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## THE BAGOBOS OF DAVAO GULF.

By FAY COOPER COLE.
(*From the Field Museum, Chicago, and the Bureau of Science, Manila.*)

This article gives in brief some of the results of an extended investigation now being carried on by the Field Museum of Natural History among the non-Christian tribes of Mindanao. The funds for this work are provided through the generosity of Mr. Robert F. Cummings, of Chicago. The detailed study of this people will appear later under the title The Tribes of Davao Gulf.

Mount Apo, the highest peak in the Philippines, is situated a few kilometers from the Gulf of Davao in southern Mindanao. The non-Christian people known as Bagobos live on its lower slopes, which in some places reach to the sea, from Daliao on the east to Digos on the west. On the eastern border of their territory they merge imperceptibly into the Atas and Guiangas, while to the west the influence of the Bilaans is strong both in material culture and in blood.

In color the Bagobos are a light reddish-brown with a slight olive tinge which is more pronounced in the women than in the men. Their hair is brown-black and varies from slightly wavy to closely curled; face hairs are generally removed, yet some men have rather full beards.

The average height of the men is about 158 centimeters and of the women 147 centimeters; the body is uniformly well developed, but never stocky. The forehead is high and full; the crown and back of the head strongly arched; and the distance from the tragus to the vertex is somewhat greater than in most Philippine tribes.

The face is high and moderately broad, with cheek bones seldom prominent. The eyes are dark or black-brown and are set far apart, while the eyeslits are oblique. The root of the nose is low; the ridge broad and inclined to be concave, although straight noses are not uncommon. The lips are broad and protruding; the chin round and well formed.

Both men and women pierce and stretch the lobes of the ears so as to admit enormous ear-plugs. Those worn by the women are usually of wood, inlaid with silver or brass, and are connected by a beaded band which passes under the chin. Wooden plugs are also much used by the men, but the most highly prized ornaments are large ivory ear-plugs, made like enormous collar buttons. Both men and women file and blacken the teeth.

The Bagobos are without doubt the most handsomely dressed wild people in the Philippines. The men confine their long hair with head kerchiefs, the edges of which are decorated with beads and tassels. A close-fitting undershirt is often worn, and above this is an elaborately beaded or embroidered coat which opens in front and seldom reaches as low as the waist. The hemp-cloth trousers scarcely reach the knee, and the bottom of each leg is decorated with a beaded or embroidered band. Two belts are worn, one to hold the trousers, the other to support the fighting or working knives which the man always carries. In lieu of pockets, each man has on his back an elaborately beaded hemp-cloth bag which is bordered with tassels, and bells of native casting. Both men and women have many strands of beads encircling the neck and often falling free on the chest. Shell bracelets are also commonly worn.

The dress of the woman is not less artistic than that of the man. Her jacket is close fitting around the neck and reaches to the skirt, so that no portion of the upper part of the body is exposed. These jackets are embroidered over the shoulders and arms, and at the neck and waist; often they have complicated designs in shell disks or beads. The skirt is made like a sack with both ends open, and is held at the waist with a cloth or beaded belt. Many strands of beads encircle the neck, and often a broad bead necklace is worn over one shoulder. A small carrying bag decorated with beads and bells is suspended from a shoulder. The women are fond of loading their arms with ornaments of brass and shell, while anklets and leglets with rattles and bells attached are commonly worn.

According to the historians of the tribe Mount Apo was the first home of the race.[1] The tradition in part is as follows:

When the world first began to be there were one man and one woman and they lived on Mount Apo near the place where the town of Cibolan now is. The

[1] Other tales concerning the origin of this people are current, but the one here given is the most often heard and generally accepted.

name of the man was Toglai and of the woman Toglibon. Many fruits grew on the mountain and the forest was filled with game, so that it was easy for them to procure food. After a while they had many children, both boys and girls, who, when they grew up, married.

One day Toglai and Toglibon told their oldest boy and girl that they should go far away across the ocean, for there was a good place for them. So the two departed and none of the Bagobos saw them again until their descendants—the white people—came back to Davao. The other children remained with their parents and were happy and prosperous until Toglai and Toglibon died and went to the sky, where they became spirits.

Shortly after their death the country suffered a great drought. No rain fell for three years; the rivers became dry, and the plants shriveled and died, so that there was no food in the land. The people said: "Manama[2] is angry and is punishing us, for he has taken away our plants and water; surely we must go to a new place where there is food or we shall die." Two started on the way toward the sunset, carrying with them stones from the Cibolan River, and in a few days reached a good land where there were water and plants, and pigs and deer abounded in great fields of grass. There they settled and in time many children were born to them. Since then they have been called Magindanau because of the stones which they carried with them when they left Cibolan.

Two others went to the southward and when they found a good land they stopped and made their home. On their journey they carried small baskets called *bira-an*, and because of this their children are known as Bira-an.[3] A pair who went to the northward carried small dolls and thus obtained the name Eto.[4]

The tradition accounts for the naming of six other tribes known to the Bagobos, and then coming to themselves it continues:

One pair only remained at Cibolan. They wished very much to go away, but were so weak from hunger and thirst that they could not walk far. One day the man crawled out into the fields once more to see if he could find some one thing alive, and when he reached there he saw a single stalk of *tubbo*—sugar cane—growing lustily. He cut a piece from the side and water began to run out until there was enough for the couple to drink. Because of this they called the place Bagobo and the people have since borne that name.

From the time of the dispersion of the people until about three generations ago the story tellers have little to add. At that time, we learn, the Bagobos had become numerous. Taopan[5] of Cibolan ruled over all their land. Under his leadership they made frequent forays into neighboring districts and returned with many slaves and rich loot. The *datu*[6] was noted as a brave warrior, but in addition to this he was a wise and just ruler, greatly beloved by all his people. When he died more than one thousand of his subjects attended the funeral, which lasted

[2] A name often applied to the greatest of all spirits, Eugpamolak Manobo.

[3] More commonly pronounced Bila-an.

[4] The name applied to the Guiangas and Atas living north and west of Daliao.

[5] P. Juan Doyle, S. J., gives the following genealogy for the Bagobo *datus:* Salingolop, Bato, Boas, Basian, Lumbay, Banga, Maliadi, Taopan, Panguilan, Manip.

[6] The Moro name for chief or ruler. The Bagobo name is *lagiamoda,* but the Moro term is in general use.

ten days. On the last day the house was decked, inside and out, with red and yellow flowers; many valuable gifts were placed beside the corpse and the place was then abandoned.

He was succeeded by his son Pangilan, whose administration, like that of his father, was firm and just. Upon his death he bequeathed the leadership of a united people to his son Manib. The new *datu* did not prove to be a great warrior and his decisions in matters of dispute were not always just, so that bad blood arose between the people of Cibolan and Talun. He was unable to quell the disturbances, and finally open warfare broke out, petty chiefs of other districts throwing off his control and ruling as *datus*. This was the condition which confronted his son Tongkaling when he found himself ruler of Cibolan.

The claims of leadership over all the Bogobos had never been relinquished, but the actual power of the *datu* outside his own district amounted to little. Tongkaling soon established his right to the name of a great warrior, and his people so prospered under his rule that upon the advent of the Americans he was much the most powerful among the several chiefs. Under the administration of Governor Bolton, Tongkaling was officially recognized as the head of the Bagobos, and with this added prestige, he has finally succeeded in gaining recognition from all the chiefs, except those about Santa Cruz, but his actual control over them is still very slight. He has been a consistent friend of the Americans, but has jealously guarded his people against outside influences, so that they are much less affected than those of other districts. For this reason this paper deals principally with Cibolan, but where radical differences occur in other districts they will be noted.

According to the long-established custom when a new ruler was to assume control, Tongkaling gave a great celebration and summoned the people from near and far. On the appointed day more than seven hundred guests had arrived and for six days they feasted, drank, danced, and made merry. On the seventh day the majority of the guests accompanied the *datu* to a great tree in the forest and there witnessed or took part in a human sacrifice.

For this occasion the *datu* had provided a decrepit old Bila-an slave for whom he had paid three *agongs*.[7] The man was fastened with his back to the tree, his hands tied high above his head. When all was ready one of the chief warriors addressed the spirits, asking them to witness that the people followed the old custom, and to let the reign of the new *datu* be one of continued prosperity without defeat in battle. The prayer finished, the *datu* placed his spear just in front of, and below the right armpit, and plunged it with full strength into the body of the slave. As soon as he had withdrawn his weapon the warriors cut

[7] Copper gongs worth about 16 pesos each. One peso is equal to 50 cents United States currency.

the body in two, across the chest, with their fighting knives, and then having loosened the parts from the tree threw them into a shallow grave which had been dug near by. The people returned to the village and continued the merrymaking during the night, after which they returned to their homes and Tongkaling was fully established as ruler.

The people have long been accustomed to obey some powerful headman and, to a certain extent, they become the servants of the new chief; but certain laws handed down by their ancestors are so well established by custom that no one thinks of changing them.

The *datu* is supreme judge in all cases, but he may, if he desires, call in the older men to help him decide the difficult ones. The levying of a fine is the common method of punishment. Should the culprit be unwilling or unable to pay, he is placed in servitude until such time as the debt is considered canceled. Should he refuse to serve, he is killed without further ado. The *datu* appoints a man for this purpose and he usually gets his victim by stealth, either by waylaying him in the road or by driving a spear through him as he sleeps on the floor of his house. When a fine is levied the *datu* retains a portion as pay for his services; if the more drastic punishment follows it serves to emphasize his power and is more valuable to him than the payment. Theft is punished with a fine; murder by death, if the victim is from the same or a friendly town, and the murder unprovoked. Incest[3] must be punished by the death of both parties, otherwise the spirits will cause the sea to rise and cover the land. The crime is uncommon, yet Tongkaling claims to have exacted the death penalty in two cases. In the first, he had the two offenders bound and thrown into the sea; in the second the culprits were fastened to a tree, in the same manner as already described, and two warriors cut the bodies in two with their fighting knives, while all the people stood by and witnessed the punishment. If a wife is unfaithful, her husband may kill both of the guilty parties without fear of punishment, provided that he leaves the spear or knife with which he kills the pair in the body of one of them. A weapon so left is a sign that the killing was because of the fault and the avenger can not be held accountable either to the *datu* or the relatives of the dead man. However, if he withdraws his weapon from the body, the brothers or relatives of the deceased have a right and duty to avenge the death. Cases are known where the husband accepted payment for his wife's affections, but it was considered a sign of weakness or cowardice, and the man lost caste.

Slavery is a recognized institution, and the need of slaves is one of the chief incentives for hostile raids against neighboring tribes. A good

[3] Intercourse between brother and sister, mother and son, father and daughter, between first cousins, between mother-in-law and son-in-law, and father-in-law and daughter-in-law comes under this head.

slave, male or female, is valued at about five *agongs*. If a slave woman bears children to her master she is usually freed at once, or if not then, she is certain to be at his death. Her children are free and legitimate heirs. It is considered a serious crime for a man to have illicit relations with another man's slave and a heavy fine will be levied on the offender. Should children be born from such a union they are treated as slaves.

