The Myology of the Bell-Magpie (Strepera) and its Position in Classification.

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MY purpose in entering on an examination of the Bell-Magpie (*Strepera*) was to endeavour to find evidence that would settle the vexed question as to whether that bird was more closely related to *Corvus* or to *Gymnorhina* and *Cracticus*. The work was carried out in the laboratories of the Biology School, University of Melbourne, under the personal supervision of Acting-Professor T. S. Hall, to whom I am indebted for many valuable suggestions and much helpful advice and direction. I am also indebted to Mr. J. A. Kershaw, F.E.S., Curator National Museum, Melbourne, for the loan of specimens and literature.

Gould was quite satisfied on this point, for he said, in the " Introduction to the Birds of Australia," page 33, the relationship of the birds of the genus *Strepera* " to the *Corvidæ*, to which they have been usually assigned, is very remote, their size and colour being, in fact, the only features of resemblance. Their whole structure and economy are, indeed, very different from those of every other bird known, except those of *Gymnorhina* and *Cracticus*, with which genera they form a very natural group, most nearly allied to the great family of the *Laniidæ*, or Shrikes."

The late Dr. Bowdler Sharpe, on the other hand, seemed unable to make up his mind on the point. In the " Catalogue of Birds in the British Museum," vol. iii., page 57, Sharpe placed *Strepera* in the *Corvidæ*, away from *Gymnorhina* and *Cracticus*. In vol. iv. of his more recently published " Hand-list of Birds," on page 278, he placed *Strepera* in the sub-family *Gymnorhinæ* of the *Laniidæ*. Mathews, apparently following Sharpe's manuscript of vol. v. of the " Hand-list of Birds," placed *Strepera* in the *Corvidæ* in his " Hand-list of the Birds of Australasia." When vol. v. of the " Hand-list of Birds " appeared, it was seen that Sharpe had placed *Strepera* in the family *Streperidæ*, following the *Corvidæ*, and had left *Gymnorhina* and *Cracticus* in the *Laniidæ*.

Mathews, in his " Reference-list," 1912, again included *Strepera* in the *Corvidæ*. He further suppressed the genus *Gymnorhina*, and placed the birds now included in that genus in the older genus *Cracticus* ; *Cracticus* was left in the *Laniidæ*. It was in the hope of settling whether *Strepera* was related to *Corvus* or to *Gymnorhina* that this work was undertaken. The results show that *Strepera*, *Gymnorhina*, and *Cracticus* are closely related, and form a natural group, probably as much entitled to family rank as many of the so-called families of the Oscines section of the Passeriformes. All writers admit the great difficulty of classifying the Oscines, for more than half of the 19,000 species of birds are included in that group. Parker exclaimed, " One hundred classifiers, one hundred so-called systems ! "

Dr. Shufeldt made a detailed study of the myology of the Raven, which he published under that title. It was thought
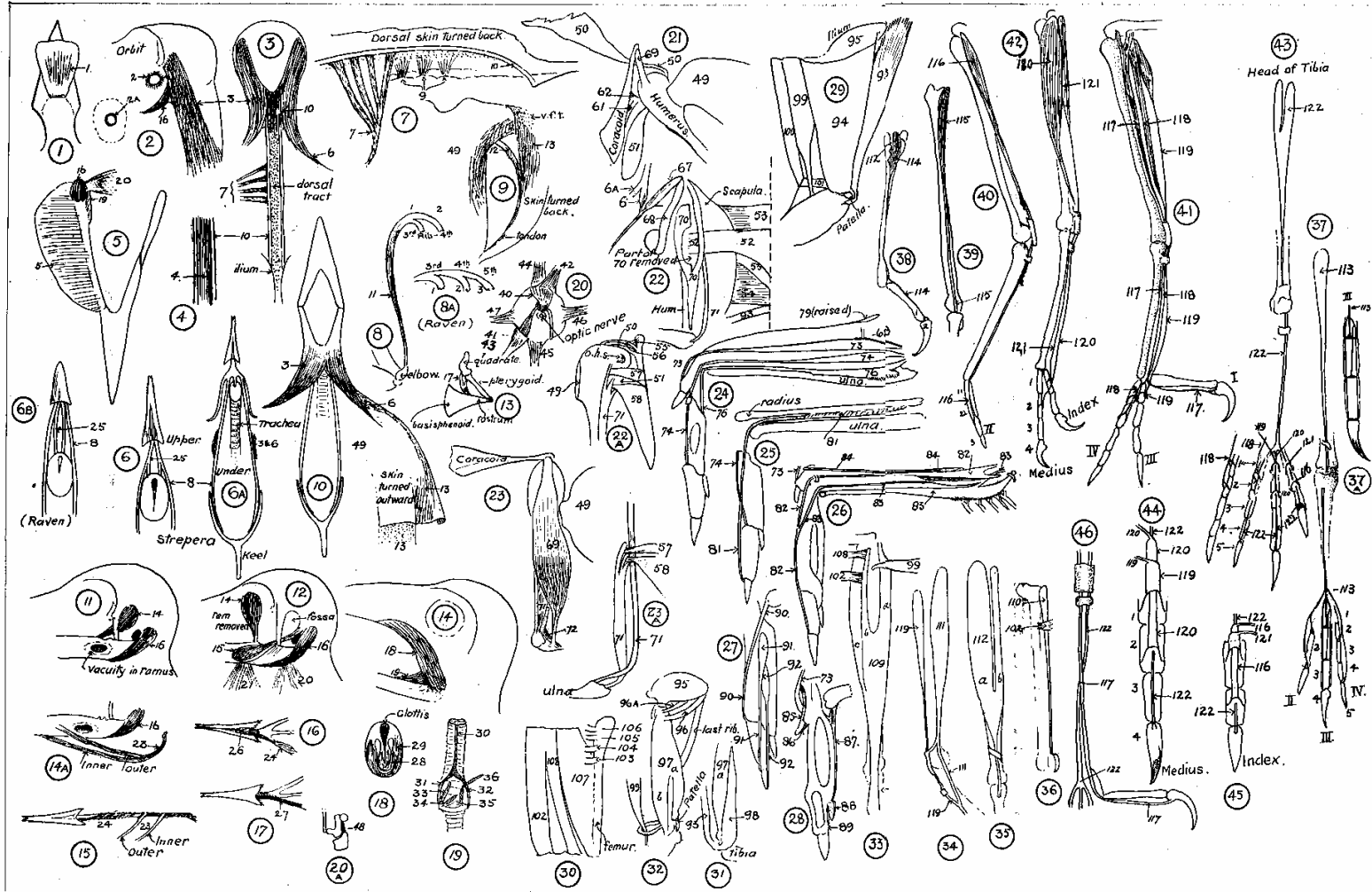
The numbers refer to the muscles as in the text.

that a detailed examination and comparison of the myology of *Strepera* with that of the Australian Raven, *Gymnorhina*, and *Cracticus*, and an examination of characters of taxonomic value, would yield evidence of a definite nature. The results support Gould's belief that *Strepera* is closely related to *Gymnorhina* and *Cracticus*. If one of these birds differs from the Raven in the position and size of a muscle, all three differ, and they differ little amongst themselves.

Professor W. K. Parker, in the " Transactions of the Zoological Society," vol. ix., 1877, page 327, said :—" In all respects, physiological, morphological, and ornithological, the Crow may be placed at the head, not only of its own great series, birds of the *Crow-form*, but also as the unchallenged chief of the whole of the *Carinatæ.*" He further placed *Gymnorhina* almost equal in rank with it, at the head of another important section. He said, concerning *Gymnorhina* :—" Suggesting to the observer its own name, Crow, with a modifying epithet, Piping, this is yet a bird which is the culmination of a very different branch of the *Ægithognathæ* from that of the true Crows of the Old World. There are not many internodes between this upper type and the Chilian and Brazilian birds that grow out below it." Again, referring to the posterior lateral processes on the palatines, he said :—" These peculiar styliform trans-palatines are found, so far as I have seen, only south of or upon the equator, and their very curious character, always correlated with other characters, might justify me in dividing the *Coracomorphæ* into *Noto-coracomorphæ* and *Arcto-coracomorphæ.*" Parker, apparently, did not examine *Strepera* or *Cracticus.* In the " Dictionary of Birds " Newton uses the term " Austro-coraces " for these birds " leading to the Crows."

Ridgway referred to Parker's views, and on page 253 of his " Birds of North and Middle America," 1904, considered that these birds should form the family *Streperidæ.* He said :— " Several of the Old World types which have been referred to the *Corvidæ* are more or less aberrant, and some of them certainly do not belong here. Among the latter may be specially mentioned the Australian genus *Strepera*, which, with the genus *Cracticus*, has by some authors been referred to the *Laniidæ*, though a more consistent view of their relationship would entitle them to the rank of a family, *Streperidæ.* Besides the *Streperidæ* and *Laniidæ*, the nearest relations of the *Corvidæ* seem to be the *Paradiseidæ.*" Ridgway, on page 254, states that " America possesses nearly half the undoubted *Corvidæ* enumerated by Dr. Sharpe in his catalogue of the *Corvidæ* in the British Museum." In a footnote he says :— " The genera *Strepera, Struthidea, Picathartes, Glaucopis, Hetera-locha, Creadion, Palculia, Graculus, Pyrrhocorax, Corcorax,* and *Podoces* are excluded from the above enumeration as being more or less doubtfully members of the family." *Struthidea* and *Corcorax* are " anomalous " Australian birds that apparently should be the subjects of a detailed examination.

Pycraft, in an article in the " Proceedings of the Zoological Society," on " The Osteology of the Gymnorhines," fills in some of the internodes referred to by Parker when he said, " There are not many internodes between this upper type (*Gymnorhina*) and the Chilian and Brazilian birds that grow out below it." Pycraft placed *Gymnorhina* at the summit of a branch of the Passeriformes. Apparently he did not examine *Strepera* or *Cracticus.*

THE MYOLOGY OF STREPERA.

In describing the muscles of *Strepera*, much assistance has been received from Shufeldt's " Myology of the Raven." As *Strepera* has the same arrangement for most of the muscles, and as Shufeldt has given a full synonymy and abundant references in notes to the classical works of Owen, Gadow, and Furbringer, his arrangement, names, and numbers for the different muscles have been adopted.

THE DERMAL MUSCLES.

There are 13 muscles named and described by Shufeldt as being connected with the skin of a Raven. These skin muscles, with the possible exception of the *dermo-ulnaris* (11), are probably more or less closely united. A bird shakes its feathers after a dust bath. One can readily conceive that, in order to work the feathers simultaneously, there should be a more or less intimate connection between the different skin muscles.

The 13 muscles have been named by Shufeldt as follow :—

1. The *dermo-frontalis.*
2. The *circumconcha.*
3. The *dermo-temporalis.*
4. The *dermo-dorsalis.*
5. The *platysma myoides.*
6. The *dermo-tensor patagii.*
7. The *dermo-cleido dorsalis.*
8. The *cleido-trachealis.*
9. The *dermo-spinalis.*
10. The *dermo-iliacus.*
11. The *dermo-ulnaris.*
12. The *dermo-humeralis.*
13. The *dermo-pectoralis.*

1. The *dermo-frontalis* [1].* Shufeldt describes this as being present only in old male Ravens. He says :—" It is about 3 centimetres long and a few millimetres wide, closely attached to the skin." I find a fine muscle stratum underlying the feathers of the head tract in *Strepera* † and the Australian Raven. Possibly the Australian Raven has not the fine muscle band, but

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* A number in brackets [ ] refers to a diagram on plate 1 or 2. A number in parentheses ( ) is the consecutive number used for the muscle by Shufeldt in " The Myology of the Raven."

† The species examined were *Strepera graculina, Corvus australis, Gymnorhina tibicen, Cracticus destructor.*

it certainly has a muscle stratum under the skin of the head. If this is not what Shufeldt meant, then it is a muscle not described by him. Shufeldt noticed in a living domesticated Raven that the bird could make the feathers above the eyes, " lateral crests," stand up so as to be very evident, not to say conspicuous.

2. The *circumconcha* [2] [2a] in the *Strepera* is, as Shufeldt describes, a muscle in the " periphery of the ear-conch." It is closely attached to the skin, and arises by a neat little tendon from the end of the supraoccipital crest.

3. The *dermo-temporalis* [3] [6a] [10] is, in *Strepera*, an important skin muscle. It is probably connected with all the skin muscles except the *dermo-ulnaris* (11). In *Strepera* the two *dermo-temporales* fuse directly with the *dermo-iliacus* (10) at either side of the narrow dorsal feather tract ; anteriorly, they are united by means of a strong fascia. The two *dermo-temporales* unite on the ventral surface and ensheathe the neck. Fibres from the *dermo-trachealis* (8) and from the *dermo-tensor patagii* (6), the muscle which sends a tendon along the propatagium to the wrist, unite with the *dermo-temporalis* on each side. Fibres from the muscle (13) of the ventral feather tract join at about the same place, thus intimately connecting the various skin muscles (3), (6), (8), and (13).

