: SOUTH ISLAND: Hamilton Swamp (Owen, 1879); Enfield (Hutton, 1893); Kapua (Hutton, 1896, Trans. N. Zealand Inst., vol. 28, p. 636); Glenmark (Hutton, 1897, op. cit., vol. 29, p. 559); Takaka (Lambrecht, 1933, Handb., p. 148); Wakapatu and Pyramid Valley (Archey, 1941, pp. 53, 140); Broken River, Waireka, Castle Rock, Waikouaiti, Papatowai, and Waipapa (Oliver, 1955, p. 559).

Genus †*Euryapteryx* Haast

Cela Reichenbach, 1852, Avium Systema Naturale, p. xxx (type by monotypy *Dinornis curtus* Owen). Preoccupied by *Cela* Moehring, 1758; *Cela* Oken, 1816; *Cela* Illiger, 1826.

Celeus Bonaparte, 1856 (after Nov. 3), C. R. Acad. Sci. Paris, vol. 43, no. 18, p. 841 (new name for *Cela* Reichenbach). Preoccupied by *Celeus* Boie, 1831.

Euryapteryx Haast, 1874 (June), Trans. N. Zealand Inst., vol. 6, p. 427 (type *Dinornis gravis* Owen, designated by Archey, 1941, p. 53).

14. *Euryapteryx gravis* (Owen)

Dinornis gravis Owen, 1870 (Jan.), Trans. zool. Soc. London, vol. 7, pt. 2, p. 141, pl. 14 (type from Kakanui, skull, coll. Baroness A. Burdett Coutts).

Emeus gravipes Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 297 (type from Kakanui, metatarsus, Brit. Mus. no. A.1591).

Emeus boothi Rothschild, 1907 (Nov. 12), Extinct Birds, p. 210 (type from Shuy River, skull, Brit. Mus.?).

Euryapteryx kuranui Oliver, 1930, N. Zealand Birds, p. 52 (type from Castle Point, skeleton, Canterbury Mus.).

QUATERNARY. NEW ZEALAND: STEWART ISLAND (Benham, 1910, Trans. N. Zealand Inst., vol. 42, p. 354). SOUTH ISLAND: Kakanui River (Owen, 1870); Shuy River and Shag River (Rothschild, 1907); Mount Arthur, Riverton, and Pyramid Valley (Archey, 1941, Bull. Auckland Inst. Mus., no. 1, pp. 56, 141); Herbert, Earnscleugh Cave, and Wakapatu (Oliver, 1955, N. Zealand Birds, ed. 2, p. 578). NORTH ISLAND: Castlepoint (Oliver, 1930); Portland Island and Waikaremoana (Archey, 1941, p. 56) Te Aute, Hunterville, and Nga Rata (Oliver, 1955).

15. *Euryapteryx geranoides* (Owen)

Palapteryx geranoides Owen, 1848 (Apr. 13), Proc. zool. Soc. London, pp. 1,

7 (measurements of skull).—Owen, 1848 (Apr. 22), Trans. zool. Soc. London, vol. 3, pt. 5, p. 361, pl. 54, fig. 1-5 (type from Te Rangatapu, skull).

Dinornis expunctus Archey, 1927 (Aug. 15), Trans. N. Zealand Inst., vol. 58, p. 152 (new name for *Palapteryx geranoides* Owen).

QUATERNARY. NEW ZEALAND: NORTH ISLAND: Te Rangatapu (Owen, 1848); Doubtless Bay and Tom Bolling Bay (Archey, 1941, Bull. Auckland Inst. Mus., no. 1, pp. 57, 141); Te Aute, Oakanga River, Coonoor, Martinborough, and Seatoun (Oliver, 1955, N. Zealand Birds, ed. 2, p. 578). SOUTH ISLAND: Takaka, Broken River, Herbert, and Papatowai (Oliver, 1955).

16. *Euryapteryx curtus* (Owen)

Dinornis curtus Owen, 1846 (July), Proc. zool. Soc. London, pt. 14, p. 48 (lectotype from East Coast district, tibia, designated by Lydekker, 1891, Cat., p. 281).

QUATERNARY. NEW ZEALAND: NORTH ISLAND: Doubtless Bay (Archey, 1941, Bull. Auckland Inst. Mus., no. 1, pp. 60, 142); Lake Ohia, Waipu, Clevedon, Poverty Bay, Te Aute, and Makirikiri (Oliver, 1955, N. Zealand Birds, ed. 2, p. 577).

17. *Euryapteryx tane* Oliver

Euryapteryx tane Oliver, 1949, Moas N. Zealand Australia, p. 105 (type from Doubtless Bay, skeleton, Auckland Mus.).

QUATERNARY. NEW ZEALAND: NORTH ISLAND: Doubtless Bay, Waipu, Lake Ohia, Clevedon, Waiotapu, Te Aute, Te Rangatapu, Waikupa, and Makirikiri (Oliver, 1955, N. Zealand Birds, ed. 2, p. 577); Wanganui and Napier (Scarlett, 1957, Proc. N. Zealand ecol. Soc., no. 4, p. 17).

Genus †*Zelornis* Oliver

Zelornis Oliver, 1949, Moas N. Zealand Australia, p. 117 (type *Euryapteryx exilis* Hutton).

18. *Zelornis exilis* (Hutton)

"Anomalopteryx(?) geranoides (?Owen)," Lydekker, 1891, Cat. Fossil Birds Brit. Mus., p. 288, fig. 65C (simply a misapplication of *Palapteryx geranoides* Owen, not a new name).

Euryapteryx exilis Hutton, 1897 (June), Trans. N. Zealand Inst., vol. 29, p. 552, pl. 48, fig. C (type from Wangaehu, skeleton, Wanganui Mus.).

QUATERNARY. NEW ZEALAND: NORTH ISLAND: Wangaehu River mouth (Hutton, 1897); Rangatapu (Lydekker, 1891); Doubtless Bay and Waiotapu (Archey, 1941, Bull. Auckland Inst. Mus., no. 1, p. 141); Wanganui and Napier (Scarlett, 1957, Proc. N. Zealand ecol. Soc., no. 4, p. 17).

19. *Zelornis haasti* (Rothschild)

Emeus haasti Rothschild, 1907 (Nov. 12), Extinct Birds, p. 210 (type from Glenmark, skull).

Emeus parkeri Rothschild, 1907 (Nov. 12), Extinct Birds, p. 211 (type from Shag Point, skull).

QUATERNARY. NEW ZEALAND: SOUTH ISLAND: Glenmark and Shag Point (Rothschild, 1907); Enfield and Riverton (Oliver, 1955, N. Zealand Birds, ed. 2, p. 580).

Family †DINORNITHIDAE Bonaparte

Dinornithidae Bonaparte, 1853 (after Oct. 31), C. R. Acad. Sci. Paris, vol. 37, no. 18, p. 646 (type *Dinornis* Owen).—*Dinornithinae* Bonaparte, 1853, op. cit., p. 646 (sous-famille).—*Dinornithoideae* Stejneger, 1884, Sci. Rec., vol. 2, p. 155.

Palapteryginae Bonaparte, 1854, Ann. Sci. nat. (Paris), vol. 1, p. 48 (type *Palapteryx* Owen).—*Palapterygidae* Haast, 1874 (June), Trans. N. Zealand Inst., vol. 6, p. 419.

Genus †*Dinornis* Owen

Dinornis Owen, 1843 (July), Proc. zool. Soc. London, pt. 11, no. 121, p. 10 (type by monotypy *Dinornis novae-zealandiae* Owen).

Megalornis Owen, 1843, Proc. zool. Soc. London, pt. 11, no. 122, p. 19 (*Dinornis* substituted for manuscript name *Megalornis* Owen in paper read at previous meeting; preoccupied by *Megalornis* Gray, 1841).

Palapteryx Owen, 1846 (July), Proc. zool. Soc. London, pt. 14, p. 46 (type *Dinornis ingens* Owen, designated by Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 224).

Movia Reichenbach, 1852, Avium systema naturale, p. xxx (type by monotypy *Dinornis ingens* Owen).

Moa Reichenbach, 1852, Avium systema naturale, p. xxx (type by monotypy *Dinornis giganteus* Owen).

Owenia Gray, 1855, Cat. Genera Subgenera Birds, p. 152 (type *Dinornis struthoides* Owen; see Bonaparte, 1856, C. R. Acad. Sci. Paris, vol. 43, no. 18, p. 841).

Tylopteryx Hutton, 1891 (Nov.), N. Zealand Jour. Sci., new issue, vol. 1, no. 6, p. 247 (type *Dinornis gracilis* Owen, designated by Richmond, 1902, Proc. U. S. nat. Mus., vol. 24, no. 1267, p. 720; *Dinornis torosus* Hutton, designated by Archey, 1941, Bull. Auckland Inst. Mus., no. 1, p. 61, in oversight of Richmond's action).

1. *Dinornis novae-zealandiae* Owen

Dinornis novae zealandiae Owen, 1843 (July), Proc. zool. Soc. London, pt. 11, no. 121, p. 8 (lectotypes from Poverty Bay, left femur, left metatarsus, Royal College of Surgeons, nos. *f*12, *m*3, designated by Archey, 1941, p. 64; casts, Brit. Mus. nos. 18588, 18590).

Dinornis struthoides Owen, 1844 (March), Proc. zool. Soc. London for 1843, pt. 11, no. 129, p. 144 (brief description).—Owen, 1844 (June 5), Trans. zool. Soc. London, vol. 3, pt. 3, p. 244 (type from Poverty Bay, metatarsus, Roy. Coll. Surg., no. *m*3).

Dinornis struthioides Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 242 (emendation).

QUATERNARY. NEW ZEALAND: NORTH ISLAND: Poverty Bay (Owen, 1843); Wanganui, Hastings, Doubtless Bay, Karamu, Mangaotaki, Waikaremoana, and Haupouri (Archey, 1941, pp. 64, 67, 142); Waipu, Tahora, Te Aute, Martinborough, Makirikiri, and Paremata (Oliver, 1955, N. Zealand Birds, ed. 2, p. 585).

2. *Dinornis torosus* Hutton

Dinornis torosus Hutton, 1891 (Nov.), N. Zealand Jour. Sci., new issue, vol. 1, no. 6, p. 247 (type from Takaka, Auckland Mus. no. A.M. 352).

Palapteryx plenus Hutton, 1891 (Nov.), N. Zealand Jour. Sci., new issue, vol. 1, no. 6, p. 248 (lectotype from South Island, tibia, selected by Archey, 1941, p. 70).

Dinornis strenuus Hutton, 1893 (May), Trans. N. Zealand Inst., vol. 25, p. 8 (lectotype from Enfield, metatarsus, selected by Archey, 1941, p. 70, Canterbury Mus. no. 1.14.13).

QUATERNARY. NEW ZEALAND: SOUTH ISLAND: Takaka (Hutton, 1891); Enfield (Hutton, 1893); Mount Arthur, Glenmark, Timaru, and Hamilton Swamp (Archey, 1941, pp. 70, 143); Kapua (Hutton, 1896, Trans. N. Zealand Inst., vol. 28, pp. 634, 642); Broken River, Herbert, Shag River, Castle Rock, Takaka Hill, and Slovens Creek (Oliver, 1955, N. Zealand Birds, ed. 2, pp. 585, 586); Rahu (Scarlett, 1957, Proc. N. Zealand ecol. Soc., no. 14, p. 17).

3. *Dinornis ingens* Owen

Dinornis ingens Owen, 1844 (June 5), Trans. zool. Soc. London, vol. 3, pt. 3, p. 247 (type from Poverty Bay, tibiotarsus, Roy. Coll. Surg. no. *t*2; cast Brit. Mus.).

Dinornis gracilis Owen, 1855 (Apr. 11), Proc. zool. Soc. London for 1854, pt. 22, p. 246 (lectotype from North Island, metatarsus, Brit. Mus. no. 32272, selected by Lydekker, 1891, Cat., p. 248).

Dinornis firmus Hutton, 1891 (Nov.), N. Zealand Jour. Sci., new issue, vol. 1, no. 6, p. 247 (lectotypes from Poverty Bay, femur, tibia, metatarsus, coll. of Rev. W. Colenso, selected by Archey, 1941, p. 68).

QUATERNARY. NEW ZEALAND: NORTH ISLAND: Poverty Bay (Owen, 1844); Karuma, Mangaotaki, Waikaremoana, Te Aute, Patangata, Kaiwaka, Hastings, and Makirikiri (Archey, 1941, pp. 68, 143); Ruakaka, Matapouri, Clevedon, Te Kuiti, Moawhango, Coonoor, Martinborough, Karori, Paekakariki, and Kaiiwi (Oliver, 1955, N. Zealand Birds, ed. 2, p. 586).

4. *Dinornis robustus* Owen

Dinornis ingens var. *robustus* Owen, 1846 (July), Proc. zool. Soc. London, pt. 14, p. 48 (lectotype from South Island, metatarsus, Roy. Coll. Surg., now apparently lost, selected by Archey, 1941, p. 71).

Dinornis potens Hutton, 1891 (Nov.), N. Zealand Jour. Sci., new issue, vol. 1, no. 6, p. 247 (types from Heathcote, femur, tibia, metatarsus, Canterbury Mus.).

QUATERNARY. NEW ZEALAND: SOUTH ISLAND: Waikouaiti (Owen, 1851, Trans. zool. Soc. London, vol. 3, pt. 4, pp. 321, 329); Hamilton Swamp (Hutton, 1875, Trans. N. Zealand Inst., vol. 7, p. 279); Heathcote (Hutton, 1891); Greymouth (Hutton, 1892, Trans. N. Zealand Inst., vol. 24, p. 113); Kapua and Enfield (Hutton, 1896, Trans. N. Zealand Inst., vol. 28, pp. 633, 645); Castle Rock, Timaru, Glenmark, Knobby Range, Tiger Hill, and Pyramid Valley (Archey, 1941, p. 144); Takaka Hill, Westport, Broken River, Papatowai, Clyde, and D'Urville Island (Oliver, 1955, p. 586).

5. *Dinornis giganteus* Owen

Dinornis giganteus Owen, 1844 (March), Proc. zool. Soc. London for 1843, pt. 11, no. 129, p. 144 (type from Poverty Bay, tibia, Roy. Coll. Surg. no. 2170; cast Brit. Mus. no. 18588).

Dinornis excelsus Hutton 1891 (Nov.), N. Zealand Jour. Sci., new issue, vol. 1, no. 6, p. 247 (lectotype from Te Aute, tibia, selected by Archey, 1941, p. 69).

QUATERNARY. NEW ZEALAND: NORTH ISLAND: Poverty Bay (Owen, 1844); Te Aute (Hutton, 1891); Doubtless Bay, Awhitu, Moawhango, Makirikiri, Maungaraki Gorge, and Hawke Bay (Archey, 1941, p. 143); Coonoor, Omaranui, and Martinborough (Oliver, 1955, p. 588).

6. *Dinornis maximus* Owen

Dinornis maximus Owen, 1867, Proc. zool. Soc. London for 1867, no. 57, p. 891 (nomen nudum).—Owen, in Haast, 1869 (May), Trans. N. Zealand Inst., vol. 1, p. 87 (types from Glenmark Swamp, femur, tibia, and part of metatarsus, Canterbury Mus.).—Owen, 1869 (June 1), Trans. zool. Soc. London, vol. 6, pt. 8, p. 497, pl. 89-90 (types from Glenmark Swamp, from same individual as Haast's types, left femur, left tibiotarsus, right tarsometatarsus, coll. of Major J. Michael, now supposed to be in Madras Mus. but apparently lost; casts Brit. Mus. no. A.161, Auckland Mus. no. A.M. 385).

Dinornis altus Owen, 1879, Extinct Birds New Zealand, pp. 253, 361, pl. 79, fig. 4 (type from South Island, left metatarsus, Brit. Mus. no. 35832).
Dinornis validus Hutton, 1891 (Nov.), N. Zealand Jour. Sci., new issue, vol. 1, no. 6, p. 247 (type from Glenmark Swamp, skeleton, Canterbury Mus.).

QUATERNARY. NEW ZEALAND: SOUTH ISLAND: Glenmark Swamp (Haast, 1869); Kapua, Enfield, and Riverton (Hutton, 1896, Trans. N. Zealand Inst., vol. 28, pp. 632, 646, 652); Pyramid Valley, Broken River, Shag Valley, Waikouaiti, and Sumner (Archey, 1941, p. 144); Raki's Table, Herbert, Awamoa, Seacliff, Colac Bay, and Invercargill (Oliver, 1955, p. 588).

7. *Dinornis gazella* Oliver

Dinornis gazella Oliver, 1949, Moas N. Zealand and Australia, p. 166 (type from Te Aute, pelvis, Dominion Mus., Wellington).

QUATERNARY. NEW ZEALAND: NORTH ISLAND: Te Aute (Oliver, 1949); Karamu, Makirikiri, and Paremata (Oliver, 1955, p. 585).

8. *Dinornis hercules* Oliver

Dinornis hercules Oliver, 1949, Moas N. Zealand and Australia, p. 174 (type from Coonoor, tibia, Dominion Mus., Wellington).

QUATERNARY. NEW ZEALAND: NORTH ISLAND: Coonoor (Oliver, 1949); Waitomo, Mangaone, Te Aute, Makirikiri, Doubtless Bay, Moawhango, Poverty Bay, and Awhitu (Oliver, 1955, p. 588).

Order APTERYGIFORMES (Haeckel)

Apterygia Haeckel, 1866, Generelle Morphologie der Organismen, vol. 2, p. 139 (type *Apteryx* Shaw).

Family APTERYGIDAE (Gray)

Apteryginae Gray, 1840, List Genera Birds, p. 63 (type *Apteryx* Shaw, Recent).

Genus †*Pseudapteryx* Lydekker

Pseudapteryx Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 218 (type by monotypy *Pseudapteryx gracilis* Lydekker).

1. *Pseudapteryx gracilis* Lydekker

Pseudapteryx gracilis Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 218, fig. 53A (type left tarsometatarsus, Brit. Mus. no. 32237a).

PLEISTOCENE. NEW ZEALAND.

Neospecies of Apterygidae from Quaternary sites:

1. *Apteryx australis* Shaw. NEW ZEALAND: SOUTH ISLAND: Timaru and Nelson (Lydekker, 1891, p. 216); Pyramid Valley (Scarlett, 1955, Rec. Canterbury Mus., vol. 6, no. 4, p. 261). NORTH ISLAND: Waingongoro (Lydekker, 1891, p. 217).

2. *Apteryx owenii* Gould. NEW ZEALAND: SOUTH ISLAND? (Lydekker, 1891, p. 218). NORTH ISLAND: Akiteo, Kamao, Opito, Hukanui, Pigeon Bush, and Rangatapu Pa (Scarlett, 1962, Notornis, vol. 10, p. 84).

3. *Apteryx haastii* Potts. NEW ZEALAND: SOUTH ISLAND: Nelson (Lydekker, 1891, p. 217).

Infraclass CARINATAE Merrem[1]

Aves Carinatae Merrem, 1813, Abh. Akad. Wiss. Berlin, p. 259.—*Carinatae* Huxley, 1887, Proc. zool. Soc. London, p. 418 (order).
Neognathae Pycraft, 1900, Trans. zool. Soc. London, vol. 15, p. 149.

Order GAVIIFORMES Wetmore and W. D. Miller

Enaliornithes Fürbringer, 1888, Untersuch. Morph. Syst. Vögel, vol. 2, p. 1543 ("gens;" type *Enaliornis* Seeley).
Colymbiformes Sharpe, 1891, Review Recent Attempts to Classify Birds, p. 71 (order; type *Colymbus* Linnaeus, i.e. loons).—*Colymbi* Gadow, 1893, Bronn Klass. Ordn., Vögel, pt. 2, pp. 76, 121, 299 (Unterordnung, for loons).
Gaviiformes Wetmore and W. D. Miller, 1926 (July), Auk, vol. 43, no. 3, p. 340 (type *Gavia* Forster).

Family †Enaliornithidae Fürbringer

Enaliornithidae Fürbringer, 1888, Untersuch. Morph. Syst. Vögel, vol. 2, pp. 1152, 1426 note, 1543, 1565 (type *Enaliornis* Seeley).

Genus †*Enaliornis* Seeley

Palaeocolyntus [sic] Seeley, 1864, Proc. Cambridge philos. Soc., vol. 1, p. 228 (nomen nudum, title only, no text).
Pelargonis [sic] Seeley, 1864, op. cit., p. 228 (nomen nudum, title only).
Pelagornis Seeley, 1866, Ann. Mag. nat. Hist., ser. 3, vol. 18, p. 110 (nomen nudum).—Seeley, 1876, Quart. Jour. geol. Soc. London, vol. 32, p. 497 footnote (type by monotypy *Pelagornis sedgwicki* Seeley; name available from this date, but rejected by Seeley and preoccupied by *Pelagornis* Lartet, 1857).
Enaliornis Seeley, 1869, Index to the fossil remains of Aves, Ornithosauria, and Reptilia from the secondary system of strata arranged in the Woodwardian Museum of the University of Cambridge, p. xvii (nomen nudum; the reference to p. 7 of this work is merely a list of elements, without description or name).—Seeley, 1876 (after June 7), Quart. Jour. geol. Soc. London, vol. 32, p. 499 (name valid from this date; type by present designation *Enaliornis barretti* Seeley).
Palaeocolymbus Seeley, 1876 (after June 7), Quart. Jour. geol. Soc. London, vol. 32, p. 497 footnote (name available from this date, but rejected by Seeley; type by monotypy *Palaeocolymbus barretti* Seeley).

1. *Enaliornis barretti* Seeley

Palaeocolyntus [sic] *Barretti* Seeley, 1864, Proc. Cambridge philos. Soc., vol. 1, p. 228 (nomen nudum, title of article only).
Pelagornis Barretti Seeley, 1866, Ann. Mag. nat. Hist., ser. 3, vol. 18, p. 110 (nomen nudum).—Seeley, 1876 (after June 7), Quart. Jour. geol. Soc. London, vol. 32, p. 496.
Enaliornis Barretti Seeley, 1869, Index Aves Woodwardian Mus., p. xvii (nomen nudum).—Seeley, 1876 (after June 7), Quart. Jour. geol. Soc. London, vol. 32, p. 499, pl. 26, fig. 1-11, 14-27; pl. 27, fig. 1-5, 19-25 (original description;

[1]New rank.

lectotype by present designation from near Cambridge, distal end of left tarsometatarsus, coll. of T. Jesson; cast Brit. Mus. no. A.1112).
Palaeocolymbus Barretti Seeley, 1876, op. cit., p. 497 footnote.

LOWER CRETACEOUS, ALBIAN (Upper Greensand). ENGLAND: Cambridgeshire: probably near Coldham Common or Granchester.

2. *Enaliornis sedgwicki* Seeley

Pelargonis [sic] *Sedgwicki* Seeley, 1864, Proc. Cambridge philos. Soc., vol. 1, p. 228 (title of article only).
Enaliornis Sedgwicki Seeley, 1869, Index Aves Woodwardian Mus., p. xvii (nomen nudum).—Seeley, 1876 (after June 7), Quart. Jour. geol. Soc. London, vol. 32, p. 501, pl. 26, fig. 12-13; pl. 27, fig. 6-7, 9-11, 13-18 (original description; lectotype by present designation, from near Cambridge, proximal end of right tibiotarsus, Woodwardian Mus.).
Pelagornis Sedgwicki Seeley, 1876 (after June 7), Quart. Jour. geol. Soc. London, vol. 32, p. 497 footnote.

LOWER CRETACEOUS, ALBIAN (Upper Greensand). ENGLAND: Cambridgeshire: probably near Coldham Common or Granchester.

Family †LONCHODYTIDAE Brodkorb

Lonchodytidae Brodkorb, 1963 (in press), Proc. XIII internat. ornith. Congr. Ithaca, p. 000 (type *Lonchodytes* Brodkorb).

Genus †*Lonchodytes* Brodkorb

Lonchodytes Brodkorb, 1963 (in press), Proc. XIII internat. ornith. Congr. Ithaca, p. 000 (type by original designation *Lonchodytes estesi* Brodkorb).

1. *Lonchodytes estesi* Brodkorb

Lonchodytes estesi Brodkorb, 1963 (in press), Proc. XIII internat. ornith. Congr. Ithaca, p. 000, fig. 1-2 (type from Lance Creek, distal part of right tarsometatarsus, Univ. Calif. Mus. Paleo. no. 53954).

UPPER CRETACEOUS, MAESTRICHTIAN (Lance formation). WYOMING: Niobrara County: Lance Creek.

2. *Lonchodytes pterygius* Brodkorb

Lonchodytes pterygius Brodkorb, 1963 (in press), Proc. XIII internat. ornith. Congr. Ithaca, p. 000, fig. 3 (type from Lance Creek, distal part of left carpometacarpus, Univ. Calif. Mus. Paleo. no. 53961).

UPPER CRETACEOUS, MAESTRICHTIAN (Lance formation). WYOMING: Niobrara County: Lance Creek.

Family Gaviidae Allen

Colymbidae "Leach," Vigors, 1825, Trans. Linn. Soc. London, vol. 14, p. 498 (type *Colymbus* Linnaeus, i.e., loons, in contrast with *Podiceps* Latham).

Colymbinae Bonaparte, 1831, Saggio di una distribuzione metodica degli Animali Vertebrati, p. 62 (subfamily for loons).

Urinatoridae Ridgway, 1887, Man. N. Amer. Birds, pp. 4, 6 (type *Urinator* Cuvier, 1800, a junior synonym of *Gavia* Forster, 1788).

Gaviidae J. A. Allen, 1897 (July), Auk, vol. 14, no. 3, p. 312 (type *Gavia* Forster).

Subfamily †Colymboidinae Brodkorb[1]

Genus †*Eupterornis* Lemoine

Eupterornis Lemoine, 1878, Recherches sur les oiseaux fossiles des terrains tertiaires inférieurs des environs de Reims, vol. 1, p. 56 (type by monotypy *Eupterornis remensis* Lemoine). Position tentative.

1. *Eupterornis remensis* Lemoine

Eupterornis remensis Lemoine, 1878, op. cit., pp. 12, 56, pl. 5, fig. 1-6 (types distal half of left ulna, phalanx 1 of index finger).

Upper Paleocene (conglomerate de Cernay). France: Dept. Marne: Châlons-sur-Vesle near Soissons.

Genus †*Colymboides* Milne-Edwards

Colymboides Milne-Edwards, 1867, Ois. Foss. France, vol. 1, pl. 54, fig. 1-14; Milne-Edwards, 1868, op. cit., vol. 1, sheet 38, p. 297 (type by monotypy *Colymboides minutus* Milne-Edwards).

Hydrornis Milne-Edwards, 1867, Ois. Foss. France, vol. 1, pl. 57, fig. 18-22; Milne-Edwards, 1868, op. cit., vol. 1, sheet 46, p. 362 (type by monotypy *Hydrornis natator* Milne-Edwards).

Dyspetornis Oberholser, 1905 (May 13), Smithsonian misc. Coll., vol. 48, pt. 1, no. 1579, p. 61 (new name for *Hydrornis* Milne-Edwards, preoccupied by *Hydrornis* Blyth, 1843).

2. *Colymboides anglicus* Lydekker

Colymboides anglicus Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 192, fig. 43 (type left coracoid, Brit. Mus. no. 30330).

Upper Eocene (Hordwell beds). England: Hampshire: Hordwell.

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[1]New subfamily. Type *Colymboides* Milne-Edwards. Storer (1956, Condor, vol. 58, pp. 413-426, fig. 1-4) enumerates many morphological differences between *Colymboides* and modern loons. In addition the hypotarsus of *Colymboides* presents an almost procellarine appearance, with two or three closed canals followed by grooves behind, and with the main hypotarsal ridges far separated on the plantar surface. In *Gavia* a single immense ring, formed by fusion of the main hypotarsal ridges, encloses all the plantar tendons.

3. *Colymboides minutus* Milne-Edwards

Colymboides minutus Milne-Edwards, 1867, Ois. Foss. France, pl. 54, fig. 1-14; 1868, vol. 1, sheet 38, p. 297 (types right humerus, right ulna, 2 left femora, Paris Mus.).

Hydrornis natator Milne-Edwards, 1867, Ois. Foss. France, vol. 1, pl. 57, fig. 18-22; 1868, sheet 46, p. 362 (type right tarsometatarsus, Paris Mus.).

LOWER MIOCENE (Aquitanian). FRANCE: Dept. Allier: Langy.

Subfamily †GAVIELLINAE Wetmore

Gaviellinae Wetmore, 1940 (Jan. 2), Jour. Morphol., vol. 66, no. 1, p. 30 (type *Gaviella* Wetmore).

