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## RESULTS OF THE DOUGLAS BURDEN EXPEDITION TO THE ISLAND OF KOMODO

### V.—OBSERVATIONS ON THE HABITS AND DISTRIBUTION OF *VARANUS KOMODOENSIS* OUWENS

BY WILLIAM DOUGLAS BURDEN

In the first of this series of papers Dr. E. R. Dunn has discussed the distribution and relationships of the giant monitor, *Varanus komodoensis* Ouwens. I mentioned in my narratives (1927) of the trip which we made to Komodo and adjacent islands some of our observations on the habits of this species. The present paper represents a summary of our more significant observations, together with some comment on the factors controlling the distribution of *Varanus komodoensis*. These notes, although admittedly incomplete, are of interest in that they add a number of new facts to our existing knowledge of the largest species of lizard living today.

It is hoped that the following observations will be of use to future field students who may visit Komodo. There is much still to be learned about the habits of *Varanus komodoensis*. June and July are ideal months to visit Komodo. I have never known a more salubrious spot to live and work in.

Komodo Island, by an act of the Dutch Colonial Government, is a game preserve. Thanks to the Governor General of the Dutch East Indies, we were given permission to secure fifteen specimens.

#### DISTRIBUTION

*Varanus komodoensis* is now known from four islands: namely, Komodo, the adjacent islands of Rindja and Padar, and the western extremity of Flores. So restricted is the range of this great lizard that certain obvious questions arise: (1) Whence did *komodoensis* come? (2) By what route did the species reach these islands? (3) If the lizards were successful in crossing large water barriers, as it is evident they must have been, what factors now prevent them from extending their range?

The first question has been answered by Dr. Dunn (1927), who concludes that *komodoensis* is derived from Australia. The weight of evi-

dence seems to be conclusive but it cannot be reviewed here. As the second question has never before been touched on, I would like to suggest a possible migration route from Australia to Komodo.

To begin with, the Lesser Sunda Islands, built up by volcanism along the axis of the Sunda fold, are of fairly recent origin. The first of them appeared above sea-level in the Pliocene (cf. Brouwer, 1925). Some are still under construction. They have never been connected by land with Australia. In fact, the physiography of the sea-bottom, as determined by soundings, indicates that a geosynclinal trough trending east-west separates the Lesser Sundas from the Sahul Shelf. Many of the islands of this group, however, have been connected with each other, for transverse faulting of the great Sunda fold has been of frequent occurrence. There is evidence indicating that Rindja and Padar and Komodo were at one time all connected and that they have subsequently, through transverse faulting, become detached, but it is inconclusive. Be this as it may, since *Varanus salvator* has succeeded in working its way from Java, the entire length of the Lesser Sunda chain, there is no reason that *komodoensis* is not capable, in like manner, of bridging extensive water barriers.

A glance at Brouwer's map (1925) of the East Indies reveals the Sahul Shelf extending northwestward from Australia nearly to Timor and northward to and including the Aru Islands and New Guinea. This shelf was, during the Pleistocene glacial periods, a part of the Australian continent. Thus, in the Pleistocene, the jump from the northward limit of Australia to the island of Timor is with the prevailing southeasterly trade-winds a fairly easy gulf to bridge, when the various methods of accidental transportation are considered. From Timor, *komodoensis* could have made its way, step by step, along the old outer arc of volcanic islands to Sumba, just as *salvator* has made its way similarly along the newer Lesser Sunda Island arc from Java to Wetar. The next jump from Sumba to Komodo under the influence of the same southeasterly trade winds is no more difficult to bridge than the original Timor jump. Here, at least, is a tentative explanation which accounts for the curious manner in which *Varanus komodoensis* bisects the range of *salvator*. There is one criticism however, namely, that, as Dr. Dunn (1927) points out, *salvator* occurs on Sumba and that inasmuch as these two species seem to be mutually exclusive, *komodoensis* must have passed that point on its migration before *salvator* arrived. This, however, is pure speculation. The ecological relation between *salvator* and *komodoensis* on Flores is as yet undetermined. However, if *komodoensis* is found on Solor, the above route will have to be modified.

