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ADVERTISEMENT.

This work is the third of a series of papers intended to illustrate the collections of Natural History and Ethnology belonging to the United States and constituting the National Museum, of which the Smithsonian Institution was placed in charge by the act of Congress of August 10, 1846.

It has been prepared at the request of the Institution, and printed by authority of the honorable Secretary of the Interior.

JOSEPH HENRY,

Secretary Smithsonian Institution.

SMITHSONIAN INSTITUTION,

Washington, February, 1876.

CONTRIBUTIONS

TO THE

NATURAL HISTORY

OF

KERGUELEN ISLAND,

MADE IN CONNECTION WITH THE UNITED STATES TRANSIT-OF-VENUS
EXPEDITION, 1874-75.

BY

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II.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1876.

A STUDY OF CHIONIS MINOR WITH REFERENCE TO ITS STRUCTURE AND SYSTEMATIC POSITION.

BY J. H. KIDDER, U. S. N., AND ELLIOTT COUES, U. S. A.

“This small family of birds [*Thinochorus*, *Attagis*, and *Chionis*] is one of those which, from its varied relations to other families, although at present offering only difficulties to the systematic naturalist, ultimately may assist in revealing the grand scheme, common to the present and past ages, on which organized beings have been created.” (DARWIN, *Voyage of a Naturalist*, New York, 1871, p. 94.)

CHIONIS MINOR, Hartlaub.

SHEATH-BILL; BEC-EN-FOURREAU.

HISTORY.

The genus *Chionis* was founded by J. R. Forster in 1788,* upon *C. alba*, discovered by him in the neighborhood of Cape Horn. In January, 1841, Dr. G. Hartlaub wrote from Bremen to the *Revue Zoölogique* † that he had discovered a new species of *Chionis* in the museum at Leyden. He described it as differing from *C. alba* by its decided inferiority in size, by the blackness of the entire beak, and particularly by the extraordinary shape of the sheath of the bill. His original description and measurements are as follows:

“CHIONIS MINOR, *Nob.*, *nivea*, *rostro nigerrimo*, *pedibus saturate fusciscentibus*, *spatio supraoculari subrotundo*, *nudo*, *nigro*, *rostri vaginâ subconcaavâ*, *antrorsum ascendente*, *apertâ* (*in Ch. albâ*, *planâ*, *incumbente*).

	<i>C. minor.</i>	<i>C. alba.</i>
<i>Long. total</i>	13 p. 2 lig.	17 p. 3 lig.
<i>rostri à fronte</i>	1 2	1 4
<i>Altit. rostri ad basin</i>	7	8
<i>Latitud. rostri ad angulum oris</i>	0 6½	7½
<i>Long. alæ</i>	9	10½
<i>tarsi</i>	1 10	1 11
<i>caudæ</i>	4 3	5½
<i>digiti medii</i>	1 8	2 1

* *Enchiridion Hist. Nat. Ins.* 1788, p. 37.

† *Rev. Zoöl.*, 1841, v. 5; *ib.* 1842, pl. 2, fig. 2.

“*Patrie inconnue.*”

In the following year he contributed a drawing (of the head) to the same periodical (pl. 2, f. 2).

In 1849 *C. minor* was figured by G. R. Gray,* under a description of the genus which was placed by him in the fifth family (*Chionididae*) of *Gallinae*, the other members of the family being *Thinocorus* and *Attagis*. The supposed relationship between these birds was first pointed out, so far as we know, by Mr. Darwin,† in 1833, when, referring to *Thinocorus*, *Attagis*, and *C. alba*, he utters the pregnant sentence we have chosen as the motto for this essay.

De Blainville meanwhile, in 1836,‡ before *C. minor* had been described, turned his attention to the anomalous relationships of the genus, and decided that its nearest affinity was with *Hæmatopus*. The position he assumed respecting its relationships requires special consideration, since it was defended with learned ingenuity and has been generally accepted without question.

He based his conclusion upon the examination of a skeleton of the trunk of *Chionis alba*, obtained from M. Baillon, of Abbeville, with some details of its internal organization and natural history obtained from M. P. E. Botta, one of his assistants at the Paris Museum. M. Botta's specimen had come on board of a ship, during a commercial voyage around the world, in latitude 55° south, longitude 64° west (between the Falkland Islands and Cape Horn). Previous to this time specimens had been exceedingly rare, only three skins being known to exist, and no anatomical material being accessible.

M. de Blainville enumerates, among those who had already treated of *Chionis*, Forster, Pennant, Latham, Gmelin, Bonnaterre, Illiger, Vieillot, Oken, Temminck, Goldfuss, Pabbé Ranzani, Quoy & Gaimard, Lesson, Wagler, Cuvier, and Isidore-Geoffroy. By these writers it had been successively and alternately considered as a wader (*échassier*), palmipede, and gallinaceous bird, allied (*rapproché*) to three different genera, or considered as a distinct family; while it had been passed over by other naturalists, who did not consider the data sufficiently full for a determination; or held to be *incertæ sedis*, “*ce qui est, en pareil cas, le parti le plus convenable.*”§

* Genera of Birds, 1849, p. 522, pl. —.

† Naturalist's Voyage around the World, p. 94; cf., also, Voy. Beagle, 4to, 1841, pp. 118, 119.

‡ Mémoire sur la place que doit occuper dans le système ornithologique le genre *Chionis* ou Bec-en-fourreau. < Ann. Sci. Nat. vi, 1836, p. 97.

§ De Blainville, l. c.

The three specimens then known to De Blainville were, first, a skin in an English collection, for a long time unique (perhaps Forster's type); second, one obtained by MM. Quoy & Gaimard from the voyage of the *Astrolabe*, in 1824; third, one obtained by MM. Lesson & Garnot, in the course of the voyage of the *Coquille*, when an individual came on board of the ship "at the distance of eighty leagues from Patagonia, the nearest land." "Anderson observed it in flocks in Christmas Harbor," but appears to have given no description by which the peculiarity of the Kerguelen species (*C. minor*) was recognized, and of which this is the first recorded observation.

M. de Blainville describes briefly the external parts of *C. alba*, and the skeleton, the latter including of the skull only the posterior part without the occiput, and being defective also as to the coccyx and limbs. He appears not to have seen either the muscles or viscera, but to have been dependent for his brief description of the latter upon the sometimes erroneous recollections of M. Botta. It should be noticed that the observations upon the natural history and habits of the genus had been made upon specimens that flew on board of ships at sea, and therefore were not under their natural or wild conditions.

His reasons for referring the genus to the vicinity of *Hamatopus* are summed up by himself (p. 106) as follows:

"1°. Le nombre des vertèbres 15—6—14—8, est le même.

"2°. Le nombre et la forme des côtes sont les mêmes.

"3°. Le sternum, de même forme générale, a deux échancrures sub-égales, la supérieure un peu plus grande que l'inférieure.

"4°. Le canal intestinal a également trois cœcums, dont deux terminaux médiocres et un median fort petit.

"5°. L'estomac est également formé d'un gésier fort petit sans jabot.

"6°. La queue est courte et composée de six paires de plumes égales.

"7°. Les ailes, formées de dix plumes à la main, sont aiguës.

"8°. Les jambes sont peu élevées, et nues seulement vers le talon.

"9°. Les tarses, non comprimés, sont également réticulés en avant comme en arrière.

"10°. La plante des doigts est élargie de manière qu'ils semblent bordés latéralement.

"11°. Ce sont également des oiseaux marcheurs et coureurs;

"12°. Habitant les rivages de la mer;

"13°. Où ils cherchent leur nourriture, consistant en coquillages et peut-être en animaux morts."

Since M. de Blainville relied almost entirely upon the characters of the sternal apparatus* in the classification of birds, it is not strange that he should have found in their resemblance to those of *Hæmatopus* conclusive evidence of natural affinity. The errors of omission and of observation in the above summary (which, it must be acknowledged, are not to be found in the description of those parts seen by De Blainville himself) will be discussed hereafter in their proper connection.

In his continuation of Bonnaterre's "Tableau encyclopédique et méthodique d'Ornithologie" (pp. 1037, 1038), M. L. P. Vieillot speaks of the *black button* on the wing, and describes the sheath of the bill as sometimes yellow, *sometimes black*. It would thus appear that *Chionis minor* was known and had been examined long before Hartlaub differentiated the species; this black color of the epidermal outgrowths being one of the principal specific features of his diagnosis. Bonnaterre's first mention of the genus (as genus 83 of his list, p. cxij) gives no points to indicate whether he was describing *C. alba* or *C. minor*.

In 1867 Mr. E. L. Layard, writing to the Ibis† from Cape Town, under date of June 17, mentions several specimens of *C. minor* brought alive to the Cape from the Crozet Islands by Captain Armson. "A single egg obtained by him was unfortunately attacked by mice on board; but enough remains to show its contour and color. The instant I saw it I was reminded of the eggs of *Hæmatopus*." He describes the egg at some length, and of the living bird says: "He is most *Hæmatopus*-like in his motions, moving with great swiftness, and feeding on meat, which he holds down between his feet and tears into shreds. He is very fearless, and attacked the cats which came near him. The legs are livid brown [!], bill black, with a pink cere around the eye, the iris of which is deep black or dark brown in color."