The *dermo-temporalis* on each side arises fleshy from the hinder part of a ridge outside the orbit and above and anterior to the temporal fossa. It extends down the sphenotic process, behind and partly under the ear, covers the *temporal* muscle (14), and runs back to the dorsal feather tract, where part of it passes directly back on to the *dermo-iliacus* (10). It spreads round the throat, and covers the *cleido-trachealis* (8), some fibres fusing with that muscle. The two *dermo-temporales* muscles (3) fuse in front of the neck, thus ensheathing it, as shown in figure [10].

4. The *dermo-dorsalis* [4] is the skin muscle underlying the dorsal feather tract ; it is covered with fat. Along each side of it the *dermo-iliacus* (10) runs as a definite narrow muscle. *Strepera* agrees with the Australian Raven, *Gymnorhina*, and *Cracticus* in the arrangement of this muscle. The American Raven, as described by Shufeldt, differs. He says :—" It (the *dermo-dorsalis*) is most prominent in the middle of the neck, where it is enclosed in a fold of the integument." In the Australian birds it is the *dermo-iliacus* (10) that is enclosed in a fold of the integument at the side of the feather tract.

The *dermo-dorsalis* becomes fainter as the head is approached, but is probably continuous with the *dermo-frontalis* (1). The *dermo-dorsalis* (4) is lost posteriorly over the caudal region.

5. The *platysma-myoides* [5] is a thin fascia with a few muscle fibres, and meets its fellow of the other side under the chin.

6. The *dermo-tensor patagii* [3] [6a] [10] [22].—Shufeldt separates the propatagium from the parapatagium, the fold between the

root of the neck and the shoulder. In the free edge of the para-patagium is a muscle, the fibres of which spread out on the neck, joining a fasciculus receiving fibres from the *dermo-temporalis* (3), the *cleido-trachealis* (8), and the *dermo-pectoralis* (13). At the distal end in *Strepera* a tendon almost immediately joins the tendon of the *tensor patagii longus* (67). Its action is to help that muscle. The *dermo-tensor patagii* (6) is described by Shufeldt as a variable muscle. He said :—" Were the variations all known and appreciated, I am confident that they would be characters of considerable taxonomic value." *Gymnorhina* and *Cracticus* agree with *Strepera*. The Raven differs in having a fairly long tendon for the *dermo-tensor patagii* before it joins the tendon from the *tensor-patagii longus* (67). The tendon is very elastic.

6*a*. The muscle [10] [22] underlying the humeral feather tract joins the *dermo-tensor patagii* by a definite muscle band.

7. The *dermo-cleido dorsalis* [7] arises from the upper inner face of the clavicle. It spreads out fanwise in several distinct branches on a mesentery, which runs vertically upwards. Some of its fibres join the *dermo-dorsalis* (4), and the *dermo-iliacus* (10), and some spread out over the skin on the outer side of the last-named muscle.

8. The *cleido-trachealis* [6] [6*a*] [10] arises from the lower part of the clavicle. It is a definite, narrow muscle, and runs along the edge of the clavicle for some distance, then passes on to the neck, where it gives some fibres to the fasciculus already referred to as being joined by fibres from muscles (3) (6) and (13). It passes on as a narrow definite band to the outer side of the upper larynx, where a junction is made.

The muscle now runs to the upper side, and in *Strepera*, *Gymnorhina*, and *Cracticus* it joins the *sterno-hyoideus* (25). In the Australian Raven [6*b*] it does not join with that muscle, but keeps outside of it, running forward to be inserted into the base of the tongue external to the insertion of the *sterno-hyoideus* (25). Shufeldt described a different arrangement in the American Raven. He says the *cleido-tracheales* " are finally inserted, touching each other by their inner borders on the anterior aspect of the superior larynx, the trachea, and the skin over these parts."

9. The *dermo-spinalis* [7] is a very delicate muscle in *Strepera*, the Australian Raven, *Gymnorhina*, and the *Cracticus*. It arises in a fascia from the first, second, and third dorsal vertebræ just posterior to the *dermo-cleido dorsalis* (7), and is soon lost to each side over the scapular region.

10. The *dermo-iliacus* [7] arises on each side from the inner angle of the ilium. It runs forward as a narrow, definite, ribbon-like band on the side of the dorsal feather tract, and continues to the upper neck, where it passes directly on to the *dermo-temporalis* (3), and is finally inserted behind the orbit on the skull.

Strepera agrees with the Australian Raven, *Gymnorhina,* and *Cracticus* in this.   Shufeldt's account of this muscle in the American Raven agrees generally with that given by Owen in the general account of the " Comparative Anatomy of Vertebrates," vol. ii., p. 111.   Shufeldt says :—" The fibres pass directly forward, as a narrow ribbon, to spread out as a thin integumental layer to be lost over the region of the shoulder blade."   This is quite different from the arrangement described above.

11. The *dermo-ulnaris* [8] arises, in *Strepera,* low down on the third and fourth ribs.   It passes directly into the post-patagium as a wide, fleshy, conspicuous muscle.   It soon narrows to a strong tendon, which runs on to join the fascia overlying the end of the ulna about the elbow joint.   In the Australian Raven [8a] there is a third tendinous origin on the fifth rib.

12. The *dermo-humeralis* [9] arises as a tough fascia attached to the post-pubic process.   It runs in a definite semicircular course past the ventral feather tract, to be inserted by a fan-like tendon into the top of the *pectoralis major* (49).   This course is followed in *Strepera, Gymnorhina,* the Australian Raven, and *Cracticus.* Furbringer figured a similar arrangement in *Anser,* and called the muscle a part of the *pectoralis major* (*M. pectoralis pars abdominalis*).

The *dermo-humeralis* gives off fibres to the ventral feather tract, and is connected with the *dermo-pectoralis* (13).   As the latter joins muscles (3), (6), and (8), the *dermo-humeralis* is thus brought into connection with the other muscles of the dermal system.

13. The *dermo-pectoralis* [10] underlies the ventral feather tract on each side of the breast.   Its fibres continue forward to join the fasciculus made up by the *dermo-temporalis* (3), the *dermo-tensor patagii* (6), and the *cleido-trachealis* (8).   It also receives fibres from the *dermo-humeralis* (12).

THE MUSCLES OF THE HEAD
(Including the muscles of the lingual apparatus, trachea, and those of the eye and ear).

These have been conveniently grouped by Shufeldt as follows :—
14–20. Muscles of the Head.
21–27. Muscles of the Tongue.
28–36. Muscles of the Air-passages.
37–48. Muscles of the Eye and Ear.

The Muscles of the Head (14–20).

Except in the case of muscle 17, the *entotympanicus,* I find that the muscles of *Strepera* agree with Shufeldt's description of the muscles in the American Raven.   The Australian Raven, *Gymnorhina,* and *Cracticus* also agree.

The muscles are—
14. The *temporal.*
15. The *masseter.*

16. The *biventer maxillæ*.
17. The *entotympanicus*.
18. The *pterygoideus internus*.
19. The *pterygoideus externus*.
20. The *digastric*.

14. The *temporal* [11], [12].—This strong muscle, assisting in closing the jaws, arises fleshy from the temporal fossa which it fills. A few fibres arise from the neighbouring parts of the skull in front, the sphenotic process, and the wall of the orbit. The fibres converge and pass downward and forward to be inserted in the coronoid process upon the upper margin of the mandible. Shufeldt found that the fibres joined those of the *masseter* (15), in the American Raven. Such a union is not conspicuous in the *Strepera*, and is restricted to, at most, but a few fibres.

15. The *masseter* [12] assists the last-named muscle ; it has its broad end below and its narrow end uppermost, arises below the *temporal* (14) from the bony ridge above the entrance to the ear, and passes downward and forward, spreading out as it goes. In passing, it makes a tendinous attachment to the upper margin of the lower jaw, and is inserted fleshy about the vacuity in the mandible. A smaller part is inserted tendinously on a small tubercle on the mandible just posterior to the main bulk of the muscles.

16. The *biventer maxillæ* [5], [11], [12], [14a], a mass of muscle, covers the articulation of the jaws posteriorly. It rises from a ridge and a neighbouring depression behind the ear, and is inserted superficially about the end and angle of the lower jaw.

17. The *entotympanicus* [13] is an interesting muscle, small and spindle-shaped. It arises fleshy from the side of the basisphenoid and the rostrum. It passes across, splitting into two—a fleshy division inserted fleshy on the quadrate, and an anterior division becoming tendinous, and inserted on a tubercle near the distal end of the posterior aspect of the pterygoid bone.

18. The *pterygoideus internus* [14] arises on the upper side of the palatine as a fleshy mass on each side. It passes backwards, outwards, and downwards, to be inserted about the angle of the lower jaw. The fleshy mass is tendinous on the inner exposed side.

19. The *pterygoideus externus* [5], [14] crosses the *pterygoideus internus* (18). It arises fleshy from the quadrate bone, runs forward and downward, to be inserted about the vacuity in the mandible on the inner side. It fills the fossa made by the peculiar posterior processes of the palatines in these Austro-coraces. Through the vacuity its fibres may be in contact with those of the *masseter*.

20. The *digastric* [5] [12] is a thin semi-transparent muscle, difficult to trace exactly. It arises from the base of the skull, on the basitemporal, about opposite the angle of the lower jaw.

Its fibres run to the middle line, spreading out fan-wise, and meeting the fibres of the corresponding muscle of the other side in a faint raphe. It covers the superior larynx, and is joined by a thin fascia to the *mylo-hyoideus* (21), another superficial muscle. Each passes directly beneath the base of the tongue, and is united to it by fascia ; it is also united to the long branch of the hyoid. Shufeldt refers to it as "this extremely attenuated muscular stratum." It is such in *Strepera* also.

The Muscles of the Tongue.

The muscles of the tongue in *Strepera* show very interesting departures from those of the American and Australian Ravens. The Australian Raven agrees with the American Raven as described by Shufeldt. The *Strepera* differs, however, in having two divisions of the *genio-hyoideus* (23) and in the union of the *sterno-hyoideus* (25) with the *cleido-trachealis* (8).

Gadow (Bronn's "Klassen VI. Band," plate xxxii.) has figured the external branch of the *genio-hyoideus* (23) on several birds, including a Cockatoo (*Microglossus aterrimus*), a Bustard (*Otis tarda*), and a Duck (*Fuligula atra*). It is interesting to find this external branch present in *Strepera, Gymnorhina,* and *Cracticus,* but absent in the Ravens.

The muscles of the lingual apparatus are numbered and named by Shufeldt as follow :—

21. The *mylo-hyoideus.*
22. The *stylo-hyoideus.*
23. The *genio-hyoideus.*
24. The *cerato-hyoideus.*
25. The *sterno-hyoideus.*
26. The *depressor-glossus.*
27. The *cerato-glossal.*

21. The *mylo-hyoideus* [11], a thin, sheet-like muscle, arises from near the inner upper margin of the mandible. It rises above the *genio-hyoideus* (23) in *Strepera* and the Australian Raven. The latter muscle is pressed close to the inside of the mandible, and the *mylo-hyoideus* is forced to pass over it and then dip down to spread out beneath the tongue. Shufeldt found it arose in the American Raven "just above the lower border and the in-turned edge of the horny sheath of the beak," and figures it as arising close to the inner lower edge of the mandible. He speaks of its "wonderfully delicate fibres." The muscle unites with its fellow in the middle line, and is bound in a fascia about the base of the tongue, though no definite insertion in the hyoid could be found. As already mentioned, this muscle is united by a thin fascia with the *digastric* (20).

22. The *stylo-hyoideus* [14a] arises on the outer side of the posterior end of the mandible. It is a flat, ribbon-like muscle, running downward and forward to be inserted tendinously on the thyro-hyal on the upper surface.

23. The *genio-hyoideus* [14a] [15], as already mentioned, differs in a marked manner in *Strepera* from the same muscle in the Raven. The Australian Raven agrees closely with the American Raven as described by Shufeldt. In *Strepera, Gymnorhina,* and *Cracticus,* an external branch arises from the bare part of the outer surface of the mandible just behind the horny sheath. It runs backwards, crosses the lower edge of the mandible, and runs obliquely backward to join the larger branch, where it is wrapped round the thyro-hyal. It undoubtedly assists this muscle in pulling the tongue forward. Professor Gadow figures a similar external branch for a Cockatoo, a Bustard, and a Duck in Bronn's "Klassen VI. Band," plate xxxii.

The main division of this muscle arises, as Shufeldt describes for the American Raven, from the inner side of the mandible nearly as far forward as the horny sheath, and is wrapped round the thyro-hyal as he described. It is bounded internally by the *mylo-hyoideus* (21), which arises above it and passes over it to the middle line.

