IV. ON THE OSTEOLOGY OF THE GENERA LASIOPYGA AND CALLITHRIX WITH NOTES UPON THE OSTEOLOGY OF THE GENERA SENIOCEBUS AND AOTUS.

By R. W. Shufeldt, C.M.Z.S.

(Plates XII–XXI.)

Not long since I had occasion to examine into the osteology of some of the Old World apes and New World tamarins and marmosets, and I soon discovered, that, although in times past much had been published on this subject, there yet remained in the matter of detail a great deal, which up to the present day has not been touched upon. To be sure we have the works of Blainville, Owen, Flower, Giebel, Huxley, Mivart, Vrolik, and many others, who have given us their time-honored contributions in this important field, but in the main these are mostly of a general nature and not especially devoted to detailed descriptions and comparisons.

Recently we have had placed before us, however, the epoch-making work of Dr. D. G. Elliot,[1] who has long been engaged upon the biology and taxonomy of the entire group of primates, for which sumptuous production he has examined an enormous body of material, including nearly all the principal types and material contained in private collections and in the great museums of the world, not to speak of what he has gathered during his personal investigations in Africa and elsewhere. Dr. Elliot with great generosity has presented a copy of this work to me, and in reply to a recent letter of inquiry states that "*Callithrix* is the proper genus in which to place *Hapale jacchus*," and that 'he places *Lasiopyga* between the genera *Rhinostigma* and *Miopithecus*, the tooth-formula of *Callithrix* being $\frac{2-2}{2-2}, \frac{1-1}{1-1}, \frac{3-3}{3-3}, \frac{2-2}{2-2} = 32$.'

It will be remembered that Mivart also states that "In the whole

[1] Three years have elapsed since the present paper was written, and it was only a few months ago that I obtained the skeleton of *Seniocebus meticulosus*. The brief description of the latter will therefore be given at the end of this article under "Closing Remarks." In the same place I will also make reference to the osteological data given by Dr. D. G. Elliot in his work, "A Review of the Primates" (Monographs A. M. N. H., Vols. I–III, 1912), with respect to the skeletons of the forms touched upon in this paper, including *Aotus miriquouina*, a skeleton of which (no. 103,917) I have examined in the U. S. National Museum.

series of Old World apes we find the same number of different kinds of teeth as in man," that is, sixteen in each jaw, or thirty-two in all; but that "*Cebidæ* have an additional premolar on each side of each jaw, and the *Hapalinæ*, besides this, have a true molar the less." These, as we know, are New World representatives of the group. (*cf.* Mivart, Article "Ape," Encyclopedia Britannica, 9th Ed., p. 164).

Recently upon going over some of the osteological mateiial representing the primates at the United States National Museum, a privilege foı which I have pleasure in thanking the curator of the Division of Mammals, Mr. Gerrit S. Milleı, Jr., and his assistant curator, Mr. Ned Hollister, I found that within recent yeaıs this collection has been greatly increased; that long and vaıied series of skulls and skeletons of many Old and New World primates are now to be found in it; and that these are daily being augmented by accessions of a similar kind from all parts of the world, where these animals find their habitats. Much of this material still remains undescribed, although Mr. Hollister has given us something upon it which has appeared in the Proceedings of the Museum and elsewhere. I have to thank him for his kindness in 'ooking up for me the synonymy of the species referred to in this paper.

Some years ago Mr. Edward S. Schmid of Washington presented me with three monkeys in the flesh, one of these being a male *Lasiopyga griseoviridis* (Desmarest) from northeastern Africa, and two adult specimens of *Callithrix jacchus* (Linnæus). Seveıal years afterwards Mr. Schmid very generously added to this list a specimen of the very rare tamarin, *Seniocebus meticulosus* Elliot, of which I made a negative and preserved the skin and skeleton. From all of the first-named three I likewise obtained complete skeletons,[2] and from them all photogıaphs of the various parts of the same, which photographs are herewith repıoduced. For comparision I have had the use of a complete skeleton of a male *Lasiopyga callitrichus* from the U. S. National Museum (No. 16365).

CRANIUM AND MANDIBLE.

(Plates XII–XVII, figs. 1–19; Plate XX, fig. 24; Plate XXI, fig. 26.)

It has long been known that the skeleton in the *Simiina* is formed upon the same general plan as *Homo*. Comparative osteology moıe-

[2] The author has generously donated the skeletons of *L. griseoviridis*, *C. jacchus*, and *S. meticulosus* to the Carnegie Museum. (Accession 5103). *Editor.*

over teaches us that in the apes, as in man, we often meet with very marked variation in the matter of form, when we come to compare the skulls of individuals belonging to the same species, and that there are very wide variations to be noted among the skulls of the various genera of apes, as in the various races of men. In long series of the skulls of apes we would also probably find more or less constant differences distinguishing the skulls of the two sexes.

In its general appearance, the skull in *Lasiopyga griseoviridis* has a far more brutish aspect than in *Lasiopyga callitrichus;* this is well shown in figures 1–8 of the plates, and the reason is very evident; for, in the first-named ape, the supra-orbital ridges are very prominent with rounded borders, and, as they lie entirely in the horizontal plane, they merge indistinguishably with each other in the middle line, lending to the entire skull a very forbidding aspect. This is further enhanced by the prominence of the remainder of the orbital peripheries, and the extreme flatness of the vault of the cranium, as compared with the more human-like rounded dome of the calvarium in *L. callitrichus.* Furthermore all the muscular lines, depressions, processes, and other osseous characters in *L. griseoviridis* are more pronounced, more prominent, sharper, and more distinct than in *L. callitrichus;* to which must be added the feature of the upper canine teeth, which in *L. griseoviridis* are much longer in proportion, more curved, and in front exhibit deep grooves running their entire length, these grooves being more internal and by no means prominent in the upper canines of the other ape. In fact the skull of *L. callitrichus* has all these characters very much reduced in prominence, and the existing differences are very much as we find them upon comparing the skull of a highbred, intelligent Caucasian with the skull of a low, savage Ethiopian, such as I have elsewhere figured in my works upon that race. These characters of the crania are also evident when we come to compare the mandibles of these two apes; for the angle at the posterior termination of the symphysis is far more rounded in *L. callitrichus* than it is in *L. griseoviridis,* and again there are the differences in the canine teeth, though these are not grooved as they are in the upper jaw. For the rest, the dental armature is well known and has been frequently described, as it likewise has been for *Callithrix jacchus,* rendering it needless to repeat here. This marmoset also has a skull which is entirely lacking in all those characters which lend such a savage and brutish aspect to the skull of the Green Guenon as just described; in fact, the skull of *Callithrix* somewhat reminds us, especially when viewed laterally, of the skull in some of the *Mustelidæ*, *e. g.*, *Spilogale putorius*, in the posterior elongation of the cranium, and the aspect of the canines. Viewed anteriorly, the facial aspect of the skull in *Callithrix* is, however, entirely Simian in all of its essential characters, with its large, cavernous, globular orbits, with their circular, unbroken peripheries, and their inner walls entirely completed in bone excepting the usual foramina. This is the case in both the species of *Lasiopyga* before me, wherein all the diameters of either orbital cavity, save the antero-posterior, are longer than the diameters measured from the peripheral borders by several millimeters. The usual foramina in either orbit are the same as they are in man. Confining ourselves for the present to the characters of the face, we note the marked transverse narrowness of the superior nasal region in *L. callitrichus*, as compared with the much broader and more rounded area in *L. griseoviridis* (Pl. XII, Figs. 1 and 2); while the anterior narial aperture is about the same in either species, being only slightly larger in the last-named form. As in most apes in this and related genera, the maxillary portion of the face is prominent and rounded, though not nearly as much so as in some of the higher Simians, as the orangs and chimpanzees. The premaxillaries form a distinctive feature, together forming the facial area, and being carried up to articulate with the nasals above, the sutural traces being more evident in *L. griseoviridis*.

In the specimen of *L. callitrichus* before me, there is neither notch nor foramen for the supraorbital nerve, while in the Green Guenon there is a minute foramen for the exit of that branch on the left side. In both skulls there are present upon either side from four to five foramina for the exit of the infra-orbital nerve. On the other hand in *Callithrix* the foramen is single. In this genus also the malar foramen is single, which is likewise the case in *L. callitrichus;* while in *L. griseoviridis* there are two upon either side. A peculiar character in the face of this last-named species is the deep transverse notch between the nasals and the supra-orbital ridge (Plate XIII, Fig. 4). In both skulls the anterior nasal spine is entirely absent; the lachrymal groove is well marked; and the canine eminence most prominent in *L. griseoviridis.*

These apes have the vomer moderately well developed, being weakest in *L. callitrichus*, in the skull of which at hand I find no turbinated bones, although at least two on either side are well developed both in *L. griseoviridis* and in the marmoset. There are in these apes no supra-orbital ridges beyond the ones formed by the superior peripheries of the orbits, as we find in most human skulls, even among the lower races of men, where such ridges are present on the frontal bone above the orbits. These latter are sometimes absent in negroes of pure strain.

With regard to the lateral aspect of these skulls (Pl. XIII, figs. 3 and 4; Pl. XVI, fig. 10) it may be observed that in all of them the extent of the cranial capacity is far greater than might be inferred from the facial view alone. This is especially true in the case of the marmosets and *L. callitrichus*. In *L. griseoviridis* the cranial dome is more depressed anteriorly. In *C. jacchus* and in *L. griseoviridis* the superior border of the zygoma is produced backward and upward, to be lost as a prominent ridge on the lamboidal suture. This feature is best seen in *L. griseoviridis*, and is wholly absent in *L. callitrichus*. As in man, the temporal fossa is deepest opposite the middle third of the zygoma, while anteriorly the space is occupied by the outward bulging of the external wall of the corresponding orbit, especially in *C. jacchus*.

The zygoma is nearly horizontal, presenting a gentle sigmoid curve, with the tubercle at its posterior extremity very much aborted, practically absent in *C. jacchus* and *L. callitrichus*. The mastoid process, likewise, does not constitute a prominent feature in these skulls, and is only faintly indicated in the marmoset, in which conspicuous auditory bullæ are developed, a character which is entirely absent in *Lasiopyga*. The mastoid foramen is above the aural opening in *C. jacchus*, while it is found posterior to it, and at the base of the skull, in *Lasiopyga* (*Cf.* Pl. XV, fig. 7, to the right). Extensive, shallow, and flat, the glenoid fossa is hardly deserving of the name, and it is only in *L. callitrichus* that it presents any concavity at all. However, the post-glenoid apophysis is strong and pointed in all of these apes, and materially contributes to the articulatory surface for the mandible and to keeping it in place.

Apparently absent in *C. jacchus*, the styloid process is very small in *L. callitrichus*, though better developed in *L. griseoviridis*.

In the temporal fossa, the wing of the sphenoid always appears to articulate by suture with the parietal of the same side. This fact is mentioned for the reason that Owen, in his Anatomy of Vertebrates

(Vol. II. p. 533) stated that "In the still smaller monkeys (*Cercopithecus*) the cranial cavity forms a larger portion of the skull. In *C. ruber*, the alisphenoid joins the parietal on the left side, not on the right. The postglenoid process is pointed, and in some (*Cerc. albogularis*) the mastoid also." He gives a figure (Fig. 353) showing this joining of the alisphenoid with the parietal on the left side, and in stating that it did not do so in *C. ruber* on the right, he evidently considered the character constant in that species, in which I am forced to believe that he was mistaken. Mivart states that "In *Nyctipithecus* the alisphenoid is almost shut out from the parietal by the close approximation of the squamosal to the malar," which is doubtless true.[3] Low down in the temporal fossa in *C. jacchus*, the shortened wing of the sphenoid makes quite extensive contact with the parietal, and the malar bone here may be pierced by one or two large perforating foramina, which lead into the back of the orbit. There may be only one of these, or they may be absent. No such foramina are to be found in *Lasiopyga*. All these apes possess an osseous *meatus auditorius externus*, leading directly into the auditory bulla in *Callithrix*, where no auditory process is present, the latter only being conspicuously developed in *Lasiopyga*.

Viewed from above, it will be observed that there are some very striking differences in the skulls of *Lasiopyga callitrichus* and *L. griseoviridis* (Pl. XIV, figs. 5 and 6). In *L. griseoviridis* the prominent orbital arch almost conceals the orbits from view; which is not the case in *L. callitrichus*. Again, in *L. griseoviridis*, the temporal ridges are conspicuously developed, but are practically absent in *L. callitrichus*. In both these apes, no parietal foramina are met with, though I have never as yet failed to find them in the skull of man.[4]

[3] On the left side in the skull of a *Pongo*, collected by Dr. W. L. Abbott on August 11, 1907 (West Borneo, Bayu, Sempang River), and now in the collection of mammalian skeletons in the U. S. National Museum (No. 145,322), there is a temporo-frontal articulation, which separates the alisphenoid from the parietal by several millimeters; while on the left side of the skull of *Simia* (No. 142,202, Coll. U. S. Nat. Mus.), collected by Dr. W. L. Abbott in West Borneo in 1905 (Sakaiam River), the arrangement is the same as in the vast majority of human skulls, that is to say, the alisphenoid articulates with the temporal, the parietal, the frontal, and the malar.