On the 28th of November, 1867,‡ Dr. P. L. Sclater exhibited to the Zoological Society a skin of *Chionis minor*, "being that of an individual of this species which had been transmitted living to the society by E. L. Layard, and brought from the Crozet Islands by Captain Armson." This was doubtless the same individual referred to by Mr. Layard in the passage just quoted.

* À ces élémens les plus importans d'une évaluation un peu positive des rapports naturels de cet oiseau (puisque j'ai montré, depuis long-temps, que l'appareil sternal, avec ses annexes, les renferme dans cet classe d'animaux) j'ai pu joindre quelques détails d'organisation intérieure, etc." (*Op. cit.*, p. 99.)

† Ibis, 1867, p. 458.

‡ Proc. Zool. Soc. 1867.

October 26, 1868,* the receipt of two specimens of *C. minor* by the Zoological Society, from Mr. Layard, was recorded without further particulars. They came from the Crozet Islands.

In the Journal of Anatomy and Physiology for November, 1839,† appeared a letter from R. O. Cunningham, M. D., naturalist to Her Majesty's surveying-ship Nassau, with a figure of the cœca, part of the intestine, the stomach, and larynx of *Chionis alba*, accompanied by some measurements. He found that "the legs present a decided resemblance to *Hæmatopus*, and the sternal characteristics are similar."

An egg of *C. minor* was received by the Zoological Society, January 17, 1871,‡ concerning which Prof. Alfred Newton said: "No egg of either species of this genus had before been known, and this confirms, by its appearance, the systematic position of the form shown by osteology, its affinity, namely, to the plovers."

We have been able to find a record, therefore, of but four specimens of this species, viz: 1. That in the Museum at Leyden, from which the original description was made, of unknown locality; 2. A specimen sent to the Zoological Society by Mr. Layard, from Cape Town, brought from the Crozet Islands; and, 3, 4. Two specimens from the Crozet Islands, also sent to the Zoological Society by Mr. Layard, in 1868.

The literature of the species is meagre, and we do not find that any attempt has been made either to verify or refute De Blainville's conclusions, otherwise than by inspection of external characters, beyond Mr. Cunningham's brief notes upon the digestive system. Authors who have differed from De Blainville respecting the systematic position of the genus have simply placed it where they pleased, apparently without feeling called upon to show cause for the faith that was in them.

The late expedition to observe the transit of Venus at Kerguelen Island afforded an opportunity to improve our acquaintance with this species, which was taken advantage of. Several specimens were preserved in alcohol, a number of skins were secured, and, during a stay of four months upon the island, as frequent and careful observations as possible upon the behavior of the bird during life § were made by Dr. Kidder.

It bears a strong resemblance to the pigeons in form and mode of

* Proceedings Zool. Soc. 1868.

† Pp. 87-89.

‡ Proc. Zool. Soc. 1871, p. 57.

§ See Bull. No. 2, Nat. Mus. 1875 . 1 *et seq.*, for full description of habits, etc.

flight; is easily domesticated, remarkably fearless of man, dislikes water, cannot swim, is largely a vegetable-feeder, and its usual note is a harsh croak. These characteristics, taken together with its attitudes, gait, pugnacity, ready companionship with domestic fowls, and some obvious peculiarities in the structure of the digestive system, seemed to indicate affinity with the *Gallinae* rather than with *Hamatopus*, so far as superficial characters have weight. And so strong was this impression, based upon field-observation only, in the mind of the observer, that we have made a somewhat extended anatomical examination of two of the alcoholic specimens, and have studied the slender literature of the subject, with the hope of furnishing the materials upon which to base inquiries that may establish the proper position of this confessedly doubtful group. Allowing due weight to the authority and great name of De Blainville, it is proper to remember that this particular species (*C. minor*), at least, differs from the type-species (*C. alba*), as described, in that it is largely a vegetable-feeder; that there is no record of its having been seen "far out at sea";* and in the characters upon which the diagnosis of the species is based.

For comparison with Hartlaub's original description, the field-measurements of eleven specimens are here quoted: †

List of specimens, with measurements.

Smithsonian Institution number.	Original number.	Date.	Sex.	Length.	Extent.	Wing.	Tail.	Bill.	Head.	Tarsus.	Middle toe.	Longest claw.	Remarks.
		1874.											
68956	27	Oct. 12	♂	15.50	30.50	9.00	.....	1.50	1.35	2.00	1.85	0.50	Skin.
68957	31	Oct. 16	♀	14.00	29.00	8.50	.....	1.35	1.65	1.85	1.60	0.45	Do.
68955	32	Oct. 16	♂	15.00	31.00	9.50	.....	1.50	1.60	1.80	1.60	.....	Skin with sternum.
.....	33	Oct. 18	♂	.....	.....	.....	.....	.....	.....	.....	.....	.....	Disembowled and in alcohol.
68958	67	Nov. 14	♂	15.75	32.00	9.35	.....	1.50	1.75	1.75	1.60	0.40	Skin.
.....	127	Dec. 5	♂ (?)	15.00	30.00	9.00	4.65	1.45	.....	1.65	1.55	0.50	Alcohol.
.....	146	Dec. 11	♂ (?)	14.50	29.00	8.50	.....	.....	.....	1.75	1.50	0.50	Do.
.....	203	Dec. 29	♂ (?)	16.50	30.50	9.00	4.85	1.50	.....	1.85	1.75	0.50	Alcohol and carbolic acid.
.....	204	Dec. 29	♀ (?)	15.25	29.15	8.85	4.50	1.35	1.65	1.75	1.65	0.50	Do.
.....	205	Dec. 29	♂ (?)	15.50	29.85	8.85	4.75	1.35	1.65	1.75	1.55	0.45	Do.
.....	206	Dec. 29	♀ (?)	15.75	28.85	8.50	4.75	1.35	1.75	1.75	1.65	0.50	Do.

* *Vid.* Darwin, *Voy. round the World*, p. 94, and Cunningham, *Jour. Anat. and Phys.* 1869, p. 88.

† From Bull No. 2, Nat. Mus., *loc. cit.*

DESCRIPTION.

The first specimen selected for examination was taken from alcohol November 5. The field-measurements, from the flesh, are as follows:—

Smithsonian number.	Original number.	Date of collection.	Sex.	Length.	Extent.	Wing.	Tail.	Bill.	Head.	Toes.	Middle toe.	Longest claw.	Remarks.
146		1874. Dec. 11	♀	14.50	29.00	8.50	.....	.....	.....	1.75	1.50	0.50	Preserved in alcohol.

Plumage universally pure white, very soft and downy. Under plumage slate-colored. Bill black, stout, conical; mandibles of equal length. Chord of culmen 1.22, gape 1.35, depth 0.80, width 0.55; depth of upper mandible 0.37, width 0.40; depth of lower mandible 0.30, width 0.55. Commissure nearly straight, with only a slight downward curve towards apex of bill. Lying over the upper mandible like a saddle, with the pommel tilted up into the air, is the horny black sheath which has given to this bird one of its trivial names. From the insertion of the frontal feathers to its anterior end, this sheath measures 0.50. The flaps of the saddle project downward and backward below the tomial line, its anterior margin presenting two curves, convex forward, including one curve, convex posteriorly. The "pommel" part of the sheath projects above the mandible, like a hood, 0.20 inch. From gape to apex the sheath measures 1.00; perpendicular depth 0.70, width of "pommel" 0.30, of sheath between lower margin of flaps 0.45. At the sides the flaps are firmly soldered to the upper mandible, so that, in this species at least, erection of the sheath (attributed to *C. necrophaga* or *C. alba* by Latham, Lesson and Cuvier,*) is impossible. Structurally continuous with the sheath, and extending backward and upward from its posterior portion, is a thick, black, tumid strip of naked skin, deeply pitted by numerous follicular openings, some of which near the edges give passage to hair-like feathers. It lies in contact with the eyelid superiorly, and the portion uncovered by feathers measures 0.55 by 0.30. Upon clipping away the frontal feathers, this black caruncle is found to extend entirely across the forehead, as a squarish frontal hood, covered by white feathers so thickly as to be invisible in its anterior and central two-thirds. Its upper margin (somewhat wider than the lower) is abruptly distinct, just opposite the highest part of the eyelid. The width of the caruncle at its upper and widest part is 1.10; its height from the lowest inser-

* Animal Kingdom, London, Orr & Co., 1849, p. 250.

tion of the feathers is 0.70. As already stated, the sheath is continuous structurally with this caruncular fold, the epidermal tissue of the latter losing its follicles and assuming a horny structure at the wide angle between the forehead and bill. In appearance the structure is strongly suggestive of the frontal papillose casque borne by the turkey* (*Meleagris*). Opposite the central concavity in the sinuous border of the side-flap of the hood appears, uncovered by the sheath, about half the aperture of the nostril, oval in outline, with its long axis nearly parallel with, but inclining slightly toward, the rictus. The nostrils are pervious. The eyelids are thickened and everted, during life of a pale pink, whence the name "sore-eyed pigeon." Iris, dark-brown to black.

