COMPARATIVE OÖLOGY OF NORTH AMERICAN BIRDS.

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The only object of this paper is to bring together what is already well known in regard to the oölogy of North American birds, placing it before the ornithologist in a more condensed form than it is usually given and in a comparative way. The question of the variation in the matter of form and coloration of the eggs of the birds of this and other countries has interested the writer for many years, and in the light of our present knowledge of the relations existing between birds and reptiles, both in this age and the past ages of the world, I have often wondered at what the causes were that eventually brought about the variation in color and form of which I have just spoken.

So far as the writer is concerned, he is not aware of the discovery of the eggs of any of the now extinct forms of reptiles, either fossil or subfossil, and it is beyond all probability that we will ever know what the eggs of *Archæopteryx*, or any of the toothed birds of the Kansas Cretaceous beds (*Hesperornis*, *Ichthyornis*, and others), or, indeed, any of the smaller extinct types of Aves, looked like. We have in our possession but very little upon this subject. Of the extinct *Dinornis* of New Zealand, and of the ponderous *Epyornis* of Madagascar, also extinct, we have their eggs in a subfossil state, but except in the point of size they probably did not markedly depart from those of existing Ostrich types of birds (*Struthionidæ*) now living and most nearly related to them.

All of the eggs of the common African Ostrich (*Struthio camelus*) that I have examined have been of a more or less ellipsoidal form, unitinted, and with hard, flinty, and externally polished shells.* Their peculiar mode of incubation is well known and has been faithfully described by Lichenstein.† During the breeding season a cock Ostrich associates

*North African Ostriches, strange to say, differ remarkably from those of the Cape of Good Hope birds, in so far as the eggs of the former have a perfectly smooth, ivory-like surface, while those of the latter are rough-surfaced and dinted all over with minute punctures; yet no specific difference seems to obtain between the forms of the birds themselves from the two localities mentioned.

† Lichenstein, M. H. K.: Reise im südlichen Africa, II, pp. 42–45 (Berlin, 1812).

with four or five hens and the latter all lay their eggs in the same nest until some thirty are deposited. The male bird incubates during the night and the hens take turns during the day.

The main facts to bear in mind here are that the eggs average about 30 in number, are ellipsoidal in form, and are unspotted, being a yellowish-white in color, with a hard shell. The South American Ostriches (*Rhea*) essentially agree in these characters.* We meet with exceptions, however, among the *Ratitæ* in the Cassowaries and Emus. The mode of incubation here is much the same as in the Ostriches, but Cassowaries (*Casuaridæ*) lay dark-green and rough-shelled eggs, while the Emus (*Dromæidæ*) make a shallow nest in the ground, in which they lay from 9 to 13 eggs of a bluish-green to a dark bottle-green color; the period of incubation being eighty days, the cock bird performing the duty of hatching. *Apteryx* lays but a single egg two or three times a year. It is enormous for the size of the bird, and is deposited in a hole in the ground. Authors differ in their opinion as to the question of incubation. Some hold it is performed by both sexes, while others contend that it is performed only by the female. The Ratite birds are, structurally, the most reptilian forms of the class *Aves* we have in existence, yet were we to depend upon a study of their methods of incubation and their eggs it would be but an uncertain clew as to what we might be led to expect either in the higher groups of carinate birds, or in existing reptiles, or in extinct forms of either class, or finally, in lowly organized birds of other groups. We have the main facts, however, that in the *Ratitæ* the eggs may in number range from one to many; in color from yellowish-white to a green (never spotted or streaked, etc.); in form ellipsoidal (always?); and incubated by one or both of the sexes. Let us look at one or two other peculiar groups of birds and then pursue the subject in a different direction. In the case of the Penguins (*Impennes*), they lay two white or greenish-white eggs in a rude nest on the ground or in a burrow, while, on the other hand, the Tinamous (*Crypturi*) lay eggs which are "remarkable objects, curiously unlike those of other birds. Their shell looks as if it were of highly burnished metal or glazed porcelain, presenting also various colors, which seem to be constant in the particular species, from pale primrose to sage green or light indigo, or from chocolate brown to pinkish orange."†

Incubation is performed by the male,‡ a strong Ratite character; nest "a mere scrape, insufficiently lined with a few grass-leaves."§ Herr von Nathusius has further observed that the minute structure of the eggshell of a Tinamou "is quite different from that of the true Galli,

*Newton, A.: Art. "Rhea," Encyclo. Brit., 9th ed., Vol. xx, p. 506.

†Newton, A.: Art. "Tinamou," Encycl. Brit., 9th ed., Vol. xxiii, p. 403.

‡Bartlett, Mr.: P. Z. S., 1868, p. 115, Pl. xii.

§Hudson, Mr.: In Argent. Orn. v. ii, p. 210.

and more resembles that of apteryx."* In form they are more or less globular and completely opaque. This last-named character in the eggs of birds is a very interesting one to the student. Prof. Newton, who has thrown so much light for us upon the subject of avian oölogy, remarks upon this point that "In form, eggs vary very much, and this is sometimes observable in examples not only of the same species but even from the same mother, yet a certain amount of resemblance is usually to be traced according to the natural group to which the parents belong. Those of the Owls (*Strigidæ* and of some of the *Picariæ*—especially those which lay the glossy eggs above spoken of—are often apparently spherical, though it is probable that if tested mathematically none would be found truly so; indeed it may be asserted that few eggs are strictly symmetrical, however nearly they may seem so, one side bulging out, though very slightly, more than the other. The really *oval* form with which we are most familiar needs no remark, but this is capable of infinite variety caused by the relative position and proportion of the major and minor axis. In nearly all the *Limicolæ* and some of the *Alcidæ* the egg attenuates very rapidly towards the smaller end, sometimes in a slightly convex curve, sometimes without perceptible curvature, and occasionally in a sensibly concave curve.

The eggs having this pyriform shape are mostly those of birds which invariably lay 4 in a nest, and therein they lie with their points almost meeting in the center and thus occupying as little space as possible and more easily covered by the brooding parent. Other eggs, as those of the Sand Grouse (*Pteroclidæ*), are elongated and almost cylindrical for a considerable part of their length, terminating at each end obtusely, while eggs of the Grebes (*Podicipedidæ*), which also have both ends nearly alike, but pointed, are so wide in the middle as to present a biconical appearance.†

The remarkable variation in both color and form of the eggs of many of our North American birds can nowhere be better studied and appreciated than is the splendid quarto (with its many beautifully colored plates), recently published by Capt. Bendire,‡ and in the treatises of corresponding magnitude of other authors, as those of Wolley, Thiene-

* Journ. für wissensch. Zoologie., 1871, pp. 330–355. Mr. Lucas, of the U. S. National Museum, tells me that the egg of Apteryx is white, and the shell like that of a hen's egg.

† Newton, A.: Art. "Birds" Encycl. Brit., ninth ed., vol. III, p. 775. See also in this connection the valuable contributions to the subject by des Murs, Traité général d'Oologie ornithologique (8 vo. Paris: 1860).

‡ Bendire, Charles: Life Histories of North American Birds, with special reference to their breeding habits and eggs, 12 lith., plates Washington, 1892. (U. S. Nat. Mus.) Special Bull. No. 1. The author of this superb work promises to produce in the future similar volumes treating of other groups of our birds. Those dealt with in the present installment are the gallinaceous birds, the Pigeons, and Birds of Prey, in which latter group he includes the somewhat heterogeneous assemblage of the American Vultures, the *Falconidæ*, and the Owls.

mann, Hewitson, Brewer, of this country, Taczanowski, Lefèvre, Bädeker, and special memoirs in the publications of the learned societies.

With the information then upon the form of birds' eggs in general given as above by Newton, and the facts that birds so low in the scale of organization as the Ostriches, Emus, Cassowaries, Apteryx, Tinamous, and Penguins lay eggs varying all the way from 1 to 30, being either globular or ellipsoidal in form, white or unitinted in color, with highly polished shells or the reverse case, I turned to the oölogy of existing reptiles to ascertain if possible what its study would offer in contrast. With this in view I communicated with my friend Prof. Samuel Garman, of the Museum of Comparative Zoölogy of Harvard College, and in his reply the following facts were kindly placed at my disposal.* That distinguished herpetologist, observes: "All eggs of reptiles, so far as I know, are white. Those eggs with a limy covering are pure white; those leather-covered, without the lime, are sometimes dingy to yellowish, or flesh tinted. Marine tortoises lay spherical eggs. So, also, do various river tortoises, as *Podocnemys* of the Amazon. In species laying ellipsoidal eggs individuals sometimes vary to the spheroidal, in the snapping tortoise (*Chelydon*) for instance. Some of the land or box tortoises lay a very small number of eggs, possibly the smallest among the reptiles. The largest number is attained by sea tortoises, species of which are said to lay more than 200 in a season. The Crocodiloidea also lay large numbers. Some of the smaller lizards lay very few; the average will probably be smaller in lizards than in tortoises or snakes. The lizard's eggs with which I am acquainted are all ellipsoidal in shape. A near approach to the spheroid is made in some cases, as *Gonatodes*, a small Geckoid. The greatest departure from the spheroid is seen in some snakes, as for instance *Scatophis* or *Pityophis*. Of tortoises or lizards I know none that incubate, though some of the latter have acted as if keeping guard over the eggs until hatched. As you are aware various lizards and snakes hatch the eggs before extrusion, being ovoviviparous. The pythons coil around the eggs to hatch them. Both ends of the reptile egg are usually alike; neither is pointed as in a bird. The alligator, as you know, has a habit of nesting like that of the *Megapodes* of the birds."

It is as well to remark at this point that, according to Wallace,† the

* Dr. Leonard Stejneger, curator of the department of reptiles, U. S. National Museum, also sent me a letter on the same subject, for which I desire to express my thanks. Such information as he was able to furnish me, however, is contained in Prof. Garman's letter, where the ground is more fully covered.

† Wallace, A. R., The Malay Archipelago, New York, 1869, p. 166. Upon pages 402 and 403 of this work the author also says of *M. wallacei* that it "comes down to the seabeach to deposit its eggs; but instead of making a mound or scratching a hole to receive them, it burrows into the sand to the depth of about 3 feet obliquely downward and deposits its eggs at the bottom. It then loosely covers up the mouth of the hole, and is said by the natives to obliterate and disguise its own footmarks

Megapodes lay *brick-red* eggs, and Sharpe tersely remarks in his Classification of Birds, "Nest *none*. Eggs deposited in a mound raised by many of the birds in concert. Young hatched without the intervention of the parent bird, and able to fly almost from birth" (p. 68). It would seem then that in the nesting habits of the *Megapodes*, we see not a little to remind us of the corresponding habits in some of the reptiles. According to Gibson crocodiles "are oviparous, depositing their eggs, from 20 to 60 in number and inclosed in a calcareous shell, in holes made in the sand or mud of the river side, where they are left to be hatched by the heat of the sun, or as in the case with certain American species, in hillocks formed by themselves which they hollow out and fill with leaves and other decaying vegetable matter, where the eggs are hatched by the heat generated in the decomposing mass."* The very distinguished herpetologist, Prof. E. D. Cope, also briefly writes me thus, his communication being dated Philadelphia, December 15, 1892: "As to reptile eggs I know of none excepting those of Crocodilia, which are not elliptic and white. Tortoises lay more eggs than either lizards or snakes, so far as known. No incubation among reptiles is known to me excepting in the cases of Pythonid snakes. I must add that a great deal remains to be known on the subject."