24. The *cerato-hyoideus* [15] is in *Strepera* as Shufeldt describes it for the American Raven. Arising from the thyro-hyal, it is inserted by a fine, stiff tendon on a bony tubercle on the cerato-hyal. The Australian Raven agrees in the position and course of this muscle, but differs in having a fleshy insertion. *Gymnorhina* and *Cracticus* agree with *Strepera.*

25. The *sterno-hyoideus* [6] [6a] in *Strepera* arises fleshy on each side from the anterior edge of the superior larynx. The two muscles run directly forward to meet at the base and be inserted together into the cerato-hyal. The *cleido-trachealis* (8) on each side, however, instead of being inserted in the cerato-hyal just to the outer and lower side of each *sterno-hyoideus,* as it is in the Australian Raven, joins the corresponding *sterno-hyoideus* in *Strepera, Gymnorhina,* and *Cracticus* at about one-third of its length from its origin. Shufeldt found that the *cleido-tracheales* (8) in the American Raven are different. He says the *cleido-tracheales* "are finally inserted, touching each other by their inner borders on the anterior aspect of the superior larynx, the trachea, and the skin over these parts." Shufeldt found that some fibres of the *sterno-hyoideus* (25) were continued into the soft part of the tongue in the American Raven. No fibres going into the soft part of the tongue were observed in any of the birds dissected.

26. The *depressor-glossus* [16] is a short muscle in the middle line on the under side of the tongue. It arises, as Owen and Shufeldt describe, on the under surface of the basihyal. The fibres contract, and become tendinous, to be inserted at the tip of the tongue bone.

27. The *cerato-glossal* [17] is a small muscle arising on the upper surface of the basihyal and running to the thyro-hyal. Owen describes it similarly for the Fieldfare.

Muscles of the Upper Larynx (2) [18].

28. The *constrictor-glottidis.*
29. The *thyreo-arytenoideus.*

Muscles of the Lower Larynx (7) [19].

30. The *tracheo-lateralis.*
31. The *broncho-trachealis posticus.*
32. The *broncho-trachealis anticus.*
33. The *broncho-trachealis brevis.*
34. The *bronchialis posticus.*
35. The *bronchialis anticus.*
36. The *sterno-trachealis.*

These muscles have been so well described by Müller, Owen, Shufeldt, and other writers that they are amongst the best known of bird muscles.   As *Strepera* and the other birds dissected agree with the descriptions of Owen and Shufeldt, it is not proposed to describe the muscles in detail.   Drawings of the muscles of the *Strepera* have been made from the dissections.

In *Strepera* these muscles of the syrinx are well developed, and are inserted into the ends of the cartilaginous half-rings of the bronchi.   *Strepera* is, therefore, placed amongst the Acromyodian birds, or Oscines.

Muscles of the Eye (37–47) [20].

37. The *orbicularis palpebratum.*
38. The *levator palpebræ superioris.*
39. The *depressor palpebræ inferioris.*
40. The *quadratus nictitantis.*
41. The *pyramidalis nictitantis.*
42. The *obliquus superior.*
43. The *obliquus inferior.*
44. The *rectus superior.*
45. The *rectus inferior.*
46. The *rectus externus.*
47. The *rectus internus.*

These muscles agree in *Strepera* exactly with what Shufeldt and Owen have figured in other birds.   Drawings have been made from the dissections of the *Strepera,* but it is not proposed to add a full description, when that has already been done by Shufeldt, Owen, and others.

The Muscle of the Ear (1).

48. The *tensor-tympani* [20a].—This muscle, I find, differs in *Strepera* and the Australian Raven from what Shufeldt figures for the American Raven.   In *Strepera* it arises fleshy from the inner lower border of the quadrate bone and the neighbouring part of the lower mandible.   It runs closely apposed to the quadrate bone, to be inserted on the lower outer edge of the tympanum.   Shufeldt found it arose in the American Raven from the " inner end of the quadrato-jugal bone, and the contiguous surface of the quadrate."

THE MUSCLES OF THE UPPER EXTREMITY (45).

These are grouped by Shufeldt as follow :—

    I.—The pectoral muscles   3
    II.—Dorsal muscles   15
    III.—Tensor-patagii muscles   2
    IV.—Muscles of the brachium   4
    V.—Muscles of the forearm and hand   ..   13
    VI.—Muscles of the hand   8

                           —
                          45

I.—The Pectoral Muscles.

  49. The *pectoralis major*.
  50. The *pectoralis secundus*.
  51. The *pectoralis tertius*.

These muscles are concerned with the raising and lowering of the wing, and are of great importance to flying birds. *Strepera,* the Australian Raven, *Gymnorhina,* and *Cracticus* agree with Shufeldt's description of these muscles in the American Raven.

49. The *pectoralis major* [9] [23] is the largest muscle in *Strepera.* It arises from the whole under surface of sternum (except the part occupied by the *pectoralis secundus* and *tertius*), the keel, and the posterior aspect of the clavicle. It passes upward and forward, covers the biceps, receives the insertion of the *dermo-humeralis* (12), and is inserted on the outer side of the humerus on a special crest.

50. The *pectoralis secundus* [21] [22a] arises from the deeper part of the keel and a large part of the sternum between the coracoid and the clavicle. The flattened fibres converge and pass upwards and outwards, becoming a rounded, strong tendon. This passes up through the opening formed by the scapula, coracoid, and clavicle, and, continuing outward and downward, is inserted to the outer side of the radial crest of the humerus, a short distance in front of the insertion of the large breast muscle (49). The *pectoralis secundus* is concerned with raising the wing. Its purpose is achieved by means of this beautiful pulley arrangement, while the centre of gravity is still kept low by having the bulk of the muscle on the ventral side.

51. The *pectoralis tertius* [21] is smaller than the preceding muscle. It arises alongside (50) on the sternum and on the outer side of the coracoid bone. Its fibres converge, and form a strong tendon, which passes up to be inserted on the ulnar crest of the humerus. The contraction of this muscle assists in raising the wing.

II.—Dorsal Muscles of the Upper Extremity (15).

Shufeldt numbers and names these as follow :—

  52. The *latissimus dorsi*.
  53. The *trapezius*.
  54. The *rhomboideus*.
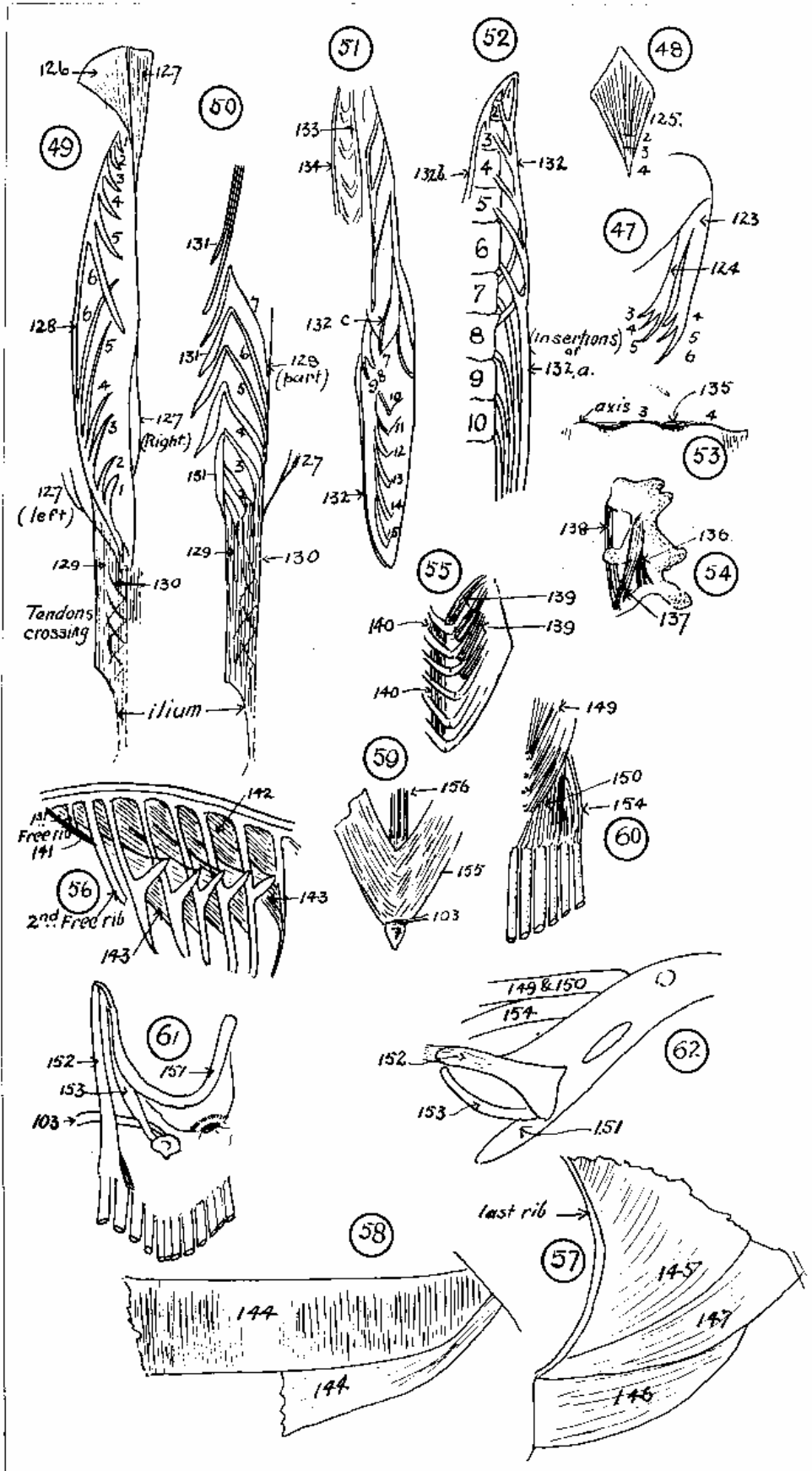
The numbers refer to the muscles as in the text.

55. The *coraco-humeralis.*
56. The *scapulo-humeralis.*
57. The *supraspinatus.*
58. The *teres et infraspinatus.*
59. The *serratus magnus anticus.*
60. The *subclavius.*
61. The *coraco-brachialis.*
62. The *teres minor.*
63. The *levator scapulæ.*
64. The *thoraco-scapularis.*
65. The *subscapularis.*
66. The *serratus parvus anticus.*

52. The *latissimus dorsi* [22] is a superficial muscle. It is not so well developed in *Strepera, Gymnorhina,* and *Cracticus* as in the Australian Raven. Shufeldt found in the American Raven it consisted of two distinct slips, and figures it as extending back in the mid-line as far at least as the line joining the posterior end of the scapula. The Australian Raven agrees with this. *Strepera, Gymnorhina,* and *Cracticus,* on the other hand, have a much smaller and narrower muscle, corresponding to the anterior slip of the muscle in the Raven. It arises as a thin fascia from the neural spines of the first and second vertebræ that bear full ribs. The fibres converge, pass under the *deltoid* muscle and the scapula head of the *triceps* muscle to the humerus, to be inserted on the shaft behind the insertion of the *pectoralis major* (49).

53. The *trapezius* [22] is much longer in *Strepera.* It is visible both before and behind the *latissimus dorsi* (52), and not before only, as in the Raven. It passes from the vertebræ to the scapula. Posteriorly, it overlies part of the *rhomboideus* (54). *Gymnorhina* and *Cracticus* agree with *Strepera.*

54. The *rhomboideus* [22] arises from the neural spines of the first four dorsal vertebræ, and runs obliquely outwards to the scapula, as described by Shufeldt.

55. The *coraco-humeralis* [22a], a small muscle, arises, as Shufeldt found in the Raven, from the outer side of the head of the coracoid, near the origin of the *biceps.* In *Strepera* it is fleshy, and runs across to be inserted on the palmar aspect of the humerus, anterior to the insertion of the *pectoralis major* (49).

56. The *scapulo-humeralis* [22a] runs from the neck of the scapula as a narrow, cord-like muscle, to be inserted between the insertion of the *pectoralis secundus* (56) and the *pectoralis major* (49).

57. The *supraspinatus* [22a] [23a] is a flat muscle arising from the scapula and passing directly across to be inserted in the pneumatic fossa of the humerus between the internal and external heads of the *triceps.* The joint tendon of the *teres minor* (62) and *coraco-brachialis* (61) is inserted just posterior to this muscle.

58. The *teres et infraspinatus* [22a] [23a] is a large, flat, triangular muscle arising from the whole length of the scapula behind the

origin of the *infraspinatus* (57). Its fibres converge to be inserted on the ulnar margin of the pneumatic fossa of the humerus between the two branches of the external head of the *triceps*. Shufeldt could divide this muscle on the American Raven into two parts. In *Strepera*, the Australian Raven, *Gymnorhina*, and *Cracticus* this muscle does not show a distinct division into two.