[4] Since this was written I have undertaken the examination of some seven thousand human skulls in the collection of the U. S. National Museum, with a view to obtaining certain data from them. These skulls are of both sexes and all

The frontal bone extends far backward, while the occipital is shut out from view in this aspect of the skull in these two monkeys. The marmosets have the temporal ridges also but very faintly indicated; the parietal foramina absent, and the form of the skull much elongated in some individuals, shorter in others.

Theie is little demanding special description in the cranial cavity of these monkeys which is not already known to anatomists. The 'sella turcica' is well marked, with its posterior clinoid process, and the usual foiamina exist foi the entrance and exit of vessels and nerves. The tentorium is not ossified in *Lasiopyga*, though the cerebellar fossæ are fairly well differentiated.

Upon basal view these skulls are all interesting when studied in connection with an average human skull viewed in the same manner. In *Lasiopyga callitrichus* and *L. griseoviridis* the characters are much alike, while very decided differences are found to exist when we come to compare these with the corresponding characters in the skull of *Callith ix jacchus*. In the latter the auditory bullæ occupy much of the space, being large and elongated, and directed forwards and inwards to a point about the middle of the cranial base, where their apices are separated by a distance of several millimeters. For the rest, the surfaces are singularly smooth; the sutures nearly obliterated; the pterygoidal plates of the sphenoid prominent, with the hamular processes conspicuous; two very distinct and circumscribed foramina are present upon either side, one just external to either condyle, and the other somewhat larger, immediately external to the anterior apex of either auditory bulla. The palatal root is short antero-posteriorly, with the sutures nearly obliterated. The plane of the occiput and foramen magnum makes an angle of about 45° with the *basis cranii*.

In *Lasiopyga* the anterior palatine fossa is mesially and longitudinally divided by the vomer (Pls. XIV and XV, figs. 5–8). The palate is twice as long as it is wide, and markedly concave from side to side. Traces of the sutures between the bones are persistent until late in life. The posterior palatal grooves are very deep in *L. callitrichus*, the foramen occupying its usual site posteriorly.

ages, representing all the known races of the world, both recent and prehistoric. The opportunity to study them is due to the kindness of Dr. Ales Hrdlicka, Curator of the Division of Physical Anthropology, the work having been undertaken for a certain purpose. It is more than likely that I may now meet with human skulls in which the parietal foramina will be found to be absent, as many of these skulls appear to reveal remarkable anomalies.

The external pterygoidal plates of the sphenoid are very prominent, quadiilateral in outline, and turned outwardly; the internal plates are not more than one-fifth the size of these; but each supports a distinct hamular process. Either pterygoidal fossa is deep and has from two to twenty minute foramina at its base. The basilar process of the occipital is broad and elongated, but does not extend as far forward as the petrous portion of the temporal upon either side. The carotid foramen is very distinct and circular, and I find no posterior condyloid foramen present. The foramen ovale is of fair size, and located as in the cranium of man. Other small cranial foiamina and openings are also present. The vomer is bifurcated posteriorly, the bifurcations receiving the sharp palatal process of the sphenoid. This is a striking feature of the base of both of these skulls (*Cf.* Plate XV, figs. 7 and 8).

In *L. callitrichus* the occipital surface is very smooth and lacking in depressions; while in *L. griseoviridis* it is decidedly roughened for muscular attachment two-thirds of the way up to the lamboidal suture, and in this area presents mesially a raised, longitudinal crest, the internal occipital crest, which merges into the general surface of the bone at its extremities.

The foramen magnum is subcirculai in outline, and rather large for the size of the animal in either species. The condyles are elongated and narrow, and occupy half the periphery of the anterior margin of the foramen. Mesially they are separated by a very shallow notch. The occiput makes an angle with the *basis cranii* of about 45°, that of the plane of the foramen magnum being considerably less. Another well-marked character, piesent on either side in both species, is the Glaserian fissure, occupying a position similar to what we find in anthropotomy.

Lasiopyga has a strong and powerful mandible, with its two parts in the adult thoroughly and indistinguishably fused at the symphysis; *Callithrix* has the ramal portion very thin, broad and quadrilateial in outline; while the body is not as strong in proportion as it is in some of the higher apes. The infradental and mental foramina are minute and single. Internally at the symphysis neither tubercles nor fossa are found in *Callithrix;* while in *Lasiopyga* a deep fossa is always present where the "genial tubercles" are found in man, and at the base of this fossa we find a circular foramen piercing the bone in the median line, to appear externally at the center of the bone, half-way between the alveolar process and the inferior border. The infradental and mental foramina are generally single in *Lasiopyga* as in *Callithrix;* but there are two foramina on either side in the jaw of *L. callitrichus* before me. In this last species the coronoid process is higher than the condyle on either side, and the sigmoid notch shorter and deeper than it is in *L. griseoviridis.* In *Lasiopyga* the notch is always long and shallow (Plate XIII, figs. 3, 4, and Plate XVI, fig. 10). The areas for the attachment of muscles, especially for the buccinator and internal pterygoid, are more or less roughened. The angle of the ramus is always rounded, and instead of their being a 'mental process' to represent a chin, as in man, the mandible in all these apes slopes from the teeth downwards and backwards as shown in Plate XIII, figs. 3, 4, and Plate XVI, fig. 10.

I find no good figures of the skeleton of *Lasiopyga* in the literature accessible to me. The one which has so long done duty in Huxley's "The Anatomy of Vertebrate Animals," is incorrectly drawn in nearly all particulars; it has no canine teeth, the zygoma is not that of an ape, in short it is not a skeleton of *Lasiopyga.*

Almost all of the laryngeal box in these apes ossifies in the adult, certainly in *Callithrix*, while the trachial rings seem to be only formed in cartilage, or, at the most, in elementary bone. De Blainville, Owen, Mivart, and other comparative anatomists have all referred to the enormously developed body of the *hyoid* in *Mycetes seniculus;* while Flower and others have described the hyoid in other New and Old World apes, as in *Cynocephalus porcarius* and *Lagothrix humboldtii*, cerato-hyals and epi-hyals being found in the last-named species. Flower further stated in his *Osteology of the Mammalia* that "In very few of the Old World monkeys is there any ossification in the anterior hyoid arch; but in some *Cercopitheci* a short, bony, cerato-hyal is found. This occurs also in the American Monkeys, with occasionally the addition of a second piece (epi-hyal)." It would appear that the presence of an ossified stylo-hyal in any of the apes is of extremely rare occurrence, though sometimes a very small tympano-hyal became ossified.

In the skeleton of *Lasiopyga griseoviridis* (C. M., No. $\frac{5103}{1}$) the basi-hyal is large and completely ossified. It has a length of 1.3 cm., and a width above of 1.2 cm. It is broad above, and narrow below, where it bifurcates, the processes thus formed being separated by a rounded notch. Posteriorly it is deeply concave, especially above, being correspondingly convex in front, where there is a blunt, longitudinal crest developed on the median line. At its supero-external angles, short, stout apophyses project, each having on its end an articular facet for a rather ong, curved thyro-hyal. Neither cerato-hyals nor epi-hyals are present.

THE AXIAL SKELETON.

(Plates XVIII–XIX, figs. 21, 22.)

THE VERTEBRÆ.

Flower among others has given us more or less full descriptions of the bones composing the skeleton of the trunk in the Primates. In the third edition of his *Osteology of the Mammalia*, on pages 78 and 79, he presents a table in which is set forth, under the five divisions of the vertebral column, the number of vertebræ found in each division. In the table *Homo sapiens* is compared in this way with no fewer than thirty-eight species of Apes from different parts of the world. In the list we find five species of *Lasiopyga* (*Cercopithecus*), including *L. griseoviridis* and also *Callithrix jacchus*.

In the specimen of *L. griseoviridis*, the skeleton of which I prepared, the animal had lost about half of its tail either prior to or after capture. Hence this part of the skeleton is imperfect. The tail is perfect in the skeleton of *Lasiopyga callitrichus* in the U. S. National Museum, and I have in my own collection a skeleton of *C. jacchus* in which the tail is perfect.

In his specimen of *Lasiopyga griseoviridis* Flower found seven cervical, thirteen thoracic, six lumbar, two sacral, and twenty-five caudal vertebræ. Upon comparing this with the skeleton of *L. griseoviridis* at hand, I find it has seven cervical, twelve thoracic, seven lumbar, and three sacral vertebræ. In counting the thoracic vertebræ, I am guided by those which support a pair of ribs, and in counting the lumbars, those are included which extend between the last thoracic and the first sacral,—a sacral being understood to be a vertebra which articulates with the pelvis and coössifies with one or more vertebræ succeeding it. In *L. griseoviridis* three such vertebræ coössify to form a sacrum, and following these, every vertebra belongs to the caudal series.

In the U. S. N. M. specimen of *Lasiopyga callitrichus*, No. 16365,—Flower did not make any record for this species,—I find seven cervical, twelve thoracic or dorsal, seven lumbar, three sacral, and twenty-eight caudal vertebræ. In only one species of *Lasiopyga* (*Cercopithecus*) did Flower find twenty-eight caudals, and that in *L. patas*.

Now coming to *Callithrix jacchus* (*Hapale*), of which I have two skeletons, I find in one seven cervicals, thirteen thoracics or dorsals, six lumbars, three sacrals, and twenty-eight caudals, the distal caudal being less than 2 mm. long and as fine as a human hair. This agrees with Flower, except as to the caudal vertebræ, of which he records only twenty-three, or six less than I find in a perfect specimen. Owen states in his Anatomy of Vertebrates that "Nineteen is the usual numbei of dorso-lumbar vertebræ in the Platyrrhine group, the Spider-monkeys (*Ateles*) offering the exception of eighteen, viz: D. 14, L. 4." This agrees with my count above. Owen also states that in most Platyırhines the number of caudal vertebræ are usually thirty or upwards, "*Ateles paniscus* having thirty-three caudals." This is entirely at variance with what we find in the table given by Flower. Mivart states that "The dorsal vertebræ vary in number from eleven, as sometimes in *Cercopithecus* [*Lasiopyga*] and *Macacus*, to fourteen, as sometimes in *Hylobates*, oı even to fifteen, as in *Nyctipithecus* [*Aotus*]." So faı as *Lasiopyga* goes, this is not only different from Flower's count for five different species of *Lasiopyga* (*Cercopithecus*), but it is evidently incorrect. But this is only one instance out of many where these two eminent anatomists disagree with respect to the number of vertebræ found in the several divisions of the spinal column of the Primates. We are dealing here, however, only with *Lasiopyga* and *Callithrix*.

In the atlas of both these genera of apes there are two foramina, on either side, one above and one below the transverse process, for the passage of vessels. They lead to a common opening, which is found just posterioı to the superior articular surface for the occipital condyle. It is for the passage of the vertebral artery, on either side; but exactly in what manner the branching takes place I shall be unable to state, until an opportunity occurs to dissect another specimen in the flesh. In man the foramen for the vertebral artery is single on each side. The vertebral vein may upon quitting the cranium pass through the other foramen. Owen seemed to believe that both perforations weıe for the vertebral artery in the marmoset (*Hapale jacchus*) when he stated that in that species "The transverse process of the atlas is perforated lengthwise and vertically by the vertebral artery, and the neural arch is perforated." The vertebral canal passes through all the cervical vertebræ increasing in calibre as it approaches the thorax, save in the last vertebra. In both *Lasiopyga* and *Callithrix* the inferior lamellæ of the transverse processes are broadened from side to side, and their extremities expanded, thus forming lengthened, longitudinal processes. These inferior lamellæ are absent in the seventh cervical vertebra. The neural spine in the axis is thick and relatively large; is much smaller in the third cervical, becomes sharp and pointed in the fourth, after which it gradually becomes sharper and longer to and including the seventh or last cervical.

The seventh cervical in both *Lasiopyga* and *Callithrix* has a demi-facet on either side of the centrum to form part of the articulation of the first pair of ribs.

In *Lasiopyga*, and especially in *L. callitrichus*, the neural spines of the dorsal vertebræ are long, rather pointed, but with slightly expanded apices. They become progressively and gradually shorter as we proceed backward, and less and less inclined in that direction (Plate XVIII, fig. 21). The last two thoracic vertebræ have characters approaching those of the anterior lumbars. In the last dorsal vertebra the transverse processes are aborted, a gradual diminution from the strong ones in the fore part of the series having taken place and they are supplanted by the sharp-pointed pleurapophyses, directed backwards, so that on the last dorsal we have a pair of these, as well as a pair of ribs, which articulate only with the centrum of that vertebra. These spine-like pleurapophyses persist in the lumbar vertebræ, including the penultimate, becoming smaller and smaller, and disappearing entirely on the last lumbar. In articulation they powerfully assist in holding the prezygapophyses in place, being in any instance situated just below a postzygapophysis, thus forming a recess into which the prezygapophysis of the vertebra next following accurately fits. Transverse processes commence again on the first lumbar, and become more and more prominent to and including the last one of this series (Pl. XIX, fig. 22).

