White River tertiary formations, and with associated remains of *Hyopotamus* and *Titanotherium*, probably indicates the end of the eocene, which was succeeded by the more extensive miocene deposits of the Mauvaises Terres, and the pliocene deposits of the Niobrara River.

On some Cretaceous REPTILIA.

BY E. D. COPE.

NATANTIA.

CLIDASTES Cope.

This genus is established on a species represented by a single dorsal vertebra, which was found by my friend Prof. O. C. Marsh, of Yale College, in a marl pit near Swedesboro', Gloucester Co., N. J. Its form is highly characteristic, and resembles considerably that of such genera of Iguanidæ as Euphryne and Dipsosaurus, and in some degree those of Cyclura and Iguana. It differs from the dorsals of known serpents in having a zygosphen on the plane of the anterior zygapophysis, and in having the costal articular surface continuous with and covering the diapophyses. It differs from the genera of Iguanidæ mentioned in the very small amount of upward direction which the face of the articular ball of the centrum exhibits. This face is nearly vertical, meeting the lower plane at a slightly less angle than the upper. It is much more strongly convex transversely than vertically. The neural arch rises from the anterior three-fourths of the centrum, the zygapophysis coming off from the edge of the cup, and the diapophysis from ·2 of the length behind it. The zygapophysis is more prominent than the zygosphen, and the sinus between them is floored by a thin horizontal plate at its fundus.

The general form of the vertebra is depressed. The zygapophyses are spread apart, and their outer margin continues in a straight line from the diapophyses. The diapophyses are directed upwards, and are vertical compressed in form; they are opposite to about equal portions of the centrum and neural arch. Their posterior face is slightly concave, and the upper face behind forms, with the neural arch, a deeply concave line. The convexity of the ball is not so great as in the Crocodilia, and, with the thin lipped cup, resembles that of Mosasaurus; this resemblance is heightened by the slightly depressed upper outline of the ball, and the form of the diapophyses. The inferior face of the centrum presents a median obtuse ridge, and nearly flat lateral faces, which are concave antero-posteriorly. The cup is broader than deep, and has a slightly concave outline; the base of the zygosphen originates opposite the middle of the neural canal. The latter is a broad vertical oval.

CLIDASTES IGUANAVUS Cope, sp. nov.

In this species the articular face of the zygosphen is inclined at an angle of 45°, while that of the zygapophysis is a little more horizontal. The posterior zygapophyses are broken off.

	In.	Lin.
Length of centrum below	2	0·5
Width of cup	1	6·8
Depth "	1	1·5
Width between extremities diapophysis	3	0·5
Depth articular face diapophyses		10·5
From diapophysis to end zygapophysis		9
Between zygosphen and zygapophysis		4·5
Width centrum anterior to ball		15
Width of neural canal behind		5·5

While there is a probability that this animal was a forerunner of the Iguanian type of Lacertilia, it possessed, no doubt, strong relationships to Mosasaurus. Its nearest ally is Macrosaurus, in some of the vertebræ of which a slight groove, beside the zygapophysis, is the rudiment of the zygantrum. If of the same proportions as Iguana and Amblyrhynchus, its length would not have been much different from twelve feet, or that of the largest alligators of the Mississippi.

OPHIDIA.

PALÆOPHIS Owen.

PALÆOPHIS LITTORALIS Cope. Proc. Acad. Nat. Sci. Philad. 1868, 147.

This, with the following, is the only serpent whose remains have been found in the United States in deposits older than the post-pliocene. We owe its preservation to Dr. Knieskern, of Shark River, N. J., best known by his botanical investigations. It is in possession of the New Jersey State Geological Survey, and has been submitted to me by Prof. Geo. H. Cook, the Director, for examination. The specimens consist of three vertebræ, neither of them perfect; the most so with neural arch, but with diapophyses broken off.

The more perfect is an anterior dorsal, with two hypapophyses, the anterior small and directed forwards, the posterior larger, and directed vertically downwards. The ball has some superior up-look, though the groove which bounds it is but little oblique. Centrum much compressed behind the middle. Plane of basis of zygapophysis opposite floor of neural arch; zygapophysis directed slightly upwards and outwards, continuous by a broad wing running posteriorly, with the diapophysis. Neural arch well elevated, (broken off behind). The basis of the neural spine is narrow on the anterior part of the arch, and does not reach the anterior margin.