Genus †*Gaviella* Wetmore

Gaviella Wetmore, 1940 (Jan. 2), Jour. Morphol., vol. 66, no. 1, p. 28 (type by original designation *Gavia pusilla* Shufeldt).

4. *Gaviella pusilla* (Shufeldt)

Cavia pusilla Shufeldt, 1915 (Feb.), Trans. Connecticut Acad. Arts Sci., vol. 19, p. 70, pl. 13, fig. 106 (type proximal portion of left carpometacarpus, Yale Peabody Mus. no. 864).

OLIGOCENE (White River group). WYOMING: Niobrara County: near Lusk.

Subfamily GAVIINAE (Allen)

Gaviinae Wetmore, 1940 (Jan. 2), Jour. Morphol., vol. 66, no. 1, p. 30.

Genus *Gavia* Forster[1]

Colymbus Linnaeus, 1758, Syst. Nat., ed. 10, vol. 1, p. 135 (type *Colymbus arcticus* Linnaeus, designated by Gray, 1855, Cat. Gen. Subgen. Birds, p. 125, and by Lawrence, 1858, Rept. Expl. Surv. R.R. Pac., vol. 9, p. 887). Generic name suppressed by the International Commission, when it could not decide which was the type species.[2]

Cavia Forster, 1788, Enchiridion historiae naturali, p. 38 (type *Colymbus immer* Brünnich; see Allen, 1907, Bull. Am. Mus. nat. Hist., vol. 23, p. 290).

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[1] *Gavia*, sp. indet., recorded from Middle Miocene (Calvert formation) near Plum Point, Calvert County, Maryland (Wetmore, 1941, Auk, vol. 58, p. 567).

[2] It would seem that *Colymbus* should be restored as the generic name of the loons, with the names of the corresponding higher taxa altered accordingly. The designation of *Colymbus arcticus* as type of the genus long antedates the designation of a grebe, *Colymbus cristatus* Linnaeus, by Baird, Brewer, and Ridgway (1884, Water Birds N. Amer., vol. 2, p. 425) and by Hellmayr and Conover (1948, Field Mus. Publ., zool. ser., vol. 13, pt. 1, no. 2, p. 18). The action of Brisson (1760, Ornithologia, vol. 6, p. 33) in "eliminating" the loons from *Colymbus* appears to have no bearing under the rules as written, in spite of the urging of Stejneger (1882, Proc. U. S. nat. Mus., vol. 5, p. 42) and Allen (1897, Auk, vol. 14, p. 312), who were operating under a different code. Salomonsen (1951, Proc. X internat. ornith. Congress, pp. 149-154) has outlined the history of this nomenclatorial controversy. I use *Gavia* here, with reluctance, in deference to the International Commission.

5. *Gavia palaeodytes* Wetmore

Gavia palaeodytes Wetmore, 1943 (June 23), Proc. New England zool. Club, vol. 22, p. 64, fig. 1-2 (type from Pierce, left coracoid, Mus. Comp. Zool. Harvard no. 2369; cast Brodkorb coll.).

LOWER PLIOCENE (Bone Valley gravel). FLORIDA: Polk County: Pierce (Wetmore, 1943); Brewster (Brodkorb, 1953, Condor, vol. 55, p. 212).

6. *Gavia concinna* Wetmore

Gavia concinna Wetmore, 1940 (Jan. 2), Jour. Morphol., vol. 66, no. 1, p. 25, fig. 1-4 (type from Sweetwater Canyon, proximal portion of left ulna, U. S. Nat. Mus. no. 16160).

LOWER PLIOCENE (Bone Valley gravel). FLORIDA: Polk County: near Brewster (Brodkorb, 1953, Condor, vol. 55, p. 211).

MIDDLE PLIOCENE (Etchegoin formation). CALIFORNIA: Monterey County: Sweetwater Canyon east of King City (Wetmore, 1940).

MIDDLE PLIOCENE (San Diego formation). CALIFORNIA: San Diego County: San Diego (Howard, 1949, Publ. Carnegie Instn. Washington, no. 584, p. 185).

7. *Gavia howardae* Brodkorb

Gavia howardae Brodkorb, 1953 (July 20), Condor, vol. 55, no. 4, p. 212, fig. 1B (type from San Diego, distal portion of left humerus, Los Angeles Mus. no. 2111).

MIDDLE PLIOCENE (San Diego formation). CALIFORNIA: San Diego County: San Diego. Reported in error from Florida (Wetmore, 1956, Smithsonian misc. Coll., vol. 131, no. 5, p. 7).

8. *Gavia portisi* (Regàlia)

Colymbus portisi Regàlia, 1902, Palaeontogr. italica, vol. 8, p. 231, pl. 27, fig. 19-20 (type from Orciano Pisano, cervical vertebra, Roberto Lawley coll. on deposit in Istituto di Studi Superiori in Florence).

MIDDLE PLIOCENE (argille marine). ITALY: provincia di Pisa: Orciano Pisano near Valle di Fine.

Neospecies of Gaviidae from Pleistocene and *prehistoric sites:

1. *Gavia stellata* (Pontoppidan). DENMARK: Mejlgaard, Havnoe, Erteboelle, Gudumlund, Klintesoe, Havelse, Soelager, Orum Aa, and *Kolding Fjord

(H. Winge, 1903, Vidensk. Meddel. naturh. Foren. Copenhagen, vol. 6, p. 91). IRELAND: Shandon cave (Lydekker, 1891, Ibis, p. 394). ENGLAND: Mundesley (E. T. Newton, 1883, Geol. Mag., p. 97, pl. 3). ITALY: Grotta Romanelli and Grotta dei Colombi? (Lambrecht, 1933, Handb. Palaeorn., p. 731). ALASKA: *St. Lawrence Island (Friedmann, 1934, Jour. Washington Acad. Sci., vol. 24, p. 86); *Amaknak Island and *Cape Denbeigh (Friedmann, 1934, op. cit., pp. 231, 237); *Kodiak Island (Friedmann, 1935, op. cit., vol. 25, p. 46); *Cape Prince of Wales (Friedmann, 1941, op. cit., vol. 31, p. 405). CALIFORNIA: Newport Bay (Howard, 1958, Condor, vol. 60, p. 136); *Emeryville (Howard, 1929, Univ. Calif. Publ. Zool., vol. 32, p. 326).

2. *Gavia arctica* (Linnaus). DENMARK: Fannerup, Mejlgaard, Erteboelle, Maglemose, Klintesoe, Soelager, *Borresbjerg, and *Kolding Fjord (H. Winge, 1903, Vidensk. Meddel. naturh. Foren. Copenhagen, vol. 6, p. 91). ALASKA: *St. Lawrence Island (Friedmann, 1934, Jour. Washington Acad. Sci., vol. 24, p. 86); *Kodiak Island (Friedmann, 1935, op. cit., vol. 25, p. 46); *Dutch Harbor (Friedmann, 1937, op. cit., vol. 27, pp. 432, 435); *Cape Prince of Wales (Friedmann, 1941, op. cit., vol. 31, p. 405). WASHINGTON: *Puget Sound (L. Miller, 1960, Wilson Bull., vol. 72, p. 394). CALIFORNIA: San Pedro and ?Newport Bay (Howard, 1949, Condor, vol. 51, p. 21); *Buena Vista Lake (DeMay, 1942, Condor, vol. 44, p. 228).

3. *Cavia immer* (Brünnich). NORWAY: Vardo (Lambrecht, 1933, Handb. Palaeorn., p. 731). IRELAND: Edenvale Cave (Lambrecht, 1933). ALASKA: *Kodiak Island (Friedmann, 1934, Jour. Washington Acad. Sci., vol. 24, p. 234); *Little Kiska Island (Friedmann, 1937, op. cit., vol. 27, p. 436); *Cape Prince of Wales (Friedmann, 1941, op. cit., vol. 31, p. 405). WASHINGTON: *Puget Sound (L. Miller, 1960, Wilson Bull., vol. 72, p. 394). CALIFORNIA: San Pedro? (L. Miller, 1914, Univ. Calif. Publ. Geol., vol. 8, p. 33); Del Rey Hills? (Howard, 1936, Condor, vol. 38, p. 211); Lomita? (Howard, 1944, Bull. S. Calif. Acad. Sci., vol. 43, pt. 2, p. 75); Newport Bay (Howard, 1949, Condor, vol. 51, p. 21); *Emeryville (Howard, 1929, Univ. Calif. Publ. Zool., vol. 32, p. 325). NOVA SCOTIA: *Bear River and *Timber Island Brook (Halifax Mus.). MARYLAND: between Chesapeake Beach and Plum Point (Wetmore, 1962, Smithsonian misc. Coll., vol. 145, no. 2, p. 3). FLORIDA: Lake Monroe (Brodkorb, 1953, Condor, vol. 55, p. 214); Rock Spring (Woolfenden, 1959, Wilson Bull., vol. 71, p. 185); Wakulla Spring (Brodkorb coll.); *Big Pine Key (Wetmore, 1935, Auk, vol. 52, p. 300); *Good's shellpit (Neill, Gut, and Brodkorb, 1956, Amer. Antiquity, vol. 21, p. 388); *Green Mound (Hamon, 1959, Auk, vol. 76, p. 533); *Summer Haven (Brodkorb, 1960, Auk, vol. 77, p. 342). The supposed records from DENMARK (Lambrecht, loc. cit.) refer to *Gavia arctica*.

4. *Gavia adamsii* (Gray). ALASKA: *St. Lawrence Island (Friedmann, 1934, Jour. Washington Acad. Sci., vol. 24, p. 86); *Amaknak Island, *Cape Denbeigh, and *Kowieruk (Friedmann, 1934, op. cit., pp. 231, 237); *Kodiak Island (Friedmann, 1935, op. cit., vol. 25, p. 46); *Dutch Harbor and *Little Kiska (Friedmann, 1937, op. cit., vol. 27, pp. 432, 435-436); *Cape Prince of Wales (Friedmann, 1941, op. cit., vol. 31, p. 405).

Order PODICIPEDIFORMES (Fürbringer)

Podicipitiformes Fürbringer, 1888, Untersuch. Morph. Syst. Vögel, vol. 2, pp. 1543, 1565 (subordo; type *Podiceps* Latham).—*Podicipediformes* Sharpe, 1891, Review Recent Attempts to Classify Birds, p. 71 (order).—*Podicipedes* Gadow, 1893, Bronn Klass. Ordn., Vögel, pt. 2, pp. 76, 121, 299 (Unterordnung).

Family †BAPTORNITHIDAE American Ornithologists' Union

Baptornithidae American Ornithologists' Union, 1910, Check-list North Amer. Birds, ed. 3, p. 378 (type *Baptornis* Marsh).

Genus †*Baptornis* Marsh

Baptornis Marsh, 1877, Amer., Jour. Sci., ser. 3, vol. 14, p. 86 (type by monotypy *Baptornis advenus* Marsh).

1. *Baptornis advenus* Marsh

Baptornis advenus Marsh, 1877, Amer. Jour. Sci., ser. 3, vol. 14, p. 86 (type from Wallace Co., juvenile right tarsometatarsus, Yale Peabody Mus. no. 1465).

UPPER CRETACEOUS, CONIACIAN (Smoky Hill chalk member of Niobrara formation). KANSAS: Wallace County (Marsh, 1877); Butte Creek in Logan County (Lambrecht, 1933, Handb. Palaeorn., p. 258).

Genus †*Neogaeornis* Lambrecht

Neogaeornis Lambrecht, 1929, Pal. Zeitschr., vol. 11, p. 121 (type by monotypy *Neogaeornis wetzeli* Lambrecht).

2. *Neogaeornis wetzeli* Lambrecht

Neogaeornis wetzeli Lambrecht, 1929, Pal. Zeitschr., vol. 11, p. 121, fig. 1-4 (type from San Vicente Bay, tarsometatarsus, Kiel Univ. Mus.).

UPPER CRETACEOUS, MAESTRICHTIAN (Quiriquina beds). CHILE: Prov. Concepción: west end of San Vicente Bay, Tumbes peninsula (Lambrecht, 1929); Cerro del Concejo, Vegas del Gualpen, southeast of San Vicente in Dept. Talcahuano (Schneider, 1940, Revista Chilena Hist. Nat., p. 51).

Family PODICIPEDIDAE (Bonaparte)

Podicepinae Bonaparte, 1831, Saggio di una distribuzione metodica degli Animali Vertebrati, p. 62 (type *Podiceps* Latham.)—*Podicipidae* Bonaparte, 1853, C. R. Acad. Sci. Paris, vol. 37, no. 18, p. 646.—*Podicipedidae* Coues, 1880 (Sept. 30), Bull. U. S. geol. geog. Surv. Terr., vol. 5, no. 4, p. 1039.—*Podicipitidae* Forbes, 1884 (Jan.), Ibis, ser. 5, vol. 2, no. 5, p. 119.—*Podicipetidae* Allen, 1907 (Apr. 15), Bull. Amer. Mus. Nat. Hist., vol. 23, p. 287.

Genus *Podiceps* Latham

Podiceps Latham, 1787, Supplement to the General Synopsis of Birds, vol. 1, p. 294 (type *Colymbus cristatus* Linnaeus).

1. *Podiceps oligoceanus* (Shufeldt)

Colymbus oligoceanus Shufeldt, 1915 (Feb.), Trans. Connecticut Acad. Arts Sci., vol. 19, p. 54 (type distal part of left femur, Yale Peabody Mus. no. 983).—Wetmore, 1937, Proc. California Acad. Sci., ser. 4, vol. 23, no. 13, p. 197, fig. 6-7 (type restudied).

Lower Miocene (John Day formation). Oregon: Malheur County: lower reaches of Willow Creek.

2. *Podiceps pisanus* (Portis)

Fulica pisanus Portis, 1889, Gli ornitoliti del Valdarno superiore e di alcune altre località plioceniche di Toscana, p. 13, fig. 24-25 (type distal part of right humerus, Istituto di Studi Superiori, Florence).—*Podicipes pisanus* Regàlia, 1902, Palaeontogr. ital., vol. 8, p. 233, pl. 27 (1), fig. 21-22 (type restudied).

Middle Pliocene (argille marine). Italy: prov. di Pisa: Orciano Pisano near Valle di Fine.

3. *Podiceps subparvus* (L. Miller and Bowman)

Colymbus subparvus L. Miller and Bowman, 1958 (March 6), Los Angeles County Mus., Contr. in Sci., no. 20, p. 6, fig. 5 (type distal part of right femur, Los Angeles Mus. no. 2568).

Middle Pliocene (San Diego formation). California: San Diego County: San Diego (Washington Boulevard freeway south of University Avenue).

4. *Podiceps parvus* (Shufeldt)

Colymbus parvus Shufeldt, 1913 (July 9), Bull. Amer. Mus. Nat. Hist., vol. 32, art. 6, p. 136 in part, p. 155 in part, pl. 39, fig. 477 only (lectotype from Fossil Lake, right tarsometatarsus, Am. Mus. Nat. Hist. no. 3570, selected by Wetmore, 1937, Proc. California Acad. Sci., ser. 4, vol. 23, p. 199, fig. 14-15).

Lower Pleistocene (Tulare formation). California: Kern County: Standard Oil Company well, Title and Guaranty and Trust no. 1, in section 1, Township 25 South, Range 23 East (Wetmore, 1937).

Middle Pleistocene (Fossil Lake formation). Oregon: Lake County: Fossil Lake (Shufeldt, 1913).[1]

[1]Records from the Middle Pliocene San Diego formation of California (Miller and Bowman, 1958) probably refer to some other species.

5. *Podiceps dixi* Brodkorb

Podiceps dixi Brodkorb, 1963 (in press), Quart. Jour. Florida Acad. Sci., vol. 26, no. 1, p. 000, fig. 1-2 (type from Reddick, proximal part of right carpometacarpus, Brodkorb no. 1113).

MIDDLE PLEISTOCENE (Reddick beds). FLORIDA: Marion County: Dixie Lime Products Company mine, 1 miles south of Reddick.

Genus †*Pliodytes* Brodkorb

Pliodytes Brodkorb, 1953 (Dec.), Ann. Mag. nat. Hist., ser. 12, vol. 6, p. 953 (type by original designation *Pliodytes lanquisti* Brodkorb).

6. *Pliodytes lanquisti* Bordkorb

Pliodytes lanquisti Brodkorb, 1953 (Dec.), Ann. Mag. Nat. Hist., ser. 12, vol. 6 p. 953, fig. (type from Brewster, right coracoid, Brodkorb no. 299).

LOWER PLIOCENE (Bone Valley gravel). FLORIDA: Polk County: south of Brewster.

Neospecies of Podicipedidae from Pleistocene and *prehistoric sites:

1. *Podiceps ruficollis* (Pallas). DENMARK: Erteboelle and Soelager (H. Winge, 1903, Vidensk. Meddel. naturhist. Foren. Copenhagen, vol. 6, p. 90). IRELAND: Newhall Cave and Edenvale Cave (Lambrecht, 1933, Handb. Palaeorn., p. 731). ITALY: Grotta dei Colombi (Lambrecht, 1933). GERMANY: Weimar-Taubach (Lambrecht, 1933).

2. *Podiceps dominicus* (Linnaeus). BRAZIL: Lapa da Escrivania (O. Winge, 1887, E Mus. Lund., vol. 1, no. 2, p. 25).

3. *Podiceps rufopectus* (Gray). NEW ZEALAND: *Pyramid Valley Swamp (Scarlett, 1955, Rec. Canterbury Mus., vol. 6, p. 261).

4. *Podiceps auritus* (Linnaeus). ITALY: Grotta Romanelli, Terra d'Otranto, and Grotta dei Colombi (Lambrecht, 1933, Handb. Palaeorn., p. 731). HUNGARY: Pilisszanto (Lambrecht, 1913, Aquila, vol. 20, p. 428). MONGOLIA: Sjara-Osso-Gol, Ordos (Lambrecht, 1933, p. 731). ALASKA: *Kodiak Island (Friedmann, 1935, Jour. Washington Acad. Sci., vol. 25, p. 46). CALIFORNIA: San Pedro? (Howard, 1949, Condor, vol. 51, p. 21). NOVA SCOTIA: *Whynacht (Halifax Mus.). TENNESSEE: bone caves (Shufeldt, 1897, Amer. Natural., vol. 31, p. 646). FLORIDA: Seminole Field (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 12); Rock Spring (Woolfenden, 1959, Wilson Bull., vol. 71, p. 185). Erroneous records include Fossil Lake, Oregon (Shufeldt, 1892, Jour. Acad. nat. Sci. Philadelphia, vol. 9, p. 396; corrected by Howard, 1946, Publ. Carnegie Instn. Washington, no. 551, p. 148), and Itchtucknee River, Florida (Wetmore, 1931, p. 12), the latter based on a large humerus of *Podilymbus podiceps*, formerly Florida Geol. Surv. no. V-4619, now Brodkorb no. 8001.

5. *Podiceps caspicus* (Hablizl). HUNGARY: Nagyharsany Berg? (Lambrecht, 1916, Aquila, vol. 22, p. 174). WASHINGTON: *Puget Sound (L. Miller, 1960, Wil-

son Bull., vol. 72, p. 394). OREGON: Fossil Lake (Shufeldt, 1892, Jour. Acad. nat. Sci. Philadelphia, vol. 9, p. 396). CALIFORINA: San Pedro (Howard, 1949, Condor, vol. 51, p. 21); *Buena Vista Lake (DeMay, 1942, Condor, vol. 44, p. 228). NEVADA: Smith Creek Cave (Howard, 1952, Bull. S. Calif. Acad. Sci., vol. 51, pt. 2, p. 54). KANSAS: Jones Sink (Downs, 1954, Condor, vol. 56, p. 209). Recorded also from Middle Pliocene Edson beds of Ogallala formation, Sherman County, Kansas (Wetmore, 1937), Condor, vol. 39, p. 40), but needs comparison with newly described forms.

6. *Podiceps cristatus* (Linnaeus). DENMARK: Mejlgaard, Havnoe, Krabbesholm, Virksund, Erteboelle, Maglemose, Klintesoe, Hoensehals, Havelse, Soelager, Aalborg, and *Roesborg Soe (H. Winge, 1903, Viddensk. Meddel. naturhist. Foren. Copenhagen, vol. 6, p. 90). SWEDEN: near Önnarp (Lambrecht, 1933, Handb. Palaeorn., p. 731). IRELAND: Kesh Cave, Edenvale Cave, Bantick Cave, and Newhall Cave (Lambrecht, 1933). ENGLAND: Cambridgeshire fens (Milne-Edwards, 1868, Ibis, p. 364). ITALY: Grotta Romanelli (Lambrecht, 1933).

7. *Podiceps grisegena* (Boddaert). DENMARK: Erteboelle (H. Winge, 1903, Vidensk. Meddel. naturhist. Foren. Copenhagen, vol. 6, p. 90). CZECHOSLOVAKIA: Certova dira (Capek, 1910, Ber. V Internat. Orn. Kongr. Berlin, p. 941). ITALY: Grotta dei Colombi? (Lambrecht, 1933, Handb. Palaeorn., p. 731). ALASKA: *Kodiak Island (Friedmann, 1934, Jour. Washington Acad. Sci., vol. 24, p. 234). WASHINGTON: *Puget Sound (L. Miller, 1960, Wilson Bull., vol. 72, p. 394). NOVA SCOTIA: *Whynacht (Halifax Mus.). Recorded in error from Fossil Lake, Oregon (Shufeldt, 1892, Jour. Acad. nat. Sci. Philadelphia, vol. 9, p. 396; see Howard, 1946, Publ. Carnegie Instn. Washington, no. 551, pp. 148, 190).

8. *Aechmophorus occidentalis* (Lawrence). WASHINGTON: *Puget Sound (L. Miller, 1960, Wilson Bull., vol. 72, p. 394). OREGON: Fossil Lake (*Aechmophorus lucasi* L. Miller, Feb. 4, 1911, Univ. Calif. Publ. Geol., vol. 6, no. 4, p. 83, fig. 1-3; types tarsometatarsus, coracoid, femur, Univ. Calif. Mus. Paleo. nos. 12603-12605). CALIFORNIA: Rodeo and San Pedro (L. Miller, 1912, Univ. Calif. Publ. Geol., vol. 7, pp. 112, 115); Manix (Compton, 1934, Condor, vol. 36, p. 168); Del Rey Hills (Howard, 1936, Condor, vol. 38, p. 211); Newport Bay (Howard, 1949, Condor, vol. 51, p. 21); *Emeryville (Howard, 1929, Univ. Calif. Publ. Zool., vol. 32, p. 329); *Buena Vista Lake (DeMay, 1942, Condor, vol. 44, p. 228). Specimens from Fossil Lake and some of the Californian localities average large and are perhaps recognizable as a temporal subspecies, *Aechmophorus occidentalis lucasi* L. Miller.

9. *Podilymbus podiceps* (Linnaeus). OREGON: Fossil Lake (*Podilymbus magnus* Shufeldt, July 9, 1913, Bull. Amer. Mus. nat. Hist., vol. 32, art. 6, pp. 136, 155 in part, pl. 38, fig. 439-440, 449 only; types two left tarsometatarsi, AMNH no. 3574). CALIFORNIA: McKittrick (L. Miller, 1925, Univ. Calif. Publ. Geol. Sci., vol. 15, p. 307); Rancho La Brea (Howard, 1936, Condor, vol. 38, p. 34); *Buena Vista Lake (DeMay, 1942, Condor, vol. 44, p. 228). NEVADA: Smith Creek Cave (Howard, 1952, Bull. S. Calif. Acad. Sci., vol. 51, pt. 2, p. 54). ARIZONA: *Grand Falls (Hargrave, 1939, Condor, vol. 41, p. 207). TEXAS: Groesbeck Creek (Midwestern Univ.). ARKANSAS: *Lake Texarkana (Southern Methodist Univ.). FLORIDA: Seminole Field and Itchtucknee River (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 12); Haile (Brodkorb, 1953, Wilson Bull., vol. 65, p. 49); Reddick (Brodkorb, 1957, Jour. Paleont.,

vol. 31, p. 134); Arredondo (Brodkorb, 1959, Bull. Florida State Mus., vol. 4, p. 273); Rock Spring (Woolfenden, 1959, Wilson Bull., vol. 71, p. 185); Vero Beach, stratum 2 (Weigel, 1963, Florida geol. Surv. Spec. Publ., no. 10, p. 25); Santa Fe River (Brodkorb, 1963, Auk, vol. 80, p. 115); Jennys Spring, Hornsby Spring, and Lake Monroe (Brodkorb coll.); Bradenton (Univ. Florida); Bluffton, *Good's shellpit, *Lemon Bluff, and *Silver Glen Springs (Neill, Gut, and Brodkorb, 1956, Amer. Antiquity, vol. 21, p. 388); *South Indian Field (Weigel, 1959, Florida Anthropologist, vol. 12, p. 73). PUERTO RICO: *Barrio Canas (Wetmore, 1938, Auk, vol. 55, p. 53). MEXICO: near Tepexpan (Wetmore, 1949, Condor, vol. 51, p. 150). BRAZIL: Lapa da Escrivania (O. Winge, 1887, E Mus. Lund., vol. 1, pt. 2, pp. 4, 25). Specimens from Fossil Lake and some of the Floridian localities average large and are perhaps recognizable as a temporal subspecies, *Podilymbus podiceps magnus* Shufeldt.

Order SPHENISCIFORMES Sharpe

Spenisciformes Sharpe, 1891, Review of Recent Attempts to Classify Birds, p. 71 (type *Spheniscus* Brisson).

Family SPHENISCIDAE Bonaparte[1]

Spheniscidae Bonaparte, 1831, Saggio di una distribuzione metodica degli Animali Vertebrati, p. 62 (type *Spheniscus* Brisson).

Subfamily †PALAEEUDYPTINAE Simpson

Palaeeudyptinae Simpson, 1946 (Aug. 8), Bull. Amer. Mus. nat. Hist., vol. 87, p. 69 (type *Palaeeudyptes* Huxley).

Anthropornithinae Simpson, 1946 (Aug. 8), Bull. Amer. Mus. nat. Hist., vol. 87, p. 69 (type *Anthropornis* Wiman).

Genus †*Palaeeudyptes* Huxley

Palaeeudyptes Huxley, 1859, Quart. Jour. geol. Soc. London, vol. 15, p. 670 (type by monotypy *Palaeeudyptes antarcticus* Huxley).

1. *Palaeeudyptes marplesi* Brodkorb[2]

UPPER EOCENE (Burnside marl). NEW ZEALAND: SOUTH ISLAND: Burnside near Dunedin in Otago.

UPPER EOCENE (Transitional marl member of Blanche Point marls). SOUTH AUSTRALIA: Witton Bluff, at south end of Christie's Beach, 16 miles south of Adelaide (*Palaeeudyptes* cf. *antarcticus* Simpson, 1957, Rec. S. Austr. Mus., vol. 13, no. 1, p. 52, fig. 1; S. Austr. Mus. no. P10870).

2. *Palaeeudyptes antarcticus* Huxley

Palaeeudyptes antarcticus Huxley, 1859, Quart. Jour. geol. Soc. London, vol. 15, p. 670, fig. 1-2 (type from Kakanui, right tarsometatarsus, Brit. Mus. no. A.1048).

LOWER OLIGOCENE (type apparently from Kakanui limestone; others from the younger Maerewhenua greensand). NEW ZEALAND: SOUTH ISLAND: Kakanui near Oamaru (Huxley, 1859); Duntroon, Earth-

[1]A fragmentary femur of an unidentified penguin has been recorded from the Lower Eocene Heretaungan stage at Gore Bay, Cheviot, New Zealand (Marples, 1952, Pal. Bull., N. Zealand geol. Survey no. 20, p. 51).

[2]New species. Type from Burnside marl, left tarsometatarsus, Otago Mus. no. C.50.28; associated elements, Otago Mus. nos. C.50.25-47; referred specimens, Otago Mus. nos. C.48.73-81. Tarsometatarsus large and stout, with internal edge of shaft strongly concave (in *P. antarcticus* tarsometatarsus smaller, with internal edge nearly straight). Femur likewise large. Humerus short, with shaft sigmoid instead of straight. Ulna small. See Marples, 1952, Pal. Bull. N. Zealand geol. Surv., no. 20, pp. 31, 53, 55, 56, pl. 2, fig. 1; pl. 4, fig. 5; pl. 5; fig. 3, 6; pl. 8, fig. 1, 10, 11.

quakes near Duntroon, and Seal Rock near Brighton (Marples, 1952, Pal. Bull. N. Zealand geol. Surv., no. 20, p. 28).

MIDDLE OLIGOCENE (Burnside greensand). NEW ZEALAND: SOUTH ISLAND: Burnside near Dunedin (Marples, 1952).

