

Article XVII.—A REVIEW OF THE DIVING PETRELSCONTRIBUTIONS FROM THE BR. WSTER-SANFORD COLLECTION.—3¹

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PLATES XX TO XXIV

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INTRODUCTION

The diving petrels (*Pelecanoididæ*) comprise a strikingly homogeneous, monogeneric, obviously ancient group of *Tubinares*, the members of which exhibit few characters that might indicate their relationships with other divisions of the order. They have therefore always presented a difficult problem to taxonomists. Confined entirely to the southern hemisphere, where they have long been pointed out as biological analogues of the auklets and murrelets of the north, the *Pelecanoididæ* have become distributed through a broad south temperate and subantarctic belt, one species alone having extended its range northward along the west coast of America into the tropics.

¹First contribution, 1917, 'A New Albatross from the West Coast of South America.' Bull. Amer. Mus. Nat. Hist., XXXVII, pp. 861-864. Second contribution, 1918, 'A Study of the Atlantic *Oceanites*,' Bull. Amer. Mus. Nat. Hist., XXXVIII, pp. 117-146.

Five species, representing four subgenera, are recognizable among the numerous specimens studied by the writers. Relatively speaking, the distinctions between the subgenera are subtle, if not slight. When we add to this the facts that reasonably large series of properly prepared specimens have never until within the last few years been brought together, and that the ranges of two species have been found to be of extraordinary extent, it is not surprising that the specific and geographic status of the various representatives has been so generally misunderstood. So able a systematist as Dr. Coues wrote in 1866 that the three species which he provisionally recognized might "without great violence" be considered as extremes of a single very variable type. This investigator's material, however, was doubtless insufficient for him to appreciate certain structural characters of the bill upon which the current classifications are largely based. It is noteworthy that two of the forms to which Coues referred have, by both a previous and a later authority, been relegated to different genera.

MATERIAL AND ACKNOWLEDGMENTS

Approximately 500 specimens of *Pelecanoididæ* in American collections, and 100 specimens in European collections, have been examined by the writers in the preparation of the present review. Of this number, one hundred and eighty-seven skins, belonging to the Brewster-Sanford Collection, were taken in Peru, Chile, the Fuegian region, and the Falkland Islands by Mr. R. H. Beck, between 1913 and 1915. Two hundred and forty-six skins, comprising the type and topotypes of a newly described species, were collected in the breeding seasons of 1912, 1913, and 1914, at the island of South Georgia, by the senior writer and by Mr. Joseph G. Correia, of New Bedford, Massachusetts. Specimens of the Old World diving petrels are still regrettably scarce in American museums, but we have had at our disposal the skins collected at Kerguelen Island by Dr. Kidder in 1872, besides a small series of birds from New Zealand and its outliers.

Our hearty thanks for the loan of material are due the following institutions and individuals: the United States National Museum, through Dr. Charles W. Richmond; the Philadelphia Academy of Natural Sciences, through Dr. Witmer Stone; the Museum of Comparative Zoology, through Mr. Outram Bangs; the Carnegie Museum, through Mr. W. E. Clyde Todd; the Boston Society of Natural History, through Mr. W. Sprague Brooks; the Michigan University Museum, through Dr. Alexander G. Ruthven; the Public Museum of Milwaukee, through

Mr. Henry L. Ward; the California Academy of Sciences, through Dr. Barton W. Evermann; and Mr. James H. Fleming, of Toronto.

In May 1919, after this paper was already in proof, the junior writer was enabled to make a brief visit to several museums in England and France, and to examine there a large amount of especially interesting material pertinent to the present study. This material included the types or type series of six described forms of *Pelecanoididæ* (*Puffinuria garnotii lessoni* Mathews, *Puffinuria garnotii magellani* Mathews, *Pelecanoides urinatrix belcheri* Mathews, *Pelecanoides exsul* Salvin, *Pelecanoides dacunhæ* Nicoll, and *Pelecanoides urinatrix coppingeri* Mathews), two of which are not represented by topotypes in American collections. Many courtesies and facilities were extended by Mr. Charles Chubb and Mr. David A. Bannerman, of the British Museum, by Mr. Gregory M. Mathews, of the Austral Avian Museum, by Dr. Ernst Hartert, of the Zoological Museum, Tring, and by Dr. E.-L. Trouessart, of the Museum National d'Histoire Naturelle, Paris, to all of whom we are glad to acknowledge our indebtedness and express our appreciation. The results of our all too brief studies in these institutions have been incorporated in the present work.

We are also much indebted to Dr. Frank M. Chapman and Dr. W. D. Matthew, of The American Museum of Natural History, for reading the manuscript; to Dr. R. E. Coker, of the United States Bureau of Fisheries, for placing at our disposal his account of *Pelecanoides garnoti* in advance of its publication in his paper on the guano birds of Peru¹; to Dr. Harry C. Oberholser, of the United States Biological Survey, for helpful advice and criticism during the course of our investigations; and to Mr. James P. Chapin, of The American Museum of Natural History, for making the sectional drawing of the bill of *Pelecanoides garnoti* which is reproduced in Fig. 1.

HISTORY

The early history of the nomenclature of the diving petrels is summarized by Mathews in the 'Birds of Australia,' II, pp. 232-239. The important steps in the successive discoveries, descriptions, and revisions are listed and brought up to date below.

1789. GMELIN ('Syst. Nat.,' p. 560) founded the species *Procellaria urinatrix* from the description in Latham's Synopsis, which was in turn based upon Forster's drawing made from a specimen taken in Queen Charlotte Sound, New Zealand.

¹1919, Proc. U. S. Nat. Mus., LVI, pp. 449-511.

1824. QUOY AND GAIMARD ('Voy. Uranie et Physicienne, Zool.,' p. 135, Pl. XXXVII) described and figured *Procellaria berard* from a specimen which came on board their vessel near the Falkland Islands.

1828. LESSON ('Manuel d'Orn.,' II, p. 394) described *Puffinuria garnoti* from birds taken on the coast of Peru. In the same year the species was figured ('Voy. Coquille,' Pl. XLVI).

After 1828, as Mathews remarks, the various names were confusedly used for many years. The specific term *urinatrix* was at times employed for all the forms; *berard* was applied to breeding birds of New Zealand and elsewhere; even Forster's *nomen nudum*, *Procellaria tridactyla*, was revived for the New Zealand bird.

1866. COUES (Proc. Phil. Acad. Sci., pp. 188-190) published a thorough structural description of the genus and, without having seen sufficient material to be fully confident of his own judgment, he admitted three species—*garnoti*, of the west coast of South America, *urinatrix*, of "Australian Seas," and *berardi*, of the highly indefinite "Southern Oceans." Coues evidently recognized only distinctions in size among the diving petrels, for he held the opinion "that the colors of the plumage of all three are identical."

1896. SALVIN ('Cat. Birds Brit. Mus.,' XXV, pp. 437-439). A reconsideration of the material and literature was undertaken by Salvin in his monograph. He synonymized *P. berard* with *P. urinatrix*, giving the range of the species as "Australian and New Zealand Seas; also those of Cape Horn and the Falkland Islands." At the same time he proposed a new species, *P. exsul*, from the southern Indian Ocean, a range bounded on both sides by that of his revised *urinatrix*.

1906. NICOLL (Bull. Brit. Orn. Cl., XVI, p. 103) added to the list of described species *Pelecanoides dacunhæ*, based upon examples collected at the island of Tristan da Cunha, in the South Atlantic.

1907. REICHENOW ('Deutsche Südp. Exp.,' IX, Zool., pp. 493, 558) united *exsul* with *urinatrix* on the ground that birds answering Salvin's description of each species are found in the same breeding localities.

1910. GODMAN ('Monogr. Petrels,' pp. 299-306) treated the taxonomic status of the diving petrels in an exceedingly casual and uncritical manner and, so far as can be judged from his textual descriptions, the titles for his largely conventional colored plates of *P. urinatrix* and *P. exsul* have been transposed! Godman was unable to perceive any difference between New Zealand specimens and those from the extreme south of South America; neither could he distinguish between *exsul* and

dacunhæ, which he accordingly synonymized. Finally he questioned the specific distinctness of *urinatrix* and *exsul* but provisionally recognized the latter, while fully accepting *urinatrix* and *garnoti*.

1912. MATHEWS ('Birds of Australia,' II, pp. 232-239) reviewed the whole subject, as far as the literature is concerned, and recognized *exsul*, *dacunhæ*, and *berard*, as geographic races of typical *Pelecanoides urinatrix* of the "Australian and New Zealand seas." He gave, however, no tables of measurements or other cogent reasons for accepting these subspecies, merely grouping them in a convenient geographical way and saying that they are "determinable." In the same place he created a new name, *P. urinatrix coppingeri*, for a diving petrel from the "Straits of Magellan."

Furthermore, Mathews revived Lesson's genus *Puffinuria* for the large diving petrel of the west coast of South America, giving, on pages 232 and 233 of the work cited, his reasons for this step. In this genus he placed *P. garnotii garnotii*, from Peru; *P. garnotii lessoni*, from Chile; and *P. garnotii magellani* from the Strait of Magellan; the last two forms being described as new.

1912. MATHEWS (Austral Avian Rec., p. 84) separated the Australian diving petrel as *Pelecanoides urinatrix belcheri*.

1916. MURPHY AND HARPER (Bull. Amer. Mus. Nat. Hist., XXXV, pp. 65-67) described a new subspecies, *P. u. chathamensis*, from the Chatham Islands, and a new species, *P. georgica*,¹ from South Georgia in the subantarctic Atlantic.

1918. LOOMIS, in his 'Review of the Albatrosses, Petrels, and Diving Petrels' (Proc. Calif. Acad. Sci., (4) II, part 2, No. 12, pp. 66, 67), recognized but two species, *urinatrix* and *garnoti*.

CRITICAL NOTES ON THE GENUS *PELECANOIDES*

Salvin's synopsis of the family Pelecanoididæ (*loc. cit.*, p. 342) contains the statement, since universally accepted, that the "second" primary is slightly the longest. According to the modern method of quill enumeration, the vestigial, outermost flight feather of Tubinares is reckoned as the eleventh; the "second" primary of Salvin's system is therefore equivalent to the ninth. Examination of our material, however, does not support Salvin's statement. In the hundreds of specimens that have passed through our hands, the tenth (outermost functional—"first") primary is the longest whenever the quills have attained full

¹Properly *georgicus*.

growth. In this feature the diving petrels therefore agree with all other members of the order except the *Thalassidrominæ* and *Oceanitinæ*.

Coues (*loc. cit.*, p. 189) apparently based his succinct structural description of the group¹ entirely upon specimens of *Pelecyanoides garnoti*, but with minor exceptions it would apply to the genus as extended in the present paper.

Mathews ('Birds of Australia,' II, p. 232) published the following as justification for the establishment of a second genus, *Puffinuria*.

I would here only note the differences between the species *P. urinatrix* and *P. garnoti* in that feature [the bill]. The former has the nostrils elongate, narrow and parallel the distensible sac contained by the rami of the under-mandible is pronounced and unfeathered [*sic*]. The latter has a longer bill with the nostrils less elongate proportionately, and more triangular shaped, with a noticeable projection from the inner edge; this can also be seen in the preceding species, but it is very minute. In addition the rami of the lower mandible do not enclose a wide distensible sac, which is also partly feathered. . . I consider that the genus *Puffinuria* should be recognized.

The formation of the nostrils in the two proposed genera is further illustrated by line drawings.

In spite of the obscure wording, Mathews has here called attention to characters of taxonomic significance. As a critique of his remarks, however, we offer the following observations: (1) specimens before us, representing *Pelecyanoides exsul* from Kerguelen Island and subspecies of *Pelecyanoides urinatrix* from the Chatham Islands and the Falklands, have the distensible sac between the rami feathered for more than half its length; (2) the bill of the newly-described species, *Pelecyanoides georgicus*, which was unknown to Mathews, is in some respects structurally intermediate between those of *urinatrix* and *garnoti*, the nostrils being shorter and less closely appressed than those of *urinatrix*, but not so widely spread posteriorly as in *garnoti*. In its inferior aspect, the bill

¹Coues' characterization is as follows:

"The perfectly vertical nostrils are surrounded by an elevated wall, whose contour, in consequence of a slight emargination posteriorly, and a corresponding protuberance anteriorly, on the median line, is somewhat cordiform. The wall has considerable thickness basally; but much bevelling superiorly gives it an extremely thin edge. The internasal septum is moderately thick; and from either side a process projects transversely into the nasal orifice. In shape each nostril is suboval; being somewhat elongated anteriorly, and a straightening of its inner border being produced by their mutual apposition.

"The dertrum or unguis is long, reaching quite to the nostrils; and, for this family, is only moderately uncinated. Except at its extreme base it is distinctly carinated, and its sides are much compressed.

"The myxa is unusually small and narrow, with a very acute tip, and extremely concave gonyx. The sulci separating the myxotheca from the rest of the mandible, and the lateral one on the gnathidia are strongly marked.

"The unusual amount of divarication of the concavo-convex gnathidia, which causes so wide a submentum, is, in the upper mandible, accompanied by a corresponding dilation of the lateral elements; which latter are also turgid and inflated.

"The tarsus is excessively compressed, and at the same time very deep antero-posteriorly; giving to its transverse section a narrowly elliptical shape, like that which obtains in the *Colymbidæ*. It is reticulated as in the *Procellariidæ*, and also the majority of the *Alcidæ*, though *Mergulus* has anteriorly transverse imbricated scales. The proportions of the anterior toes are as in the other *Procellariidæ*."

of *georgicus* is more broadly wedge-shaped than that of any of its congeners, though it is built on the fundamental plan of the *garnoti* bill with diverging instead of parallel rami. The lateral flanges of the internasal septum are larger in *georgicus* than in *urinatrix*, and they extend farther anteriorly, i.e., to the axial center of the nostril as in *garnoti*.

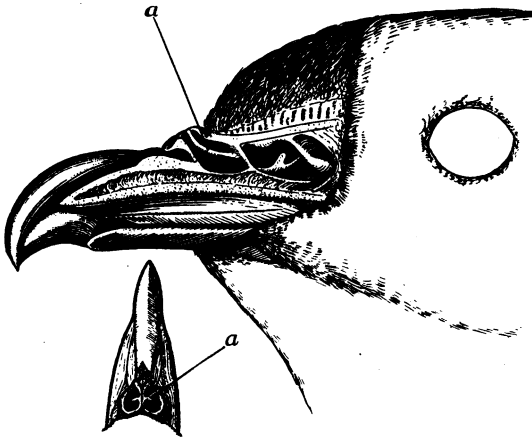


Fig. 1. Sagittal section through the left narial passage, and dorsal view of the bill, of *Pelecanoides garnoti*, showing the paraseptal process (a).

These narial flanges, which are referred to by both Coues and Mathews, are apparently peculiar to the Pelecanoididæ among Tubinæres. We can find no trace of them in *Puffinus*, *Pterodroma*, or a dissected embryo albatross (*Diomedea exulans*). They may represent an accessory fold of the anterior concha vestibuli; they differ, of course, from the folds on the nasoturbinals in lacking olfactory epithelium, being covered quite to their bases with the black, horny integument of the naricorn. Probably they are neomorphs in the Pelecanoididæ, and it may be assumed from their construction that they function in breaking up the stream of water which must tend to force its way into the nostrils during the bird's plunge from flight. A related specialization for diving habits is obvious in the upwardly directed nostrils, and it is significant that the species with the largest and widest nostrils has the best developed flanges. In view of the uncertain homologies of these flanges, they may be called "paraseptal processes." Their appearance and extent are shown in the accompanying illustrations.

The development and position of the anterior ends of the paraseptal processes, which project visibly into the nostrils, vary markedly in the

several representatives of the family. The condition in several species and subspecies is portrayed, along with other morphological details of the bill, in figure 3.

SYNOPSIS OF THE SUBGENERA OF *PELECANOIDES*

The structural intergradations mentioned above are, in our opinion, sufficient to bridge any supposed generic demarcation between *Pele-*

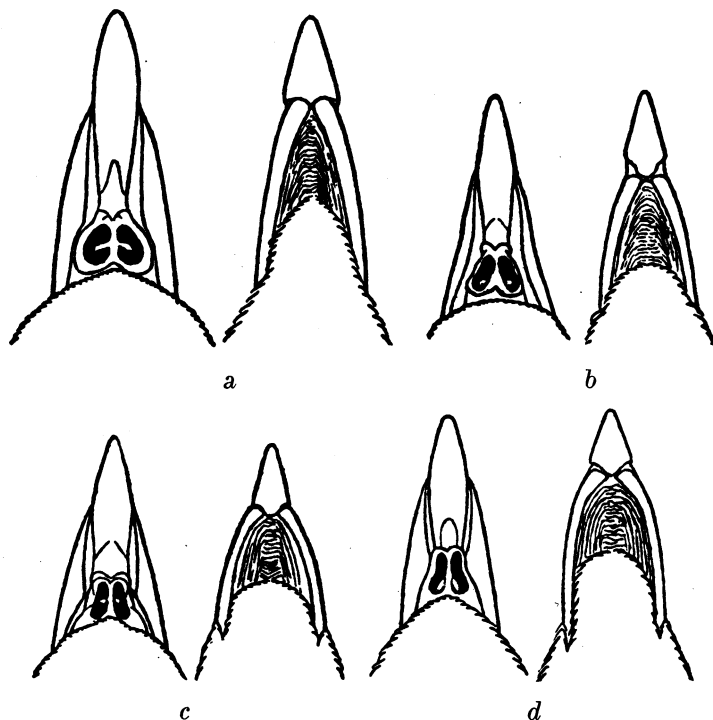


Fig. 2. Dorsal and ventral aspects of the bills of four subgenera of Pelecanoididae, drawn to scale but enlarged: a, *Puffinuria* (*Pelecanoides garnoti*); b, *Porthmornis* (*Pelecanoides magellani*); c, *Pelagodyptes* (*Pelecanoides georgicus*); d, *Pelecanoides* (*Pelecanoides urinatrix berard*). See also Plate XXII, fig. 2.

canoides and "*Puffinuria*," the species of which are so essentially alike in the sum of their characters. Nevertheless, since certain combinations of characters, including particularly the architecture of the bill, and to a lesser extent, the proportions of wing, tail, metatarsus, and toes, appear to represent more than specific distinctions among the diving petrels, the names *Pelecanoides* and *Puffinuria*, together with two additional names here proposed for the first time, may be applied subgenerically.

1.—Bill relatively slender in proportion to length (exposed culmen exceeding twice the width of bill at base), the sides tapering gradually from base to tip. Mandibular rami diverging from the gonys at a very acute angle, enclosing a narrow, sharply pointed interramal space. Outline of combined nasal orifices broad and cordate, the walls of the tubes horny and firm, the nostrils appressed. Anterior end of paraseptal process strongly developed and projecting prominently into middle of nostril. Claws relatively blunt and stout; claw of middle toe shorter than third phalanx; claw on inner toe not extending beyond base of claw on middle toe. Tail less than twice the length of exposed culmen, and but slightly longer than tarsus. Wing more than three and one-half times as long as tail. *Puffinuria*.

2.—Bill relatively slender in proportion to length (exposed culmen about equal to twice the width of bill at base), the sides tapering gradually from base to tip. Mandibular rami diverging at a very acute angle, as in subgenus *Puffinuria*. Outline of combined nasal orifices broad and cordate, but the walls of the tubes moderately thin and often warped somewhat in dried skins; nostrils widely divergent posteriorly. Anterior end of paraseptal process weakly developed, inconspicuous, and projecting only into posterior part of nostril. Claws relatively sharp and slender; claw of middle toe shorter than third phalanx; claw on inner toe not extending beyond base of claw on middle toe. Tail more than twice the length of exposed culmen, and one-third longer than tarsus. Wing less than three and one-half but more than three times as long as tail. *Porthmornis*,¹ new subgenus.

3.—Bill relatively broad in proportion to length (width at base equal to three-fifths of exposed culmen), the sides tapering sharply from base to tip. Mandibular rami diverging at a relatively wide angle, enclosing a short, broad interramal space. Nasal eminence thin-walled, the shape of the oval, closely appressed nostrils in dried skins always more or less altered by shrinking. Anterior end of paraseptal process strongly developed, and projecting almost as prominently into middle of nostril as in subgenus *Puffinuria*. Claws relatively sharp and slender; claw of middle toe longer than third phalanx; claw on inner toe extending beyond base of claw on middle toe. Tail more than twice the length of exposed culmen, and one-third longer than tarsus. Wing not more than three times as long as tail. *Pelagodyptes*,² new subgenus.

4.—Bill relatively stout and blunt, tapering abruptly near the tip, but almost as wide in the middle as at the base owing to the expansion of the lateral elements of the maxilla and the bowing of the mandibular rami (exposed culmen about equal to twice the width of bill at base). Rami nearly parallel for the greater part of their length, but converging abruptly toward the tip, enclosing an obtusely pointed interramal space. Myxa proportionately shorter and smaller than in any of the other subgenera. Nasal eminence thin-walled, the shape of the elongate, reniform, closely appressed nostrils in dried skins always more or less altered by shrinking. Anterior end of paraseptal process weakly developed, inconspicuous, and projecting only into posterior part of nostril. Claws relatively sharp and slender; claw of middle toe shorter than third phalanx; claw on inner toe not extending beyond base of claw on middle toe. Tail more than twice the length of exposed culmen, and at least one-fourth longer than tarsus. Wing more than three but less than three and one-half times as long as tail. *Pelecanoides*.