The body is full and heavy. When at rest the head is withdrawn toward the body and the tarsi are nearly concealed by the plumage. Plumage universally pure white, remarkably soft and downy. "After-shaft" of body-feathers distinct and soft, measuring rather more than half the length of the main shaft. Wing primaries 10; first three about of the same length, the second being, perhaps, a trifle the longest. The inner remiges equal the longest primaries. Tail slightly rounded, spreading widely in flight. Rectrices 12, inner and outer vanes of nearly equal width, innermost being rather the wider.

Tibia is naked for 0.40 inch, but covered to below the joint by extremities of feathers. Tarsus is pale flesh-color, 1.70 inch; stout, flattened on its internal surface; narrower posteriorly than anteriorly; covered by prominent hexagonal scales, which merge gradually into scutellations on the toes anteriorly. Middle toe measures 1.5, longest claw 0.45 inch. A strong and distinct row of marginal scales fringes each toe, and a small web connects bases of third and fourth toes. First toe placed at the inner side of tarsus, distinctly above the level of the rest, and with its under surface directed externally. Claws strong, stout, blunt, convex above, concave and deeply grooved beneath; black above, pale horn-whitish below. Joints stout and large.

DISSECTION.

MUSCLES OF THE UPPER EXTREMITY.

Pectoralis major arises from external border of clavicle in its whole length excepting its coracoid enlargement; from the whole length of

* This extension of the caruncular casque across the forehead, being hidden by feathers, has, we believe, never before been noticed, previous descriptions having mentioned only the obviously naked strip along the eye.

lower border and about one-half the lateral surface of carina; and from the posterior and external third of the body of sternum, to be inserted by a broad flat tendon into the palmar margin of the pectoral crest of humerus. The pectoralis major is partly cleft, posteriorly and inferiorly, but the two parts coalesce to be inserted by a single tendon as above.

Second pectoral arises from sterno-clavicular membrane, from the angle between the body and keel of sternum to within 0.25 inch of its posterior end, and from all of the body not occupied by the conjoined segments of pectoralis major. It is inserted by a very long cylindrical tendon, gliding through a tendinous sheath given off from the neighborhood of coraco-clavicular articulation, beneath the angle of their junction, into radial tubercle of humerus, 0.50 inch below its articulating surface. This is the *levator humeri*.

Third pectoral ("pectoralis minimus" Coues*) arises fleshy, pyramidal, from external border near superior external angle of sternum and from the adjoining margins of sternum and coracoid, for about one-third their length, to be inserted by a round tendon directly into inner border of humerus, near its head. In origin and function this muscle agrees with *pectoralis minimus* of Coues, and of Owen, 1836 (but not with third pectoral of Owen, 1866, being an adductor and external rotator but *not* a levator of humerus; arising from external border, *not angle*, of sternum; and passing through no trochlear groove, but being inserted by a *straight* tendon into radial tuberosity of humerus, which it depresses, not elevates).

The article in Todd's Cyclop. Anat. describes the third pectoral-substantially as it is here given; but in Anat. Vert., ii, 1866, p. 97, apparently by some oversight, Professor Owen redescribes the third pectoral in much the same terms as he does the second, making it out to be a levator.

Latissimus dorsi shows no peculiarity of origin or insertion. Anterior fibers are a thin narrow band of pale muscle. Posterior are darker, stouter, and blend, before insertion, with anterior. A few muscular fibers pass downward from sterno-coracoid articulation, parallel with sternal ribs.

Extensor plicæ alaris arises from coraco-clavicular articulation, sending its tendon downward along the pectoral ridge of humerus. It is triangular in form, covering the rest of the muscles of the shoulder-joint. Just beneath it lies the—

* Osteology, etc., of *Colymbus torquatus*, Mem. Bost. Soc. Nat. Hist. i, 1868.

Deltoideus, arising from coracoid end of scapula, filling the space between the tendon of pectoralis medius and latissimus dorsi, to be inserted into the pectoral ridge of humerus.

Biceps presents nothing unusual.

Infraspinatus and *teres major** are represented by a single muscle, which arises from the entire dorsal margin of scapula, and is inserted into the ulnar tuberosity of humerus.

A stout fasciculus of soft, dark muscle, which arises from nearly the whole of the internal surface of coracoid and of the adjoining stout strip of membrane, passes outward and upward through humero-coracoid space to be inserted into the anterior tuberosity of the humerus. Perhaps this is the muscle described by Owen† as the analogue of coraco-brachialis, and said by him to “attain its greatest relative size in the *Rasores*, where it arises from almost the whole of the coracoideum.”

Triceps extensor cubiti is divided into two distinct muscles, as usual.

Numerous isolated fibres, representing *platysma myoides*, originate from anterior half of clavicle and proceed upward between the layers of the superficial fascia, to be inserted into the skin, superficial surface of œsophagus, and crop.

MUSCLES OF THE LOWER EXTREMITY.

Sartorius as usual.

Rectus femoris and *tensor vagina femoris* (*abductor magnus* of Owen) arise thin and fan-shaped, by a membranous aponeurosis from the superficial fascia of the back and from outer margin of sacrum and ischium, to be inserted by *two* tendons, the uppermost going to the anterior part of the sheath of *cruræus*, the lowermost to the head of fibula. The muscle is very thin and its tendon a delicate aponeurosis.

Glutæi and *cruræus* (including internal and external *vasti*) present no characters of particular interest.

Biceps arises just above inner hamstring muscle from ischium, and is inserted into fibula, fully 0.8 inch below the knee-joint.

Semimembranosus and *semitendinosus* are inserted into tibia at about the same level, above insertion of biceps.

Adductores and *gastrocnemius* not noted as peculiar.

* *Vid.* Owen, *Comp. Anat. and Phys.*, vol. ii, p. 95. Lond., Longmans, 1866.

† Owen, *l. c.*, p. 97.

The thickening and expansion of the conjoined tendon, just over the posterior part of tibio-tarsal-joint, is very marked, adding much to the lever-power of the muscle.

VISCERA.

On removal of sternum and scapular girdle, the ribs being cut through at a short distance from the sternal margins, only trachea, pericardium, and liver became visible, covering in the rest of the viscera. A considerable deposit of finely granular sabulous matter was found upon the serous covering of the lungs and viscera, which was preserved for future examination. There is no sternal fold of trachea, its bifurcation appearing just above *manubrium sterni*. *Œsophagus* lies beneath and to the right side of trachea. It is dilated into a very wide, triangular, definitely-circumscribed ingluvies, which measures in the alcoholic specimen about 1.50 by 1.09 inch.

Proventriculus is but a slight dilatation of *œsophagus*, well provided with secreting glands internally. The glands are cylindrical in shape, and some of them measure quite 0.10 inch in length. They are disposed in a zone of unequal width about the proventricular opening of the stomach, extending very much further upward anteriorly than posteriorly, where the lining of the proventriculus soon becomes reticulated. The orifices of the glands are very large, and their general structure and disposition are clearly visible to the naked eye.

Gizzard is elongated, 1.50 by 0.80 inch. Tendinous centres are situated *laterally*, a band of stout muscle passing downward over the anterior and central portion, spreading out over the bottom of the viscus, and curving sharply over posteriorly as a thick fleshy lip, the margin of which sinks into a deep sulcus, concave superiorly, and extending nearly the whole width of the stomach. From the centre of this sulcus passes upward a stout muscular fascicle, diverging as it ascends so as to cover the posterior surface of the stomach, and its sides above the lateral tendinous centers. The duodenum is given off from the right side, 0.50 inch from the lower border of proventriculus. Internally, the stomach is deeply rugous, the rugæ running for the most part axially, but merging in the upper third into a rough pavement of irregular prominences, produced by transverse sulci crossing the longitudinal. The principal grinding surfaces are, as was to be expected from the external arrangement of muscle, anterior and posterior instead of lateral, as usually is the case. The gizzard contained several pebbles, three as large as a grain of coffee, the beaks of two cephalopods, shells of small patellæ, and a considerable mass of pale green vegetable matter.