The neural spines of the lumbars are conspicuously developed, rather high, elongate, oblong, and are in each of these vertebræ nearly as long as its centrum. Essentially all of these characters are repeated in the spinal column of the marmoset; but in it the neural spines of the last dorsals are not as long or as pointed. These monkeys have long, slender ribs, requiring no special description. Barring the last pair, they articulate between the vertebral centra, thus giving rise to demifacets to accommodate them. In *Lasiopyga* eight of these articulate with the sternum by means of cartilaginous hæmapophyses or costal ribs; in *Callithrix* only seven are so joined; the last three in the first-named species are "floating ribs," while the costal ribs of the ninth pair articulate with the lower margins of the costal ribs of the eighth pair. The sternal ends of these costal ribs articulate *between* the several pieces composing the sternum, which latter remain separate bones apparently throughout life. A large, triangular manubrium surmounts the series, and the xiphoid process at the distal end is rather large and expanded, particularly in *Callithrix*.

In *Lasiopyga* the three sacral vertebræ in the adult are firmly fused together to form one single bone, the lateral processes of the first being conspicuously thrown out to mold themselves on an extensive iliac articulation of the pelvis upon either side. In *Callithrix* only the two first sacrals thus coössify, and the third closely resembles the first caudal vertebræ (Pl. XIX, fig. 22).

Lasiopyga callitrichus has the first three caudal vertebræ of a distinctive type. In some respects they resemble the last sacral vertebra, but all the processes are slenderer, more prominent and projecting. Moreover, we find rudimentary chevron-bones here present, lapping the centra, but not fusing with them. In *Callithrix* the three anterior caudals more closely resemble the last sacral of that genus, and the chevron-bones are small. The fourth caudal vertebra in *L. callitrichus* differs very markedly from the one which precedes it, as it is more elongated, and its prezygapophyses are distinct, short, stout processes directed forwards and outwards, and its postzygapophyses are fused into one long, rather slender process, which springs from the middle of the centrum to arch backwards. The lateral or transverse apophyses are broad, outstanding, triangular lamellæ and different from those of any other vertebra anterior to it. There is a rudimentary pair, which are stronger in the fifth caudal, after which they become much reduced. In the fourth and fifth caudals, the chevron-bones, completely ossified, are V-shaped in form, free, and articulate with the centrum anteriorly and below, encroaching very slightly on the vertebra next beyond. This encroachment is better marked on the part of the chevron-bone of the fifth caudal, after which these elements become double and distinct, and more and more rudimentary as we follow the vertebræ distad until they finally disappear entirely on the fourteenth or fifteenth caudal. This is also the fate of the outstanding processes, each vertebra, as we approach the end of the tail, becoming more rod-like and longer with enlarged extremities, and rudimentary in character with diminished calibre to and including the tenth, after which they progressively shorten again and become shorter and shorter to the end of the appendage, the last ten or twelve being merely rudimentary little rodlets, the terminal caudal being only 5 mm. long as compared with the seventh, for example, which has a length of 35 mm.

The characters of the caudal vertebræ in *Callithrix* in many ways resemble those of *Lasiopyga*, though the chevron-bones are more rudimentary and the apophyses in the anterior caudals not so conspicuous. Only the first four caudals in *Lasiopyga* have the neural canal a closed tube, though it may exist in the fifth, where its calibre becomes of mere hair-like proportions. It is better marked in the fifth caudal of *L. griseoviridis*, in which species the fifth caudal more closely resembles the third, which is not the case in *L. callitrichus*. *Callithrix* has its few anterior caudals much flattened out from above downwards Mivart noted that "Chevron-bones and processes for their attachment are altogether wanting only in the *Simiinæ* and in *Macacus inuus*. They attain their maximum in *Ateles*, where they present almost every variety of development in one or other part of the caudal region."

In those monkeys having prehensile tails, as in *Ateles* for example, the processes of the caudal vertebræ are exceptionally well-developed in order to afford attachment for the caudal muscles employed in the grasping power of the appendage in this genus; and it is a well known fact that all the vertebræ in these animals vary considerably throughout the group.

THE APPENDICULAR SKELETON.

THE FORE LIMB. (Plate XX, fig. 23).

In his excellent article "Ape" in the *Encyclopædia Britannica*, Professor Mivart has given us the proportions of bones, particularly the long bones of the skeletons of a great many of the representatives of the group here under consideration. This has been done so fully that it obviates the necessity of touching upon this part of the subject in the present contribution, as the space can be better utilized for presenting the description of the actual characters. In this connection it is to be noted that Mivart in the aforesaid article, treating of the "Appendicular Skeleton," refers to *Lasiopyga* but once, and that is when he says that "The index digit, with its metatarsal, compared with the spine, is as 38 to 100 in *Simia*, and it varies thence down to 21 in *Cercopithecus*." I find in *Lasiopyga callitrichus* it is less than 18.

The Clavicle. In this same skeleton the clavicle has a length of 4 cm., and, when duly articulated with the sternum and scapula, the surface which corresponds with the anterior in man, in the ape become the superior, and the other surfaces change aspects accordingly. This is also the case in *Callithrix*. In *Lasiopyga griseoviridis* the clavicle has a length of 4.7 cm., while in *C. jacchus* it has a length of only 2 cm. In all of these species its form is to a large extent similar, and its mode of articulation interesting. We find its sternal extremity enlarged, bearing an extensive facet mesially for articulation with the sternal manubrium above the costal cartilage of the first rib, the interval in *Callithrix* being considerable and proportionately much less in *Lasiopyga*. The scapular end of the bone is very much curved downward especially its outer, expanded part, where it materially assists in protecting the articulation for the head of the humerus. This expanded portion in *L. griseoviridis* is largely scooped out to form a notable fossa, which is not as well marked as in *L. callitrichus*, and absent in *Callithrix*. When duly articulated with the coracoid and acromion processes, the clavicle closes in a large, circular foramen between these two apophyses and the adjacent border of the glenoid cavity, assisted as it is by the scant trapezoid ligament.

The Scapula. *Lasiopyga* and *Callithrix* have the scapula much alike in all of its essential characters. Its form is not a little different from its form in man. As compared with the latter, we find in *Lasiopyga* that the superior and internal borders are of equal extent, and no very definite "superior angle" occurs at their juncture, as in man, where the internal or vertebral border is fully four times longer than the superior. Again in the ape the spine of the scapula, which is conspicuously developed, is continued to the internal border; not so in man, where a very considerable smooth surface intervenes, over which in life the trapezius muscle glides. There is no evidence of any "suprascapular notch" in *Lasiopyga*, and the external border of the bone is much thickened and profoundly grooved from the neck of the bone almost to the inferior angle, the grooving being broadest and deepest at its upper part, and gradually shallowing and narrowing as the lower angle is approached. The acromion process is large and strong and only slightly bent, while the smaller coracoid process is straight, flat on its glenoidal and outer surfaces, and joined to its base at a right angle. The scapular neck is well defined, and the articular surface for the humeral head of the bone of the arm is pear-shaped with the larger end below. The subscapular fossa of the anterior aspect is smooth throughout, but generally exhibits a shallow groove running longitudinally from below the neck almost to the inferior angle.

The Humerus. Among the higher races of men the shaft of the humerus is normally always straight, while in *Lasiopyga griseoviridis* its shaft is not only somewhat twisted upon itself, but very decidedly curved for its entire length; the concavity of this curvature, extending from the head to the internal condyle, is along its inner aspect, the corresponding convexity being down the other side of the bone. This curvature is less evident in the shaft of the humerus in *Lasiopyga callitrichus*, while in *Callithrix jacchus* the humeral shaft is almost straight. It is a strong, big, heavy bone in *Lasiopyga* with a large, semiglobular head, the upper surface of which is on a level with the tuberosities. We find the nutrient foramen at the juncture of the middle and lower third of the shaft, above the internal condyle in *Lasiopyga;* while in *Callithrix* it is just below the head at the upper end of the bone. *Lasiopyga* has the internal condyle but very moderately produced, while the marmoset has it very conspicuously produced; and again, in the first-named genus, the outer crest of the trochlea for the ulna is very sharp, prominent, and produced distad; the trochleæ are in the same plane in *Callithrix.* The olecranon fossa in *Lasiopyga* is always pierced by a large circular foramen, which does not occur in my skeletons of *Callithrix*, though the bone is quite thin at the site. The usual grooves for muscles and nerves are present, the musculo-spiral groove being particularly well marked in *Lasiopyga*, in which genus no part of the shaft can be said to be cylindrical, so pronounced are its borders and the longitudinal grooves between them. No such distinctive features as either an anatomical or a surgical neck exists in the humeri of these apes, and in *Lasiopyga* the head of the bone does not unite solidly with the shaft until comparatively late in the life of the individual. It has an extreme length in *L. griseoviridis* of 12.3 cm., in *L. callitrichus* of 11 cm., and in *Callithrix* of 4.3 cm.

The Radius. In *Lasiopyga* only the proximal fifth, including the head, of the shaft of the radius is straight and moderately compressed, the balance of the bone being greatly curved for its entire length, this curvature having its concavity toward the interosseus space in the articulated skeleton. The shaft gradually, though moderately, increases in caliber for its lower four-fifths, presenting three sharp borders, the surfaces between them exhibiting longitudinal grooves. *Callithrix* also possesses a radius like this, but in it these grooves are absent. Both have a circulai head with a moderate central depression at its summit, and the distal extremity larger than the proximal. The bicipital tuberosity is elongate and not perceptibly raised above the surface of the shaft. Distally the styloid process is fairly well-produced, and this epiphysis does not unite with the shaft until late in life, a remark which also applies to the ulna, and, as already stated above, to the head of the humerus.

The Ulna. Lasiopyga has an unusually straight ulna, it being slightly curved in the marmosets. It gıadually diminishes in caliber from the big olecranon to the distal end, where we find a styloid process pıesent, and articulation with the carpus takes place, which is not the case with this extremity of the radius. *Lasiopyga* has the greater and lesser sigmoid cavities of the ulna extensive and very concave; in fact, this end of the bone very much resembles the proximal end of the ulna in man. In the Green guenon its shaft is deeply and longitudinally grooved for the lesser sigmoid cavity down to a point about its middle. Below this point the shaft is more or less cylindrical in form.

The Carpus and Manus. Coming now to the carpus and the manus, Mivart has pointed out that the "carpus consists, in *Troglodytes*, of the same eight bones as in man. In all the other genera there is a ninth bone, the *intermedium*." Flower in the third edition of the *Osteology of the Mammalia*, on page 286, figures the bones of the carpus of a Baboon (*Cynocephalus anubis*) where the intermedium is present, and there called the *centrale*, so there are also in the wrist-joint of this animal nine bones. In the Baboon there is also another bonelet present, it being the "radial sesamoid," which is free and articulates with the margins of the trapezium and scaphoid. It belongs to the tendon of the *flexor carpi radialis* muscle. All this agrees with what we find in the carpus of *Lasiopyga* and *Callithrix*, in each of which genera the unciform is larger than the magnum, and the pisiform very prominent, and in articulation making a right angle with the shaft of the ulna.

The bones of the *metacarpus* are proportionally longer, more curved, and narrower than in man; but, together with the *phalanges*, are the same in number. These last are also more curved than they are in man, the distal pha anges being compressed from above, downwards, except in *Callithrix*, where the compression is in the other direction, being curved, as in some birds, and sharply pointed, having the form of the distal d'gital thecæ which encase them. In *Lasiopyga*, a pair of sesamoids are found on the palmar aspect at the metacarpo-phalangeal joints, and also at the joints beyond the index and minimus digits.

THE HIND LIMB. (Plate XVIII, fig. 21; Plate XIX, fig. 22, and Plate XXI, fig. 25).

The Pelvis. Differing considerably in form from the pelvis in *Homo*, and likewise from the big pelvis in *Troglodytes* with its great, broad ilia, the ilium as a who'e in *Lasiopyga* is much elongated and comparatively narrow. Either ilium rises considerably above the sacral articulation to a point opposite the middle of the penultimate lumbar vertebra in the articulated skeleton. Its crest is moderately convex and roughened, and it is here that the bone is broadest, gradually narrowing as it approaches the acetabulum. Upon its outer surface it is concave, and correspondingly convex upon its inner surface, where it presents an extensive roughened area for articulation with the sacrum. The anterior border is sharp, while the posterior border is rounded, the thickest part of the bone being just anterior to the cotyloid cavity. This causes the greater sacro-sciatic notch to be long and shallow, while the lesser one is hardly deserving of a name. In form, the acetabulum very closely approaches what we find in man, and the bone at its base is very thin, though never exhibiting any perforations. There is an interval of bony surface between the cotyloid notch and the large subcircular obturator foramen.