Now, as to the third question, why does *Varanus komodoensis* occur over such a very limited area? In consideration of what is known of other varanids, one is forced to the conclusion that there is a definite answer to the problem, that there are, so to speak, "limiting factors." It is these factors which we wish to determine. In order to facilitate this study, it will be well to record here the observations of the writer made during four weeks residence on Komodo, from June 9 to July 10, 1926. Until some hypothesis is offered to account for the facts, we must regard any observations as important whether or not they have an apparent bearing on the problem.

#### ENVIRONMENT

Komodo consists of a semi-arid, rather open, rugged country covered with alang-alang grass, *Imperata cylindrica*, stately gubbong or lontar palms, *Borassus flabelliformis*, and clumps of jungle into which *komodoensis* may retreat when danger threatens. The lizards were found both in the open country and in the jungle. So far as could be gathered from native descriptions, Rindja is strikingly like Komodo, as is also the only section of Flores in which these lizards are found. It is possible, therefore, that the restricted distribution of this beast is to be accounted for by the limits of a specific type of environment. Perhaps the western tip of Flores is the only section of that large island which affords suitable conditions for the survival of *Varanus komodoensis*, or, possibly the lizard has only recently established itself on Flores and has therefore not yet had time to extend its range. This is a matter for investigation. From the descriptions of De Rooij, it is evident that the western tip of Flores bears a striking resemblance to the typical Komodo landscape. It may be, therefore, that environmental factors are responsible for the restriction of range.

Padar, a small island lying east of Komodo, is for the most part an arid, upraised coral reef, and judging from the scarcity and size of the lizards (no large tracks were seen on the island) we may infer that the environment here is not wholly suitable. We have then, it would seem, an animal which dislikes both extreme aridity and dense jungle, but which seems rather to demand a combination of both.

#### RELATION TO OTHER ANIMALS AND FEEDING HABITS

On Komodo, *komodoensis* takes the place of the tiger of Asia and the lion of Africa as the formidable carnivore. Komodo is the local word for rat, yet strangely enough, we found no rats on the island. In certain sections of the East Indies, rats have been known to increase in propor-

tion to the decrease of *Varanus salvator*. Perhaps the Komodo rats have been wiped out by the lizards, since the island was named. As our traps yielded only one shrew, it is evident that the lizards do not subsist on small mammals. According to the evidence of stomach contents, and later confirmed by watching animals feeding on killed game, deer (*Cervus timoriensis*) and wild boar (*Sus vittatus*) form their staple diet, though birds and eggs no doubt often make an addition to the menu. As the giant monitors are plentiful on Komodo, we cannot imagine that enough deer and wild boar die a natural death to afford them a constant food supply. The logical conclusion then is that *Varanus komodoensis* deliberately attacks and kills these herbivores, a conclusion that is further supported by the fact that on one occasion I witnessed a large lizard that seemed to be stalking a wild boar. The boar eventually got wind of the approaching reptile and made off at top speed. The conclusion is supported yet again by a story related to me by the Dutch Resident of Bima, Sumbawa, in which he stated that a large lizard (the very one incidentally which eventually reached the Amsterdam Zoo) had, while chained to a tree on the outskirts of the town, jumped upon an old pony that strayed within reach. On asking to see the pony which had been attacked (in order to observe the scars), I was informed that the unfortunate beast had been so severely lacerated that it had to be shot.

According to the natives, wild horses are plentiful on the island of Rindja where they form the chief food supply of the giant lizard. I can hardly credit the tale but it is interesting, if true. On Padar, the lizards live almost entirely on turtle eggs which they dig up on the beaches. This was determined from the droppings which often contained undigested remains of egg shells. Further, the specimens we brought alive to New York ate hen eggs and Sachs (1927) reports the same for a specimen later brought to the Berlin Zoo.

