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Arthur Barre, M.D., M.S.

from his friend the Author.

MONOGRAPH

ON

THE AYE-AYE

(*Chiromys madagascariensis*, Cuvier).

BY

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Dear Dr. SANDWITH,

I have pleasure in dedicating to you this Monograph, which is the result of a long-desired opportunity at length enjoyed through your energy; which, in higher matters and graver exigencies, has earned for you the reward of your Sovereign and the esteem of your Country.

Believe me,

Sincerely yours,

RICHARD OWEN.

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MONOGRAPH

ON

THE AYE-AYE

(*CHIROMYS MADAGASCARIENSIS*, Cuv.).

§ 1. *Historical Introduction.*

THIS mammal was discovered by Sonnerat, in the island of Madagascar, about the year 1780, and was first described and figured in the work by that traveller, entitled 'Voyage aux Indes Orientales et à la Chine, depuis 1774 jusqu'en 1781,' Paris, 2 vols. 4to, 1782.

In the second edition (8vo, 4 vols.) of this work, published in 1806, from which I quote, the description is given in vol. iv. p. 121; and the engraving of the animal, copied into subsequent works treating of the Aye-aye, down to Ellis's 'Madagascar,' of 1858[1], forms plate 99 of the quarto volume of 140 plates accompanying the 8vo text of Sonnerat.

The stuffed skin which is the subject of the above engraving was presented by Sonnerat to Buffon[2], and is now in the Museum of Zoology, in the Garden of Plants, Paris, where, until very recently, it was the unique representative in Europe of the singular animal in question.

Sonnerat commences his description by stating that, "although the Aye-aye much resembles a Squirrel, yet it differs therefrom by some essential characters, being also allied to the Lemur and the Monkey[3]." Describing the fore foot, Sonnerat specifies the long, slender, naked joints of the middle digit, "which the animal," he says, "makes use of to draw out of holes in trees the worms which form its food[4]."

Sonnerat had both a male and female, which, on board ship, were fed on cooked rice, and lived only two months. He obtained them from the west coast of Madagascar, which he affirms to be the part of the island they inhabit. The natives of the east coast declared that his specimens were the first they had seen; and their cry of

[1] 'Three Visits to Madagascar,' by the Rev. William Ellis, 8vo, 1858, p. 144.

[2] "J'ai examiné de près la peau d'un de ces animaux que M. Sonnerat m'a donné pour le cabinet du Roi." —*Buffon*, Hist. Nat. Suppl. tom. vii. 4to, 1789.

[3] "Ce quadrupède se rapproche beaucoup de l'Écureuil; cependant, comme on le verra, il en diffère par des caractères essentiels: il tient aussi du Maquis et du Singe" (*op. cit.* p. 122). M. de Blainville can scarcely have had this passage in memory when he wrote, "mais jamais Sonnerat n'a cherché ses rapports naturels avec d'autres animaux connus" ('Ostéographie,' "Mémoire sur l'Aye-aye," 4to, 1840, p. 34).

[4] "Les deux dernières articulations du doigt du milieu sont longues, grêles, dénuées de poils: il s'en sert pour tirer des trous des arbres les vers qui sont sa nourriture" (*ib.*).

astonishment, "aye-aye!" on beholding the odd-looking quadruped, suggested the name which Sonnerat gave to it[1].

Buffon, after his close examination of the skin of the Aye-aye presented to the Royal Museum by Sonnerat, concludes that it is more closely allied to the genus of Squirrels than to any other, and that it also has some relation to the kind of Jerboa which he (Buffon) had called "Tarsier" in his 13th volume, 1769[2]. This animal is now recognized as a Lemurine quadrumane. After describing the hind feet, Buffon remarks that "the opposable character of the thumb, with the flattened nail, separates the species widely from the genus of Squirrels; and that, of all the animals that have the flattened thumb, the 'Tarsier' is that which most resembles the Aye-aye[3]." Buffon's acute discernment of resemblances is thus well exemplified; but as he believed the Tarsier to be a kind of Jerboa (it is the "Woolly Jerboa" of Pennant), it is plain that he ranked the Aye-aye with the Rodents.

Gmelin, accordingly, entered the species as "*Sciurus madagascariensis*" in the 13th edition of the 'Systema Naturæ,' 1790.

Cuvier, placing it under the same name at the end of the Squirrels, in his 'Tableau Elémentaire de l'Histoire Naturelle' (8vo, 1798, p. 136), remarks, in reference to the opposable thumb on the foot, that "it is, amongst the Rodents, what the Opossums are amongst the Carnassials;" and he adds,—"Sonnerat alleges that it subsists on the worms which it extracts from the hollows of trees and fissures of the bark by means of its slender digit[4]." Sonnerat, however, speaks only of the burrows or holes ("des trous des arbres") whence the Aye-aye extracts its larval food.

Schreber, in whose system the limb-characters preponderated, placed the Aye-aye in the genus *Lemur*, as *L. psilodactylus*; and Dr. Shaw adopted the name and the implied affinities[5]. De Blainville gave it a like position in his "Prodrome d'une Nouvelle Distribution Systématique du Règne Animal," published in the 'Bulletin de la Société Philomathique' (Paris, 1816), where the Aye-aye is placed amongst the "Pithécoïdes," or the group that follows the "Singes"[6].

In the meanwhile, however, Cuvier had availed himself of the means at his command

[1] *Op. cit.* p. 124. Not the cry of the animal, as some writers have supposed.

[2] "Il m'a paru se rapprocher du genre des Écureuils plus que d'aucun autre; il a aussi quelque rapport à l'espèce de Gerboise que j'ai donnée sous le nom de Tarsier, vol. xiii." (Hist. Nat. Supplément, vol. vii. p. 269).

[3] "Ce caractère de doigt l'éloigne beaucoup du genre de l'Écureuil. De tous les animaux qui ont le pouce aplati, le Tarsier est celui qui se rapproche le plus de l'Aye-aye" (*ib.* p. 270).

[4] "Qu'il est parmi les Rongeurs ce que les pédimanes sont parmi les Carnassiers." "Sonnerat prétend qu'il vit des vers qu'il tire des creux des arbres et des fentes des écorces, au moyen de son doigt plus grêle" (*op. cit.* p. 136).

[5] "Long-fingered Lemur" (General Zoology, vol. i. part 1. p. 109, pl. 34, 1800).

[6] "Pithécoïdes, les Makis, les Loris, l'Aye-aye," p. 117. In a later work on the Aye-aye, published in 1841, as part of his 'Ostéographie,' M. de Blainville alludes to a memoir on the animal read by him to the Société Philomathique in May 1816; but the 'Bulletin' for that year contains merely the reference above cited, and in a note the author states that want of space prevents his adding the explanatory remarks which his table of Mammifers needed.

for obtaining further insight into the affinities of the Aye-aye. The skull and such limb-bones as were in Sonnerat's stuffed specimen were carefully extracted and prepared. The skull of the Aye-aye is figured in the first edition of the 'Règne Animal,' in the plate (pl. 2) containing those of anomalous quadrupeds; and M. de Blainville, in the subsequent account of these specimens in his 'Ostéographie,' alludes to them as due to these researches of his great predecessor. It was scant justice, however, to say that, in both editions of the 'Règne Animal,' Cuvier, while ranking the Aye-aye among the Rodentia, restricts himself to indicating its transitional character to the Lemurs[1]; for, in the description of the plate (figs. 1, 2, 3) in which the skull is figured, Cuvier states,—"To the teeth of a Rodent the Aye-aye unites a head very similar to that of the Quadrumana, principally in regard to the zygomatic arch, the orbit,"[2] &c.

It was through a mistake of M. de Blainville's that his astonishment was excited, which he so emphatically expresses, by Cuvier's hesitation to class the Aye-aye with the Lemurs after having obtained a knowledge of the tarsal structure. Had the ankle bones, figured by De Blainville in pl. 5 of his 'Ostéographie des Lemurs,' been actually extracted by desire of Baron Cuvier from the skin of the *Chiromys*, as stated in the above-cited part of that work (p. 46), one can scarcely doubt but that the great naturalist would have recognized the full force of their indications of its affinity. As I shall afterwards show, however, those tarsal bones do not belong to the Aye-aye, but to a true Galago—probably *Otolicnus crassicaudatus*, Wagn., of which Cuvier figures a stuffed specimen in pl. 1. fig. 1 of the same volume of the 'Règne Animal' in which the figure of the Aye-aye's skull appears. I suspect it to have been from the skin of the "Grand Galago" there figured that the bones of the leg and foot referred to below had been extracted[3].

By the figure and brief notice of the Aye-aye's skull, Cuvier, in fact, supplied the first rectification of the ground derived by Buffon, from the head of the Aye-aye, for approximating it to the Squirrels; and it has the more significance, in regard to the value of the affinity supposed to be indicated by the dentition, through the presence of

[1] "M. Cuvier ait persisté, dans les deux éditions de son 'Règne Animal,' à ranger l'Aye-aye parmis les Rongeurs, à côté des Écureuils, en se bornant à dire qu'il fait le passage aux Makis."—*De Blainville, op. cit.* p. 27.

[2] "Planche ii. figs. 1, 2, 3, l'Aye-aye (*Cheiromys*, C.), qui, à des dents de Rongeurs, unit une tête fort semblable à celle des quadrumanes, principalement pour ce qui regarde l'arcade zygomatique, l'orbite," &c. (Règne Animal, ed. 1. tom. iv. 1817, p. 181; ed. 2. tom. iii. 1830, p. 429).

[3] "M. Laurillard m'a remis, en outre, les quatre os principaux du métatarse, c'est-à-dire, l'astragale, le calcanéum, le scaphoïde et le cuboïde, qui avaient, sans doute, été tirés de la peau bourrée de la collection zoologique, sur la demande de M. Cuvier. Or, à eux seuls ils devaient suffire pour déterminer la place de l'Aye-aye à côté du Tarsier et des Galagos; car le calcanéum et le scaphoïde offrent la même forme et le même allongement singulier qui a déterminé Daubenton à donner au premier de ces animaux le nom sous lequel il est encore désigné; ce que j'avais supposé autrefois d'après le seul examen de l'individu monté. La figure que nous en donnons dans la planche (v.) de notre Ostéographie des Lemurs suffira pour mettre cette assertion hors de doute; aussi est-il véritablement étonnant que M. Cuvier, qui avait à sa disposition ce tarse," &c.—*De Blainville*, "Mém. sur l'Aye-aye," p. 27.

the figure of the skull of the Wombat, with a like rodent pattern of teeth, in the same plate with that of the Aye-aye, where they are associated together as "Mammifères anomaux." In my 'Odontography,' I cite other instances of glirine dentition in mammals of non-rodent orders; where, treating of the teeth of *Chiromys*, in chap. ix., *Quadrumana*, I remark,—"In this genus of Lemurine animals, as in *Desmodus* amongst the Bats, and *Sorex* amongst the Insectivores, the dentition is modified in analogical conformity with the rodent type" (4to, 1842, p. 435). In my "Classification of the Mammalia" ('Proceedings of the Linnean Society,' April 1857), I state,—"The flying Lemurs (*Galeopitheci*), the rodent Lemurs (*Chiromys*), the slow Lemurs (*Loris*, *Otolicnus*), forbid any generalization as to teeth or nails in the *Quadrumana*" (p. 35).

One need merely allude to the idea of the affinities of the Aye-aye to the Opossums, emitted by Geoffroy St.-Hilaire in the early notice in which he proposed first the generic name of *Daubentonia*[1]: the idea, however, was adopted by Lacépède in the constitution of his Order "Pédimanes" in the 'Classification des Mammifères,' published in 1798.

Illiger, in rectifying the heterogeneous character of Lacépède's "Pédimanes," places the Aye-aye in his Family "Leptodactyli," where it is associated with the Tarsiers and Galagos[2].

MM. Fischer de Waldheim[3], Oken[4], and Waterhouse[5] adopted this view, which is also supported argumentatively by M. F. Cuvier in the 'Supplément' of the third volume of the 'Dictionnaire des Sciences Naturelles,' 1816.

Notwithstanding, however, these testimonies, and the remarks, depreciating Baron Cuvier's share in the elucidation of the nature of the Aye-aye, published by De Blainville, unbiassed zoologists of note and experience have testified their sense of the need of further knowledge of the organization of the *Chiromys* by the place assigned to it in their justly esteemed works. Prof. Milne-Edwards, for example, in his useful 'Elémens de Zoologie,' retains the *Chiromys* in the Ordre "Rongeurs," and the "Tribu des Sciuriens," with the admission that "it belongs almost as much to the Quadrumana as to the Rodentia[6]." Professor Van der Hoeven, also, whose careful researches into the anatomy of certain *Lemuridæ* justly add weight to his estimate of the signification of the little that was then known of the organization of *Chiromys*, nevertheless, in both editions of his richly stored 'Handbuch der Zoologie,' retains the Aye-aye among the Rodents, remarking that it

[1] 'Décade Philosophique,' no. 28, 1796. This term, having been appropriated by botanists for a genus of *Leguminosæ*, has been allowed to lapse by the general consent of zoologists, including Geoffroy himself, who, with De Blainville and all original investigators of the animal, have communicated their observations on it as the *Chiromys* of Cuvier (Leçons d'Anat. Comp. vol. i., 1800).

[2] 'Prodromus Systematis Mammalium et Avium,' 8vo, 1811.

[3] 'Tableaux de Zoographie,' 1813.

[4] 'Handbuch der Naturgeschichte, &c., Zoologie,' 8vo, 1816.

[5] "Observations on the Classification of the Mammalia," Ann. and Mag. Nat. Hist. vol. xii. p. 408 (note).

[6] "Mais qui tiennent presque autant des Quadrumanes que des Rongeurs" (p. 348).

"has the external form of *Galago*, a genus of Lemurids, and forms (by its arched skull also) in some degree the transition from the Rodents to the Quadrumanes."

In the admirable translation of this work, for which English naturalists are indebted to the laborious and accomplished Professor of Anatomy in the University of Cambridge, the verdict of the Dutch zoologist is left unchallenged[1], and it is from the point of view thus attainable in 1858 that I have started in availing myself of the materials at command for gaining further and surer insight into the nature and affinities of the so-called *Chiromys madagascariensis*.

In that year the Hon. H. Sandwith, M.D., C.B., proceeded to the Mauritius, of which he had been appointed Colonial Secretary; and, prior to his departure from England, he applied for, and received from me, special instructions as to the most interesting and desirable objects of natural history in that colony. Amongst these, besides the bones of the Dodo and Solitaire, I specified, as obtainable from the neighbouring island of Madagascar, the bones and eggs of the *Epyornis*, and, above all, a specimen, alive or preserved in spirits, of the Aye-aye (*Chiromys*).

In March 1859, I was favoured with the following letter from my accomplished and energetic correspondent:—

"Mauritius, January 27, 1859.

"My dear Mr. Owen,—After very great difficulty and much delay, I have at length obtained a fine, healthy, male, adult Aye-aye, and he is enjoying himself in a large cage which I have had constructed for him. And now I have some questions to ask you. Do you want him dead or alive? It will, of course, be much easier to send his dead body home, if that will do; and, if so, how am I to preserve him? If you want him alive, you must tell me so without delay, as I think it would be dangerous to send him home so as to arrive in the cold season. I observe he is sensitive of cold, and likes to cover himself up in a piece of flannel, although the thermometer is now often 90° in the shade. He is a most interesting little animal, and from close observation I have learned his habits very correctly. On receiving him from Madagascar, I was told that he ate bananas; so of course I fed him on them, but tried him with other fruit. I found he liked dates, —which was a grand discovery, supposing he be sent alive to England. Still I thought that those strong rodent teeth, as large as those of a young Beaver, must have been intended for some other purpose than that of trying to eat his way out of a cage—the only use he seemed to make of them, besides masticating soft fruits. Moreover he had other peculiarities,—*e. g.*, singularly large, naked ears, directed forward, as if for offensive rather than defensive purposes; then, again, the second finger of the hands is unlike anything but a monster supernumerary member, it being slender and long, half the thickness of the other fingers, and resembling a piece of bent wire. Excepting the head and this finger, he closely resembles a Lemur.

[1] 'Handbook of Zoology,' by J. Van der Hoeven, translated by the Rev. Prof. Clark, F.R.S., 8vo, vol. ii. 1858, p. 695.

"Now, as he attacked every night the woodwork of his cage, which I was gradually lining with tin, I bethought myself of tying some sticks over the woodwork, so that he might gnaw these instead. I had previously put in some large branches for him to climb upon; but the others were straight sticks to cover over the woodwork of his cage, which *alone* he attacked. It so happened that the thick sticks I now put into his cage were bored in all directions by a large and destructive grub, called here the *Moutouk*. Just at sunset the Aye-aye crept from under his blanket, yawned, stretched, and betook himself to his tree, where his movements are lively and graceful, though by no means so quick as those of a Squirrel. Presently he came to one of the worm-eaten branches, which he began to examine most attentively; and bending forward his ears, and applying his nose close to the bark, he rapidly tapped the surface with the curious second digit, as a Woodpecker taps a tree, though with much less noise, from time to time inserting the end of the slender finger into the worm-holes as a surgeon would a probe. At length he came to a part of the branch which evidently gave out an interesting sound, for he began to tear it with his strong teeth. He rapidly stripped off the bark, cut into the wood, and exposed the nest of a grub, which he daintily picked out of its bed with the slender tapping finger, and conveyed the luscious morsel to his mouth.

"I watched these proceedings with intense interest, and was much struck with the marvellous adaptation of the creature to its habits, shown by his acute hearing, which enables him aptly to distinguish the different tones emitted from the wood by his gentle tapping; his evidently acute sense of smell, aiding him in his search; his secure footsteps on the slender branches, to which he firmly clung by his quadrumanous members; his strong rodent teeth, enabling him to tear through the wood; and lastly, by the curious slender finger, unlike that of any other animal, and which he used alternately as a pleximeter, a probe, and a scoop.

"But I was yet to learn another peculiarity. I gave him water to drink in a saucer, on which he stretched out a hand, dipped a finger into it, and drew it obliquely through his open mouth; and this he repeated so rapidly, that the water seemed to flow into his mouth. After a while he lapped like a cat; but his first mode of drinking appeared to me to be his way of reaching water in the deep clefts of trees.

"I am told that the Aye-aye is an object of veneration at Madagascar, and that if any native touches one, he is sure to die within the year; hence the difficulty of obtaining a specimen. I overcame this scruple by a reward of £10.

"I quite despair of obtaining the bones of the *Epyornis* or *Dodo*, though I have made every effort. I shall always be proud to be of service.

"Believe me, yours very faithfully,

"H. Sandwith."

On the receipt of this acceptable and interesting communication, I wrote to say that, in the event of there being any misgiving as to effecting a safe transmission of the living Aye-aye to England, it might be more advantageous to science if the animal were killed by chloroform, its arterial system injected, the cranial cavity exposed, the abdominal cavity and alimentary canal injected with alcohol, and the whole animal then immersed in a keg of colourless spirit.

Before my reply reached Dr. Sandwith, the Aye-aye had escaped. It was, however, recaptured on a neighbouring sugar-plantation in the Mauritius. Accordingly, on the receipt of the above instructions, Dr. Sandwith at once proceeded to fulfil them; and the result was the reception, at the British Museum, of our now unique example of the *Chiromys madagascariensis*, in the excellent state of preservation which has admitted of the following description being taken from it.

Before, however, entering upon this, I may remark that other testimony than my correspondent's had been given of the accuracy of Sonnerat's original statement of the office of the slender middle digit of the fore paw. M. Liénard, of the island of Mauritius, communicated, in 1855, to the French Academy of Sciences[1] some of his observations on a young male Aye-aye, which was brought from Madagascar, and lived some weeks in captivity. When a mango-fruit was offered, the Aye-aye first made a hole in the rind with his strong fore teeth, inserted therein his slender middle digit, and then, lowering his mouth to the hole, put into it the pulp which the finger had scooped out of the fruit. When one hand was tired, he used the other, and often changed them. On presenting him with a piece of sugar-cane, he held it by both hands, and, tearing it open with his teeth, sucked out the juice.

A third observer, M. A. Vinson, affirms, in reference to an Aye-aye brought from Madagascar to the Ile de la Réunion in 1855, where it lived about two months in captivity, that it selected the larvæ it liked best by the sense of smell; and that, when "café au lait" or "eau sucrée" was offered, it drank by passing its long and slender digit from the vessel to its mouth with incredible rapidity[2].

§ 2. *External Characters.*

The male Aye-aye, transmitted to me in spirits by the Hon. Dr. Sandwith, is represented of the natural size in Plates I. & VI., and of half the natural size in Plates III., IV., & V. The full-grown female Aye-aye is figured, of half the natural size, in Plate II.,

[1] Comptes Rendus, Septembre 3^{me}, 1855.

[2] "Il ne voulait pas des larves de tous les arbres indistinctement; il les reconnaissait en les flairant. Il était très-friand de café au lait, d'eau sucrée, qu'il buvait à l'aide de ce long doigt qu'il passait et repassait incessamment du vase à la bouche avec une incroyable agilité" (Comptes Rendus de l'Acad. des Sciences, Oct. 1855, tom. xli. p. 640). [In the female Aye-aye, now living in the Gardens of the Zoological Society (August 1862), Mr. Bartlett informs me that, "in feeding, the fourth, which is the longest and largest finger, is thrust forward into the food, while the slender middle finger is raised above the others, and the first and second fingers are lowered: in this position the hand is drawn rapidly backward and forward, the side of the fourth finger passing between the tips of the animal's mouth as the head is somewhat turned sideways; and in this manner the food is deposited in the mouth."]

from the drawing of the living animal by JOSEPH WOLF. That gifted artist devoted his peculiar skill in depicting animal physiognomy to all the designs of the external characters of the Aye-aye, which have been so admirably rendered, in lithography, by Mr. ERXLEBEN, for the present Monograph.

The following dimensions are taken from the body of the male specimen:—

	Ft.	in.	lin.
Total length from the muzzle in a straight line to the end of the tail	3	0	0
Total length from the muzzle in a straight line to the root of the tail	1	3	6

The tail to the end of the terminal hairs is thus rather longer than the body.

	Ft.	in.	lin.
The length of the head	0	4	6
Its breadth between the ears	0	2	7
——— below the ears	0	4	0
——— across the zygomata	0	2	10
——— across the base of the muzzle	0	1	2
——— across the eyes, from one outer canthus to the other	0	2	2
Interspace of eyes, from one inner canthus to the other	0	1	1
Breadth of nose external to the nostrils	0	1	0
From the internal canthus to the end of the nose	0	1	4
Length of the ear	0	3	4
Breadth of the ear	0	2	2
Length of fore limb, from the head of the humerus	0	11	5
——— of hind limb, from the head of the femur	0	13	0
——— of antibrachium	0	4	0
——— of fore foot	0	4	10
——— of the leg	0	5	0
——— of the hind foot	0	4	6
——— of digits of fore foot:—			
pollex (*I.*)	0	1	2
index (*II.*)	0	1	11
medius (*III.*)	0	2	10
annularis (*IV.*)	0	3	4
minimus (*V.*)	0	2	1
Length of digits of hind foot:—			
hallux (i.)	0	1	6
second (ii.)	0	1	6
third (iii.)	0	1	9
fourth (iv.)	0	1	9½
fifth (v.)	0	1	8

The Aye-aye resembles in size, and somewhat in shape, a domestic Cat; but its head, especially with the ears, is larger; the hind limbs are longer, and the tail is still more so in proportion to the body. Both fore and hind limbs have a greater proportion of the first segment free of the trunk, but especially the femoral one; and both thigh and leg are longer in proportion to the foot than in the Cat. The trunk presents its greatest circumference about the hinder third of the thorax, measuring here about ten inches round. The head is short, broad, and rather deep, convex lengthwise, and rather flattened transversely above, becoming suddenly contracted and compressed at the short and deep muzzle. The neck is short and thick. The tail is rather longer than the body, straight, but flexible, and covered with long and rather loose and coarse hairs, growing pretty equally all round, and making the terminal half rather thicker than the basal one, the end quickly narrowing to the terminal fascicle of hairs. On the trunk the pelage consists of an inner woolly coat, almost concealed by the long hairs which form the outer coat and impart the colour to a great proportion of the animal. The prevailing tint is a deep fuscous, approaching to black; overspreading the back, the flanks, the tail, and limbs, becoming subrufous upon the belly and inner side of the arm and thigh, and lightening into yellowish grey upon the throat and sides of the head. The dark colour is relieved by scattered long white hairs, most conspicuous upon the dorsal aspect, from the occiput to the base of the tail; more scantily dispersed upon the arm and part of the forearm, and upon the thigh and leg. Upon the face, the throat, the forearms, the inner side of the legs, on the sessile scrotum and inguinal region, the longer hairs are wanting or very scanty. The chief part of the ears, the end of the nose, the palm from the pisiform prominence onward, the sole from the calcaneal prominence, and the corresponding aspect of the digits, are naked. The wool, or short coat of hair, is close-set, finely and irregularly wavy, from its lustre rather silky than woolly; where it is shortest, it is of a light grey; where it grows longer, as on the cheeks, forehead, dorsal part of the wrists and ankles, and about the privy parts, this hair usually presents three colours—light fuscous near the root, light grey or brownish grey at the middle, including two-thirds of the length, with a dark fuscous tip. Upon the forearms this tint prevails. The long hair is deep fuscous, or with a white tip, usually about one-third the length of the hair; and these bicoloured hairs are most numerous on the parts of the pelage above mentioned as being relieved by their scattered silvery-white colour. On the back and tail the hair attains a length of from three to four inches, is slightly wavy or straight, and greyish at the root.

The profile of the head (Pl. VI.) describes a slight convexity from the vertex to the interorbital space, is then straight to the end of the nose, where it bends abruptly down at nearly a right angle, and curves back over the mandibular symphysis, which makes no chin, to the slightly concave under border of the head, where, about two inches from the symphysis, the outline curves down into the neck.

The eyes are rather prominent, directed forward; their openings round, exposing only the cornea and iris, which is of a light brown hue, and, by daylight, reducing the pupil to the size of a pin's head (Pl. II.). The pupil is widely open at dusk, when the animal is most active. The eyelids close, with a slit almost transverse, 7½ lines (0·016) long, with the outer canthus higher than the inner one, and the plane of each opening inclines a little outward. There is a large nictitating fold at the inner canthus.

The muzzle is short, but deep,—the peculiarly developed incisors and their sockets, with the concomitant deep 'symphysis mandibulæ,' giving it great vertical and small transverse extent; the latter character is heightened by contrast with the great expansion of the head to the setting-on of the ears, which expansion suddenly begins with the outspanning of the fore part of the zygomata, supporting the thick masseter muscles. The fore part of the 'rictus oris' is very narrow, and the whole extent to the angles, following the semi-elliptical curve which it makes, does not exceed 2½ inches. The opening of the mouth, in profile, is straight, and scarcely an inch in length. The lips have an obtuse but not prominent border; they increase a little in thickness at the angles of the mouth; the inner surface is smooth, with a fuscous pigment. The upper lip is short or shallow; it is connected at its fore and inner part by a kind of frænum or fold of the inner membrane, which extends into the basal interspace of the upper incisors: a few short black whiskers project from it. The interspace between the lower lip and the mandible is much deeper, extending below the frænal fold that penetrates the basal interspace of the lower incisors; from the margin of the lower lip to the reflexion of its smooth inner skin upon the incisive alveoli measures 9 lines. There is a slight protuberance of an oblong form from the inner part of each side of the lower lip. The short fine hairs or down of the lower lip, gradually gaining length as they recede from the lip-border, are of a lighter grey than those of the upper lip. From amongst them there project a few scattered longer hairs, also increasing in length as they approach the chin, where a few of the longest form black whiskers, the others retaining the greyish tint.

