XIII. *On the Homologies of certain Muscles connected with the Shoulder-joint.* By
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(PLATE XLVII.)

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THE main points of the paper which I have herewith the honour of laying before the Linnean Society are, first, that the *pectoralis secundus s. levator humeri* of birds finds its homologue in the *subclavius* of mammals, and not in the *pectoralis minor* of anthropotomy, and, secondly, that the "epicoraco-humeral" muscle, as described by Mr. Mivart in the *Echidna hystrix* and in the *Iguana tuberculata*, is the homologue of the two former of the three muscles now mentioned. A minor issue will be raised as to the source whence the sternal factor of the avian *levator humeri* comes to be added to the reptilian epicoraco-humeral, which, as its name implies, has no such mesial point of origin: and it may be stated at once that, though the mammalian *subclavius* furnishes instances of two methods whereby the *subclavius* of Man may acquire such an accessory point of origin, viz. either by borrowing from the *rectus abdominis*, or by simple apposition to its head, from the cartilage of the first rib, of fibres from the præsternum on which it abuts; the analogy of other animals seems to point to its being in this latter way that this addition is made. Some other points of less moment will arise in the discussion of these questions, or be brought forward at the conclusion of the argument as to the pectoral muscles. Of the four figures which accompany this paper, the first two represent the bony structures of the shoulder-girdle of the Crocodile, and the coraco-scapular bone of the Emu; whilst the third and fourth represent certain of the muscles arising from these bones and passing to the upper extremity in either case. Dissections from these two animals have been chosen for figuring, amongst other reasons, because the structural arrangements of the classes to which they respectively belong express, as has been remarked by anatomists from the time of Meckel ('Vergleichende Anatomie,' vol. iii. p. 194) to that of Mr. Parker ('Shoulder-Girdle,' 1868, pp. 142, 192), certain of the problems of morphology in plainer language than those of most other animals. It was whilst dissecting these and other animals in the light furnished me by Mr. Mivart's papers on the myology of the *Echidna hystrix* (Trans. Linn. Soc. xxv. 1866) and the *Iguana* (Proc. Zool. Soc. June 27, 1867)¹ that I came to entertain the

¹ In the former of these two papers (at p. 395) a very extensive, if not exhaustive, bibliography was given of the many disquisitions which had previously appeared on the subject of the Homology of the limbs and their muscles. To Mr. Mivart's list the following memoirs may be added, most of which are either contemporaneous with or posterior in date to his paper.

Hermann Pfeiffer. *Zur vergleichenden Anatomie des Schultergerüsts.* Giessen, 1854.

Professor Haughton. "On the Muscular Anatomy of the Crocodile," *Proceedings of the Royal Irish Academy*, June 26, 1865; *Ann. and Mag. of Nat. Hist.* Ser. iv. No. 4, April 1868.

Dr. Macalister. "On Irregularity in the Muscles of the Shoulder," and "On the Homologies of the Flexor

views which I now put forth, and in which I should have more confidence if I knew them to be in accordance with his views.

The *pectoralis secundus s. levator humeri* of ordinary birds arises from a greater or less extent of the keel and lateral portions of their sternum; and narrowing into a tendon as it passes along the inner aspect of the coracoid and the inferior surface of the coraco-clavicular membrane, from both of which structures it may receive an accession of muscular fibres, it winds over a pulley formed for it by the bone just mentioned, to be inserted between the insertion of the great pectoral on the radial tuberosity of the humerus, internally, and the tendon of the deltoid as it passes down to its attachment on the outer aspect of the bone, externally. The tendon of the *levator humeri* holding thus an intermediate position between the tendons of the deltoid and the great pectoral, may receive an accession of muscular fibres from the mesoscapular portion of the scapula; or these fibres, which may have a separate nerve-supply, may have also a separate insertion from that of the *levator* on the humerus. But the pulley arrangement furnished by the coracoid enables the *levator* in its simplest form to act as a powerful *levator* of the humerus.

The "subclavius" of anthropotomy arises from the cartilage of the first rib, a region into the constitution or near neighbourhood of which Mr. Parker has shown the epico-racoid to enter in several mammals¹. Under cover of a dense fascia (the "costocoracoid membrane," which may be taken to represent in fibrous tissue² an aborted large-celled

Muscles of the Vertebrate Limb," Cambridge Journal of Anatomy and Physiology, May 1867. "On Muscular Anomalies, and their bearing on Homotypical Myology," Proceedings Royal Irish Academy, December 9, 1867. "Contributions towards the formation of a correct System of Muscular Homologies," Ann. and Mag. of Nat. Hist. Ser. iv. No. 5, May 1868.

Dr. Hair. "On the Arrangement of the Muscular Fibres of the Alligator," Cambridge Journal of Anatomy and Physiology, November 1867.

Professor Pagenstecher. "Ein Vergleich der Muskulatur des Drill mit der des Menschen," Der Zoologische Garten, Zeitschrift für Beobachtung, Pflege und Zucht der Thiere, April and May 1867, Frankfurt.

W. F. Vrolik. Den Carpus der Zoogdieren. 1866. Leiden.

Wood. "Varieties in Human Myology," Proc. Roy. Soc. vol. xiii. p. 299 (June 16, 1864), vol. xiv. p. 385 (June 1865), vol. xv. p. 239 (June 1866), p. 524 (May 1867). "The Comparative Anatomy of the Muscles of the Shoulder," Cambridge Journal of Anatomy and Physiology, November 1866.

Jeffries Wyman. "On the Symmetry and Homology of Limbs," Proc. Boston Nat. Hist. Soc. vol. xi. June 1867, *ibique citata*.

My thanks are due to Messrs. Vrolik, Mivart, Haughton, Wood, and Wyman, for their courtesy in sending me copies of their papers, several of which were thus rendered accessible to me much earlier than they otherwise would have been. Mr. Parker's magnificent volume on "the Shoulder-Girdle," recently (1868) published by the Ray Society, furnishes, here and there, hints and guidance for the determination of muscular homologies which no writer can for the future afford to ignore. One of the many pleasing fruits of studying this work is the feeling that by so doing one has fairly earned a right to spare one's self the task of criticising views which must have been formed before Mr. Parker's labours were published.

¹ See 'Shoulder-Girdle,' pl. 26. fig. 10, *Mus decumanus*; fig. 5, *Mus minutus*; figs. 1 and 2, *Mus musculus*; fig. 5, *Mus sylvaticus*.

² For the representation in fibrous tissue by adult structures of what was cartilage in the embryo, see Parker, *loc. cit.* pp. 182, 184, 197, 198. For the existence of the cartilaginous band, above mentioned, see Gegenbaur, 'Untersuchungen zur vergleichenden Anatomie,' 1865, vol. ii. pp. 15-17, cited, Parker, *loc. cit.* p. 223. Prof. Pagenstecher, who, however, does not mention Prof. Gegenbaur's discovery, speaks, in the description of the dissection of a Drill,

cartilaginous band which reached in the embryo from the acromion to the præsternum) the *subclavius* of Man passes up to be inserted into the costal surface of the outer half of the clavicle. The relation held by this fascia to the muscle furnishes, as I shall hereafter strive to show, a most important means for differentiating the *pectoralis minor* of the Mammal from its *subclavius*. The variations which the *subclavius* presents in anthropotomy cast light, as such variations sometimes do, upon its homological representatives in the lower animals. One of the most important of these variations is the junction to the *subclavius* of another muscle, which, as arising ordinarily from the sternum, may be called a “sternoclavicular” muscle¹, and may be thought, by virtue of this its point of origin, to supply to the human *subclavius* the sternal factor which it requires to make its origin co-extensive with that of an avian *pectoralis secundus*. The prolongation of the *subclavius* to the acromion and scapula, so very common in quadruped mammals, is rare in the human subject, its fibres appearing to be, as it were, arrested by the largely developed distal end of the clavicle. One instance of such an arrangement is given as follows by Mr. Wood in the ‘Proceedings of the Royal Society,’ June 1865, p. 384.

“In a thin female subject of low stature was found, on the right side only, the remarkable muscle given in fig. 4. It consisted of a roundish fusiform slip (*a*), arising tendinous from the first cartilage below the *subclavius*, close to the *manubrium sterni*, passing across the subclavian vessels and nerves, quite distinct from the last-named muscle, and inserted into the upper border of the scapula and suprascapular ligament, where it was connected, to some extent, with the origin of the *omo-hyoideus* (*e*). From this point of insertion another slip of muscular fibres passed forwards, upwards, and outwards, to be inserted, with the *subclavius*, into the outer third of the clavicle.