¹πορθμός, a strait + όρνις, bird.

²πέλαγος, the open sea + δόκτης, a diver.

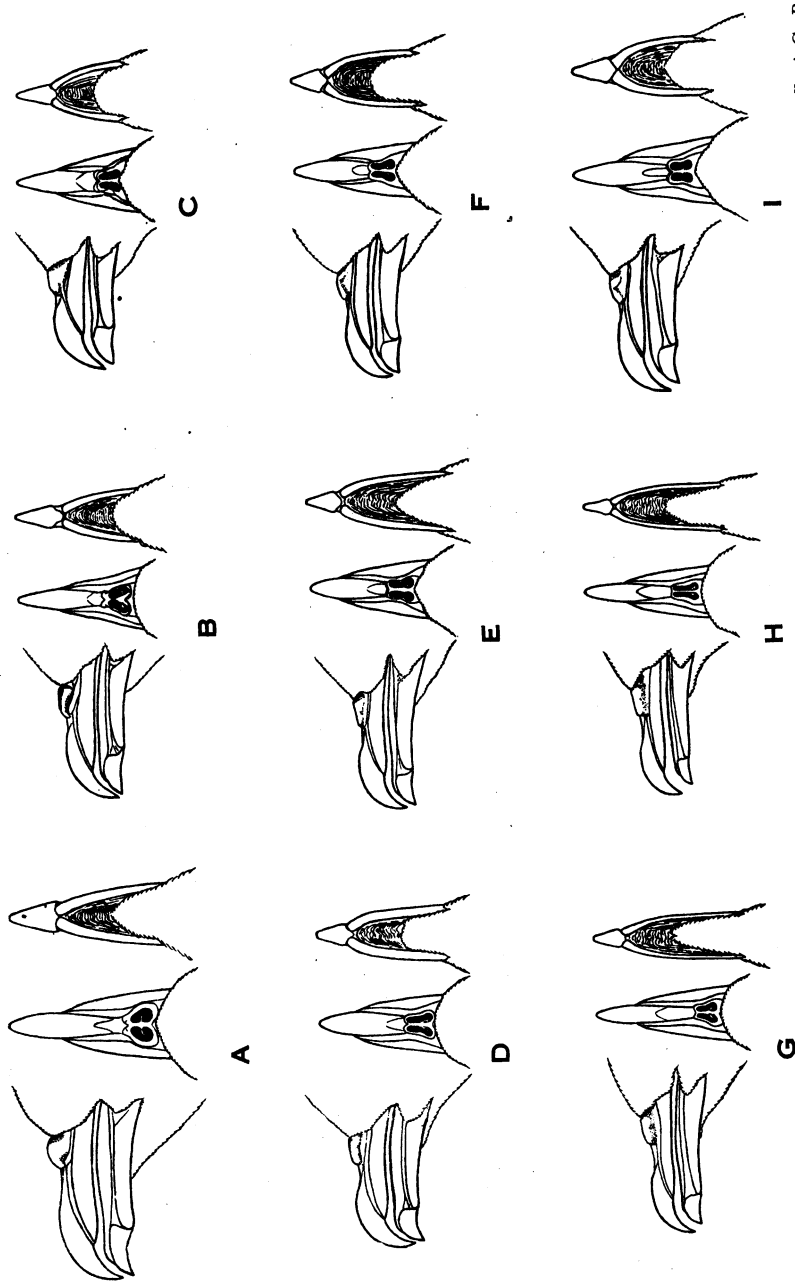


Fig. 3. Bills of nine species and subspecies of Pelecanoididae, drawn from adult specimens; all figures life-size, A, *P. gornoti*; B, *P. moqellani*; C, *P. georgicus*; D, *P. urinator urinator*; E, *P. urinator chathamensis*; F, *P. urinator berard*; G, *P. urinator dacotae*; H, *P. urinator coppingeri*; I, *P. casul.*

SYSTEMATIC ACCOUNT OF THE SPECIES AND SUBSPECIES

In the pages that follow, the writers aim to establish the taxonomic status and the approximate geographic ranges of five species of diving petrels, namely *Pelecanoides garnoti*, *magellani*, *georgicus*, *exsul*, and *urinatrix*, representing four different subgenera. At the same time, we are aware that a great amount of work remains to be done in the way of studies of the life histories of the Pelecanoididæ, researches into genetic relationships, revisions of certain forms at present weakly represented in American collections, and perhaps the discovery of undescribed races at imperfectly explored, subantarctic islands. The various subspecies will be treated as critically as the material at our disposal permits, but a final revision of the races of *urinatrix* is a task that must await an ornithologist who enjoys the opportunity to study larger series of skins from the New Zealand region, the South Atlantic, and both coasts of temperate South America.

Names of colors, where used originally, are chiefly those of Ridgway's 'Color Standards and Nomenclature' (1912). All measurements are in millimeters. In addition to the minimum and maximum, the average of each series of measurements is given in parentheses. Our measurement of depth of bill is taken just in front of the nasal eminences.

References under each species are chiefly to works quoted or cited in our text. For a complete bibliography, the monographs of Salvin (1896), Godman (1910), and Mathews (1912, 'Birds of Australia,' II) should be consulted.

PELECANOIDES LacépèdeSubgenus **PUFFINURIA** Lesson**Pelecanoides garnoti** (Lesson)

Plates XXI, Figure 1, XXII, Figure 1, XXIV, Figure 1

Puffinuria garnotii LESSON, 1828, 'Manuel d'Orn.,' II, p. 394; 1828, 'Voy. Coquille,' Atlas, Pl. XLVI.

Pelecanoides garnoti COUES, 1866, Proc. Acad. Nat. Sci. Philadelphia, XVIII, p. 190.

SALVIN, 1896, 'Cat. Birds Brit. Mus.,' XXV, p. 439. GODMAN, 1910, 'Monogr. Petrels,' p. 307. LOOMIS, 1918, Proc. Calif. Acad. Sci., (4) II, No. 12, p. 67.

P [uffinuria] garnotii garnotii MATHEWS, 1912, 'Birds Australia,' II, p. 239.

P [uffinuria] garnotii lessoni MATHEWS, 1912, 'Birds Australia,' II, p. 239.

Halodroma garnoti COKER, 1908, Bull. U. S. Bur. Fisheries, XXVIII, pp. 361, 362.

TYPE SPECIMEN.—Not known, but well figured in 'Voy. Coquille,' Atlas, Pl. XLVI.

TYPE LOCALITY.—Coast of Peru, between San Gallan Island and Lima.¹

¹No definite locality is given in the description of the species by Lesson, who says, "*Le puffinure de Garnot habite par grandes troupes le long des cotes du Pérou.*" His colleague Garnot, however, in the course of his remarks on the anatomy of the species, states: "*Cet oiseau habite les parages entre San-gallant et Lima*" ('Voy. Coquille,' I, part 2, p. 611).

GEOGRAPHIC RANGE.—Western coast of South America, from Lobos de Tierra Island, Peru (lat. 6° 27' 45" S.), at least to Valparaiso, Chile.

GENERAL CHARACTERS.—Largest of the Pelecanoididæ; nearest to *P. magellani*, but much larger, especially in length of bill, wing, and tarsus. Gonys more concave than in any other species. Natal down whitish.

ADULTS (SEXES ALIKE).—Upper surface black, each feather with a terminal band of glossy black, preceded by a grayish black area, which shades into the grayish white basal portion; the shafts mostly dark; scapulars mostly dusky neutral gray on outer web, grayish white on inner web, more or less concealed by the plumage of the interscapulum, but forming in many specimens an irregular, blotchy diagonal stripe; wings glossy black, more or less tinged with brownish, especially on primaries; secondaries narrowly tipped with whitish; inner webs of primaries clove-brown; under wing-coverts whitish, more or less washed with light mouse-gray, the shafts mostly dark; rectrices glossy black, fading to glossy brownish black, paler on the under surface; anterior part of forehead and lores suffused with clove-brown; under surface white; auriculars and malar region chætura black; a fuscous area extending from the sides nearly to the middle of the breast, and sometimes extending entirely across as a faint mottling; axillaries dark mouse-gray to black; sides and flanks strongly washed with deep mouse-gray, the feathers sometimes narrowly tipped with whitish; feathers of tibia mouse-gray; down plumules and after-shafts over entire body deep mouse-gray. Paraseptal processes situated at the longitudinal center of the septum. Bill black; iris brown; tarsus and toes bluish; webs black.¹

Adult Male.—Length (skins), 217–238 (228.7); wing, 130–141 (136); tail, 33–43 (36.7); exposed culmen, 19–22 (20.4); width of bill, 8.5–10.5 (9.6); depth of bill, 7–9 (8.3); tarsus, 30–34 (32.9); middle toe and claw, 34–39 (36.9).²

Adult Female.—Length (skins), 209–239 (221.9); wing, 130.5–144 (136.6); tail, 33.5–41 (36.5); exposed culmen, 19–21 (19.7); width of bill, 8.5–10 (9.2); depth of bill, 7–8 (7.6); tarsus, 32–34 (32.5); middle toe and claw, 34.5–40 (36.3).³

NESTLING.—Natal down (protoptyle) between pale gull-gray and white, attached to the tips of the mesoptyle down, which is mouse-gray in color but which fades appreciably before it is finally molted.

SPECIMENS EXAMINED.—Total number, 127, as follows:

Peru: Lobos de Tierra, 1⁴; Macabi Island, 1⁵; Ancon, 50^{4, 6}; Callao Bay, 5^{4, 6, 7, 8}; Chilca, 1⁶; Ballestas, North Island, 1⁸; San Gallan Island, 8^{6, 8}; Independence Bay, 1⁸

Chile: Coquimbo Bay, 2⁴; Valparaiso, 52^{4, 6, 8}; no specific locality, 1⁴

Locality unknown: 4^{4, 9, 10}

¹Colors of soft parts as stated on Beck's labels. In many cases, however, he gives the color of the iris as black or blackish.

²Twenty specimens.

³Twenty specimens.

⁴Collection Brit. Mus.

⁵Collection Mich. Univ. Mus.

⁶Brewster-Sanford Collection.

⁷Collection Acad. Nat. Sci. Phila.

⁸Collection U. S. Nat. Mus.

⁹Collection Boston Soc. Nat. Hist.

¹⁰Collection Zool. Mus., Tring.

NESTING SEASON.—Apparently throughout the year.

EGG.¹—Six collected at San Gallan Island, Peru, on July 4, 1913, range in form from short ovate to elongate ovate, one being extremely pointed at the smaller end; white, lusterless; measurements,² 48.5×33.6, 46×34.5, 46.7×34.2, 48×37, 47×34, 45×33 (average, 46.8×34.4). Average volume of the six, 24 cubic centimeters.

Mathews (*loc. cit.*, pp. 232, 233) has proposed to separate this form from the other species of *Pelecanoides* under the generic name *Puffinuria*. Our grounds for not according it this rank are given on pages 500-502.

Mathews (*loc. cit.*, p. 239) has also separated the bird of the coast of Chile from that of the coast of Peru, in the following words:

P [uffinuria] garnotii lessoni, subsp. n.; coast of Chili.

This form is much larger than the Peruvian bird, and has a noticeably heavier bill, with the inner wing-coverts gray and white-mottled.

Our examination of a very much larger series of specimens than was at Mathews' disposal has convinced us that the Chilean birds—from as far south, at least, as Valparaiso—are not entitled to subspecific recognition. The average measurements of Peruvian and Chilean specimens are presented in the following table:

TABLE I

	WING	TAIL	EXPOSED CULMEN	WIDTH OF BILL	DEPTH OF BILL	TARSUS	MIDDLE TOE AND CLAW
Ten Males from Peru ³	135.0	37.5	20.5	9.5	8.6	32.8	36.7
Ten Males from Chile ⁴	137.1	37.9	20.4	9.8	8.0	33.1	37.2
Ten Females from Peru ⁵	136.0	35.9	19.7	9.3	7.7	32.6	36.0
Ten Females from Chile ⁴	137.2	37.1	19.8	9.2	7.5	32.5	36.7

These differences in measurements are clearly too slight to warrant the separation of the Chilean birds as a distinct form. Furthermore, the coloration of the under wing-coverts seems too variable a character in the *Pelecanoididæ* to be of appreciable value in separating subspecies.

Still another subspecies proposed by Mathews (*P. g. magellani*) will be discussed under *Pelecanoides magellani*.

From Mr. Beck's notes on the labels of the Brewster-Sanford specimens, it appears that the species begins breeding on the coast of Peru in April.⁶ On May 8, 1913, he landed from a rowboat on one of the Pescadores Islets, eight miles off Ancon (thirty miles northwest of Lima)

¹The eggs described by Oates (1901, Cat. Birds' Eggs Brit. Mus., I, p. 161), under *P. garnoti*, clearly do not belong to this species.

²Cf. also Dr. Coker's measurements, p. 513.

³Ancon, 7; San Gallan Island, 2; Callao Bay, 1.

⁴Valparaiso.

⁵Ancon, 8; San Gallan Island, 1; Chilca, 1.

⁶Dr. Coker's account (cf. pp. 511-513) makes it clear that the breeding season is prolonged throughout the year.

and found a single diving petrel nest, the chamber of which lay under a rock at the end of a tunnel through the soft but stony soil; it was lined with a number of cormorant feathers. On July 3, 1913, at San Gallan Island, off Pisco, he took three adults (two males and one female) on their nests and three nestlings varying in age from a few days to a number of weeks, the oldest of them having molted nearly all its mesoptyle down (Pl. XXI). On the following day, July 4, he collected six eggs, two of which were fresh-laid. In five out of the six instances a parent bird (Pl. XXIV) was incubating. The nest cavities, some of which were lined with a few diving petrel feathers, were either shallow hollows scratched out under rocks, or tunnels excavated to a depth of three or more feet. Some of them were dug into sandy flats, and some in the talus of hillsides. Beck likened the burrows to those of Cassin's auklets (*Ptychoramphus aleuticus*) of the Lower California islands. The principal colony of diving petrels, where the nests were very thickly distributed, was in a canyon about a mile from the water. Similar burrows were occupied by breeding Inca terns (*Larosterna inca*), and in a few cases the terns and diving petrels used a common entrance leading to their respective nest chambers.

The six eggs collected at San Gallan Island share with the eggs of almost all species of Tubinares a remarkable variation in shape. In volume, however, they are relatively uniform, ranging between 23 and 25.2 cubic centimeters, the average cubic contents of the six being 24 cc. They are therefore strikingly larger than eggs of *Pelecanoides georgicus* or *Pelecanoides urinatrix*. The average volume of two eggs of *Pelecanoides urinatrix berard*, for instance, is but 16.7 cc.; that of four eggs of *Pelecanoides georgicus*, 16.2 cc.

The following record is from Mr. Beck's field note-book.

Forty miles south of Salaverry, Peru, Jan. 5, 1913. Single diving petrels, and groups of as many as seven, seen from the steamer, ten or fifteen miles offshore. Their flight, when rising from the water, was similar to that of auklets. Some of the birds dived instead of rising.

Ten miles north of Callao, January 6. Numbers of divers seen, sometimes singly, never more than seven or eight together. In avoiding the steamer, they would sometimes dive and sometimes fly.

Off Ancon, Peru, April 24, 1913. Outside the islets, eight miles offshore, diving petrels were not uncommon. All were working southward, while under observation, from 12 o'clock noon until 3 p. m.

April 28. Only a half dozen diving petrels seen during a trip eight miles offshore and back again. One of the birds shot had molted its wing quills. It swam along under water a short distance with its wings spread. At first I thought it was a wounded bird.

May 1. Three or four diving petrels seen flying north. They passed my bait without paying any heed to it, although other petrels, such as *Thalassidroma tethys* and *Oceanites gracilis*, came to the bait freely.

May 5. Numbers of diving petrels seen, mostly flying southward. Four or five were shot on the water and one of the wounded birds opened its wings and swam as murrelets do beneath the surface. Small sardine-like fish were abundant, and the stomachs of some of the divers were filled with them.

May 15. Twenty-nine diving petrels, mostly flying toward the south, were collected along with forty specimens of other petrels. The ocean was discolored with minute feed. Some of the divers were in the water, and now and then a number of them would burst out within a radius of a hundred yards. One of the specimens had lost all its flight feathers, the molt, therefore, being like that of an auklet or murre instead of in the usual petrel style in which the quills molt one or two at a time.

May 19. A half dozen diving petrels seen flying northward out of Callao Bay.

Six miles northwest of San Lorenzo Island, June 21. Many diving petrels on the water, singly, or in scattered groups of five or six.

Off Chilca, June 24. A single diver shot when it alighted near my bait.

June 28. A number of diving petrels seen sitting on the water just north of the Chincha Islands.

Arica, Chile, Aug. 25. Several diving petrels seen while we lay at anchor.

Iquique, Aug. 26. Diving petrels common just to the northward of the town.

Taltal [lat. 25° 30' S.], Aug. 28. Four or five seen flying near the steamer.

Valparaiso, Nov. 8. Scattering examples of diving petrels flying southward one to three miles offshore.

Nov. 11. A few divers; one shot. All the sea-birds are flying south at this season.

Nov. 19. Many divers working southward. They gave the boat a wide berth.

Nov. 24. Three or four seen.

Nov. 28. The last of the divers seen, still going south.

On October 22, 1913, Mr. Beck ran forty miles out to sea in a motor boat from Corral, the port of Valdivia, Chile (lat. 40° S.), but did not see a single diving petrel. Neither did he observe any on subsequent southward trips, so that the vicinity of Valparaiso is the southernmost point from which we have actual records of *Pelecanoides garnoti*. He saw none of these birds during his sojourn at the islands of the Juan Fernandez group, which lie about 450 miles off Valparaiso. In short, the geographical distribution and the breeding range appear to have the same limits, both being confined within the field of the cold Humboldt Current.

Mr. Beck's splendid series of 104 specimens, taken during the months of February to July and also in November, reveal many particulars of the life history.

This species, in common with numerous other tropical sea-birds, has a very protracted breeding season, or, rather, the date of deposition of the egg varies widely. Early in May, for instance, Mr. Beck dis-

covered nests, as recorded above; on July 3 he took several young birds, one of which was almost fully fledged, yet a day later he found fresh eggs. The subantarctic representatives of *Pelecanoides*, such as *magellani* and *georgicus*, have an apparently much more definite and limited season of egg-laying.

Certain seemingly vagarious features of the molt in *Pelecanoides garnoti* are doubtless also to be correlated with the life conditions of the tropical environment. A study of the majority of the skins in the Brewster-Sanford series indicates that normally a complete molt occurs between August and October, for most of the November specimens are in new plumage, while from this month forward the series as a whole shows progressive wear of the feathers up to and including the following winter season (July). Two specimens, referred to in Beck's notes of April 28 and May 15, were, however, molting at that time, and had lost at once most of the tail quills and all the remiges, both primary and secondary. Their condition is extraordinary for tubinarine birds, among which no doubt the phenomenon would be practicable only in this specialized, diving family to which the power of flight is not wholly essential. The state of the plumage in these two skins appears, moreover, to be out of harmony with conditions among nearly all of the other hundred specimens.

A few skins of non-breeding birds taken in July (the physiological status being indicated by Mr. Beck's careful notations regarding the sex organs) we believe to be yearlings that have not yet undergone the first molt of their teleoptyles.¹ The same condition is known to obtain in the genus *Oceanites*. Immature examples of *Pelecanoides garnoti* are apparently determinable even when they are more than a year old, for, while they have at this age acquired new wing quills, the rectricial molt is often found to have been incomplete, and one or more of the bleached, juvenal tail feathers, abraded as the plumes of only young petrels are wont to be, contrast strongly with their heavily pigmented successors. Such old rectrices are unquestionably more weathered and frayed than the corresponding year-old feathers of adult birds.

It is interesting to note that the first of the two neossoptyle plumages of *Pelecanoides garnoti* is whitish, whereas that of *P. georgicus* and *P. urinatrix* is dark gray. An analogy is to be found in the natal downs of two closely related penguins that have rather similar adult plumages, the chick of *Aptenodytes forsteri* being white, that of *A. patachonica*

¹The terms used in this paper for the plumage generations are those of Pycraft in Godman's 'Monograph of the Petrels.'

brown. The color of the neossoptyles in *Pelecanoides magellani* is unfortunately not known. The juvenal plumage of *Pelecanoides garnoti*, as shown by a fledgling taken from the nest, is indistinguishable from that of the adult. Even the complete, though faint, collar is visible on the jugulum of the young bird.

The following zoological and economic notes on this species were courteously placed at our disposal, after the remainder of our paper had gone to the editor, by Dr. R. E. Coker, of the United States Bureau of Fisheries. Dr. Coker has had long experience in the habitat of Garnot's diving petrel, and the account below is extracted from his manuscript on the habits and economic relations of the guano birds of Peru. These notes, with slight verbal alterations, have since been published.¹

Among the petrels, one is of particular interest and importance—the “*potoyunco*” (*Pelecanoides garnoti*)—a diving petrel, an abundant bird and a significant guano-producer. These petrels nest in considerable numbers in favored locations on the islands, and the guano formed in their subterranean chambers is considered particularly rich in nitrogenous matter. Only one egg is laid at a time, but the laying season extends throughout the year.

