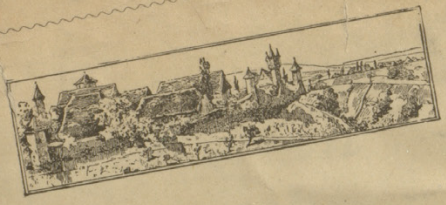


Child of My Love, "Lean Hard."

CHILD of my love, "LEAN HARD,"
And let Me feel the pressure of thy care;
I know thy burden, child—I shaped it,
Poised it in My own hand, made no proportion
In its weight to thine unaided strength;
Before I ever laid it on, I said,
"I shall be ever near, and, while she leans on Me,
"This burden shall be Mine, not hers,
"So shall I keep My child within the circling arms
"Of Mine own love,"—Here lay it down, nor fear
To impose it on a shoulder which upholds
The government of worlds—yet closer come,
Thou art not near enough; I would embrace
thy care,
So I might feel My child reposing on My heart.
Thou lovest Me! I doubt it not,
Then, loving Me, "LEAN HARD."

C. Caswell, Edmund Street, Birmingham.—25 copies, post-free, 4d.

VOL IV.

Notes on Natural History

Lectures.

Delivered by Prof Huxley F.R.S. &c

Royal School of Mines

Session 1871-72

Geo. M. Dawson

Lecture 69.

May 3. 72

Characteristics of the Reproductive Apparatus in Lamprida more especially in birds. The Testes are symmetrically developed & in communication with the cloaca by Vasa deferentia. Copulatory organs grouped under thumparus.

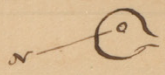
1 Among Chelonia Crocodilea, & the ostrich there is a simple corpus like penis grooved on its posterior aspect & attached to the front wall of the Cloaca.

2. Among the Rheidae, Casuaridae, Apterygidae, & many aquatic birds there is also a simple penis, but it can be retracted in a spiral manner by a ligament on each side.

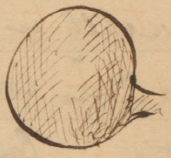
3. In Lacertilia & Ophidia there are two copulatory organs. developed at the sides of the Cloaca.

The female apparatus consists of two ovaries, & oviducts which in their lower part become dilated, & secrete first albumen, & then very generally a coriaceous, or calcareous covering for the ovum.

The ova are developed in ovisacs, or Graafian follicles

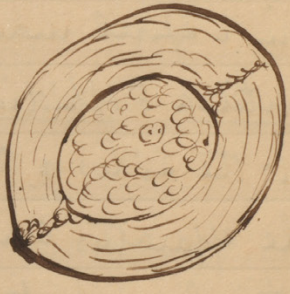


Graafian follicle.



Graafian follicle

Section Graafian follicle.



Egg.

Oviduct.

as in the higher Vertebrata, but among Lamprida the vessels are much larger, & protrude grape like from the ovary. Only the cells contained in the follicle become modified & the true ovum, the rest undergo change similar to fatty degeneration & are converted into an accessory yolk of considerable size. Surrounding the whole is the evolution of the vascular membrane of the ovary, & a zone round the graafian follicle is thinner & less vascular than the rest, & constitutes the line of rupture when the ovum is set free. The cellular lining of the follicle continues to form up yolk cells, & the ovum enlarges & shows its several germinal spots. Then a membrane, the vitelline membrane, surrounds the whole mass of yolk. The follicle bursts & allows the ovum enclosed in its vitellus & vitelline membrane to escape. This is received by the open end of the oviduct (in birds usually only the left oviduct remains functional.) The oviduct then dilates to the so called uterine chamber which secretes the albuminous fluid. The egg descends spirally & the first part of the albumen which is very thick is thus twisted up to form the chalaze which projects like a tuft at either end of the yolk. Then more fluid albumen is added.

before this time impregnation has taken place. Next a very viscid secretion forms a parchment-like coating round the ovum the membrana putaminis. This completes the processes in many Sauropsidans but in Crocodilia & Aves a porous calcareous shell is added.

The primitive ovum divides & subdivides after impregnation till a mass of cells is formed on one side of the food yelk & immediately beneath the vitelline membrane. This patch is paler than the rest, is known as the cicatricula or tread, & is the blastoderm. It consists of an upper layer small, & a lower layer of larger cells, the Epi & hypoblast respectively. The development has been traced. When laid change ceases in the egg till suitable conditions of temperature. Some lizards & snakes are ovo-viviparous. The egg remains in the body till hatched. The Sauropsidan egg therefore is impregnated & really an embryo before it is laid.

In Birds, Lizards, Snakes a horny knob develops on the Pre maxilla apparently to facilitate egress from the shell.

Classification of Birds

All known can be divided into three great groups Saururae. Ratitae, & Carinatae.

The Saururae include only the genus archaeopteryx, known by a single fossil which shows characters different from any other bird. The Head is unfortunately lost. There seems to have been no Sternum. The furculum very strong & curved. The bones of the manus were not ankylosed, the digits bore strong curved claws. Great quill feathers sprung from the manus as in birds. The pelvis is bird like. The tail exceedingly curious being composed of many & long vertebrae, & bearing a row of quill feathers on each side. Hind limb exceedingly primitive. The Tibia was ankylosed with the astragalus & Calcaneum. The Tarso metatarsus ankylosed. The Hallux modified as in perching birds, its metatarsus long free & thrown back

All other birds have the metacarpels ankylosed & the tail very short They are divided to Ratitae & Carinatae. The former have no sternal keel. The latter have a sternal keel (with one or two partial exceptions.)

3

A Lallemand

3

3

The Ratitae are further divided into the following groups.
Apterygidae, Casuaridae, Rheidae, Dinornithidae & Struthionidae.

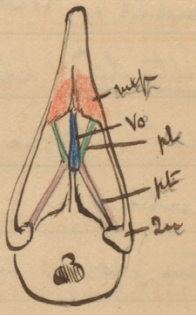
Apterygidae Represented by Several Species of the genus Apteryx. Feathers down like with no barbs. Wings hidden & very rudimentary. Sternum & Shoulder girdle very weak. No Clavicles. Diaphragm better developed than in any other bird.

Casuaridae Inhabiting Australia & neighbouring islands, & coinciding very closely in distribution with the Australoid type of man. Feathers down like with after-shaft nearly as large as the primary. Limbs elongated. Three toes. Hallux absent. Wing small. Rudimentary clavicles.

Dinornithidae Closely allied to the two last groups. Recently extinct in New Zealand. Fore limb still more rudimentary.

These three groups are all confined to islands, & island areas East of India.

Rheidae. S. America. Plumage down like. Three toes on each foot. Fore limb much better developed, but still bearing no stiff quill feathers. Pelvis exceedingly peculiar. The Ischia coming together dorsally just beneath the Sacrum.



Struthionidae. The ostriches. Sinyl genus Struthio. Feathers somewhat better differentiated. No Clavicles. Coracoids have a foramen as in reptiles. Wings pretty well developed. Pollex & index unguiculated. Foot has only two toes functional. Pollex having disappeared, & the metacarpal of the index only represented by a splint. 2 June. The third toe has 4 phalanges & is the largest. The fourth has 5.

Remains apparently of Ratitae are found in the older tertiaries.

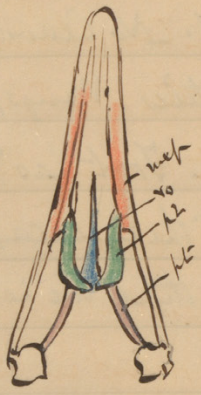
Lect 70.

III Carinatae are divided into four groups.

Dromeognathae Vomer broad behind, & interposing between the pterygoids, the palatine, & basisphenoidal rostrum. This group includes the tinamous.

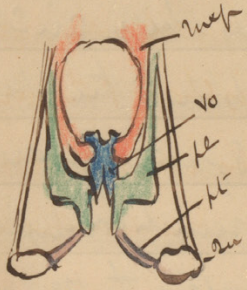
In the three remaining groups the vomer is narrow behind & the pterygoids & palatines articulate largely with the basisphenoidal rostrum.

Schizognathae. Maxillo-palatines free. Vomer pointed in front. (The Plovers &c &c) This group includes birds variously modified according to their habits. The Plovers & Cranes &c constitute a wading group. The legs & neck are much



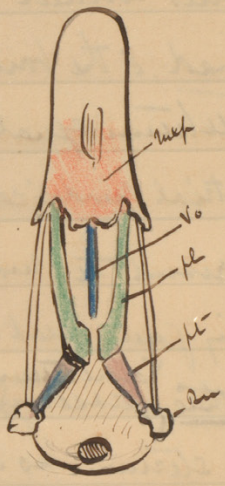
elongated. The feathers do not reach to the Loffrage, or part of the Leg corresponding to the heel. Web between toes absent or very small. The Hallux may be set higher than the other toes & pointed backwards. The gulls, petrels, albatross &c constitute a group much resembling Terns in the last. In most the power of flight is very great. In the albatross the humerus is very greatly elongated. All Terns & often diver. The extreme of this type is found in the auks where the wings are very short & scarcely used for flight. In Terns an approach to the Cursores modifications found in the penguins. The penguins are completely aquatic. The body is supported on the whole sole of the foot. Feathers close set, not divided into regions, almost scale-like. No division into primary & secondary feathers, except with regard to the tail feathers which are stronger than the rest. The wings are used as paddles & the skeleton much modified. The Scapulae, coracoids, & furculum are of great size. The humerus, & radius & ulna are much compressed on the distal end of the humerus the facet for the radius is in front of, & above that for the ulna. The three digits are also ankylosed & flattened. The vertebral centra are nearly spherical in front & deeply concave behind in the cervical region.

Sternum



Larrak.