“This muscle seems to be the same as that given in the author’s first series under the name of a double *subclavius*, with the addition of a connecting slip to the clavicle. It seems to the author to represent pretty closely the *sternoscapular* muscle, while contributing to support the thorax in the Pachyderms and Ruminants, in which animals it is continued as far as the manubrium.”

It is singular that in the Crocodile some of the fibres of the *omohyoid* are, in young specimens at least, continuous with fibres of the *epicoraco-humeral*; and it is obvious that if, in the case just quoted from Mr. Wood’s paper, the fibres thus continuous with the *omohyoid* had been prolonged a little, so as to become continuous with those of the *deltoid* or *supraspinatus*, we should have had here a muscle corresponding both in origin and in insertion very closely with the *pectoralis secundus* s. *levator humeri* of the bird.

Now, as the following account of a dissection from the Guineapig will show, just such a muscle exists in that animal:—

In the Guineapig (*Cavia aperia*), the *subclavius* muscle, the smaller “sternoscapular” of Mivart and Murie (Proc. Zool. Soc. June 1866, p. 398) arises from a small surface on

Mandrilla leucophaea (Zool. Gart. April 1867, p. 128), of a very fine but strong elastic band, which ran along the upper or anterior border of the *pectoralis minor* from the coracoid to the anterior end of the second rib, as being the homologue probably of the coracoid of Monotremes, Birds, and Reptiles.

¹ For instances of this “second subclavius” see Wood, Proc. Roy. Soc. June 1864, p. 300, June 1865, p. 384, and June 1866, p. 238; Macalister, Proc. Roy. Irish Acad. Dec. 1867.

the præsternal proosteon and from the cartilage of the first rib, exteriorly to which latter point of origin the epicoracoid has coalesced with the vertebral rib. It passes up behind the osseo-cartilagino-fibrous bar made up of ligaments, præcoracoid, clavicle, and meso-scapular segment (see Parker, *l. c.* pl. 24. fig. 6) and reaching from the apex of the anterior prolongation of the sternum to the acromion and coracoid. Some of its fibres are inserted into the coraco-clavicular ligament, and some, though fewer, into the clavicle itself. But from the clavicle it receives a large accession of muscular fibres in return; and these, joining with the fibres of the original muscle, pass on to be inserted along the anterior edge of the acromion, and also to become continuous along the mesial or downward-looking edge of the metacromion with fibres of the deltoid, which take origin from the ligament prolonged inwards from the acromion to the clavicle. Thus, though the greater part of the fibres of the *subclavius* are arrested by a bony fixation into the acromion, which, it will be recollected, is, in these proportions at least, an exclusively mammalian development, it becomes, by the continuity of its innermost fibres with the soft tissues placed mesially to that process, more or less physiologically as well as morphologically equivalent to the *pectoralis secundus* or *levator humeri* of the bird. A larger muscle, the larger "sternoscapular" of Mivart and Murie, arises from the mesosternum in the Guineapig, and takes a similar course to that of the "subclavius," with which it interchanges fibres at the clavicle, to which they both have an attachment. It is inserted, however, along the upper vertebral border of the scapula; and three-fifths of the entire length of the spine of that bone intervene between its insertion and that of the *subclavius*. If we consider that the "subclavius" here has an origin, as it has also in the Crested Agouti, *Dasyprocta cristata* (Mivart and Murie, *l. c.* p. 398), and in other mammals, from a sternal as well as from a costal element in immediate connexion with the epicoracoid, and, indeed, also with the præcoracoid, we may think ourselves justified in regarding the muscle with these points of origin as the morphological equivalent, as to its origin at least, of the entire *pectoralis secundus* of the bird, independently of the "greater sternoscapular" muscle. But, inasmuch as the *pectoralis secundus* of the bird shows some tendency to self-multiplication, as seen in the suborder Gallinæ, it may be well to consider the two sternoscapular muscles as, either severally or fused, homologous with either two distinct *pectorales secundi* or a single one. The *rectus abdominis* is prolonged up to the first rib, and is overlapped in the Guineapig by a muscle homologous with that figured at *e o* in fig. 3, of the Crocodile's shoulder-joint muscles; but it does not give any tendinous or muscular factor to the *subclavius* here, as it does in the Wombat (*Phascolomys wombat*). A description of the arrangement of these parts in this latter animal will be found in my description of fig. 3, which, though taken from a dissection of a Crocodile, makes the account of the structures, as seen in the Wombat, much more intelligible. Both descriptions alike warn us not to lose sight of the possibility that the avian *levator humeri* may have borrowed a factor from the anterior prolongation, over the sternum, of the *rectus abdominis*. The arrangement of these selfsame structures in the Aardvark (*Orycteropus Capensis*) enforce the same lesson. In this animal (a detailed account of the myology of which, by J. C. Galton, Esq., appears in the Linnean Society's 'Transactions,' vol. xxvi. p. 571) the *subclavius* arises from the manubrium, from the cartilage of the first rib, and

from the tendon of the *rectus abdominis* as it passes upwards to be inserted into the manubrium and first rib. The muscle is folded upon itself much as the *pectoralis major* is in the human subject; the concavity of the pouch thus formed looks inwards. The inferior or superficial portion of the muscle passes upwards; and its tendon spreads into the fascia covering the *supraspinatus*, and thus is inserted into the acromion at its root, whilst towards its apex, by the intermediation of fascia covering the acromion, it can act upon the fibres of the deltoid taking origin there. The portion of the muscle which lies deeper or more dorsally is inserted into the coracoid, into and along the coraco-acromial ligament, into a detached ossicle, which lies outside the angle formed by the meeting of acromion and clavicle, and finally into the clavicle. But the clavicle seems to give fibres to the *subclavius*, as well as to receive the insertion of fibres from it; these fibres, however, are but few in number, and seem to lie between the superficial and the deep portions of the muscle.

The *subclavius* of certain New-World Monkeys (*Myctes seniculus* and *Myctes Geoffroyi*) furnish us with a stepping-stone whereby to pass from the *subclavius* of the three mammals just treated of to the *subclavius* of anthropotomy. In these Monkeys the *subclavius* takes origin from the junction of the first costal cartilage, not with the sternum, but with the rib, and it is inserted into the outer and under surface of the clavicle and into the coracoid. But it has no origin from the sternum, and no scapular nor any humeral insertion, either direct or indirect.

The human *subclavius* may have an insertion into the coracoid (Wood, Proc. Royal Soc. June 1864, p. 300); but such an aberrant slip as that recorded by Ganzer (cited by Mr. Macalister, Cambridge Journal of Anatomy, May 1867, p. 318) as passing in the human subject "from the cartilage of the first rib to the capsule of the shoulder beneath the *pectoralis minor*" I should be inclined to look upon as merely a part of the deeper layers of the *pectoralis major*, which took origin as much higher than those layers do ordinarily reach as the slip of muscle *eo*, figured from the Crocodile in fig. 3, appended to this paper, takes origin higher than the external oblique does ordinarily.

I may now pass by a natural transition to a vindication of my proposition, that the *pectoralis secundus* or *levator humeri* of the bird does not find its homologue in the *pectoralis minor* of the mammal. For the establishment of this negative proposition, it is not sufficient to say that in each of the mammals from dissections of which I have described a *subclavius* apparently homologous in origin, course, and insertion with the avian *pectoralis secundus* a muscle homologous with the human *pectoralis minor* is also found, and that this coexistence disproves the view which asserts these two *pectorales* to be homologous; for the *pectoralis minor* may be multifid, and many instances have been put on record in which it forms a groove for a portion of its fibres in the coracoid and, working in it as over a pulley, comes, either directly or through the intermediation of the *supraspinatus* (which these fibres join), to act as an elevator of the humerus (see Macalister, Proceedings Royal Irish Academy, Dec. 1867; Cambridge Journal, May 1867, p. 317; Wood, Proceedings Royal Society, May 1867, p. 524, June 1866, p. 231); and it is plain *à priori* that for the formation of an avian *pectoralis secundus* by the *pectoralis minor*, and for the alteration of its functions from that of a depressor into that of a *levator*

humeri, all that is necessary is the provision for its tendon of some such pulley-like arrangement by the coracoid. What I have to show is that, as a matter of fact, the muscle which, in the economy of nature, has been worked up into the avian *levator humeri* is one and not the other of two, either of which, so far as we can see, might have been so employed.