	Lin.
Length centrum (ball to edge cup)	8·25
Depth ball	4·25
Width "	5·
" between extremities of zygapophyses	8·
Depth cup and neural arch	7·5
Width neural arch behind	2·25

A strong ridge extends from the zygapophysis posteriorly parallel with the centrum. There is no ridge continued from the zygosphen. Except a slight ridge below the fossa, which is above and back of the diapophysis, the surface of the vertebra is smooth.

Another vertebra is rather broader in proportion to its length, and less compressed.

	Lin.
Length (as above)	7·8
Width ball	5

In both the ball has a subtriangular outline. In the more perfect, the base of the neural canal is divided by a narrow longitudinal epapophysis.

Locality.—The eocene green sand bed of Shark River, Monmouth Co., N. J.

PALÆOPHIS HALIDANUS Cope, sp. nov.

A single vertebra represents this species. It indicates one of the largest of the genus, being little different from the P. typhæus of Owen in size. The bulk of the vertebra is double that of the P. littoralis. In addition to this point, it differs from the latter in the greater transverse diameter of the cup and ball; these are transversely oval; in the P. littoralis subtriangular ovate; the centrum is naturally less constricted and broader in the former. The articular face of the zygapophysis is broadly ovate in the P. halidanus, narrowly in the smaller species; while there are indications of similar posterior hypapophysis in both, the anterior in the P. halidanus appears to have been smaller.

As compared with the species described by Owen, the cup and ball are more transverse than in any noticed in the British Fossil Reptiles approaching that figured by him in pl. 3, fig. 22–4; the ball has not the oblique, up-looking profile of that species, but forms a nearly regular arc, with its posterior margin superiorly a little behind its position inferiorly. The hypapophysial ridge is considerably interrupted, as in the P. typhæus, while P. littoralis agrees with the P. toliapicus in having it continuous. The two last named species differ in the development of their hypapophyses; in the American species both are large, especially the posterior; in the English, the anterior process is weak or wanting; the ridge connecting the zygapophyses disappears in the P. toliapicus and continues in the P. littoralis. The general proportions of the centrum are slender, as in P. toliapicus, and not so stout as in P. porcatus Owen.

The diapophyses in the P. halidanus are not so pedunculate as in P. typhæus, though they are separated above by a notch from the vertical ala which descends from the zygapophysis, which I do not find in the P. littoralis They approach near the margin of the cup in their transverse extent below.

The horizontal ridge between the zygapophyses is strongly marked, and in the specimen in hand comes off from the anterior vertical ala below the zygapophysis, rather than from the plane of that process, as in P. littoralis. The neural canal is depressed behind, below the margin of the ball, and has an obtuse epapophysis along the median region of its median line. There is no ridge parallel to the hypapophysis. The cup is partially broken, but its transverse diameter appears to have been one-fourth greater than the vertical. The transverse plane of the face of the zygapophysis is transverse. A large part of the neural arch is broken away.

	Lines.
Length from edge up to convexity of ball	12·75
Width between anterior zygapophyses	13·5
" of cup	8·4
Depth "	6·2
Least width centrum at middle	5·3
Width neural canal	4·

Locality.—This serpent was found by my friend O. B. Kinney in the excavations of the Squankum Marl Company, at Squankum, Monmouth Co., N. J., a few miles south of Shark River. The horizon is eocene.

This animal was probably a sea-serpent distantly allied to the Boas, and far exceeding in dimensions those at present inhabiting the Indian Ocean. Its size was similar to that of the very largest of terrestrial serpents of the modern era, and was probably proportioned to a length of twenty feet.

CHELONIA.

ADOCUS Cope.

Emydoid tortoises, in which the rib-heads of the posterior costal bones are represented by rudimental laminæ, and the anterior by a crest or truncate ridge in addition. Vertebral scuta narrow; external surfaces smooth or nearly so.

Name from Α, and Δωκος, rafter (*i. e.*, rib-head).

This genus, now first characterized, differs from Emys in the absence of costal capitula of the costal plates of the carapace, a feature pointed out by Leidy in the type species. It also possesses a character of Pleurosternum in the presence of a series of marginal dermal plates on the sternal bridge. It belongs to the true Emydidæ, having the eight paired sternal bones instead of ten of the first-mentioned. The markings of the dermal plates of the plastron are not distinct. Besides the species here described, it includes A beatus (Emys Leidy), A. firmus (Emys Leidy), A. pravus (Emys Leidy), and A agilis Cope. It represents Emys in our cretaceous, as Osteopygis Cope does Chelydra, and Taphrosphys Cope (type Platemys sulcatus Leidy) does Hydraspis.

