THE HABITS, EXTERNAL FEATURES AND SKELETAL SYSTEM OF CALOTES VERSCOLOR
PART I

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Introduction

The lizard, *Calotes versicolor*, which is usually studied as a type of the Lacertilia, in the Universities in South India, is the commonest and most extensively distributed form. The absence of suitable text-books dealing with the structure and development of Indian types is keenly felt by students and teachers alike. Although our students dissect the Indian forms, yet, they have to depend upon descriptions of foreign types detailed in textbooks such as those of Parker and Haswell,¹ De Beer,² Parker, T. J.,³ and Potter, G. E.⁴

I have, therefore, ventured to describe the habits, external characters and skeletal system of this common South Indian lizard and hope to offer an account of the other systems in the near future. The paper is divided into two parts. The first part deals with the habits, external features and the appendicular skeleton. The second part deals with the structure of the skull.

Material and Methods

The specimens were collected in and around the precincts of the Intermediate College, Bangalore. A large number of Alizarine preparations of the entire skeleton of both young and adult forms were made following the usual methods, but that suggested by Rahimulla and Das⁵ gave slightly better results. A number of dry preparations of the skeleton were also made. A study of serial sections of decalcified adult skulls was also made, to bring out the more intricate details of the relationship of the bones.

My warmest thanks are due to Prof. A. Subba Rau for the valuable guidance given to me during the course of the work and for having gone through my manuscript and given me helpful suggestions. My thanks are also due to Messrs. B. A. Rama Iyengar and S. Jayarama Sarma for much help in the preparation of the illustrations.
Habits and External Features.—*Calotes versicolor* is found in fields, gardens and hedges, on trees and shrubs during all seasons of the year but it is plentiful during the months of May to November, which happen to be its breeding season. It has often been found living in crevices between stones in our College compound. Its specific name *versicolor* or colour changing refers to the fact that it can change its colour to some extent under ordinary circumstances and this colour change is very remarkable during the breeding season. It can often be observed basking in the warm sun, always on the alert for some unwary prey. It is frequently called the Bloodsucker, but how it came to be called by that name is difficult to say, because it is incapable so far as my own observation goes, of the quality attributed to it.

The lizard is mainly insectivorous, the food consisting mostly of insect larvae, various kinds of insects such as Grasshoppers, Butterflies and Beetles. In the laboratory, I have been able to keep them living on a diet of Cockroaches. Mr. McCann⁶ has remarked that to its insect food, it adds birds, eggs and nestlings during the seasons. For this statement, he says, he has ample evidence. He also mentions that it is able to overpower and eat small lizards, small frogs and tiny crabs and that it also feeds on earthworms.

The adult male is distinctly of a stronger build and larger size than the female, which is relatively slender. An average male measures about 15 inches in length, the length from snout to vent varying from 4 to 4·75 inches and the length from the vent to the tip of the tail varying from 10 to 10·5 inches. An average sized female measures only about 12 to 13 inches, the distance from the vent to the tip of the tail being about 9 inches. Boulenger⁷ records the distance from snout to vent as 4½ inches and tail 11 inches. Gadow⁸ says that the animal attains a length of 14 inches, 11 of which are taken up by the tail. Again Malcolm Smith⁹ has given a detailed account of the specific characters of this lizard and in the course of his account he mentions that "Specimens from the Indian Peninsula (males) range from 120 mm. (4·8") to 140 mm. (5·6") in body length, with a tail 300 mm. (12") to 350 mm. (14"). The increase in size does not appear to be confined to certain localities, but may occur in any part of the peninsula." While the specimens collected by me generally agree with the measurements given by Gadow and Boulenger, none has come up to the size mentioned by Malcolm Smith. In the adult male, the base of the tail is markedly swollen, and owing to the presence of larger muscles, the lower jaw of the male shows a characteristic curve which is not to be found in that of the female.
Annandale (1900) has given an account of the courtship of this lizard. Both J. J. Asana and Charles McCann have given detailed accounts of the breeding habits of this lizard. One has often observed this lizard sitting on a hedge or fence and nodding its head in a characteristic manner. In this connection McCann remarks as follows: "As for the bowings and noddings of the head, they may be observed at all times and can be produced by other emotions as well as by sexual excitement. If disturbed, bloodsuckers will bow and nod their heads exactly as when courting. Personally, I think it is a threatening attitude, which serves the animal for purposes both offensive and defensive."

