REPTILES THAT JUMP AND FLY

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INTRODUCTION

When, as an undergraduate, I returned to Cambridge after the War, I had the good fortune to be supervised by Dr Hugh B. Cott, who had been in charge of army camouflage in North Africa. We remained very good friends until his death about 15 years ago. Hugh's interests ranged from adaptive colouration in animals (Cott, 1940), through various aspects of tropical biology to the edibility of birds and their eggs; but his favourite animals were birds and reptiles, especially crocodiles. This latter interest culminated in his important study of the Nile Crocodile (1961).

I shared his liking for herpetology - as a child, my own favourite animals had always been crocodiles, followed by elephants. It was only later that I added jumping-spiders and Solifugae (Camel-spiders) to the list. (When I was a child, amphibia were easy to come by, Crested, Smooth and Palmate newts, frogs and toads were all fairly common. Reptiles were naturally seen less often although, according to my diary, I found four Adders, two of them black, within 100 yards of each other at Effingham, Surrey, on 6 May 1935).

Cott was strongly of the opinion that predation is, by far, the most important of the selective factors that are responsible for animal adaptation, and his enthusiasm for the subject aroused my own interest in the subject of defensive responses among animals (cf. Cloudsley-Thompson, 1980; 1994; 1995). He was a superb photographer and an accomplished artist. Of all the lecturers who taught me, he was the only one ever to use the adjective 'beautiful' whilst describing a species of animal (or plant). 'Interesting' or 'intriguing' were the more usual expressions.

JUMPING

But there was one thing about which Hugh Cott did not tell me. Surprisingly, some lizards and snakes are able to enhance their chances of escape from predatory enemies by jumping, or saltation. This is particularly marked in Pygodidae of the genera *Aclys*, *Delma,* and *Ophidiocephalus* : *D. tincta* is one of the most excitable species known. When an individual is disturbed, it is said to twist its body and jump about in a fantastic display of aerobatics.

Over 30 species of snake-lizards (Pygopodidae) are distributed throughout Australia, Tasmania, and New Guinea. Their tails are extremely long, exceeding the length of the head and body, and there are no front limbs. The back legs are reduced to mere flaps, which are often quite small, and their movement is snakelike. Pygopodidae is the only reptile family endemic to the Australasian region: and it is allied to the geckos (family Gekkonidae). Although saltations may account for a high rate of success in escaping predation, escape *per se* is probably not the sole function of the response. Rather, it appears to be a mechanism for startling or disorienting potential predators, and for eliciting misdirected strikes. Furthermore, the long tail is readily autotomised. When first broken off, its lively movements serve to confuse the enemy long enough for a snake-like lizard to make its escape.

Other lizards, such as the Asian desert *Phrynocephalus mystaceus* (Agamidae) are also capable of jumping. *P. mystaceus* sometimes burrows rapidly into the sand when threatened. If the source of danger is nearby, however, the lizard jumps, rises high on its legs, and faces the intruder, threatening defensively. Many fast-running species make jumps when escaping speedily - as do others, such as *Basiliscus basiliscus* (Iguanidae), *Crotaphytus collaris* (Iguanidae) and *Chlamydosaurus kingii* (Agamidae) which adopt a bipedal posture under such conditions. Doubtless many of the lighter bipedal dinosaurs would also have been able to leap and jump like fighting cocks, to judge by the massive claws on their back legs. This would apply, for example, both to Coelurosaurs such as *Deinonychus* and *Velociraptor*, as well as to ornithomimosaurians including *Ornithomimus, Callimimus* and *Struthiomimus* spp.

Whereas, in other carnivorous dinosaurs, the third toe was the longest, the second and fourth being considerably shorter, in *Deinonychus anterrhopus* the fourth and third toes were of equal length and the dinosaur walked and ran only on these two toes. The first toe was short, with a small backward-pointing claw from which the animal got is generic name which means 'terrible claw'. When the dinosaur walked along, this claw was raised clear of the ground. It could, however, have been swung through a very long arc and, when brought into action in defence, or when disembowelling prey, would have been driven backwards with the power of the entire limb. Not only would *Deinonychus* have had to balance on one leg whilst tearing prey that was grasped by the long-clawed fingers of the hands, but it might well have jumped and slashed at an enemy with the claws of both legs simultaneously. The discovery of the remains of about five individuals with those of a large herbivore weighing some six times as much as a single *D. anterrhopus* suggests that these dinosaurs may well have hunted in packs, just as lions do today, and were thus able to tackle prey very much larger than themselves (Halstead & Halstead, 1981).