The small intestine passes out from the gizzard on the right side, curving sharply backward (parallel to spine) for 3 inches, and returning upon itself to the level of its exit from the gizzard. Within this fold lies the *pancreas*, moulded to the intestine on each side, and quite filling the interspaces of its curved surfaces. It is, therefore, about 3 inches in length, constricted along its central axis, and spreading out along both its ventral and dorsal surfaces. The anterior end is the larger, opposite to which the hepatic and gall ducts empty into the duodenum at least 6 inches from the gizzard. The pancreatic duct was lost in dissection, at a point about half an inch beyond the entrance of the hepatic duct, so that the point at which it empties into duodenum was not accurately determined, but it is certainly below the termination of hepatic duct. The intestine of this alcoholic specimen measures 44 inches in all; that of a fresh specimen, measured in the field, being 48 inches in length.* The cæca, which are quite as large in diameter as the intestine itself, are each 8 inches long, terminating in a mammillar point. From the origin of cæca to anus the distance is 3 inches; 23 inches below gizzard is another small cæcal appendage, rather less than 1 inch long.

Pericardium is large and full, occupying the central parts of thorax. A process of the pericardium is produced downward upon and between the lobes of the liver. The *heart* is large, and of the usual color. On each side of the trachea are to be seen the superior cavæ, with their branches, and beneath these lie the carotid arteries, which are double, the left being rather larger than the right. They dip beneath the trachea and œsophagus, converge, lying upon the anterior cervical muscles, run parallel for about half an inch, and divide into branches about an inch and a half above the first rib. The specimen not being injected, we were unable to determine whether or no there is an anastomosis between these arteries. The bifurcation of the trachea appears above the sternum, presenting no sternal fold in this species.

The liver is very large, extending on both sides for half an inch beyond the level of the acetabula. Left lobe nearly as large as right. Posteriorly and superiorly, it is deeply grooved by contact with the other viscera; anteriorly, a long-tailed process passes forward and upward, ending in a sort of suspensory ligament; the process of pericardium

* Mr. Cunningham records the length of the intestine of the larger species, *C. alba*, as but 40 inches, the cæca as 7 inches each; distance between their origin and the anus, $2\frac{1}{2}$ inches. (Journ. Anat. and Phys. 1869, p. 89.)

above mentioned being, in fact, though not homologically, the principal suspender of the liver. The posterior margin of the right lobe presents two deep incisions, separating three pointed processes of liver tissue. The left lobe is sharply unciform, the concavity of the hook looking upward. A decided thickening of the isthmus, on the superior surface of the liver, indicates the third lobe. Gall-bladder distinct, empty; biliary ducts very large.

The left ovary was found to have been quite active, resembling a bunch of grapes. We counted twenty-six vesicles as large as No. 6 shot, eleven of these being as large as No. 3, besides very many large enough to be distinct.

Oviduct tortuous; much enlarged; longitudinal plicæ very distinct and laminated, like the leaves of a book. The sex of this specimen, which had black wing-spurs, proves that that feature is not distinctive of male birds, as we had supposed.*

Kidneys are large, 1.95 inch; moulded on their superior (dorsal) surface to fit the irregularities of the sacrum. Near the termination of the ureter, in the cloaca, are noticeable two small glandular bodies.

Palate is wide posteriorly, bounded at the sides and anteriorly by the projecting edges of the bill. Half an inch from the tip of beak, in the median line, is a minute longitudinal crest; 0.10 inch behind this a decided tooth-like, bony process, directed backward; 0.20 inch posterior to this are six tooth-like villi, directed backward and arranged, like a comb, in a horizontal row. Here the lateral palatal ridges become prominent. Marking the anterior end of the aperture of the posterior nares, and 0.30 inch behind the last-named process, are two longer tooth-like villi; on each side of this slit, in the sulcus between central and lateral palatal ridges, are six minute separate villi in a longitudinal row. Behind the slit for the Eustachian tube there is a transverse comb-like row of villi on each side, directed backward and limiting the upper and back part of the pharynx.

SKELETON.

SKULL.—On examination of the skull as a whole, the brain cavity appears relatively very large and high. The frontal region is much inflated, and the whole arch very convex. The attachments for muscles are generally not well marked, and the depression (crotophyte) for the insertion of the temporal muscle is almost obsolete.† Prominent points

* B 11. No. 2, Nat. Mus. 1875, p. 1.

† These observations are very different from those of Mr. T. C. Eytton on the skull of *Chionis alba*. He found the "cranium with a very small cavity for the brain; occipital

are: two deep fossæ just above and parallel to the superior orbital margins, a prominent bony crest (for the support of the caruncle) in front of these, the large size and subcircular form of the foramen magnum—all of which will be described in detail below.

Occipital bone is convex inferiorly and irregularly trapezoidal in shape. Its crest is less prominent than usual, although quite distinct; shaped like a bow, with its extremities distinctly defined as far as the superior border of the *meatus auditorius externus*. The condyle is small and spherical (not nicked, as in *Gallinæ*). *Foramen magnum* is nearly circular in outline, its anterior border being cut off so as to form a high, broad arch. It measures in antero-posterior diameter 0.21, in transverse diameter 0.32 inch. On each side of the condyle is a broad space for ligamentous attachments; laterally and posteriorly to these its paroccipital(?) portions extend downward as vaginal processes, protecting the posterior border of the external auditory meatus. From the foramen magnum to the crest extends upward a prominent median ridge, flanked by lesser ridges on each side from the lateral portions of the foramen.

Sphenoid is irregularly pyramidal in shape, being produced forward into a long cultrate spine (*basisphenoid*), embraced by the two prongs of the *vomer* and upon which ride the *palatine* and *pterygoid* bones. There are no distinct basipterygoid processes. Only the marginal portions of the basisphenoid contribute to the floor of the orbits, its orbital plates passing upward and outward to complete a septum between the brain and orbit. This septum is perforated in the median line by two irregular foramina for the transmission of the optic and olfactory nerves. The inferior (optic) foramen is heart-shaped, the apex of the figure being directed upward, and the lateral lobes much prolonged. The superior (olfactory) foramen presents the outline of the ace of clubs. As these are the chief anterior foramina of the brain-case, they probably transmit other nerves distributed to the orbit and face, as well as the olfactory and optic. Rising from the superior margin of the basi-sphenoid is the *inter-orbital septum*, perforated anteriorly in this species by an irregular vacuity, and posteriorly by an extension forward of the optic and olfactory foramina already noted. The interorbital septum is, however,

ridge very prominent; * * * * ridges for the attachment of the masseter muscles strongly marked." (*Osteologia Avium*, London, 1867, p. 176.) As we cannot believe there is any marked difference in the skulls of *C. alba* and *C. minor*, we simply fail to appreciate the pertinence of the author's remarks in this case.

properly speaking, incomplete only as regards the irregular foramen above mentioned. It is marked anteriorly by prominent stout bridges of bone, disposed so as to form the letter Y, which are continuous apparently with the notable exostosis marking the anterior portion of the frontal bone.

Parietal and *temporal* bones are not distinctly limited, owing to the complete ossification of the brain-case. The external auditory meatus is large, and so well protected by its surrounding periotic processes as to seem to be almost a tubular prolongation of the skull.

Os quadratum is in shape somewhat like a molar tooth, its crown being directed downward, and one fang (*i. e.* orbital process) projecting upward, forward, and inward nearly to the body of the basisphenoid. It presents five articulating facets; one inferior, broad, triangular, and marked by three marginal mammillæ, for the mandible; one external to and a little above this, for the zygoma; two, on its upper surface, for articulation with the temporal; and one, internal to these, for the pterygoid.

Pterygoids are relatively slender, 0.32 inch long, flattened from side to side, and slightly twisted upon themselves. They diverge from the palato-ptyerygoid articulation at an unusually wide angle, rather more than 90°.

Vomer is long, slender, bifid posteriorly, apparently extending from pterygo-palatine articulation to beyond the anterior extremity of the *maxillo-palatines*. Its complete ankylosis with the palatines, however, renders it impossible to determine exactly its posterior limit. Its superior surface is deeply channeled for its whole length. Beneath the vomer are to be found the *maxillo-palatines* and *palatines*, the latter soldered together on each side, but quite separated in the middle line.

Palatines are thin laminae, irregularly concavo-convex. They present two prominent laminae, external and internal. The external, which constitutes most of the bone, flares widely outward and downward, ending behind transversely, yet with a gently-rounded angle. From its under surface descends obliquely inward the much smaller internal lamina, like a keel.

Maxillo-palatines.—These bones are rather stout, squarish, tumid bodies, anteriorly joining the palatines at a point, but in all the rest of their extent entirely separated therefrom, as they also are from the vomer and from each other. The "body" is a very thin osseous wall, inclosing a hollow cavity. Anteriorly the *palatines* are produced as maxillary

processes to form the lateral borders of the palate and part of the osseous support of the basal portion of the bill.

From these accounts it appears that the palatal structure, as a whole, is what Huxley calls *schizognathous*.

