XXXIV.—*On the Toxic Action of the Bite of the Boomslang or South-African Tree-Snake* (Dispholidus typus). By F. W. Fitz-Simons, F.Z.S., &c., Director, Port Elizabeth Museum, Cape Colony.

This is the snake which recent events have made famous all over the Cape Colony. Recently one bit an assistant in our Museum with nearly deadly effect; then another in our collection of living snakes deliberately swallowed another individual of its own species, almost as big as itself. These incidents have caused heated discussions everywhere, as, in the first place, the Boomslang has been regarded as a non-venomous snake, and, secondly, it has hitherto been believed that when snakes swallow each other it is of the nature of an accident—as, for instance, when two snakes seize and attempt to swallow a frog, rat, or some other form of prey, neither caring to let go, the bigger snake naturally engulphs the smaller. In the case of the Boomslang referred to, the act was deliberate in every sense of the word.

Some live frogs were introduced into the cage containing five of these tree-snakes, one of which managed, by superior agility, to capture and swallow several of the former, much to the annoyance of one of its fellows. The latter worked itself into a state of great excitement and attacked its companion viciously, seizing it in various parts of its body. Eventually it gripped the other firmly by the neck and gradually worked its head forwards until it reached the other's jaws, whereupon it began to deliberately swallow it with a succession of spasmodic gulps, accompanied by heaving, forward movements.

After a lapse of twenty minutes it had swallowed one half of the struggling, writhing victim. I then had it removed and photographed, and, during the process, so intent was it upon the work it had in hand that the swallowing process went merrily on, and the photograph shows it in the act of raising its jaw in order to take another mouthful. Being desirous of preserving these specimens as evidence of the occurrence, I removed a little tobacco-juice with a feather from a dirty pipe and passed the feather between the jaws of the Boomslang.

Almost instantly a curious vibratory thrill passed through the snake from head to tail, the muscles relaxed, and the snake lay a lifeless mass within two minutes of the introduction of the tobacco-juice, demonstrating the rapid prussic-acid-like action of this poison upon the vital functions.

This Boomslang was of the striped, black and yellowish-green variety, measuring 4 ft. 9 inches, whilst the victim was the brown variety 3 ft. 11 inches long.

The Boomslang is placed in the British Museum Catalogue of Snakes by G. A. Boulenger in the family Colubridæ, series Opisthoglypha, subfamily Dipsadomorphinæ. The definition of the Opisthoglypha is "a division of snakes with one or more of the posterior maxillary teeth grooved," most, if not all, being regarded as poisonous to a very slight degree, paralysing their prey before deglutition.

Now this is a very important point to bear in mind, viz., one of the Opisthoglypha has been classified in many text-books of science as a non-venomous snake, or one not dangerous to man, as it is my present intention to prove the very opposite.

Sir Andrew Smith in his 'Zoology of South Africa' remarks: "As this snake, in our opinion, is not provided with a poisonous fluid to instil into wounds which these fangs may inflict, they must consequently be intended for a purpose different to those which exist in poisonous reptiles. Their use seems to offer obstacles to the retrogression (retention) of living animals, such as birds &c., while they are only partly within the mouth; and from the circumstances of these fangs being directed backward and not admitting of being raised so as to form an angle with the edge of the jaw, they are well fitted to act as powerful holders when once they penetrate the skin and soft parts of the prey which their possessors may be in the act of swallowing. Without such fangs escapes would be common; with such they are rare."

He goes on further to say: "The natives of South Africa regard the Boomslang as poisonous, but in their opinion we cannot concur, as we have not been able to discover the existence of any glands manifestly organized for the secretion of poison. The fangs are enclosed in a soft pulpy sheath, the inner surface of which is commonly coated with a thin glairy secretion. This secretion may possibly have something acrid and irritating in its qualities, which may, when it enters a wound, occasion pain and even swelling, but nothing of greater importance."

Naturally I accepted this generally current belief, and in consequence I and my assistants freely handled these snakes, taking no precautions against being bitten, deeming such to be superfluous, until, "like a bolt from the blue," Mr. James Williams, an assistant, was bitten, and came within a hair's-breadth of losing his life.