Adocus petrosus Cope.

This species is represented by portions of four costal bones, parts or wholes of six marginal bones, most of the right hyosternal, and a posterior portion of the right hyposternal, with the head of the os coracoideum. They were found in the West Jersey Marl Company's pits, Gloucester Co., N. J., in the same locality whence the Lælaps was procured.

The hyosternal bone is preserved in its axillary margin, and is continuous with two marginals of the carapace of the same side. Two of the costals are adjacent, and give the outlines of the vertebral bones and scutes. These show the inferior outline to be very convex, the whole, from angle to angle of the marginal bones of opposite sides, amounting to an arc of about 124 degrees. Each hyosternal is slightly concave below the plane of their common suture. Each thins out laterally, though the one preserved is very thick on the axillary margin. There is little difference between the thickness at the mesosternal and hyposternal sutures. All the sutures have minute rugosities, differing much from sternals in A. agilis and Taphrosphys, which are very ragged, and resembling those of Pleurosternum pectorale m. The piece of hyposternal is even thicker than the hyosternal. The bone is everywhere remarkable for the thickness of its dense layer, and the closeness of the texture of the spongy. The former is one-third the thickness of the sternal and costal bones fractured.

The scute sutures of the inferior surface are obsolete; those of the dorsal surface are like those of Adocus, *i. e.*, the vertebrals with bracket-shaped lateral borders, with the costal proceeding from the point of the bracket.

The marginal bones vary much in thickness proximally. They have two proximal sutures, one side convex, the other concave. Four have a heavy border, round in section; in two of these it is considerably everted. Another has a rather thin margin, slightly decurved, with a submarginal groove separating it from the most massive portion. The costal bones are strongly convex in their length, indicating an arched carapace.

Measurements.

	In.	Lin.
Hyosternal width	3	9
" " to origin axillary abutment	2	1·5
" length on median suture	2	1·5
" thickness near mesosternal line		9
" " " hyposternal "		7·2
Hyposternal thickness near posterior suture		9
Costal width	1	7·5
" thickness vertebral suture		8
Marginal No. 1 width	2	1·5
" " length	1	7
" " proximal thickness		3
" No. 5 " "		8·2
" " length	1	6
" " width	1	7·5
" " width dermal scute		9

This animal is therefore a species of considerable size, though less than most of those described here, and particularly convex and solid in every part, While the sutural lines of the hyosternal measure about the same as in A. firmus (Emys Leidy), it is much more convex and not so thick at the mesosternal suture. The marginal bones are relatively just half the size. The Pleurosternum pectorale differs in being very much flatter, and in having a more discoid mesosternal bone. The hyosternals are also much thicker at their union with the marginals than in the present.

A portion of a hyo- or hyposternal bone collected at the same place, and near or at the same time, may be referred to a larger individual of the same species or to A. firmus. It exhibits a wedge for a diagonal gomphosis between the two sutures, which are preserved. The thickness on the median suture is 14 lines.

DINOSAURIA.

LÆLAPS Cope.

LÆLAPS AQUILUNGUIS Cope.

External form and position in Lælaps.

The short fore-limbs of this genus suggest at once the habit of standing upon the hind limbs chiefly, yet this disproportion is no sufficient reason therefor, and is seen to exist in the tailless Batrachia, where no such position is assumed. It exists to a less degree among the modern lizards, whose position we well know to be always horizontal.

Lælaps had, however, no doubt an erect position, for the following reason: The head and neck of the femur are at right angles to the direction of motion on the condyles, or in the same plane as the transverse direction of the condyles. This indicates that the femur has been reflexed and extended in a plane parallel with that of the vertebral column. The relations of articulation are those of birds, and different from those of reptiles, where the directions of the proximal and distal condyles of the femur are oblique to each other, and the proximal of a vertically elongate form, thus allowing the femur to be obliquely directed as regards the axis of the body, so that in a prone position it rested on the ground equally clear of the body and the flexed tibia.

The resemblance of the tibia, with its high crest and embracing astragalus, as well as the slender fibula, to those of the birds, confirms this position; so do types of the iliac and sacral structures. The same is suggested by the great bird-like reptile tracks found in many places.