The naked end of the nose, pink-coloured in the living animal, is of a triangular form (Pl. X. fig. 1), including the nostrils, which, from their inner rounded and wider part, curve slitwise upward and outward to the corresponding angles of the naked space. This is impressed by a median and two lateral grooves which meet upon the middle of the upper lip, at its frænum within the mouth. The lateral less deep grooves begin at the lower and wider part of the nostrils. There may be also seen a feeble linear impression extending across the end of the nose from between the inner and lower ends of the nostrils. The concavity, directed upward and inward, of the obliquely curved nostrils is formed by a slight prominence of an obtuse 'ala,' which does not quite touch the thick, rounded lower and outer border of the aperture. The breadth of the nose is 11 lines (0·024); the length of the nostril 5½ lines (0·011); between the upper ends of the nostrils measures, in a straight line, 7 lines (0·015); between their lower ends, 3 lines (0·006); from the lower end of the nostril to the mouth is 3⅓ lines (0·007). The fine silky hairs at the circumference of the naked tract commence very short, and gradually lengthen as they recede therefrom. Many longer hairs project through the down, forming a kind of scattered moustache along each upper lip and external to the nostrils; the longest of these hairs are nearly black.

The shorter hairs below the orbits on the fore part of the cheeks are of a grey brown, with lighter tips; and this colour extends round the outer and upper part of the orbit, where it expands in simulation of eyebrows. But the latter name may better be given to a tuft of about a dozen long, black, slender vibrissæ which project from a slight swelling above the inner angle of the eye-slit, and diverge as they rise.

The base of the nose and the interorbital space present a deeper or subfuscous yellowish-grey colour, which also prevails upon the hind half of the cheeks, where several of the longer hairs have whitish tips. Here, however, are about six long black vibrissæ projecting about an inch below the outer angle of the eye-slit.

Nine dark-coloured hairs grow from the inner surface of the upper eyelids near to, but not from, the palpebral border, and form a defensive series like short eyelashes. Such are not developed from the lower eyelids; but short fuscous hairs grow from the outer surface of both lids close to the palpebral border, and gradually lengthen as they recede therefrom, marking a well-defined dark border, like the kohl-pigment of Eastern beauties, of from 2 lines to 3 lines broad, round the eyes, the adjoining circle of lighter grey heightening the difference by contrast. The grey colour of the cheeks, a little deepened at their middle, is continued over the lower part of the face and the chin, upon the neck, graduating into the fuscous upon the chest; but the hair of the belly is of a lighter fuscous than that of the back.

From the forehead the long hairs gradually increase in length to the occiput, and from the cheeks to the setting-on of the ears.

The auricle presents a subelliptic form, 3 inches 4 lines by 2 inches 2 lines in the chief diameters. The anterior hollow very gradually deepens from the obtusely rounded tip to the tragus; expanding also to the middle of the ear, and then contracting to where the concavity becomes semitubular by the forward production of the basal borders of the auricle. At this part is shown a distinct 'tragus,' along the base of which the hair abruptly ceases. The lower and hinder part of the basal border forms an 'antitragus,' on the outside of which grow hairs of an inch or more in length. This antitragus is continued above into a ridge gradually subsiding upon the inner surface of the auricle, and representing the lower part of the prominence called 'antihelix.' Above the 'tragus' a vertical fold projects backward, as it were, formed by the reflected border of the upper and fore part of the base of the auricle: it gradually subsides as it rises, and represents the beginning of a 'helix.' Long, wavy, silky hairs grow from its outer side. Similar hairs project from the basal fourth of the outer or back part of the auricle, which elsewhere consists of a seemingly smooth, but minutely granulate, shining, naked skin, like parchment, but of a dark fuscous hue, showing the ramifications of blood-vessels on the outside, and numerous whitish dots on the inside, and giving a deep vinous tint by transmitted light. The fuscous pigment is not developed on the tragus and antitragus. These large ears appear, by their muscles and contracted attachment, to have much and varied movement: at rest they usually stand out horizontally, adding greatly to the breadth of the head; but their conch can be directed wherever the sound is to be caught that attracts the animal's attention.

The neck is short and thick. The shoulder-prominence is about the ear's breadth behind the ear. The elbow, with the lower half of the humerus, stands freely from the chest. The forearm is robust, subcompressed, slightly tapering to the wrist; it cannot be brought in extension to a line with the humerus. The hand turns freely in the prone or supine position, the former being the habitual one. The hair is continued upon the back part of the wrist, and sparingly, by short hairs, upon the same side of the fingers; these hairs are so few, fine, and short, as to be scarcely discernible on the attenuated middle digit, the skin of which is darkened by pigmentum. The naked palm, continued back upon the 'os pisiforme,' presents a protuberance there, matched by one on the radial side; there is also one at the base of the thumb, and smaller ones at the base of the index, annulus, and fifth digits. The thumb stands out at an acute angle with the index, slightly enlarging to its tumid extremity, beyond which the compressed, obtuse claw hardly projects: it is an opposable member, and makes a prehensile hand, but in a less perfect degree than in the Catarrhine Quadrumana. The second, fourth, and fifth digits present a conformable and ordinary thickness, have a cushion on the palmar side of their penultimate joint, and a more tumid one upon their last phalanx, beyond which the obtuse claw, narrower and longer than that of the thumb, freely projects. The fifth finger is rather longer than the second; the fourth is almost twice as long as the second. But the most singular feature of the hand is the attenuated middle finger, which seems as if stricken and withered by palsy: it is rather shorter than the fourth, but is less than half its thickness. The cleft between the second and third fingers is deeper than that between the third and fourth. The base of the third is slightly tumid: its first phalanx is slender and longer than that of the corresponding phalanx of the fourth finger; but the second and third phalanges are shorter. The animal can freely divaricate and approximate the digits for a variety of applications of the long-fingered hand (Pls. I. & VI.).

The hind limb is longer than the fore limb, and rather stronger. A great proportion of the thigh is free. The knee consequently projects much below the abdomen. The foot is comparatively short; the heel low, and naked below, with the rest of the sole, which is black, save on the prominences. The sole gains breadth to the base of the hind thumb, or 'hallux,' which stands out at a rather more open angle with the other digits than in the hand. The hallux is longer and thicker than the pollex, especially at its last joint, which is backed by a true nail, broader than long, and not reaching to the end of the terminal expansion. The four other toes are nearly of equal length and thickness, the second being the shortest by a little, the fifth next in length. Each is armed with a slightly curved, rather thick, subacute claw. The hair on both fore and hind limbs is nearly black, with a little admixture of white-tipped hairs at their thick beginning.

The tail shows no habitual twist or bend, but hangs straight from the trunk in the dead animal. It is flexible in all directions, and the long, coarse, slightly wavy hairs grow equally from it all round: most are nearly black, but reflect a rufous tint in some lights, through admixture of hairs that retain that colour at the base. In the living female the tail is usually carried in a curve, concave downward. In the male the penis, unerect, projects about an inch from the pubis, of a subconical form, with a terminal transverse orifice of the prepuce, which is of a whitish colour. The testes make slight prominences below and at the sides of the penis (Pl. IV.).

From the foregoing description we may infer that the small quadruped is arboreal, the limbs being organized chiefly for grasping; and this power is given in the greater and more exclusive degree to the hind feet, as in all climbers. The wide circle of the 'open eye' or fully expanded eyelids, the large iris, and the pupil reducible to a minute point when the iris is contracted, indicate a climber of nocturnal habits. The development of the organ of hearing bespeaks the acute possession of that sense. The chief office of the tail may be inferred to be that of adding to the protective non-conducting covering of the body when the animal is in repose. In taking this attitude, Dr. Vinson states that the Aye-aye depresses the head between the fore paws, bends over it the tail, which is for that purpose depressed and curved forward; then, slowly rolling its body into a ball, covers the whole by the outspread hairs of the encircling tail. The female, in the Menagerie of the Zoological Society, shows the same use and disposition of the tail, in repose. Thus Dr. Vinson's animal slept the greater part of the day, moving about and making its efforts to escape during the night. Having once succeeded, it climbed the nearest tree and moved about, leaping from branch to branch with the agility of the *Lemur catta*; but its ordinary life in captivity suggested the idea of its being an indolent and rather slow-moving animal. Its cry is a plaintive grunt[1].

§ 3. *Skeleton* (Pls. VII.-IX.).

The bones of the Aye-aye have a compact texture, and, although the specimen affording those here described was transmitted in spirits, they show, after a short maceration, a pure white colour. The number of vertebræ between the skull and sacrum is twenty-six, of which thirteen are dorsal, six lumbar, and seven cervical. The sacral vertebræ are two by anchylosis and connexion with the ilia, but three by antero-posteriorly extended and co-articulated transverse processes; the caudal vertebræ are, accordingly, twenty-three or twenty-two,—the sum-total of vertebræ being fifty-one, exclusive of the four cranial. The true vertebræ describe one slight curve convex

[1] Comptes Rendus de l'Acad. des Sciences, Paris, 22 Octobre, 1855.

backward from the middle dorsal to the penultimate lumbar, beyond which there is a slight bend in the opposite direction to and including the sacrum. The bodies of the dorsal vertebræ gradually lengthen and deepen as they approach the loins, with a narrower and at last almost carinate under surface. The last two ribs join their own centrum close to the front intervertebral space; the rest have the usual intervertebral articulation of the head. The first rib is the shortest (9 lines) and thickest; the others increase in length to the ninth, and then gradually shorten to the thirteenth, which is 1 inch 3 lines in length. The tubercle and diapophysial articulation exist to the eleventh rib; the twelfth and thirteenth articulate only by the head. The diapophysis, longest on the first dorsal, very gradually shortens to the eleventh, where the beginnings of the metapophysis and anapophysis are manifest. These processes become widely separated in the twelfth and thirteenth dorsals, and the diapophysis is lost. The neural spines are of equal length throughout the dorsal series; suddenly extending to 3½ lines on the first, they gain gradually in fore-and-aft extent from the fifth dorsal to the last (Pl. VII. D). The vertical spine is on the eleventh dorsal, towards which the rest of the dorso-lumbar series slightly incline.

The vertebræ go on increasing in size to the fifth of the lumbar series,—the diapophyses more especially, which recommence in the first lumbar; these processes are directed forward and downward, as well as outward, are truncate, with the anterior angle a little produced (*d*, fig. 8, Pl. IX.); that of the last lumbar is similar in shape and direction, but is smaller than the two preceding. The anapophysis (*ib. a*) overlaps the front margin of the following vertebræ to the fifth lumbar, in which it becomes too short; it disappears in the sixth. The metapophysis (*ib. m*) overhangs the back part of the neural arch of the preceding vertebra. The neural spine decreases from the third to the last lumbar (Pl. VII. L), where it has 3 lines of length. The cartilage of the first rib is flattened, 5½ lines long, and 2½ lines broad; in the rest it is more slender and rounded, increasing in length to the tenth, where it equals in length the bony part, and is attached to near the end of the ninth cartilage, which is the last that joins the sternum; the remaining cartilages are pointed, and rapidly shorten to the thirteenth, which is 8 lines long (*ib. h*). The first cartilage articulates with the manubrium (Pl. IX. *h*, $_{59}$), the second to the seventh inclusive with the joints of seven sternebers, the eighth with the seventh sterneber, and the ninth to the joint between the seventh and eighth sterneber (*ib. h*, $_{61}$). Of these eight bones, the first, from its superior size, carinate outer surface, and clavicular articulations, is termed the ' manubrium;' the next six are narrow in proportion to their length, and similar in size and shape. The last, long and slender, may be regarded as the peduncle of the broad ' cartilago ensiformis.'

The bodies of the cervical vertebræ are broad, short, and flattened below in the last five. The last three (Pl. IX. fig. 6, $_{5,6,7}$) have no neural spines: there are tubercular beginnings of these in the fourth and third; in the second it is 2 lines long, thick, and produced anteriorly; in the atlas it is as a small tubercle. The seventh cervical has a simple slender diapophysis, 2 lines in length; in the sixth it coalesces with the tubercle of a short pleurapophysis (*ib.* 6, *pl.*), also confluent by the head with the centrum, and projecting outward, backward, and downward, with an obtuse end. The vertebral artery, in its forward course, enters the canal between the pleur- and di-apophyses. The pleurapophysis simply completes that bony canal in the fifth cervical, making a short angular projection outward and forward in the fifth, fourth, and third cervicals. The low, flat neural arch is narrowest in the fifth. The shape and disposition of the zygapophyses give an imbricate character to the union of those arches in the last six cervicals. The body of the axis is carinate below; that of the atlas has the usual state of an 'odontoid process' (*ib.* fig. 4, *ex*); the hypapophysial bar (*ib.* fig. 1, *ex*) uniting with the neurapophysial pillars or crura of the atlas is carinate. Besides the wide canals for the vertebral arteries in the 'transverse processes' of the atlas, the neural arch is perforated above the base of that process on each side for the passage of a nerve.

The Skull.—The curve of the cranial vertebræ brings, in the usual position of the occiput on the atlas, the premaxillary extremity (Pl. VII. 22) parallel with the xiphoid cartilage (*ib.* 61), in the direction of the trunk's axis. The skull of the Aye-aye, in comparison with ordinary quadrupeds of its size, is remarkable for the large proportion of the cranium to the face, and the extreme shortness of the latter in advance of the orbits. Its profile contour, from the upper border of the foramen magnum, is a convexity curving rapidly from the occipital to the parietal region, and continued with a bold convexity to the root of the nose, whence it slopes straight to the nostril. The cranium is still more convex transversely (Pl. VIII. figs. 1 & 4); it expands a little in advance of the lambdoid ridge, and gradually, but very slightly, contracts to the postorbital processes; these, meeting with the malar, complete the bony rim of the orbit, which opens widely beneath that part of the frame into the temporal fossa.

The basioccipital extends to the fore part of the large tympanic bullæ (*ib.* fig. 2, *m*), to abut against which its margins are slightly produced; it is smooth and slightly convex below, without hypapophyses. The occipital condyles are long and narrow, about 2 lines apart at their under ends, and extending upward and outward to the middle of the foramen magnum. The plane of this opening forms with the basioccipital an angle of 125°, its aspect being downward and backward: the foramen is nearly circular, $6\frac{1}{2}$ lines in diameter, that of the cranial cavity being 1 inch 7 lines across its widest part transversely. The paroccipital is a low eminence, and the mastoid (*ib.* figs. 1 & 2, 8) in front of it is hardly more prominent; neither process extends freely downward. The superoccipital is a thin plate moulded on the middle and lateral lobes of the cerebellum, and showing outwardly their respective prominences. The mastoid is impressed by the pit for the cerebellar appendage (*ib.* figs. 5 & 6, *e*). The lambdoid suture is nearly in the line of the low transversely arched ridge; it is a little in advance above, where the suture shows slight crenulations, and gets behind the ridge before it passes down between the mastoid and superoccipital.

The interparietal (*ib.* fig. 1, $_{3}$) is a small triangular bone, without trace of sagittal suture, 10 lines in length, and the same across the base, which is posterior, forming the middle part of the lambdoidal suture. The outer surface of the interparietal is divided into three nearly equal longitudinal tracts by the back part of the temporal ridges. The exposed inferior surface of the basisphenoid is rather shorter and broader than the basioccipital, but it is prolonged further along the cranial floor, where it is expanded by a large sinus (*ib.* fig. 6), and coalesces with the presphenoid. The alisphenoid developes the ectopterygoid ridge, extending from between the squamosal and tympanic to the outer side of the entopterygoid ; both plates are imperforate. Above the back part of this ridge is the foramen ovale (*ib.* figs. 2 & 5, *f*), three lines in advance of which is the foramen rotundum. The natiform protuberances form deep depressions in the alisphenoid, on each side the flat square platform of the cranial surface of the basisphenoid, in the middle of which is the subcircular pituitary pit (*ib.* fig. 5, *k*). There are no clinoid processes. The alisphenoids join the parietals, which contribute the greatest share to the formation of the calvarium. The tympanic (*ib.* fig. 2, $_{28}$), coalescing with the petrosal, is, together with that element, expanded into an oval bulla (*ib.* *x*) on each side of the basisphenoid. The sagittal suture is almost a harmonia, 11 lines in length. The temporal ridges extend each to within $1\frac{1}{2}$ line of the hind part of the sagittal suture, but diverge as they pass to the postorbitals. The parietals, impressed from within to transparent thinness by the longitudinal convolutions of the cerebrum, do not exceed half a line in thickness elsewhere. Between the root of the zygoma and the lambdoid ridge there extends a ridge at right angles to the latter.

The coronal suture crosses the cranium transversely three lines behind the postorbitals : the frontal suture remains ; its length is 1 inch 5 lines ; like the sagittal, it is a harmonia. The fore part of the frontals (Pl. VIII. fig. 1, $_{11}$) projects a little between the origin of the nasals (*ib.* $_{15}$), and also between the nasals and maxillaries ; they then join the lacrymals, form the upper half of the inner wall of the orbit, and unite behind with the orbitosphenoid, alisphenoid, and parietal. The postorbital process is three-sided, almost 5 lines in length, contracting to its junction with the malar (*ib.* $_{26}$) : there is a slight depression at its base, defining the superorbital ridge. This ridge is entire, neither perforated nor notched. The olfactory fossa, within the cranium (*ib.* fig. 5), is subcircular, $7\frac{1}{2}$ lines in breadth, and 6 lines in length. The median septum is produced with a 'crista galli.' The frontal sinuses (*ib.* *j*) give no outward indication, but are large and extensive, about 3 lines at their widest part from front to back wall, extending 1 inch 4 lines transversely into the bases of the postorbitals, and backward to within 5 lines of the coronal suture ; they are divided from each other by a median bony septum ; each division communicates with the nasal chamber by a median orifice, and by a lateral one with the antrum. The nasals (Pl. VII. $_{15}$)

are straight lengthwise, convex across, and the more so as they approach their free ends; they join above with the frontals (*ib.* 11), and at the sides with the premaxillaries (*ib.* 22). The presphenoid is short, smooth on the under surface, and concave there transversely. The vomer quickly assumes the form of a vertical plate, with the free hind border concave.

The palatines form the hinder third of the bony palate; the suture of each with the maxillary is slightly convex forward: they are divided from the inner alveolar wall of the last two molars by a groove which deepens into a fissure, bounded beyond the last molar by the pterygoid (Pl. VIII. fig. 2). The maxillary forms more than the middle third of the palate, leaving the smallest share of the roof of the mouth to the premaxillary (*ib.* 22). The facial plate of the maxillary (Pl. VII. 21) extends by a narrow produced apex to the lacrymal, but is excluded from the frontal by the junction of the lacrymal with the premaxillary; it is, transversely, convex at its outer, concave at its inner or fore part, both in a slight degree; its middle is perforated by a small antorbital foramen; its hinder angle is produced a little way beneath the molar. The anterior half of the alveolar border is edentulous, but sharp: the posterior half is excavated by the sockets of the four grinders; of these sockets the first is the smallest, and is a simple cavity; the second (Pl. VIII. fig. 8, m 1) divides into three depressions for one large inner and two small outer fangs; the like divisions of the third socket (*ib.* m 2) are less deep; the fourth socket is simple, larger and more oblong than the first. These four sockets are in a straight line and parallel with those of the opposite maxillary.

The premaxillaries (Pl. VII. 22) constitute a larger share than the maxillaries to the facial wall; on the palate they form merely the fore and outer boundaries of the incisive fissures (Pl. VIII. fig. 2, *o*), and extend only one line behind the incisors. On the face they reach the frontals, rising as high as the nasals, between which and the maxillaries they interpose a broad plate, circumscribing, with the nasals, the external nostril. The socket of the incisor curves upward and backward to the maxillary, in which it is continued to beneath the orbit.

The malar bone (Pl. VII. 26) is long and deep, especially below the orbit, of which it forms the lower half; and where it bends outward to expand that cavity, it unites with the lacrymal and extensively with the maxillary anteriorly, and bifurcates behind,—the narrower branch (Pl. VIII. fig. 4, 26) mounting to the postorbital (*ib.* 12), the broader one (*ib.* fig. 2, 26) continuing backward to the squamosal (*ib.* 27).

This essentially facial or maxillary element (Pls. VII. & VIII. 27) is anchylosed not only with the mastoid (8) and petrosal (16), but also with the tympanic (28); its cranial plate forms the outer and back part of the depression for the natiform protuberance (Pl. VIII. fig. 5, 27), and terminates by a convex upper border overlapping the contiguous borders of the alisphenoid and parietal (Pl. VII. 27). The surface for the mandible (Pl. VIII. fig. 2, *x*) is broad and flat, save where its inner border bends down upon the side of the petro-tympanic bulla (*ib.* 16). There is no ridge behind it to prevent the free movements of the mandible backward and forward, accompanying the rodent action of the great scalpriform incisors. The outer facet of the zygomatic process shows a depression in front of the meatus auditorius.

The mandible (Pl. VIII. figs. 3, 7, & 9) is short and deep: each ramus is compressed and straight; they converge at an acute angle to a short ligamentous symphysis. The condyle (*x*) is sessile, narrow, rather long, convex both across and lengthwise, and the latter most so, looking backward and upward, and placed on the level of the grinding-teeth. The thin borders of the ascending ramus diverge from the condyle as they pass, the one downward and inward to the low angle (figs. 7 & 9, *y*), and the other forward and upward to the better-marked and more advanced coronoid (*ib. z*), the obtuse end of which is nearer the last molar (fig. 7, m_3) than the condyle. Both sides of the postmolar half of the ramus are almost flat. A slight ridge above the angle bounds the surface for muscular insertion behind; and here the angle is a little inflected.

The entry of the dental canal (figs. 3, 7, *t*) is on the line from the back molar to the condyle, but rather nearer the latter. The fore border of the coronoid (*z*) is almost straight, and slopes forward, parallel with the hind border (*y*, *x*) of the ascending ramus, to the outside of the jaw, below the alveolus of the middle molar (fig. 9, m_2). The lower border of the ramus from the angle undulates, first convex, then concave, finally convex as it curves slightly upward to the alveolar border of the great incisor. The short diastema (figs. 7, 8, *d*), almost equal to the fore-and-aft breadth of the incisor (*i*), is concave and sharp. The small single outlet of the dental canal (Pl. VII. 32, *o*) is below the fore part of the first molar. The symphysis does not reach to the angle between the anterior and inferior borders of the horizontal ramus.

The sockets of the three molars occupy an extent of 5½ lines (·0012): the first and second sockets are divided into two depressions; the third is a simple oblong-conical cavity.

The socket of the incisor (fig. 9) has the external border of the outlet sinuous, the internal border convex; it is very narrow in proportion to its length, and makes no projection on either the outer or inner side of the ramus; it extends in a regular curve beneath the molar series to the base of the coronoid process, the tooth it contains (*i*, *p*) describing a semicircle.

Bones of the fore limb.—The scapula (Pls. VII. 51, IX. figs. 12, 13) is 2 inches long, with a basal breadth of 1 inch; the base is straight between the root of the spine and the beginning of the lower angle, but curves forward to that and to the upper angle. The supraspinal fossa is less than half the breadth of the infraspinal one; and the upper costa inclines at its fore part to near the spine, before it curves out again to the coracoid (Pl. IX. figs. 12, 13, 52). The infraspinal fossa is made deep by the height of the spine and the outbending of the lower border. The spine rises to a height of 5 lines before expanding into the acromion, which attains a breadth of 4 lines, and is slightly twisted on itself. The surface on its anterior or inner border which it gives to the clavicle (*ib.* fig. 12, 58) is 3 lines long. The length of the acromion (fig. 13, *a*) is 6 lines; that of the coracoid (*ib.* 52) is 7 lines: it is a simple compressed process, 2 lines in breadth. The subscapular surface (Pl. IX. fig. 13) has a shallow channel parallel with the origin of the spine, below which it is convex transversely; it is gently concave lengthwise at the fore part; there are no intermuscular ridges or crests on this surface. The glenoid cavity (*ib.* fig. 12, *o*) is a long oval, 6 lines by 3 lines, with the apex above, and rather produced. The clavicle (*ib.* 58), 1 inch 5 lines in length, has a double bend upward and outward, and a half twist on itself: the sternal end expands to a breadth of 3 lines; the acromial end is more gradually and less expanded.

The head of the humerus (Pl. IX. fig. 15) has a long-oval form, regularly convex, and surpassing in both breadth and length those dimensions of the glenoid cavity. The great tuberosity projects on one side to the same height; the small tuberosity is somewhat lower. A sharp deltoid ridge (*ib.* fig. 14, *d*) extends from the fore part of the great tuberosity halfway down the shaft. The anterior flattened surface meets the posterior convex surface of the upper half of the shaft at an obtuse ridge along the inner side. The supinator crest (*ib.* *s*) begins below the middle of the shaft, near its back part, standing well out, and thence passes in an almost straight line to the ecto-condyloid tuberosity (*c*): it equals two-fifths the length of the humerus. The internal ridge projects from nearly the fore part of the distal fourth of the shaft, bridging over the humeral artery and median nerve on its way to the entocondyloid tuberosity (*e*), where it coalesces with a shorter and sharper ridge, completing the epicondyloid foramen. The inner tuberosity is much more prominent than the outer one. The fore part of the lower third of the shaft is convex transversely; the back part (fig. 15) is concave. The anconeal fossa is oblong, of moderate depth, and imperforate. The tubercle (*r*) for the radius forms nearly half of the fore part of the elbow-joint; the back part is exclusively formed by the well-defined trochlear cavity (*u*) for the ulna. The humerus (Pl. VII. 53) reaches to the tenth rib, when bent upon the chest.

The radius (*ib.* 54) is of equal length with the humerus, and offers no peculiarities for description; the head is nearly circular. The articular cavity at the head of the ulna (*ib.* 55) forms a laterally emarginate semicircle; below its outer side is a flat surface for the radius; the ulnar side of the bone below the cavity shows a longitudinal fossa: the upper half of the bone is bent, with the convexity backward. The ulna is the longest bone of the fore limb; it is compressed below the humeral joint, and gradually narrows to the lower fifth of the shaft, which is three-sided, with two of the dividing angles sharp ridges.

The wrist-bones (Pl. VII. 56, Pl. IX. figs. 17, 18) are ten in number, including a supplemental sesamoid on the outer side of the scapho-trapezial joint. The scaphoid (*ib.* fig. 18, *s*) is the longest, presenting its convex articular surface to the outer two-thirds of the radial concavity (*ib.* fig. 17, 54), and articulating with the lunare (*ib.* fig. 18, *l*), which completes the wrist-ball; at its distal surface it joins the 'intermedium' (*i*), the trapezium (*t*), and the trapezial sesamoid (*o*): the cuneiform (*c*) offers a cup for the hemispheric end of the styloid process of the ulna (fig. 17, 55), and a flatter surface for the pisiform (*ib. p*); this wrist-bone is long, and its articular surface is divided between the ulnar process and the cuneiform. The intermedium and cuneiform combine to form the cup for the ball common to the magnum (*m*) and unciform (*u*), of which the latter bone contributes the largest share. The intermedium (*i*) articulates with the trapezoid (*z*). The distal series of carpal bones have the usual relations to the metacarpals.

The metacarpal of the pollex (Pls. VII. & IX. fig. 17, I) articulates with the trapezium, and touches the trapezoid and the base of the second metacarpal: this (*ib.* II) is supported by the trapezoid. The base of the middle metacarpal (*ib.* III) is notched for a firmer articulation with the magnum, as that of the fifth metacarpal (*ib.* V) is for the outer division of the distal surface of the large unciform. The first, second, fifth, and fourth metacarpals progressively increase in length, with similar proportions as to thickness; but the middle metacarpal is double the length of the second, and suddenly contracts into a shaft more slender by half than the contiguous metacarpals. The proximal phalanx of the thumb is the shortest; that of the index is one-third longer; that of the minimus is rather thicker, and is one line longer than that of the index; that of the annulus is rather thicker, and is one-third longer than that of the minimus. The proximal phalanx of the middle finger is a slightly bent filamentary bone, about two lines shorter than that of the fourth finger. The second phalanx of the fifth is $1\frac{1}{2}$ line longer than that of the second; that of the fourth finger is almost twice the length of that of the second; the filamentary one of the third is not longer than that of the fifth finger: all these phalanges are slightly bent, concave towards the palm. The ungual phalanges are all modified for the support of claws, are short, and are less unequal in length, that of the thumb being the shortest and broadest. The hand is the longest segment of the fore limb; it exceeds that of the ulna by 1 inch.