MIDDLE? OLIGOCENE (Gambier limestone). SOUTH AUSTRALIA: Pritchard Brothers' Quarry, 7½ miles WNW of Mt. Gambier (Palaeeudyptinae, gen. et sp. indet., A, Simpson, 1957, Rec. S. Austral. Mus., vol. 13, p. 56, fig. 3; S. Austral. Mus. no. P 10863); referral tentative.

Genus †*Pachydyptes* Oliver

Pachydyptes Oliver, 1930, New Zealand Birds, p. 86 (type *Pachydyptes ponderosus* Oliver.)

3. *Pachydyptes ponderosus* Oliver

Pachydyptes ponderosus Oliver, 1930, N. Zealand Birds, p. 86, fig. (type from Fortification Hill, humerus, Dominion Mus. at Wellington no. 1450).

UPPER EOCENE (Runangan stage). NEW ZEALAND: SOUTH ISLAND: Fortification Hill near Oamaru (Oliver, 1930); Taylor's quarry at Cormacks near Oamaru (Marples, 1952, N. Z. Geol. Surv. Pal. Bull. 20, p. 37).

Genus †*Archaeospheniscus* Marples

Archaeospheniscus Marples, 1952 (May), Pal. Bull. N. Zealand geol. Surv., no. 20, p. 40 (type by original designation *Archaeospheniscus lowei* Marples).

4. *Archaeospheniscus lowei* Marples

Archaeospheniscus lowei Marples, 1952 (May), Pal. Bull. N. Zealand geol. Surv., no. 20, p. 40, pl. 2, fig. 4; pl. 4. fig. 4 (type incomplete skeleton, Otago Mus. no. C.47.20).

LOWER OLIGOCENE (Maerewhenua greensand). NEW ZEALAND: SOUTH ISLAND: Duntroon in North Otago.

5. *Archaeospheniscus lopdelli* Marples

Archaeospheniscus lopdelli Marples, 1952 (May), Pal. Bull. N. Zealand geol. Surv., no. 20, p. 41, text-fig. 2, pl. 3, fig. 9; pl. 4, fig 6; pl. 5, fig. 4; pl. 8, fig. 5 (type postcranial skeleton, Otago Mus. no. C.47.21).

LOWER OLIGOCENE (Maerewhenua greensand). NEW ZEALAND: SOUTH ISLAND: Duntroon.

Genus †*Duntroonornis* Marples

Duntroonornis Marples, 1952 (May), Pal. Bull. N. Zealand geol. Surv., no. 20, p. 42 (type by original designation *Duntroonornis parvus* Marples).

6. *Duntroonornis parvus* Marples

Duntroonornis parvus Marples, 1952 (May), Pal. Bull. N. Zealand geol. Surv., no. 20, p. 42, pl. 8, fig. 3-4 (type left tarsometatarsus, Otago Mus. no. C.47.31).

LOWER OLIGOCENE (Maerewhenua greensand). NEW ZEALAND: SOUTH ISLAND: Duntroon.

Genus †*Platydyptes* Marples

Platydyptes Marples, 1952 (May), Pal. Bull. N. Zealand geol. Surv., no. 20, p. 37 (type by original designation *Pachydyptes novaezealandiae* Oliver).

7. *Platydyptes novaezealandiae* (Oliver)

Pachydyptes novaezealandiae Oliver, 1930, N. Zealand Birds, p. 86 (types from Oamaru district, humerus, radius, ulna, scapula, 2 vertebrae, Dominion Mus. no. 1451).

LOWER OLIGOCENE (Maerewhenua greensand). NEW ZEALAND: SOUTH ISLAND: Duntroon (Marples, 1952, Pal. Bull. N. Zealand geol. Surv., no 20, p. 38; needs confirmation, radius and ulna only).

LOWER? OLIGOCENE (Wharekuri limestone?). NEW ZEALAND: SOUTH ISLAND: Waitaki Valley? (not Oamaru as labeled?, Marples, 1952).

MIDDLE? OLIGOCENE (Waitakian stage?). NEW ZEALAND: SOUTH ISLAND: Oamaru district (Oliver, 1930).

8. *Platydyptes amiesi* Marples

Platydyptes amiesi Marples, 1952 (May), Pal. Bull. N. Zealand geol. Surv., no. 20, p. 39, pl. 4, fig. 3; pl. 5, fig. 5 (types from Hakataramea valley, humerus, radius, Otago Mus. no. C.50.61).

MIDDLE OLIGOCENE (Waitakian stage). NEW ZEALAND: SOUTH ISLAND: Hakataramea valley in South Canterbury (Marples, 1952); White Rocks near Duntroon (Marples, 1952; possibly Duntroonian age).

Genus †*Korora* Marples

Korora Marples, 1952 (May), Pal. Bull. N. Zealand geol. Surv., no. 20, p. 43 (type by original designation *Korora oliveri* Marples).

9. *Korora oliveri* Marples

Korora oliveri Marples, 1952 (May), Pal. Bull. N. Zealand geol. Surv., no. 20 p. 43, pl. 8, fig. 7-8 (type tarsometatarsus, Otago Mus. no. G.48.7).

MIDDLE OLIGOCENE (Waitakian stage). NEW ZEALAND: SOUTH ISLAND: Hakataramea valley in South Canterbury.

Genus †*Anthropodytes* Simpson

Anthropodytes Simpson, 1959 (July 23), Proc. Roy. Soc. Victoria, vol. 71, pt. 2, p. 113 (type by original designation *Anthropodytes gilli* Simpson).

10. *Anthropodytes gilli* Simpson

Anthropodytes gilli Simpson, 1959 (July 23), Proc. Roy. Soc. Victoria, vol. 71, pt. 2, p. 113, fig. 1 (type right humerus, Nat. Mus. of Victoria, no. P 17167).

LOWER? MIOCENE (Balcombian stage). AUSTRALIA: western Victoria: south end of Devil's Den, on east bank of Glenelg River, north of Dartmoor.

Genus †*Notodyptes* Marples

Notodyptes Marples, 1953 (June), Scient. Rept. Falkland Is. Depend. Surv., no. 5, p. 11 (type by original designation *Notodyptes wimani* Marples).

11. *Notodyptes wimani* Marples

Notodyptes wimani Marples, 1953 (June), Sci. Rept. Falkland Is. Depend. Surv., no. 5, p. 11, pl. 2, fig. 2 (type left tarsometatarsus, Brit. Mus. no. A.3331).

LOWER MIOCENE (Seymour Island beds). SEYMOUR ISLAND.

Genus †*Anthropornis* Wiman

Anthropornis Wiman, 1905, Bull. geol. Instn. Upsala, vol. 6, p. 249 (type by monotypy *Anthropornis nordenskjöldi* Wiman).

Pachypteryx Wiman, 1905, Bull. geol. Instn. Upsala, vol. 6, p. 250 (type by monotypy *Pachypteryx grandis* Wiman).

12. *Anthropornis nordenskjoeldi* Wiman

Anthropornis nordenskjöldi Wiman, 1905, Bull. geol. Instn. Upsala, vol. 6, p. 249, pl. 12, fig. 6 (type left tarsometatarsus, Upsala Mus.).

LOWER MIOCENE (Seymour Island beds). SEYMOUR ISLAND.

13. *Anthropornis grandis* (Wiman)

Pachypteryx grandis Wiman, 1905, Bull. geol. Instn. Upsala, vol. 6, p. 250, pl. 12, fig. 3 (type distal part of right tarsometatarsus, Upsala Mus.).

LOWER MIOCENE (Seymour Island beds). SEYMOUR ISLAND.

Genus †*Orthopteryx* Wiman

Orthopteryx Wiman, 1905, Wiss. Ergebn. Schwed. Sudpolarexped., vol. 3, no. 1, p. 27 (type by monotypy *Orthopteryx gigas* Wiman).

14. *Orthopteryx gigas* Wiman

Orthopteryx gigas Wiman, 1905, Wiss. Ergebn. Schwed. Sudpolarexped., vol 3, no. 1, p. 27, pl. 8, fig. 2 (type pelvis, Upsala Mus.).

LOWER MIOCENE (Seymour Island beds). SEYMOUR ISLAND.

Genus †*Eosphaeniscus* Wiman

Eosphaeniscus Wiman, 1905, Bull geol. Instn. Upsala, vol. 6, p. 280 (type by monotypy *Eosphaeniscus gunnari* Wiman).
*Eosphenisc*us Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, pp. 97, 132, 165 (emendation).

15. *Eosphaeniscus gunnari* Wiman

Eosphaeniscus gunnari Wiman, 1905, Bull. Geol. Inst. Upsala, vol. 6, p. 280, pl. 12, fig. 5 (type right tarsometatarsus, Upsala Mus.).

LOWER MIOCENE (Seymour Island beds). SEYMOUR ISLAND.

Genus †*Delphirnornis* Wiman

Delphinornis Wiman, 1905, Bull. geol. Instn. Upsala, vol. 6, p. 250 (type by monotypy *Delphinornis larsenii* Wiman).

16. *Delphinornis larsenii* Wiman

Delphinornis larsenii Wiman, 1905, Bull. geol. Instn. Upsala, vol. 6, p. 250, pl. 12, fig. 1 (type left tarsometatarsus, Upsala Mus.).

LOWER MIOCENE (Seymour Island beds). SEYMOUR ISLAND.

Genus †*Ichtyopteryx* Wiman

Ichtyopteryx Wiman, 1905, Bull. geol. Instn. Upsala, vol. 6, p. 251 (type by monotypy *Ichtyopteryx gracilis* Wiman).
Ichthyopteryx Lambrecht, 1933, Handb. Palaeorn., p. 231 (emendation).

17. *Ichtyopteryx gracilis* Wiman

Ichtyopteryx gracilis Wiman, 1905, Bull. geol. Instn. Upsala, vol. 6, p. 251, pl. 12, fig. 4 (type distal part of right tarsometatarsus, Upsala Mus.).

LOWER MIOCENE (Seymour Island beds). SEYMOUR ISLAND.

Genus †*Arthrodytes* Ameghino

Arthrodytes Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, p. 143 (type by original designation *Paraptenodytes grandis* Ameghino).
Anthrodytes Simpson, 1957 (Apr. 30), Rec. S. Australian Mus., vol. 13, no. 1, p. 68 (lapsus or misprint for *Arthrodytes;* only included species *Anthrodytes? andrewsi* [Ameghino]).

18. *Arthrodytes grandis* (Ameghino)

Paraptenodytes grandis Ameghino, 1901, An. Soc. cien. argentina, vol. 51, p. 81 (lectotype from San Julián, distal part of left femur, Ameghino coll. or Buenos Aires Mus., selected by Simpson, 1946, Bull. Amer. Mus. nat. Hist., vol. 87, p. 34).—*Arthrodytes grandis* Ameghino, 1905, An. Mus. nac. Buenos Aires, vol. 13, pp. 144, 166, pl. 5, fig. 35; pl. 6, fig. 36 (types restudied).

LOWER MIOCENE (Juliense member of Patagonia formation). ARGENTINA: Ter. Santa Cruz: San Julián.

Subfamily †PALAEOSPHENISCINAE Simpson

Palaeospheniscinae Simpson, 1946 (Aug. 8), Bull. Amer. Mus. nat. Hist., vol. 87, art. 1, p. 69 (type *Palaeospheniscus* Moreno and Mercerat).

Genus †*Palaeospheniscus* Moreno and Mercerat

Palaeospheniscus Moreno and Mercerat, 1891 (May), An. Mus. La Plata, Pal. arg., vol. 1, pp. 16, 29 (type *Palaeospheniscus patagonicus* Moreno and Mercerat, designated by Ameghino, 1891, Rev. argentina Hist. nat., vol. 1, p. 447).

Apterodytes Ameghino, 1901, An. Soc. cien. argentina, vol. 51, p. 81 (type by monotypy *Apterodytes ictus* Ameghino). Preoccupied by *Apterodytes* J. Hermann, 1783, Tabl. Affin. An., p. 235.

Palaeoapterodytes Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, p. 156 (new name for *Apterodytes* Ameghino, because of similarity to "*Apterodyta* Sop. 1786," i.e. *Apterodita* Scopoli, 1786, Deliciae florae et faunae insubricae, pt. 2, p. 91).

19. *Palaeospheniscus gracilis* Ameghino

Palaeospheniscus gracilis Ameghino, 1899 (July), Sinopsis geológico-paleontológica, Suplemento, p. 9 (type from "Guaranítico de Patagonia," right tarsometatarsus, Ameghino coll.).—Ameghino, 1905, An. Mus. nac. Buenos Aires, vol. 13, pp. 111, 163, pl. 2, fig. 9 (type from golfo de San Jorge, redescribed).

Apterodytes ictus Ameghino, 1901, An. Soc. cien. argentina, vol. 51, p. 81 (type from Golfo de San Jorge, proximal half of right humerus, Ameghino coll., perhaps now in Buenos Aires Mus.).—*Palaeoapterodytes ictus* Ameghino, 1905, An. Mus. nac. Buenos Aires, vol. 13, pp. 120, 164, pl. 3, fig. 16 (type redescribed).

Palaeospheniscus medianus Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, pp. 108, 162, pl. 1, fig. 6 (type from Trelew, right tarsometatarsus, Museo La Plata).

LOWER MIOCENE (Patagonia formation, Juliense member).[1] ARGENTINA: Ter. Chubut: Gulf of San Jorge and Trelew (Ameghino, 1905).

20. *Palaeospheniscus patagonicus* Moreno and Mercerat

Palaeospheniscus patagonicus Moreno and Mercerat, 1891 (May), An. Mus. La Plata, Pal. arg., vol. 1, pp. 16, 31; 1891 (Aug. 5), pl. 1, fig. 7-9, 12-13,

[1]Type of *P. gracilis* attributed to Oligocene Deseado formation, but according to Simpson, 1946, probably drift from basal part of Patagonian.

15-16, 21, 23, 27; pl. 2, fig. 5 (lectotype from Trelew, left tarsometatarsus, La Plata Mus. no. 34, designated by Ameghino, 1891, Rev. argentina Hist. nat., vol. 1, p. 447).

LOWER MIOCENE (Patagonia formation, Juliense member). ARGENTINA: Ter. Chubut: Trelew.

21. *Palaeospheniscus menzbieri* Moreno and Mercerat

Palaeospheniscus menzbieri Moreno and Mercerat, 1891 (May), An. Mus. La Plata, Pal. arg., vol. 1, pp. 17, 33; 1891 (Aug. 5), pl. 1, fig. 3, 5-6, 10-11, 14, 17, 22, 24; pl. 2, fig. 6 (lectotype from Ter. Chubut, right tarsometatarsus, Mus. La Plata no. 62, designated by Ameghino, 1891, Rev. arg. Hist. nat., vol. 1, p. 447). Ameghino, 1905, An. Mus. nac. Buenos Aires, vol. 13, pp. 103, 162, pl. 1, fig. 3 (type from Trelew redescribed).

Palaeospheniscus interruptus Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, pp. 104, 162, pl. 1, fig. 4 (type from Trelew, right tarsometatarsus, Mus. La Plata).

[?]*Palaeospheniscus planus* Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, pp. 109, 163, pl. 1, fig. 7; pl. 2, fig. 7 (type from Golfo de San Jorge, left tarsometatarsus, coll. Ameghino).

LOWER MIOCENE (Patagonia formation, Juliense member). ARGENTINA: Ter Chubut: Trelew; Golfo de San Jorge.

22. *Palaeospheniscus rothi* Ameghino

Palaeospheniscus rothi Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, pp. 110, 163, pl. 2, fig. 8 (type from Trelew, left tarsometatarsus, La Plata Mus.).

Palaeospheniscus intermedius Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, pp. 113, 163, pl. 2, fig. 10 (type from Golfo de San Jorge, left tarsometatarsus, Ameghino coll.).

Palaeospheniscus affinis Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, pp. 114, 163, pl. 2, fig. 11 (type from Trelew, left tarsometatarsus, La Plata Mus.).

LOWER MIOCENE (Patagonia formation, Juliense member). ARGENTINA: Ter. Chubut: Trelew; Golfo de San Jorge.

Genus †*Perispheniscus* Ameghino

Perispheniscus Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, p. 117 (type by monotypy *Perispheniscus wimani* Ameghino).

Treleudytes Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, p. 156 (type by monotypy *Treleudytes crassa* Ameghino).

23. *Perispheniscus robustus* (Ameghino)

Palaeospheniscus robustus Ameghino, 1895, Bol. Inst. geog. argentina, vol. 15, p. 588, fig. 1 (type from Trelew, left humerus, Brit. Mus.).

Perispheniscus wimani Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, pp. 117, 164, pl. 2, fig. 14; pl. 3, fig. 14-15 (type from "costas de Patagonia," left tarsometatarsus, La Plata Mus.; referred humerus, Ameghino coll.).

Treleudytes crassa Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, p. 156, text-fig. 4 (type from Trelew, left tarsometatarsus, La Plata Mus.).

LOWER MIOCENE (Patagonia formation, Juliense member). ARGENTINA: Ter. Chubut: Trelew.

Genus †*Parasphenisc*us Ameghino

Paraspeniscus Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, p. 115 (type by original designation *Palaeospheniscus bergi* Moreno and Mercerat).

24. *Parasphenisc*us *bergi* (Moreno and Mercerat)

Palaeospheniscus bergi Moreno and Mercerat, 1891 (May), An. Mus. La Plata, Pal. arg., vol. 1, pp. 18, 34; 1891 (Aug. 5), pl. 1, fig. 2, 4, 18-20, 25-26; pl. 2, fig. 7-8 (lectotype from Trelew, left tarsometatarsus, La Plata Mus., selected by Ameghino, 1891, Rev. argentina Hist. nat., vol. 1, p. 447). *Parasphenisc*us *bergi* Ameghino, 1905, An. Mus. nac. Buenos Aires, vol. 13, pp. 115, 163, pl. 2, fig. 12 (type redescribed).

LOWER MIOCENE (Patagonia formation, Juliense member). ARGENTINA: Ter Chubut: Trelew.

25. *Parasphenisc*us *nereius* (Ameghino)

Palaeospheniscus nereius Ameghino, 1901, An. Soc. cien. argentina, vol. 51, p. 81 (type from Golfo de San Jorge, left tarsometatarsus, Ameghino coll.). *Parasphenisc*us *nereius* Ameghino, 1905, An. Mus. nac. Buenos Aires, vol. 13, pp. 116, 163, pl. 2, fig. 13 (type redescribed).

LOWER MIOCENE (Patagonia formation, Juliense member). ARGENTINA: Ter. Chubut: Golfo de San Jorge.

Subfamily †PARAPTENODYTINAE Simpson

Paraptenodytinae Simpson, 1946 (Aug. 8), Bull. Amer. Mus. nat. Hist., vol. 87, p. 69 (type *Paraptenodytes* Ameghino).

Genus †*Paraptenodytes* Ameghino

Paraptenodytes Ameghino, 1891 (Dec. 1), Rev. argentina Hist. nat., vol. 1, p. 447 (type by monotypy *Palaeospheniscus antarcticus* Moreno and Mercerat).

Metancyclornis Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, p. 129 (type by original designation *Paraptenodytes curtus* Ameghino).

26. *Paraptenodytes antarcticus* (Moreno and Mercerat)

Palaeospheniscus antarcticus Moreno and Mercerat, 1891 (May), An. Mus. La Plata, Pal. arg., vol. 1, pp. 16, 30; 1891 (Aug. 5), pl. 2, fig. 1-2, 4 (lectotype from mouth of Río Santa Cruz, associated right femur, tibiotarsus, tarsometa-

tarsus, La Plata Mus. nos. 2, 4, 6, designated by Ameghino, 1905, p. 139).—*Paraptenodytes antarticus* [sic] Ameghino, 1891, Rev. argentina Hist. nat., vol. 1, p. 447 (lapsus).—*Paraptenodytes antarcticus* Ameghino, 1905, An. Mus. nac. Buenos Aires, vol. 13, pp. 139, 166, pl. 5, fig. 32; pl. 6, fig. 33-34 (types restudied).

LOWER MIOCENE (Patagonia formation, Juliense member). ARGENTINA: Ter Santa Cruz: mouth of Río Santa Cruz. Ter. Chubut: south side of Río Chubut opposite Gaiman (Simpson, 1946, Bull. Amer. Mus. nat. Hist., vol 87, p. 9).

27. *Paraptenodytes andrewsi* Ameghino

Paraptenodytes andrewsi Ameghino, 1901, An. Soc. cien. argentina, vol. 51, p. 81 (types from San Julian, associated right humerus, right coracoid, proximal part of right scapula, Ameghino coll., now perhaps in Buenos Aires Mus.).—*Arthrodytes andrewsi* Ameghino, 1905, An. Mus. nac. Buenos Aires, vol. 13, pp. 146, 166, pl. 7, fig. 37; pl. 8, fig. 38-39 (types redescribed).

LOWER MIOCENE (Patagonia formation, Juliense member). ARGENTINA: Ter. Santa Cruz: San Julián.

28. *Paraptenodytes curtus* Ameghino

Paraptenodytes curtus Ameghino, 1901, An. Soc. cien. argentina, vol. 51, p. 81 (type from San Julián, right tarsometatarsus, Ameghino coll.).—*Metancyclornis curtus* Ameghino, 1905, An. Mus. nac. Buenos Aires, vol. 13, pp. 129, 165, pl. 4, fig. 25-26 (type redescribed).

LOWER MIOCENE (Patagonia, formation, Juliense member). ARGENTINA: Ter. Santa Cruz: San Julián.

Genus †*Isotremornis* Ameghino

Isotremornis Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, p. 134 (type by original designation *Isotremornis nordenskjöldi* Ameghino).

29. *Isotremornis nordenskjoeldi* Ameghino

Isotremornis nordenskjöldi Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, pp. 134, 165, pl. 4, fig. 28 [fig. 28a is duplicated, the upper one representing this species]; pl. 5, fig. 29-31 (holotype from San Julián, proximal part of left tarsometatarsus, with associated right humerus, distal half of left humerus, distal half of left femur, Ameghino coll., now perhaps in Buenos Aires Mus.; the right humerus was designated as lectotype by Simpson, 1946, p. 33, but this action appears invalid in view of Ameghino's wording).

LOWER MIOCENE (Patagonia formation, Juliense member). ARGENTINA: Ter. Santa Cruz: San Julián.

Genus †*Pseudospheniscus* Ameghino

Pseudospheniscus Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, p. 123 (type by original designation *Pseudospheniscus interplanus* Ameghino).

30. *Pseudosphensicus interplanus* Ameghino

Pseudospheniscus interplanus Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, p. 123 (type distal part of left tarsometatarsus, from San Julián, Ameghino coll., now perhaps in Buenos Aires Mus.).

Pseudospheniscus planus Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, p. 164, pl. 3, fig. 19 (same type; as first reviser I select *P. interplanus*).

LOWER MIOCENE (Patagonia formation, Juliense member). ARGENTINA: Ter. Santa Cruz: San Julián.

31. *Pseudospheniscus concavus* Ameghino

?*Pseudospheniscus concavus* Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, p. 124 (type from San Julián, distal half of right tarsometatarsus, Ameghino coll., now perhaps in Buenos Aires Mus.).

Pseudospheniscus convexus Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, p. 164, pl. 3, fig. 20 (same type; as first reviser I select *P. concavus*).

LOWER MIOCENE (Patagonia formation, Juliense member). ARGENTINA: Ter. Santa Cruz: San Julián.

Genus †*Neculus Ameghino*

Neculus Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, p. 127 (type by original designation *Neculus rothi* Ameghino).

32. *Neculus rothi* Ameghino

Neculus rothi Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, pp. 127, 165, pl. 4, fig. 23 (type from Trelew, distal part of left tarsometatarsus, La Plata Mus.).

LOWER MIOCENE (Patagonia formation, Juliense member). ARGENTINA: Ter. Chubut: Trelew.

Subfamily SPHENISCINAE (Bonaparte)

Spheniscidae Bonaparte, 1831, Saggio di una distribuzione metodica degli Animali Vertebrati, p. 62 (type *Spheniscus* Brisson).

No extinct fossil species.

Neospecies of Spheniscinae from Pleistocene sites:

1. *Eudyptes crestatus* (J. F. Miller). NEW ZEALAND: Waikouaiti (Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 196).
2. *Megadyptes antipodes* (Hombron and Jacquinot). NEW ZEALAND: Waikouaiti (Lydekker, 1891, p. 195).
3. *Eudyptula minor* (J. R. Forster). NEW ZEALAND: Waikouaiti (Lydekker, 1891, p. 197).

Order PROCELLARIIFORMES Fürbringer

Procellariiformes Fürbringer, 1888, Untersuch. Morph. Syst. Vögel, vol. 2, p. 1544 (intermediäre subordo; type *Procellaria* Linnaeus).

Family DIOMEDEIDAE (Gray)

Diomedeinae Gray, 1840, List Genera Birds, ed. 1, p. 78 (subfamily; type *Diomedea* Linnaeus).

Genus †*Gigantornis* Andrews

Gigantornis Andrews, 1916, Proc. zool. Soc. London, p. 519 (type by monotypy *Gibantornis eaglesomei* Andrews). Position tentative.

1. *Gigantornis eaglesomei* Andrews

Gigantornis eaglesomei Andrews, 1916, Proc. zool. Soc. London, p. 519, fig. 1-2 (type sternum, Brit. Mus.).

MIDDLE EOCENE (Ameki formation). NIGERIA: Omobialla district: Ameki, Port Harcourt Railway.

Genus †*Manu* Marples

Manu Marples, 1946, Trans. Roy. Soc. N. Zealand, vol. 76, pt. 2, p. 133 (type *Manu antiquus* Marples). Position tentative.

2. *Manu antiquus* Marples

Manu antiquus Marples, 1946, Trans. Roy. Soc. N. Zealand, vol. 76, pt. 2, p. 133, pl. 6, fig. 7-9.

LOWER OLIGOCENE (Macrewhenua greensand). NEW ZEALAND: South Island: near Duntroon in North Otago.

Genus *Diomedea* Linnaeus

Diomedea Linnaeus, 1758, Syst. Nat., ed. 10, vol. 1, p. 132 (type *Diomedea exulans* Linnaeus).

3. *Diomedea californica* L. Miller

Diomedea californica L. Miller, 1962 (Nov. 28), Condor, vol. 64, no. 6, p. 471, fig. 1 (type left tarsometatarsus, Univ. Calif. Mus. Paleo. no. 61392).

MIDDLE MIOCENE (Temblor formation). CALIFORNIA: Kern County: Sharktooth Hill, 7 miles northeast of Bakersfield.

4. *Diomedea anglica* Lydekker

Diomedea anglica Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 189, fig. 42 (types from Red Crag at Foxhall, right tarsometatarsus, phalanx 1 of toe IV, Ipswich Mus.; casts Brit. Mus. no. A.87).

LOWER PLIOCENE (Bone Valley formation). FLORIDA: Polk County: Pierce (Wetmore, 1943, Proc. New England zool. Club, vol. 22, p. 66; identification uncertain, specimen not comparable to type).

UPPER PLIOCENE (Coralline Crag). ENGLAND: Suffolk: Foxhall (Lydekker, 1891, Ibis, p. 395; specimen not comparable with type).

LOWER PLEISTOCENE (Red Crag). ENGLAND: Suffolk: Foxhall (Lydekker, 1891, Cat., p. 189).

Neospecies of Diomedeidae recorded from Pleistocene and *prehistoric sites:

1. *Diomedea exulans* Linnaeus. ENGLAND: Ilford (Lambrecht, 1933, Handb. palaeorn., p. 732). CHATHAM ISLANDS (Lambrecht, 1933, p. 273).

2. *Diomedea albatrus* Pallas. JAPAN: *Iki Island (Kuroda, 1959, Bull. biogeog. Soc. Japan, vol. 21, p. 73). ALASKA: *St. Lawrence Island (Friedmann, 1934, Jour. Washington Acad. Sci., vol. 24, p. 87); *Amaknak Island and *Kodiak Island (Friedmann, 1934, op. cit., pp. 231, 234); *Dutch Harbor, *Little Kiska, *Atka Island, and *Attu Island (Friedmann, 1937, op. cit., vol. 27, pp. 432-437). OREGON: *Maxwell Point (Wetmore, 1928, Condor, vol. 30, p. 191). CALIFORNIA: Del Rey Hills (Howard, 1936, Condor, vol. 38, p. 212); Newport Bay and ?San Pedro (Howard, 1949, Condor, vol. 51, p. 23); *Emeryville (Howard, 1929, Univ. Calif. Publ. Zool., vol. 32, p. 332).

3. *Diomedea nigripes* Audubon. ALASKA: *Kodiak Island (Friedmann, 1935, Jour. Washington Acad. Sci., vol. 25, p. 46). CALIFORNIA: San Pedro? (L. Miller, 1914, Univ. Calif. Publ. Geol., vol. 8, p. 34).

4. *Diomedea chlororhynchos* Gmelin. NEW ZEALAND: Waikouaiti (Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 189).