Polygamy is common, kinship and the lack of funds forming the only restrictions to the number and choice of wives a man may have.

Certain prohibitions exist as to the wearing of the clothing which distinguishes successful warriors and priestesses, but punishment in these cases is meted out by the spirits and not by the *datu*.

Cibolan is not a compact village, but consists of many small dwellings scattered along the mountain sides close to the clearings in which the people raise rice, corn, *camotes*,[9] and hemp. These houses are generally of one room with the floor raised high above the ground. The sides are of flattened bamboo, in which small, rectangular openings or peep holes are cut. The sides of the roof rise to a steep peak which, at the top, overhangs the ends. Entrance to the house is gained by a ladder or notched pole. Stones, sunk in a bed of ashes, form the stove which stands near the door. A raised platform, about one and one-half meters wide, at the far end of the room serves as a bed for part of the family.

In time of danger, or during festivals, the people assemble at the house of the *datu*. This is an immense structure, built on the same general plan as the smaller houses, but capable of holding about two hundred people. Elevated, box-like enclosures are constructed along the sides of the room where the *datu* and some of his daughters or wives keep their belongings, and in which they sleep. The elevated platform at the end of the room is occupied at night by the fighting men, while the balance of the household—men, women, children, and dogs—use the floor. Along the walls are fastened spears, shields, looms, musical instruments, and what not, and in the center of the room hang six large *agongs* which furnish music for the dancers. Near to these are two tall bamboo poles, decorated with stripped leaves. These and numerous other devices and receptacles in other parts of the room are for the spirits who control the lives and happiness of the people.

To describe in detail the numerous spirits known to the Bagobos, or the ceremonies made to secure their good will, would exceed the limits of this paper, but a few must be mentioned in order to give a clearer insight into the lives of the people. Eugpamolak Manobo[10] is the chief of all spirits. It was he who created the world. No ceremony should be made without calling on him and offering him some white food or object of value.

[9] Sweet potatoes.
[10] Also called Manama.

The term *diwata* is applied to a powerful class of spirits who live near to and serve the great spirit. Toglai and Toglibon have already been mentioned as the first man and woman. Since their death they have assumed important places in the spirit world. All marriages and births are caused by them, and they also keep close watch over the lives of men. The *tigyama* are a class of spirits, one of whom watches over each family. When children of two families marry their *tigyama* merge into one, who assumes guardianship of the pair. Taragomi owns all articles of food and is guardian of the fields and crops. A shrine is built for him in the center of the field, and after the rice is gathered a great ceremony is made to thank him for the successful harvest. The *buso* are low, mean spirits who eat dead people and have some power to injure the living. They are sometimes identified with the spirits of the dead. All these and many more are addressed by the priestesses or "doctors."

The "doctor" is known as *mabalian* and is generally a woman past middle life—a woman of influence and a skilled weaver—who has been warned by the spirits to become *mabalian*. It may be that a friendly spirit has imparted a new remedy to her, and to this knowledge she adds all that the older priestesses can teach her of the art of healing the sick, of the duties of a midwife, and the manner of conducting ceremonies and offerings for the higher beings.

The weavers of hemp cloth are under the special patronage of the spirit Baipandi, who taught the women the intricate method of overtying the warp so that portions of the thread do not receive the dye. She also taught the designs which are woven into the fabrics, and the art of embroidery and bead work. Particular spirits are also the patrons of the iron and brass workers.

Two very powerful spirits are still to be mentioned. These are Mandarangan and his wife Darago. They are the guardians of the warriors and can be addressed only by the *magani*. The name *magani* is a term applied to a man when he has killed two or more persons. He is then entitled to wear a peculiar, chocolate-colored head covering with white patterns in it. After his score has reached six he is permitted to wear a blood-red suit and carry a bag of the same color. His dress does not change as the number of his victims increases, but his influence grows with each life put to his credit. A man who kills an unfaithful wife and her admirer may count the two on his score; he may also count those of his townspeople whom he has killed in fair fight, but unprovoked murder will be punished by death. He may go to an unfriendly town and kill without fear of censure from his own people, and the fact that he generally attacks from ambush or at night does not detract from the honor due him for the deed. The *magani* is one of the chiefs in a war party; he is also chosen to inflict the death penalty when it is decreed, and it is usually men of this class who assist in the human sacrifices.

Each year when the constellation *balatik* [11] appears in the sky a human sacrifice should be held in honor of the two patron spirits of the *magani*.[12] This should be done regardless of good or bad times, but any person who has been troubled by evil spirits during the year, or any family in which a death has occurred, may have a part in the sacrifice by making a small payment to the *datu* who is furnishing the victim.

On the appointed day people gather from near and far to witness the ceremony. The slave is tied, as before described, and the *datu* directs the spear so that it will enter the body just below the right arm. All persons who have purchased a part in the sacrifice may take hold of the spear and at a given signal it is thrust through the body of the victim. the *magani* who is willing to pay the highest price for the honor then cuts the body in two with his fighting knife, after which it is buried.

At the sacrifice which took place at Talum in December, 1907, parts of the body were presented to certain guests and were carried away. However, this does not seem to be the general custom. No part of the corpse is eaten or tasted at this time, but warriors sometimes eat portions of the livers of brave enemies, thinking thus to gain in valor.

A short time after this offering a great ceremony known as *ginem* is held.[13] During its progress two festooned poles are raised by the *magani*, who afterwards gather around them and one by one confess to the spirits, Mandarangan and Darago, all their warlike deeds; the number of lives they have taken; the slaves captured; and in short all that entitles them to be known as *magani*.

Offerings are provided for other spirits in another part of the house, but the ceremony is made chiefly to secure the good will of the war deities.

Other ceremonies are held in honor of the patron spirit of the blacksmiths, of the brass workers, and of the weavers. When a field is to be cleared, the first rice planted, and at the time of reaping, the spirits are consulted and offerings are made to them. After all the grain is safely stored a thanksgiving feast, rivaling the *ginem* in importance, is held.

Severe sickness is cured by appealing to unseen beings, and those evilly disposed are frequently appeased by the erection of a small shrine, on which offerings are placed. Daily actions are often determined by omens imparted by the birds, and at the critical periods of life the superior beings are always consulted.

When a birth is expected, the husband summons a *mabalian*, who at once begins to administer certain medicines calculated to cause an easy delivery. She spreads out a mat in the center of the floor and on this

[11] A constellation which appears about the middle of December.

[12] Some of the people insist that the sacrifice is partly in honor of Balakat, the spirit who loves blood.

[13] Datu Anisig of Talum informed the writer that the sacrifice should occur during the first day of the *ginem*, just before the festooned poles are raised in the house.

places many valuable articles of wearing apparel, weapons, and *agongs*. These she offers to the spirits, beseeching them to permit an easy birth, and to give good health to the mother and child. The articles offered at this time may be used by their former owners, but as they now belong to the spirits they can not be disposed of unless others of equal value are substituted.

The *mabalian* cuts the umbilical cord and assists in the removal of the afterbirth, which she places in a bamboo tube, covers with ashes and then hangs to the side of the house, where it remains until it falls of its own accord. The child must be placed at once on a soft piece of bark for "its bones are soft and our hands are hard and will injure it," and water is poured over it. The *mabalian* must then rub a mixture of clay and medicine on its eyes, and on the eyes of all who witnessed the birth, otherwise they would become blind. For her services she receives from five to twenty pesos, according to the wealth of the family and the sex of the child. Twins are accepted without question, but triplets are killed at once by filling their mouths with ashes. "If this is not done the parents will die, for they are like animals."

Marriage among the Bagobos takes place much later than is common among most Philippine tribes, the couple often being eighteen or twenty years of age. As a rule the parents of the boy select the girl and negotiate the match. Going to the house of the girl they casually broach the subject, and if her parents are favorable a certain day is set to discuss the details. This meeting is attended by the friends and relatives of both families, and two headmen or *datus* must also be present to represent the contracting parties. The price the girl should bring varies according to the wealth of the interested parties and the accomplishments of the bride. Whatever the sum paid, the father of the girl must make a return present equal to one-half the value of the marriage gift "so that he does not sell his daughter like a slave."

Usually marriage does not take place until a year or more after this settlement, and during the interval the boy must serve his father-in-law to be. When the time for the final ceremony arrives the relatives and friends assemble and for two or three days they feast and make merry. A *mabalian* spreads a mat on the floor, places on it many valuable articles and then offers all to the spirits, in order that they may be pleased to give the couple a long and prosperous life together. Finally, she puts a dish of rice on the mat and after offering it to the spirits she places it between the boy and girl as they sit on the floor. The girl takes a handful of the rice and feeds it to the boy, who in turn feeds her, and the ceremony is complete. The couple may then go to their new home, but for several years the girl's family will exact a certain amount of service from the groom.

When a person is critically ill, he is removed from his own house to another in order that he may be under the care of the good spirits residing there. Should it become evident that he will die he is taken back to his own place, otherwise his family must reimburse the owner of the house in which the death occurs for bringing evil or unfriendly spirits into their dwelling.

Unless the deceased has been a person of considerable importance the body is kept only until a coffin can be hollowed out of a split log. He is then dressed in good clothes and placed in the coffin together with his weapons or other prized articles; the top of the log is fitted over the lower half and he is buried beneath the house. From that time until a human sacrifice has been made the family is required to wear old clothes, to eat poor food, and to abstain from dancing and other pastimes.

It is possible to remove the taboo by making a special sacrifice, but more commonly all the families in which deaths have occurred will buy a part in the yearly offering, made after the appearance of the constellation *balatik*.

# ILLUSTRATIONS.

PLATE 1.

FIG. 1.

FIG. 2.

PLATE II.

FIG. 1.

FIG. 2.

PLATE III.

FIG. 1.

FIG. 2.

PLATE IV.

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# THE SKELETON IN THE FLYING LEMURS, GALEOPTERIDÆ.

By R. W. Shufeldt.
(*Washington, D. C.*)

## INTRODUCTION.

Osteological material for the present contribution has been furnished by Professor J. B. Steere of Ann Arbor, Michigan, and by Mr. Richard C. McGregor, of the Bureau of Science, Manila, P. I. What this material consists of, together with letters and other notes accompanying it, will be set forth further on in the present introduction.

A number of comparative anatomists have touched upon the morphology of probably several of the species of the flying lemurs, but until the present time it appears that no fully illustrated and detailed account of the osteology of these remarkable animals has been published.

Owen,[1] in giving the characters of the skeleton of the Insectivora, briefly refers to the skull and some few of the limb bones of *Galeopithecus*, and in the case of the skull, unfortunately, he does not make it sufficiently clear as to whether the description does not likewise apply to *Pteropus*. Thus he says:

> This [that is the skull] in *Pteropus* and *Galeopithecus* manifests the lissencephalous affinity by the squamosal being perforated by a venous canal behind the root of the zygoma, by the suspension of the malar, in the zygoma, by the distinct petrotympanic, by the vertical occiput, small cranial cavity, and blended orbital and temporal fossæ. The orbit is partly defined behind by long and slender processes of the frontal, which is perforated by a superciliary foramen. The parietals usually coalesce at the sagittal suture, but rarely develop a crest.