I cannot adopt Prof. Pagenstecher's views (Zool. Gart. April 1867, p. 125), according to which the two mammalian *pectorales* are referred to two entirely distinct sets of muscles, the *pectoralis major* being one of a ventral, and the *pectoralis minor* one of a dorsal series. The single fact of their both receiving a nerve-supply from the same nerve (the internal anterior thoracic) seems to be conclusive against the validity of this suggestion. And I believe further that it is impossible to observe how the posterior fascicles of the *pectoralis major* in the lower mammalia have their tendons prolonged up from the lesser tuberosity of the humerus and the bicipital groove, which is bridged over by pectoral tendons, to the coracoid process without being convinced that the *pectoralis minor* of anthropotomy is but a specialized anterior fascicle of the deeper portions of the *pectoralis major*. The commonest variation, according to Mr. Macalister (Cambridge Journal of Anatomy and Physiology, May 1867, p. 317), which the *pectoralis minor* exhibits in Man is an insertion of the lowest part of its tendon, missing as it were the coracoid process, into the *coraco-brachialis* muscle.

The arguments which I shall now adduce to show that the *pectoralis minor* is not the homologue of the avian *pectoralis secundus* will at the same time go some way towards proving that the primary insertion of the mammalian muscle is a humeral one, more or less internally to the tendon of the superficial layers of the greater pectoral, whilst the primary insertion of the avian is also a humeral one, but one more or less externally placed to that of the great pectoral depressor of the humerus. The attachment of the mammalian pectoral to the coracoid is secondary in its history; and the like place in the series of its specializations is held by the development of the coracoid pulley in the history of the avian *pectoralis secundus*. The insertion of the "subclavius" into the clavicle and the junction of the "*pectoralis minor*" with the *supraspinatus* will be seen in the course of the argument to be exclusively mammalian developments. Now there are three lines of argument for showing the homological identity or non-identity of any two muscles. The first line of argument shows that they hold the same or different relations to the other structures they are connected with at their origin, in their course, or at their insertion. The second shows that they are or are not supplied by the same nerve or nerves. The third shows that either in their adult condition or in the condition of development they are independent or connate. A comparison of the *pectoralis minor* of the mammal with the *pectoralis secundus* of the bird furnishes us, under each of these three heads, with an argument for their non-identity. Under the first head I would observe, as Prof. Pagenstecher has already been quoted as doing, that the *pectoralis minor* of the mammal lies to the outer side of the costocoracoid membrane, to the inner side of the homological representative of which structure, viz. the coracoid, the *pectoralis secundus* of the bird passes. I do not mean to deny, nor yet to affirm, that the *pectoralis minor* of the mammal may not be one of the same series of

muscular fasciculi as its *subclavius*; what I do affirm is, that there is a certain landmark between these two muscles enabling us to separate them into two sets, and that there is a similar separation recognizable in the bird, of similar muscles by means of a similar landmark. Under the second head I shall show that the *subclavius* of the mammal is supplied by a nerve homologous with the nerve which supplies the *pectoralis secundus* of the bird, and that the *pectoralis minor* is not supplied by that nerve, but by the same nerve as that which in the bird supplies the great pectoral. And, thirdly, I shall show that in the developing bird it is possible to see that the *pectoralis major* is really the equivalent of both pectorals of the mammal. The facts of the anatomical arrangements in any single bird will give my arguments in their most intelligible form; and I will proceed to give them in an account of the structures in question, as seen in the common Sparrow-Hawk (*Accipiter Nisus*).

The *pectoralis secundus s. levator humeri* has a much smaller area of origin from the sternum and its keel in the Sparrow-Hawk (*Accipiter Nisus*) than in the Common Fowl. It receives, however, an accession of fibres, first from the anterior inferior angle of the coracoid, and secondly from a large head which, arising from the posterior or upper surface of the coracoid groove in the sternum, from the lateral aspect of the sternal rostrum, from the upper surface of the inner angle of the coracoid itself, and, finally, from the upper surface of a fibrous band which passes from the posterior lip of the coracoid groove in the sternum to fix itself to the posterior and inner edge of the coracoid at about the middle of the height of the bone, may be considered the homologue of the large "coraco-brachialis superior" of Gallinaceous birds*. A dense band of ligamentous tissue (homologous probably with the præcoracoid of the Lizards) stretches in the coraco-clavicular membrane from the sternal rostrum to the upper end of the clavicle; and from it a thin sheet of muscular fibres arises, which joins the tendon of the *pectoralis secundus* in the pulley, as does also a slender slip of muscle which passes from the mesoscapula. The main mass of the *pectoralis secundus* is of a deeper colour, especially in young birds, than these two latter muscles, which join its tendon; and it is to be remarked that the main mass, as well as the former of these accessory slips, takes origin from the fibrous band in the coraco-clavicular ligament.

A ligament passes from the anterior exterior angle of the coracoid at its sternal articulation (the "epicoracoid" of Parker) to be inserted on the sternum at a point about opposite the articulation of the third sternal rib. It limits the fibres of the *pectoralis secundus* mesially from those of the so-called "subclavius" (no. xi. of Schoepss †) externally, at the point where these latter pass upwards and inwards to attach themselves to the base of the coracoid. Inasmuch, then, as the two layers of the "subclavius" of the bird are homologous serially with the two layers of the intercostals, this ligament may be considered homologous with the mesial attachment of the costo-cora-

* The lower part of this latter muscle is aborted as far as its ordinary direction is concerned, its upper part being represented by a very slender slip which arises from the posterior aspect of the mesocoracoid region close to the glenoid, and, taking the usual course of a coraco-brachialis, is inserted with the subscapularis.

† "Beschreibung der Flügelmuskeln der Vögel. Von C. G. Schoepss," Meckel's Archiv, 1829, p. 72.

coid membrane which separates the "subclavius" of the mammal from the insertion of the internal intercostals, the serial homologues of the deep layer of the *subclavius* of the bird.

Secondly, the nerve which supplies the *pectoralis secundus* of the bird is obviously homologous with the nerve which supplies the subclavius of the mammal, and not with the nerves which supply the greater and lesser pectorals in that class. The nerve to the bird's *pectoralis secundus* comes, in the *Accipiter Nisus*, from the anterior factors and lower aspect of the brachial plexus; and the nerve corresponding to the external respiratory of Bell comes off from the dorsal surface of the same part of the plexus, just as the subclavius and external respiratory do in Man, whilst the nerve to the great depressor pectoral muscle comes off lower down, and does not send any branch to the *pectoralis secundus*, which, if it were the homologue of the *pectoralis minor*, it would do. In the Sparrow-Hawk the trunk formed by the first and second of the cervical nerves, which join to form the plexus, gives off nerves to the *subscapularis*, the *teres major*, the *subclavius*, and the *pectoralis secundus*. The nerve to the last muscle is the first one given off from the front of the plexus, and it gives no branch to any other muscle. The external respiratory nerve, which passes down behind the brachial plexus and between the *serrati antici* and the ribs, has one root from the second factor of the plexus and one from the third. Its origin, therefore, and distribution, and its relation to the nerve to the *pectoralis secundus*, are close enough in resemblance to those of the human external respiratory to leave no reasonable doubt as to its homological identity with that nerve, and, by consequence, as to the identity of the nerve to the avian *pectoralis secundus* with the nerve to the mammalian *subclavius*. The nerve to the *pectoralis major* of the Sparrow-Hawk is given off from a point lower down in the plexus; and the three main trunks, which mainly make up the plexus, seem, as in the Alligator, all to give factors to it. It can scarcely be doubted that this nerve is the homologue of the two anterior thoracic nerves of the mammal.

If, thirdly, we are asked, Where is the second pectoral of the mammal to which the anterior thoracic nerves supply fibres as well as to the pectoralis? the answer furnishes us with our third argument, and runs thus:—In the young Sparrow-Hawk it is easy to divide the pectoral mass into two strata, the upper and deeper of which is much the feebler, but which is continued into a tendon continuous, indeed, with that of the *pectoralis magnus* on its deep surface, but prolonged upward, from its primary insertion into the inner tuberosity, very distinctly to the coracoid, being loosely connected with the tendons of the *biceps*, and ultimately attached (which the tendon of the *biceps* is not) to the *precoracoid epiphysis* of the clavicle. The description which I have given of the posterior layers of the great pectoral of the young bird is not, as far as I know, verifiable in the muscle, though it is in the tendon, of the adult. But it corresponds very closely with a description of the posterior layers of the great pectoral in the Common Rat, *Mus decumanus*; and it is difficult to see how it is possible to deny the homology of the upper fascicles of the posterior layer of the great pectoral in this animal with the *pectoralis minor* of Man. The nerve-trunk which thus supplies in the bird what I hold to be the homologue of the two *pectorales* of anthropotomy does, it is true, give off a nerve to one other muscle, viz. the *coraco-brachialis inferior*,

or *pectoralis tertius*, a muscle which arises from the posterior three-fifths of the outer and inferior edge of the coracoid, and is inserted into the inner tuberosity just inside the most mesially placed portion of the crateriform rim which it throws up round the mouth of the pneumatic inlet. But this nerve-trunk seems to me to be the homologue of the musculo-cutaneous nerve of anthropotomy, which supplies the *coracobrachialis*, and is given off from the same outer cord of the plexus, whence the external anterior thoracic arises.