Among the CRACES the nest is placed in a tree, the eggs are *white* and two in number. (Sharpe, *loc. cit.*, p. 68.)

With the facts that I have enumerated in the foregoing paragraphs at our command, we can next pass to the consideration of the oölogy of the various groups of birds occurring in the avifauna of the United States, and here, relying as I do upon the published works of authors, who are widely recognized as authorities in such matters, I find the greatest amount of variance in the descriptions. These differences of opinion refer to the number of eggs laid by any particular species of bird, to the coloration of the eggs, and to the questions of nesting and incubation. In cases where, from the rarity of specimens, or where the eggs of certain species are known to vary even in the clutch laid by the same individual, and so on, there may be some excuse for this, but in cases where hundreds or even thousands of eggs of the same species have been examined by competent describers, it would seem that it is about time we had something like uniformity in description. This is only too frequently not the case, as the reader later on will soon discover.

Among our more lowly organized groups of birds stand the Divers (*Urinatoroidea*), and Grebes (*Podicipoidea*), related as they are to the

leading to and from the hole by making many other tracks and scratches in the neighborhood. It lays eggs only at night. * * * All these birds seem to be seminocturnal. * * * The eggs are all of a rusty-red color, and very large for the size of the bird."

* Gibson, John, Art. "Crocodile," Encycl. Brit., 9th ed., vol. VI, p. 593.

extinct toothed-birds of the genus *Hesperornis*,* and yet their nidification is not as indicative of reptilian affinity as is that of some of the higher groups. Of course it is not at all likely that we shall ever know what the eggs of any of the toothed birds looked like, or much less what their breeding habits were, but it is fair to presume that it differed in important particulars from existing *Pygopodes*. I am of the opinion, however, that all the early reptiles and reptile-like birds laid *white* eggs, of either an ellipsoidal or of a spheroidal form, and they were not hatched by the parents. In number they may have been few or many.

Authors appear to be agreed that with respect to the Grebes they build a nest of rushes and sedges, etc., which to a greater or less extent floats upon the surface of the water in ponds and marshes among the reedy growths there occurring. They differ, however, in their descriptions of the eggs. Newton says their eggs have "a chalky white shell almost equally pointed at each end;"† Ridgway states "eggs 2 to 5, dull white, bluish-white, or very pale bluish-green," while Coues observes that "the eggs are more numerous than in other pygopodous birds, frequently numbering 6 to 8: elliptical, of a pale or whitish color, unvariegated; commonly covered with chalky substance.‡ Dr. Sharpe, in his Classification of Birds, says the eggs are white,§ but does not mention the number laid by members of this group. Both in form and color, then, Grebes' eggs remind us of reptiles', which is not the case in either particular with the Divers. Here we find according to Coues that the *Colymbidæ* "lay two or three dark-colored spotted eggs in a rude nest of rushes by the water's edge" (*loc. cit.*, p. 789), while Ridgway declares the eggs to be but two, "elongate-ovate, deep brown or olive, latter sparsely speckled or spotted with dark brown and blackish" (*loc. cit.*, p. 7). Sharpe says nothing about their being spotted, but that they are two in number and of a "dark olive-brown" (*loc. cit.*, p. 7). The eggs of these birds are probably spotted and the fact is an important one, as it is not only a point of difference between their eggs and those of the Grebes, but in that particular they differ from the eggs of any known reptile. They are the first eggs that have markings on them that we meet with among the lower groups of our birds. The difference in form is equally important, as it is likewise the first departure from the reptilian ellipsoidal or spheroidal form of egg, it being in the Divers larger at one end than it is at the other.

The TUBINARES is another group wherein we find the birds laying, as a rule, an ovate or subovate egg that may be spotted or pure white.

*Shufeldt, R. W., Concerning the taxonomy of the North American Pygopodes, based upon their osteology. Jour. of Anat. and Phys., vol. XXVI, Lond., 1892, p. 199.

†Art. "Grebe," Encycl. Brit., 9th ed., Vol. XI, p. 80.

‡Ridgway, Robert: A Manual of North American Birds, 1887, p. 4. For the American Eared Grebe this author gives "eggs four to eight" (p. 6).

Coues, E. Key to North American Birds, 1884, rev. ed., p. 793.

§*Loc. cit.*, p. 71.

The following table compiled from Coues's Key (rev. ed.) and Ridgway's Manual will fairly present the oölogical characters of this group.

Oölogy of North American Tubinares.

Species, etc.	Coues.	Ridgway.
General characters, the Albatrosses.		Egg single, ovate or elliptical ovate, white, sometimes speckled or sprinkled on large end with reddish brown (p. 50).
D. albatrus	Single egg, on the ground, nearly equal ended; white; both sexes incubate.	
Phæbetria fuliginosa		Egg white, minutely sprinkled with brown on larger end (p. 53).
PROCELLARIIDÆ		Egg single, white (unless adventitiously stained) (p. 53).
Fulmarus glacialis	Egg single, white, with rough brittle shell, resembling a hen's egg in size and shape (p. 778).	
Puffinus puffinus. (Manx Shearwater.)	Egg single, dead white, smooth, 2.35 × 1.60 (p. 786).	
Oceanodroma leucorhoa, Leach's Petrel.	Egg single, white; nest in burrows in the ground (p. 781).	

Passing next to the Auks (ALCÆ) we find Dr. Sharpe briefly referring to them as follows: "Egg single, white when in a burrow, otherwise of varied and beautiful color and markings when laid on a rock" (*loc. cit.*, p. 71), and Coues states it differently, inasmuch as he says "eggs few or single, plain or variegated" (Key, p. 797.) Ridgway agrees with Sharpe, declaring the "egg single," though "variable as to form and color" (Manual, p. 8). Coues, in describing the egg of *Alle*, again finds an exception to Sharpe's diagnosis, for he says the "single egg" laid by that bird is pale greenish-blue (Key, p. 811), but confirms his statement given above that Auks lay more than a single egg, in his description of *Uria grylle*, and he remarks of that species, the Common Black Guillemot, that the "eggs, 2 to 3, sea-green, greenish-white or white, spotted and blotched most irregularly with blackish-brown, and with purplish shell markings" (Key, p. 815). According to this authority then an Auk may lay as many as 3 eggs, and another species may lay a blue unmarked egg. The Great Auk, probably now extinct, and one of the most ancient types of the suborder ALCÆ, laid, as we know, a single egg, which was a milk white, spotted and blotched with dark brown. In form the eggs of Auks assume some modification of the *ovate*, but are never ellipsoidal or spheroidal. We take it then, judging from such premises, that these birds stand much higher above the reptiles than do any of the Ostrich types. It would seem that this subject will bear its share of thorough revision, for as I write these lines I ascertain through the kindness of Capt. Bendire, who has kindly given me access to the superb collection of birds' eggs of the U. S. National Musem, that *Alle alle* normally lays 2 eggs, and that they are of a very pale greenish-blue, almost white. They are very uniform, both in form and color, and the collection contains eight or ten sets of them. This

does not fully agree with either the statements of Coues or Ridgway; and we find similar discrepancies in the next suborder or the LONGIPENNES, as the subjoined table clearly shows.

Oölogy of Longipennes.

Species, etc.	Coues.	Ridgway.
General description	Eggs, generally 3, light-colored, with numerous heavy dark blotches. Nidification normally terrestrial. (Key, pp. 733, 774.)	None given. (Manual, p. 20.)
Xema sabinii	Eggs 3, * * * brownish-olive, sparsely splashed with brown. 1.75 × 1.25. (Key. p. 753.)	Eggs 2–5, * * * deep olive (varying in intensity, however), rather indistinctly spotted or blotched with brown. 1.78×1.26. (Manual, p. 38.)
Sterna antillarum. (Least Tern.)	Eggs, 1, 2, or 3 in number; ground color, varying from pale clear greenish to dull pale drab, speckled all over with small splashes, etc. 1.20 to 1.30 × 0.99. (Key, p. 767.)	Eggs 2–4, white, buffy white, or buff, spotted with brown or purplish gray. 1.28 × 0.91. (Manual, p. 46.)
Rhynchops nigra	Eggs 3 in number, pure white, spotted and splashed with dark browns and blackish, and pale neutral tint. (Key, p. 773.)	Eggs 2–5, white, buffy white, or pale buff, marked with large bold spots of rich dark or deep brown, and smaller, fainter spots of purplish gray. (Manual, p. 49.)

Gulls, Jaegers, Terns, and Skimmers (*Rhynchops*) all lay eggs of some form of the ovate or "short" ovate. *Chionis minor*, it may be interesting to know in this connection, "lays 2 or 3 eggs,"* which according to Dr. Kidder differ much in color, the general tint, however being a *café au lait*, irregularly blotched with several shades of dark sepia-brown, chiefly near the larger end; but according to Dr. Sharpe the blotches are of a "purple" color (*loc. cit.*, p. 72).

As we know, among the *Limicolæ*, the eggs are generally four in number, with a ground color of some shade of buff or olive, more or less spotted and blotched, and of a pyriform shape. The markings are commonly of some shade of brown, almost black in some instances, or purplish. Coues, in his "Key," ignores the eggs of a great many of the limicoline birds, including such interesting forms as the Woodcock, Oyster Catchers, and Turnstones. The study of the oölogy of this group is important, for "Perhaps the greatest scientific triumph of oölogists lies in their having fully appreciated the intimate alliance of the *Limicolæ* (the great group of Snipes and Plovers), with the *Gariæ* (the Gulls, Terns, and other birds more distantly connected with them), before it was recognized by any professed taxonomist, L'Herminier, whose researches have been much overlooked, excepted; though to such an one was given the privilege of placing that affinity beyond cavil" (Huxley, Proc. Zoöl. Soc., 1867, pp. 426, 456–458; *cf. Ibis*, 1868, p. 92).†

If for our present purposes we include in a suborder (HERODIONES) the Ibises, the Storks, the Herons, Egrets, Bitterns, and their natural

* Kidder, J. H.: Bull. U. S. Nat. Mus. No. 3, 1876, p. —

† Newton A., Art. "Birds," Encyl. Brit., p. 773.

allies, we have an interesting group, presenting a number of peculiarities in their oölogy. Dr. Sharpe says of the Ibises ("*Plataleæ*") that in *Platalea* the eggs are "greenish-white" with spots, while in *Ibis* they are "green" (*l. c.*, p. 75). Now, Coues makes the statement that the eggs of our American Spoonbill (*Ajaja*) are usually 3 in number, "nearly elliptical and white" (*Key*, p. 652), while Mr. Ridgway gives an entirely different description of them when he says that they are "ovate, white, or buffy white, blotched, spotted, and strained with various shades of brown" (Man., p. 123).