Pubis and Ischium. Deep and prominent, the symphysis pubis is in life firmly united by ligament, and the pubic arch presents the same sexual characters as we find in the pelvis of man. The tuberosity of the ischium, with the adjacent ramus of the pubis and ischium, is curved forward, thus forming a concave surface anteriorly below the obturator foramen. This tuberosity is most extensive externally, gradually narrowing as it approaches the pelvic outlet or pubic arch, and its surface is much roughened for attachment of the ischial callosities in this genus.

Barring its very much smaller size, the pelvis in *Callithrix* presents essentially the same characters as the bone in *Lasiopyga*. It is, however, proportionately shorter, the obturator foramen proportionately larger, and more circular, thus causing the cotyloid notch to be nearer to its margin, while the ischio-pubic surfaces, internal and external, are flat, and the tuberosity of the ischium is but very slightly enlarged. From its external point to the anterior pubic angle, the border of this pelvis is uniformly convexly curved and almost sharp. The spine of the ischium is absent in *Callithrix*, and very rudimentary in *Lasiopyga*. Mivart found this process prominent in *Simia*.

The Femur. Apart from the matter of relative size, the femur in *Lasiopyga griseoviridis* presents the same characters as are met with in that bone in *Lasiopyga callitrichus;* in the former it has an extreme length of 14.8 cm., and in the latter of 13.2 cm. In *Callithrix jacchus* it is only 5.4 cm. long.

In *Lasiopyga* the femoral head is smooth, hemispherical in form, and presents a deep pit for the insertion of the *ligamentum teres*. The neck is as well marked as it is in *Homo*, but it does not make quite as open an angle with the axis of the shaft, and the massive trochanter major rises somewhat above both it and the head of the bone. The digital fossa which it overshadows is deep and circumscribed, and on the posterior surface leads by a groove almost to the summit of the very prominent trochanter minor, which groove is bounded by a definite trochanterian line, no "spiral line" as in man being found opposite it on the anterior aspect. Strong and highly polished, the cylindrical shaft of the femur is considerably curved between the extremities, the curve being quite uniform with the convexity in front.

The *linea aspera* is fairly well seen, and a single nutrient foramen is found on the posterior surface of the shaft at a point between its middle and upper third. Distally, the bone is much enlarged, and in many respects resembles this extremity in the femur of man. The lower points of the condyles, however, are in the same plane, the internal condyle being the lower in man. There is a deep intercondylar fossa between the jutting, prominent condyles posteriorly. Each of these, in this locality, is surmounted by a large sesamoid, which in each case articulates with it at its summit. Similar sesamoids of relatively similar proportions are found in the skeleton of *Callithrix* occupying like positions. No authority at hand mentions these sesamoids, certainly not Huxley, Mivart, or Flower, yet they are very conspicuous in the skeleton of *Lasiopyga*. A large, ovate, elongate *patella* is present in all the apes here being considered, it being uniformly convex anteriorly, and very shallowly doubly concave posteriorly, a very faint mid-longitudinal elevation appearing between the two concave surfaces.

Callithrix has a femur presenting a number of points unlike those just described for *Lasiopyga*. The head of the bone comes considerably nearer being a complete sphere. The upper fourth of the bone› or down as far as the well-developed lesser trochantei, is gently bent anteriorly, while below the "trochanterian line" there is an extensive, circumscribed triangular surface, which is not found in *Lasiopyga* at all. Its shaft is quite straight, for its posterior third wide, and flattened in the antero-postero direction.

In the *short external lateral ligament*, just above the head of the fibula in *Callithrix*, a minute sesamoid is present, but I fail to find its counterpart in either species of *Lasiopyga*.

The Tibia. The tibia of *Lasiopyga griseoviridis* is 14.3 cm., of *L. callitrichus* 12.4 cm., and of *Callithrix jacchus* 5.4 cm. in length; the fibula in any case being but very little shorter. Essentially all the characters we find in the human tibia and fibula are repeated in the same bones in these apes, even including *Cal ithrix*. Apart from the matter of the great difference in size in such a comparison, it is truly remarkable how similar they really are. *Lasiopyga* has the upper third of its shaft more compressed transversely, and here it is quite concave in the longitudinal direction as far down as the junctuie of the middle and upper thirds. This is not as evident in *Callithrix*, in which form the tibia exhibits considerable compression for its entire length until we neai the enlarged distal extremity in both genera, when the bone is somewhat flattened in the opposite direction to accommodate itself for articulation with the astragalus. The tibial crest is much rounded off in these apes, and the tubercle for the insertion of the ligamentum patellæ is very rudimentary. The internal malleolus is prominent, and its long axis is in line with the axis of the tibial shaft.

The Fibula. The fibula is a slender bone, extremely so in *Callithrix*, straight, more or less cylindrical, barring the moderately flattened surfaces for muscular insertion, and presenting the usual enlarged ends for articulation with the tibia above, and below with the astragalus, its malleolus being quite as long as that process in the tibia. This is a departure from what we find in man, where the fibula extends much beyond the tibia, causing the external malleolus of the leg to be the lower of the two.

The Tarsus. As in all other simians and apes, we find in the tarsus of *Lasiopyga* and *Callithrix* the seven usual bones, and these have practically the same relative size, and articulate in much the same manner as in *Homo.* When ligamentously articulated as in life, they form a plantar double arch, an antero-posterior one, and a transverse one. We also find in the foot of each of these genera the paired sesamoids on the plantar aspect, beneath the metatarso-phalangeal articulations as in the manus; but they appear to be absent from the more distal joints. There is also in these genera another sesamoid present, which I fail to find elsewhere described for the apes, although it may have, and probably has, been described. It occurs in both *Lasiopyga* and the marmoset, and consists in a somewhat sizeable segment, semiellipsoidal in form, and articulates with the postero-external angle of the cuboid, being embedded in the tendon of the *peroneus longus* muscle as it passes this point on its way to its insertion at the infero-posterior internal angle of the base of the metatarsal of the hallux. It may be conveniently named the *peroneal sesamoid.*

Most of the observable departures in the form of the podial bones from those in man are due to the peculiar twisting of the foot in the ape. Both the astragalus and the calcaneum are rather large bones with extensive articular surfaces, the posterior moiety of the latter being concave on its inner side and slightly bent in that direction. The area for the insertion of the *tendo Achillis* on its hinder aspect is abruptly defined by a sharp line. The anterior articular surface of the os calcis for the scaphoid or navicular bone is concave; whereas the corresponding facet on the astragalus is convex. The cuboid and scaphoid are of about the same size, and articulate with each other in the middle line of the foot. The middle cuneiform is the smallest of the three cuneiform bones, while the saddle-shaped ectocuneiform and the scaphoid dip down far below all the others in the sole of the foot. Mivart has described in his article in the Encyclopædia Britannica many of the characters of the tarsal bones and phalanges, and compared their proportions, especially for *Simia, Ateles, Hylobates, Pithecia, Troglodytes, Lagothrix* and *Cebus,* but has little or nothing to say of *Lasiopyga* and *Callithrix.* The morphology of the tarsus in the latter is much the same as we find it in *L. callitrichus.*

Metatarsus and Phalanges. All of the metatarsal and phalangeal bones, save the terminal joints, are considerably curved, the concavity being palmad. This is most evident in *Lasiopyga callitrichus;* rather less in *L. griseoviridis*, and least of all in *Callithrix*. In the marmoset, as in its hand, the terminal joints of the pes are laterally compressed, much curved, and pointed. In *Lasiopyga* it is the third metatarsal which is the longest bone of the tarsus and possesses the biggest shaft; while in *Callithrix* the fourth metatarsal is a shade longer than the third, and its shaft is about equal in caliber with it. In proportion to the size of the animal, the marmoset possesses a long and narrow foot, its slender tarsal bones and toe-joints exhibiting but little curvature, are when articulated almost parallel to each other, and to this the hallux forms no exception.

CLOSING REMARKS.

This paper has aimed especially to point out the main skeletal differences, especially in the skull and axial skeleton, which may exist between two species of apes which have been placed in the same genus, viz., *Lasiopyga callitrichus* and *L. griseoviridis*. It also essays to clear up faulty records and illustrations of previous writers, particularly in the matter of the correct number of vertebræ in various divisions of the spinal column. It gives in detail the osteology of *Callithrix*. The illustrative plates should possess value, and should especially prove to be of assistance to those engaged in the study of the craniology of this group.

In the first volume of "A Review of the Primates" Dr. Elliot gives considerable information concerning the "Bald-headed Tamarins" of the genus *Seniocebus*. They are placed by him in Family I of Suborder 2 of the Anthropoidea, and three species are described, viz.: *S. bicolor*, *S. meticulosus*, and *S. martinsi*. Their dental formula is given thus: I. $\frac{2-2}{2-2}$; C. $\frac{1-1}{1-1}$; P. $\frac{3-3}{3-3}$; M. $\frac{2-2}{2-2} = 32$.

The literature relating to this genus and the marmosets, covering the eaily wiitings of Linnæus (1758) to date, is quite extensive.

Elliot places the tamarins in the four genera *Seniocebus*, *Cercopithecus*, *Leontocebus*, and *Œdipomidas*. Formerly they were airayed with the marmosets either in the genus *Hapale* or in *Callithrix*.

"The chief difference between members of *Callithrix*," says Elliott, "and the species now under consideration [*Seniocebus*] is found in the teeth, the canines of the lower jaw being longer than the incisors, a distinction deemed by some authors as perhaps hardly sufficient to cause the Tamarins to become separated generically from their relatives. Tamarins and Marmosets resemble each other, and the skulls with the large brain-case are much alike" (p. 179).

Elliot gives a number of plates, each presenting four views of skulls of the several genera and species named above. The one of *Seniocebus* (1½ natural size) is very good (Plate XXII). It closely resembles the skull of *Callithrix leucopus* (Plate XXVII. ½ larger than nat. size).

There are but four or five skins of *Seniocebus meticulosus* in the hands of science, and probably not more than three skeletons. One of the latter appears to be in the American Museum of Natural History (New York); I understand there is one in the U. S. National Museum (not examined by me), and, finally, one prepared by myself, which has been placed in the Carnegie Museum at Pittsburgh. Thus it will be seen that this little monkey is one of the rarest species known. The type was obtained in northern Colombia (Rio San Jorge).

I have carefully compared in all of its details my skeleton of *Seniocebus meticulosus* with the corresponding characters of the skeleton, as presented in two adult skeletons and other osteological material before me representing *Callithrix jacchus*, and I fail to find any characters in the skeleton of the former (the teeth do not belong to the skeleton) which point to such a thing as generic differences separating these two species. Some slight differences are apparent, but they are entirely referable to individual variation, and it is safe to say that they will not be found to be constant. The fact that the canine teeth of the mandible in *Seniocebus* are longer than the incisors, whereas they are not so in *Callithrix*, by no means furnishes sufficient reason for creating a new genus for the former. Moreover, although they are not quite as pointed as they are in *Seniocebus*, we sometimes find the lower canine in *Callithrix jacchus* somewhat longer than the outer incisor upon either side; so that, too, proves to be a variable character among these species (Compare Figs. 9 and 10 of Plate XVI of this paper) and consequently an unreliable feature upon which to base generic differences.

As is the case among human skulls, the facial angle differs in different individuals. For example, the facial angle in the skull of *Seniocebus* I have in my collection is markedly less than it is in the skull of that form figured by Elliot (Vol. 1, Plate XXII), where it practically agrees with the facial angle of the skulls of *Callithrix jacchus* now at hand.

With respect to these skeletons, there is nothing like the differences which are to be found in and which characterize the skeletons of *Lasiopyga callitrichus* and *Lasiopyga griseoviridis*, as set forth above. The nature of these differences are well exemplified in the skulls of these two species of apes in the figures given in Plates XII–XV.

The skeletal characters of the trunk and limbs in the case of *Seniocebus* practically agree in all particulars with the corresponding features in any of the marmosets of the genus *Callithrix;* and in my opinion, the fact of the matter is, in so far as their osteology goes, there are no constant characters to be found which justify the creation of different genera to contain these tamarins and marmosets. The lower canines in a skull of *Callithrix leucopus*, as figured by Elliot (Plate XXVII), are exactly the same in character, both in form and in relative lengths, as compared with the mandibular incisors, as they are seen to be in *Seniocebus meticulosus* (Plate XXII), or, as for the matter of that, in *Cercopithecus midas* (Plate XXIII) or in *Leontocebus* (Plate XXIV) or *Œdipomidas* (Plates XXV and XXVI). All these animals belong in the same genus, each presenting excellent distinguishing *specific* characters, which characters are external rather than internal.