By studying the four figures appended to this paper, and the descriptions given of them, a better comprehension of the bearings of my position, that the *pectoralis secundus* of the bird is homologically identical with the epicoraco-humeral of the reptile, will be gained than could be conveyed by any disquisition, however lengthy, if unaccompanied by illustrations. The name "epicoraco-humeral" has been given by Mr. Mivart (Trans. Linn. Soc. vol. xxv. p. 383; Proc. Zool. Soc. June 27, 1867, p. 778) to a muscle found both in the *Echidna hystrix* and in the *Iguana tuberculata*, which arises from the pre-coracoid and epicoracoid in the reptile, and from the epicoracoid in the reptile-like mammal, and is "inserted into the summit of the radial tuberosity between the insertions of the *pectoralis major* and *deltoid*." It was by recognizing in the shoulder-muscles of the Crocodile (fig. 3, *eh*) the homologue of this Saurian muscle, and by comparing it, when thus recognized, with the highly simplified *pectoralis secundus* (fig. 4, *eh*) of the Emu (*Dromaius Novæ Hollandiæ*), that I came to hold the view which I now put forth. The great reduction, already spoken of, which the sternal origin of the accipitrine *levator humeri* has undergone, as compared with the vast *pectoralis secundus* of the Gallinæ, prepares us somewhat for finding in the Emu a *pectoralis secundus* which, while it coincides in insertion, differs little in origin from the *epicoraco-humeral* of the Crocodile, except in the possession of a small head from the middle point of the sternum. The essential relations held by the muscles lettered *eh* in each of the two figures 3 & 4, to the surrounding parts, seem to be much the same in the intervals between their origin and insertions. The crocodilian muscle, however, receives a head from the visceral surface of the scapula, in compensation for the absence of the fibres which in the Emu arise from the coraco-clavicular membrane and sternum, but which in the Reptile appear to have been displaced by its great pectoral from its less-developed sternum. The *pectoralis secundus* of the Sparrow-Hawk, as already described, receives in a similar way an accession of fibres from the visceral surface of the coracoid and sternum. It is possible that the fascicle *ei* in the Crocodile, if the homologue of a dislocated anterior segment of *rectus abdominis* may foreshadow the sternal prolongation of the avian *levator humeri*. But though this muscle seems exceedingly ready to build up extraneous elements into its own mass, it is perhaps more easy, with our knowledge of this muscle as it is to be described hereafter in the Frog, to conceive the *epicoraco-humeral* as encroaching from its own area on to that of the sternum, than to conceive of it as fusing with a "rectus thoracis," even though the *subclavius* of the Wombat does actually do this. Another point of difference is presented by the retention in the Emu of a rudiment of the coracoidal pulley, which is not indicated in the Crocodilian shoulder-girdle, either as a nascent or as a retrograding structure. The pec-

toralis secundus of birds does not by any means invariably receive fibres from the coracoid; it does receive such an accession in the Sparrow-Hawk, but it does not do so in the Pigeon (*Columba livia*) for example; it may (as seen in great simplicity in the Emu and Apteryx) have a mesoscapular factor actually joined to its tendon, and inserted so as to be one in function with it, and it may be considered, therefore, to be essentially a sterno-præcoraco-scapular muscle. The sternal factor is lost in the Ostrich (*Struthio camelus*), and in the Rhea (*Rhea Americana*). Similarly the muscle figured at *eh*, fig. 3, from the Crocodile, is simply a "præcoraco-scapularis," with one head arising from the anterior surface of the expanse of bone constituted by the confluence of scapula and coracoid in front of the glenoid cavity, and with a second which joins the first on its mesial border as it passes round from the internal surface of the scapular, and is inserted into the outer tuberosity of the humerus, in close connexion with the upper edge of the great pectoral. In the descriptions given of this muscle, both in the Crocodile and in the *Ornithorhynchus*, it has been confounded with the *deltoid*. It is, however, shown by its innervation to be separate from it in nature; and its insertion lies between the insertions of the *deltoid* externally and that of the *pectoralis major* internally. This muscle has a single tendon in the Sparrow-Hawk, with three muscular heads converging upon it. In the Gallinaceous birds (*Gallus gallinaceus* and *Phasianus Colchicus*) the *levator-humeri* apparatus consists of three muscles, distinct both in origin and insertion, and innervated from two distinct sources. The largest of the three levator muscles of the Gallinaceous *humerus* has a very extensive origin from the sternum; but, as is the case in the Pigeon also, it has no distinct accession of fibres from the coracoid; but from the coracoid on its inner aspect, from the coraco-clavicular membrane, and from a small portion of the sternum a lesser *levator humeri* arises, which is inserted, after passing through the coraco-scapular canal and over the coracoid pulley, together with the tendon of the greater *levator*, between the point of insertion of this muscle (which is a little lower down, and more externally placed) and that of the great pectoral to its inner side. With the tendon of the greater pectoral *depressor* that of the lesser *levator* is very closely connected, as is that of the *epicoraco-humeral* of the Crocodile; and it is only the presence of the pulley arrangement which converts cooperation into antagonism. Thirdly, the small muscle which has been described as passing to the single *levator* tendon of the Sparrow-Hawk from the mesoscapula of that bird, has in the Gallinæ a larger size, a more extensive origin, and a separate insertion. It arises from the uppermost and innermost scrap of the scapula, *i. e.* from the "mesoscapula" of Parker, from the ligament which passes along the inner aspect of the coracoscapular canal from the mesoscapula to the *coracoid*, and from the innermost and uppermost scrap of the coracoid itself. Its tendon is inserted externally to that of the smaller *levator humeri*, internally and proximally to that of the great *levator*. In the common Goose this muscle, the "deltoides externus" of Meckel, is fused with a muscle of the same origin as the smaller *levator* of the Fowl; and we have thus an intermediate stage between the trifid insertion of the levator-apparatus of the Fowl and the single tendon of the Hawk. It will be obvious that the "deltoides externus" of the common Fowl corresponds, both as to origin and insertion, with the anterior or præglenoid head of the "epicoraco-

humeral" of the Crocodile, and that its smaller *levator humeri* corresponds as closely, *as to its insertion*, with the postscapular head of that reptilian muscle; and it might seem, therefore, that the larger *levator humeri* muscle of the Fowl remains without a separate homologue in the Reptile, were not this muscle innervated by the same *subclavius* nerve as the reptilian epicoraco-humeral, whilst the smaller *levator humeri* is, together with the *deltoides externus*, innervated from the circumflex. To an objector who denies the validity of this argument, and lays stress on the fact that the reptilian muscle has not the sternal factor of the avian *pectoralis secundus*, I reply, first, in the Emu a muscle very unmistakably homologous with the *præcoraco-scapularis* of the Crocodile possesses but a very small sternal factor; and, secondly, in the Ostrich (*Struthio camelus*), which also retains a *pectoralis secundus*, this sternal factor is aborted and lost. Stages of successive degradation from a highly specialized structural arrangement may well serve to guide our judgments in problems such as these, if it be true that the essential elements of a structure are the last which it loses so long as it retains any actual functional power at all. But, thirdly, lower types than even the scaly or loricated Reptile may have an *epicoraco-humeral* with a sternal factor. This is the case in the Frog, where the *epicoraco-humeral* (the "pars clavicularis deltoidei" of Ecker, 'Die Anatomie des Frosches,' p. 97) arises from what Mr. Parker (Shoulder-Girdle, pp. 79 and 80, and pl. v.) has shown to be the *præcoracoid* and the *omosternum*.

With this I close my case for proving that the *epicoraco-humeral* of the Reptile is the homologue of the *pectoralis s. levator humeri* of the Bird. It is not necessary for the acceptance of this conclusion that a person should accept also the Theory of Progressive Evolution. By speaking of organs as being "*homologically identical*," a person who is either averse to pronounce himself, or anxious to secure a dispassionate consideration from all parties, or both, may avoid pledging himself either to the theory which teaches that they are so by virtue of the "secret bond" of their "conformity to type," or to that which explains their oneness by a reference to "genetic affinity." As to which of the two theories a man will take for his guide in research, so far as any theory can serve for a guide in research, much will depend upon the idiosyncrasies, original or acquired, of individual minds. But though the theory may have only a subjective, the facts have an objective cogency.

