

Experiments with Snakes.

By W. HORNER ANDREWS, B.Sc., M.R.C.V.S.

INTRODUCTION.

Early in the year 1911, at the suggestion of Dr. Theiler, I began to collect living snakes for the purpose of studying the effects of their bites on the various domesticated animals.

There were several reasons in favour of commencing this work.

In the first place there is, of course, a very considerable literature on the subject of snake venom and its effects.

In addition to Calmette's valuable text-book on the subject, numerous articles have appeared from time to time in various scientific periodicals, but in practically all cases such publications have referred to the symptoms and lesions produced in man, as a result of accidental infection, to those reproduced in laboratory animals by experimental inoculation, or to certain reactions observed *in vitro*.

The knowledge thus acquired would naturally permit us, with a fair degree of confidence, to predict the effects likely to be observed in the domesticated animals, but verification is always desirable, when applying to particular cases the results of previous generalisation, and our original conceptions are not infrequently found to require some modification.

In the second place, the vast majority of the recorded observations and experiments refer to the venoms of the commoner snakes of India and Indo-China, Australia, and America, and very few publications dealing with the venoms of South African snakes are known to me (see Appendix III.).

Thirdly, there appeared to be some measure of doubt as to the innocuity of certain kinds of snakes commonly considered to be non-venomous. I refer here to certain members of the *Opisthoglypha*, the "back-fanged" division of the *colubridae*, and in this connection the results obtained are of considerable theoretical, and some practical, importance.

With regard to the direct practical importance of the subject, it may be said that although South Africa harbours a considerable number of species of venomous snakes, and although several of these species, such as the puff-adder, may fairly be described as common, yet the number of human beings actually succumbing to the effects of snake-bite appears to be quite small.

Cases among domesticated animals, on the other hand, are reported with comparative frequency, especially in the warmer parts of the sub-continent, but in the majority of cases the actual bite is not witnessed, and the diagnosis of the cause of the animal's condition is not, as a rule, based on very reliable data.

Moreover, the specific identity of the snake concerned in any such case is rarely established.

The primary object of these experiments, therefore, was separately to test each common South African species of snake on the various domesticated animals, and to establish definite data on which to base, as far as possible, a reliable diagnosis.

The data here required were the chief ante-mortem symptoms, and the post-mortem lesions easily detected by the naked eye.

With this object in view, it was obviously desirable to reproduce, as far as possible, natural conditions with regard to the dose of venom employed, and to the mode of its introduction into the animal tissues.

It was therefore decided to cause the snake under observation actually to bite the experimental subject, and this method was followed in practically all of my experiments.

The majority of these experiments were performed on ordinary domesticated animals, but in certain special cases small laboratory animals were used, and in one case the subject of the experiment was a baboon.

It is evident that the ordinary large domesticated animals are not very suitable subjects for the more detailed study of the action of various venoms on particular organs and tissues, and that for such work, and for the study of the phenomena of immunity, it is essential to use quantitative methods, with dried venom.

I was able, however, to make a number of observations on some such points, and these have been duly recorded.

I have also thought it advisable to include a few observations, of a general character, on the behaviour of various South African snakes in certain respects, and, for the information of those interested in geographical distribution, I have added a list of all the snakes received by me at Onderstepoort, together with the localities in which they were captured.

A number of observations on the histology of the lesions presented have been made, but, through lack of sufficient time in which to complete them, such observations are not at present available for this report.

With regard to the identification of the snakes used in these experiments, I am much indebted to Messrs. J. Hewitt (of the Albany Museum) and P. Methuen (of the Transvaal Museum, Pretoria), to whom the majority of the snakes have been submitted.

Methods of Manipulation:

Safe methods of capturing and manipulating snakes have been well described by Calmette in his classical work; there are also some useful hints (and excellent illustrations) on this subject in Mr. F. W. Fitz Simon's popular book "The Snakes of South Africa."

For our purpose two methods have commonly been used, viz.:—

(1) For manipulating large snakes we employ a pole of about six feet in length, pierced near one end by two holes, about one inch apart.

A stout cord, knotted at one end, is passed through the two holes and the snake is held, immediately behind the head, in the small loop of cord between the holes. (*Vide* Plate 59.)

The further end of the pole, together with the loose unknotted end of the cord, may be held in one hand, care being taken to keep the cord sufficiently (but not excessively) taut throughout the manipulations.

With the other hand it is advisable to secure the tail of the snake, or this may be done by an assistant, and it is always wise to ensure the impossibility of the snake being able to throw any coils around the manipulator's arm, or around any strong, stationary object.

The cord should have a diameter of about 3 or 4 millimetres; a thinner cord than this, even if sufficiently strong, is more apt to injure the snake, while with material of greater thickness the grip is less secure. In the latter case there may be some danger of the snake, by a sudden contraction of the body and neck muscles, succeeding in withdrawing the head from the loop, and this is more likely to occur if the snake is allowed to obtain, with the tail, a hold on any rigid object.

With reasonable care, however, the method is simple, more or less harmless to the snake, and quite effective; it can conveniently be used for the capture of living snakes in the field, or when collecting venom from captive snakes.

After the first instinctive feeling of repulsion has been overcome, the worker will soon acquire the ability to handle snakes with considerable dexterity, but it is always well to reduce the risks to a minimum.

(2) Smaller snakes, such as Schaapstekers or young individuals of larger species, are more easily held with forceps, or with the hand, and the use of strong forceps is generally to be preferred for biting experiments, as it is then possible to allow the snake greater freedom for striking.

The snake, secured by one of the methods described above, was brought into contact with a selected region of the experimental subject, and was allowed to bite freely. In some instances it was necessary to irritate the snake before any attempt to bite was made, and in certain cases all attempts to induce the snake to bite proved unavailing.

The bitten animal was placed in a loose box and freed from all restraint, as far as possible; it was observed at short intervals (or watched continuously in many cases), and all the symptoms were recorded at the time of the observation.

Classification :

A knowledge of the outlines of the classification of snakes is of importance to every man living in a country such as South Africa, and it is particularly useful to the medical or veterinary practitioner.

Harmless snakes, which may, moreover, perform a useful service in keeping down the numbers of rats and mice, are frequently the cause of much unnecessary excitement, and may even produce serious nervous symptoms in human beings who are very susceptible to the influence of suggestion.

On the other hand, certain venomous snakes may easily be mistaken for harmless species; thus the yellow or Cape cobra bears a

fairly strong *superficial* resemblance to the harmless mole snake (*Pseudaspis cana*), and the night adder and the egg-eating snake (*Dasypeltis scabra*) are very frequently confused.

Anyone taking a deep or special interest in classification will naturally consult the Catalogue of Snakes of the British Museum, and the publications on South African systematics by Mr. Boulenger, Mr. J. Hewitt, and Dr. L. Gough, but, for those not conversant with the subject, a brief account of the chief divisions recognised may be of some assistance.

The order Ophidia is divided into five families, and these families include a very considerable number of different genera and species. The chief differences which are utilised for classification purposes are connected with the dentition, the character and relative positions of the scales, particularly those of the head, the eye, and the size and arrangement of the maxillary and adjacent bones.