A similar confusion of description is extended to the eggs of Ibises. Coues says the eggs of the Glossy Ibis (*P. falcinellus*) are ovoidal in shape and "greenish-blue" in color (Key, p. 649), while Ridgway remarks that both Glossy Ibis and White-faced Glossy Ibis lay eggs of a "plain greenish verditer blue" color (Manual, p. 114); and Coues says the last-named species lays green eggs, 3 or 4, rarely 5 in number (Key, p. 651). Ridgway states that both the White Ibis and the Scarlet Ibis (*G. alba* and *rubra*) lay eggs that are "greenish-white, buffy, or pale brownish, stained, blotched, and spotted with brown" (Manual, p. 123). Coues describes the eggs (3 in number) of *G. alba* as being of a "dull, chalky white, blotched, and spotted with pale yellowish and dark reddish-brown" (Key, p. 651). When Dr. Sharpe in his description said the eggs of the *Ibis* were "green," as cited above, he must have referred to the Glossy Ibis, and *not* the Sacred Ibis (*Plegadis falcinellus* and *not Ibis æthiopica*), though he says "*Ibis*." Newton observes that the eggs of the Sacred Ibis "are of a dingy white, splashed, spotted, and speckled with reddish-brown;" and further remarks of the Glossy Ibis (*P. falcinellus*) that "one of the most remarkable things about this species is that it lays eggs of a deep sea-green color, having wholly the character of heron's eggs, and it is noticed that it often breeds in company with herons, while the eggs of all other Ibises, whose eggs are known, resemble those of the Sacred Ibis." (Art. "Ibis," Encyl. Brit., v. XII, p. 607.)

Tantalus loculator, according to Coues, lays "eggs 2 to 3, elliptical in contour, shell rough, with flaky substance; color white (Key, p. 653), while Ridgway contends that the eggs of this bird are "usually more or less stained, in streaks, with pale brownish." (Manual, p. 125.)

Mr. Ridgway says that all our North American Herons (*Ardea, Nycticorax*) lay "plain, bluish-green eggs, varying in depth of color" (*l. c.*, p. 128); Sharpe remarks that the eggs of the *Ardeæ* are "generally blue" (*l. c.*, p. 75); while Dr. Coues pretty thoroughly covers the ground for the Herons when he observes that they "are altricial, and generally nest in trees or bushes (where their insessorial feet enable them to perch with ease), in swampy or other places near the water, often in large communities, building a large, flat, rude structure of sticks. The eggs vary in number, coincidently, to some extent, with the size of the species; the larger Herons generally lay 2 or 3, the smaller kinds 5 or 6; the eggs are somewhat elliptical in shape and usually of an unvarie-

gated bluish or greenish shade." (Key, p. 656.) When we come to the Bitterns, however, a peculiar difference is to be noted, and the description of their oölogical characters are set forth in the subjoined table:

Eggs of American bitterns.

Species.	Cones.	Ridgway.
Botaurus lentiginosus	Nests on the ground; eggs, 3–5; brownish-drab, with a gray (*not* green) shade. 1.90 to 2.00 × 1.50. Key, p. 664.)	Eggs pale olive-drab, orp ale isabella color. 1.88 × 1.43. (Manual, p. 126.)
B. exilis	Eggs, 3–5, elliptical, white, with faintest tinge of bluish 1.92 × 1.22 (*l. c.*, p. 665).	Eggs white, or greenish-white. 1.20 × 0.93. (*l. c.*, p. 127).

If the Bitterns are to be considered as a subfamily of the *Ardeidæ* (*Ardeæ* Sharpe), it can not be truly said that all the representatives of such a group lay *blue* eggs.

More uniformity seems to exist among authors in their descriptions of the eggs of the Cranes, Rails, and their allies (suborder PALUDICOLÆ). Selecting the works I have thus far consulted, we find the following characters variously given:

Oölogy of the Paludicolæ.

Species, etc.	Cones.	Ridgway.
Cranes (*Grus*)	Nest on the ground; eggs few (p. 666).	Eggs pale olive or olive buffy, spotted with brown, reddish-brown, and purplish-gray.
Grus americana	Eggs 2 (or 3?) 3.75 × 2.65 light brownish-drab, rather sparsely marked, except at great end, with large irregular spots of dull chocolate brown, with paler obscure shell-markings; shell rough, with numerous warty elevations and punctulate (p. 667).	Size 4.04 × 2.50.
Aramus		Eggs 4–7 (sometimes as many as 15?) (2.32 × 1.70, pale dull buff, spotted, daubed, and stained with brown and purplish-gray (p. 136).
A. giganteus		
Rallas	The eggs are numerous, generally variegated in color (p. 670).	Eggs 6–15, white, buffy white, dull buff, or pale brownish-buff, rather sparingly spotted and speckled with rusty brown and purplish-gray (p. 137).
Porzana noveboracensis	Eggs about 6, rich, warm buffy-brown, marked at the great end with a cluster of reddish-chocolate dots and spots (p. 674).	Eggs 6 or more, creamy-buff densely sprinkled and speckled on larger end with rusty brown (p. 140).
Crex crex		Eggs about 11, light-buff or pale olive buff, spotted longitudinally with cinnamon brown or rusty and purplish gray (p. 140).
Ionornis martinica	Not recorded (p. 676)	Eggs 6–10, pale cream color or creamy white, speckled (sometimes, also, sparingly spotted), chiefly around larger end with brown and purplish gray (p. 141).
Gallinula galeata	Nidification exactly that of the coot (p. 675).	Eggs 8–13; buff, pale buff, brownish-buff, or buffy brown, sparsely spotted with dark brown (p. 141).
Fulica americana	Eggs about a dozen, broad, shaped like an average hen's egg, clear clay color, uniformly and minutely dotted with dark brown, the spots usually mere pin-heads, sometimes large blotches. 1.75 to 2.00 long by 1.20 to 1.35 broad (pp. 676, 677).	Eggs 6–12, pale dull buff, finely dotted or sprinkled with brownish-black and purplish-gray. 1.91 × 1.32 (pp. 141, 142).

From what this table shows it would appear that in so far as their oölogy seems to indicate, the Cranes and Rails are not very intimately related and I find Dr. Sharpe, in his Classification of Birds, placing them widely asunder, though he retains the "*Aramí*" with his GRUIFORMES (order XIX), and the "*Podicæ*" with the RALLIFORMES (Order X). Dr. Gadow retains them both in GRUIFORMES. (P. Z. S. 1892, pp. 244, 245).

Our next group is the STEGANOPODES, and I find considerable difference of opinion exists not only as to the number of eggs normally laid by steganopodous birds, but as to the general character of those eggs. Coues, in presenting the oölogy of the group, says: "The eggs are very few, frequently only one, usually if not always plain-colored, and incrusted with a peculiar white chalky substance" (p. 719).

THE SULIDÆ.

Dr. Sharpe.....Egg, 1 only, white, with a chalky texture (p. 77).

Dr. Coues.....Egg, generally single, is plain in color, and incrusted with a calcareous matter (p. 720).

(*Sula bassana*).....Egg, single, pale, greenish-blue, flaked over with white chalky substance (p. 720).

Mr. Ridgway (*Sulidæ*).....Eggs 1–2, elliptical or elongate-ovate, chalk-white superficially, but beneath the calcareous crust pale greenish-blue (p. 75).

THE PHALACROCORACIDÆ.

Dr. Sharpe (in the Anhingidæ).....Eggs four, white or light-blue, with a chalky texture (p. 77).

Dr. Coues (not including the *Plotidæ*).....Eggs are commonly two or three, of elliptical form, and pale greenish color, overlaid with a white chalky substance (p 726).

Mr. Ridgway (not including the *Anhingidæ*).....Eggs 2–5, elongate-ovate, pale bluish green, with a more or less continuous white chalky crust (p. 77).

Dr. Coues (*Plotus anhinga*)..Eggs 3–4, like cormorant eggs in color and texture, but narrow and elongate (p. 730).

THE PELECANIDÆ.

Dr. Sharpe.....Egg, one only, white with a chalky texture (p. 77).

Dr. Coues (*P. fuscus*).....Eggs 2–3, white, chalky, elliptical (p. 723).

Mr. Ridgway (*Pelecanus*)....Eggs 1–4, oval, ovate, or elongo-ovate, with rough chalky shell, pure white, but usually much blood stained (p. 81).

THE FREGATIDÆ (Frigate birds).

Dr. Sharpe.....Egg only one, white, much smoother than those of *Sula* (p. 77).

Dr. Coues (*Tachypetes aquilus*).....Eggs 2–3 in number, are greenish-white, with a thick smooth shell. 2.90 × 2.00. (P. 731.)

Mr. Ridgway (*Fregata aquila*).....Eggs (usually only 1), pure white, oval, ovate, or elongo-ovate. 2.70 × 1.83. (P. 83.)

Dr. Coues makes no record of the characters of the egg of *Phaëthon* in his "Key" (pp. 731, 732), but Ridgway describes the egg of the genus (common char.) as "egg ovate, dilute claret-brown or whitish, speckled, sprinkled, spotted or blotched with deep claret-brown" (p. 74). Dr. Sharpe says of his *Phaethontes*, "Egg, one only; mottled reddish-brown" (p. 76). This is a curious departure from the steganopodous birds generally, and so far as it goes, reminds us of the *Longipennes* in color, that is being spotted, but *Steganopodes*, in being but one of them laid.

Prof. Newton says *Sula bassana* lays only a "single egg" with "a white shell of the same chalky character as a Cormorant" (A. N., Art. "Gannet," Encyl. Brit., vol. x, p. 71), but that *Pelecanus*, or the Pelicans, lay "2 eggs commonly" (Art. "Pelican," *loc. cit.*, vol. XVIII, p. 475). Here certainly authors do differ most widely. Dr. Sharpe declaring that Pelicans lay but "one egg only." Prof. Newton says two, and Ridgway says they lay as many as *four*.

A similar diversity of opinion appears to be extended to the oölogy of the representatives of the next group of birds, the ODONTOGLOSSÆ.

Prof. Sharpe says the Flamingoes lay a "*single* white egg" (*l. c.*, p. 76), while most other authorities claim the clutch consists of *two* for those birds. Ridgway says "eggs [not how many] are pure chalk-white and of an elongate ovate, or cylindrical ovate" form. (Manual p. 121.) Possibly he may mean *two* or *more*.

Dr. Coues is positive about it when he observes for *Phœnicopterus ruber*, "Eggs 2, 3.25×2.10, with thick shells, roughened with white flaky substance, bluish when this is scraped away" (p. 679). Flamingoes' eggs have been known for a long time, and Newton, quoting Dampier, observes* that these birds "never lay more than two eggs and seldom fewer."

Coming next to the Swans, Geese, Ducks, and their allies (ANSERES), the statements are more uniform in character, and the general one of Dr. Coues "the eggs are usually of some plain pale color, as greenish, drab, or creamy: the clutch varies in number, commonly ranging from half a dozen to a dozen and a half" (p. 681); or that of Dr. Sharpe, "eggs numerous, creamy buff, or greenish white, or pure white" (p. 76), will probably cover the ground. Our Swans lay from 2 to 5 eggs, rough-shelled, and of a dull white color (Coues), while among the Geese we find *Philacte canagica* lays 5 eggs, which are white, "with fine pale brown dotting, giving a general pale dirty brown color," and *Branta canadensis* lays as many as "5 to 9, ellipsoidal, smooth, pale dull greenish" (Coues, pp. 686–688). The number becomes still greater among the Ducks, and our American Wigeon (*M. americana*) often lays as many as 12 eggs of a "dull pale buff" color, and the little Buffle-head (*C. albeola*) as many as 14, they being of an ellipsoidal form and of a "buffy-drab tint (between greenish-olive and rich creamy-white"

*Newton, A.: Art. "Flamingo," Encycl. Brit. vol. IX, p. 286, cites Dampier, New Voyage round the World, ed. 2, corrected, vol. I, p. 71, London, 1697.

(Coues, p. 706). Eider Ducks also lay from 8 to 10 drab-colored eggs, and the Mergansers lay about an equal number—they being white in the Hooded Mergansers (*L. cucullatus*) (Ridgway). Swans and Geese, then, as a rule, lay the fewest number of eggs, and certain varieties of the smaller species of Ducks the greatest number, and at least one anserine bird lays spotted eggs (*P. canagica*—the Emperor Goose).

