

Experiments with Snakes.

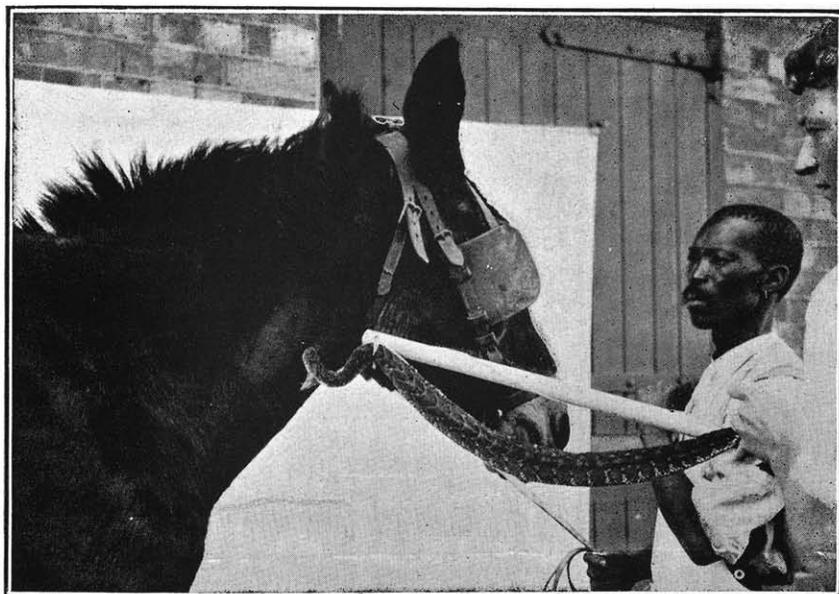


Plate No. 59.]

A puff-adder (*Bitis arietans*) biting a mule. (The snake in this instance is held too far from the head, and in most cases the snake, if so held, would have bitten the stick.)

Experiments with Snakes.

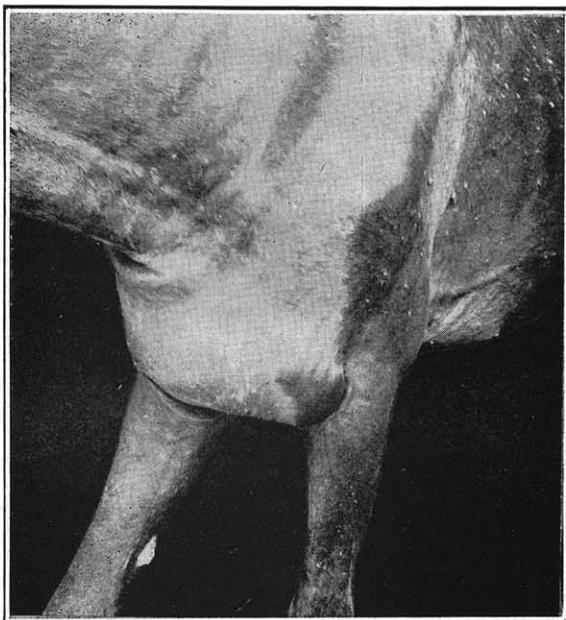


Plate No. 60.]

Horse 5202, bitten by *Sepedon hæmachates*.
(Showing the local swelling on the second day)

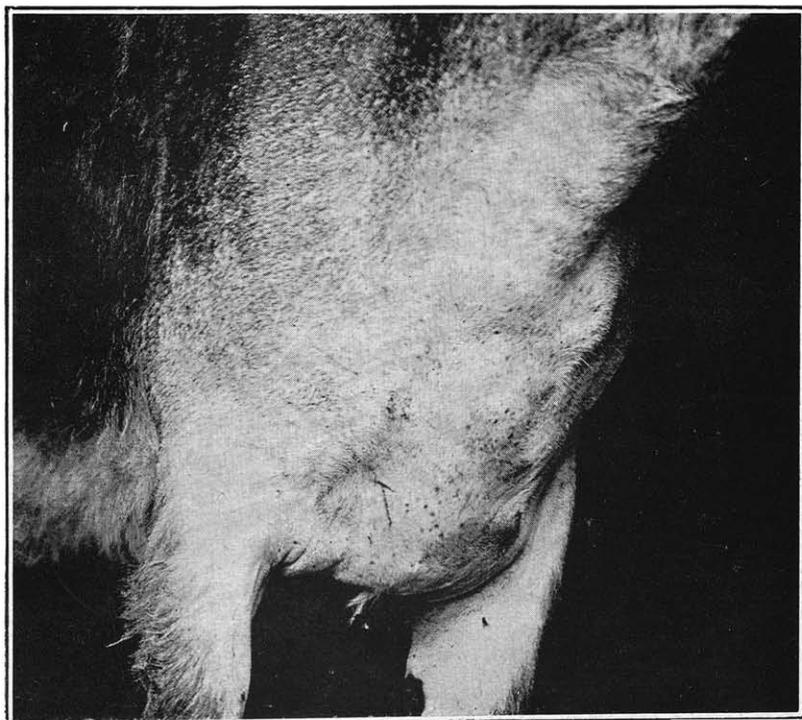


Plate No. 61.]