According to Elliot (*l. c.*, Vol. II, pp. 1–20) there are fifteen species in the genus *Aotus* of the family *Cebidæ*, they being known by the vernacular name of Douroucoulis. They are chiefly nocturnal in habit, and, "with one exception, *A. rufipes* from Nicaragua, Central America, whose habitat is somewhat doubtful, the species of this genus are found only in South America, and are distributed across the continent from the Atlantic to the Pacific Ocean."

Elliot figures the skull (four views) of but one of these species, namely *Aotus miriquouina* (Vol. II, Plate I) and gives some of its measurements (p. 11). There is a complete skeleton of this species in the collections of the U. S. National Museum, and this I have before me at the present writing (No. 103917 ♂).

The skull is quite different from the one figured by Elliot, it being more elongate and vertically compressed, while the breadth of the brain-case (35 mm.) is the same in each. In the skull which he figures, however, the "occipito-nasal length" measures but 57 mm., while in the skull belonging to the National Museum this diameter measures 67 mm. This is an excellent example of individual variation, in so far as it refers to the skulls of these animals belonging to the same species.

As will be seen in my figures, the orbital cavities in the skull of *Aotus miriquouina* are circular and of great size, being hemispherical in form, each in its entirety, with the margins sharp, except where they are formed by the nasals and frontals. The vault of the cranium, superficially, is smooth, and probably it wi l be found that the direction of the lines of the sutures exhibits in different skulls as many variations as we find among human skulls, as well as those of other anthropoids. For example, in the skull figured by Elliot the *coronal suture* forms an arc with the concavity forwards; in the skull at hand it forms an angle, the sharp apex of which, directed backward, is met by the anterior extremity of the sagittal suture. On the lateral aspect of this skull it will be noted that the squamous portion of the temporal is small, as is likewise the case with the alisphenoid. This allows the parietal to make an extensive articulation with the malar of the same side, while the alisphenoid is far removed from both the frontal and parietal bone, articulating with the temporal and malar far down in the fossa nearly opposite the zygoma. The aural apertures are circular in outline, and the bullæ conspicuously elevated with their osseous walls inclined to be thin. These bulbous enlargements of the "petrous portion" of either temporal bone are entirely absent in such an ape as *Lasiopyga callitrichus*. The occiput is especially prominent, and there are two marked concavities between it and the foramen magnum, placed side by side, transversely.

The form of the *mandible* in *Aotus* is well shown in the figures on the plates, and it is to be noted that the ramal walls are thin, while the symphysial is thick and strong. The "sigmoid notch" between the coronoid process and condyle is narrow and semi-circular in outline, the process rising considerably above the condyle.

The *hyoidean apparatus* in this specimen has been lost, and so has the *atlas* vertebra.

In the "spinal column" we find seven cervicals; twelve dorsals; nine lumbars; three sacrals and twenty-five caudals. There are thirteen pairs of ribs, *nine* pairs of which join with the sternum through costal ribs. An abnormality is seen here in the elongation of the pleurapophysis of the second lumbar vertebra on the left side, articulating with the extremity of which there is a small, free rib, some seven mm. in length.

The three *sacral vertebræ* are thoroughly fused together, their neural spines forming a single piece, with all sutural traces obliterated. The lateral processes of the first sacral vertebra make very extensive articulations, on either side, with the *pelvis*, the latter being of an elongate form with narrow ilia and large, sub-circular obturator foramina.

With respect to the skeleton of the limbs of *Aotus miriquouina*, the bones present nothing worthy of special note. But little curvature is present in any of the long bones, they all being for the most part straight and slender (see Plate XVII, fig. 20, for the skeleton of the pectoral limb of the left side).

The *clavicle* shows the sigmoid curve very markedly, particularly at the outer moiety. The blade of the *scapula* is flat and triangular in outline.

The *pisiform* is prominent and long, and when duly articulated makes a right angle with the line of the shaft of the corresponding ulna.

The *humerus* has a length of 6.7 cm. and the ulna of 7.2 cm.

In the *pelvic limb* the shaft of the *femur* is very straight and cylindrical, the bone having a length of 9 cm., the trochanter minor being well developed, and the *caput femoris* hemispherical in form.

The supracondylar sesamoids are present, and another small one is found on the summit of the tibia, just above the articulation of the fibular head.

For its upper two-thirds the shaft of the *tibia* is much flattened transversely, and somewhat bowed to the front.

The *fibula* is straight and slender, especially the proximal half of its shaft, while its distal extremity is much enlarged to form the *external malleolus*.

The skeleton of the *pes* presents nothing peculiar, though it may be said that it is of an elongate form with the *metatarsal* joints and *phalanges* inclined to be quite straight and rather slender; but this does not apply to the short and tapering ungual joints.

EXPLANATION OF THE PLATES.

PLATE XII.

FIG. 1. Facial view of the skull, mandible included, of *Lasiopyga callitrichus*. Left lower-mid-incisor tooth missing. (Coll. U. S. National Museum, No. 16365.)

FIG. 2. Facial view of the skull, mandible included, of *Lasiopyga griseoviridis*. Several incisor teeth missing. Both figures natural size, from photographs by the author. (C. M. Cat. Mamm. No. $\frac{5103}{1}$.)

PLATE XIII.

FIG. 3. Right lateral view of the skull, including the mandible, of *Lasiopyga callitrichus*. Same specimen as in Plate XII, Fig. 1.

FIG. 4. Right lateral view of the skull, including the mandible, of *Lasiopyga griseoviridis*. Same specimen as in Plate XII, Fig. 2. Both figures natural size, from photographs by the author.

PLATE XIV.

FIG. 5. Direct superior view of the skull, mandible removed, of *Lasiopyga callitrichus*. Same specimen as shown in Plate XII, Fig. 1, and Plate XIII, Fig. 3.

FIG. 6. Direct superior view of the skull, mandible removed, of *Lasiopyga griseoviridis*. Several incisor teeth missing. Same specimens as shown in Plate XIII, Fig. 2, and Plate XIII, Fig. 4. Both skulls natural size, and from photographs by the author. Both of these skulls are from individuals not fully adult, judging from the sutures in the crania, and from the fact that in other parts of the skeletons the epiphyses are not firmly united with the shafts of the long bones to which they belong.

PLATE XV.

FIG. 7. Direct basal view of the skull of *Lasiopyga callitrichus*, ♂, mandible removed; dental armature complete. Same specimen as shown in Plates XII–XIV, Figs. 1, 3 and 5.

FIG. 8. Direct basal view of the skull of *Lasiopyga griseoviridis*, ♂, mandible removed; three incisor teeth missing. Same skulls as in Plates XII–XIV, Figs. 2, 4 and 6. Both skulls natural size, from photographs by the author.

PLATE XVI.

FIG. 9. Superior view of the mandible of *Callithrix jacchus;* all the teeth missing. Not fully adult individual; belongs to the cranium shown in fig. 12.

FIG. 10. Left lateral view of skull, including mandible, of *Callithrix jacchus*, adult male; dental armature complete.

FIG. 11. Left lateral view of skull, including mandible, of *Seniocebus meticulosus*, adult male; some of the teeth missing.

FIG. 12. Superior view of the cranium of *Callithrix jacchus;* mandible removed (fig. 9); teeth missing; not fully adult.

FIG. 13. Superior view of the cranium of subadult specimen of *Callithrix* (sp.?) male. No. 35640, Coll. U. S. Nat. Mus. (Mandible shown in fig. 14.) Died at National Zoölogical Park.

FIG. 14. Mandible of *Callithrix* sp.?, seen from above. Belongs to the cranium shown in fig. 13.

FIG. 15. Left lateral view of the skull, including mandible, of *Aotus miriquouina*. No. 103917, Coll. U. S. Nat. Mus. Dental armature complete.

All figures natural size and photographed from the specimens by the author.

PLATE XVII.

FIG. 16. Antero-oblique view of the skull of *Callithrix jacchus* (Same as shown in figs. 9 and 12 of Plate XVI of this article).

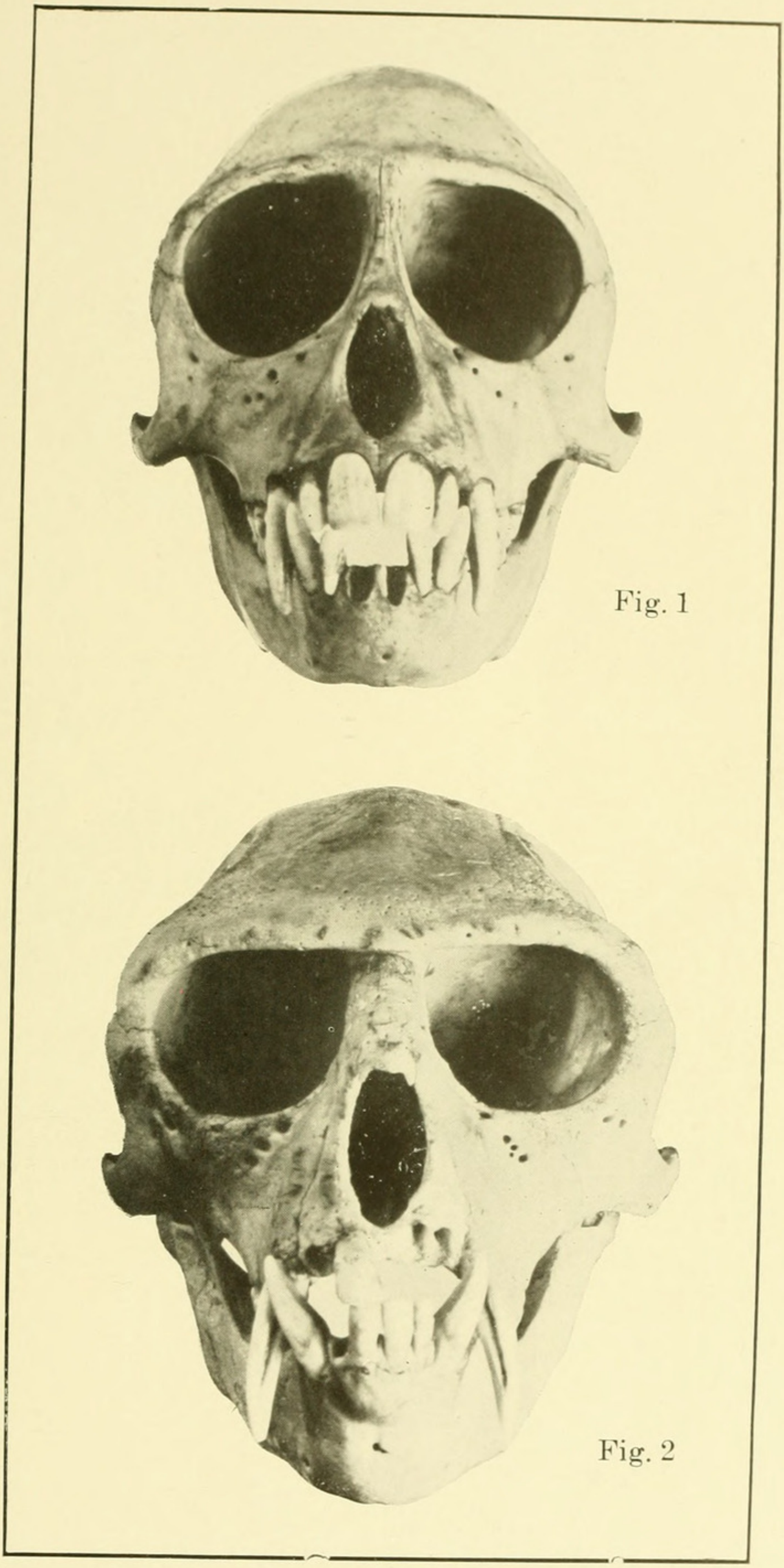


FIG. 1. *Lasiopyga callitrichus.* U. S. N. M., No. 16365.
FIG. 2. *Lasiopyga griseoviridis.* C. M., $\frac{5103}{1}$.