During November 1907 we had occasion to transfer our

collection of live snakes to their new apartments, and Mr. Williams was carrying a large variegated Boomslang when it suddenly buried its teeth in the muscles of his bare forearm, just below the elbow-joint. It gripped with great power and held on firmly. We disengaged its jaws, and I suggested treating the wound, but he would not hear of such a thing, and believing, as I did at the time, that it was a non-poisonous snake I did not insist. The wound smarted a little and he went on working. Within an hour a throbbing headache had manifested itself, accompanied by oozing of blood from the mucous membranes of the mouth, followed by vomiting.

Meanwhile the wound was slowly oozing blood, and the muscles in the vicinity were somewhat swollen. He was then taken to Dr. Bruce, who declared him to be suffering unmistakably from the effects of virulent poison which was seriously affecting the blood and mucous membranes. During the night Williams's condition gradually and progressively became more alarming, and he was taken to the Provincial Hospital the following day in a state of utter collapse. He steadily grew worse, and blood oozed continuously from all the mucous surfaces, viz. the mouth, nose, stomach, bladder, and bowels. Then the blood began to ooze into the tissues and caused large blackish-purple swollen patches under the skin. One eye and its surrounding tissues, both forearms for two-thirds their length, a portion of the abdomen, hip, and thigh, were all charged with extravasated blood, presenting a dreadful sight.

The venom of *Dispholidus typus* evidently contains a poison which acts upon the endothelial cells lining the capillaries. This action is particularly characteristic of the poison of the Crotalinæ and is most marked after poisoning by the South American vipers of the genus *Lachesis*.

Flexner has given the name "hæmorrhagins" to the constituents of poisons possessing this action and regards them as special cytolysins for endothelial cells.

Williams rapidly grew worse after the second day in hospital, severe abdominal pains setting in and inability to retain even water in the stomach. From this time he rapidly sank, and on the evening of the third day after being bitten I went to the hospital, accompanied by Mr. William Armstrong, J.P., who took what we believed to be his dying deposition, the doctor declaring him to be in an extremely critical condition, which might result in death before the morning. He lingered on in this state, bordering between life and death, till about the sixth day, when a slow

improvement began to manifest itself, and from this time onward his condition rapidly improved, and in three weeks he was discharged from the hospital still in a weak, debilitated state, and although he gradually regained strength, he had relapses of slight bleeding from the mucous membranes of the mouth, and one eye was occasionally affected: and even three months after the accident, slight discoloration in the tissues surrounding one of his eyes showed itself for a few days. Apart from this, he has otherwise entirely recovered his health and strength, thanks to the skilful treatment in the first instance by Dr. Bruce, followed by the effective treatment whilst in hospital under the care of Drs. Pottinger and Wallace.

Some years ago a local gentleman was bitten by a Boomslang snake and died a few days later, but the general belief was, and is, that he died of blood-poisoning consequent upon pricking and irritating the wound with some foreign substance. A well-known gentleman, who saw him shortly after being bitten, says:—"I questioned him as to whether he had experienced any effects from the bite, and he certainly gave me to understand that he had not, and attributed the whole trouble to the rash use of a needle, and making too deep a puncture with it. He told me that he felt quite well as far as his health was concerned, and I was surprised to hear a few days afterwards that his death was attributed to the bite of the Boomslang; I had always been under the impression it was a case of ordinary blood-poisoning."

I have made very careful enquiry into this case, and it seems the gentleman at first showed no very apparent signs of constitutional disturbance, but subsequently symptoms set in very similar to those exhibited by Williams, viz. oozing of blood from the gums and extravasation of blood into the tissues on various parts of the body, then death. This would seem to indicate that in this case there was a smaller dose of venom discharged into the wounds than was the case with Williams, which took a longer period to manifest its effects.

I closely cross-questioned Williams, and he admitted that within half an hour of being bitten he felt a curious, restless, dizzy, and languid feeling, but refused at the time to admit it, thinking it to be due to some other cause, believing so fully that the Boomslang was perfectly harmless. However, in Williams's case the symptoms were such as to leave no possibility of a doubt that he suffered directly and unmistakably from some deadly and extremely potent venom, and local medical opinion was unanimous on this latter point.

