

REPTILES. Reptiles were the ruling animals on the planet for many millions of years during the Mesozoic Era. Today the only big dinosaur-like reptiles are some of the CROCODILIANS and MONITOR LIZARDS. There are about 6000 species of reptiles in the world of which about 540 are found in India. All are ectothermic, that is their body temperature varies according to the surrounding temperature. Almost all are covered with scales which vary in form from the armour of the crocodilians to the smooth shiny scales of the burrowing snakes.

The majority of Indian reptiles are oviparous: one or two eggs in the case of geckos, 20 for a cobra and 40 or more for a saltwater crocodile. A number of SNAKES like the vine snake, sand boas and most of the sea snakes bear living young, these are called ovoviviparous, referring to the fact that the eggs are incubated internally. Snakes lay their eggs in holes in the ground or trees, in crevices or caves. Lizards like chameleons and garden lizards dig holes for their eggs while monitors use termite mounds. Crocodiles, gharial and turtles have particular breeding seasons like the rest of our reptiles, and come ashore to dig holes in which to deposit their eggs.

In general Indian reptiles are carnivorous, snakes and crocodilians strictly so, while a number of TURTLES and a few agamid lizards include vegetable matter in their diets. Tortoises, the land-dwelling cousins of turtles, are almost totally vegetarian, grazing and browsing on a wide range of leaves, flowers and fruit.

See plate 3 facing p. 48, plate 9 facing p. 128, plate 16 facing p. 193 and plate 19 facing p. 256.

RESPIRATION. Respiration, or breathing in land animals, is the process by which oxygen is supplied to the animal body for its energy needs.

Oxygen is essential for life, and except anaerobic bacteria, no living organism can survive without free oxygen. Aquatic animals, whose requirement is relatively small, derive their oxygen from the air dissolved in water, whereas terrestrial animals derive it directly from the air they breathe. This oxygen is consumed for the activity of the animal, and waste gas in the form of carbon dioxide is thrown out.

In aquatic animals the gills constitute the respiratory system. This consists of a feather-like membrane, which, as the water passes over it, extracts the oxygen of the dissolved air, and throws out carbon dioxide. In land animals tracheal tubes, and in land vertebrates the lungs, take up oxygen from the air, and pass it to the blood, which carries it to all parts of the body. Some fishes respire through the vascular rectum where exchange of gases takes place with water which is alternately sucked in and squirted out through the anus. Annelids breathe through the skin, and molluscs through their mantle,

amphibia use both skin and lungs for breathing while higher vertebrates breathe only through the lungs. Lungs are spongy organs containing thousands of small air spaces, the alveoli. These are lined by a thin membrane surrounded by a rich network of blood vessels, the exchange of gases between the blood and alveolar air being made across the alveolar membrane.

The respiratory system, in addition to maintaining oxygen supply, also has certain subsidiary functions. Breathing can also help in temperature regulation, the panting of dogs in hot weather being a mechanism for discharge of excess heat.

The lungs of whales are probably hydrostatic as well as respiratory in function. Whales have capacious nasal chambers storing a large amount of air which would otherwise be forced out of the lungs by the enormous hydrostatic pressure during a deep plunge. The aperture from the nasal chamber to the lung can be closed off by a stopper-like arrangement, to permit the expulsion of stale air which comes out together with water vapour as a waterspout.

Chameleons have lungs which can swell up, perhaps to frighten predators. The inflatable lungs of a sea turtle act as floats, to help in maintaining its balance in turbulent water. Birds' lungs are connected with a system of air sacs which helps the bird, by adjusting the air contents, to alter the position of its centre of gravity and balance during flight. The flying muscles pump the reserve of fresh air from the air sacs to the lungs and also control respiratory movements. The faster the flight the greater is the automatic supply of air drawn through the lungs. Birds do not get out of breath or suffer from mountain sickness at high altitude. This is probably because the increase of wing-strokes in rarefied air brings in a compensatory supply of air. The frigate bird, which easily maintains a speed of 100 miles an hour, has the best-developed air sacs.

RHINOCEROSES. The first rhinoceroses lived about 50 million years ago. They were small, horse-like creatures with rather slender legs, hairy hides and no horns. The rhinoceroses soon became one of the dominant and most diverse groups of mammals. Among the many different forms which evolved was the largest land mammal ever to have walked the earth—the 6-metre-tall *Baluchitherium* which lived in Pakistan and Mongolia 20 million years ago.