My first acquaintance with these birds was when at night in a small boat we often sailed close by them floating on the surface of the water and apparently quite unobservant of the boat. Not more than once have I seen them on the water by day—though the fishermen say that but one bird of the pair is at the nest during the day, the other remaining out on the ocean. On the islands, as far as my observations go, they are strictly nocturnal, coming and going only after dark and before the light of morning. They are more readily recognizable by sound than sight, and, as they fly obscurely about over the island, uttering their little croaks, they are very suggestive of bats.

The nests are made in the side of the hill, often just beneath a large rock or sheltered under the hard salty crust. It is an odd experience to sit at such a place and hear the mysterious sounds from subterranean homes. Over and over again, with the voice of a frog unvaried in pitch or rhythm, they repeat the sequence of notes—two longs, a short and a long, the last note slightly longer than the first two. Another more complicated sound is made by some, and it is possible that the calls are distinctive of the sexes.

The potoyunco is a comparatively small bird, measuring about ten inches in full length, from end of bill to tip of tail, and weighing half a pound. The general color is black above and white below. The body is thickly covered with feathers, beneath which is a thick gray down, the dense coat making the bird appear to possess a very large body. Viewed from below, the body is oval in form—like a large white egg—the wings and the short stout neck seeming disproportionately small appendages.

A number of the nests were observed at the Ballestas north island, and the birds were heard on the Chinchas; but the lofty San Gallan was the island *par excellence* for potoyuncos, as the potoyuncos were easily the principal bird of this large island.

¹1919, Proc. U. S. Nat. Mus., LVI, pp. 462-465.

San Gallan, 2.3 by 1.5 miles, is mostly dry, barren and dusty, but with high hills reaching well into the clouds, and, only there, in the moist altitudes, teeming with plant life. Everywhere over the island are large spots perforated by the holes of the potoyuncos as they undermine the hard dry crust of the lower hillsides, or burrow back underneath the vegetation of the cloud-wrapped peaks more than a thousand feet above sea-level.

Searching for these birds in the daytime one is guided only by the openings of the burrows, as their voice is rarely heard during the day. One may try quite a number of nests without result, as the burrow may either be unoccupied or, more often, too deep for the arm to reach to the nest. Still, so abundant are the nests on San Gallan,¹ that a considerable number of birds or eggs may be captured in an hour or two. Once reached, the birds are easily taken, as they make almost no effort at resistance. Sometimes after they are out, they try to bite, but without inflicting injury. Occasionally they will rush out into the hands held at the mouth of the gully.

At night, when one may be guided by the voices of the birds and avoid exploring the unoccupied homes, it is much easier to take them. It is thus that the laborers and fishermen catch them abundantly; for the potoyunco is valued for food in fresh or salted condition.

If liberated, they run rapidly over the ground, flapping the wings but unable to rise except after a run of ten or twenty feet. Then, with exceedingly rapid movement of their short wings, they make for the ocean with a queer zigzag flight. Reaching the ocean they fly low over the water a little distance, settle upon the surface, and then swim away, making short shallow dives.

When placed on the ground in my tent, the diving petrels displayed peculiar movements. The body is covered with a very thick coat of feathers so that, lying on the ground, the body seems to flatten out remarkably, while the wings, pushed a little out on the sides, increase the apparent width until the body has quite a turtle-like form. As they crawl rapidly along, the legs are spread well out to the sides and the body is barely if at all lifted from the ground. I noticed that with some the body was slightly raised, with others not at all. In any case the movement is a reptilian creep rather than a walk. When I started one under my sleeping bag it began to burrow with strong backward sweeps of the feet used alternately, and sent the dirt flying with great force. Two birds were placed outside in holes in the ground, each secured by a line attached to the leg. They made a little effort to burrow, but soon stopped. At 10 at night I found them trying to go toward the water. Placing them back in the holes, I left them again, hoping to ascertain the rate of excavation. Unfortunately, in the morning only the bones of the legs remained, and the tracks of gallinazos accounted for the disappearance of the birds.

Presumably both condors and gallinazos (buzzards) may be accounted enemies of the potoyuncos, although their subterranean life and nocturnal flights give them substantial protection from predatory birds. Certainly the chief enemy is man. About the signs of old camp-fires numberless wings of the potoyuncos were often observed. For a while I was puzzled by the many signs of sacks having been dragged

¹Since the present paper was set in type the senior author has visited San Gallan and other parts of the Peruvian coast. Accounts of his observations on the diving petrels have been published in the 'Brooklyn Museum Quarterly' as follows: Vol. VII, pp. 91, 93, 239 241, 242; Vol. VIII, pp. 97, 98, 102, 104, 105.

down the high hillsides, until it was observed that these trails led in almost every case to the grounds where there were burrows of potoyuncos—even to those near the very tops of the peaks. The ground was not torn up as if guano had been the object of search, and the abundant evidence of discarded wings of potoyuncos completed the story. The fishermen assured me that these birds were very good when salted, and that the laborers on the islands regularly brought back quantities of potoyuncos salted down. The fishermen with me asked permission to take the birds for food. This was refused, but without great effect, for I counted twenty-one birds drying in the sun one morning, and I know that they had first eaten all they had wanted.

A great many nests were examined, to find in each nest, if tenanted, only one egg or one young bird. The eggs are purest white, with very thin shell, and they are very variable in shape. Some are short and well rounded, with little difference between the ends, while others are very elongate and rather pointed at the smaller end. The measurements of six eggs of the potoyunco were as follows:

	1	2	3	4	5	6
Length	4.85	4.75	4.5	4.5	4.35	4.3 cm.
Width	3.1	3.6	3.4	3.3	3.3	3.4 cm.

A "pichon," or fledgling, at the stage when the wing feathers are first appearing, is a large shapeless mass of fat and down, with nearly the dimensions of its parents, and of equal weight. Its soft coating of gray down measures 3-4 cm. in thickness ($1\frac{1}{2}$ inches more or less). If a single tuft of down is pulled out there is found growing out of the blue sheath the delicate little feather which, for about 1 cm., is white (if from the lower side of the body) or black (if from the back); many of the barbs of the little feathers are with delicate plumes of down, which are dark gray for about 2 cm. and possess white tips of 1 cm. length. The head protruding from this great ball of down appears almost bald with only a close crop of gray down.

Valued as it is for food and readily open to capture, the potoyunco must eventually be brought near to extinction unless effective efforts for its protection are made. It will be unfortunate, indeed, if the potoyunco and the penguin, two water fowl which produce a fertilizer of high quality, shall, through mere human negligence or wastefulness, become lost to the guano industry. Valuable the potoyuncos may be as food, or the penguins for the skins or fat, and we may impose little personal blame on those who desire the food or the skins or the oils; but the fact remains that, when the food or the skin and oil is taken, the bird is lost to the future, while the removal of the guano is a benefit gained without loss. With due care each of these important species may not only be preserved to the future, but may be restored to a condition of far greater abundance and value than at the present time.

Subgenus **PORTHEMORNIS** Murphy and Harper

Pelecanoides magellani (Mathews)

Plates XX, XXI, Figure 2, XXII, Figure 1

Pelecanoides Berardi GOULD, 1841, 'Zool. Voy. H. M. S. Beagle,' part 3, 'Birds,' p. 138 (part).

Pelecanoides urinatrix SALVIN, 1896, 'Cat. Birds Brit. Mus.,' XXV, p. 437 (part). CRAWSHAY, 1907, 'Birds Tierra del Fuego,' p. 142. NICOLL, 1909, 'Three Voyages of a Naturalist,' pp. 160, 180; 1904, *Ibis*, pp. 41, 47. GODMAN, 1910, 'Monogr. Petrels,' p. 299 (part). TOWNSEND, 1910, *Pop. Sci. Monthly*, July, p. 6.

P [uffinuria] garnotii magellani MATHEWS, 1912, 'Birds Australia,' II, p. 239.

TYPE SPECIMEN.—Not designated in Mathews' description, which was probably based upon specimens in the British Museum.

TYPE LOCALITY.—Strait of Magellan.

GEOGRAPHIC RANGE.—Chilean, Fuegian, and Patagonian coastal and inland waterways, from Cape Horn north on the Pacific side of the continent to Trinidad Channel, and on the Atlantic side to Puerto Deseado, Province of Santa Cruz, Argentina.

GENERAL CHARACTERS.—Nearest to *garnotii* in general form of bill, to *urinatrix* in size. Differs from all other members of the family in the possession of white tips to feathers of back, upper rump, and wing-coverts (in fresh plumage), and in having a conspicuous falcate whitish area extending from the side of the neck to the occiput; the upper breast, moreover, is always pure white (never crossed by a mottled collar). Natal down not seen.

ADULTS (SEXES ALIKE).—Upper parts glossy black; feathers of the back and upper rump with narrow white tips, which disappear with wear (showing best in August specimens, entirely absent in some March specimens); scapulars dusky neutral gray (lighter on the inner web), with a terminal band of white (broader on the inner web); the scapulars forming a broken but distinct diagonal stripe of white; wing-coverts and secondaries glossy brownish black, the former with narrow, the latter with conspicuous, white tips and edges, which largely disappear with wear; primaries blackish brown, slightly glossed, becoming paler on the inner web; under wing-coverts white, a few feathers near the edge of the wing with dark shafts and splashed with blackish mouse-gray; rectrices black (fading to blackish brown), paler on the under surface, and several of the lateral feathers with narrow white tips, which disappear with wear; lores and anterior part of forehead suffused with clove-brown; under parts white, cheeks and sides of neck dark mouse-gray, the feathers with narrow white tips, except in worn plumage; a more or less distinct patch of white, falcate in shape, behind the cheeks, extending from the throat to the occiput; axillaries varying from dark to blackish mouse-gray; sides and flanks washed or broadly banded with dark neutral gray, the feathers with white tips, and the shafts black subterminally; feathers of tibia fuscous; down plumules and aftershafts over entire body deep neutral gray. Paraseptal processes situated posterior to the longitudinal center of the septum and not prominently developed. Bill blackish; iris brown; tarsus and toes bluish, webs black.¹

Adult Male.—Length (skins), 204–218 (209.8); wing, 120–133.5 (125.7); tail, 36–44 (40.5); exposed culmen, 15–17 (16); width of bill, 7.5–9 (8.1); depth of bill, 6–7 (6.4); tarsus, 26–30 (28.1); middle toe and claw, 31–36.5 (34).²

Adult Female.—Length (skins), 197–227 (208.5); wing, 121–132.5 (128); tail, 34–43.5 (39.3); exposed culmen, 15–17 (16.2); width of bill, 7–8.5 (7.9); depth of bill, 6–7 (6.2); tarsus, 27.5–29.5 (28.2); middle toe and claw, 31.5–36 (34.1).²

NESTLING.—Not seen.

SPECIMENS EXAMINED.—Total number, 87, as follows:

¹Color of soft parts from Beck's notations on labels. Nicoll writes: "Iris black; bill black; tarsi and toes blue-grey, with a black line down back of tarsus, webs black."

²Twenty specimens.

Chile and Argentina: Antonio Island, Trinidad Channel, 1¹; Molyneux Sound [lat. 50° 17' S., long. 74° 54' W.], 2¹; Caroline Island, 2²; London Island, 11²; Rey-non Island, 1²; Hoste Island, 1²; False Cape Horn, 25²; Strait of Magellan, 19¹ 2²; Woods Bay [Strait of Magellan], 1¹; Punta Arenas, 18²; "Puerto Prat., Ultima Esperanza, Patagonia," 1¹; lat. 48° 27' S., long. 65° 36' W., 2.²

Locality unknown: 3.¹ 3.⁴

NESTING SEASON.—November to March.

EGG.—Not seen.

Pelecanoides magellani, the diving petrel inhabiting the complex of Fuegian waterways, is a very well-marked and distinct species, probably the most distinctive and certainly the handsomest representative of the family. It is surprising that both Salvin⁵ and Godman⁶ should have synonymized it with *urinatrix*. Mathews considered it merely a sub-species of *garnoti*, and he described it in the following words.⁷

P [uffinuria] *garnoti magellani*, subsp. n. Straits of Magellan.

This bird is easily referable to the genus *Puffinuria* by its bill characters, and is separable from the preceding [*P. g. lessoni*] by its inferior size and the pure white coloration of the inner wing.

The differences in proportions and bill structure between this bird and *P. garnoti* are altogether too marked to admit of their being considered races of the same species, as we have pointed out in our synopsis of the subgenera. Furthermore, the invariable whiteness of the throat, and the white tips on feathers of the upper parts, are unique, qualitative characters (Plates XX-XXII).

A skin in the British Museum (No. 81.5.1.6075) is evidently the one which Salvin listed as specimen "r" under *Pelecanoides urinatrix* in the 'Catalogue of Birds,' XXV, p. 438, with the comment, "Type of *Haladroma tenuirostris* Eyton." One of the labels on the specimen itself bears the following data: "*Haladroma tenuirostris* Eyton. Original." This name appears nowhere else in the literature, so far as we have discovered, and is, accordingly a *nomen nudum*. Though neither locality nor date appear upon the labels, the specimen must have come from the Magellan region, since it is a *Pelecanoides magellani* beyond a doubt. It is evidently an immature bird, with a weak bill and measurements generally below the average.

The best published observations on *Pelecanoides magellani* in nature are those of Charles Darwin (cf. Gould, *loc. cit.*), who supplied Gould

¹Collection Brit. Mus.

²Brewster-Sanford Collection.

³Collection Mus. Comp. Zool.

⁴Collection Zool. Mus., Tring.

⁵Cat. Birds Brit. Mus., XXV, p. 437

⁶Monogr. Petrels, p. 299.

⁷Birds Australia, II, p. 239.

with the account quoted below. In referring, however, to its occurrence "as far north as the Chonos Archipelago," he was unaware of the existence of another diving petrel (*Pelecanoides urinatrix coppingeri*), which probably inhabits this part of the coast. Darwin wrote as follows:

This bird is common in the deep and quiet creeks and inland seas of Tierra del Fuego, and on the west coast of Patagonia, as far north as the Chonos Archipelago. I never saw but one in the open sea, and that was between Tierra del Fuego and the Falkland Islands. This bird is a complete auk in its habits, although from its structure it must be classed with the Petrels. To the latter Mr. Gould informs me, its affinity is clearly shewn by the form of its beak and nostrils, length of foot, and even by the general colouring of its plumage. To the auks it is related in the general form of its body, its short wings, shape of tail, and absence of hind-toe to the foot. When seen from a distance and undisturbed, it would almost certainly be mistaken, from its manner of swimming and frequent diving, for a grebe. When approached in a boat, it generally dives to a distance, and on coming to the surface, with the same movement takes flight: having flown some way, it drops like a stone on the water, as if struck dead, and instantaneously dives again. No one seeing this bird for the first time, thus diving like a grebe and flying in a straight line by the rapid movement of its short wings like an auk, would be willing to believe that it was a member of the family of petrels. . . . I observed at Port Famine, that these birds, in the evening, sometimes flew in straight lines from one part of the sound to another; but during the day, they scarcely ever, I believe, take wing, if undisturbed. They are not very wild: if they had been so, from their habit of diving and flying, it would have been extremely difficult to have procured a specimen. The legs of this bird are "flax-flower blue."

The general likeness of the diving petrels and the auklets has been mentioned in the literature many times since Darwin wrote the paragraph just quoted, but it has not hitherto been pointed out that the plumage of this species, *Pelecanoides magellani*, now for the first time fully recognized, so strikingly resembles the winter plumage of the dovekie (*Alle alle*). The remarkable similarity between these two unrelated birds involves not only size, the approximate proportions of the limbs and tail, and absence of the hind toe, but also the color and texture of the whole dorsal and ventral surfaces, the common possession of a falcate white area at the sides of the neck, and the presence of white markings on the proximal flight feathers and their coverts. Indeed, the homoplastic resemblance of the Fuegian diving petrel and the dovekie, illustrated in Plate XX, constitutes one of the best examples of convergent evolution known among vertebrates.

As regards the pygopode-like character of the feathers of diving petrels, Coues has written as follows:

In the wings and tail the urinatorial aspect is most decidedly marked. The very short wings, with their stiff, falcate, subacuminate primaries hardly reach to the end of the exceedingly abbreviated tail.

The plumage is essentially diverse from that of any other Procellariid, in its compact imbrication, and oily glossiness, which comes nearest to that of the Loons; and is eminently adapted to resist the action of the water in which the habits of this species cause them so constantly to be submerged.

The analogy existing between the diving petrels and the auklets will be referred to again in the discussion of *Pelecanoides georgicus* (pp. 530-533).

Nicoll has given the following account of the present species.

I first saw these curious little Petrels the day before we reached the Straits of Magellan. I watched them all the afternoon rising under our bows, flying for a short distance with a feeble fluttering flight, and then diving again suddenly into the water. They were abundant all through the Straits and Smythe's Channel, but were not easy to shoot, as they dived at the flash of the gun.¹

In Molineux Sound two examples of the diving petrel were obtained. . . . When skinning this bird, one cannot fail to be struck by the curious formation of the gizzard, which is soft and flabby, and is, in fact, merely an enlargement of the proventriculus. All those I examined were crammed with small fishes.²

Mr. Beck saw a great deal of this diving petrel during his several wanderings in the intricate Magellanic waterways, where he collected seventy-eight specimens. He did not succeed in finding an egg or nestling, although on Hermite Island, just northwest of Cape Horn, a dog scratched at a crevice under a large boulder, and Mr. Beck believed that a diver was nesting within. A native sealer told him that he had once found a nest of this bird on one of the islands to the westward of Cockburn Channel. It was several hundred feet above sea-level, and was unearthed by his dog while they were searching for sea-otter holes on a rocky hillside.

Mr. Beck's notes do not confirm Nicoll's observations that the straits-living diving petrel flies in a less sustained and less vigorous manner than the pelagic species of Tristan da Cunha.³ At the western end of Cockburn Channel, in the vicinity of Cape Horn, and off the east coast of Patagonia, Beck often saw *Pelecanoides magellani* flying straightaway for long distances—quite out of sight, in fact. He reports that when the birds flew low they sometimes struck the crests of choppy waves, being checked for a moment in their course and then recovering. His notes further state that this species does not feed in flocks like the whalebirds (*Pachyptila*) but, rather, individually or in very small, scattered groups. They appeared to feed particularly in "streaks" on the water caused doubtless by the effluvia of their prey. Beck occasionally saw single birds pop into flight from beneath the surface. The stomachs of some that he shot were distended with invertebrates.

¹1904, *Ibis*, p. 47.

²1909, 'Three Voyages of a Naturalist,' 2d Ed., p. 180.

³Cf. p. 542.

The following notes are extracted from Mr. Beck's journal.

Punta Arenas, July 8 and 9, 1914. Diving petrels scattering; about thirty collected in the strait north of the town.

Nov. 17. Coming by steamer from the Atlantic into the Strait of Magellan; a few diving petrels off Cape Virgenes. Within the strait they were much less common than they had been three months before.

London Island, at the western end of Beagle Channel, Nov. 30. Diving petrels came into the protected bay for shelter from a williwaw; several shot.

Caroline Island, Dec. 7-14. Two diving petrels collected.

Lort Bay, False Cape Horn (Hoste Island), Dec. 26. Out in boat for two hours, and shot twenty diving petrels, which were common. Many came into the bay from the northward to feed.

Between Hermite and Wollaston islands, Dec. 28. One diver seen.

London Island, Jan. 18, 1915. Rain and squalls all day, but diving petrels did not come into the bay as they usually do in such weather. Only one seen and collected.

Junction of Beagle Channel and Magellan Strait, western Tierra del Fuego, Jan. 21. A few diving petrels seen.

Twenty miles north of Punta Arenas, March 6. Fifteen or twenty shot.

Lort Bay, April 7, 8, and 9. Where dozens of diving petrels had been seen in December, only one was noted during these three April days.

Lort Bay, April 20. Two seen.

At sea, 80 miles east of San Sebastian Bay, Argentina (east coast of Tierra del Fuego). High southwest winds. Three diving petrels seen.

Off Rio Gallegos, Patagonia (60 miles north of the eastern entrance of the Strait of Magellan), May 11. Strong south wind. Diving petrels were common five to ten miles offshore in the heavy sea.

Between Rio Gallegos and Rio Santa Cruz, May 24. Many diving petrels among other fishing birds, 20 miles offshore.

Four miles off Cape Virgenes, May 26. Two diving petrels noted.

Strait of Magellan, east of Punta Arenas, June 11. A few diving petrels seen.

Ushuaia, Beagle Channel, July 15 (mid-winter). One or two seen.

False Cape Horn, July 25. Two seen.

Off the mouth of the Rio Gallegos, Argentina, Aug. 8. A strong offshore wind, and a swift tide, during the forenoon. Several diving petrels were noted, keeping within two or three miles of the land.

At sea, 50 miles northeast of Rio Gallegos, Sept. 10. Three or four diving petrels seen.

At sea, 40 miles east of Puerto Deseado, Sept. 13. Two seen.

At sea, lat. 48° 27' S., 65° 36' W., Sept. 15. Several diving petrels collected.

Punta Delgada, Strait of Magellan, Oct. 4. Many diving petrels flying within the Strait.