It is by no means unexpected that bipedal, and even quadrupedal reptiles, should be able to jump. It is more surprising to learn that some snakes are able to do the same. For instance, the 'jumping viper' *Bothrops nummifer* (Crotalinae), which receives its Spanish name 'mano de piedra' from its resemblance in appearance to an implement used in crushing corn for tortillas, is particularly savage. A stocky, terrestrial pit-viper of Mexico, Guatemala, Honduras, San Salvador and Panama, it spends the day basking on, or sheltering beneath or inside fallen logs, piles of leaves and so on. At dusk, it becomes more active and may forage actively or wait in ambush for the small rodents, lizards and frogs on which it preys. It lives up to its name by sometimes striking with such force that it actually leaves the ground and makes a short jump. When striking from the side of a log, or from a bank, it may even be able to propel itself from more than a metre. It strikes defensively as well as in offence and, when thoroughly frightened, flails about, striking wildly, and turning quickly to keep the enemy in view. Similar behaviour has been observed in other ground-dwelling species of the genus, and provides and explanation for their popular name, 'lance snakes'. Some speedy Colubridae, such as the large green rat snake (*Ptyas nigromarginatus*) of southern Asia, can hurtle through the air down steep slopes for considerable distances in pursuit of prey or escape from enemies. *Chrysopelea* spp. (see below) are also able to jump from the branches of the trees among which they live. Finally, cryptozoologists have reported a mysterious jumping snake from the environs of Sarajevo. Could this be *Coluber viridiflavus*, the Western Whip Snake?

GLIDING AND FLYING

No modern reptiles are able to fly, but some can glide for considerable distances. Of these, the most remarkable are the flying dragons (*Draco* spp.: Varanidae) of South East Asia, flying geckos (*Ptychozoon* spp.: Gekkonidae) of the same region, and flying snakes. In *D. volens* and related species, the body is depressed and can be extended sideways by five or six elongated ribs. These flying lizards glide through the air, buoyed up by scaly fingers which run along the sides of the head, limbs, body and tail, and by webs between the digits (Fig. 1). *Kuehneosaurus* sp. (Fig. 2) of the Upper Triassic Period, about 220 million years ago, was another well adapted flying lizard.

Fossils of another Triassic reptile, *Sharovipteryx mirabilis*, show that this, too, was a glider. Its hind limbs were more than three times as long as the fore legs. Their proportions exceeded those of agamid lizards, such as *Otocrypsis* and *Amphibolurus* spp., which run and jump with the trunk elevated so that the forelimbs may, or may not, touch the ground between strides. *S. mirabilis* was probably a runner and jumper too which, like modern flying lizards, inhabited the terminal branches of trees. The membrane or 'patagium' between its limbs and elongated tail almost certainly served as a gliding membrane. It may also have aided camouflage, reducing the outline of the creature as, for instance, do the lateral flaps of certain Pacific geckos (Cloudsley-Thompson, 1994).

Back-fanged colubrid tree snakes of the genus *Chrysopelea* (e.g. *C. ornata*) not only scale the trunks of forest trees by pressing the coils of their bodies against irregularities in the bark; but they can glide obliquely through the air with bodies rigid and ventral surface concave so that they present maximum resistance to the air. They can also spring from one branch to another by coiling their bodies and then rapidly straightening them.

Only four taxa of animals have acquired powered flight with true wings. These are insects, pterosaurs, birds and bats. Whereas the early pterosaurs would have been gliders, later forms possessed large, keeled breast-bones for the attachment of the powerful wing muscles necessary for true flapping flight. The pterosaurs first appeared in the fossil record during the Upper Triassic, and flourished until the close of the Cretaceous Period, some 155 million years later. Two separate types are recognised: the Rhamphorhynchoidea which had long, stiff tails, and the Pterodactyloidea (Fig. 3) whose tails were short. Many of the members of both groups were no larger than pigeons, but some of the Cretaceous pterodactyls were huge. *Quetzacoathus* had an estimated wing span of 11 m and was the largest flying animal known. Computer studies of *Pteranodon* have shown that pterosaurs were adapted for low-speed flying and, like large birds, would have soared on weak thermals. Their low stalling speeds enabled them to take off by facing into the wind with wings extended, and they probably did not fly when strong winds were blowing. The long crest on the back of the head (Fig. 3) would have counteracted the twisting effect of wind on the beak (McGowan, 1991).

CONCLUSION

Escape from enemies and capture of prey are undoubtedly the two components of natural selection that have most influenced the morphology and life styles of reptiles. Which of them has been the more important in the evolution of the ability to jump, glide or fly, cannot easily be determined because those three endowments have multiple functions and are used both in defence and offence.

Fig. 1. Flying dragons (*Draco volens*) (From Cloudsley-Thompson, 1994. After H. Gadow, 1901) (Length approx. 15 cm).