The paragraph continues in confused and inaccurate generalities to the end and closes with the statement that "in *Galeopithecus* the coronoid is small." Little more than this is added to his description of the skeleton, in fact only that

> In the Colugo (*Galeopithecus*) the ulna terminates in a point at the lower

[1] Anatomy of Vertebrates (1866), 2, 387, 388.

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fourth of the radius;[2] all the five digits of the hand, like those of the foot, have claws supported on deep compressed ungual phalanges.[3]

Owen gives a figure of the skull of *Cynocephalus,* seen upon superior view, which is quite different from any of the specimens at hand. It is far more massive, broader for its length, and appears to be inaccurate in other particulars, although there exists considerable individual variation in skulls of this animal, when series of them are compared.[4]

The skeleton is not touched upon by Mivart,[5] although he makes record of the interesting fact that "in many tortoises both the knee and the elbow are rather twined outwards, than the former forwards and the latter backwards, as is also the case in the Flying Lemur (*Galeopitheous*) amongst beasts."

This anatomist placed *Cynocephalus* in the order Insectivora, and the Lemuridæ among the Primates, a classification which now few would agree to, in so far as the latter are concerned.

Five years prior to this Huxley[6] presents a much fuller account of the structure of the species here being considered and practically agrees with Mivart in the matter of their classification.

He sees "no reason for dissenting from Professor Peter's view that *Galeopitheous* belongs neither to the Primates, nor to the Cheiroptera, but that it is an aberrant Insectivore." In fact, as he says on the previous page of the same work, it is "the most aberrant form of the *Insectivora.*"

When studying the skeleton of any animal among the Vertebrata, it is always interesting, and even important, to know something of that animal's habits, and no anatomist appreciated this fact better than Huxley.

We are not surprised then to find, in the work just cited, references to the "arboreal and frugivorous habit" of *Cynocephalus,* and to its "very long and slender limbs." Also that these limbs "are connected with one another, with the sides of the neck and body, and with the tail, by a great fold of the integument, which is called *patagium;* and, unlike the web of the Bat's wing, is hairy on both sides, and extends between the digits of the pes. By the help of this great parachute-like expansion, the *Galeopitheous* is enabled to make floating leaps,

[2] Authors do not agree with respect to the character of the articulation of the ulna with the radius, some stating that the two bones are ankylosed, and others that they are not. Huxley claimed that they are. It is to be noted here that Owen and others employed the name *Galeopitheous volans* for the flying lemur, and where quotations are made, as in the above instance, from those authors, that name will be used. For *Galeopitheous volans* we now write *Cynocephalus volans,* and the latter will be used in this paper, except in quotations. The Malayan genus is *Galeopterus.* See Miller, *Proc. Biol. Soc. Washington* (1906), **19**, 41; Thomas, *Ann. & Mag. Nat. Hist.* (1908), VIII, **1**, 252–255.

[3] *Op. cit.*, 393.

[4] *Op. cit.*, 388.

[5] Lessons in Elementary Anatomy (1877), 10.

[6] The Anatomy of Vertebrated Animals (1872), 383.

from tree to tree, through great distances. When at rest, the *Galeopitheci* suspend themselves by their fore- and hind-feet, the body and the head hanging downward; a position which is sometimes assumed by the Marmosets among the *Primates*."

Selecting from this account only such parts as refer to the skeleton, we note that Huxley observed that in *Cynocephalus* "the fore-limbs are slightly larger than the hind-limbs" and further that "the pollex and the hallux are short, and capable of considerable movement in adduction and abduction, but they are not opposable; and their claws are like those of the other digits.

"The occipital foramen is in the posterior face of the skull. The orbit is nearly, but not quite, encircled by bone. The lachrymal foramen is in the orbit. The bony roof of the palate is wide and its posterior margin is thickened. There is a strong curved post-glenoidal process of the squamosal, which unites with the mastoid, beneath the auditory meatus, and restricts the movement of the mandible to the vertical plane. A longitudinal section of the skull shows a large olfactory chamber projecting beyond that for the cerebral lobes, and two longitudinal ridges, upon the inner face of the latter, prove that these lobes must have possessed corresponding sulci. The tentorial plane is nearly vertical and the floccular fossæ are very deep." All these points are characteristic and correctly stated. "The ulna" he adds, "is very slender inferiorly, where it becomes anchylosed to the distal end of the radius, [?] which bears the carpus. When the ilia are horizontal, the acetabula look a little upward and backward as well as outward. The fibula is complete. As in the Sloths and most Primates, the navicular and cuboid readily rotate upon the astragulus and calcaneum so that the *planta pedis* is habitually turned inward." [7]

In giving the dental formula, Huxley also refers to the peculiar pectination of the lower, single-fanged, incisor teeth, but these structures will be touched upon later on.

Passing to the work of another writer who has investigated the anatomy of the family Galeopteridæ we find that Flower points out a number of the characters of the skeleton in these "aberrant Insectivores," [8] now being examined. Briefly, he says:

The characters of the family are those of the suborder *Dermoptera*, to which may be added that the orbit is nearly surrounded by bone, the zygomatic arches are well developed, the tympanics form bullæ osseæ, the ulna is distally united with the radius, the tibia and fibula are distinct, the pubic symphysis is long.

Then follow descriptions of other parts of structure of these animals. Flower, it is observed, agrees with Huxley with respect to the ankylosis of the bones of the forearm, but that is one of the points that the present paper will settle.

From another work [9] by the same author we learn that in *Cynocephalus* "each vertebra bears at its hinder end a pair of hypopophysial tubercles;" that the number of trunk vertebræ is 21 (15 thoracic and 6 lumbar); that the tail is

[7] The Anatomy of Vertebrated Animals (1872), 382, 383.

[8] Osteology of the Mammalia in Encyclopedia Britannica, 9th ed., 15, 401.

[9] Osteology of the Mammalia, 39.

long; that the number of vertebræ in the spinal column apparently varies for the species thus:

| | Cervical. | Thoracic. | Lumbar. | Sacral. | Caudal. |
|---|---|---|---|---|---|
| G. volans | 7 | 13 | 5 | 5 | 15 |
| | 7 | 13 | 6 | 5 | 14+ |
| | 7 | 14 | 8 | 4 | 17 |
| G. philippinensis | 7 | 14 | 6 | 4 | 17+ |

That the "cranium much resembles that of the *Lemurina*, having a considerable and vaulted cerebral cavity, large orbits, nearly vertical occipital plane, large olfactory fossæ, a well-developed zygomatic arch sending up a postorbital process to meet a corresponding one from the frontal so as either partially or completely to encircle the orbit behind, and tympanics ankylosed with the other cranial bones, dilated into a bulla, and produced externally into a tubular auditory meatus. The face is generally elongated, and narrow anteriorly, but in *Galeopithecus* it is broad and depressed." [10] That the coracoid of the scapula "is greatly developed and bifurcated"; that "the radius and ulna are fused together distally"; "the symphysis of the pelvis, as already stated above, is long"; and, finally, that "the fibula and tibia are complete and remain distinct" throughout the life of the individual.

About a year ago, Mr. Richard C. McGregor, of the Bureau of Science, Manila, kindly forwarded to me for description two adult specimens of *Cynocephalus*, probably *C. philippinensis* (Waterhouse).

Mr. McGregor wrote as follows:

We have on hand two skeletons of *Galeopithecus*, both of which are being sent to you by mail. These were collected near Guindulman, Bohol, where the species is fairly common. A considerable number are killed by the natives, but I did not learn that the fur was used by them. In Cebu there were between 20 and 30 skins of this species for sale in a store; they came from Bohol, of course, as the species is unknown in Cebu. It is found also in Mindanao, Samar, and Basilan.

This animal seems to be strictly arboreal and to feed exclusively on the leaves of trees. It is an animal difficult to see, as whenever it suspects danger it remains perfectly quiet and hugs a branch. Its colors are quite protective. When moving in a tree it is very cautious and seems to glide rather than to move like a squirrel or other small mammal; in fact, its movements impressed me as being very snake-like. The native name is "Ca-guán."

The color of the pelage, even of specimens from one locality, varies greatly, running from seal brown to light gray and from unspotted to thickly spotted with gray.

Padre Elera, in Fauna de Filipinas (1895), 1, 16, lists five species: *Galeopithecus volans* (Shaw), *G. rufus* Geoff. & Cuv., *G. variegatus* Geoff. & Cuv., *G. marmoratus* Temm., and *G. philippinensis* Waterh. as being found in the Philippines, but I doubt if so many species should be credited to these Islands.

[10] In the paragraph just quoted Flower intended to cover not only *Cynocephalus*, but likewise *Tupaia*, *Macroscelides*, and *Rhynchocyon*.—R. W. S.

You may make such use as you wish of the specimens sent, and return them to the Bureau of Science at your convenience.

During the summer of 1908 I communicated with Professor J. B. Steere, of Ann Arbor, Michigan, whose work as a naturalist in the Philippines many years ago is well known. In his courteous reply Professor Steere wrote me that he had collected the skeleton of a specimen of *Galeopithecus* (adult), which he had preserved in the rough; he also had the young, consisting of two fœtuses in spirits. He later on donated the skeleton for my use, but was unable to find the preserved specimens of the young which would have been very valuable additions to my material. The letter he wrote me was interesting, but I have been unable to put my hand on it for some time past, and so recently wrote him again for data, but upon this occasion no reply has been received. In any event I remember Professor Steere wrote me that he collected the skeleton about twenty years ago (1887–88?), but upon which island he had forgotten, and he had no other data, and there was no label on the specimen, so the sex of the individual is likewise unknown. It has been carefully cleaned by me for description in the present connection. Without doubt it was a larger form than the ones from which Mr. McGregor obtained his skeletons, and it leads me to believe that the Steere specimen belonged to a different species. Mr. McGregor in his letter, given above, does not specifically diagnose the two specimens he sent, so that there is some doubt as to whether I really have the skeleton of a true "*G. philippinensis*" at hand, although the material admits of obtaining the characters of the skeleton at least in so far as the genus is concerned.

The McGregor specimens show numerous shot holes in the skulls, and these have given rise to considerable mutilation. This is not the case with the larger skeleton from Steere. It is possible that the examples from McGregor may not be fully adult, a suspicion which is borne out by an examination of the long bones where the epiphysial sutures do not, as yet, seem to have entirely disappeared. Still there are differences to be observed; and while the two McGregor specimens seem to be representatives of the same species, exhibiting only certain individual variations in the skull upon comparison, the skull of the one from Steere, which is fully adult, although possessing the same general characters, has the superficial appearance of having belonged to some other species of the genus.

The "hyoidean apparatus" is missing in the case of all three of these skeletons; all the skeletal ungual joints of manus and pes, so peculiar in their morphology, have probably been retained upon the skins in the case of the specimens from the Bureau of Science, while they are present upon the toes of the skeleton from Steere, and consequently their general characters can be given here.