Family PROCELLARIIDAE (Boie)

Procellaridae Boie, 1826, Isis von Oken, vol. 19, col. 980 (type *Procellaria* Linnaeus).

Genus *Puffinus* Brisson

Puffinus Brisson, 1760, Ornithologia, vol. 1, p. 56 (type by tautonomy *Procellaria puffinus* Brünnich).

1. *Puffinus raemdonckii* (Van Beneden)

Larus raemdonckii Van Beneden, 1871, Bull. Acad. Sci. Belgique, ser. 2, vol. 32, no. 11, p. 258, fig. 1 (lectotype from Rupelmonde, distal part of left humerus, designated by Brodkorb, 1962, Auk, vol. 79, p. 707).

MIDDLE OLIGOCENE (Rupelian sand). BELGIUM: East Flanders: mouth of the Rupel. Prov. Antwerp: Edeghem (Van Beneden, 1871).

2. *Puffinus arvernensis* Milne-Edwards

Puffinus arvernensis Milne-Edwards, 1871, Ois. Foss. France, vol. 2, p. 572 (nomen nudum).—Milne-Edwards, in Shufeldt, Proc. Acad. nat. Sci. Philadelphia, p. 510, pl. 24, fig. 1-2 only (type from St.-Gérand-le-Puy, left tarsometatarsus, Paris Mus.).

LOWER MIOCENE (Aquitanian). FRANCE: Dept. Allier: Saint-Gérand-le-Puy. The record from the Tortonian at Grive-St.-Alban (Shufeldt, 1896) must represent some other species or a mixing of localities.

3. *Puffinus micraulax* Brodkorb

Puffinus micraulax Brodkorb, 1963 (in press), Quart. Jour. Florida Acad. Sci., vol. 26, no. 2, p. 000, fig. 0 (type from Gainesville, distal part of left humerus, Univ. Florida no. 4872).

LOWER MIOCENE (Hawthorne formation). FLORIDA: Alachua County: Gainesville.

4. *Puffinus aquitanicus* (Milne-Edwards)

Procellaria aquitanica Milne-Edwards, 1874, Bibl. École hautes Études Paris, sect. sci. nat., vol. 11, art. 3, p. 6, pl. 12, fig. 1 (type distal part of humerus).

MIDDLE MIOCENE (Burdigalian). FRANCE: Dept. Gironde: Faluns de Saucats.

5. *Puffinus antiquus* (Milne-Edwards)

Procellaria antiqua Milne-Edwards, 1874, Bibl. École hautes Études Paris, sect. sci. nat., vol. 11, art. 3, p. 7 (type proximal part of humerus).

MIDDLE MIOCENE (Burdigalian). FRANCE: Dept. Gironde: Faluns de Saucats.

6. *Puffinus conradi* Marsh

Puffinus conradi Marsh, 1870, Amer. Jour. Sci., ser. 2, vol. 49, no. 146, p. 212 (type distal part of left humerus, Acad. Nat. Sci. Phila. no. 13360; cast U. S. Nat. Mus.).—Shufeldt, 1915, Trans. Connecticut Acad. Arts Sci., vol. 19, p. 62, pl. 8, fig. 63-64 (type restudied).—Wetmore, 1926, Auk, vol. 43, p. 463 (type restudied).

MIDDLE MIOCENE (Calvert formation). MARYLAND: Calvert County.

7. *Puffinus inceptor* Wetmore

Puffinus inceptor Wetmore, 1930 (July 15), Proc. California Acad. Sci., ser. 4, vol. 19, no. 8, p. 86, fig. 1-3 (type from Sharktooth Hill, distal part of right humerus, Calif. Acad. Sci. no. 5223).

MIDDLE MIOCENE (Temblor formation). CALIFORNIA: Kern County: Sharktooth Hill, 7 miles northeast of Bakersfield.

8. *Puffinus priscus* L. Miller

Puffinus priscus L. Miller, 1961 (Oct. 3), Condor, vol. 63, no. 5, p. 399, fig. 1 center (type from Sharktooth Hill, distal third of left humerus, Univ. Calif. Mus. Paleo. no. 58185).

MIDDLE MIOCENE (Temblor formation). CALIFORNIA: Kern County: Sharktooth Hill.

9. *Puffinus mitchelli* L. Miller

Puffinus mitchelli L. Miller, 1961 (Oct. 3), Condor, vol. 63, no. 5, p. 400, fig. 1 right (type from Sharktooth Hill, distal half of right humerus, Univ. Calif. Mus. Paleo. no. 58184).

MIDDLE MIOCENE (Temblor formation). CALIFORNIA: Kern County: Sharktooth Hill.

10. *Puffinus diatomicus* L. Miller

Puffinus diatomicus L. Miller, 1925 (Aug.), Publ. Carnegie Inst. Washington, no. 349, p. 111, pl. 1-2, 7a (type from near Lompoc, skeleton impression, Univ. Calif. Mus. Paleo. no. 26541).

UPPER MIOCENE (Valmonte diatomite member of Monterey shale). CALIFORNIA: Los Angeles County: San Pedro breakwater (L. Miller, 1935, Univ. Calif. Los Angeles Publ. biol. Sci., vol. 1, p. 74); Lomita (Howard, 1955, Los Angeles County Mus., sci. ser. no. 17, p. 14); Sherman Oaks (Howard, 1962, Condor, vol. 64, p. 512).

UPPER MIOCENE (basal 1000 feet of Sisquoc formation). CALIFORNIA: Santa Barbara County: Johns Mansville "Celite" mines, 3½ miles south of Lompoc (L. Miller, 1925).

11. *Puffinus felthami* Howard

Puffinus felthami Howard, 1949 (June 22), Publ. Carnegie Instn. Washington, no. 584, p. 194, pl. 2, fig. 4, 6 (type distal part of right humerus, Los Angeles Mus. no. 2037).

LOWER PLIOCENE (Repetto formation). CALIFORNIA: Orange County: 3 miles north of Corona del Mar.

12. *Puffinus kanakoffi* Howard

Puffinus kanakoffi Howard, 1949 (June 22), Publ. Carnegie Instn. Washington, no. 584, pp. 187, 195 note, pl. 2, fig. 3, 5 (type tarsometatarsus, Los Angeles Mus. no. 2122).

MIDDLE PLIOCENE (San Diego formation). CALIFORNIA: San Diego County: San Diego.

Genus †*Argyrodyptes* Ameghino

Argyrodyptes Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, p. 121 (type by original designation *Argyrodyptes microtarsus* Ameghino).
Argyrodytes Trouessart, 1906, Rev. crit. Paléozool., vol. 10, pp. 90, 251 (emendation).

13. *Argyrodyptes microtarsus* Ameghino

Argyrodyptes microtarsus Ameghino, 1905 (Nov. 30), An. Mus. nac. Buenos Aires, vol. 13, pp. 121, 164, pl. 3, fig. 17-18 (lectotype by present designation distal part of left tibiotarsus, Ameghino coll., with associated distal part of right femur, now perhaps in Buenos Aires Mus.).

Lower Miocene (Patagonia formation, Juliense member). Argentina: Ter. Santa Cruz: Río Seco at San Julián.

Genus †*Plotornis* Milne-Edwards

Plotornis Milne-Edwards, 1878, Bibl. École hautes Études Paris, sect. sci. nat., vol. 11, art. 3, pp. 4-5 (type by monotypy *Plotornis delfortrii* Milne-Edwards).

14. *Plotornis delfortrii* Milne-Edwards

Plotornis delfortrii Milne-Edwards, 1878, Bibl. École hautes Études Paris, sect. sci. nat., vol. 11, art. 3, pp. 4-5, pl. 11 (types tarsometatarsus and distal part of humerus).

Middle Miocene (Molassee de Léognan). France: Dept. Gironde: Léognan near Bordeaux.[1]

Neospecies of Procellariidae from Pleistocene and °prehistoric sites:

1. *Macronectes giganteus* (Gmelin). New Zealand: Waingongoro (Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 187).

2. *Fulmarus glacialis* (Linnaeus). Norway: Vardo (Lambrecht, 1933, Handb. Palaeorn., p. 732). Alaska: °St. Lawrence Island (Friedmann, 1934, Jour. Washington Acad. Sci., vol. 24, p. 87); °Kodiak Island (Friedmann, 1934, op. cit., p. 234); °Dutch Harbor and °Attu Island (Friedmann, 1937, op. cit., pp. 435, 438). California: San Pedro (L. Miller, 1914, Univ. Calif. Publ. Geol., vol. 8, p. 35); Newport Bay (Howard, 1949, Condor, vol. 51, p. 21).

3. *Puffinus leucomelas* (Temminck). Japan: °Iki Island (Kuroda, 1959, Bull. biogeog. Soc. Japan, vol. 21, p. 73).

4. *Puffinus diomedea* (Scopoli). Portugal: Grotte de Furinha (Lambrecht, 1933, Handb. Palaeorn., p. 732). Gibraltar: Devils Tower (Bate, 1928, Jour. Roy. anthrop. Inst., vol. 58, p. 104). Sardinia: Grotto Pietro Tamponi on Tavo-

[1] *Fulmarus*, sp. indet., recorded from Middle Miocene Calvert formation at Chesapeake Beach, Maryland (Wetmore, 1926, Auk, vol. 43, p. 464).

lara Island (*Puffinus eyermani* Shufeldt, 1896, Proc. Acad. nat. Sci. Philadelphia, p. 511, pl. 24, fig. 3-4, 8; types right tibiotarsus, right tarsometatarsus, now U. S. Nat. Mus. no. 2166).

5. *Puffinus gravis* (O'Reilly). NOVA SCOTIA: Reid site (Halifax Mus.).

6. *Puffinus griseus* (Gmelin). SARDINIA: Grotta Pietro Tamponi (Regàlia, 1897, Avicula, vol. 1, p. 165); Monte Giovanni? (Lambrecht, 1933, Handb. Palaeorn., p. 732). ALASKA: *Dutch Harbor, *Little Kiska, and *Attu Island (Friedmann, 1937, Jour. Washington Acad. Sci., vol. 27, pp. 435-438).

7. *Puffinus tenuirostris* (Temminck). ALASKA: *St. Lawrence Island and *Amaknak Island (Friedmann, 1934, Jour. Washington Acad. Sci., vol 24, pp. 87, 231); *Cape Prince of Wales (Friedmann, 1941, op. cit., vol. 31, p. 405).

8. *Puffinus puffinus* (Brünnich). DENMARK: *Ordrup Mose (*Oestrelata* sp., H. Winge, 1903, Vidensk. Meddel. naturhist. Foren. Copenhagen, vol. 6, p. 92). GIBRALTAR: Devils Tower (Bate, 1928, Jour. Roy. anthrop. Inst., vol. 58, p. 104). SARDINIA: Grotta Pietro Tamponi? (Lambrecht, 1933, Handb. Palaeorn., p. 732). ITALY: Buca del Bersagliere (Lambrecht, 1933). BERMUDA: *caves (*Puffinus mcgalli* Shufeldt, Oct. 1916, Ibis, p. 630; type sternum; Brit. Mus.?). BAHAMAS: *Gordon Hills on Crooked Island (Wetmore, 1938, Auk, vol. 55, p. 51). FLORIDA: Melbourne (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 13). CALIFORNIA: San Pedro (L. Miller, 1914, Univ. Calif. Publ. Geol., vol. 8, p. 35); Del Rey Hills (Howard, 1936, Condor, vol. 38, p. 212); Newport Bay? (Howard, 1949, Condor, vol. 51, p. 21). Includes *Puffinus opisthomelas* Coues.

9. *Puffinus lherminieri* Lesson. BERMUDA: *caves (*Puffinus parvus* Shufeldt, Oct. 1916, Ibis, p. 632; types miscellaneous elements; Brit. Mus.?); Rail Cave, *Shearwater Cave, and *Castle Harbour Islands (Brodkorb coll.); *Cockroach Island (Wetmore, 1962, Smithsonian misc. Coll., vol. 145, no. 2, p. 15). BAHAMAS: *Gordon Hills on Crooked Island (Wetmore, 1938, Auk, vol. 55, p. 51). ST. THOMAS: *midden (Wetmore, 1918, Proc. U. S. nat. Mus., vol. 54, p. 514). ST. CROIX: *Concordia (Wetmore, 1937, Jour. Agr. Univ. Puerto Rico, vol. 21, p. 6). BARBUDA: caves (Univ. Florida). ANTIGUA: *Mill Reef midden (Univ. Florida).

10. *Pterodroma cahow* (Nichols and Mowbray). BERMUDA: *caves (*Aestrelata vociferans* Shufeldt, Oct. 1916, Ibis, p. 633; practically a nomen nudum except for generic characters; types Brit. Mus.?); Wilkinson Quarry and *Cockroach Island (Wetmore, 1960, Smithsonian misc. Coll., vol. 145, no. 2, p. 16); Rail Cave, Crane Crevice, and Wilson's Cave (Brodkorb coll.). BAHAMAS: *Gordon Hills on Crooked Island (Wetmore, 1938, Auk, vol. 55, p. 51).

11. *Pterodroma hasitata* (Kuhl). MARTINIQUE: *Paquemar (Wetmore, 1952, Auk, vol. 69, p. 460).

Family OCEANITIDAE (Salvin)

Oceanitinae Salvin, 1896, Cat. Birds Brit. Mus., vol. 25, pp. xiv, 343, 358 (subfamily; type *Oceanites* Keyserling and Blasius).

Hydrobatidae Mathews, 1912, Birds Australia, vol. 2, p. 9 (type *Hydrobates* Boie). Family name preoccupied by *Hydrobatidae* Gray, 1869, Hand-list Gen. Sp. Birds, pt. 1, p. 266 (type *Hydrobata* Vieillot, 1816, a junior synonym of *Cinclus* Bechstein, 1802) and antedated by *Oceanitinae* Salvin.

Genus *Oceanodroma* Reichenbach

Oceanodroma, Reichenbach, 1852, Avium systema naturale, p. iv (type by original designation *Procellaria furcata* Gmelin).

1. *Oceanodroma hubbsi* L. Miller

Oceanodroma hubbsi L. Miller, 1951 (March 27), Condor, vol. 53, no. 2, p. 78, fig. 1 (type skull, vertebrae, pelvis, left leg, Univ. Calif. Mus. Paleo. no. 39979).

UPPER MIOCENE (Capistrano formation). CALIFORNIA: Orange County: 1 mile south of Capistrano Beach.

Neospecies of Oceanitidae from the Quarternary:

1. *Oceanodroma hornbyi* (Gray). CHILE: Tocopilla (Stresemann, 1924, Ornith. Monatsber., p. 61).

Family PELECANOIDIDAE (Gray)

Halodrominae Bonaparte, 1856, C. R. Acad. Sci. Paris, vol. 37, no. 18, p. 643 (type *Halodroma* Illiger, 1811, a junior synonym of *Pelecanoides* Lacépède, 1800).

Pelecanoidinae Gray, 1871, Hand-list Genera and Species of Birds, pt. 3, pp. x, 102 (type *Pelecanoides* Lacépède).

Neospecies of Pelecanoididae from the Pleistocene.

1. *Pelecanoides garnotii* (Lesson). PERU: Islas de Lobos de Afuera (Clarke, 1882, Proc. philos. Soc. Glasgow, vol. 13, p. 573).

Order PELECANIFORMES Sharpe

Pelecaniformes Sharpe, 1891, Review of Recent Attempts to Classify Birds, p. 76 (type *Pelecanus* Linnaeus).

Suborder SULAE Sharpe

Sulae Sharpe, 1891, Review of Recent Attempts to Classify Birds, p. 76 (type *Sula* Brisson).

Family †ELOPTERYGIDAE Lambrecht

Elopterygidae Lambrecht, 1933, Handbuch Palaeorn., p. 287 (type *Elopteryx* Andrews)

Genus †*Elopteryx* Andrews

Elopteryx Andrews, 1913 (May), Geol. Mag., n.s., decade 5, vol. 10, no. 5, p. 195 (type by monotypy *Elopteryx nopcsai* Andrews).

1. *Elopteryx nopcsai* Andrews

Elopteryx nopcsai Andrews, 1913 (May), Geol. Mag., n.s., decade 5, vol. 10, no. 5, p. 195, fig. 1-2 (type from Szentpéterfalva, proximal part of left femur, Brit. Mus.).

UPPER CRETACEOUS, MAESTRICHTIAN (Transylvanian freshwater limestone). RUMANIA: Transylvania: Szentpéterfalva near Hatszeg (=Haţeg).

Genus †*Argillornis* Owen

Megalornis Seeley, 1866, Ann. Mag. nat. Hist., ser. 3, vol. 18, p. 110 (type by monotypy *Lithornis emuinus* Bowerbank). Preoccupied by *Megalornis* Gray, 1841, List. Gen. Birds, ed. 2, p. 85).

Argillornis Owen, 1878, Quart. Jour. geol. Soc. London, vol. 34, p. 124 (type *Argillornis longipennis* Owen).

2. *Argillornis emuinus* (Bowerbank)

Lithornis emuinus Bowerbank, 1854, Ann. Mag. nat. Hist., ser. 2, vol. 14, p. 263, fig. (type from Sheppey, "tibiotarsus" = shaft of humerus, Brit. Mus. no. 38941).

Lithornis emuianus Seeley, 1866, Ann. Mag. nat. Hist., ser. 3, vol. 18, p. 110 (lapsus or emendation).

Argillornis longipennis Owen, 1878, Quart. Jour. geol. Soc. London, vol. 34, p. 124, pl. 6, fig. 1-3, 7-12, 16 (types from Sheppey, fragments of associated right and left humeri, Brit. Mus. nos. A.5-9).

Argillornis longipes "Sharpe," Lambrecht, 1933, Handb. Palaeorn., p. 282 (lapsus; spelled correctly in Sharpe, 1899, Hand-list, vol. 1, p. 240).

LOWER EOCENE (London clay). ENGLAND: Kent: Sheppey Isle at mouth of Thames (Bowerbank, 1854): Eastchurch (Seeley, 1866).

MIDDLE EOCENE (Bruxellian). BELGIUM: Etterbeek near Brussels (Dollo, 1909, Ann. N. Y. Acad. Sci., vol. 19, no. 4, p. 111). Needs restudy.

Genus †*Eostega* Lambrecht

Eostega Lambrecht, 1929, C. R. X Congr. internat. Zool. Budapest 1927, p. 1272 (type by monotypy *Eostega lebedinskyi* Lambrecht).

3. *Eostega lebedinskyi* Lambrecht

Eostega lebedinskyi Lambrecht, 1929, C. R. X Congr. internat. Zool. Budapest 1927, p. 1272, fig. 12-13 (type from Kolozsmonostor, mandible, Wiener Naturhistorische Hofsmuseum).

MIDDLE EOCENE (Steinbruch Grobkalk). RUMANIA: Transylvania: Kolozsmonostor near Kolozsvár (Kluj), in the Siebenbürgen.

Family PHALACROCORACIDAE (Bonaparte)

Phalacrocoraceae Bonaparte, 1853, C. R. Acad. Sci. Paris, vol. 37, no. 18, p. 643 (type *Phalacrocorax* Brisson).
Phalacrocoracinae Bonaparte, 1854, Ann. Sci. nat. (Paris), vol. 1, p. 38.

Subfamily †GRACULAVINAE Fürbringer

Graculavinae Fürbringer, 1888, Untersuch. Morph. Syst. Vögel, vol. 2, p. 1565 footnote (type *Graculavus* Marsh).

Genus †*Graculavus* Marsh

Graculavus Marsh, 1872, Amer. Jour. Sci., ser. 3, vol. 3, p. 363 (type *Graculavus velox* Marsh, by gen. et sp. nov. convention, and by designation of Hay, 1902, Bull. U. S. Geol. Surv., no. 179, p. 533).
Limosavis Shufeldt, 1915 (Feb.), Trans. Connecticut Acad. Arts Sci., vol. 19, p. 19 (substitute name for *Graculavus* Marsh, considered inappropriate).

1. *Graculavus velox* Marsh

Graculavus velox Marsh, 1872, Amer. Jour. Sci., ser. 3, vol. 3, p. 363 (type from Hornerstown, proximal end of left humerus, Yale Peabody Mus. no. 855).

UPPER PALEOCENE (Hornerstown marl). NEW JERSEY: Ocean County: Hornerstown.

2. *Graculavus pumilus* Marsh

Graculavus pumilus Marsh, 1872, Am. Jour. Sci., ser. 3, vol. 3, p. 364 (lectotype from Hornerstown, "distal" [proximal] end of right humerus, Yale Peabody Mus. no. 1209, designated by Shufeldt, 1915, where said to be from Battle Creek, Kansas!).

UPPER PALEOCENE (Hornerstown marl). NEW JERSEY: Ocean County: Hornerstown.

Subfamily PHALACROCORACINAE Bonaparte

Phalacrocoracinae Bonaparte, 1854, Ann. Sci. nat. (Paris), vol. 1, p. 38 (type *Phalacrocorax* Brisson).

Genus †*Actiornis* Lydekker

Actiornis Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 56 (type by original designation *Actiornis anglicus* Lydekker).

3. *Actiornis anglicus* Lydekker

Actiornis anglicus Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 56, fig. 13 (type from Hordwell, proximal part of right ulna, Brit. Mus. no. 30328).

MIDDLE EOCENE (Hordwell beds). ENGLAND: Hampshire: Hordwell.

Genus *Phalacrocorax* Brisson

Phalacrocorax Brisson, 1760, Ornithologia, vol. 1, p. 60 (type *Pelecanus carbo* Linnaeus).

Oligocorax Lambrecht, 1933, Handb. Palaeorn., p. 290 (type *Graculus littoralis* Milne-Edwards, designated by Brodkorb, 1952, Condor, vol. 54, p. 175).

Miocorax Lambrecht, 1933, Handb. Palaeorn., p. 291 (type *Phalacrocorax femoralis* Miller, designated by Brodkorb, 1952).

Paracorax Lambrecht, 1933, Handb. Palaeorn., p. 292 (type *Phalacrocorax destefanii* Regàlia, designated by Brodkorb, 1952).

Australocorax Lambrecht, 1933, Handb. Palaeorn., p. 292 (type *Phalacrocorax vetustus* DeVis, designated by Brodkorb, 1952).

4. *Phalacrocorax mediterraneus* Shufeldt

Phalacrocorax mediterraneus Shufeldt, 1915 (Feb.), Trans. Connecticut Acad. Arts Sci., vol. 19, p. 58, pl. 15, fig. 138 (type from Gerry's Ranch, proximal part of right carpometacarpus, Yale Peabody Mus. no. 943).

LOWER or MIDDLE OLIGOCENE (White River formation). COLORADO: Weld County: Gerry's Ranch at Chalk Bluffs, Township 11 North, Range 64 West.

5. *Phalacrocorax littoralis* (Milne-Edwards)

Graculus littoralis Milne-Edwards, 1863 (after June 29), C. R. Acad. Sci. Paris, vol. 56, p. 1222 (type from Dept. Allier; almost a nomen nudum). —Milne-Edwards, 1867, Ois, Foss. France, vol. 1, sheet 33, p. 263, pl. 42, fig. 5-12; pl. 43, fig. 1-7; pl. 44, fig. 1-8 (types complete left coracoid from Saint-Pourçain in coll. Poirrier; complete right humerus from Billy in coll. Milne-Edwards; and from Dept. Allier in coll. Milne-Edwards proximal part of left metatarsus, proximal two-thirds of left ulna, proximal part of left femur, and distal end of left tibia; all figured but the last two not described).

LOWER MIOCENE (Aquitanian). FRANCE: Dept. Allier: Saint-Pourçain and Billy (Milne-Edwards, 1867); Vaumas and Langy (Paris, 1912, Rev. française Ornith., vol. 4, p. 289).

LOWER MIOCENE (Hydrobienkalk?). GERMANY: harbor construction at Frankfort am Main (Lambrecht, 1933, Handb. Palaeorn., p. 290).

6. *Phalacrocorax miocaenus* (Milne-Edwards)

Graculus miocaenus Milne-Edwards, 1867, Ois. Foss. France, vol. 1, sheet 32, p. 255, pl. 39, fig. 5-18; pl. 40-41; pl. 42, fig. 1-4 (types from Langy, left tarsometatarsus, left tibia, right femur, pelvis, sternum, upper fragment of furculum, left coracoid, several scapulae, right humerus, right ulna, radius, carpometacarpus, alar digits II-1 and III, coll. Milne-Edwards).

LOWER MIOCENE (Aquitanian). FRANCE: Dept. Allier: Langy (Milne-Edwards, 1867); Vaumas (Paris, 1912, Rev. Franç, Orn., vol. 4, p. 289); St.-Gerand-le-Puy and Montaigu (Lambrecht, 1933, Handb. Palaeorn., p. 290).

7. *Phalacrocorax subvolans* Brodkorb

Phalacrocorax subvolans Brodkorb, 1956 (Sept. 24), Condor, vol. 58, no. 5, p. 367, fig. 1 (type from Thomas Farm, proximal part of right humerus, Univ. Florida no. 4500).

LOWER MIOCENE (Thomas Farm local fauna, Hawthorne age). FLORIDA: Gilchrist County: Thomas Farm, 8 miles north of Bell.

8. *Phalacrocorax marinavis* Shufeldt

Phalacrocorax marinavis Shufeldt, 1915 (Feb.), Trans. Connecticut Acad. Arts Sci., vol. 19, p. 56, pl. 14, fig. 114, 116-118, 122 (types from Willow Creek, distal parts of 2 humeri, distal part of left tarsometatarsus, proximal half of right ulna, Yale Peabody Mus. no. 936).

LOWER MIOCENE (John Day formation). OREGON: Malheur County: Willow Creek.

9. *Phalacrocorax intermedius* (Milne-Edwards)

Graculus intermedius Milne-Edwards, 1867, Ois. Foss. France, vol. 1, sheet 34, p. 266, pl. 43, fig. 8-11 (type from Orleanais, proximal part of right humerus, coll. Nouel, now apparently in Paris Mus.)

UPPER MIOCENE (Faluns de Touraine). France: prov. Orléanais.

10. *Phalacrocorax praecarbo* Ammon

Phalacrocorax praecarbo von Ammon, 1918, Abh. naturwiss. Ver. Regensburg, vol. 12, p. 28, fig. 3 (type from Mayer and Reinhard clayworks, upper end of left coracoid, Mus. Naturw. Vereins zu Regensburg).

UPPER MIOCENE (Braunkohlen der Oberpfalz). BAVARIA: clayworks of Mayer and Reinhard, between Dechbetten and Prüfening near Regensburg.

11. *Phalacrocorax femoralis* L. Miller

Phalacrocorax femoralis L. Miller, 1929 (July 15), Condor, vol. 31, no. 4, p. 167, fig. 58-59 (type from Poyer quarry, skeleton impression, Univ. Calif. at Los Angeles, reverse in coll. Dr. Frederick Kellogg, Los Angeles).

UPPER MIOCENE (Modelo formation). CALIFORNIA: Los Angeles County: quarry of Dan J. Poyer, in NW ¼ of section 18, Township 1 North, Range 17 West, near Calabasas.

12. *Phalacrocorax wetmorei* Brodkorb

Phalacrocorax wetmorei Brodkorb, 1955 (Nov. 30), Florida Geol. Surv. Rept. Invest., no. 14, p. 12, pl. 3, fig. 10-11 (type from Brewster, right coracoid, Brodkorb coll. no. PB 530).

LOWER PLIOCENE (Bone Valley gravel). FLORIDA: Polk County: Brewster and Pierce (Brodkorb, 1955).

LOWER PLIOCENE (Alachua clay). FLORIDA: Alachua County: near Newberry (Brodkorb, 1963, Spec. Publ. Florida geol. Surv., no. 2, paper 4, p. 2).

13. *Phalacrocorax leptopus* Brodkorb

Phalacrocorax leptopus Brodkorb, 1961 (Nov. 7), Quart. Jour. Florida Acad. Sci., vol. 24, no. 3, p. 170, fig. 1 (type from Juntura, proximal half of left tarsometatarsus, Univ. Ore. Mus. Nat. Hist. no. F-7994).

LOWER and MIDDLE PLIOCENE (Juntura beds). OREGON: Malheur County: Juntura.

14. *Phalacrocorax kennelli* Howard

Phalacrocorax kennelli Howard, 1949 (June 22), Publ. Carnegie Instn. Washington, no. 584, p. 188, pl. 3, fig. 7-8 (type from locality 1080, upper half of left coracoid, Los Angeles Mus. no. 2127).

MIDDLE PLIOCENE (San Diego formation). CALIFORNIA: San Diego County: San Diego, locality 1080 on Washington Boulevard freeway.