When we come to examine the oölogy of the great Columbo-gallinaceous group, one well represented in the avifauna of the United States, it is possible to make the comparisons quite extensive, owing to Bendire's exhaustive labors, as seen in his fine quarto volume already spoken of at the beginning of this paper. This I shall endeavor to do in a table, incorporating also the observations of Dr. Coues and Mr. Ridgway, and giving the majority of the species of the two suborders (*Gallinæ* and *Columbæ*):

Oölogy of American Gallinæ.

[Pagination after Dr. Coues's name refers to his "Key" (rev. ed. 1884), after Ridgway's to his "Manual," and after Bendire's his "Life Histories of North American Birds." Nomenclature of A. O. U. "Checklist."]

Groups, species, etc.	Dr. Coues.	Ridgway.	Bendire.
Colinus	Eggs white, pyriform, numerous (*Ortyx*. p. 589).	Eggs numerous (12 to upward of 20), pyriform-ovate, white, usually more or less stained (adventitiously?) with light brown (p. 187).	Eggs varying from 12–18; in form from round ovate to subpyriform in shape; are dull white in color, slightly glossy, sometimes stained with grass or soil (pp. 4, 6). *C. virginianus*.
Oreortyx pictus	Eggs colored; a miniature of the ruffled grouse's, only distinguished by smaller size (p. 591).	Eggs cream color or creamy buff, varying in depth of color (p. 190).	Same as Ridgway. Shape short ovate; resemble unmarked eggs of ruffed grouse (p. 14).
Callipepla squamata	Eggs 10–12–16, rather elliptical than conical, white, minutely freckled with buff (p. 594).	Eggs white, buffy white or pale buffy, usually more or less distinctly sprinkled or speckled with brown (p. 191).	Number ranges from 9–16. Lusterless; pale buff; markings sharp, small, brown to fawn, equally distributed (p. 21).
Cyrtonyx	Not given	Egg (identification very doubtful) plain white (p. 194).	Eggs 10; rather glossy, white; generally ovate in form (p. 40).
Dendragapus obscurus	Eggs creamy-buff, finely freckled all over with chocolate-brown, seldom with any large spots (p. 579).	Eggs 8–15, buffy or pale brownish, sprinkled, speckled, or more rarely spotted with dark brown (p. 194).	Eggs average 8–12; ovate in shape; pale cream to cream buff; more or less spotted over entire surface with fine dots of chestnut-brown (p. 49).
Bonasa umbellus	Eggs very characteristic, from creamy white to creamy buff, usually immaculate, sometimes minutely dotted, etc.; pyriform (p. 585).	Eggs 6–10 or more, buffy, usually plain, sometimes speckled with brown (p. 197).	Eggs 8–14, average 11, ovate or short ovate, milky white to pinkish buff, occasionally finely speckled, etc. (p. 63).
Lagopus	Eggs very heavily colored, with bold confluent blotches of intense burnt-sienna color, upon a more or less reddish-tinted buff ground (p. 586).	Eggs about 10–16, more or less heavily spotted or marbled with dark brown or black on a buffy or light-rusty ground (p. 198).	Eggs average 11–16, ovate to elongo-ovate, cream color to reddish buff, some specimens heavily marked with confluent blotches and markings (p. 74).
Tympanuchus	Pale greenish-gray, with sometimes a glaucous bloom, usually unmarked, sometimes very minutely dotted with brown (p. 584).	Eggs 8–12, light drab, olive, or dull buffy, etc. (p. 202).	

Oölogy of American Gallinæ—Continued.

Groups, species, etc.	Dr. Coues.	Ridgway.	Bendire.
Centrocercus	Essentially agrees with Ridgway.	Eggs 6–15, varying from pale olive buff to light olive greenish, speckled, sprinkled, or spotted with deep brown (p. 205).	Essentially ditto.
Meleagris	Not given	Eggs 10–18 or more, light buffy, thickly (but sometimes indistinctly) speckled or sprinkled with brown (p. 206).	The ground color varies from pale creamy white to creamy buff (p. 116).
Ortalis vetula maccalli	Eggs generally 3, with a thick, granular, and very hard shell, like a guinea fowl's, oblong, oval, buff-colored, or creamy white, large for the bird (p. 573).	....do	Do.
	COLUMBÆ.		
Columba fasciata	Eggs 2, equal-ended, white, glistening (p. 565).	For the family *Columbidæ*. Eggs 2, plain white or buffy white (p. 210).	Large for size of bird; " " pointed elliptical ovate, pure white, glossy (p. 127).
Ectopistes migratorius	Eggs 1 or 2, equal-ended (p. 566).		Eggs 1 or 2, elliptical oval, pure white, slightly glossy (p. 138).
Zenaidura	....do		Eggs 1 or 2, pure white, oval or elliptical oval, or elliptical ovate (p. 142).
Zenaida	Not given		Eggs 2, pure white and oval, more rounded than pigeons usually are (p. 144).
Engyptila	Not given		Eggs 2, elliptical oval, cream buff, glossy (p. 145).
Melopelia	Eggs 2, white or creamy (p. 569).		Eggs 2, seldom 1; when fresh a rich creamy tint; as incubation advances fades to a dull dead white (p. 147).
Columbigallina, Scardafella.			Eggs 2, white.
Geotrygon martinica			Not known.
Starnœnas			Not positively known.

As will be seen from this table, and as has long been known, the eggs of the Fowl series differ very materially from those of the Columbine series of birds. In this connection I quote the following from Dr. Sharpe: "As far as their osteology goes the sand grouse are very columbine, and had they occurred in a fossil state only they would probably have been placed in the Columbæ. * * * Nest none. Eggs three, double-spotted, equally rounded at both ends. Nestling Galline. Young clothed with down like the young of a Partridge, but more variegated with white tufts." (Class of Birds, p. 69.)

Among the *Cathartidæ* and Raptorial birds (ACCIPITRES), exclusive of *Striges*, we find a great diversity of eggs, both in the matter of form and color. This seems to be especially true of the Hawks, Eagles, and their allies, where not only the same species may lay very different-appearing eggs, but in some cases the same individual may do likewise and variously

tinted eggs be discovered in the same clutch. According to Bendire the California Vulture (*Pseudogryphus*) lays *two* elongate ovate, slightly glossy eggs of a uniform light grayish-green color and unspotted. They differ from the eggs of other Vultures in that they are "close grained and deeply pitted" (p. 161). Of the Turkey Vulture (*Cathartes aura*) he observes that "two eggs are usually laid, occasionally but one, and very rarely three. These are among the handsomest eggs of the *Raptores*. Their ground color is generally a light creamy tint, occasionally a dull, dead white, with a very faint trace of green in some few instances. They are blotched, smeared, and spotted with various shades of reddish-brown, chocolate, and lavender, the markings usually predominating about the larger end of the egg, and very irregular in outline. In eggs belonging to the same set the markings frequently differ greatly in size and intensity, one being heavily marked and the other but slightly. Occasionally an egg is found which is entirely unspotted. The eggs also vary greatly in shape; the majority are elongate ovate, a few are ovate, others elliptical ovate, and now and then one is perfectly cylindrical ovate" (p. 164). *Catharista atrata*, on the other hand, lays eggs which "are readily distinguished from those of the Turkey Vulture by their different ground color, somewhat larger size, and fewer markings as a rule. By far the greater number of eggs are elongate ovate, a few are short ovate, others elliptical ovate. Their ground color is a pale gray-green; in none of the specimens before me can it be called a creamy white; the tint is perceptibly different. In an occasional specimen it may be called pale bluish-white, like well-watered milk, but the first-mentioned color predominates. "The markings vary from chocolate to reddish-brown of different tints, and mixed among these, in about half of the specimens, are found shell markings of lilac and lavender; in an occasional specimen these predominate over the first-mentioned tints. In the series before me all the markings are rather irregular in shape and are clustered about the larger end of the egg. They are usually large and seldom confluent. A few eggs are but slightly marked, and the spots are small and fine, but none are entirely unspotted." (*Loc. cit.*, pp. 167, 168.)

We now come to the *Falconidæ*, a group of birds which are known, as a rule, to lay very beautiful eggs, and one has but to examine the richly colored and thoroughly accurate figures in Capt. Bendire's work to fully appreciate this fact.

Ridgway observes that *Elanus leucurus* lays from 2 to 3 eggs, but Bendire says they lay more than that commonly, and that the "set varies from 3 to 5, generally 4." They are of great beauty, the "ground color is creamy white, and they are heavily marked over their entire surface with irregular confluent blotches and smears of dark blood red and claret brown, of different degrees of intensity, the smaller end being often the more heavily colored. But little of the ground color is visible

in the majority of the specimens. Some sets are much lighter than others, possibly a second laying. The eggs are usually oval in shape." (Bendire.) Coues contends that one of these Kites may lay as many as 6 eggs, and that in form they are "subspherical." (p. 525.)

The question of the difference in egg markings of birds of the same species, or even, as I have said, in the eggs of the same individual, is one of great interest. From all that has been gathered it would appear to largely depend upon the physical condition of the parent bird at the time of depositing the egg. Captivity and fright have also their influence, the secretions of the oviduct being often checked or even entirely arrested at such times. Age likewise has much to do with it, and the fact is now pretty well established that the older a bird is the more intensely will its eggs be colored, meaning, as I do, of course, those species which lay colored eggs, either tinted all over or with varied markings. Young birds of the first season lay lighter eggs in all respects, for example, than those individuals which have bred for many years.

Another American Kite, *Ictinia mississippiensis*, lays, according to Bendire, usually but *two* eggs, or at the most 3. "They are rounded, ovate in shape, pale bluish white in color, and unspotted, or, as the rarest exception, show 'a few minute deeper blue shell markings.' (P. 179.) The eggs of this species were unknown to Dr. Coues. They are frequently adventitiously stained. The Everglade Kite (*Rostrhamus sociabilis*) also lays 2 or 3 eggs which are 'blotched, marbled, and stained with various shades of brown on a paler (sometimes bluish white) ground color.'" (Ridgway, p. 226.) In the Marsh Hawk we find a greater number of eggs laid (*Circus hudsonius*), as many as 6 according to Bendire (p. 186), and 8 in Ridgway's account (p. 226). They are commonly plain, with a white or bluish white ground color, but may be blotched and spotted with light buff and brown markings. They assume some form of the ovate in contour, and are generally glossy-shelled and smooth.

Oölogy of the genus Accipiter.

Species.	Ridgway.	Bendire.
A. velox	Eggs 2–5, white, greenish white, or bluish white, usually very heavily blotched with brown. 1.47 × 1.16. (p. 227.)	Eggs 4–5 (7 in one case), oval or short ovate; pale bluish or greenish white, heavily blotched, spotted, and marbled with various shades of brown. Some specimens ground color, hidden by confluent markings of cinnamon rufous. The different patterns of marking are endless in variety (p. 191).
A. cooperi	Usully plain bluish white, rarely faintly spotted with pale brownish. 1.93 × 1.50. (pp. 227, 228.)	Eggs 2–6 (varying with locality), pale bluish or greenish white (fades out in time). Many (50 per cent) are variously spotted (p. 195).
A. atricapillus	Eggs 2–3; white or glaucous white, sometimes very faintly marked with pale brownish. 2.31 × 1.74. (p. 228.)	Eggs 2–5; pale bluish white in color and unspotted (p. 198).

