

**Taxonomic review of the fossil Procellariidae (Aves:  
Procellariiformes) described from Bermuda by R. W. Shufeldt**

Storrs L. Olson

Division of Birds, National Museum of Natural History, Smithsonian Institution, Washington,  
D.C. 20560, U.S.A., e-mail: olsons@si.edu

*Abstract.*—The literature and specimens relevant to the three new species of petrels (Procellariidae) proposed by R. W. Shufeldt from Quaternary fossils from Bermuda were re-examined. A case is made for citing all three binomials as dating from Shufeldt's earlier preliminary publication (1916) rather than his later monograph (1922). *Aestrelata vociferans* Shufeldt, 2 October 1916, was correctly synonymized with *Aestrelata cahow* Nichols & Mowbray, 31 March 1916, and a lectotype is designated here. *Puffinis mcgalli* Shufeldt, 1916, was correctly synonymized with *Puffinus puffinus* Brünnich, 1764, with the holotype evidently representing a casual occurrence. A lectotype is designated for *Puffinus parvus* Shufeldt, 1916. This taxon is not synonymous with *Puffinus lherminieri* Lesson, 1839, being much smaller, and is provisionally retained until its status relative to other taxa in the *Puffinus assimilis/lherminieri* complex can be assessed.

Because seabirds of the family Procellariidae are usually the most prevalent members of the fossil avifaunas recovered in Bermuda, it is desirable to resolve several taxonomic and nomenclatural problems that were introduced in two papers by R.W. Shufeldt (1916, 1922) in which he named three new species of petrels and shearwaters from fossil remains of uncertain age obtained in several caves in Bermuda. Although his names were all subsequently synonymized, these actions were taken without reference to Shufeldt's original material, most of which is now to be found in the Carnegie Museum of Natural History, Pittsburgh (not the British Museum, as surmised by Brodkorb, 1963). The objectives of this review are: (1) to establish the original citation for each of Shufeldt's names; (2) to attempt to identify at least parts of the type series upon which each species was based and designate lectotypes where appropriate; and (3) to determine autoptically the identity and validity of each of Shufeldt's taxa.

Considering the deficiencies of the comparative osteological material available to Shufeldt, his studies of Bermudan fossils are quite exemplary. Regardless of the ultimate fate of Shufeldt's names, his analysis of the specimens and his conclusions were for the most part meritorious—something that cannot be said for many of his other studies of fossil birds. Shufeldt's first contribution to Bermudan paleontology (Shufeldt 1916) was intended only as a preliminary introduction to a larger work. He had progressed at least as far as mounting the plates for this proposed monograph, as at this point he refers specifically to the plate and figure numbers of the unpublished larger manuscript. The figure numbers mentioned at this time correspond exactly with those published later (Shufeldt 1922), although the plates were renumbered according to the sequence necessitated by the journal in which they appeared. Publication of the definitive paper was originally to have been through the American Museum of Natural History, but this never took place;

the paper was delayed (7 years) and eventually was issued in the Carnegie Museum series. That a delay was forthcoming must have been apparent to Shufeldt in 1916, as he included an addendum to his preliminary paper in which he named his new taxa, although the descriptions accompanying the names were very spare. Some of the names have been construed as *nomina nuda* at this point (e.g., Brodkorb 1963:246), but for reasons given below I consider all of Shufeldt's names to date from the 1916 publication.

There were several collections of Bermudan fossils upon which Shufeldt based his descriptions of *Aestrelata vociferans*, *Puffinus mcgalli*, and *P. parvus*. The original one, upon which he had been invited to work by F. A. Lucas "Director of the American Museum of Natural History" (Shufeldt 1916:623), had been obtained by L. L. Mowbray. Material from this collection was identified by Shufeldt (1922) as being from the American Museum (AMNH). Another collection was obtained by Edward McGall and was referred to in Shufeldt (1922) as the McGall Collection. Apparently the AMNH material was never returned and most of Shufeldt's material that has been traced so far is in the collections of the Carnegie Museum. Furthermore, at least one specimen identified in Shufeldt (1922) as coming from the AMNH collection was exchanged from the Carnegie Museum to the Smithsonian Institution in 1932 (USNM 320059, accession no. 117209). (All USNM and CM catalog numbers refer to series in the ornithological rather than paleontological collections.)