Of the five families mentioned, only two, the Colubridae and the Viperidae, are of special interest to the pathologist, as these two families include all the venomous snakes.

The Colubridae are arranged, according to certain striking differences in their dentition, in three divisions or series, viz., the aglypha, opisthoglypha, and proteroglypha.

In the *aglypha*, the upper jaw bears a considerable number of teeth arranged in two series; the outer maxillary series are more numerous than the inner palatine teeth.

These teeth are all solid, and members of this division are quite harmless.

In the *proteroglypha*, the palatine teeth are more or less similar to those of the aglypha, although generally fewer in number.

A great difference is shown, however, in the maxillary teeth, for instead of the series of more or less small solid teeth which is present in the aglypha, we usually find here, on each side, only a single large tooth or fang, situated near the anterior extremity of the maxillary bone, and, immediately behind this fang, a number of accessory or replacing fangs in different stages of development.

The large fang is more or less deeply grooved, and the base of this groove is in communication with a duct leading from a highly specialised poison-gland, which is situated behind the orbit.

These proteroglyphous colubridae are all venomous.

The *opisthoglypha* are morphologically intermediate between the aglypha and proteroglypha.

In these snakes the maxillary teeth may be reduced in number, but there are always some solid teeth, similar to the maxillary teeth of the aglypha.

In addition to these, however, there are a small number of somewhat larger teeth possessing a distinct groove, and situated towards the *posterior* extremity of the maxilla.

The grooves in these larger teeth do not communicate with any large gland and duct, but there is a small glandular structure situated near the base of the teeth.

The question of the ability of these opisthoglyphous snakes to inflict bites dangerous to domesticated animals, is discussed fully in this paper.

Finally the family Viperidae is characterised by the peculiar form of the maxillary and some adjacent bones.

The maxilla of the viper is very short, and freely movable in the vertical direction.

The dentition is very similar to that of the proteroglyphous colubridae, but the fang is very large, with a sharp point, and it is pierced by a more or less completely closed channel. Vipers usually have a triangular head, a flattened body, and a very short tail, but these characters are not constant.

Finally it may be remarked that colour is often a very unreliable guide in classification, although in some species certain markings and colours are quite characteristic, and more or less constant.

Many species show considerable variation in this respect, however, and in some species (e.g., the Cape cobra) the differences may be quite remarkable.

SNAKES USED IN THE EXPERIMENTS.

The following common South African snakes were tested by the method previously described:—

- | | | |
|--------------------|---------------------------|---|
| <i>Colubridae.</i> | (1) <i>Aglypha.</i> | 1. <i>Ablabophis rufulus</i> (Brown Water Snake). |
| | | 2. <i>Lamprophis aurora</i> (the Night Snake). |
| | | 3. <i>Boodon lineatus</i> (the House Snake). |
| | | 4. <i>Simocephalus capensis</i> (three-cornered Snake). |
| | | 5. <i>Dasypeltis scabra</i> (Egg-eater). |
| | (2) <i>Opisthoglypha.</i> | 6. <i>Tarbophis semiannulatus</i> (Tiger Snake). |
| | | 7. <i>Leptodira hotamboeia</i> (Herald Snake). |
| | | 8. <i>Trimerorhinus rhombeatus</i> (Schaapsteker). |
| | | 9. <i>Trimerorhinus tritaeniatus</i> (Schaapsteker). |
| | | 10. <i>Psammophis furcatus</i> (a Sand Snake). |
| | | 11. <i>Dispholidus typus</i> (the Boomslang). |
| | (3) <i>Proteroglypha.</i> | 12. <i>Naia haie</i> (Egyptian Cobra). |
| | | 13. <i>Naia flava</i> (Yellow Cobra). |
| | | 14. <i>Sepedon haemachates</i> (Ringhals). |
| <i>Viperidae.</i> | | 15. <i>Causus rhombeatus</i> (Night Adder). |
| | | 16. <i>Bitis arietans</i> (Puff Adder). |

In recording the results obtained, the above-mentioned families and divisions have been treated separately.

Experiments with Aglypha:

These snakes have been pronounced by all authorities to be non-venomous, in spite of the fact that many species have been shown to possess glands ((parotid and superior labial) secreting a digestive juice with poisonous properties.

In order to verify this opinion, it was determined to test a few of the common species of South African aglypha on small animals.

Specimens of the five species mentioned were, therefore, forced to bite guinea-pigs, rabbits, and, in a few cases, rats and mice.

In no case were any of the symptoms of venom-intoxication recorded, and the larger animals were not visibly affected in any way; the mice were naturally mechanically injured by the pressure of the jaws.

Experiments with Opisthoglypha:

Several of these snakes have long been regarded as poisonous by the natives and farmers of South Africa, and more especially the boomslang and the so-called Schaapstekers.

Popular opinion concerning snakes, however, is apt to be rendered unreliable by faulty observations, prejudice, and mistakes in classification, and by ophiologists these snakes have almost universally been considered to be venomous only to a slight degree, and to be unable to produce serious lesions in man and the larger mammals.

Thus Sir Andrew Smith, in his "Zoology of South Africa" (quoted by Mr. Fitz Simons) remarks: "As this snake (the Boomslang), in our opinion, is not provided with a poisonous fluid to instil into the 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 of living animals, such as birds, etc., while they are only partly within the mouth 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 organised for the secretion of poison."

Again Calmette (Les Venius, etc., 1907, page 4) writes:— "Presque tous les serpents classés dans ces trois sous-familles (i.e., the three sub-families of the Opisthoglypha) sont venimeux, mais à un faible degré. Ils ne sont pas dangereux pour l'homme. Leur venim ne fait que paralyser leurs proies avant la déglutition: il ne constitué pas pour eux un moyen efficace de défense ou d'attaque."

Later, referring to the sub-family Dipsadomorphinae, which includes all the opisthoglypha in our list, he remarks:—

"Aucun de ces reptiles n'est susceptible d'occasionner d'accidents sérieux chez l'homme, à cause de la disposition particulièrement défectueuse de leur appareil venimeux."

Such opinions have been almost universally accepted, but in 1907 Mr. Williams, of the Port Elizabeth Museum, was bitten by a Boomslang and nearly succumbed to the effects, the most striking clinical feature of the case being the occurrence of very pronounced subcutaneous haemorrhage, and haemorrhage from the mucous membranes.

Mr. F. W. Fitz Simons then took up the question, and dissected out the poison glands of a number of Boomslangs. Some of these were sent to Mr. Robertson, of Grahamstown, and from histological examination he pronounced them to be glandular structures capable of secreting.

Mr. Fitz Simons found that small pieces of gland, when introduced under the skin of rabbits, caused death within 15 minutes, and by intravenous inoculation of an emulsion of the poison glands of a Boomslang, he was able to kill a Cape jackal more or less instantaneously.

He also performed a number of experiments in which some ten fowls and three ducks were actually bitten by Boomslangs, in every case with fatal results.