Bones of the hind limb.—The pelvis is long and narrow; the os innominatum equals in length the last five lumbar vertebræ.

The ilium (Pl. VII. 62, Pl. IX. figs. 19, 20, 62) is a long narrow bone, slightly expanded at both ends, and subcompressed at its upper half, where the sides look outward and inward, the borders forward and backward; of these the anterior one is the thinnest, and is slightly concave. The ilium articulates with the two first sacral vertebræ, just touching the second by a projection above its middle (*ib.* fig. 19, 62); about half an inch of the lamelliform part of the bone (*ib.* fig. 20, *l*, 62) projects freely in advance of this attachment, on each side the transverse processes of the last lumbar vertebra, with a slight divergence. The iliac bones incline to the acetabula at an angle of 140° with the lumbo-sacral axis. There is an elongate tuberosity above the acetabulum for the origin of the rectus femoris. The ischia (*ib.* 63) are continued almost in a line with the ilia, the posterior contour describing a very feeble curve concave backwards. They diverge to the tuberosities (*t*) for an extent about equal to that of the ischio-pubic symphysis, the tuberosities being slightly everted : a small projection (fig. 19, 63) behind the lower part of the acetabulum divides the great from the small ischiadic notches, both of which are very shallow. The obturator foramina (*o*) are oval, 9 lines by 6 lines in the two diameters. The pubic bones (*ib.* 64) pass from the acetabula (fig. 19, *a*) at almost a right angle with the ilio-ischial axis ; they converge to the symphysis (64, *s*) at an angle of 80°. There is a slightly marked ilio-pectineal prominence.

The femur (Pl. VII. 65) has a straight shaft, with the upper end a little inclined forward, and the lower joint projecting as much backward : it is one-third longer than the humerus. The head (Pl. IX. fig. 21, *a*) is an oblong or subelliptic convexity, with the longer axis from behind forward and downward, having the pit for the round ligament near its lower border. The neck is short : the great trochanter (*t*) rises to the height of the head ; it diminishes in breadth as it descends, and at the outer and lower part is developed into a small tubercle (*u*). Opposite to this the lesser trochanter (*s*) projects from the inner side to a greater degree. The shaft of the femur is, transversely, less convex behind than before ; it preserves its shape and thickness to the beginning of the condyloid expansion. The orifice for the medullary artery is at the back part, one-fourth of the length from the head : the canal ascends. The inner condyle is rather the largest. The outer border of the rotular groove projects most. There is a sesamoid bone (Pl. VII. 65') in each origin of the gastrocnemius.

The tibia (*ib.* 66) is about two lines shorter than the femur, and soon contracts below the head to a compressed shaft, giving a long and narrow subelliptic section ; at the upper half it is very slightly bent, with the convexity forwards. A roughish surface is continued from the tuberosity nearly one-third of the way down the fore and outer part of the shaft. The orifice of the medullary canal is one-fourth of the way down, just within the posterior border : the canal slopes downward. The malleolar part of the distal expansion is long : two slight vertical ridges at the back part of the expansion bound a wide and shallow groove for the flexor tendons. The tibia is one-fifth longer than the ulna. The fibula (*ib.* 67) touches the tibia only by the two extremities articulating with that bone, leaving an interosseous space co-extensive with their shafts. The outer malleolus is shorter and thicker than the inner one. There is a sesamoid in the external lateral ligament of the knee-joint, at its insertion into the head of the fibula.

The tarsal bones (Pl. VII. 68, Pl. IX. fig. 22) are seven in number. The naviculare (*s*) has its shallow concavity for the astragalus (*a*) supplemented by the strong ligament arising from its posterior and inferior margin, and inserted into the fore part of the inner malleolus ; anteriorly it articulates with the three cuneiform bones, and externally at its fore part with the os cuboides ; its depth exceeds its length. The astragalus (*a*) has a grooved posterior border ; the upper articular surface is broader before than behind. The part thence extending to the anterior ball, with the rest of the bone, is of equal length, and is inclined inward to the naviculare. The calcaneum (*d*) offers two articular surfaces to the astragalus, rather far apart; the lever projects moderately beyond the hinder surface, and is curved a little upward and inward. The lower border is narrow and straight. The anterior surface for the cuboid is concave at the lower part. The ento-cuneiform (*i*) presents a concavity to the lower and outer half of the great convexity of the naviculare; it offers at the anterior half of its outer part a trochlear surface, concave in one direction, convex in the opposite, to the powerful hallux, between which and the second toe the ento-cuneiform projects upon the dorsum of the foot. The meso- (*m*) and ecto- (*e*) cuneiform bones are narrower; the outer one (*e*) is of nearly equal length with the inner (*i*), the middle one (*m*) being the shortest. The cuboid (*b*) is large and long, with the lower half of its calcaneal surface convex, the upper half concave, for an interlocking joint with that bone; it is almost square and flat above, grooved externally and beneath for the peroneus longus, and, as usual, it supports the two outer toes.

The base of the metatarsal of the hallux (*i*) is broad, and its under border is produced into contact with that of the second metatarsal. The base of this metatarsal (*ii*) is interlocked for a small extent between the ento- and ecto-cuneiforms; it is half as thick as the first metatarsal, and of the same length, but appears longer from its more advanced articulation and the greater proportion of the shaft to the articular ends. The third metatarsal (*iii*) is a little longer than the second; the fourth (*iv*) has nearly the same length, and so has the fifth (*v*) by reason of the backward production of the outer angle of its base. The proximal phalanx of the fourth toe is the longest; that of the middle toe is about one line shorter; those of the second and fifth are half a line shorter than that of the third; the proximal phalanx of the hallux is the shortest and thickest. The middle phalanx of the second toe is the shortest; that of the fourth, which is the longest, exceeds it by three lines; those of the third and fifth are of intermediate length. The ungual phalanx of the hallux is short, broad, expanded, indicating the nail-shaped appendage which it bears; the ungual phalanges of the other toes are subcompressed and obtusely pointed, conformably with their more claw-shaped weapons.

The following parts retained their epiphysial condition:—the head of the humerus, the carpal ends of the radius and ulna, the femoral condyles, the upper end of the tibia, the lower end of both tibia and fibula. The animal may not, therefore, have attained its full size.

	Ft.	in.	lin.
Length of skull (including incisors)	0	3	5
——— of vertebral column	2	3	6
——— from occiput to sacrum	0	9	0
——— of sacrum (by anchylosis)	0	1	6
——— of tail	1	5	3
——— of cervical	0	1	8

	Ft.	in.	lin.
Length of dorsal	0	4	6
——— of lumbar	0	3	2
——— of sternum	0	3	3
——— of scapula	0	2	0
——— of clavicle	0	1	5
——— of humerus	0	3	3
——— of radius	0	3	3
——— of ulna	0	3	10
——— of manus	0	4	9
——— of pollex (including metacarpal)	0	1	8
——— of index (including metacarpal)	0	2	9
——— of medius (including metacarpal)	0	3	11
——— of annularis (including metacarpal)	0	4	4
——— of minimus (including metacarpal)	0	3	0
——— of pelvis	0	3	0
——— of femur	0	4	9
——— of tibia	0	4	$7\frac{1}{2}$
——— of pes	0	4	4
——— of hallux (metatarsal included)	0	1	10
——— of fourth medius (metatarsal included)	0	3	4

§ 4. *Teeth.*

The dental formula of *Chiromys* is—

$$i. \frac{1-1}{1-1},\ c. \frac{0}{0},\ p. \frac{1-1}{0-0},\ m. \frac{3-3}{3-3}, = 18.$$

The incisors (Pl. VIII. figs. 6 & 8, *i*, *i*) are long, large, much compressed, regularly curved in segments of equal circles, the upper pair describing one-fourth, the lower pair one-half of such circle. The upper incisor (*ib. i*), 1 inch 4 lines long, following the convex border, is $3\frac{1}{2}$ lines from before backward, and one line across (*ib.* fig. 4); the outer side is flat, the inner side rather convex; the worn cutting surface is concave, with the fore part produced, forming an obtuse point. The front or convex border of the tooth is coated by enamel, extending nearly a line's breadth upon the outer side (fig. 8, *e*), and for a rather less extent upon the inner side: it is one-third of a line in thickness. The dentinal body of the tooth (*ib. d*) has a central slightly discoloured axis of osteodentine. The exposed part of the tooth measures six lines at the fore, and two lines at the back, border in length; the implanted part (fig. 8) extends through the premaxillary into the maxillary to above the molars, where the pulp is situated close to the thin convex plate of bone below the orbit. The pulp-cavity of the tooth is a long cone with a widely open base; the apex reaches to near the opening of the socket. As they approach this outlet, the teeth converge and come into contact at the anterior half of their cutting surfaces for an extent of two lines from the point (fig. 4). The exposed part of the tooth resembles the crown of a canine rather than of an ordinary rodent incisor, and projects more forward than downward; but, in the partial investment of enamel, the hollow base, and persistent pulp, the Aye-aye's incisor is a true chisel-tooth.

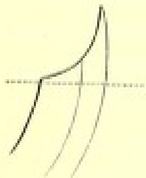
The lower incisor (fig. 9, *ī*), which has greater fore-and-aft breadth, but hardly so much transverse thickness as the upper one, has the enamel (*e*) continued further upon the sides, especially the outer one; here it is extended fully two lines from the front border, and upon the inner side (fig. 7, *ī*) rather more than one line. The long diameter of the incisor is 5 lines; the length, following the convex curve, is 2 inches 7 lines; the depth of the pulp-cavity (fig. 9, *p*) is 1 inch 8 lines. The exposed part of the tooth measures nine lines at its fore part; but the cutting surface slopes thence, with a deep concave curve, to the back part of the alveolar border, where scarcely a line's extent of the concave border of the tooth protrudes. The exposed part of the tooth has thus more the shape of the crown of a canine than has that of the incisor above. The implanted part of the tooth extends to within five lines of the apex of the coronoid process (*ib. z*). The pulp-cavity, in both upper and lower incisors, is deeply stained by the hæmatosine of the active reproducing matrix.

In the upper jaw (figs. 6 & 8) the first grinder (*p* 4) is six lines distant from the incisor; it answers to either the last premolar or last milk-molar in the placental diphyodont type; it has an obtuse crown, covered by thick enamel, of a subtrihedral shape, the longest side backward, the shortest outward; it is implanted by a simple, thick, subconical fang. The second grinder (*m* 1), answering to the first true molar in the type-formula, has an unequal-sided quadrate crown, with the narrowest side forward; the grinding surface is channelled from before backward; the outer wall is feebly divided into two low lobes by an external notch; the inner wall has a convex bulge next the palate. The whole crown has a simple but thick coat of enamel: it is implanted by two small and short outer roots and one thick and longer inner root: the longest diameter of the crown is 2 lines. The third grinder (*m* 2) resembles the former, but its front side is as long as the back one: it is similarly implanted. The last grinder (*m* 3) has a full oval crown, with the small end outward; the grinding surface has a middle depression surrounded by three low tubercles, the inner one the largest, the hind one much the smallest. It is implanted by a short thick fang, slightly notched at the apex. The position of the crowns of these teeth is such that the direction of their interspaces is oblique, from within, outward and forward; but the grinding surface looks directly downward. A magnified view of that surface is given at fig. 10, Pl. VIII.

The three lower grinders are true molars, and are a little in advance of the crowns of their homotypes above. Each has a shallow longitudinal depression on its grinding surface, with simple undivided outer and inner boundaries, uniting at their fore part in the first grinder, and with a very small lobe interposed behind in the last. Each has a simple cap of enamel, like the molars above. The mid-molar (*m* 2) is rather the largest, the first (m 1) is the narrowest ; in this and the second the implanted base is divided into an anterior and posterior root (fig. 9) ; it remains simple in the last (m 3). The longest diameter of the mid-molar does not exceed 2 lines ; these teeth are, therefore, very small in proportion to the incisors, and the molar series is singularly small in proportion to the entire skull and body of the Aye-aye[1].

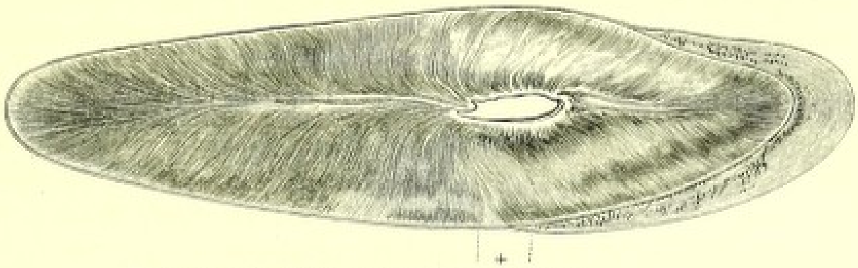
The following is the result of a microscopic examination kindly undertaken by my friend James Salter, Esq., F.L.S., of the teeth of the *Chiromys* :—" The transverse section of the Aye-aye's lower incisor, taken through the dotted line in fig. 1, is singularly like

Fig. 1.



Lower incisor, *Chiromys*.

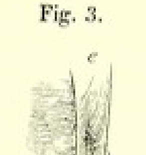
Fig. 2.



Transverse section of incisor of Aye-aye, magnified 12 diameters.

the outline of a vertical section of the lower cuspidatus of man, the outer surface of the former corresponding with the front of the latter (fig. 2). The enamel is thick and hard ; it clothes the tooth on the outer surface by about twice the extent that it does on the inner ; it is naked, except just at its edge, where it (fig. 3, e) is slightly overlapped by the cement (*ib.* c) or crusta petrosa, which extends up to the worn part of the tooth, and covers all the dentine which is not protected by enamel ; on the inside surface of the tooth, however, this covering is reduced to the merest film. The cement at the part of the incisor examined (its distal extremity) is very thin, and only a transparent layer, without lacunæ. The pulp-cavity was sealed by an exceedingly thin layer of secondary dentine, so thin that the vessels of the pulp reached within less than a line of the surface. The point where the section was made exposed the vascular pulp. In the molar tooth the bulk of the crown is composed of enamel, which is bare,—not covered, that is, by cement.

Fig. 3.



Portion of incisor (* fig. 2) of Aye-aye, mag. 60 diameters.

" It can scarcely be said that the teeth present any *histological* characters of marked peculiarity. If, however, one thing is more noticeable than another (especially in the incisor section), it is the large number of

[1] Since this sheet was in type, I have learnt from Prof. Gervais, of Montpellier, that the jaws of a young *Chiromys*, presented by M. de Lastelle to the Museum of Natural History, Paris, exhibit a molar anterior to the three in the lower jaw, corresponding to, but smaller than, the anterior one above. In this immature specimen, the last of the three true molars has not cut the gum. By the time this takes place, the first small molar is shed in the lower jaw : it is retained in the upper one : it may be a deciduous or milk-molar, d 4 instead of p 4, in both jaws. M. Gervais has figured this phase of dentition in his 'Histoire Naturelle des Mammifères,' vol. i. p. 176

dentinal tubes which enter the enamel, as is conspicuous in most marsupials. This, however, is an inconstant structural condition; it is found in many other mammalian teeth, differing in individuals of the same species, and also in different teeth of the same individual, and is not of the zoological value that has been imagined. I should, therefore, attach very little importance to the circumstance as seen in a single specimen only."—J. S.

The very compressed form of the incisors and the obliquity of their narrow working surface allowing the enamelled ends only of the upper and lower pair to come into contact, give almost a pointed form to those ends, which are thus adapted to pare away very narrow strips of the bark and the wood they may be operating on; whilst the great fore-and-aft breadth of the incisors, and the angle at which their front or enamelled borders converge in each pair, adapt them to penetrate deeply and quickly into the substance of a bough. In all these characters their special adaptation to the work of exposure of the slender canals of the wood-boring caterpillars becomes very obvious. The length and curved implantation of the teeth, and the provision for their perpetual renovation, are conditions of equal fitness for the daily repetition of such eroding operations. By these adaptive modifications the front teeth of the Aye-aye doubtless resemble in their broader features the scalpriform incisors of the true Rodents; but to infer that, therefore, the food of the Aye-aye was similar, and that it subsisted, like the Squirrel and Beaver, *e. g.*, on the coarser vegetable products, would be as fallacious as to conclude, from the shape and proportions of the canine teeth in the male *Troglodytes*, that the Gorillas and Chimpanzees were flesh-eaters. The diet is best indicated by the molars; and the functions of specially developed teeth in a state of nature are made known by observations on living animals. The true relations of the dental characters by which the highest Quadrumane resembles a Carnivore, and the lowest one resembles a Rodent, are elucidated by the totality of their organization respectively.

§ 5. *Muscles.*

In this section I restrict myself to a description of those parts of the muscular system which seem to throw most light on the affinities of *Chiromys*, and my remarks chiefly relate to the muscles of the limbs.

The *platysma myoides* (Pl. X. fig. 1, 8) is well developed, covering all the muscles on the front and sides of the neck, and extending upon the sides of the deep mandibular rami.

The *sterno-cleido-mastoideus* consists of two portions, which are more than usually distinct to their insertions. The sternal portion (*ib.* 9), commencing by a short roundish tendon from the outer angle of the manubrium, becoming fleshy, expands to the breadth of five lines, is flat, and covers the cleidal portion (9′), arising fleshy from the median third of the clavicle. The sternal portion is inserted into the mastoid, and the ridge continued thence upon the occiput. The cleidal portion contracts to its insertion, which is tendinous, at the back of the mastoid. The two portions are continuous along the front margin, and separate behind, the sternal overlapping the other.

The *omo-hyoideus* arises fleshy from the upper costa of the scapula, and passes obliquely upward and forward, crossing the carotid artery, becoming flattened, with a breadth there of three lines, to be inserted into the hyoid, along with the sterno-hyoideus, and to the aponeurosis connecting the beginning of the tendon of the digastricus to the hyoid.

The anterior bellies of the pair of *digastrici* muscles are closely blended together, and fill up the anterior interspace of the rami of the lower jaw. The tendon of each digastricus, commencing at the hyoid, is about five lines in length; the posterior belly consists of two fasciculi of muscular fibres, and arises from the lower part of the mastoid.

The *sterno-hyoidei*, each five lines in breadth at their origin, gradually contract as they ascend towards their insertion, and are closely connected at the middle line, covering the larynx and trachea.

The *sterno-thyroidei* are much smaller muscles; they arise behind and externally to the sterno-hyoidei, and pass along the side of the trachea, to be inserted below the thyro-hyoideus into the thyroid cartilage.

The *longus colli* is a powerful muscle, especially thick at the part which is attached to the pleurapophyses of the sixth and fifth cervicals.

The principal muscle of the lower jaw is the *masseter*, of a quadrate form, one inch five lines in breadth by one inch four lines in depth; it arises from the lower margin of the zygoma, and from a very strong aponeurosis continued thence over the greater part of the outer surface of the muscle. It consists of two portions, an external and an internal. The external fibres pass downward almost parallel, to be inserted into the lower border of the posterior half of the mandible; they are separated by a thin glistening aponeurosis from the internal portion, the fibres of which pass a little forward as well as downward. These two portions blend together anteriorly; the inner portion is inserted into the outer surface of the broad ascending ramus. There is no trace of an accessory masseter, such as exists in most Rodents.

The *temporal* muscle attains four or five lines in thickness: besides its cranial origin, it derives many fibres from the strong temporal fascia, attached to the upper border of the zygoma, before passing under the arch to be inserted into the coronoid process.

The *pterygoideus internus* arises by a strong narrow tendon from the outer part of the base of the spheno-pterygoid ridge, and expands, its fibres diverging, to be inserted into the slightly inflected angle and the lower border of the inner depression of the ascending ramus of the mandible. The inner or exposed surface of the pterygoideus internus is in great part covered by a glistening aponeurosis.

The *pterygoideus externus* has a broader and more extended origin; its fibres run more parallel, and slightly converge to their insertion into the upper half of the inner surface of the ascending mandibular ramus.

Muscles of the Upper Limb.—The muscles (*trapezius* and *levatores*) which attach the scapula to the head and neck are large and strong. The *latissimus dorsi* arises from the back part of the last five ribs, and from the broad tendon common to it with the sacro-lumbalis and longissimus dorsi: the fibres converge, as they pass over the lower part of the scapula, to terminate in the strong flattened tendon (Pl. XI. fig. 1, $_{16}$), which is inserted into the internal ridge of the proximal third of the humerus. Near the beginning of the tendon, on its inner side, is attached the accessory muscle (*ib.* $_{22d}$) of the long portion (*ib.* $_{22a}$) of the *triceps*, by which the influence of the great dorsal muscle, most effective in the action of climbing, is extended to the lower end of the humerus and the olecranon.

The *teres major* (Pl. XI. figs. 1 & 2, $_{12}$) arises from the lower costa of the scapula; its tendon, passing along the upper part of that of the *latissimus dorsi*, is inserted into the lesser tuberosity of the humerus.

The *teres minor* (*ib.* fig. 2, $_{10}$) is not much inferior in size: it arises from the infra-spinal space beneath the origin of the scapular spine; extends forward over the origin of the triceps, and under the deltoid, to be inserted into the greater tuberosity.

The *subscapularis*, of which a portion is shown in Pl. XI. fig. 1, $_{13}$, has the usual origin from the inner surface of the scapula, by three principal fasciculi, which converge to a broad thin tendon, closely attached to the part of the capsule of the shoulder-joint over which it passes, to be inserted into the lesser tuberosity of the humerus above the *teres major*.

The *deltoïdes* (Pls. X. & XI. figs. 1 & 2, $_{15}$) has the usual extensive origin from the outer part of the clavicle, contiguous to the clavicular part of the pectoralis major, and from the acromion to near the beginning of the scapular spine. The fibres converge to their insertion into the strong ridge along the middle of the fore part of the upper half of the humerus.

The *pectoralis major* (Pls. X. & XI. fig. 1, $_{17}$) consists of an upper smaller ($_{17a}$) and a lower larger ($_{17b}$) portion. The first derives its origin from the sternal half of the clavicle and the manubrium sterni; its fibres pass transversely outward, overlapping the insertion of the second portion, and passing to the lower part of the pectoral ridge of the humerus. The larger portion of the pectoralis major arises from the fore and lateral part of the body of the sternum, and from the cartilages of the eighth, ninth, and tenth ribs. The fibres converge to their insertion into the upper two-thirds of the pectoral ridge.

The *pectoralis minor* arises from the side of the manubrium, and from the sternal ends of the first to the fifth ribs: it is inserted by a broad tendon, spreading over the head of the humerus, to be attached to the great tuberosity.

The *biceps brachii* (Pls. X. & XI. fig. 1, $_{20}$) rises by a short and thick tendon (*a*), which soon becomes distinct from the coraco-brachialis, from the coracoid process, and by a long flattened and strong tendon (*ib.* b) from the upper border of the glenoid cavity. The two portions of muscle unite about one-third down the humerus, and the muscle passes over the fore part of the elbow-joint, becoming tendinous (*ib.* c), to be inserted, as usual, below the proximal tubercle of the radius.

The *coraco-brachialis* (Pls. X. & XI. fig. 1, 14) arises from the whole lower border of the coracoid process by a broad tendon, which is closely attached to the capsule of the shoulder-joint where it passes over the joint, becomes fleshy near its origin, and is inserted along the inner side of the middle third of the shaft of the humerus; the portion (14 b) which has its insertion extended to the entocondyloid ridge seems to have an almost distinct origin by a larger tendon, from the end of the coracoid process.

The *brachialis anticus* (*ib.* fig. 1, 21) lies to the outer side of the lower half of the coraco-brachialis; arising from the outer side of the deltoid ridge, and from the outer and fore part of the middle and lower third of the humerus: it is inserted into the coronoid process of the ulna. The inner fasciculus of this muscle, described by Vrolik[1] in *Stenops tardigradus*, is wanting in *Chiromys*, as in *Tarsius*[2] and *Stenops gracilis*.

The *triceps extensor antibrachii* presents the same complexity as in most Quadrumana. The 'long portion' or 'head' (Pl. XI. fig. 2, 22 a) arises from the rough facet behind the glenoid cavity; the fleshy part is broad, thin, and short, ending in a broad tendon covering the lower half of the back part of the humeral muscles, and receiving the accessory head (*ib.* fig. 1, 22 d) from the latissimus dorsi; it is inserted into the olecranon. The 'external portion' (*ib.* fig. 2, 22 b) arises below the lesser tuberosity and contiguous part of the humeral shaft, and continues fleshy to near its insertion by a broad tendon into the outer border of the olecranon. The internal portion (*ib.* fig. 1, 22 c) arises from the inner and back part of the shaft of the humerus, beginning below the insertion of the teres major: it is thick and fleshy; the fibres, converging to a very short but broad tendon, are inserted, with the preceding, into the olecranon, and are attached to the outer part of the capsule of the elbow-joint. The lower portion of this muscle is noted by Burmeister[3] as an '*anconeus sextus*' in the *Tarsius*, and appears to be almost as distinct a part in the Aye-aye (Pl. XI. fig. 1, 22 c). Its fibres come from above the entocondyloid ridge to near its lower end, and are inserted into the inner part of the olecranon. Vrolik[4] speaks of an auxiliary fascicle to the triceps from the back part of the humerus in *Stenops*.

The *supinator longus* (Pl. XI. figs. 1 & 2, 23) has its long fleshy origin extended from the middle of the humerus to near the end of the ectocondyloid ridge, where it is partly covered by the origin of the *extensor carpi radialis longus*: its fibres converge as they

[1] Recherches d'Anatomie Comparée, sur le Genre *Stenops*, &c., 4to, 1843, p. 45.

[2] Burmeister, *op. cit.* [3] *Op. cit.* p. 32. [4] *Op. cit.* p. 44.

pass along the upper and fore part of the forearm, below the middle of which the tendon commences whereby it is inserted into the outer part of the carpal tuberosity of the radius.

The *extensor carpi radialis longus* (Pl. XI. fig. 2, 24) arises from the lower part of the ectocondyloid ridge; it is less broad than the supinator, from which it is divided by the radial nerve; its tendon begins about the middle of the forearm, is crossed by the *abductor longus pollicis* (*ib.* 25), passes, with the tendon of the *extensor carpi radialis brevis* (*ib.* 26), through a synovial sheath in the dorso-carpal ligament, gives off a strong aponeurosis to the scaphoid and trapezium, and is finally inserted into the back part of the base of the metacarpal of the index finger.

The *extensor carpi radialis brevis* (*ib.* 26) arises from the outer and lower part of the ectocondyloid tubercle, in common with the *extensor digitorum* (*ib.* 27): its tendon begins lower down than that of the long carpal extensor, but has a similar course until it has passed through the dorso-carpal ligament (x), when it diverges to be inserted into the base of the metacarpal of the digitus medius.

The *extensor carpi ulnaris* (Pl. XI. fig. 2, 28) arises from the lowest part of the ectocondyloid protuberance: its tendon begins about the lower third of the ulna, near the end of which it passes through a pulley of the dorso-carpal ligament, and inclines outward to be inserted into the back and outer part of the base of the fifth metacarpal.

The *extensor digitorum communis* (Pl. XI. fig. 2, 27), arising, in common with the *extensor carpi radialis*, from the ectocondyloid tubercle, accompanies that muscle in close attachment therewith down half the forearm, then separates therefrom to allow the abductor longus pollicis (*ib.* 25) to glide between them, and at about the same part of the forearm itself divides into two fasciculi terminating in the extensor tendons. These pass beneath the dorso-carpal ligament, beyond which they are connected together by strong fasciæ, forming, apparently, a broad band upon the metacarpus where the separate tendons diverge to the second, third, fourth, and fifth digits. They expand as they pass over the proximal joints, where they are connected with the divisions of the shorter extensor tendons. A deep-seated extensor, forming almost a separate muscle, sends subsidiary tendons (27 *a*) to the fourth and fifth digits, expanding upon the capsules of the proximo-digital joints. In this respect *Chiromys* resembles *Tarsius*[1], and differs from *Stenops*, in which, according to Vrolik[2], the deep extensor of the fourth and fifth fingers is wanting.