The Brewster-Sanford series of *Pelecanoides magellani* comprises specimens collected during the months of January, March, July, August, September, November, and December. Adults shot in November and December had enlarged gonads and bare brood-patches; a female taken at London Island on November 30 contained an "egg ready to lay within

two days." By March some of the young birds leave the nest. A female fledgling (Brewster-Sanford Coll., 2855) collected at Punta Arenas on March 6, 1915, shows the diagnostic characters of the species, i.e., the very black dorsal surface, pure white throat, falcate area behind the cheeks, and broad white edgings on the proximal wing feathers. It lacks, however, the beautiful white terminations of the dorsal body feathers, which markings are therefore proved to be indicative of maturity. The fledglings have, moreover, weak bills and small claws, such as are characteristic of juvenal *Tubinares* in general.

The annual molt of the Fuegian diving petrel occurs between the first of April and the end of June, for specimens taken in July are in very bright plumage, with new remiges and rectrices and with the delicate, white, lunulate, terminal markings distributed all over the interscapular region and upper rump. From July onward the abrasion of the plumage is so uniform that the authors find it easy to guess, with approximate correctness, the dates of capture of individual specimens merely by noting the condition of their plumage. March birds are relatively worn and dingy, and in nearly all instances the white edgings on the back have entirely disappeared. The progress of wear and fading throughout the year is illustrated by three typical examples in figure 2 of plate XXI.

The series of skins at our disposal presents considerable evidence that the young do not molt their contour feathers during the first season. December specimens of *Pelecanoides magellani*, for instance, are of two kinds, viz., birds with moderately worn plumage, which are evidently adults, and others, with feathers very much worn and frayed, which we believe to be the young of the preceding breeding season. Some of the latter specimens have particularly ragged quills, and they all lack the white interscapular markings. The plumage sequences of this species are therefore assumed to be virtually the same as those of *Oceanites oceanicus*, which have been worked out in some detail by Murphy.¹

Subgenus **PELAGODYPTES** Murphy and Harper

Pelecanoides georgicus Murphy and Harper

Plates XXII, Figures 1 and 2, XXIII, Figures 1 and 2.

Pelecanoides urinatrix variety *Berardi* VON DEN STEINEN, 1890, 'Die Deutschen Exp. und ihre Erg.', II, p. 240.

Pelecanoides urinatrix LÖNNBERG, 1906, Kungl. Sv. Vet. Akademiens Handlingar, XL, No. 5, p. 73. GODMAN, 1910, 'Monogr. Petrels,' p. 299 (part). MURPHY, 1914, Auk, XXXI, pp. 450, 456.

¹1918, Bull. Amer. Mus. Nat. Hist., XXXVIII, pp. 118-122.

Pelecanoides exsul LÖNNBERG, *op. cit.*, p. 74.

Pelecanoides georgica MURPHY AND HARPER, 1916, Bull. Amer. Mus. Nat. Hist., XXXV, p. 66.

TYPE SPECIMEN.—No. 132451, American Museum of Natural History; adult male; collected December 26, 1914, by Joseph G. Correia.

TYPE LOCALITY.—Cumberland Bay, South Georgia, latitude 54° 16' S., longitude 36° 26' W.

GEOGRAPHIC RANGE.—South Georgia, Macquarie Island, and waters adjacent to each.

GENERAL CHARACTERS.—Size small, approximating that of *P. urinatrix chathamensis*; bill proportionately wider at the base, and tapering more sharply, than in other Pelecanoididae; mottling of jugulum decidedly variable, becoming very pronounced in some specimens. Natal down gray.

ADULTS (SEXES ALIKE).—Upper parts glossy black; scapulars grayish white, with an obscure subterminal band of deep neutral gray, broader and slightly darker on outer web; the scapulars more or less overlaid and concealed by the dark inter-scapulars, but forming in many specimens a broad, conspicuous diagonal stripe; wings glossy black, more or less tinged with brownish, especially on primaries; secondaries generally edged narrowly with whitish, and primaries becoming pale on edge of inner web; under wing-coverts white, sometimes mottled with pale neutral gray, and the shafts sometimes dark terminally; rectrices blackish brown, with a slight gloss, paler on the under surface, and the worn lateral feathers sometimes showing whitish edges; anterior part of forehead and lores suffused with clove-brown; under parts white; cheeks and sides of neck deep neutral gray, the feathers narrowly tipped with white; this gray mottling varying much in intensity and distribution, and in some specimens extending completely across the jugulum; axillaries, sides, and flanks barred more or less strongly with neutral gray, the feathers tipped with white; feathers of tibia deep mouse-gray; down plumules and aftershafts over entire body varying from deep mouse-gray to dark mouse-gray, with lighter tips. Paraseptal processes situated at the longitudinal center of the septum. Bill black, rami of mandible slaty; iris seal-brown; tarsi and toes flax-flower blue; webs black.¹

Adult Male.—Length (skins), 193–218 (202.6); wing, 104–122 (112.7); tail, 34–42 (37.7); exposed culmen, 14–16 (14.9); width of bill, 8–10 (8.9); depth of bill, 5.5–6 (5.8); tarsus, 22–26* (24.4); middle toe and claw, 27–33 (30.1).²

Adult Female.—Length (skins), 181–215 (198.2); wing, 104–120 (113.8); tail, 34–43 (38.2); exposed culmen, 14–16 (14.7); width of bill, 8–9.5 (8.8); depth of bill, 5–6 (5.7); tarsus, 21–26 (24.2); middle toe and claw, 26–32 (29.9).³

NESTLING.—Protoptyle down light mouse-gray on the upper surface of the body, pallid mouse-gray beneath, where it is also much shorter than above; throat and sides of head nearly bare. Mesoptyle down drab-gray; longer, less dense, and of looser texture above than on the ventral surface. Contour feathers appearing first on the bare parts of head and throat, then on wings, tail, and back. Down lost progressively from head, wings, back, flanks, and breast, clinging longest on the belly, and fading decidedly with age (Fig. 4).

¹Colors of soft parts as noted in living specimen.

²One hundred specimens; only twenty, however, measured for total length and for depth of bill.

³Eighty-five specimens; only twenty, however, measured for total length and for depth of bill.

SPECIMENS EXAMINED.—Total number, 250, as follows:

South Georgia, 247^{1, 2, 3}; Macquarie Island, 2³; "Island south of New Zealand,"
1.³

NESTING SEASON.—November to March.

EGG.—Ovate, short ovate, or oval; pure white, lusterless; measurements of four specimens, 38.5×32, 39×30, 39×31, 41×32.3 (average, 39.4×31.3). A "runt" egg is subspherical and measures 24.5×22. Average volume of the four normal eggs, 16.2 cubic centimeters.

Observations on *Pelecanoides georgicus* were made by the senior writer in 1912–1913 during the South Georgia Expedition of the Brooklyn Museum and The American Museum of Natural History. A large series of beautifully prepared specimens of diving petrels was subsequently collected at South Georgia by Mr. Joseph G. Correia, of New Bedford, Mass. The following data on the life history of the species are taken chiefly from Mr. Murphy's notebook, but in part from information supplied by Mr. Correia.

Divers were first observed at sea in latitude 50° 12' S., longitude 34° 47' W., on November 20, 1912. This is about 280 miles north of South Georgia. None were noted again until February 24, 1913, when many were seen at dusk in the main channel of the Bay of Isles, South Georgia. On February 27 a breeding colony was discovered in a broad valley which runs eastward from the head of Possession Bay between two high, symmetrical mountain peaks. The floor of the valley is partly of broken stone, partly grassy, with some water-saturated moss and several glacier streams. *Pelecanoides* burrows were distributed from the shore of the bay to the higher slopes two miles inland, not only on banks and knolls, but also on the flat itself, wherever a little bed of clay and sand covered with vegetation was raised a foot or so above the general stony level. The excavations were hardly larger than field-mouse holes, at least at the entrance (7 cm. in diameter, according to von den Steinen); but some of them were as much as six feet in length. As a general rule, they led down steeply for a few inches and then ran horizontally but with sharp lateral turns. Some tunnels were doubled back almost on their own tracks, and often there was a diverticulum just outside of the nest chamber. Here and there a burrow ran beneath a roof of the tangled roots of a rosaceous herb (*Acæna adscendens*). It frequently happened that the course was changed by stones encountered during the digging, and that the nest chamber lay under a stone. The chambers were unlined except for a little down and an occasional bit of lichen, perhaps

¹Collection Brooklyn Mus., now in part distributed.

²Collection Amer. Mus. Nat. Hist.

³Collection Zool. Mus., Tring.

introduced by accident. Most of the nests contained well-grown young, a few of which had all but lost the down. Each of two nests dug open on March 3 held one adult bird, but neither egg nor young.

All the young divers found were exceedingly fat, except for one or two poor starvelings which were reduced to a condition of mere feathers and bones, and which had crawled to the mouths of their burrows in vain expectation of their parents, when no doubt the latter had been accounted for by some skua (*Catharacta*) days or perhaps weeks before. Other nests contained emaciated dead young, and told of the consummation of similar tragedies.

During a snowstorm on the evening of March 13, two diving petrels (Pl. XXIII), dazzled by a lantern, flew on board our vessel which lay at anchor in Possession Bay. The captain of a Norwegian "floating whaling-factory" informed us that when he had moored his steamer in Possession Bay one January night, the decks had suddenly swarmed with divers attracted by the lights.

On March 15, 1913, our vessel stood to sea from Possession Bay, when the senior writer fortunately had occasion to make a trip in a row-boat to a neighboring whaling station for the purpose of posting mail. Shortly after sunset we started on a ten-mile pull to the brig offshore, and as soon as we were well beyond the mouth of the bay our boat was continually in the midst of innumerable small Tubinares flocking over the calm dusky sea. *Oceanites*, *Fregetta grallaria*, *Petrella capensis*, and diving petrels made up the bulk of these birds, which fluttered all about us like bats. Diving petrels also covered the water in swimming flocks, and often took to flight at the approach of the boat, usually diving again within a short distance. In spite of the diminutive size of their wings, they seemed to fly at very high speed.

Divers were observed on the bays of South Georgia throughout the year by members of the German 'Transit of Venus' Expedition. Doubtless most of them spend the months of the southern winter on the neighboring or distant seas, returning to the breeding grounds in October. The excavation of their long burrows through hard, stony, often frozen soil is a tremendous task, accomplished entirely at night by the employment of both the bill and the strongly clawed feet. Before dawn the birds discontinue their labor and retreat to sea, so avoiding their ever-present enemy, the skua. That numbers of them are nevertheless captured is indicated by dismembered skeletons on the ground in the neighborhood of the colonies.

When the burrows have been completed, the mated pair can usually be found together, until the egg is laid, after which only one bird remains in the nest chamber at a time. After hatching, the young bird is invariably left quite alone between daybreak and dark. Not infrequently the diver colonies are temporarily obliterated by a heavy covering of snow.

The advent of man at South Georgia has brought a more insidious enemy of the divers than the skua, for in the subterranean runways of introduced rats have been found great quantities of cleanly picked *Pelecanoides* bones.

No food substances were found within the stomachs of South Georgian diving petrels, but only occasional pebbles. A stomach preserved in alcohol contains four fragments of clay-slate, the largest of which measures 10×6 mm.

All of the 247 specimens of South Georgian diving petrels examined by the writers (except possibly one, an undated specimen of von den Steinen's) were taken between the dates November 29 and March 13, or within the limits of the breeding season. The series, therefore, throws no light upon the molt, which, in this most austral species of the family, is doubtless postnuptial and very regular.

Growth and molt of the downy plumages of young birds are illustrated in figure 4. The smallest specimen (110 mm. in total length) is clothed with short, straight protoptyles, varying in color from pallid mouse-gray beneath to a slightly darker gray above. The dorsal down is much longer; the throat and the sides of the head are practically bare. The next specimen is evidently considerably older (185 mm. in length), and is clad in long, dense, rather curly mesoptyle down, drab-gray in color and of looser texture above than below. The contour plumage is appearing in the form of pin-feathers on the bare throat and cheeks, and the primaries have sprouted to a length approaching 30 mm., although the rectrices have scarcely punctured the skin. Fig. 4 sufficiently indicates the further progress of growth, but it is interesting to note that the last tufts of much bleached mesoptyles cling to the center of the belly, where they serve as a cushion or mattress until the nestling has attained practically its full development.

One of our fledglings, taken from the burrow, had lost the last trace of its down as early as March 15. The juvenal plumage is indistinguishable from that of breeding birds, except that no mottled areas on the jugulum are to be seen among our series of fledglings, and the brownish tinge on forehead and lores is usually fainter and less extensive than in

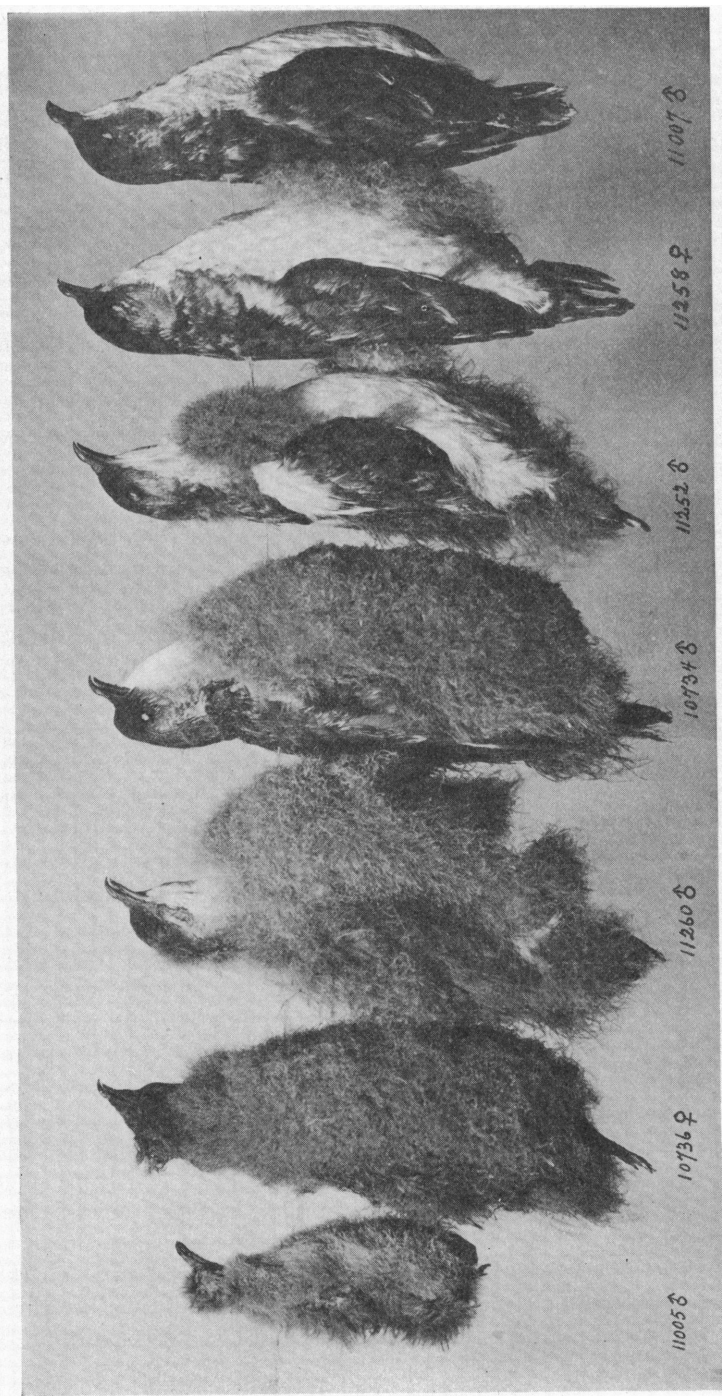


Fig. 4. Growth and molt of the neossoptyles in nestlings of *Pelecanoides georgicus*. The seven specimens, all in the collection of the Brooklyn Museum, were taken at various colonies in South Georgia between the dates February 8 and March 15.

adults. Young birds taken after they have left the nesting grounds are at once determinable, however, because of their weak and slender bills. A knowledge of this has enabled us to understand by analogy the status of immature diving petrels of other species collected at sea in the New Zealand region and elsewhere.

This species was considered by the writers to be confined entirely to South Georgia and vicinity, until the present paper was already in proof. It was then discovered that two specimens in the Tring Museum, collected at Macquarie Island, were almost, if not quite, identical with South Georgia specimens. In the shape of the bill and the nasal orifices, in the position of the paraseptal processes at approximately the longitudinal center of the septum, and in practically every detail of plumage, they exhibit such exceedingly close affinities with *P. georgicus* that we feel unable to separate them even subspecifically. The measurements of the two specimens, an adult male and female, collected in October 1899 and received from H. Travers, are, respectively, as follows: length (skins), 186, 182; wing, 107.5, 109.5; tail, 39, 35; exposed culmen, 14.5, 14.5; width of bill, 8, 8; depth of bill, 6, 6; tarsus, 22, 23; middle toe and claw, 27.5, 28. The same museum contains a third specimen, an adult male, which, according to the data on the label, was found in the London market in frozen condition on March 2, 1905, and came from an "Is. S. of New Zealand." This island, in all likelihood, was Macquarie, for the specimen agrees entirely with the two mentioned above and is quite unlike any others which we have examined from the whole New Zealand region. Its measurements are: length (skin), 176; wing, 110.5; tail, 36; exposed culmen, 14.5; width of bill, 7.5; depth of bill, 6; tarsus, 23.5; middle toe and claw, 28.5. Most of the measurements of these three specimens are slightly below the average, but above the minima, for the large series from South Georgia. The mottling at the sides of the neck does not extend across the jugulum in any of these three, as it does in some of the South Georgia specimens.

The discovery of these representatives of *P. georgicus* from Macquarie Island is of exceptional interest from several points of view. In the first place, South Georgia and Macquarie Island are situated on almost exactly opposite sides of the South Pole, and are over 8000 miles distant from each other across the South Atlantic and Indian oceans along the parallel of latitude. Though both are situated at the same latitude, South Georgia lies within and Macquarie Island without the extreme limit of pack-ice. Apparently, then, the exact limit of the pack-ice is not a significant factor in the distribution of the species. The

occurrence of *P. georgicus* at two such widely separated localities is perhaps somewhat comparable with the distribution of *Bulweria bulweri*, *Oceanodroma castro*, and *Oceanodroma leucorhoa*, although there is no continental barrier between the extremes of its range, as there is between the Atlantic and Pacific ranges of the other three species just mentioned. Indeed, we may now look with some confidence for the discovery of *P. georgicus*, or some closely allied representative of the subgenus *Pelagodiptes*, at other subantarctic islands lying between the 53d and 60th parallels of south latitude, such as the South Sandwich group, Lindsay (or Bouvet) Island, McDonald and Heard Islands, Emerald Island, and the islets of Nimrod and Dougherty (if they really exist).

Several diving petrels were observed by the 'Scotia' expedition in latitude 52° 31' S. to 51° S., longitude approximately 9° W. From climatic considerations it appears likely that these were *P. georgicus* rather than *P. u. dacunhæ*.

The peculiar value of our large series of South Georgian diving petrels, not only to this review but to a comprehension of the biology of Tubinares in general, lies in the fact that an intensive study of these specimens, which comprise birds of so many different ages and physiological conditions, may help in solving problems among other species represented only by fragmentary material. With this in mind, it will be of interest to consider the question of variation within so well-defined a species as this isolated, insular form.

Color

Dichromatism is a familiar phenomenon among Tubinares, but color variation in *Pelecanoides georgicus* seems to be confined wholly to the extent of gray mottling at the sides of the white throat, across the jugulum, and along the flanks. The extremes of variation among the specimens that we have examined are illustrated in figure 2 of plate XXIII. It was this difference that led Lönnberg to record his South Georgia specimens as representing both "*Pelecanoides urinatrix*" and "*Pelecanoides exsul*." As a matter of fact, the mottling of *georgicus* does not approach that of *P. exsul* in either distinctness or extent. It seems, however, to vary in approximately the same degree as within the subspecies *P. u. urinatrix*. On the other hand, the variation of mottling from individual to individual is of much wider amplitude than in *Pelecanoides garnoti*, in which species the faint, fuscous mottling is remarkably uniform; in *Pelecanoides magellani* there is never any trace whatsoever of a jugular collar. We can determine no correlation between the

color variation of *Pelecanoides georgicus* and sex, age, season of capture, or condition of plumage. As regards coloration and size, we can only say, with reserve, that more of the mottled birds are above the average in dimensions than below.

Form and Dimensions

There has been a tendency, beginning as far back as the date of Coues' monograph and recently emphasized by Loomis (*op. cit.*), to attribute an extraordinary amount of individual variation of structure and dimensions to tubinarine species. Since our large collection of adult, breeding specimens of *Pelecanoides georgicus*, numbering nearly two hundred skins, offers an exceptional opportunity for the investigation of individual variation as distinct from variation of other kinds, we have made detailed measurements of the entire series, and these are summarized in Tables II to IV.

Table II lists in chronological order the average measurements of groups of breeding petrels captured within their burrows during three months of the nesting season. The data for 100 males and 85 females are listed separately, the number of specimens included for each date being indicated in the third vertical column. The object in tabulating these figures was to determine whether there existed a sequence in size which might be correlated with age, that is, whether the younger birds (i.e., those with smaller proportions, especially of bill), breeding for the first time, showed a tendency to reproduce earlier or later in the breeding season than their elders. The senior writer has observed such seasonal differences, obviously associated with difference in age, in the large albatross; *Diomedea exulans*. But, as the table demonstrates, no such conclusion can be drawn in the case of *Pelecanoides georgicus*. The evidence for seasonal variability in size of breeding birds is entirely negative.