Today only five rhinoceros species survive and they are all gravely threatened with extinction, by loss of habitat and poaching for their valuable horns. The Black Rhinoceros (*Diceros bicornis*) and the White Rhinoceros (*Ceratotherium simum*) live in Africa, whereas the Greater One-horned or Indian (*Rhinoceros unicornis*), the Lesser One-horned or Javan (*R. sondaicus*) and the Asian Two-horned or Sumatran (*Dicero-*

RHINOCEROSSES

rhinus sumatrensis) rhinoceroses live in Asia.

Only the Greater One-horned or Indian Rhinoceros survives on the Indian subcontinent, although until early in this century there were a few Sumatran rhinos in the hills of northeastern India. Indian rhinos were once widely distributed on the flood plains of the Indus, the Ganga and the Brahmaputra rivers. Accurate representations of the Indian rhino found at Mohenjodaro indicate that the species occurred as far south and west as the present Sind province in 2000 B.C. The Mogul Emperor Babur hunted rhinos at Nowshera near Peshawar as late as 1519. The extent of the historical distribution of the Indian rhino to the east is complicated by confusion in the literature between the Indian and Javan rhinos. The Indian rhino has probably never been found far east of the present boundaries of India and Bangladesh, but there are a few records from northern Burma up until 15 or 20 years ago. Today the Indian rhino numbers fewer than 1500 individuals restricted almost entirely to eight small protected areas in Assam, West Bengal and Nepal: notably the Kaziranga National Park in Assam and the Royal Chitawan National Park in Nepal.

The Indian rhinoceros is the second largest of the five living species. Adult males weigh up to 2070 kg and stand up to 186 cm at the shoulder. Adult females are slightly smaller, weighing about 1600 kg and measuring about 160 cm at the shoulder. Both sexes have a single well-developed horn on the nose, which reaches a maximum length of about 60 cm but is normally between 15 and 45 cm long. In common with the other two Asian species of rhinoceros, both sexes have a pair of lower incisor tusks which reach lengths of up to 20 cm in adult males and are used in combat in preference to the horn. The chewing teeth (the molars and premolars) are high-crowned with a complex pattern of enamel which indicates a diet mainly of grass. The prehensile upper lip is used to gather in tall grasses and shrubs, but the tip can be folded under and opposed against the lower lip for cropping short grasses with the lips only. Two folds of skin encircle the body,

one behind the forelegs and one in front of the hindlegs. There are deep skin folds around the neck, particularly in adult males, and the skin of the rump is also folded and studded with tubercles.

The typical habitat of the Indian rhinoceros is the alluvial plain grasslands and woodlands of the often meandering rivers of northern India, where the grass may reach heights of 8 metres, where the *Bombax* trees flower in the spring time, and where abandoned river-beds and ox-bow lakes provide ample wallows and swampy feeding grounds. The rhinos' diet is varied. In Nepal 183 food species belonging to 57 botanical families have been recorded, but grass (50 species) made up between 70 and 90 percent of their diet according to the season. Other foods include shrubs, saplings, fruits and aquatic plants. Considerable seasonal variation in the availability of these foods results in regular movements of rhinos between types of vegetation. Most rhino movements are local and related to the availability of different foods, or flooding during the monsoon. As the rhinos have become more and more restricted to protected areas and their previous ranges have been cultivated, they have begun to raid the rice and maize crops of surrounding villages more frequently.

Although many rhinos may be seen grazing or wallowing together, they are generally solitary in habit and move independently of one another or in small groups. The most permanent associations are between cows and calves. For over three years they remain together, the mother only driving the youngster away shortly before the birth of a new calf. Some calves may stay with their mothers for up to five years. Physical contact is very important for a calf, which will often rub its head and flanks along its mother's body, sometimes climbing on to her back if she is lying down, or biting her ears and horn, or licking her skin. Frequently a calf frolics around the mother, sometimes picking up a stick in its mouth and charging back and forth with it like a young puppy. The mother rarely joins in the game, but if disturbed incessantly she will stand and suckle her calf from the side or between the hind legs. Nursing continues with decreasing frequency until the calf is over two years old.

Calves are always curious to initiate encounters with other rhinos, but mothers chase off strangers, sometimes quite fiercely. It is normally cows with calves that attack humans—and occasionally kill them—if surprised at close quarters. Oddly, however, cows sometimes leave their small calves unattended while they graze up to nearly a kilometre away. This only happens with calves younger than six months, and may explain how tigers can occasionally get near enough to kill calves. Each year about six calves are lost to tigers in Kaziranga and one or two in Chitawan. During the second year after the birth of her calf a cow comes into estrus again and is fertilized by a bull. The new calf is born after a



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Great Indian Rhinoceros cow with new-born calf,
Kaziranga, Assam $\times \frac{1}{20}$

gestation period of about sixteen months. The older calf, driven away by its mother, suddenly becomes much more nervous. Young males in particular are subject to attacks by adult bulls and they respond to this risk by fleeing at the slightest hint of danger, standing alert at the crack of a twig or the approach of any animal. They also band together in groups of two or three, sometimes up to seven or eight, or with another cow-calf pair.