15. *Phalacrocorax destefani* Regàlia

Phalacrocorax de stefani Regàlia, 1902, Palaeontogr. ital., vol. 8, p. 225, pl. 27, fig. 4-14 (types from Orciano Pisano, cervical vertebra, furculum, coracoid, humerus, ulna, femur, tibiotarsus, tarsometatarsus, Roberto Lawley coll., on deposit in Gabinetto di Geologia, Istituto di Studi Superiori at Florence).

MIDDLE PLIOCENE (argille marine). ITALY: Provincia di Pisa: Orciano Pisano near Valle di Fine.

16. *Phalacrocorax idahensis* (Marsh)

Graculus idahensis Marsh, 1870, Amer. Jour. Sci., ser. 2, vol. 49, p. 216 (type from Castle Creek, proximal half of left carpometacarpus, Yale Peabody Mus. no. 527).—*Phalacrocorax idahensis* Shufeldt, 1915, Trans. Connecticut Acad. Arts Sci., vol. 19, p. 68, pl. 6, fig. 44 (type restudied).

MIDDLE PLIOCENE (Chalk Hills formation). IDAHO: Owyhee County: Castle Creek, about 10 miles northwest of Grand View. Referred specimens from the Lower Pleistocene Glenns Ferry formation in the Hagerman lake beds, Idaho (Wetmore, 1933, Smithsonian misc. Coll., vol. 87, no. 20, p. 5), and from the Lower Pliocene Bone Valley gravel at Brewster, Florida (Brodkorb, 1955, Florida geol. Surv. Rept. Invest., no. 14, p. 14), are not comparable to the type and probably represent other species.

17. *Phalacrocorax macer* Brodkorb

Phalacrocorax macer Brodkorb, 1958 (Oct. 31), Wilson Bull., vol. 70, no. 3, p. 237, fig. 1 (type from sec. 28, right carpometacarpus, Univ. Mich. Mus. Paleo. no. 33918).

LOWER PLEISTOCENE (Hagerman lake beds of Glenns Ferry formation). IDAHO: Twin Falls County: section 28, Township 7 South, Range 18 East, opposite Hagerman.

18. *Phalacrocorax rogersi* Howard

Phalacrocorax rogersi Howard, 1932 (May 16), Condor, vol. 34, no. 3, p. 118, fig. 19 (type from Veronica Springs, left coracoid, Santa Barbara Mus. no. 32.1).

LOWER PLEISTOCENE (Santa Barbara formation). CALIFORNIA: Santa Barbara County: Veronica Springs stone quarry.

19. *Phalacrocorax macropus* (Cope)

Graculus macropus Cope, 1878, Bull. U. S. geol. geog. Surv. Terrs., vol. 4, no. 2, p. 386 (lectotype tarsometatarsus, Am. Mus. Nat. Hist. no. 3555, selected by Howard, 1946, Publ. Carnegie Instn. Washington, no. 551, p. 153).

MIDDLE PLEISTOCENE (Fossil Lake formation). OREGON: Lake County: Fossil Lake. The specimen reported from the Lower Miocene Arikaree sandstone of Montana (Shufeldt, 1915, Auk, vol. 32, p. 485) is unidentifiable even to family (cf. Wetmore, 1955, Condor, vol. 57, p. 371).

20. *Phalacrocorax pampeanus* Moreno and Mercerat

Phalacrocorax pampeanus Moreno and Mercerat, 1891 (May), An. Mus. La Plata, Pal. arg., vol. 1, pp. 19, 35; 1891 (Aug. 5), pl. 18, fig. 8 (type from Lujan, proximal part of right humerus, La Plata Mus. no. 82).

UPPER PLEISTOCENE (Pampas formation). ARGENTINA: Prov. Buenos Aires: Lujan.

21. *Phalacrocorax gregorii* DeVis

Phalacrocorax gregorii DeVis, 1906, Ann. Queensland Mus., no. 6, p. 18, pl. 5, fig. 6; pl. 6, fig. 3-5; pl. 7, fig. 1-4; pl. 8, fig. 1-2 (types from various localities near Lake Eyre, premaxilla, fragments of 2 coracoids, 7 humeri, carpometacarpus, 7 femora, 4 tibiotarsi, 6 tarsometatarsi, 7 pelves).

UPPER PLEISTOCENE (Katipiri sands, Malkuni fauna). SOUTH AUSTRALIA: Wankameminna; Malkuni; Kalamurina; Wurdumankula; Wurdulumankula; Mulcani, all on lower Cooper near Lake Eyre.

22. *Phalacrocorax vetustus* DeVis

Phalacrocorax vetustus DeVis, 1906, Ann. Queensland Mus., no. 6, p. 22, pl. 8, fig. 3-7; pl. 9, fig. 1-5, 7 (types from localities near Lake Eyre, fragments of 3 coracoids, 7 humeri, 2 ulnae, 4 carpometacarpi, 2 femora, 2 tibiae, 1 tarsometatarsus).

UPPER PLEISTOCENE (Katipiri sands, Malkuni fauna). SOUTH AUSTRALIA: Malkuni; Kalamurina; Wurdumankula; Wurdumulankula, all on lower Cooper near Lake Eyre.

Genus †*Pliocarbo* Tugarinov

Pliocarbo Tugarinov, 1940, Doklady Akad. Nauk S.S.S.R., vol. 26, no. 2, p. 197 (type *Pliocarbo longipes* Tugarinov).

23. *Pliocarbo longipes* Tugarinov

Pliocarbo longipes Tugarinov, Doklady Akad. Nauk S.S.S.R., vol. 26, no. 2, p. 197, fig. 1-2 (type from Slobodka, tarsometatarus).

LOWER PLIOCENE (Meotian stage). UKRAINE: Slobodka near Odessa.

Neospecies of Phalacrocoracidae from Pleistocene and *prehistoric sites:

1. *Phalacrocorax auritus* (Lesson). OREGON: Dry Creek (L. Miller, 1944, Condor, vol. 46, p. 27); Fossil Lake? (Howard, 1946, Publ. Carnegie Instn. Washington, no. 551, p. 156). CALIFORNIA: Santa Monica (L. Miller, 1925, Condor, vol. 27, p. 145); San Pedro (Howard, 1949, Condor, vol. 51, p. 23); Manix Lake? (Howard, 1955, U. S. geol. Surv. profess. Paper, no. 264-J, p. 202); *Emeryville (Howard, 1929, Univ. Calif. Publ. Zool., vol. 32, p. 312);

*Buena Vista Lake (DeMay, Condor, vol. 44, p. 228). NEVADA: Rattlesnake Hill? (Wetmore, 1940, Smithsonian misc. Coll., vol. 99, no. 4, p. 13); Crypt Cave (Howard, 1958, vol. 60, p. 412). IDHAO: Hagerman (Wetmore, 1933, Smithsonian misc. Coll., vol. 87, no. 20, p. 6); Twin Falls County (Brodkorb, 1958, Wilson Bull., vol. 70, p. 237). IOWA: *Mill Creek (Hamon, 1961, Plains Anthropologist, vol. 6, p. 209). NOVA SCOTIA: *Bear River (Halifax Mus.). FLORIDA: Seminole Field, Melbourne, Hog Creek near Sarasota, Itchtucknee River, Rock Spring, and Vero Beach (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 13); Bradenton (Wetmore, 1945, Auk, vol. 62, p. 459); Lake Monroe and Lake Washington (Brodkorb coll.); *Good's shellpit, *Lemon Bluff, and *Bluffton (Neill, Cut, and Brodkorb, 1956, Amer. Antiquity, vol. 21, p. 388); *South Indian Field (Weigel, 1959, Florida Anthropologist, vol. 12, p. 73); *Green Mound (Hamon, 1959, Auk, vol. 76, p. 533); *Castle Windy (Bullen and Sleight, 1959, Rept. Bryant Foundation Amer. Studies, no. 1, p. 20).

2. *Phalacrocorax olivaceus* (Humboldt). BRAZIL: Lapa da Escrivania and Lapa da Lagoa do Sumidouro (O. Winge, 1887, E Mus. Lund., vol. 1, no. 2, p. 5).

3. *Phalacrocorax carbo* (Linnaeus). NORWAY: Vardo (Lambrecht, 1933, Handb. Palaeorn., p. 733). DENMARK: Fannerup, Mejlgaard, Havnoe, Krabbesholm, Erteboelle, Gudumlund, Maglemose, Klintesoe, Soelager, *Erlang Vig, *Vejleby, *Borrebjerg, *Barsmark, *Noerre Broby, *Vimose, *Vangede Brogaards Mose, and *Ordrup Mose (H. Winge, 1903, Vidensk. Meddel. naturhist. Foren. Copenhagen, vol. 6, p. 99). IRELAND: Newhall Cave (Lambrecht, 1933). SCOTLAND: Caithness (Lydekker, 1891, Ibis, p. 388); Cnoc-Sligeach Oransay (Lambrecht, 1933). ENGLAND: Grays (Milne-Edwards, 1867, Ois. Foss. France, pl. 42); West Runton (E. T. Newton, 1887, Geol. Mag., p. 147). GIBRALTAR: Devils Tower? (Bate, 1938, Jour. Roy. anthrop. Inst., vol. 58, p. 104). ITALY: Grotta Romanelli (Lambrecht, 1933). ALASKA: *Kodiak Island (Friedmann, 1933, Condor, vol. 35, p. 30). NOVA SCOTIA: *Port Jollie (Halifax Mus.).

4. *Phalacrocorax penicillatus* (Brandt). CALIFORNIA: Santa Barbara? (Howard, 1931, Condor, vol. 33, p. 30); Newport Bay, San Pedro, and Santa Monica (Howard, 1949, Condor, vol. 51, pp. 21-27); *Emeryville (Howard, 1929, Univ. Calif. Publ. Zool., vol. 32, p. 312).

5. *Phalacrocorax pelagicus* Pallas. ALASKA: *St. Lawrence Island, *Amaknak Island, and *Kodiak Island (Friedmann, 1934, Jour. Washington Acad. Sci., vol. 24, pp. 88, 231-234); *Dutch Harbor, *Little Kiska, and *Attu Island (Friedmann, 1937, op. cit., vol. 27, pp. 432-438); *Cape Prince of Wales (Friedmann, 1941, op. cit., vol. 31, p. 405). CALIFORNIA: *Emeryville (Howard, 1929, Univ. Calif. Publ. Zool., vol. 32. p. 312).

6. *Phalacrocorax capillatus* (Temminck and Schlegel). JAPAN: *Iki Island and *Doiga-hama? (Kuroda, 1959, Bull. biogeog. Soc. Japan, vol. 21, p. 73).

7. *Phalacrocorax urile* (Gmelin). ALASKA: *St. Lawrence Island and *Cape Denbeigh (Friedmann, 1934, Jour. Washington Acad. Sci., vol. 24, pp. 88, 237).

8. *Phalacrocorax aristotelis* (Linnaeus). NORWAY: Vardo (Lambrecht, 1933, Handb. Palaeorn., p. 733). SCOTLAND: Oransay, Caithness (Lydekker, 1891, Ibis, p. 388). GIBRALTAR: Devils Tower (Bate, 1928, Jour. Roy. anthr. Inst., vol. 58, p. 104). MONACO: Grotte de l'Observatoire (Lambrecht, 1933). PORTUGAL: Grotte de Furninha (Lambrecht, 1933). ITALY: Grotta dei Colombi (Regàlia,

1893, Arch. Antrop. Etnol., vol. 23, p. 262); Grotta Romanelli and Buca del Bersagliere (Lambrecht, 1933).

Family ANHINGIDAE Ridgway

Plotinae Bonaparte, 1831, Saggio di una distribuzione metodica degli Animali Vertebrati, p. 61 (type *Plotus* Linnaeus, 1766, a junior synonym of *Anhinga* Brisson).

Anhingidae Ridgway, 1887, Manual N. Amer. Birds, p. 73 (type *Anhinga* Brisson).

Genus †*Protoplotus* Lambrecht

Protoplotus Lambrecht, 1930, Wet. Meded. Dienst Mijnb. E. Indies, no. 17, p. 15 (type *Protoplotus beauforti* Lambrecht).

1. *Protoplotus beauforti* Lambrecht

Protoplotus beauforti Lambrecht, 1930, Wet. Meded. Dienst Mijnb. E. Indies, no. 17, p. 15, text-fig. 1-4, pl. 2-3 (type from Sipang, skeleton impression, Mus. Mijnbouw Bureau van den Opoporigsdienst der Nederl. Indischen Regierung, Bandoeng, Java; casts in Kgl. Ung. Geol. Anstalt, Budapest).

MIDDLE? EOCENE (freshwater fish beds). SUMATRA: Sipang.

Genus *Anhinga* Brisson

Anhinga Brisson, 1760, Ornithologia, vol. 1, p. 60; vol. 6, p. 476 (type *Plotus anhinga* Linnaeus).

2. *Anhinga pannonica* (Lambrecht)

Plotus pannonicus Lambrecht, 1916, Mitt. Jahrb. ungar. geol. Anst., vol. 24, p. 1, fig. 1, 3, 5, 7 (types from Tataros, carpometacarpus, cervical vertebra, Kgl. Ung. Geol. Anstalt, Budapest).

LOWER PLIOCENE (Pannonian beds). HUNGARY: Komitat Bihar: Tataros.

3. *Anhinga parva* (DeVis)

Plotus parvus DeVis, Proc. Linn. Soc. N. S. Wales, vol. 3, no. 2, p. 1286, pl. 35, fig. 10 (type from River Condamine, left humerus, Queensland Mus.?).

UPPER PLEISTOCENE (Darling Downs beds). QUEENSLAND: north bank of River Condamine, 3 miles from Chinchilla.

4. *Anhinga laticeps* (DeVis)

Plotus laticeps DeVis, 1906, Ann. Queensland Mus., no. 6, p. 17, pl. 6, fig. 1-2 (types from lower Cooper, cranium, pelvis, Queensland Mus.?).

UPPER PLEISTOCENE (Katipiri sands, Malkuni fauna). SOUTH AUSTRALIA: lower Cooper Creek, near Lake Eyre.

5. *Anhinga nana* (Newton and Gadow)

Plotus nanus E. T. Newton and Gadow, 1893, Trans. zool. Soc. London, vol. 13, p. 288, pl. 34, fig. 1-5 (types from Mare aux Songes, humerus, pelvis, tarsometatarsus, Cambridge Univ.).

QUATERNARY. MAURITIUS: Mare aux Songes (Newton and Gadow, 1893).

QUATERNARY. MADAGASCAR: Sirabé (Andrews, 1897, Ibis, p. 358).

Neospecies of Anhingidae from Pleistocene and *prehistoric sites:

1. *Anhinga anhinga* (Linnaeus). FLORIDA: Melbourne (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 14); Rock Spring (Woolfenden, 1959, Wilson Bull., vol. 71, p. 185); Itchtucknee River (McCoy, 1963, Auk, vol. 80, p. 000); Lake Monroe (Brodkorb coll.); *Lemon Bluff (Neill, Gut, and Brodkorb, 1956, Amer. Antiquity, vol. 21, p. 388).

Family SULIDAE (Reichenbach)

Sularinae Reichenbach, 1849, Avium systema naturale, p. 00 (type *Sula* Brisson).—*Sulinae* Bonaparte, 1853, C. R. Acad. Sci. Paris, vol. 37, no. 18, p. 643.

Genus *Sula* Brisson

Sula Brisson, 1760, Ornithologia, vol. 1, p. 60 (type *Pelecanus piscator* Linnaeus).

1. *Sula ronzoni* Milne-Edwards

Mergus ronzoni Gervais, 1849 (1851?), Mém. Acad. Sci. Lett. Montpellier, sec. sci., vol. 1, p. 220 (nomen nudum).

Sula ronzoni Milne-Edwards, 1867, Ois. Foss. France, vol. 1, sheet 34, p. 271, pl. 44, fig. 9 (type from Ronzon, pelvis, Mus. Saint Pierre at Lyon).

LOWER OLIGOCENE (marnes calcaires de Ronzon). FRANCE: Prov. Auvergne: Ronzon near Puy-en-Velay.

2. *Sula arvernensis* Milne-Edwards

Sula arvernensis Milne-Edwards, 1867, Ois. Foss. France, vol. 1, sheet 34, p. 267, pl. 43, fig. 12 (type from Gannat, pelvis, coll. Milne-Edwards).

UPPER OLIGOCENE (calcaire de Gannat). FRANCE: Dept. Allier: Gannat.

3. *Sula universitatis* Brodkorb

Sula universitatis Brodkorb, 1963 (in press), Quart. Jour. Florida Acad. Sci., vol. 26, no. 2, p. 000, fig. 0 (type from Gainesville, proximal part of left carpometacarpus, Brodkorb coll. no. 8505).

LOWER MIOCENE (Hawthorne formation). FLORIDA: Alachua County: Gainesville.

4. *Sula pohli* Howard

Sula pohli Howard, 1958 (Aug. 15), Los Angeles County Mus. Contr. in Sci., no. 25, p. 4, fig. 1-2 (type from Studio City, wings, pectoral girdle, sternum, Los Angeles Mus. no. 2674; reverse Pohl Mus. no. PV68).

UPPER MIOCENE (Monterey shale, Valmonte diatomite member). CALIFORNIA: Los Angeles County: Studio City, Ventura Boulevard between Whitsett Avenue and Coldwater Canyon Road.

5. *Sula willetti* L. Miller

Sula willetti L. Miller, 1925 (Aug.), Publ. Carnegie Instn. Washington, no. 349, p. 112, pl. 3, 8 (type from Lompoc, skeleton impression, Univ. Calif. Mus. Paleo. no. 26542).

UPPER MIOCENE (Monterey shale, Valmonte diatomite member). CALIFORNIA: Los Angeles County: Lomita? (Howard, 1958, Los Angeles County Mus. Contr. Sci., no. 25, pp. 3, 10); Sherman Oaks (Howard, 1962, Condor, vol. 64, p. 512).

UPPER MIOCENE (Sisquoc formation). CALIFORNIA: Santa Barbara County: Johns Manville mines, 3½ miles south of Lompoc (L. Miller, 1925).

6. *Sula guano* Brodkorb

Sula guano Brodkorb, 1955 (Nov. 30), Florida Geol. Surv. Rept. Invest., no. 14, p. 9, pl. 1, fig. 2, 5; pl. 2, fig. 8 (type from Brewster, left coracoid, Brodkorb no. 301).

LOWER PLIOCENE (Bone Valley gravel). FLORIDA: Polk County: Brewster.

7. *Sula phosphata* Brodkorb

Sula phosphata Brodkorb, 1955 (Nov. 30), Florida Geol. Surv. Rept. Invest., no. 14, p. 11, pl. 1, fig. 3, 6; pl. 2, fig. 9 (type from Brewster, right coracoid, Brodkorb no. 302).

LOWER PLIOCENE (Bone Valley gravel). FLORIDA: Polk County: Brewster.

8. *Sula humeralis* L. Miller and Bowman

Sula humeralis L. Miller and Bowman, 1958 (March 6), Los Angeles County Mus. Contr. in Sci., no. 20, p. 9, fig. 2 (type from San Diego, distal end of right humerus, Univ. Calif. Mus. Paleo. no. 45889).

MIDDLE PLIOCENE (San Diego formation). CALIFORNIA: San Diego County: San Diego.

Genus †*Microsula* Wetmore

Microsula Wetmore, 1938 (Jan. 14), Proc. U. S. Nat. Mus., vol. 85, p. 25 (type by original designation *Sula avita* Wetmore; subgenus).

9. *Microsula pygmaea* (Milne-Edwards)

Sula pygmaea Milne-Edwards, 1874, Bibl. École hautes Études Paris, sect. sci. nat., vol. 11, art. 3, p. 8, pl. 12, fig. 2 (type from Léognan, left humerus, Delfortrie coll.).

MIDDLE MIOCENE (molasse de Léognan). FRANCE: Dept. Gironde: Léognan.

10. *Microsula avita* (Wetmore)

Sula avita Wetmore, 1938 (Jan. 14), Proc. U. S. nat. Mus., vol. 85, p. 22, fig. 2-3 (type from Plumpoint, distal part of right humerus, U. S. Nat. Mus. no. 13854).

MIDDLE MIOCENE (Calvert formation, zone 10). MARYLAND: Calvert County: near Plumpoint.

Genus *Morus* Vieillot

Morus Vieillot, 1816, Analyse d'une nouvelle ornithologie élémentaire, p. 63 (type *Pelecanus bassanus* Linnaeus).

11. *Morus loxostyla* (Cope)

Sula loxostyla Cope, 1870 (Dec.), Trans. Amer. philos. Soc., n.s., vol. 14, p. 236, fig. 53 (type from Calvert Co., left coracoid, Cope coll.).

Sula atlantica Shufeldt, 1915 (Feb.), Trans. Connecticut Acad. Arts Sci., vol. 19, p. 62, pl. 15, fig. 123 (type from New Jersey, left coracoid, Yale Peabody Mus. no. 937).—Wetmore, 1926, Auk, vol. 43, p. 465 (type restudied).

MIDDLE MIOCENE (Calvert formation). MARYLAND: Calvert County: Chesapeake Beach (Wetmore, 1926, Auk, vol. 43, p. 465).

MIDDLE MIOCENE (Kirkwood formation, *Ammodon* beds; see Marsh, 1893, Am. Jour. Sci., p. 412). NEW JERSEY: apparently Farmingdale in Monmouth County.

12. *Morus vagabundus* (Wetmore)

Moris vagabundus Wetmore, 1930 (July 15), Proc. Calif. Acad. Sci., ser. 4, vol. 19, p. 89, fig. 4 (type from Sharktooth Hill, distal end of right humerus, Univ. Calif. Mus. Paleo. no. 31062).

MIDDLE MIOCENE (Temblor formation). CALIFORNIA: Kern County: Sharktooth Hill, in sec. 25, Township 28 South, Range 28 East, 7 miles northeast of Bakersfield (Wetmore, 1930); west branch of Granite

Creek, in sec. 28, Township 27 South, Range 28 East, 11 miles north of Bakersfield (Compton, 1936, Proc. Calif. Acad. Sci., ser. 4, vol. 23, p. 84).

13. *Morus lompocanus* (L. Miller)

Sula lompocana L. Miller, 1925 (Aug.), Publ. Carnegie Instn. Washington, no. 349, p. 114, pl. 4, fig. 7b, 9 (type from Lompoc, skeleton impression, Univ. Calif. Mus. Paleo. no. 26544).

UPPER MIOCENE (Sisquoc formation). CALIFORNIA: Santa Barbara County: Johns Manville mines, 3½ miles south of Lompoc.

14. *Morus peninsularis* Brodkorb

Morus peninsularis Brodkorb, 1955 (Nov. 30), Florida Geol. Surv. Rept. Invest., no. 14, p. 8, pl. 1, fig. 1, 4; pl. 2, fig. 7 (type from Brewster, left coracoid, Brodkorb no. 148).

LOWER PLIOCENE (Bone Valley gravel). FLORIDA: Polk County: Brewster.

15. *Morus reyanus* (Howard)

Moris reyana Howard, 1936 (Sept. 15), Condor, vol. 38, no. 5, p. 213 (type from Del Rey Hills, left coracoid, Los Angeles Mus. no. 991).

UPPER PLEISTOCENE (Palos verdes sand). CALIFORNIA: Los Angeles County: Del Rey Hills, 2 miles east-northeast of Playa del Rey (Howard, 1936). Orange County: Newport Bay (Howard, 1949, Condor, vol. 51, pp. 21-29).

Genus †*Palaeosula* Howard

Palaeosula Howard, 1958 (Aug. 15), Los Angeles County Mus. Contr. in Sci., no. 25, p. 12 (type by original designation *Sula stocktoni* Miller).

16. *Palaeosula stocktoni* (L. Miller)

Sula stocktoni L. Miller, 1935 (March 12), Univ. Calif. Los Angeles Publ. biol. Sci., vol. 1, p. 75, fig. 2 (type from Lomita, wings, sternum, coracoid, Univ. Calif. Mus. Paleo. no. 32105).

UPPER MIOCENE (Monterey shale, Valmonte diatomite member). CALIFORNIA: Los Angeles County: near Lomita; El Sereno (Howard, 1958, Los Angeles County Mus. Contr. Sci., no. 25, pp. 3, 12).

Genus †*Miosula* L. Miller

Miosula L. Miller, 1925 (Aug.), Publ. Carnegie Instn. Washington, no. 349, p. 114 (type by monotypy *Miosula media* Miller).

17. *Miosula media* L. Miller

Miosula media L. Miller, 1925 (Aug.), Publ. Carnegie Instn. Washington, no. 349, p. 114, pl. 5 (type from Lompoc, skeleton impression, Univ. Calif. Mus. Paleo. no. 26543).

Upper Miocene (Sisquoc formation). California: Santa Barbara County: Johns Manville mines, 3½ miles south of Lompoc.

18. *Miosula recentior* Howard

Miosula recentior Howard, 1949 (June 22), Publ. Carnegie Instn. Washington, no. 584, p. 190, pl. 2, fig. 1-2 (type from San Diego, distal part of right tibiotarsus, Los Angeles Mus. no. 2117).

Middle Pliocene (San Diego formation). California: San Diego County: San Diego.

Neospecies of Sulidae from Pleistocene and *prehistoric sites:

1. *Sula dactylatra* Lesson. St. Croix: *Concordia (Wetmore, 1937, Jour. Agr. Univ. Puerto Rico, vol. 21, p. 6).

2. *Sula sula* (Linnaeus). Rodriguez: *superficial deposits (Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 46). St. Croix: *Concordia (Wetmore, 1937. Jour. Agr. Univ. Puerto Rico, vol. 21, p. 6).

3. *Sula leucogaster* (Boddaert). Bahamas: *Cordon Hills on Crooked Island (Wetmore, 1938, Auk, vol. 55, p. 52). St. Thomas: *midden (Wetmore, 1918, Proc. U. S. nat. Mus., vol. 54, p. 514). St. Croix: *Concordia (Wetmore, 1937, Jour. Agr. Univ. Puerto Rico vol. 21, p. 6).

4. *Morus bassanus* (Linnaeus). Norway: Vardo (Lambrecht, 1933, Handb. Palaeorn., p. 733). Denmark: Fannerup, Erteboelle, Hesseloe, *Borrebjerg, and *Ordrup Mose (H. Winge, 1903, Vidensk. Meddel. naturhist. Foren. Copenhagen, vol. 6, p. 100). Scotland: *Caithness (Lydekker, 1891, Ibis, p. 388); *Colonsay, *Oransay, *Orkney, and *Androssan (Lambrecht, 1933). Ireland: *Whitepeak Bay (Lambrecht, 1933). England: *Whitburn (Lambrecht, 1933). Nova Scotia: *Whynacht (Halifax Mus.). Florida: Green Mound (Hamon, 1959, Auk, vol. 76, p. 533); *Castle Windy (Bullen and Sleight, 1959, Rept. Bryant Found. Amer. Studies, no. 1, p. 20); *Summer Haven (Brodkorb, 1960, Auk, vol. 77, p. 342).

Suborder PHAETHONTES Sharpe

Phaethontes Sharpe, 1891, Review Recent Attempts to Classify Birds, p. 76 (type *Phaethon* Linnaeus).

Family Phaethontidae (Bonaparte)

Phaetonidae Bonaparte, 1853, C. R. Acad. Sci. Paris, vol. 37, no. 18, p. 643 (type "*Phaeton*" Linnaeus).

Genus †*Prophaeton* Andrews

Prophaeton Andrews, 1899, Proc. zool. Soc. London, p. 776 (type by monotypy *Prophaeton shrubsolei* Andrews).

1. *Prophaeton shrubsolei* Andrews

Prophaeton shrubsolei Andrews, 1899, Proc. zool. Soc. London, p. 776, text-fig. 1-2, pl. 51, fig. 1-2 (type from Sheppey, skull, pelvis, femur, Brit. Mus.).

LOWER EOCENE (London clay). ENGLAND: Kent: Sheppey Isle at mouth of Thames.

Neospecies of Phaethontidae from *prehistoric sites:

1. *Phaethon lepturus* Daudin. RODRIGUEZ: *superficial deposits (Lambrecht, 1933, Handb. Palaeorn., p. 732). BERMUDA: *Cockroach Island (Wetmore, 1962, Smithsonian misc. Coll., vol. 145, no. 2, p. 17).

Suborder †ODONTOPTERYGIA Spulski

Odontopterygia Spulski, 1910 (Apr. 4), Zeitschr. deutsch. geol. Ges. Monatsber., Abh. 22, no. 7, p. 521 (Ordnung; type *Odontopteryx* Owen).—*Odontopteryges* Lambrecht, 1933, Handb. Palaeorn., p. 304 (subordo).—*Odontopterygiformes* Howard, 1957 (Feb. 1), Santa Barbara Mus. nat. Hist., Bull. Dept. Geol., no. 1, p. 21 (order).