The Experiments.—It now became imperative to demonstrate whether the Boomslangs were really venomous or not, as this case of Williams would not by any means be accepted by scientific men as proof positive. Naturalists and others handle these snakes and make pets of them under the belief that they are non-venomous, and, moreover, in the public interest this question had to be decided for all time, especially so as the Boomslang is one of the commonest of South African snakes.

The following are the results of the experiments :—

A large brown Boomslang was held by the neck and induced to bite the bared thighs of three fowls in quick succession. The first fowl died in 13 minutes, the second in 15 minutes, the third in 3 hours and 4 minutes.

A variegated male Boomslang bit the bared thighs of two fowls within the space of one minute. The first fowl died in 9 minutes, the second in 45 minutes.

A fowl bitten slightly lived two days and died, the wound oozing blood, and the mucous membranes of mouth being inflamed and congested.

A variegated (greenish-yellow and black) Boomslang bit a fowl on the thigh. I killed the snake and injected some of its blood into the victim. No effect. The fowl died in 12 minutes.

A brown Boomslang bit a fowl on the thigh. I killed the snake and injected contents of its gall into the fowl, which died in 11 hours.

Another fowl was bitten and injected with the serum of the blood of the snake that bit it. No effect; died in 14 minutes.

A brown Boomslang bit a duck on the thigh. Progressive exhaustion; slight oozing of blood in mouth; rapid heart's action; paralysis; death in 17 minutes.

A second duck bitten by the same snake immediately after the first one. Same symptoms ; died in 35 minutes.

A variegated Boomslang bit a duck on the neck. Within three minutes it fell on its back completely paralysed; lay still for another five minutes; struggled feebly when touched. Died in 19 minutes.

A variegated female Boomslang bit a large cock fowl on the comb. Blood oozed from the cock's nostrils one minute after being bitten. It began to mope, then suddenly sprang four feet up into the air and fell a dead mass, three minutes after being bitten.

These experiments were repeated over and over again with all varieties and both sexes of Boomslangs. In all cases

death occurred within 20 minutes of the first bite; the fowls and ducks which were subjected to the second bite from the same snake usually lived from 15 minutes to two hours; not a single fowl recovered.

The fowls and ducks seemed to suffer little or no pain beyond irritation at seat of puncture for a minute or two. Within two or three minutes they showed unmistakable signs of collapse, and with a spasmodic jerk or two would suddenly expire. In some cases complete prostration would supervene five or ten minutes before death.

A few higher animals of greater vital tenacity were also experimented with, and the characteristic slow oozing of blood from the fang-punctures was noticeable, as was the case with Williams. The animals in every case gradually grew worse, and after about 12 hours were chloroformed, it being evident they were slowly sinking under the potent effects of that subtle, death-dealing venom.

Some folks will regard these experiments as cruel, but they were conducted in order that human life might be saved, for in no other way could I have rapidly and conclusively demonstrated to the public that the Boomslang is not only venomous, but exceedingly so. I can go further, and claim that the venom of the Boomslang is equal in its death-dealing power to that of the dreaded Cobra (*Naia flava*) and Ringhals (*Sepedon hæmachates*), for I forced these snakes to bite several fowls by baring the thigh and holding the snake's head close up against the flesh, when in every instance it would deliver a full and complete bite.

In all cases I made the snake give a second bite to make absolutely sure a lethal dose had been injected. The fowls all died in from five to twenty minutes—the average being fifteen minutes. In every case fowls bitten twice on the bared thigh by puff-adders (*Bitis arietans*) survived from four up to twelve hours, some recovering completely. The majority bitten by night-adders (*Causus rhombeatus*) were very sick for a couple of days, then recovered, one or two dying after twelve hours.

It will be seen by the results of the above experiments that the bite of the Boomslang destroys the life of a fowl just as rapidly as that of the Cobra, and that the venom of the puff-adder is in comparison very slow in its action and not nearly so virulent.