These results were extremely interesting and suggestive, but the case of Mr. Williams might possibly be considered to have been merely one of coincidence, or of accidental septic infection of the wound inflicted by the snake, and the results of the experiments on birds would not permit us, with any degree of certainty, to assert that similar effects could be produced in the larger mammals, including man.

In 1908 Dr. W. Frei, working in this Laboratory, came to the conclusion that certain members of the Opisthoglypha are venomous, but as he worked with small laboratory animals, and in most cases injected glandular emulsions with a syringe, the results, however interesting, were not necessarily applicable to cases of bites inflicted by such snakes on larger animals.

It appeared desirable, therefore, to test the Boomslang and other opisthoglyphous snakes on some of the larger mammals, and, on account of what Calmette terms "*la disposition particulièrement défectueuse de leur appareil venimeux,*" it was of special importance to preserve, as far as possible, natural conditions with regard to the introduction of the venom, by causing the snake to bite the animal under observation.

The five species of Opisthoglypha previously mentioned were tested as described in the following pages:—

I.—DISPHOLIDUS TYPUS—THE BOOMSLANG.

This species was tested on:—

One baboon, which recovered from the effects of one bite, but which died as a result of a second bite, inflicted after an interval of 25 days.

Two horses. One horse died, but the other showed only some degree of dullness, which passed off rapidly. In the latter case the snake used was exceptionally fierce and aggressive, and was found to have broken off the fangs on one side, as a result of biting fiercely at the stick employed in its capture.

One mule, which succumbed.

Five sheep, of which three died.

One of the other two sheep was bitten by the snake with the broken fangs, of which mention has been made above.

The other sheep which failed to develop serious symptoms, was bitten by a snake immediately after the latter had inflicted what proved to be a fatal bite on another sheep.

In ten experiments there were six deaths, one recovery after serious illness, and three cases in which, probably for the reasons mentioned, the snake failed to introduce any significant amount of venom into the subject of the experiment.

In view of the importance of the results, the following detailed clinical descriptions are given:—

Baboon 1.—Young female (adult).

December 29th, 1911—12.40 p.m.—bitten on the right shoulder by a female Boomslang.

The baboon showed signs of great fear, even when the snake (secured to a pole) was more than ten yards distant.

The snake bit well, separating the jaws widely and holding firmly for 1-2 minutes.

During the following five minutes, the baboon was frightened and restless, but in a short time it became quieter, and it was soon eating, drinking, and moving about actively in play.

The wound on the shoulder was bleeding slightly, and the baboon occasionally touched the wound with the left hand, and smelled and tasted the finger tips with some appearance of anxiety, which, however, was very transitory.

5 p.m. A hard, but not painful, swelling was noticeable in the region of the bite; the general health and activity were not affected.

10 p.m. The swelling was rather larger, and drops of blood were still oozing from the wound. The baboon appeared to be rather dull and quiet, but was possibly merely sleepy.

December 30th, 1911, 7 a.m. The swelling had increased in size, and was situated chiefly over the shoulder and the external aspect of the arm, but it had also extended around the arm to the inner side, and inferiorly down to the elbow.

Blood was still oozing from the wound, and the appearance of the floor showed that this process must have occurred fairly freely during most of the night, if not continuously. It is probable that this bleeding had been favoured and increased by interference with the wound on the part of the baboon, but the punctures showed no evident signs of laceration.

The animal was somewhat depressed, but was fairly active.

At mid-day the wound was still bleeding slightly. The baboon was distinctly dull and depressed, and occasionally touched the wound, and gazed at it.

At 5 p.m. it was dull and depressed, and showed great thirst. It was able to walk, and was fully conscious of its surroundings, but was inclined to lie quietly on the side for considerable periods.

Slight bleeding from the punctures continued.

December 31st, 1911, 10 a.m. The baboon was lying on the side, and was very dull and sleepy in appearance, but it rose occasionally, and walked a little. It would neither eat nor drink, but occasionally bit idly at any small articles within reach.

During the greater part of the day, the baboon was lying quietly on the left side, occasionally kicking with the right leg, and sometimes touching the head and the region of the bite with the hand.

At 4 p.m. it appeared in some respects to be better, and attempted to drink water and to eat fruit, but after eating eagerly for a few minutes, it would become languid and stop, and then remain motionless for several minutes, during which it appeared partially to have lost consciousness. On some occasions this stage of semi-consciousness

supervened when the hand, clutching some fruit, had been raised half-way to the mouth, and it then remained in this position for several minutes. Finally, the animal would appear to waken, and it would then continue to eat.

If lifted to its feet, the baboon would walk a few steps, and would then sink down, and lie on the side or back, as if fatigued.

January 1st, 1912. The baboon was rather stronger, and occasionally rose and walked, but it soon became fatigued, and relapsed into a recumbent position. The appetite had much improved.

There was a livid discoloration of the skin over the right arm and shoulder, descending almost to the elbow, and extending for two inches on to the breast

January 2nd, 1912. In the morning the animal was very much stronger and brighter; it was eating readily, and showed much activity in climbing, etc.

In the afternoon it appeared to be rather tired and depressed.

January 3rd, 1912. The swelling had almost disappeared, and the wound had dried up. The animal was active and cheerful.

January 4th, 1912. The baboon appeared to be quite normal, and no symptoms developed later.

On January 23rd, 25 days after the first bite, the experiment was repeated, with a fatal result.

Baboon I.—as before. January 23rd, 1912.

12.23 p.m. The baboon was bitten, in the abdominal region by *Dispholidus typus*. The snake bit very well, retaining a grip for nearly four minutes, and "worrying" the fold of the skin.

At 2 p.m. nothing abnormal was noticed.

At 4 p.m. there was a distinct swelling over the bitten area, but the baboon was active and cheerful.

At 5 p.m. the swelling had visibly increased much in size, and the baboon was rather dull and melancholy.

Throughout the evening, and until midnight, the swelling was noticed to be increasing in size, and the depression became more marked, but there was no loss of consciousness, and the animal moved about languidly.

At 8 p.m. the visible membranes were noticed to be rather pale, and at 11 p.m. they were quite distinctly paler than normal.

January 24th. At 7 a.m. the baboon was found lying on the left side, with the eyes closed. If touched, it would open the eyes and grunt, but it soon relapsed into the former somnolent condition.

Food was refused, but occasionally the animal would sit up and drink a little water, very soon falling back weakly.

There was a diffuse swelling along the abdomen, and one could see a large livid area around the bite, and two smaller livid areas extending over the abdomen, anterior to it. There was also one small circular livid area in the right axilla.

At 9 a.m. the condition had not altered.

At 11 a.m. the baboon was much weaker, the extremities were cold, and the visible mucous membranes were almost white.

Respiration was slow, irregular, laboured, and sighing.

The eyes were closed, and the animal appeared to be unconscious of movement, noise, light or pain.

Death occurred at noon, 23½ hours after the infliction of the bite.

The record of the post-mortem examination is as follows:—

Baboon—female, young adult. Examined two hours after death. Condition good, rigor mortis absent. A diffuse soft swelling extended over the abdomen, and down the right leg.