From this it will be seen that the eggs of Hawks may vary greatly in the same genus, from an unspotted white egg (*A. atricapillus*) to a *greenish white* egg, heavily marked all over (*A. velox.*).

Harris's Hawk (*Parabuteo*) also lays three or four eggs, which are white or a buff white, and show more or fewer light brown markings. About half the eggs of this species also lack markings. The eggs of our common Red-tailed Hawk (*Buteo borealis*), which I have collected upon numerous occasions, vary wonderfully in point of size. There are generally *four* to the clutch, and have a ground color of bluish white. Some have spots, others are irregularly marked with various brownish tints, which markings are of the greatest variety, no two specimens being exactly alike in pattern with respect to size, color, intensity, or distribution. Unspotted eggs occur in the same set with spotted ones. Bendire says of the Zone-tailed Hawk (*Buteo abbreviatus*) that its "eggs vary from 1 to 3 in number, usually 2, and seem to be for the most part unspotted. They are oblong oval in shape, pale bluish white in color, and the shell is rather smooth and finely granulated." (p. 233.)

Hawks of the genus *Falco* as a rule lay dark-colored eggs, more or less covered all over with markings of various shades of brown. *Falco mexicanus*, however, lays from 2 to 5 creamy white eggs, more or less sprinkled over with madder-brown spots and markings. Other whitish-colored eggs of species of this genus may have the ground color almost entirely hidden or obscured by the markings being so numerous and close together. The egg of the Aplomado Falcon is an instance of this kind. Audubon's Caracara (*Polyborus cheriway*) also lays from 2 to 3 eggs, which, according to Bendire, are "oval in shape; the ground color, when visible, which is not often the case, is creamy white, and in the majority of specimens is entirely hidden, the egg appearing to be of a uniform rufous cinnamon of different shades, some of the darker approaching vinaceous rufous. This is again overlaid with irregular blotches and spots of dark chocolate, claret, brown, and burnt umber. Most of these eggs are heavily marked, a few, however, only slightly, and in these the markings are usually small and more regular in outline, a few are unspotted, and although the ground color is not visible it is entirely overlaid with an even-colored cinnamon tint." (pp. 317, 318.) It would be impossible here, without far exceeding the limits of space, to begin to describe the eggs of the Osprey (*Pandion*). They are all wonderfully handsome, but vary in size, form, ground colors, and markings to an endless degree. To view Capt. Bendire's beautifully-colored figures of them (Pl. XI) one can hardly believe that they were laid by the same species of bird. Still the eggs of *Polyborus* shown upon the same plate vary quite as much and in the same particulars, and even more so in the matter of size.

Eagles, as in the case of the Falcons and Hawks, lay but few eggs, rarely more than three, and they also range from a pure white egg (*Haliæëtus leucocephalus*) to one showing upon its surface speckles, spots,

blotches, and a clouding with brown and gray (*Aquila*). Bendire remarks of the Harpy Eagle (*Thrasaëtus harpyia*) that "I have been unable to find a correct description of the egg of this species," and he supplies one from the specimens of that bird in the U. S. National Museum, and observes "the eggs are white, with yellowish-brown dots and washes, and about as long, though not quite as heavy, as a hen's egg. Of these eggs the Harpy lays 4 or 5, but never hatches more than 2, and, if the Indians can be believed, feeds the first two eaglets that make their appearance with the contents of the remaining eggs" (p. 271).

Coming next to the PSITTACI, I find that neither Coues nor Ridgway give in their works the number of eggs laid by our Carolina Paroquet (*Conurus carolinensis*); the former says "eggs whitish, 1.40 × 1.05, elliptical in shape, rough in texture" (p. 496), and the latter, "eggs 1.39 × 1.07, ovate, short ovate, or rounded ovate, pure white" (p. 270). Dr. Sharpe says simply "egg white" for his Order *Psittaciformes* (p. 83). I am of the opinion that the fact is not exactly known, and the truth of the matter is, we stand sadly in need of a knowledge of much in the biology of this entire and large group of most interesting birds.

COCCYGES: The parasitic habits of the European Cuckoo (*C. canorus*) are too well known to require comment here, and Coues observes that "the American Cuckoos have been declared free of suspicion of such domestic irregularities: but, though pretty well behaved, their record is not quite clean: they do sometimes slip into the wrong nest. The curious infelicity seems to be connected in some way with the inability of the female to complete her clutch of eggs with the rapidity and regularity usual among birds, and so incubate them in one batch. The nests of our species of *Coccygus* commonly contain young by the time the last egg of the lot is laid" (p. 471). Such habits, however, are departed from by the genus *Crotophaga*, birds which build a large nest for the use of a number of the species to lay in in common. In *Geococcyx* and *Coccygus*, species that lay numerous eggs at irregular intervals, we find often a fresh egg just laid and perhaps a nestling half as large as the parent bird, with an intermediate gradation of eggs in various stages of incubation and young grading up to the size of the one just mentioned.

Crotophaga ani may lay as many as 8 eggs, which according to Coues are "greenish" and to Ridgway a "dull glaucous-blue," but they are always more or less overlaid with a white substance chalky in nature, that in the recently laid egg easily washes off. Our Ground Cuckoo (*Geococcyx*) also lays white eggs or of a pale buff-white, and there may be as many as a dozen deposited before the bird completes her irregularly lain clutch. Opinions do not agree as to the number of eggs laid by our common Yellow-billed Cuckoo (*C. americanus*), Dr. Coues stating "eggs 4 to 8, pale greenish" (p. 476), and Ridgway, "eggs 2 to 4, dull pale glaucous-green or glaucous-white" (p. 273). And the latter authority says of the Black-billed Cuckoo (*C. erythrophthalmus* "eggs 2

to 4, deep glaucous-green or verditer-blue" (p. 274). The present writer discovered the nest of one of this latter species many years ago in New England, and it had *four* eggs in and *two* nestlings. It was a very slight affair for a nest, loosely put together with scanty material of twigs, etc., and placed upon the horizontal bough of a small apple tree.

I have never seen the eggs of any of the TROGONES, and personally know nothing of the nesting of our United States species *T. ambiguus*. Prof. Newton, however, remarks, "so far as has been observed, the nidification of these birds is in holes in trees, wherein are laid without any bedding 2 roundish eggs, generally white, but certainly in one species (Quezal) tinted with bluish-green" (Art. "Trogon," Encycl. Brit., vol. XXIII, p. 584). Doctor Sharpe makes a like statement, but no exceptions thereto. "Nest in hole of tree, eggs white" (Class. of Birds, p. 82).

We have two species of Kingfishers (ALCYONES) in our avifauna, *Ceryle alcyon* and *Ceryle cabanisi*. Either species usually lay *six* pure white eggs of an ovate or oval form. They are characterized by having smooth, glossy shells, which in the case of the last named species is very thin and brittle, having the appearance of being composed of porcelain. Such glossy and glassy, pure, white eggs are also laid by every species of our Woodpeckers (PICI), and those birds are very numerous in our avifauna—nearly forty of them. Ridgway in his "Manual" barely mentions the eggs of these birds, and Coues simply says that in form they are "rounded" (p. 479). Most all the species lay 6 to the clutch, but in *Dryobates villosus* and *Colaptes* 7 are sometimes taken. Probably in nearly all the species the eggs are more or less of an oval or ovate shape; all that I have ever collected I have found to be so.

In noticing the eggs of our Owls (STRIGES), I will rely almost entirely upon Bendire's work, so frequently quoted in this article.

Oölogy of Owls.

Asio wilsonianus.....Eggs 3–6 (sometimes 7); pure white; oval; shell smooth, finely granulated and rather glossy.

Asio accipitrinus.....Eggs 4–7 (rarely more); white; oval to elliptical ovate; sometimes nearly equally pointed at each end.

Syrnium nebulosum.....Eggs 2–4 (4 are rare); pure white; not very glossy; oval or rounded oval.

Scotiaptex cinerea.....Eggs 2–4; dull white; broad elliptical oval.

Nyctala t. richardsoni.....Eggs 3–7; pure white; oval; almost lusterless.

Megascops asio.....Eggs 4–5 (rarely 7 or more); pure white; oval or nearly globular; moderately glossy.

Megascops flammeolus.....Eggs 3–4; white, with a faint creamy tint; oval; shell strong, finely granulated; slightly glossy.

Bubo virginianus.....Eggs 2–3; white; little or no gloss; rounded oval; shell thick, coarsely granulated.

Nyctea nyctea.....Eggs 3–10 (usually 5–7); white, creamy tint in some cases; oblong oval in shape; no luster; a few corrugated lines starting a trifle beyond the center of the egg and run to the longer axis in most specimens.

Oölogy of owls—Continued.

Surnia ulula	Eggs 5–8; white; smooth; glossy.
Surnia u. caparoch	Eggs 3–7; white; oval or oblong oval; somewhat glossy; smooth, fine grained.
Speotyto cunicularia hypogæa	Eggs 6–11; (not rare to find 11); pure white when washed; rounded ovate and very glossy; shell close-grained and rather smooth.
Glaucidium gnoma	Eggs 4?
G. g. californicum	Eggs 3–4; dull milky white, with a faint creamy tint; lusterless; peculiarly pitted with punctures; very thin shells, almost semitranslucent.
G. phalænoides	Eggs 4; oval; compared with the last species shells much thicker; coarsely granulated; no pittings or punctures, but on the contary show a few slight protuberances on their surfaces.
Micropallas whitneyi	Eggs 2–5; commonly 3; pure white; oval; finely granulated and rather glossy.

From this table it will be seen that our largest Owls lay both the least number (*Bubo*) as well as nearly the greatest number (*Nyctea*) of eggs, the greatest number, however, probably being laid by the Burrowing Owls (*Speotyto*). In other words, it may be tersely said that our *Striges* lay from two to a dozen white, oval eggs, varying somewhat with the species.

An equally useful table for the oölogy of our CAPRIMULGI can be compiled from Dr. Coues's "Key," and his descriptions of the eggs of those birds is quite full.

The following is what he records upon the subject:

Oölogy of N. American Caprimulgi.

Antrostomus carolinensis	Eggs 2; 1.15 × 1.05; heavily marked in intricate pattern with browns and neutral tints.
A. vociferus	Eggs 2; 1.25 × 0.90; creamy white; heavily marked with browns and neutral tints.
Phalænoptilus nuttalli	Eggs 2; 1.05 × 0.80; elliptical; white.
Nyctidromus albicollis	Eggs 2; 1.25 × 0.92; creamy buff, spotted with pinkish brown and lilac.
Chordeiles virginianus	Eggs 2; elliptical; 1.52 × 0.87; finely variegated with stone-gray and other neutral tints, over which is scratched and pitted dark olive-gray; but the pattern and tints are very variable.
C. texensis	Eggs 2; heavily veined and marbled; 1.20 × 0.87.

The most remarkable exception, if it be true, among these birds, then, is the *elliptical white egg* of *Phalænoptilus*. For the *Caprimulgi* as a group, Dr. Sharpe says: "Eggs white, with scroll-like markings and spots" (p. 18), and Ridgway, for the family *Caprimulgidæ*, "Eggs deposited on bare ground, dead leaves, gravel, or sand, 2 broadly elliptical—oval, plain or spotted" (Manual, p. 297), and of *Phalænoptilus nuttalli*, "0.99 × 0.78, plain dead white, usually with a faint buffy or pinkish tinge" (p. 299). This latter author's descriptions of the eggs of

our Goatsuckers differ quite materially from those of Dr. Coues, which is probably due to the fact that the eggs of the several species themselves differ to such a marked degree both in color, form, and markings.