Identifying Shufeldt's type material is made more difficult by the fact that none of the specimens involved had been cataloged or numbered. It should be noted that McGall and Anthony Tall evidently sent additional specimens to Harvard University, the British Museum, and perhaps elsewhere (Shufeldt 1922:384), but Shufeldt never examined these specimens and they certainly have no claim as types.

*Pterodroma cahow* (Nichols & Mowbray, 1916)

*Aestrelata cahow* Nichols & Mowbray, 1916 (31 March):194.

*Aestrelata vociferans* Shufeldt, 1916 (2 October):633, Shufeldt, 1922:365.

*Oestrelata vociferans*: Lambrecht, 1933: 271.

*Pterodroma cahow*: Bent, 1922 (19 October):112 (new combination with *A. vociferans* in synonymy); Brodkorb, 1963: 246.

*Lectotype* (here designated).—*Aestrelata vociferans* Shufeldt 1916, skull (neurocranium with attached maxillary rostrum and right quadratojugal) included with USNM 320059. Measurements: total length 74.7 mm; cranium length 40.2, cranium width at postorbital processes 29.5, cranium depth 21.1; least width interorbital bridge 10.4, width at naso-frontal hinge 10.3; length of rostrum from naso-frontal hinge 36.2; length of nostril 11.4; length of premaxilla anterior to nostril 20.0.

This specimen can be identified unequivocally as the fossil of *Aestrelata vociferans* illustrated in Shufeldt (1922) as Figure 5 on Plate 16, by the shape of the small flange of bone projecting ventrally nearly across the ventral interorbital fenestra. This flange is extremely variable in *Pterodroma cahow* and may range from a small pointed projection to a continuous bridge across the fenestra. The distinctive shape in USNM 320059 is exactly as shown in Shufeldt's figure (Fig. 1a, b), and all other variations, such as positions of small foramina, correspond exactly as well. In Shufeldt (1916: 635) it is stated that "The differences in the osseous mandibles of a Petrel (*Aestrelata vociferans*) and a Shearwater (*Puffinus lherminieri*) are easily appreciated upon comparing those parts in figs. 5 & 6 of pl. i." This reference is to figures in the then unpublished manuscript. The plates were renumbered in Shufeldt 1922, so that plate 1 became plate 16g in which Fig. 5 is the specimen designated here as lectotype. In