The sternum has an enormous keel for the attachment of the great muscles used in "flying" through the water.
The pelvic bones connect loosely with the sacrum. The tarso-metatarsus is broad, & the bones are not so completely fused as usual. This is the extreme aquatic modification of the Schizognathae.
The Terrestrial modification is best shown in the fowls. The Pigeons represent the modification with greatest powers of flight. The legs being quite weak.
Aegithognathae Vomer truncated in front Passerines, Swifts, humming-birds, woodpeckers &c
The typical sternum has double posterior notches, & a well developed manubrium. A great many birds are included, & all have a great similarity. The Swifts & Humming birds have very great powers of flight, but obtained in exactly the opposite way from that of the ~~Albatrosses~~ Albatross. Here the humerus is short, & the fore arm & manus immensely elongated. In all the proper passerine birds there are three front toes, & a Single back one. The woodpeckers however have Scansorial feet, two toes being turned in each direction.
Desmognathae The maxillo palatines united. The raptorial or birds of prey belong here. The beak is strong & curved, & the



foot adapted for powerful holding. The Parrots are very peculiar. The Pre-maxillary apparatus is movable on a hinge, & may there is a complete bony ring below the orbit. The palatine bones are vertically elongated, & form plates projecting into the mouth. The distal articular surface of the Quadrate is elongated forwards & backwards. There is generally a pneumatic foramen. The tarso-metatarsus is short & broad, the foot-scansorial. The Coccygomorphae are difficult to classify the dromaeognathous palate seems the only common character. The anserines, flamingoes, Storks, & Cormorants are closely allied. The region between the orbit & nasal apertures is long. The mandible spoon shaped at the symphysis, & has a long posterior angle. The culmen well developed. Sternum broad, & having a strong keel. The tarso metatarsus is short in proportion to the tibia. The Flamingoes seem half way from the ducks & geese (anserines) to the herons & Storks. The latter constitute the wading group of the dromaeognathae, & in many respects resemble the Schizorhinae (Scattered) waders. The Cormorants have a large area formed by the palatines behind the nostrils. The hallux is turned back, but still connected to the other toes by a web.


arctyea
Austro-
Columbia
australasiá
Novazelamá

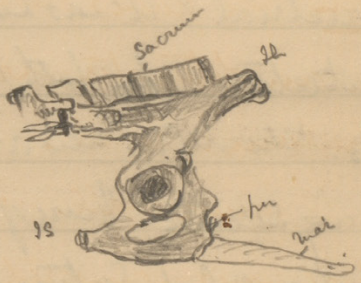
The distribution of existing birds is very interesting, & Sclater has given the best means of distinguishing distribution provinces for the terrestrial animals in general. We may draw a great line passing north of Mexico, round the Cape, South of India & Wallace & between the islands of Bally & Lombock to the north of New Guinea & Australia. The great Northern division is called arctogea & is characterised by one great division containing the gallinaceous birds. The remainder of these birds inhabit the regions to the south of the great line. New Zealand & adjacent islands forms the province of Novazelandia, characterised by the apteryx, dinornithidae &c. Australia & adjacent regions are included in an australasian province. The Emus & Cassowaries, together with several peculiar parrots are characteristic. Austro columbia, or S. America & Mexico is another great division inhabited by Rheidae & many other peculiar birds. The Struthionidae are found in Africa & Arabia. The arctogeal area can again be divided into a circumpolar region. An african & the Sahara, & an Indian. These divisions have however a great general similarity.

The great provinces are no less characterised by the general distribution
of the mammalia. Arctogea encloses one great assemblage
of mammals. Austro-Columbia & Australasia have each
their own peculiar animals, & Novazelania is characterised by
a remarkable absence of mammalia. (Dididia & Chelonia) (See paper in Proceedings Zool Soc)
Range in Time A few years back birds were only known in
the tertiary. They were found however in the Eocene of Paris
much like existing forms, & divided into specially modified
waders, raptores &c as today. Now Tracks, almost certainly
bird tracks are known in the Trias of Connecticut. The toe being
turned back in a characteristically ornithic manner.
The archaeopteryx also from the Solenhausen slates. In the
Upper Greensand of this country, & New Jersey bird remains
are found. In the latter place abundantly, & representing very
closely the types of the modern ducks, plovers, cranes &c.
The Younger Milne Edwards has restored an immense bird
fauna of the French Miocene, in which Flamingoes, parrots &c
are found.
It is very strange that so far no remnant of any of the
Ratitae has been found in Eocene or Miocene rocks. This
type of bird is no doubt the oldest, & must have existed
somewhere meanwhile.

Lect-71. May 7.

The Mammalia have been already characterised.
They are divisable to 3 great groups. Ornithodelphia.
Didelphia & Monodelphia.
Ornithodelphia, are nearest to the Sauropsida & are undoubtedly the earliest type of mammals which we know. They are now only represented by two genera, & are known nothing of their distribution in time. The ornithorynchus & Echidna are the only genera. Ornithorynchus has soft fur, & strong clawed swimming feet. A flat beak covered with integument. It is an inhabitant of Australia & aquatic. The Echidna is quite terrestrial. It has Hedgehog like spines & is called the spiny anteater. In both genera the vertebrae are devoid of epiphyses. The atlas & axis are Sauropsidan, the odontoid remaining seperate. Many of former cervical ribs are united to the centra only by Suture as in the crocodile. In ornithorynchus the Sacrum is composed of 2 vertebrae, in Echidna of 3 or 4. The skull is very singular, & Specially ornithic in appearance, the skull bones early beam

no teeth in Echidna
4 horny teeth in Ornithorynchus.



Pelvic arch Echidna.

run together as in birds, & the back of the cranial cavity is rounded & broad. In ornithorynchus the fore part is flattened, & bill like. The articular condyles of the mandible are very small almost obsolete in Echidna. In both animals the ramus of the lower jaw is very small. The molleus particularly large.

The pectoral arch is very peculiar. The coracoid is large & articulates directly with the sternum. In front of it is a considerable ossification, the epicoracoid. The scapula is broad. There is a T shaped interclavicle which supports the clavicles. The clavicles become connected with the acromian processes of the scapulae. Behind the sternum is divided into sternebrae in a manner different from any Sauropsid.

Pelvic arch The pubes & Ischia meet in ventral symphysis & include an obturator foramen. In ornithorynchus the acetabulum is solid? In Echidna a great vacuity exists in its inner wall. There are two so called marsupial bones connected by cyanmatous union with the front margins of the pubes. They are really ossifications in the course of the external abdominal muscle.

In ornithorynchus a sort of spur grows out from the

astragalus, is perforated, & gives passage to the secretion of a gland.

Brain The cerebral hemispheres are proportionately large. In Echidna they are curiously enough somewhat convoluted. The olfactory lobes are large. The anterior commissure very large & the corpus callosum quite small. The hippocampus minor is well shown on the inner sides of the hemispheres. The Cochlea is only slightly coiled.

Reproductive organs. At the anterior end of the cloaca (or Gen.-urin. sinus) are 5 apertures. one in the middle line for the bladder, ~~xxxxx~~ ~~xxxxxx~~. & two on each side the openings of the genital duct & ureters. The latter as in Lacerta (& in these animals only among mammals) do not open to the bladder. The Ova are very large. There is no vagina distinct from the uterus. The latter dilates on each side & forms a pair of uterine chambers resembling that of such an animal as the fowl. The mammary glands are placed ventrally one on each side. They open in depressed areas into which the young thrust their heads when sucking.

It seems from recent investigation that in the higher vertebrate mammalia, as in the human subject & the cow

Foetal mammary gland.

areola

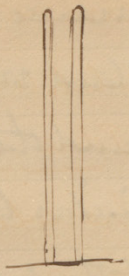
Human.

Cow.

the mammary glands at their first appearance in the foetus are only epidermic structures. The gland ramifies inwards, & the surface rises up in a ridge round their openings. Here we have a structure substantially similar to that found in the Monotremes. In the human subject the inclosing wall disappears, & is only represented by the areola while the centre grows up & forms a teat. In the cow the walls grow up over the openings of the gland. Therefore there seem to be two classes of teats in the higher mammalia.

The testes of the ornithodelphia remain in the abdomen, & never descend. The Vasa deferentia open in the cloaca at positions corresponding with those of the oviducts in the female. The penis lies on the front wall of the cloaca. It is ~~grooved~~ canaliculated but not in direct connection posteriorally with the Vasa deferentia. Thus resembles the Crocodilian structure.

Didelphia. Here the general structure of the skeleton is much nearer the ordinary mammalian type. The os odontoideum soon unites with the second vertebra. The atlas is usually not quite closed above & bone. The shoulder girdle is quite in its ordinary mammalian form. The coracoid

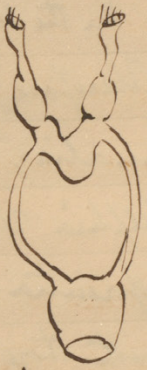


Mullerian ducts.

Fowl.

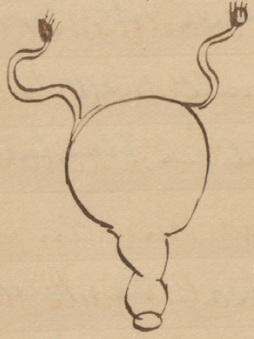
Ornithodelphia.

Lower Didelphia



Kangaroo.

Rabbit &c



Apes &c

Very early unites with the scapula to form a caracoidal process. There is no interclavicle. The clavicles articulate with the manubrium of the sternum as usual. Ilium forms floor of acetabulum. Completely ossified. Marsupial bones connect with the pubis as before. The palatine & maxillary bones are often incompletely ossified leaving a space in the roof of the mouth. The most distinctive skull character is the turning in of the posterior process of the mandible. In Carnivora there is a posterior process well developed, but it is not turned in.

There is no cloaca. The rectum is always distinct from the genitourinary opening, though often very close to it. The penis well developed, & is traversed by a continuous uro-genital canal. The ureters open to the bladder. The corpora cavernosa do not cavernosa unite with the Ischium. The testes descend, pass out through the inguinal ring & protrude in front of the penis. In the female the Vagina is quite distinct from the urinary passage. The mouths of the fallopian tubes are fimbriated. The oviducts are enlarged to form uteri. In the lower forms they uteri are only applied together, in

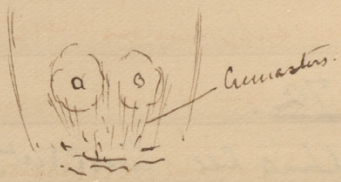
the Kangaroos they open into each other. In the didelphia therefore it is not that the uteri are distinct, but the vaginae. In all the higher mammals the vaginae completely coalesce, & in the highest the single uterus has not been termed but is globular. The mullerian ducts are thus in different animals variously modified. In the fowl they are simply swollen to form uterine enlargements, & are soon becomes atrophied. In the Ornithodelphia they present the same structure but both are present. In the didelphia the outer ends of the mullerian ducts (vaginae) remain distinct. Higher up the uterine enlargements may become applied or coalesce. In all other mammals coalescence is complete & the vagina single.