According to Newton, "The Guacharo (*Steatornis*) is said to build a bowl-like nest of clay, in which it lays 2 to 4 white eggs, with a smooth but lusterless surface, resembling those of some Owls." (Art. "Guacharo," Encycl. Brit. 9th ed. Vol. XXI, p. 227.) And we may add, this is not the only character we know of that indicates caprimulgostrigine affinity.

The Humming-birds need not detain us long; and it is very remarkable that for so large a group there is such complete uniformity, so far as we are at present aware, in their oölogy. Tersely it may be said that the TROCHILI all lay *two pure white* eggs, large for the bird in any species, and generally of an elliptical-oval, or elliptical-ovate form. These eggs remind me somewhat of the eggs of our smaller existing lizards.

In another suborder, the CYPSELI we are still ignorant of the character of the eggs of several of the species, but those of *Chætura pelagica* are well known. In that species from 4 to 5 are usually in a set. They are pure white, and narrowly elliptical in shape. The eggs of *Cypseloides niger* have as yet not been collected by any naturalist that I am aware. The eggs, too, of *Micropus melanoleucus* are unknown to me.

Lastly we come to that great host of birds included in the PASSERES, and here I propose to contrast the descriptions of Coues and Ridgway, confining myself principally to the various genera, occasionally only to the family where the eggs of the birds in the latter are very similar. Where birds of the same group differ to any marked degree such differences will be noted. Where the eggs of others are unknown the fact will also be shown; and I trust that such a table, condensed and compared, although it may add nothing that is new to the subject, will yet prove to be useful to the working oölogist.

Oölogy of North American Passeres.

Families, genera, etc.	Coues.	Ridgway.
1. TYRANNIDÆ.		
Milvulus forficatus	Eggs 4–5; white, boldly blotched with reddish on the surface, and lilac shell-spots.	Eggs 3–5; .88 × .66; pure white or creamy white, boldly but sparingly spotted with rich madder-brown and lilac-gray.
Tyrannus tyrannus	Eggs usually 4–6, white, rosy, or creamy, variously spotted or blotched in bold pattern with reddish and darker brown surface spots and lilac shell-markings.	Eggs 3–5; white, spotted with rich madder-brown or chestnut, and lilac-gray. [Eggs of this genus are particularly handsome objects.—R. W. S.]
Pitangus derbianus	Not given	Eggs 3–5, buffy white, speckled and spotted (the markings mostly longitudinal), chiefly on larger end, with madder-brown and purplish gray.

Oölogy of North American Passeres—Continued.

Families, genera, etc.	Coues.	Ridgway.
1. TYRANNIDÆ—continued.		
Myiozetetes texensis	Not given	Eggs unknown.
Myiodynastes luteiventris	Not given	Not given.
Myiarchus	Eggs scratched and snarled, but chiefly scrawled lengthwise with dark brown in close and intricate pattern.	Eggs 3–6, curiously marked with fine penlines and intricate pencilings of black and various shades of rich purplish-brown over a buffy or creamy brown.
Sayornis	Eggs, white (sparsely dotted; *S. fusca*).	Eggs 3–6, pure white, sometimes finely but sparsely speckled round larger end with dark brownish.
Contopus	Eggs spotted	Eggs 2–4, pale cream-color, handsomely wreathed round larger end with spots of rich brown and lilac-gray or lavender.
Empidonax	Eggs spotted (*E. flaviventris*) or white (*E. minimus*); also *E. obscurus*, where they are 3–4 and large.	Descriptions of eggs of the difficult genus practically agree with those given by Dr. Coues: *E. acadicus* eggs 2–4; creamy white, spotted chiefly on larger end.
Pyrocephalus r. mexicanus	Not given	Eggs 2–4, pale olive buff, or dull buffy (rarely nearly white), boldly and heavily spotted, chiefly in wreaths around larger end or near middle, with dark vandyke-brown or brownish-black and purplish-gray.
Ornithion imberbe	Nest and eggs unknown	Not given.
2. OSCINES.		
Laniidæ	Eggs 4–6; speckled	Eggs 4–7, dull whitish, spotted with light brown or olive.
Ampelidæ	Eggs spotted; (narrow and elongate; 3–6. *A. cedrorum*).	Eggs 3–5, pale dull bluish or pale purplish-gray, spotted and dotted with dark brown, black and purplish.
Hirundinidæ	Eggs pure white, unmarked: *Iridoprocne bicolor, Tachycineta thalassina, Cotile riparia, Stelgidopteryx serripennis, Progne subis.* Eggs thickly speckled; *Hirundo horreorum, Petrochelidon lunifrons.*	Agrees with Coues.
Alaudidæ—		
Otocoris	Eggs very variable in tone, but always profusely and heavily marked with brownish-gray, or dark stone-gray, upon a grayish or greenish white ground; in some cases the whole surface nearly uniform.	Eggs 3–5, pale olive, pale dull buffy, dull olive, wnitish, etc.; finely but usually densely speckled or sprinkled with olive-brown (rarely pale cinnamon-buff, speckled with cinnamon rusty).
Certhiidæ	Lay numerous white speckled eggs (p. 272).	Eggs 5–9, white or creamy white, speckled or spotted, chiefly on or round the larger end, with reddish-brown.
Vireonidæ	(*Vireo.*) Eggs white, spotted (p. 330).	Eggs white, usually more or less dotted, or sparsely speckled round larger end with brown or blackish.
Motacillidæ—		
Motacilla		Eggs 3–5, whitish, thickly speckled with brown.
Anthus	Eggs 4–6, very dark colored	Eggs with pale ground color, but the dense speckling of brown gives nearly a uniform brown to the whole shell.
Sylviidæ—		
Regulus	Eggs 6–10; fully speckled	Eggs 5–10, whitish or buffy, minutely freckled with brown (sometimes apparently immaculate).
Polioptila	Eggs 4–5; fully speckled	
Cœrebidæ	Not given	(*Certhiola.*) Eggs 2–4, white or buffy white, finely speckled or sprinkled chiefly on larger end with umber brown.

Oölogy of North American Passeres—Continued.

Families, genera, etc.	Coues.	Ridgway.
2. OSCINES—continued.		
Mniotiltidæ	The American warblers lay from 3–7 eggs, some 3–4, etc. As a rule, they are white, or creamy white, or pale greenish or bluish white, or grayish, or even pinkish. They are more or less spotted, etc., chiefly round the larger end, with various shades of brown or lilac, or roan black, less commonly speckled all over. Species very numerous, and the eggs varying for each species.	
Siurus		Eggs 3–6, pure white or creamy white, spotted with reddish-brown and lilac-gray.
Icteria	Egg 3–5, white and speckled with brown.	
Cinclidæ	Eggs, about 5, pure white	Eggs 3–5, plain pure white.
Troglodytidæ	Eggs of three patterns, (1) those densely spotted; (2) those sparsely spotted, and (3) those pure white. Generally numerous, some species laying as many as 10. I give a species of each from Coues, using the nomenclature of his "Key."	
(1) *Telmatodytes palustrus*	Eggs 6–10, very dark colored, being so thickly dotted with chocolate-brown as to appear almost uniformly of this color.	
(2) *Salpinctes obsoletus*	Eggs, 5–8; crystalline whiteness, sparsely sprinkled with reddish-brown dots.	(*Campylorhynchus.*) Eggs with the ground color whitish, creamy white, or salmon buff nearly masked by dense sprinkling of reddish-brown, general hue light brownish-pink.
(3) *Cistothorus stellaris*	Eggs white	
MIMINÆ.		
Oreoscoptes	Eggs 4, light greenish-blue, heavily marked with brown and neutral tint.	
Mimus	Eggs 4–6, bluish-green, heavily speckled and freckled with several brownish shades.	
Galeoscoptes	Eggs 4–6, deep greenish-blue, not spotted.	
Harporhynchus		Eggs very variable in coloration, but usually speckled.
H. rufus	Eggs 4–6, whitish or greenish, speckled with brown.	
H. crissalis	Eggs, usually 2, emerald green, unspotted. (The exception for the genus.)	Eggs plain pale greenish-blue.
Turdidæ:		
Myadestes	Eggs, 4; bluish-white, freckled with reddish-brown.	Eggs, 3–6; whitish, speckled with reddish-brown.
Turdus		
T. mustelinus	Like *Merula migratoria*	Eggs, 2–5; plain greenish-blue.
T. alicieæ		Eggs greenish-blue, spotted with rusty brown.
Merula		Eggs, 3–5; plain bluish (very rarely speckled with brown).
Cyanecula suecica		Eggs, 3–5; pale olive, olive-greenish or brownish, deeper on or around larger end (sometimes uniform).
Sialia		Eggs 3–6 plain, pale greenish-blue.
Saxicola œnanthe	Eggs, 4–7; greenish-blue without spots.	Eggs, 4–7; plain, pale greenish-blue (very rarely white).
Paridæ:		
Parus	Eggs, 6–8; white fully sprinkled with reddish-brown.	(White, usually speckled).
Psaltriparus	Eggs, 6–9; white, unmarked.	(Pure white).
Auriparus	Eggs, 4–6; pale bluish, speckled with brown.	(Chiefly around larger end).
Tanagridæ	Dull greenish-blue, fully spotted with brown and lilac.	(*Piranga*): 3–5, bluish or greenish, spotted with brown.
Euphonia		Eggs creamy-white, with a few scattered spots and blotches, principally at the larger end, of two shades of brown.

Oölogy of North American Passeres—Continued.

FRINGILLIDÆ.

NOTE.—There are upwards of 150 species of Finches, Sparrows, Grosbeaks, Cross-bills, etc., in the United States avifauna, and they lay a great variety of eggs, and it would be quite impracticable to describe or classify even a part of them here, so I resort to the plan of only presenting the characteristic types. Of these eggs many are spotted, with a ground color of white, various shades of pale green and blue, and the spotting near the larger end in a wreath. White eggs, sparsely spotted, are not common, and in my selections I have endeavored to show the differences that exist.

Families, genera, etc.	Coues.	Ridgway.
Pinicola enucleator	Eggs 4; greenish-blue, spotted and blotched with dark brown and lilac shell-spots.	
Leucosticte	Eggs 3–6; pure white	Eggs pure white.
Spinus tristis	Eggs 4–6; bluish-white, normally unmarked.	

NOTE.—In the numerous species of the genera *Poocætes, Ammodramus, Melospiza, Junco, Carpodacus, Spizella, Loxia, Zonotrichia, Chondestes* (4–7, white, with zigzag lines, as in some *Iteridæ*), *Passerella, Calcarius, Pipilo*, and others, the eggs, although showing almost an infinite variety of patterns, all have the common character of *markings* upon them of some kind or other. They constitute the great bulk of United States "fringilline" birds. Exceptions are seen in the other genera as given below.

Families, genera, etc.	Coues.	Ridgway.
Amphispiza bilineata	Eggs 4–5, whitish, unmarked	Eggs plain greenish or bluish white.
A. b. nevadensis	Eggs greenish, profusely spotted, etc.	Eggs speckled with brown.

NOTE.—The case of *Amphispiza* is one of a plain egg and a marked one in the same genus of birds.