The *abductor longus pollicis* (Pl. XI. fig. 2, 25) arises from the lower part of the ectocondyloid tuberosity, descends on the radial side of the *extensor longus pollicis* as far as the middle of the antibrachium, then diverges obliquely radiad, decreasing in breadth as it passes over the tendons of the two radio-carpal extensors, passes with them through the dorso-carpal ligament, and goes to be inserted into the radial side of the metacarpal of the pollex.

[1] Burmeister, *op. cit.*

[2] *Op. cit.* p. 45.

The *extensor longus pollicis* (Pl. XI. fig. 2, 37) arises from the upper third of the ulna, passes down the back part of the interosseous space, becomes tendinous at the lower third of the forearm, bends radiad beneath the index and medius tendons of the common extensor, and, after passing through the dorso-carpal ligament, proceeds to its insertion into the back part of the proximal phalanx of the thumb.

Beneath the foregoing, arising from the middle of the ulna and interosseous ligament, is a small muscle, answering to the 'indicator,' but dividing into two slender tendons, which, after connexion with those of the superficial extensors, go respectively to the index and medius digits, dividing upon the proximal phalanx, and uniting to be inserted into the base of the distal phalanx.

Some of the smaller muscles of the digits are indicated in the description of the Plates.

The forearm of the Aye-aye appears to be incapable of being naturally brought into a straight line with the humerus, but freely bends within the limits of the obtuse angle to which it can, with moderate force, be stretched.

The *pronator teres* (Pls. X. & XI. fig. 1, 32) arises, in close connexion with the *palmaris longus*, from the lower and fore part of the entocondyloid ridge, and is inserted by a broad flat tendon into the radius at and above its middle part. The carneous fibres continue on the outer part of the muscle to near its insertion.

The *flexor carpi radialis* (*ib.* 31), with a similar but deeper origin, continues fleshy to the middle of the forearm: its long tendon passes under the vola-carpal ligament to be inserted into the base of the index metacarpal.

The *palmaris longus* (*ib.* fig. 1, 30), with a similar but superficial origin, is a more slender muscle, becomes tendinous halfway down the forearm, and is inserted partly into the vola-carpal ligament, and partly expands into the volar fascia.

The *flexor carpi ulnaris* (*ib.* fig. 1, 29) is the largest of the superficial flexors of the forearm: it arises, fleshy, from the entocondyloid ridge, and by fascia from the ulnar ridge of the proximal part of the ulna; its fibres converge to a tendon at the lower third of the forearm, which is inserted into the outer part of the pisiform (*p*), and, by a strong fascia, thence continued to the base of the fifth metacarpal.

The *flexor digitorum sublimis* (Pl. XI. figs. 1 & 3, 35) arises from the entocondyloid prominence of the humerus and from the coronoid process of the ulna, being covered there by the *palmaris longus* and *flexor carpi ulnaris*; it divides below the middle of the forearm into two fasciculi, each of which again divides. The tendons of the radial divisions (fig. 3, *a*, *b*) pass near each other, through the vola-carpal ligament, and diverge at the palm to the index and medius digits—the latter being a very slender tendon in relation to the slenderness of that finger. The ulnar pair of tendons have a similar course, rather removed from the preceding, to the annulus (*c*) and minimus (*d*) digits. Each tendon splits, as usual, at the base of its digit, giving passage to the tendon of the deep flexor, and itself being inserted into the sides of the proximal phalanx. Besides these four tendons, a short and strong one (fig. 4, *e*) is sent off from the inner or back part of the ulnar division of the *flexor sublimis* to join chiefly the division of the *flexor profundus* which supplies the middle finger.

The deep flexors of the digits (Pl. XI. fig. 4, $_{33}$) are two in number. The one on the radial side arises by three heads, the longest (*a*), answering to the *flexor longus pollicis*, from the upper part of the radius; the second (*b*) is a distinct strip, from the radius and interosseous space; the third (*c*) arises from the middle of the ulna, and from the interosseous space: the two first heads unite, and afterwards join with the third head, forming a strong tendon which, at the carpus, divides into two, one going to the distal phalanx of the thumb, the other to that of the forefinger; but this is united at the wrist with the tendons of the ulnar division of the *flexor profundus*. This division (*d*) arises from the entocondyloid tubercle and the whole of the fore part of the upper two-thirds of the ulna: it receives an accessory fasciculus from the middle of the ulna: their common tendon unites as it passes under the carpal ligament with that of the radial division by the short strip of tendon (*f*), then proceeds independently, and divides into two strong tendons—one for the fourth, the other for the fifth finger. The slender tendon of the middle finger comes off very near the point of union of the radial with the ulnar division of the *flexor profundus*, and also near the connecting tendon (*e*) between the superficial and deep flexors; so that the action of all the flexor masses may be concentrated on that slender middle finger.

The tendon of the fasciculus representing the *flexor longus pollicis* has an adhesion to the supplementary carpal ossicle and attached part of the transverse fascia, beyond which adhesion (Pl. X. fig. 1, $_{34\,a}$) it sends the more distinct tendon to the pollex; but the effect of this attachment is to oppose, not the pollex only, but the pad at its outer base, which is supported by the supplemental ossicle (Pl. IX. fig. 17, *o*) in the grasping act, when the radial is opposed to the ulnar side of the hand. The fleshy part of both flexors, but especially of the deeper-seated muscles, continues far on towards the hand, as in other *Lemuridæ*, and also as in the climbing *Rodentia*, thus enabling the muscles to continue their action as finger-benders in the bent position of the hand itself[1]. The tendons of the deeper flexors are thicker than those of the superficial flexors; but both those of the middle digit are very slender.

The *pronator quadratus* rises from the fore part of the lower fourth of the ulna. Its fibres pass obliquely outwards and downwards, to be inserted into the corresponding fore part of the radius. Both the pollex and minimus have their abductor and adductor muscles and short flexors. The tendons of the deep flexors give attachment to four lumbricales. Some of these minor muscles of the digits are noticed in the description of the Plates.

Muscles of the Lower Limbs.—The *psoas magnus* (Pl. XII. fig. 1, $_{1}$) presents a character of unusual length, corresponding with that of the lumbar region, from which it chiefly arises, its highest or foremost origin being from the last dorsal vertebra. An inner

[1] Vrolik, *op. cit.* p. 45.

and superficial portion (*a*) may be recognized as an ill-defined psoas parvus, but becomes distinct below where it is inserted into the ileo-pectineal ridge. An outer portion (*b*) more especially unites itself with the *iliacus internus*, and, with the main body of the psoas, passes on to be inserted into the lesser trochanter, the unusual prominence of which relates mainly to the power of this great flexor of the trunk on the thighs and reciprocally.

The *iliacus internus* (*ib.* 2) is a long and thin or flat muscle from the fore part of the ilium, behind and exterior to the psoas, with which, especially the outer fasciculus, it unites below, for a similar insertion in the lesser trochanter.

The *tensor vaginæ femoris* (Pls. XII. & XIII. fig. 1, 3) is represented by a small external fasciculus from the anterior superior spine of the ilium, which extends into the fascia covering the fore and outer part of the thigh.

The *sartorius* (Pls. XII. & XIII. 15) is a long, flat, rather broad muscle, arising fleshy between the iliacus internus and ecto-gluteus[1] from the anterior border of the ilium, passing obliquely across the inner side of the thigh, slightly expanding to be attached to about an inch of the upper part of the spine of the tibia (Pl. XIII. fig. 2, 15) and to a thin fascia covering the knee-joint (Pl. XII. *f*).

The *gracilis* (*ib.* 14) rises fleshy from the whole of the symphysis pubis, and is similar in shape and size to the sartorius, but rather thicker and narrower: it is partly covered by the sartorius as it passes to its insertion, which is by a narrow tendon, into the spine, one inch below the head, of the tibia, the tendon at its insertion uniting with that of the semi-tendinosus (21), which is behind it.

The *ectogluteus*[2] (Pl. XIII. fig. 1, 4) is represented by a series of conjoined fasciculi having an origin extended from the anterior spine of the ilium to the sacral and first two caudal vertebræ. The fibres converge and pass over the great trochanter and subjacent part of the ischium to be inserted into the back and outer part of the femur, from half an inch below the great trochanter to the ectocondyloid ridge. A small tendon is developed from the anterior border, near its insertion, over which tendon the longer posterior fleshy fibres are, as it were, twisted in descending.

The *semitendinosus* (Pl. XIII. figs. 1, 2, & 3, 21) has a double origin: one slender (*a*) from the second caudal vertebra, adjoining the caudal origin of the gluteus; the other (*b*) thicker, in common with the long head of the 'biceps,' from the outer and back part of the tuber ischii. The muscle formed by their junction is a flat band, and becomes

[1] *Gluteus maximus* of anthropotomy. (See 'Osteology of Chimpanzees,' &c., p. 15.)

[2] The three muscles answering to *gluteus maximus*, *gluteus medius*, and *gluteus minimus*, in Man, do not present the proportions indicated by those names in any inferior animal. The property distinguishing them throughout the mammalian series is 'relative position,' conveniently indicated by the terms proposed.

Ectogluteus, syn. gluteus maximus.

Mesogluteus, syn. gluteus medius.

Entogluteus, syn. gluteus minimus.

tendinous for about an inch in length, where it passes to the inner side of the tibial to be inserted into the spine, along with the tendon of the *gracilis* (fig. 2, 21 & 14).

The ischial origin of the *biceps* (Pl. XIII. fig. 1, 20) is by a slender fasciculus, partly tendinous, which, receiving an accession of carneous fibres from the femur, expands as it descends to be inserted into the fascia (*c*) covering the head of the tibia and the origin of the *peroneus longus*, and, finally (*d*), into the fore, upper, and outer part of the tibial spine.

The *semimembranosus* (Pl. XIII. figs. 2 & 3, 22) arises from the under and fore part of the tuber ischii, beneath the common origin of the biceps and semitendinosus: it is a strong, fleshy, subtrihedral muscle; becomes flattened, contracted, and tendinous where it passes over the inner head of the gastrocnemius, and then beneath the internal lateral ligament (*x*), to be inserted into the inner and fore part of the head of the tibia.

The *adductor longus femoris* (Pl. XIII. fig. 2, 12') arises from the symphysis pubis, adjoining the pectinæus, and beneath the origin of the gracilis, fleshy, and is inserted into the inner side of the femur, from the lesser trochanter to the entocondyloid ridge, being conjoined in the lower half of its insertion with the *adductor magnus*.

The *adductor magnus* (Pl. XIII. fig. 3, 12) arises from the ramus and tuber ischii, and is inserted by a series of somewhat loose fasciculi into the inner side of the femur from below the small trochanter to the intercondyloid space.

The *mesogluteus* (Pl. XIII. fig. 3, 5) is a long and very thick muscle, arising from the outer side of the ilium and the fascia covering the sacrum, the fibres converging to be inserted into the upper part of the great trochanter.

The *entogluteus* arises from the lower part of the ilium and adjoining part of the ischium, to near the tuberosity, and is inserted into the great trochanter on the inner side of the *mesogluteus*. The great ischiatic nerve and artery lie between the posterior margins of these muscles. The *entogluteus* is attached to the underlying part of the capsule of the hip-joint.

The *vastus externus* (Pl. XIII. figs. 1 & 3, 17) arises from the fore and under part of the trochanter major, by a short tendon, visible on its outer side only. It rapidly swells into a large fleshy mass, forming the outer part of the thigh, and converges to a flattened tendon, which is closely blended with the capsule of the knee-joint as it passes to its insertion into the upper and outer part of the patella. It sends off no fleshy fasciculus to the *rectus femoris*, as observed by Vrolik in *Stenops*[1].

The *rectus femoris* (Pls. XII. & XIII. figs. 1–3, 16) rises by a strong round tendon from the upper part of the acetabulum, and by a shorter tendon (fig. 3, *b*) from the inferior spine of the ilium. The muscle becomes fleshy at the junction of these, is fusiform, the strong subdepressed tendon being inserted into the upper part of the patella.

The *vastus internus* (Pls. XII. & XIII. figs. 1 & 2, 18) arises from the fore part of the great trochanter, becomes attached by a fascia to the inner side of the rectus femoris,

[1] *Op. cit.* p. 46.

developes a slender tendon on that side, which goes to the ligamentum patellæ, and then spreads into a thin fascia attached to the inner side of the knee-joint and ligamentum patellæ.

The *cruræus* (Pl. XIII. figs. 2 & 3, 19) arises from the whole of the inner and fore part of the femur, quitting the bone only at the lower end to spread over the upper part of the capsule of the knee-joint prior to being inserted into the corresponding part of the patella. The outer division of the cruræus (fig. 3, 19′) is rather a distinct muscle, which might be termed the deep-seated vastus externus: it arises from the fore and outer part of the femur to the condyloid expansion, and is inserted by a fascia into the outer part of the ligamentum patellæ and capsule of the knee-joint.

The *pectinæus* (Pl. XIII. fig. 2, 13) arises from the upper part of the pubis, near the symphysis, and is inserted below the lesser trochanter. Beneath it are strong and thick *gemelli*, converging from their origin on the anterior surface of the pubis and ischium to the interspace between the small and large trochanter.

The *gastrocnemius* (Pls. XII. & XIII. 27) arises by the usual outer (fig. 2, 27, *a*) and inner (fig. 2, 27, *b*) heads from the back part of the corresponding condyles, the tendons being strengthened each by a sesamoid ossification. The outer head principally receives the accession of fibres from the upper part of the fibula, called *soleus* (fig. 3, 28); after which they combine into a single mass, which becomes tendinous on the outside, about halfway down the leg, but continues fleshy on the inside to near the insertion into the calcaneum. A small 'plantaris' fascicle sends its tendon by the side of the os calcis to the strong fascia covering the sole.

The *flexor digitorum longus pedis* (Pls. XII. & XIII. figs. 1 & 2, 32) arises from the back part of the head of the fibula and the interosseous space. It forms a flattened tendon behind the lower fourth of the tibia, which glides through a channel behind the inner malleolus, expands beneath the tarsus, gives origin to the short flexors (Pl. XII. fig. 1, 36), sends off a tendon (Pl. XIII. fig. 2, *m*), which is joined by a tendon (*ib. n*) from the *flexor hallucis*, to go to the second digit (*ii*); then proceeds a short way, receives a second smaller tendon (*ib. e*) from the *flexor hallucis*, and finally divides into the flexor tendons of the three outer toes. The first of the short flexor muscles (Pl. XII. fig. 1, 36) sends a long and slender tendon to the first phalanx of the fifth toe; the second (*ib.* 36′), to that of the fourth toe; whilst the third (*ib.* 36″) is inserted into the large and long flexor tendon continued from the muscle itself.

The *flexor longus hallucis* (Pl. XII. fig. 1, & Pl. XIII. fig. 2, 31) arises from the back part and inner ridge of the tibia, and from the interosseous space, halfway towards the lower end of the bone. The fleshy fibres are continued on the inner surface to the malleolar ligament; the fleshy fibres on the outer side of the muscle, much higher up. The tendon glides through the groove behind the inner malleolus, sends off a small tendon (*e*) to join the division of the general *flexor* moving the three outer digits, and then divides into the flexor tendon of the hallux (*h*) and a tendon (*n*) joining that part of the general flexor tendon from which the tendon of the second digit proceeds. Thus, the major part of this muscle expends itself upon the flexion of the ordinary toes. These junctions between the *flexores digitorum* and *hallucis* combine the two muscles in a common action of grasping; and the strength of the muscle, sending the long tendon to the hallux, gives it the requisite power of rotating the foot, through that member, in a convenient position for grasping.

The *tibialis anticus* (Pl. XIII. figs. 1 & 3, 24) arises from the upper half of the fore and outer surface of the tibia, becomes tendinous towards the lower third of the bone, glides through a pulley of the ligamentum transversum (x), and is inserted into the entocuneiforme.

The *peroneus longus* (Pl. XIII. figs. 1 & 3, 25) arises from the head and upper two-thirds of the outer part of the fibula and contiguous part of the interosseous fascia, becomes tendinous towards the lower fourth of the leg, passes, with the tendon of the *peroneus brevis*, in the same sheath behind the outer malleolus, diverges to the cuboid, winds round the outer part of that bone in a groove, and, crossing the bases of the three middle metatarsals, is implanted into the base of that of the hallux.

The *peroneus brevis* (Pl. XIII. fig. 3, 26) lies beneath the *peroneus longus* (*ib.* 25), arises from the lower two-thirds of the fibula, and from the aponeurotic septum between it and the *extensor digitorum* (37); its tendon passes through the same sheath, behind the outer malleolus, with that of the peroneus longus, and then through a distinct sheath on the calcaneum, above the tendon of the peroneus longus, whence it passes on to its insertion into the base of the fifth metatarsal.

The *extensor longus hallucis* (Pl. XIII. fig. 3, 39) lies behind and partly beneath the *tibialis anticus* (24), arises from the outer and fore surface of the tibia, from near the head, a short way down; converges to a tendon about the lower third of the leg, which passes through a sheath in the transverse ligament (x), is bound down on the tarsus by a small ligamentous sheath attached to the naviculare, and thence passes along the outer part of the phalanges of the hallux to the ungual one, into which its terminal expansion is inserted.

The *extensor communis digitorum* (Pl. XIII. figs. 1 & 3, 35) arises by a distinct head from near the head of the fibula, and by a stronger portion from the upper half of the fibula and the interosseous fascia. The tendon from the first portion divides, to be attached to the second and third toes; that from the second part of the muscle (35′) passes through a distinct sheath, and divides to go to the fourth and fifth toes. Both primary tendons, before their division, are expanded upon the tarsus and partially united to each other.

The *extensor brevis hallucis* (Pl. XIII. fig. 3, 40) arises from the upper and tibial side of the calcaneum; its fleshy fibres converge as they pass beneath the tendons of the long extensor to a tendon which is attached to the metatarsal of the hallux.

There are similar but smaller short extensors (*ib.* 41) arising from the calcaneum, and inserted into the metatarsal of the second digit and that of the third digit, expanding in each upon the capsule of the joint of the first phalanx. There is a small abductor and an adductor (*ib.* fig. 2, 42) of the hallux. Interosseous muscles serve to extend and abduct the fourth and fifth digits.

§ 6. *The Brain.*

The brain of the Aye-aye, viewed from above (Pl. XII. fig. 3), presents an oval form, with the small and obtusely pointed end forwards; it measures 2 inches 2 lines in length, 1 inch 7 lines in greatest breadth, and 1 inch 3 lines in height. The cerebrum (*ib.* fig. 4, A) covers the olfactory lobes (*ib.* C) in front, and about one-third of the cerebellum (*ib.* B) behind. The length of the cerebrum is 1 inch 10½ lines; its breadth is 1 inch 6 lines, each hemisphere measuring 9 lines across its broadest part, which is at about the junction of the middle with the hinder third.

The hemispheres are simply and symmetrically convoluted; each shows the longitudinal fissure (2, 2), which slightly diverges from its fellow as it advances, and bifurcates,—one branch curving forward and inward, bounding anteriorly the medio-longitudinal convolution *a*; the other bending outward and downward to bound the suprasylvian convolution *b*. The length of the fissure *a*, to its bifurcation, is 1 inch; it is of moderate depth. External to it is the suprasylvian fissure (3, 3), in the form of an irregular arch: the part of the hemisphere, viz. the 'sylvian' or 'temporal' convolution (*c*), which it defines, is indented by a short vertical fissure (6). A shallow vascular impression goes from the summit of the suprasylvian fissure towards the longitudinal one. A shallow indentation (5) divides the suprasylvian convolution (*b*, *b*) from the anterior lobe. These fissures or anfractuosities, which are very symmetrical in the two hemispheres, mark out the folds or convolutions called the longitudinal (*a*, *a*), the suprasylvian (*b*, *b*), and sylvian (*c*, *f*) convolutions, the latter terminating below in the 'natiform protuberance,' *n*. The continuation of *a* with *b* forms the hinder protuberance of the cerebrum: its inferior and internal surface is smooth and unfissured. The bifurcation of the fissure (2) marks out the anterior lobe, which is also divided by a shallow vascular groove, continued from the lower branch of fissure (2) from the fore part of the suprasylvian convolution (*b*). The anterior lobes are marked by a few feeble indentations, not symmetrically repeated, but of which one (1) seems to answer to the one so marked in the brain of the Cat. There is sufficient resemblance in the pattern of the markings of the cerebral surface of the *Chiromys* and Cat, to determine the homologous fissures and folds, and I use the same figures and letters to indicate these as in the 'Memoir on the Cheetah,' in the first volume of the 'Zoological Transactions'[1]. But, in the

[1] "Anatomy of the Cheetah," Zool. Trans. vol. i. p. 129, pl. 20. fig. 4. In this memoir, read September 1833, I published my first attempt at determining the homologous convolutions of the cerebrum, a subject which was extended in a subsequent Course of Hunterian Lectures at the Royal College of Surgeons, and illustrated by the preparations and coloured diagrams now in that Institution.

number and disposition of the primary convolutions and fissures, the brain of *Chiromys* most closely resembles that of *Lemur* proper [1].

The cerebellum has a large and prominent superior 'vermiform' lobe (Pl. XII. figs. 3 & 4, *m*), a pair of small lateral lobes (*ib. n*), and the 'flocculus' (*ib. o*). The inferior vermiform lobe (*ib. l*) extends beyond the superior, where it rests upon the back part of the fourth ventricle. Behind the flocculus (*o*) is the tract (*s*) where the white matter appears, and to which can be traced the 'crus cerebelli ad pontem.' The breadth of the cerebellum, including the 'flocculi,' exceeds, by about a line, that of the cerebrum: the length of the cerebellum is 9 lines; the uncovered extent is 6 lines, from the posterior border of the cerebrum.

The pons Varolii (Pl. XII. fig. 2, *v*) is but slightly prominent, defined anteriorly from the cerebral crura (*u*) by a feeble transverse interrupted linear groove and by the third pair of nerves (^{3}), and posteriorly chiefly by the sixth pair (^{6}). The basilar artery feebly impresses the middle line of the pons. The pyramidal bodies, *p*, are feebly defined, and slightly expand to their insertion into the pons, where they received the nerves of the sixth pair (^{6}). The cerebral crura (*u*), short and thick, are divided by the infundibular fissure, in front of which is the single median mammillary body. The optic nerves (fig. 2, ^{2}) form a chiasma, of which the breadth is twice that of the length. The olfactory nerves commence by a broad white tract (*e*) from the outer and under part of the sylvian fissure, from which it can be traced to the corpus striatum, and by a low grey protuberance (*i*) near the back and lower part of the hemispheric fissure. The nerve is closely connected with the under part of the anterior lobe to near its terminal expansion (c), which does not extend beyond the anterior lobes of the cerebrum.

The *corpus striatum* (Pl. XII. fig. 5, *s*) is 11 lines in length, and has its anterior larger rounded end closely fitting the fore part of the ventricle, which is not prolonged into a horn-shaped bend beyond it. A broad choroid plexus covered the tænia semicircularis dividing the corpus striatum from the thalamus (*t*), beyond the outer and back part of which the ventricle extended about a line backward, and then was continued with the great hippocampus downward. The posterior indent (fig. 5, *i*) is the beginning of that extension which forms the "*scrobiculus loco cornu posterioris*" of Tiedemann[2], in higher Quadrumana. There was no crenation on the convex border of the hippocampus, nor any digital eminence. In other particulars of cerebral structure and in the disposition of the cerebral nerves *Chiromys* closely agrees with *Stenops*.

There is a delicate tapetum at the back of the cavity of the eyeball. The axis of the lens is one-third its transverse diameter.

[1] See Prep. No. 9, Physiol. Series, Hunterian Museum, determined, by dissection of the *Lemur mongoz*, to belong to that species, in 1832; 'Physiological Catalogue,' vol. i. 4to, p. 3.

[2] 'Icones Cerebri Simiarum, &c.' Folio. 1821.

§ 7. *Digestive System.*

The Mouth.—The characters of this aperture, and of the lips, jaws, and teeth, have been already described. The symphysis of the jaw, united by ligament only, and for a limited extent, permits a slight divaricating movement of the rami with their large incisors; much less, however, than that in the Phalangers or Kangaroos. On the palate (Pl. XII. fig. 6), anteriorly, are three transverse ridges, slightly convex forward, progressively increasing in breadth, followed by four transverse pairs of ridges, curving more obliquely backward as they approach the pharynx. The tongue (Pl. XII. figs. 7, 8, 9) is rather narrow, deep, slightly expanding anteriorly, and rounded at the tip, without an intermolar rising. The free portion is short, thick, fleshy, obtuse; it projects, in the passive state, three lines beyond the apex (*ib.* figs. 8 & 9, *a*) of the sublingual plate (*b*). This body is flat, triangular or leaf-shaped, the free apex (*a*) very short: a filamentary longitudinal ridge, or *lytta*, of cartilaginous firmness, projects from the middle of the under surface. A narrow free fold of membrane (*c*) is continued backward from each side of the base of the sublingual plate to the corresponding side of the pharynx. On the dorsum of the tongue (fig. 7) the tactile papillæ are short, subobtuse, rather large for the size of the tongue, becoming larger near the fauces. About one inch and a half from the apex of the tongue are a pair of fossulate papillæ, about two lines apart.

The soft palate is a broad and deep fold overarching the root of the tongue in front of the epiglottis. The uvula is represented by a short and narrow median longitudinal fold, projecting from the back surface close to the margin. The tonsils (fig. 7, *c*) project as compressed processes, two lines in length, one on each side of the pharynx. The epiglottis (*ib.* *e*) appears as a thick, transverse, semilunar fold, slightly swollen and notched at the middle; when pressed backwards, it bridges over the anterior half of the glottis.

The back part of the beginning of the œsophagus appears to include a thick plexus of veins. The œsophagus, commencing opposite the middle cervical vertebra, passes along the middle line, immediately beneath the spine, inclining slightly to the left, where it enters the thorax; in which cavity it is continued, in the posterior mediastinum, where it lies more loosely than in Man.

Disposition of the Abdominal Viscera.—On exposing the abdominal cavity, the stomach (Pl. XIV. fig. 1) was seen occupying the upper part, extending from the left to the right hypochondria. Below the left side of the stomach appeared part of the spleen (*ib.* *k*). Above the stomach, reaching to within half an inch of the lower margin of the ribs, was the liver, but confined to the epigastric and right hypochondriac regions. The convolutions of the intestines extended over the rest of the cavity, the large intestines occupying the lower third, and the urinary bladder, with the urachal duplicature, appearing at the lowest part.

The suspensory duplicature of peritoneum, having the remains of the umbilical vein at its free margin, enters between the fissure of the cystic lobe defining the umbilical lobule to its left, whither it is reflected from the middle line of the diaphragm. The great epiploon was packed in folds between the stomach and the mass of small intestines; it was continued from the great curvature of the stomach, and sent a process upward and forward which adhered to a notch in the border of the cystic lobe of the liver. The right kidney (Pl. XII. fig. 1, *k*)[1], resting on the transverse processes of the second and third lumbar vertebræ, was higher or more advanced by half its own length than the left kidney. The adrenal bodies (*ib. u*) lay upon the inner and upper ends of the kidneys.

Alimentary canal.—The œsophagus (Pl. XIV. fig. 1, *a*), having perforated the diaphragm in the usual place and way, has a course of about a third of an inch in the abdomen before terminating at the cardiac orifice (*ib. b*) of the stomach. This orifice is situated nearer the pylorus (*p*) than to the cardiac end (*c*). The stomach (Pl. XIV. fig. 1, *b*, *c*, *d*, *e*) is of a simple, full, subglobular form: it measures 3 inches 3 lines long, when moderately distended; 2 inches 6 lines from the cardia to the middle of the great curvature (*d*), both in a straight line; the pyloric end projects about half an inch beyond the pylorus (*p*). A narrow glistening tract of fine aponeurotic fibres (*f*) runs parallel with, and a little below, the short curvature (*g*) between the cardiac and pyloric orifices, and from this tract the fibres of the outer muscular layer radiate. A narrow but well-marked crescentic fold projects into the cavity from the lesser curvature, four lines to the right of the cardia, subsiding about an inch down the fore and hind walls: this fold appeared after the cavity had been fully distended, and it marks out internally the division between the cardiac and pyloric compartments. The pylorus is a subcircular aperture, above which projects a short thick longitudinal prominence.