With regard to the serial homologies of the fore and hind limbs, and, first, with regard to the representation of the ulna by the fibula and of the radius by the tibia, I have much pleasure in referring to Professor Pagenstecher's views, inasmuch as with many other of his conclusions I cannot bring myself to agree. But anybody who will look at his figures of the bones of the human arm and leg, placed side by side, each in the position which best shows their homotypical relationship, will have good reason for acquiescing in the view stated in the following sentence. In those figures we have the limb in either case so flexed as to have the angle formed at the knee and elbow respectively pointing upwards; the forearm is supinated, and the hand segment hyper-extended, so as to make almost a right angle with the long axis of the forearm. The ulna then lies and is directed a little posteriorly and dorsally as regards the radius; and the thumb and great toe, as also the little finger and the little toe, occupy, severally, corresponding posi-

tions. A very similar position, I may observe, is instinctively assumed by a man when he uses his pectoral muscles for the purpose for which quadrupeds ordinarily employ them, viz. for raising and supporting the trunk upon the fore limbs. And an observation of the position assumed by a man who puts himself into a quadrupedal posture for the purpose of drinking at a stream, or who raises himself by the help of his arms from a low seat by placing his hands on the table at which he is sitting, will illustrate the relations of the *extensor* and *flexor*, and of the inner and outer aspects of the two limbs, as well as the most detailed parallelization of the skeletal elements.

Secondly, a study of Mr. Parker's descriptions and histories of the shoulder-girdle will leave no doubt on the mind of any one, I apprehend, as to the serial homology of the *coracoid* with the *ischium*, and of the *præcoracoid* with the *os pubis*. The shoulder-girdles of the Frog and the Chelonians are especially instructive when compared with the pelvic girdle of the Crocodiles. Express utterances as to the relationship of the two sets of bones may be found in Mr. Parker's work 'On the Shoulder-Girdle and Sternum,' at pp. 7, 59, and 83.

Professor Huxley's view (which has been adopted by Mr. Mivart, and a similar one to which, I am informed by Professor Turner, of Edinburgh, was entertained by his predecessor Professor Goodsir), as to the homotypical relationship of the *subscapularis* and *teres major*, not to the *iliacus* and *psoas*, but to the middle and smallest *gluteus*, is a third point for discussion, and one which does not admit of being decided quite so cursorily as the two I have already glanced at. For the acceptance of this apparent paradox, it is necessary first to accept the principle that the true homology of a muscle is to be determined by its insertion (see Mivart, Trans. Linn. Soc. vol. xxv. p. 398 and 400). To this principle I should give a general assent, without forgetting that we may find exceptions to it, such as the insertion of the *pectoralis major* of the Sparrow-Hawk into both tuberosities of the humerus, such as the occasional insertion, in the way of corollary to this first exception, of the *pectoralis minor* into the outer tuberosity of that bone, or such, thirdly, as the insertion of the *psoas* of the Crocodile on the outer, while the *iliacus* is inserted on the inner side of the femur. In these cases, however, rudiments at least of the primitive insertion in the shape of aponeurotic bands will ordinarily be left remaining, as if to indicate that it has been, so to say, not by an arbitrary transference, but by a gradual lateral extension that the alteration of the point of attachment has been effected: and the essential character of a muscle may be considered to be as little affected by these transgressions of its ordinary limits laterally, as the essential character of a muscle which is ordinarily inserted into the proximal segment of a limb is considered to be affected by its occasional prolongation into a distal segment, by fascia or aponeurosis, which may finally be specialized into a tendon. There are, however, three sets of anatomical facts to which I would draw attention, as they seem to me to make the denial of the homotypical relation of the *iliacus* and *subscapularis*, and the ranking of the latter muscle with the *glutei*, less of a stumblingblock. First, there can be no reasonable doubt that the essential character of the muscle I have called "epicoraco-humeral" in the Crocodile, is determined by its innervation and by the insertion or wedging in of its tendon on the outer surface of the humerus between those of the *pectoralis major* and *deltoid*. Yet,

as is seen by fig. 3, this muscle receives a head from a surface of the scapula as completely turned *viscerad* as the iliacal surface of the ilium ever is. The origin of the slender *epicoraco-humeral* of the Chamæleon is limited to the external surface of its *coracoid* and *præcoracoid*; but its *supraspinatus*, if we may so style the muscle which comes next in order from below upwards after the deltoid, does receive just such a factor from the visceral surface of the scapula as does the *epicoraco-humeral* of the Crocodile. This muscular belly having the stem of the scapula placed exteriorly to it reminds one forcibly of the relation held by the os ilii to the *iliacus*; but the lesson which it teaches does not depend upon such resemblances as this, but upon the retention to some extent by the Chamæleon of the primitive rod-like character of the scapula, which makes it easier for us to see how it may rotate any one of its surfaces, when developed like the fluting on a column, into several different bearings in different animals. It is easier for us to understand how a muscle can wrap its origin round and about the various aspects of a cylindriform, than it is for us to conceive of similar indifferentism in the various surfaces of a many-faceted bone; and upon the conquering of this difficulty depends our power of homologizing the *spinati* with the *iliacus* *.

A second argument in the same direction presents itself from another quarter, that of innervation. The homologies of the nerves of the two limbs are much masked by the *iliopsoas* having carried with it in front of the pubic arch the anterior crural nerve—as also by the separation from this nerve of the peroneal trunk, which is seen, by its distribution, to correspond mainly with those elements of the musculo-spiral nerve which are distributed in the distal segments of the upper limb. But if we place side by side, with diagrams of the nerves of the two limbs, such as those given in plates iii. and iv. of Mr. Flower's "Diagrams," tables which give the spinal nerves to which the nerves of the limbs are ultimately traceable, we see that the suprascapular nerves correspond with the nerves to the *iliacus*, and the nerve to the *subclavius* with the *obturator's* branch to the inner head of the *pectineus*. The branch from the anterior crural, or from its internal cutaneous division, to the outer head of the *pectineus* answers to the circumflex, whilst the muscle, by having these two sources of nerve-supply, corresponds, even curiously, with the two *levatores humeri* of the Fowl, and the *glutei*-nerves and muscles are then left as homologues of the subscapular, *teres major*, and *latissimus dorsi*.

Thirdly, there can be little doubt that the *coraco-brachiales*, *superior* and *inferior*, of Meckel (no. xvi. and xvii. of Schoepss), in the bird correspond, not only to the *adductores* in the lower limb, but also to the *obturator internus* and *externus*, arising as they do, the former from the visceral, and the latter from the external surface of the parts homologous with the points of origin of the two *obturatores*. Now, close as is the relation between the tendons of the smaller *glutei* and the *obturatores* at the external or larger trochanter of the human femur, it is not at all more intimate than that which subsists between the tendons of the *coraco-brachiales* and those of the *subscapularis* and *teres major* on the lesser tuberosity, as represented by the crateriform rim of the pneumatic foramen. If the

* The so-called "third or deep head" of the *Iliopsoas* (see Henle, Handbuch Anat. Mensch. i. 3. 242), the *musculus iliacus internus minor* of Luschka (Anat. Mensch. ii. 2. 131) is described by the latter anatomist as lying quite exteriorly to the pelvic cavity. It comes thus to correspond most instructively with a *teres minor*. Similarly helpful is the large size of the facet of origin of the *teres major* in such an animal as *Ursus maritimus*.

superior *coraco-brachialis*, the origin of which is described in my account of the muscles of the Sparrow-Hawk, be the homologue of the *obturator internus*, it is difficult to deny the homology of the *subscapularis* (with the tendon of which its tendon fuses) with the *gluteus medius*, which holds so much the same relation by its tendon to the *obturator internus*.

Leaving now the subject of the homology of the *subscapularis* and *teres major* with the *glutei*, I may refer to the nerve-supply of the *teres minor* from the same nerve, the circumflex, which supplies the *deltoid*, as showing that this muscle is really but a divarication of the *deltoid* posteriorly, as a similar line of argument shows the *tensor fasciæ femoris* to be of the *gluteus medius*. The difficulty, therefore, as to the nomenclature of the muscle, which in Saurians and the monotrematous *Echidna* (see Mivart, Trans. Linn. Soc. vol. xxv. p. 384, and Proc. Zool. Soc. June 1867, p. 778; Stannius, Handbuch der Zootomie, ii. p. 126) has been sometimes called “*teres minor*” and sometimes “a second part of the *deltoid*,” may be met by saying that the posterior factor of the “*deltoid*” is not, in these lower animals, differentiated into a superficially placed “*deltoid*” and a deeper lying “*teres minor*.” There is ordinarily no *infraspinatus* differentiated from a *supraspinatus* in either bird, saurian, or Crocodile. But both these latter classes possess the muscle which, with the origin of the *teres minor*, has the insertion of the *teres major*, and is called “subscapulo-humeral” by Macalister (Proceedings Royal Irish Academy, December 1867) and Wood (Proceedings Royal Society, May 23, 1867, p. 534), “*infraspinatus secundus*” by Professor Haughton, “*teres major*” by Stannius (Zootomie, ii. p. 128, 2nd ed.), and, finally, “*teres minor*” by many anatomists, though incorrectly, if the insertion is to determine the name and nature of a muscle rather than its origin. Meckel (Vergleichend. Anatomie, iii. p. 512) uses this last nomenclature, speaking of a muscle with the origin and insertion specified as a “*teres minor*,” and stating that it is found in the Horse, in Ruminants, in the Aï, and in the Mole. A few birds possess this accessory *teres major*. In the common Fowl it arises from the outer surface of the scapula, a little way anteriorly to the downward-growing process, so well marked in the Gallinæ and in the Dodo, which receives the tendon of the anterior portion of the *serratus anticus*. It is inserted on the posterior lip of the pneumatic foramen, a point serially homologous with that of the insertion of the smaller *glutei* of human anatomy.