59. The *serratus magnus anticus* agrees with Shufeldt's description of the muscle in the American Raven. It has three digitations, arising from the second, third, and fourth dorsal ribs, and running upwards to be inserted at the end of the scapula.

60. The *sub-clavius* arises from the space between the sternal process and the coracoid, as well as from a fossa beneath the coracoid. It is covered to a large extent by the *pectoralis tertius* (51). The contraction of this muscle causes the coracoid to slide along its bed upon the sternum, and holds the coracoid firmly in position.

61. The *coraco-brachialis* [21] is in *Strepera* a longer muscle than in the Australian Raven. It arises from a small area on a tuberosity near the base of the coracoid and passes directly up parallel with the coracoid, to be inserted on the ulnar tuberosity of the humerus in company with the tendon of the next-mentioned muscle.

In the Australian Raven there is no special tuberosity for the origin of this muscle. It arises in the Raven about level with the anterior insertion of the previous muscle (60). *Gymnorhina* and *Cracticus* agree with *Strepera*.

62. The *teres minor* [21] arises from the anterior part of the scapula. It is a "chunky" little muscle passing under the scapula and behind the coracoid to join the preceding muscle, the *coraco-brachialis* (61). These two muscles assist in the down beat of the wing and in retaining the humerus in its shallow glenoid cavity.

The next four muscles (63–66) are deep muscles concerned with binding the scapula to the body.

63. The *levator-scapulæ* are two fleshy muscle bands arising from the lateral processes of the vertebræ with free ribs. They run directly backwards to be inserted in the scapula.

64. The *thoraco-scapularis* is a muscle arising by three digitations from the free rib and the first two dorsal ribs. The fibres converge and pass upwards as a thin flat tendon, dividing the *subscapularis* (65) into two, to be inserted on the lower edge of the scapula.

65. The *subscapularis* is an interesting muscle. It arises on the under side of the scapula as two large flattened sheets, which allow the tendon of the *thoraco-scapularis* (64) to be inserted between them. These sheets converge and pass into a short, strong tendon inserted into the ulnar tuberosity close to the

combined tendon of the *coraco-brachialis* and the *teres minor* (61 and 62).

66. The *serratus parvus anticus* consists of three muscle bands arising from the first free rib and the next two true ribs. These arise above the origins of the *serratus magnus anticus* (59) and the *thoraco-scapularis* (64). The fibres form a flat sheet inserted on the inferior margin of the scapula.

The *levator scapulæ* (63), the *thoraco-scapularis* (64), and the *serratus parvus anticus* (66) are parts of the one system of muscles binding the scapula to the chest.

III.—*The Tensor Patagii Muscles* (2).

67. The *tensor patagii longus.*

68. The *tensor patagii brevis.*

67. The *tensor patagii longus* [22] arises by a common tendon with (68) from the inner side of the head of the clavicle. The tendon soon becomes fleshy, and forms a thin, spindle-shaped muscle, giving off a very elastic tendon, which runs in the front edge of the patagium. It passes over the end of the radius to the side of the tendon of the *extensor metacarpi radialis longus.* It is attached to the *os radiale* of the wrist and the fascia about the wrist-joint. The tendon, soon after leaving the muscle part, is joined by the tendon from the *dermo-tensor patagii* (6). About a quarter of an inch on the proximal side of the beginning of its tendon the *tensor patagii longus* gives off a tendinous thread over half an inch in length. This is inserted into the anterior lateral face of the *pectoralis major* (49).

68 The *tensor patagii brevis* [22] [24] arises by a common tendon with the *tensor patagii longus* (67) from the head of the clavicle. It soon broadens out into a strong muscle that narrows again and gives off a strong tendon which runs down parallel to the humerus till it meets the *extensor metacarpi radialis longus* (73). Here the tendon bifurcates, and one short part runs directly outwards along the top of that muscle (73), and soon merges with that muscle. The other runs back with, but distinct from, the tendon of the muscle (73). to be inserted just below the external condyle of the humerus. The insertion of the tendon of the muscle itself is on the outer aspect of the tubercle, as Shufeldt found in the American Raven. The *Strepera*, Australian Raven, *Gymnorhina*, and *Cracticus* agree in this. They also agree in a point not mentioned for the American Raven, and that is that the muscle gives off a tendinous loop, which arises a little higher than the tendon and runs in the patagium, to be inserted in the *pectoralis major* (49), as shown in diagram [22]. This loop resembles one figured in a Picarian bird, *Buceros rhinoceros,* by Garrod in the "Proceedings of the Zoological Society of London," 1876, pp. 506-519, plate xix., fig. 2. Garrod, as already remarked, found this muscle of taxonomic value.

IV.—Muscles of the Brachium (4).

69. The *biceps.*
70. The *deltoid.*
71. The *triceps.*
72. The *brachialis anticus.*

69. The *biceps* [21] [23] is a very large and powerful muscle arising as a flat tendon from the outer part of the head of the coracoid and from the ulnar tuberosity of the humerus. The muscle passes over the *pectoralis major* and forms a big muscular belly. The fibres converge to a strong tendon inserted in the ulna. It is a strong flexor of the forearm.

70. The *deltoid* [22] is distinctly divided into two portions. The first portion is long and narrow, arising from the anterior part of the scapula and neighbouring part of the clavicle. This narrow band runs about half-way down the humerus, where it joins the big muscular part of the *deltoid,* which arises fleshy from the os humero-scapulare and the outer surface of the humerus down nearly the whole length of the shaft, except about the insertion of the *latissimus dorsi* (52). Both parts converge to form a strong subcylindrical tendon, which is inserted into the proximal side of the external condyle of the humerus. This muscle may be of taxonomic value, as it differs in other birds I have examined.

71. The *triceps* [22] [22a] [23] [23a] is divided, as in the Raven, into three portions, one of which, the scapular head, is entirely separated from the rest.

The scapular head arises from the upper side of the scapula just behind the glenoid cavity. It forms a long, thick muscle strand that passes down under the *supraspinatus* (57) and the *teres et infraspinatus* (58) to be inserted as a strong tendon at the proximal end of the ulna.

The internal and external heads of the *triceps* are in close connection except at their proximal ends. They arise on the back of the humerus, allowing the *supraspinatus* (57) to be inserted between them. The external head further divides to allow the *teres et infraspinatus* (58) to be inserted. The two heads soon fuse, and a strong muscle, closely attached to the humerus, runs down to form a broad, flat tendon, which passes across to be inserted into the radial side of the olecranon process of the ulna. The enclosing fascia binds the three parts of the *triceps* together. This muscle is the powerful extensor of the arm.

72. The *brachialis anticus* [23] is a small, narrow muscle passing across from the inner side of the distal extremity of the humerus to the lateral surface of the proximal end of the ulna.

V.—Muscles of the Forearm and Hand.

Thirteen muscles are named by Shufeldt, as follow :—

73. The *extensor metacarpi radialis longior.*

74. The *extensor digitorum communis.*
75. The *supinator brevis.*
76. The *flexor metacarpi radialis.*
77. The *pronator brevis.*
78. The *pronator longus.*
79. The *extensor ossis metacarpi pollicis.*
80. The *anconeus.*
81. The *extensor indicis longus.*
81a. The *flexor digitorum sublimis.*
82. The *flexor digitorum profundus.*
83. The *flexor carpi ulnaris.*
84. The *flexor carpi ulnaris brevior.*

73. The *extensor metacarpi radialis longior,* or *longus* [22] [24], agrees with Shufeldt's description of this muscle in the American Raven. It arises from the humerus, and is inserted by a very strong tendon into the apex of the metacarpus. It receives the tendon of the *tensor patagii brevis* (68), as already described.

74. The *extensor digitorum communis* [24] arises from the humerus just below the external condyle. It forms a long spindle-shaped muscle below the *extensor metacarpi radialis longior* (73), and soon forms a long tendon, which passes in a groove over the distal end of the ulna. It gives off a small branch to the outer side of the base of the pollex. It is continued down a groove on the metacarpus through a pulley provided for it, and is inserted near the front edge of the proximal phalanx of the index finger.

75. The *supinator brevis* lies under the *extensor digitorum communis* (74). It arises from the external condyle of the humerus below the tendon of (74), and passes directly across to be attached to the outer side of the radius for about one-third of its length. It is a feeble muscle in the birds dissected.

76. The *flexor metacarpi radialis* [24] is the large lower muscle of the forearm. It arises by two heads—one, tendinous, from the external condyle of the humerus, and the second, also tendinous, from the ulna beyond the olecranon process. It is closely attached to the bone for a considerable distance. Becoming tendinous, it passes through the fibrous sheath on the outer side of the distal end of the ulna, and goes directly to be inserted on a prominent process on the upper hinder border of the metacarpal.

77. The *pronator brevis* arises tendinous just above the internal condyle of the humerus and passes across to be inserted on the ulnar side of the radius.

78. The *pronator longus* is a more powerful muscle, similar to 77. It arises below the latter from the internal condyle of the humerus, and passes across, under, and behind 77 to be inserted below it on the radius.

79. The *extensor ossis metacarpi pollicis* [24] is an extremely fine thin muscle with a hair-like, glistening tendon. It arises in front of the greater sigmoid cavity of the ulna, and forms a straight,

2

thin muscle, quite hidden by surrounding muscles. It is soon
converted into a hair-like tendon, which passes in close connection
with the large tendon of the *extensor metacarpi radialis longior*
(73), to be inserted close by it on the palmar side of the first meta-
carpal. Shufeldt found it " the smallest and most delicate
muscle of the forearm " in the American Raven ; so it is in
Strepera and the other birds dissected.

80. The *anconeus* arises by a strong tendon from the external
condyle and passes directly to the inner side of the ulna, to be
attached for rather more than half its length.

81. The *extensor indicis longus* [25] arises fleshy from more than
the inner half of the ulnar side of the radius as an inconspicuous
muscle. It gives rise to a narrow tendon of great length that
passes down almost to the tip of the hand. It passes over the
groove at the distal end of the ulna, directly down the front of
the metacarpus and the proximal phalanx of the index finger,
to be inserted at the base of the distal phalanx of that finger.

81*a*. The *flexor digitorum sublimis* is a strong tendinous band
with some muscle fibres. It is superficial to the lower muscles
of the forearm on the inner side. It runs from the internal condyle
of the humerus to the wrist, where it is bound firmly, and then
passes on as a tendinous cord to the index finger. Gadow figures
it similarly in *Falco tinnunculus*.

82. The *flexor digitorum profundus* [26] arises by two strong
fleshy heads from the proximal end of the ulna. The *brachialis
anticus* and *biceps* are inserted between these two heads. The
fibres from these heads soon merge, and the common muscle is
attached to the ulna for a short distance. The long tendon
passes through the fibrous loops on the wrist. It runs to the front
upper edge of the end of the metacarpal along the anterior upper
edge of the proximal phalanx of the index finger, joins a fibrous
sheath, and is inserted into the ulnar side of the base of the distal
phalanx of this finger.

83. The *flexor carpi ulnaris* [26] in *Strepera* differs from the
American Raven as described by Shufeldt. Shufeldt describes
this muscle as arising in the American Raven by " two strong
tendons which merge into a strong fusiform muscle occupying
rather more than the posterior half of the under side of the
forearm. From the anterior apex of this muscle a powerful and
subcylindrical tendon stretches directly to the back of the ulnare
ossicle of the carpus, where it makes an extensive attachment.
Just before reaching this ossicle the tendon of the *flexor carpi
ulnaris* differentiates off a small tendinous slip, which, passing
through a fibrous loop at the ulnar side of the carpus, goes
obliquely downwards to the tendon of the *flexor digitorum
profundus* and merges with it."
    In *Strepera* the two parts are distinct. They arise as Shufeldt
described for the American Raven. The tendon of the lower part

passes through the humero-ulnar pulley, forms the fleshy mass of the under side of the arm, becomes a very strong tendon, and is inserted directly into the ulnare ossicle. The upper part arises as a strong tendon from the internal condyle of the humerus outside the humero-ulnar pulley, and, becoming fleshy, runs parallel to, and closely bound with, but (except for a tendinous connection) remaining distinct from the main part of the muscle. Its fine tendon runs on above the strong tendon of the main part and behaves as Shufeldt stated for the branch that he described as arising from the main tendon before it was inserted on the ulnare ossicle. The tendon of the upper part runs on in a sheath above that of the lower part ; it passes above the ulnare ossicle and across the metacarpal to join the tendon of the *flexor digitorum profundus* (82).

Gymnorhina, Cracticus, and the Australian Raven agree with *Strepera* in having the upper part (except for the tendinous connection) distinct from the lower part.

A superficial fascia with muscle fibres about the elbow arises from near the tendon of the lower part of this muscle. A branch is given off to each secondary, as figured by Gadow on plate xx.*a,* fig. 1, of the work before mentioned.