Frontal bone is marked by two very distinct deep fossæ, occupying nearly the whole roof of the orbit, separated from one another by a prominent central ridge, and bounded anteriorly by a curious exostosis, which supports the fleshy caruncle of the forehead. The floor of this fossa is perforated by an anterior large circular foramen, transmitting the nasal duct of the gland which occupies the fossa. Behind this are several irregular perforations, disposed in a line parallel with the orbital margin. This last (the orbital margin) extends horizontally as a thin lamellar process, completing the roof of the orbit on each side. The remarkable exostosis above referred to may be described as consisting of two prominent bosses, one on each side, separated by a shallow central fossa, and presenting somewhat the outline of a bat with wings extended. From the external portion of each "wing" runs downward, parallel with the nasals, a slender bone (*maxilla*), articulated above by an expanded condyle, joining, below, the rest of the maxilla at the base of the bill. A narrow linear space is left between these bones and the nasal on each side. The construction of these parts is what Garrod calls *schizorhinal*.

Zygoma or malar bone is long (1.00 inch) and slender, of uniform diameter throughout, extending from the *os quadratum* to the base of the bill. It diverges rather widely from the middle line, the distance between its posterior attachments measuring 1.00 inch. *Lachrymals* are distinct, although small, easily detached, and liable to be overlooked. They are crooked little nibs of bone, with heeled base of support.

Mandible expands posteriorly into a flat articulating head, marked superiorly by a deep, irregularly concave glenoid cavity. On the internal side of this projects upward, and a little inward, a stout pyramidal process, slightly hooked toward its apex. Directly behind the articulation projects the *angle of the mandible*, a lamellar rostrum, nearly square in outline and very slightly canted upward; 0.15 inch in diameter. Externally there is a low pyramidal prominence, its apex filling the angle between zygoma and os quadratum, at their articulation. The body of the mandible is continued forward to the symphysis as a thin strip of bone, flattened from side to side, and sending upward a very thin lamella from its external surface to complete the contour of the bill. At

about the middle of the mandible, this lamella is incomplete, leaving a long, oval foramen, parallel to ramus, measuring 0.40 by 0.10 inch.

General measurements of skull.

	Inches.
Occipital crest to tip of bill.....	2.60
Occipital crest to fronto-maxillary articulation.....	1.40
Width of skull at base.....	1.00
Width between meatus auditorii.....	0.42
Extreme length of brain case.....	1.00
Extreme height of brain case.....	0.75
Width of frontal crest.....	0.80
Height of frontal crest, middle line.....	0.50
From fronto-maxillary articulation to tip of bill.....	1.40

The length of the symphysis is about one-fourth that of the entire mandible.

VERTEBRÆ.—*Cervical* are thirteen in number, differing considerably in shape. The second, third, and fourth show a distinct and prominent neural spine, which becomes very small on the fifth, and can scarcely be said to exist at all on the others. The second, third, fourth, ninth, tenth, eleventh, and twelfth present also very prominent laminar hyp-apophyses, which are not developed on the others. The bodies of the first four are very short, rapidly lengthening to the ninth, which is the longest, and again diminishing to the thirteenth, which is about as long as the fifth. All the cervical vertebræ but the atlas present large and distinct vertebral foramina, narrowing gradually toward the skull. The arteries which pass through these would seem to be of unusual size, since the bodies of the vertebræ are deeply grooved beneath for their reception. Rudimentary ribs are distinct on the last five cervical vertebræ, as uncinatè processes directed downward and backward from the extremities of the transverse processes. They are less obvious farther up the neck.

Dorsal are eight in number, each carrying a rib, of which all but the first and last articulate also with sternum. Each rib articulates both with the body and transverse process of its vertebra, leaving a space between its tubercle and head, which completes a morphological continuation of the vertebral foramina. From the third to the eighth inclusive the dorsal vertebræ show very prominent lamellar neural spines, forming, by their apposition end to end, a continuous thin perpendicular ridge, which projects above the dorsum of the bird. The bodies of the fourth and fifth are much compressed and flattened from

side to side, making a semblance to a series of prominent lamellar hypapophyses along this part of the column. The transverse processes also of all except the first dorsal are very thin and broad, projecting as a series of flat tiles above the heads and tubercles of the ribs. The last dorsal lies between the crests of the ilia, beneath and abutting against which the rib which it bears comes out. The *sacro-lumbar* vertebræ, *i. e.*, those which are anchylosed with each other and which articulate with the pelvis, appear to be thirteen in number. Viewed from above, the broad, expanded portion of the sacrum (opposite the acetabula) shows six inter-trabecular spaces, the contour of the exposed surface being approximately diamond-shaped, about $\frac{3}{4}$ inch broad at the widest part by $1\frac{1}{8}$ inches in length. The median line above is flat, without indication of spinous processes. Viewed from below, the conjoined centra of the *sacro-lumbar* vertebræ are a narrowly fusiform mass, broadest about opposite the middle of the ilia. Inferiorly they are flattened and somewhat excavated, though anteriorly pinched together and deepening to join the articulation with the last dorsal vertebræ. The trabeculæ are longest and most distinct opposite the acetabula, two of them being especially prominent, while anteriorly four or five are conspicuous. Then follows an interspace of about the same length, in which they nearly disappear; nor are they strongly marked toward the posterior extremity of the column.

The *caudal*, *i. e.*, unanchylosed post-sacral vertebræ, are nine in number, considering the pygostyle as one. Pygostyle is simply laminar, with thickened under edge, irregularly quadrilateral in shape; long diameter, $\frac{1}{2}$ inch. Of the other vertebræ, the transverse processes of the intermediate ones are shorter than those of either extremity. Moderate neural spines, with no obvious hypapophyses except on penultimate vertebra. The whole series presents no special characters.*

* Comparison with De Blainville's vertebral formula will show several points to be considered.

In the first place, De Blainville is in expressed doubt as to the number of post-sacral vertebræ, and his formulæ, as given at p. 102 and at p. 106, differ with each other, the first being 15—6—14—7=42, the other being 15—6—14—8=43. Accounting for this discrepancy on the supposition of imperfection of his specimen, we throw the post-sacrals out of further consideration, and turn attention to the remaining elements of his formula, which are really less different from ours than appears at first sight, we giving 13—8—13, and he 15—6—14.

For we reckon the last costiferous vertebra as dorsal, he as sacral. This leaves the numeration of non-costiferous anchylosed lumbo-sacrals the same, namely, 13, in each case, adding one to his numeration of dorsals. We furthermore reckon as a dorsal

Sternum measures 2.40 inches by 1.20 at upper borders, and is therefore exactly twice as long as broad. (Others measure 2.5 by 1.3, No. 32♂; 2.42 by 1.20, No. 232.) The manubrial process projects slightly in front of anterior border, sending downward a small, thin beak-like process. Articulating surface for coracoid extends from external and posterior margin of manubrial process, nearly meeting its fellow above it backward and outward, to an angular prominence on the ridges limiting sterno-coracoid articulation .80 inch from the manubrial process. When the coracoid has been removed, the anterior margin of sternum is nearly transverse, showing only a shallow curve upon each side. The costal process projects laterally beyond lateral margins of sternum 0.22 inch, and behind coracoid articulation. There thus presents on each side a triangular space, defined in front by the ridge limiting sterno-coracoid articulation, its base occupied by a grooved facet for coracoid, and its two other sides constituted by the horizontal and lateral margins of the costal process.

The ridge limiting sterno-coracoid articulation inferiorly is prominent and sinuous—bow-shaped. It extends nearly to lateral margin of sternum, which is a thickened ridge, bearing facets for the articulations of ribs on its flattened wide edge, and passing upward to join costal process at nearly a right angle. Costal process is flat and obtusely pyramidal in shape. It projects upward and outward, and covers the posterior aspect of sterno-coracoid articulation. Body is slightly constricted at its middle part, where it measures 1.00, expanding again posteriorly to measure 1.40 inches from apex to apex of its external laminæ. Posterior border is convex, the xiphoid process being cut off transversely. The posterior border is deeply incised on each side by two notches, of which the inner measures .40 and the outer .45 in depth, measuring from the curved margin indicated by the extremities of the intervening strips of bone (hyposternal elements of Owen). The outer notch is thus *a little deeper* than the inner, yet, owing to the convexity of the posterior borders of the lateral parts of the sternum, the two laminæ limiting the notches are almost exactly of equal length. The margins of the lateral sternal elements are thickened, as already stated, becoming stoutest in the area

that vertebra which bears a distinct, though small and asternal, rib. Removing this disputed one from his cervical series, and adding it to the dorsal series, gives the eight dorsals we enumerate. The only discrepancy, in total numeration of cervical, dorsals, and sacro-lumbar, between his count (35) and ours (34) is one cervical. There being certainly but thirteen cervicals in our specimens, *C. alba* must possess one more cervical than *C. minor*, unless De Blainville miscounted.

occupied by the articulations of sternal ribs, about junction of anterior and middle thirds. Here the ridge is re-enforced by the thickened line, limiting externally the area of origin of pectoralis medius. At the posterior edge of costal process it bifurcates, becoming continuous on the one side with the ridge limiting coraco-sternal articulation, and with the external and posterior margin of the costal process on the other. The area occupied by the origin of pectoralis medius is the thinnest part of the bone. *Keel* begins strictly at apex of manubrial process, whence a sort of beak is given off, its margin looking downward and backward for 0.30 inch. Then follows a sharp angle, with a quite deeply excavated curve, backward, downward, and forward again, to the most prominent part of the rostrum. The anterior border of the keel is therefore quite deeply concave, and its anterior extremity pointed. Its inferior border is slightly convex, and runs backward and upward, bifurcating at its extremity to join the angles of the expanded gladiolus. It measures along its curve 2.1, and at its deepest part, opposite the anterior angle, 0.80 inch. Its anterior border is much thickened by a stout ridge, proceeding backward and downward from the internal angle of sterno-coracoid articulation.