Families, genera, etc.	Coues.	Ridgway.
Peucæa		Eggs 3–5, plain white or bluish-white.
Embernagra	Eggs pure white, unmarked	Eggs 2–4, plain pure white.
Calamospiza	Eggs 4–5, pale bluish-green, normally unmarked, occasionally speckled.	Nest and eggs not distinguishable with certainty from those of *Spiza americana*.

ICTERIDÆ.

NOTE.—The so-called "Grosbeaks" of the genera *Habia, Cardinalis, Pyrrhuloxia* all lay handsomely marked eggs, but in the genus *Guiraca* the eggs are a "pale greenish-blue or bluish-white," and not marked. In *Passerina* (some of the species (*P. amæna*) the eggs are also plain.

Families, genera, etc.	Coues.	Ridgway.
Dolichonyx	Eggs 4–6, stone-gray, dotted, mottled, and clouded with dark brown.	Eggs 2–5, dull white or brownish, white, heavily spotted or blotched with vandyke-brown-usually with a few fine lines or irregular markings of blackish.
Molothrus (parasitic)	Eggs white, fully speckled, and dashed with browns and neutral tints.	Dull white, greenish-white or brownish-white, speckled or spotted more or less densely with brown.
Agelæus	Eggs 4–6; pale blue, fantastically dotted, blotched, clouded, and scrawled over with dark or even blackish-brown and paler or purplish shell marks.	Agrees with Coues.
Xanthocephalus	Eggs 3–6; gray-green spotted, as in *Scolecophagus*, with reddish-brown, not scrawled as in *Agelæus*.	(Occasionally pen-lined.)
Sturnella	Eggs 4–6; crystal white, speckled with reddish and purplish (very variable).	Eggs 3–6; white, speckled with reddish-brown, blackish-brown, and lilac-gray.
Icterus—		
I. galbula	Eggs 4–6; shaded white, irregularly spotted, blotched, clouded, and especially scrawled with blackish-brown, etc., and shell markings.	Description practically agrees.

Oölogy of North American Passeres—Continued.

CORVIDÆ.

NOTE.—In the genus *Quiscalus* the eggs are also peculiarly marked, as in the Orioles, but not so with *Scolecophagus*.

Families, genera, etc.	Coues.	Ridgway.
Pica	Eggs 6–9; pale drab, dotted, dashed, and blotched with purplish-brown.	Eggs 3–10; pale olive-buffy, dull white, or very pale greenish, variously marked with brown.
Cyanocitta— *C. cristata*	Eggs 5–6, broad, drab-colored, with brown spots.	Eggs (3–5?), pale olive, isabella-color, greenish or buffy, rather sparcely spotted or speckled with brown.
Aphelocoma— *A. woodhousei*	Not specifically given.	Eggs 3–6, pale green, rather sparcely marked with very distinct dots or small spots of deep madder-brown.
Xanthoura— *X. luxuosa*	Eggs 3–4, greenish-drab, marked as usual with browns.	Eggs 2–4, pale buff or pale grayish-buff, thickly speckled with umber-brown.
Perisoreus— *P. canadensis*	Eggs 3–4, yellowish-gray or pale green, finely dotted and blotched with brown and slate or lavender, especially about the larger end; others more uniformly and largely blotched; variation wide, as in other jays.	Eggs dull white, drab-white, or very pale grayish-buff, speckled with hair-brown or grayish-brown or lilac-gray.
Corvus (common char.)	(*C. corax.*) Eggs 4–8, oftener 4–5, greenish, dotted, blotched and clouded with neutral tints, purplish and blackish brown.	Eggs 2–7, bluish-green, pale olive or olive, spotted or dashed (or both) with olive-brown (sometimes nearly uniform olive from density of markings).
Picicorvus— *P. columbianus*	Eggs light grayish-green, speckled and blotched with grayish-brown and lilac, chiefly about the larger end.	Eggs dull white, sparingly speckled, chiefly on larger end with brown and purplish-gray.
Cyanocephalus— *C. cyanocephalus*	Eggs 3–4, greenish-white, profusely spotted with light brown and purplish.	Eggs 3–5, pale greenish-blue or greenish-white, thickly but finely speckled with olive-brown.

STURNIDÆ.

S. vulgaris	Not given.	Egg 4–7, plain pale greenish-blue or bluish-white.

This article would not be complete did I not add to it some of the excellent observations of Prof. Alfred Newton and others relative to the eggs of birds. After I have done this, I will draw up my "Concluding remarks." Newton briefly gives us some excellent observations upon the "forms of the markings" on birds' eggs, and these it is not difficult to see "have been deposited on the shell a short time before its exclusion, are primarily and normally circular, for hardly any egg that bears markings at all does not exhibit some spots of that form, but that in the progress of the eggs through that part of the oviduct in which the coloring matter is laid on many of them became smeared, blotched, or protracted in some particular direction. The circular spots thus betoken the deposition of the pigment while the egg is at rest, the blurred markings show its deposition while the egg is in motion, and this motion would seem often to be at once onward and rotatory, as in-

dicated by the spiral markings not uncommonly observable in the eggs of some birds of prey and others—the larger end of the egg (when the ends differ in form) making way for the smaller."*

"At the same time the eggs of a great number of birds have, besides these last and superimposed markings, more deeply seated stains, generally of a paler and often of an altogether different hue, and these are evidently due to some earlier dyeing process. The peculiar tint of the ground color, though commonly superficial, if not actually congenital with the formation of the shell, would appear to be diffused soon after." (Art. "Birds," Encycl. Brit., 9th ed., Vol. III, p. 773.) This distinguished ornithologist also invites attention to the fact that "the size of eggs is generally but not at all constantly in proportion to that of the parent. The Guillemot (*Alca troile*) and the Raven (*Corvus corax*) are themselves of about equal size. Their eggs vary as ten to one." (*Loc. cit.*, p. 775.) Many other examples of this among our American avifauna will be recalled by the thoughtful oölogist. Reasons for these discrepancies are not far to seek, *i. e.*, nestling Ravens lay long in the nest after birth, whereas young Guillemots are larger and better developed at the time of hatching. Then the number of eggs laid by a Raven may be as many as 8 (see table), and, as we know, the Guillemot lays but one, giving either bird about the same egg surface to cover during incubation.

From my reading of avian oölogical works I find that certain explanations, or partial explanations have been put forth as the reasons for the variations in the colors of the shells of birds' eggs. I formulate these as follows:

BIOLOGICAL LAWS EXPLANATORY OF THE VARIATION IN COLOR OF THE SHELLS OF EGGS IN THE CLASS AVES.

1. In many instances the general color and markings are in conformity with the law of protective coloration.

2. Where both sexes are more or less brilliantly colored the eggs are generally laid where they are not exposed to view, and where the parent hatching them is also concealed to a greater or less extent. This is effected by either the form of nest constructed or by the eggs being laid in burrows or hollow trees. The eggs of such birds are, as a rule, not handsomely marked, or often only white. Otherwise in general, irrespective of plumage, birds that lay in such places as have just been mentioned usually lay white eggs.

*That the larger end is protruded first was found on actual experiment by Mr. Bartlett, superintendent of the gardens of the Zoölogical Society, to be the case commonly, but as an accident the position may be sometimes reversed, and this will most likely account for the occasional deposition of markings on the smaller instead of the larger end, as not unfrequently shown in eggs of the Sparrow Hawk (*Accipiter nisus*). The head of the chick is always found at the larger end. [For a beautiful example of the heavy deposition of nearly all the color at the small end of the egg, see the one figured by Bendire of *Accipiter velox*, Pl. V, Fig. 17.—R. W. S.]

3. Where the general tone of the plumage of the incubating parent is in harmony with its environment, the eggs, as a rule, are laid in open nests or places where they are fully exposed to view. Such eggs are frequently very handsomely tinted and marked, or the reverse may be the case.

4. When the female alone incubates, and is of dull or somber plumage, the male bird brilliantly feathered, the third law, as a rule, is operative.

5. Frequently birds that lay eggs in open and exposed places, as directly on the ground, rock, or sand, without any apology for a nest, their eggs are either tinted, or colored and marked, or both, so as to be in harmony with their surroundings.

6. It is probable that the earliest forms of birds laid white, ellipsoidal eggs, varying in number to the clutch from one to many. Possibly in some of the lower types of existing birds such an ancestral trait has persisted.

7. In certain instances where birds lay exposed to view either white or light tinted eggs, or those not otherwise protectively colored, they have the habit of covering the clutch over with leaves, etc., when, for any purpose, the incubating parent temporarily quits the nest.

8. Birds, irrespective of the character of the coloration of their plumage, which habitually lay in inaccessible places, their eggs are often either white or light-tinted and exposed to view.

9. Both the age of the bird and the physical condition of its constitution at the time of laying an egg have their influence upon the coloration of its shell. Changes in the constitution may be due to external causes, as fright, etc., or to internal causes, as disease, etc. The richest colored eggs of any species (that lay other eggs than white ones) are laid by that species at its prime.

10. The positions of the egg as it passes down the oviduct, as well as its motions, effect the pattern of its markings.

CONCLUDING REMARKS.

In the light of what has been presented in this paper we can now briefly review some of the oölogical peculiarities of the birds of North America.

Many Grebes (*Podicipoidea*) have the habit of covering over their numerous white eggs with bits of vegetation when the parent temporarily quits the nest (seventh law), but whether the Loons (*Urinatoroidea*) ever resort to this means of protection I am not at present informed, though I am inclined to think they do not. The eggs of the latter, however, harmonize better with their surroundings (fifth law).

The American *Tubinares*, with but one or two exceptions, as far as known, lay white eggs, but they are protected, from the fact that they are laid either in inaccessible or little frequented places (eighth law). Birds rather low in the scale of organization, as the Short-tailed Alba-

tross (*D. albatrus*), which lay a "nearly equal-ended white egg," and where for many ages there may have been no special reason for it to take on any other form or a pattern of varied coloration, possibly may have done so through a long line of avian ancestors (sixth law). Among the *Alcæ* I am not sure whether *Alle* lays its two unitinted eggs in a concealed nest or the reverse. Otherwise the coloration of the eggs of the birds of this group can all be explained under the second, third, and eighth laws as given above. I am inclined to think that the handsomely marked eggs laid by the *Longipennes* gain protection under the operation of the fifth law, and in many cases where I have collected the eggs of Gulls and Terns I have noticed that they often harmonize admirably with their surroundings. It is almost a universally conceded fact that this is distinctly so in the case of the *Limicolæ*, where it is sometimes most beautifully exemplified.

Bitterns among the *Herodiones* are striking examples where the species lay unitinted eggs, but the sitting bird has a plumage that is in complete harmony with the environment of the nest. Even the long pointed brown or dark-green feathers of the back and head simulate the thin lengthy sedge leaves when matted in mass on the ground. With Herons which build in trees such a protection is less evident. In the *Rallidæ* both the plumage of the bird and the coloration of the eggs themselves are protective. This is also the case with the *Gruidæ*, another family of the *Paludicolæ*.

Passing next to the *Steganopodes* we meet with another group of bird forms, morphologically more or less lowly organized, which for ages in the world's history have probably laid their eggs in the most inaccessible of places, and it is just possible that the eggs they now lay, sometimes single and sometimes few (Cormorants), may be more or less like those that were laid by their very early ancestors. The elliptical white eggs of the *Sulidæ*, covered with a calcareous crust, are very different affairs from the more ordinary appearing eggs of water birds higher in the scale of organized bird life. And, notwithstanding their evident anserine affinities this may also apply to the Flamingoes (*Odontoglossæ*).