84. The *flexor carpi ulnaris brevior* [26] agrees in *Strepera* with the same muscle in the American Raven as described by Shufeldt. It arises beneath (82) from the middle third of the upper side of the ulna, becomes tendinous, and runs directly above the tendon of (82) to the carpus. Its tendon winds round in front of the radiale bone to be inserted upon the outer edge of the top of the *carpo-metacarpus.*

VI.—*The Muscles of the Hand.*

Shufeldt names these as follow :—
    85. The *extensor proprius pollicis.*
    86. The *flexor brevis pollicis.*
    87. The *flexor minimi digiti.*
    88. The *flexor minimi digiti brevis.*
    89. The *abductor minimi digiti.*
    90. The *flexor metacarpi brevis.*
    91. The *interosseous dorsalis.*
    92. The *interosseous palmaris.*

In *Strepera* these muscles agree closely with Shufeldt's careful description of them as they occur in the Raven.

85. The *extensor proprius pollicis* [28] is a neat muscle, well suited for extending the thumb. It arises from the ulnar side of the tendon of the *extensor metacarpi radialis longior* (73), becomes tendinous, and is inserted into the antero-ulnar side of the pollex.

86. The *flexor brevis pollicis* [28] arises fleshy from the side of the metacarpal, becomes tendinous, and is inserted into the apex of the pollex.

87. The *flexor minimi digiti* [28] arises fleshy from the posterior side of the upper end of the metacarpal, and is joined by a distinct branch from the ulna. It runs down a groove provided for it, and the delicate tendon is inserted into the base of the phalanx of the medius finger.

88. The *flexor minimi digiti brevis* [28], a fleshy, rudimentary muscle, arises from the distal posterior aspect of the metacarpal, becomes tendinous, and is inserted at the apex of the phalanx of the medius.

89. The *abductor minimi digiti* [28] is a small rudimentary muscle—indeed, almost a ligamentous band. It arises from the anterior proximal aspect of the medius digit, passes outwards, and is inserted upon the posterior edge of the proximal phalanx of the index finger.

90. The *flexor metacarpi brevis* [27] arises partly fleshy and partly tendinous from the outer side of the distal extremity of the ulna in the superficial fascia to which the primary wing quills are bound. The fleshy part soon ceases, and the delicate superficial tendon runs obliquely down the *carpo-metacarpus* to be inserted at the base of the proximal phalanx of the index finger on its ulnar side in front. This is not an easy muscle to dissect. The tendon runs so superficially that there is danger of removing it when the primaries are freed from the hand, to which they are so firmly lashed.

91. The *interosseous dorsalis* [27] is the outer and higher of two flat paper-like muscles that are found in the long vacuity in the index and medius metacarpal, as described by Shufeldt for the Raven. It sends a slender tendon in a shallow groove to be inserted at a point on the anterior aspect of the base of the distal phalanx of the index digit.

92. The *interosseous palmaris* [27] lies in the same vacuity under and more distally than the *interosseous dorsalis* (91). Its tendon passes more posteriorly to the outer side of the index digit even to the apex of that digit.

THE MUSCLES OF THE LOWER EXTREMITY.

Shufeldt named 30 muscles in the lower extremity of the Raven. I find in *Strepera* and the Australian Raven one additional muscle, the *gluteus quartus* of Mayer, quoted by Owen. Shufeldt named the thigh muscles as follows :—

93. The *sartorius.*
94. The *gluteus primus.*
95. The *gluteus medius.*
96. The *gluteus minimus.*
97. The *extensor femoris (crurœus, vastus externus).*
98. The *vastus internus.*
99. The *biceps flexor cruris.*
100. The *semitendinosus.*

101. The *accessory semitendinosus.*
102. The *semimembranosus.*
103. The *femoro-caudal.*
104. The *obturator externus.*
105. The *obturator internus.*
106. The *gemellus.*
107. The *adductor longus.*
108. The *adductor magnus.*

93. The *sartorius* [22] [29] [31], the most anterior of the superficial fleshy muscles of the thigh, arises from the anterior border of the ilium and by a thin fascia from the neural spine of the fourth dorsal vertebra. In *Strepera* it passes downward, becomes more fleshy, passes round the patella, and is inserted in a semitendinous fascia about the summit of the tibia. Shufeldt finds, in the American Raven, that the *sartorius* is inserted into the patella as well as about the tibia. It is not inserted into the patella in *Strepera* and the Australian Raven.

94. The *gluteus primus* [29] is extremely thin. In the central part it is, indeed, but a tendinous fascia. It covers the edge of the *sartorius* (93) in front. It arises from nearly the whole length of the supero-internal margin of the ilium. In front of the acetabulum the origin is a thin fascia ; behind it is fleshy. The fibres converge towards the patella. They join with the *extensor femoris* (97), and form a tendinous coating for the knee. The patella is formed in this " aponeurotic ligament," which is inserted in the cnemial crest of the tibia. The central part of this extensive muscle is almost entirely fascia-like, so that it might almost be considered as consisting of two muscles.

95. The *gluteus medius* [29] [32], a thick, fleshy muscle, arises from the entire supero-internal margin of the front part of the ilium. It fills the concavity and passes back as a strong tendon, to be inserted on the proximal extremity of the femur.

96. The *gluteus minimus* [32] is almost hidden by (95). It is a small muscle running from the anterior edge of the outer side of the ilium and the last rib. It forms a tendon which is inserted into the outer aspect of the upper third of the femur.

96a. The *gluteus quartus* [32] of Professor Mayer, quoted by Owen (" Vert. Anat.," vol. ii., p. 100), is present in *Strepera*, the Australian Raven, *Gymnorhina*, and *Cracticus*. It is a very small muscle, arising, as Owen states, fleshy from the outer edge of the ilium, posterior to the origin of the *gluteus minimus* (96). Its fibres run parallel with those of that muscle and become tendinous. The tendon winds up on to the outer face of the femur, to be inserted into the trochanter immediately below the insertion of the *gluteus medius* (95). The *gluteus quartus* is quite hidden by the *gluteus medius.*

97. The *extensor femoris* [31] [32] is a powerful muscle consisting of two well-marked parts—viz., the *vastus externus* and the

cruræus. The *vastus externus* arises on the femur at the base of the trochanter, and by fleshy fibres right down the shaft of the bone almost to the condyle.

The *cruræus* is bulky, and arises by a tendon from the anterior aspect of the trochanter, and by fibres down the shaft of the femur. These two muscles and the *gluteus primus* (94) merge and form the " aponeurotic ligament " already referred to as being spread over the knee, and inserted in the cnemial crest of the tibia.

The ambiens muscle is absent in the birds under notice, so that these birds are " anomalogonatous," as all Passerine birds are.

98. The *vastus internus* [31] is a distinct muscle on the inner side of the leg. It arises on the inner side of the femur just below the head, and is attached down the bone in a straight line, spreading out to be inserted along the inner border of the summit of the tibia just above the insertion of the *sartorius* (93).

99. The *biceps flexor cruris* [29] [32] [33] arises broadly by a tendinous fascia from the post-acetabular ridge. It is flat and triangular, and rapidly converges to form a round, cord-like tendon, which passes through a tendinous loop from the lower part of the femur and is inserted into a tuberosity on the back of the fibula, some little distance down that bone. The effectiveness of the muscles is greatly added to by the tendinous loop. The weight is distributed, and a more rapid and more complete inflection of the leg is secured by its means.

100. The *semitendinosus* [29], a broad, flat muscle, arises from the hinder part of the post-acetabular ridge and by a thin fascia from the caudal muscles beneath. It passes obliquely downwards to meet the *accessory semitendinosus* (101) at a tendinous raphe which merges behind with the inner head of the *gastrocnemius* muscle (109). *Strepera* and the other birds agree exactly with the American Raven as described by Shufeldt in this muscle.

101. The *accessory semitendinosus* [29] is a flat, board-like muscle arising from the back of the distal end of the femur. It passes directly upward and backward to meet the *semitendinosus* (100) in the tendinous raphe previously mentioned.

102. The *semimembranosus* [30] [36], a long, flat, ribbon-like muscle, arises from the outer surface of the ischium. It passes downward and forward, and becomes a delicate wide tendon that is inserted into the tibial shaft.

103. The *femoro-caudal* [30] [59] [61], one of the muscles used in the famous attempts of Garrod to classify birds by the presence or absence of certain leg muscles, is an interesting muscle, and agrees, in *Strepera*, with what Shufeldt has described for the American Raven. It arises tendinous from the pygostyle, and passes forward first as a rounded tendon. It becomes a flat muscle, and converges to a flat tendon, to be inserted on the

outer side of the femur, about one-third of its length down the shaft of that bone.

The *accessory femoro-caudal*, another of Garrod's muscles, is absent in the Raven and the birds under notice. He used five muscles. These were :—

The *ambiens.*
The *femoro-caudal* (denoted by A).
The *accessory femoro-caudal* (denoted by B).
The *semitendinosus* (denoted by X).
The *accessory semitendinosus* (denoted by Y).

The first and third are absent in the birds under discussion. Their muscular formula on Garrod's system is A X Y—that is, the *femoro-caudal*, the *semitendinosus*, and the *accessory semitendinosus* are present, as they are in the Piciformes and the Passeriformes, except the Drongo (*Dicruridæ*), which has the muscle formula A X.

104. The *obturator externus* [30] is a thick, fleshy muscle arising from the lower posterior half of the ilium. It runs forward as a fleshy mass, becomes tendinous, and is inserted on the femur below the trochanter and above the insertion of the *femoro-caudal* (103). This muscle is bent down to provide for the passage of the sciatic nerve and artery above it.

105. The *obturator internus* [30] in *Strepera* agrees with Shufeldt's description of the muscle in the Raven. It arises internally from the ventral surface of the ischium. It has a central tendon, to which the fibres converge. The strong tendon passes up through the obturator foramen to be inserted overlying the *gemellus*, into the outer aspect of the trochanter of the femur.

106. The *gemellus* [30] is a fleshy, thick muscle between the back of the femur and the pelvis. It arises on the outer side of the pelvis, and passes directly with the tendon of the *obturator internus* (105), to be inserted on the trochanter of the femur.

107. The *adductor longus* [30], a flat, board-like muscle, arises from the lateral aspect of the pelvis below the *obturator externus* (104). It passes downward and forward to be inserted down the back of the femur, from above the insertion of the *femoro-caudal* (103) down to the internal condyle. It is closely related to the next muscle, the *adductor magnus* (108).

108. The *adductor magnus* [30] is longer and more slender in *Strepera* than is (107). It arises below the ischiatic fossa on the outer lateral edge of the pelvis. Its fibres pass to be inserted into the internal condyle of the femur. The internal head of the *gastrocnemius* is attached to this muscle above its insertion. It is also bound in a fascia with the *adductor longus* (107).

THE MUSCLES OF THE LEG AND FOOT.

These are named by Shufeldt—

109. The *gastrocnemius.*
110. The *soleus.*

111. The *peroneus longus.*
112. The *tibialis anticus.*
113. The *extensor longus digitorum.*
114. The *extensor hallucis brevis.*
115. The *tibialis posticus.*
116. The *flexor perforatus indicis secundus pedis.*
117. The *flexor longus hallucis.*
118. The *flexor perforatus annularis primus pedis.*
119. The *flexor perforatus medius primus pedis.*
120. The *flexor perforatus medius secundus pedis.*
121. The *flexor perforatus indicis primus pedis.*
122. The *flexor perforans digitorum profundus.*

109. The *gastrocnemius* [33] is a very large muscle ensheathing most of the middle leg. *Strepera* agrees with the American Raven as described by Shufeldt. This muscle is made up of three large divisions. The first, the external head, arises on the outer condyle of the femur by a short, strong tendon. It then becomes a spindle-shaped muscle merging into a tendinous expansion about two-thirds of the way down the tibia. The internal head arises from the outer surface of the inner condyle of the femur ; it is broad and fleshy. The distal end of the *adductor magnus* (108) makes a tendinous connection with it close to its origin. Its fibres run down the back of the leg, and merge into the tendinous expansion of the external head. The tibial head has a broad fleshy origin from the summit of the tibia and the edge of the procnemial crest, and is the largest of the three divisions. Its fibres converge low down, become tendinous, and join the tendinous expansion previously mentioned. The common broad tendon develops a flattened cartilaginous plate that rides over the true tibial cartilage. The tendon passes on and merges into the strong fascia that binds about the tarso-metatarsus.

110. The *soleus* [36] is under the tibial head of the *gastrocnemius* (109). It arises in the cnemial crest, and is overlain below its origin by the insertion of the *semimembranosus* (102). It soon converges and becomes tendinous, sending down a long, thin tendon to the proximal end of the tibial cartilage.