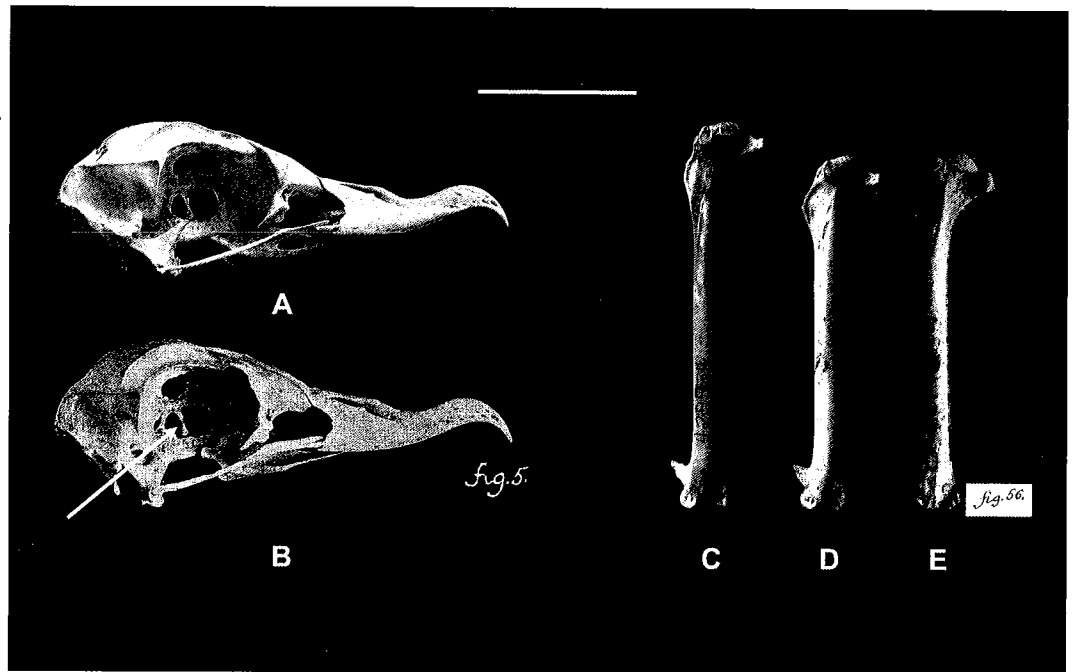


Fig. 1. A, lectotype of *Aestrelata cahow* Shufeldt (1916), USNM 320059; the quadratojugal and quadrate were separated from the rest of the skull subsequent to Shufeldt's photograph and may not have been rejoined in exactly the same position; the quadrate is not necessarily from the same individual as the skull and is not to be considered as part of the lectotype. B, Shufeldt's illustration (1922: fig. 5, plate 16) of the same specimen; arrow indicates the diagnostic flange of bone in the interorbital foramen that identifies the photograph with USNM 320059. C, left humerus of *Puffinus lherminieri* USNM 428934 from Bermuda. D, left humerus, lectotype of *Puffinus parvus* Shufeldt (1916), CM 16539. E, Shufeldt's illustration (1922: fig. 56, plate 25) of the same specimen; the markings on the shaft and bit of matrix in the olecranal fossa identify the photograph with CM 16539.

the legend, this was identified as being part of the series that was supposed to be in AMNH (see above).

USNM 320059 was received from the Carnegie Museum in exchange in 1932. The label with this specimen reads "Skeleton of adult 'Cahow' | *Aestrelata vociferans* sp. nov. Shuf. | Made as perfect as the bones in the | collection would allow R. W. S[hufeldt]. | 11 Dec. '15."

*Paralectotypes*.—Because of adhering matrix, discolorations, or individual osteological variation, the following specimens can be identified with photographs in Shufeldt (1922) and are therefore unequivocally part of his type series. Shufeldt's figure number follows the current museum number: skulls CM 16533 (fig. 1), 16534 (fig.

2), 16535 (fig. 3); sterna 16537 (fig. 26), 16538 (fig. 27). Skull CM 16536 may be the one illustrated in fig. 4, but if so, both quadratojugals are now lacking and I did not detect any peculiarity of the specimen that would allow it to be certainly identified with the figure.

*Remarks*.—Of the new names for Bermudan petrels introduced by Shufeldt, the citation for *Aestrelata vociferans* presents the most difficulties, as no characters of the species itself are actually mentioned and no specimens were illustrated in Shufeldt (1916). Nevertheless, he did discuss osteological characters of the fossils that definitely refer them to *Aestrelata* (= *Pterodroma*) as opposed to *Puffinus*. Only one species of *Pterodroma* has ever been found

in fossil deposits on Bermuda, and Shufeldt identified his new species with the "cahow" of legend, which was later definitely established as being a species of *Pterodroma* (Murphy & Mowbray 1951). Furthermore, Shufeldt specifically refers to bones of the new species illustrated in plates prepared for his monograph published later (Shufeldt 1922) and unequivocally identifies them by figure number and plate number. Therefore, it is now possible to identify particular specimens of Shufeldt's new species based on information given in the 1916 publication. Thus, it may be argued, as I believe, that *Aestrelata vociferans* is valid as of Shufeldt 1916 rather than Shufeldt 1922. It is a moot point, however, as *A. vociferans* Shufeldt 1916 is still a junior synonym by 6 months of *A. cahow* Nichols & Mowbray, 1916. If *A. vociferans* is dated from Shufeldt 1922, Bent (1922:114), who had access to Shufeldt's manuscript, effectively synonymized Shufeldt's name 17 days later by saying that it was "apparently the same bird" as *A. cahow* of Nichols & Mowbray.