In its relation to man, *komodoensis* is instinctively wary. This seems strange in view of the fact that Komodo has, until recently, been uninhabited. There was no indication that the giant monitors would attack man, but like all carnivores, they will fight desperately when cornered. As with other varanids, the tail is used as a weapon of defense. The lizards are obviously antagonistic toward each other. Two specimens of approximately equal size will, occasionally, fight for their prey. This observation, originally recorded by Ouwens' collectors is substantiated by Dr. Dunn (unpublished field notes).

They are so voracious that they will eat any rotten meat including that of their own kind. If one of their number is wounded, it is subject

to attack. But, although these beasts are cannibalistic, we do not know whether a large lizard will purposely hunt down and devour a small one. Judging, however, from the celerity with which small animals invariably made way for the larger ones, it looked as though they felt themselves to be too dainty a morsel to tempt fortune.

In watching from a blind, it is interesting to see how the feeding lizards used their teeth which are so well adapted to cutting and tearing (Fig. 1). The flattened, recurved teeth have sharp serrated edges.

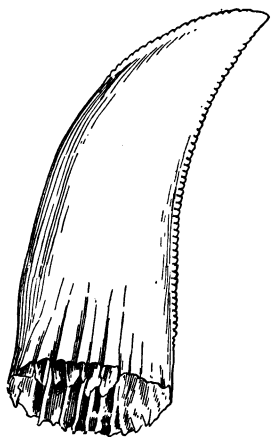


Fig. 1. Tooth of *Varanus komodoensis* Ouwens.

When a lizard bites, he rocks back and forth on braced legs throwing all his weight into each backward movement so that the teeth literally saw and cut their way through the hide of the prey. It is remarkable to see the ease with which a piece of tough hide can be cut out of the flank of a dead water-buffalo by these specialized, homodont teeth. When a piece of flesh has been detached through the see-sawing motion above described, the whole slab is gulped down regardless of size. As the morsel descends, the skin of the neck becomes greatly distended. Then, the beast licks his chops with his thin yellow tongue, rubs both sides of his face on the ground, as if to clean it, and lifts his head high, the better to observe the landscape. On one occasion, a lizard swallowed the entire hind quarters of a deer at one gulp—hoofs, legs, hams, vertebræ and all. The feeding process, though loathsome to watch (the writer frequently saw lizards run off with long strips of intestine dangling from their jaws) is, nevertheless, of great interest in that it probably gives us a fairly accurate picture of the way in which carnivorous dinosaurs devoured their prey. When disturbed at a feast, they were apt to vomit the contents of their stomach. One would hardly expect to find such an immediate nervous reflex in so low an order of vertebrates.

A most interesting problem, mentioned above, is to determine the relation between *komodoensis* and *salvator* in western Flores. It has been noted that these two predatory species, occupying as they do practically the same environmental niche, would seem to be mutually exclusive. What then is their relation on Flores? Do they invade each others' domain or is there an unseen boundary line between the habitat of the two species, and if so, why?

## HOME RANGE OF THE INDIVIDUAL AND THE QUESTION OF DEAFNESS

There is no reason to believe that the home range of the individual lizard is in any way restricted on Komodo. The animals seem to wander all over the island up into the mountains and down again. Some specimens which we killed at sea-level contained the bones of wild buffalo. Buffalo do not occur on Komodo below two thousand feet. The nearest ones were certainly six or seven miles away so that, although the lizards no doubt prefer to return to their own burrows at nightfall, they are willing, on occasion at least, to wander afield. There was no indication that they prefer the warmer temperature of sea-level. Food supply rather than temperature seems to be the governing factor.

From the fact that these lizards did not usually appear at the baits which we set out for them till on toward ten o'clock in the morning when the sun was getting very warm, we accepted the general belief of the natives that they almost invariably seek an underground retreat at night. This may be due to the chill air that comes on rapidly after the sun goes down, or again, it may be that they are unable to detect approaching danger except by sight, and therefore prefer the safety of their burrows when visibility is low.