Skin.—A large livid area over the pubic region, where bitten, and on each side of the abdomen was a livid patch extending forwards to the sternum. There was also a small circular livid area in the right axilla, and a large area over the outer side, front, and half of the inner side of the right leg, where the latter was swollen.

Subcutaneous tissue—showed areas of marked haemorrhagic infiltration, occurring over the abdomen, up to the chest wall, inside the left arm, above and below the left knee (in front), and all around the right leg from the knee to the ankle.

This infiltration was quite superficial, in the subcutaneous connective tissue, and the subjacent muscles were not involved.

Pleural, pericardial and peritoneal cavities.—Empty and normal.

Lungs.—Collapsed normally. Pale and bloodless on section.

Trachea and bronchi.—Mucous membrane pale.

Bronchial glands.—Normal.

Heart.—In systole. Epicardium normal. Left ventricle contained partially coagulated blood. Endocardium showed one small ecchymosis. Right ventricle empty, endocardium normal.

Liver.—Parenchyma very pale, lobulation indistinct, consistency soft. Gall-bladder contained viscid dark-green bile.

Kidneys.—Capsule easily stripped. On section very pale, almost white.

Spleen.—Pulp soft, moist, rather pale.

Stomach.—Mucosa very pale.

Jejunum and ileum.—Mucosa very pale.

Caecum.—Mucosa generally pale; a few small haemorrhages.

Colon.—Contents mixed with blood. Mucosa showed small punctiform haemorrhages.

Horse 6,246. February 23rd, 1912.

3.28 p.m. The horse was bitten on the inferior aspect of the neck by a Boomslang (female), the snake retaining the grip for 5½ minutes.

No symptoms were seen until 9 p.m., when some degree of dullness was noted.

February 24th, 9 a.m. The horse was dull, and not feeding well. At noon the depression was more pronounced, the head was hanging, and no attempt to eat was made. Respiration was normal, but the pulse was rather slow, weak, and infrequent.

At 7 p.m. the animal was very dull and disinclined to move, the head was hanging very low, and the pulse was weak.

The buccal and conjunctival mucosae were rather pale, except where the left conjunctiva showed two small ecchymoses.

At midnight the depression was very pronounced, the pulse was hardly perceptible, and actual blood was present in the mouth.

February 25th. Throughout the day the animal was dull, weak, and depressed. It stood chiefly against the wall, with the head hanging low, and the eyes half closed. Respiration was regular but slow, and the pulse was very weak and infrequent.

The visible mucous membranes were very pale, there were some ecchymoses under the left conjunctiva, and blood was trickling from the mouth, which, however, showed no wounds, and no signs of rupture of any large blood vessel.

There was no blood at the anus, and the small quantity of faeces passed was quite free from blood.

February 26th. At 7 a.m. the horse was found dead, 63½ hours after the infliction of the bite. Post-mortem examination made within a few hours of death.

Aged grey gelding, in fair condition.

Subcutaneous tissue.—At the base of the neck, on the inferior aspect, was a patch of haemorrhagic infiltration about the size of the hand. Similar patches occurred on the elbow, and shoulder.

There was also more diffuse subcutaneous oedema (not haemorrhagic). Costal pleura showed petechiae.

Pericardium.—100 c.c. slightly blood-tinged liquid.

Lungs.—Only half collapsed. Pleura showed ecchymoses. Lung tissue on section showed oedema, and small haemorrhages.

Trachea and bronchi contained froth. Mucosa showed petechiae.

Bronchial and Mediastinal glands.—Oedematous and haemorrhagic.

Heart.—Epicardium showed small haemorrhages. Left ventricle contained coagulated blood. Endocardium showed a few petechiae. Right ventricle contained coagulated blood. Endocardium pale.

Liver enlarged. Parenchyma pale, lobulation very distinct, consistency friable. Capsule showed a few small fibrous filaments.

Kidneys.—Capsule easily detached, and surface of cortex had a somewhat marble-like appearance, with punctiform haemorrhages.

Cortex, on section, found to be studded with small haemorrhages.

Suprarenal glands.—Normal.

Spleen.—Pulp was moist, and showed some haemorrhagic areas.

Stomach contained food material and blood. Fundus of stomach contained some blood coagula, and the mucosa showed some surface erosions.

Jejunum.—Mucosa showed a few petechiae.

Ileum.—Mucosa showed a few petechiae.

Caecum.—Some petechiae near the apex.

Colon.—Some parasitic nodules, and petechiae.

Mule 5,724. January 3rd, 1912.

11.30 a.m. The mule was bitten on the left side of the breast by a Boomslang (male).

12.30 p.m. A small oedematous swelling was noticeable over the site of the bite. The mule was feeding quietly, the respirations were normal, and the pulse 35.

During the remainder of the day the animal showed no symptoms whatever of general disturbance; the swelling became more prominent, but did not extend laterally.

January 4th. The general health was unimpaired, and the swelling was less prominent.

January 5th. Drops of blood were trickling from the wound, but the oedema had become more diffuse, and was hardly noticeable. The general health was good throughout the day, but at 8.30 p.m., the mule appeared to be rather dull.

January 6th. When first seen the animal showed slight dullness, but there was nothing in its condition or behaviour to attract notice. At 9.30 a.m. the mule was reported to be lying quietly, in a normal position.

At 10.30 a.m. the mule appeared to be in a state of great pain or excitement. It was sweating profusely, the pupils were dilated, and the pulse 50 to 60 a minute, fast and hard. The mule repeatedly lay down and rose again.

Until 2 p.m. the animal stood fairly quietly for the greater part of the time, occasionally wandering restlessly around the box. The sweating continued, and the pulse was frequent and fast.

At 2.30 p.m. the animal was found staggering around the box, and blundering heavily into the walls and manger; it was blowing and sweating profusely, the head was hanging low, and the penis was hanging out of the sheath, urine being swished from side to side. The ears were erect, and the tail was carried normally. For a few minutes the mule stood quietly in a corner of the box. It was quite conscious of the entrance and approach of any attendant, and, when offered food, it took a mouthful, but the teeth were not closed on the food, and no mastication was attempted.

At 2.40 p.m., 75 hours after the bite was made, the mule suddenly fell dead against the wall of the box, lying with the head bent on the body, the spine arched (convex superiorly), and the legs fully extended. *Post-mortem examination* made one hour after death.

An aged brown mule gelding, in good condition. Rigor mortis absent.

Subcutaneous Tissue. At the site of the bite, on the left breast, there was gelatinous infiltration, and in most parts the lesion was haemorrhagic. The muscles of the jugular furrow were normal, but the fascia enclosing the superficial muscles showed gelatinous and haemorrhagic infiltration.

In addition to the primary lesion, there were a considerable number of areas of haemorrhagic infiltration of the subcutaneous connective tissue, scattered about the body.

On the left side the following lesions occurred:—

- (1) An area 10 centimetres in diameter, situated over the superior portion of the scapula.
- (2) A patch 10 centimetres in diameter, situated immediately behind the shoulder.
- (3) Two small patches lying superior to No. 2.
- (4) An area 15 centimetres in diameter, situated halfway along the back.
- (5) An area 10 centimetres in diameter, in the patellar region.
- (6) An area 10 centimetres in diameter, situated in the middle region of the leg, on the anterior aspect.