Coracoid measures 1.30 inches in length, and consists of a subcylindrical shaft and two expanded extremities, bearing three articulating facets. The scapular extremity is produced upward and forward, terminating in a prominent facet for the articulation of the clavicle. This articulating head arches over inward, so as to constitute, by aid of a coraco-scapular ligament, a considerable foramen continuous upon the coracoid with a deep groove which runs down upon its lower face, and is bounded by a ridge of bone internally. Three-tenths of an inch above and behind the anterior end of the coracoid is a broad articulating surface, extending entirely across the posterior face of the bone, for the scapula. At the external junction of scapula and coracoid is the glenoid cavity. The shaft of coracoid is inferiorly convex, superiorly flat, and toward its posterior end slightly concave. It sends off a remarkable sickle-shaped spine from the outer side of its posterior head, which curves slightly upward and extends just to the extremity of the costal process of sternum. Internally to this, on its posterior margin, is a triangular spine, extending backward, which fits into a corresponding depression in the ridge limiting sterno-coracoid articulation. From this spine the articulating facet extends inward, arching upward at the same time, and measures 0.40 from without inward. Including the external spine above referred to, the bone measures .63 across its base.

Scapula is long and sword-shaped. It is flattened from before backward near its articulation, and from side to side from its middle third outward, being slightly twisted upon itself. It articulates with the coracoid by a broad oblique head, marked posteriorly by three prominences, and measures 2.10 inches in length by an average width of 0.15 inch.

Furculum is moderately stout, **U** instead of **V** shaped, its sides at first parallel, then curving gently toward each other. It runs backward, with little downward inclination, and its apex is directly beneath the *manubrium sterni*, falling far short of the apex of the sternal keel. There is no prominent process at the union of its two elements, only a small mass of bone, facing the manubrium.

Ribs are eight in number, of which all but the first and last articulate with sternum. Splint ribs are distinct, averaging 0.40 inch in length, slightly curved, pointed, and directed obliquely upward and backward; but we cannot say how many there are, owing to the carelessness of the person who boiled the subject.

Humerus measures 2.70 inches in length; a slender bone, slightly curved, like an italic *f*. Its head is much expanded and flattened from without inward, covering the region of the joint as with a shield, convex externally, concave internally. It is marked by many deep grooves and depressions for muscular attachments, and by a very prominent ridge along its dorsal surface, whereto are attached the tendons of the pectoralis major and minor, latissimus dorsi, and scapular muscles.

The forearm is slightly longer than the humerus, measuring 2.9 inches from elbow to wrist. The *radius* measures 2.70 inches, and the *ulna* 2.80 inches. Both bones are rather stout for their length. Just below the carpal joint is given off from the radial side of the carpus a prominent exostosis, knob-shaped, 0.30 inch long by 0.20 inch wide at the base, growing out perpendicularly to the axis of the bone. This knob supports the wing-spur, is undoubtedly bony, but presents no recognizable evidence of independent ossification. The principal bone of the metacarpus, that representing the middle finger, carries two phalanges, measuring together 1.20 inches. To its ulnar side is attached at each end the metacarpal bone of the fourth finger, which acts as a splint-bone, being quite separate excepting at its extremities. This fourth metacarpal carries but a single phalanx. The radial metacarpal is a small spicule.

Femur measures 2.1 inches in length. Trochanter is flattened so as

to protect the joint externally, and rises above the margin of acetabulum.

Tibia is much longer than femur, 3.30 inches. Its head is much expanded, with a very prominent anterior flattened process, triangular in shape and curved slightly outward.

Fibula is distinct above; united to tibia by a thin, bony bridge along the middle part of its course; becoming free again as a very slender rod, which is finally fused with tibia at about its center, and quite lost an inch above its tarsal extremity.

Tarso-metatarsus terminates in three double condyloid facets, claw-like, partly separated. The outermost is shortest (highest), the middle longest, and the innermost one intermediate in length. About one-tenth of an inch above the junction of the middle and innermost elements is a foramen quite through the bone from before backward, and about large enough to admit an ordinary pin. From the head to the end of the middle division of its lower part the bone measures 1.75 inches, to the inner division, 1.65, and to the outer, 1.50, inches.

Toes are four in number. The first toe, articulated to the metatarsus above the level of the rest, has two elements. Its accessory metatarsal is very short. The second toe, articulating with the inner condyle, has three elements, successively diminishing in length. The third toe has four elements, similarly diminishing; and the fourth toe has five, of which the first is longest, the second and fourth next and equal, the third next, and the fifth shortest.

Pelvis is long, compressed anteriorly in the middle line of its dorsal surface, expanded posteriorly, and diverging so as to include the sacrum. The crests of the ilia extend so far forward as to cover the articulation of the last rib, and are separated in the middle line only by the lumbar neuropophyses, to which they are closely apposed, being turned up to form a sheath. Eight-tenths of an inch from the anterior margin of the pelvis the ilia begin to diverge, inclosing a hastate interval, which is filled up by the sacrum. Here the dorsal surface of the ilia becomes convex (from concave), presenting a well-defined, smooth surface for the origin of the gluteal muscles. Posteriorly, the ilium ends in a sinuate border limited externally by a prominent ridge, which terminates posteriorly in a considerable spine, the tuberosity of the ischium. The *acetabulum* is perforate, protected posteriorly and superiorly by a prominent bony lip, which separates it from the ischiatic foramen. Between the ischiatic foramen and the acetabulum, and inferior to both, is the obturator

space, limited below by the pubis and above by the ischium. It is converted during life into an oval foramen by a stout ischio-pubic ligament. The ramus of the ischium runs downward and backward as a long falcate process, flat, thin, and curved on the flat somewhat inward. The *pubis* is long, very slender, shaped like an italic *f*, and crosses the ischium externally to its ramus, extending 0.40 beyond it, curving inward as it passes backward. Both ischium and pubis extend considerably beyond the coccyx posteriorly, and approximate each other, inclosing, with ilium, an irregular, circular outlet, of which the sacro-pubic diameter is 1.30 and the inter-ischiatric 1.10 inches. Internally the ilia are deeply excavated opposite the sacrum for the kidneys, so that the acetabular and ischiatic foramina pass out *laterally* from the cavity so formed. Its roof is crossed by the sacral trabeculæ, and encroached upon by the sacrum, somewhat like the ridge-pole and lateral ties of the roof of a house. This iliac cavity is limited anteriorly by the margin of a ridge formed by the fusion of the ischium and pubes. Posteriorly, although the rami of the ischium do not articulate or fuse together, they *touch*, doubtless closing during life the whole obturator space, here very long and narrow.

STATEMENT OF CONCLUSIONS DEDUCED FROM THE FOREGOING.

HABITS, GENERAL APPEARANCE IN LIFE, AND EXTERNAL CHARACTERS.

The observer is first struck by the strong resemblance which *Chionis* bears to the pigeons, in general appearance, gait, and mode of flight. The general shape of the body is of an ordinary columbine character, the head being notably small, as usual in that group, the neck short and full, and the body plump; the tail, moreover, having but 12 rectrices. The sheath of the bill may furnish a distant analogy with the soft, swollen membrane which covers the nostrils throughout the *Columbæ*. But this is a mere resemblance, the affinity indicated being, as will be seen later, with such sheaths as the *Procellariidæ* and especially *Lestridinæ* bear. The strongly convex outline of the frontal feathers at the base of the upper mandible is a very decided columbine feature. These superficial resemblances to *Columbæ* are not correlated with more important structural characters, and are themselves overbalanced by other external features, which indicate relationship with other groups. Thus the pterylosis is entirely different, large after-shafts and abundant down

being present. The pterylosis stops above the suffrago; the inner remiges reach to the ends of the primaries in the folded wing. As to the exterior portions of the body not covered with feathers, the feet are entirely different from those of the pigeons, in the shortness and elevation of the hallux and other features, while the bill, aside from the sheathed portion, is altogether diverse. The reference of this form, therefore, to, or even near, the *Columbæ* is out of the question.

The only external character indicating a *passerine* affinity is the form and size of the beak, which are decidedly corvine; an analogy which, however, is as feeble as that deduced from the croaking note of the bird when on its feet, and has, of course, no taxonomic significance.