The unravelling of the identity of the bird known to Bermuda's early settlers as the "cahow" is well summarized by Murphy & Mowbray (1951). This bird was once incredibly abundant and provided the early colonists with a ready supply of food. But it was so overexploited by man and introduced mammals that it had seemingly disappeared before its identity could be made known to naturalists. A living example of a *Pterodroma* was taken in Bermuda in 1906 by L. L. Mowbray, but was referred to a species that breeds in New Zealand (Bradlee 1906). Not until a decade later was this specimen described as the type of a new species, *Aestrelata cahow* (Nichols & Mowbray 1916), almost simultaneously with Shufeldt's (1916) preliminary note. Shufeldt deserves a fair amount of credit for developing our knowledge of the Cahow, as his paleontological studies were as seminal as any in providing documentation that the Cahow was one of the gadfly pet-

rels now recognized in the genus *Pterodroma*.

*Puffinus puffinus puffinus* (Brünnich, 1764)

*Puffinus puffinus bermudae* Nichols & Mowbray, 1916 (31 March):195.

*Puffinus mcgalli* Shufeldt 1916 (2 October):630; Shufeldt, 1922:354.

*Puffinus puffinus puffinus*: Dwight 1927:243 (with *P. p. bermudae* in synonymy).

*Puffinus puffinus*: Wetmore, 1931:407 (footnote; suggested synonymy of *P. mcgalli*); Lambrecht, 1933:269; Wetmore, 1962:16; Brodkorb, 1963:246.

*Holotype*.—*Puffinus mcgalli* Shufeldt 1916, sternum CM 16531, with a split in the carina from which a piece of bone is missing, also lacking the tip of the carina and tips of some of the posterior processes.

*Referred specimen*.—In an addendum, Shufeldt (1922:381, footnote) identified what he believed to be a pedal phalanx 2.8 cm in length that he thought "belonged to an adult specimen of *Puffinus mcgalli*, and possibly to the same individual" as the holotypical sternum. This specimen (CM 16532) is still in the same box with the holotype and measures 28.7 mm. It is actually the left tibiotarsus of a juvenile passerine bird with the proximal end quite porous and incompletely ossified. It has no status whatsoever as a type.

*Remarks*.—Shufeldt (1916) based *Puffinus mcgalli* on a sternum that was stated to be larger than that of *P. lherminieri* and smaller than that of *P. major* (= *P. gravis*), in addition to which a measurement of the holotype was provided. This is quite sufficient to establish the name *P. mcgalli* at this point. Wetmore (1931:407), presumably on the basis of size and geographical probability, suggested that *P. mcgalli* was probably synonymous with *P. puffinus* and was followed by Lambrecht (1933). Later, Wetmore (1962:16) considered that Shufeldt's figures of the sternum of *P. mcgalli* "agree exactly with a sternum of a female *Puffinus puffinus puffinus*." Brodkorb (1963) fol-

lowed Wetmore's lead, but no one since Shufeldt had ever critically examined the specimen.

The shape of the manubrial area, the angle of the sterno-coracoidal processes, and other features establish that the holotype is correctly referred to the genus *Puffinus*, as opposed to *Pterodroma*. In size, it is within the range of *Puffinus puffinus puffinus*: length along midline 58.0 mm, width across posteriormost costal facets 25.4 mm. In a series of 10 skeletons of *Puffinus puffinus puffinus* the length was 52.2–58.0 (avg. 55.1) and width 23.9–27.2 (avg. 25.7). This is larger than *Puffinus lherminieri* but smaller than any of the other Atlantic species of *Puffinus*. Thus *Puffinus mcgalli* Shufeldt, 1916, was correctly synonymized with *Puffinus puffinus* Brünnich, 1764.