Among the contents of the stomach were portions of a semitransparent colourless pulp, which, under the microscope, were seen to consist of hexagonal cells, combined with long fibres of a brown colour; and these, under pressure, exhibited a moniliform structure. In the cellular structure were traces of a spiral vessel. The whole was indicative of the remains of the pulp of some tropical fruit. No evidence of larvæ or other insects was observed.

The duodenum (Pl. XIV. fig. 1, *h*), after its usual curve, crosses the spine below the root of the mesentery, then turns up the left side to commence the three principal folds of the small intestine (*i*), on the border of the mesentery, by which, with the cæcum, they are freely suspended. A duplicature of peritoneum is continued from the end of the duodenum, and from the lower part of the beginning of the colon, to the first lumbar vertebra, attaching them thereto. The colon, after a course of three or four inches, forms a long narrow fold (*ib.* fig. 2, *c*, *e*), five inches in length, then passes to the left, above and behind the root of the mesentery, and descends along the left lumbar and hypogastric regions to form the rectum.

[1] This figure was drawn on the stone, from the original drawing, without reversing.

The duodenum is about 4 lines in diameter. The length of the small intestines, when detached from the mesentery, is about 4 feet. Here and there they show slight constrictions, as at *i*, *i*, fig. 1. The length of the cæcum (Pl. XIV. fig. 2, *f*), from the end of the ileum (*ib. b*), is 2 inches 7 lines. The first inch (*f*) of the cæcum is 10 lines in diameter; the rest (*g*), measuring 1 inch 9 lines in length, is 3 lines in diameter. The cæcum suddenly contracts to this dimension, and terminates rather obtusely here, resembling an appendix vermiformis; but this is not marked off by any valvular structure from the wider part of the cæcum, and it is continued, as in the human fœtus, directly from the end of the wider part, or cæcum proper.

The large intestines are about 1 foot 10 inches in length. The colon, moderately distended, is 1 inch 2 lines in diameter at its commencement, and gradually decreases in width. Beyond the first enlargements (*c*, *c*) it is not sacculated, but is slightly puckered on a longitudinal band (*x*), which may be traced a few inches from the beginning of the gut, where two or three pouch-like protrusions appear on inflation. The ileo-colic aperture is slit-shaped, bounded by two low ridges, that next the cæcum being most produced.

The contents of the colon were of a dark pultaceous character; nothing more definite could be distinguished in them than vegetable tissues like those in the stomach, but more sparing and in more minute aggregates. Both were evidences of the food supplied to the Aye-aye after its recapture.

The mesenteric gland forms a mass at the root of the mesentery, 2 inches 3 lines in length, and half an inch across its widest part.

Alimentary Glands.—The parotid gland, flattened and lobulated, has a subtriangular form, measuring 1 inch 3 lines by 1 inch, extending in front of the ear from a little above the meatus to beneath the mandible, where it comes in contact with the submaxillary gland. The parotid duct leaves the gland about three lines above the lower margin of the mandible, crosses the masseter, and penetrates the buccal membrane close to the *angulus oris*, nearer the upper than the lower molars.

The submaxillary gland is thicker, more globose in form, and more compact in texture than is the parotid; it is 10 lines in length by 5 in breadth. I neglected to trace its duct before removing the glands in dissecting the digastric and other muscles, which I much regret.

The liver, 3½ inches in breadth and 2 inches in length, consists of the usual three primary lobes, viz., the 'right,' 'cystic,' and 'left' lobes[1]. The 'right' is the smallest, and sends off a ridge-like process, representing the 'Spigelian lobule.' The 'cystic' lodges the gall-bladder in a fissure traversing a third of the length of the lobe from its free margin; and an 'umbilical lobule' is marked out on its left, by the suspensory peritoneal fold including the umbilical vein. The left lobe, which is the largest, is

[1] I adhere to the homology and nomenclature of the hepatic divisions in the Mammalia, used in my "Catalogue of the Physiological Series," Mus. Coll. Chir. 4to, vol. i. (1833) pp. 237, 238.

notched posteriorly, but otherwise is entire. The fundus of the gall-bladder makes no appearance upon the convex side of the liver. The cystic duct receives the hepatic half an inch from the neck of the bladder: the common duct, after a course of nine lines, enters the back part of the duodenum, about six lines from the pylorus.

The pancreas is a broad thin gland; it extends from the splenic vessels to the duodenum, continuing as the 'small pancreas,' a little way beyond the entry of the duct, which is close to that of the gall-duct, and here sending off numerous narrow processes into the fold of the mesentery.

The spleen is an elongated, trihedral body, bent at nearly a right angle on itself, the lower portion being nearly half the length of the upper one (*a*, *b*).

§ 8. *Respiratory and Circulating Organs.*

The glottis (Pl. XII. fig. 7, *g*), a slit of 6 lines in length, is bounded by slender, well-defined 'chordæ vocales' proceeding from the arytenoids (Pl. X. fig. 3, *t*) to the fore part of the thyroid (*ib. r*). Between these and the overlapping epiglottis (*e*) is included a large and deep pouch, from which a small median sacculus (*ib. s*) is produced between the beak of the thyroid and the thick basal attachment of the epiglottis. The thyroid cartilage (*ib. r*) is shaped like the keel-less prow of a boat, being more than usually extended forwards and contracted. The cricoid (*ib. c*) is notched at the middle of its broad posterior part: the thyro-cricoideal space is small. Both cricoid and thyroid were partially ossified, and would probably become more so in older individuals. The thyroid gland is represented by two separate small flattened bodies, closely attached to the sides of the third to the seventh tracheal rings, inclusive. The tracheal tube (*ib. l*), about 3 inches in length, is rather flattened from before backward. The rings, about twenty-six in number, are unclosed behind; their free ends meet there, without overlapping, and, by the elasticity of the connecting tissue, can be drawn apart. The bronchial tubes are more flattened, and about 5 lines in length, before entering the lungs.

The right lung (Pl. X. fig. 3) is divided into three lobes (*ib. f*, *g*, *h*), with the lobulus impar (*ib. i*). The latter is grooved interiorly by the great post-caval vein, or inferior vena cava, and extends from the pleural space to the middle of that vein. The middle lobe is the smallest, and lies anterior to the interspace of the other two; it is trihedral, and, as it were, penduculate, swelling out after its origin. The left lung is divided into two (*ib. m*, *n*) lobes, the lower being the largest, and notched near its lower end.

The heart is rounded, subdepressed, with an obtuse apex. The arteria innominata gives off both carotids and the right subclavian, then the left subclavian. The aorta, bending over the left bronchus, takes the usual course through the thorax into the abdomen. Here it gives off the gastric (Pl. XII. fig. 1, *g*), the mesenteric (*ib. m*), and the renal (*ib. r*) arteries, which ascend obliquely to the kidneys. About an inch below the renal are sent off the spermatic arteries (*ib. s*); below these is the inferior mesenteric (*ib. i*).

One inch and a half below the renal arteries, the aorta divides into the common iliacs (*l*) and the caudal artery (*t*). The mesenteric artery, first describing one large arch, next gives off a series of smaller secondary arches, from which the branches proceed directly to the intestine. The artery to the mesocolon is a branch of the mesenteric. The mesocolic artery forms two small arches at the base of the fold of the colon, and gives off the vessels to the rest of that intestine, without any anastomotic arches. The axillary artery (Pl. X. fig. 2, & Pl. XI. fig. 1, *x*) is continuous, from the subclavian to the brachial (*ib. r*), as a single tube, not broken up into numerous small branches as in the slow Lemurs. This was the case in both the upper limbs of the Aye-aye, in which a variety was observed in the giving off of the ordinary branches. In the right arm, the brachial artery gave off the superior profunda (Pl. X. fig. 2, *o*), the inferior profunda (*u*), and the anastomotica magna (*s*), with the medullary nutrient artery and small muscular twigs. In the left arm, the brachial sent off the radial artery (Pl. XI. fig. 1, *d*) from about the middle of its course, which, after distributing a muscular branch to the biceps, passed over the bend of the elbow-joint to its usual position by the side of the supinator longus (23). In both arms the brachial artery was continued as an undivided trunk to the entocondyloid foramen, through which it passes along with the median nerve (*m*). The iliac artery (Pl. XII. fig. 1, *l*), in like manner, is continued into the femoral (*ib. f*) as a simple undivided tube: it sends off the internal iliac (*n*) at the usual place. The posterior tibial artery is the only one which shows any disposition to break up or quickly divide into a number of small branches; these are distributed chiefly to the muscles arising from the long tendons, or other parts, as flexors or adductors of the toes.

§ 9. *Renal Organs.*

The right kidney (Pl. XII. fig. 1, *k*), situated as before described, is higher by half its own length than the left (*ib. m*)[1]. The right kidney is 12 lines, the left one is 11 lines in length, the latter being the broadest, viz. 9 lines, with proportionate thickness. The cortical part (Pl. XII. fig. 10, *c*) is about 2 lines in thickness: the tubuli of the 'medullary' part (*m*) converge to a single short obtuse papilla (*p*). The ureters (*ib.* fig. 11, *u*) have the usual course and termination in the urinary bladder (*ib. b*). The renal arteries ascend obliquely to reach the pelvis of the kidney. The adrenals (supra-renal bodies, Pl. XII. fig. 1, *u*, *u*), proportionally larger than in the larger Quadrumana, correspond in general shape with the kidneys; but the right is narrower in proportion to its length.

The urinary bladder (Pl XII. fig. 11, *b*) is of a longish oval form; when moderately distended, it measures about $1\frac{1}{2}$ inch in length and an inch in diameter. The ureters terminate in the usual oblique manner in the neck of the bladder.

[1] The mirror was not used in engraving the drawing, and the right and left sides are reversed in the Plate.

§ 10. *Generative Organs.*

The testes are lodged in a sessile scrotal prominence on each side, and a little below the base of the penis. Their vaginal tunic communicates by a contracted aperture with the peritoneal cavity, into which they cannot be returned, but are permanently external to it.

The vasa deferentia (Pl. XII. fig. 11, *v*) take the usual course to the neck of the bladder, and become slightly enlarged above their entry into the notch of a flattened heart-shaped prostate. There are no vesiculæ seminales. The prostate gland (*ib. p*) is 5 lines in length by 4 in breadth, slightly concave on the broader posterior surface which is applied to the rectum. The two anterior surfaces meet at an open angle, along the middle of the fore part. The muscular part of the urethra, beyond the prostate, is 7 lines in length: along each side of it is a flattened oval gland (*ib. w*) 6 lines by 4 lines, slightly concave behind and convex in front; these answer to 'Cowper's glands.' Their ducts penetrate the back part of the bulb. This part of the urethra is 6 lines long by 3 in breadth, surrounded by an 'accelerator muscle' of half a line in thickness: the spongy structure of the bulb is exposed at *l*. The corpus cavernosum has a distinct septum, with a thick ligamentous capsule, as is shown in the section of the penis (*ib.* fig. 12). The 'erectores' (*ib.* fig. 11, *e*, *e*) have the usual origin and attachments. There is also a pair of strong 'levatores penis,' arising from the fascia crossing the vena dorsalis, and inserted by a common tendon into the ossiculum penis.

§ 11. *Comparison of the External Characters and Dentition.*

In deducing the natural affinities of *Chiromys* from the ordinary zoological or external characters, and commencing by a comparison of its general form and proportions, I find its nearest resemblance to be to the Malmags (*Otolicnus*, Illig., *Galago*, Geoffr.) amongst the *Lemuridæ*; especially to the species called 'Great Galago' (*Otolicnus crassicaudatus*) from the south-eastern part of Africa, and to the 'Black Galago' (*O. alleni*) from Fernando Po. There is the same general character of the pelage, with the long hairy tail, and the same degree of liberation of the limbs from the trunk; the same breadth of head and large naked ears; but, in the shortness of the muzzle, the *Tarsius*, perhaps, more resembles the *Chiromys*. The proportionate length of the digits of the hand is almost the same; but the third digit is much more slender in *Chiromys*. The hallux of the foot has the flat nail as in all the Lemurs, with the strength and opposable position of that member; but the four unguiculate toes are more nearly of the same length in *Chiromys*; and the tarsal segment is as short as in *Lichanotus* and *Lemur* proper. Although the muzzle is deeper and less pointed than in the *Lemuridæ*, conformably with the large bent incisors and their sockets, it is less deep and is much shorter than in any Rodent, in which order the eyes are placed further back, and are lateral, the premaxillaries being larger and longer, and the whole head being compressed in the Rodents. The nostrils are more terminal in *Chiromys*, and are but partially, instead of being wholly, lateral as in Rodents. The upper lip is not bifid as in Squirrels, nor curved downward and backward to cover the lower scalpriform teeth as in most Rodents. Although the mouth is less cleft than in the Lemurs, it is more so than in any Rodent of the same size, and the hairs are not extended upon the inner surface of the angle of the mouth. In *Tarsius* there are fasciculi of few and long vibrissæ, from the exterior of the lips and eyebrows, almost as in *Chiromys*.

The trunk is broader, less arched, and larger in the chest than in most Rodents; and the pelage of the Aye-aye has not the uniform, close-set, shining character as in that order.

In all Squirrels, the under part of the tail presents an almost naked narrow mid-tract, from which the long hairs diverge: the Aye-aye resembles the Malmags in their growth uniformly from the whole circumference of the tail.

In proceeding to a comparison of the locomotive members of the Aye-aye, we obtain an instructive test of the relative value of digital and dental characters in determining the ordinal affinities of a Mammal. Had the limbs only of the Aye-aye first reached the zoologist, it can scarcely be doubted but that the same conclusion of their being those of a Lemur would have been arrived at, as was expressed by the name applied to the Aye-aye by the naturalists (Schreber, Illiger) who guided themselves by the characters of the locomotive organs in the ordinal grouping of the mammalian class. The fore limbs and hind limbs have the same difference of length, and the same general proportions to the trunk, in *Chiromys* as in *Galago*. The fingers of the hand—long, slender, sub-nude, freely divergent from their metacarpal articulations—have also nearly the same proportional length, one to the other, in *Chiromys* and *Galago*. The superior length of the fourth finger, which begins, in the descending order of Quadrumana, to be manifested in *Ateles*, is general in the *Lemuridæ*, *Tarsius* being an exception, and reaches its maximum in the Aye-aye. The inferior length of the index, slightly manifested in *Ateles*, is more marked in most *Lemuridæ*, as it is in *Chiromys*; but amongst the slow Lemurs it is carried to the extent of malformation, as, *e. g.*, in *Perodicticus*.

Although in many Rodents, and especially in the Squirrels, the fore toes have considerable mobility, they are but four in number, the thumb being a mere vestige: they are more parallel, in their usual position; they are shorter in proportion to the hand or limb, are thicker, and more hirsute. The pollex in *Chiromys* has the same degree of opposability as in other *Lemuridæ*: it is shorter, but thicker than the other fingers, especially at the last segment. The extent of the naked palm is another lemurine or quadrumanous character. The attenuated mid-digit is a curious speciality of the Aye-aye. Even in this, perhaps, may be discerned an affinity to the nocturnal *Lemuridæ*, in which the hand is the seat of other extreme varieties. In *Perodicticus*, for instance, the index is reduced to its metacarpal bone, its first phalanx, and a vestige of its second phalanx, which forms an unarmed tubercle, as if the finger had been there amputated: in *Chiromys* the medius seems to be atrophied, though retaining its length and normal joints.

The hind feet of *Chiromys* are strictly 'pedimanous,' while their secondary modifications best accord with the lemurine pattern of the grasping foot. The extent of the naked sole, the long and narrow tarsus, the thick, terminally enlarged thumb, with its flat nail, all proclaim that affinity; the difference from other *Lemuridæ* being only shown by the more nearly equal length of the four unguiculate toes.

The Aye-aye has a pair of nipples situated one on each side the umbilicus, and on a rather lower level, as in the Tarsier; but there is no trace of a pectoral pair in addition to the ventral pair. The Rodents have three or more pairs of nipples.

Even in regard to the dentition, some very significant approximations to the Rodent-like type in *Chiromys* are offered by the *Lemuridæ* among the Quadrumana. Thus, in the Indris (*Lichanotus*) the lower incisors are reduced to a single pair; and, of the two pairs above, the anterior pair is the longest. In the Tarsiers, also, where a single pair of lower incisors is opposed to two pairs above, the foremost of them is conspicuously the longest, even longer than the canine. In *Propithecus diadema*, Bennett, the first incisor much exceeds the lateral one in size.

The well-marked division of the upper incisor of the Aye-aye into an anterior thicker enamelled portion and a posterior suddenly narrow portion, might suggest the idea of its being the homologue of two incisors blended together; but the larger anterior incisor in *Propithecus*, usurping nearly the whole of the premaxillary, gives the truer view of the nature of the scalpriform pair in *Chiromys*.

The single pair of large inferior incisors, associated, as they are, with the pollicate foot in the Aye-aye, reminds one of the mandibular dentition and feet of the Phalangers; and if such an approach to the Rodent type be made by these pedimanous marsupials without masking their true lyencephalous affinities, as little need it prevent a recognition of the Lemurine nature of the *Chiromys*, where a single pair of upper scalpriform incisors is also paralleled by the marsupial Wombat, which offers the same extreme modification of the dentition of its group,—a relation which Cuvier seems to intimate by associating the skulls of the two 'anomalous' quadrupeds on the same plate of the 'Règne Animal.'

The incisors, although by their size, curvature, depth of implantation, and structure they most closely resemble the scalpriform teeth of the Rodents, yet they are much narrower in proportion to their depth, or fore-and-aft diameter, than in any known Rodent. In this compressed character they more resemble the first upper incisors of *Propithecus*, Benn., and the canines of *Lemur* proper: the shape of the inserted part of the crown is much more laniariform than scalpriform. Nevertheless they are true incisors, like those in *Phascolomys*, but have less resemblance to those of Rodents than in that marsupial. In both the Wombat and the Aye-aye the exposed parts of both upper and lower incisors project more forward, and meet each other more obliquely, than in the true Rodents, in which their direction is more vertical. The molar teeth, on the other hand, oppose each other more vertically than in the Rodents, and show no inclination to the outward bend of the upper and the inward one of the lower molars, so common in that order. The molar teeth, by their simple coronal cap of enamel, depart still more from the complex Rodent type of these teeth, and manifest their essentially quadrumanous nature. Like *Stenops*, *Otolicnus*, and *Tarsius* amongst the *Lemuridæ*, they are more numerous above than below, in the adult Aye-aye—a difference which is rare and exceptional among the *Rodentia*. Their fewness and smallness is a speciality in *Chiromys* among the *Lemuridæ*. The soft, nutritious, readily masticable nature of the food of the *Chiromys* is indicated by their small size and simple obtuse crowns. A reference to the excellent account of the skull and dentition of *Chiromys*, given by De Blainville in his 'Ostéographie,' will show that I have reproduced most of the comparisons which were there first urged in support of its Lemurine affinities. The opportunity of examining a fœtal or very young Aye-aye is much needed to determine the fact of rudimental transitory teeth, between the retained incisors and molars[1].

§ 12. *Comparison of the Skeleton.*

The number of the 'true' vertebræ, and of each of their three kinds ($c\,7$, $d\,13$, $l\,6=26$) in *Chiromys*, agrees with that in *Lemur*, *Tarsius*, and *Sciurus* (as exemplified by *Sc. bicolor*): this, indeed, is a common formula in ordinary quadrupeds. But both in the *Lemuridæ* and *Sciuridæ* there are great differences: in *Stenops tardigradus*, *e. g.*, the formula is $c\,7$, $d\,16$, $l\,8=31$; and in a large flying Rodent (*Anomalurus pelii*) it is $c\,7$, $d\,15$, $l\,10=32$.

The affinities of *Chiromys* are shown rather by the structure of the vertebræ. In the agile Squirrels, which, on the ground, progress by bounds with considerable flexure of the spine, such action is indicated by the much stronger inclination of the vertebral spines before and behind the eleventh dorsal, towards that centre of the spinal inflexions, than is seen in *Chiromys*. The diapophysis, moreover, is distinctly developed on the vertebra, *e. g.* the ninth dorsal in *Sciurus bicolor*, the tenth in *Anomalurus*, where the combined met- and an-apophyses form the ridge above it; and the diapophysis continues to be distinctly developed in the succeeding vertebræ, in which both the metapophysis and anapophysis have become distinct, as is the case in most, if not all Rodents: whereas in *Chiromys*, as in other Quadrumana, the diapophysis is suppressed, or nearly so, in the last two dorsal vertebræ in a degree which is misleading, and has misled, in the attempt to determine the homologies of the lumbar transverse processes. These processes in the *Sciuridæ* are longer and more inclined forward than in *Chiromys* and the *Lemuridæ*. The pleurapophysial parts of the cervical transverse processes are

[1] The interesting observation by Prof. Gervais, cited at p. 27, had not come under my notice when the above passage was in type: it still leaves the uterine and milk stages of dental development to be determined.

more developed in the 3–6 cervical vertebræ in *Sciuridæ*—the axis is longer in proportion to the atlas—than in *Chiromys*.

The chevron-bones (hæmapophyses) are two in number in the caudal region, and are confined to the interspaces between the third and fourth, and fourth and fifth vertebræ in *Chiromys*; they are similarly restricted in number and position in the long-tailed *Lemuridæ*: in the Squirrels and other long-tailed Rodents the hæmal arches may be traced along a much longer proportion of the caudal region.

In comparing the skull of the Aye-aye with that of a Squirrel or other Rodent of equal bulk of body, the first great distinction is shown by the superior size, both absolute and relative, of the brain-case; especially in the part due to the size and convexity of the parietal and frontal bones; making the region, which is low and flat in the *Sciuridæ*, an expanded convex dome in the Aye-aye. The foramen magnum is relatively larger to the cranial cavity in Rodents than in the Aye-aye; it is also vertical in position, looking directly backward; and the superoccipital does not bulge out beyond and behind it, as in *Chiromys*, in which the plane of the foramen is turned as much downward as in other *Lemuridæ*. The cranial vertebræ follow each other in a more straight line, in Rodents; which, with the position of the occipital condyles and aspect of the foramen magnum, causes the premaxillary end of the skull to be on nearly the same line as the cervical axis in the ordinary position of the head. The alisphenoids do not reach the parietals in *Rodentia*, but they rise to the height of the squamosals for that purpose in the Aye-aye, as in most Quadrumana. In the *Chiromys* the bony frame of the orbit is entire; in the Rodents it is widely incomplete behind; and, in the species where a postorbital process is present, it ends in a free point. In the complete circumscription of the rim of the bony orbit, *Chiromys* exemplifies its quadrumanous affinity; whilst it shows the special family to which in that order it belongs, by the deficiency of the wall partitioning the orbital from the temporal cavity. The Lemurs, in this defect, indicate the transition to the lower unguiculate Gyrencephala, the *Galeopithecus* offering the last step by the incompleteness of the orbital frame-ring behind. The outlook of the orbits, obliquely forward, upward, and outward, but least so in the last direction, differs significantly from the direct outward aspect of those cavities in most Rodents. The paroccipital projects freely in *Sciuridæ* and other Rodents; in some, as in the Capybara and Coypu, to a great length. The zygomatic part of the squamosal begins in the Aye-aye at the lambdoidal ridge and extends forward; in Rodents it begins much in advance of that ridge, and inclines downward before bending forward. The malar bone by its width and depth, expanding the orbit by its outer convexity, and uniting behind with the frontal as well as with the squamosal, speaks for the Lemurine and against the Rodent affinities of *Chiromys*: but, as in other *Lemuridæ*, it does not join the alisphenoid, as it does in higher Quadrumana. The posterior plate of the squamosal is long and narrow in Rodents, clamping the tympanics and mastoids to the sides of the cranium; no approach to this character is seen in *Chiromys*. The facial plate of the maxillary in Rodents is either almost used up by a large antorbital vacuity (*Anomalurus*), or if entire, as in *Sciurus*, is scooped by a deep vertical channel. In *Sciurus bicolor* the maxillary as well as the premaxillary joins the broad frontal; in *Anomalurus pelii* a larger lacrymal is interposed, as in *Chiromys*; but no Rodent shows the lacrymal fossa and foramen on the facial plate, external to the rim of the orbit, as in *Chiromys*: this is a very significant mark of the close affinity of this genus with the *Lemuridæ*, in which the entry of the lacrymal canal is external to the orbit. The interposition of the premaxillary between the nasal and maxillary is one of the most marked differences in the skull between *Chiromys* and other Quadrumana; its agreement in this respect with Rodents depends upon the anomalous development of the incisors. The nasal septum is continued almost to the hinder opening of the nasal passages in *Chiromys* as in *Lemuridæ*, but is far from reaching that orifice in the *Sciuridæ*. The pterygoid processes of the alisphenoid show no trace, in *Chiromys*, of the canal for the ectocarotid, so general in *Sciuridæ* and other families of *Rodentia*.

Viewing the Aye-aye as among the lowest forms of Quadrumana, it is interesting to find a reappearance of the frontal sinuses which the highest of that order exhibit, but which are wanting, as a rule, in the intermediate series, from the Apes to the normal *Lemuridæ* inclusive. The maxillary series of sockets converge more or less anteriorly in all Rodents,—least so, perhaps, in *Sciurus*; but there is no such convergence in *Chiromys*. The diastema is chiefly in the maxillary, and is sharp, in *Chiromys*; it is chiefly in the premaxillary, and is smooth, broad, and convex, in *Rodentia*. In this order the squamosal is peculiar for its length, its straight upper border, and the detachment of the zygomatic process from the fore part of the outer side; it forms a deep longitudinal groove for the mandibular condyle, and does not anchylose with the petrotympanic element. None of these characters are shown in the squamosal of the Aye-aye, which conforms with that in the *Lemuridæ*, and more especially departs from the Rodent type in the broad flat articular surface for the lower jaw; but this has no posterior ridge. A well-ossified palate is an exception in the *Rodentia*, and the *Sciuridæ* show best that exception; but in these the prepalatine or incisive vacuities are longer than in *Chiromys*, and the postpalatine notch is deeper: in the breadth of the bony palate the Squirrels come nearest to the Aye-aye.

The mandibular condyle in *Chiromys* approaches the form of that in *Rodentia* by the superiority of its fore-and-aft over its transverse diameter; but, in its oval convexity, it resembles more nearly the condyle in *Tarsius* than that of any Rodent. In all Rodents the condyle of the mandible is higher than the level of the grinders; the angle of the jaw is produced backwards beyond it; the long and narrow coronoid process curves back to nearly the same vertical line with the condyle. The symphysis reaches the lower border of the ramus, and the curved incisive socket projects more or less from the inner surface. All these Rodent characteristics of the mandible are wanting in *Chiromys*. In certain *Lemuridæ* (*Stenops*, *Lichanotus*, Illig., *Propithecus*, Bntt.) the angle of the jaw is rounded off; but it is nearly on a vertical line with the condyle: its advanced position in *Chiromys* is a speciality in the Quadrumanous series. It is one which leads it still further from the Carnivora; and the sessile condyle contrasts strongly with the pedunculate one, especially in the small extinct Ferines (*Plagiaulax* and *Triconodon*) of the Purbeck beds, where a concomitant difference is shown in the dentition; trenchant teeth, grooved as in the lower carnassials of *Thylacoleo*, holding, in them, the place of the thick flat-crowned molars of *Chiromys*.

The scapula of *Chiromys* differs from that of Rodents, and resembles that of Lemurs, in the proportions of the supra- and infra-spinal fossæ. The subscapular surface does not show the intermuscular cristæ which are usually so well marked in Rodents. The lower border, though well everted, has less the character of a second spine than it shows in the Squirrels.

The perforation above the internal condyle of the humerus is the rule in the *Lemuridæ*; it is the exception in the *Rodentia*. The perforation between the condyles is common in the *Rodentia*[1]; it is not present in the *Lemuridæ*. In the foregoing comparison the humerus of *Chiromys* agrees with that in the *Lemuridæ*. In its relative length to the thorax, for example, the humerus of *Chiromys* agrees with that shown by *Lemur* and *Nycticebus*: in *Sciurus* and most Rodents the humerus is relatively shorter; only in the volant *Pteromys* and *Anomalurus* the humerus differs as much, or more, by its greater length, as it does in *Galeopithecus*, from that in *Chiromys*. The straight outline of the deltoid ridge in the Aye-aye's humerus is a Lemurine feature: its lower part projects and forms an angle in *Sciurus*. The configuration of the elbow-joint is more Lemurine than Sciurine in *Chiromys*.