The external resemblances to the *Gallinæ* are much more obvious and important. The contour-feathers have large after-shafts—at least half as long as the main shafts. There is a curious gallinaceous trait exhibited in the mode of holding the wings during life—drooping and parallel with the tail instead of meeting each other above it. The frontal caruncular casque presents an obvious resemblance to the combs which ornament so many of the typical *Gallinæ*. The few tail feathers and contour of those of the forehead are, however, columbine rather than gallinaceous, while the elongation of the inner remiges and general shape of the wing is rather grallatorial. The feet, in almost every particular, are thoroughly gallinaceous, even to the character of the marginal fringe of the toes, which retains strong pectinations instead of presenting the smooth border characterizing the feet of many of the *Grallatores*. The points in which the feet differ from those of most *Gallinæ* are: The reticulation instead of the anterior scutellation of the tarsus, and nakedness of the lower portion of the tibiæ; both these features being essentially grallatorial, though shared by the gulls. As to other naked portions of the body: The presence of the wing-spur indicates affinities lower than the *Gallinæ* so far as it has any taxonomic value, such spurs being a rare accident of higher (*i. e.*, more recent) birds, and its development being most pronounced in older, more generalized types—struthious birds, for instance. The abundance of gray down is an indication of relationship with pelagic birds, and by so far removes the bird from the neighborhood of *Gallinæ*. The legs are altogether below the average grallatorial length, and the small extent (one-half inch) of the unfeathered part of the tibia seems to assimilate it, as De Blainville has observed, with the gulls. The system of coloration also is extremely gull-like. The bird, in fact, closely resembles super-

ficially *Pagophila eburnea*, or *Pagodroma nivea*. The thoroughly anomalous bill offers nothing of interest in this connection. On the other hand, the bird's omnivorous diet, habits under confinement, easy domestication, dislike of water, entire inability to swim, and many other points in its habits, are strongly gallinaceous characteristics, by so much removing it from the vicinity of either grallatorial or natatorial birds.

Proceeding to consider the relationships of *Chionis* with *Grallæ* as to external features, the following points present themselves: A small, flat, twelve-feathered tail, a wing with the inner remiges equaling the longest primaries, a tibia bare below, a completely reticulate tarsus. These are all grallatorial features. As to other indications to be afforded by external characters alone, we should not omit to refer to a struthious feature already noted by W. K. Parker (Trans. Zool. Soc., vol. v, p. 207) in the following terms: "There are certain curious, thoroughly *marine* plovers (*Chionis*), in which the sheathing of the upper jaw is very perfect. They thus retain a struthious character, but in an exaggerated condition."

Upon one point which we consider important, the required data are wanting. We refer to the nature of the bird, whether altricial or præ-social. The now well-known egg itself has been perhaps hastily considered to be decidedly pluvialine; yet, for all we can see, it is quite as thoroughly larine. Now, as we shall see beyond, the relationships of the bird are nearly balanced between the plover-snipe and the gull-petrel groups. If *Chionis* lays regularly four eggs, and if the young run about at birth, this would be a great argument for De Blainville; if it lays two or three eggs, and rears its young in the nest, the boot would be on the other leg.

In summing external characters, therefore, we see how exactly *Chionis* stands between grallatorial and natatorial birds, retaining slight but perfectly distinct traces of several other types of structure.

Inasmuch as M. de Blainville is the only naturalist who has made any careful study of this genus (based upon specimens of *C. alba*), and as his conclusion that its nearest affinities are with *Hæmatopus* have never been formally disputed, it seems proper to consider here the external features upon which this distinguished naturalist based his deductions.

In the first place, De Blainville labored under the disadvantage of never having seen a specimen of *C. minor* (it had, indeed, not been dif-

ferentiated at the time of his description) which we regard as clearly the type species of the family. Secondly, the description of the living bird to which he had access related only to individuals observed under the unnatural conditions of confinement on shipboard, which may account for the discrepancies between his and our descriptions of its habits, and tends to invalidate the conclusions which he draws therefrom. While he has stated fairly and accurately many of the resemblances to *Hæmatopus*, or in other words to *Grallatores*, he seems to us to have failed to give due weight to the many important points of difference from that family, some of which we have already discussed, and others of which will appear in a stronger light as we proceed to examine the internal structure.

MUSCULAR AND DIGESTIVE SYSTEMS.

The muscular system affords less important and decisive indications than either the digestive or osseous. According to our dissections, the general disposition of the pectoral muscles which act upon the humerus is, as would have been anticipated from the mode of flight, rather gallinaceous than grallatorial. This statement is borne out by the relative development of the several pectorals, the bulk and extensive origin of a "*coraco-brachialis*" (see page 94), and a specialization of a sort of *platysma myoides* with reference to its action upon a large crop. A tolerably minute description of the more important muscles has been given on a preceding page as material for further comparisons than we are at present prepared to undertake.

In the digestive system we meet at the outset with several gallinaceous characters. The breadth of the mouth, especially near the base of the bill, shape of the tongue, and general disposition of the several palatal and lingual appendices, are rather those of a gallinaceous than of a grallatorial bird. In the shore-birds, among which *Hæmatopus* falls, narrowness of the bill and constriction of the whole buccal cavity is a very distinctive feature. The slender œsophagus of *Chionis*, much narrower than is usual in shell-eating birds, presents the extremely rasorial feature of a large and circumscribed crop. The proventriculus is not a marked dilatation of the œsophagus. Its solvent glands differ widely from those of the *Gallinæ* in their simple structure, approaching, in this respect, to those of various water birds, such as the swan and gannet. But the low taxonomic value of this feature is illustrated by the marked differences exhibited by those of so nearly related birds as the swan and goose, for example. No greater value attaches to the disposition

of the zone of glands as a whole, since it varies widely in closely-allied genera.

The gizzard appears to be unique, so far as we know, in the antero-posterior, instead of lateral disposition of its masses of muscle. The development of muscle is intermediate between the great masses found in the *Rasores* (and such *Natatores* as the goose) and the less considerable layers found in *Grallatores*, but altogether different from the thin membranous bags of fish-eating birds like gulls. The length of the intestine (about three times that of the bird), and its calibre, do not differ greatly from the same characteristics in *Rasores*. The cæca are very long, and dilated toward their blind ends; in this respect totally unlike the grallatorial type, in which the cæca, when present, are commonly small and simple.

The third cæcum, of uncertain significance, is distinct, although small. This appendage is found in various grallatorial, some struthious, and many other birds. On the whole, it is safe to say that the digestive canal is decidedly rasorial in character.

OSSEOUS SYSTEM.

From a decided position among *Gallinæ*, on the other hand, certain parts of the skeleton exclude this bird as effectually as the existence of a sternal keel renders the consideration of struthious affinities unnecessary in this connection. The sternum departs furthest from that of a struthious bird, and next most widely from the very peculiar rasorial form. The most cursory inspection throws out at once the deeply-cleft, strongly specialized sternum of gallinaceous birds. It is of a very simple generalized type, presenting characteristics to be found in widely diverse groups of birds, but on the whole resembles most closely the commonest form of the sternum of the *Laridæ*, with a marked likeness also to the breast-bone of a plover. The obvious resemblance of this bone to that of *Hæmatopus* is the central point of De Blainville's argument. Yet we are inclined to believe that the sternal characters upon which De Blainville most relies as distinctively pluvialine are simply the most generalized features of the bone—those which, under various modifications, are to be found in the greatest number of different groups. And simple comparison shows beyond dispute a greater resemblance of this sternum to that of the gulls than to that of wading birds.

The general form, the existence of a prominent manubrial process, the width and extent of the costal margins, the great prolongation of

the costal processes, the development of the keel relative to the size of the body of the bone, the general disposition of the coraco-sternal articulation, and the doubly-notched posterior border, are all thoroughly gull-like. The point of difference of this sternum from that of the gulls, is a moderate rounding of its posterior margin, so that the outer of the two spurs of bone does not reach so far back as the inner; the reverse being the case in *Laridæ*. Such form of the posterior margin is a common gallatorial character; nevertheless, in *Limosa*, for instance, this border is perfectly transverse. Moreover, the difference between *Chionis* and *Larus* in this respect is less than the difference between *Larus* and its near neighbor *Lestris*. In the wading birds the manubrium is either absent or quite small, the keel is very deep in proportion to the extent of the body, and the body is compressed anteriorly, and very deeply hollowed. As to all of these features, the sternum of *Chionis* differs from that of the plovers and approaches that of the gulls. In comparison with either plovers or gulls, there is a feature peculiar to *Chionis* in the relation borne by the furculum to the sternum. For both gulls and plovers have a strongly bent furculum with a well developed posterior spine reaching nearly to the apex of the sternal keel; whereas, in *Chionis* the furculum is scarcely bent, has no spine whatever, and its apex is closer to the manubrium than to the sternal keel. In place of a posterior spine there is a slight process of bone directly facing the manubrium.