This occurrence of *Puffinus puffinus* as a fossil in Bermuda is unique, as no other fossils of the species have ever been encountered among the thousands of bones of seabirds collected so far. Although this species is a common offshore visitor to Bermuda, there are only three records of attempted breeding (Bradlee et al. 1931, Bourne 1957). The first was a specimen "captured while sitting on its solitary egg in a rocky hole on a small island in Castle Harbor, in April, 1864" (Reid 1884:274). The second record, more doubtful, was another bird sitting on an egg in an island in Castle Harbor in May 1877 tentatively recorded as *Puffinus opisthomelas* (Reid 1884:276). The final record was a specimen taken "March 10, 1905, sitting on a single white egg in a crevice in Gurnet Head Rock" (Nichols & Mowbray 1916). This was described as a new subspecies, *Puffinus puffinus bermudae* Nichols & Mowbray, 1916, that was later definitively synonymized with *Puffinus puffinus puffinus* by Dwight (1927).

In an instance perhaps similar to those on Bermuda, a single incubating Manx Shearwater was found in June 1973 on Penikese Island, Massachusetts, west of Martha's Vineyard (Bierregaard et al. 1975), but breeding evidently did not continue there

(Lee & Haney 1996). The first North American breeding colony of the species was established in 1977 on Middle Lawn Island, southern Newfoundland, and by 1981 the population had grown to an estimated 350 individuals (Storey & Lien 1985). There is no evidence that *Puffinus puffinus* was ever able to establish such a colony on Bermuda at any time in the last 400,000 years and all the records, including the fossil sternum described as *Puffinus mcgalli*, appear to have resulted from single individuals or pairs.

*Puffinus parvus* Shufeldt, 1916

*Puffinus parvus* Shufeldt, 1916:632; Shufeldt, 1922:356.

*Puffinus lherminieri*: Wetmore, 1931:407 (footnote; suggested synonymy of *P. parvus*); Lambrecht, 1933:270; Wetmore, 1962; Brodkorb, 1963:246.

*Lectotype* (here designated).—*Puffinus parvus* Shufeldt, 1916, left humerus, CM 16539 (fig. 56 of Shufeldt 1922). Measurements: Total length 58.8 mm; proximal width 10.7, depth of head 3.3, width and depth of shaft at midpoint  $3.8 \times 2.6$ , distal width 7.9.

*Paralectotypes* (figure numbers from Shufeldt 1922 in parentheses).—CM 16540 right humerus (fig. 55), 16541 right humerus, 16542 left humerus, 16543 left humerus, 16544 right ulna (fig. 43), 16545 right ulna, 16546 left ulna (fig. 44), 16547 left radius (fig. 45), 16548 right carpometacarpus (fig. 67), 16549 right phalanx 1 of major alar digit (fig. 74), 16550 left coracoid (fig. 92), 16551 incomplete furcula (fig. 79), 16552 right tibiotarsus (fig. 119), 16553 left tibiotarsus (fig. 120), 16554 right tarsometatarsus (fig. 107), 16555 right femur, 16556–58 left innominates.

*Remarks*.—The name *Puffinus parvus* dates from Shufeldt (1916), as there this taxon was specifically characterized as being smaller than *P. lherminieri* and as belonging to a group of small shearwaters having a short, rather than an elongate sternum. The type material he listed (p. 632)

as 12 bones from what he called the AMNH series (of which only one certainly, and three probably, can now be accounted for) and the following from the McGall collection: "five perfect humeri, three ulnae, a radius, a carpo-metacarpus, a proximal joint of an index digit, a coracoid, an inferior mandible, an imperfect os furculum, a tarso-metatarsus, an os innominatum of the left side; subsequently there also came to light an imperfect cranium." These lists were repeated nearly verbatim in Shufeldt (1922:356) save that the last imperfect cranium is omitted and that specimen is no longer present, so perhaps he subsequently re-identified it. In an addendum, Shufeldt (1922:385) listed and identified a further series of 77 specimens of *Puffinus parvus* collected by McGall and Tall that also was deposited in the Carnegie Museum, where all but the 5 sterna and 2 of the fragmentary furculae may still be found. It is very clear from Shufeldt's statements (e.g., 1922:385), however, that the first two collections constituted the type series and that the additional specimens were referred only subsequent to his 1916 paper and thus have no status as types.