111. The *peroneus longus* [34] is a very large muscle which covers the front of the leg. It arises from the cnemial crest, and the fascia that covers the knee-joint. The fibres, very tendinous on the inner side, fit closely round the leg, run down to and become a small tendon. This bifurcates and gives one short branch to the upper part of the tibial cartilage. The smaller branch goes to the outer side of the tarso-metatarsus, and joins the tendon of the *flexor perforatus medius primus pedis* (119). Thus, the *peroneus longus* assists in flexing the toes in *Strepera* as in the Raven.

112. The *tibialis anticus* [35] arises as two distinct heads—the larger on the front of the tibia up between the cnemial crests, the second from a depression in the ridge of the outer condyle of

the femur.   The two parts pass down as a large muscle, and converge about two-thirds of the way down into a strong tendon. This passes through the oblique " fibro-cartilaginous bridge " above the condyles of the tibia to be inserted on a special tubercle on the tarso-metatarsus.

113. The *extensor longus digitorum* [37] [37a] arises fleshy from the cnemial crest and from a small part of the tibia under the larger part of the last muscle (112).   Its fibres pass down on the inner front side of the tibia as a long slender muscle.   It gives rise to a strong tendon, which passes under the fibro-cartilaginous loop mentioned under the *tibialis anticus* (112) and a bony bridge in front of the tarso-metatarsus.   It passes down to the trochleæ of the basal toe-joints, where it divides into three tendons.   So far, *Strepera* agrees with the American Raven as described by Shufeldt, but it differs considerably from Shufeldt's description of the insertions of the tendons of the toes.   Shufeldt says :— " These slips pass respectively over the superior aspects of the second, third, and fourth toes, bifurcating as they do so beyond the basal joints, to be inserted at the base of the distal ones.   At the proximal extremity of each series of phalanges the tendons are bound down in the median grooves intended for their passage and guidance by a strong, fibrinous, fascia-like sheath."

In *Strepera* I find the arrangement on the medius toe is quite different from that on the index and the annularis toes.   Shufeldt describes each as being the same in the American Raven.   On the medius toe [37a] the tendon divides into three, the inner branch runs along the top inner border of the phalanges to be inserted in the fascia at the base of the ungual phalanx.   The second division runs only to a fascia ensheathing the proximal end of the second phalanx.   The third division almost immediately divides into two, the inner of which goes on to be inserted at the proximal end of the third phalanx, the other runs over the outer upper margin of the second and third phalanges to be inserted at the base of the ungual phalanx.   The Australian Raven, *Gymnorhina*, and *Cracticus* agree.

On the index toe the tendon bifurcates at about two-thirds of the length of the basal phalanx.   The first slip is inserted in the mid-line into the proximal end of the second phalanx ; the second slip runs on to join a fascia at the proximal end of the third or ungual phalanx.

The fourth (annularis) toe has five phalanges.   The tendon runs past the distal phalanx, and about half-way along the second phalanx it bifurcates.   One slip is inserted at the proximal end of the third phalanx, the other slip runs on, bifurcating about the middle of the fourth phalanx into two equal branches, which are inserted on each upper lateral margin of the ungual (fifth) phalanx.   There is no insertion on the basal, second, or fourth phalanx.   *Strepera*, the Australian Raven, *Gymnorhina*, and *Cracticus* agree in the insertions of these tendons.

114. The *extensor hallucis brevis* [38] is a small but very inter-esting muscle. *Strepera* agrees with the American Raven as described by Shufeldt for this muscle, which arises fleshy from the front of the inner head of the tarso-metatarsus, and from the neighbouring fascia about the tendons, especially that of the *tibialis anticus.* The delicate fibres pass down in a shallow groove along the shaft of the bone. They give rise to a strong tendon which passes round the accessory metatarsal and along the outer side of the basal joint of the hallux to be inserted into the base of the ungual phalanx.

115. The *tibialis posticus* [39] arises from the fibula below the insertion of the *biceps flexor cruris* (99) from the adjacent parts of the tibia. Some of its fibres blend with the *flexor perforans digitorum pedis* (116), which partly overlies its anterior upper part. It forms a strong tendon, which is inserted into the outer, upper edge of the tarso-metatarsal bone.

116. The *flexor perforatus indicis secundus pedis* [40] [43] [45] is a small spindle-shaped muscle arising from the external condyle of the humerus. Its fibres blend with those of the anterior border of the *tibialis posticus* (115), and soon form a tendon which passes through the tibial cartilage and the hypotarsus down the back of the tarso-metatarsus and under the annular ligament of the foot. It here forms a sheath for the perforating tendon, and bifurcates into two slips about the middle of the second phalanx of the index toe. Each slip of tendon is inserted into the lower side about the middle of the second phalanx.

117. The *flexor longus hallucis* [41] [46] arises tendinous by two heads. The first arises from the under surface of the femur and the second from the external condyle. The fibres soon unite, and pass down the back of the leg, narrowing to form a strong tendon. This tendon passes through the tibial cartilage and the hypotarsus to the inner side of the leg, and runs down the back of the tarso-metatarsus, superficial to the tendon of the *flexor perforans digitorum profundus* (122), to the apex of the accessory metatarsal bone. It winds round to the inner side of it, and runs in a groove to be inserted on a tubercle on the base of the ungual phalanx of the hallux. This is one of the plantar tendons made so famous by Garrod. This is more fully set out after the descrip-tion of muscle 122.

118. The *flexor perforatus annularis primus pedis* [41] [43] has a long name, but, as it is given according to Shufeldt's effective system, it is self-explanatory. It is the muscle whose tendon is perforated on the fourth toe (corresponding to the ring finger), and is inserted into the first phalanx of that toe. This muscle in *Strepera* arises tendinous from the under side of the humerus, and runs down closely applied to the last muscle (117). The fibres flatten out, and then converge to form a tendon which runs through the tibial cartilage and the hypotarsus with the tendon

of the next muscle (119). The tendons of these two muscles now separate ; that of the present muscle runs to the outer toe, and forms a tubular sheath for the passage of the perforating tendon of the deep flexor (122). It sends down two short slips, one to be inserted on each side near the distal end of the basal phalanx. It again runs on and finally bifurcates into two slips, one being inserted into each side of the base of the second phalanx. Thus it serves as two perforated tendons inserted into two phalanges of the fourth toe.

119. The *flexor perforatus medius primus pedis* [41] [43] [44] is the flexor muscle that is perforated by the deep flexor (122) on the medius (third toe), and is inserted on the basal phalanx of that toe. It arises fleshy from the beginning of the fleshy part of the *flexor perforatus annularis primus pedis* (118), and becomes converted into a flattened tendon. This runs, in company with the tendon of muscle 118, through the tibial cartilage and the hypotarsus down to the under side of the toes. The tendon forms a sheath for the deep flexor (122) and bifurcates. Each slip is inserted on either side about the middle of the basal phalanx of the medius toe.

120. The *flexor perforatus medius secundus pedis* [42] [43] [44] is the flexor muscle whose tendon is perforated on the medius toe, and is inserted into the second phalanx of the toe. The muscle arises from the external condyle of the humerus, from the fascia about the knee, and from the tibia, the fibula, and neighbouring muscles. It is a large fusiform muscle, forming a strong, flat tendon. This passes through the tibial cartilage and the hypotarsus to the under part of the third toe (medius). It perforates the tendon of the basal phalanx (119), and forms a sheath to be perforated by the tendon of the deep flexor (122). It then bifurcates, and is inserted into either side of the second phalanx of the medius toe.

121. The *flexor perforatus indicis primus pedis* [42] [43] [45] is the flexor that is perforated by the tendon of the deep flexor on the index toe, and is inserted on the basal phalanx. It arises just posterior to the *flexor perforatus medius secundus pedis* (120) from the external condyle of the femur by a thin tendon. It becomes fleshy, but soon narrows and becomes converted into a strong tendon. This passes through the tibial cartilage and the hypotarsus. It passes to the second toe, and, after forming a sheath for the passage of the deep flexor (122), it bifurcates, and the slips are inserted into either side of the basal phalanx of the index toe.

122. The *flexor perforans digitorum profundus* [43] [44] [45] [46] agrees with this muscle, as described by Shufeldt, in the Raven. It arises from the hinder part of the external condyle of the femur, from the upper part of the posterior aspect of the tibia, and from the posterior face of the shaft of that bone. It tapers directly downward into a strong tendon, which passes through

the tibial cartilage and through the hypotarsus near the inner side. It runs directly down the back of the tarso-metatarsus, between the bone and the tendon of the *flexor longus hallucis* (47). In this part the tendon develops a flattened bony rod. At the lower end of the tarsus the tendon trifurcates, forming three strong tendons, which run one to each toe. Each runs in a deep groove on the under side of the toe to be inserted into a tubercle at the base of the ungual phalanx. Each tendon passes through or perforates the tendon of muscles inserted on the more proximal phalanges of the toes.

The branch on the index toe perforates the tendons of the *flexor perforatus indicis secundus pedis* (116) and the *flexor perforatus indicis primus pedis* (121)—that is, the tendon of muscle 116 wraps round or ensheathes the tendon of 122 for some distance and then bifurcates into two slips, one of which is inserted on either side of the second phalanx of the index. The tendon of 121 is wrapped round both 116 and 122 for a short distance. It bifurcates, and the slips are inserted, one into either side of the basal phalanx. Both 116 and 122 perforate 121, while 116 is perforated by 122. Similarly, on the medius toe 122 perforates 119 and 120, while on the annularis toe 122 perforates 118, which, however, after ensheathing 122 and bifurcating, and having two slips inserted into either side of the basal phalanx, runs on (still ensheathing 122) to bifurcate again and be inserted on either side of the third phalanx. As the three branches of the tendon of the *flexor perforans digitorum profundus* (122) perforate other tendons, the word "*perforans*" is part of the name of this muscle. The arrangement of the tendons of these flexor muscles is of much taxonomic value. In the birds under examination the tendon of the *flexor perforans digitorum profundus* (122) passes through the hypotarsus to the outer side. It then passes down the middle line, becomes flattened and ossified, passing under the tendon of the *flexor longus hallucis* (117), but without being joined by a vinculum or loop to that muscle. This relation holds in all Passerine and some Picarian birds. Professor Sundevall and Professor Garrod found these deep plantar tendons of much value as a guide to classification.

THE MUSCULATURE OF THE TRUNK.

The muscles of the freely movable neck are well developed : on the other hand, the muscles of the rigidly supported back region are poorly developed. Twelve muscles were described by Shufeldt for the American Raven. The *Strepera* and other birds under notice agree closely in the size and arrangement of these muscles.

The careful descriptions and full details given by Shufeldt render comparison of the *Strepera* with the Raven a comparatively simple task, though the dissection of the neck muscle is by no means an easy one. The neck muscles have been named by Shufeldt as follows :—

123. The *complexus.*
124. The *rectus capitis anticus minor.*
125. The *flexor capitis inferior.*
126. The *rectus capitis posticus major.*
127. The *biventer cervicus.*
128. The *longus colli posticus.*
129. The *sacro-lumbalis.*
130. The *longissimus dorsi.*
131. The *obliquus colli.*
132. The *longus colli anterior.*
133. The *rectus capitis lateralis.*
134. The *trachelo-mastoideus.*
135. The *interspinales.*
136. The *interarticulares.*
137. The *obliquo-transversales.*
138. The *intertransversales.*

123. The *complexus* [47] in *Strepera* is, as Shufeldt described for the Raven, a well-developed muscle arising from the sixth, fifth, and fourth vertebræ. The fibres soon unite and run forward as a flat, ribbon-like muscle, to be united with the corresponding muscle by fascia and inserted into the skull a short distance above the occipital ridge.

124. The *rectus capitis anticus minor* [47] is closely connected by fascia with the last muscle (123). It arises from the hypapophyses of the second, third, and fourth vertebræ, and runs forward bound to the anterior side of the *complexus* (123) to be inserted on the same line of the skull.

125. The *flexor capitis inferior* [48] is a masssive muscle in the mid-line. It might almost be regarded, as Shufeldt pointed out, as an " azygos " muscle, so closely are the two muscles blended. It arises in common with 124 from the hypapophyses of the second, third, and fourth cervical vertebræ. It passes forward on the base of the skull to be inserted into the basitemporal. The branches of the one carotid artery can be seen posterior to this muscle mass.

126. The *rectus capitis posterior major* [49] arises from the neural spine of the second vertebra. Its fibres spread out to be inserted, almost touching their fellow of the opposite side on the back of the skull.

127. The *biventer cervicus* [49] [50] is a remarkable muscle on each side. It arises from the neural spine of the first and second thoracic vertebræ and the adjacent muscular and tendinous network. It passes forward along the upper surface of the neck, becomes tendinous at the groove on the upper side of the neck ; again becoming fleshy and flat, it runs forward to the head, and is inserted into the occiput under the insertion of the *complexus* (123), and over that of the *rectus capitis posticus major* (126).