From tables III and IV it will be seen that the average measurements of 100 males and 85 females are so close as to be virtually the same, although most of the maximum dimensions occur among males and most of the minima among females. The amplitudes of variation for each dimension in the two sexes, as represented by percentages of the mean dimensions, for the most part agree substantially with the same data computed from 97 specimens of *Oceanites oceanicus* (Table V¹). Except in

¹Murphy, *op. cit.*, p. 127.

the case of the length of toe and claw, the noteworthy discrepancies are indeed accounted for by the fact that the *Oceanites* measurements are based upon both immature and adult specimens taken at many seasons of the year and over a wide area, whereas the *Pelecanoides* figures are derived from breeding adults in an approximately uniform state of plumage. The two tables are, in fact, comparable only when it is borne in mind that the *Pelecanoides* percentages represent true individual variation, while the *Oceanites* percentages represent individual plus age, seasonal or physiological, and possibly geographic, variation. Age and the relation of a bird's plumage at any one time to its plumage after the season of periodical renewal have an important bearing, which is too often overlooked, upon measurements that may be used as the basis of taxonomic characterization.

TABLE II

SEX	DATE	NUMBER OF SPECIMENS	WING	TAIL	EXPOSED CULMEN	WIDTH OF BILL AT BASE	TARSUS	MIDDLE TOE AND CLAW
			<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Males	Nov. 29	3	115.7	40.0	14.8	9.0	24.0	29.3
	Dec. 6	9	112.9	38.2	15.1	8.8	24.7	30.1
	Dec. 13	16	112.2	38.4	14.9	8.9	24.5	30.1
	Dec. 20	20	112.8	37.8	14.9	8.9	24.4	29.8
	Dec. 26	17	112.0	36.9	14.8	8.8	24.4	30.4
	Jan. 1	7	114.3	38.1	15.0	9.0	24.4	30.1
	Jan. 10 and 11	12	113.2	37.3	14.8	8.9	24.3	29.8
	Jan. 17	11	112.2	37.3	15.2	9.0	24.3	30.6
	Jan. 31	2	114.0	37.5	16.0	8.8	24.0	29.0
	Feb. 8, 22, and 28	3	108.7	35.3	15.2	8.8	23.3	30.3
	Total	100						
Females	Nov. 29	5	112.6	38.8	14.6	9.0	24.6	30.6
	Dec. 6	12	113.4	38.8	14.8	8.8	24.0	29.7
	Dec. 13	6	112.7	38.7	14.8	8.9	24.6	30.6
	Dec. 20	8	114.3	38.4	15.0	8.5	24.0	29.5
	Dec. 26 and 30	18	114.2	37.9	14.7	8.6	24.1	29.9
	Jan. 1	13	114.5	38.9	14.7	9.0	24.0	29.3
	Jan. 10	10	114.0	37.1	15.0	8.9	24.5	30.1
	Jan. 17	8	114.5	38.4	14.7	8.9	24.6	30.0
	Jan. 31	2	110.5	35.0	15.0	8.8	23.8	30.0
	Feb. 2 and 8	3	111.7	36.0	14.5	8.0	23.7	30.3
	Total	85						

TABLE III

	WING	TAIL	EXPOSED CULMEN	WIDTH OF BILL AT BASE	TARSUS	MIDDLE TOE AND CLAW
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Average Measurements of 100 Breeding Males	112.7	37.7	14.9	8.9	24.4	30.1
Minimum Measurement for Each Dimension	104.0	34.0	14.0	8.0	22.0	27.0
Maximum Measurement for Each Dimension	122.0	42.0	16.0	10.0	26.0	33.0
Mid-point of Amplitude of Variation	113.0	38.0	15.0	9.0	24.0	30.0
Variation on Either Side of Mid-point	9.0	4.0	1.0	1.0	2.0	3.0
Percentage of the Average to Which the Amplitude of Variation Amounts	16.0	21.0	13.4	22.5	16.4	20.0
Percentage of Specimens Attaining the Minimum for Each Dimension	1.0	4.0	17.0	4.0	1.0	1.0
Percentage of Specimens Attaining the Maximum for Each Dimension	1.0	1.0	16.0	1.0	5.0	1.0
Percentage of Specimens Varying Below the Average	42.0	43.0	34.0	28.0	55.0	68.0
Percentage of Specimens Varying Above the Average	58.0	57.0	66.0	72.0	43.0	32.0

TABLE IV

	WING	TAIL	EXPOSED CULMEN	WIDTH OF BILL AT BASE	TARSUS	MIDDLE TOE AND CLAW
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Average Measurements of 85 Breeding Females	113.8	38.2	14.7	8.8	24.2	29.9
Minimum Measurement for Each Dimension	104.0	34.0	14.0	8.0	21.0	26.0
Maximum Measurement for Each Dimension	120.0	43.0	16.0	9.5	26.0	32.0
Mid-point of Amplitude of Variation	112.0	38.5	15.0	8.8	23.5	29.0
Variation on Either Side of Mid-point	8.0	4.5	1.0	.75	2.5	3.0
Percentage of the Average to Which the Amplitude of Variation Amounts	14.0	23.6	13.6	17.0	20.7	20.0

TABLE V.—DATA FOR *Oceanites oceanicus*

	WING	TAIL	EXPOSED CULMEN	WIDTH OF BILL AT BASE	TARSUS	MIDDLE TOE AND CLAW
Percentage of the Average to Which the Amplitude of Variation Amounts in 97 Specimens from the Atlantic Ocean, Including Juvenal Birds and Molting Adults	14.0	26.0	17.0	32.0	16.0	10.0

A comparison of single full-grown skeletons of *Pelecanoides georgicus* and *Pelecanoides urinatrix urinatrix* shows more clearly than the skins that the New Zealand form is the larger, stouter bird, the differences of size being especially perceptible in the sacrum and sternum. *Pelecanoides georgicus* has broader palatines than the Old World representative, but all other elements of the skull are larger in the latter species. The maxillary and mandibular bones reveal the diagnostic differences in the formation of the bill. The number of vertebræ is the same in the two species, viz., presacral, 21; sacral, 12; coccygeal, 9. It is of much interest that *Alle alle* has also the same number and arrangement of vertebræ.

The following table records comparative measurements in millimeters of the skeletons of two adult diving petrels (*Pelecanoides*

TABLE VI

	<i>Pelecanoides georgicus</i>	<i>Pelecanoides u. urinatrix</i>	<i>Alle alle</i>
Extreme Length of Skull	48.2	51.0	51.0
Greatest Breadth of Brain-case	18.0	19.0	20.0
Length of Spinal Column	120.0	138.0	146.0
Axial Length of Sacrum	24.0	27.0	31.0
Sternum, Manubrium to Posterior End of Keel	36.0	39.6	55.5
Length of Coracoid	22.0	24.0	21.2
Wing	119.7	127.2	124.0
Proximal Element (humerus)	42.0	44.0	42.0
Mesial Element	34.5	35.0	38.0
Distal Element (manus)	43.2	48.2	44.0
Hind Limb	113.6	120.1	120.0
Proximal Element (femur)	22.6	23.8	28.0
Mesial Element (tibia, excluding cnemial crest)	40.0	41.7	44.0
Distal Element (tarsometatarsus and middle toe)	51.0	54.6	48.0

georgicus, Brooklyn Mus., 11274, South Georgia, and *Pelecanoides urinatrix urinatrix*, U. S. Nat. Mus., 18771, New Zealand), and an adult dovekie (*Alle alle*, Brooklyn Mus., 11273, Long Island, N. Y.).

The length of the distal segment of the wing inclusive of the flight feathers, i.e., the ordinary "wing" measurement of descriptive ornithology, averages 113 mm. in 185 adult specimens of *Pelecanoides georgicus*. The same dimension in *Alle alle* may be reckoned at 118 mm., a figure derived by taking the approximate mid-point between the extreme measurements (114–121.5 mm.) given for the wing of this species in Ridgway's 'Manual of North American Birds' (1900). Notwithstanding the considerably longer, stouter ribs of *Alle*, which together with the indicated greater length of its vertebral column and sternum, give it a torso a third larger and doubtless more than a third heavier than that of *Pelecanoides georgicus*, the latter would seem, so far as can be judged from the tabulated figures, to have relatively the more efficient organ of flight. We lack, however, the data to determine to what extent the comparatively shorter wing of *Alle* may be compensated for by a power unit of larger muscles and a greater expenditure of energy. Unfortunately, we have no records of the weights of these two species in the flesh. The area of the expanded wing of a single adult specimen of *Pelecanoides georgicus*, computed by means of a planimeter, is 69.7 square centimeters. That of *Alle alle*, likewise based upon one specimen, is 64 square centimeters.

The "whirr-flight" of diving petrel and dovekie rather resembles that of short-winged gallinaceous birds, such as *Colinus*. It will be of interest, therefore, to compare certain mechanical features of the wing which are shared to some extent by these three widely separated genera, and to contrast the ratios of the proximal and distal alar elements with ratios of the same sort worked out for other birds of not too dissimilar size but exemplifying distinctly different types of flight. A tern and representatives of two long-winged subfamilies of the Tubinares may serve for the latter group. In the following table the length of "manus"

TABLE VII.—LENGTH OF WING ELEMENTS IN MILLIMETERS

	HUMERUS	MANUS	"WING"
<i>Pelecanoides georgicus</i>	42	43	113
<i>Alle alle</i>	42	44	117
<i>Colinus virginianus</i>	36	34	114
<i>Gygis crawfordi</i>	51	68	240
<i>Oceanodroma leucorhoa</i>	37	43	154
<i>Oceanites oceanicus</i>	23	37	145

refers to the distal skeletal unit of the wing, from carpus to the tip of the longest phalanx; "wing," on the other hand, means the distal unit inclusive of the primary quills, as described above.

These data may be reduced to easily comprehensible ratios by dividing the lengths of "wing" and manus, respectively, by the length of the humerus. Then,

$$\text{Alar-humeral ratio} = \frac{\text{"wing"}}{\text{humerus}}$$

$$\text{Mano-humeral ratio} = \frac{\text{bony manus}}{\text{humerus}}$$

TABLE VIII

	ALAR-HUMERAL RATIO	MANO-HUMERAL RATIO
<i>Pelecanoides georgicus</i>	2.69	1.02
<i>Alle alle</i>	2.79	1.05
<i>Colinus virginianus</i>	3.17	.94
<i>Gygis crawfordi</i>	4.71	1.33
<i>Oceanodroma leucorhoa</i>	4.16	1.16
<i>Oceanites oceanicus</i>	6.30	1.61

It is interesting to note that in these six rather diverse species the ratios between distal and proximal elements of the wing, when the flight feathers are involved, vary vastly more than the ratios between skeletal elements alone. Phylogenetic and mechanical differences in the mechanism of the wings lie therefore mainly in epidermal modifications. The range of the mano-humeral ratios in the two groups, while noticeable, and doubtless not without important relations to the expenditure of energy during flight, is far less striking than that of the alar-humeral ratios. We have not tabulated the relative lengths of the mesial or ulnar element because its significance in the case of the six species under consideration appears to be of lesser importance. Among large Tubinares, such as the albatrosses, however, the marked lengthening of the mid-wing doubtless has a profound effect upon flight.

Aside from the proportions of the wings, the chief structural adaptations of *Pelecanoides georgicus* and *P. urinatrix* to their auklet-like mode of life are to be seen in the caudad extension of the primitive tubinarine sternum and rib-basket. The lower segments of the ribs are extraordinarily lengthened, meeting the superior segments at an acute angle,

as in *Alle*. The pectoral arch has been strengthened through the interlocking of the lower end of the furculum with the anterior tip of the crista sterni. In our single skeleton of *Pelecanoides georgicus*, the furculum is slightly asymmetrical and the right clavicle appears to have sustained an injury during development. The skeleton of *Alle alle*, with its elongate sternum, to which is appended an ossified ensiform membrane for the further support of the viscera, its shorter, heavier coracoids, more compact sacrum, and the almost complete "ribbing-in" of the entire thoraco-abdominal cavity, represents, in so far as the axial architecture of the bird is concerned, a higher, structurally superior adaptation to resisting the forceful impact and pressure of water during plunges from flight and subsurface progression, habits of life which it shares with *Pelecanoides*.

Subgenus **PELECANOIDES** Lacépède

***Pelecanoides urinatrix urinatrix* Gmelin**

Diving Petrel, FORSTER, 1777, 'Voy.,' I, p. 189.

Puffinuria urinatrix GOULD, 1844, 'Birds Australia,' VII, Pl. LX.

Pelecanoides urinatrix COUES, 1866, Proc. Acad. Nat. Sci. Philadelphia, XVIII, p. 190. BULLER, 1873, 'Birds New Zealand,' p. 313; 1888, 'Birds New Zealand,' II, p. 207; 1905, 'Suppl. Birds New Zealand,' I, p. 126. HUTTON, 1874, Ibis, p. 41. RAMSAY, 1888, 'List Australian Birds,' p. 24. SALVIN, 1896, 'Cat. Birds Brit. Mus.,' XXV, p. 437. GODMAN, 1910, 'Monogr. Petrels,' p. 299 (part). LITTLER, 1910, 'Handbook Birds Tasmania,' p. 184 (part). LUCAS AND LE SOUËF, 1911, 'Birds Australia,' p. 64. NORTH, 1914, 'Nests and Eggs. Birds Australia and Tasmania,' IV, p. 376.

Pelecanoides berardi BULLER, 1888, 'Birds New Zealand,' II, p. 208 (part).

Haladroma urinatrix SANDAGER, 1889, Trans. New Zealand Inst., XXII, p. 289.

GOULD, 1865, 'Handbook Birds Australia,' II, p. 483.

Pelecanoides exsul BULLER, 1905, 'Suppl. Birds New Zealand,' I, p. 127 (part).

Pelecanoides urinatrix urinatrix MATHEWS, 1912, 'Birds Australia,' II, p. 234 (part).

MATHEWS AND IREDALE, 1913, Ibis, p. 237.

Pelecanoides urinatrix belcheri MATHEWS, 1912, Austral Avian Record, I, p. 84; 1913, 'List Birds Australia,' p. 41.

TYPE SPECIMEN.—Not known, but figured in black and white by Forster.

TYPE LOCALITY.—Queen Charlotte Sound, at northern end of South Island, New Zealand.

GEOGRAPHIC RANGE.—New Zealand (North Island, South Island, Stewart Island), southeastern Australia (New South Wales, Victoria, South Australia), Tasmania, and adjacent seas.

GENERAL CHARACTERS.—Differs from any of the preceding species in striking characters listed under the description of the subgenus. Size approximately that of *Pelecanoides magellani*. Natal down gray.

ADULTS (SEXES ALIKE).—Upper parts glossy black; scapulars deep neutral gray, with a whitish terminal bar; wings glossy black, more or less tinged with

brownish, especially on primaries; inner webs of primaries clove-brown, lighter on under surface; secondaries sometimes narrowly tipped with whitish; under wing-coverts whitish, more or less washed with light mouse-gray, the shafts dark; rectrices glossy black, fading to blackish brown, paler on the under surface; anterior part of forehead and lores suffused with clove-brown; under parts white; feathers of auricular and malar regions, and sides of neck and breast, deep neutral gray, for the most part narrowly tipped with white, giving a somewhat barred appearance; jugulum obscurely mottled with neutral gray, which sometimes forms an indistinct collar; axillaries dark mouse-gray, tipped with whitish; sides and flanks washed with deep neutral gray, the feathers tipped with whitish; feathers of tibia dark mouse-gray; down plumules and aftershafts over entire body deep mouse-gray. Paraseptal processes situated posterior to the longitudinal center of the septum and not prominently developed. "Irides and bill black; legs and feet cobalt, tinged with green, the webs bluish white" (Buller).

Adult Male.—Length (skins), 182–208 (196.6); wing, 116–133 (122.6); tail, 34.5–41 (38); exposed culmen, 15.5–16.5 (16.2); width of bill, 7.5–8.5 (8.1); depth of bill, 6.5–7 (6.8); tarsus, 25–28 (26.1); middle toe and claw, 29–35 (31.9).¹

Adult Female.—Length (skins), 189–212 (198); wing, 112–123 (116.8); tail, 35–38 (36.5); exposed culmen, 16–17 (16.4); width of bill, 8–8.5 (8.1); depth of bill, 6–7.5 (6.7); tarsus, 24–28 (25.3); middle toe and claw, 29.5–33 (31.3).²

NESTLING.—"Covered with sooty-gray down; head and neck nearly bare; black feathers first appear on the wings" (Buller).

SPECIMENS EXAMINED.—Total number, 25, as follows:

New Zealand: Hauraki Gulf, 2³; Karewa Island, 1⁴; Stephens Island, 3⁵; Otago, 1⁶; near Dunedin, 1⁷; Invercargill, 1⁸; Foveaux Straits, 1⁷; Stewart Island, 3³, 8; no specific locality, 5. 3¹, 8

Tasmania, 4.³

Locality unknown, 3. 3¹, 9

NESTING SEASON.—June, July, August (Bass Strait, Buller, *loc. cit.*, p. 208); August (White Rock, east coast of Tasmania, North, *loc. cit.*, p. 376); October, November, December (islands of Bass Strait, and those off northwestern and southern Tasmania, North, *loc. cit.*, p. 376); July, August (Mokohinou Islands, N. Z., Sandager, *loc. cit.*, p. 389).

■ EGG.—"The eggs vary in shape from oval to rounded oval; others are nearly a true ellipse in form, and some are somewhat abruptly pointed at one end, the shell being close-grained, dull and lustreless. When newly laid they are pure white, but some become more or less stained and soiled, and are of a dirty leaden-hue as they approach the time of hatching" (North). Average specimens from the islands in Bass Strait measure, 37.6×31.2, 40.6×30.5, 38.9×30.5, 42.4×33, 43.9×33, 43.2×32.5, 46.5×33.5¹⁰ (average, 41.9×32). Lucas and Le Souëf give the measure-

¹Seven specimens, from New Zealand.

²Five specimens, from New Zealand.

³Collection Zool. Mus., Tring.

⁴Collection Pub. Mus., Milwaukee.

⁵Collection Carnegie Mus.

⁶Collection Calif. Acad. Sci.

⁷Collection U. S. Nat. Mus.

⁸Collection Brit. Mus.

⁹Collection Boston Soc. Nat. Hist.

¹⁰Measurements originally given in inches and hundredths; here converted into millimeters.

ments 41×31 . New Zealand eggs measure 38.1×30.5^1 (Portland Island, Buller), and 38.1×31.7^1 (Mokohinou Islands, Sandager).

The diving petrels of Australia and Tasmania have been separated by Mathews under the name of *Pelecanoides urinatrix belcheri*, the supposed subspecific characters being diagnosed as follows: "Differs from *P. u. urinatrix* in being smaller, and in having the under surface of the wings whiter and the grey of the breast not joined in a band. The nostrils are also larger."² Our examination of the type and three other specimens in the Mathews collection (all of which are labeled "Tasmania") has failed to reveal any essential character that can not be practically matched in New Zealand specimens. The average measurements of the four specimens are: length (skins), 198.5; wing, 120.7; tail, 40.2; exposed culmen, 16.5; width of bill, 7.9; depth of bill, 6.1; tarsus, 25.9; middle toe and claw, 31.5.

Buller reports that this diving petrel is "very common in the seas surrounding New Zealand, consorting in flocks, and living on medusæ and other marine productions. It is especially abundant at all seasons in the Gulf of Hauraki." He goes on to say that its flight is rather labored, consisting of a rapid fluttering movement along the surface of the water, but Hutton (*loc. cit.*, p. 41) states that this description is quite incorrect, and that the "bird flies very fairly."

Buller's account continues as follows:

They swim in the sea with the head much uplifted, and are very active on the water.

Some years ago, during a severe gale, many hundreds of them were cast ashore in the Bay of Plenty, and it was observed that a number of them were afflicted with a large flat tick measuring .25 of an inch across the body and legs.

The stomach of one I opened contained black comminuted matter and one or two small seeds, apparently of some kind of seaweed. I observed that the skin of this bird was very tough and thick, the roots of the feathers appearing underneath as in the Penguins and some other birds.

The young birds are so fat that it may truly be said of them that a wick inserted through the body of a dead one will burn as steadily as if in a lamp!

Mr. Burton found this Petrel breeding on Stephens' Island, in Cook's Strait. It also breeds on Karewa Island (off Tauranga), on the small islets of the Great Barrier, and on the "Hen and Chickens."

Sandager, writing of the species at the Mokohinou Islands, contributes the following information.

Breeds on three of the smaller, comparatively low, islands, where it forms its burrow in the peat-like substance, consisting of light soil and decayed *Mesembryanthemum*, with which they are covered. Burrowing commences in April. In July

¹Measurements originally in inches and hundredths; here converted into millimeters.

²1912, Austral Avian Record, I, p. 84.

a nest, consisting of dry flax, sticks, and grass, is formed at the end of the burrow, and a few of the earlier birds begin to lay during the last half of the month, but most of the laying takes place during August. The birds, previous to laying, are rarely found in the burrows during the day, all the work of burrowing, etc., being carried on at night. One egg only is laid in each nest.