- (7) Small patches on the inner aspect of the leg, below the hock joint.
- (8) A large patch on the inner aspect of the foreleg, extending from 17 centimetres above the knee to 12 centimetres below the joint.

On the right side there were:—

- (1) A small area on the shoulder.
- (2) An area measuring 25 x 20 centimetres, situated near the spine, and behind the shoulder.
- (3) Below No. 2 an area 8 centimetres in diameter.
- (4) A small patch, 4 centimetres in diameter, situated 10 centimetres behind No. 2.
- (5) A large patch, situated 15 centimetres from the root of the tail, and
- (6) An area measuring 7 x 6 centimetres, situated below the hock joint on the outer aspect of the leg.

Peritoneal cavity. When this was opened, a large quantity of blood escaped. On the right side, about 10 centimetres behind the last rib, the parietal peritoneum showed a dark livid area, about 20 centimetres in diameter, and at this point the abdominal wall generally showed haemorrhagic infiltration.

Pleural cavities empty.

Pericardial cavity contained 10 c.c. of blood-stained liquid.

Lungs.—Collapsed normally. The pleura was pale. On section the lung parenchyma was pale, and little blood escaped from the cut surface.

Trachea.—Normal.

Bronchial and Mediastinal Glands.—Normal.

Heart.—The epicardium presented two ecchymoses over the left ventricle. The left ventricle contained uncoagulated blood; the endocardium showed an extensive ecchymosis, but was otherwise pale. The myocardium was pale. The right ventricle was empty, and the endocardium appeared pale.

Liver.—The capsule showed a few scattered fibrous filaments. On the posterior aspect of the liver, towards the inferior border of the middle lobe, the capsule was separated from the parenchyma over an area as large as the palm of the hand, and near the inferior border there was a rupture in the capsule nearly 5 cms. in length.

The cavity formed by the detachment of the capsule contained a little coagulated blood. From this cavity several irregular channels extended obliquely upward and inward into the substance of the middle lobe, and these channels also contained some blood coagula.

The liver parenchyma generally was pale-brown in colour, with indistinct lobulation, and it was friable.

Suprarenal glands—pale on section.

Left Kidney.—On section, all three zones were pale, but there was one small haemorrhage in the pelvis.

Right Kidney.—There was one small haemorrhage in the cortex.

Spleen.—The capsule showed a few filaments and petechiae, and, about six inches from the apex, a haemorrhagic area measuring 3 x 1 centimetres.

On section, the spleen pulp generally was pale, but it contained haemorrhages, situated under the capsule and in the depth of the organ. The trabeculae showed up distinctly.

Stomach contained much soft food material. The mucosa was normal at the fundus, but bile-stained near the pylorus.

Small Intestine.—The mucosa was thickened, and red in colour.

Caecum contained a few *S. armatum*. The mucosa was normal.

Colon.—The mucosa showed an oedematous infiltration.

Sheep 2,632.

January 23rd, 1912, 1 p.m.—The sheep was bitten four times in the right thigh by a Boomslang (female).

At 2 p.m. the sheep was slightly lame, but no other symptom was noticed throughout the day.

January 24th.—At 7 a.m. the animal was lying in a normal position, but was unable to rise. The respiration was hurried, and the pulse was rather frequent and full. There was no noticeable swelling, but the area bitten showed two livid patches, not exceeding 3 centimetres in diameter.

During the morning the animal grew weaker, and the respirations became very frequent and deep.

At 2 p.m. the sheep was very weak, and the visible mucous membranes were rather pale. The respirations were rather less frequent than formerly, but were deep and spasmodic, and there were audible râles, owing to the presence of froth in the nasal cavities.

At 3 p.m. the weakness was pronounced, and the extremities were cold; the respirations were slow and stertorous, and the mucous membranes were very pale.

Death occurred at 3.20 p.m., rather more than 26 hours after the bite. *Post-mortem examination* made half an hour after death.

Merino hamel, aged, condition good, rigor mortis absent.

Blood not coagulated. *Skin*—two small livid patches inside the right thigh.

Subcutaneous tissue.—Haemorrhagic infiltration over the inner side of the right thigh, and also in two small patches on the abdominal wall, about 6 inches from the thigh.

Pericardium—10 c.c. clear liquid.

Lungs.—Not completely collapsed. On section, a few parasitic cysts were found, and the tissue showed some oedema.

Trachea—mucosa pale.

Bronchial glands—enlarged and oedematous.

Heart.—Epicardium normal. Myocardium normal.

Left ventricle empty. Endocardium normal.

Right ventricle empty. Endocardium showed a few petechiae.

Liver.—Capsule showed a few white spots, and small petechiae.

Parenchyma was pale and soft with distinct lobulation, and showed some haemorrhagic areas.

Gall bladder contained thin red bile.

Kidneys.—Capsule had formed a few fibrous adhesions and showed some haemorrhagic areas. The cortex showed, in section, numerous small haemorrhages, and the medulla was haemorrhagic.

Spleen.—Pulp soft and moist.

Stomach.—Mucosa showed haemorrhagic streaks along the folds. *Omasum* showed petechiae and haemorrhagic patches.

Jejunum.—Mucosa showed diffuse hyperaemia, and some punctiform haemorrhages.

Ileum contained a few parasitic nodules.

Caecum.—Contents blood-stained; mucosa showed haemorrhagic patches near the apex.

Colon.—Large haemorrhagic patches were found.

Sheep 3,657.

February 8th, 1912, 3.50 p.m. The sheep was bitten in the left thigh by a Boomslang.

Within five minutes one could observe a small oedematous swelling around the wound, and there was some purple discoloration of the skin around the punctures, which were bleeding slightly; the swelling was not noticeable an hour later.

For the first ten minutes the animal showed some excitement, with hurried respiration, but this soon disappeared, and for the remainder of the day, and until mid-night, no general symptoms whatever were observed.

February 9th.—At 7 a.m. the animal appeared dull and depressed, and respiration was hurried. At 9 a.m. the general condition was the same, but blood was exuding from the left nostril, and much blood was passed with the faeces. The mucous membranes were rather pale. At 10.30 a.m. the sheep was lying down, and respiration was hurried; more blood was being passed from the nostril and anus, and the mucous membranes were very pale.

At noon the condition was unchanged, and at 1 p.m. it was similar, but the animal was visibly weaker, and the respiratory movements were very hurried and shallow.

At 2 p.m. the animal was found dead, about 22 hours after the bite. *Post-mortem examination* made about one hour after death.

Merino hamel, 6 teeth, condition fair, rigor mortis absent.

Skin.—Purple discoloration over the bitten part, on the left thigh.

Subcutaneous tissue.—Inside the left thigh was an area of haemorrhagic infiltration extending down to the fetlock. There were similar areas on the right shoulder, the right leg, the right side of the breast, the left side of the breast, and the back.

Lungs pale and bloodless.