This muscle is not possessed by the Common Pigeon, but it is found in the Common Buzzard and Sparrow-Hawk, and in the Goose. The *teres major* proper is of very large size in ordinary birds; it is present in the Crocodile, but absent in saurians. It is not inserted with the *latissimus dorsi* in the Sparrow-Hawk, but passes to the anterior lip of the entrance to the pneumatic foramen, to a point just opposite to that of the insertion of the accessory *teres major*.

In birds there is no præscapular region (Parker, Shoulder-Girdle, p. 143), and consequently no *supraspinatus*. Indeed, as the *supraspinatus* of Meckel, *l. c.* p. 313 (no. xv. Schoepss), receives its nerve-supply from the circumflex, and must be looked upon as a part of the *deltoid*, birds would appear to have no “suprascapular” muscles at all, unless we may consider the deeper fibres of the præglenoid head of the *levator humeri* in the Emu and Apteryx to represent such a muscle; for there is such a muscle in the

Crocodile, underneath the epicoraco-humeral and the deltoid, and supplied by the same nerve as the former of these muscles. It takes origin from the triangular surface (*ss*, fig. 1) intercepted between the deltoid ridge, *d*, and the scapulo-coracoid fissure, and it is inserted just where the pectoral ridge sinks into the articular head of the humerus, proximally to the tendon of the *teres minor*. The suprascapular muscle is not ordinarily differentiated in reptiles into an *infra-* and *supraspinatus*. But in a Gecko, *Platydictylus*, sp.?, I have observed it to take origin from the coracoid, as well as from the scapular region of the shoulder-girdle; and by doing this, it has brought itself by origin, as it is often by innervation, into close correspondence with the *coraco-brachiales* muscles, and, serially, with the *iliacus* of reptiles.

The muscle seen in fig. 4, intercepted between the tendon of the *biceps* and that of the *pectoralis secundus* is called "deltoides internus" by Meckel; it is, however, obviously homologous with an upper segment of the *coraco-brachialis*, as seen in fig. 3 from the Crocodile, and with the "short coraco-brachialis" or "rotator humeri" of Wood (Cambridge Journal of Anatomy and Physiology, Nov. 1866, p. 49).

The muscle described by Mr. Mivart in the *Iguana tuberculata*, under the name of "gracilis," and stated by him to "represent possibly the *gracilis* of mammals," seems to me to be a serial homologue, which I have not met with elsewhere, of the *pectoralis major*. It arises from "the ischiatic symphysis" (where, in the saurians, an ossific nodule, the *os cloacæ*, may not rarely be found placed mesially, as though representing a sternum), and "from the long tendinous arch which passes from the front of the acetabulum, round behind the pubic spine, back to the symphysis just mentioned." This latter origin seems to me to correspond with the interclavicular and clavicular origin of the pectoral, as seen in some of the Sauropsida, and, as far as regards the clavicle, in mammals. Its insertion into the peroneal side of the head of the tibia seems to me to be paralleled by the insertion of the *pecto-antebrachial* of certain mammals, *e. g.* the Cat (see Straus-Dürckheim, vol. ii. p. 352, pl. vii. figs. 13, 15). Mr. Mivart, by lettering his tibial *adductor* S, may be understood, perhaps, to mean that he considers this muscle homologous with the *sartorius* of anthropotomy; and in this identification I should coincide. But the *gracilis*, which he seems to think may perhaps be represented by the muscle I suppose to be homologous with the *pectoralis major*, I think must be represented by a head which the tibial *adductor* in the *Iguana tuberculata* examined by me received from the symphysis of the ischia.

Mr. Mivart's *ilio-peroneal* seems to me to have its serial homologue in the muscle which, in many mammals, passes from the posterior vertebral angle of the scapula down to the olecranon, and which seems to be a divarication of the more commonly found "dorso-épitrochlien." As this muscle is clearly one of the series made up of the *biceps*, *semimembranosus*, and *semitendinosus*, which, like itself, take origin, in Crocodilidæ, from the ilium, it may be suggested that in the muscle just mentioned, as found in certain mammals, among which I may specify the Marten (*Mustela martes*), may be contained the homologues of the *biceps*, *semimembranosus*, and *semitendinosus*, as well as the *ilio-peroneal* of the lower limb. This great increase of the number of the muscles of the lower, as compared with that of their homologues in their upper limb, is illustrated also

by the great excess which the number made up by the *adductores* and the *obturatores* shows when compared with that of their homotypes the *coraco-brachiales*. It furnishes us with a fresh illustration of the principle laid down by Mr. Parker (Shoulder-Girdle, p. 7, note), to the effect that "the hip-girdle is always, in the higher classes, more complete as to mere mass, and lower in type morphologically, than the shoulder-girdle."

Tabular View of Muscular Homologies suggested in this Paper.

Name of Muscle in Mammal.	Homologue in Upper Extremity of Bird.	Homologue in Upper Extremity of Reptile.	Serial Homologue.
<i>Pectoralis major</i> .	Ditto.	Ditto.	"Gracilis" of Mivart, as described in <i>Iguana</i> , P. Z. S. 1867.
<i>Pectoralis minor</i> . Essentially the upper or anteriorly inserted fascicles of the deep layers of <i>pectoralis major</i> .	Ditto.	Fascicle lettered <i>ei</i> in fig. 3?	?
<i>Subclavius</i> . In mammals only is it of subordinate importance to the <i>spinati</i> .	<i>Pectoralis secundus s. levator humeri</i> .	<i>Epicoraco-humeral</i> of Mivart, as described in <i>Echidna</i> and <i>Iguana</i> , l. c. <i>Amphibian pars clavicularis deltoidei</i> as described by Ecker, <i>cleido-humeralis</i> of Pfeiffer.	Inner and deeper head of <i>pectineus</i> , supplied by obturator nerve.
<i>Coraco-brachialis brevis s. rotator humeri</i> of Wood.	<i>Deltoides inferior</i> of Meckel. No. xx. of Schoepss, Meckel's Archiv, 1829.	Upper part of <i>coraco-brachialis</i> lying superiorly to tendon of <i>biceps</i> .	Upper fascicles of <i>obturator externus</i> .
<i>Coraco-brachialis medius</i> . <i>Coraco-brachialis longus</i> .	<i>Pectoralis tertius s. coraco-brachialis inferior</i> . No. xvi. Schoepss, l. c.	Middle and longer portions of anterior <i>coraco-brachialis</i> .	Rest of <i>obturator externus</i> and adductors.
Deep portions of <i>coraco-brachialis</i> , in Monotreme. (See Mivart, p. 385, Linn. Soc. Trans. vol. xxv.)	<i>Coraco-brachialis superior</i> . No. xvii. Schoepss suggested as homologue by Mivart, l. c.	Ditto.	<i>Obturator internus</i> . This muscle is never supplied by the obturator nerve.
Deltoid.	Represented in birds by the <i>deltoides externus</i> of Meckel, no. xix. Schoepss, by the <i>deltoides superior</i> of Meckel, no. xviii. of Schoepss, and by the smaller <i>levator humeri</i> of the Fowl.	Deltoid.	Outer head of <i>pectineus</i> , supplied by anterior crural nerve or its internal cutaneous branch.
<i>Infraspinatus</i> , and <i>supraspinatus</i> .	Not found in birds as differentiated slips.	<i>Suprascapularis</i> , "infraspinatus," Mivart.	<i>Iliacus</i> , exclusively of part specified below.
<i>Teres minor</i> . Essentially a deep portion of posterior part of deltoid.	Not differentiated in birds, except Emu and other <i>Ratitæ</i> ?	Differentiated in Crocodile and Chamæleon.	<i>Musculus iliacus internus minor</i> of Luschka, Anat. Mensch. ii. 2. 131.
<i>Scapulo-humeral</i> . Essentially a part either of <i>subscapularis</i> or <i>teres major</i> .	Present in Fowl, Goose, Sparrow-Hawk, Buzzard. Absent in Pigeon.	Present in Crocodile. Absent as a differentiated slip in some saurians.	<i>Musculus scansorius</i> .
<i>Teres major</i> .	Very large in birds.	Present in Crocodile. Absent as differentiated slip in some saurians, as Chamæleon.	<i>Tensor fasciæ femoris</i> .