Lect 72.

(For characters didelphia see Anat. Vert. P 323.)

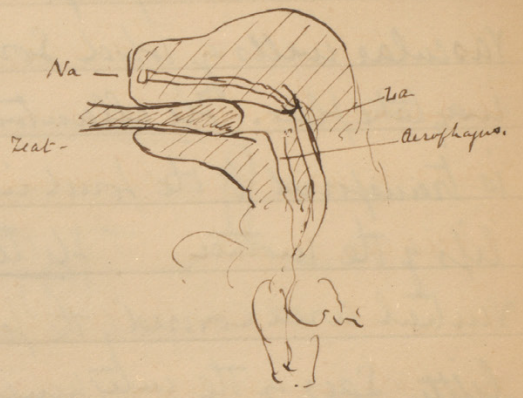
The brain of the didelphia much resembles that of the ornithodelphia.

Very little is known about the development. What we do know is derived from study of the Macropodidae (Kangaroos) The young leaves the mothers uterus in a very imperfect-

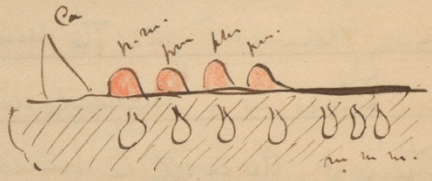

Cremaster.

State. There is a very large umbilical vesicle by means of the vascular walls of which some absorbtion of nutriment may take place. The allantois is very small. The embryo is transferred to the pouch in some way, very probably by the lips of the mother. The teats are placed on that part of the ventral area covered by the pouch, & are usually enclosed in little sacs of the integument. They protrude when the foetus becomes attached to them, & finally become very long. The mammary glands are large, & the abdominal muscular fibres which in the male are carried out by the testes & become the cremasters, are here arranged to compress the mammary glands & force the milk into the mouth of the foetus. There is a marsupium in most marsupials but it has nothing to do with the marsupial bones. A number fibres of the panniculus carnosus, a dermal muscle, pass out with the fold which constitutes the pouch & serve to hold it out & give it a certain elasticity.

The young Kangaroo is perhaps not more than an inch long, it becomes firmly attached to the teat. To prevent choking from the injection of the milk the larynx is produced



Head young Kangaroo.

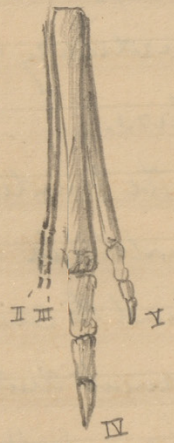


Monodelphous.

Didelphous.

upwards & closely connected with a funnel shaped projection of the soft palate in which the posterior nares lie.
The same structure turns up again in the Cetacea where it serves the purpose of allowing respiration while the animal is feeding on fish.
The palate among the Didelphia very generally shows a want of complete ossification. None are Edentatous, & in some the teeth are very well developed, & show the ordinary division into incisors, canines, premolars & molars.
Flower has discovered that only one of the grinders is succeeded vertically. In one of the Marsupialia when typically developed there are four grinders behind the canine, which are succeeded vertically by teeth of the permanent dentition. Behind these come three teeth which never have milk predecessors but are developed subsequently to the milk teeth, & are never replaced. In the Didelphia there are two teeth behind the canine which are never replaced, & it is difficult to say whether they are most like molars or premolars. The third tooth is replaced vertically in the ordinary way & is certainly a premolar. Four teeth behind this have no milk representatives & are certainly true molars.

?



Macropus.

Foot. Kangaroo

E

X

In marsupials the number of teeth is often reduced at both ends of the jaw. The grinders never have a complex grinding surface with folded enamel plates. The number of the incisors in the upper & lower jaws are different, those in the upper jaw being most numerous. Very often 8 or 10 in the upper & 6 or 8 in the lower. This is quite peculiar.

In many the Fibula is capable of movement on the Tibia & the hind limb therefore enabled to take positions like pronation & supination.

The foot varies much. There may be 5 toes or 4 or 3 or fewer. The Didelphidæ & Dasyuridæ have 4 or 5 toes all free. In all other marsupials the index & medius are curiously joined by integument. In the Kangaroos the hallux has quite vanished. The fourth toe being very long, & the 5th of some length. The lowest form of brain is found among carnivorous marsupials.

Geographical Distribution so much restricted.

The Didelphidæ or opossums inhabit the Austro-Columbian province. In Australia & Tasmania all the other forms are found. The Eocene of Montmartre has given a true

Monodelphia

Edentata or Bruta

Median incisor teeth never developed.

Austro-Columbian & Arctoid

I. Phytophaga

1 Tardigrada 2 genera Bradopus & Cholöepus.

2 Gravigrada Megatherium. Mylodon. Megalonyx &

II. Entomophaga

Aust. Columb. — 1 Muticа Myrmecophaga & Cyclothurus

Africa. — 2 Squamata Manis.

Africa. — 3 Tubulidentata Orycteropus

Aust. Columb. — 4 Loricata

α Dasypodidae Armadillos.

β Glyptodontidae. Glyptodons.

opossum & several other genera. In the oolites the Didelphidæ dasyuridae, & macropodidæ, are represented in all probability & phascolotherium, amphitherium, & plagiaulax.
Microlestes is found in the Trias it is only known & little but seems allied to plagiaulax.

Lect 73.

III. Monodelphia. odontoid peg very soon ankyloses with the second vertebra, & the cervical ribs with their vertebrae. The coracoid is a mere process on the scapula & has no connection with the sternum. Clavicles may be present or absent but there is no interclavicle. Acetabulum imperforate. No marsupial bones.
The anterior commissure & corpus callosum, as well as the cerebral hemispheres vary greatly. The cochlea is coiled. Reproductive & urinary apertures seperate from rectum. The ureters open into the bladder. The testes may remain in the abdomen or pass out in a scrotal pouch at the sides of or below the penis. The ova are small (generally not more than $\frac{1}{100}$ inch) Fallopian tubes fimbriated. Vagina simple. The cremaster has no connection with the ~~mammary~~ mammary glands.
The allantois is large & forms a placenta.

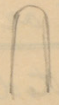
The Phytophaga. The long bones have no medullary cavities. The Zygomatic arch sends down an extraordinary vertical process. The coracoid coalesces with the acromial process. The anterior caudal vertebrae ankylose with the Sacrum, & the ischia become united with them. The foot is twisted, & rests on its outer edge. Vascular canals traverse the dentine.

The Monodelphia are logically divided to Deciduata & Non-Deciduata. The placentation of the Sirenia is however unknown, & that of the Edentata seems heterogeneous.

Edentata or Bruta. These animals show many resemblances to the Ornithodelphia, so much so that the latter were included in this group by Cuvier.
There are never any median incisors in either jaw,
The incisors are generally absent, & the animals frequently edentulous. The teeth consist of dentine & cement without enamel. grow from persistent pulps & have no roots.
Vertical replacement takes place in some armadilloes.
There are long & strong claws. The brain varies much.
The Edentata are divisible to Phytophaga living on leaves & Entomophaga living on ants & carrion.

I Phytophaga. Include the Tardigrada or Sloths & Gravigrada represented by Megatherium &c altogether extinct.
The Tardigrada. There are two genera Bradypus & Cholœpus or three & two toed sloths respectively. Cholopus.

E



Bradypus

Choloepus

In the Tardigradia, the tail is short. The limbs long, the anterior long longer than the posterior. The internal & external digits of both feet are wanting. The hind foot has always the three middle digits. In the fore foot there are sometimes only two.
The Zygomatic arch is incomplete posteriorally. The cervical Vertebrae are sometimes more, & sometimes fewer than the typical mammalian number 7. The distal end of the Fibula sends inward a peg like process which fits in a socket in the outer face of the astragalus.
In the three toed sloths the distal tarsal bones, the metatarsals, & the basal phalanges are ankylosed together. The only movements possible are then. Movement of the distal phalanges on the basal phalanges. Movement of the tarso-phalangeal synostosis on the astragalus. Peculiar movement of the astragalus on the Tibia, & Fibular peg. The muscles are very strong & keep the foot in the turned in position though the anatomical arrangement of the bones offers no difficulty to its assuming a plantigrade position.
In the two toed sloths no ankyloses of the tarsal, metatarsal, & phalangeal bones takes place. The calcaneum is twisted

Terminal phalanges of Claws.

round under the astragalus so that its proper external face is turned downwards, & the foot thrown thoroughly on the outer side ♀ the structure ♀ the bones.

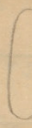
The teeth (In Tardigrada) are 5 in each side ♀ the jaw above & ♀ below. They become chisel like ♀ attrition.

The Gravigradia Extinct. Found in post-tertiary rocks ♀ S. America. In Tertiary ♀ N. America. In the Miocene ♀ Europe. Evidently terrestrial & with nearly equal limbs.

The Dorsal vertebrae have additional articulating processes. The tail is long & strong. The ulnar digit is inserted in the fore foot. A peg & socket joint allowing lateral motion formed ♀ the interlocking ♀ the Tibia & Astragalus. (Megatherium &c) Mylodon. Megalonyx.

II. Entomophaga. The Zygoma sends down no lateral process. The acromion & Coracoid are not united. The hind foot rests flatly upon a greater or less extent ♀ its whole surface.

a. Inertica The ant eaters proper ♀ S. America. Tamanoua. Myrmecophaga & Cyclothurus. The body is hairy, & the tail long sometimes prehensile. Skull much elongated. Small pre-maxillae barely connected with it. Jugal arch incomplete.



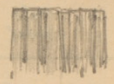
The pterygoids are very long, stretch back past the tympanic bullae & roof under over the nasal chamber, causing the posterior nares to open behind the pterygoids as in the crocodile & some cetacea.
The mandible is slender the ascending process, & the angle of the jaw obsolete. The hyoid is placed far back. The very long tongue attaches to it, & is retracted by long muscles attaching to the sternum.
The dorso-lumbar vertebrae have accessary articular processes.
The outer digit of the manus has no claw, the manus rests on its outer side where a callous pad is developed. The claws fold inward when walking.

b. Squamata Africa & S. Asia. one genus Manis.
Covered with overlapping horny scales with hairs between.
Skull, elongated. Zygoma usually incomplete. The pterygoids are much elongated but do not unite. The mandible has no ascending ramus, & a flat condyle. Mouth edentulous.
There are no clavicles. The sternum extends back & is keyed as in lizards.

c. Tubulidentata. S. Africa. Orycteropus only genus.
Body hairy. The ears are very long, in contrast to the short ears of the preceding genera. Foot-rests evenly on the ground in both limbs

1 2345

12345



Vasodentine

Zygoma
Ascendig T coronoid
Clavicles.

the hind limbs are strong for digging. Collarbone in fore foot. Hind foot pentadactylate. The skull has a complete Zygoma & well developed pre-maxillae. The dermatic ossifications constitute a large mass resembling that found in the Lamnoidia. Mandible with ascending ramus. Clavicles complete. Teeth traversed by parallel vertical canals.