128. The *longus colli posticus* [49] [50] is a complicated but very

interesting muscle. It extends for the whole length of the neck,
has many origins and many insertions. It arises directly from
the muscles along the vertebræ of the back, and also as a
glistening fine tendon from the neural spine of the first and
second thoracic vertebræ. It joins the *longissimus dorsi* (130)
by a fleshy muscle, and gives off six distinct slips, which increase
in length up the neck, as shown in the figure. These slips insert
into the postzygapophyses of successive vertebræ, and also join
the *obliquus colli* muscles (131), which are inserted into the same
structures [50]. Six other ribbon-like slips run forward to join
the main body of 128. The most posterior arises from the neural
spine of the seventh vertebra. The other five arise similarly
from the neural spine of successive vertebræ and join the same
narrow muscle band to run forward to be inserted into the
transverse process of the axis vertebra.

129. The *sacro-lumbalis* [49] [50] is closely blended with the
next muscle, the *longissimus dorsi* (130). It is the outer part of
a mass that rises along the sides of the vertebræ and on the ribs.
It arises from the anterior end of the ilium, from the space
between the ilia, and from the transverse processes of the dorsal
vertebræ. It makes insertions to the first dorsal and free ribs,
and is inserted into the diapophysis of the twelfth cervical
vertebra.

130. The *longissimus dorsi* [49] [50] is between the last muscle
(129) and the neural crest of the dorsal vertebræ. It is a mass
traversed by numerous tendons making attachments with ribs
and vertebræ. It arises as far back as possible in the angle
between the ilia and from the neural crest of the vertebræ, as
Shufeldt described for the American Raven. This muscle in
Strepera forms Xs of tendon on to the neural crests of the
vertebræ. It continues to make attachments and receive fibres
as it goes on to the base of the neck. It has four insertions on
the eleventh, twelfth, thirteenth, and fourteenth vertebræ
respectively. The last one resembles the first of the series of
seven fasciculi which make up the *obliquus colli* (131). It is also
continuous with the *longus colli posticus* (128).

131. The *obliquus colli* [50] is made up of a series of seven
fasciculi of muscle on the side of the neck. The first links up,
as Shufeldt described in the Raven, the *longus colli posticus* (128),
the *longissimus dorsi* (130), and the *sacro-lumbalis* (129). The
first arises from the diapophysis of the eleventh vertebra, crosses
over the tenth, and is inserted into the postzygapophysis of the
ninth. It is joined by the third down branch from the *longus
colli posticus* (128), as shown in the diagram. The next oblique
section arises from the tenth vertebra, passes over the ninth, and
is inserted into the eighth. It receives the fourth branch from
muscle 128. The third, fourth, and fifth oblique sections arise
similarly, are inserted similarly, and are united with muscle 128
similarly. The sixth oblique section arises from the sixth

vertebra, joins the fourth vertebra in similar way to those already described, but also passes on to be again attached to the third vertebra. The last section acts in a manner similar to that of the first five. It arises from the fifth vertebra and is inserted into the third. Muscles 128, 129, 130, and 131 are closely related. They constitute, Shufeldt says, "one of the most complicated systems of muscles that I have any knowledge of."

132. The *longus colli anterior* [51] [52] forms a somewhat similar complicated structure on the ventral surface. The arrangement in *Strepera* agrees with that of the Raven, as described by Shufeldt. He divided this muscle into three parts—a vertical portion, a superior oblique, and an inferior oblique portion. The vertical portion is the largest. It arises from the hypapophyses of the tenth to fifteenth vertebræ inclusive, runs forward along the neck, to be inserted touching its fellow on the inferior tubercle of the atlas. This division, like the *longus colli posticus* muscle (128), gives off a system of tendons becoming longer anteriorly. These are attached to the parapophyses of the vertebræ from the tenth to the fourth inclusive. At its anterior end the muscle gives off tendons to the hypapophyses of the fourth, third, and second vertebræ. It also gives off "accessory fasciculi" down to and including the eighth vertebra. Each arises from the pleurapophysis of a vertebra, and runs up to join the tendon of the *longus colli anterior*, which is inserted into the parapophysis of the vertebra next beyond. The superior oblique section of the muscle arises separately from the diapophyses of the fifth, fourth, and third vertebræ. Its fibres run forward, become tendinous, insert into the tubercle of the atlas on the outer side of the insertion of the main portion of the muscle. The inferior oblique portion arises, in *Strepera*, from the transverse processes of the seventh and sixth vertebræ, passes upwards, and is inserted by a very delicate tendon into the parapophysis of the third vertebra.

133. The *rectus capitis lateralis* [51] arises from the diapophyses of the fifth, fourth, and third cervical vertebræ. It passes obliquely upwards to form a strong tendon which is inserted into the inner tubercle on the basal ridge of the basitemporal.

134. The *trachelo-mastoideus* [51] is a well-developed, flattened muscle external to and overlapping the last muscle, the *rectus capitis lateralis* (133). It arises on the outer side of the last muscle from the diapophyses of the fifth, fourth, third, and second vertebræ. It converges, becomes tendinous, and is inserted into the outer tubercle of the basal ridge of the basitemporal.

135. The *interspinales* [53] form a series of small muscles connecting the neural spines of the vertebræ except in the dorsal region. They are best developed between the anterior and posterior cervical vertebræ.

136. The *interarticulares* [54], as Shufeldt described, extend from the postzygapophysis of one vertebra to that of the next.

137. The *obliquo-transversales* [54] are narrow muscles passing obliquely from the transverse process of a cervical vertebra, past the next vertebra, to the postzygapophysis of the vertebra next beyond.

138. The *intertransversales* [54] form two sets—(*a*) short, thick muscles extending between the transverse processes of cervical vertebræ, commencing between the third and fourth vertebræ : (*b*) muscles joining the parapophyses of successive cervical vertebræ.

139. The *triangularis sterni* [55] is an interesting muscle situated inside the thorax. It arises from the costal process of the sternum, spreads out over the costal ribs, and runs up in four digitations to be inserted one on each of the first four ribs. The first branch is very distinct, and would almost rank as a separate muscle.

140. The *intercostales* [55] are small muscles developed between the ribs. The first is the most conspicuous. It arises from the front edge of the first dorsal rib and runs obliquely forward to the last free rib.

141. The *scalenus medius* [56] is really the first of the *levatores costarum* muscles. It arises from the diapophysis and adjacent parts of the eleventh cervical vertebra. The fibres attach firmly to the end of the short free rib, and run on to be inserted into the anterior margin of the long free rib at about the middle third.

142. The *levatores costarum* [56] is a series following the *scalenus medius*. Each arises from the transverse process of a vertebra from the twelfth backward, runs obliquely downward to be inserted in the anterior face of the rib next beyond. They become more feeble posteriorly.

143. The *appendico-costales* [56] form a neat set of muscles running from the under side of the epipleural process of the rib to be inserted into the anterior edge of the rib next behind. A strong triangular membrane supports each epipleural appendage by uniting it to the rib in front of it. These are strongest in front, and decrease backwards.

144. The *obliquus externus abdominis* [58] is described by Shufeldt as the most external muscle of the abdomen. It is a very large, thin muscle layer. It arises from the dorsal ribs about the level of the base of the epipleural appendages, from the pelvis, the post-pubic element of the pelvis, and from the structures about the tail. The membrane soon develops muscle fibres ; it is attached to the ribs, passes over the sternal ribs, and is attached to the *pectoralis major* [49] and to the hinder border of the sternum. Some fibres run longitudinally backwards from the sternum to the post-pubic element of the pelvis.

145. The *obliquus internus abdominis* [57] lies under the last-mentioned muscle. It arises tendinous, as Shufeldt describes for

the Raven, from the post-pubic process and the neighbouring parts of the pelvis. It passes forward to be inserted into the posterior edge of the last rib. Its mesial border is free.

146. The *rectus abdominis* [57] arises by a tendinous membrane from the post-pubic element of the pelvis, and from the ligament that joins the two post-pubic processes. It agrees with Shufeldt's description of the muscle in the Raven. At first it is tendinous, and becomes muscular at a definite line. It runs to the sternum, and is attached, but is continued as a thin membrane to be attached to the outer side of the ribs under the other abdominal muscles which have been described.

147. The *transversales abdominis* [57] is a definite muscle, well developed in *Strepera*, as it is in the Raven. It arises from the ligament between the post pubes and the under side of the pelvis. It becomes fleshy, runs forward over the peritoneum to be inserted over the inner side of the ribs. Ventrally, it is inserted into the *linea alba*.

148. The *diaphragm.* — Shufeldt describes three rudimentary muscles in association with the diaphragm of the Raven. Though I specially dissected two specimens of each of the Raven, *Gymnorhina*, and *Strepera*, I did not succeed in satisfying myself that these rudimentary muscles were present.

The remaining muscles are concerned with the movement of the tail.

149. The *levator coccygis* [60] and (150), the *levator caudæ* of Shufeldt, are not distinct in *Strepera*, the Australian Raven, *Gymnorhina*, or *Cracticus*, though Shufeldt found them to be distinct, though closely related, and connected with fascia, in the American Raven. Shufeldt regards the *levator coccygis* as the detached portion of the *longissimus dorsi* (130), which in most reptiles is continuous to the tail. It arises from the posterior aspect of the pelvis and the caudal vertebræ. It is inserted, in *Strepera*, into the tuberosity on the anterior margin of the pygostyle and also into each neural spine of the caudal vertebræ ; further, it is inserted fleshy over the four inner tail quills on each side. Gadow, in Bronn's " Klassen der Their-Reichs," vi., Band, figures this muscle mass as " one."

151. The *transversus perinor* [62] is a flat sheet of muscle arising from the lower edge of the ischium and the post-pubic process. It forms a loop for the passage of the *femoro-caudal* muscle (103), and runs down to meet its fellow of the under side just before the anus. Gadow figures two muscles connected with the anus—a circular band about the anus and the sphincter muscle in the margin. These are present in *Strepera* and the other birds examined.

152. The *depressor-caudæ* [61] [62] arises from the posterior border of the ischium and the post pubis, as Shufeldt described for the Raven. The fibres converge, and are inserted into the base of the three outer rectrices.

153. The *depressor-coccygis* [61] [62] arises from the posterior edge of the ischium and post-pubic element of the pelvis. Its fibres converge and form a narrow muscle, which is inserted into the lower portion of the pygostyle.

154. The *lateralis caudæ* [60] [62] has, as Shufeldt described, four fasciculi, the outer being most distinct. It arises from the transverse process of the first caudal vertebra and is inserted on the outer side of the outer rectrix. The other fasciculi arise from succeeding caudal vertebræ and are inserted into the under side of the quill butts of the three outer rectrices.

155. The *lateralis coccygis* [59] arises from the posterior end of the ilium and the caudal vertebræ. It runs down to blend with its fellow over the ventral surface of the pygostyle in a white glistening fascia. It is attached to the under surface of the pygostyle, except the midspine.

156. The *infracoccygis* [59] arises from the diapophysis of the last sacral vertebra and also from the caudal vertebræ. It merges with its fellow, and runs backward, converging to be inserted into the midspine of the pygostyle.
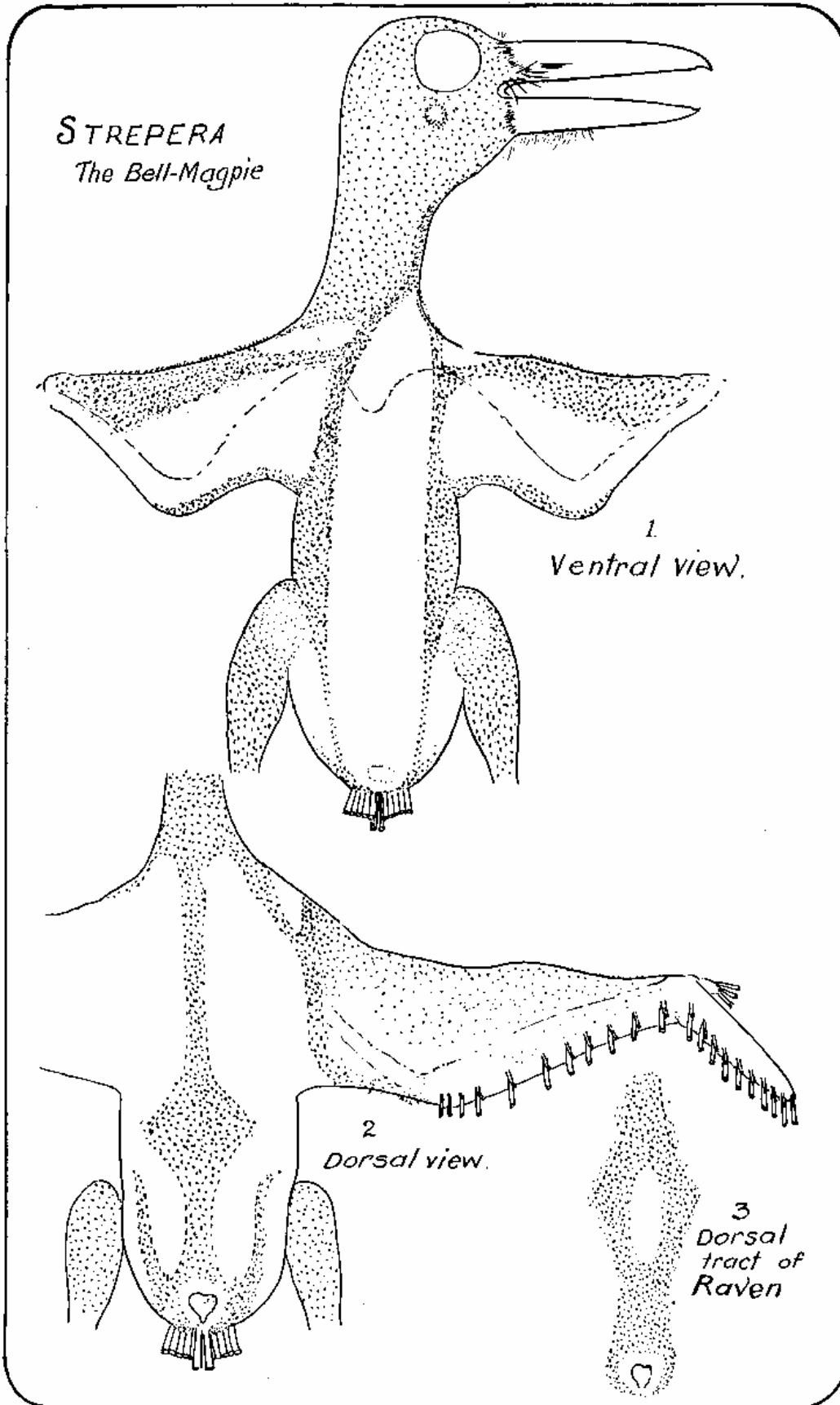
THE PTERYLOSIS OF STREPERA (Plate III.)