Trachea.—The mucosa showed injection of vessels.

Bronchial glands.—Normal.

Heart.—Epicardium pale. Heart in systole.

Left ventricle—a little uncoagulated blood. Endocardium pale.

Right ventricle—a little uncoagulated blood. Endocardium pale.

Liver.—The parenchyma was pale yellow in colour, and soft, with indistinct lobulation. The gall-bladder contained thin yellow bile.

Kidneys.—Capsule easily detached. On section, all three zones were pale and bloodless.

Spleen.—The pulp was pale, and moist in appearance.

Stomach (abomasum) contained a few wireworms. Mucosa pale.

Omasum normal.

Jejunum.—Mucosa pale.

Ileum.—Mucosa pale. Contents blood-stained.

Caecum.—Contents blood-stained; mucosa rather pale.

Colon.—Contents blood-stained; mucosa showed slight patchy hyperaemia.

SUMMARY OF SYMPTOMS PRODUCED BY THE BOOMSLANG.

(a) *Local Swelling*

In the baboon there was pronounced swelling on both occasions, being first noticeable about four hours after the bite. The swelling persisted for more than four days on the first occasion, and after the second bite it continued to increase in size until death occurred.

In the mule there was a small oedematous swelling which appeared within an hour, and increased in size for about six hours, but twenty-four hours after the bite it was hardly noticeable.

In the horse, and the three sheep which also died, no swelling was ever noticeable.

(b) *Discoloration of the skin* by subcutaneous and intradermal haemorrhage. In the majority of mammals, other than man, it is difficult to observe such changes, but in favourable positions, in the baboon and the sheep, it could be seen that each puncture of a fang was the centre of a small more or less circular livid area. These areas, in the sheep, did not exceed the size of a sixpenny piece, and were generally considerably smaller; in the baboon they extended further and became confluent.

In the baboon it was also possible to detect a livid patch not directly connected with the penetration of the fangs.

(c) *Local Pain*

The baboon showed some uneasiness, and an inclination to touch and examine the wound, and two sheep, of which one was only slightly affected generally, showed some degree of lameness in the bitten leg.

Otherwise there was no evidence of any local pain.

(d) *Haemorrhage from the Punctures:*

Some bleeding from the wound persisted for about 48 hours in the baboon, after the first bite, but no haemorrhage was observed on the second occasion.

In the mule there was considerable trickling of blood from the punctures two days after the bite, and in one sheep a similar condition was observed.

In the horse and the other two sheep (of the cases ending in death), no such haemorrhage was seen.

(e) *Nervous Excitement:*

Such symptoms were seen only in the mule, which, during the last four hours of life, was in a state of very great excitement, and showed much nervous activity.

Such symptoms only became noticeable about 70 hours after the bite.

In all the other cases, the venom had quite an opposite effect.

(f) *Nervous Depression* :

In all cases, with the exception of that of the mule mentioned above, the chief clinical symptoms were dullness, increasing depression and weakness.

The progressive weakness, and the depression, were doubtless in a large measure due to the haemorrhage which was occurring, but there appeared to be a certain degree of nervous depression of central origin.

The period elapsing after the bite, until the onset of such symptoms, varied in seven experiments between 5 and 24 hours, but in the case of the mule some dullness was first shown about 60 hours after the bite.

(g) *Haemorrhage from Mucous Membranes* :

The occurrence of haemorrhage was shown indirectly by the pallor of the mucous membranes, varying in degree, in all the fatal cases but one (a sheep).

This pallor was first noticeable some hours after the dullness had made its appearance.

In the horse which succumbed, actual blood was found in the mouth 20 hours after the bite, and in one sheep blood came away from the nostrils, and with the faeces, after about 17 hours.

(h) *Pulse* :

No changes in the pulse were noted until the stage of dullness, when it became sluggish, and less frequent.

The later progressive weakness was accompanied by a slowing of the heart beat, and a diminution in force, but such experiments as these do not permit one to form an opinion as to the occurrence of a direct influence of the venom on the heart, the vaso-motor system, or the larger vessels.

In the mule, the pulse, during the period of excitement, was frequent and fast.

(i) *Respiration* :

This was usually not affected to any marked degree, but in the later stages the respiratory movements generally became slower and more shallow.

In two cases in sheep, the animals, when no longer able to rise, nor to stand if lifted, showed frequent deep respirations, and in one of these cases the respiration became stertorous, and there was froth in the nostrils.

In the mule, during the stage of excitement, the respirations were very frequent.

(j) *Temperature* :

In several of these cases the temperature was taken at intervals, but no rise was ever noted.

In the later stages sub-normal temperatures (98-99°) were sometimes recorded.

(k) Duration :

In the baboon, death occurred in less than 24 hours after the bite.

In the mule, death occurred in less than 75 hours after the bite.

In the horse, death occurred in less than 60 hours after the bite.

In the sheep death occurred in 8, 22, and 26 hours respectively after the bite.

SUMMARY OF LESIONS SEEN POST-MORTEM :

The occurrence of local swelling and cutaneous discoloration has been discussed in connection with the symptoms recorded during life :

Rigor mortis.

In the horse this was shown only to a slight degree ; the exact time of death was not known, but the animal had probably been dead not more than three hours, and possibly for a shorter period, at the time when the autopsy was performed.

In the case of one sheep (S 3541) the examination was made 11 hours after death, and in this case rigor mortis was well marked. The case was not at all characteristic, however, for the animal was very weak before the experiment was performed, and it succumbed within the unusually short period of eight hours.

In the other fatal cases (one baboon, one mule, and two sheep), the autopsy was made within two hours of the time of death, and rigor mortis was absent.

Subcutaneous Connective Tissue :

In every case there was found, at and around the point bitten, an area of haemorrhagic infiltration of the subcutaneous connective tissue.

The lesion was quite superficial, the subjacent muscular tissue being unaffected, and in different cases the area involved varied from a more or less circular patch about 5 centimetres in diameter, to an irregularly shaped area measuring as much as 30 or 40 centimetres in one dimension.

In the baboon the primary lesion was very large, and had extended along the abdominal wall from the pubic region to the thorax, and in one sheep (S 3657) the primary lesion in the thigh had extended down the leg to the region of the fetlock.

In the other cases the primary lesion was more or less circumscribed, and limited to the region surrounding the punctures.

In addition to this primary lesion, and not directly connected with it, were similar patches of haemorrhagic infiltration, occurring on the trunk or any of the limbs, in regions possibly quite remote from that of the bite.

These lesions were found in all cases but one (the atypical case in a sheep mentioned above), but the number and extent of such lesions varied greatly in the different cases. They were particularly numerous and extensive in one sheep (S 3657), and in the mule.

Serous cavities.

Nothing abnormal was noted in the peritoneal cavity, except in the mule, in which the cavity contained much blood, and the parietal peritoneum showed a haemorrhagic area.

The pleura was affected in one case (Horse 6246), in which the costal pleura showed some petechiae, and the pulmonary pleura in parts showed ecchymoses. No pleural transudate was recorded.