The Aye-aye resembles the *Lemuridæ* and Platyrhine Quadrumana in the complexity of its carpal structure,—the 'intermedium,' sometimes described as a dismemberment of the scaphoid, sometimes as that of the magnum, being present, together with the accessory scapho-trapezial sesamoid; but the scaphoid shows the proportion in respect of length whereby the *Lemuridæ* more resemble, than do other Quadrumana, the Carnivora. The Squirrels (*S. bicolor*, e. g.) have the intermedium and the accessory sesamoid; but the scaphoid and lunare are confluent: other Rodents depart further from the Lemurine type of carpus which *Chiromys* exemplifies.

The pelvis of the *Chiromys*, in the ilio-vertebral and ilio-pubic angles, in the degree of expansion of the fore part of the ilium, in the smoothness of its outer surface, and in the moderate development of the ischial tuberosities, closely accords with the Lemurine type. It strongly departs from the Rodent type in the ilio-pubic angle, which in the Squirrels is 145°, in the Aye-aye 110°. The iliac bones, moreover, in most Rodents are

[1] The intercondyloid perforation, without the supracondyloid one, occurs in *Leporidæ*, *Capybara*, *Cavia*, *Dolichotis*, *Chinchilla*, *Lagotis*, *Myopotamus*, *Cœlogenys*, *Dasyprocta*, *Hystrix*, and *Arvicola*. The supracondyloid perforation, without the intercondyloid one, is found in *Sciurus*, *Pteromys*, *Myoxus*, *Anomalurus*, *Helamys*, and *Dipus*. Both perforations are wanting in *Castor* and *Arctomys*.

bent outwards at their summits, which are thickened and tuberous, and the outer surface is bisected by a longitudinal ridge. On the other hand, the ischial tuberosities do not bend out in Rodents, as in *Chiromys* and the Quadrumana. The obturator foramina are relatively larger in *Rodentia* than in *Lemuridæ* or in *Chiromys*.

The femur, equalling in length the last ten true vertebræ, offers, in *Chiromys*, a proportion to the trunk more common in *Lemuridæ* than in *Rodentia*. In the Squirrels, for example, the femur is relatively shorter to the trunk, and the ridge for the ectogluteus projects as a third trochanter. In most Rodents the lower extremity of the femur is less expanded, comparatively with the shaft, than in *Chiromys*, where the femur closely repeats the proportions and formal characters of that in *Lemur* proper.

The tibia, by its near equality of length with the femur, instructively proclaims the quadrumanous nature of *Chiromys*: in most Rodents, and especially those with long hind limbs, or when these have the same proportion to the trunk as in *Chiromys*, the leg is longer than the thigh, usually in a well-marked degree. The fibula is more slender in proportion to the tibia in the Squirrels and other Rodents, where it is a distinct bone, than in the Aye-aye and *Lemuridæ*; it is also situated more posteriorly: in most Rodents it anchyloses with the tibia.

Amongst the pentadactyle Rodents, the Squirrels most resemble the Aye-aye in the structure and proportions of the tarsus; but the inner part of the naviculare, which articulates with the backwardly produced angle of the ento-cuneiforme, is a distinct bone in *Sciurus* as in other pentadactyle Rodents: in *Castor* the dismembered part of the naviculare articulates with a larger proportion of the ento-cuneiforme, and there is a second accessory ossicle on the radial side of the tarsus. But the size, shape, and position of the articular surface for the hallux still further differentiate the ento-cuneiforme in *Chiromys* from that in any Rodent, relating as it does to the capital distinction of the opposable hinder thumb, which unites the Aye-aye with other Quadrumana. In the relative length of the tarsus to the leg and to the rest of the foot, the *Chiromys* most resembles *Lichanotus* and *Propithecus*: it is rather shorter than in *Lemur* proper, being less than one-third the length of the tibia, and only about one-fourth the length of the whole foot. The scaphoid and calcaneum are proportionally rather shorter than in *Lemur* proper or *Perodicticus*, Btt. The bones figured as tarsal ones of the Aye-aye in De Blainville's 'Ostéographie' (*Lemur*, pl. 5) do not belong to that animal: the calcaneum and naviculare exhibit the excessive length characteristic of *Tarsius* and *Otolicnus*[1], and agree in size, as do likewise the tibia and fibula of the same plate,

[1] *Otolicnus crassicaudatus*, Wagner, or 'Grand Galago,' of which Cuvier figures the skin in his 'Règne Animal,' ed. 1817, pl. 1. fig. 1, from which specimen the bones, supposed to belong to the Aye-aye, had probably been taken; and it might be from the examination of this very specimen that Cuvier was enabled, for the first time, to make known that, "Dans les Tarsiers et les Galagos, les os *scaphoïde* et *calcaneum* sont prolongés de manière à donner à leur tarse autant de longueur qu'à celui de certains oiseaux."—'Ossemens Fossiles,' 4to, tom. iii. p. 508 (1822).

with those bones in *Otolicnus crassicaudatus*, Wagn.[1] The sum of the osteological comparisons favours the affinity of *Chiromys* with the *Lemuridæ*, and with that section having the less elongate tarsus.

Comparison of Muscles.—Although, in a comparison of the Quadrumana with their conterminous Gyrencephalous order, the Carnivora, the size and distinctness of the clavicular portion of the *sterno-cleido-mastoideus*, in *Chiromys*, shows its resemblance to the Quadrumana; yet, as the difference depends on the non-claviculate character of the Carnivora, a remnant only of the clavicular strip of the muscle being present in those with small free clavicular bones, as the *Felines*, and being wanting in those without clavicles, we cannot derive the same evidence of the ordinal relations of *Chiromys* when we extend the comparison to the myology of those of the Lissencephalous group which have complete collar-bones. In the Squirrels, *e. g.*, a clavicular strip exists, which differs from that of *Chiromys* only in its minor relative size to the sternal portion. The well-developed *digastricus*, with its distinct intermediate tendon, is a more decisive mark of the Lemurine affinity of *Chiromys*, as against the Rodents. In the muscles of the jaw of *Chiromys*, although the masseter has unusual thickness and strength, it retains the character of that muscle in the Quadrumana, and there is no trace of the peculiarly distinct oblique strip, described as an accessory masseter, in the *Rodentia*,—especially in those with the large antorbital vacuity. In the muscles of the limbs, especially in the tendinous strip uniting the flexor sublimis and flexor profundus muscles for a partially

[1] [Prof. Gervais, of Montpellier, having visited the British Museum since the first sheets of the present work went to press, I communicated to him my suspicion as to the origin of the tarsal bones figured by De Blainville as those of the Aye-aye, in his 'Ostéographie des Lemurs,' pl. 5, and requested him to oblige me by inspecting the stuffed specimens of the Aye-aye and Galago on his return to Paris. The following is the reply with which I have been favoured by the accomplished Professor:—

"Mon cher confrère,—C'est hier seulement que j'ai pu vérifier dans les galeries du Muséum de Paris le point relatif à l'Aye-aye que vous m'aviez indiqué. Je n'ai malheureusement pas pu retrouver le tarse figuré dans l'Ostéographie, et que M. Laurillard supposait provenir de l'Aye-aye; mais une patte postérieure de la même espèce, tirée du sujet donné à la collection par M. de Castelle, ne laisse aucun doute. Comparée à la figure publiée dans le Fascicule des Lémurs, elle montre des différences analogues à celles que vous m'avez vous-même fait remarqué. J'ai examiné ensuite, ainsi que nous en étions convenu, la peau bourrée de l'exemplaire de Sonnerat. Les deux pattes de derrière n'ont point été touchées, et leurs parties osseuses, les deux tarses compris, y sont encore en place. Il n'en est pas de même du *Galago crassicaudatus*; l'individu encore unique que l'on a conserva, et qui est celui décrit par G. Cuvier et E. Geoffroy, n'a plus son tarse gauche, quoique les phalanges et les métatarsiens du même côté soient restés dans la peau, et que la patte droite soit absolument intacte. Il est évident qu'on en a retiré, après l'empaillage, le tarse aujourd'hui manquant, et tout fait supposer (je ne puis dire atteste, parceque la pièce n'est pas sous mes yeux, et qu'il ne subsiste aucune note au sujet de cette opération) que le tarse figuré comme étant celui de l'Aye-aye est bien, comme vous l'avez supposé, le tarse du *Galago crassicaudatus*.

"J'ai pensé que ces détails vous feraient plaisir, et je vous les communiquer immédiatement.

"Croyez à mon entière considération et à mon affectueux dévouement, votre très-empressé,

"Paris, 28 Octobre, 1862." "Paul Gervais."]

associated action, the Aye-aye resembles the *Tarsius* dissected by Burmeister, the *Stenops* dissected by Vrolik, and the *Perodicticus* dissected by Van der Hoeven.

Comparison of the Brain.—The brain of the Aye-aye, by the proportion and relative position of the cerebrum to the cerebellum, and by the fissures and folds of the cerebral surface, determines *Chiromys* to be a member of the wave-brained section of Mammalia, *Gyrencephala*; and in that section it most resembles, in the number and disposition of the primary convolutions of the cerebrum, as well as in general shape and proportions, the brain of *Lemur* proper. The brain of the little Tarsier (*C. tarsius*), whilst exhibiting the more constant and essential gyrencephalous character, as do other diminutive species, in the extension of the cerebrum over the cerebellum, shows an almost entire absence of superficial fissures. In that of the *Tarsius* figured by Burmeister [1], the fore part of the sylvian fissure and the short vertical fissure in the sylvian fold are all the traces of convolutions which are indicated. In the brain of the Javanese Slow Lemur (*Stenops javanicus*), described and figured by Schroeder Van der Kolk and Vrolik, the sylvian fissure extends to the upper surface of the cerebrum; the Aye-aye, in this respect, being intermediate between *Stenops* and *Tarsius*. The sylvian fold, in *Stenops*, is also indented by the vertical fissure, which is more wavy than in *Chiromys* or *Tarsius*; but the suprasylvian and medio-longitudinal fissures are wanting in *Stenops* as in *Tarsius*. *Stenops*, however, shows the bifurcate anterior ends of the medio-longitudinal fissure, and a transverse curved fissure near the back part of each hemisphere, answering to that marked 7, in the brain of the Cat, in my memoir on the Cheetah[2], which is wanting in *Chiromys*. The side of the anterior lobe in *Stenops* appears to have a deeper and better-marked vertical fissure, curved with the convexity forward: a few shallow linear indentations mark the sides of the narrower anterior lobes in *Chiromys*. This animal, therefore, like the Mongoz Lemur, associates with its superiority of size over *Stenops* and *Tarsius* a more regular and complex folding of the cerebral superficies.

In the Squirrels the cerebral hemispheres are devoid of convolutions, and do not extend over the cerebellum; and in the few larger *Rodentia*, as, *e. g.*, *Agouti* [3], *Capybara*, in which any fissuring of the cerebral surface appears, it is as a feeble trace of the medio-longitudinal fissure, and is associated with the depressed form and small proportion of the cerebrum characteristic of the Lissencephalous group. By the brain alone *Chiromys* is proved to be no Rodent, but might be recognized as a true Gyrencephale, and, in that category, as having its nearest affinity with the *Lemuridæ*.

In the absence of the digital eminence and in the restricted development of the back part of the lateral ventricle, *Chiromys* resembles *Stenops*: its brain shows no indication of the linear fissure produced backward from the beginning of the descending horn, which Burmeister figures in the brain of *Tarsius* [4].

[1] *Op. cit.* p. 30, pl. 1. figs. 1–4. [2] *Op. cit.* pl. 20. fig. 4.

[3] Prep. No. 1323 G, Physiol. Series, Hunterian Collection; Physiol. Catalogue, vol. iii. p. 29.

[4] *Op. cit.* taf. 6. fig. 15.

The 'flocculus cerebelli,' into which Foville traced the origin of the acoustic nerve, is present in most of the timid and sharp-eared Rodents; but it is likewise present in the *Stenops* and *Tarsius*, and is associated, as its presumed function might lead one to suspect, with the large external ears and well-developed auditory organ of *Chiromys*.

The 'appendiculus' is present in the cerebellum of the smaller *Lemuridæ* [1] as in that of *Chiromys*.

The rhinencephala, or olfactory bulbs, project in advance of the prosencephala in all Rodents; and this appears likewise to be the case with the *Tarsius*; but *Chiromys* agrees with the higher *Lemuridæ* and Quadrumana in the production of the anterior cerebral lobes above the olfactory lobes.

The Viscera.—In the following comparison of the internal abdominal and thoracic organs of the Aye-aye, I shall restrict myself to the Quadrumanous and Rodent orders, and herein to the Lemurine and Sciurine families respectively. In both these families the large obtuse blind end of the stomach projects far to the left of the cardia; this orifice and the pylorus are approximated; and the 'lesser curvature' is accordingly very short. But the stomach of the Aye-aye more resembles that of *Stenops* than of *Sciurus*; the œsophagus is less prolonged in the abdomen than in the Squirrels and most Rodents.

The cæcum presents a point of greater contrast between the Lemurs and the Squirrels. In the latter this gut is very long, is narrowest where the ileum enters, and increases to its blind end, which is thick and obtuse; most of the cæcum exceeding in width the rest of the large intestines. In the Lemurs the widest part of the cæcum is where the ileum enters, and it diminishes in diameter to the blind end, and, in most, rather suddenly about halfway thereto, which has led to the comparison of the cæcal half to the 'appendix cæci,' especially of the human fœtus [2]. In the characters of the cæcum, the Aye-aye strongly manifests its Lemurine affinities: this gut is scarcely one-fifth the length of the body from the muzzle to the tuber ischii, whilst in the Grey Squirrel the cæcum is half the length of the body. In this Rodent the large intestines are twice the length of the body, but they are only one-fourth longer than the body in the Aye-aye.

The small intestines are rather more than three times the length of the body in the Aye-aye, while in the young Squirrel they are seven times the length of the body.

The divisions of the liver are at, or nearly at, right angles to the surface of the gland in the Aye-aye, as in the Lemurs; in the Squirrel they are oblique and deeper, the left lobe covering almost all the others.

The tongue becomes a good test of affinity, owing to its well-marked characteristics

[1] Burmeister, *op. cit.* taf. 6. figs. 13, 16.

[2] "The cæcum is long, and terminates almost in a point, and looks like the appendix cæci in the human, especially the appendix in the fœtus."—Hunter, 'Posthumous Essays and Observations on Natural History, Anatomy,' &c., 8vo, 1860, vol. ii. p. 33 (*Stenops gracilis*). Schroeder Van der Kolk and Vrolik have made the same comparison:—"Mais il est bon d'observer que chez l'enfant en bas âge et chez les anthropomorphes l'appendice vermiforme ressemble assez au prolongement en pointe du cæcum chez le *Stenops*" ('Recherches d'Anatomie Comparée, sur le genre *Stenops*,' p. 50).

in the Rodents and Lemurines respectively. The Squirrels, like other Rodents, have a short tongue, thick vertically, and especially between the molar teeth, where the dorsum rises above the tip, forming the 'intermolar lobe,' which commonly bears the impress of the palatal furrows.

In the Aye-aye there is no structure like this: the tongue is thickest transversely, has a longer portion free, and, above all, it is characterized by the sublingual firm plate, corresponding in general form and structure with that in other *Lemuridæ* [1].

The small median supra-thyroid laryngeal sacculus is an indication of the quadrumanous nature of *Chiromys*.

In the vascular system, the disposition of the great veins entering the heart affords a test of the affinities in question. In the *Sciuridæ*, as in most other Rodents, the left trunk of the jugular and subclavian veins passes down the back part of the auricle to enter close to the orifice of the post-caval vein: in the Aye-aye, as in the *Lemuridæ* and all Quadrumana, that venous trunk crosses the fore part of the arteries rising from the aortic arch to join the corresponding trunk on the right side and to form a true 'pre-caval' vein.

The organs of generation are important indications of natural affinity in the Mammalian class, more especially the male organs, of which the sex of the Aye-aye dissected by me permits this application. In all Rodents the peritoneal opening of the serous sac of the testis is so wide, and the cremaster so large and so disposed, that the gland can be withdrawn into the abdomen, and it emerges into a temporary sessile scrotum only under the seasonal enlargement for procreation, which is considerable. Thus, the *Rodentia* are 'temporary testiconda.' The Aye-aye has not this organization: the testes are permanently 'scrotal' after their passage out of the abdomen.

The Squirrels, like other *Rodentia*, have distinct 'vesiculæ seminales' with thick glandular coats: in the *Leporidæ* the vesicula is single, but large. The absence of distinct vesicular bag or bags in the Aye-aye removes it from the *Rodentia*, whilst the size and shape of the prostate[2] and of Cowper's glands approximate it to the *Lemuridæ*.

More decisive testimony is given by the penis. The Squirrels and all *Rodentia* are 'retromingents,' the penis being bent back suddenly upon itself, with the 'glans' lying in a prepuce which opens close to the anus. In the Aye-aye, as in the *Lemuridæ* and other Quadrumana, the preputial sheath of the penis projects freely forward to the extent signified by the Linnean character 'pendulous,' applied to the 'Primates' generally in the 'Systema Naturæ.'

[1] Hunter, in *Lemur mongoz*, L.:—"The tongue has a part underneath in shape like a bird's tongue, so that it might be called double-tongued" (*op. cit.* vol. ii. p. 29). See Hunterian Preps. Physiol. Series, Mus. Coll. Chir., Nos. 1516, 1517, and 1518; Physiol. Catal. 4to, vol. iii. (1836) pp. 83 and 84; Burmeister, in *Tarsius*, *op. cit.* 1846, p. 104. pl. 6. fig. 2; Van der Kolk and Vrolik, in *Stenops*, *op. cit.* p. 52. pl. 1. fig. 5 *b*.

[2] Hunter, in *Stenops gracilis*:—"The prostatic glands are two at the basis [or the gland is left there], like the heart on playing-cards." (See Prep. Phys. Ser. Mus. Coll. Chir. No. 2564; Physiol. Catal. vol. iv. p. 101.)

§ 13. *Conclusion.*

The pressure of official duties and engagements has prevented my further unravelling the structure of this little denizen of the woods of Madagascar. I should otherwise gladly have pursued the investigation to a degree of completeness more nearly approaching that of which Burmeister has left so admirable an example in his 'Beiträge zur nähern Kenntniss der Gattung *Tarsius*,' 4to, 1846. Believing, however, that the main points required for determining the moot relationship of *Chiromys* to the Mammalian orders had been looked to, I felt it due to zoologists to submit the results to their judgment, without further delay.

The first and, to my mind, most congenial reflection that arose on the survey of these structures was their adaptive relations to the known way of life and favourite kind of food of the Aye-aye.

This quadruped is stated to sleep during the heat and glare of the tropical day, and to move about chiefly by night.

The wide openings of the eyelids, the large cornea and expansile iris, the subglobular lens and tapetum, are arrangements for admitting to the retina, and absorbing, the utmost amount of the light which may pervade the forest at sunset, dawn, or moonlight. Thus the Aye-aye is able to guide itself among the branches in quest of its hidden food. To detect this, however, another sense had need to be developed to great perfection. The large ears are directed to catch and concentrate, and the large acoustic nerve and its ministering 'flocculus' seem designed to appreciate, any feeble vibration that might reach the tympanum from the recess in the hard timber through which the wood-boring larva may be tunnelling its way by repeated scoopings and scrapings of its hard mandibles. How safe from bills of birds or jaws of beasts might seem such a grub in its teak- or ebony-cased burrow! Here, however, is a quadrumanous mammal in which the front teeth, by their number, size, shape, implantation, and provision for perpetual renovation of substance, are especially fitted to enable their possessor to gnaw down, with gouge-like scoops, to the very spot where the ear indicates the grub to be at work. The instincts of the insect, however, warn it to withdraw from the part of the burrow that may be thus exposed. Had the Aye-aye possessed no other instrument—were no other part of its frame specially modified to meet this exigency—it must have proceeded to apply the incisive scoops in order to lay bare the whole of the larval tunnel, to the extent at least which would leave no further room for the retracted grub's further retreat. Such labour, however, would have been too much for the reproductive power of even its strong-built, wide-based, deep-planted, pulp-retaining incisors: in most instances we may well conceive such labour of complete exposure of the burrow to be disproportionate to the morsel so obtained. Another part of the frame of the Aye-aye is, accordingly, modified in a singular and, as it seems, anomalous way, to meet this exigency. We may suppose that the larva retracts its head so far from the opening gnawed into its burrow as to be out of reach of the lips, teeth, or tongue of the Aye-aye. One finger, however, on each hand of that animal has been ordained to grow in length, but not in thickness, with the other digits: it remains slender as a probe, and is provided at the end with a small pad and a hook-like claw. By the doubtless rapid insertion and delicate application of this digit, the grub is felt, seized, and drawn out. But for this manœuvre the Aye-aye needs a free command of its upper or fore limbs; and, to give it that power, one of the digits of the hind foot is so modified and directed that it can be applied, thumb-wise, to the other toes, and the foot is made a prehensile hand. Hereby the body is steadied by the firm grasp of these hinder hands during all the operations of the head, jaws, teeth, and fore paws, required for the discovery and capture of the common and favourite food of the nocturnal animal.

It is interesting to note the correspondence between the breadth of the pair of incisors and the thickness of the mid-digit. The channel which those scalpriform teeth gouge out of the solid wood is not broader than is required to allow the prehensile finger to penetrate. Every line's breadth of the cutting edge of the chisel adds to the resistance which it has to overcome: its work is here reduced to the minimum requisite: but that this should be performed well and quickly, the scooping tooth is made of unusual depth, and has peculiar fore-and-aft extent, resembling in this respect the chisel for paring iron in machine-works.

Thus we have not only obvious, direct, and perfect adaptations of particular mechanical instruments to particular functions—of feet to grasp, of teeth to erode, of a digit to feel and to extract,—but we discern a correlation of these several modifications with each other, and with modifications of the nervous system and sense-organs—of eyes to catch the least glimmer of light, and of ears to detect the feeblest grating of sound,—the whole determining a compound mechanism to the perfect performance of a particular kind of work[1].

[1] The Superintendent of the Zoological Gardens communicated to the Zoological Section of the British Association at Cambridge, October 3rd, the fact that the Aye-aye then living in the Zoological Gardens refused the mealworms, weevils, and other insects which had been offered to it for food. A repudiator of the principle of final causes thereupon objected to the evidences of adaptation above cited, which I had previously communicated to the Section, "that they could have no such meaning, inasmuch as the Aye-aye would not feed on insects." I replied that the fact communicated by Mr. Bartlett received, and could only receive, its true explanation through teleology. The native habits and food of the Aye-aye exemplified its operation and purpose in the woods of Madagascar as a check upon the undue prevalence of tree-destroying Xylophagous larvæ. Had the Aye-aye possessed an indiscriminate appetite for insects, it would satisfy such appetite on much easier terms than by gnawing into hard wood for a particular kind of grub. But, as M. Liénard had testified, before Mr. Bartlett, "il ne voulait pas de larves de tous les arbres indistinctement; il les reconnaissait en les flairant." The restriction of its likings to the wood-boring kinds ensured, and was necessary to ensure, the application to their extraction of the efficient instruments with which the Aye-aye had been endowed for the purpose. Thus teleology renders the fact of the non-indiscriminate taste for insects intelligible: the negation of intention and design blinds the mind to the recognition of the significance of the fact, and leads to the more stupid blindness

But all this must have a cause; and our sole guide to a conception of its nature is the analogical connexion of its effect with that of the exercise of faculties which energize in our own intellect. Such energy, by way of foresight, invention, and adaptation, has produced many machines for useful ends; and so, through study of analogous but more perfect results, we seem to discern the exercise of like faculties in a transcendently higher degree.

To conceive the direct formation and adjustment of such an organization as the Aye-aye's to its purpose accords best with, and comes most home to, the mode of our finite human adaptive operations. And here Paley and the pure teleologist would pause. But I would next remark that we further discern the higher marvel of such a correlated organic machine being capable of reproducing itself by the act of generation. That act premised, Aye-aye after Aye-aye becomes what it is, through progressive growth and development, from the condition of a minute pellucid monadiform cell. The whole of its exquisitely adjusted structure is built up according to law. Still more marvellous, and almost transcending our scope of thought or power of clear conception, is the possibility of such organic mechanism, with its faculty of reproduction, being the necessary, but not the less fore-ordained, result of the nature and adjustment of influences forming part of the general system of our planet, with its varied forces, acting and reacting under certain conditions so as to issue in such a result.

Some minds, indeed, lose their hold of the notion of design in passing beyond the conception of a direct act of the Designer in the formation of an organic and self-reproductive machine. Yet the idea of a forecasting, designing Power is not incompatible with the conception of the constitution of an organized species by the operation of forces and influences which are part of the ordained system of things; and if the nature of such operation be not comprehended, it, at least, may be a legitimate subject of an endeavour at comprehension. The human intellect has power so to conceive the relations of numbers as to give expression to such conception, for example, by the terms of the 'Binomial Theorem'; and successive mathematicians concur in accepting and using the theorem as the true expression of such cognition. As the human intellect has been framed by its Author, it could not otherwise best express such numerical relations; and this impossibility of any other relation between the conception and expression of the theorem may be stated in terms not unusual with the old scholastic disputants, but jarring

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to any meaning in the coadjustment of special modifications which render the Aye-aye so effective an antagonist to the wood-boring larvæ of the forests it inhabits.

The great Anteater, when in captivity at the Zoological Gardens, refused to feed upon the ants which were offered in abundance to it. Their pungent formic acid seemed to disgust the animal. It was, in fact, adapted to keep in check insects of another order—the destructive *Termites*. And, in their dearth, it was kept alive, during its captivity, on milk, yolk of egg, and boiled liver chopped small. But it was not, therefore, concluded that the long tongue, huge salivary glands with their bladders, correlatively modified toothless jaws, gizzard, powerful claws, &c., were of no special use—were devoid of any explanation on the principle of design and adaptation.

against later and better taste, viz. that "God himself could not abrogate such necessary result of the necessary relations of numbers."

And, nevertheless, that result may be, and by the healthy human mind, in carefu thought, is felt to be, a high act of creative power; and the appreciation of its necessity is an endowment which engenders in such mind a spirit of grateful devotion.

So, also, conditions of existence have a creative cause, as well as the animals related to those conditions. Constructed as we find them, animals are necessarily so related, and must be affected by every change in such conditions.

But if we can conceive such conditions to change agreeably with the laws of their being,—the crust of the earth, *e. g.*, having been created to move up and down, affecting its relations to water, air, temperature, and other circumstances influencing living beings,—these beings and their dwelling-place having been created as they are, with such interdependencies,—the changes are necessary, may be called fatalistic, and yet are not the less a preordained result of the Creator of the arrangements, foreseeing the consequences of a long-continued series of operations and influences, educing new adjustments and developments out of efforts and exercises of organs stimulated by surrounding changes, or out of slight departures from parental form; which change of organs by change of exercise, and which congenital deviations or varieties, were equally a fore-ordained property of the living species.

Whether such considerations be evidence of careless thinking, and whether, as some affirm, they blot God out of creation[1], may be left to the judgment of sound and unbiassed intellects.

The adaptation of the earth to our well-being, by its waters and lands, with localized

[1] On the appearance of the work in which I first expressed the opinion that the "orderly succession and progression of organic phenomena may be the result of natural laws or secondary causes," whilst admitting ignorance of their nature or mode of operation ('Nature of Limbs,' 8vo, 1849, p. 86), I was assailed as follows:—"But it is not German Naturalists alone who are contributing to diffuse scientific Pantheism. We have in England an anatomist and physiologist, Richard Owen, who, in a lecture on the 'Nature of Limbs,' which was delivered at the Royal Institution in February last, and has since been published, brings all his profound scientific knowledge and demonstrative skill in support of what is called the 'Theory of Development.' This theory, as our readers may know, assumes that God did not interpose to create one class of creatures after another, as a consequence of each geological revolution; but that, through long course of ages, one class of creatures was developed from another." The writer then quotes from the lecture to show that its author "concludes that God has not peopled the globe by successive creations, but by the operation of general laws." ('Little Lectures on Great Topics,' *Manchester Spectator*, December 8, 1849.)