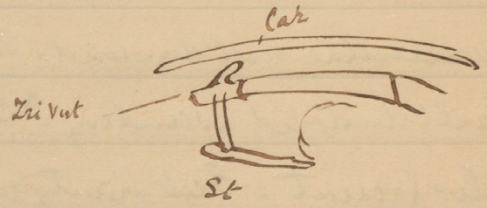
d. Loricata. A carapace composed of epidermic scales & dermal scutes as in the crocodile. Under side of body hairy. There is generally a cephalic shield, a nuchal shield, a scapular shield. Then a number of free bands, & lastly a pelvic shield which becomes attached to the ilia & ischia. The tail is also often covered with scales. In Chlamydophorus only the pelvic shield is developed.

The premaxillae well developed. Zygoma complete. Mandible with well developed ascending & coronoid processes. Clavicles present. Feet plantigrade or nearly. always 5 toes in the hind foot.

The loricata are divisible into Dasypodidae & Glyptodontidae.

The Dasypodidae or armadillos. There is always a movable series of zones of scutes in the armour. The nasal bones

? formation



project beyond the premaxillae. There is at best a very rudimentary process from the Zygoma. The teeth of the upper & lower jaw alternate. The odontoid (Vertebra) is ankylosed with some of its successors. The subsequent Cervical Vertebrae have peculiar articulating surfaces, & so have the hinder dorsal & lumbar. Some of the Caudals are always ankylosed with the Sacrum, & their transverse processes unite with the ischia.

Glyptodontidae. Glyptodon. The carapace is in one piece. The nasal bones short & broad. The anterior part of the Zygoma forms a great downward process. The Symphysis long & the posterior alveoli are on the inner face of the rami. The teeth are trilobed & placed obliquely. The last Cervical & 5 two anterior dorsal Vertebrae are ankylosed to form a "triverterbral" bone, which lies on the third dorsal. The head of the first rib is fixed in it, is very strong & articulates below with the Sternum probably constituted a respiratory Apparatus. The dorso-lumbar vertebrae are immovably united.

(The triverterbral bone thus does not answer to the synostoses in the anterior Cervical region of the armadillo. Two other ribs were no doubt connected with the triverterbral bone but must have been quite small & subsidiary. The neural Spines have coalesced to form a great muscular attachment.

E

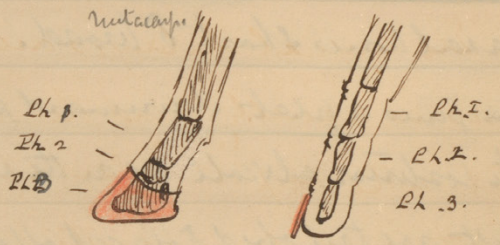


Diagram of horses foot & human middle finger.

Lect 74

Non Deciduate Mammalia. Ungulata

This is a well defined group. The placenta is diffuse, or cotyledonary. All have milk teeth succeeded by permanent teeth. The teeth consist of Dentine, Enamel, & Cement. The grinders are broad & have ridged or folded enamel. Clavicles never present. Limbs have 4 or fewer complete digits. The ungual phalanges are inclosed in horny hoofs. When as is usually found the weight of the animal is supported on the hoof it is said to be unguligrade. Some rest on the under surfaces of the phalanges & are digitigrade. Metacarpal & Metatarsal bones elongated. The mammae are few & inguinal, or numerous, & abdominal. Intestine has a large caecum. Cerebral hemispheres convoluted. Surface of cerebellum uncovered.

The Ungulata are divisible to perissodactyla & Artiodactyla The division is artificial & nearly obliterated by fossil forms.

Ungulata

Perissodactyla

1. Equidae. Equus, Hipparion. Anchitherium?
2. Rhinoceratidae Rhinoceras.
3. Tapiridae Tapirus. Coryphodon.
4. Palaeotheridae Anchitherium, Palaeotherium
5. Macraucheniidae Macrauchenia.

Artiodactyla

Non Ruminantia.

1. Suidae Sus. dicotyles.
2. Hippopotamidae Hippopotamus.
3. Anoplotheridae Anoplotherium &c

4. Ruminantia

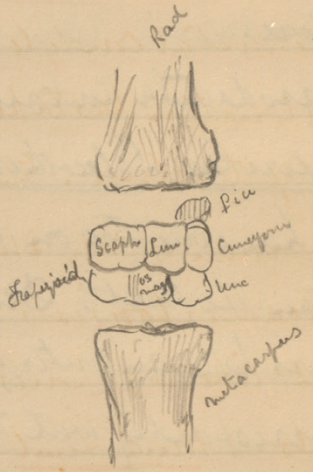
a. Tragulidae Tragulus. Hyomoschus
b. Cotylophora. Bos. ovis. cervus. antelope.
c. Camelidae Camelus Auchenia.

In Perissodactyla. Dorsolumbar vertebrae not fewer than twenty-two. Third digit of each foot symmetrical in itself. Toes of the hind foot odd in number. Femur has a third trochanter. The two facets on the front face of the astragalus very unequal, the ~~the~~ less articulating with the cuboid. Posterior premolars generally very like the molars. When the head has horny appendages they are median, & have no bony core.

The Perissodactyla contain the families. Equidae. Rhinocerotidae. Tapiridae, Palaeotheridae & Macraucheniidae.

I Equidae have one toe on each foot much stronger, & longer than the rest. Dental formula $\frac{3.3.}{3.3.}$ $\frac{1'1}{1'1}$ $\frac{4'4}{4'4}$ $\frac{3.3}{3.3}$
The upper molars have an outer bicrescentic wall, & two inner ridges corresponding with the crescents & curving more or less backward & inward.

In the Horse e.g. The cervical vertebrae are strongly opisthocoelous, & the dorsal & lumbar vertebrae even retain this character more or less. The last lumbar articulates on the sacrum, & the penultimate on the ultimate lumbar by a movable joint. The nasals are long & only attached to the pre-maxillary bones for a short distance, the bones



Left Carpus Horse

long separated & a gap for the greater part of their length. The orbit is completed by bone. The palatine plates of the palatine bones are very short. Fore limb. There is no distinct acromian process. The radius is much the larger bone. The ulna is really present in its whole length but very slender in the middle & ankylosed with the radius. Above it sends out to form the great olecranonic process, & enlarges below to form part of the distal condyle. As in most cursorial animals complete pronation has taken place, the Radius being twisted in front of the Ulna. The Carpus has its ordinary elements, but the Trapezium is very small, or completely absent. The metacarpus consists of three bones. A large median, & two splint like side bones representing the first & fifth metacarpels. Hind Limb. The Femur has a large third trochanter. The Fibula is represented only by a stick like bone sticking to the proximal head of the Tibia, & a small piece at the distal end forming part of the condyle. These two parts are quite separate. The metatarses are just in the same state as the metacarpels. Dentition. There are 6 incisors. Behind them come the very small canines

Then a long gap or diastema, & then 6 grinding teeth above & below. A little in front of the anterior premolar is a small tooth, which very soon drops out. It is probably the first premolar, & is not replaced by a permanent tooth. The p. m. in the young are therefore 4 in number. In the adult 3 premolars, & 3 molars. Each incisor has a deep pit, or "mark" in its surface which in old age is worn away.

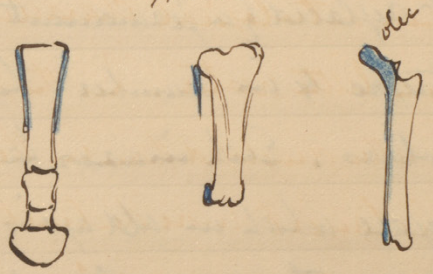
The grinding surfaces of the upper molars consists of 4 crescents with two inner fillers, & that of the lower molars of two crescents with two inner fillers. The upper crescents concave outwards, the lower concave inwards. Constituting a very efficient grinding apparatus. As in mature age the formation of new tooth is stopped, & roots formed there is a natural limit placed to the life of the animal.

The Equidae highly specialized as they are can be traced back to the Eocene, & their history forms as complete an instance of progressive evolution & modification as can be expected from palaeontology. True horses are found in the later Miocene deposits of Europe & America, & in the later Miocene of the Sewalek Hills in India. Together with horses in the

Comparative diagrams Equus. Hipparion
& Anchitherium.

Horse

Pliocene &
Recent.

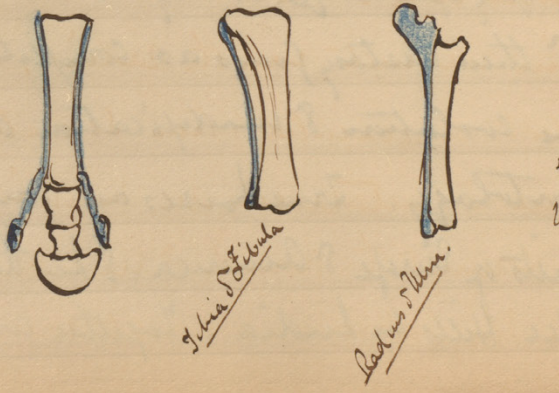


Upper Miocene

Hipparion

Lower Miocene

Anchitherium.



Eocene.

latter locality remains of Hipparion are found. Hipparion remains are also known from deposits of similar age in Greece & Germany. These animals very much resemble the horse in most of their osteological characters. The depression in the cheek bone is a little greater. In the fore limb however the Ulna is much better developed than in the Horse. The fibula in the hind limb is larger & more distinct. The natural metacarpels & metatarsels are much larger & stronger, & bear three phalanges & little hoofs. The teeth are very similar to the ordinary equine type. No true horses are known to be contemporaneous with the oldest of these animals.