The body is elongated and consists of a head, neck, trunk and long tapering tail. The length of the head is about one and a half times its width. The trunk is compressed laterally and flattened ventrally. The tail is long and cylindrical ending in a point in normal specimens. Malcolm Smith (1935) remarks that many lizards have the power of breaking off the tail at will and that among the Oriental species, it is possessed by the Geckos, Lacertids, Skinks and Ophisaurus. "The break occurs not between two vertebrae, but across the body of a vertebra, at a transverse septum of cartilage which develops during the ossification of the bone." When the tail is broken, these lizards are able to reproduce a new one. It is not, however, a complete organ. The vertebrae are not reproduced, but in their place a non-segmented rod grows; new muscles are acquired, but the scales which cover the new tail, resemble exactly the old ones. But in Calotes, neither this kind of autotomy, nor regeneration occurs. The injured end of the tail is only repaired, leaving a short, blunt tail.

The limbs are moderate in size. The hind limbs are longer than the fore-limbs. The whole body and tail are covered with strongly keeled epidermal horny scales arranged in an overlapping manner. The body is light brown or greyish dorsally with dark bands across the tail. Transverse bands of a dark brown colour are present on the trunk also. Dark streaks are seen radiating from the eye at its posterior end. The younger forms and the females are provided with two light yellow bands on the dorsolateral surface of the trunk. A full-grown male is usually more or less uniform golden yellow in colour with a greenish tinge. The throat region assumes a scarlet red colour during the breeding season and there is often a black transverse bar across the throat. During the breeding season, the male assumes a bright scarlet colouration extending over the head and a portion of the trunk. The female is not so brightly coloured. The cheeks of the adult male are swollen but there is no gular sac.
**Exoskeleton.**—The scales on the body are not uniform in size. The scales on the dorsal surface of the head are unequal and are not keeled. None of them is enlarged. There is a special shield on the parietal foramen, prominently visible on the top of the head. Two well separated spines are present on each side of the posterior part of the head above the ear. Along the sides of the upper and lower lips are a series of 11 to 13 labials. These are elongated and rectangular. On the ventral surface of the head, the scales are longer and are not keeled. In the trunk, the dorsal scales are broadly triangular, slightly mucronate and feebly keeled. All the scales point posteriorly, *i.e.*, towards the tail. The ventral scales of the trunk are strongly keeled and mucronate. The number of scales round the middle of the trunk varies from 37 to 52. There is a crest of triangular scales on the head and trunk along the mid-dorsal line. The nuchal and dorsal crests are continuous and well developed in the male. The crest is composed of triangular spines pointing posteriorly and gradually diminishing in size towards the posterior part of the trunk. The scales on the dorsal surface of both fore and hind limbs are smooth and not keeled, whereas the scales on the ventral surface of both limbs are distinctly keeled and mucronate. The scales near the root of each limb are smaller in size. The scales in front of and behind the vent are also smaller. The scales on the tail are arranged in longitudinal rows, parallel to each other and are distinctly keeled. The number of rows is greater near the base of the tail, about 24 and fewer towards the tip. Like most lizards, *Calotes* also sheds its epidermal covering periodically. The skin is dry and devoid of glands. Femoral pores on the thighs are absent. There are no osteoderms in the skin.

The head is somewhat pyramidal and dorsoventrally flattened; the openings of the external nares are situated near the anterior end of the snout on its dorsal surface. The mouth is a wide slit-like opening running round the anterior border of the head. It is bounded by the upper and lower lips. At the sides of the head are two eyes, one on each side. Each is provided with upper and lower opaque eyelids which are movable and with a transparent third eyelid or nictitating membrane which can be withdrawn to the anterior angle of the orbit. About half an inch posterior to the eye on each side is a circular brown patch of skin—the tympanic membrane—slightly sunk below the level of the skin.

The cloacal aperture is a transverse slit situated between the hind limbs, at the root of the tail.