Aggressive interactions between rhinos, in particular between males, are frequent and sometimes result in the death of one of the combatants. Ten different vocal displays and visual displays such as the baring of the incisor tusks are used during encounters. Adult bulls fight among each other to determine a dominance order. The dominant bull in any one area will tolerate the presence of other bulls so long as they do not challenge him or attempt to mate with females in the area. The self-confident, dominant males display by squirting their strong-smelling urine in long jets behind them from their backward-pointing penises. They also drag their toes in the earth while walking, to make long parallel furrows on which the urine falls. These dominant males appear indifferent and even curious when disturbed by man, and may follow human scent instead of fleeing from it. They patrol their domains, visiting the numerous piles of dung which are typical of 'rhino country' and following the scent of any females in estrus. The mating chases of Indian rhinos are renowned for their length and noisiness: the female 'squeak pants' as the male charges after her for up to several kilometres. Although there is no proof, it is possible that this behaviour is a way for the female to advertise the fact that she is in estrus and to ensure that in the thick bush and grassland she is not mated by a bull of inferior strength.

Threats to the continued survival of the Indian rhino include poaching, encroachment by cultivators and stock-grazers, erosion as a result of annually increasing flood levels, and invasion of some of the Indian reserves by exotic plants. Ninety percent of the surviving rhinos live in two National Parks containing a total of only 500 km² of suitable habitat. Any catastrophe in Chitawan or Kaziranga, such as an epidemic disease or severe flooding, could drastically deplete the total rhino population. It is to guard against such an event that Indian rhinos have begun to be translocated to other protected areas within the former range of the species. As well as spreading out the population and insuring against a catastrophe in one reserve, removal of animals from the densely populated Kaziranga Park is helping to prevent overcrowding. Also, some of the smaller, isolated reserves in West Bengal and Assam may benefit from the introduction of new genes into their rhino populations.

W.A.L.

See UNGULATES.

RHIZOME. The rhizome is an underground, dorso-ventral stem or branch which grows horizontally under the surface of the soil. Rhizomes are usually brownish in colour so that they are easily mistaken for roots. However, they are distinctly divided into nodes and internodes, bear scaly leaves at the nodes, and possess axillary as well as apical buds and thus can be easily distinguished from them. In several instances, adventitious roots may also develop at the lower surface of their nodes.

The more common types of rhizomes are rather fleshy due to the storage of food materials in them. Since an apical bud in them gives rise to the annual shoot which dies at the close of the season, leaving a scar, the rhizome continues its growth by a lateral bud. Common examples of such categories are ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*) which are profusely branched. The rhizome of *Canna*, on the other hand, belongs to the other group since it shows poor branching. Rarely monopodial rhizomes may be found as in ferns like *Pteris*. A special type of rhizome is the root-stock of *Alocacia* which grows vertically rather than horizontally. The creeping sobole may be considered either as a thin rhizome or a runner.

From a single rhizome, several saplings can be obtained by dividing it into sections, each with at least one bud. For example, in certain orchids the rhizome is used to propagate the variety. Similarly, the rhizomes of several weeds get cut into sections during soil cultivation and each portion becomes potentially a new plant.

If we examine the internal tissue organization of rhizomes, it is seen that the cortex is usually parenchymatous, but it may consist of spongy or more compact tissues. In some genera it is made up of relatively thick-walled cells also.

In members of the Pineapple family (Bromeliaceae), the rhizome shows somewhat quantitative difference because here the periderm is often formed by the suberization of the outer cortex by the cell division. There are well developed intercellular air-spaces in the ground tissue as well. In some cane-like palms (e.g. *Bactris* and *Rhapis*), and climbing palms, creeping rhizomes are found. The rhizomes of *Rhapis* do not differ markedly from the aerial stems. Grass rhizomes are well developed and similar in structure to the culms. It is generally seen that sclerenchyma is less developed, and the ground tissue frequently serves for the storage of starch or other food reserves.

See also ROOT.

RIBBON FISHES of the family Trichiuridae, also known as hair-tails, are as the name suggests flattened, long ribbon-like forms with sharp teeth and long compressed jaws and a pointed tail. Two species, *Trichiurus lepturus* and *Lepturacanthus savala*, are more common among their six species. They occur on both coasts of

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