The pericardial cavity, in both the horse and the mule, contained liquid tinged with haemoglobin, and in one sheep it contained clear, colourless liquid.

Lungs.—In the horse the pleural covering showed ecchymoses, and section of the lungs showed the presence of small haemorrhages in their substance.

In the other cases no such lesions occurred, and the lungs appeared very pale and bloodless.

In the horse, and in two sheep, there was some pulmonary oedema.

Trachea.—Contained some liquid and froth in those cases in which pulmonary oedema occurred.

The mucous membrane was usually pale, but in one sheep there was some noticeable injection of vessels, and in the horse a few petechiae were recorded here.

Bronchial lymphatic glands.—These were enlarged and oedematous in the horse, and in one sheep; in the former case there was also some haemorrhage into the glandular tissue. In the other cases these glands were normal in appearance.

Heart.—The organ appeared to be arrested in systole.

The epicardium was normal or rather pale, except in the horse and mule, in which it showed ecchymoses.

The cavities of the heart contained some blood, which was coagulated in the horse, partially so in the baboon, and uncoagulated in the other cases.

In the baboon and the two equines, the endocardium in the left ventricle showed ecchymoses or petechiae, and in one sheep petechiae were recorded in the right ventricle.

In the other two sheep, the endocardium generally was very pale.

Liver.—The parenchyma in all cases was pale in colour, and of softer consistency than normally; the lobulation was generally indistinct to the naked eye.

In one sheep there were haemorrhagic areas in the parenchyma, and in the mule there was an extensive rupture in the capsule, and lesions in the neighbouring parenchyma, due to profuse haemorrhage.

Kidneys.—In one sheep, and in the horse, the cortex was studded with numerous small haemorrhages, and in the mule one such haemorrhage was present in each kidney. The sheep in question showed also much haemorrhage into the medulla of the kidney.

The parts of the kidneys not directly affected by haemorrhage, and the kidneys generally in the other cases, were very pale and bloodless.

Spleen.—In the horse, the substance of the spleen showed some haemorrhages, and in the mule there were some petechiae and a large haemorrhage, under the splenic capsule, and haemorrhagic areas occurred in the pulp.

In all cases the pulp generally was rather pale, with a moist appearance.

Stomach (or *Abomasum*, in the sheep).

This organ contained actual blood only in the case of the horse, and in this case the mucosa showed some patches of surface erosion, with haemoglobin staining.

In one sheep there were haemorrhagic streaks along the summits of the folds.

In the other cases the mucous membrane was noticeably pale.

Omasum.—In one sheep petechiae and haemorrhagic patches were found; the organ appeared to be normal in the other two cases.

Rumen and Reticulum normal in all the sheep.

Small intestine.

In one sheep the contents of the terminal portion were intermixed with blood. The mucosa, in the horse and the mule, and in one sheep, showed some petechiae, small haemorrhages, or patches of hyperaemia, but, except where directly affected by such lesions, it was paler than normal in all cases.

Caecum.—In two sheep the ingesta were intermixed with blood.

In the baboon, horse, and one sheep, the mucosa showed some petechiae or small haemorrhages, but in other parts, and in the other cases, it was normal in appearance, or rather pale.

Colon.—Blood was present in the lumen of the bowel in the baboon, and in two sheep.

The mucosa showed petechiae, or haemorrhagic patches of greater or lesser extent, in the baboon, the horse, and one sheep.

In the mule the mucosa had undergone an oedematous infiltration, not haemorrhagic in character, and in one sheep (S 3657) no visible points of haemorrhage were found in the alimentary canal, although actual blood was intermixed with the ingesta in the ileum, caecum and colon.

Action of Boomslang Venom on the Blood:

In the cases of Boomslang bite recorded in the preceding pages, small quantities of blood (5-10 c.c.) were withdrawn at intervals from the jugular vein.

Half of the blood was allowed to coagulate in a tube, and the other half was examined for any trace of haemolysis.

The method employed was to add to the blood half of its volume of a 5% solution of Potassium citrate, and immediately to centrifuge.

The serum expressed after coagulation was also examined for any traces of blood pigment.

(1) In all the cases terminating in death, there was a distinct loss of coagulative power. The blood taken during the last few hours of life often remained liquid for three or four hours, and coagulation, when it occurred, was incomplete.

In one case (S 3657), blood taken four hours before death was kept in the laboratory until ultimately it putrefied, but no coagulation was observed.

(2) Haemolysis was only recorded in one case (S 3657), in blood taken 30 minutes after death, and in this case the pigment had coloured the plasma to a degree hardly noticeable.

It would be very desirable to study the action of this venom on blood *in vitro*, with the advantage of being able to make quantitative determinations.

2. *Trimerorhinus Rhombeatus*, the Spotted Schaapsteker :

Snakes of this species (and *T. tritaeniatus*) have received from the Boers the name of "Schaapstekers" (from the Dutch "schaap," sheep, and "steken," to pierce, prick or stab).

By the farmers they have commonly been blamed for causing a number of deaths among sheep, although by zoologists they have been considered to be more or less harmless.

At first great difficulty was experienced in inducing snakes of this species to bite, and for this reason failure attended several attempts to observe the effects of bites on sheep.

As a preliminary experiment, to determine whether any active venom was present, a Schaapsteker was taken immediately after death, the region above the fangs was compressed with the fingers, and the fluid exuding from the sheath enclosing the fangs was collected.

It may here be noted that this fluid is opaque and milky-white in appearance, unlike the venom of ordinary colubridae and viperidae, which is clear and transparent when first collected, and which has generally a slight yellow colour.

Small *unmeasured* quantities of this fluid were at once introduced, on the point of a small scalpel, into the inner femoral muscles of two guinea-pigs, which died in seven and seventeen minutes respectively.

In consequence of this proof of the existence of a venom, the experiments with sheep were again attempted, and after some little difficulty we succeeded in two cases in inducing spotted Schaapstekers to bite a sheep.

One of the sheep died in 45 hours, but the other was never visibly affected, and we have since been unable to perform any further experiments with this species.

We would not, therefore, be justified in stating definitely that *Trimerorhinus rhombeatus* is able to inflict bites fatal to sheep, as this one case might conceivably be merely one of coincidence, but the case is sufficient to indicate that this species may probably prove to be capable of so doing, and that further investigation of this matter is very necessary.

The following detailed descriptions refer to the three fatal cases above-mentioned :—

Guinea-pig 9. February 15th, 1912.

12.38.—Venom from a dead *T. rhombeatus* was introduced into a small incision in the muscles of the left thigh, on the point of a small scalpel.

12.40.—Muscular twitching noticed, especially marked in the left hindleg, which was extended.

Muscular contractions became general, and increased in frequency and force, until the legs no longer supported the weight,

12.42.—The guinea-pig was lying on the right side, and the muscular spasms became less frequent and weaker, until there was only an occasional twitch.

12.45.—Death occurred, 7 minutes after the injection.

Guinea-pig 10. February 15th, 1912.

12.40 p.m.—Venom from the same snake as in the previous experiment, but a smaller quantity, was similarly introduced into the muscles of the right thigh.