Table (*continued*).

Name of Muscle in Mammal.	Homologue in Upper Extremity of Bird.	Homologue in Upper Extremity of Reptile.	Serial Homologue.
<i>Pyriformis.</i>			In <i>Macropus major</i> a thin muscular slip arises from superior border of scapula near the origin of <i>omohyoid</i> . It passes down over the tendon of the <i>subscapularis</i> , with which muscle it is closely connected for an inch and a half, and it is also attached to the tendon of the <i>biceps</i> as it glides over the inner tuberosity of the humerus. It is inserted on the inner side of humerus above but close to the tendon of the <i>teres major</i> , overlying and giving fibres to the inner head of the <i>triceps</i> . This muscle corresponds with the iliac head of the <i>pyriformis</i> . The <i>acromio-trachelian</i> corresponds with its sacral head.
External and internal intercostal of anterior intercostal space.	" <i>Subclavius</i> " of birds.	<i>Subclavius</i> of reptiles.	External and internal intercostal muscles.
<i>Biceps femoris.</i> <i>Semimembranosus.</i> <i>Semitendinosus.</i>			Muscle arising from posterior vertebral angle of scapula, and passing down to olecranon. Lettered + t. in Cuvier and Laurillard's 'Planches de Myologie,' pls. 100, 104, 108.

DESCRIPTION OF PLATE XLVII.

Fig. 1. Scapulo-coracoid arch of Crocodile (*Crocodylus vulgaris*).*sc.* Scapula.*cr.* Coracoid.*gl.* Glenoid cavity.*bc.* Facet of origin of biceps. Round this portion of the coracoid the head of the "epicoraco-humeral" muscle which comes from the inner surface of the scapula winds.*pcr.* Præcoracoid. The surface whence the coracoid head of the "epicoraco-humeral" muscle arises extends from the point lettered *pcr* up to the line of fissure between scapula and coracoid, and a little beyond it.*d.* Ridge on scapula, giving origin to deltoid.*tc.* Facet of origin of triceps.*ss.* Surface of origin of supraspinatus.*crf.* Coracoid foramen.Fig. 2. Scapulo-coracoid arch of Emu (*Dromaius Novæ Hollandiæ*). Adult.*sc.* Scapula.*cr.* Coracoid.*gl.* Glenoid.*pcr.* Præcoracoid.*cla.* Line of clavicular abutment on scapula.

Between the points *pcr* and *gl*, and below *cla*, lies the præglenoid expanse, made up by factors both from scapula and coracoid. From this expanse the coracoid head of the epicoraco-humeral muscle takes origin. The deltoid takes origin from the scapula immediately above and behind the line *cla*.

Fig. 3. Muscles in connexion with the scapulo-coracoid arch and upper extremity of Crocodile (*Crocodilus biporcatus*). The same arrangement has been noted in *Alligator lucius*, with scarcely any differences.

- p m.* Pectoralis major. The muscle has been divided, and its origin from the sternum and inter-clavicle turned mesially, and its tendon of insertion into the greater tuberosity of the humerus turned outwards. *p m'*, tendon of pectoralis major.
- eh.* "Epicoraco-humeral" of Mivart (Trans. Linn. Soc. vol. xxv. 1866, p. 383), a bicipital muscle; its inner head winds round the coracoid face of the præglenoid expanse, to take origin from the visceral surface of the scapula; its outer head arises from the præcoracoid, and, to a small extent, from the præscapular portion of the præglenoid expanse, where it is in close relation with the deltoid. The inner of these two heads is intimately connected at its insertion with that of the pectoralis major, and, together with the tendon from the other head, occupies on the humerus a position between that of the tendon of the deltoid externally and inferiorly and that of the pectoralis major internally and inferiorly. The insertion of the omohyoid corresponds with the origin of the præglenoid head of the epicoraco-humeral; and the fibres of the two muscles are, to some slight extent, continuous with each other, at least in young specimens.
- ei.* Muscular fascicle which arises from second sternocostal cartilage in the same series as the external oblique and intercostals, but which may also be looked upon as homologous with an anterior segment of the "rectus abdominis," which is often not distinguishable from the former of these muscles. It ends in a delicate tendon, which loses itself, along the coracoid groove, in the sternum and the origin of the pectoralis major. The rectus abdominis in many ordinary mammals has an insertion into the first rib (see Professor Turner, 'Cambridge Journal of Anatomy and Physiology,' May 1868, p. 393), from which the ordinary mammalian subclavius arises; and in the order Monotremata it has, in both species of *Echidna* and in the *Ornithorhynchus*, an insertion into the coracoid at no great distance from the area of origin of their epicoraco-humeral, which I hold to be the homologue of the subclavius of other mammals. The prolongation of the tendon of this muscular fascicle (*ei*) may be considered to be due to the withdrawal of the Crocodile's epicoraco-humeral to the upper end of the coracoid. Finally, as the rectus is often fused with the pectoral, we may regard this fascicle as a nascent pectoralis minor.
- eo.* Muscular fascicle arising from the tip of the freely ending cartilage of the first thoracic rib (a point homologous with the points of origin of the several fascicles of the external oblique), and passing downwards and forwards to end in an aponeurosis attached mesially to the sternum and continuous with that of the external oblique. By contracting a close adhesion to the fibres of the anterior prolongation of the rectus abdominis instead of passing freely over them, as here, this muscular slip may, in other animals, as *e.g.* *Cynocephalus hamadryas*, assume the appearance of an outer head to this anterior prolongation. But its true character of homology with the fascicles of the external oblique is seen as plainly in the Guineapig (*Cavia aperia*) and the Aardvark (*Orycteropus Capensis*), and, according to Meckel (Vergleich. Anatomie, p. 454), in the Raccoon (*Procyon lotor*) and in the Hedgehog (*Erinaceus Europæus*), as it is here. In the Wombat (*Phascalomys wombat*) the true relations of this fascicle are very clearly seen; and a fascicle, obviously homologous with the one lettered *ei* in the Crocodile, passes from under it to join the subclavius arising from the first rib. This latter muscle arises, thick and fleshy, from the first rib in the Wombat, and is inserted into the outer end of the clavicle, and, by means of the fascia covering the supraspinatus muscle, into the whole length of the spine of the scapula. Before its insertion it is joined by a fine tendon from a delicate muscular belly, arising from the sixth costal cartilage, and homologous with the muscular fasciculus figured here at *ei*. Over this fascicle, which might be described in the Wombat as a second head of the subclavius, there passes inwards from the outer part of the first rib a muscular fasciculus, homologous with the

one here figured in the Crocodile as *eo*, to end in a broad tendinous aponeurosis over the sternum, opposite the third and fourth costal cartilages. It is probable, on the whole, that this fascicle *eo* may be really the homologue of the muscular slip which is called "rectus thoracis" by Professor Turner, *l. c.*, and which, as figured and described by him, appears to have a tendency to be produced obliquely inwards towards the sternum. (See 'Cambridge Journal of Anatomy and Physiology,' May 1868, pp. 393, 394, *ibique citata*.)

scl. Subclavius or triangularis sterni muscle, the "pectoralis secundus" of Houghton, and "costo-coracoid" of Mivart (Proc. Zool. Soc. June 1867, p. 776). Its superficial layer arises from the free cartilage of the second thoracic rib, and from the intermediate and sternal elements of the third and fourth thoracic ribs, and is inserted along the posterior edge of the coracoid. This muscle is obviously homologous with the similarly stratified muscle of similar origin and insertion in the bird, which is ordinarily called "subclavius," *e. g.* by Schöppss (Meckel's Archiv, 1829); but it cannot be homologous with the pectoralis secundus or levator humeri of the bird, inasmuch as the two muscles coexist with each other there. The same reasoning shows that it is not homologous with a pectoralis minor, though the slip which, in *Alligator lucius*, it gives to the muscle *ei* may be so in part.

cb. Coraco-brachialis, arising from anterior four-fifths of humeral edge of coracoid.

bc. Tendon of biceps, passing to be inserted on cephalic edge of coracoid.