The true state of the case is simply this: my assailant has his own notions of the exterminating character "of each geological revolution," and of the way in which "God, thereupon, interposed to create one class of creatures after another." But there are phenomena which God, in His unsearchable ways, permits to be known by His observant instruments; and these phenomena, faithfully interpreted, plainly indicate that He has been pleased to operate differently from what some prefer to believe. Thereupon the interpreter is charged with "blotting God out of creation." But in such charge truly lies the impiety. Could the pride of the heart be reached whence such imputation came, there would be found, unuttered,—"Unless every living thing has come to be in the way required by my system of theology, Deity shall have no share in its creation."

coal, chalk, &c., through secondary causes which have developed the present varied condition of its surface by means of slow physical and organic operations through long ages, is not the less clearly recognizable as the act of all-adaptive Mind, because we have abandoned the old error of supposing it to be the result of a primary, direct, and sudden act of creational construction.

So neither would the phenomena of the long succession of organized species justify the notion, nor do I believe they would suggest, that they were the result of blind chance, if it should be demonstrated that they, too, are the result of secondary influences operating through long ages. It may be true that many of the aims of derivative tendencies miss their end: but myriads of germs never reach perfection; and the proportion of such short-coming is much greater in the phenomena of human life. These serve to exemplify abundantly in how small a degree the doings of the highest created agent here square with the ideal of the aim and end of his existence: yet he is not, therefore, argued to be a thing of chance. The succession of species by continuously operating law is not necessarily a "blind operation." Such law, however dimly discerned in the properties and successions of natural objects, intimates, nevertheless, a preconceived progress. Organisms may be evolved in orderly succession stage after stage, towards a foreseen goal; and the broad features of the course may still show the unmistakeable impress of divine volition.

But the conception of the origin of species by a continuously operative secondary cause or law is one thing; the knowledge of the nature and mode of operation of that cause is another thing.

One physiologist may accept, another refute or reject, a transmutational or natural-selective hypothesis; and both may equally hold the idea of the successive coming-in of species by law[1].

What I have termed the 'derivative hypothesis' of organisms, for example, holds that these are coming into being, by aggregation of organic atoms, at all times and in all places, under their simplest unicellular condition; with differences of character as many as are the various circumstances, conditions, and combinations of the causes educing them,—one form appearing in mud at the bottom of the ocean, another in the pond on the heath, a third in the sawdust of the cellar, a fourth on the surface of

[1] No relaxation is more agreeable to the inductively drudging mind than an occasional release from the trammels of fact, to soar in the regions of conjecture, and indulge in easily feigned creative ways and means. Those who yield least to this enjoyment respect most the workers who refrain; whilst he who most hastily and clamorously welcomes each new phase of the hypothesis-inventing faculty is apt to be least charitable to his more cautious or reticent fellow-labourers. But I would offer this consolation to those whom Professor Grant stigmatizes as "species-mongers" ('Tabular View of the Primary Divisions of the Animal Kingdom, &c.,' 8vo, 1861, p. vi.):—For all the intents and purposes of the descriptive and recording naturalist, species are constant; they will last our time. When the existing binomial units of botanical and zoological specific lists cease to show their present distinctive characters, the *Homo sapiens* of Linnæus will have merged into another, probably a higher, specific form.

the mountain rock, &c., but all by combination and arrangement of organic atoms through forces and conditions acting according to predetermined law. The disposition to vary in form and structure, according to variation of surrounding conditions, is greatest in these first-formed beings; and from them, or such as them, are and have been derived all other and higher forms of organisms on this planet. And thus it is that we now find energizing in fair proportions every grade of organization from Man to the Monad. Each organism, as such, also propagates its own form for a time under such similitude as to be called its kind.

Specific characters are those that have been recognized in individuals of successive generations, propagating similar individuals, as far back as observation has reached; and which characters, not being artificially produced, are ascribed to nature. Instead of referring such characters to an originally distinct creation, the derivative hypothesis, whilst admitting their transmissibility and their maintenance for an unknown period through generative powers obstructive of departure from such characters, holds that observation has not yet reached the actual beginning of such species, nor the point at which variation stops.

Now, the foregoing hypothesis is at present based on so narrow and, as respects the origin of life, so uncertain a foundation of ascertained facts[1], that it can be regarded only as a kind of vantage-ground artificially raised to expand the view of the outlooker for the road to truth, and perhaps as supporting sign-posts directing where that road may most likely be fallen in with.

In the meantime different hypotheses, guesses, and beliefs have been propounded in explanation of the way of the origin of species. And the Aye-aye lends itself with advantage as a test of some of these.

Buffon assumes the direct or immediate primitive creation of a certain number of organic forms, which may truly and intelligibly be called 'types.' These, left to the operation of secondary laws in a 'world accursed,' have had degenerate successors; and the departures from type, varying according to the diversity of deteriorating influences, are represented by the majority of the naturalist's species of the present day. Applying his principle to those he had treated of in his great 'Histoire Naturelle[2],' Buffon believed that he was able to reduce them to fifteen primitive stocks. The theory of 'degeneration' assumes a course of change inversely to that of 'derivation'; which, moreover, rigidly excludes the operation of any cause, not in the actual category of powers, of the origin of the parent forms of organic beings. I will not occupy time in attempting to show how the 'degeneration-hypothesis' could have operated in producing the various remarkable correlated structures in the organization of the Aye-aye: it might have been regarded by Buffon as a primitive type, or an 'isolated form.'

[1] Annales des Sciences Naturelles, 1861, p. 33 (Pasteur); *ib.* 1862, p. 277 (Pouchet; able in refutation of objectors to Heterogeny, and full of resource in its support).

[2] Tome xiv. p. 311.

According to the modifying influences suggested by Lamarck, a Lemurine quadruped, attracted by the noise of a boring caterpillar in the bough on which it happened to be perched, instinctively applied its incisors to the bark, and, by frequent repetition of such efforts, increased the mass of the gnawing muscles ; which, stimulating the growth of the bone, led to concomitant modifications in the size and proportion of the jaws. The incisors, by repeated pressure, either became welded into a single pair above and below ; or, the stimulus to excessive growth being concentrated on one incisor, the neighbouring teeth became atrophied by disuse, and by derivation of their nutrient fluid to the contiguous pulp ; hence the preponderating size of the pair of front teeth, and the extent of edentulous space behind them. Concomitantly with the efforts excited by the particular larvivorous tendency of a certain Madagascar Lemur to expose the canal in which its favourite morsel lay hidden, were repeated endeavours to poke the longest finger into the burrow so laid open. The repeated squeezing of the soft skin, with the compression of the nerves and vessels, permanently affected the growth of such digit, and kept it reduced to the blighted state, whereby it happens to be suited to the work of extracting the larva. Lamarck supposes all these changes to be gradual, and effected only through long succession of generations ; he assumes that changes of structure, due to habitual efforts and actions, are transmissible to offspring ; and he finally invokes, like his successors, the requisite lapse of time and long course of generations. It is to be supposed that, until the modifications of dental and digital structures were brought about, the grub-hunting Lemur subsisted on the necessary proportion of fruits and other food more readily obtainable under the ordinary Lemurine conditions of existence.

That the same finger should be the seat of the wasting influences on both hands, and in all Aye-ayes, strikes one as a result hardly to be looked for on the hypothesis of the cause of such specific structures propounded by Lamarck : that there should be a modification of the muscles of the forearm, whereby both *flexor sublimis* and *flexor profundus* combine their action upon the same tendon, pulling the probe-like digit, is left unaccounted for. The physiologist finds still more difficulty in accepting the explanation of the way in which the peculiar conditions of the incisors could be brought about. The action of muscles pressing upon the bony sockets might affect the growth of teeth filling such sockets, but could not change a tooth of limited growth, like the incisors of an ordinary Lemur, into a tooth of uninterrupted growth. Besides, the crowns of both the scalpriform incisors of the *Chiromys* and the ordinary small incisors of other Lemurines are formed according to their specific shape and size before they protrude from the gum. They acquire so much development while the animal still derives its sustenance from the mother's milk. In the Aye-aye the chisel or gouge is prepared prior to the action of the forces by which it is to be worked. The great scalpriform front teeth thus appear to be structures fore-ordained—to be pre-determined characters of the grub-extracting Lemur ; and one can as little conceive the development of these teeth to be the result of external stimulus or effort, as the development of the tail, or as the atrophy of the *digitus medius* of both hands. I have, on a former occasion, tested the Lamarckian hypothesis of transmutation by the phenomena of the dentition of the male Gorilla[1], and have not yet seen a refutation of my argument. A strong superorbital ridge may project, as an occasional variety, in Man; and may be supposed to exemplify the way in which, on the degeneration-hypothesis, Man might sink into the Ape. But such a fact in no way affects the physiological conclusions against the Lamarckian doctrine of transmutation.

There remains, then, to be seen whether the subsequently propounded hypothesis of 'natural selection' will afford us a better or more intelligible view of the origin of the species called *Chiromys madagascariensis*.

I may remark, on the outset, that this hypothesis differs from Lamarck's in invoking a supernatural commencement of organisms which are held to have been "descended from some one primordial form, into which life was first breathed"[2]. And herein is one main distinction between it and the 'derivative hypothesis,' which maintains that single-celled organisms, so diversified as to be relegated to distinct orders and classes of *Protozoa*, are now, as heretofore, in course of creation, or formation, by the ordained potentiality of second causes; with innate capacities of variation and development, giving rise, in long course of generations, to such differentiated beings as may be distinguished by the terms 'plant' and 'animal;' from which all higher animals and plants have, through like influences, ascended, and are being ascensively derived. This, as the naturalist knows, is mere hypothesis, at present destitute of proof. But it is more consistent with the phenomena of life about us, with the ever-recurring appearance of mould and monads, and with the coexistence, at the present time, of all grades of life rising therefrom up to Man, than is the notion of the origin of life which is propounded in Mr. Darwin's book 'On the Origin of Species by Natural Selection.' Applying to the Aye-aye the illustration of his hypothesis, as submitted by Mr. Darwin to the Linnean Society[3], it may be admitted that the organization of a Lemur, feeding chiefly on fruits or birds, but sometimes on grubs, is, or might become, slightly plastic, in the sense of being subject to slight congenital variations of structure. We may, also, suppose changes to be in progress in the woods of Madagascar, causing the number of birds to decrease, and the number of insects to increase, especially of those the larvæ of which are xylophagous. The effect of this might be that the Lemur would be driven to try to catch more grubs. His organization being slightly plastic, those individuals with the best hearing, the largest front incisors, and the slenderest middle digit, let the difference be ever so small, would be to that extent favoured, would tend to live longer, and to survive during that time of the year when birds or fruits were scarcest; they

[1] Trans. Zool. Soc. vol. iii. p. 381, and vol. iv. p. 175. See also 'Classification of the Mammalia,' 8vo, 1859, p. 101.

[2] Darwin, 'On the Origin of Species,' p. 414.

[3] Proc. Linn. Soc. August 1858, p. 49.

would also rear more young, which would tend to inherit these slight peculiarities. Were the Lemurs to be reduced to this insect-food, those individuals less plastic than the incipient Aye-aye, or not varying in the same way, would become extinct.

The varieties of condition of the human mind are manifold, and may be exemplified by the fact that there are some with modes and habits of thought which lead them to entertain no more doubt that such causes, in a thousand generations, would produce a marked effect upon the Lemurine dentition and limbs, adapting the form and structure of the Quadrumane to the catching of wood-boring grubs instead of birds, than that any domesticated quadruped can be improved by selection and careful breeding; whilst to other minds the propounding of such plastic possibilities leaves no sense of any knowledge worth holding as to the origin of the species called *Chiromys madagascariensis*, no help to the conception of such origin which is at all equivalent to so wide a departure from actual experience of facts. We know of no changes in progress in the Island of Madagascar, necessitating a special quest of wood-boring larvæ by small quadrupeds of the Lemurine or Sciurine types of organization. Birds, fruits, and insects abound there in the ordinary proportions; and the different forms of *Lemuridæ* coexist, with their several minor modifications, zoologically expressed by the generic terms *Lichanotus*, *Propithecus*, *Chirogaleus*, *Lemur*, and, we may now confidently add, *Chiromys*.

That organic species are the result of still operating powers and influences is probable, from the great palæontological fact of the succession of such so-called species from their first appearance in the oldest-known fossiliferous strata: it is the more probable, from the kind and degree of similitude between the species that succeeds and the species that disappears, never to return as such; the similitude being, in the main, of a nature expressed by the terms of "progressive departure from a general to a special type." Creation by law is suggested by the many instances of retention of structures in palæozoic species which are embryonal and transitory in later species of the same order or class; and the suggestion acquires force by considering the analogies which the transitory embryonal stages in a higher species bear to the mature forms of lower species. Every new instance of structures which do not obviously, and without straining, receive a teleological explanation, especially the great series of anatomical facts expressed by the "law of vegetative or irrelative repetition,"—all congenital varieties, deformities, monstrosities,—oppose themselves to the hypothesis of the origin of a species by a primary or immediate and never-repeated act of adaptive construction.

Such series of facts, with those treated of in my works 'On the Homologies of the Vertebrate Skeleton' and 'On the Nature of Limbs,' appear to me to be the chief grounds in zoological science for the hypothesis of a continuously operative secondary creational law. That this law works by derivation of one species from a previous species, of a new from an old species, is made probable by the demonstrated unity of plan in the Articulate and Vertebrate types of organization, and by the approximations to such unity of type in the molluscous and some lower forms of organized beings.

The phenomena of parthenogenesis have made known unexpected and strange instances of great degrees of difference of form between the self-subsistent independent generative product and the producing organism. But the "derivative hypothesis" is, at present, as I have already admitted, little more than an indication of a route of research by which the mode and way of derivation may be ultimately better understood.

The terms in which the zoologist would express the sum of the observations above recorded on the Aye-aye would be, "that it was related by affinity to the *Quadrumana*, and by analogy to the *Rodentia*." And such terms become intelligible if they mean that the Aye-aye has been derived, in common with other existing *Lemuridæ*, from some pre-existent animal of a more generalized Lemurine type of organization, in departing from which it has gained a character, *e. g.* the dental one, very like that which prevails in the *Rodentia*, without losing the more numerous and essential characters of its inherited Lemurine organization.

The terms in which the anatomist would express the sum of his observations on the structural resemblances traceable from the Aye-aye throughout the *Lemuridæ* would be, that the principle of 'unity of organization' prevailed through such group. And such term would have a more intelligible meaning on the hypothesis that these singularly diversified Lemurs were genetically related by descent from a common ancestral form.

Whilst admitting the general evidence, therefore, in favour of 'creation by law,' I am compelled to acknowledge ignorance of how such secondary causes may have operated in the origin of the *Chiromys*. Darwin seems to be as far from giving a satisfactory explanation of them as Lamarck.

One discerns in the *Lemuridæ*, if we therein include the *Galeopitheci*, such a range of variety in their dentition as suggests the idea of instability of character, or of unusual plasticity, in that part of their organization.

The varieties of the limbs, also, as manifested by the long ankle-bones of *Otolicnus* and *Tarsius*, by the reduction of the index to a stump in *Perodicticus*, and by the atrophy of the medius in *Chiromys*, in like manner indicate a tendency to deviate from type in the hands and feet of this Quadrumanous family.

Why the forefinger in both fore limbs should have been, as it were, amputated—reduced to a short stump—in one kind of *Stenops*, and why it should be much shorter than usual in others, is not intelligible in reference to any known use or peculiar application of the upper hand in that kind of Slow Lemur.

The purpose of the probe-like middle finger is more readily discerned in the Aye-aye. The function of the large comb-like lower incisors in *Galeopithecus*, and that of the gouge-like strong incisors of *Chiromys*, have received explanation. Some might discern, in the greater length of the middle upper incisor of *Propithecus* and *Tarsius* as compared with that of the lateral incisor, and the reduction of the lower incisors to a single pair, a step in the transition from the Lemurine type of dentition to the extreme modification of that type in *Chiromys*. But all the surmises and guesses as to the conditions of such changes, all the attempts to explain how they were brought about—if they have been brought about—by still operative causes, are inadequate and unsatisfactory.

The real knowledge which we possess of the *Chiromys* is limited to certain particulars of form, structure, habits, relations of structure thereto, likeness and unlikeness to other creatures, and geographical limitation. Far be it from me to imply that zoology may never know more than the nature and relations of the animal as it now exists.

Although one of the greatest intellects has warned us of the futility of our finite endeavours to penetrate the mystery of the beginning of things, the attempts to dissipate that which still enshrouds the origin of species cannot but be fraught with collateral advantages to zoological science.

DESCRIPTION OF THE PLATES.

PLATE I.

Male Aye-aye (*Chiromys madagascariensis*, Cuv.), natural size.

PLATE II.

Female Aye-aye (*Chiromys madagascariensis*, Cuv.), half the natural size: from the animal living in the Gardens of the Zoological Society, October 1862.

PLATE III.

Male Aye-aye, from the specimen transmitted, in spirits, by Dr. Sandwith, C.B., in the attitude of exposing the burrow of its favourite larval food: half the natural size.

PLATE IV.

Front view of the same specimen: half the natural size.

PLATE V.

Back view of the same specimen: half the natural size.

PLATE VI.

View of the head in profile, and of the fore limbs, of the male Aye-aye: natural size.

PLATE VII.

Skeleton of the male Aye-aye: natural size. The letters and numbers are explained in the text.

PLATE VIII.

Skull, Teeth, and Hyoid Arch of the Male Aye-aye.

Fig. 1. Upper surface of skull.
Fig. 2. Under surface or base of cranium.
Fig. 3. Upper view of mandible (under jaw).
Fig. 4. Front view of skull.
Fig. 5. Upper view of cranial cavity.
Fig. 6. Side view of cranial and nasal cavities.
Fig. 7. Inner side of mandibular ramus.
Fig. 8. Teeth of left maxilla (upper jaw), *in situ*, with roots exposed.
Fig. 9. Outer side of mandibular ramus, with the base of incisor exposed, and the three molars added above, with the roots exposed.
Fig. 10. Grinding surface of upper and lower molars of the right side: magnified.

In the figures showing the teeth,—*i*, incisor; *e*, enamel; *d*, dentine; *p*, pulp; *p* 4, last premolar, fourth of the typical series (or last milk-molar), retained in the upper jaw; *m* 1, first molar; *m* 2, second molar; *m* 3, third molar.

Fig. 11. Malleus: natural size.
Fig. 12. Incus: natural size. Figures of these 'ossicula auditus,' magnified, are given below.
Fig. 13. Side view of hyoid arch: ^{41}, basihyal; ^{40}, epihyal; ^{39}, ceratohyal; ^{38}, stylohyal; ^{46}, thyrohyal.

The following are the parts indicated by letters in the figures of the skull:—

a. Precondyloid foramen.
b. Jugular foramen.
c. Internal auditory foramen.
d. Tympanic cavity, exposing co-articulated parts of malleus and incus.
e. Appendicular fossa.
f. Foramen ovale.
g. Foramen rotundum.
h. Foramen opticum.
i. Olfactory fossa, with cribriform plates.
j. Sinus frontalis.
k. Pituitary fossa.
l. External auditory foramen.

m. Entocarotid foramen.
n. Pterygo-palatine foramen.
o. Incisive foramen.
p. Vomerine fissure.
q. Sinus sphenoidalis.
s. Naso-maxillary foramen.
t. Dental foramen.
u. Mental foramen.
v. Antorbital foramen.
x. Condyloid process } of mandible or lower jaw.
y. Angular process } of mandible or lower jaw.
z. Coronoid process } of mandible or lower jaw.

PLATE IX.

Fig. 1. Atlas vertebra, front view.
Fig. 2. Atlas vertebra, back view.
Fig. 3. Atlas vertebra, side view.
Fig. 4. Axis vertebra, front view.
Fig. 5. Axis vertebra, side view.
Fig. 6. Cervical vertebræ, side view.
Fig. 7. Fourth lumbar vertebra, upper view.
Fig. 8. Fourth and fifth lumbar vertebræ, side view.
Fig. 9. Sacrum, upper view.
Fig. 10. Five first caudal vertebræ, upper view.
Fig. 11. Sternum and clavicles, front view.

In the foregoing figures:—*e x*, hypapophysis of atlas; *c a*, centrum of atlas, anchylosed as the 'odontoid process' with—*c x*, centrum of axis; *n*, neural arch; *n s*, neural spine; *d*, diapophysis; *pl*, pleurapophysis; *m*, metapophysis; *a*, anapophysis; *z*, zygapophysis; *h*, hæmapophyses; 58, clavicle; 59, manubrium; 61, xiphisternum.

Fig. 12. Right scapula, coracoid, and clavicle; front view.
Fig. 13. Right scapula, inner view.
Fig. 14. Left humerus, front view.
Fig. 15. Left humerus, back view, with lower articular surface beneath.
Fig. 16. Upper ends of right radius and ulna, side view.
Fig. 17. Lower ends of right radius and ulna, with bones of hand.
Fig. 18. Carpal bones.

s, scaphoid; *i*, intermedium; *l*, lunare; *c*, cuneiforme; *p*, pisiforme; *t*, trapezium; *z*, trapezoïdes; *m*, magnum; *u*, unciforme; *o*, sesamoid.

Fig. 19. Right os innominatum, side view.

Fig. 20. Ossa innominata, front view.

Fig. 21. Upper end of left femur, front view.

Fig. 22. Bones of the right foot.

Fig. 23. Portion of tarsus of *Otolicnus crassicaudatus*; from De Blainville, 'Ostéographie des Primates' (*Lemur*, pl. 5).

s, naviculare; *a*, astragalus; *d*, calcaneum; *i*, entocuneiforme; *m*, mesocuneiforme; *e*, ectocuneiforme; *b*, cuboïdes.

(All the figures are of the natural size.)

PLATE X.

Fig. 1. Superficial muscles of neck and fore limb.

Fig. 2. Axillary and brachial artery *in situ*.

Fig. 3. Larynx, trachea, and lungs.

(Natural size: the letters and figures are explained in the text.)

PLATE XI.

Fig. 1. Deep-seated muscles of arm, with the axillo-brachial artery, and origins of muscles of the forearm.

Fig. 2. Superficial muscles of the fore limb, outer and back view.

Fig. 3. Flexor sublimis perforatus.

Fig. 4. Flexor profundus perforans.

PLATE XII.

Fig. 1. Renal and adrenal organs *in situ*; abdominal aorta and its primary branches; superficial muscles of the hind limb, inner and plantar view (the drawing has been engraved without the use of the mirror).

Fig. 2. Brain, base view.

Fig. 3. Brain, upper view.

Fig. 4. Brain, side view.

Fig. 5. Brain, with prosencephalic or 'lateral' ventricle exposed.

A, cerebrum; B, cerebellum; C, rhinencephalon; *a*, longitudinal convolution; *b*, suprasylvian convolution; *c*, sylvian convolution; *m*, upper vermiform lobe of cerebellum; *n*, lateral lobe; *q*, appendicle; *o*, flocculus; *p*, pyramidal tracts: *n*, fig. 2, natiform protuberance; *u*, crus cerebri; *v*, pons Varolii.

Fig. 6. Palatal ridges, and grinding surface of the upper teeth.

Fig. 7. Tongue, fauces, pharynx, and glottis.

Fig. 8. Under surface of the tongue, showing the 'lytta' or sublingual plate, *a*, *b*.

Fig. 9. Side view of the tongue and sublingual plate.

Fig. 10. Longitudinal section of a kidney.

Fig. 11. Back view of the urinary bladder, muscular and bulbous parts of urethra, and accessory genital glands.

Fig. 12. Transverse section of penis.

(All the foregoing parts of the male Aye-aye are represented of the natural size.)

PLATE XIII.

Fig. 1. Superficial-seated muscles of the hind limb, outer and rotular view.

Fig. 2. Deeper-seated muscles of the hind limb, inner and plantar view.

Fig. 3. Deeper-seated muscles of the hind limb; outer and rotular view, or on the 'dorsum' of the foot: half the natural size.

(The numerals are explained in the text.)

PLATE XIV.

Fig. 1. The stomach, duodenum, and spleen.

Fig. 2. The cæcum, with the termination of the ileum and commencement of the colon.

(These parts of the male Aye-aye are of the natural size.)

THE END.

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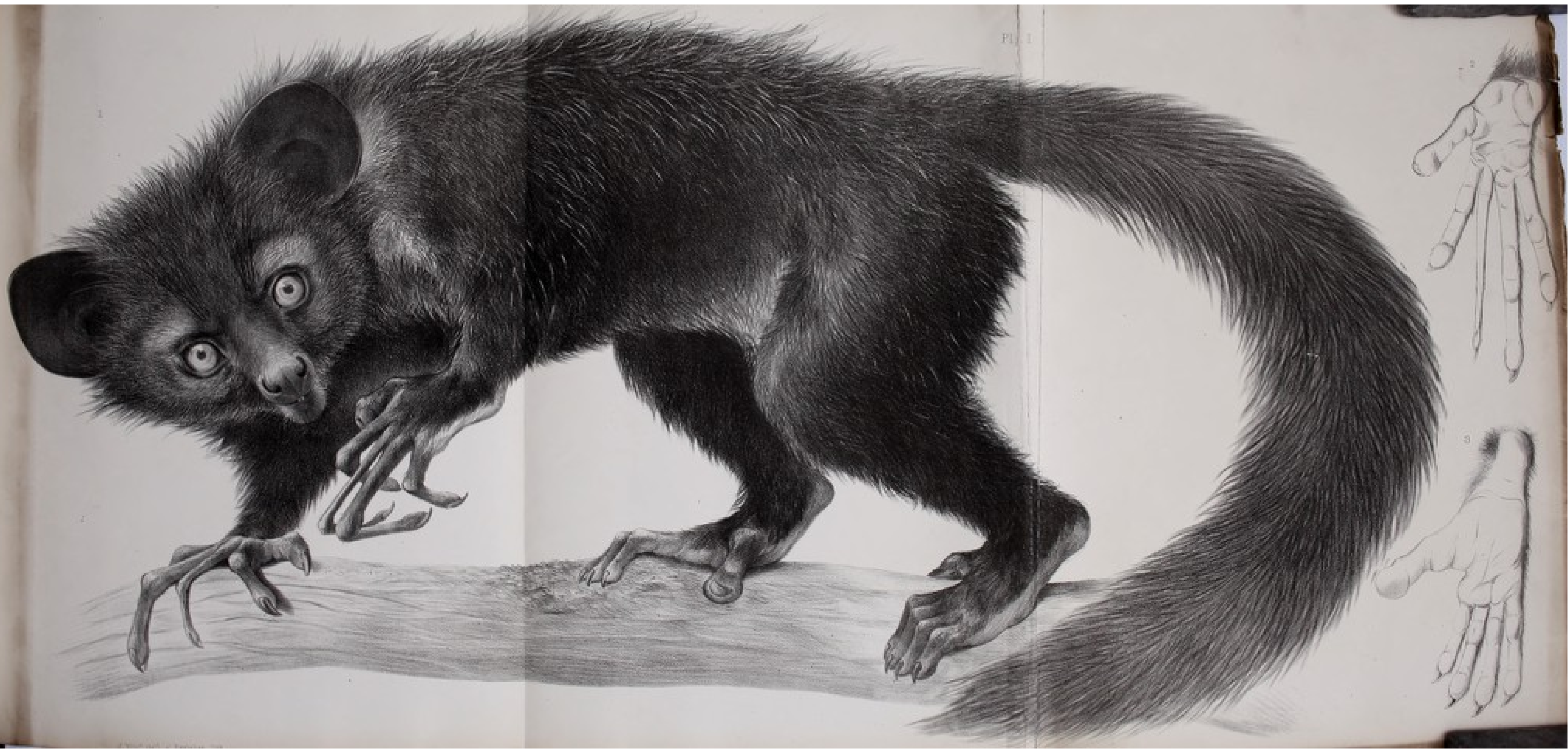

Pl. I

Pl. II.