Family †ODONTOPTERYGIDAE Lambrecht

Odontopterygidae Lambrecht, 1933, Handb. Palaeorn., pp. ix, 304 (type *Odontopteryx* Owen).

Genus †*Odontopteryx* Owen

Odontopteryx Owen, 1873 (read June 25), Quart. Jour. geol. Soc. London, vol. 29, pt. 1, p. 511 (type by monotypy *Odontopteryx toliapicus* Owen).
Odontornis Owen, 1873 (read June 25), Quart. Jour. geol. Soc. London, vol. 29, pt. 1, p. 521 footnote (equivalent to *Odontopteryx:* "I should have preferred the term *Odontornis* for my genus; but it is bespoke for Marsh's subclass.").

1. *Odontopteryx toliapica* Owen

Odontopteryx toliapicus Owen, 1873 (read June 25), Quart. Jour. geol. Soc. London, vol. 29, pt. 1, p. 511, pl. 16-17 (type from Sheppey, skull, Brit. Mus. no. 44096).

LOWER EOCENE (London clay). ENGLAND: Kent: Sheppey Isle.

Family †PSEUDODONTORNITHIDAE Lambrecht

Pseudodontornithidae Lambrecht, 1933, Handb. Palaeorn., pp. ix, 305 (type *Pseudodontornis* Lambrecht).

Genus †*Pseudodontornis* Lambrecht

Pseudodontornis Lambrecht, 1930 (Jan. 25), Geol. hungarica, ser. pal., fasc. 7, p. 1 (type by monotypy *Odontopteryx longirostris* Spulski).

1. *Pseudodontornis longirostris* (Spulski)

Odontopteryx longirostris Spulski, 1910 (Apr. 4), Zeitschr. deutsch. geol. Ges. Monatsber., Abh. 22, no. 7, p. 507, fig. 1-7 (type from unknown locality, skull, Albertus-Magnus Univ., Königsberg).—Lambrecht, 1930, Geol. hungarica, ser. pal., fasc. 7, p. 1, text-fig. 3, 6; pl. 1-2 (type restudied).

MIOCENE? BRAZIL OR GERMANY?

Genus †*Osteodontornis* Howard

Osteodontornis 1957 (Feb. 1), Santa Barbara Mus. nat. Hist., Bull. Dept. Geol., no. 1, p. 3 (type by original designation *Osteodontornis orri* Howard).

2. *Osteodontornis orri* Howard

Osteodontornis orri Howard, 1957 (Feb. 1), Santa Barbara Mus. nat. Hist., Bull. Dept. Geol., no. 1, p. 3, fig. 2-8 (type from Tepusquet Canyon, incomplete skeleton impression, Santa Barbara Mus. no. 309).

UPPER MIOCENE (Monterey shale, Valmonte diatomite member). CALIFORNIA: Santa Barbara County: west side of Tepusquet Creek, flagstone quarry of C. Antolini & Sons (Howard, 1957). Los Angeles County: Sherman Oaks (Howard and White, 1962, Los Angeles Co. Mus., Contr. Sci., no. 52, p. 3, fig. 2-5).

Family †PELAGORNITHIDAE (Fürbringer)

Pelagornithinae Fürbringer, 1888, Untersuch. Morph. Syst. Vögel, vol. 2, p. 1565 footnote (subfamily; type *Pelagornis* Lartet).—*Pelagornithidae* Wetmore, 1930, Proc. U. S. nat. Mus., vol. 76, p. 2.

Genus †*Pelagornis* Lartet

Pelagornis Lartet, 1857 (read Apr. 6), C. R. Acad. Sci. Paris, vol. 44, no. 14, p. 740 (type by monotypy *Pelagornis miocaenus* Lartet).

1. *Pelagornis miocaenus* Lartet

Pelagornis miocaenus Lartet, 1857 (read Apr. 6), C. R. Acad. Sci. Paris, vol. 44, no. 14, p. 740 [separate includes a plate, fide Milne-Edwards] (type from Armagnac, left humerus, Paris Mus.).—Milne-Edwards, 1867, Ois. Foss. France, vol. 1, p. 273, pl. 45 (type restudied).

Pelagornis delfortrii Lambrecht, 1933, Handb. Palaeorn., p. 282 footnote (nomen nudum).

MIDDLE MIOCENE (molasse coquillière marine de l'Armagnac). FRANCE: Dept. Gers: Armagnac (Lartet, 1857).

MIDDLE MIOCENE (molasse de Léognan). FRANCE: Dept. Gironde: Léognan (Milne-Edwards, 1874, Bibl. École hautes Études, Paris, sec. sci. nat., vol. 11, art. 3, p. 1).

Suborder †CLADORNITHES Wetmore

Cladornithes Wetmore, 1960 (June 23), Smithsonian misc. Coll., vol. 139, no. 11, pp. 4, 25 (suborder; type *Cladornis* Ameghino).

Family †Cladornithidae (Ameghino)

Cladornidae Ameghino, 1895 [separate apparently published 1894], Bol. Inst. geog. argentino, vol. 15, cahiers 11-12, p. 584 [85 of separate] (type *Cladornis* Ameghino).

Cladornithidae Wetmore, 1930, Proc. U. S. nat. Mus., vol. 76, no. 2821, p. 2.

Genus †*Cladornis* Ameghino

Cladornis Ameghino, 1895 [1894?], Bol. Inst. geog. argentino, vol. 15, cahiers 11-12, p. 585 [86 of separate] (type by monotypy *Cladornis pachypus* Ameghino).

1. *Cladornis pachypus* Ameghino

Cladornis pachypus Ameghino, 1895 [1894?], Bol. Inst. geog. argentino, vol. 15, cahiers 11-12, p. 585 [86 of separate], fig. 35 (type from *Pyrotherium* beds, distal part of right tarsometatarsus, now in Brit. Mus.).

Lower Oligocene (Deseado formation). Argentina: Ter. Santa Cruz: Río Deseado.

Family †Cyphornithidae Wetmore

Cyphornithidae Wetmore, 1928 (March 15), Canad. Dept. Mines, Geol. Surv. Bull., no. 49, p. 4 (type *Cyphornis* Cope).

Genus †*Cyphornis* Cope

Cyphornis magnus Cope, 1894 (May 31), Jour. Acad. nat. Sci. Philadelphia, ser. 2, vol. 9, p. 449, (type by monotypy *Cyphornis magnus* Cope).

1. *Cyphornis magnus* Cope

Cyphornis magnus Cope, 1894 (May 31), Jour. Acad. nat. Sci. Philadelphia, ser. 2, vol. 9, p. 451, pl. 20, fig. 11-16 (type from Carmanah Point, proximal part of left metatarsus, Can. Geol. Surv. no. 6323).—Wetmore, 1928, Canad. Dept. Mines, Geol. Surv. Bull., no. 49, p. 1, fig. 1 (type restudied).

Lower Miocene (Carmanah Point beds). British Columbia: Vancouver Island: Carmanah Point.

Genus †*Palaeochenoides* Shufeldt

Palaeochenoides Shufeldt, 1916 (Aug.), Geol. Mag., n.s., decade 6, vol. 3, p. 347 (type by monotypy *Palaeochenoides mioceanus* Shufeldt).

2. *Palaeochenoides mioceanus* Shufeldt

Palaeochenoides mioceanus Shufeldt, 1916 (Aug.), Geol. Mag., n.s., decade 6, vol. 3, p. 347, pl. 15 (type from Stono River, distal part of left femur, U. S. nat. Mus.).—Wetmore, 1917, Jour. Geol., vol. 25, no. 6, p. 555, fig. 1 (type restudied).

LOWER MIOCENE (Hawthorne formation). SOUTH CAROLINA: Charleston County: near source of Stono River.

Suborder PELECANI Sharpe

Pelecani Sharpe, 1891, Review Recent Attempts to Classify Birds, p. 76 (type *Pelecanus* Linnaeus).

Family PELECANIDAE Vigors

Pelecanidae Vigors, 1825, Trans. Linn. Soc. London, vol. 14, pp. 498, 504 (type *Pelecanus* Linnaeus).

Genus *Pelecanus* Linnaeus

Pelecanus Linnaeus, 1758, Syst. Nat., ed. 10, p. 132 (type *Pelecanus onocrotalus* Linnaeus).

1. *Pelecanus gracilis* Milne-Edwards

Pelecanus gracilis Milne-Edwards, 1863, C. R. Acad. Sci. Paris, vol. 56, p. 1222 (nomen nudum).—Milne-Edwards, 1867, Ois. Foss. France, vol. 1, sheet 32, p. 350, pl. 38-39 (types from Labeur, furculum and upper part of tarsometatarsus, coll. Poirrier; also from Langy, upper end of humerus, complete femur, scapula, coll. Abbot Vandenhecke).

LOWER MIOCENE (Aquitanian). FRANCE: Dept. Allier: Labeur near Vaumas and Langy (Milne-Edwards, 1867); Saint-Gérand-le-Puy (Lambrecht, 1933, Handb. Palaeorn., p. 277). Dept. Puy-de-Dôme: Montaigut (Lambrecht, 1933).

2. *Pelecanus intermedius* Fraas

Pelecanus intermedius O. Fraas, 1870, Jahresh. Ver. Naturk. Württemberg, vol. 26, p. 281, pl. 13, fig. 3-4 (type from Hahnenberg, skull and mandible, Stuttgart Mus.).

UPPER MIOCENE (obere Süsswassermolasse). GERMANY: Württemberg: Hahnenberg (Fraas, 1870); Steinhaim (Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 39).

3. *Pelecanus fraasi* Lydekker

Pelecanus fraasi Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 44, fig. 10A (type from Klein-Sorheim, cranium, Brit. Mus. no. 47862).

UPPER MIOCENE (obere Süsswassermolasse). BAVARIA: Klein-Sorheim. Württemberg: Lierheim near Hahnenberg (Lydekker, 1891).

4. *Pelecanus cautleyi* Davies

Pelicanus cautleyi Davies, 1880, Geol. Mag., decade 2, vol. 7, p. 26 (type from Siwalik Hills; distal end of left ulna, Brit. Mus. no. 39740).—*Pelecanus cautleyi* Lydekker, 1884, Pal. indica, ser. 10, vol. 3, pt. 4, p. 137, pl. 14, fig. 11 (type restudied).

LOWER PLIOCENE (Siwalik series). INDIA: United Provinces: Siwalik Hills.

5. *Pelecanus sivalensis* Davies

Pelicanus(?) sivalensis Davies, 1880, Geol. Mag., decade 2, vol. 7, p. 26 (type from Siwalik Hills, distal end of right ulna, Brit. Mus. no. 39745).—*Pelecanus sivalensis* Lydekker, 1890, Rec. geol. Surv. India, vol. 23, p. 235, fig. 2 (type restudied).

LOWER PLIOCENE (Siwalik series). INDIA: United Provinces: Siwalik Hills.

6. *Pelecanus odessanus* Lambrecht

Pelicanus odessanus fossilis Wildham, 1886, Schrift. Neuruss. Ges. Naturf. Odessa, vol. 10, Beilage, p. 4, pl. 5, fig. 1-4 (non-binomial).—*Pelecanus odessanus* Lambrecht, 1933, Handb. Palaeorn., p. 279 (types from Slobodka, coracoid, tarsometatarsus).

LOWER PLIOCENE (Meotian). UKRAINE: Slobodka near Odessa.

7. *Pelecanus halieus* Wetmore

Pelecanus halieus Wetmore, 1933 (Dec. 27), Smithsonian misc. Coll., vol. 87, no. 20, p. 3, fig. 1-2 (type from sec. 16, proximal part of right radius, U. S. Nat. Mus. no. 12233).

LOWER PLEISTOCENE (Glenns Ferry formation, Hagerman Lake beds). IDAHO: Gooding County: NW ¼ of section 16, Township 7 South, Range 13 East, 2 miles west of Hagerman.

8. *Pelecanus grandiceps* DeVis

Pelecanus grandiceps DeVis, 1906, Ann. Queensland Mus., no. 6, p. 16, pl. 5, fig. 1-3 (type from lower Cooper, left quadrate, left coracoid, distal part of left tarsometatarsus).

UPPER PLEISTOCENE (Katipiri sands, Malkuni fauna). SOUTH AUSTRALIA: lower Cooper Creek near Lake Eyre.

9. *Pelecanus proavus* DeVis

Pelecanus proavus DeVis, 1892, Proc. Linn. Soc. N. S. Wales, ser. 2, vol. 6, p. 444, pl. 24, fig. 6 (type from Queensland, proximal part of carpometacarpus).

UPPER PLEISTOCENE (Darling Downs beds). QUEENSLAND (DeVis, 1892).

UPPER PLEISTOCENE (Katipiri sands, Malkuni fauna). SOUTH AUSTRALIA: lower Cooper Creek (DeVis, 1906, Ann. Queensland Mus., no. 6, p. 17, pl. 5, fig. 4-5).

Genus †*Liptornis* Ameghino

Liptornis Ameghino, 1895, Bol. inst. Geog. argentino, vol. 15, cahiers 11-12, p. 99 (type by monotypy *Liptornis hesternus* Ameghino).

10. *Liptornis hesternus* Ameghino

Liptornis hesternus Ameghino, 1895, Bol. Inst. geog. argentino, vol. 15, cahiers 11-12, p. 99 (type lower cervical vertebra, Brit. Mus.).

MIDDLE MIOCENE (Santa Cruz formation). ARGENTINA: Ter. Santa Cruz: Cueva.

Neospecies of Pelecanidae from Pleistocene and *prehistoric sites:

1. *Pelecanus onocrotalus* Linnaeus. ENGLAND: Norfolk (Lydekker, 1891, Ibis, p. 387). SWITZERLAND: *Neuenberger See (Lambrecht, 1933, Handb. Palaeorn., p. 732).

2. *Pelecanus crispus* Bruch. DENMARK: Havnoe (H. Winge, 1903, Vidensk. Meddel. naturhist. Foren. Copenhagen, vol. 6, p. 100). ENGLAND: Feltwell Fen (Newton, Proc. zool. Soc. London, p. 702); Burnt Fen near Littleport (Harmer, 1898, Geol. Mag., p. 418). AZERBAIJAN: Bingada near Baku (*Pelecanus crispus palaeocrispus* Serebrovsky, 1941, Doklady Akad. Nauk S.S.S.R., vol. 33, p. 472).

3. *Pelecanus erythorhynchos* Gmelin. OREGON: Fossil Lake (Howard, 1946, Publ. Carnegie Instn. Washington, no. 551, p. 153; Shufeldt's earlier records erroneous); Dry Creek? (L. Miller, 1944, Condor, vol. 46, p. 26). CALIFORNIA: Manix (Compton, 1934, Condor, vol. 36, p. 167); *Emeryville (Howard, 1929, Univ. Calif. Publ. Zool., vol. 32, p. 312); *Buena Vista Lake (DeMay, 1942, Condor, vol. 44, p. 228). NEVADA: Rattlesnake Hill (Wetmore, 1940, Smithsonian misc. Coll., vol. 99, no. 4, p. 10). SOUTH DAKOTA: *Corson County (L. Miller, 1961, Bull. S. Calif. Acad. Sci., vol. 60, pt. 3, p. 125). KANSAS: Shorts Creek (Stettenheim, 1958, Wilson Bull., vol. 70, p. 197). OKLAHOMA: Beaver County (Mengel, 1952, Auk, vol. 69, p. 81). IOWA: *Mill Creek (Hamon, 1961, Plains Anthropologist, vol. 6, p. 209). ILLINOIS: *Snyder and *Cahokia (Parmalee, 1958, Auk, vol. 75, p. 170).

4. *Pelecanus occidentalis* Linnaeus. CALIFORNIA: Carpinteria (DeMay, 1941, Publ. Carnegie Instn. Washington, no. 530, p. 64); *Emeryville (Howard, 1929,

Univ. Calif. Publ. Zool., vol. 32, p. 312); *Buena Vista Lake (DeMay, Condor, vol. 44, p. 228). ILLINOIS: *Modoc (Parmalee, 1958, Auk, vol. 75, p. 170 [needs confirmation]). FLORIDA: *Castle Windy (Bullen and Sleight, 1959, Rept. Bryant Found. Amer. Studies, no. 1, p. 20). PUERTO RICO: *Barrio Canas (Wetmore, 1938, Auk, vol. 55, p. 53). ST. CROIX: *Concordia (Wetmore, 1937, Jour. Agr. Univ. Puerto Rico, vol. 21, p. 6).

Suborder FREGATAE (Sharpe)

Fregati Sharpe, 1891, Review Recent Attempts to Classify Birds, p. 77 (suborder; type *Fregata* Lacépède).—Wetmore and W. D. Miller, 1926, Auk, vol. 43, no. 3, p. 341).

Family FREGATIDAE Garrod

Fregatidae Garrod, 1874 (read Feb. 3), Proc. zool. Soc. London, p. 117 (type *Fregata* Lacépède).

Neospecies of Fregatidae from *prehistoric sites:

1. *Fregata magnificens* Mathews. ST. THOMAS: *midden (Wetmore, 1918, Proc. U. S. nat. Mus., vol. 54, p. 515). ANTIGUA: *Mill Reef midden (Univ. Florida).

Order ARDEIFORMES (Wagler)

Ardeae Wagler, 1830, Natürliches System der Amphibien mit vorangehender Classification der Säugethiere und Vögel, p. 000 (ordo; type *Ardea* Linnaeus). Wagler, 1831, Isis von Oken, Heft 4, p. 530.—*Ardeiformes* Gadow, 1892, Proc. zool. Soc. London, p. 240 (order).

Tantali Wagler, 1830, Nat. Syst. Amphib. Säugeth. Vögel, p. 000 (ordo; type *Tantalus* Linnaeus, 1758, a synonym of *Mycteria* Linnaeus, 1758).—Wagler, 1831, Isis von Oken, Heft 4, p. 530.

Herodiones Bonaparte, 1853, C. R. Acad. Sci. Paris, vol. 37, no. 18, p. 642 (ordo; type *Herodias* Boie, 1822, a junior synonym of *Egretta* Forster, 1817). —Bonaparte, 1854, Ann. Sci. nat. (Paris), p., 37.—*Herodii* Cope, 1889 (Oct.), Amer. Natural., vol. 23, no. 274, p. 871 (suborder).

Ciconiae Bonaparte, 1854, Ann. Sci. nat. (Paris), p. 37 ("tribus," i.e. suborder of *Herodiones*; type *Ciconia* Linnaeus).—*Ciconiiformes* Garrod, 1874, Proc. zool. Soc. London, pp. 117, 122 (order).

Suborder PHOENICOPTERI Fürbringer

Phoenicopteri Fürbringer, 1888, Untersuch. Morph. Syst. Vögel, vol. 2, p. 1565 (gens; type *Phoenicopterus* Linnaeus).—*Phoenicopteriformes* Sharpe, 1891, Review Recent Attempts to Classify Birds, p. 76 (order).

Family †Torotigidae Brodkorb

Torotigidae Brodkorb, 1963 (in press), Proc. XIII internat. ornith. Congr. Ithaca, p. 000 (type *Torotix* Brodkorb).

Genus †*Gallornis* Lambrecht

Gallornis Lambrecht, 1931, Bull. Mus. Hist. nat. Belgique, vol. 7, no. 30, p. 1 (type by monotypy *Gallornis straeleni* Lambrecht). Position tentative.

1. *Gallornis straeleni* Lambrecht

Gallornis straeleni Lambrecht, 1931, Bull. Mus. Hist. nat. Belgique, vol. 7, no. 30, p. 1, fig. 1-3 (type from Auxerre, proximal end of femur, Brussels Mus.).

Lower Cretaceous, Neocomian. France: Dept. Yonne: Auxerre.

Genus †*Parascaniornis* Lambrecht

Parascaniornis Lambrecht, 1933, Handb. Palaeorn., p. 335 (type by monotypy *Parascaniornis stensiöi* Lambrecht). Position tentative.

2. *Parascaniornis stensioi* Lambrecht

Parascaniornis stensiöi Lambrecht, 1933, Handb. Palaeorn., p. 335, fig. 116 (type from Ivö, vertebra, Mineralogical-Geological Museum, Copenhagen).

Upper Cretaceous, Campanian (Shell fragment limestone). Sweden: Ivö.

Genus †*Torotix* Brodkorb

Torotix Brodkorb, 1963 (in press), Proc. XIII internat. ornith. Congr. Ithaca, p. 000 (type by original designation *Torotix clemensi* Brodkorb).

3. *Torotix clemensi* Brodkorb

Torotix clemensi Brodkorb, 1963 (in press), Proc. XIII internat. ornith. Congr. Ithaca, p. 000, fig. 4-5 (type distal part of right humerus, Univ. Calif. Mus. Paleo. no. 53958).

UPPER CRETACEOUS, MAESTRICHTIAN (Lance formation). WYOMING: Niobrara County: Lance Creek.

Family †SCANIORNITHIDAE Lambrecht

Scaniornithidae Lambrecht, 1933, Handb. Palaeorn., p. 334 (type *Scaniornis* Dames).

Genus †*Scaniornis* Dames

Scaniornis Dames, 1890 (read Jan. 8), Bihang svenska Vet.-Akad. Handl., vol. 16, pt. 4, no. 1, p. 4 (type by monotypy *Scaniornis lundgreni* Dames).

1. *Scaniornis lundgreni* Dames

Scaniornis lundgreni Dames, 1890 (read Jan. 8), Bihang svenska Vet.-Akad. Handl., vol. 16, pt. 4, no. 1, p. 4, pl. (types from Annetorp quarry, right humerus, coracoid, scapula, Univ. Lund).

LOWER PALEOCENE (Saltholmskalk). SWEDEN: Annetorp quarry near Limhamn.

Family †TELMABATIDAE Howard

Telmabatidae Howard, 1955 (March 11), Amer. Mus. Novit., no. 1710, p. 23 (type *Telmabates* Howard).

Genus †*Telmabates* Howard

Telmabates Howard, 1955 (March 11), Amer. Mus. Novit., no. 1710, p. 3 (type by original designation *Telmabates antiquus* Howard).

1. *Telmabates antiquus* Howard

Telmabates antiquus Howard, 1955 (March 11), Amer. Mus. Novit., no. 1710, p. 3, fig. 1-8 (type from Cañadón Hondo, postcranial skeleton, Am. Mus. Nat. Hist. no. 3170).

LOWER EOCENE (Casamayor formation). ARGENTINA: Ter. Chubut: Cañadón Hondo near Paso Niemann, south of Río Chico del Chubut.

Family †AGNOPTERIDAE Lambrecht

Agnopteridae Lambrecht, 1933, Handb. Palaeorn., p. 333 (type *Agnopterus* Milne-Edwards).

Genus †*Agnopterus* Milne-Edwards

Ptenornis Seeley, 1866, Ann. Mag. nat. Hist., ser. 3, vol. 18, p. 109 (inadequate description and no specific name).
Agnopterus Milne-Edwards, 1868, Ois. Foss. France, vol. 2, pl. 89, fig. 10-15 (type by monotypy *Agnopterus laurillardi* Milne-Edwards).—Milne-Edwards, 1870, op. cit., vol. 2, sheet 11, p. 83.

1. *Agnopterus hantoniensis* Lydekker

Agnopterus(?) *hantoniensis* Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 96, fig. 23 (type from Hordwell, right coracoid, Brit. Mus. no. 30325).

Upper Eocene (Hordwell beds). England: Hampshire: Hordwell (Lydekker, 1891). Isle of Wight: Hempstead? (Seeley, 1866, Ann. Mag. nat. Hist., p. 109).

2. *Agnopterus laurillardi* Milne-Edwards

Agnopterus laurillardi Milne-Edwards, 1868, Ois. Foss. France, vol. 2, pl. 89, fig. 10-15; 1870, vol. 2, sheet 11, p. 83 (type from environs de Paris, distal part of tibiotarsus, Paris Mus.).

Upper Eocene (gypse de Montmartre). France: Dept. Seine: Montmartre.

3. *Agnopterus turgaiensis* Tugarinov

Agnopterus turgaiensis Tugarinov, 1940, Doklady Akad. Nauk S.S.S.R., vol. 26, no. 3, p. 308, fig. 2 (type from Lake Chelkar-Teniz).—*Agnopterus turgaensis* Belyaeva, 1962, Cat. Tertiary Fossil Sites of Land Mammals in U.S.S.R., p. 8).

Upper Oligocene (*Indricotherium* beds). Kazakstan: Lake Chelkar-Teniz.

Family Phoenicopteridae Bonaparte

Phoenicopteridae Bonaparte, 1831, Saggio di una distribuzione metodica degli Animali Vertebrati, p. 59 (type *Phoenicopterus* Linnaeus).

Genus †*Elornis* Aymard

Elornis Aymard, 1856, Congr. sci. France, vol. 1, p. 234 (type *Elornis littoralis* Aymard, designated by Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 80).
Helornis Lydekker, 1891, Ibis, ser. 6, vol. 3, p. 396 (emendation).

1. *Elornis anglicus* Lydekker

Elornis(?) *anglicus* Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 80, fig. 22 (type from Hordwell, left humerus, Brit. Mus. no. 36792).

Upper Eocene (Hordwell beds). England: Hampshire: Hordwell.

2. *Elornis littoralis* Aymard

Elornis littoralis Aymard, 1856, Congr. sci. France, vol. 1, pp. 234, 267 (lectotype from Ronzon, humerus, suggested by Lydekker, 1891, Cat., p. 80).
Elornis antiquus Aymard, 1856, Congr. sci. France, vol. 1, p. 234 (types from Ronzon, proximal part of tarsometatarsus, humerus).

LOWER OLIGOCENE (marnes calcaires de Ronzon). FRANCE: Dept. Haut Loire: Ronzon near Puy-en-Velay.

3. *Elornis grandis* Aymard

Elornis grandis Aymard, 1856, Congr. sci. France, vol. 1, pp. 234, 267 (type from Ronzon, proximal part of humerus).

LOWER OLIGOCENE (marnes calcaires de Ronzon). FRANCE: Dept. Haut Loire: Ronzon near Puy-en-Velay.

Genus †*Tiliornis* Ameghino

Tiliornis Ameghino, 1899 (July), Sinopsis geológico-paleontológica, Suplemento, p. 9 (type by monotypy *Tiliornis senex* Ameghino).

4. *Tiliornis senex* Ameghino

Tiliornis senex Ameghino, 1899 (July), Sinopsis geológico-paleontológica, Suplemento, p. 9 (type from "Guaranitico de Patagonia," coracoid).

LOWER OLIGOCENE (Deseado formation). ARGENTINA: Patagonia.

Genus *Phoenicopterus* Linnaeus

Phoenicopterus Linnaeus, 1758, Syst. Nat., ed. 10, vol. 1, p. 139 (type *Phoenicopterus ruber* Linnaeus).

5. *Phoenicopterus croizeti* Gervais

Phoenicopterus croizeti Gervais, 1849, Mem. Acad. Sci. Lett. Montpellier, sec. sci., vol. 1, p. 220 (nomen nudum; based on "Flamant semblable au *Ph. ruber*, P. Gerv., Ois. foss., p. 21").—Gervais, 1852, Zool. et Pal. Françaises, ed. 1, p. 233, pl. 2, fig. 4-5 (types tarsometatarsus from Gergovie and skull from Clermont-Ferrand).

LOWER MIOCENE (Aquitanian). FRANCE: Dept. Puy-en-Dôme: Clermont-Ferrand and Gergovie (Gervais, 1852); Chaptuzat and Cournon (Milne-Edwards, 1869, Ois. Foss. France, vol. 2, p. 572); Perignat and Sauvetat (Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 78). Dept. Allier: Chavroches, Gannat, Allets, and Langy (Milne-Edwards); Saint-Gérand-le-Puy (Lydekker). Dept. Somme: Créchy (Lambrecht, 1933, Handb. Palaeorn., p. 344).

LOWER MIOCENE (Hydrobienschichten). GERMANY: Prov. Rheinhessen: Budenheim near Mainz (Lambrecht).

6. *Phoenicopterus floridanus* Brodkorb

Phoenicopterus floridanus Brodkorb, 1953 (June 9), Nat. Hist. Misc., no. 124, p. 1, fig. 1-2 (type from Brewster, distal part of right tibiotarsus, Brodkorb no. 147).

LOWER PLIOCENE (Bone Valley gravel). FLORIDA: Polk County: Brewster.

7. *Phoenicopterus stocki* L. Miller

Phoenicopterus stocki L. Miller, 1944 (June), Wilson Bull., vol. 56, no. 2, p. 77, fig. 1-2 (type from Rincón, distal end of tibiotarsus, Los Angeles Co. Mus. no. C.I.T. 3245).

MIDDLE PLIOCENE (Chihuahua formation). MEXICO: Chihuahua: Rincón de la Concha, near Yepomera, valley of Río Papigochic.