Gould's account of this petrel is as follows:

I observed that this curious little bird was very abundant in Storm Bay, and off many parts of the coast of Van Diemen's Land. . . . It possesses none of those great powers of flight common to the rest of the family [i.e., order], but has this loss amply compensated for by its powers of diving, which are so great that it is even said to fly under water. It thus gives chase to shrimps and other small crustaceans, fry of fish, etc., upon which it feeds; and in turn finds a destroying enemy in the Barracoota, a ravenous fish so called by the colonists, and which is very common in the seas off the southern parts of Australia. Its flight is a curious fluttering motion, performed so close to the surface that it rarely rises high enough to top the waves, but upon being met by them makes progress by a direct course through instead of over them.

Littler reports that it breeds on one of the islands of the Kent group, in Bass Strait.

Buller quotes Mr. A. J. Campbell, who writes:

On some isolated islets in Bass's Strait, Diving-Petrels are numerous. They generally remain in the vicinity of these rocks, but at times disappear for two or three months. During June and July the birds come ashore to scrape out or prepare their nest-burrows. The laying-season occurs about the end of July, and continues for about a fortnight. Each female bird deposits one egg only in a burrow, which is from 6 to 8 inches deep, under ground or under a ledge of rock.

The information quoted below is from North's exhaustive work on the nests and eggs of Australian and Tasmanian birds.

The single egg of this species is deposited at the enlarged end of a burrow in the earth, or sandy soil, from one to two feet in length; sometimes these burrows are branched, and in them have been frequently found pairs of birds. Diving Petrels were found breeding on North-east Island . . . in Bass Strait, during November, 1890, . . . the burrows at that time containing mostly young birds nearly fledged.

October, November and December are the usual breeding months on the islands of Bass Strait, and those off the North-western coast of Tasmania and Southern Tasmania. That this Petrel may breed a second time, or possibly another colony of birds may have a different breeding time, is proved by Mr. Oldham finding it laying in August, 1907, on the White Rock,¹ on the eastern coast of Tasmania.

From the foregoing accounts it appears that this diving petrel, like *P. garnoti*, has a decidedly prolonged or variable nesting season. It is perhaps significant, in this connection, that these two forms have warmer habitats than any of the other diving petrels whose nesting seasons are definitely known. It is natural that the reproductive season of the forms inhabiting the colder regions should be more definitely limited to the months of the subantarctic summer.

¹A fresh egg was collected at this place on August 22, 1907.

***Pelecanoides urinatrix chathamensis* Murphy and Harper**

Haladroma urinatrix GOULD, 1865, 'Handbook Birds Australia,' II, p. 483 (part).

Pelecanoides berardi BULLER, 1888, 'Birds New Zealand,' II, p. 208 (part). FORBES, 1893, Ibis, p. 542.

?*Pelecanoides* species CHILTON, 1909, 'Subantarctic Islands New Zealand,' II, p. 566.

Pelecanoides urinatrix FORBES, 1893, Ibis, p. 541. BULLER, 1905, 'Supplement Birds New Zealand,' I, p. 126 (part). GODMAN, 1910, 'Monogr. Petrels,' p. 299 (part).

Pelecanoides exsul GODMAN, 1910, 'Monogr. Petrels,' p. 304 (part).

Pelecanoides urinatrix urinatrix MATHEWS, 1912, 'Birds Australia,' II, p. 234, (description and plate).

Pelecanoides urinatrix chathamensis MURPHY AND HARPER, 1916, Bull. Amer. Mus. Nat. Hist., XXXV, p. 65.

TYPE SPECIMEN.—No. 151112, U. S. National Museum; adult male; collected in February 1893; received from S. Dannefaerd.

TYPE LOCALITY.—Chatham Islands.

GEOGRAPHIC RANGE.—Chatham Islands, Snares Island, Auckland Islands, and adjacent waters; probably also Bounty and Antipodes Islands.

SUBSPECIFIC CHARACTERS.—Similar to *Pelecanoides urinatrix urinatrix*, but averaging smaller in practically all dimensions, particularly bill and wing.

Adult Male.—Length (skins), 182–196 (186.8); wing, 110–114 (112.4); tail, 34–39 (36.5); exposed culmen, 14–16 (15.2); width of bill, 7–8 (7.4); depth of bill, 5–6.5 (6); tarsus, 24–26 (24.9); middle toe and claw, 29.5–33 (31).¹

Adult Female.—Length (skins), 175–187 (179.3); wing, 109.5–116.5 (113); tail, 34.5–40 (37.8); exposed culmen, 14.5–15.5 (15.2); width of bill, 7–7.5 (7.3); depth of bill, 6; tarsus, 24; middle toe and claw, 29–30 (29.7).²

NESTLING.—Mesotyle down mouse-gray on upper surface of the body, light mouse-gray beneath.

SPECIMENS EXAMINED.—Total number, 21, as follows:

Chatham Islands, 17.^{3, 4, 5, 6}

Snares Island, 2.⁷

Auckland Islands, 2.^{6, 7}

NESTING SEASON.—"I have obtained information on good authority of eggs being collected after August 15th which contained embryos, and fresh eggs again in October" (Seymour, cf. Buller, *loc. cit.*, p. 208).

EGG.—"The eggs vary in form from oval to nearly round and are more or less pointed at one end; ground-color white. Dimensions: 35.6×29.2, 35.6×27.9, 38.1×27.9, 34.3×27.9, 35.6×29.2, 33×27.9, 38.1×28.2, 36.8×29.2, 33×27.9"⁸ (Forbes, *loc. cit.*, p. 541); average, 35.6×28.4.

At the time the writers described this subspecies, the small amount of material available showed a decided difference in dimensions between Chatham Island birds and New Zealand birds. While this difference is

¹Six specimens: four from Chatham Islands, one from Snares Island, and one from Auckland Islands.

²Three specimens, from Chatham Islands.

³Collection Zool. Mus., Tring.

⁴Collection Acad. Nat. Sci. Phila.

⁵Collection U. S. Nat. Mus.

⁶Collection Carnegie Mus.

⁷Collection Brit. Mus.

⁸Measurements converted from inches and hundredths into millimeters.

less striking in the much larger series of specimens that have since been examined, it still appears sufficient, in the case of practically all specimens with authentic data, to separate *chathamensis*. It is noteworthy in this connection that a large proportion of the indigenous birds of the Chatham Islands, which lie about 500 miles east of New Zealand, have been found to be distinct from their counterparts of the latter insular "mainland."

The diver from Snares Island and the smaller of the two forms found at the Auckland Islands also seem referable to *chathamensis*. The smaller size of *chathamensis*, as compared with *urinatrix*, is apparently correlated with the lower mean annual temperature of the islands it inhabits and with their greater proximity to the limit of floating icebergs. This form may also be expected on Bounty and Antipodes Islands, where climatic conditions are probably intermediate between those at the Chatham Islands and at the Auckland Islands.

The occurrence of more than one form at a single locality, such as the Auckland Islands, is very exceptional in this family. The distinctness of Auckland Islands specimens of *P. u. chathamensis* and *P. exsul* may be judged, in part, from the following average dimensions of two specimens of the former and three specimens of the latter, the measurements of *chathamensis* being given first: length (skins), 184.5, 208.3; wing, 110.5, 119.8; tail, 37.5, 38.5; exposed culmen, 13.7, 16; width of bill, 7.2, 8.7; depth of bill, 6.2, 6.5; tarsus, 24.7, 26.2; middle toe and claw, 29, 33.5. The specimens of *exsul* are further distinguished by bill characters and by the much heavier and more uniform mottling of the jugulum.

The Chatham Island diving petrel may be the form which Gould (1844, 'Birds Australia') saw at sea "about 20 degrees to the eastward of New Zealand, taking mollusks from the surface of the ocean."

Waite, in Chilton's 'Subantarctic Islands of New Zealand,' writes as follows of birds seen near one of the islands.

. . . we found the water to be dotted with little diving-petrels. . . . By repeatedly diving and swimming under water these little birds failed to increase their distance from the boat, and they took to wing. In rising from the water they used their legs with a paddling action, flew a short distance with a seemingly labored or erratic flight, and then dropped on to the water at a supposedly safe distance.

***Pelecanoides urinatrix berard* (Quoy and Gaimard)**

Plates XXII, Figure 2, XXIV, Figure 2

Procellaria berard QUOY AND GAIMARD, 1824, 'Voy. Uranie, Zool.,' p. 135, Pl. xxxvii.

Pelecanoides berardi ABBOTT, 1861, *Ibis*, p. 164.

Pelecanoides garnoti OATES, 1901, 'Cat. Birds' Eggs Brit. Mus.,' I, p. 161² (part).

Pelecanoides urinatrix GODMAN, 1910, 'Monogr. Petrels,' p. 299 (part).

P[elecanoides] urinatrix berard MATHEWS, 1912, 'Birds Australia,' II, p. 238.

TYPE SPECIMEN.—Not known, but figured by Quoy and Gaimard.

TYPE LOCALITY.—At sea, near the Falkland Islands.

GEOGRAPHIC RANGE.—Falkland Islands north to the coast of the Province of Buenos Aires, Argentina.

SUBSPECIFIC CHARACTERS.—Size approximating that of *P. u. urinatrix*, but generally with smaller bill, longer tail, and longer middle toe and claw. The mottling across the jugulum is more pronounced than in *P. u. urinatrix*, less pronounced than in *P. u. dacunhae*, and not so dense and extensive as in *P. exsul*.

Iris brown, bill black, feet blue with blackish webs (R. H. Beck, label).

Adult Male.—Length (skins), 195–227 (208.2); wing, 117.5–125.5 (121.1); tail, 39.5–46 (42.7); exposed culmen, 15–16 (15.5); width of bill, 7–8 (7.4); depth of bill, 6–6.5 (6.2); tarsus, 24.5–27 (25.7); middle toe and claw, 32–36.5 (33.4).¹

Adult Female.—Length (skins), 198–201 (199.3); wing, 117–123 (120.5); tail, 40–44 (41.5); exposed culmen, 15.5–16 (15.7); width of bill, 7.5–8 (7.7); depth of bill, 6; tarsus, 25–25.5 (25.2); middle toe and claw, 32–33 (32.5).²

NESTLING.—Not seen.

SPECIMENS EXAMINED.—Total number, 12, as follows:

Falkland Islands: Kidney Island, 5³ 4; Cuchon Island, 1³; no specific locality, 5.⁴

Argentina: offshore, between San Mathia and Necochea, 1.⁵

NESTING SEASON.—Sitting on egg in November (R. H. Beck, label).

EGG.—Two collected at Kidney Island, in November 1915, are respectively rounded ovate, or almost subspherical, and elliptical ovate; white, lusterless; measurements, 35.2×31, 38.8×29.5 (average, 37×30.3). Average volume of the two, 16.7 cubic centimeters.

Under the name *P. garnoti*, Oates (*loc. cit.*, p. 161) records two eggs from the Falkland Islands and one from Kerguelen. The dimensions for the three are 39.4×30.9, 39.4×31.75, and 40.9×33, but unfortunately the author does not designate the Falkland specimens.

It was only after the writers had long been familiar with large series of specimens of *P. garnoti*, *P. magellani*, and *P. georgicus*, representing, respectively, the subgenera *Puffinuria*, *Porthmornis*, and *Pelagodyptes*, that they eventually had access to a few specimens from the Falkland Islands and from the coast of Chile at about latitude 50° S. It was then a matter of no small surprise to ascertain that the birds from these localities represented two forms of the *P. urinatrix* group (*P. u. berard* and *P. u. coppingeri*), subgenerically distinct from all their nearest neighbors. Thus all four subgenera of *Pelecanoididae* are found in the Western Hemisphere, whereas only two subgenera, represented by three species, are known from the Old World.

¹Four specimens.

²Three specimens.

³Brewster-Sanford Collection.

⁴Collection Brit. Mus.

⁵Collection Amer. Mus. Nat. Hist.

The description of *Procellaria berard* by Quoy and Gaimard, and all subsequent published references to the Falkland Islands diver, are too incidental to be of any assistance in assigning the form to its proper place within the family. Mathews undoubtedly realized its true position, but presented no evidence in support of his conclusion. Even after Mr. Chubb had kindly supplied us with detailed measurements of six Falkland



Fig. 5. Egg of *Pelecanoides urinatrix berard*, photographed *in situ* by R. H. Beck, after the opening of a burrow at Kidney Island, Falklands, November 6, 1915.

specimens in the British Museum, we were still at a loss as to the affinities of the bird; but the problem was solved, practically at a glance, when Mr. Beck sent five beautifully prepared specimens from the field.

Mr. Beck saw one diving petrel, presumably *Pelecanoides urinatrix berard*, about seventy-five miles due south of the Falkland Islands on one of the latter days of September 1915. On November 6, of that year, he visited Cuchon Island, East Falkland, and found the first burrow, which contained a male diving petrel sitting upon a heavily incubated egg. On the same date he also landed at Kidney Island, which is but four miles from Cuchon, and found a second burrow in a patch of tussock grass (*Poa flabellata*) not far from the water. By digging and pulling out

the manure-like humus around the nest, he managed to obtain a photograph of the sitting bird. The entrance to the nest was under a slab of rock, but the tunnel twisted about for three feet and ended in an enlarged chamber which was lined with a few dry blades of tussock grass. On November 18 he captured three more diving petrels in their nests on Kidney Island. He discovered, moreover, that abandoned *Pelecanoides* burrows are used as nesting sites by the small, dendrocolaptid "tussock-bird" (*Cinclodes*).

On December 16, at Sea Lion Island, Mr. Beck found the foot and leg of a diving petrel within the stomach of a short-eared owl (*Asio flammeus sanfordi* Bangs).

***Pelecanoides urinatrix dacunhæ* Nicoll**

Pelecanoides urinatrix VERRILL, 1895, Trans. Connecticut Acad., IX, part 2, p. 449 (part). CLARKE, 1905, Ibis, p. 264; 1913, 'Rep. Sci. Results Voy. Scotia,' IV, part 14, sect. IX, p. 286.

Pelecanoides dacunhæ NICOLL, 1906, Bull. B. O. C., XVI, p. 103; 1906, Ibis, p. 674; 1909, 'Three Voyages of a Naturalist,' 2d Ed., pp. xv, xxix.

Pelecanoides exsul GODMAN, 1910, 'Monogr. Petrels,' p. 304 (part).

P[elecanoides] urinatrix dacunhæ MATHEWS, 1912, 'Birds Australia,' II, p. 238.

TYPE SPECIMEN.¹—No. 1906. 12. 21. 58, British Museum; adult female; collected January 17, 1906, by M. J. Nicoll.

TYPE LOCALITY.—The shore waters of the island of Tristan da Cunha.

GEOGRAPHIC RANGE.—Tristan da Cunha, Gough Island (?), and adjacent waters.

SUBSPECIFIC CHARACTERS.—Apparently most closely allied to *P. u. berard*, but with generally smaller dimensions. Feathers of cheeks, sides of neck, and jugulum with conspicuous, dark brownish shafts.

ADULT FEMALE.²—Upper parts glossy black, largely faded and worn to dull blackish brown; scapulars grayish white, with broad subterminal band of deep neutral gray, darker on outer web; scapulars more or less overlaid and concealed by dark interscapulars; wings glossy black, largely faded and worn to blackish brown, especially on the primaries; a faint indication of light edging to secondaries, but practically lost through wear; under wing-coverts white, strongly washed with deep neutral gray, the shafts of the feathers dark for practically their entire length; rectrices blackish brown, with a slight gloss, and paler on under surface; lores and anterior part of forehead suffused with clove-brown; under parts white; cheeks and sides of neck deep neutral gray, the feathers narrowly tipped with white; this gray mottling extending across the jugulum, though faint in the middle; feathers of the mottled parts (cheeks, sides of neck, and jugulum) with conspicuous, dark brownish

¹The original describer did not designate a type specimen but used as cotypes two adult females in the British Museum, both collected at Tristan da Cunha on January 17, 1906. We find, however, that the label of No. 1906. 12. 21. 58 is marked "Type," and accordingly we hereby designate this specimen as the type.

²Description of the type, which is in worn and faded plumage.

shafts (these being especially prominent in the cotype; likewise evident, but not so striking, in *berard*); axillaries, sides, and flanks strongly washed (or broadly banded) with deep neutral gray, the feathers with conspicuous blackish shafts; feathers of tibia deep mouse-gray; down plumules and aftershafts mouse-gray. Paraseptal processes situated posterior to the longitudinal center of the septum. "Bill black, a blue streak on upper mandible at gape; tarsi and toes bright blue, webs blackish."¹

Adult Female.—Length (skins), 202–204 (203); wing, 108–113 (110.5); tail, 36.5–37 (36.7); exposed culmen, 15.5–16.5 (16); width of bill, 7; depth of bill, 5–5.5 (5.2); tarsus, 24; middle toe and claw, 29–31 (30).²

NESTLING.—Not seen.

SPECIMENS EXAMINED.—Total number, 2,³ both from Tristan da Cunha.

NESTING SEASON.—A single egg from Gough Island was collected between September and January.

EGG.— 40×29.5^4 (Gough Island).

Most of our information concerning this little-known form of *Pelecanoides* is contained in the following account by Nicoll.⁵

The most interesting birds which we saw, however, were some diving petrels, which proved to belong to a species not hitherto recorded from Tristan da Cunha. Superficially these petrels resemble the diving petrel of the Straits of Magellan, but they are somewhat smaller and have a much greater power of flight. On several occasions I saw them rise off the water and fly away out of sight, whereas those found in the Magellan Straits drop into the water after a flight of about fifty to one hundred yards. The Tristan da Cunha diving petrels are constantly exposed to rough weather and breaking waves, and in consequence have to take wing continually to avoid being drowned, and this fact may account for their greater powers of flight.

They were met with soon after we left the yacht, and became more numerous as we approached the land. Half a mile from the shore they were on all sides of us, and appeared continually close to the boat, when instead of diving they at once took to flight, and passed away at a great speed.

It is perhaps significant that Mrs. K. M. Barrow⁶ makes no reference to this species in a list of birds observed by her during a long residence at Tristan. Nicoll's statement that the island is over-run with rats suggests the possibility that the burrowing *Pelecanoides* have been forced to confine their nesting to some of the neighboring and uninhabited islands of the Tristan group. (Cf. *P. georgicus*, p. 523.)

The specimen taken by the 'Scotia' expedition off Gough Island, 250 miles distant from Tristan, probably belongs to the same form.

¹Nicoll, notation on label of the type. W. Eagle Clarke (Ibis, 1905, p. 264) states of a Gough Island specimen that "the tarsus and toes in life are cobalt-blue and the webs and claws black."

²Two specimens. The type has the smaller measurements in wing, culmen, depth of bill, and middle toe and claw.

³Collection Brit. Mus.

⁴Converted into millimeters from Verrill's measurements in inches. An "egg from Gough Island, marked 'supposed to be a diver,' measures 1.57×1.16 ," (Verrill). The width is copied by mistake as 1.6 inches by Clarke (Ibis., *loc. cit.*, and Rep. Sci. Results 'Scotia,' *loc. cit.*).

⁵1909, 'Three Voyages of a Naturalist,' pp. 67, 68.

⁶1910, 'Three Years in Tristan da Cunha,' p. 275.

The measurements of the egg secured on Gough Island by Comer would not be likely to apply to the egg of any bird, other than a *Pelecanoides*, that nests there.

***Pelecanoides urinatrix coppingeri* Mathews**

Pelecanoides urinatrix SALVIN, 1896, 'Cat. Birds Brit. Mus.,' XXV, p. 437 (part).

GODMAN. 1910, 'Monogr. Petrels,' p. 299 (part).

P[elecanoides] urinatrix coppingeri MATHEWS, 1912, 'Birds Australia,' II, p. 238.

TYPE SPECIMEN.—No. 80.8.3.30, British Museum; adult female; collected October 16, 1879, by Dr. R. W. Coppinger.

TYPE LOCALITY.—Cockle Cove, Pilot Island, Trinidad Channel, Chile (latitude 50° 5' S., longitude, 75° 3' W.).²

GEOGRAPHIC RANGE.—Known definitely only from Cockle Cove, Trinidad Channel, and Cove Harbor, Messier Channel, Chile.

SUBSPECIFIC CHARACTERS.—Apparently nearest to *P. u. berard*, but averaging smaller; scarcely any trace of mottling across the jugulum, as in *berard* and *dacunhæ*.

Adult (Male?).—Length (skin), 193; wing, 116; tail, 41; exposed culmen, 16; width of bill, 7; depth of bill, 6; tarsus, 25; middle toe and claw, 31.³

Adult Female.—Length (skins), 165–206 (185.5); wing, 106–111 (108.5); tail, 36–38 (37); exposed culmen, 15.5–16 (15.7); width of bill, 7; depth of bill, 5.5; tarsus, 25–25.5 (25.2); middle toe and claw, 31.⁴

NESTLING.—Not seen.

SPECIMENS EXAMINED.—Total number, 4,⁵ as follows:

Chile: Cove Harbor, Messier Channel, 2; Cockle Cove, Trinidad Channel, 1; (? 'Strait of Magellan,' 1).

NESTING SEASON.—Unknown.

EGG.—Not seen.