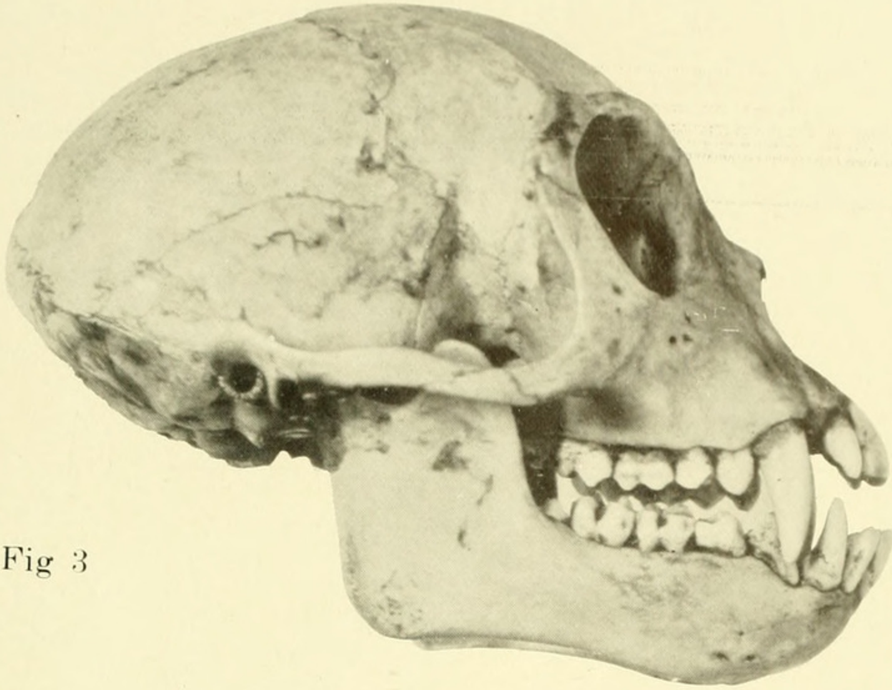


Fig 3

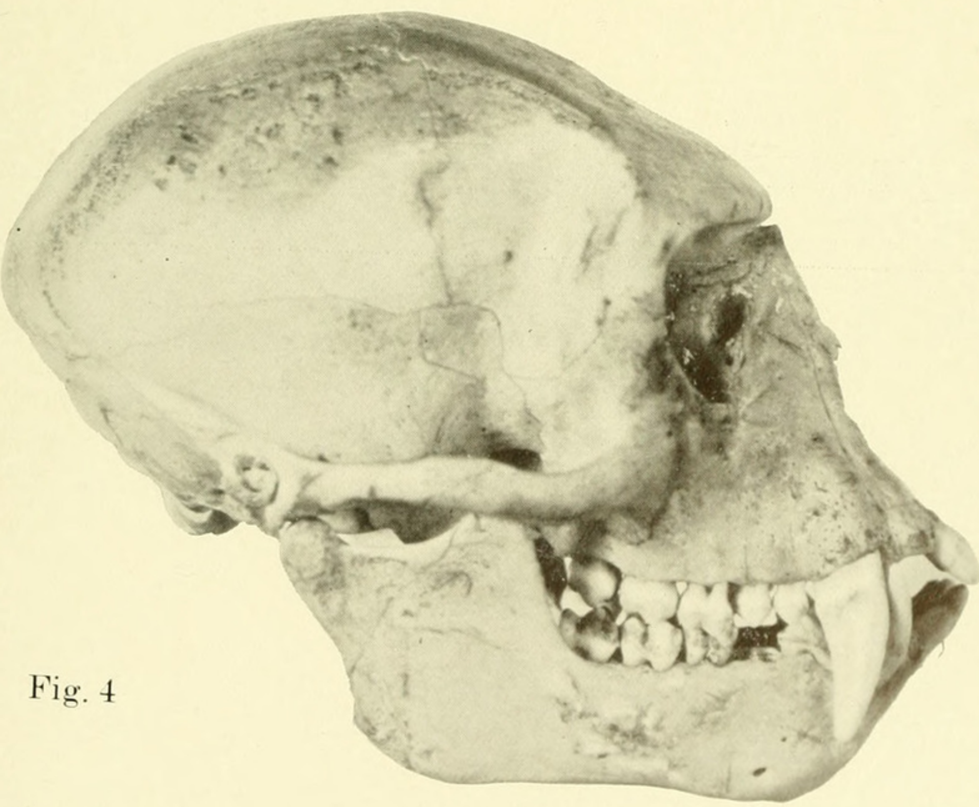


Fig. 4

Fig. 3. *Lasiopyga callitrichus.* U. S. N. M., No. 16365.
Fig. 4. *Lasiopyga griseoviridis.* C. M., No. $\frac{5103}{1}$.

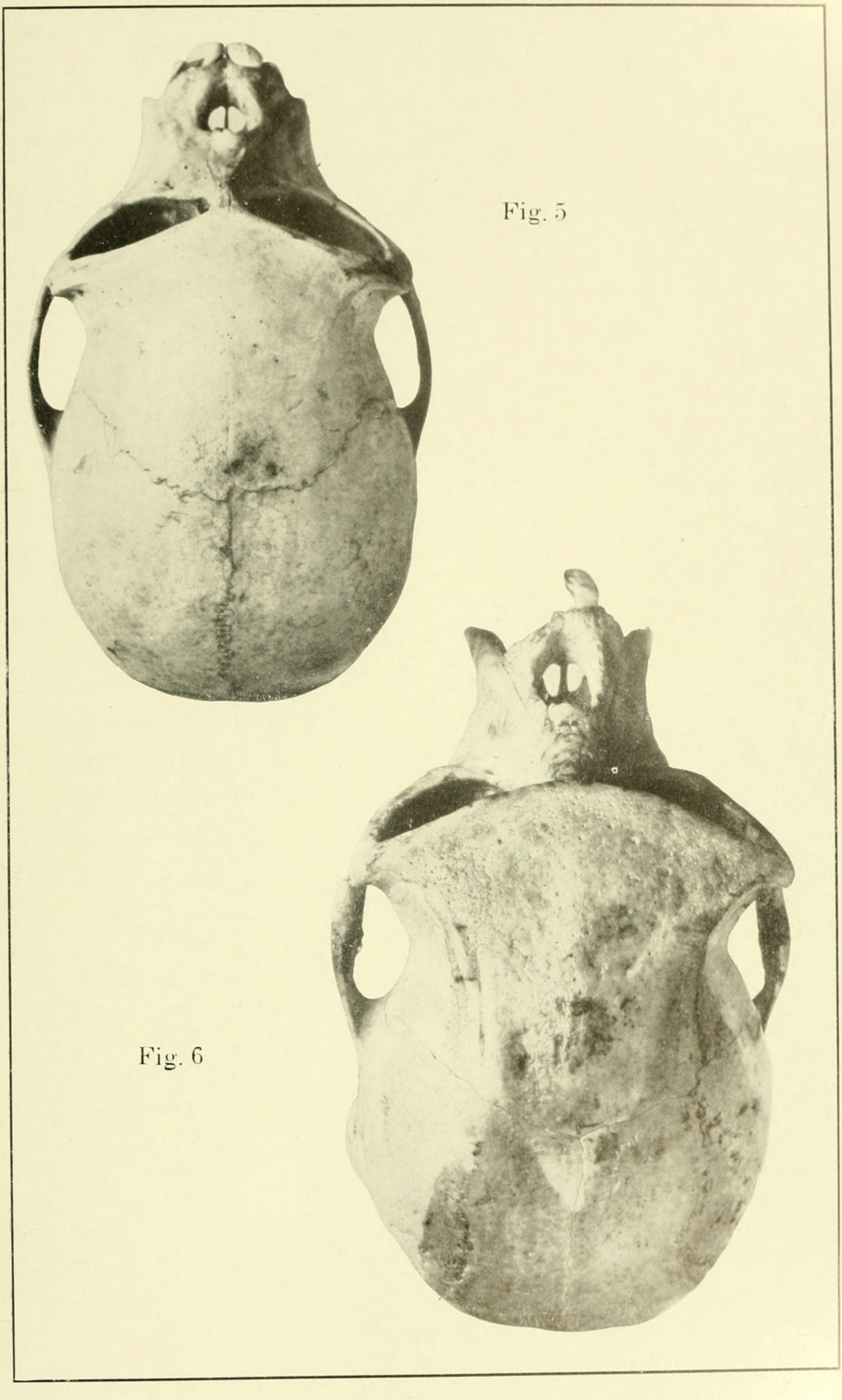


FIG. 5. *Lasiopyga callitrichus.* U. S. N. M., No. 16365.
FIG. 6. *Lasiopyga griseoviridis.* C. M., No. $\frac{5103}{1}$.

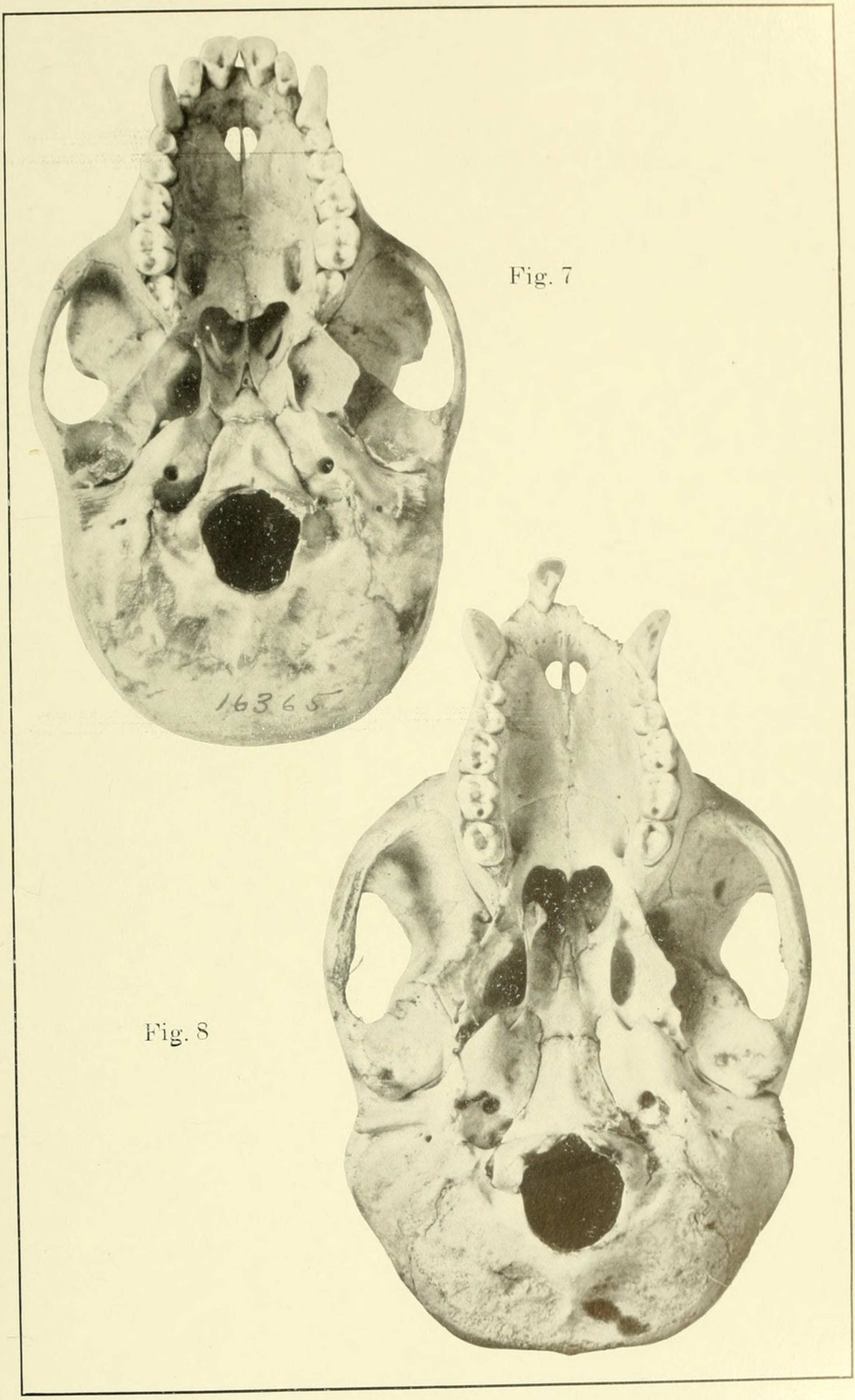


Fig. 7. *Lasiopyga callitrichus.* U. S. N. M., No. 16365.
Fig. 8. *Lasiopyga griseoviridis.* C. M., No. $\frac{5103}{1}$.