8. *Phoenicopterus copei* Shufeldt

Phoenicopterus copei Shufeldt, 1891 (Sept.), Amer. Natural., vol. 25, no. 297, p. 820.—Shufeldt, 1892, Jour. Acad. nat. Sci. Philadelphia, vol. 9, p. 410, pl. 15, fig. 11, 13; pl. 17, fig. 28-29, 38 (types from Fossil Lake, distal end of left tarsometatarsus and wing phalanx, Am. Mus. no. 3485).

MIDDLE PLEISTOCENE (Fossil Lake formation). OREGON: Lake County: Fossil Lake (Shufeldt, 1891).

UPPER PLEISTOCENE (Manix lake beds). CALIFORNIA: San Bernardino County: Manix? (Howard, 1955, U. S. geol. Surv. profess. Paper, no. 264-J, p. 202).

9. *Phoenicopterus minutus* Howard

Phoenicopterus minutus Howard, 1955 (June 8), U. S. geol. Surv. profess. Paper, No. 264-J, p. 202, pl. 50, fig. 1-7 (type from Manix, right tibiotarsus and associated proximal part of tarsometatarsus, Los Angeles Mus. no. 2445).

UPPER PLEISTOCENE (Manix lake beds). CALIFORNIA: San Bernardino County: Manix.

Neospecies of Phoenicopteridae from Pleistocene and *prehistoric sites:

1. *Phoenicopterus ruber* Linnaeus. PUERTO RICO: *Barrio Canas (Wetmore, 1938, vol. 55, p. 53). ST. CROIX: *Concordia (Wetmore, 1937, Jour. Agr. Univ. Puerto Rico, vol. 21, p. 7). ANTIGUA: *Mill Reef midden (Univ. Florida).

2. *Phoenicopterus chilensis* Molina. ARGENTINA: Luján (Ameghino, 1891, Rev. argentina Hist. nat., vol. 1, p. 445).

Family †Palaelodidae (Stejneger)

Palaelodontidae Stejneger, 1885, Stand. nat. Hist., vol. 4, p. 154 (type *Palaelodus* Milne-Edwards).
Palaelodidae Fürbringer, 1888, Untersuch. Morph. Syst. Vögel, vol. 2, p. 1565.
Paloelodidae Howard, 1955, Amer. Mus. Novit., no. 1710, p. 22.

Genus †*Palaelodus* Milne-Edwards

Palaelodus Milne-Edwards, 1863 (read June 29), C. R. Acad. Sci. Paris, vol. 56, p. 1220 (type *Palaelodus ambiguus* Milne-Edwards, designated by Milne-Edwards, 1869, Ois. Foss. France, vol. 2, p. 59).
Paloelodus Milne-Edwards, 1868, Ois. Foss. France, vol. 1, pl. 82-89; 1869, vol. 2, sheet 8, p. 58 (typographical error for *Palaelodus*?).—O. Fraas, 1870, Jahresh. Ver. Naturk. Württemberg, vol. 26, p. 285 (emendation).

1. *Palaelodus goliath* Milne-Edwards

Paloelodus goliath Milne-Edwards, 1868, Ois. Foss. France, vol. 1, pl. 87; pl. 88, fig. 1-3; 1870, vol. 2, p. 79 (lectotype from Langy, tarsometatarsus, selected by Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 95).

Lower Miocene (Aquitanian). France: Dept. Allier: Langy (Milne-Edwards, 1871, vol. 2, p. 572); Saint-Gérand-le-Puy (Lambrecht, 1933, Handb. Palaeorn., p. 341). Dept. Somme: Créchy (Lambrecht, 1933).

Lower Miocene (Hydrobienkalk). Germany: Hessen: Budenheim, Kastel Bruch, River Hessler between Wiesbaden and Mainz, and Neuer Bruch (Lambrecht, 1933).

2. *Palaelodus crassipes* Milne-Edwards

Palaelodus crassipes Milne-Edwards, 1863 (read June 29), C. R. Acad. Sci. Paris, vol. 56, p. 1221 (almost a nomen nudum; type from dept. Allier, element not specified).—*Paloelodus crassipes* Milne-Edwards, 1868, Ois. Foss. France, vol. 1, pl. 88, fig. 4-11; pl. 89, fig. 1-5.—Milne-Edwards, 1870, Ois. Foss. France, vol. 2, sheet 10, p. 77.

Lower Miocene (Aquitanian). France: Dept. Allier: Langy and Gannat (Milne-Edwards, 1871, vol. 2, p. 572); Saint-Gérand-le-Puy [not Ciernat?] (Lambrecht, 1933, Handb. Palaeorn., pp. 341, 884). Dept. Puy-de-Dome: Montaigut le Blin (Lambrecht, p. 341).

3. *Palaelodus ambiguus* Milne-Edwards

Palaelodus ambiguus Milne-Edwards, 1863 (read June 29), C. R. Acad. Sci. Paris, vol. 56, p. 1221 (descr. type from dept. Allier).—*Paloelodus ambiguus* Milne-Edwards, 1868, Ois. Foss. France, vol. 1, pl. 82-84, pl. 85, fig. 1-11; 1869, vol. 2, sheet 8, p. 60 (types redescribed).

LOWER MIOCENE (Aquitanian). FRANCE: Dept. Allier: Gannat, Billy, Langy, Vaumas, and Saint-Gérand-le-Puy? (Milne-Edwards). Dept. Puy-de-Dôme: Cournon and Chaptuzat (Milne-Edwards); Pont-du-Château and Perignat (Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 83). Dept. Somme: Créchy (Lambrecht, 1933, Handb. Palaeorn., p. 341).

LOWER MIOCENE (Hydrobienkalk). GERMANY: Hesse: Weisenau (Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 83); River Hessler between Wiesbaden and Mainz, "Dickkopf" near Monsheim, Budenheim, and Kasteler Bruch (Lambrecht, pp. 340, 670).

4. *Palaelodus minutus* Milne-Edwards

Paloelodus minutus Milne-Edwards, 1868, Ois. Foss. France, vol. 1, pl. 86, fig. 17-20; 1870, vol. 2, sheet 10, p. 75 (lectotype from Allier, tarsometatarsus, coll. Milne-Edwards, selected by Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 92).

LOWER MIOCENE (Aquitanian). FRANCE: Dept. Allier: Langy (Milne-Edwards, 1871, Ois. Foss. France, vol. 2, p. 572); Saint-Gérand-le-Puy (Paris, 1912, Rev. française Ornith., vol. 4, p. 291); Chavroches (Lambrecht, 1933, Handb. Palaeorn., p. 342). Dept. Somme: Créchy (Lambrecht, p. 667).

LOWER MIOCENE (Hydrobienkalk). GERMANY: Hesse: Kastel Bruch and Budenheim (Lambrecht).

5. *Palaelodus gracilipes* Milne-Edwards

Palaelodus gracilipes Milne-Edwards, 1863 (read June 29), C. R. Acad. Sci. Paris, vol. 56, p. 1221 (almost a nomen nudum; type from Allier).—*Paloelodus gracilipes* Milne-Edwards, 1868, Ois. Foss. France, vol. 1, pl. 85, fig. 12-16; pl. 86, fig. 1-16; 1870, vol. 2, sheet 10, p. 73 (types redescribed).

LOWER MIOCENE (Aquitanian). FRANCE: Dept. Allier: Langy, Gannat, Vaumas, and Saint-Gérand-le-Puy (Milne-Edwards, 1871, vol. 2, p. 572).

6. *Palaelodus steinheimensis* Fraas

Paloelodus steinheimensis O. Fraas, 1870, Jahresh. Ver. Vaterl. Naturk. Württemberg, vol. 26, p. 285, pl. 7, fig. 13 (type from Steinheim, distal end of left tibiotarsus, Stuttgart Mus.).

UPPER MIOCENE (obere Süsswassermolasse). GERMANY: Württemberg: Steinheim (Fraas). Records of *P. goliath* from Goldberg (Lambrecht, p. 670) and *P. ambiguus* from Goldberg, Spitzberg, Steinheim, and Hahnenberg (Lambrecht, pp. 339, 678) may be referable

to this large species, whereas the records of *P. gracilipes* from Steinheim (Fraas, p. 286) and *P. minutus* from Goldberg (Lambrecht, pp. 342, 670) suggest the presence of an undescribed small species in the Upper Miocene.

Genus †*Megapaloelodus* A. H. Miller

Megapaloelodus A. H. Miller, 1944 (June 22), Univ. Calif. Publ. geol. Sci., vol. 27, no. 4, p. 86 (type by monotypy *Megapaloelodus connectens* A. H. Miller).

Megapalaelodus Wetmore, 1951, Proc. X. internat. ornith. Congr., pp. 58, 66 (emendation).

7. *Megapaloelodus connectens* A. H. Miller

Megapaloelodus connectens A. H. Miller, 1944 (June 22), Univ. Calif. Publ. geol. Sci., vol. 27, no. 4, p. 86, fig. 1-2 (type from Flint Hill, distal end of right tarsometatarsus, Univ. Calif. Mus. Paleo. no. 37367).

Lower Miocene (Rosebud formation). South Dakota: Bennett County: Flint Hill, 9 miles WSW of Martin (A. H. Miller, 1944).

Upper Miocene (Barstow formation). California: San Bernardino County: Barstow (L. Miller, 1950, Condor, vol. 52, p. 69; 1952, Condor, vol. 54, p. 296); elements not comparable to type and may represent another species.

8. *Megapaloelodus opsigonus* Brodkorb

Megapaloelodus opsigonus Brodkorb, 1961 (Nov. 7), Quart. Jour. Florida Acad. Sci., vol. 24, no. 3, p. 173, fig. 2 (type from Juntura, proximal end of left tarsometatarsus, Univ. Ore. Mus. Nat. Hist., no. F-5459).

Lower Pliocene (Juntura beds). Oregon: Malheur County: Juntura.

Suborder PLATALEAE Newton

Plataleae A. Newton, 1884, Encyclop. brit., ed. 9, vol. 18, p. 47 (type *Platalea* Linnaeus).

Ibides Coues, 1884 (April or later), Key N. Amer. Birds, ed. 2, pp. ix, 648 (type *Ibis* Cuvier, a synonym of *Threskiornis* Cray).

Family †Plegadornithidae (Wetmore)

Pelagodornithidae [sic] Wetmore, 1962 (June 26), Smithsonian misc. Coll., vol. 145, no. 2, p. 3 (type *Plegadornis* Wetmore,).—*Pelagodornithoidea* [sic] Wetmore, 1962, op. cit., p. 3 (superfamily).

Genus †*Plegadornis* Wetmore

Plegadornis Wetmore, 1962 (June 26), Smithsonian misc. Coll., vol. 145, no. 2, p. 1 (type by original designation *Plegadornis antecessor* Wetmore).

1. *Plegadornis antecessor* Wetmore

Plegadornis antecessor Wetmore, 1962 (June 26), Smithsonian misc. Coll., vol. 145, no. 2, p. 1, fig. 1 (type from Hewletts farm, distal part of left humerus, U. S. Nat. Mus. no. 22820).

UPPER CRETACEOUS, SANTONIAN (Mooreville tongue of Selma chalk). ALABAMA: Greene County: Hewletts farm, 3 miles northeast of Boligee.

Family PLATALEIDAE Bonaparte

Plataleinae Bonaparte, 1838, Geographical and comparative list of the birds of Europe and North America, p. 48 (subfamilia; type *Platalea* Linnaeus).—*Plataleidae* Bonaparte, 1853, C. R. Acad. Sci. Paris, vol. 37, no. 18, p. 643 (familia).

Ibinae Bonaparte, 1853, C. R. Acad. Sci. Paris, vol. 37, no. 18, p. 643 (subfamilia; type "*Ibis*, Savig. Cuv. (*Threskiornis* Wagl.)", see Bonaparte, 1854, Ann. Sci. nat. (Paris), p. 38; *Ibis* in this sense is preoccupied by *Ibis* Lacépède, 1799).—*Ibididae* Coues, 1884 (April or later), Key N. Amer. Birds, ed. 2, pp. ix, 648.

Plegadidae Mathews, 1913 (Jan.), Auk, vol. 30, no. 1, pp. 93, 95 (type *Plegadis* Kaup).

Threskiornithidae Richmond, 1917 (Aug. 16), Proc. U. S. nat. Mus., vol. 53, no. 2221, pp. 580, 636 (type *Threskiornis* Gray).

Subfamily THRESKIORNITHINAE (Richmond)

Ibinae Bonaparte, 1853, C. R. Acad. Sci. Paris, vol. 37, no. 18, p. 643 (type *Ibis* Savigny, Cuvier, not *Ibis* Lacépède).

Eudociminae Bonaparte, 1854, Ann. Sci. nat. (Paris), p. 38 (type *Eudocimus* Wagler).

Threskiornithidae Richmond, 1917 (Aug. 16), Proc. U. S. nat. Mus., vol. 53, no. 2221, pp. 580, 636 (family; type *Threskiornis* Gray).—*Threskiornithinae* Wetmore and W. D. Miller, 1926, Auk, vol. 43, p. 341).

Genus †*Ibidopsis* Lydekker

Ibidopsis Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 74 (type by original designation *Ibidopsis hordwelliensis* Lydekker).

1. *Ibidopsis hordwelliensis* Lydekker

Ibidopsis hordwelliensis Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 74, fig. 20 (type from Hordwell, distal part of right tibiotarsus, Brit. Mus. no. 36793).

UPPER EOCENE (Hordwell beds). ENGLAND: Hampshire: Hordwell.

Genus †*Ibidopodia* Milne-Edwards

Ibidopodia Milne-Edwards, 1868, Ois. Foss. France, vol. 1, sheet 59, p. 465 (type by monotypy *Ibidopodia palustris* Milne-Edwards).

2. *Ibidopodia palustris* Milne-Edwards

Ibidopodia palustris Milne-Edwards, 1868, Ois. Foss. France, vol. 1, sheet 59, 465, pl. 71, fig. 17-21 (lectotype cranium from Langy, selected by Lydekker, 1891, p. 74).

LOWER MIOCENE (Aquitanian). FRANCE: Dept. Allier: Langy.

Genus *Eudocimus* Wagler

Eudocimus Wagler, 1832, Isis von Oken, p. 1232 (type *Scolopax rubra* Linnaeus).

3. *Eudocimus paganus* (Milne-Edwards)

Ibis pagana Milne-Edwards, 1868, Ois. Foss. France, vol. 1, sheet 57, p. 450, pl. 69-70, pl. 71, fig. 1-12 (types numerous elements from Langy and Saint-Gérand-le-Puy).

LOWER MIOCENE (Aquitanian). FRANCE: Dept. Allier: Langy and Saint-Gérand-le-Puy (Milne-Edwards). Dept. Puy-de-Dôme: Montaigut (Lambrecht, 1933, Handb. Palaeorn., p. 331).[1]

Genus †*Protibis* Ameghino

Protibis Ameghino, 1891 (Dec. 1), Rev. argentina Hist. nat., vol. 1, p. 445 (type by monotypy *Protibis cnemialis* Ameghino).

4. *Protibis cnemialis* Ameghino

Protibis cnemialis Ameghino, 1891 (Dec. 1), Rev. argentina Hist. nat., vol. 1, p. 445 (type from Monte Observación, distal part of tibiotarsus, now in Brit. Mus.).—Ameghino, 1895, Bol. Inst. geog. argentino, vol. 15, p. 98, fig. 42 (type redescribed).

MIDDLE MIOCENE (Santa Cruz formation). ARGENTINA: Ter. Santa Cruz: Monte Observación.

Genus *Plegadis* Kaup

Plegadis Kaup, 1829, Skizz. Ent.-Gesch. Eur. Thierw., p. 82 (type *Tantalus falcinellus* Linnaeus).

5. *Plegadis gracilis* A. H. Miller and Bowman

Plegadis gracilis A. H. Miller and Bowman, 1956 (March 5), Wilson Bull., vol. 68, no. 1, p. 38, fig. 1 d-e (type from Cita Canyon, proximal part of left tarsometatarsus, Univ. Calif. Mus. Paleo. no. 45088).

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[1]A similar species occurs in the Upper Miocene at Steinheim (Fraas, 1870, Jahresh. Ver. Naturk. Württemberg, vol. 26, p. 284) and Lierheim (Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 73).

LOWER PLEISTOCENE (Cita Canyon beds). TEXAS: Randall County: Cita Canyon, at Newton Harrell-Edd Ranch.

Genus *Carphibis* Reichenbach

Carphibis Reichenbach, 1853, Avium systema naturale, p. xiv (type *Ibis spinicollis* Jameson).

6. *Carphibis condita* (DeVis)

Ibis(?) conditus DeVis, 1906, Ann. Queensland Mus., no. 6, p. 10, pl. 2, fig. 2 (type from Wurdulumankula, femur).

UPPER PLEISTOCENE (Malkuni fauna, Katipiri sands). SOUTH AUSTRALIA: Wurdulumankula near Lake Eyre.

Subfamily PLATALEINAE Bonaparte

Plataleinae Bonaparte, 1838, Geogr. comp. List Birds Eur. N. Amer., p. 48 (type *Platalea* Linnaeus).

Genus *Platalea* Linnaeus

Platalea Linnaeus, 1758, Syst. Nat., ed. 10, vol. 1, p. 139 (type *Platalea leucorodia* Linnaeus).

7. *Platalea subtenuis* DeVis

Platalea subtenuis DeVis, 1892, Proc. Linn. Soc. N. S. Wales, ser. 2, vol. 6, p. 443, pl. 24, fig. 5 (types from Queensland, fragmentary femur and tibiotarsus).

UPPER PLEISTOCENE (Darling Downs beds). QUEENSLAND.

Neospecies of Plataleidae from Pleistocene and *prehistoric sites:

1. *Nipponia nippon* (Temminck). JAPAN: *Iki Island? (Kuroda, 1959, Bull. biogeog. Soc. Japan, vol. 21, p. 68, pl. 1, fig. D-E).

2. *Theristicus caudatus* (Boddaert). BRAZIL: Lapa da Escrivania? (Winge, 1887, E. Mus. Lund., vol. 1, no. 2, p. 29).

3. *Eudocimus albus* (Linnaeus). FLORIDA: Seminole Field (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 18); Haile (Brodkorb, 1953, Wilson Bull., vol. 65, p. 49); Itchtucknee River (McCoy, 1963, Auk, vol. 80, p. 000). BAHAMAS: *Cordon Hills on Crooked Island (Wetmore, 1938, Auk, vol. 55, p. 52). PUERTO RICO: *Barrio Canas (Wetmore, 1938, Auk, vol. 55, p. 53).

4. *Eudocimus ruber* (Linnaeus). VENEZUELA: *Hacienda Tocoron? (Wetmore, 1935, Auk, vol. 52, p. 329).

5. *Plegadis falcinellus* (Linnaeus). PUERTO RICO: *Barrio Canas (Wetmore, 1938, Auk, vol. 55, p. 53).

6. *Plegadis chihi* (Vieillot). CALIFORNIA: Rancho La Brea (L. Miller, 1925, Publ. Carnegie Instn. Washington, no. 349, p. 73); *Emeryville (Howard, 1929, Univ. Calif. Publ. Zool., vol. 32, p. 312); *Buena Vista Lake (DeMay, 1942, Condor, vol. 44, p. 229).

7. *Platalea alba* Scopoli. MADAGASCAR: *Sirabé (Andrews, 1897, Ibis, p. 358).

8. *Ajaia ajaja* (Linnaeus). CALIFORNIA: Rancho La Brea? (Howard, 1930, Condor, vol. 32, p. 84). FLORIDA: Rock Spring (Woolfenden, 1959, Wilson Bull., vol. 71, p. 185).

Suborder ARDEAE Wagler

Ardeae Wagler, 1831, Isis von Oken, p. 530 (ordo; type *Ardea* Linnaeus).

Family ARDEIDAE Vigors

Ardeidae "Leach," Vigors, 1825, Trans. Linn. Soc. London, vol. 14, pp. 488-490 (type *Ardea* Linnaeus).

Genus †*Proherodius* Lydekker

Proherodius Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 60 (type by original designation *Proherodius oweni* Lydekker).

1. *Proherodius oweni* Lydekker

Proherodius oweni Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., pp. 60, 363, fig. 75 (type from Primrose Hill, fragmentary sternum, Brit. Mus. no. 43164).

LOWER EOCENE (London clay). ENGLAND: Middlesex: Primrose Hill and St. James' Park (Lydekker.)

Genus †*Eoceornis* Shufeldt

Eoceornis Shufeldt, 1915 (Feb.), Trans. Connecticut Acad. Arts Sci., vol. 19, p. 39 (type by monotypy *Eoceornis ardetta* Shufeldt).

2. *Eoceornis ardetta* Shufeldt

Eoceornis ardetta Shufeldt, 1915 (Feb.), Trans. Connecticut Acad. Arts Sci., vol. 19, p. 39, pl. 13, fig. 102 (type from Henrys Fork, fragmentary sternum, Yale Peabody Mus. no. 891).

MIDDLE EOCENE (Bridger formation). WYOMING: Uinta County: Henrys Fork.

Genus †*Botauroides* Shufeldt

Botauroides Shufeldt 1915 (Feb.), Trans. Connecticut Acad. Arts Sci., vol. 19, p. 33 (type by monotypy *Botauroides parvus* Shufeldt).

3. *Botauroides parvus* Shufeldt

Botauroides parvus Shufeldt, 1915 (Feb.), Trans. Connecticut Acad. Arts Sci., vol. 19, p. 33 (type from Spanish John's Meadow, distal part of left tarsometatarsus, Yale Peabody Mus. no. 1030).

MIDDLE EOCENE (Bridger formation). WYOMING: Sweetwater County: Spanish John's Meadow.

Genus †*Proardea* Lambrecht

Proardea Lambrecht, 1933, Handb. Palaeorn., p. 311 (type by monotypy *Ardea amissa* Milne-Edwards).

4. *Proardea amissa* (Milne-Edwards)

Ardea amissa Milne-Edwards, 1892, C. R. 2. Congr. internat. ornith. Budapest, p. 73 (type from phosphate de Chaux, tarsometatarsus, Paris Mus.).
Ardea armissa Paris, 1912, Rev. française Ornith., vol. 4, p. 291 (lapsus).

UPPER EOCENE or LOWER OLIGOCENE (phosphorites du Quercy). FRANCE: Dept. Tarn-et-Garonne: Chaux.

Genus †*Goliathia* Lambrecht

Goliathia Lambrecht, 1930 (Jan. 25), Geol. hungarica, ser. pal., fasc. 7, p. 30 (type by monotypy *Goliathia andrewsi* Lambrecht).

5. *Goliathia andrewsi* Lambrecht

Goliathia andreswi Lambrecht, 1930 (Jan. 25), Geol. hungarica, ser. pal., fasc. 7, p. 30, fig. 7 (type ulna, Brit. Mus. no. A.883).

UPPER EOCENE or LOWER OLIGOCENE (Fayum series). EGYPT: Fayum (exact locality unknown).

Genus †*Ardeacites* Haushalter

Ardeacites Haushalter, 1855, Merkwürdige fossile Tierüberreste aus der Allgäuer Molasse, p. 11 (type by monotypy *Ardeacites molassicus* Haushalter).

6. *Ardeacites molassicus* Haushalter

Ardeacites molassicus Haushalter, 1855, Merkwürdige fossile Tierüberreste aus der Allgäuer Molasse, p. 11, pl. 2, fig. 1 (type from Allgäu, humerus, Munich Mus., now lost).

UPPER MIOCENE (obere Meeresmolasse). BAVARIA: Allgäu near Harbartshofen.

Genus †*Botaurites* Ammon

Botaurites von Ammon, 1918, Abh. Naturw. Ver. Regensburg, vol. 12, p. 31 (type by monotypy *Botaurites avitus* von Ammon).

7. *Botaurites avitus* Ammon

Botaurites avitus von Ammon, 1918, Abh. Naturw. Ver. Regensburg, vol. 12, p. 31, fig. 5-6 (type from clay works, 7th or 8th cervical vertebra, Naturw. Verein zu Regensburg.)

UPPER MIOCENE (Braunkohlen der Oberpfalz). GERMANY: Württemberg: clay works of Mayer and Reinhard, between Dechbetten and Prüfening.

8. *Botaurites similis* (Fraas)

Ardea similis O. Fraas, 1870, Jahresh. Ver. Naturk. Württemberg, vol. 26, p. 284, pl. 7, fig. 14 (type from Steinheim, distal end of right tibiotarsus, Stuttgart Mus.).

UPPER MIOCENE (obere Süsswassermolasse). GERMANY: Württemberg: Steinheim.

Genus *Ardea* Linnaeus

Ardea Linnaeus, 1758, Syst. Nat., ed. 10, vol. 1, p. 141 (type *Ardea cinerea* Linnaeus).

9. *Ardea aurelianensis* Milne-Edwards

Ardea aurelianensis Milne-Edwards, 1871, Ois. Foss. France, vol. 2, sheet 74, p. 585 (type from Suèvres, humerus).

UPPER MIOCENE (faluns de Touraine). FRANCE: Dept. Indre-et-Loire: Suèvres northeast of Tours.

10. *Ardea perplexa* Milne-Edwards

Ardea perplexa Milne-Edwards, 1868, Ois. Foss. France, vol. 1, pl. 96, fig. 1-3; 1869, vol. 2, sheet 14, p. 108 (type from Sansan, distal part of right humerus).

UPPER MIOCENE (gisement lacustre de Sansan). FRANCE: Dept. Gers: Sansan.

11. *Ardea brunhuberi* von Ammon

Ardea brunhuberi von Ammon, 1918, Abh. Naturw. Ver. Regensburg, vol. 12, p. 30, fig. 4 (type from clay works, proximal end of left metacarpus, Naturw. Verein zu Regensburg).

UPPER MIOCENE (Braunkohlen der Oberpfalz). GERMANY: Württemberg: clay works of Mayer and Reinhard, between Dechbetten and Prüfening.

12. *Ardea polkensis* Brodkorb

Ardea polkensis Brodkorb, 1955 (Nov. 30), Florida Geol. Surv. Rept. Invest., no. 14, p. 17, pl. 4, fig. 13-15 (type from Brewster, proximal part of right tarsometatarsus, Brodkorb no. 308).

LOWER PLIOCENE (Bone Valley gravel). FLORIDA: Polk County: Brewster.

13. *Ardea lignitum* Giebel

Ardea lignitum Giebel, 1860 (Sept.), Zeitschr. Naturwiss., vol. 16, no. 9, p. 152, pl. 1, fig. 3 (type from Rippersroda, distal part of left femur).

UPPER PLIOCENE (Braunkohle von Rippersroda). GERMANY: Thuringia: Rippersroda.

Genus *Nycticorax* Forster

Nycticorax Forster, 1817, Syn. Cat. Brit. Birds, p. 59 (type *Ardea nycticorax* Linnaeus).

14. *Nycticorax fidens* Brodkorb

Nycticorax fidens Brodkorb, 1963 (Feb. 8), Florida Geol. Surv. Spec. Publ., no. 2, paper 4, p. 3, pl. 1 (type from McGehee farm, left femur, Univ. Florida no. 3285).

LOWER PLIOCENE (Alachua clay). FLORIDA: Alachua County: C. C. McGehee farm, section 22, Township 9 South, Range 17 East, 3.6 miles north of Newberry.

15. *Nycticorax megacephalus* (Milne-Edwards)

Ardea megacephala Milne-Edwards, 1873, Bibl. École hautes Études Paris, sec. sci. nat., vol. 9, art. 3, p. 8, pl. 14, fig. 1-14 (types from Rodriguez).

QUATERNARY. RODRIGUEZ ISLAND.

Genus †*Palaeophoyx* McCoy

Palaeophoyx McCoy 1963 (in press), Auk, vol. 80, no. 3, p. 000 (type by original designation *Palaeophoyx columbiana* McCoy).

16. *Palaeophoyx columbiana* McCoy

Palaeophoyx columbiana McCoy, 1963 (in press) Auk, vol. 80, no. 3, p. 000 fig. 1 (type from Itchtucknee River, right coracoid, Brodkorb no. 32).

UPPER PLEISTOCENE (Itchtucknee River beds). FLORIDA: Columbia County: Itchtucknee River.

Genus *Butorides* Blyth

Butorides Blyth, 1852, Cat. Birds Mus. Asiatic Soc., p. 281 (type *Ardea javanica* Horsfield).

17. *Butorides mauritianus* Günther and E. Newton

Butorides mauritianus Günther and E. Newton, 1879, Philos. Trans. Roy. Soc. London, vol. 168, extra vol., p. 424, pl. 41, fig. a-f (types from Mare aux Songes, Cambridge Univ., casts in Brit. Mus.).

QUATERNARY. MAURITIUS ISLAND: Mare aux Songes.