The copulatory organs in the male are paired. They arise from the lateral and posterior corners of the cloaca and are kept concealed in
copulatory sacs, one on each side of the cloaca. Each penis is a tube of erectile tissue bifid at the tip and can be everted like the finger of a glove. When at rest and withdrawn, each forms a slight, conical, longitudinal swelling on either side of the root of the tail. The males can always be recognised by the root of the tail being swollen.

The anterior limbs spring one from each side of the body near the anterior end of the trunk towards its ventral side. Each consists of three divisions: the proximal or brachium, middle or anti-brachium, and distal or manus. The distal division is terminated by five digits provided with horny claws, the first digit being the shortest. It is designated as the thumb or pollex. The third and fourth fingers are nearly equal in length. The posterior limbs arise one from each side of the body near the posterior end of the trunk, towards the ventral side. Each hind limb when stretched reaches as far as the tympanum of that side and consists of three divisions; proximal or thigh, middle or shank and distal or foot. The pes or foot terminates in five clawed digits, of which the first or hallux is the shortest. The fourth toe is longer than the third. The second and fifth toes are nearly equal in length. The fifth toe is wide apart from the others.

The Endoskeleton

The Endoskeleton consists of the skull, the vertebral column and the appendicular skeleton.

The Vertebral Column.—This is divisible into the following regions: a cervical region of eight vertebrae, a thoracicolumbar region of fifteen vertebrae and a caudal region of a large number of vertebrae varying in number from 40 to 52 in specimens examined by me.

The Cervical Region.—The first vertebra or Atlas (Fig. 2 A and B) differs from the other cervical vertebrae. It has no distinct centrum. It is a ringlike bone consisting of three parts. The ventral part represents a portion of the centrum and the thin dorso-lateral (Do-Lat.) parts are the neurapophyses. Between the two neurapophyses stretches in the living animal, a transverse horizontal ligament (Lig.) which separates the space inside the ringlike Atlas, into a dorsal portion, the neural canal (Neur.), through which passes the spinal cord, and a ventral space, into which fits the odontoid process of the Axis or second vertebra. On the anterior aspect of the ventral portion of the Atlas, is a smooth articular facet for articulation with the single occipital condyle of the skull. On the ventral surface of the middle piece is a sub-vertebral wedge-bone (vent.) and on each side is a small lateral process (L.). There is no neural spine on the neural arch. The
neurapophyses do not quite meet dorsally, but are separated by a narrow space bridged over by membrane in the living animal. The axis or second vertebra, which is the largest of the cervical vertebrae (Fig. 2, C and D), differs from the other vertebrae of the cervical region. Its centrum has a short, conical, odontoid process (od.) projecting anteriorly and occupying the space below the transverse ligament of the Atlas. The odontoid process of the Axis represents the centrum of the Atlas, which has become fused with it. The line of
union or suture is visible under strong magnification. The axis bears anteriorly a pair of smooth surfaces—the pre-zygapophyses (pr. zy) and on its posterior face, a pair of post-zygapophyses (pt. zy). The posterior face of its centrum is convex. The neural arch of the axis bears dorsally a large posteriorly directed neural process (N.P.). On the ventral side of the axis is a fairly large sub-vertebral wedge bone (Hyp.) or hypapophysis pointing posteriorly. The other six cervical vertebrae are all similar in structure, except that the seventh and eighth have no hypapophyses. Each has a short, cylindrical centrum (Fig. 2 E and F cent) deeply concave anteriorly, a pair of projecting processes bearing the pre-zygapophyses. At the sides and slightly behind the neural spine, is a pair of processes bearing the post-zygapophyses. From the anterior part of the ventral surface of the centrum arises a short posteriorly pointed hypapophysis (Hyp.).