The clue to the true affinity of the bird furnished by these gull-like sternal characters, is traceable in every part of the skeleton.

To begin with the skull. The *Gallinæ* may be at once thrown out of the discussion by the absence in *Chionis* of the following, among other, distinctively "*alectoromorphic*" features.* The occipital condyle is simple, not notched; there are no basiptyergoid facets, the pterygoids articulating with the basisphenoid only at their extremities; the internal lamellæ of the palatine bone are strongly developed instead of rudimentary; and the shape of the palatines, as a whole, is radically different. The maxillo-palatines are long and spongy, instead of being lamellar. Vomer is large, conspicuous, and completely ankylosed with the palatines. The articulation of the quadrate bone with the temporal is very different, nor is there in front of this bone the immense fenestrated process so conspicuous in *Gallinæ*. The angle of the mandible is not strongly upcurved. There are great pits on top of the skull for the

* Huxley on Classification, P. Z. S. 1867, p. 459.

lodgment of the nasal glands not seen in *Gallinæ*. In fact, the curious frontal bosses found on some cocks are one of the most obvious points of resemblance, aside from the fact that the palates of both are *schizognathous*; but a fortuitous exostosis like this has, of course, no classificatory significance.

On the other hand, every important feature of the skull is identical with the characters presented by the skull of the gulls. So perfect is the resemblance that after careful comparison the principal discrepancy between the two skulls that we are able to detect is the wider divergence of the pterygoids from each other, and the consequently more posterior position of the palato-ptyergoid articulation in the skull of *Chionis*. The most trifling details of the gull's skull are repeated in that of *Chionis*. It is needless to enumerate them. There is, however, a character of uncertain value in the front of the gull's orbit, where a strong transverse plate of bone projects, bounding the orbit anteriorly; no such formation being found in *Chionis*, wading, or gallinaceous birds. As to the angle of the mandible, it is found to be in *Chionis* essentially as in the gulls, yet with a slight production posteriorly, much like that found in some wading birds. In general, the slight differences observed between the details of the skulls of *Chionis* and gulls are differences of degree only; a less development of bony ridges and processes, a greater relative breadth, and less forcible expression of differential details. The difference in the form of the rostrum, which is likely to attract attention, is of no significance whatever, since extraordinary differences in this respect are found among the *Laridæ* themselves (*cf. Rhynchops, e. g.*)

Nitzsch first, from consideration of the pterylosis alone, and Huxley subsequently, with reference to the skeleton, have demonstrated a very close, although not generally recognized, connection between the great plover-snipe group and the gulls; and in discussing the affinity of *Chionis* to the gulls, we might be supposed to imply nearly or quite as intimate relationship with the plovers. But in *Chionis* we miss precisely those characters which are relied upon to distinguish the plovers from the gulls, namely, an extensive naked space above the suffrago as regards pterylosis, and the presence of distinct basi-ptyergoid processes as regards osteology. Furthermore, plovers do not possess the great pits on top of the skull which are so conspicuous in *Laridæ* and in *Chionis*, their rostrum is slender and elongate, their maxillo-palatines are never swollen or spongy (as in *Chionis*), and the angles of their mandibles are produced into slender recurved processes.

Throughout the skeleton, minute and careful comparison, bone by bone, shows only close similarity between *Chionis* and the gulls, as great as that already signalized in treating of the skull. In short, had we only the skeleton of *Chionis* to go upon, we should be obliged to place the genus in *Laridae*; its peculiarities being less widely diverse from those characterizing that family than are to be found within the limits of the family itself.

We thus find in *Chionis* a connecting link, closing the narrow gap between the plovers and gulls of the present day. In our opinion, this group represents the survivors of an ancestral type from which both gulls and plovers have descended. And this opinion is strongly supported by the geographical isolation of its habitat, affording but few conditions favorable to variation.*

In the practical matter of classification, it is evident that *Chionis* is not exactly referable to either of the two groups between which it stands. A consideration of its external characteristics, its digestive system, or its osteology, solely, would lead to very widely diverse conclusions. For we have presented in this bird a genus with the general appearance, gait, and flight of a pigeon, with the beak and voice of a crow; with the habits of a wader, yet dreading the water, and with the pugnacity and familiarity with man of a rasorial bird. With the last group its digestive system would certainly place it, to say nothing of the long after-shafts of the feathers. And osteological comparison establishes its position definitely between the gulls and plovers, but rather nearer to the former.

* It is interesting to note in this connection that the fauna of Kerguelen Island is rather remarkable as containing several forms of animal life whose structure would give no clue whatever to their habits, so aberrant has been the progress of their variation in the peculiar conditions under which they live. Thus the great southern skua (*Buphagus skua antarcticus*, Bull. No. 2 Nat. Mus., p. 11) has there adopted the habits of a land-hawk; three very remarkable genera of apterous *Diptera* occupy the place and live the life of leaf-eating and carnivorous beetles; and the only beetles found by Dr. Kidder were curculios (in a country without trees or shrubs), and a small water-beetle (*Oethebius*), living at a distance from any body of fresh water. The curculios lived upon the rocks and moss, and had lost their northern habit of simulating death, while one genus of apterous *Diptera* had taken up the habit, and lived upon the leaves of the largest plants there represented. Several orders of insects, including *Hymenoptera*, *Hemiptera*, *Orthoptera*, and *Neuroptera*, among the commonest elsewhere, are here entirely absent; so that those which are represented are placed altogether anomalous surroundings. As Latreille has said (Hist. Nat., vol. xi, p. 51), "*La nature en général a un certain nombre de modèles qu'elle reproduit avec des modifications dans tous les classes, et même dans les ordres.*"

Such distinctive characteristics, amounting almost to anomalies, certainly appear to us to be of a super-family value; equivalent in taxonomic importance to those upon which the groups which Professor Huxley has characterized by the termination "*-morphæ*" are founded. Much of the discussion which *Chionis* has occasioned has grown out of the tacit assumption that it was merely a genus or family, which *must go somewhere* in a pre-established system; the fact being simply, that it is a member of no recognized group, and must consequently alone constitute one of super-family grade.

Such a group, therefore, we propose to establish, upon the following combination of characters:

CHIONOMORPHÆ.

Palate schizognathous; no basiptyergoid facets; divergence of the pterygoids greater than 90°; maxillo-palatines inflated or spongy, not laminar; angle of mandible not hooked; nasals schizorhinal; marked supraorbital fossæ.

Furculum without a spine; its apex nearer manubrium sterni than the point of the keel; a small bony process over its symphysis, facing manubrium. Osseous system thoroughly Larine.

A definitely circumscribed crop; a strongly muscular gizzard, the muscular masses being antero-posterior instead of lateral; very long cæcal appendages. Digestive system generally resembling that of the Gallinæ.

Contour-feathers with well-developed after-shafts; abundant gray down-feathers; tibiae naked below; rectrices 12; inner remiges equaling the longest primaries; outline of frontal feathers convex.

Beak corvine, peculiarly sheathed.

Feet not palmate; digits, 4; hallux short and elevated.

There being but a single family and genus recognized in this group, it is difficult, if not impossible, to distinguish those characters which are of family value from those which may prove to be only generic. Indeed, it is rather upon the extraordinary combination here presented, of very diverse characters, than upon the importance attaching to those of any single "system" of the birds' anatomy that we base the suborder hereby proposed. We regard the Chionomorphs as constituting exactly the heretofore unrecognized link between the Charadriomorphs and Cecomorphs, nearer the latter than the former, and still nearer the common ancestral stock of both.

Mr. A. R. Wallace (Remarks on the value of osteological characters in

the classification of birds) "will not allow that the osteological characters are an all-sufficient guide (in classification), believing that the whole structure of a bird and its corresponding habits may be profoundly modified, while its sternum may closely resemble a common form, and *vice versa*." (See *Ibis*, 1864, pp. 36-41.) *Chionis* is a forcible illustration of this sound remark.

It seems worth while to note a generic distinction probably existing between *Chionis alba* and the so-called *C. minor*. We have not had the opportunity of examining the former, and must judge solely by the descriptions thereof which have been published. According to De Blainville there is even a difference in the number of the cervical vertebræ. He describes *C. alba* as possessing one more cervical vertebra than we find in *C. minor*. No descriptions allude to the extension of the caruncular casque entirely across the forehead in either species. The various descriptions of *C. alba* indicate a very different arrangement of the caruncular folds about the eye; the sheath of the bill in *C. alba* is flat and closely apposed to the upper mandible, as in *Lestris*, while in *C. minor* it is canted upward anteriorly and tubular, almost as in the petrels.

These characteristics, among others, seem to us to be supra-specific; and in view of the fact that we consider *Chionis minor* to be undoubtedly nearest to the ancestral type, we propose to call it *Chionarchus*. Its name would then be in strictness *Chionarchus minor* (Hartl.).

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