The pterylosis or arrangement of the feathers on a bird was first studied by Nitzsch, whose important work on "Pterylography," edited by Burmeister, was published in 1833, after the death of the author. Fortunately, the Ray Society in 1867 published a translation of Nitzsch's "Pterylography," edited by Dr. Sclater. *Strepera, Gymnorhina,* and *Cracticus* agree closely in the feather tracts; *Corvus* differs in having an apterium, or space without feathers, in the centre of the dorsal feather tract. This is an important difference. The primaries are ten in each case; the tenth or outermost is the shortest. There are eleven secondaries, and the eleventh or innermost is very short in each genus. The fifth cubital or secondary is present in all the birds examined, so that these birds have a quincubital wing.

The fifth cubital is present in Passeres, *Colius,* Humming-Birds, and Nightjars. It is variable in Kingfishers and Swifts, and is absent in many widely-separated groups, including, amongst others, *Anseres, Herodii, Columbidæ, Accipitres, Psittaci,* and *Striges.*

Goodchild ("Proceedings Zoological Society," 1886, pp. 184–203) has found the arrangement of the wing coverts uniform in the chief groups.

The wing coverts are arranged in the usual Passerine manner in these birds. The greater coverts of the secondaries do not exceed half the length of the corresponding secondary, and they overlap with the proximal edge covered by the feather next inside it. The median coverts have the distal edges overlapped by the feather in front of each. Passerine birds and Woodpeckers have this arrangement. The tenth primary is considerably

STREPERA
The Bell-Magpie

1.
Ventral view.

2
Dorsal view.

3
Dorsal
tract of
Raven

The Pterylosis of Strepera.

reduced, being less than half the length of the longest primary ; the ninth quill is always less than the eighth.

The pterylosis indicates that *Strepera* is related to *Gymnorhina* and *Cracticus*, and not to *Corvus*.

There are six pairs of rectrices or tail quills. The centre pair is placed higher, one feather on each side of the pygostyle close to the bone. The other five pairs have upper tail coverts. Coverts are absent from the centre pair.

Gymnorhina has dense, closely webbed and hooked contour feathers.

Cracticus has looser plumage, while *Strepera* has the feathers still more loosely webbed and hooked.

The oil-gland has no tuft of short feathers.

The young birds are faintly mottled and marked on their plumage, and are not similar to the adult in *Cracticus* and *Gymnorhina*. Not enough material is at hand for a satisfactory examination of the phases of *Strepera*, though I examined the specimens in the National Museum, Melbourne.

The young of *Corvus* are like the adults, but are duller.

THE CONVOLUTIONS OF INTESTINES AND CÆCA.

The convolutions of the intestines agree closely in all the birds examined, whether they are examined by tracing the coils as set out by Gadow ("Proceedings Zoological Society," 1889, pp. 303–316) or by opening out the folds and spreading the sheet bounded by mesentery out flat, as described by Mitchell ("Transactions Linnean Society," second series, vol. viii.: Zool., pp. 173–275).

Strepera has a bend in the last ascending branch which is absent in the other birds examined.

The quotients obtained by dividing the actual length of the intestine from the pyloric to the anus by the distance from the first thoracic vertebra to the anus are as follow :—

$$\textit{Strepera} \quad .. \quad \frac{26\frac{3}{4}''}{4\frac{1}{8}} = 6.48$$

$$\textit{Raven} \quad .. \quad .. \quad \frac{29\frac{1}{2}''}{5\frac{1}{2}} = 5.36$$

$$\textit{Cracticus} \quad .. \quad \frac{11\frac{1}{4}''}{2\frac{7}{8}} = 3.91$$

$$\textit{Gymnorhina} \quad .. \quad \frac{14\frac{3}{4}''}{4} = 3.68$$

The cæca vary in length. In

Raven　　　they are $\frac{5}{8}''$ long.
Strepera　　,,　　,,　$\frac{1}{2}''$ long.
Gymnorhina　,,　　,,　$3/16''$ long.
Cracticus　　,,　　,,　$3/32''$ long.

THE PALATE.

The palate, as in all members of the Passeriformes, is ægithognathous — that is, the vomer is truncated and the maxillo-palatines do not fuse. The palate of *Strepera*, however, is not the usual ægithognathous type, but is the " compound ægithognathous " form of Professor W. K. Parker, who, in the " Transactions of the Zoological Society," ix., 1877, p. 327, described the palate of *Gymnorhina* as being very different from that of the normal *Corvus* type.

Gymnorhina and *Cracticus* show a fuller development of this modification than *Strepera* does. In *Gymnorhina* the vomer is forked, the nasal septum and the walls of the olfactory chamber are ossified, and the palate is converted into a desmognathous palate. It, however, is not the usual desmognathous palate formed by the fusion of the maxillo-palatines with the septum. *Gymnorhina* and *Cracticus* have the olfactory chamber so strongly ossified that the foramen is almost filled, but in *Strepera* the ossification has not proceeded so far. The vomer is much modified. In *Gymnorhina* and *Cracticus* it is strongly forked in front. In *Strepera* the forking is seen only on the upper surface. The pterygoids are fused with the palatines in *Gymnorhina*, *Strepera*, and *Cracticus*, not hinged as they are in *Corvus*. Huxley made use of the characters of the palate in classification. His famous paper marked a distinct advance in the classification of birds (" Proceedings Zoological Society," 1867).

THE CAROTID ARTERY.

The carotid artery in *Strepera* is single ; it is the left carotid found in the Passeres and many other birds, the right carotid being absent. It runs forward partly in a special canal formed on the ventral side of the middle cervical vertebræ, and divides into two at the base of the skull, thus serving as two carotids.

STERNUM AND RIBS.

The sternum in *Strepera* has a large single notch in the posterior border on each side. It has also a large Y-shaped external spine on the anterior upper border. These two features are characteristic of the Passerine sternum.

Pycraft records an epipleural appendage on the posterior rib, and says the ribs are very broad and strong. Possibly his specimen was abnormal. The specimens examined by me of *Strepera*, *Gymnorhina*, and *Cracticus* had the epipleural appendage smaller and shorter on the next to last rib, and the last rib had no appendage. The ribs were not noticeably broad or strong, as Pycraft found in his specimens of *Gymnorhina*.

THE POSITION OF STREPERA IN CLASSIFICATION.

Dr. Stejneger says, in " The Riverside Natural History," vol. iv. : The Birds, p. 458 :—" There seems to be no single

character by which the Passeres can be separated from all the rest of the birds." They, however, possess certain characters which are not combined in the same way in a bird of any other order. These characters are referred to in the following summary :—

In *Strepera* the *ambiens* muscle of the thigh is absent. This bird, therefore, belongs to Garrod's sub-class *Anomalogonatæ* (abnormally-kneed). Its muscle formula is A X Y, denoting that the *femoro-caudal*, the *semitendinosus*, and the *accessory semi-tendinosus* muscles are present. The anomalogonatous birds include the Passeriformes and the Piciformes. *Strepera* has short cæca on the intestine and has a nude oil-gland. These characters exclude it from the Piciformes, and leave it in the Passeriformes.

The second, third, and fourth toes are directed forwards, and the well-developed hallux is directed backwards. The *flexor longus hallucis* tendon is superficial to, and not united with, the tendon of the *flexor perforans digitorum*.

These characters confirm the inclusion of *Strepera* in the Passeriformes.

The intrinsic muscles of the syrinx are attached to the ends of the cartilaginous half-rings of the bronchi. *Strepera*, therefore, belongs to the Acromyodian section of the Passeriformes.

The tendon of the *tensor patagii brevis* muscle of the arm joins the *extensor metacarpi radialis longior* muscle, but does not fuse with the tendon of that muscle. It runs just external to it, to be inserted immediately below the insertion of the *extensor metacarpi radialis longior*. *Strepera* is, therefore, a member of the *Passeres Normales*. *Atrichia*, the remarkable Australian Scrub-Bird (two species), is the only Acromyodian genus in which the tendon of the *tensor patagii brevis* differs in its insertion from that of *Strepera*. In *Atrichia* the tendon fuses with the tendon of the *extensor metacarpi radialis longior*. *Atrichia* is thus accorded the honour of Sub-division I., *Passeres Abnormales*.

Sharpe has, in the catalogue of Passeriformes or Perching Birds in the British Museum, vol. iii. (1877), subdivided the *Passeres Normales* into " sections," and again into " groups," which are made up of families. In his " Hand-list of Birds," however, he did not provide for " sections " or " groups," but divided the *Passeres Normales* into 48 families. Oates, in his notes on Passeres in " The Fauna of British India : Birds," vol. i., p. 6, said :— " No success has attended the efforts of anatomists to sub-divide the Acromyodi into two or more groups by internal characters."

We are concerned with three only of the forty-eight families of Sharpe's " Hand-list of Birds." They are : — Family 17, *Laniidæ* ; family 47, *Corvidæ* ; and family 48, *Streperidæ*. These are shown as follows in " The Hand-list of Birds," Order XXXVI., vol. iii., 1901 :—

PASSERIFORMES.

Sub-Order I. : Mesomyodi.

Sub-Order II. : Acromyodi.

(A) *Passeres Abnormales*, 1 family.

Atrichornithidæ : Scrub-Birds, 2 species.

(B) *Passeres Normales*, 48 families.

Family XVII. : *Laniidæ* (vol. iv., 1903).

Sub-Family I. : *Gymnorhinæ*.

1. *Pityriasis*.

2. *Gymnorhina*.

3. *Cracticus*.

4. *Strepera*.

Family XLVII. : *Corvidæ* (vol. v., 1909).

Family XLVIII. : *Streperidæ* (vol. v., 1909).

1. *Strepera*.

The palate of *Strepera* is not the typical ægithognathous form, but a desmognathous type which has been developed by the ossification of the nasal sac and septum, as already explained. It has also a long process backward from the outer end of the palatines. These characters place *Strepera* in the Gymnorhines of Pycraft with *Gymnorhina* and *Cracticus*, and away from the *Corvidæ*. The presence of the external branch of the *genio-hyoideus* muscles, of the single anterior branch in the *latissimus dorsi* muscles, and the insertion of the *cleido-tracheales* muscles into the *sterno-hyoideus* muscles in *Strepera*, *Gymnorhina*, and *Cracticus* further justify the grouping of these birds, and their separation from *Corvus*.

The pterylosis of *Strepera* agrees with that of *Gymnorhina* and *Cracticus*. It differs from that of *Corvus* in having no apterium in the dorsal feather tract. This is an added reason for the combining of *Strepera*, *Gymnorhina*, and *Cracticus*, and their separation from *Corvus*.

This investigation supports Ridgway in his belief that *Strepera* certainly does not belong to the *Corvidæ*, and that " a more consistent view of their relationship would entitle them (*Strepera* and *Cracticus*) to the rank of a family, *Streperidæ*." Sharpe's action in placing *Strepera* in the family *Streperidæ* was fully justified. The results of the examination show that *Gymnorhina* and *Cracticus* must also be included in that family.

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