The Thoracic-lumbar Region.—This is made up of fifteen vertebrae of almost uniform size and structure. A description of one of the anterior thoracic vertebrae is given. It (Fig. 2 L) consists of a pro-cœulous centrum which bears dorsally the neural arch with a short mid-dorsal posteriorly directed neural spine (N.Sp.). From the anterior border of the neural arch are given off one from each side, two horizontal processes which bear smooth articular facets on their dorsal surfaces. These are the pre-zygapophyses. Similarly, from the posterior border of the neural arch are given off two horizontal processes bearing on their ventral surfaces two smooth articular facets. These are the post-zygapophyses. Each vertebra possesses also two capitular facets, one on each side, at the junction of the centrum and neural arch. These serve for the articulation of the ribs. Each thoracico-lumbar vertebra fits by the anterior concave face of its centrum to the convex posterior face of the centrum anterior to it, while its pre-zygapophyses are overlapped by the post-zygapophyses of the preceding vertebra. There are no transverse processes in this region. Between successive vertebrae are left small spaces, the inter-vertebral foramina, which serve for the exit of the spinal nerves from the spinal cord.

The Sacral Region.—There are two sacral vertebrae which are considerably smaller than the last lumbar. Each (Fig. 2 H) has a short centrum and two large, expanded, outwardly directed transverse processes to which the ilia of the pelvic girdle are attached and a neural arch with a caudally directed neural spine (N. Sp.). The posterior pair of transverse processes is somewhat smaller and is situated at a slightly lower level than the anterior pair.
The Caudal Region.—The caudal vertebrae vary in number from 40 to 52 in complete normally developed tails. The most usual number in fully developed adult specimens is about 50 vertebrae. The anterior caudal vertebrae (Fig. 2 G) resemble the sacral but have longer centra with long caudally directed neural spines and slender outwardly directed transverse processes. The anterior caudal vertebrae, except the first two, have chevron (Chev.) bones attached to the ventral surfaces of the centra. Each chevron bone is Y-shaped, the paired upper limb of the Y articulating with facets immediately beneath the concave facet of the centrum (and not beneath the convex facet as in Laceria viridis Parker), while, the stem or lower limb is free and is pointed caudally. The fourteenth caudal and all the vertebrae posterior to it are simpler in structure losing the neural spines and transverse processes, so that they are reduced to small rod-like centra.

As already remarked above, the tail when it happens to break, does not as in Geckones and most Lacertae, break off in the middle of a vertebra. There is no cartilaginous septum in the middle of any caudal vertebrae. Specimens have not been found with broken tails regenerated to their original length. In this respect, therefore, Calotes differs from the other forms mentioned above.

The Ribs and Sternum

The ribs are slender curved rods of bone tipped at their free ends with cartilage. Movable bony ribs are attached to the last four cervical as well as to all the thoracico-lumbar vertebrae, but all the ribs are not of equal length. At their vertebral ends the ribs articulate with the capitular facets of the corresponding vertebrae. The ribs borne on the 5th and 6th cervical vertebrae are short, curved rods possessing free cartilaginous tips. The ribs borne on the 7th and 8th cervical vertebrae are longer rods, also possessing free cartilaginous tips. None of the cervical ribs reaches the sternum. The first four pairs of thoracic ribs are long and reach the sternum. Each of these consists of a dorsal bony portion—the vertebral rib—articulating with the capitular facet of the corresponding vertebra by an undivided head and of a ventral cartilaginous portion—the sternal rib—attached to the postero-lateral edge of the sternum. The first two pairs of ribs are directly attached, while the next two pairs are attached to the xiphisternal processes of the sternum. These four pairs of thoracic ribs with their attachment to the sternum form a conical thoracic cage narrow anteriorly near the neck and broad posteriorly and serving to enclose and protect the lungs and heart and related structures. The remaining eleven pairs of thoracico lumbar
ribs are not attached to the sternum but their ventral ends are free and tipped with cartilage. They project out horizontally from their respective vertebrae. These ribs have a distinct caudal curvature, so that each pair when viewed from the dorsal side, has the appearance of a bent bow. They gradually diminish in size until the last rib in the series is reduced to a very short process less than half an inch in length.