The Anchitherium Here modification is much greater. The orbits are open behind. The teeth much simplified & like those of palaeotherium. Most of the bones however are still fairly horse-like. The Ulna is now however stronger & may remain distinct from the radius. The fibula is complete & not represented by two separated stales. The metacarpels & metatarsels are much larger & stronger. The side toes come to the ground, & are nearly as long as the middle toe. The foot was no doubt mostly digitograde. These animals come from older miocene & newer Eocene & lead back towards palaeotherium.

Left fore foot.

(as in the horse.)

Lect 75 May 13

2. Rhinocerotidae. Second, third & fourth toes are nearly equally developed in both fore & hind feet.
Dental formula I. $\frac{1.1}{1.1}$ (or $\frac{0.0}{0.0}$) C $\frac{0.0}{0.0}$ PM $\frac{4.4}{4.4}$ M $\frac{3.3}{3.3}$.
Upper incisors differ from lower in form, & are sometimes ~~[illegible]~~ absent. They are never folded as in the horse.
Skin thick. Upper lip produced. Horns sometimes developed, may be one or two in middle line. Distal phalanges hoofed but weight of body supported also on a callous pad developed below the metacarpels, or metatarsals, which are short.
No Frontal or Zygomatic processes, the orbit & Temporal fossa forming one cavity. Nasals immense & seperated from pre-maxillae by maxillae. Mandibular condyle transverse & convex. Coronoid & ramus extends slightly above the condyle. Inner & outer tables of bony bones of skull seperated by great air chambers. Scapula has no acromian process. Radius & Ulna ankylosed. Ilia as in horse. Femur has third trochanter. Pully of the astragalus not deeply grooved, nor oblique. Facet for Cuboid very small. The first of the four milk molars as in the horse is smaller than the other, & is not replaced.

outer sides

Rhinoceros. Horse. Rhinoceros. Horse.

Upper molar Lower molar

The structure of the molars is quite similar to that in the horse but a simplification on the type. The roots are soon developed. The laminae of the upper molars are nearly transverse. The lower molars have only a few crescentic laminae concave outwards, no pillars are developed, & the cement does not fill up the spaces between the wall & the laminae.

The Genus Rhinoceros now found in Africa & Asia.

The African Genus have smooth skin. Two horns, & no incisors in the adult.

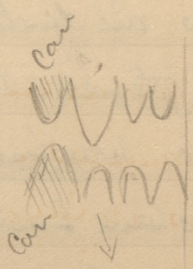
The Asiatic have one horn (except the Sumatran) well developed incisors, & the skin folded into shields.

Known fossil from the Miocene. Rhinoceros Tichorhinus of the glacial epoch was woolly & had the nasal septum ossified.

3. Tapiridae There are four toes on the front foot though the ulna does not reach the ground, & three toes on the hind foot. Dental formula $I \frac{3.3}{3.3}$ $C \frac{1.1}{1.1}$ $P m \frac{4.4}{3.3}$ $M \frac{3.3}{3.3}$

The snout prolonged into a short proboscis.

The skull is partly Rhinocerotic partly equine. As in the horse there is a sagittal crest. The post-tympanic processes are of moderate size, & do not unite with the post glenoidal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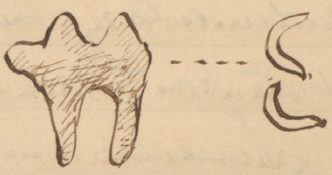
processes beneath the meatus. As in the Rhinoceros, the tympanic is quite rudimentary. The post-glenoidal process large. Orbit not seperate from temporal fossa. Nasals widely seperated from the premaxillae which are small & early anchylosed.

The Scapula has no acromian process, & the coracoid only represented by a tubercle. The femur has a strong trochanter.

The outer upper incisors are larger than the canines, the outer lower incisors smaller than the canine & early drop out. The diastema very large. The 6 posterior molars in the upper jaw, & the five posterior molars in the lower jaw present nearly the same structure. A low outer wall with 2 slight concavities in the maxillary, & convexities in the mandibular teeth, on the outer side. From this two ridge-like laminae run inward & a little backward across the crown. Here then we have the perissodactyle molar in its simplest form. If the valleys were deepened, curvatures of the laminae & walls increased, turn the laminae more decidedly backward, & cause them to develop accessory ridges & fillers. The upper molar of the Tapir will pass through the structure of the Rhinoceros to that of the horse.



Ant. L. P. m. of Tapir.

L. m. of Rhinoceros.

In the anterior lower premolars, the anterior basal process which exists in all is excessively developed, & the crown becomes pericentric like the rhinoceros's lower grinder. This seems to show the way in which the change of pattern in the ungulates has been effected

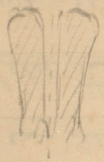
Tapiridae now confined to E. Asia, & S. America.
Known in European Miocene, & closely allied genera in Eocene.

4. Palaeotheridae Entirely extinct. They are known in the Eocene & older Miocene. Closely allied with horses & Tapirs. Patterns of molars like Rhinoceros
3 digits in manus as well as pes. 3-1-4-3

5. Macraucheniidae. Found in S. American Quaternary
Tridactylate. ~~There is no diastema, but~~ the dentition is ~~otherwise~~ much like the horse. The skull is also Horse like but the nasals are very short. The Vertebrae of the neck are like those of the Camelidae, the cervical arteries passing & boles in the sides of the neural arches.

3

3



Artiodactyla. The dorso-lumbar vertebrae always fewer than 22, & rarely more than 19. The third digit is asymmetrical with itself, & usually symmetrical with the fourth digit. Functional toes of the hind foot 2 or 4 in number. The femur has no third trochanter. The facets for the navicular & cuboid, on the distal face of the astragalus are nearly equal. The posterior premolar is usually a good deal smaller than the molars. Stomach more or less complex. Coecum smaller than in perissodactylates. When horns are present, they are double, supported on the frontal bone, & have osseous cores. The artiodactyla are conveniently divided in Ruminantia & Non Ruminantia.

Non Ruminantia, Have usually more than one pair incisors in the upper jaw. They are devoid of horns & the stomach has rarely more than two divisions.

The non ruminantia are divided into 3 families.

Suidae, Hippotamidae, & Anoplotheridae.

? if enough.
? fut.

I Suidae. Skin of moderate thickness, hairy; the limbs slender, & the third & fourth toes considerably longer than the first & fifth. Teats abdominal. Scrotum.

The molars are multituberculate or transversely ridged. The teeth in Sus are 44 in number & show the characteristic mammalian arrangement very well. $i\frac{3.3}{3.3}$ $c\frac{1.1}{1.1}$ $p.m.\frac{4.4}{4.4}$ $m\frac{3.3}{3.3}$

(The order of succession of the teeth is of great use in making out the fragments of a jaw & is very constant. The first true molar is the first permanent tooth which comes in place, & it does so before the premolars are shed. Thus the first molar can often be distinguished. It is much worn compared to the premolars in front of it which have just lately replaced the deciduous premolars. The second true molar may be a little worn & the third not in place, still less so.)

The tuberculation of the hyp teeth somewhat hides the resemblance to the teeth of the tapirs &c. The tubercles are however really placed on transverse ridges. The bony cannons are bent upward & outward in both genera.

In Dicotyles (peccary) the transverse ridges on the molars are as distinct as in the Tapir.

∧ Scant Lair. Lyginal teats.
orbits nearly complete posteriorly. Nasals δ, p. mx
form a long union. Mandible with backwardly
produced angle

2. Hippopotamidae. Short-stout tetradactyle limbs all four toes resting on the ground.

Dental formula of the adult $i\frac{2.2}{2.2}$ $c\frac{1.1}{1.1}$ $pm\frac{3.3}{3.3}$ $m\frac{3.3}{3.3}$.

The molars show a double trefoil pattern when ground down. Hind or last inferior molar trilobed. Incisors straight & tusk-like. Canine attributes wears the anterior face of the upper, & posterior face of the lower; hoe canine away. Now only living in Africa, but abounded in Europe in later tertiary times. Skeleton very pig like.

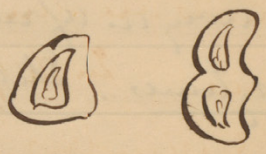
3. Anoplotheriidae Eocene & Miocene.

There is no diastema, this is unusual, but happens in man & some insectivores. The upper & lower molars have the same general structure as in Rhinoceros. but the lamina of the upper are bent back more nearly parallel with the outer wall, & a stray conical pillar is developed on the inner side of the anterior lamina.

Skeleton partly like pigs, partly like Ruminants.

3 – 1 – 4 – 3

$\frac{0}{3} \quad \frac{2}{1} \quad \frac{3}{3} \quad \frac{3}{3}$ dental formulae



outer side.

p. m. m.

Upper jaws.

outer side

Molars. molar of horse

Showing the probable change of pattern found in horse.

Lect 76.

The Ruminantia

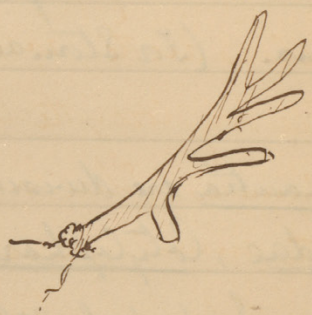
Are the most completely differentiated animals among the artiodactyles. They constitute a homogeneous group. As a rule they have no incisors in the upper jaw, but a callous pad against which the incisors of the lower jaw act. The lower jaw always has incisors, & the canines are inclined forwards & resemble incisors so much, that the ruminants are often said to have eight cutting teeth in the lower jaw. In the upper jaw there are 6 grinders on each side, 3 premolars, & 3 molars. The patterns of the premolars, resemble that of one half of a molar. The molars are easily referable to the horse type. The roots of the teeth are soon formed. The molars of the lower jaw are doubly convex outwards. It seems as though the fold in the horses tooth where the anterior & posterior lamina meet had separated. The premolars are simpler but not as in the upper jaw like half molars. The most anterior premolar is very simple. In all ruminants the third molar differs from the rest { having a long posterior heel. The hindermost premolar in the milk dentition has the same peculiarity.

Fore Limb the acromian process is fully well developed. The Radius & Ulna are united. The third & fourth metacarpals are fused to form a characteristic Cannon bone. The phalanges of the 2d & fifth digits are present & form small dew claws, the second & ~~third~~ fourth metacarpals are absent in all but Hyaemoschus. The hind limb is quite similar. There is no third trochanter. There is a peculiar bone, the Malleolar which represents the distal end of the Fibula & articulates with the Calcaneum & Astragalus. The great majority possess horns. (For Stomach & act of rumination See Book P 379.