The distribution of this diving petrel is interesting. It is evidently a subspecies of the *P. urinatrix* group, being not easily separable from *berard*. Yet between the known ranges of the two forms lies almost the entire habitat of *P. magellani*.⁶ *P. u. coppingeri*, in turn, seems to occupy an area intermediate between the ranges of *P. garnoti* and *P. magellani*. Except for the occurrence of both *P. u. coppingeri* and *P. magellani* in the Trinidad Channel, the ranges of the four subgenera of *Pelecanoides* are apparently quite distinct.

It is rather probable that the range of the present form extends to the northern limit of the inland waterways of Chile, or to about latitude

¹Not designated in the original description, but in a letter from Mr. Mathews to the senior writer.

²The locality given on the label is "Cockle Cove, Magellan." Apparently in Dr. Coppinger's time the name Magellan was loosely applied to a much larger region than nowadays.

³One specimen.

⁴Two specimens.

⁵Collection Brit. Mus.

⁶Whether the specimen from the "Strait of Magellan" came actually from the strait itself, is not determinable. (Cf. foot-note 2, above.) Moreover, it might be referred almost as readily to one as to the other of the two very similar forms, *berard* and *coppingeri*.

41° 40' S. Darwin's record of diving petrels in the Chonos Archipelago has already been mentioned (p. 516). It may likewise be assumed that the following notes from Mr. Beck's journal refer to *coppingeri*.

Early July, 1914. Diving petrels common between Ancud and Puerto Montt, Gulf of Chacao, Chile. A few seen later in the Pacific about thirty miles off Guamblin Island (44° 45' S.), and again off the Gulf of Penas (47° 30' S.).

***Pelecanoides exsul* Salvin**

Pelecanoides urinatrix COUES AND KIDDER, 1875, Bull. U. S. Nat. Mus., No. 2, p. 36.

KIDDER AND COUES, 1876, idem, No. 3, p. 17. SALVIN, 1881, 'Challenger Reports, Zool.,' II, part 2, p. 146. WYVILLE THOMSON, 1885, editor, 'Challenger Reports, Narrative,' I, part 1, p. 359. MOSELEY, 1892, 'Notes Naturalist Challenger,' p. 181. VERRILL, 1895, Trans. Connecticut Acad., IX, part 2, p. 449. OATES, 1901, 'Cat. Birds' Eggs Brit. Mus.,' I, p. 161.

Pelecanoides exsul SALVIN, 1896, 'Cat. Birds Brit. Mus.,' XXV, p. 438. HALL, 1900, Ibis, p. 30. WILSON, 1907, 'Nat. Antarct. Exp., Zool.,' II, part 2, p. 107. GODMAN, 1910, 'Monogr. Petrels,' p. 304 (part).

P[elecanoides] urinatrix exsul MATHEWS, 1912, 'Birds Australia,' II, p. 238.

Diver, DU BATY, 1912, 'Fifteen Thousand Miles in a Ketch,' p. 180.

TYPE SPECIMEN.—Not designated, but in the collection of the British Museum.

TYPE LOCALITY.—Here fixed at Kerguelen Island.¹

GEOGRAPHIC RANGE.—Crozet Islands, Kerguelen Island, Auckland Islands, and waters adjacent to each.

GENERAL CHARACTERS.—Distinguished from all forms of *P. urinatrix* by the following: average greater width of bill; mandibular rami not quite so nearly parallel; anterior ends of gnathidia turned inward more at lower edge, bringing the tips of these elements closer together at the symphysis, and disclosing their surfaces more broadly to view from the ventral aspect; jugulum more heavily and distinctly mottled with deep neutral gray.

ADULTS (SEXES ALIKE).—Upper parts glossy black; scapulars deep neutral gray, with a whitish terminal bar; wings glossy black, more or less tinged with brownish, especially on primaries; inner webs of primaries clove-brown, lighter on under surface; secondaries narrowly tipped with whitish; under wing-coverts whitish, more or less washed with light mouse-gray, the shafts dark; rectrices glossy black, fading to blackish brown, paler on the under surface, and the worn tips with a trace of whitish; anterior part of forehead and lores suffused with clove-brown; under parts white; feathers of auricular and malar regions, and sides of neck and breast, deep neutral gray, for the most part tipped with white; this mottling extending completely across the jugulum, and becoming only slightly less distinct in the middle; axillaries mouse-gray; sides and flanks washed with deep neutral gray, the feathers tipped with whitish and the shafts dark; feathers of tibia mouse-gray; down plumules and aftershafts over entire body mouse-gray. Paraseptal processes situated posterior to the longitudinal center of the septum and not prominently developed. "Bill generally black;

¹Godman ('Monogr. Petrels,' p. 304) remarks: "Salvin gives no dimensions, so I have not been able to determine from which specimen in the British Museum his description was taken, but I have no doubt that it was from a Kerguelen example; he also includes the birds from the Crozet Islands under the heading of *P. exsul*."

lavender-blue at quadrate basal portion of lower mandible. Iris ash-colored; not visible during life, when only the black pupil appears. Tarsus and foot lavender-blue" (Kidder).

Adult Male.—Length (skins), 189–251 (213.8); wing, 118–121.5 (119.7); tail, 35–40.5 (38.2); exposed culmen, 15.5–17 (16.2); width of bill, 8.5–9.5 (8.9); depth of bill, 6.5–8 (7.1); tarsus, 26–27 (26.4); middle toe and claw, 30.5–36 (33.2).¹

Adult Female.—Length (skins), 205–218 (211.5); wing, 118.5–121 (119.7); tail, 35.5–39.5 (37.5); exposed culmen, 16; width of bill, 9; depth of bill, 6–7 (6.5); tarsus, 26–26.5 (26.2); middle toe and claw, 32–33 (32.5).²

NESTLING.—Mesoptyle down light mouse-gray.

SPECIMENS EXAMINED.—Total number, 28, as follows:

Crozet Islands, 3.^{3, 4}

Kerguelen Island, 20.^{3, 4, 5}

Auckland Islands, 3.^{3, 4}

Locality unknown, 2.^{4, 6}

NESTING SEASON.—October to February.

EGG.—"White, with a few red specks at one end" (Moseley). "Regular ovoid, tending in some specimens to ellipsoidal. . . Shell is white, thin, brittle, compact, and homogeneous in structure. No color-markings" (Kidder and Coues). Size! 41×29.2, 41×32.2, 42×32, 41.9×31.7 (Kidder); average of 4, 41.5×31.3. Verrill gives the dimensions of two as 38.5–39×31–32, and states that the "shell is thin, friable, and rather smooth, but shows shallow depressions under the lens. The shape, in one, is an almost perfect, but very broad, ellipsoid; the other is also very broad but tends somewhat to the ovate form. The color is creamy white, much stained (by contact with the earth?) with dirty yellowish." Oates records the measurements of eight specimens as follows: 33–39×28–33.

Considerable doubt and confusion have existed regarding the status of this diving petrel, even after it was described by Salvin as a distinct species. A long and careful study of the subject has led us to concur with Salvin in according specific rank to *exsul*. This decision is based not only upon the rather slight but doubtless significant differences of plumage and bill structure between this form and *P. urinatrix*, as pointed out above, but also upon the fact that both *P. exsul* and *P. u. chathamensis* occur on a compact group of small islands, the Auckland Islands. In the light of the modern conception of the subspecies, it would be extremely difficult, not to say impossible, to account for the presence of both of these birds on the Auckland Islands if they were no more than subspecifically distinct.

The range of *exsul*, with its narrow latitudinal confines and its great longitudinal extension from the Crozet Islands to the Auckland Islands,

¹Six specimens, from Kerguelen.

²Two specimens, from Kerguelen.

³Collection Brit. Mus.

⁴Collection Zool. Mus., Tring.

⁵Collection U. S. Nat. Mus.

⁶Collection J. H. Fleming.

⁷All measurements originally in inches; here converted into millimeters.

is somewhat analogous to that of *P. georgicus*. The narrow strip of subantarctic seas which it occupies is evidently intermediate between corresponding strips on the north and south occupied, respectively, by various forms of *P. urinatrix* and by *P. georgicus*. So far as known, the Auckland Islands are the only land area where the range of *exsul* overlaps that of another species.

The diving petrel is one of the most abundant breeding birds at Kerguelen Island, making its nest burrow beneath the mounds of an umbelliferous plant (*Azorella selago*) that grows in dense masses on the hillsides. Dr. Kidder found it to be one of the two species most commonly seen and heard at night, the other being *Halobæna*. The note of the *Pelecanoides*, writes Kidder,

is somewhat similar to the mew of a cat, with a marked rising inflection of sound. The bird cannot rise from level ground in flight, but, once in the air, flies strongly and rapidly, with a rapidly fluttering motion of the wings, very like the flight of the common English sparrow. It burrows in the same localities as *Halobæna*, digging less deeply and making fewer turns in its burrow, and seems to remain therein during the day, being exclusively nocturnal in its habits when near its nest. Lays one egg, as large as a pigeon's, white, and not sharply pointed; first found by me December 10. I did not succeed in finding any young up to January 10, the date of our departure.

Du Baty records his impressions of the voice of Kerguelen diving petrel in the following words.

The diver is another night bird, and it has a peculiar cry like the mewing and miauling of a cat. There were times, as I stood on deck in the night watch listening to this bird, when I could almost have believed that I was back in Paris in a room under the attics where the cats were on the prowl and indulging in their witches' chorus.

The 'Challenger' naturalists¹ record the following observations on this petrel.

It is to be seen on the surface of the water in Royal Sound [Kerguelen Island] when the water is calm, in very large flocks. On two days [in January] when excursions were made in the steam pinnace, the water was seen to be covered with these birds in flocks, extending over acres, which were black with them. The habits of the northern Little Auk are closely similar to those of this bird; so close is the resemblance, that the whalers have transferred one of their familiar names for the Little Auk to the Diving Petrel. These Petrels dive with extreme rapidity, and when frightened, rise, flutter along close to the water, and drop and dive again; it is a curious sight to see a whole flock thus taking flight. The birds breed in enormous quantities on the islands in Royal Sound, making holes in the ground like the Prions; they are readily attracted by a light, and some were caught on board through coming to the ship's lights. The single egg is white, with a few red specks at one end.

¹ Moseley and others.

The statement that there are "red specks" at one end of the egg would seem to be an error, for, although recorded on the authority of that most observant and scrupulous naturalist, Professor Moseley, it is at variance with the testimony of all others, both with regard to this species and to diving petrels in general.

Hall found this bird common at Kerguelen in the summer season of 1897-1898, and collected specimens by exposing the ship's light on dark nights.

Dr. Wilson, who lost his life with Scott after the discovery of the South Pole, has recorded the following excellent description of the flight of the diving petrels which he observed in the southern Indian Ocean to 122° east and as far south as 51°.

In mid-ocean one may see a small petrel, quite alone, flying fast and straight close over the wave-tops, until suddenly, like a stone, it disappears into the water. If the sea is particularly calm, it may be seen that its wings flap rapidly for three or four strokes, then follows a quick short sail, the bird seldom rising more than a foot or two from the surface of the water. Its flight seems to be hurried and in a straight line, coming to an abrupt termination as the bird dips. It is not easy to observe at sea, but its flight is so peculiar that it cannot well be mistaken for any other form of petrel.

GENERAL DISCUSSION OF THE EVOLUTION AND DISTRIBUTION OF THE PELECANOIDIDÆ

The taxonomy of minor groups remains largely a matter of opinion, and, in preparing the foregoing sections of this paper on a little-known family of birds, the writers have regarded the presentation of ordered facts as of greater moment than the construction of a new system of classification. We trust that our descriptive data, based in the main upon large series of specimens, have at least been made communicable; that they may be used and, if necessary, reinterpreted by later workers. If we have succeeded in discovering and recording essential facts of the morphology, life history, and distribution of the birds, the particular systematic rank that we have ascribed to each of the several divisions of the Pelecanoididæ is at best of secondary importance.

We believe, nevertheless, that our classification dividing the single genus of this small family into four subgenera, and one of the latter in turn into two species and five subspecies, is in harmony with the actual conditions of structural and genetic relationship. This does not imply that the various subspecies, species, or subgenera, as the case may be, have precisely equal value, because nature is seldom uniform and conventional. Of the geographical races of *Pelecanoides urinatrix*, for instance, *dacunhæ*, *berard*, and *coppingeri* are clearly more sharply marked

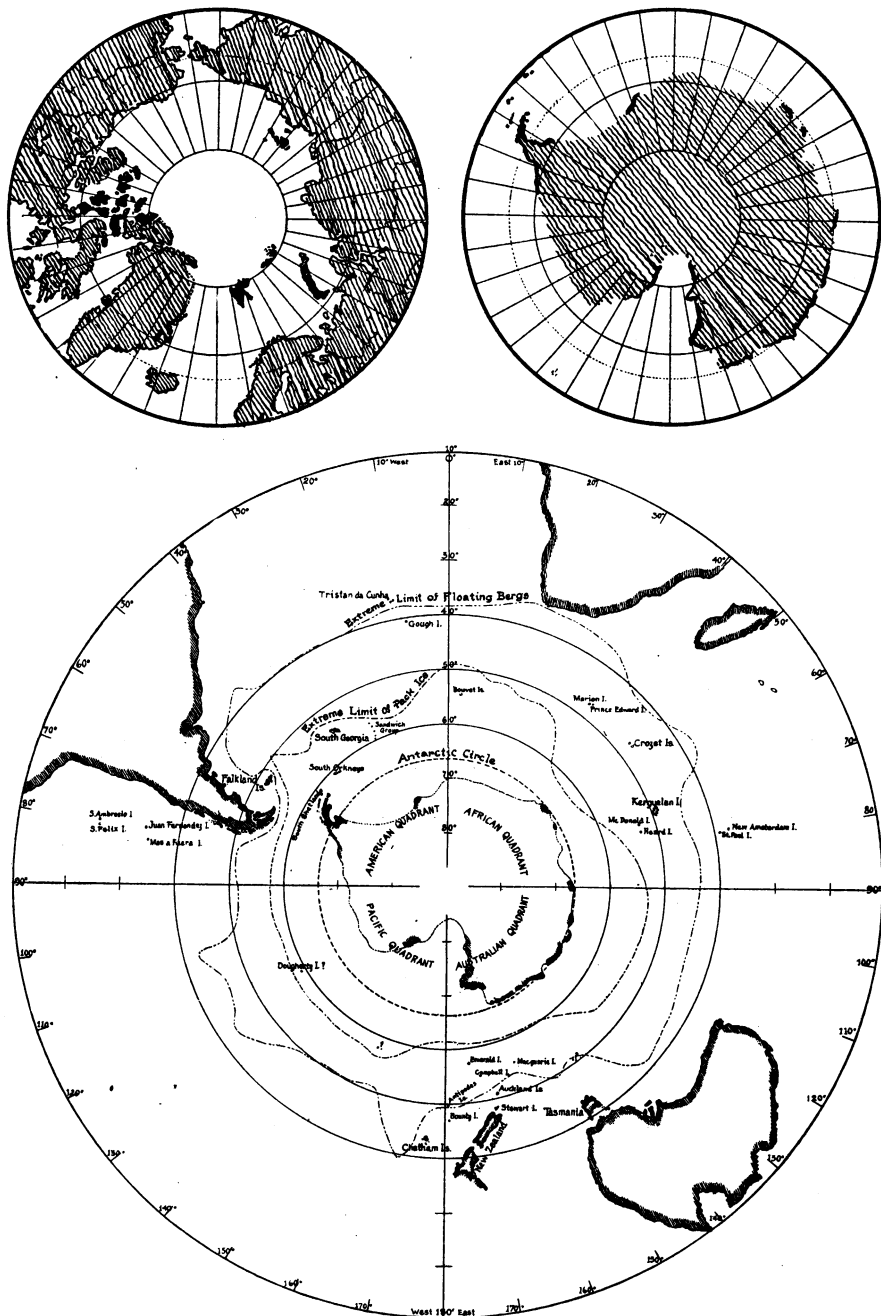


Fig. 6. Sketch maps in polar projection showing the relative distribution of land and water about the poles, the limits of pack and drift ice in the southern hemisphere, and the true geographical relations of the breeding grounds of all forms of Pelecanoididae.

Owing to the notoriously great extension of polar physiography and climate around the southern axis of the world, the conditions of zoological distribution in antarctic and subantarctic regions have been more limiting and inflexible than in the arctic, since at least late Tertiary time. Arctic sea-birds might fly from the shores of one northern continent to those of another directly across the restricted North Polar Sea. Antarctic birds, on the other hand, would be prevented from utilizing correspondingly direct routes by the absolute barrier of the Antarctic Continent, with its high elevation and enormous area. The subantarctic, insular breeding grounds, moreover, are separated by vast stretches of ocean, and the paths of dispersal connecting many of them must, for the reasons stated, have roughly followed arcs of the latitudinal lines rather than the shorter chords. In the case of two antipodal breeding grounds of diving petrels, namely South Georgia and Tasmania, the discrepancy between the transpolar distance and the categorical flight-route along the parallel of latitude amounts to about 1300 statute miles.

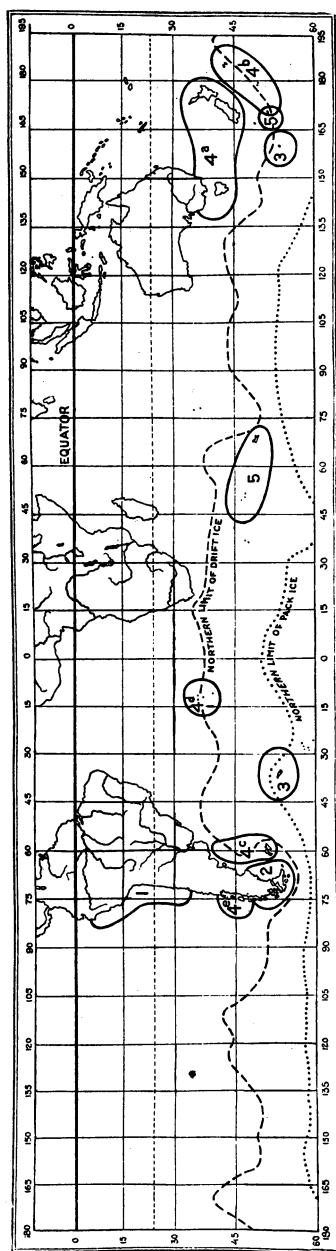


Fig. 7. Distribution of the Pelecanoididae

Ranges of the five species are denoted by figures: those of the subspecies of *Pelecanoides urinator* by letters following the figure 4.

1. *P. garai*. Coasts of Peru and Chile.
2. *P. magellani*. Coasts of Peru and Chile.
3. *P. georgicus*. South Georgia and Macquarie Island.
4. *P. urinator urinator*. New Zealand, Tasmania and the southeastern coast of Australia.
- 4b. *P. urinator chathamensis*. Chatham Islands, and southerly outliers of New Zealand (?).
- 4c. *P. urinator deardi*. Falkland Islands, north of Gough Island, to the coast of Argentina.
- 4d. *P. urinator decurte*. Tristan da Cunha, and Gough Island (?).
- 4e. *P. urinator copingeri*. Northern parts of the Fuegian Archipelago of Chile.
5. *P. exsul*. Kerguelen and Crozet Islands, Auckland Islands.

off from the typical subspecies than is *chathamensis*; and yet none of the former has attained sufficient divergence to raise it to the grade of species. In the case of *dacunhæ*, *berard*, and *coppingeri* we may assume that complete geographic isolation has been an important asset to the evolutionary processes that have so markedly differentiated these three forms from other representatives of the *urinatrix* group, while similarity of the subantarctic life environment has at the same time tended to keep all the races fairly uniform. Of the opposing factors—one centrifugal, the other centripetal—it may be conjectured that the former would ultimately gain the upper hand and fashion full species out of races which may now be considered incipient species.

Figure 7 shows that the circumpolar distribution of the *Pelecanoidi*dæ, excepting only *P. garnoti*, is confined within a belt bounded by the 35th and 60th parallels of south latitude. Excluding again the range of *garnoti*, practically all the regions inhabited by diving petrels are characterized by tempestuous weather, a high scale of cloudiness, and heavy precipitation. All the habitats, even that of the tropical *garnoti*, are situated in relatively cold oceans in which the annual variation in surface temperature nowhere exceeds 6.6° C. Furthermore, the shores of all the breeding grounds are bathed by effluents of the Antarctic Drift, only slightly tempered, in a few instances, by warm counter currents.

In longitudinal extent the range of the species *Pelecanoides urinatrix*, as may be seen on the map, is practically as great as that of the whole family, but it is proportionately more restricted in its breadth north and south. The known range of *urinatrix* lies, for example, entirely outside of the extreme limit of pack-ice. The mean annual temperature of the atmosphere at the breeding grounds of the geographical races of *urinatrix* varies from 5.5° C. at the Falklands to 10° C. on the coast of Tasmania.

At South Georgia, which lies within the limit of pack-ice, and at Macquarie Island, the meteorological conditions are distinctly more severe than at any of the islands inhabited by *urinatrix*, and the summer temperature is notably lower. The climate is, in some respects, polar rather than subantarctic, the mean annual temperature at South Georgia being below 1.5° C. *Pelecanoides georgicus* is therefore endemic in a more inclement zone than any part of the known range of *P. urinatrix*. In view of this, determination of the status of the diving petrel of Bouvet Island, where a representative will almost certainly be found, and of that of the South Sandwich Islands, where a resident form may be looked for with only slightly less confidence, can not fail to prove of extraordinary interest. In fact, the accompanying map (Fig. 7) seems to show

such a remarkable correlation between the distribution of the diving petrels on the one hand and temperature, latitude, and the geographical limits of floating polar ice on the other, that future discoveries at islands not yet ornithologically investigated may serve to put this apparent correlation to a conclusive test. If resident diving petrels occur at some of the unknown or little-known subantarctic islands and if our present ideas upon the distribution of the group are substantially correct, the affinities of the unknown birds at the respective islands should prove to be specifically as follows:

Gough, Amsterdam, St. Paul, Bounty, and possibly Antipodes Islands. *P. urinatrix*.