The Sternum.—The sternum is a thin pentagonal plate of cartilage slightly concavo-convex, with its convex surface on the ventral aspect. It consists of two parts. The anterior part of the sternum is thinner than the posterior part and consists of a conical plate with straight but slanting edges anteriorly forming an angle and the two lateral edges are curved inward. This part is supported by the anchor-shaped inter-clavicle or episternum. The anterolateral edges of this part of the sternum are grooved ventrally to receive the coracoid on each side. The posterior part of the sternum is thicker than the anterior part. This main part is pentagonal, the anterior and posterior-lateral margins being nearly equal, while the posterior transverse margin is very short. The posterior angles pass into the two
xiphisternal horns (X. sti). The postero-lateral margins are notched at two places to receive the first two thoracic ribs. In the posterior half of the sternum are two oval fontanelles, one on each side, separated by a median flat band. These two fontanelles are the sternal fenestrae, and they are covered by membrane in the living animal. At the angle of union of the antero-lateral and postero-lateral margins of this main part of the sternum is given off on each side, a cartilaginous process (St. Pr.), projecting upward and outward. The two xiphisternal horns or cornua are directed caudally and diverge posteriorly passing outwards and upwards. The xiphisternal horn on each side is notched at two places to receive the third and fourth thoracic ribs.

Before passing on to a description of the appendicular skeleton, it is worth-while to make a comparison between Calotes and some other lizards regarding some of the skeletal features mentioned above.

The number of vertebrae in the cervical and sacral regions is constant in Lacerta and Tupinambis (Albert M. Reese[^12]), viz., 8 in the cervical and 2 in the sacral regions as in Calotes. But the number in the thoracicolumbar region is very variable. Thus, Reese states that in Tupinambis there are 17 vertebrae in this region and Parker and Haswell as well as Parker have noted the presence of twenty-two vertebrae in Lacerta agilis and Lacerta viridis. In the caudal region, the number of vertebrae in Tupinambis is said to be about 65, while in Lacerta it is said to be of a “considerable but indefinite number”. In Lacerta viridis, the first three thoracic ribs are united to the postero-lateral edges of the sternum, the fourth and fifth with its cornua. In Tupinambis, the first three thoracic ribs are directly attached to the sternum, while the fourth, fifth and sixth ribs are attached to the cornua of the sternum. Again, in Lacerta, there are five pairs of cervical ribs borne on the last five cervical vertebrae, while in Tupinambis there are said to be six pairs of cervical ribs borne on the third to the eighth cervical vertebrae. In Lacerta, all the thoracicolumbar vertebrae are said to bear ribs, though the last few are very short, while in Tupinambis, the last thoracicolumbar vertebra is devoid of ribs.

As regards the sternum, both in Lacerta and Tupinambis, there is only one median fontanelle. In Agama (Kingsley[^13]) and in Stellio (W. K. Parker[^13]) there are two fontanelles. Parker has given a list of lizards studied by him showing in a tabular form the number of ribs attached directly to the sternum and the number attached to the xiphisternal processes. He has also given a list of lizards studied by Rathke in which the number of ribs attached directly and indirectly has been given. The
general conclusion of Rathke is as follows: “But generally speaking, the number of the ribs which are intimately connected with the sternum and to which the name of ‘true ribs’ can be applied, not only varies with the genus, but is also very various in different species.” This observation has been corroborated by Parker but he remarks that “f further observations are needed to show whether some types are really more variable than others and what is the greatest variation in the adult condition of the most variable types”.

The Appendicular Skeleton

The appendicular skeleton comprises the skeleton of the pectoral and pelvic girdles and the related limbs.