## OSTEOLOGY OF THE FLYING LEMURS.

### THE SKULL.

As has already been pointed out in the Introduction, there exists considerable variation in the three skulls at hand for examination, which may be due to age, sex, individual variation, or to the skulls having belonged to different species, or to all of these factors more or less combined. Some differences are to be observed even in the case of the two skulls from the Bureau of Science, skulls which, presumably, are from representatives of the same species. The skull from the skeleton collected by Steere evidently belonged to a very old animal, the bones being hard and smooth, with all sutural traces entirely obliterated. Moreover, it is of a clear ocher color and the teeth are considerably worn down. The other two skulls present every evidence of having belonged to much younger individuals; they are quite white; the dental cusps are sharp, and some of the cranial sutures are still traceable.

In so far as size is concerned some of the apparent differences can be demonstrated by measurement, for which purpose the metric system is employed and the results set forth in the following table:

*Measurements of the cranium of Cynocephalus.*

| Specimens. | Extreme length on median line from occipital crest to anterior end of nasal. | Greatest width; intermalar diameter. | Interapical distance between postorbital process of frontal and malar. | Greatest diameter of an orbital periphery. | Greatest transverse diameter at base of occipital area. | Median diameter from foramen magnum to anterior apex of premaxillary spine. |
|---|---|---|---|---|---|---|
| | *mm.* | *mm.* | *mm.* | *mm.* | *mm.* | *mm.* |
| Professor Steere No. 1 | 66 | 43 | 10 | 17 | 31 | 61 |
| Bureau of Science No. 2 | 63 | 42 | 11 | 17 | 27 | 61 |
| Bureau of Science No. 3 | 64 | 45 | 5 | 17 | 30 | 61 |

In some instances, where convenient, in the following description of the skeleton of *Cynocephalus,* the numbers 1, 2, and 3, given to the specimens in the above table may be employed to designate the particular skeleton referred to. This will consist in placing the number in parentheses after any statement made or character described.

In form, after the removal of the mandible, the skull is broad, somewhat compressed from above, downward, and elongate in the anteroposterior direction. When viewed from above it will be observed that the facial portion, anterior to the orbits, contributes very considerably to the marked general breadth of the skull. Its surface is quite smooth, being broadly convex from side to side, and rounded off anteriorly, thus causing the superior mandibular arch in front to be likewise broadly curved. (Plate II, figure 3.) In some skulls a smooth, low, longitudinal elevation bounds the nasals upon either side, all to a few millimeters in front (1, 3), but this character is not invariably present (2), while in other skulls, the sockets of the canines, and to a lesser degree, the first one or two molars, are indicated on the sides of the maxillaries by smooth, vertical elevations (3), absent in others.

Posteriorly we find the smooth character of the facial portion carried backward to include the frontal region between the orbits, and the narrow parietal space as far back as the occipital crest. This median parietal space lies between the temporal ridges (the latter are always strongly marked), and is broadest where it passes into the frontal area, gradually contracting as we pass backward, to expand slightly again as it arrives at the occipital crest. Its area is determined by the temporal ridge bounding the temporal fossa upon either side. (Plate II, figure 3.)

Anteriorly we see the floors of the orbits, and upon either side, the arch of the zygoma, while posteriorly the broad, concaved piers of the zygomatic arches look directly upward. Between these is the rather ample, semiglobular cranium or brain-case, either side of which, within the temporal fossa, may exhibit considerable muscular rugosity (1), or it may be comparatively smooth (2, 3). Among the few distinctive characters upon this aspect of the skull are the very prominent post-orbital processes of the frontals. They are more or less raised above the interorbital frontal area and jut out from it upon either side. As the periphery of an orbit is nearly circular in outline each contributes to this circularity at its supero-posterior arc. In some skulls the decurved free extremity of the process is produced backward and downward farther than it is in others, thus more nearly completing the bony circlet of the orbit, especially where the postorbital process of the malar is similarly produced, as it is in some skulls (3).

The opening for the supraorbital nerve may be either a "notch" or a foramen and, in any case, occurs far forward upon the orbital rim. It is more in evidence in some skulls (1) than in others, and in one of the specimens here being examined it is a notch on the left side and a foramen on the right (1), while in the other two skulls it is a less conspicuous foramen on both sides. The infraorbital foramen is usually very minute in all skulls and can be distinctly seen only upon lateral view. (Plate I, figure 2.)

Upon regarding the skull from in front there is to be observed the rather large, circular opening of the anterior nares, through which may be seen the vomer and the scrolled ethmoturbinals, two in number, on either side, with the smaller one beneath. The periphery of the anterior narial orifice may (1), or may not (2, 3), be completed in bone. Owen, in his figures of the skull of *Cynocephalus*, has it so completed by the otherwise intervened free angles of the maxillaries coössifying with the anterior apex of the vomer.[11]

Passing to the posterior view of the skull we find the entire occipital area to be in the vertical plane, the longitudinal axis of the skull being perpendicular to it. The line of the very definitely marked occipital crest is semicircular in outline and there is a strong, median, vertical crest, that passes from the middle point of the occipital crest to the supero-middle point on the periphery of the foramen magnum. The base line of the occipital area is perpendicular to this median crest, while the condyles project slightly below it. These latter are large, semi-ellipsoidal in form, inclined toward each other inferiorly, with their flat sides facing each other and the median plane. They project posteriorly considerably beyond the large and subcircular foramen magnum. The exoccipitals are massive projections with their flat bases in the horizontal plane. (Plate I, figure 1.) In some specimens each of these bases is marked with a deep groove, passing forward and inward toward the median plane (2, 3). A more or less median "occipital prominence" exists above the foramen magnum on the posterior aspect of the skull and is better marked in some specimens than in others.

Chief among the points of interest on the lateral aspect of the skull is the capacious orbit, which is posteriorly incompleted by bone (Plate I, figure 2), and with the plane of its periphery directed outward, forward, and upward. The orbital wall within is entirely completed in bone anteriorly, including the floor below, while posteriorly it is equally lacking in this respect, the whole space in this locality merging with the temporal fossa in its rear. The postorbital process of the malar occupies a mid-point on the strong and twisted zygoma. The posterior root of the latter is broad and starts from an extensive base line on the side of the cranium.

Within the orbit the foramen rotundum and foramen ovale are distinct and occupy their usual sites. The lacrymal foramen is well marked in some skulls (2), minute in others (1), while the other foraminal openings for nerves, are of remarkably small caliber. Elliptical in outline with its major axis vertical, the osseous meatus auditorius externus is likewise small as compared with the size of the cranium. It is found in the deep recess between the posterior root of the zygoma and the exoccipital of the same side.

The basis cranii (Plate I, figure 1) is especially remarkable for the fact that a large share of it lies in the same horizontal plane (see figure 2 of Plate I), which is rather unusual in mammalian skulls. Nearly one-

[11] Anatomy of Vertebrates (1866), 2, 388, fig. 253 and 3, 312, fig. 247. Both of these figures are very different representations of the basal view of the skull of *Cynocephalus*. They are altogether too wide for their length and they are quite crude in the matter of delineation.

half of the inferior portion of the occipital condyles constitutes the sole part of the skull that falls below this plane, the roof of the mouth being only slightly above it. This latter area is laterally bounded by the teeth, but has a free premaxillary margin in front. Its outline is a broad U with its convexity forward. All sutures among the bones, maxillaries, premaxillaries, and palatines have been entirely absorbed, without leaving the slightest trace of their original lines of articulation. The surface is extremely smooth, being slightly concave from before, backward, and rather more so from side to side. The palatine foramina are minute and are situated far back, one on either side, close to the margin of the posterior nares, and even posterior to the anterior peripheries of the same, indicating that the palatal bones contribute but a small share to the bony roof of the mouth. This latter, anteriorly, is deficient in bone, there being a median, circular vacuity found there between the premaxillaries.

Jutting into this anterior palatine fossa, in the middle line from behind, is a sharp, free spine; this is the anterior apex of the vomer. (Plate I, figure 1.) In some skulls (2, 3) this free anterior end of the vomer is in contact, or may unite, with the produced median extremities of the premaxillaries, and thus convert the palatine fossa into a pair of anterior palatine foramina, each elliptical in outline with the major axes directed longitudinally. Owen's skull had this formation, but not so the one collected by Steere, wherein the sharp-edged alveolar incisor margin is noncontinuous to the extent of at least 5 millimeters in the median part. Both skulls from the Bureau of Science agree with Owen's figures (cited above) in that the anterior spine of the vomer is produced forward, bifurcates, and each minute bifurcation either meets, or coössifies with, the premaxillary of its own side. This character at once commands attention upon glancing at the basis cranii of the skull. At the hinder boundary of the vault of the buccal cavity we see the posterior narial apertures. Each is rounded in front, with the convexity so directed, the free margins being embellished with a raised osseous rim that is continued backward, on either side, to terminate as the minute inferior fork of the bifurcation of the hamular process of the sphenoid. The posterior nasal spine is rather large with rounded apex. It occurs in the imaginary plane passing through the centers of the second molars. As apertures, the posterior narial ones are considerably compressed in the vertical direction, which is compensated for by their width.

Each zygomatic arch has a broad base anteriorly, being composed, as usual, of the malar and maxillary bones, its base line including rather more than the second premolar and all three molars. Standing well out from the side of the face, this part of each zygomatic arch has its inferior surface directed downward and outward at an angle of about 45° with the median plane (Plate I, figure 1).

Although the teeth are structures not belonging to the osseous system in the Mammalia, they are so intimately associated with the mandibles in the skull among all higher mammals and have been so extensively employed in the matter of classification, that to entirely ignore them in any general work upon the osteology of an animal belonging to that class would be considered an almost unpardonable oversight. Anatomists have by no means neglected the dental armature of *Cynocephalus* and we meet with accounts of it in a number of works on comparative anatomy. Here, however, reference will be made to only two authorities, Owen and Flower.

Owen and Flower agree on the dental formula of *Cynocephalus* and, as given in their works, it agrees with all three of the specimens at hand. According to Owen [12] the dental formula of the genus is:

$$i\,\frac{2.2}{3.3};\ c\,\frac{1.1}{1.1};\ p\,\frac{2.2}{2.2};\ m\,\frac{3.3}{3.3}=34.$$

Owen also states that—

> The two anterior incisors of the upper jaw are separated by a wide interspace. In the Philippine Colugo they are very small, with simple sub-bilobed crowns; but in the common Colugo (*Lemur volans* Linn.; *Galeopithecus Temminckii* Wat.) their crown is an expanded plate with three or four tubercles; the second upper incisor presents the peculiarity of an insertion by two fangs in both species of *Galeopithecus*.[13]
>
> In the lower jaw the crowns of the first two incisors ($i$), present the form of a comb, and are in this respect unique in the class MAMMALIA. Figure 249 [Owen's figure] shows a section of one of these teeth magnified. This singular form of tooth is produced by the deeper extension of the marginal notches on the crown, analogous to those on the edge of the new-formed human incisor, and those of certain shrews, the notches being more numerous as well as deeper.
>
> Each of these broad pectinated teeth is implanted by a single conical fang, and is excavated by a pulp cavity, which divides into as many canals as there are divisions of the crown, one being continued up the center of each to within a short distance of its apical extremity. The medullary canal or branch of the pulp cavity is shown in some of the divisions of the crown, (at $p$). Each division has its proper investment of enamel, ($e$), which substance is continued for a short distance upon the common base.
>
> The deciduous teeth appear not to cut the gum before birth, as they do in the true Bats. In a fœtus *Galeopithecus Temminckii*, with a head one inch and a half in length, I found the calcification of the first incisor just commenced in the closed alveolus, the second incisor and the rest represented by the vascular uncalcified matrices. The upper milk teeth consist of two incisors, a canine and two molars, which latter are displaced and succeeded by the two premolars. The deciduous teeth are six in number in the lower jaw, the incisors being pectinated, but much smaller than their successors. The true molars are developed and in place before the deciduous teeth are shed.