Fig. 4. Muscles in connexion with the scapulo-coracoid arch and upper extremity of the Emu, *Dromaius Novæ Hollandiæ*.

pm. Pectoralis major. This muscle has a few fibres of origin in an aponeurosis playing over the lower and outer angle of the coracoid; it arises also from the three anterior sternal ribs, and from a triangular space on the sternum, lying between the two other points of origin. It is inserted into the great tuberosity of the humerus by a tendon attached distally and internally to those of the epicoraco-humeral and deltoid.

eh. Epicoraco-humeral muscle. It arises from the mesial point of the sternum or "rostrum" of the bone, from the coraco-clavicular membrane extending from the sternal rostrum up to the clavicle, and, thirdly, from an irregularly quadrangular præglenoid headland, which, as verified in a young specimen, is constituted by scapula as well as by coracoid. It is inserted into the humerus a little proximally and internally to the deltoid, and superficially to the coraco-brachialis. It is obviously the homologue of the pectoralis secundus s. levator humeri of ordinary birds. (See Meckel on Anatomy of Cassowary, Meckel's Archiv, 1830, p. 255. 5.)

bc. Tendon of biceps inserted into the humeral, and not, as in the Crocodile, into the cephalic edge of the coracoid. Between this tendon and that of the epicoraco-humeral or pectoralis secundus is seen the coraco-brachialis muscle, much reduced in size as compared with its homologue in the Crocodile. It has lost all the portion which arose mesially to the insertion of the biceps, and which Meckel called "coraco-brachialis inferior s. pectoralis tertius," and Schöppss *l. c.* "pectoralis medius." Neither Schoepss nor Meckel seems (as far as the name "deltoides inferior" can show, which they have given to the small muscle arising in ordinary birds from the lip of the coracoid underneath the tendon of the biceps, and inserted into the upper part of the great pectoral tuberosity) to have recognized its homology with the upper part of the coraco-brachialis muscle of the Crocodile and the *coraco-brachialis brevis s. rotator humeri* (Wood) of mammals. The only difference, however, between the muscle which Meckel and Schoepss call "deltoides inferior" in the common Fowl and that which I have called in the Emu "coraco-brachialis" is, that the larger biceps of the former animal has overlaid and stunted the muscle which the smaller biceps of the Emu has allowed to retain its reptilian proportions superiorly to its own insertion.

d. Deltoid, overlying and concealing from view a *teres minor* not found ordinarily in birds.

tc. Triceps.

Postscript, Dec. 11, 1868.

Several memoirs bearing more or less directly upon the subjects treated of in this paper have appeared, or at least come into my hands, subsequently to June 14th, 1868. First among them I may mention the paper on "Variations in Human Myology," which was read June 18th, 1868, before the Royal Society, by John Wood, Esq., F.R.C.S. In this paper, as published in the Royal Society's Proceedings, vol. xvi. no. 104, will be found an excellent figure of that common modification of the *pectoralis minor* which converts it into a more or less perfect *levator humeri*, so far as function is concerned. But that it was not a morphological equivalent of the *pectoralis secundus* of the bird would have been shown, I apprehend, first, by its relation to the costo-coracoid membrane, and, secondly, by its innervation. Meckel, in his 'Vergleichende Anatomie,' iii. p. 318, speculates as to whether the bird's "pectoralis secundus" is to be regarded as a divarication of the great pectoral, or as a specialization of a part of the deltoid. Now, as I hold that the *pectoralis minor* is essentially a part of the *pectoralis major*, I should say that Mr. Wood's figure shows that a *levator humeri* may be formed in the former of these two ways; and that such a muscle may be formed in the second of these two ways also is shown by the history I have given, pp. 618, 619 of this paper, of the smaller *levator humeri* in the Fowl. But that the ordinary *levator humeri*, s. *pectoralis secundus*, of birds, which coexists with the smaller *levator* in the Fowl, corresponds, as a matter of fact, to the epicoraco-humeral of the Reptile and the *subclavius* of the Mammal, is shown by the history of its relations to surrounding parts, by its nerve-supply, and by the history of the development of the great pectoral. Nor does functional correspondence enable us to argue to morphological identity here more than anywhere else.

Secondly, Professor Goodsir's 'Anatomical Memoirs' have, since last June, been published under the able editorship of his successor, Professor Turner; and in the first volume, at p. 452, may be found an exposition of the views of the late great anatomist, alluded to at p. 620 of this paper, as to the "morphology of the muscles of the limbs." With reference to this paper, I would remark that it seems incorrect to class the *obturator internus* with the *subscapularis*, because in many birds there coexists, with a *subscapularis*, a "coraco-brachialis superior" (no. xvii. Schoepss), which takes origin from the visceral surface of the coracoid bone and from the same aspect of the coraco-clavicular membrane. The tendon of this muscle may fuse with that of the *subscapularis*; and the bicipital muscle thus formed may receive its nerve-supply from a single nerve: but this nerve has never been observed by me to be the same as that which supplies the "coraco-brachialis inferior" (no. xvi. Schoepss), any more than the nerve of the *obturator internus* is ever the same as that of the *obturator externus*. But it is plain that the *coraco-brachialis superior* must represent the *obturator internus*, and the *subscapularis* the gluteal muscle, which, as mentioned at pp. 621, 622 of this paper, is so closely united with that obturator.

Neither can I coincide with the late Edinburgh Professor's comparison of the *teres minor* and *infraspinatus* to the *gluteus minimus* and *medius*—first, because I cannot but think that the *musculus iliacus internus minor* (see pp. 622–624 *supra*) is homologous with the *teres minor*, and, secondly, because I cannot consider the innervation of these

upper-limb muscles to be in any way homologous with that of the *glutei*. The *spinati* and *glutei* do, it is true, resemble each other in attaining their greatest development in mammals; and the so-called "*gluteus maximus*" and "*medius*" of the Crocodilidæ (of Dr. Hair, 'Cambridge Journal of Anatomy and Physiology,' Nov. 1867) may be seen, by their innervation from the anterior crural, not to correspond to the similarly named muscles of mammals. But concomitant variation within the limits of a single class does not make two sets of muscles, with essentially different insertion and innervation, to be serially homologous.

Few anatomists would now deny that the os pubis is the homologue, not of the clavicle, but of the præcoracoid; but though I have myself accepted the comparison of the *iliacus* to the *spinati*, I should not so positively dissent from Professor Goodsir's comparison of it to the deltoid as I do from his other comparisons here specified.

But I may be permitted, perhaps, to say that the *recti abdominis* can scarcely be considered to form, as Professor Goodsir ranks them as forming, a class apart from the external and internal *obliqui*; for the arrangement of these muscles, as seen, for example, in the common Fowl and the common Pigeon severally, seems to me to show that the *rectus abdominis* may be considered to be a specialization in one animal of one, and in another of the other of these muscles. Neither is evidence wanting to show that the *recti abdominis* should, instead of being placed in a class by themselves, have the *pectorales* as well as the *obliqui* ranked with them*.

Thirdly, a copiously illustrated memoir on the subject of this paper, "Die Muskeln der vorderen Extremitäten der Reptilien und Vögel," by Dr. Rüdinger, of Munich, has come into my hands quite recently. In it, however, I can find no views enunciated as to the homology of that most distinctively avian specialization the *pectoralis secundus*. At p. 105, however, of this memoir I find a statement as to the muscles of saurians which confirms the view I had previously formed as to the homology of the muscular bellies which pass in certain animals (see p. 623) from the scapula to the forearm with the hamstring muscles of the lower limb. His words run thus:—"Nur erhebt sich zwischen dem lateralen Kopfe (des Triceps) und dem Deltoideus ein vom Schulterblatt *besonderer länglicher Muskel*, welcher da, wo gewöhnlich das Ligamentum intermusculare externum angebracht ist, nach unten gelangt, an der Beugeseite des Vorderarms Verstärkung erhält, und, theilweise mit der Aponeurose der am untern Ende des Humerus entspringenden Muskeln zusammenhangend, seinen Ansatz mit einer dünnen runden Sehne an der Beugeseite des Radius findet."

Finally, I should add that I have strengthened the conclusions which I laid before the Linnean Society in June last by employing, as suggested to me at the meeting by Dr. Boycott, the evidence which may be drawn from the facts of innervation. But as this line of evidence has not, so far as I know, been touched upon in any other memoir upon this subject, I have not thought it necessary to keep the particular arguments which belong to it apart from the rest of the text.

* See Mivart, Proc. Zool. Soc. June 27, 1867, p. 776. Meckel, Vergleich. Anatomie, iii. pp. 155, 197. Ecker, Anatom. Frosches. p. 95. See also, at page 626 of this memoir, the description of Fig. 3, *ei*.

Fig. 4.

Fig. 1.

Fig. 2.

Fig. 3.