Neospecies of Ardeidae from Pleistocene and *prehistoric sites:

1. *Ardea cinerea* Linnaeus. DENMARK: Ertebolle, Maglemose, *Vejleby, and *Barsmark (H. Winge, 1903, Vidensk. Meddel. naturhist. Foren. Copenhagen, vol. 6, p. 99). IRELAND: Ballycotton, Edenvale, and Newhall caves (Lambrecht, 1933, Handb. Palaeorn., p. 734). ENGLAND: Clevedon Cave and *Glastonbury (Lambrecht, 1933); *Colchester (Bate, 1934, Ibis, p. 391). FRANCE: Essone near Corbeil (Milne-Edwards, 1871, Ois. Foss. France, vol. 2, p. 601). ITALY: *Castello nel Trentino (Lambrecht, 1933). SWITZERLAND: *Moosseedorf and *Robenhausen (Lambrecht, 1933). GERMANY: Hohlefels near Schelklingen (Lambrecht, 1933). CZECHOSLOVAKIA: Certova dira (Capek, 1910, Ber. V internat. ornith. Kongr. Berlin, p. 941). HUNGARY: Puskaporos (Lambrecht, 1912, Aquila, vol. 19, pp. 297, 305). FINLAND: Ladogasee (Lambrecht, 1933)

2. *Ardea herodias* Linnaeus. OREGON: Fossil Lake (Shufeldt, 1913, Bull. Amer. Mus. nat. Hist., vol. 32, pp. 153, 157). CALIFORNIA: Rancho La Brea (L. Miller, 1909, Univ. Calif. Publ. Geol., vol. 5, p. 306); McKittrick (L. Miller, 1925, Univ. Calif. Publ. Geol., vol. 15, p. 317); *Emeryville (Howard, 1929, Univ. Calif. Publ. Zool., vol. 32, p. 312); *Buena Vista Lake (DeMay, 1942, Condor, vol. 44, p. 228). FLORIDA: Seminole Field, Itchtucknee River, Melbourne, Bradenton, and *Vero Beach stratum 3 (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 14); Rock Spring (Woolfenden, 1959, Wilson Bull., vol. 71, p. 185); *Good's shellpit and *Lemon Bluff (Neill, Gut, Brodkorb, 1956, Amer. Antiquity, vol. 21, p. 388); *South Indian Field (Weigel, 1959, Florida Anthropologist, vol. 12, p. 73); *Castle Windy (Bullen and Sleight, 1959, Rept. Bryant Found. Amer. Studies, no. 1, p. 20). ST. CROIX: *Concordia (Wetmore, 1937, Jour. Agr. Univ. Puerto Rico, vol. 21, p. 7).

3. *Ardea cocoi* Linnaeus. VENEZUELA: *Los Tamarindos (Wetmore, 1935, Auk, vol. 52, p. 329). ARGENTINA: Luján (Ameghino, 1891, Rev. argentina Hist. nat., vol. 1, p. 445).

4. *Ardea purpurea* Linnaeus. ITALY: Grotta Romanelli and Buca del Bersagliere? (Lambrecht, 1933, Handb. Palaeorn., p. 734).

5. *Butorides virescens* (Linnaeus). CALIFORNIA: Rancho La Brea (Howard, 1936, Condor, vol. 38, p. 34); McKittrick (DeMay, 1941, Publ. Carnegie Instn. Washington, no. 530, p. 35); *Buena Vista Lake (DeMay, 1942, Condor, vol. 44, p. 228). FLORIDA: Seminole Field (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 16); Itchtucknee River (McCoy, 1963, Auk, vol. 80, p. 000); *Vero Beach stratum 3 (Weigel, 1963, Spec. Publ. Florida geol. Surv., no. 10, p. 25).

6. *Casmerodius albus* (Linnaeus). CALIFORNIA: Rancho La Brea (Howard, 1936, Condor, vol. 38, p. 34); McKittrick (DeMay, 1941, Publ. Carnegie Instn. Washington, no. 530, p. 35); *Buena Vista Lake (DeMay, 1942, Condor, vol. 44, p. 228). FLORIDA: Seminole Field, Venice, and Melbourne (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 15); Itchtucknee River, (McCoy, 1963, Auk, vol. 80, p. 000); *Hialeah (Laxson, 1953, Florida Anthropologist, vol. 6, p. 98); *Good's shellpit and *Lemon Bluff (Neill, Gut, and Brodkorb, 1956, Amer. Antiquity, vol. 21, p. 388); *South Indian Field (Weigel, 1959, Florida Anthropologist, vol. 12, p. 73); *Vero Beach stratum 3 (Weigel, 1963, Spec. Publ. Florida geol. Surv., no. 10, p. 25). CUBA: Baños de Ciego Montero (Wet-

more, 1928, Amer. Mus. Novit., no. 301, p. 1). VENEZUELA: *Los Tamarindos (Wetmore, 1935, Auk, vol. 52, p. 329).

7. *Ardeola ralloides* (Scopoli). ITALY: Buca del Bersagliere (Lambrecht, 1933, Handb. Palaeorn., p. 734).

8. *Florida caerulea* (Linnaeus). CALIFORNIA: McKittrick (DeMay, 1941, Publ. Carnegie Instn. Washington, no. 530, p. 35); Rancho La Brea (Howard, 1962, Los Angeles County Mus. Contr. Sci., no. 58, p. 20). FLORIDA: Seminole Field (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 16); Itchtucknee River (McCoy, 1963, Auk, vol. 80, p. 000).

9. *Florida thula* (Molina). FLORIDA: Bradenton (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 15); *Vero Beach stratum 3 (Weigel, 1963, Spec. Publ. Florida geol. Surv., no. 10, p. 25). Tentative record from Rancho La Brea, California (Howard, 1936, Condor, vol. 38, p. 35), withdrawn (Howard, 1962, Los Angeles County Mus. Contr. Sci., no. 58, p. 20).

10. *Egretta garzetta* (Linnaeus). ITALY: Bersagliere (Lambrecht, 1933, Handb. Palaeorn., p. 734).

11. *Mesophoyx intermedia* (Wagler). MADAGASCAR: *Sirabé (Andrews, 1897, Ibis, p. 358).

12. *Hydranassa tricolor* (Müller). FLORIDA: Seminole Field (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 15).

13. *Nyctanassa violacea* (Linnaeus). FLORIDA: Seminole Field (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 16); *Vero Beach stratum 3 (*Larus vero* Shufeldt, 1917, Jour. Geol., p. 18, type left carpometacarpus, formerly Florida Geol. Surv. no. V320, now in U. S. Nat. Mus., cast coll. Brodkorb; see Wetmore, 1931). ST. CROIX: *Concordia (Wetmore, 1937, Jour. Agr. Univ. Puerto Rico, vol. 21, p. 7). ST. THOMAS: *midden (Wetmore, 1918, Proc. U. S. nat. Mus., vol. 54, p. 515). ANTIGUA: *Mill Reef midden (Univ. Florida).

14. *Nycticorax nycticorax* (Linnaeus). CALIFORNIA: Rancho La Brea (Howard, 1929, Condor, vol. 31, p. 252); McKittrick (L. Miller, 1935, Condor, vol, 37, p. 75); *Buena Vista Lake (DeMay, 1942, Condor, vol. 44, p. 228). FLORIDA: Bradenton and Itchtucknee River (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 16); Rock Spring (Woolfenden, 1959, Wilson Bull., vol. 71, p. 185). NUEVO LEON: San Josecito cave (L. Miller, 1943, Univ. Calif. Publ. Zool., vol. 47, p. 150).

15. *Ixobrychus minutus* (Linnaeus). ITALY: Buca del Bersagliere? (Lambrecht, 1933, Handb. Palaeorn., p. 734).

16. *Ixobrychus exilis* (Gmelin). CALIFORNIA: *Buena Vista Lake (DeMay, 1942, Condor, vol. 44, p. 228). CUBA: Baños de Ciego Montero (Wetmore, 1928, Amer. Mus. Novit., no. 301, p. 2). BRAZIL: Lapa da Escrivania (O. Winge, 1887, E Mus. Lund., vol. 1, no. 2, p. 30).

17. *Botaurus stellaris* (Linnaeus). DENMARK: Maglemose and *Bodals Mose (H. Winge, 1903, Vidensk. Meddel. naturhist. Foren. Copenhagen, vol. 6, p. 99). ENGLAND: Cambridgeshire (Milne-Edwards, 1868, Ibis, p. 364); Burwell fens, Reach fens, and *Glastonbury (Lambrecht, 1933, Handb. Palaeorn., p. 734). FRANCE: tourbières (Milne-Edwards, 1871, Ois. Foss. France, vol. 2, p. 601).

18. *Botaurus lentiginosus* (Rackett). OREGON: Fossil Lake (includes *Ardea paloccidentalis* Shufeldt, 1892, Jour. Acad. nat. Sci. Philadelphia, vol. 9, p. 411, pl. 17, fig. 31, type distal part of right tarsometatarsus, Amer. Mus. Nat. Hist.

no. 3483; see Howard, 1946, Publ. Carnegie Instn. Washington, no. 551, p. 156). CALIFORNIA: Rancho La Brea (L. Miller, 1921, Condor, vol, 23, p. 129); *Buena Vista Lake (DeMay, 1942, Condor, vol. 44, p. 228). NORTH DAKOTA: *Morton County (L. Miller, 1961, Bull. S. Calif. Acad. Sci., vol. 60, pt. 3, p. 125). IOWA: *Mill Creek (Hamon, 1961, Plains Anthropologist, vol. 6, p. 209). FLORIDA: Seminole Field and Hog Creek at Sarasota (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 17); Rock Spring (Woolfenden, 1959, Wilson Bull., vol. 71, p. 185); Vero Beach (Weigel, 1963, Spec. Publ. Florida geol. Surv., no. 10, p. 26).

Family COCHLEARIIDAE Ridgway

Cancromidae Bonaparte, 1853, C. R. Acad. Sci. Paris, vol. 37, no. 18, p. 643 (type *Cancroma* Linnaeus, 1766, a junior synonym of *Cochlearius* Brisson, 1760).

Cochleariidae Ridgway, 1887, Manual N. Amer. Birds, p. 122 (type *Cochlearius* Brisson).

No fossil record.

Family SCOPIDAE (Bonaparte)

Scopinae Bonaparte, 1853, C. R. Acad. Sci. Paris, vol. 37, no. 18, p. 643 (sous-famille; type *Scopus* Brisson).

No fossil record.

Family BALAENICIPITIDAE (Bonaparte)

Balaenicepinae Bonaparte, 1853, C. R. Acad. Sci. Paris, vol. 37, no. 18, p. 643 (sous-famille; type *Balaeniceps* Gould).

No fossil record.

Suborder CICONIAE Bonaparte

Tantali Wagler, 1831, Isis von Oken, p. 530 (ordo; type *Tantalus* Linnaeus, 1758, a synonym of *Mycteria* Linnaeus, 1758).

Ciconiae Bonaparte, 1854, Ann. Sci. nat. (Paris), p. 37 ("tribus," i.e. suborder; type *Ciconia* Linnaeus).

Family CICONIIDAE (Gray)

Tantalidae Bonaparte, 1831, Saggio di una distribuzione metodica degli Animali Vertebrati, p. 57 (type *Tantalus* Linnaeus, a synonym of *Mycteria* Linnaeus).

Ciconiinae Gray, 1840, List Genera Birds, p. 000 (type *Ciconia* Brisson).

Mycteriinae American Ornithologists' Union, 1908, Auk, vol. 25, no. 3, p. 363 (type *Mycteria* Linnaeus).

Subfamily CICONIINAE Gray

Ciconiinae Gray, 1840, List Genera Birds, p. 000 (type *Ciconia* Brisson).

Genus †*Pelargopappus* Stejneger

Pelargopsis Milne-Edwards, 1868 (after April), Ois. Foss. France, vol. 1, sheet 58, p. 460 (type by original designation *Pelargopsis magnus* Milne-Edwards). Preoccupied by *Pelargopsis* Gloger, 1841.

Pelargopappus Stejneger, 1885, Stand. nat. Hist., vol. 4, p. 163 (new name for *Pelargopsis* Milne-Edwards).

Pelargoides Lydekker, 1891, Nature, vol. 45, p. 71 (new name for *Pelargopsis* Milne-Edwards).

Pelargodes Lydekker, 1892 (Apr. 1), Proc. zool. Soc. London for 1891, p. 477 (emendation of *Pelargoides* Lydekker).

Pelargocrex Milne-Edwards, 1893 (July 4), Bull. Brit. ornith. Club, vol. 1, p. 54 (new name for *Pelargopsis* Milne-Edwards).

1. *Pelargopappus stehlini* (Gaillard)

Pelargopsis stehlini Gaillard, 1908, Ann. Univ. Lyon, n.s., vol. 1, fasc. 23, p. 82, text-fig. 21, pl. 4, fig. 5-8 (type from Quercy, distal end of right tarsometatarsus, Basel Mus. no. QH.146).

UPPER EOCENE or LOWER OLIGOCENE (phosphorites du Quercy). FRANCE: plateau of Quercy.

2. *Pelargopappus trouessarti* (Gaillard)

Pelargopsis trouessarti Gaillard, 1908, Ann. Univ. Lyon, n.s., vol. 1, fasc. 23, p. 84, text-fig. 22, pl. 4, fig. 9-12 (type from Quercy, distal end of left tarsometatarsus, Basel Mus. no. QH.147).

UPPER EOCENE or LOWER OLIGOCENE (phosphorites du Quercy). FRANCE: plateau of Quercy.

3. *Pelargopappus magnus* (Milne-Edwards)

Pelargopsis magnus Milne-Edwards, 1868 (after April), Ois. Foss. France, vol. 1, sheet 58, p. 460, pl. 72, fig. 1-19 (lectotype from Langy, distal part of tarsometatarsus, Paris Mus., designated by Lydekker, 1891, Cat. Foss. Birds Brit. Mus., pp. 67-68).

LOWER MIOCENE (Aquitanian). FRANCE: Dept. Allier: Langy and Saint-Gérand-le-Puy (Milne-Edwards, 1868). Dept. Puy-de-Dôme (Lydekker, 1891).

Genus †*Propelargus* Lydekker

Propelargus Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 65 (type by original designation *Propelargus cayluxensis* Lydekker).

4. *Propelargus cayluxensis* Lydekker

Propelargus cayluxensis Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 66, fig. 16 (type from Bach, distal part of right tarsometatarsus, Brit. Mus. no. A.109).

UPPER EOCENE or LOWER OLIGOCENE (phosphorites de Bach). FRANCE: Dept. Lot: Bach.

5. *Propelargus edwardsi* Lydekker

Propelargus edwardsi Lydekker, 1891 (Nov. 3), Proc. zool. Soc. London, p. 479, fig. 3 (types from Saint-Gérand-le-Puy, right coracoid, left metacarpus, Brit. Mus.).

LOWER MIOCENE (Aquitanian). FRANCE: Dept. Allier: Saint-Gérand-le-Puy.

6. *Propelargus olseni* Brodkorb

Propelargus olseni Brodkorb, 1963 (in press), Quart. Jour. Florida Acad. Sci., vol. 26, no. 2, p. 000, fig. 00 (type from Tallahassee, left tarsometatarsus, Brodkorb no. 8504).

LOWER MIOCENE (Hawthorne formation). FLORIDA: Leon County: Tallahassee, Switchyard B, Seaboard Airline Railroad Company.

Genus †*Palaeoephippiorhynchus* Lambrecht

Palaeoephippiorhynchus Lambrecht, 1930 (Jan. 25), Geol. hungarica, ser. pal., fasc. 7, p. 18 (type by monotypy *Palaeoephippiorhynchus dietrichi* Lambrecht).

7. *Palaeoephippiorhynchus dietrichi* Lambrecht

Palaeoephippiorhynchus dietrichi Lambrecht, 1930 (Jan. 25), Geol. hungarica, ser. pal., fasc. 7, p. 18, pl. 3, fig. 1-4 (type from Qasr-el-Qurun, skull, mandible, Naturaliensammlung, Stuttgart).

LOWER OLIGOCENE (Fayum series, fluviomarine beds). EGYPT: Fayum: Qasr-el-Qurun.

Genus †*Ciconiopsis* Ameghino

Ciconiopsis Ameghino, 1899 (July), Sinopsis geológico-paleontológica, Suplemento, p. 8 (type by monotypy *Ciconiopsis antarctica* Ameghino).

8. *Ciconiopsis antarctica* Ameghino

Ciconiopsis antarctica Ameghino, 1899 (July), Sinopsis geológico-paleontológica, Suplemento, p. 8 (type from "formación guaranítica," metacarpus).

LOWER OLIGOCENE (Deseado formation). ARGENTINA: Patagonia.

Genus †*Amphipelargus* Lydekker

Amphipelargus Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 68 (type by original designation *Amphipelargus majori* Lydekker).

9. *Amphipelargus majori* Lydekker

Amphipelargus majori Lydekker, 1891 (Apr. 25), Cat. Foss. Birds Brit. Mus., p. 69, fig. 18 (type from Samos, distal end of left tibiotarsus, Brit. Mus. no. A.123).

LOWER PLIOCENE (Samos beds). GREECE: Samos Island.

Genus *Leptoptilos* Lesson

Leptoptilos Lesson, 1831, Traité d'Ornithologie, livr. 8, p. 583 (type *Ardea dubia* Gmelin).

10. *Leptoptilos falconeri* (Davies)

Argala falconeri Milne-Edwards, 1868, Ois. Foss. France, vol. 1, sheet 56, p. 449 footnote (nomen nudum).—Davies, 1880, Geol. Mag., decade 2, vol. 7, p. 24, pl. 2, fig. 4 (lectotype from Siwalik Hills, distal part of right tibiotarsus, Brit. Mus. no. 39753, designated by Lydekker, 1884, Mem. geol. Surv. India, Palaeontologia indica, ser. 10, vol. 3, pt. 4, p. 139).

LOWER PLIOCENE (Siwalik series). INDIA: United Provinces: Siwalik Hills (Davies, 1880). Punjab (Lydekker, 1884).

11. *Leptoptilos titan* Wetmore

Leptoptilos titan Wetmore, 1940 (Sept.), Jour. Paleont., vol. 14, no. 5, p. 447, fig. 1-5 (type from Watoealang, left tarsometatarsus, Mining and Geological Survey, Dept. Netherlands Indies, no. 3313).

UPPER PLEISTOCENE (Solo River beds). JAVA: Watoealang, near Solo River.

Genus *Ciconia* Brisson

Ciconia Brisson, 1760, Ornithologia, vol. 1, p. 48; vol. 5, p. 361 (type *Ardea ciconia* Linnaeus).

12. *Ciconia gaudryi* Lambrecht

Ciconia gaudryi Lambrecht, 1933, Handb. Palaeorn., p. 323 (type from Pikermi, humerus, Paris Mus.).

LOWER PLIOCENE (Pikermi red clay). GREECE: Attica: Pikermi.

13. *Ciconia maltha* L. Miller

Ciconia maltha L. Miller, 1910 (Aug. 5), Univ. Calif. Publ. Geol., vol. 5, no. 30, p. 440, fig. 1-7 (type from Rancho La Brea, left tarsometatarsus, Univ. Calif. Mus. Paleo. no. 11202).

Jabiru? weillsi Sellards, 1916, Eighth Ann. Rept., Florida geol. Surv., p. 146, text-fig. 15c, pl. 26, fig. 1-4 (type from Vero Beach, right humerus, formerly Fla. Geol. Surv. no. 5961, now in U. S. Nat. Mus., cast coll. Brodkorb).

MIDDLE PLEISTOCENE (Bruneau formation). IDAHO: Owyhee County: Barbour Ranch, 3.8 miles east of Bruneau-Mountain Home bridge (L. Miller, 1944, Condor, vol. 46, p. 27).

UPPER PLEISTOCENE (American Falls lake beds.). IDAHO: Power County: American Falls (Howard, 1942, Publ. Carnegie Instn. Washington, no. 530, p. 189).

UPPER PLEISTOCENE (tar pits). CALIFORNIA: Los Angeles County: Rancho La Brea (L. Miller, 1910). Santa Barbara County: Carpinteria (L. Miller, 1931, Univ. Calif. Publ. geol. Sci., vol. 20, p. 366). Kern County: McKittrick (L. Miller, 1935, Condor, vol. 37, p. 75).

UPPER PLEISTOCENE (Manix lake beds). CALIFORNIA: San Bernardino County: Manix (Howard, 1955, U. S. geol. Surv., profess. Paper, no. 264-J, p. 202).

UPPER PLEISTOCENE (Itchtucknee River beds). FLORIDA: Columbia County: Itchtucknee River (Wetmore, 1931, Smithsonian misc. Coll., vol. 85, no. 2, p. 17).

UPPER PLEISTOCENE (Pamlico formation). FLORIDA: Flagler County: Bon Terra Farm, 6½ miles south of Marineland (Howard, 1942). Orange County: Rock Spring (Woolfenden, 1959, Wilson Bull., vol. 71, p. 185). Brevard County: Melbourne (Wetmore, 1931). Indian River County: Winter Beach (Brodkorb coll.); Vero Beach (Sellards, 1916). Pinellas County: "Seminole Field" in St. Petersburg (Wetmore, 1931). Sarasota County: Venice (Wetmore, 1931); Warm Mineral Springs (Brodkorb coll.).

UPPER PLEISTOCENE (springs deposits). CUBA: Prov. Santa Clara: Baños de Ciego Montrero (Wetmore, 1928, Amer. Mus. Novit., no. 301, p. 2).

Genus †*Pelargosteon* Kretzoi

Pelargosteon Kretzoi, 1962 (Feb.), Aquila, vol. 67-68, p. 169 (type by monotypy *Pelargosteon tothi* Kretzoi).

14. *Pelargosteon tothi* Kretzoi

Pelargosteon tothi Kretzoi, 1962 (Feb.), Aquila, vol. 67-68, p. 169 (type from Betfia no. 5, fragmentary sternum, Oradea Mus. no. 1899/1).

UPPER LOWER PLEISTOCENE (Biharian fauna). RUMANIA: Betfia.

Genus †*Prociconia* Ameghino

Prociconia Ameghino, 1891 (Dec. 1), Rev. argentina Hist. nat., vol. 1, p. 445 (type by monotypy *Prociconia lydekkeri* Ameghino).

15. *Prociconia lydekkeri* Ameghino

Prociconia lydekkeri Ameghino, 1891 (Dec. 1), Rev. argentina Hist. nat., vol. 1, p. 445 (new name for "*Palaeociconia australis*, Moreno," Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 65, fig. 15; types from Lagoa Santa, distal ends of right and left tarsometatarsi, Brit. Mus. nos. 18878, 18879).

UPPER PLEISTOCENE (cavern deposits). BRAZIL: Minas Geraes: cave near Lagoa Santa.[1]

Genus †*Palaeopelargus* DeVis

Palaeopelargus DeVis, 1892, Proc. Linn. Soc. N. S. Wales, ser. 2, vol. 6, p. 441 (type by monotypy *Palaeopelargus nobilis* DeVis).

16. *Palaeopelargus nobilis* DeVis

Palaeopelargus nobilis DeVis, 1892, Proc. Linn. Soc. N. S. Wales, ser. 2, vol. 6, p. 441, pl. 20, fig. 4 (type from Queensland, distal part of carpometacarpus).

UPPER PLEISTOCENE (Darling Downs beds). QUEENSLAND.

Genus †*Xenorhynchopsis* DeVis

Xenorhynchopsis DeVis, 1906, Ann. Queensland Mus., no. 6, p. 9 (type by present designation *Xenorhynchopsis tibialis* DeVis).

17. *Xenorhynchopsis tibialis* DeVis

Xenorhynchopsis tibialis DeVis, 1906, Ann. Queensland Mus., no. 6, p. 10, pl. 1, fig. 6 (types from Lower Cooper, distal ends of right and left tibiotarsi).

UPPER PLEISTOCENE (Katipiri sands, Malkuni fauna). SOUTH AUSTRALIA: lower Cooper Creek, east of Lake Eyre.

18. *Xenorhynchopsis minor* DeVis

Xenorhynchopsis minor DeVis, 1906, Ann. Queensland Mus., no. 6, p. 10, pl. 2, fig. 1 (lectotype by present designation, from Unduwampa, distal end of right tibiotarsus).

UPPER PLEISTOCENE (Katipiri sands, Malkuni fauna). SOUTH AUSTRALIA: Unduwampa and Wurdulumankula (DeVis, 1906).

Genus *Xenorhynchus* Bonaparte

Xenorhynchus Bonaparte, 1855, Conspectus generum avium, vol. 2, p. 106 (type *Mycteria australis* Shaw).

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[1]Referred without supporting evidence to genus *Jabiru* Hellmayr by Patterson and Kraglievich (1960, Publ. Mus. Mar del Plata, vol. 1, p. 8, footnote). If Lydekker's figure is accurate, such action is unwarranted. *Ciconia maltha* Miller needs comparison with this species.

19. *Xenorhynchus nanus* DeVis

Xenorhynchus nanus DeVis, 1888, Proc. Linn. Soc. N. S. Wales, vol. 3, p. 1287, pl. 35, fig. 11 (lectotype by present designation, from Darling Downs, distal part of right tibiotarsus).

UPPER PLEISTOCENE (Darling Downs beds). QUEENSLAND: north bank of River Condamine, 3 miles from Chinchilla (DeVis, 1888).

UPPER PLEISTOCENE (Katipiri sands, Malkuni fauna). SOUTH AUSTRALIA: Wurdulumankula (DeVis, 1906, Ann. Queensland Mus., no. 6, p. 9).

Subfamily MYCTERIINAE American Ornithologists' Union

Tantalidae Bonaparte, 1831, Saggio di una distribuzione metodica degli Animali Vertebrati, p. 57 (family; type *Tantalus* Linnaeus, a synonym of *Mycteria* Linnaeus).

Mycteriinae American Ornithologists' Union, 1908, Auk, vol. 25, no. 3, p. 363 (type *Mycteria* Linnaeus).

Genus *Ibis* Lacépède

Ibis Lacépède, 1799, Tableau Oiseaux, p. 18 (type *Tantalus ibis* Linnaeus).

20. *Ibis milne-edwardsi* (Shufeldt)

Tantalus milne-edwardsi Shufeldt, 1896, Proc. Acad. nat. Sci. Philadelphia p. 513, fig. 1 (type from Grive-St.-Alban, proximal part of right tibiotarsus, U. S. Nat. Mus. no. 2168).

UPPER MIOCENE (Tortonian). FRANCE: Dept. Isère: Grive-St.-Alban.

Genus *Mycteria* Linnaeus

Mycteria Linnaeus, 1758, Syst. Nat., ed. 10, vol. 1, p. 140 (type by monotypy *Mycteria americana* Linnaeus).

21. *Mycteria wetmorei* Howard

Mycteria wetmorei Howard, 1935 (Sept.), Condor, vol. 37, no. 5, p. 253, fig. 47 (type from Rancho La Brea, lower mandible, Los Angeles Mus. no. K3527).

UPPER PLEISTOCENE (tar pits). CALIFORNIA: Los Angeles County; Rancho La Brea in Los Angeles.

Neospecies of Ciconiidae from Pleistocene and *prehistoric sites:

1. *Ciconia ciconia* (Linnaeus). ENGLAND: *Silchester (Lambrecht, 1933, Handb. Palaeorn., p. 735). FRANCE: Grotte de Lunel-Vieil (Milne-Edwards, 1871, Ois. Foss. France, vol. 2, p. 000). SWITZERLAND: Salève, *Moosseedorf, and *Robenhausen (Lambrecht, 1933). CZECHOSLOVAKIA: Holubic (Lambrecht, 1933).

2. *Ciconia nigra* (Linnaeus). DENMARK: Vester Ulslev (H. Winge, 1903, Vidensk. Meddel, naturhist. Foren. Copenhagen, vol. 6, p. 99).

3. *Euxenura galeata* (Molina). ARGENTINA: *Llajta-Maüca and *Las Represas in Santiago del Estero (Kraglievich and Rusconi, 1931, Physis, vol. 10, p. 240).

4. *Ibis ibis* (Linnaeus). SARDINIA: bone breccia (*Tantalus bresciensis* Giebel, 1847, Fauna der Vorwelt, vol. 1, pt. 2, pp. 28, 40: type ulna; a nomen nudum here, possibly previously described by de la Marmora or Keferstein).

5. *Ibis leucocephalus* (Pennant). INDIA: Karnul district in Madras (Lydekker, 1891, Cat. Foss. Birds Brit. Mus., p. 70, fig. 19).

6. *Mycteria americana* Linnaeus. FLORIDA: Itchtucknee River (McCoy, 1963, Auk, vol. 80, p. 000); *Castle Windy (Bullen and Sleight, 1959, Rept. Bryant Found. Amer. Studies, no. 1, p. 20). VENEZUELA: *Los Tamarindos (Wetmore, 1935, Auk, vol. 52, p. 329).