[12] Anatomy of Vertebrates (1866), 3, 311–313.

[13] If we rely upon this diagnosis based upon the teeth, the specimens here being studied are certainly not *C. volans;* but that would not prove them all to be *C. philippinensis*, as there may be other species having the two anterior incisors of the superior mandible like it.—R. W. S.

Flower committed one or two errors in giving the osteological characters of the *Galeopteridæ*[14] and then briefly dismissed the subject of the teeth thus:

> *Galeopithecus* ($i\ \frac{2}{3}$, $c\ \frac{1}{1}$, $pm\ \frac{2}{2}$, $m\ \frac{3}{3}$; second upper incisors and canines with two roots), with two species *G. volans* and *G. philippinensis*. The former, the Flying Lemur of Linnæus, distinguished from the latter by the form of the upper incisors, has a total length of nearly 2 feet.

Now in the upper jaw the two widely separated, anterior, incisors are not only "very small," as Owen points out, but they are, also, at least twice pectinated, and sometimes exhibit a faint indication of a third pectination, which may be discovered by the use of a lens (2). The second pair of upper incisors are the largest teeth in the upper jaw, extending downward below the canines, and very considerably below any of the molars. They are each two-fanged, distinctly triangular in form with a very sharp apex, and are compressed. Both their surfaces, as in the case of the canines, are fluted, the markings running from the base to the apex. A canine of the superior mandible has the same form as the second incisor, only it is somewhat shorter, and wider in the antero-posterior direction.

As stated upon a previous page both the molars and premolars of both jaws in the Steere specimen are very much worn and, therefore, do not present the true characters of these teeth. In the upper jaw the premolars are all two-fanged and offer certain definite characters, the second pair closely approaching in their morphology the anterior pair of true molars. A first upper premolar has a rather complicated tubercular crown consisting of two outer, triangular, sharp-pointed cusps arranged antero-posteriorly to each other; their outer surfaces are flat and longitudinally fluted; their inner surfaces are convex and similarly marked. The inner portion of the crown in the first upper premolar exhibits two more very rudimentary cusps; these in the second premolar tend to become three, as in the leading true molar. The outer cusps in all the true molars agree with those of the premolars, being the most reduced in the last molar. Their inner crowns, that is, the buccal aspect of the crowns, develop from three to four small, sharp, trihedral cusps, and these are partly overshadowed by the inwardly directed pair of outer cusps of any particular molar. All the true molars seem to be three fanged, the largest root being internal, with a pair of much smaller ones placed antero-posteriorly side by side externally. In one specimen (3) the crowns look directly upward, in another (2) they face more toward the median plane, which is decidedly the case in the specimen where they are much worn (1). Through this cause, in the latter, the second premolar has come to resemble very much the leading true molar next to it, its outer cusps being only a little sharper and more pronounced.

[14] *Encyc. Brit.*, 9th ed., **15**, 401.

Before completing our study of the basis cranii, it will be as well to finish with the teeth, and to this end examine those of the mandible or the lower jaw. For this purpose one of the specimens (2) from the Bureau of Science will be used, as in it the dental armature is unusually perfect. (Plate I, figure 2.) This specimen presents other interesting features, for on the right side there is to be noted the eruption of a second canine tooth immediately external to the canine belonging to the full set. The former is closely pressed against the latter and is nearly of equal size, although only about two-thirds of the crown has made its appearance. A similar eruption is seen in the case of both second premolars. At the outer side of each, but not in contact with them, a minute cusp is making its appearance just within the alveolar margin. This is another second premolar struggling to the surface. The anterior cusp of the first premolar in this jaw closely resembles the canine next in front of it; the crown of the second premolar possesses characters very much like those of the first true molar, but the cusps are a trifle longer and sharper than they are in the latter.

Six perfect incisors are found in this specimen, three in either side of the mandible. The two pairs in front very closely resemble each other, while the last incisor upon either side is quite different. All are single fanged, and in the dried skull easily tumble out of their sockets. In this particular they markedly depart from the molars, which require some little force to extract them with the fingers. Owen, in his above-cited figure of a section of one of the first incisors of the lower jaw, makes seven elongate pectinations on the tooth, while in the four now being considered, there are at least eleven of these structures. The crowns of the two central incisors are somewhat narrower than in the pair to their outer sides, otherwise, as has been remarked, they are similar. The exposed part of the tooth in any case is nearly square in outline. As normally implanted the teeth point almost directly forward; that is, their anterior and posterior surfaces, including the cutting edges, lie almost in the horizontal plane, and, excepting prehension, it is difficult to understand the use for which they can be employed. In young specimens these four incisors are of a glistening, enamel white, while in old age they become stringy and flexible. Each is gently concave on its inner (here upper) aspect, and correspondingly convex on its outer surface or, in reality, its inferior surface. Owing to their pectination, the free distal edges are minutely serrated. The pectinations are of nearly uniform length, the proximal ones being the shortest in any particular tooth. They are subcylindrical in form, extremely delicate in structure, although very strong, and it requires a lens of some power to reveal the fact that the interstices among them are carried down to their bases; distally, they are apparently in close contact, but not fused. No other living mammal possesses such teeth as these.

Passing to one of the third lower incisors a very different tooth is seen. The coronal portion is antero-posteriorly elongated; as naturally implanted, it is directed upward; it is slightly concave on buccal aspect and correspondingly convex on its outer surface; it presents five pectinations which become smaller and smaller from before backward; the fifth pectination is sometimes very rudimentary. This tooth is much thicker than any one of the four thin, front incisors just described. These six incisors are very nearly, or quite, in contact and there is no true diastema among the teeth of either jaw. The very wide interval between the two anterior incisors of the upper jaw can hardly be considered a true diastema.

The last premolar, and the true molars of either side of the mandible, develop from four to five sharp-pointed, trihedral cusps that vary considerably in size and, packed together along the alveolar border, lend to the series a very complicated appearance. The largest cusps are external and median, while the much smaller ones are, as a rule, ranged internally.

With the jaws normally articulated and tightly closed, the abruptly inturned, sharp-pointed, external cusps of the molars and last premolars of the upper jaw lie entirely without the alveolar margin of the lower jaw, and in mastication act as true cutters rather than as grinders. When the mandible is thus normally articulated, and we regard the skull as a whole upon its basal aspect, all these aforesaid cusps are in full view, even their apices, which is a very remarkable arrangement.

Returning to the base of the skull we next observe the far backward extension of the pterygoidal wings of the sphenoid, with the rather deep longitudinal valley that exists between them. These wings turn slightly outward, and at the postero-inferior angle of each there is to be noted the not very large, bifurcated, hamular process already referred to above.

Passing mesially from the posterior end of the vomer from beneath the posterior nasal spine, there is a prominent ridge, or line, running backward almost to the anterior margin of the foramen magnum. This line is most conspicuous and sharpest in its anterior part, and at its posterior ending merges gradually into the general surface on the basitemporal. Between the backward sloping termination of a pterygoidal wing and the glenoid fossa, upon either side, occurs the foramen ovale, the largest pair of foramina in the basis cranii. Each transmits, on its own side, the third division of the fifth nerve, the small meningeal artery, and the small petrosal nerve.

The glenoid fossæ constitute prominent features on the base of this skull: either one is large (elongo-elliptical in outline, with the major axis perpendicular to the cranial axis), flat, and smooth, the articular surface being in the horizontal plane, and completely overlying the inferior surface of the posterior root of the zygoma. (Plate I, figure 1.) These fossæ are separated mesially by an average distance of 15 millimeters.

venous, and arterial foramina are all to be observed at their ordinary sites.

As above remarked, *Cynocephalus* has a powerful mandible or lower jaw. (Plate I, figure 2, and Plate II, figure 4.) Taken as a whole this bone possesses a deep U-shaped outline, with the limbs of the body and the rami rather more diverging in some specimens (1) than in others (2, 3), where they may be quite parallel to each other anteriorly beyond its ramal portion. In front the symphysis is strong, deep, and firmly united, exhibiting a prominent mental process below, while its concave inner surface is smooth. Beyond either ramus the body of the jaw is thick from side to side, with its straight, upper, alveolar margin deeply marked with the sockets of the various teeth, and its lower border, parallel to it, rounded and smooth. The mesial line of the symphysis is directed from below, forward and upward, at an angle of about 45° with the imaginary mid-longitudinal line of the bone. The ramal portion of either limb is considerably deeper than the body, extending both above and below it, being as a whole gradually turned outward from it at an angle of 35° or more. Its outer surface is smooth and looks forward and outward, while its inner surface, also smooth, presents two conspicuous ridges for the pterygoidal muscles and is directed backward and inward. Again, the outer surface is very moderately convex below, as compared with the markedly concave inner surface. At the upper anterior margin of this concavity we note the inferior dental foramen situated almost in line with the alveolar border, at the base of the coronoid process, and some 6 millimeters posterior to the last molar tooth. The angular border is thickened, circular in outline, and finished off with a raised rim. Externally and superiorily, the ramal portion is concave, that is, between the coronoid and condylar process, a concavity that is gradually lost as we approach the middle of the ramal area, or surface, upon this aspect of the bone.

The mental foramina, upon either side, appear to be three or four in number, a few millimeters apart, and all in the longitudinal line extending from a point opposite the second incisor to include the last premolar, well within the lower border of the dentary portion of the jaw. Between the base of the coronoid process and the last molar tooth there exists a deep pit, the use of which can not here be determined, although in life it probably harbors the tendon of insertion of the buccinator muscle.

The coronoid process is, as a whole, situated above any other portion of the mandible, being flattened from side to side, slightly thicker at the base than above, and shaped like a cat's claw with the apex directed backward. (Plate II, figure 4.) It is directed upward and outward at an angle of about 45° with the transverse diameter of the condyle, from which it is separated by a considerable interval. The axis of the condyle is perpendicular to the median plane, its smooth articular surface extending entirely over its superior convex aspect. From before backward it measures about 2 millimeters; transversely it averages 1 centimeter, being very slightly larger at its inner than at its outer extremity; a concavity occupies the entire surface of the former, while the latter is bluntly rounded off. In very old specimens, and perhaps in others, the two limbs of the mandible after prolonged maceration part company at the symphysis, exposing there a roughened, subelliptical surface, whose major axis is identical with the symphysial axis.

### THE TRUNK SKELETON.

There has been given on a former page (p. 142) of the present memoir, the number of vertebræ in the spinal column of two species of *Cynocephalus,* ar recorded by Flower, viz, three specimens of "*G. volans*" and one specimen of "*G. philippinensis.*" This second exhibits, if correct, some remarkable variations in this part of the skeleton.