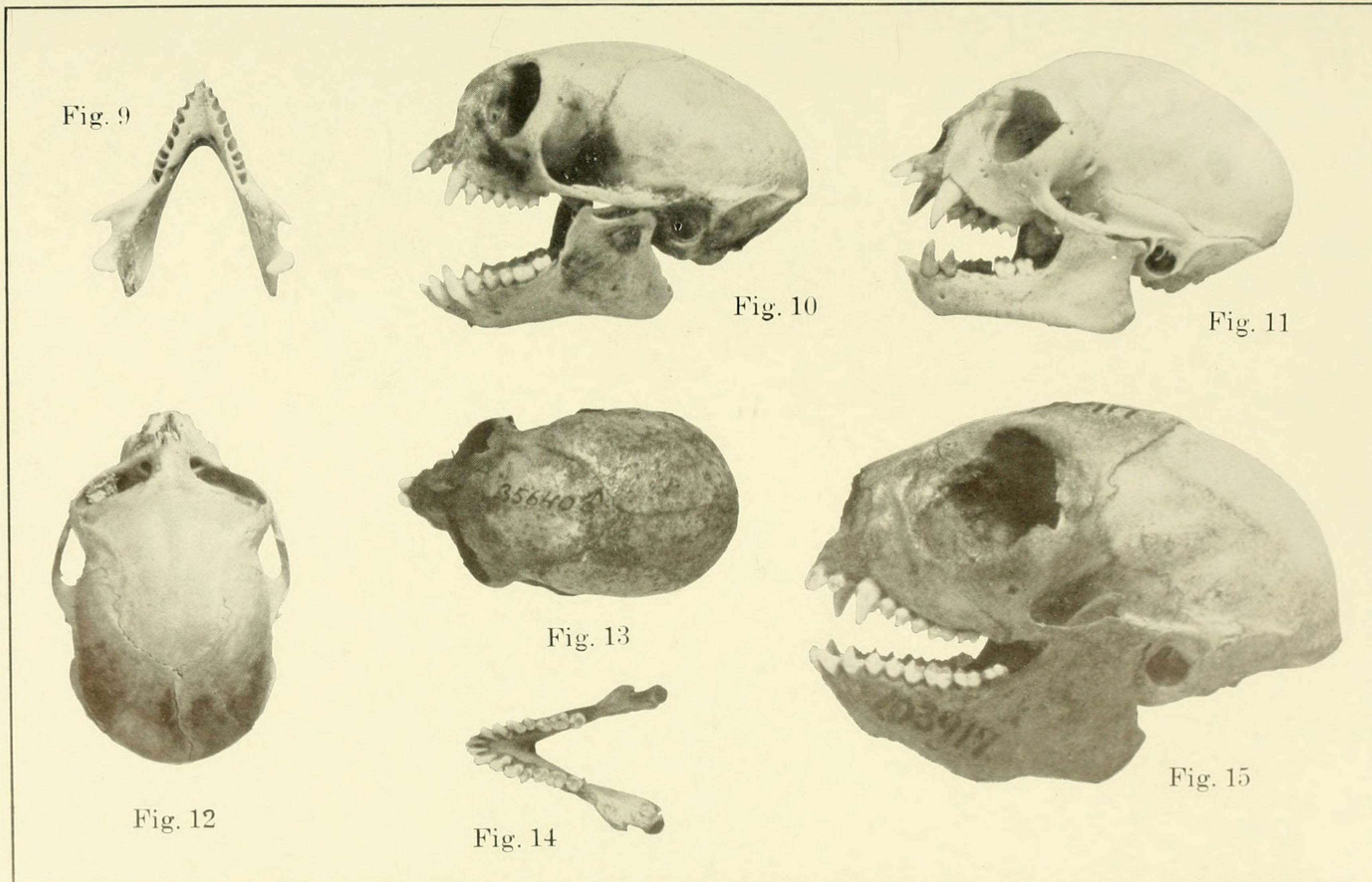


Fig. 9 Fig. 10 Fig. 11 Fig. 12 Fig. 13 Fig. 14 Fig. 15

FIGS. 9, 10, 12. *Callithrix jacchus*. C. M., No. $\frac{5103}{2}$. FIG. 11. *Seniocebus meticulosus*. C. M., No. $\frac{5103}{3}$. FIGS. 13, 14. *Callithrix* sp. (?). U. S. N. M., No. 35640. FIG. 15. *Aotus miriquouina*, U. S. N. M., No. 103917.

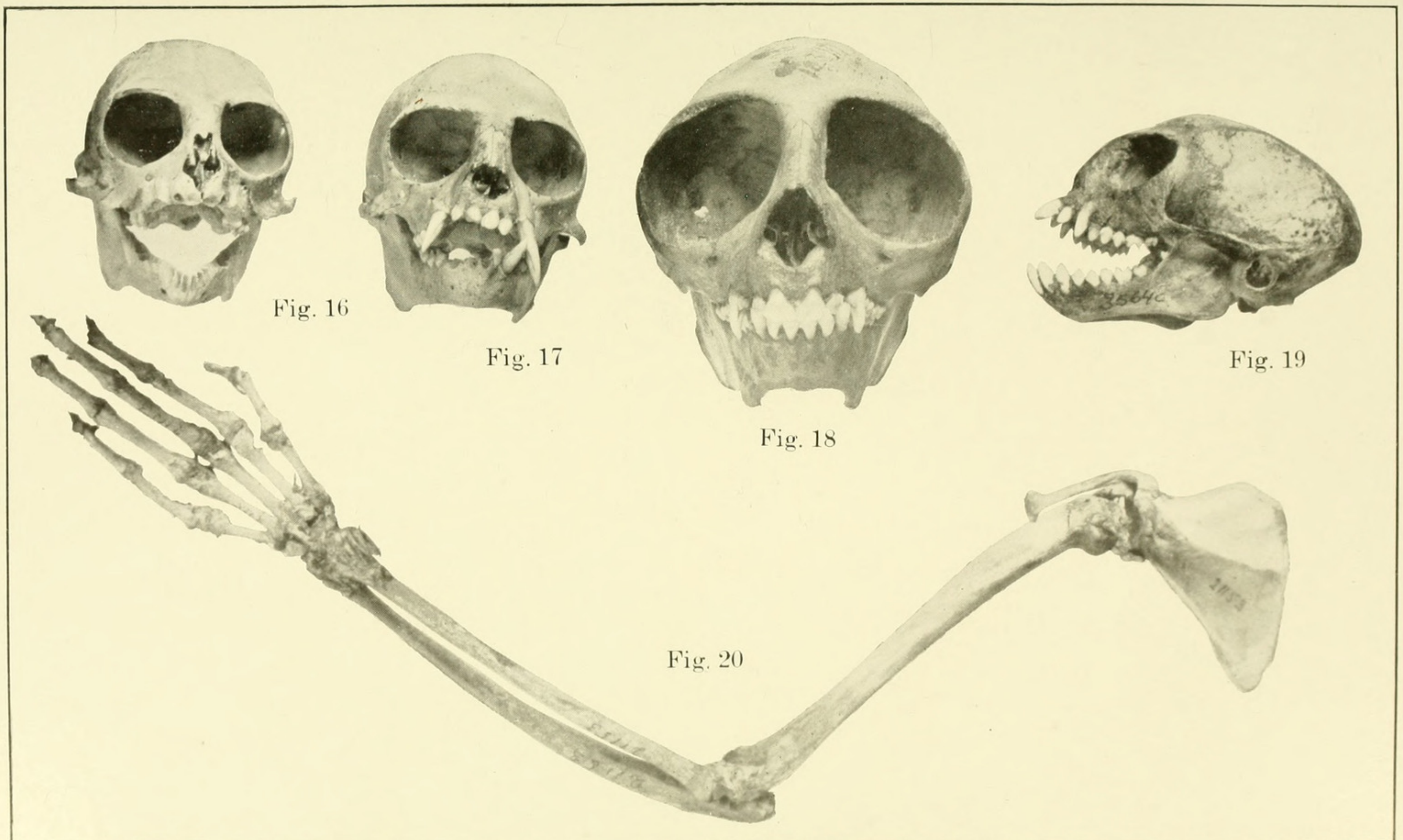


Fig. 16. *Callithrix jacchus* C. M., No. $\frac{5103}{2}$. Fig. 17. *Seniocebus meticulosus*. C. M., No. $\frac{5103}{3}$. Figs. 18, 20. *Aotus miriquouina*. U. S. N. M., No. 103917. Fig. 19. *Callithrix* sp. (?). U. S. N. M., No. 35640.

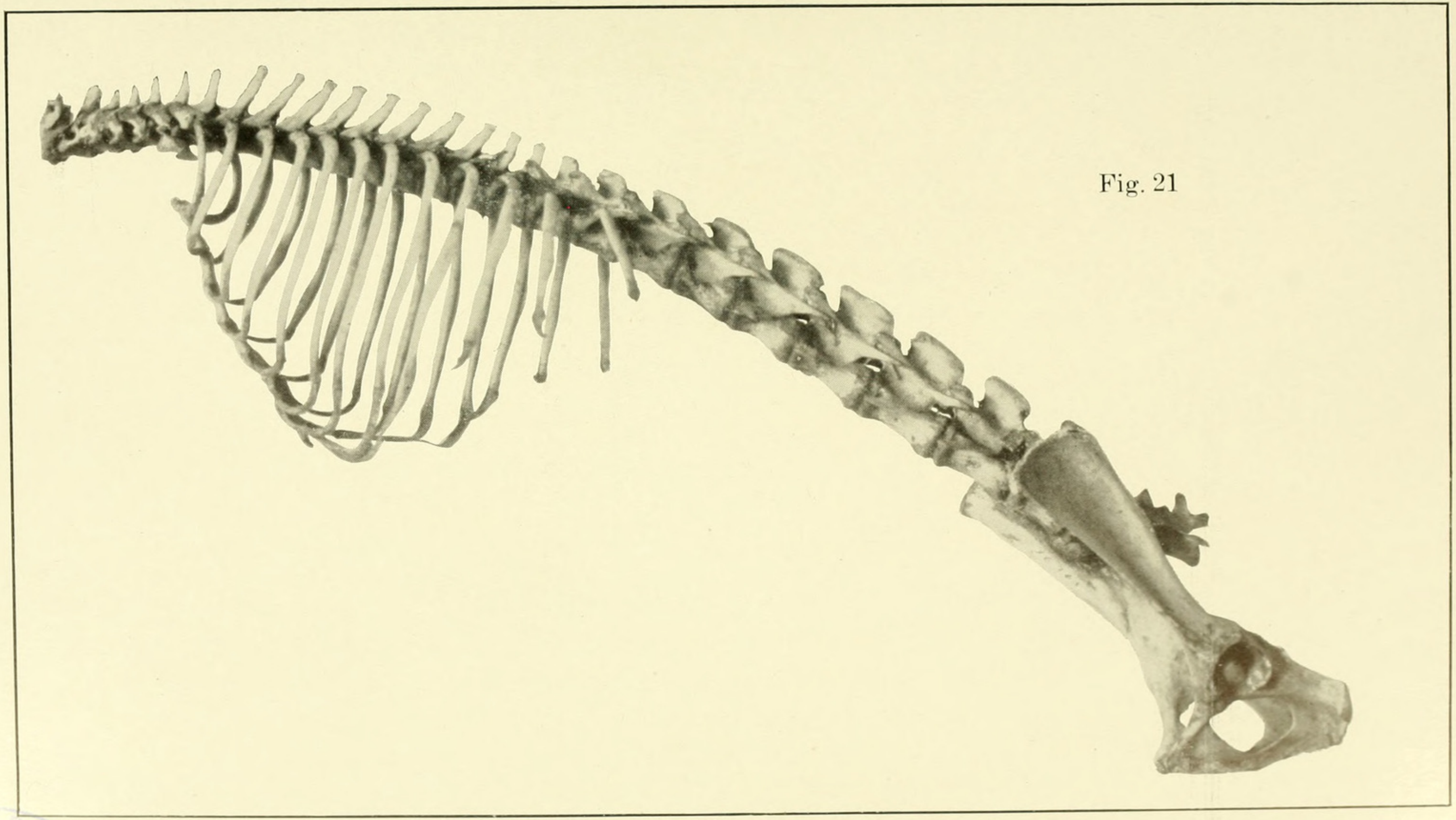


Fig. 21. *Lasiopyga callitrichus*. U. S. N. M., No. 16365.