The reasons why the Boomslang does not always inflict a venomous bite are two. The fangs are grooved and comparatively small, and if the bite is delivered through clothing

the venom is absorbed by the material and the fangs barely scratch the flesh. Secondly, the fangs are set halfway back in the upper jaw, and are three in number on each side, exactly under the eyes, and naturally unless the Boomslang's grip be full and complete these fangs do not penetrate the flesh. During my experiments I observed that the Boomslang in every case made as good a grip as possible on the animal, then almost instantly, with a heaving, forward movement and disengagement of the teeth of the upper jaw from the victim's flesh, it would take a fresh and more secure hold, the upper jaws in which the fangs are set being capable of being pushed downwards, exposing the fangs and forcing their points forward: the jaw then closes with a snap and the snake worries the flesh, with the evident intention of forcing the venom into the punctures, as well as enlarging them for the freer ingress of the poison.

Sir Andrew Smith, the great naturalist and author, says in his 'Zoology of South Africa': "As this snake, in our opinion, is not provided with a poisonous fluid to instil into the wounds which the fangs may inflict, they must consequently be intended for a purpose different to those which exist in poisonous reptiles. We have not been able to discover any glands manifestly organised for the secretion of poison."

I was by no means inclined to accept this as final, and carefully dissected the heads of several Boomslangs, and in every case I discovered a small gland on each side of the head, lying immediately behind and above the grooved fangs, and it could be clearly seen that it had a connection with the cavity at the root of the grooved fangs and that it was the gland which secreted the sticky fluid found in the sheath enveloping the fangs.

The next move was to ascertain if the organ was really a gland capable of secreting any fluid, whether venomous or not. Dr. Robinson, of the Veterinary Institute at Grahamstown, made a microscopical examination of its structure, and reports it is undoubtedly glandular and capable of secreting. Subsequent experiments by myself bear out this statement, and, moreover, under the microscope, a sticky, colourless fluid, identical with that found in the sheath, was observed in the structure of the glands and was pressed out upon the microscopical slide with the tip of a lancet. Small pieces of these glands were cut up and inserted under the skin of rabbits, and slight pressure applied for an instant. Within 15 minutes the rabbits were dead. One was stricken with

complete paralysis within five minutes of the insertion of the fragment of gland.

These experiments conclusively prove these glands to be capable of secreting a very virulent venom, and that they are the glands which produce the glairy sticky fluid within the sheaths enveloping the fangs. These poison-glands are comparatively small, less than a sixth the size of those of a puff-adder. That they secrete a venom, potent and virulent, seems now hardly to admit of a doubt. Sir Andrew Smith claims the fangs are simply used for the retention of the prey, such as birds, which would otherwise escape. This is partly, but not wholly so. When a Boomslang seizes a live bird it grips with great tenacity. The bird struggles frantically for a minute or two and is then overcome by the potent action of the venom injected through the snake's grooved fangs. It then leisurely proceeds to swallow the birds, feathers and all.

Boomslangs are very timid creatures and will not bite unless roughly handled, or an attempt be made to seize them, hence the reason so few people are bitten by them. I have handled these snakes freely in the past, and friends have done likewise without any attempt on the part of the snake to bite. Boomslangs are essentially tree-snakes, being quite at home in the foliage of the trees, through which they can travel with great rapidity. They vary in colour, some being a bright greenish yellow, banded with black; others are vivid grass-green, banded with black; whilst others, again, are dark uniform brown above, shading into paler on the abdomen, some specimens approaching the greyish tint. The coloration of the female is not quite so brilliant as that of the male. This is particularly noticeable in the greenish-yellow and black varieties.

Boomslangs frequently descend to the ground in search of food and may often be seen basking in the sun on the bare ground in the vicinity of some thicket, into which they rapidly glide if disturbed. In captivity they become very tame and will take food from the fingers. Those in the Port Elizabeth Museum readily eat dead food—such as birds, chameleons, lizards, and frogs—whether fresh or stale.

On several occasions female Boomslangs, both Variegated and Brown, have laid batches of eggs varying in number from a dozen to twenty-three, containing a yellowish fluid, with no sign of incubation having already begun.