Flower discovered 7 cervical vertebræ in all four of the specimens he examined, while he found 13 thoracic in two "*G. volans;*" 14 in another; and 14 in "*G. philippinensis.*" Still more remarkable is the record he left with respect to the lumbar vertebræ present in this animal, for in "*G. volans*" these ranged 5, 6, and 8, while in the specimen of "*G. philippinensis*" there were 6 of these vertebræ. Coming to the sacrals, he claims to have found 5 in two of "*G. volans,*" 4 in another, and 4 in "*G. philippinensis.*"

As *Cynocephalus* has a long slender tail, we are not greatly surprised at any variation that may occur there, especially as some of these vertebræ may be lost for one reason or another, and at the best they are likely to vary somewhat in this division of the column. Flower found in "*G. volans*" 14+, 15, and 17 caudal vertebræ, and 17+ in the specimen of "*G. philippinensis*" he examined. Taking his total count for the vertebral column it stands thus: "*G. volans*" 45+, 45, and 50, and for his specimen of "*G. philippinensis*" 48+. In other words no two specimens, without regard to species, were in agreement in this particular.

Upon careful count, the three specimens here being examined show the following for the number of vertebræ in the spine:

*Number of vertebræ in Cynocephalus.*

| Specimens. | Cervical. | Thoracic. | Lumbar. | Sacral. | Caudal. | Total. |
|---|---|---|---|---|---|---|
| Professor Steere No. 1 | 7 | 13 | 9 | 3 | 19+ | 51+ |
| Bureau of Science No. 2 | 7 | 13 | 8 | 3 | 18+ | 49+ |
| Bureau of Science No. 3 | 7 | 13 | 7 | 4 | 16+ | 47+ |

If by a + in his account of the number of caudal vertebræ present Flower meant that certain terminal caudals were missing, no such meaning is here intended to be conveyed. In the above table a + does not mean that the skeleton with respect to the number of caudal vertebræ is imperfect in any of the specimens examined, but that the skeleton of the tail is finished off distally by an apparently rudimentary vertebra which lacks the posterior moiety. The truth of this has been confirmed in my specimens by the use of the microscope. For example, caudal vertebræ 11 to 15 in specimen number 2, very much resemble, upon a casual glance, some of the joints of the manus or pes, with a shaft and articular extremities. Now the minute terminal vertebra of the tail in specimen number 2 (and in others) if compared with a phalangeal joint, appears to have been broken in two at the middle of the shaft, or at a point that in reality is the middle of the centrum of the vertebra. The + stands for this "nib" or rudimentary terminal caudal vertebra in my specimens, and as such is entitled to recognition in the total count. (See figure 17, plate V.)

From an examination then of six individuals, three of Flower and three here, it may be stated with certainty that the number of vertebræ in the spinal column of *Cynocephalus,* irrespective of species, is markedly variable, after we pass the 7 cervicals, which are invariably present in all specimens. There may be 13 or 14 thoracic vertebræ (bearing ribs); from 5 to 9 lumber vertebræ; from 3 to 5 sacrals, or those that fuse together to form the "sacrum;" and, finally, from 14 to 19 caudals, which in most cases possess in addition (a +) a rudimentary one at the termination of the tail series.

Throughout the class Mammalia, even including man, the number of caudal vertebræ present in any particular species is subject to considerable variation. This becomes less and less the case as we pass from the tail to the cervical division of the spine, where with but very few exceptions 7 is the rule. *Manatus* among the Sirenia has but 6 cervical vertebræ; which is also the case with *Cholœpus* among the Edentates, while in the same group (Edentata) *Bradypus* possesses 9. At the present writing no other exception to this rule is known to me in the class.

The count may be made to vary, too, by the number we elect to represent the pelvic sacrum. In *Cynocephalus* as in other mammals, man included, the number varies also with the number that fuse together to form the sacrum. Where they have thus coössified, the bones so united have been here considered as sacral vertebræ; 3 in two instances; 4 in another. In man they vary from 4 to 6.

All these facts led Flower [15] to state that—

> It must never be forgotten that although the division of the vertebral column into distinct regions is convenient for descriptive purposes, at the contiguous extremities of the regions the characters of the vertebræ of one region are apt to blend into those of the next, either normally or as peculiarities of individual skeletons.

[15] Osteology of the Mammalia, 78.

In describing the spinal column in any mammal it has been the rule of the present writer to consider all those vertebræ between the skull and the first one in the chain, proceeding backward, that bears a pair of true, free ribs, as cervical vertebræ; all those bearing a pair of true, free ribs, as dorsal or thoracic vertebræ; all those between these last and where they coössify to form the "pelvic sacrum," as lumbar vertebræ; all those fusing together between the ilia of the pelvis, as sacral vertebræ; and all the rest to the end of the column, or chain, as caudal vertebræ. This rule has been here applied to *Cynocephalus*. (Figures of vertebræ will be found upon Plates II to V of the present memoir, that is figures 7, 8, 10, 11, 12, 13, 14, and 17.)

In describing the spinal column of the insectivore here being considered, the specimen furnished by Steere has been selected; constant references, however, will be made to the others, designating them as 2 and 3, respectively, as already indicated.

There is nothing especially unusual in the vertebral column of *Cynocephalus*, as it is strictly mammalian in character, with all of the vertebræ reduced to their simplest forms for an insectivorous animal. Even in the matter of number these bones may agree with others among the Insectivora, as in the case of the common European mole (*Talpa europæa*), which has in its vertebral column 7 cervical, 13 thoracic, 6 lumbar, 5 sacral, and 11 caudal vertebræ, the tail simply being somewhat longer in *Cynocephalus*.

Viewed in its entirety in the latter it is to be noted that the atlas is by far the largest vertebra in the chain; the axis is the next in size and is considerably smaller, being about equal in bulk to the last lumbar. The succeeding five cervical, and the first dorsal are all large vertebræ, which very gradually decrease in size as we approach the dorsal region of the spine. From the second dorsal to the seventh inclusive the vertebræ continue gradually to diminish in size; except the terminal caudals, the seventh dorsal is about the smallest one in the column; beyond the seventh dorsal the vertebræ gradually increase again, become much larger and of different character in the lumbar region, and terminate with the largest one of all, which articulates with the anterior vertebra of the pelvic sacrum. The first lumbar bears considerable resemblance to the last dorsal, but is distinguished by not supporting a pair of facets for ribs.

The vertebræ composing the sacrum fuse very solidly, but the lines of demarcation between the central and the neural spines are always more or less distinguishable, more so in some specimens (1 and 3) than in others (2). The first caudal vertebra, which is free, resembles the last sacral, and the same may be said of the second, third, and fourth caudals, although the resemblance becomes gradually less evident as we proceed toward the end of the tail. This dissimilarity continues to increase rather rapidly, although never abruptly, as we follow the caudal series to its termination, each succeeding vertebra having its various apophyses disappear, becoming lengthened and much simpler in character, straight and subcylindrical, and with interarticulations of the most primitive kind. As we come to the last four or five caudals they gradually shorten again, being in this region represented by mere delicate straight rods, with slightly enlarged articular ends, and finally terminate in a minute osseous tip, the smallest vertebra in the entire series, hardly worthy of the name (figure 17).

No neural spine occurs upon the atlas vertebra, although a very prominent one, arising from the entire length of the neural arch is to be found upon the axis. Its superior border is convex from before, backward. The neural spine in the remaining five cervicals is very markedly reduced in size, in each bone being represented by a mere stumpy process. In the first dorsal it starts to increase again, being situated posteriorly and directed backward. It then gradually increases in size; becomes nearly vertical, quadrilateral in outline, and almost imperceptibly dwarfs once more to include the eighth dorsal, when again its proportions increase, and this continues as we pass through the lumbar region. In the mid-series of the vertebræ in this latter locality in the Steere specimen, the neural spine is a very conspicuous feature of the bone, being lofty, quadrilateral in outline, and with a thickened superior border; it extends the entire length of the neural arch, being about one-half the size on the last lumbar vertebra. In other individuals these neural spines are not nearly so conspicuous (figure 17) as the ones just described (figure 7, Plate II).

Neural spines are always present upon the sacrum, but here by fusion they constitute a single plate of bone, being individualized only by the thickened superior borders (figure 8). This plate is not so high posteriorly as it is in front, while at the same time it extends the entire length of the sacral neural arch.

On the leading caudal vertebra we find a fairly well-developed neural spine of about the same size as the one on the last dorsal vertebra. It is centrally situated. This is the case with the next two succeeding caudals, but in these the neural spine is becoming aborted, while in the fourth caudal it may be only just evident, to entirely disappear in the vertebra next following, and not be produced again for the balance of the vertebral elements in the skeleton of the caudal appendage.

A mere mesial raised line represents the hæmal process or hæmapophysis, in the axis and the third cervical vertebra; for the rest of the column no such structure is present, while the caudal vertebræ appear to be entirely lacking in chevron bones. These last are found in many mammals, as, for example, among marsupials, the Edentata, Cetaceæ, many rodents, carnivores, and even in some Insectivora, as *Rhynchocyon*, where, according to Flower, they "are well developed and bifid."[10]

[10] Osteology of the Mammalia (1885), 73.

Returning to the atlas (figure 10) we find, in addition to characters already ascribed to it, that it possesses upon its anterior aspect the usual two, extensive, cup-shaped facets intended for the condyles at the back of the cranium. They face forward and inward in about equal proportions, and are completely out of view when the vertebra is regarded from directly above. The neural canal is short and cylindrical, being covered by the broad neural arch above, but very slightly so protected ventrally. Each apophysial, transverse, lateral expansion is twice pierced by foramina; the anterior ones are for the vertebral arteries and suboccipital nerves, the other pair, entering the neural canal at its sides, are for the vertebral arteries. On the posterior floor of the neural canal, the articular surface for the odontoid process of the axis and the entire fore part of the latter bone, save its neural spine, are continuous, thus affording very considerable play between the two bones. The under sides of the nearly horizontal, lateral, apophysial plates of the atlas are decidedly concave, with the mesial, almost entirely aborted, hypophysial tubercle standing between them behind.

This ventral surface of the atlas is bounded in front by a deep concave articular border with the concavity directed backward. A similar border with thickened edge forms the posterior boundary; its concavity, which is not so profound, is directed forward. Between the nearest points of these two concave borders in the middle line, the separating isthmus of bone measures only a few millimeters. The margins of the lateral edges of this vertebra are sharp and convex outward.

Passing next to the axis, or second cervical vertebra, it is to be noted that its odontoid process is but fairly well produced, being bluntly triangular in form, considerably compressed from above, downward, and together with the rest of the articular surface on that aspect of the bone, projecting entirely beyond the neural spine above it. This is by no means always the case in mammals, for among certain Felidæ and Canidæ it may be observed that the anterior projection of the neural spine in this vertebra overhangs the odontoid process. There are no prezygapophyses, while the postzygapophyses are much aborted, the elliptical articular facets, which they support in other vertebræ being represented, one on either side, by similar surfaces situated beneath the neural laminæ. They project beyond the small and vertically much compressed centrum, which presents, posteriorly, a rather large facet for the third vertebra. (Plate III, figure 11.) The transverse processes are moderate in size, triangular in outline, and much compressed in the vertical direction. No foramen for the passage of the vertebral artery, on either side, is to be found in the axis, while the cylindrical neural canal is much smaller than it is in the atlas. In fact it has about the same caliber and form throughout the cervical series as it has in the axis now being considered.