The pectoral girdle is depicted in Fig. 3 A and B. It consists on each side of the supra-scapula, scapula, coracoid, pro-coracoid and clavicle. There is a median anchor-shaped inter-clavicle. The supra-scapula is a broad, high, cartilaginous plate partly calcified, extending inwards towards the vertebral column on the dorsal side of the body, overlapping the last three cervical vertebrae. At its lower or ventral end, it is connected to a rectangular, slightly curved bone—the scapula. At its inner end the scapula articulates with the coracoid and it contributes to the dorsal half of the glenoid cavity. Along the anterior edge of the scapula is a small projection, representing the meso-scapula. This is the acromial lobe. There is no pre-scapula. The coracoid is a very broad bony ray, semilunar below. It is bifurcate on its anterior side and has a single long, oval fenestra (Cr. F.) formed by a narrow anterior bar, the procoracoid and a broad posterior part—the coracoid proper, which bears the ventral half of the glenoid cavity. Each coracoid articulates at its outer end by an oblique suture with the inner end of the scapula and just above the glenoid cavity there is, in the head of the coracoid, a small foramen for the passage of a nerve. A cartilaginous epicoracoid lies on the inner side of the procoracoid and coracoid proper. There is a semi-elliptical space between the meso-scapula and the pro-coracoid. This is the coracoscapular notch. The epi-coracoids do not meet in the median line, but are kept far apart by the presence of the broad sternum in the middle. Such a condition obtains also in Stellio cordylinus (W. K. Parker) wherein Parker remarks as follows: “The epicoracoids in this flat bellied lizard are kept far apart by the intrusion of the broad sternum, a condition which is normal in birds, where the coracoids overlap only exceptionally.” The clavicles are slender curved rods of bone loosely attached to the anterior border of the shoulder-girdle.
At their inner ends they meet and articulate in the middle line with one another and also with the anterior end of the median inter-clavicle. At its outer end each clavicle is attached to the anterior border of the scapula at about the middle of its length, to the meso-scapular process by fibrous tissue. At the point of union of the two clavicles at their inner ends, an angle is formed. The interclavicle or epi-sternum is a small anchor-shaped bone consisting of an anterior knob and a median posterior process. The anterior knob is trifid and the transverse bars given off from it are forked, the hinder limbs of the fork being smaller than those in front; they both curve backwards, the smaller forks being more distinctly or deeply curved. The two transverse bars support the anterior edge of the front part of the sternum. The median-posterior process is dagger-shaped and is applied to the ventral surface of the anterior half of the sternum, the end of the process stopping short of the fontanelles in the posterior part of the sternum. The inter clavicle in Calotes is altogether different in appearance from the cruciform inter-clavicle of Lacerta. Another feature in the pectoral girdle is that in Lacerta, the outer end of the clavicle articulates with the anterior end of the inter-clavicle and the inner end of the supra-scapula and does not anywhere touch the scapula. In Calotes, however, the outer end of the clavicle articulates with the meso-scapula and does not at all reach the supra-scapula.

The Anterior Limbs

The anterior limbs arise just behind the neck, springing from the trunk towards its ventral surface. Each anterior limb can be stretched anteriorly beyond the tip of the snout and posteriorly as far as the point of origin of the hind limb. Each of the fore-limbs is divisible into three portions, the upper arm or brachium, the fore-arm or anti-brachium and the hand or manus. The manus ends in five clawed digits. The bony framework of the upper arm or brachium consists of the humerus, which is an elongated bone about an inch in length, consisting of a cylindrical shaft of true bone and broader proximal and distal extremities with epiphyses of calcified cartilage. At the proximal end is a hemispherical and smooth head which articulates with the scapula and coracoid in the glenoid cavity. On its pre-axial or radial border, the shaft is produced into a large process, the radial tuberosity and on its post-axial or ulnar border into a small ulnar tuberosity for the insertion of muscles. The distal end or trochlea is pulley-like. It is divided into inner and outer condyles for articulation with the proximal ends of the fore-arm bones (viz., radius and ulna). The condyle for the radius is on the external or pre-axial border and is smaller in
size while the condyle for the ulna is larger and is internal on the post-axial border. Both these condyles are immediately proximal to the trochlea.

The radius and ulna are nearly equal in size and each consists of a long shaft and terminal epiphyses of calcified cartilage. The radius is a slender bone, slightly curved at either end and is pre-axial in position when the limb is stretched at right angles to the trunk. The proximal end of the radius is provided with a shallow cup-like depression which articulates with the radial condyle on the pre-axial border of the distal end of the humerus. The distal end of the radius is cup-shaped for articulation with the carpus and is produced on its pre-axial border into a radial styloid process. The ulna is a slightly larger bone than the radius and is on the post-axial border of the forearm. It is also slightly curved at either end. Its proximal end is thicker and extends beyond the articulation with the humerus. This projection is the olecranon process on which the extensor muscles are inserted. This process furnishes the concave sigmoid cavity for articulation with the ulnar condyle at the distal end of the humerus. The
distal end of the ulna is provided with a distinct convex articular surface for articulation with the carpus.