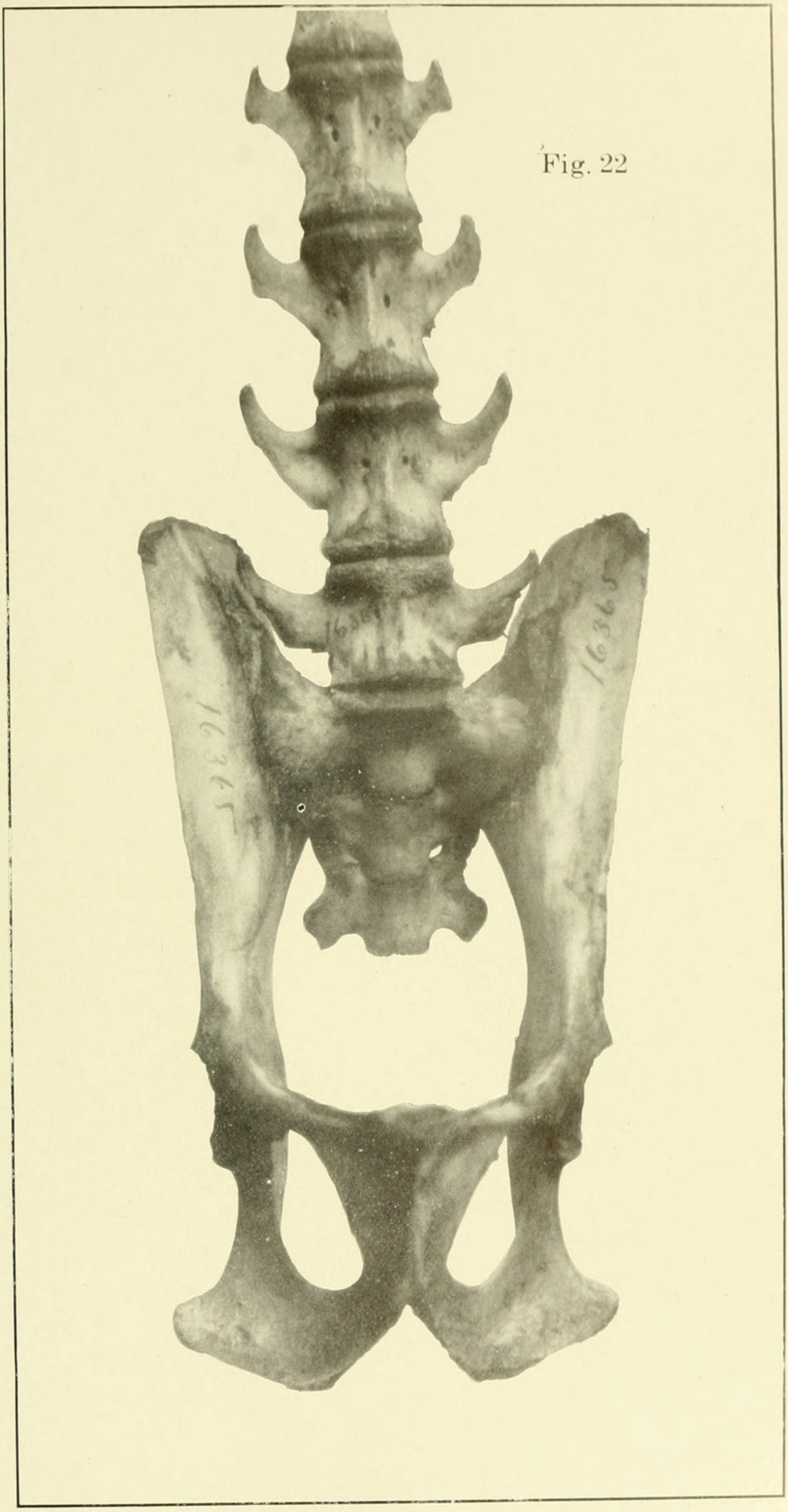
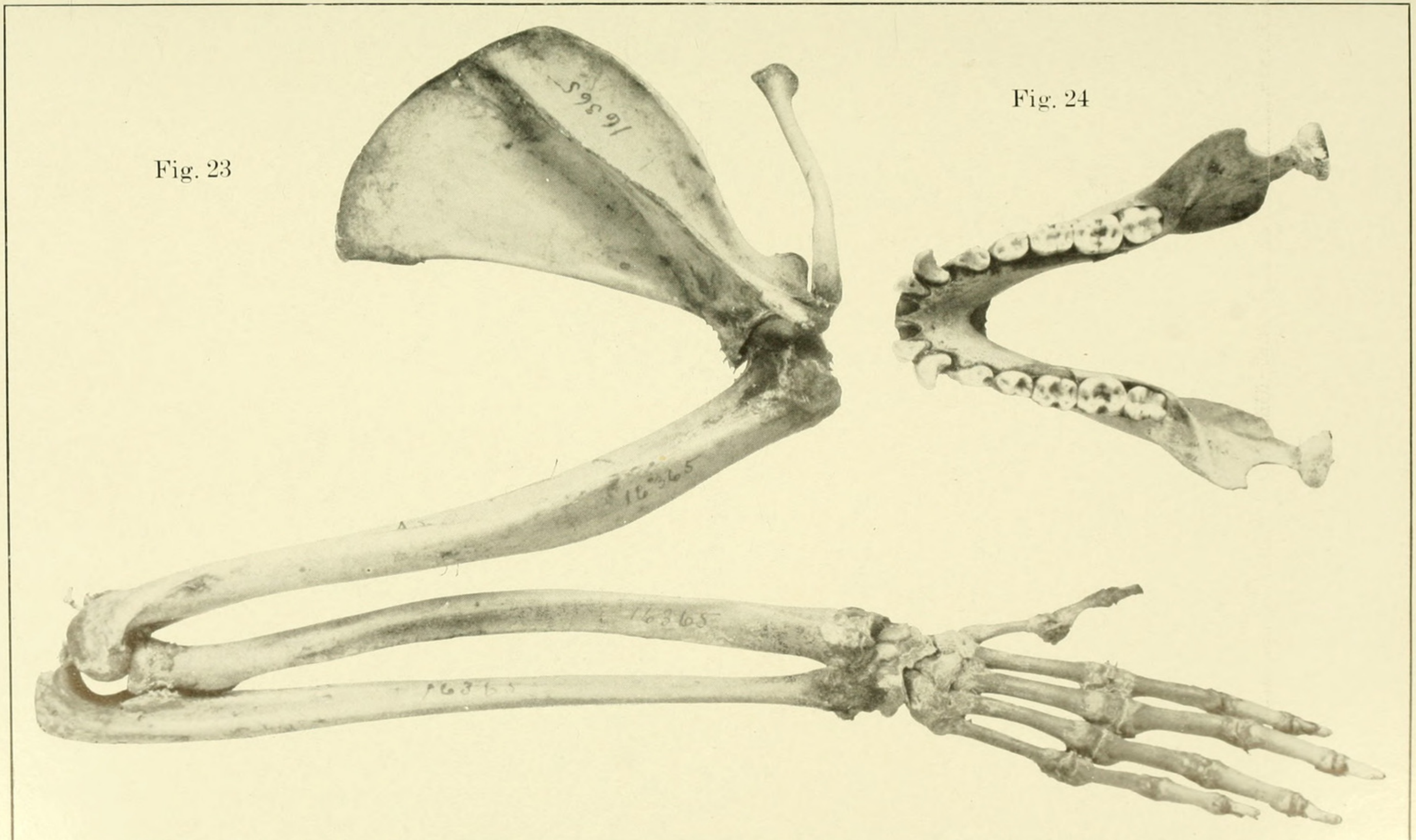


Fig. 22. *Lasiopyga callitrichus.* U. S. N. M., No. 16365.

Fig. 23

Fig. 24



FIGS. 23, 24. *Lasiopyga callitrichus.* U. S. N. M., No. 16365.

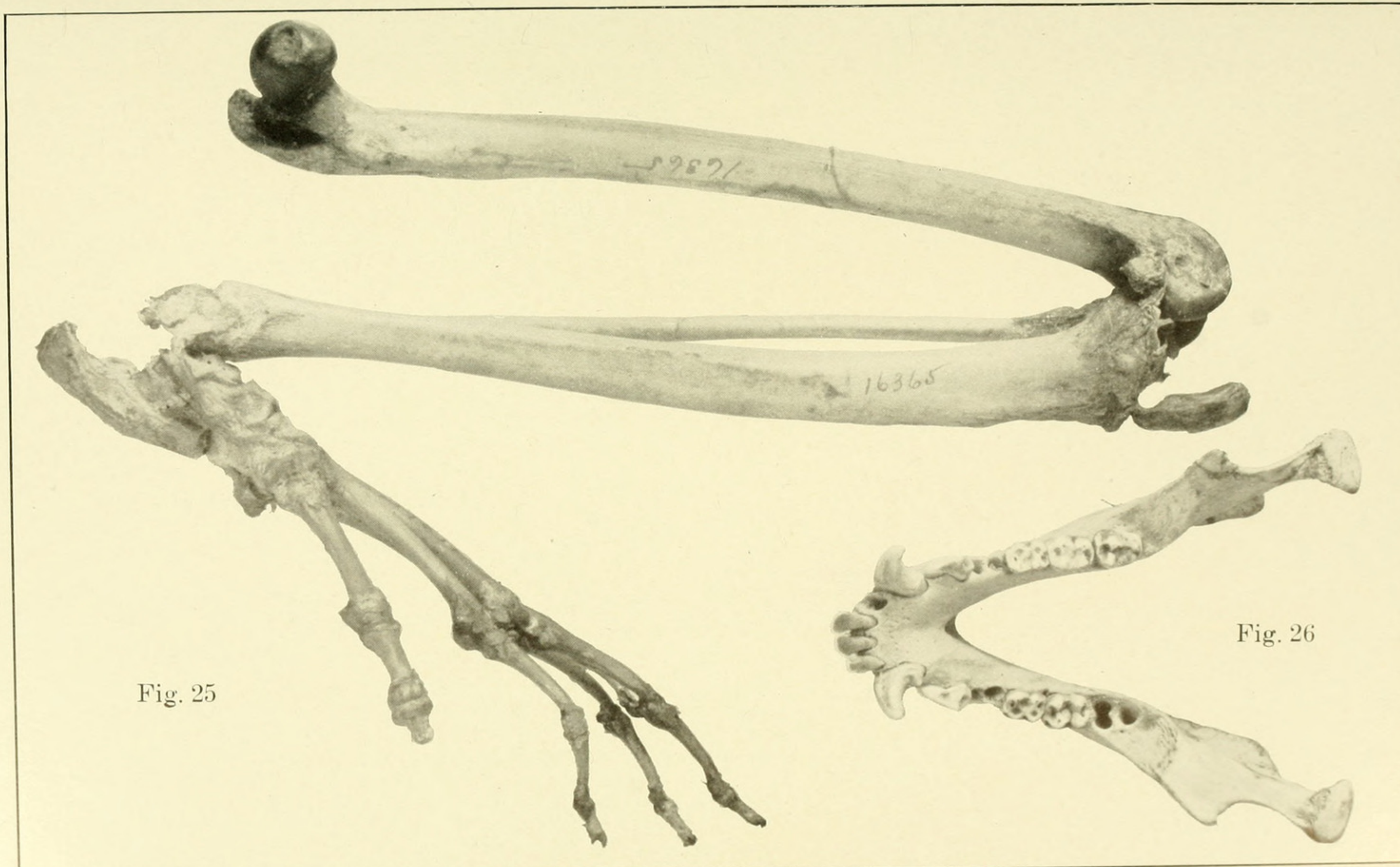


FIG. 25. *Lasiopyga callitrichus.* U. S. N. M., No. 16365. FIG. 26. *L. griseoviridis.* C. M., No. $\frac{5103}{1}$.

FIG. 17. Antero-oblique view of the skull of *Seniocebus meticulosus*. Some teeth missing. Same specimen as shown in Plate XVI.

FIG. 18. Direct front view of the skull of *Aotus miriquouina*. (Note how the upper teeth overlap those of the mandible when the jaws are closed, as they are in this figure.) Same specimen as shown in fig. 15 of Plate XVI above.

FIG. 19. Lateral view of the skull of *Callithrix* sp.? Dental armature complete. Same specimen as figs. 13 and 14 of Plate XVI above.

FIG. 20. Left pectoral limb of *Aotus miriquouina*, outer aspect, with scapula and clavicle attached. Some of the bones slightly thrown from their normal positions. The skull shown in fig. 18 of this plate belonged to the same skeleton.

All the figures in this plate are of natural size, from photographs taken by the author.

PLATE XVIII.

FIG. 21. Skeleton of trunk of *Lasiopyga callitrichus*, left lateral view, reduced rather less than one-half. Belonged to the skeleton of which the skull in Pl. XII, Fig. 1, is a part. Coll. U. S. Nat. Mus., No. 16365. Slightly rotated in the figure in order to better show the character of the pelvis, which, although belonging to the lower extremity, is left attached. Photographed by the author.

PLATE XIX.

FIG. 22. Anterior view of the pelvis, posterior lumbar vertebræ and sacrum of *Lasiopyga callitrichus*. From the skeleton of the same individual shown in preceding plates (Coll. U. S. N. M., No. 16365). Natural size, photographed from the specimen by the author.

PLATE XX.

FIG. 23. Right pectoral limb of *Lasiopyga callitrichus* with scapula and clavicle articulated therewith. From same skeleton as figures previously given (Coll. U. S. N. M., No. 16365). Natural size, outer aspect. The total length of the humerus in the specimen is 11 cm. The limb is rotated so as to show the skeleton of the hand upon the dorsal aspect. Photographed by the author.

FIG. 24. Mandible of *Lasiopyga callitrichus;* seen directly from above. Same jaw as shown in figs. 1 and 3 of Plates XII and XIII.

PLATE XXI.

FIG. 25. Left pelvic limb, including patella, ligamentously articulated, of *Lasiopyga callitrichus*, from the skeleton of the same individual to which belonged the arm shown in Pl. XX, fig. 23. Photographed by the author and about natural size, inner aspect. Extreme length of femur in the skeleton 13.5 cm.

FIG. 26. Mandible of *Lasiopyga griseoviridis* seen directly from above. Same jaw as shown in figs. 2 and 4 of Plates XII and XIII.