The remaining five cervicals are all very much alike, and we find each of them perforated upon either side, in the longitudinal direction, by the foramen for the vertebral artery. In each the centrum is much compressed from above, downward, which results in giving the articular facet at either end a transverse elliptical form, the concave one being behind, the convex one in front. The prezygapophyses are quite individualized and project directly forward beyond the centra and the neural arch. Postzygapophyses practically agree with what has been described for the axis. All these vertebræ have a broad, compressed appearance with their flat ventral aspects quadrilateral in outline. Small and stumpy in the third cervical, the transverse processes become gradually more conspicuous to include the seventh, or last cervical, where they are produced both forward and backward from a broad common pedicle.

Among the leading dorsal vertebræ the centra are much compressed as we found them in the cervicals, but they gradually become more cylindrical in form to the close of the series. Reniform in outline, the articular facets at either end have their concave edges upward.

Greatly reduced in size and caliber throughout the dorsal region, the neural canal is slightly compressed from above, downward, in the first few dorsals, finally to become cylindrical among the ultimate ones. This continues to be the case through the lumbar vertebræ, until we arrive at the last lumbar, where the canal is very much compressed from above, downward, and with this form passes through the sacrum and the first four caudal vertebræ. On the fourth caudal the spinal cord receives its last and very scant osseous protection, passing through a delicate little arch on the superior aspect of the bone, posteriorly.

Among all the dorsal vertebræ the diapophyses, or transverse processes, are short and thick, and in all cases project directly outward from their bases. At their nether extremities we note the usual facets for the tubercles of the ribs articulated with them at these points. The capitular facets for the heads of the ribs are shared in each case throughout the dorsal series by two vertebræ, by which is meant that one-half of the facet (a demifacet) is on the centrum of one vertebra and the other half on the side of the centrum of the vertebra next following it. No exception to this rule has been met with in the three specimens examined. Zygapophysial processes here present their usual mammalian characters, the postzygapophyses only becoming differentiated as true processes in the last few bones of this region.

The intervertebral foramina for the entire spinal column are formed about as they are throughout the mammalian series, including man. They are large in the cervical region, very much smaller in the dorsal section, and increase in size again in the lumbar where they are longitudinally slit-like, and are found in each case between the centrum and the long, backwardly directed, spiny anapophysis on either side, at the posterior end of the vertebra (figure 7).

These anapophysial processes of the lumbar vertebræ, where present, are quite characteristic. Each one on either side forms a deep notch with the postzygapophysis next to it on the same vertebra. Into this notch, when the bones of the spine are normally articulated, fits the prezygapophysis (of that side) of the next succeeding vertebra, the combination making a very close interlocking articulation, which, when taken altogether for the six leading lumbars, accounts for the remarkable fixity and stability of this part of the column in *Cynocephalus*. In the last two lumbar vertebræ these anapophysial processes are entirely aborted, as are the transverse processes in the first two lumbars. After that, however, these diapophyses begin to appear again, being represented by thin, quadrilateral, horizontal plates of bone of good proportions. They are thick and strong in the last lumbar, and claw-shaped in the three that precede it with the apices of the claws directed to the front. (Plate IV, figure 13.) Metapophyses of a very rudimentary type are also to be seen in the mid-lumbar vertebræ; in any case the most of the projection belongs in reality to the anterior zygapophysis, an exception being found in the last lumbar vertebra, where these processes are much better defined and rather more prominent.

In Steere's specimen the sacrum is a very solid bone, composed of three vertebræ thoroughly fused together. The leading one has double the bulk of the last, while the middle one is massive anteriorly and slopes away behind (Plate IV, figure 14). Anteriorly, the first sacral presents the usual facets, processes, and surfaces to articulate with those on the hinder aspect of the last lumbar. So, too, the posterior face of the third sacral is similarly modified in order to meet the requirements of an articulation with the anterior face of the first caudal vertebra. Laterally, the entire mass of the first sacral and the anterior moiety of the second, are enlarged, thickened, and curved ventrad to support on their outer aspect a large, subelliptical, articular surface for the ilium of the same side. This surface looks upward and outward, and the major axis of the ellipse is in line with the longitudinal axis of the spinal column, being parallel to the long axis of the ilium when the bones are normally articulated. There are two pairs of foramina on the ventral surface of the sacrum for the exit of the anterior roots of the spinal nerves. Similar pairs of foramina, for the posterior roots, occur on the dorsal aspect of the bone directly opposite these; then the foramina for the pairs of roots of the spinal nerves both anterior and posterior to these are only completed when the last lumbar and first caudal vertebræ are in position and duly articulated in the column, being represented only by shallow notches in front and behind when we study the sacrum as a single bone.

Considerable compression in the vertical direction is noticed in the first four caudal vertebræ. The fifth is rather stocky, after which they commence to elongate and lose their apophyses and the other usual vertebral characters of the bones in the fore part of the column. The lateral processes, especially, are developed in the first four caudals, most so in the third and fourth, where they are extensive horizontal plates with circular limiting borders. Zygapophysial processes are well developed in the leading caudals, particularly the prezygapophyses, which subsequently, as we pass down the skeleton of the tail, become a pair of rounded tubercles situated side by side on the supero-anterior aspect of the bone. These persist in a number of vertebræ as we pass toward the end of the tail.

On the ventral aspect of the skeleton of this part of the vertebral chain in Steere's specimen, between the sixth and seventh and the seventh and eighth vertebræ, and situated directly over the intervertebral articulations, we note a pair of minute ossicles, ellipsoidal in form, and placed side by side, at an interval of about one millimeter. They are perfectly free and are held in place by delicate ligaments. Possibly similar pairs may be found posteriorly between a few more vertebræ, but after that they surely disappear altogether. These last have evidently been lost in the specimen, and it is fair to presume that these ossicles probably represent rudimentary chevron bones.

Flower,[17] under the Insectivora, makes no mention of the ribs and sternum, although he lightly touches upon them for *Talpa, Sorex, Erinaceus,* and *Rhynchocyon.*

Viewed as a whole the osseus framework of the thorax in *Cynocephalus* is quite in keeping with what we meet with in this part of the skeleton in any average mammal, being decidedly more so than in *Talpa,* although the mole and the colugo each possess 13 pairs of ribs.

The chest capacity of *Cynocephalus* is considerable, notwithstanding the fact that it is much contracted anteriorly, where it is bounded by the first pair of ribs, the first dorsal vertebra, and the presternum. From this region it gradually, though very uniformly, expands to the plane of its posterior termination, where it has an average transverse diameter of 6 centimeters.

Owing to the greater size of the leading dorsal vertebræ and to the small dimensions of the ribs themselves the first three pairs of ribs have, upon either side, greater intervals between them than any other members of the series. These ribs are somewhat roundish in form, although exhibiting a disposition to flatten at their vertebral ends as we pass backward. In the fourth pair this flattening associated with an increased width is pronounced, and from thence on is continued to include the last pair. This accounts for the decrease in the width of the intercostal spaces after passing the third pair of ribs, so that each intercostal space is about equal to the ribs that bound it. There is very little difference in the width of the ribs from the fifth to the thirteenth pair, inclusive,

[17] Osteology of the Mammalia, 94–96.

and each one is nearly as wide at its sternal end, where it is joined by a costal rib, as it is at its angle. Those forming the first pair are the shortest in the series; the sixth, seventh, and eighth pairs are of about equal length and are, at the same time, the longest ones of all.

Seven of the leading pairs of ribs are joined to the sternum through the intervention of costal ribs; in the eighth pair the costal ribs are very long and attenuated, and lack but very little of meeting the distal extremity of the mesosternum. After this they rapidly shorten, the ninth, tenth, and sometimes the eleventh articulating in sequence with each other's lower borders; the twelfth and thirteenth are thus joined by a ligamentous membrane only, and are practically floating costal ribs. (Figure 17.) The first pair of costals are the shortest of all that unite the vertebral ribs with the anterior end of the presternum, occupying facets, one upon either side, just behind where the clavicles articulate. Like all the others they are curved, the concavity of the curvature looking forward. From the first to the last, or seventh, pair of costals this curvature continues, although it is here principally, indeed, almost entirely confined to the outer third of the bone, especially in the last two or three pairs. They become progressively longer as we pass backward, and all seem to be composed of true bone, although a little elementary in character. The distal pairs of costals are still more cartilaginous, but there is evidence of osseous tissue in all of them. At their sternal ends they articulate upon facets situated *between* the joints of the presternum and mesosternum, the sixth and the seventh articulating at the distal end of the posterior joint of the mesosternum. None of the costals ever articulates with the xiphisternum.

All the thoracic ribs articulate with the dorsal vertebræ in the way usual among mammals and they present the common characters of these bones. They are somewhat narrower in some specimens (1) than in others (2, 3), but wide or narrow, any single rib in mid-series varies but little in its own width from angle to costal articulation. All present the usual curvature, although here it involves almost the entire continuity of the bone and is most pronounced dorsad.

If we select a "true rib" of the eighth pair as an example we find that its capitulum is well developed; the elliptical double facet is rather large and placed longitudinally on the bone. The "neck" is but moderately constricted; the "tubercle" is but feebly pronounced, and owing to the short transverse process of the dorsal vertebra, is quite close to the capitulum. The "angle" is but very faintly indicated, and is entirely absent in the last three pairs of true ribs. As in the rest of the series, the "body" of the twelfth rib is very flat with rather sharp anterior and posterior borders. These last in Steere's specimen are far more rounded. Posteriorly and at the same time dorsad, there is a faint groove running down the border of this rib. It harbors in life the intercostal vessels and nerve, while its borders give attachment to the internal and external intercostal muscles.

A very shallow concavity, or pit, occupying the ventral end of all the true ribs, is intended for articulation with the outer extremity of the corresponding costal rib.

Between the head and tubercle in most of the true ribs of this animal we meet with a single nutrient foramen, usually upon the posterior aspect of the bone. It is extremely minute in some of the ribs and varies somewhat in locality.

*Cynocephalus* possesses an ordinary and rather stout sternum, the parts consisting of spongy bone overlaid by an extremely thin outer covering of compact tissue. As usual in most mammals it is divided into the presternum (manubrium), the mesosternum (gladiolus, etc.), and the xiphisternum (ensiform cartilage, or xiphoid appendage, etc.). Sometimes the parts of the mesosternum are designated as sternebræ, the whole being frequently called the "breast bone." (Figure 17.)