Just above the olecranon process is a small nodule-like bone—the brachial patella—which is very prominently seen in alizarine preparations of the skeleton. The presence of a brachial patella has not been recorded in *Lacerta*. Reese\textsuperscript{11} mentions the existence of this bone in *Tupinambis* as follows:—“In the tendon attached to the olecranon process is a small calcification or sesamoid bone; in fact, this entire tendon seems to be somewhat calcified.” Kingsley\textsuperscript{12} states that a brachial patella is rarely found in the elbow joint of Tetrapoda.

The carpus or wrist consists of nine small irregular nodule-like bones arranged in three rows. The carpal joint is intra-carpal lying between the proximal and distal row of carpals. The proximal row contains two bones. The radiale is a flattened bone articulating at its proximal end with the concave facet at the distal end of the radius. The ulnare is slightly larger and flattened. Its proximal end is cup-shaped and articulates with the convex distal extremity of the ulna. The distal row consists of five irregular and slightly elongated bones—the Carpalia—one for each metacarpal. The first carpal articulates with the distal end of the radiale while the fourth and fifth carpals articulate with the distal end of the ulnare. The second and third carpals articulate with the distal end of the centrale which lies between the radiale and the ulnare. There is a middle row consisting only of a small centrale intercalated between the radiale and ulnare proximally and the second and third carpalia distally. In addition, there is a small irregular bone on the ulnar side of the carpus. This bone is the pisiform or accessory carpal bone. It is somewhat larger than the rest of the carpals and is on the post-axial side of the distal end of the ulna. In *Lacerta*, Parker mentions the presence of an inter-medium between the radiale and ulnare in the proximal row. Such an inter-medium is not found in *Calotes*.

The metacarpus consists of five elongated bones—the metacarpals; each metacarpal is slender and cylindrical and terminates at either end in epiphyses of calcified cartilage. The fifth metacarpal is the shortest, the third is the longest and the first, second and fourth are almost of equal length.

The manus or hand consists of five clawed digits, each composed of a number of phalanges. The digits are not all of equal length. The third digit is the longest and the first digit is the shortest. The fourth is slightly longer than the second, while the first and fifth are of about the same
length, and are considerably shorter than the second. The first digit is composed of two, the second of three, the third of four, the fourth of five and the fifth of three phalanges. The distal phalanx in each digit is curved and bears a horny claw.

The Pelvic Girdle

The pelvic girdle consists of two tri-radiate bones meeting together in a median symphysis so as to form a composite structure. On each side, the tri-radiate bone consists of three separate elements, the ilium, the ischium and the pubis. At the point where these three bones meet is a shallow cup, the acetabulum, on the outer side. This concave cup furnishes the articular surface for the rounded head of the femur or thigh bone. The acetabulum is imperforate and shows clearly the tri-radiate suture, where the three bones meet. The ilium (Il.) is a compressed rod-like bone,

![Fig. 5. Pelvic Girdle of Calotes. (Nat. size)](image)

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flattened from side to side, passing upwards and backwards to articulate with the transverse processes of the two sacral vertebrae. The ilium is narrow towards the sacral end and broad towards the acetabular end. It has on its dorsal side, a short process close to the acetabulum representing the pre-acetabular process. The pubis is antero-ventral in position and flattened dorso-ventrally. It passes downwards, forwards and inwards to meet its fellow in the median pubic symphysis. There is a small nodule of calcified cartilage—the epi-pubis (Ep. Pb.), between the anterior ends of the two pubic bones. At its posterior broad end, the pubis meets the anterior end of the ilium and furnishes on its outer side, a portion of the acetabulum. A small foramen (for.) is situated near the acetabular end of the pubis. This foramen transmits the obturator nerve. Anterior to this foramen, the pubis
is provided with a triangular process on its outer side. This process is the pre-pubic process (P. Pb.). Anterior to this, the pubis becomes narrow and bends inwards to meet its fellow in the symphysis. The ischium is a shorter but broader bone curved inwards at its anterior border. It is postero-ventral in position and flattened dorso-ventrally. It passes downwards and inwards to meet its fellow in the symphysis ischii, a strip of calcified cartilage being interposed between the two bones in the middle line. At its outer end, the ischium meets the other two bones, viz., the ilium and pubis to form the acetabulum. Between the pubes and ischia is the “foramen Cordiforme” which is a wide heart-shaped space. In the fresh state, a median ligament (lg.) divides this space into two obturator foramina (ob. fo.). A small rod of bone, the os cloacæ or hypo-ischium (Hp. Is.) passes horizontally in an antero-posterior direction from the symphysis ischii along the ventral wall of the cloaca, giving support to it. It is bifid at its posterior end.