12.53.—General muscular contractions started, and increased until the animal was shaken by a rapid series of strong spasms. The legs gave way beneath the body, but the guinea-pig was still conscious of its surroundings, and attempted to crawl away when approached or touched.

12.56.—The guinea-pig rolled over on to the side, and the muscular contractions stopped.

No corneal reflex was now obtained.

12.57.—Death was found to have occurred, 17 minutes after the injection.

Sheep 3,666, Merino Ewe. 7th May, 1912.

3.5 p.m.—Bitten in the right thigh by a *Trimerorhinus rhombeatus*, which bit well, and retained the hold for about 2 minutes.

During the afternoon the sheep was blowing slightly, probably from excitement.

8th May.—No symptoms noticed.

9th May, 9 a.m.—Noticed to be lame in the right hindleg.

Respiration was hurried, and the nostrils were working very noticeably.

12.30 p.m.—Retching violently, and vomiting.

12.40.—Lying on the side, and the signs of life were barely perceptible.

12.43.—Found to be dead, 45 hours after the bite.

Post-mortem examination made within 2 hours of death.

Merino Hamel, 6 teeth, condition fair, rigor mortis absent. Blood not coagulated.

Subcutaneous tissue showed a little haemorrhagic infiltration on the right thigh, in the region bitten.

Peritoneal and pleural cavities empty.

Pericardium contained 1 c.c. clear liquid.

Lungs.—The left lung had formed a few small fibrous adhesions with the chest wall. Pleura of both lungs showed several small ecchymoses. Lung tissue slightly oedematous.

Trachea contained froth.

Bronchial Glands, hyperaemic.

Heart.—The cavities contained uncoagulated blood.

Epicardium, endocardium, and myocardium all appeared normal.

Liver.—The organ was enlarged. On section the parenchyma was pale, and showed fairly distinct lobulation; the consistency was soft and friable. The gall-bladder contained thin green bile.

Kidneys.—Capsule easily stripped. There was well-marked congestion of all three zones, and the kidneys were of softer consistency than normal.

Spleen.—Normal in size. The pulp was paler than normal, and rather soft, and the trabeculae showed up distinctly.

Stomach (or Abomasum) contained liquid ingesta. There was diffuse hyperaemia of the mucosa.

Omasum.—The mucosa was slightly congested.

Jejunum.—The mucosa showed diffuse hyperaemia.

Ileum, Caecum, and Colon, all showed diffuse hyperaemia of varying degree.

Sheep 3870, Merino Ewes. 10th May, 1912.

11.30 a.m.—Bitten by two spotted Schaapstekers, one in each thigh. The snakes bit well.

No symptoms of local or general disturbance of health were observed.

3. *Trimerorhinus Tritaeniatus*, the *Striped Schaapsteker*:

As is indicated by the popular name, this snake is commonly supposed by farmers to be accountable for many of the cases of snake-bite occurring among sheep.

In performing experiments with this species, one encounters the same difficulty, in inducing the snake to bite sheep or dogs, as with *T. rhombeatus*, but smaller animals, such as rabbits and guinea-pigs, are readily bitten.

Striped Schaapstekers were induced to bite one sheep, two dogs, one rabbit, and three guinea-pigs, with the following results:—

- (a) Sheep—no visible effect.
- (b) Dogs—one showed some local swelling, and lameness persisting for two days; the other dog was not visibly affected.
- (c) Rabbit died 20 minutes after the bite.
- (d) Guinea-pigs—two succumbed, within 30 and 35 minutes respectively. The third guinea-pig, which was bitten by a young snake about five inches in length, showed no symptoms of disturbance.

Rabbit 1. February 22nd, 1912. A large white buck rabbit.

11.40 a.m.—Bitten by a *T. tritaeniatus* in the abdominal wall, on an area over which the hair had been clipped with scissors.

11.49.—Muscular tremors started.

11.51.—Violent contractions of the spinal muscles, the back being contracted and curved in such a way as to lift the forelegs from the ground. The forelegs were flexed, and working spasmodically.

11.52.—The rabbit fell on one side, and remained in this position. There were occasional muscular tremors, and the respirations were infrequent and spasmodic. The corneal reflex was only given when the cornea was actually touched.

Any stimulus applied to the skin, and especially pinching over the spinal column, excited violent, general muscular spasms.

11.56.—Reflexes failing, respirations more frequent and fast. The back and the legs became gradually straighter, and at 12 noon death was found to have occurred, 20 minutes after the bite.

Guinea-pig 5. 13th February, 1912.

3.25 p.m.—The guinea-pig was bitten in the abdominal wall, on a patch from which the hair had been cut with scissors, by a *Striped Schaapsteker*.

3.35.—The animal showed a few sudden muscular contractions, and then became dull and quiet.

3.40.—The guinea-pig showed the very sudden onset of violent general muscular contractions. The jerking legs were unable to support the body, which rested on the ground, on the abdominal wall. The jaws were also working. These contractions continued for four minutes.

3.44.—The guinea-pig lay on one side, showing occasional muscular contractions, which became progressively weaker and less frequent.

3.50.—Corneal reflex absent.

4 p.m.—Death had occurred 35 minutes after the bite.

In another guinea-pig, dying 30 minutes after the bite, the symptoms were more or less the same.

Post-mortem lesions :

In both cases the blood showed no traces of haemolysis, but coagulation, which occurred normally in the rabbit, appeared to be incomplete in the guinea-pig.

No local lesion of any sort was found in the guinea-pig, but in the rabbit there were three small haemorrhagic areas, not exceeding 1 centimetre in diameter, in the dermis, in the vicinity of the punctures.

In the guinea-pig, the heart showed petechiae under the endocardium, and there was a very little haemorrhage into the peritoneal cavity; there were no other lesions patent to the naked eye.

In the rabbit, the liver and kidneys appeared to be congested.

4. *Leptodira hotambocia*, the Red-lipped, or Herald Snake :

Members of this species, when first captured, are very aggressive, and no difficulty is experienced in arranging for the infliction of a bite on an animal.

Herald snakes were allowed to bite :—

One sheep, three rabbits, and five guinea-pigs.

In most cases the hair was cut as short as possible, and the snakes were allowed to bite freely, and to retain the hold for several minutes, but in no case was there any visible disturbance of general health, and no local lesion in any form was noticeable.

5. *Psammophis furcatus*, a Sand Snake :

Members of this species were forced to bite two rabbits and two guinea-pigs, but no effects whatever were noticeable.

6. *Tarbophis semiannulatus*, the Tiger Snake :

One experiment was performed with this species, a guinea-pig being bitten in the abdominal wall, with negative results.

GENERAL CONCLUSIONS FROM EXPERIMENTS WITH OPISTHOGLYPHA.

(1) With regard to *Dispholidus typus*, the Boomslang, it has been shown that :—

(a) This snake is capable of delivering a bite fatal in its effects to horses, mules, sheep, and baboons.

It can scarcely be doubted, therefore, that man himself would succumb to the effects of the bite, where the snake had been able to secure, with the jaws, a favourable hold on a part not sufficiently protected by clothing, etc.