The Ruminantia are divisible into three groups.

Tragulidae, Colyclaphara, & Camelidae.

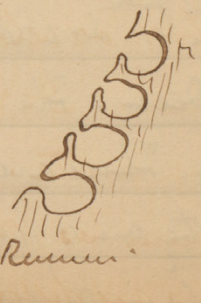
Tragulidae. Improperly called the Musk deers. They inhabit the hotter parts of Asia & Africa. Dentition like other ruminants. The metacarpels & metatarsals of the second & fifth toes are complete, & in ~~both~~ both limbs the metatarsals & metacarpels of the third & fourth digits anchylose very late in life if at all. The Psalterium is only represented by a narrow tubular passage. Placenta diffuse. In all the ruminants the blood corpuscles are



Very small, here they are not more than $\frac{1}{10,000}$ gramme.

Cotylophora. The outer metacarpals & metatarsals are here incomplete proximally, & those of the third & fourth digits very early ankylose in the cannon bone. The chorionic villi are gathered together in cotyledons which may be convex or concave. All the cotylophora except Moschus are provided with horns. They may be of two kinds. 1 Unsheathed in a horny epidermic case, 2 not so sheathed. In the first-class are the horns of the antelopes, Sheep, Goats, Oxen &c. The bony core of the horn is hollow & has cellular processes of the frontal sinuses. These horns are nearly always present throughout life, the animals possessing them are sometimes called Cavicorna. There are two varieties of the second kind of horn. In Giraffes the horn cores are attached over the Coronal sutures, & never become ankylosed to the skull. The integument of the horn is soft & hairy through life.

In the Deer. The frontal bones grow out into solid processes. These are at first covered by soft integument. When they are of full size a projection or burr grows out at the base, the integument is cut off & dies away.


Side of Rumen

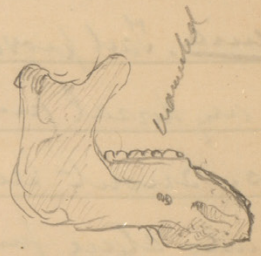
The horns are shed again after the rutting season. Absorption of bone & necrosis takes place in the pedicel of the horn below the burr. Fracture soon takes place at this point, & the beam & its branches, including the basal burr fall off. Cotyliophora in all parts of world but Australasian province.

Camelidæ Camels & Llamas. Are devoid of horns. & unlike the other ruminants walk on the palmar & plantar surfaces of the phalanges of the third & fourth toes which alone are developed. The arches of the cervical vertebræ instead of the transverse processes are perforated & the carotid artery. The navicular & cuboid bones are not ankylosed. The cannon bones have strong median grooves. The premaxillæ have a single strong incisor in each side. Large curved pointed canines are developed in each jaw. Not more than 5 grinding teeth in a continuous series above or below. There are detached premolars near the canines. Perforations in the walls of the rumen serve to store up water. The groove from the gullet to the abomasum has only a single groove. The blood corpuscles are different from all other mammalia, being elliptical.

All three groups of the Ruminants are probably represented from the Miocene.

Lect 77.

Sirenia. Tail provided with a flattened horizontal fin, with no dorsal fin. Integument thick & has very few hairs. Snout broad & nostrils on upper side head. Fore limbs alone functional, & provided with rudiments of nails. No ear has no pinna. The mammae differ in position from those of either ungulates, or Cetacea, & being thoracic. Neck very short & has only 6 vertebrae in manatus. (& Dugong & Halicore) In the posterior thoracic Vertebrae the zygapophyses do not articulate. There is no sacrum, the rudimentary ilia attach to the last lumbar vertebra. Caudals with large sub-vertebral bones. In the Skull the posterior face of the Supra occipital is inclined upward & forward. The parietals meet in a Sagittal Suture. The frontals send forwards very large Supraorbital processes. The nasals are absent & so the nostrils come open widely on the top of the head. The zygomatic processes of the Squamosal are very short, unlike the Cetacea.



Manatee

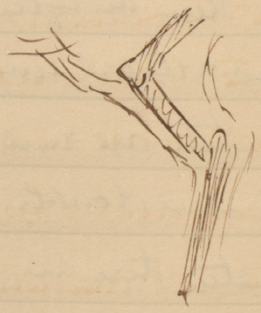
Halicore Cylindrical teeth, no enamel, no roots.
Incisor tusks in male

Manatus. Molar molars. Enamelled rolled grinders.

There is also a large jugal bone. The premaxillaries are very large & produced. In the Manatus they project forward, in the Halicore they are bent down. The lower jaw is much more like that of an ungulate than a cetacean. There is a large ascending coronoid process. The Scapula has a great acromian process. The fore limb has the usual construction. The digits are bound together & integument. There are some modifications of mouth armature. In the Rhytina the premaxillary surface of the palate, & opposed part of the mandible are covered with mammillated, rugose, horny plates developed from the epithelium. There form the only masticatory apparatus In Halicore there are cylindrical teeth devoid of enamel & have no vertical succession, nor true fangs roots. In Manatus there are milk molars, & the grinders are enamelled & have double transverse ridges.

In the Manatee there are no incisors, In Halicore there are incisors which remain abortive in the female but in the male project as a pair of small tusks.

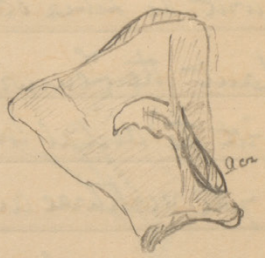
The apical part of the Septum Ventriculorum is deeply cleft. The diaphragm extends very far back dorsally, & the lungs which are very large come to lie over the abdomen in part.

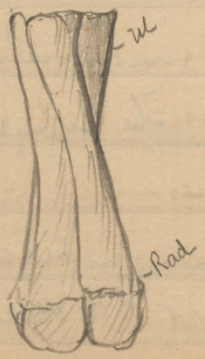


Horse

Here are only 2 living genera. Halicore & Manatus. The former from the Indian ocean & Australia, the latter from the African & American shores of the S. Atlantic. Rhytina is only extinct since about 100 years. It was an inhabitant of Behring's Strait.

Proboscidia massive animals walking on the extremities of the five toes, & on a great cushion which unites them & forms a Sole behind them. They differ from all other Quadrupeds in the structures of the hind limb when walking. In the horse &c. found the femur bent forward at an acute angle with the body & its joint with the Tibia & Fibula concealed in the flank. In the Elephant the Femur is at right angles to the body axis, & its joint with the distal bones forms the conspicuous knee. The centra of the vertebrae are far more flattened than in any other terrestrial mammal, this is particularly the case in the neck where though the full mammalian number (7) are present the neck is very short. The epiphyses as in the whales long remain distinct from the bones.
The Skull is prodigious in size. The air cavities of the bones are very greatly developed, & the various constituents of the skull very early fuse together completely


Scap


Ul
Rad

The supra-occipital slopes forwards & upwards & extends far over the skull. As in the Sirenia the pre-maxillaries are immense. The nasals are very short, & the nasal passages nearly vertical. The zygomatic bone forms only the middle part of the zygomatic arcade, as in rodents. The air chambers not only honeycomb the roofing bones of the skull, but are largely developed in the floor, even in the Basi-occipital. All these chambers (like the frontal air cavities in ourselves) communicate with the nose. The skull is thus very light for its size, & strikingly contrasts with the solid mandible. The mandible has a declivous symphysis, & a high ascending portion.

The Scapula has a great spine in the middle of its crest, & an acromian process. The fore limb is more massive than the hind. It is in a position of complete pronation, the Radius being turned at its distal end quite to the inner side of the ulna, & fixed there, though not ankylosed. The metacarpals & phalanges are short & broad. The distal phalanges hoof-like. The Ilia are much expanded outwardly. The Femur has a rough general resemblance to the human & has given rise to stories of giants. Its head however has no pit for the attachment of a round ligament.

Lokodon

Euelphas.

There are only two kinds of teeth Incisors & molars. The former are composed of dentine & Cement, & in recent elephants are only developed in the upper jaw. They constitute the tusks.

The molars are composed of dentine, enamel, & Cement, & are ridged transversely. There are 6 molars, but only two are ever present at once, & they have no vertical Successors. The first developed is the smallest, the others are successively larger. The first tooth is pushed out by the second, the second by the third & so on. In the Asiatic Elephants the intervals between the ridges of the molars are deep, narrow, & filled with cement. In the African shallow & open, the cement only forming a crust over the surface.

The Mastodon had small tusks in the lower jaw as well as the large maxillary tusks. The grinders most resembled the African elephant & sometimes had Vertical Successors.

The Miocene Deinotherium had a pair of large downwardly directed tusks on the mandible.

The Proboscidea at present found only in Asia & Africa the two forms are very distinct genera & should not therefore be spoken of as Elephas africanus, & E. Indicus, but by Falkoners names Loxodon & Euelephas.

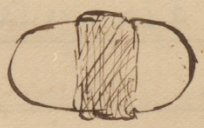
Carnivora

a. Fissipedia

1. Arctoidea Bears, Weasels. Procyonidae.
2. Cynoidea. Canidae.
3. Ailuroidea. Felidae. Hyaenidea. Civets.

b. Pinnipedia.

1. Otariidae. Eared seals.
2. Trichechidae. Walruses.
3. Phocidae. ordinary seals.

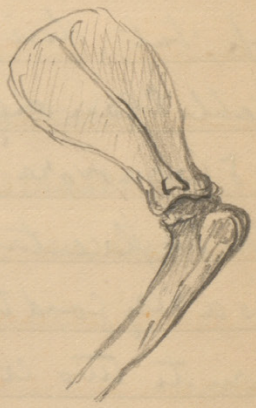


Elephas primigenius of the drift is close to the Asiatic elephant. Elephants are known as far back as the Miocene. In Miocene & Pliocene times they are accompanied by Mastodon.

Lect 78.

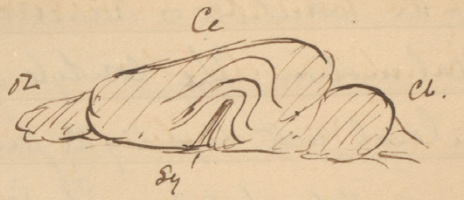
The Carnivora have a zonary placenta, the ends of the chorion being devoid of villi. The Proboscidea & Hyracoidea have the same character but are very different otherwise. The Cetacea are very close to the Carnivora, in fact almost a branch of this group, but their placentation is diffuse. This is remarkable & can only be explained by supposing that both Cetacea & Carnivora had branched from some common stock before the placental characters were developed.