In the CM collections was a container of bones labelled in Shufeldt's hand "McGall Collection | *Puffinus parvus* Shuf. sp. nov | Nov. 27 1915 | Fragile." This series corresponds exactly to Shufeldt's list of this collection, less the cranium mentioned above, except that it has been augmented by a right and left tibiotarsus, a right femur, and an additional two innominate bones. Although no tibiotarsus was listed for the McGall collection in either of Shufeldt's publications, the legend for Shufeldt's (1922) fig. 119 of a right tibiotarsus identifies it as being from the McGall collection, whereas the left tibiotarsus in fig. 120 is identified as being from the AMNH series, in which there was only a single tibiotarsus. The femur and the additional two innominates are doubtless the femur and two of the four innominates listed for the AMNH series, which has otherwise disappeared.

I think that there can be no question that all 21 of these bones may be safely regarded as syntypes of *Puffinus parvus* Shufeldt. Several can be identified with photographs in Shufeldt (1922) and from these I have selected as lectotype a humerus with distinctive markings making it individually identifiable (Fig. 1d, e). All of the remaining bones in this series may be considered paralectotypes and have been listed above with their current catalog numbers and reference to the figure numbers in Shufeldt (1922) where appropriate.

Without having seen the material, Wetmore (1931) suggested in a footnote that *Puffinus parvus* was probably the same as the living Audubon's Shearwater *Puffinus lherminieri* Lesson, 1839, in which he was followed by Lambrecht (1933). Later, in examining a few remains of small *Puffinus* found in 1958 on Cockroach Island, Harrington Sound, Bermuda, Wetmore (1962) noted what seemed to be two size classes but considered that the smaller one consisted of juveniles. Although he stated (p. 16) that "Shufeldt (1916 p. 632) noted two apparent size groups and named the smaller one *Puffinus parvus*," I cannot interpret anything in Shufeldt's publication as indicating that he thought there were two size classes. Wetmore also noted that Shufeldt's (1922) photographs of the bones of *P. parvus* were not to the scale indicated, as Shufeldt himself had pointed out, however (p. 362 footnote). Wetmore concluded that *P. parvus* was not a valid taxon and synonymized it with *P. lherminieri*, and he was followed by Brodkorb (1963).

After having examined Shufeldt's type-series and much more extensive fossil material from Bermuda dating from the middle Pleistocene onward, I have concluded that *Puffinus parvus* is indeed a much smaller species than *P. lherminieri* (Fig. 1c, d). The systematics of the *Puffinus lherminieri/P. assimilis* assemblage is very complex and imperfectly understood. *Puffinus parvus* needs comparison with the Atlantic taxa known as *Puffinus affinis baroli*, which oc-

curs in the Azores, Madeira group, and Canary Islands, and *Puffinus lherminieri boydi* of the Cape Verde Islands (Jouanin & Mougin 1979). Unfortunately, there is almost no skeletal material of these taxa available for comparison. Apparently, *P. parvus* was exterminated after human arrival in Bermuda, after which *P. lherminieri* was able to colonize the island for a brief period before it became extinct itself as a breeding bird in the late 20th century. Ironically, both species are present in the Cockroach Island material. Further investigation of the small shearwaters of Bermuda is under way, but for now *Puffinus parvus* Shufeldt, 1916, is retained as a taxon that is clearly distinct from *P. lherminieri*.

#### Acknowledgments

I thank Kenneth C. Parkes and Robin Panza, Carnegie Museum of Natural History, Pittsburgh (CM), for making Shufeldt's material available and for supplying catalog numbers. The figure is by Brian Schmidt, Division of Birds, National Museum of Natural History, Smithsonian Institution (USNM).

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Associate Editor: Gary R. Graves