Prince Edward and Marion Islands. *P. exsul*.

Campbell, Emerald, McDónald, Heard, Lindsay (or Bouvet), South Sandwich, and Dougherty Islands. *P. georgicus*.

It is at least gratifying to feel that an hypothesis of geographical distribution may be empirically confirmed or eliminated.

The only alternative to accepting the theory of an isothermal type of distribution of the insular, subantarctic diving petrels, as now known, is to assume that the resident birds of such widely separated localities as South Georgia and Macquarie Island, for instance, are products of convergent evolution—that the action of similar environments has nipped in the bud every differential tendency and has produced homoplastic counterparts which, on morphological grounds, cannot be separated even subspecifically!

However important climatic factors may be, the complex of influences controlling the present distribution of most forms of diving petrels is by no means fully understood. What sort of external limitation or competitive interaction, for instance, keeps apart the adjacent Fuegian and Falkland birds? The determinants of the aberrant range of *Pelecanoides garnoti*, on the other hand, are more readily comprehensible than those of any of the other species. The cold Humboldt Current, which flows northward and laves the west coast of South America to within a few degrees of the equator, combines with other natural features, such as the Andean barrier and the prevailing southwesterly winds, to maintain more regular and favorable oceanic and meteorological conditions than are to be found along any similar continental shore. For a thousand nautical miles on the Peruvian seacoast the surface temperature of the ocean water changes scarcely at all, nor is the variation according to hour, day, or month, significant. At the Chincha Islands, the extremes of annual variation are not more than 1.3° C.

apart.¹ Evaporation is slight, and the proximity of cold sea-water and heated land makes condensation and precipitation of moisture virtually impossible. The chilled, viscous water absorbs oxygen freely, which, in combination with the clear sunlight, supports an abundant growth of algæ. The latter in turn furnish subsistence to the teeming plankton and nekton fauna upon which the diving petrels feed. The extraordinary circumstance of a subantarctic current, with its exhaustless resources of uniform food supply, washing equatorial continental shores, accounts beyond a doubt for the distribution of *Pelecanoides garnoti*, as well as of the penguin, *Spheniscus humboldti*, northward into the heart of the tropics. Where the Humboldt Current meets a warm, southward-flowing current—El Niño—at a point varying between 3° and 7° 30' south latitude, the warmer, lighter stream overflows the colder, and the northward extension of the diving petrel is abruptly checked.

The same general conditions also partly explain the characteristics, physiological as well as structural, which differentiate *P. garnoti* from its congeners. Alone of all the family, it inhabits a mild region of rainless, relatively placid seas with their invariable surplus of accessible food. The factors which inhibit increase of size in the more southerly species are apparently not effective, and this largest and most northerly of diving petrels has, moreover, overcome the limitations of a fixed breeding season—a system which is so rigidly imposed upon all the subantarctic forms—and has assumed the continuous breeding custom common to many tropical sea-birds. Throughout the whole family, there is an obvious tendency toward decrease in size with decrease in temperature of the habitat.

The insular species of diving petrels, including *georgicus*, *exsul*, and the races of *urinatrix*, appear to make migrations of considerable extent, or at least to lead truly pelagic lives during part of the year. In the systematic accounts we have cited records of these birds at points far from land in the South Atlantic, Indian, and Pacific oceans. The continental species, *garnoti* and *magellani*, on the other hand, would seem to be strictly littoral. Neither form has been recorded from any offshore locality; *P. magellani* has not invaded the territory of its neighbor, *P. u. berard*; *P. garnoti* is unknown at Juan Fernandez.² Further evidence of the permanent residence of these two species within

¹Coker, R. E., 1918, Geographical Review, February, pp. 127-135.

²A map showing the distribution of the Pelecanoididæ in the Atlas of Zoogeography (Bartholomew's Physical Atlas, V, 1911), Plate xvii, Map 5, is misleading in that the range of these birds is carried entirely across the Pacific Ocean. There is yet no evidence that diving petrels occur in any part of the Pacific between the littoral waters of South America and the New Zealand region. Certainly in the case of *Pelecanoides garnoti* the area of distribution and the breeding range appear to have the same limits; both seem to be confined within the scope of the cold Humboldt Current.

the environs of their actual breeding ranges is to be found in their notably uniform plumages (cf. p. 526), a condition contrasting strongly with the wide amplitude of individual variation in *P. georgicus*, for instance. This is in accord with the recognized truth that, other factors being equal, so-called stationary species exhibit a lesser degree of individual variation than species which undertake long periodic migrations.

Mathews advances the opinion that the great age of the family of diving petrels, as an offshoot from some more generalized tubinarine stem, is indicated by the fact that the nostrils of even nestlings point directly upward and show no trace of the horizontal tubes such as are common to all other birds of the order. Upon a similar criterion we may judge that the parting of the ways of the four subgenera within the single genus is also of ancient standing, because the bills of very young specimens show as well as those of adults the diagnostic differences in the structure of the nasal orifices and the form of the mandibular rami.

In the complete absence of a fossil record, and of knowledge of a secular alteration of antarctic climate during the Tertiary, we can perhaps draw no sure conclusions regarding the origin and dispersal of the Pelecanoididæ. Nevertheless, the line of reasoning which W. D. Matthew¹ has so successfully used to explain the distribution of various higher groups of vertebrates from holarctic centers is applicable in a very interesting way to this small family of birds. All the known subgenera and species of diving petrels except *P. exsul* are indigenous within a distance of twelve hundred miles of the southern extremity of South America. It would seem, therefore, that those agencies which have been governing the course of evolution within the family have been most active in the region referred to, and that the point of original dispersal is, indeed, not far from Cape Horn. In this locality we find to-day *Pelcanoides magellani*, the most strongly marked and distinctive of all diving petrels, and in this sense the most advanced member of the genus. The Fuegian species represents, as it were, the latest wave in the flood of evolutionary progression rising from the contiguous cradle of the race, which is never the locality where a *primitive* member is to be sought. The more distant *Pelecanoides garnoti* has, except for its increase in size, differentiated much less from the family type. Still more distant and isolated diving petrels, such as *Pelecanoides georgicus* and the antipodal races of *P. urinatrix* (e.g., *P. u. chathamensis*) share with one another strong superficial resemblances of color and pattern, small size, etc., which are due, we assume, not to close relationship, nor to homo-

¹Matthew, W. D. 1915. 'Climate and Evolution,' Ann. N. Y. Acad. Sci., XXIV.

plasy, but rather to the retention among these conservative forms of primitive, nonadaptive characters. The species of diving petrels confined exclusively to the New World (*magellani*, *garnoti*) occupy, as has been shown, a wide range in environments, biotic as well as physical, extending from the arid coast of northern Peru to the islets of Cape Horn; but the species *urinatrix*, *exsul*, and *georgicus*, which, according to the hypothesis here advanced, began their invasion of the Eastern Hemisphere from the Falkland Islands, have found a series of equable habitats in a subantarctic belt of the southern oceans. Because of the relatively uniform, even if cloudy and blustery, environment throughout their range, they have thus far radiated, if at all, only to the extent of forming variants worthy of the rank of subspecies. Peripheral representatives of *urinatrix* and *georgicus*, particularly the subspecies of the New Zealand region, are probably most like the ancestral type of diving petrel; and they now exist exactly where we should expect to find them, viz., as far as possible from their point of origin.

The principal desiderata for further study of this interesting group are as follows:

1. Skeletons of the five species.
2. Downy young of *Pelecanoides magellani*, so that it may be determined whether the neossoptyles of this species resemble in color those of *P. garnoti*, *P. georgicus*, or of neither.
3. A study of representative series of specimens from the Australian and New Zealand habitats, especially from the southern outliers of New Zealand. As regards the diving petrels known to inhabit the Auckland, Antipodes, and Campbell Islands, there has yet been advanced little or no information of critical value.
4. A search for breeding representatives at the South Sandwich group, Lindsay (or Bouvet) Island, Marion and Prince Edward Islands, Heard and McDonald Islands, and the South Pacific islets of Nimrod and Dougherty, if the last two exist, which now seems doubtful.¹

PLATE XX

Homoplasy in sea-birds of two orders and two hemispheres. The skins at the right and left ends of the series are subantarctic diving petrels (*Pelecanoides magellani*); the two central skins are boreal auklets (*Alle alle*). Cf. pp. 516 and 530.

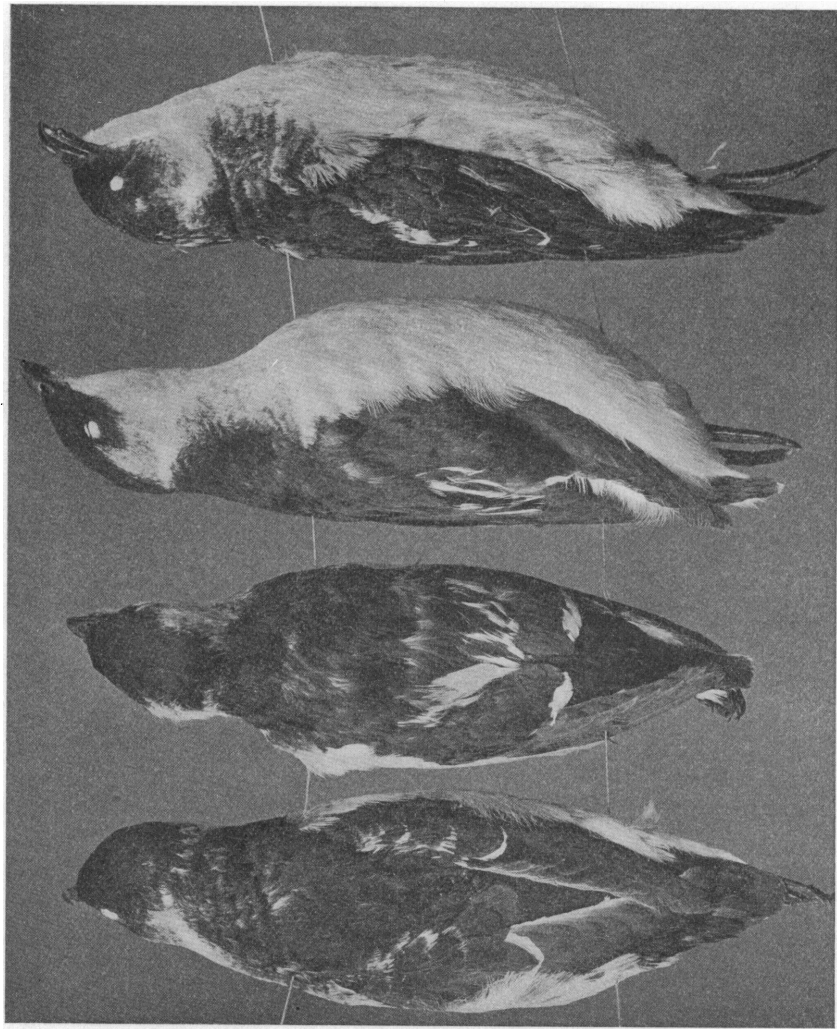


PLATE XXI

Fig. 1. Nestlings of *Pelecanoides garnoti* (Brewster-Sanford Collection 1164, 1165) taken at San Gallan Island, Peru July 3, 1913. The two downy plumages of this species differ markedly in color from the corresponding plumages of *P. urinatrix* and *P. georgicus* (Cf. text-fig. 4, p. 524).

Fig. 2. Progressive wear of the plumage in adult males of *Pelecanoides magelani*. At the left, bird in entirely new plumage taken in the Strait of Magellan, August 1, shortly after the completion of the annual molt. In the center, bird from Reynon Island, Chile, December 21, showing the effects of wear which has nearly obliterated the white edges of the feathers on the back. At the right, bird with the white edgings entirely effaced, taken at Punta Arenas, Argentina, on March 6, or shortly before the inception of the annual molt.

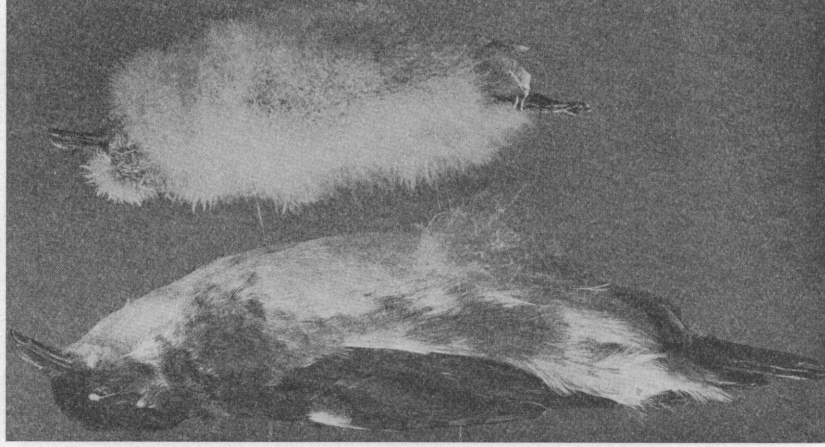


Figure 1

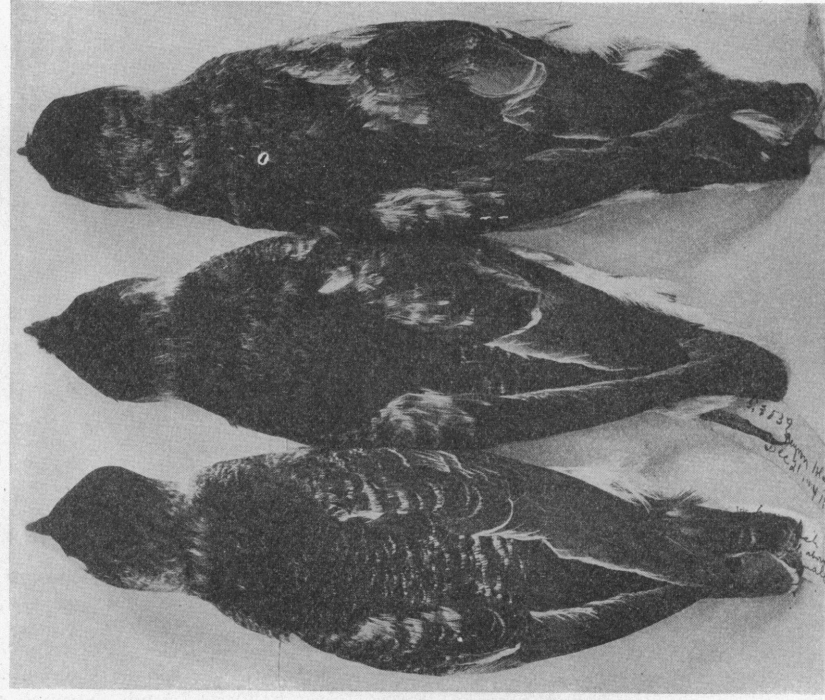


Figure 2

PLATE XXII

Fig. 1. From left to right, mature males of *Pelecanoides garnoti*, *P. magellani*, and *P. georgicus*.

Fig. 2. Structural differences of subgeneric value shown in a ventral view of the bills of four breeding specimens of diving petrels. At the left, two males of *Pelecanoides urinatrix berard* (subgenus *Pelecanoides*), Falkland Islands, November 1915; at the right, one male and one female of *Pelecanoides georgicus* (subgenus *Pelagodyptes*), South Georgia, January 1913.

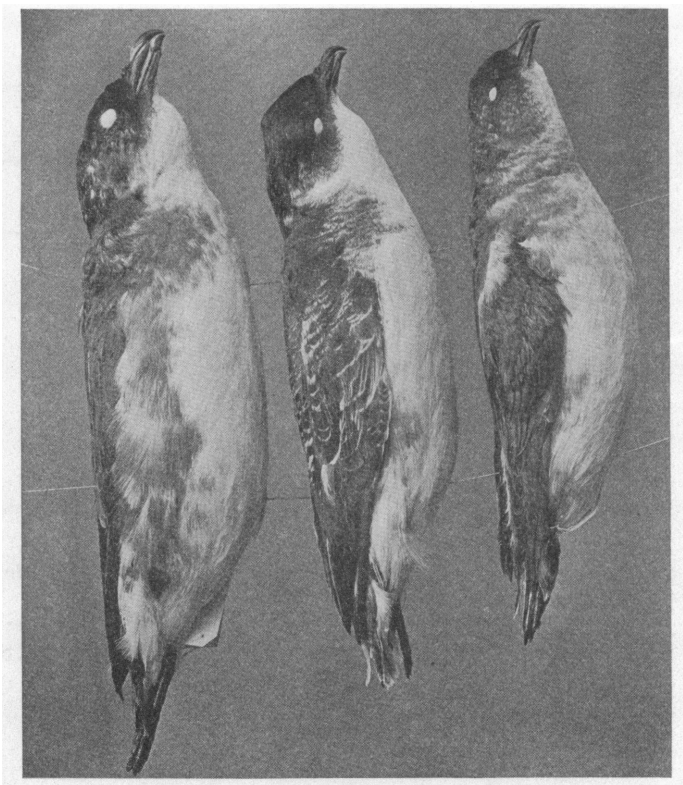


Figure 1

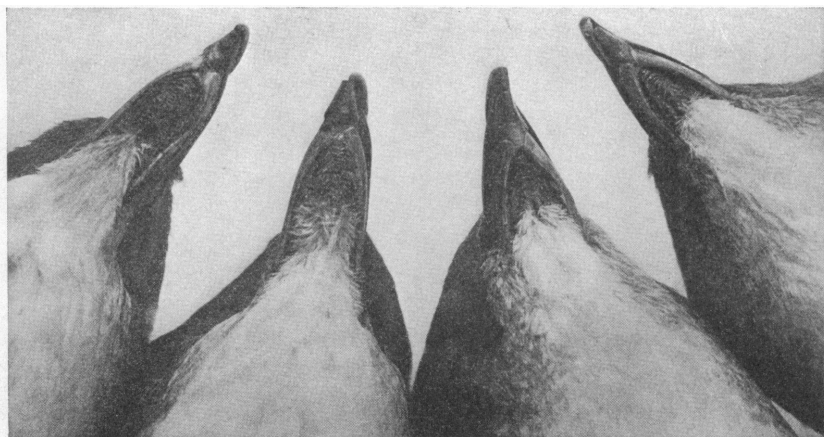


Figure 2

PLATE XXIII

Fig. 1. *Pelecanoides georgicus*. Photograph from life of a bird which flew on board a vessel in Possession Bay, South Georgia, March 13, 1913.

Fig. 2. Individual variation in the extent of mottling on the jugulum, illustrated by two breeding females of *Pelecanoides georgicus* collected at Cumberland Bay, South Georgia, in December 1914.

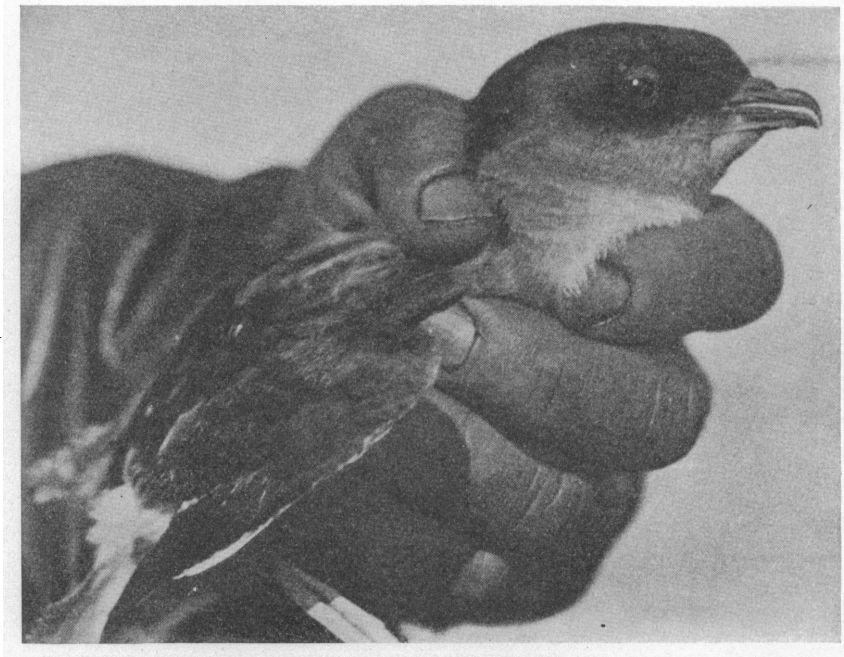


Figure 1



Figure 2

PLATE XXIV

Fig. 1. *Pelecanoides garnoti* and its egg, after the opening of a burrow on San Gallan Island, Peru, July 4, 1913.

Fig. 2. *Pelecanoides urinatrix berard*, after the opening of its nest-burrow on Kidney Island, Falkland Islands, November 6, 1915.

Both photographs by Rollo H. Beck.



Figure 1



Figure 2