The hind limb (Fig. 6) is longer than the fore-limb and springs from the ventral aspect of the trunk towards its posterior end. Each hind limb consists of three divisions termed respectively, the thigh, the shank or crus and the foot or pes. The pes or foot terminates like the manus in five clawed digits, of which the first or hallux is the smallest. The thigh contains a single rod-like bone—the femur (Fem.). It is a fairly stout bone slightly curved in the middle with a cylindrical shaft and broad ends terminating in epiphyses of calcified cartilage. At its proximal end is a distinctly rounded and smooth head which articulates with the bones of the pelvic girdle in the shallow cup of the acetabulum. On its pre-axial side is a stout process—the trochanter—for the insertion of muscles. On the post-axial side the trochanter is poorly developed and insignificant. The distal end of the femur is pulley-shaped with two condyles for articulation with the proximal end of the tibia. A small rounded sesamoid bone is situated in front of the knee joint imbedded in a tendon. This is the patella. In addition to this, there are two small nodule-like sesamoid bones on the pre-axial side of the femur, just below its distal end and another small sesamoid bone on the post-axial side of the distal end of the femur attached to its ventral surface. Similar sesamoid bones have been recorded in Tupinambis by Reese and in Lacerta viridis by Parker.

The middle division of the hind limb contains two bones of unequal size—the tibia and the fibula. The tibia is pre-axial in position and the fibula is post-axial in position when the limb is stretched at right angles to the trunk. The tibia is a stouter bone than the fibula and is
Fig. 1
_Calotes versicolor_
slightly curved in the middle with broader ends. Its proximal end is provided with two articular surfaces for articulation with the external and internal condyles at the distal end of the femur. The fibula is a slender bone slightly curved towards its distal extremity. Its two extremities are also broad and stout. At its proximal extremity, the fibula articulates with a small prominence or tuberosity slightly above the external condyle at the distal end of the femur. The distal end of the fibula is convex and projects slightly beyond the distal end of the tibia and articulates with one of the tarsal bones—the tibio-fibulare.

The tarsus consists of three bones, divisible into a proximal and a distal row. The ankle joint is intra-tarsal, \textit{i.e.,} bending takes place between the proximal and distal row of tarsals. The proximal row consists of a single large bone—the tibio-fibulare (Tb. Fb.). This is a horizontally expanded
irregular bone having two concave articular surfaces on its proximal side for articulation with the distal ends of the tibia and fibula. The distal surface of the tibio-fibulare articulates with the proximal ends of the distal row of tarsals. Of these, there are two separate tarsal bones (dist-tars.). The first is a small calcified nodule in contact with the proximal end of the third meta-tarsal. The second is a larger bone giving attachment to the fourth meta-tarsal.

There are five meta-tarsal bones articulating at their proximal ends with the distal ends of the tarsalia and at their distal extremities with the phalanges of the toes. The first meta-tarsal is short. The second is slightly longer. The third and fourth are almost equal, while the fifth meta-tarsal is a peculiar crooked bone very characteristic in appearance. It is massive and irregular and quite different from the rest. The toes are five in number, each consisting of small rod-like cylindrical bones, the phalanges. The number of phalanges in the toes of the foot, is as follows, viz., 2, 3, 4, 5 and 4 for digits 1, 2, 3, 4 and 5. The distal phalanx of each toe is slightly curved and supports a horny claw.

As compared with *Lacerta agilis* and *L. viridis* (Parker, T. J.3) which have only three phalanges in the fifth toe, *Calotes* has four phalanges in the fifth toe agreeing in this respect with *Tupinambis* which also has four phalanges in the fifth toe.

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