But as to the supposed deafness of *Varanus komodoensis*, there is more to be said. Mr. Aldegono reported that the beast is quite deaf, so much so, "that if care is taken that the animal does not see the hunter, the latter may make as much noise as he pleases without the animal being aware of his presence." This observation has been confirmed by subsequent observers, *i.e.*, the collectors sent to Komodo by Ouwens and by Dr. Dunn and myself. We would frequently sit chatting and laughing in a boma watching lizards not twenty yards away that were wholly unaware of our presence. On several occasions we shouted but the shouts had no effect and we concluded, therefore, that Mr. Aldegono was correct. Recently, a letter from Miss Joan B. Procter of the London Zoo, to whom I had written for information concerning the pair of *Varanus komodoensis* now residing at the New Reptile House there, says: "and they certainly are not deaf." When in their cave they have been known to come out when the keeper calls and obviously to pay attention to his voice when he speaks to them. And she concludes, "I think there is no question whatever that they can hear quite as well as other large *Varanus*." "On the other hand," she says, "in common with many of the larger and more powerful species, they do not always bother to pay attention to sounds and will frequently sit with a wooden expression when noises are made for experimental purposes." I wonder why, on Komodo,

the lizards should have been so very wary of the sight of man and so wholly indifferent to the sound of his voice. I do not feel that the question of their hearing is settled as yet. It is possible that the small black eyes which are sunk beneath projecting supra-orbital bones are so accute that *Varanus komodoensis* relies on them entirely to detect danger.

The long, bifurcated tongue is used as a sensory organ, but we know nothing more concerning its specific function.

#### NUMBERS AND DIMENSIONS

Komodo island is about twenty-two miles long by twelve in width. As our operations were restricted to the general region adjacent to Sawa Bay and from there to the summit of the island, I can say nothing about the southern portion which was never visited. The natives in the convict settlement of Sawa Bay (the only inhabitants of this island) could give us no reliable information, but it is obvious that, if game is plentiful on the southern half of the island, the lizards must be equally abundant there, where they have never been molested by man. Any estimate of the actual numbers on the island would be mere guesswork. Suffice it to say that I saw with my own eyes approximately fifty different lizards, at least ten of which were full-grown beasts. One can frequently recognize individuals. Where such recognition was possible, I have of course excluded them from the count. In the same length of time, Dr. Dunn saw fifty-four.

Whether at any time the lizards were much more plentiful than they are now is doubtful. As the island today is full of game, the lizards cannot ever have had a much greater food supply.

Recently, trappers and poachers have bagged a good many skins but, owing to the bony plates or osteoderms, the hides have no commercial value. Moreover, as the Dutch Colonial Government has had the wisdom to make of the island a game preserve, poachers will be dealt with severely.

A word as to size. The largest male which we secured measured 2.765 meters, approximately 9 feet, 2 inches; the largest female 6 feet, 6 inches. As Dr. Dunn (1927) has pointed out, it would seem after an examination of no less than 73 specimens that the reports published by Ouwens as emanating from Messrs. Aldegon and Koch, in which it was stated that the former had shot some specimens between 6 and 7 meters in length, are utterly inaccurate. The report that Sergeant Becker killed one of 4 meters is also unsupported by material evidence. Further,

Sachs (1927, p. 455) quotes Becker in a recent publication as saying that he never killed or saw a specimen over 3.60 meters. It is believed therefore that these reports can be dispensed with. Sachs, however, stated that a specimen of *komodoensis* brought to Senckenberg Museum measured 3 meters, in spite of an estimated loss of some 25 cm. of tail. He does not state, however, that these measurements were taken before the animal was skinned. So much depends on how an animal is measured that I feel that more details are necessary before this record measurement can be accepted.

The weight of a half-starved eight-foot specimen at the Zoo when it finally died was a hundred pounds.