How must a reptilian form with elongate vertebral column and heavy tooth-bearing cranium have stood erect? The elongate form of the femur as compared with the tibia is only seen among animals who walk erect, in man; in the birds and kangaroos the femur is very much shorter than the tibia; besides these no other vertebrates progress on the hind limbs entirely. The lizards, which are prone, present the long femur exceeding or equalling the tibia.

The bird-like reptile did not, however, exhibit the slight flexure between femur and tibia presented by man. The acetabulum in the known Dinosaurs is not or but weakly completed below, or what would be in man anteriorly, indicating that the weight of the body was supported by a femur placed at a strong angle with the longitudinal axis of the ilium; otherwise the head of the femur would be most readily displaced. If, therefore, the ilium were more or less erect, the femur was directed forwards; if horizontal, the femur must have projected downwards. I have shown, however, that the position and therefore the ilium was oblique or erect; therefore the femur was directed very much forwards.*

There are, however, other reasons for believing that the femur was directed forwards, and somewhat upwards from the ilium. One is, that the centre of gravity of an elongate reptilian dorsal and sternal region must have been further forwards than in the short-bodied bird, and therefore the knee must have been further forward, in order to bring the support—*i. e.*, the tibia, etc.—beneath it. Another is, that the articulation of the tarso-metatarsal bones with

* The remarks of Prof. Owen on this relation in Megalosaurus are so pertinent, that they are introduced here:

"The backward position and production of the corresponding articular prominences or condyles in both femur and tibia, indicate that these bones were joined together at an angle, probably approaching a right one, when in their intermediate state between flex on and extension; and that the motion of the tibia could not have taken place to the extuet required to bring the two bones to the same line."

the tibia is excessively oblique, requiring that one or both sections of the limb should be very oblique to the vertical line. As the tarso-metatarsal elements support the weight immediately on the ground, and as it is obvious that the leverage moving the great weight of the body on its support must have been the gastrocnemius and soleus muscles extending the tibia on the metatarsal segment as the fixed point, and as there is no indication of correspondingly powerful muscles to flex the metatarsals on the phalanges, it is obvious that the latter has been the more vertical, and the former the more oblique segment. And if the tibial segment has been oblique, for reasons just given, the femur must have been oblique also.*

The length of the femur has had relation to another peculiarity as well, as follows:

In an animal designed to walk erect, it is necessary that the centre of gravity should be transferred as far posteriorly as is consistent with the type. In LæIaps and other Dinosauria we have very elongate pubic and iliac bones, and, as I have before described, these appear to have been designed to enclose and support an abdominal mass, in a position beneath the sacrum, and posterior to the position observed in quadrupedal mammals and reptiles. We would thus have a prominent keeled belly between the femora, supported by elongate curved ischia behind, and slender pubes directed downwards in front. In Poecilopleurum the space between the latter and the sternum was occupied by abdominal ribs. The length of femur places the arc through which the knee moves beyond this projection.

The confluence of a greater number of vertebræ to form a sacrum, seen in this order and in the birds, would seem to have a direct relation to the support of the above-mentioned greater weight by it, than in horizontal vertebrata, where the weight is distributed throughout the length of the vertebral column.

The shifting of the neural arches backwards, seen in the same orders, pointed out by Owen, would have a mechanical relation to the same necessity,—*i. e.*, their partial transfer over the intervertebral spaces naturally tending to strengthen the union of the sacral elements.

The foot need not, however, have been placed precisely beneath the centre of gravity of the body, as the animal was furnished with a tail of greater or less weight. This member bears, however, little proportion to the great size of those seen in Iguanodon, Hadrosaurus, etc., but exhibits a commencement of the reduction which is so striking among the birds.

The proportions of the metatarsus are only to be ascertained by an examination of those of allied species, as L. macropus and Megalosaurus bucklandii. As all the other bones are more slender than those of the latter, so were no doubt these bones longer in proportion to their breadth. I have estimated it above as equal to a little over half the tibia.

The digits in the genus Lælaps have not, in all probability, been more than four. The less bird-like forms of Hylæosaurus and Iguanodon have had, according to Owen, but three metatarsals, and it is not according to the *rule of successional relation* that there should be any repetition of a reptilian character, in a point of prime importance in measuring the steps of succession between reptiles and birds. Lælaps, and probably Megalosaurus also, had but three digits directed anteriorly, and a fourth lateral or rudimental.