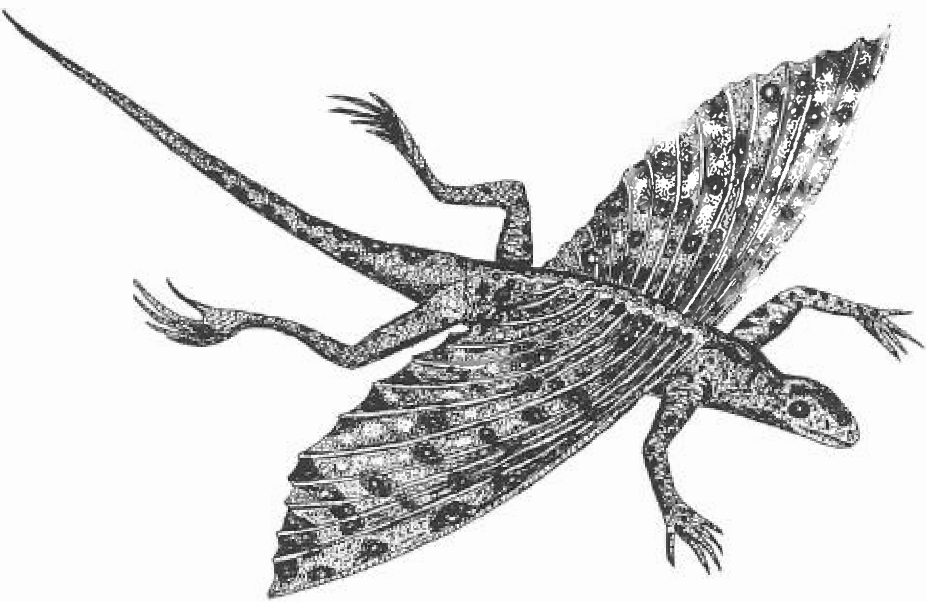

Fig. 2. Reconstruction of *Kuehneosaurus* sp.: Upper Triassic. (From Cloudsley-Thompson, 1994. After A. Charig, 1979) (Length approx 75 cm).

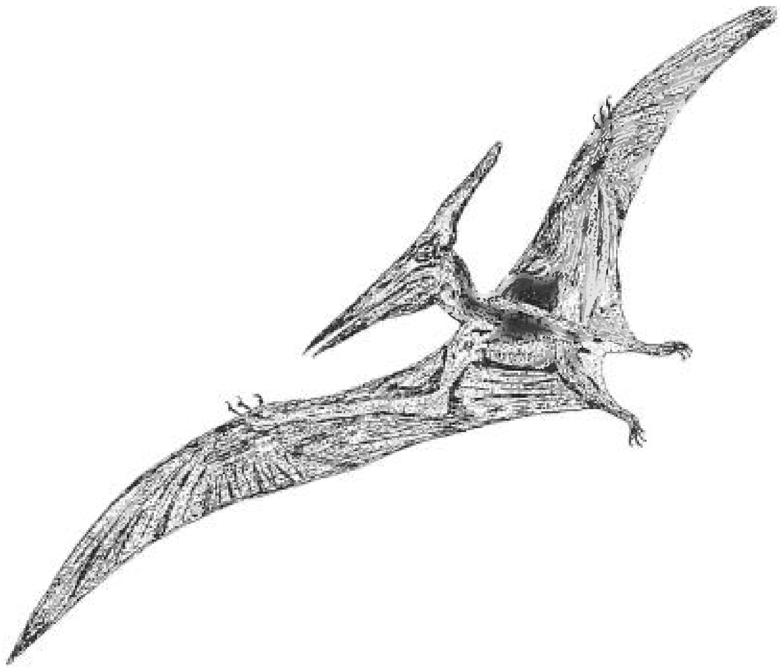

Fig. 3. Reconstruction of *Pteranodon* sp.: Upper Cretaceous. (From Cloudsley-Thompson, 1994) (Wing span approx 7 m).

Certainly, however, nobody who has studied the behaviour of reptiles in the field would disagree with the opinion expressed by Hugh Cott that the most conspicuous adaptations seen in most animals have been engendered in response to predation.

REFERENCES

Cloudsley-Thompson, J.L. (1980). *Tooth and Claw. Defensive Strategies in the Animal World.* J.M. Dent & Sons, London. 252 pp

Cloudsley-Thompson, J.L. (1994). *Predation and Defence Amongst Reptiles.* R & A Publishing, Taunton, Somerset. *viii* + 138 pp

Cloudsley-Thompson, J.L. (1995). A review of the anti-predator devices of spiders. *Bulletin of the British Arachnological Society*, **10**(3): 81-96.

Cott, H.B. (1940). *Adaptive colouration in animals.* Methuen, London. *xxxii* + 508 pp

Cott, H.B. (1961). Scientific results of an enquiry into the ecology and economic status of the Nile Crocodile (*Crocodilus niloticus*) in Uganda and Northern Rhodesia. *Transactions of the Zoological Society of London*, **29**: 211-356.

Halstead, L.B. & Halstead, J. (1981). *Dinosaurs.* Blandford Press, Poole, Dorset. 170 pp

McGowan, C. (1991). *Dinosaurs, Spitfires, and Sea Dragons.* Harvard University Press, Cambridge, Mass. *x* + 365 pp.