The dog is a very good typical Carnivore, & lies about mid way from the two extreme modifications; & does not present any very marked degree of peculiarity when compared to the typical mammal. A notable modification of the skull is the great size of the tympanic bulla. The bulla is partly divided by a cruciform partition. The bears lie at one extreme having no partition, the Cats at the other, & have the bulla almost completely divided.



The Articulation of the mandible is transverse & hinge like only allowing vertical motion. The condyle of the mandible is low down & on a level with the fang bearing teeth. The coronoid process well developed. The Scapula has a well developed Spinous ridge, & large Supra-Spinous fossa. The olecranar fossa at the distal end of the humerus is perforated. The Radius & ulna are complete. In the Carpus the ~~radius~~ Scaphoid & lunar are anchylosed. The toes are never fewer than four in the Carnivora. In the dog there are five toes in the fore foot the pollex being shortest. The last ungual phalanges have Sockets & Ridges for the insertion of claws, & during life are drawn backward from above by ligaments in such way as to prevent the claws under ordinary circumstances coming on the ground. In the Cats &c this arrangement is still more perfect, & they fold back into sheaths. In the hind foot the Hallux is Rudimentary, (though often present in carnivora e.g. bear)

As in other Carnivores the Stomach is Simple; the coecum never very large; The liver many lobed. The brain. The Cerebellum is never completely covered by the cerebrum. The Sylvian fissure is well developed, & usually Surrounded by three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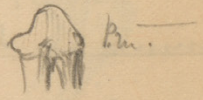


convolutions. Among the pinnipede Carnivora the brain becomes much broader & extremely convoluted.

In the dog the dentition is very complete. Only two teeth are wanting to give the full mammalian number (44). The adult formula is. i $\frac{3.3}{3.3}$ c $\frac{1.1}{1.1}$ p.m. $\frac{4.4}{4.4}$ m $\frac{2.2}{3.3}$ = 42

The upper incisors have trilobed crowns, but in the outer pair the middle cusp is very large & the outer cusp almost obsolete. The Canines are strong & pointed. The three anterior premolars are triangular, the hinder edges divided into two lobes by a notch. The fourth, is very large & distinctly three-fanged. It is the upper Carnassial, or Sectorial tooth. The molars are broad crushing teeth, more or less obscurely 4 lobed.

In the Lower jaw. The crowns of the incisors are all three-lobed. The Canines are like those of the upper jaw. The four premolars resemble the three anterior premolars of the upper jaw. The first molar is here large & constitutes the Lower Carnassial tooth. It bites within the Carnassial of the upper jaw. The second molar is broad & quadricuspidate, the third very small & simple. Beginning with the canines each tooth on the upper jaw bites behind its representative on the lower jaw, & thus it is that

Fissipedia. Hind limbs as usual. Tail free to the root
Pinna of the ear fully developed. Hallux shorter than the other
digits. Phalanges of both feet clawed.

the posterior premolar of the upper jaw comes to bite opposite & outside the anterior molar of the lower, & constitute the carnassial teeth. The Bears present an extreme with regard to teeth. The dental formula is the same as in the dog, but the crowns are all more or less obtuse, & the sectorial teeth loose their marked characters. The Cats are in the other extreme, & here the teeth are most differentiated & reduced in number. Dental formula: $\frac{3.3}{3.3}$ C $\frac{1.1}{1.1}$ p.m. $\frac{3.3}{2.2}$ m $\frac{1.1}{1.1}$ = 30 The canines are long & sharp. The premolars are sharp, & the hindmost (carnassial) has hardly any internal process. The single upper molar is small & flat. In the lower jaw the first premolar is the last tooth. It is large & cutting but the last has nearly disappeared.

Among the pinnipedia there are some animals very aquatic in habit. (Otter e.g.) & a curious change in the skull is apparent. The brain case is rounded, & the orbits close together. From such pinnipedes we may pass to the Seals among pinnipedia. The Seals have the hind limbs stretched backward & united with the tail. Space between the orbits very narrow

Pinnipedia. Tail united to the hind limbs by a fold of integument, & are [illegible] in most, stretched out in a line with the axis of the trunk. Toes united by webs. Nails sometimes abortive. Inner & outer digits of the fes very large. Incisor teeth (see their cutting form.

E

head rounded. Interorbital region remarkably flattened between
The supra-occipital advancing between the posterior parts of the
parietals. There is no supraorbital process.

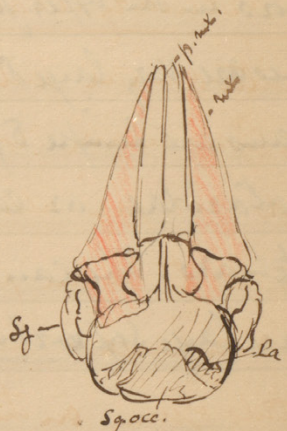
The Walruses more resemble the bears among pinnipedes. The
dentition however is very curious there is only one pair of
incisors in the upper jaw & none in the lower. The upper
canines are very large & tusk-like. The premolars & molars in
both jaws are simple & flat-topped.

The otariidae or eared seals are also in many ways
like the bears. They can walk on all fours & have long necks.
There are large supraorbital processes

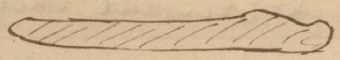
If in such animals as the otariidae, or the true seals the
premaxillary region were prolonged to a great snout. The
jugal processes of the squamosal enlarged. The coronoid
processes of the lower jaw small. We would have
at once the structure of skull of such an animal as the
Zeuglodon of the tertiary, which is really a Cetacean though
in many ways transitional towards the carnivores.
The cervical vertebrae of Zeuglodon are distinct. The Nasal bones

Seal.

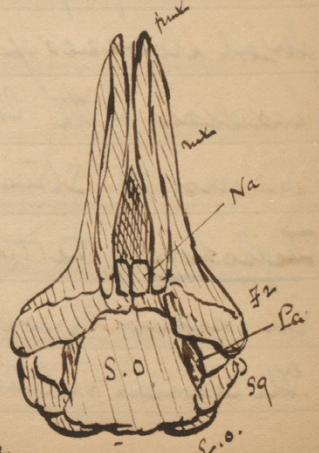
Zeuglodon



Whale



Mandible of Zeuglodon.



Fœtal whale

trough short and longer than in any other Cetacean. The zygomatic processes of the Squamosals are large & thick. The supra-orbital processes of the frontals wide & expanded. The Radius & Ulna articulated movably on the humerus.

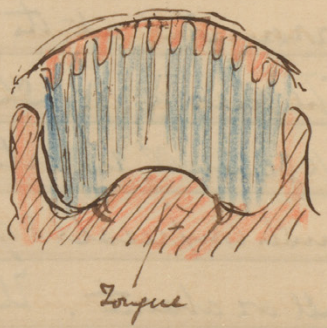
The ordinary Cetacea are a step further in the same direction. The inter-orbital part of the skull is extremely flattened (laterally). The brain case nearly globular. The Squama occipitalis extends very far upward & forward & pushes the parietals quite apart the one from the other. The supra-orbital processes are very large. The Nasals hardly distinguishable, & the nostrils opening in the upper surface of the head. The maxillae produced to a long snout & bend up over the front part of the skull. The premaxillae are also very long but almost completely surrounded at the sides by the maxillae. The mandible has a very short coronary process. The teeth have generally no vertical successors. The cervical vertebrae much compressed & often ankylosed. The odontoid very small or absent. The posterior dorso-lumbar vertebrae have rudimentary zygapophyses which fail

Cetacea

1. Zeuglodontia Zeuglodon &c. Eocene.

2. Delphinoidea

3. Balænoidea



& articulate. The fore limbs only are developed. The pelvic girdle being represented only by rudiments of ischia, disposed horizontally & having attachment to the corpora cavernosa. In the fore limb the spine of the scapula is very small. The humerus is short & stout, & the radius & ulna not movable upon it or each other, being bound together with ligaments & integument.

The Cetacea are divisible into two groups besides the group of the Lissodontia which includes the Zeuglodon.
The Balaenoidea. Have no teeth, in the adult state, but great whalebone plates. Nasal apertures double.
The Delphinoidea have teeth & no whalebone plates. The skull shows a curious tendency to asymmetry.
Single nasal opening.
The Baleen plates. The young balaenoid has rudimentary teeth, though they are never functional. The mucous membrane of the upper jaw becomes raised in transverse folds, the epithelium on which develops great plates of horny substance. These become frayed at their lower edges, & constitute with the tongue (against which they depend) & the great cheeks a very efficient strainer.

Discoidea

Insectivora - Rodentia

Chiroptera

Lemuridae

Primates

Simiadae

Arctopithecini

Platyrrhini

Catarrhini.

Anthropidae

Hominidae.

The Carnivora are first known in the Eocene. In the Miocene the groups all are represented & there are true Cetaceans.

Lect 79. May 17. 1872

Discoidea. The diendmons placenta is disc-like. The division is more one for convenience than anything else; still the various members of the group are closely united.

Insectivora are nearest the common type, or stem, of the series of animals. In looking for a typical group several things must be remembered. The limb should be pentadactylate. The Brain least modified. The dentition nearest the typical mammalian formula. The insectivora comply with all these requirements with regard to the Discoidea, & in fact seem nearer them any other animals to the original stem of the Monodelphia, which leads up to the carnivorous on one side the ungulates on the other.
They are consequently rather a hard group to define.
They always have more than two incisors in the mandible.
The molar teeth are always coated with enamel, have

tuberculated clorons & form roots. The fore limb has no proper patagium. The digits provided with claws. The hallux is not opposable. The only character distinctive between insectivora & Rodents is the number of incisors, the two groups thus come very close.

In nearly all the clavicles are well developed (except Potamogale) Stomach simple. Testes do not protrude in scrotum. The Cerebellum is uncovered by the cerebrum, the brain almost free of Sulci & Gyri. None attain to a large size. The insectivora are very diverse in organization, the Hedgehog is about a central form. The Shrews tend towards the Rodentia. The Tupaiæ tend toward the Lemurs. They have the orbits ossified behind, & probably have much better developed brains than most other insectivores.