It is true that Deslongchamps ascribes five digits to Pœcilopleurum, after a careful study of abundant material. He was, however, much more impressed with the Crocodilian affinities of that reptile than with any other, and did not recognize the avine in the astragalus. It seems to me quite possible that one of his toes can be dispensed with,—for example, the second, of which but one phalange is said to remain. If we ascribe the fractured extremity of the bone

* Probably in a squatting posture the animal rested on the entire sole as far as the heel, though not under ordinary circumstances; as I have suggested in Amer. Naturalist, i, 28, Mycteria and other wading birds assume a similar position at times.

regarded (Tab. viii, fig. 6) as the first phalange of the fourth digit, to the metatarsal of the same, the phalange referred to the second may find another place. The fifth digit also rests on the evidence of one phalange only. Though the reasoning of Deslongchamps in referring these pieces is good, it seems to me that renewed study might result in ascribing to this genus three toes anteriorly and one appendicular,—his first.

The predominance of Reptilian characters in the Dinosauria, as indicated by the structure of the vertebræ and other points, renders it probable that the vertebral column did not present that remarkable flexure where the cervical and dorsal series are joined, which is seen in the birds, but rather that they were more or less continuous, and formed a continuum from the sacrum to the nape. The cervicals may have been somewhat elongated, as in some birds, yet this is not probable in view of the necessary balance to be preserved, which would not admit of much projection of the cranium anteriorly. The cervicals of Hadrosaurus are not so long as in the modern Varani; in Iguanodon they are similar, while their rather oblique articular faces indicate the elevation of that region, and of the position of the cranium. In the case of these animals, there is not the same necessity for a long neck as in the birds, for even in Lælaps and other genera which probably never used the fore limbs in progression, they furnished a support to the body when the head was employed in taking food, etc., on the ground.

The caudal region affects the general proportions of a vertebrated animal materially. In Lælaps it is shorter than in any known Dinosaur, measuring less than the hind limb by half a foot. It was cylindrical, slender towards the tip, and in fact not unlike that of a dog, and probably capable of motion similar to the latter. When the Lælaps stood erect, the tail would trail its extremity on the ground, but could furnish little support.

Comparison with other Dinosauria.

The species with which detailed comparisons can be made, are the Pœcilopleurum bucklandii Deslongchamps, and Megalosaurus bucklandii Mantell. All three were of nearly similar size. The Pœcilopleurum is better known than the Megalosaurus, and furnishes many similar parts. Thus the humeri possess the same disproportionately small size, the extremity of the tibia is similarly expanded and flattened, and is similarly embraced by the astragalus. There are, however, abundant specific differences in all the bones described by Deslongchamps. In the same manner the Lælaps aquilunguis presents abundant specific differences from the Megalosaurus bucklandii. The slender curved femur differs from the massive straight one of the latter; the tibia is more slender, and more flattened distally; its extremity is wedge-shaped, not rhombic as in the European species. The claws of Megalosaurus are relatively shorter and less curved.

The generic relations with these two types must be understood. Lælaps is obviously distinct from Pœcilopleurum in the structure of its feet. In the former the phalanges are slender, in the latter massive, and mostly broad. The claws are more different; in the former compressed and hooked; as broad as deep in the latter, and but little curved. They are prehensile in the former, in the latter not at all, or adapted only for defense; they present a very small point of insertion, compared with the large knob of the former; they also exhibit a deep groove on the side, which is weak in Lælaps. The difference in this respect is about that between a raptorial and rasorial bird.

As compared with Megalosaurus, Lælaps probably had very short fore-limbs. I have pointed out the difference in the femur, which is perhaps not more than specific, though this cannot be positively asserted. The difference in the form of the extremity of the tibia I suspect also to indicate more than specific difference. The bone described by Owen (Palæontographical Society) as scapula, furnishes means of estimating the size of the humerus. The glenoid cavity is some six inches in diameter, indicating a humerus of four times the size of that of Lælaps at least. The claws also of the Megalosaurus are intermediate between those of Lælaps and Pœcilopleurum, being less compressed and hooked than in the first.