The presternum is here short and trihedral in form, with its blunt third angle situated mesially, and articulating in life with the anterior end of the first sternebra of the mesosternum. Its outer anterior angles are for articulation with the first pair of costal ribs. The sharper antero-mesial angle has, running between it and the distal end of the bone, a low mesial raised crest which stands between the lateral aspects of this joint of the sternum. Dorsally it is flat, while anteriorly the triangular surface is very moderately concaved. Its longitudinal diameter averages about 8 millimeters, and it is scarcely any wider at its widest part in front.[18]

Passing to the mesosternum we find it composed of four sternebræ closely resembling one another in form, and differing but little in the matter of size. They are vertically compressed, smooth bones, narrower at their middle than at their extremities, and in life articulate with each other in the manner usual among mammals. They average about 4 millimeters in width, and rather more in length, the anterior one being 5 millimeters long and the third or longest one about 8 millimeters long. They present the usual facets at their anterior and posterior angles for articulation with the costal ribs.

The xiphisternum varies considerably in form, although it may be described as a cartilaginous appendage, about as long as the third sternebra. Occasionally it appears to be in two bits, one behind the other, the anterior one exhibiting a very faint disposition to ossify. Viewing the thorax from in front, it will be noticed that in most specimens the

[18] The presternum in *Cynocephalus* is entirely different from that bone as we find it in the mole (*Talpa europæa*), as will be seen by examining Flower's figure of the latter. Osteology of the Mammalia, figure 34.

sternal ends of the seventh pair of costal ribs articulate with each other in the mesial line, and at the same time with the distal end of the last sternebra. The xiphisternum is united to the mesosternum at the dorsal aspect of this triple articulation; this is an unusual arrangement among mammals, possibly not existing in any other known species. It is entirely different in *Talpa*, and very probably in other insectivores.

In the articulated skeleton the xiphisternum is about opposite the tenth dorsal vertebra, and the entire sternum has an average length of 4.5 centimenters.

[*To be concluded.*]

# ILLUSTRATIONS.

PLATE A.

Skeleton of a flying lemur. By permission. Reduced. From the mounted specimen in the collection of the United States National Museum.

PLATE I.

FIG. 1. Basal aspect of the skull of *Cynocephalus;* lower mandible removed, and a few teeth missing. Adult. Very slightly enlarged. Specimen from Professor J. B. Steere.

2. Left lateral view of the skull of *Cynocephalus*, with lower mandible articulated *in situ*, and the dental armature complete. Hyoidean apparatus removed. About adult. Very slightly enlarged, and in same proportion as figure 1. A specimen from the Bureau of Science, Manila, P. I.

PLATE II.

FIG. 3. Superior aspect of skull of *Cynocephalus*, lower mandible removed. Same specimen as shown in figure 1 of Plate I. Exact natural size.

4. Lower mandible of *Cynocephalus* seen upon direct superior view. Dental armature complete. This jaw belongs to the skull shown in figure 3. Exact size of the specimen.

5. Left scapula of *Cynocephalus* seen upon direct ventral view, and natural size. The absence of the superior angle, and the foraminal vacuities in the blade are normal. The rounded superior angle of the right scapula in this specimen is perfect. The bone belonged to the same individual from which the skull and mandible were taken shown in figures 3 and 4.

6. Left femur of *Cynocephalus* seen upon anterior view and slightly enlarged. Note the almost entire absence of the pit for the ligamentum teres. From the same specimen as figures 3, 4, and 5.

7. Lumbar vertebræ of *Cynocephalus*, being the third to the seventh, inclusive, and seen upon left lateral aspect. Natural size; from the same specimen as the other bones in this plate.

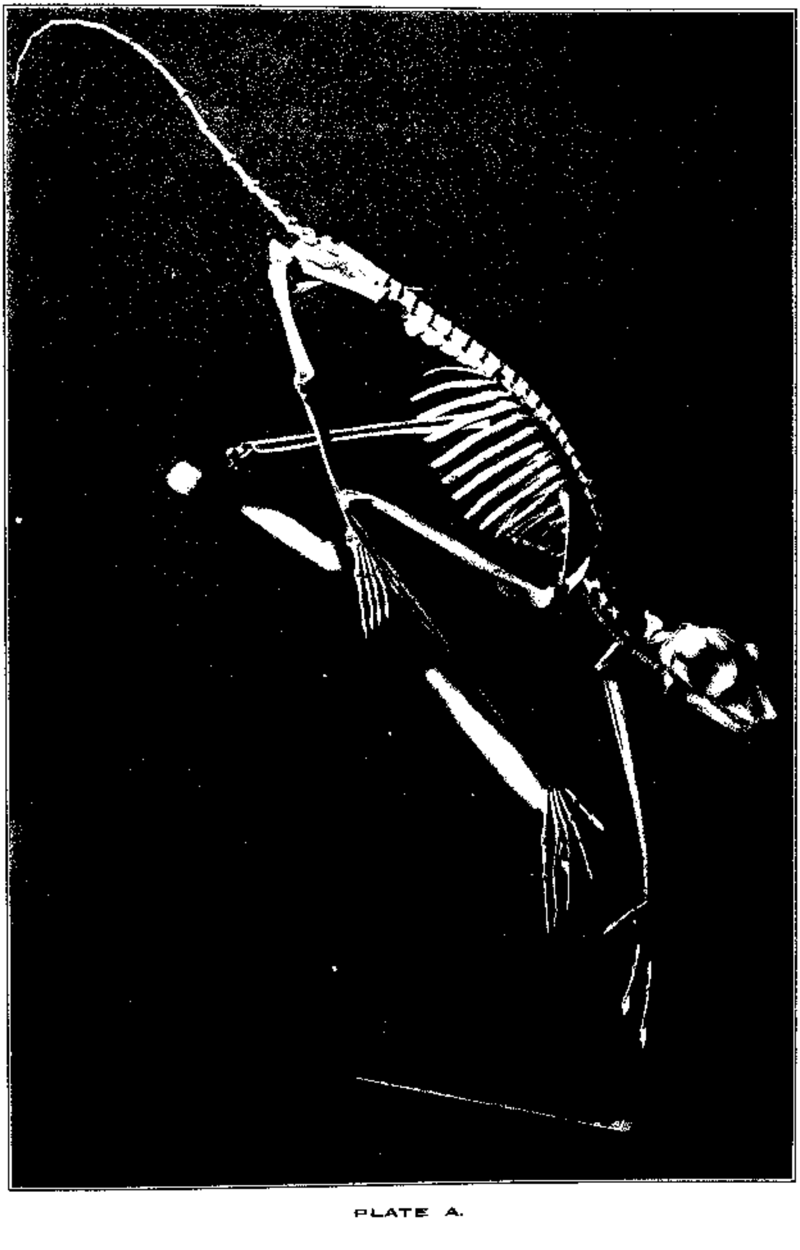

PLATE A.

*Fig. 1.*

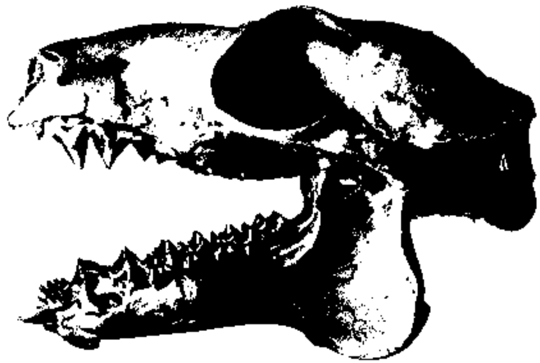

*Fig. 2.*

PLATE I.

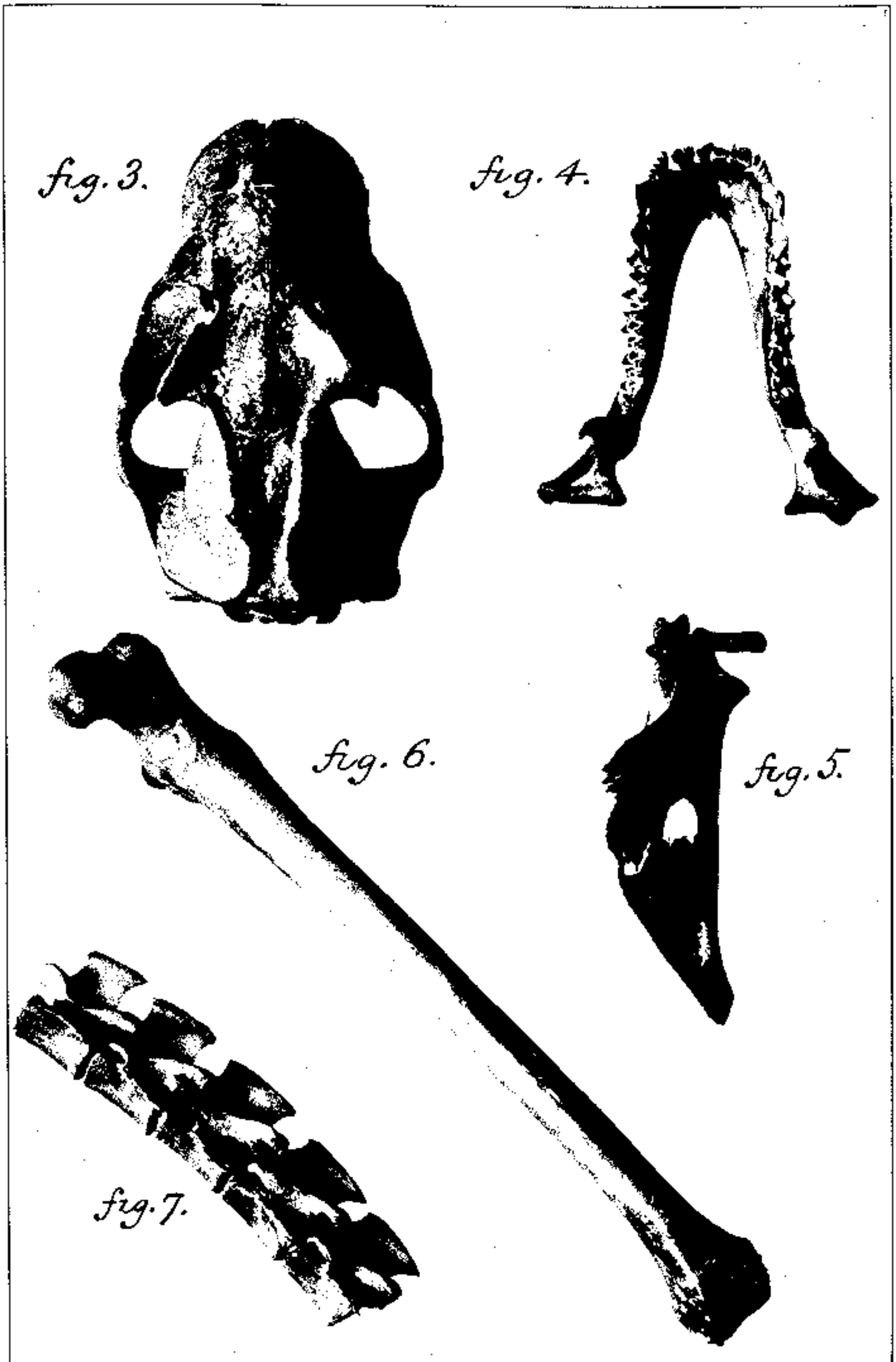


PLATE II.

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