The moles & Galeopitheci are aberrant. The former specially modified for burrowing. The latter arboreal, & having a cloaky skin stretched from the fore to the hind limbs. This is used in gliding from tree to tree, & similar in some ways with the patagium of the bats. The fore limb however is quite different from the arboreals.

C

The cervical vertebrae are large. The ribs long & curved inclosing a spacious chest. orbit not divided from temporal fossa. premaxillae small. An elongated bone on the inner side of the ankle helps to support the patagium This is the Calcar.

The connecting links between the Insectivora & Cheiroptera have disappeared.

The Cheiroptera. The skull & brain present nothing very peculiar. There is a patagium uniting the fore limbs & body & stretching between the elongated fingers. Of these the third, fourth, fifth, & very often the second are devoid of claws. The pollex is always provided with one. The normal position of the last spinal column, is, very much bent, the hinder part almost forming a right angle with the fore part. The thigh, when at rest on the ground, is bent upwards & backwards, & the knee bends backwards. The orbit is not divided & bone from the temporal fossa. The phalanges of the manus are enormously elongated; the arrangement for flight thus more resembling that found amongst the Pterosauria, than that in birds. Also in relation to the power of flight is the development of a ridge on the manubrium of the sternum, & the large size of the Clavicles.

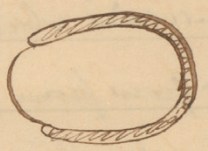
C

Premaxillary bones large. orbits never shut off from the temporal fossae. Clavicles very generally present.

D

The Rodentia are well characterised by their dentition. There are no ~~xxxxxxx~~ Canines. The mandible never contains more than two incisors which are placed one on each side of the symphysis & grow from persistent pulps through life. The enamel of the front of them teeth as very thick, & the hinder parts wear away & leave a cutting edge. All except the Hares & Rabbits have two similar incisors in the premaxillae. These animals have four upper incisors. The molars are from two to 6 in the upper jaw, 2 to 5 in the lower. The diastema is long. The articulation of the mandible is quite different from what we found among Carnivores. The glenoid & condyle are antero-posteriorly elongated. There is not very much modification on the Rodent type. In the Jerboa Lemmer, a leaping animal; the metatarsels are much elongated, only three are present, & they are ankylosed to form a bone similar to the cannon bone.

The Lemuridae. Have strong affinities with the Insectivora & with the Primates. They have been classed under the latter head, but quite lately it has been shown that the placentation



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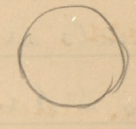


is exceptional. The placenta is not discoidal, but cup like & envelops the chorion completely except at the cephalic end. It thus on the whole seems better to separate the Lemurs from the Primates & constitute them a separate order. They are distinguished from the insectivora by having a hallux modified for prehension. The orbit is completed behind. The dentition similar to that of the insectivora. They differ from the primates by having the cerebellum uncovered by the cerebrum, & the latter smooth. The clitoris is perforated for the passage of the urinary fluid. This is quite exceptional. The aye aye is one of the most exceptional forms & resembles the rodents by having two incisors in the upper & lower jaw which grow from persistent pulps. The canines are rudimentary.

The Primates when taken without the Lemurs are a well defined group. The pes is modified for prehension, the hallux being freely movable on the ectocuneiform bone. This constitutes the only important modification of the foot. In the Gorilla &c the hallux has a very free movement

in adduction & abduction on a fully shafed joint. In man there is very little movement of this kind.

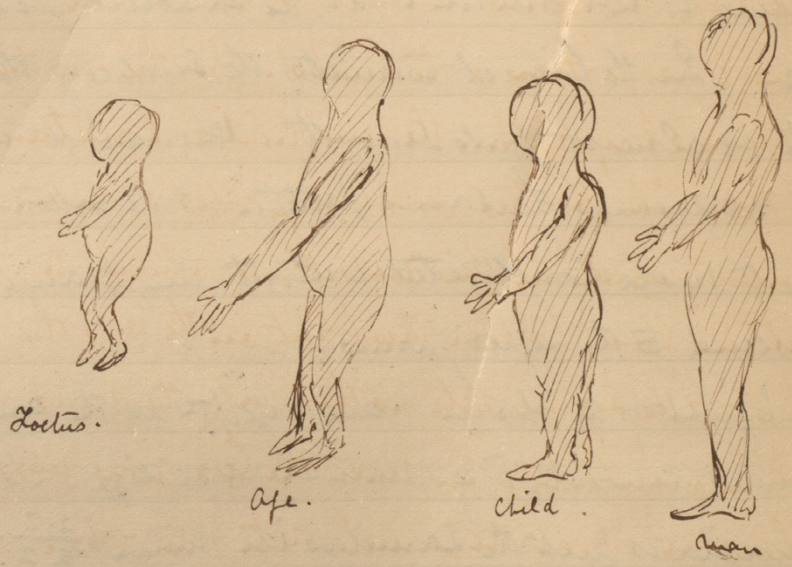
The incisors are two on each side above & below. Canines always present. There are usually two premolars, & two molars. In the Brain. The Cerebral hemispheres are large, extend back over the Cerebellum & generally completely cover it. The lateral Ventricles extend backward also & constitute posterior cornua, on the wall of each of which is a small projection known as the hippocampus minor. This structure is not known to be of the smallest possible importance. In the lowest-primates the surface of the brain is finite, or almost-finite smooth. Whenever it is convoluted it assumes the same pattern, & the pattern only becomes more & more complicated without any change of type as we ascend to the higher forms.

In The highest of the apes in many respects are the Simiadae the Skull rounded, smooth, & of relatively large size. The dental formula is just the same as in man $i\frac{2\cdot2}{2\cdot2}$ $c\frac{1\cdot1}{1\cdot1}$ $pm.\frac{2\cdot2}{2\cdot2}$ $m.\frac{3\cdot3}{3\cdot3}$. The tubercles of the teeth are also the same in number & arrangement. The Gorilla has very large

outer side

Upper molar

Lower molar



Lactus.

Ape.

Child.

Man

Canines, in the Chimpanzee they are smaller, & the diastema is quite small. The second upper molar has the same pattern as that of man, & so have the lower molars.

The most remarkable differences between the apes & man do not then lie in the brain; nor in the skull, for though the adult skulls are dissimilar, they are quite alike in the foetal state, & only differ by the relative development of parts. The dentition we have seen to be quite similar.
The greatest difference seems to be in the law of growth of the young & proportions of the limbs. In the apes the fore limbs are always longer than the hind limbs, sometimes immensely elongated. The foetus' however of apes & man are much more nearly alike in this respect at about the middle of intrauterine life. From this point in the apes the legs continue to grow at the same rate as the body, the arms much more quickly in proportion. In man the legs grow more quickly & the arms at about the general rate of the body. In apes also the skull soon ceases to grow at the same rate as the body while in man it continues to increase for a long time.

At birth the middle of the human body is about the umbilicus but in consequence of the rapid growth of the legs it is in the adult about the symphysis pubis. In Apes it remains near the middle of the body through life.

May 17. 1872

George M. Dawson

Order Carnivora Head of moderate Size & body Long. Cervical Vertebrae free & unankylosed. Dorso-lumbar Vertebrae almost always 20, & always articulated & their zygapophyses. Sternebrae numerous & compressed laterally. Supraorbital enlargements of the frontal when they exist, of ~~Small~~ moderate size. Orbit & temporal fossa communicate. Articulation of mandible transverse. Clavicles absent or very small. Scapula with distinct Spine & large Supra-Spinous fossa. In the carpus the scaphoid & lunare are united. Digits never less than 4 & are always unguiculate. Stomach Simple. Liver Subdivided. In the brain three convolutions round the Sylvian fissure. Superior turbinal bones large & complicated.

Range in Time.

		Range
Class Pisces.		
Order Dipnoi		Living
Marsipobranchii		Living
Elasmobranchii	U. Sil	Living
Teleostii	Chalk.	Living
Ganoidei	U. Sil.	Living
Dipnoi.		Living.
Class Amphibia.		
Order Laurobatrachia		Living
Labyrinthodontia	Carb & Trias.	
Gymnophionia		Living
Batrachia		Living

Class Reptilia.

Sub Class Pleurospondylia			**Rays**
Order	Chelonia	Trias of Lias	Living

Sub Class Eryptospondylia			
Order	Plesiosauria	——	Trias Chalk
	Lacertilia	——	Permian Living
	Ophidia	——	Tertiary

Sub Class Perospondylia			
Order	Ichthyosauria		Trias Chalk.

Sub Class Suchospondylia			
Order	Crocodilia	——	Trias Living
	Dicynodontia	——	Trias
	Ornithoscelida	——	Permian Chalk
	Pterosauria	——	Lias Chalk

Class Aves

order Saururae —— obsolete

Ratitae Living

Carinatae Grensand Living.

Class Mammalia

Sub Class Ornithodelphia

order Monotremata Living

Sub Class Didelphia

order Marsupialia Trias Living

Sub Class Monodelphia

Order Edentata —— Miocene Living

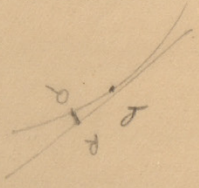
Ungulata —— Eocene Living
Zeuglodontia —— Tertiary
Sirenia —— Miocene Living
Cetacea —— Eocene Living

Hyracoidea —— Living
Probascidia —— Miocene Living
Carnivora —— Eocene Living

Rodentia —— Eocene Living
Insectivora —— Tertiary Living
Cheiroptera —— Living
Lemuroidea —— Living
Primates. —— Miocene Living.

Plesiosauria. Last vertebra in which
intercentral suture cuts costal articular
surface = Last cervical.
Atlas & axis often ankylosed.
In cervical vertebrae ribs fit on each side
of articular surfaces. distal ends produced
forwards as in Crocodiles. Post-cervical &
ant. dorsal ribs carry & arter. process
raised. Centrums vary as go backwards.
& descend somewhat lower on the centrum
Sacral ribs expanded. Caudals have ribs
ankylosed only late in life & well devel.
Chevron bones.

Ichthyosaurus. only dist. just Caudal & precaudal. Caudal with Chevron bones.
Most anterior Cervical region face tuberc. for rib on upper part Centrum.
Post dorsal region descend & approach & coalesce in Caudal region & single tubercle



$\eta \cdot \frac{\alpha}{\delta} = \sigma$

$\alpha \cdot \frac{\delta}{\Pi} = \eta$

N.B.

Tabulate structures & test.

2240

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11200

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78400