J. Wolf, del.t – J. Erxleben, lith.

M. & N. Hanhart, Imp.t

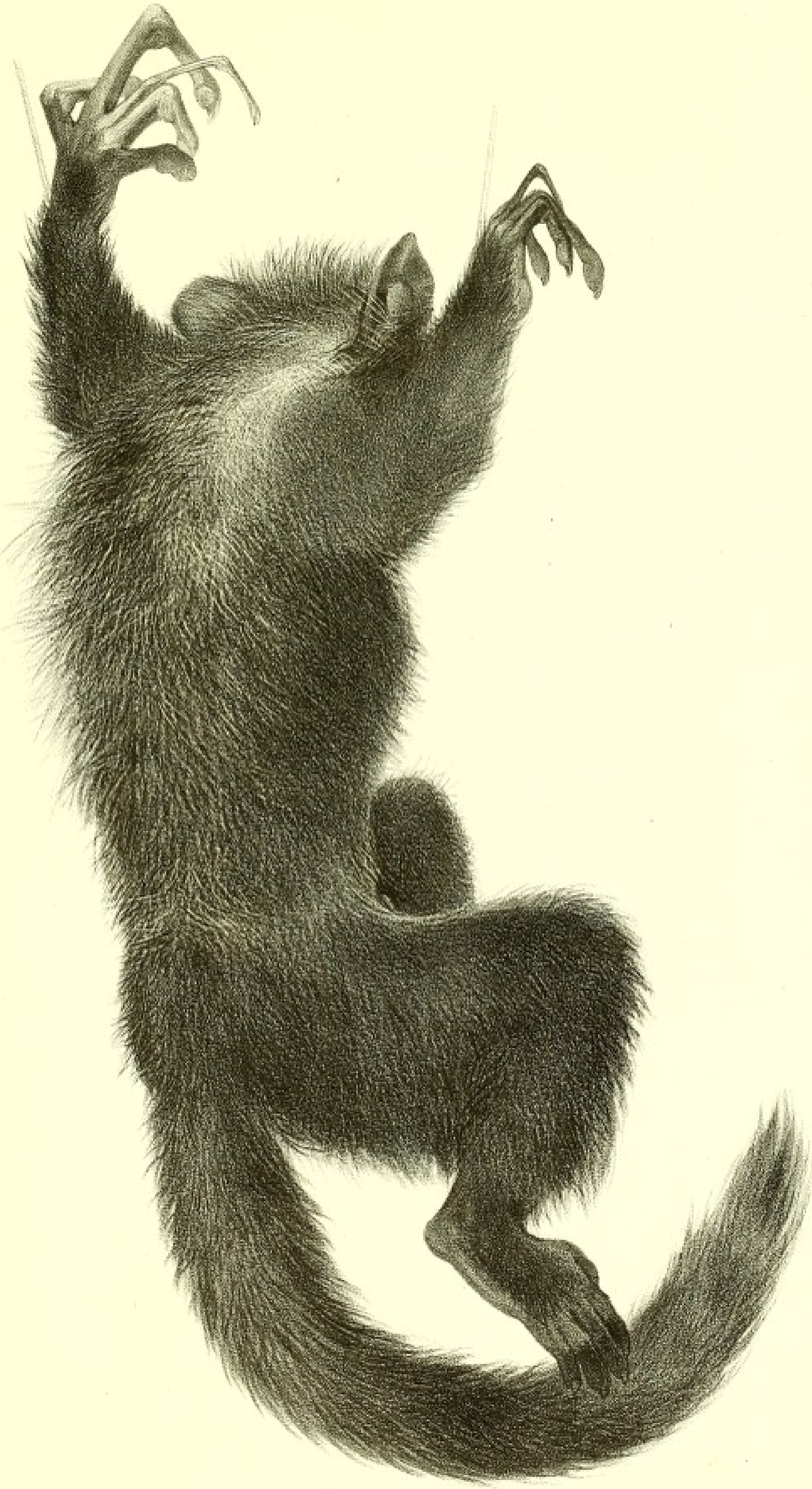
J. Wolf, delt. J. Erxleben, lith. M. & N. Hanhart, Impt.

Pl. IV.

J. Wolf, delt. J. Erxleben, lith.

M. & N. Hanhart, Impt.

Pl. V.



J. Wolf, del[t] J. Erxleben, lith.

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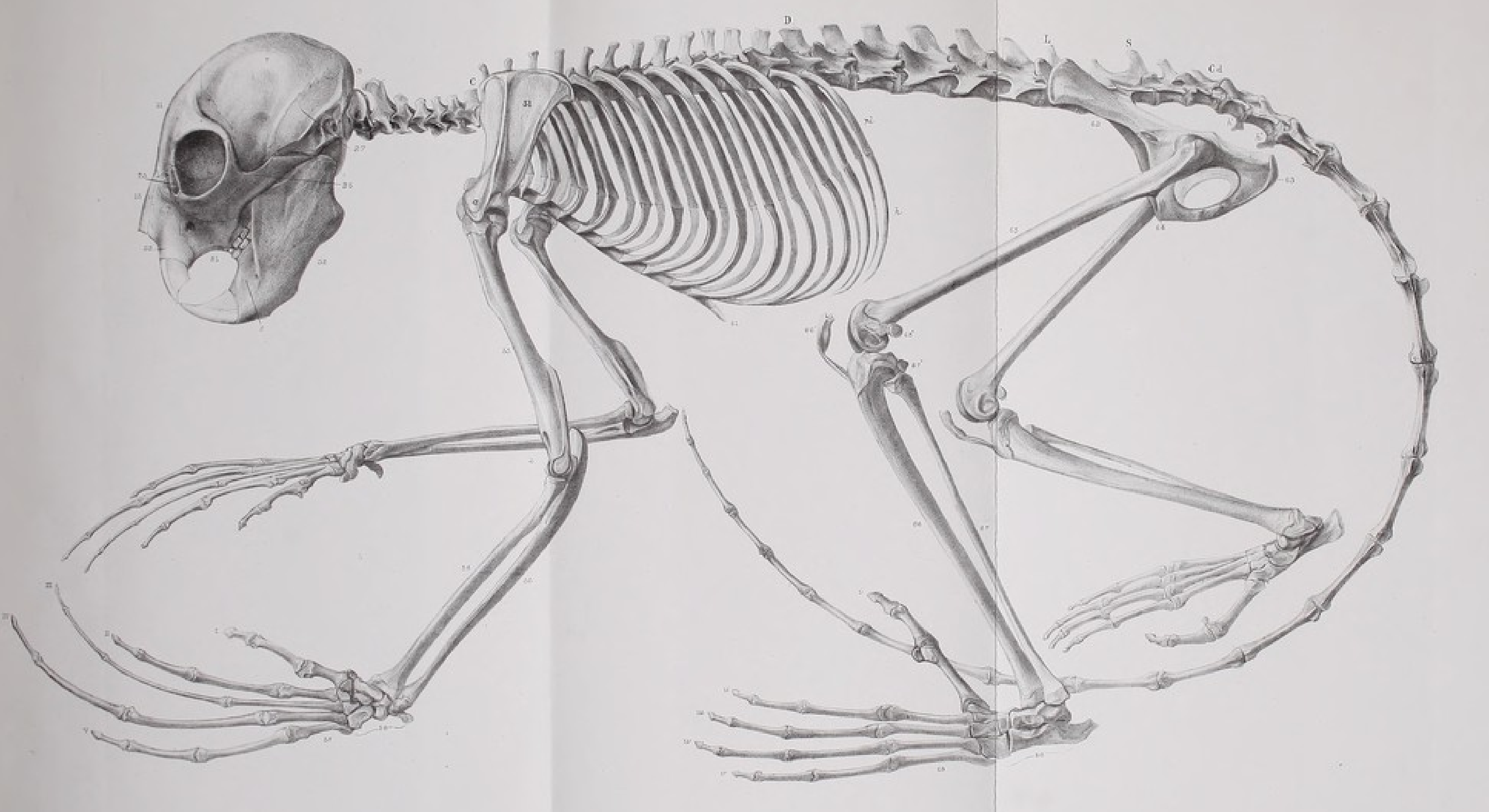
Pl. VII.



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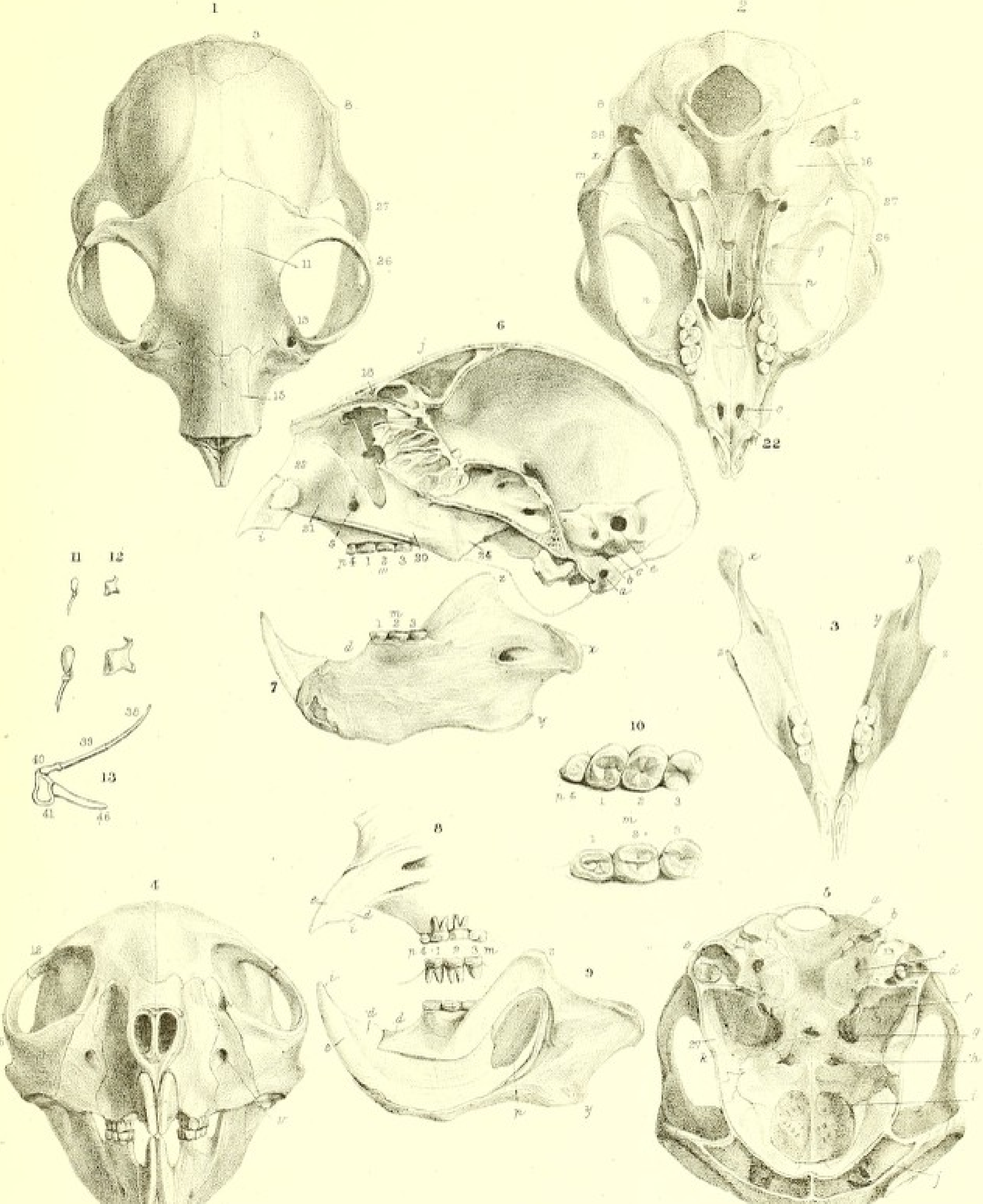
Pl. VIII.



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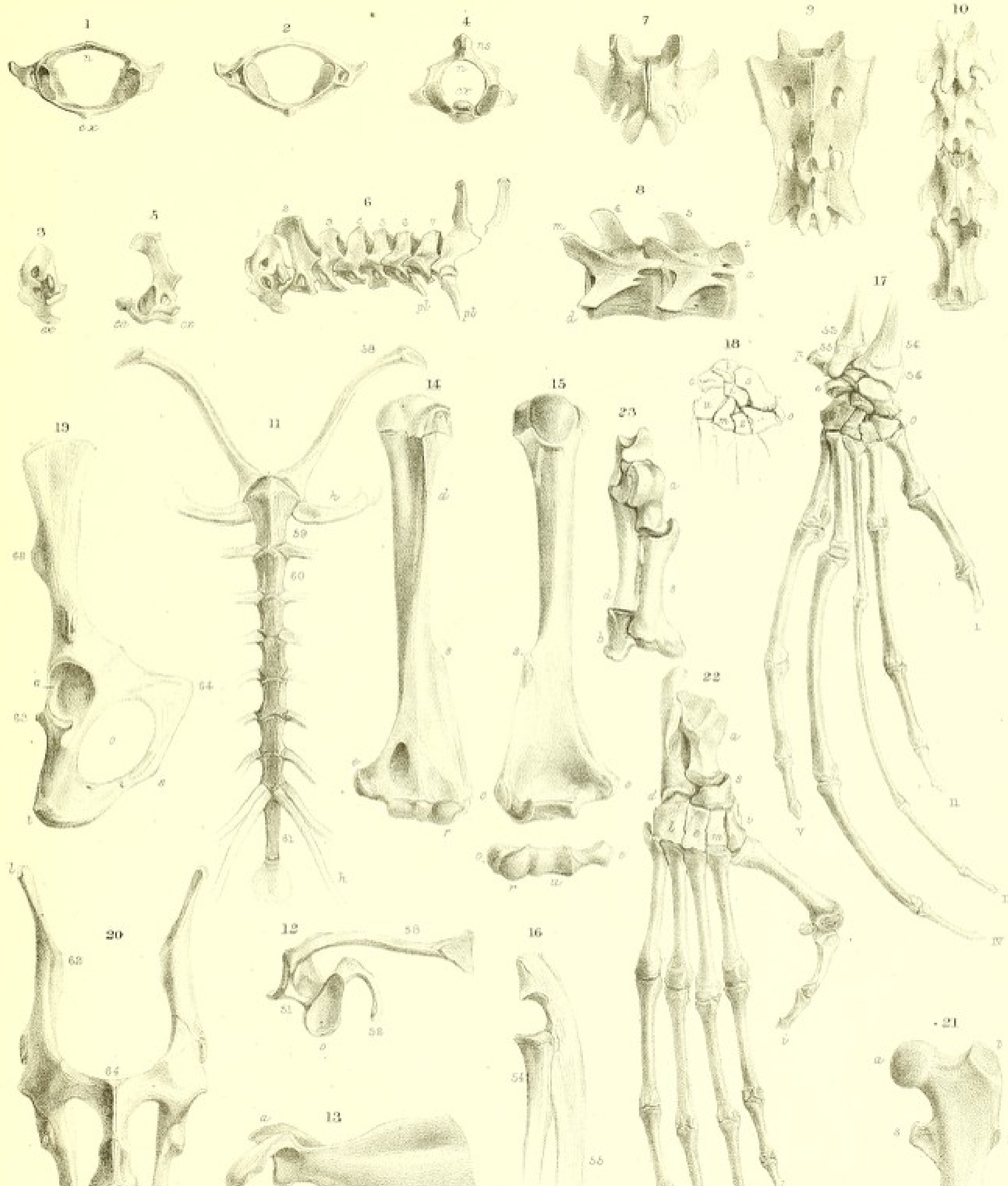

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Pl. X.

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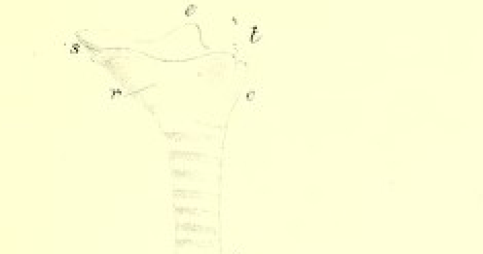

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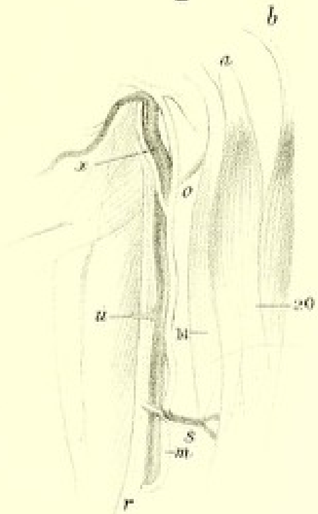

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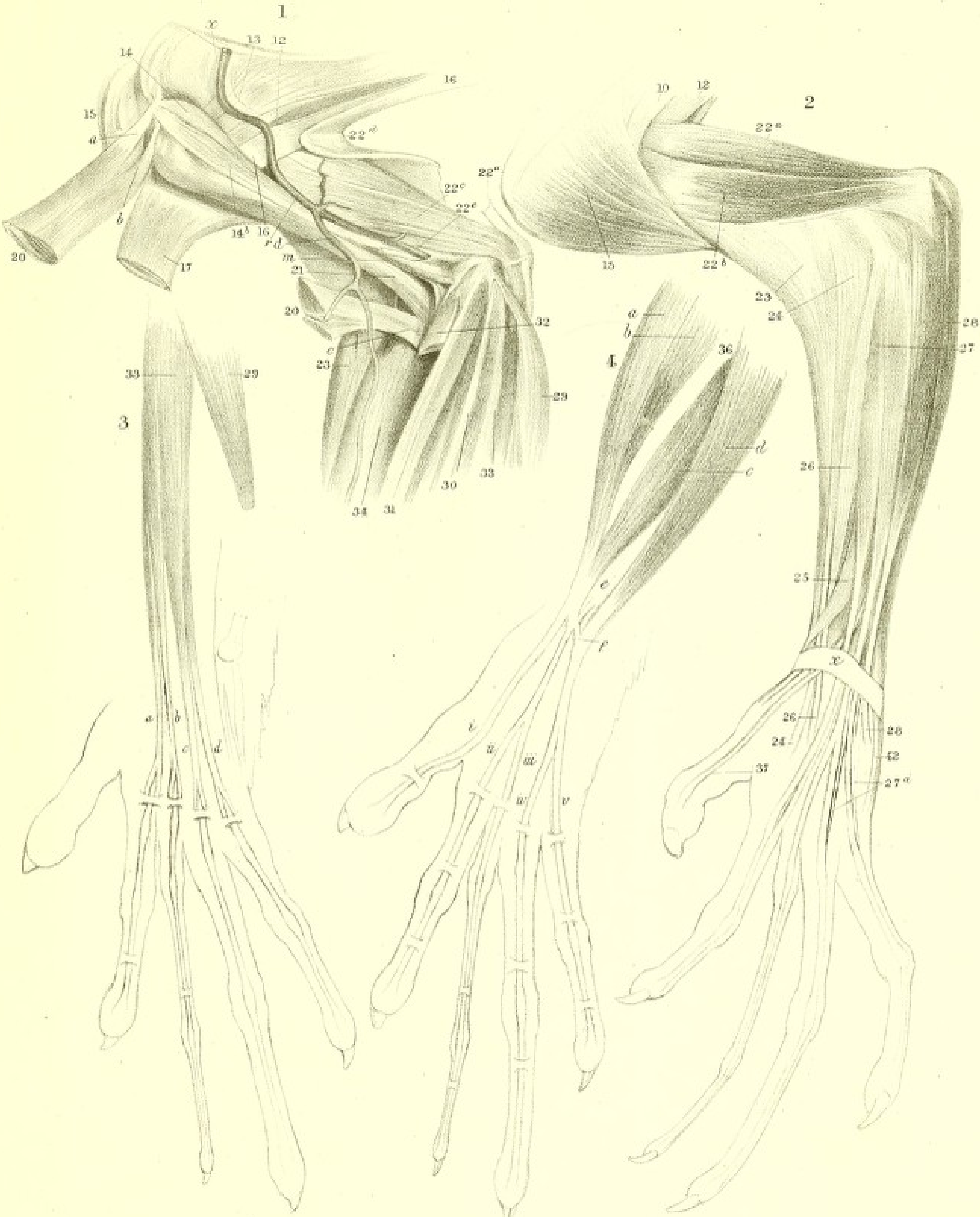
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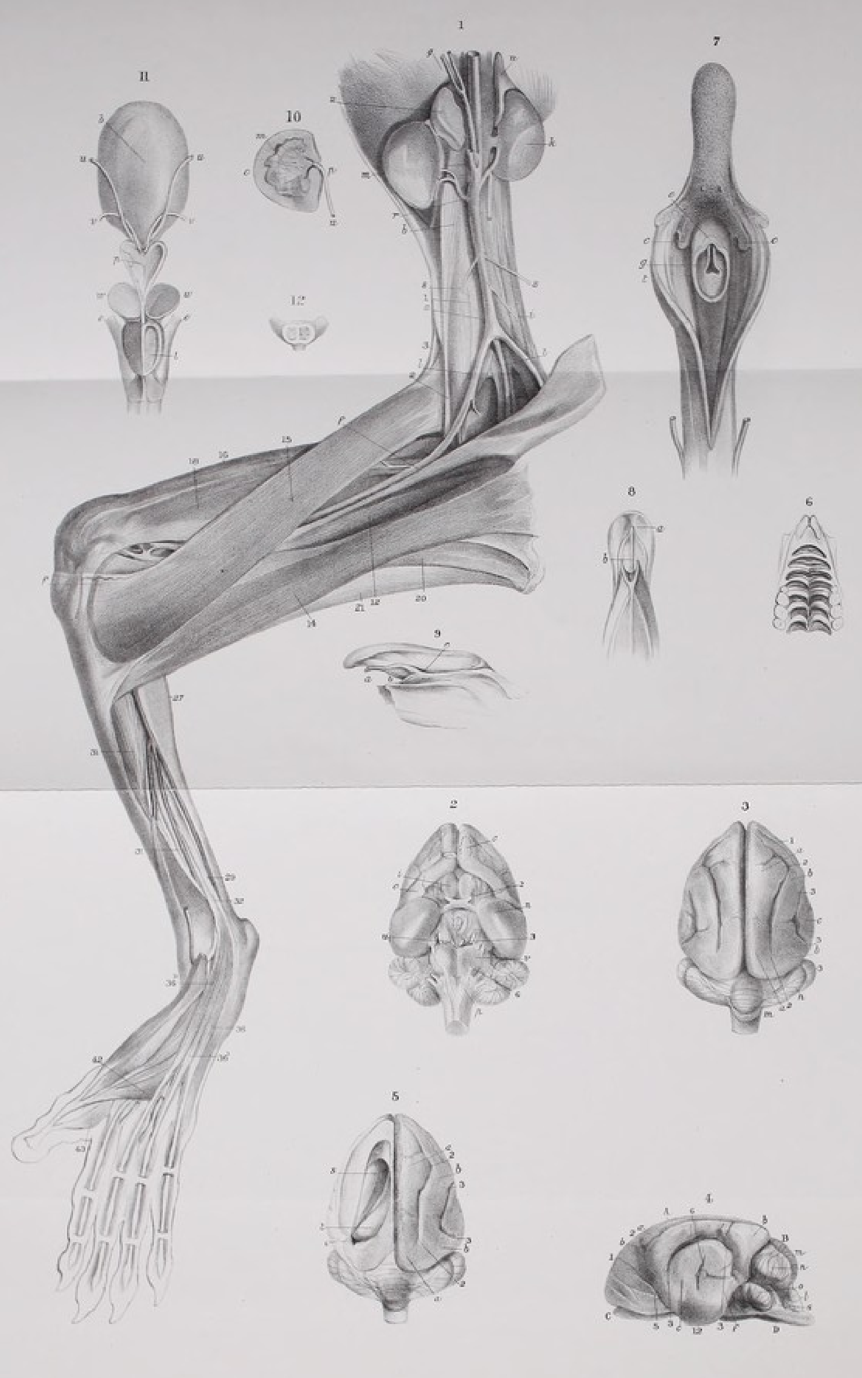
Pl. XII



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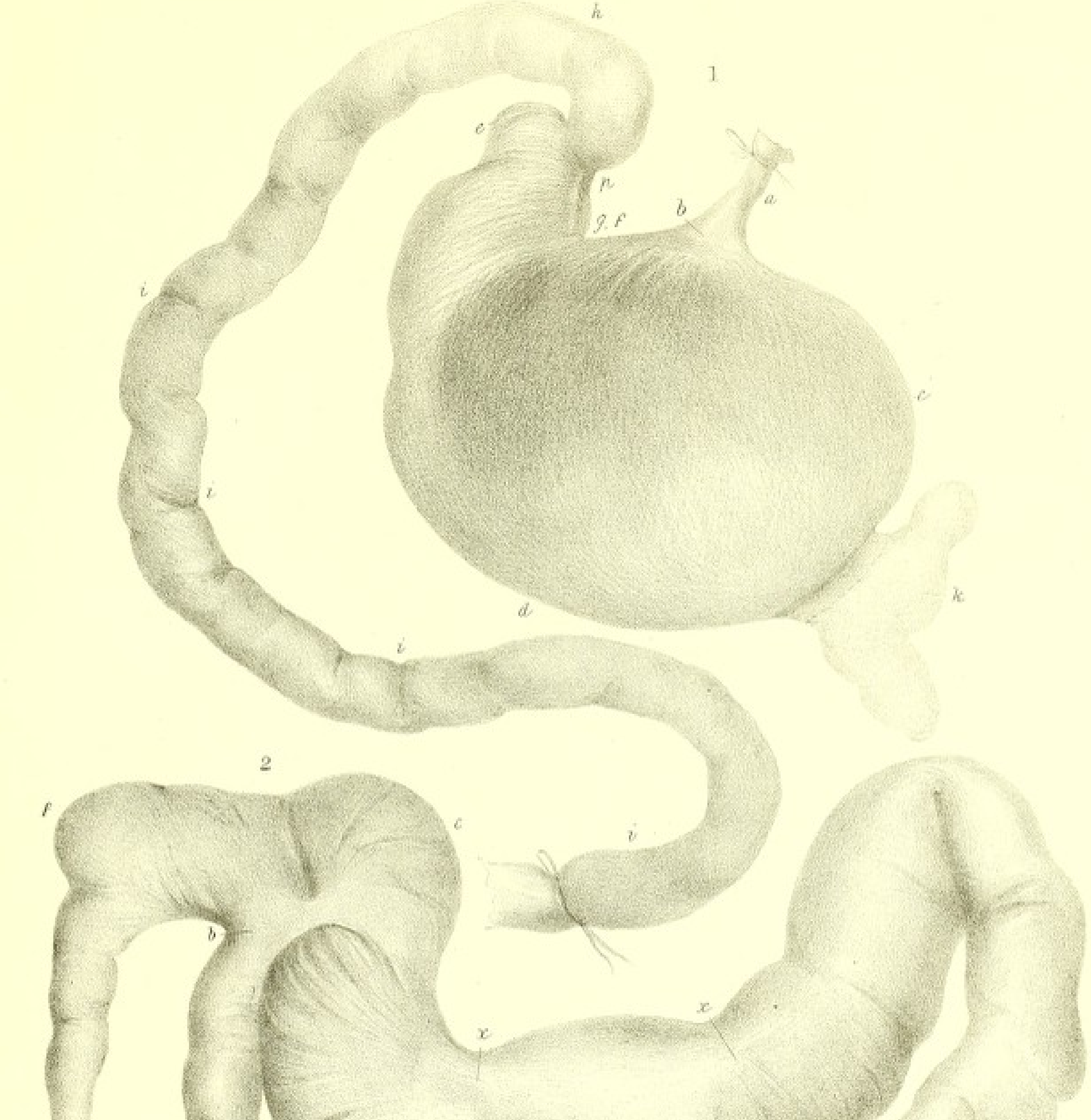
Pl. XIV.



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