Size.—In estimating the length of this reptile we have the lengths of the limbs and tail, and proportions of parts of the jaws to rely on. There is some reason to believe that the lengths of the hind leg and of the tail were similar. In erect animals, as the Kangaroo and Ostrich, the length of the vertebral column anterior to the sacrum about equals the length of the hind limb. In the present form the limb is increased by the greater length of the femur than in either, but is shorter than that of the bird by the abbreviation of the metatarsals. The proportions would then remain about the same as in the bird, were it not that a head larger than in that class has evidently been borne upon the cervical vertebræ, more as in the Kangaroo. It appears then that the increased length of the femur in Lælaps may be added to the proportions of the Kangaroo, thus giving a nearer equality between the lengths of the hind limb and the body and head together. The length would then be seventeen feet, divided as follows:

	Ft.	In.
Tail	8	6
Body and neck	6	6
Head	2	
Total	17	

This is probably the size of the Barnesboro individual, which is in all probability young, as the sacral vertebræ are entirely disunited. The phalange from Mississippi, above described, is very much larger than any of the former, and may have belonged to an adult animal. In any case it indicates a gigantic reptile of twenty-three feet or more in length.

The femur of the young individual is as long as that described by Owen (Palæontographica) as belonging to Megalosaurus. As that genus was probably more bulky anteriorly than Lælaps, its length, as compared with the dimensions of the hind limb, is greater. If, however, it approached Lælaps in proportions, as is probable, the length of thirty feet assigned to it appears too great. In fact it cannot have been larger than the Mississippi, or adult Lælaps aquilunguis.

Thus the original estimate of the lengths of these carnivorous Dinosaurs is still further reduced. Owen accomplished part of this by estimating on the mammalian and rejecting the reptilian type; the introduction of the avine element places the proportion at about the proper point in respect to the Goniopoda at least.

The elevation of the head of Lælaps would no doubt depend more upon the pleasure of the animal, than in a more quadrupedal form. Nine feet above the ground is a probable estimate for the young one, and twelve for the adult.

Movements.—The mind will picture to itself the actions and habits of such strange monsters as the Dinosauria, and in respect to some of the genera there is considerable basis for speculation.

That monsters walking on two posterior limbs have inhabited the earth, has been familiar to all since the publication, by Hitchcock and Deane, of the histories of the great foot-tracks of the Triassic Red Sandstone of the Connecticut valley. Such tracks have been discovered by Jno. Smock, in the same formation, in New Jersey, and by Dr. Chas. Hitchcock in Pennsylvania. Prof. Hitchcock ascribed the tracks described by him to birds. Prof. Agassiz* expresses the belief that they were made by vertebrates combining characters of existing classes, perhaps of reptiles and mammals, rather than by birds. Now a carnivorous Dinosaur probably allied to Lælaps, as proven by a portion of

* Contrib. Nat. Hist. U. S., 1857, vol. i.

the jaw with teeth, in the Academy's Museum, the Bathygnathus borealis of Leidy, has left its remains in the red sandstone of Prince Edward's Island, of the same age, and we safely conclude that some of the large-clawed biped tracks of Hitchcock are those of that animal. Dr. Leidy has suspected that this would prove to be the case, as he asks* "was this animal probably not one of the bipeds which made the so-called bird tracks in the sandstone of the Connecticut valley?" This enquiry was, after an examination of the form of Lælaps, answered in the affirmative.† I have ascribed these tracks to reptiles allied to Lælaps, and Huxley believes also that they were made by Dinosauria.‡

The creatures which strode along the flats of the Triassic estuary have been various in species and genera, as pointed out by Hitchcock. Some were purely biped; some occasionally supported themselves on a pair of reduced fore-limbs. There are impressions where these creatures have squatted on their haunches. One can well imagine the singular effect which these huge gregarious reptiles would produce, standing motionless, goblin-like, on a horizon lit by a full moon; or lying with outstretched neck and ponderous haunches basking in the noonday sun; or marching or wading slowly along the water's edge, ready for a plunge at passing fishes or swimming reptiles. But in the active pursuit of terrestrial prey did such an animal as the Lælaps run like the Ostrich, or leap like the Kangaroo? So far as the Triassic tracks go, there is no evidence of leapers, only runners, fell upon an exhausted quarry. Or were they only carrion eaters, tearing and devouring the dead of age and disease? Probably some were such, but the prehensile claws of Lælaps are like instruments for holding living prey.

Lælaps has a long femur; those great leapers the Kangaroos have a short one; the cursorial birds, however, have a similar form of femur, but they do not leap. So this form is not conclusive. The modern Iguanas have long femora, and they all progress by their simultaneous motion; they only leap; but man with his long femur runs only. The question then does not depend on the form of the femur.