Oölogists generally express the opinion that the pale unitinted eggs of the Anseres are protected against the pillaging of ordinary marauders, from the fact that nearly all birds of this group build their nests or lay their eggs in inaccessible localities (eighth law). It must be remembered, however, and it is a very interesting fact, that in the case of the Swans (*Cygninæ*) the dull white shells of their eggs are frequently adventitiously stained by the soil and especially by the wet and decaying vegetation composing the rude nest in which they are deposited. This often discolors them with a brownish, dirty shade, thus rendering them the more difficult to be seen upon casual observation. This applies likewise to the eggs of many Ducks (*Anatinæ*). But Ducks, too, often lay drab, greenish or buffy tinted eggs harmonizing with their

surroundings, and such hues are also characteristic of the eggs of the arboreal building Ducks, such as *Aix*, for example, which lays drab-colored eggs, smooth and ellipsoidal in form. The still more typical tree-Ducks of the genus *Dendrocygna* may lay white eggs (*D. autumnalis*).

With our *Gallinæ*, birds which always build their simple nests upon the ground, we find their large clutches of eggs either *white*, or else more or less protectively marked, or finally made so by adventitious staining (*Colinus*). These birds, however, as a rule, wear a plumage that is preëminently in harmony with the nest surroundings, and additional protection is undoubtedly afforded from the fact that the incubating birds are all close sitters. There is an interesting exception in this suborder in the case of the Massena Partridge (*Cyrtonyx*). This curious bird, described by Vigors in 1830, remained comparatively unknown up to the year 1890, at which time not an egg of the species was in the possession of science, and even at this writing it is one of the United States game birds with which we are the least familiar as to its breeding or other habits. Strikingly showy in plumage it lays a glossy, white egg, but it resorts to breed to the mountainous ravines in the western part of country, and this fact, in so far as man is concerned, at least, is the reason its nest has been so rarely discovered (eighth law). Judging from its other habits it is probably, too, a very close sitter.

Pigeons (suborder *Columbæ*) lay, as a rule, white eggs, and both sexes incubate in some of the species. Many of them are somber in plumage, and make their nests upon the ground, or very near it. So far as known they lay but two eggs to the set, but many of them breed several times in the season. Those, like *Ectopistes*, which formerly resorted to the forests in numberless hosts for the purpose, have been largely exterminated through man's agency. It would seem that with such a species it mattered not what color their eggs may have assumed, it would have afforded no protection whatever against any class of despoilers. On the other hand, a little dove-like *Columbigallina* frequently saves its eggs by the habit it has of pitching suddenly off the nest and fluttering about on the ground as if wounded, and leading away the would-be robber of its treasures. Still, this bird, too, will build in the most exposed sites about the habitations of men, where their very gentleness and familiarity often protects them. If many should resort to this latter practice, and men rarely disturbed them when breeding, it would manifestly afford a double protection, for egg-eating mammals and birds, so common in the forests, would not likely be found in such localities, and thus their nests be exempt from plunder from such sources. Other birds, as many of the *Limicolæ*, have the trick of playing wounded when their eggs are endangered by man's approach; but it is a question in my mind whether, in many cases, it does not defeat its very object, inasmuch as it often inspires the in-

truder to search for the nest. I have never had the opportunity to observe how the subterfuge affects other animals below man.

The Accipitrine birds lay, as a rule, notoriously handsome eggs, but they are commonly protected in two ways: (1) By the inaccessible places where the species build their nests, as well as from the fact (2) that many of the larger raptorial birds are fully capable of defending them against robbery, often driving off man himself. Buzzards (*Cathardidæ*), I believe, never defend their eggs by direct attack, nor do I personally know of an instance where they vomit the contents of their stomachs over the intruder, as I have had some of the Herons serve me (*Ardea virescens*). It is a remarkable fact that the eggs of *Cathartes* and *Pseudogryphus* differ so in their characters, and we have at present no explanation to offer on the subject. It has its significance, however, and future researches may solve such problems. Audubon states that our Carolina Paroquet deposits its two eggs, which are light greenish-white, in the hollow of a tree, and that many females of the species lay them together at the bottom of the same cavity (*Conurus*: PSITTACI). They are examples of the second law given above, and this apparently applies with equal truth to the TROGONES.

Exactly why the COCCYGES should lay either white or unitinted eggs the present writer, at this time, does not pretend to know. They fall under the exceptions to the third law, or are examples of somber-plumaged birds that lay eggs like those to which reference has just been made, in open and exposed nests. Possibly in the future such circumstances as the facts that *C. americanus* lays "*glaucous-white*" eggs, *C. erythrophthalmus* "*verditer-blue*" ones, and *Geococcyx* "*white*" ones may aid, slender as such clues usually are, in unraveling the true affinities of this group, but our knowledge in such premises must then be far more extensive than it is now.

The oölogy of ALCYONES, PICI, and STRIGES, in each and every group, affords strong support to the truth of the second law and its general proposition, as does that of all our caprimulgine birds (CAPRIMULGI), save *Phalænoptilus nuttalli*, support the truth of the fifth law. The writer will be obliged to have the opportunities to study the surroundings of the places of deposit of the eggs of a great many Common and Nuttall's Whip-poor-wills before expressing an opinion as to why the first should lay an egg with a creamy-white shell, heavily marked with browns and neutral tints, and the latter a white one. It is remarkable in another light, for *Steatornis* and the owls lay white eggs.

Every variety of the means of protection exemplified in the case of the eggs of birds is to be seen in the TROCHILI. In the first place, the eggs of Humming-birds are inconspicuous from the fact that they are so small and few in number. The nests, also small, are frequently so constructed as to perfectly harmonize with the surroundings. The nests are often built in very inaccessible places, and so, difficult to be seen

or reached on that account. The nests are sometimes so constructed as to hide the eggs from view; in most instances the plumage of the back of the incubating bird is in complete harmony with the environment of the nest, and, finally, the eggs are too small to be of any value scarcely to any egg-eating animal.

The somber-plumaged Swifts (CYPSELI), so far as is known of our North American species, lay their four or five white eggs in some cavity where they are hidden from the general view (second law, last part), and in this agreeing with some of the Swallows among the *Passeres* that do likewise.

There are some curious and interesting examples and departures to be seen in our great and compact group of passerine birds (PASSERES). If we consider the *Corvidæ* to be the most highly organized family of the suborder, and *Corvus* the highest genus, then in it we find the species laying somewhat numerous, dark-colored and marked eggs (*C. corax*); but these characters rapidly change directly within the family, for *Cyanocephalus* lays only three or four eggs, which are white, tinged with greenish and profusely spotted, and such characters are continued into the next group, the *Sturnidæ*, where, however, they are more prolific layers (*S. vulgaris*), and the eggs, as a rule, are not marked. Then, passing by for the moment all the intermediate interrelated families, we find in the Clamatores, *Tyrannus*, which lays but four or five eggs, white, boldly and handsomely spotted with brilliant browns, and yet, too, in that very family (*Tyrannidæ*) we discover *Empidonax minimus* laying white eggs and unspotted. But just how a Raven comes to lay dark-colored, heavily marked eggs, and a small Flycatcher white ones I am inclined to believe we shall never exactly know. They both in this particular come under the third law, the Raven under the first part of it and the Flycatcher under the second.

The matter of coloration for protective purposes in this group would hardly seem to account for the characteristic colors of the eggs of the several families of passerine birds; nor, as I have heard it advanced, has the light anything to do with it, although my own observations lead me to think that crows are more frequently away from their nests during the period of incubation than are the smaller *Passeres*. They are not as close sitters. Such a theory, however, immediately becomes untenable when we take species like *Ampelis cedrorum* and *Petrochelidon lunifrons* into consideration. The first lays a dark-colored, heavily marked egg in an open nest, the parent being a close sitter, while the second, a Swallow, lays a white, thickly speckled egg in a covered nest, and is not especially a close sitter. Other Swallows, which lay pure white eggs in burrows (*C. riparia*) may fall under the operation of the last part of the second law (see above). Affinity of the birds again seems to have hardly anything to do with it in some cases, for even among species very closely related the eggs are very different.

Good examples of this are seen among our wren (*Troglodytidæ*). These birds all lay in places where their eggs are not exposed to view, yet some of them lay pure white eggs, and others those which are very dark and densely spotted. It is seen again in *Harporhynchus*, where *H. rufus* lays whitish eggs speckled with brown, and its first cousin in the same genus, *H. crissalis*, two emerald-green and unspotted eggs. Such apparent anomalies would appear almost to defy a correct solution.

When we come to the *Fringillidæ* it is even still more difficult to account for the peculiarities of the colors assumed by the shells of their eggs. Here we find species of the same genus, habits alike, nesting alike, and the localities inhabited much alike, and yet laying very different appearing eggs. For example, the Black-faced sage Sparrow (*A. bilineata*), which lays whitish, unmarked eggs, and the California sage Sparrow (*A. belli*), which lays greenish-blue speckled eggs.

Another interesting case is one that I have alluded to in my table on the oölogy of the *Passeres* given above, and we find it among the "Grosbeaks." Those birds, so called, usually all lay handsomely marked eggs; but the Blue Grosbeak (*G. cærulea*) lays a plain egg quite like the one laid by the Indigo Bird of the genus *Passerina* (*P. cyanea*), only larger. Now, the Blue Grosbeak in plumage and other characters is strikingly like an Indigo Bird, and I believe that this is an instance pointing to the affinity of the two forms; indeed, I further believe that the Blue Grosbeak is more nearly related to our Indigo Bird than are some of the other species they have placed in the same genus with the latter, as, for instance, *Passerina ciris* and *Passerina versicolor*, birds that lay pearly-white eggs speckled with brown of two shades. When I say this I am also aware that the eggs of the Indigo are occasionally speckled. In the popular mind the name "Grosbeak" has given the impression that a number of birds in this country so designated are much of the "same kind of species," whereas in reality the affinity in several instances is not so close as is generally supposed. For example, *Guiraca* is structurally much more nearly related to *Passerina cyanea* than it is to *Habia*, and still nearer than it is to either *Cardinalis* or *Pyrrhuloxia*.

Finally, among our *Icteridæ* we find beautiful examples of that class of cases (fifth law) where the male bird is of very handsome plumage; the female (the incubator) more or less somber in that respect; and where the eggs, more or less exposed to view (oftener less or partially concealed), are very remarkably and exquisitely decorated.

My examinations and studies of the oölogy of North American birds have clearly shown me that we should strive more and more towards correct and exact observation in such matters. It is especially needed to have before the oölogist abundance of material, and they should seek to employ a common nomenclature in the description of colors, tints, hues, and shades. This is also applicable to the descriptions of

forms and to the measurements of eggs. In regard to the last, or the measurements of eggs, it is a matter of the very highest importance to the avian oölogist. Throughout the present paper I have frequently, but not always, contrasted the measurements as given us by different authorities, and it will be seen that the variance in statements in this particular is often quite as great as are the descriptions of form and color. The fact is the eggs themselves of the same species vary greatly in size, and averages taken from large series constitutes the only kind of data that can be safely relied upon. Nests and their environments are deserving of the most painstaking studies and descriptions, and frequent comparisons should be made of the nests of birds of allied families and groups. The best oölogical works are those which are fully illustrated with the most correct colored figures of eggs. In many instances a full knowledge of the breeding habits, nesting, and oölogy of birds will be of powerful assistance in determining the affinities of avian types. From a scientific standpoint avian oölogy has accomplished much in the past and will undoubtedly do so in the future.