#### COLORATION, MOVEMENT, AND POSTURE

The color of *Varanus komodoensis* Ouwens describes as being a dark brown. As seen in the open, the animal appears to be rather a greenish black, a color which stands out conspicuously against a green or light-brown background. It is rather by their actions, habits and poses that the beasts protect themselves. When traveling in the open grass country, they keep their heads close to the ground, and stride along in a most ungainly fashion, the head swinging heavily from side to side, the body twisting snakily, the tip of the tail usually dragging a short distance from the tip but sometimes held rigidly off the ground. This walk was so characteristic that we used to refer to it as the "Komodo walk." It can only be described as slow, deliberate and ponderous. There is a lot of lost motion and the movements are ugly. This is to be accounted for by the angle at which the humerus and femur bones project laterally from the body—a disadvantageous angle which with the evolution of mammals has been completely overcome. When running, the awkward gate seems to be smoothed out somewhat as the lizard skims along flipping its feet around to the side and covering the ground at a pace which I do not believe could be equalled by man. When the beast stops to look about, it lifts its head slowly above the grass and then for some time remains perfectly motionless. It is then that the monitor will observe the slightest movement in the landscape. If the hunter blunders into view, *komodoensis* studies him attentively, then ducks out of sight into the grass and slithers away to be seen no more.

On just two occasions I saw a lizard sit back on its hind legs and tail, its forelegs dangling at its side, as if trying to lift its head high to get a better view. In this pose there was a striking though superficial resemblance to certain dinosaur restorations.



Dr. Dunn observed two young lizards up in trees. The ability to climb doubtless enables a young specimen to secure birds' eggs before it is strong enough to pull down larger game.

#### SWIMMING HABITS

As swimmers the dragon lizards cannot be accounted more than moderately proficient. Although they show no aversion to water and will take to it readily, their movements, when in water, are awkward. Of five that we released from a cage on the beach of Telok Sawa, three took to the water and two raced back into the jungle. Of the three that entered the water, one male swam out into the bay and disappeared. He carried his head well above the waves so that he resembled paintings of mosasaurs. The other two lizards remained entirely submerged for a full two minutes and then appeared about seventy yards off, having swum that distance under water. When pursued in a boat they will, instead of struggling and trying to swim off, lie motionless, as if playing dead, with their heads beneath the water and their forelegs up over their backs. Where was this instinct developed and what is its significance? Occasionally, when crowded, they make a few feeble efforts with their tails. On leaving these two to their own devices, they soon swam down along the beach for about a mile and then waddled off into the jungle.

#### BURROWS

Two types of burrows predominate: those excavated under the roots of trees in the steep-faced banks of stream-made gulleys and those under rocks and large boulders. The former are usually found in the jungle, whereas the latter, occurring as they do in the open country, are frequently accompanied by a level sandy spot which is undoubtedly used for sun baths. Occasionally, these bare, sandy places are far removed from any burrows. I never observed a lizard taking a sun bath, but Dr. Dunn succeeded in sneaking up behind a rock and poking one with his rifle while the beast was basking. Typical basking places were seen only at high altitudes. This suggests that only the chilled lizards have the habit of basking in the same spot for long periods. Dr. Dunn noted that all the burrows observed by him faced the west. This would seem to be an adaptation for catching the rays of the hot afternoon sun. A few of the burrows found by Dr. Dunn in open fields were not under rocks. Hence the lizards exhibit a certain variety of taste in selecting their den sites.

## SUMMARY

(1) *Varanus komodoensis* reached Komodó by flotsam-jetsam methods from Australia via Timor and Sumba during the Pleistocene.

(2) The species frequents open woodlands.

(3) It feeds on deer, pig, and water-buffalo, but may take birds or eggs.

(4) Its teeth are blade-like, recurved, and with sawtooth edges. These are very effective in cutting through tough hides.

(5) *V. komodoensis* avoids man but reacts only to visual stimuli. This suggests that the species is deaf.

(6) The species is abundant on Komodo, one observer recording fifty or over in four weeks' time.

(7) Food supply rather than temperature controls the distribution of the individuals on the island.

(8) Young individuals can climb trees, adults are terrestrial and walk with the whole body and all but a spot near the tip of the tail well off the ground.

(9) Experiments demonstrate that the species will take voluntarily to the sea. It swims clumsily but for long periods with success.

(10) Burrows are either under roots in the woods or under rocks in the open. They are rarely dug in open fields at a distance from rocks or other cover.

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