I have suggested on a former occasion that Lælaps took enormous leaps and struck its prey with its hind limbs. I say, in describing it, "The small size of the fore limbs must have rendered them far less efficient as weapons than the hind feet, in an attack on such a creature as Hadrosaurus; hence perhaps the latter were preferred in inflicting fatal wounds. The ornithic type of sacrum elucidated by Prof. Owen suggests a resemblance in the use of the limb."

The lightness and hollowness of the bones of the *Lælaps* arrest the attention. This is especially true of the long bones of the hind limbs; those of the fore limbs have a less considerable medullary cavity. In this respect they are quite similar to those of Cœlosaurus Leidy, of which its describer remarks, "that the medullary cavity of the tibia is large, and the walls thin and dense," "being intermediate in this respect between the characters of the mammals and birds."

The mutual flexure, as well as the lightness and strength of the great femur and tibia, are altogether appropriate to great powers of leaping. The feet must have been elongate, whatever the form of the tarsi; the phalanges, or finger bones, were slender, nearly as much so relatively as those of an eagle, while the great claws in which they terminated were relatively larger and more compressed than in the birds of prey. There was no provision for the retractibility observed in the great carnivorous mammalia, but the size of the inferior basal tuberosity indicates the insertion of a great tendon of a powerful flexor muscle. The slight grooves at the base, and deeper one on each side of the phalange, suggest the usual horny sheath, which, prolonging the point of the claw, would give it a total length of eleven inches.

* Journal Acad. Nat. Sciences, 1854, 329.
† American Naturalist, 1867, 27. Hay's Medical News and Reporter, 1868.
‡ Proceedings Royal Society, London, 1868, p. Natural Science Review, 1868.

The fore limbs must indeed have been of very little use, and it is very difficult to imagine an animal running and seizing the prey it overtakes with the hind limb. If it were not a carrion feeder it must have leaped. We are informed by Hochstetter,* that the Apteryx leaps with the utmost ease over objects two and three feet in height, that is, higher than its own head. Huxley suggests that the Compsognathus "hopped" along on its hind limbs. The bulk of Lælaps is no objection to its leaping, for the giant extinct Kangaroos, Macropus atlas and titan, found in the postpliocenes of Australia, did not fall far short of these reptiles in this respect. We may add that Lælaps had smaller allies, as L. macropus one-half, and Cœlosaurus antiquus one-fourth or fifth the size, whose remains, so far as they go, indicate an identity of habit. Deslongchamps says of Pœcilopleurum bucklandii, that it "could project itself with prodigious force, as a spring which unbends itself; but this could not have been on a solid surface, since the fore limbs are too weak to resist the shock of the fall of such a heavy body." He supposed it to be marine in its habits, accustomed to battling a stormy sea. However, his objection to leaping on land is obviated by understanding that progressive movement was entirely performed by the hind limbs.

On the Origin of GENERA.

BY EDWARD D. COPE, A.M.

Introduction.—The present fragmentary essay is a portion of what other occupation has prevented the author from completing. It does not therefore amount to a complete demonstration of the points in question, but it is hoped that it may aid some in a classification of facts with a reference to their signification. When all the vast array of facts in possession of the many more learned than the writer, are so arranged, a *demonstration* of the origin of species may be looked for somewhere in the direction here attempted to be followed.

Conclusions of any kind will scarcely be reached, either by anatomists who neglect specific and generic characters, or secondly by systematists who in like manner neglect internal structure. Such will never perceive the system of nature.†

Analysis of the subject.

I. Relations of allied genera.
  First; in adult age.
  Second; in relation to their development.
    α. On exact parallelism.
    β. On inexact or remote parallelism.
    γ. On parallelism in higher groups.
    δ. On the extent of parallelisms.
II. Of retardation and acceleration in generic characters.
  First; metamorphoses in adult age.
    α. The developmental relations of generic and specific characters.
    β. Probable cases of transition.
    γ. Ascertained cases of transition.
  Second; earlier metamorphoses.
    δ. The origin of inexact parallelisms.

* New Zealand Amer. Transl., 181.

† It might seem incredible that either class should systematize with confidence, yet a justly esteemed author writes even at the present day, " However, there is scarcely a systematist of the present day who does not pay more or less attention to *anatomical* characters, in establishing the higher groups!" (The italics are our own,) As though a system was of any value which is not based on the *whole structure*, and as though *lower* groups were only visible in external characters: in a word, as though external (muco-dermal, dental, etc.) characters were not "anatomical!"