Horse bitten by *Sepedon hæmachates*.

Experiments with Snakes.

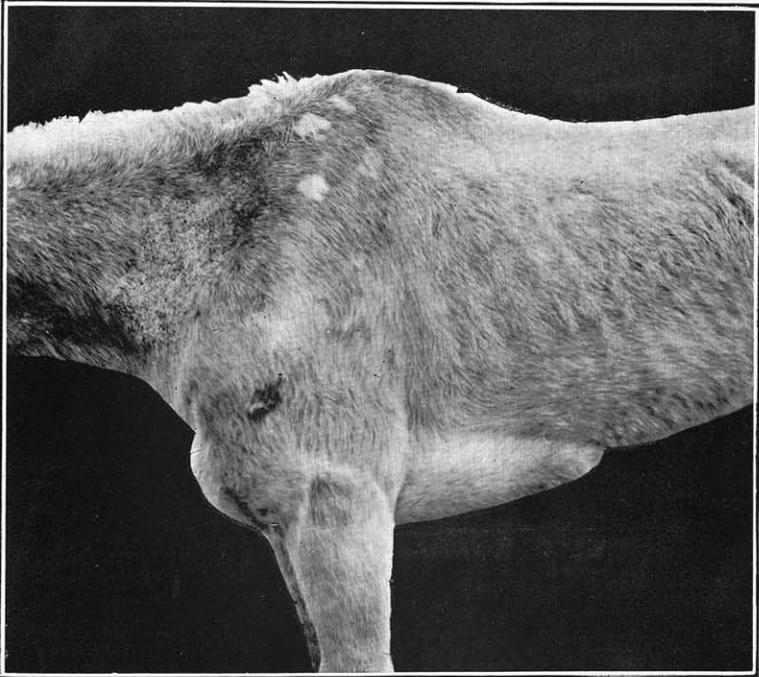


Plate No. 62.]

Horse 5900, bitten by a puff-adder
(Showing the local swelling 24 hours after the bite).

(4) Animals not succumbing early from asphyxia, generally exhibit symptoms of general depression.

This state of depression may be interrupted by periods of restlessness and motor excitement, but it usually lasts until death occurs, or until there are general signs of recovery.

(5) *Respiration and Pulse.*

These are affected by pain, when present, and they show differences corresponding to the general conditions of excitation and depression.

The vast majority of fatal cases, if not all, appear to terminate by paralysis of the respiratory apparatus, and the heart may continue to beat for three or four minutes, or even longer, after respiration has ceased.

(6) *Temperature.*

In the majority of our cases the rectal temperature was taken at intervals of two or three hours.

In a few cases a rise of not more than 1° Fahrenheit was noted, and in the later stages sub-normal temperatures were sometimes recorded.

SUMMARY OF LESIONS NOTICEABLE *POST-MORTEM*— PROTEROGLYPHÆ.

Rigor mortis was present only in one case, in which the autopsy was performed ten hours after death; in other cases it was absent after an interval of even three hours.

Subcutaneous Connective Tissue.

A local lesion was noticeable in all but two cases, the latter being two sheep bitten by *Naia flava* and *Sepedon* respectively; only a small area was affected in a mule and a sheep bitten by *Naia flava*, and the dog dying as a result of a bite from a ringhals showed only slight oedema around the punctures.

There were extensive lesions in the horse and two sheep which succumbed to bites inflicted by *Naia haie*, and also in the horse bitten by *Naia flava*, and a sheep bitten by a *Sepedon*.

The areolar connective tissue was infiltrated with a serous yellowish liquid, and the subjacent muscular tissue was involved only in the horse which succumbed to *Naia haie* bite.

In the two horses which were bitten by *Naia haie* and *Naia flava* respectively, the lesion was hæmorrhagic in parts, but in one sheep which was bitten by *Sepedon* there was extensive hæmorrhagic infiltration.

Serous Cavities.

The pericardial cavity in most cases contained some amount of liquid, but this was tinged with blood-pigment only in the horse which succumbed to the effects of a bite from a *Naia flava*.

The peritoneal and pleural cavities were generally empty, but they contained blood-tinged liquid in the cases of two sheep, bitten by *Naia haie* and *Sepedon* respectively.

Lungs.—A few sub-pleural hæmorrhages were recorded in one case, that of a sheep bitten by *Naia flava*.

Pulmonary oedema was present in a horse and two sheep which died from *Naia flava* bite, in two sheep which succumbed to *Naia haie* bite, and in one sheep which died after a bite from *Sepedon*.

In a few cases there was some degree of pulmonary congestion.

Trachea and bronchi contained froth in cases of pulmonary oedema, and in some cases there was hyperæmia of the mucosa; petechiæ were present in one sheep, which died from the bite of a ringhals.

The bronchial lymphatic glands were rather enlarged and hyperæmic in three sheep (one bitten by *Naia haie* and two by *Naia flava*), and they were slightly oedematous in the horse which was bitten by *Naia flava*.

Heart.—In half of the cases recorded, ecchymoses or petechiæ were noticeable under the epicardium or endocardium, and in some instances the myocardium was of softer consistency than normal.

In one case, that of a sheep bitten by *Naia flava*, the heart had stopped in systole; in all other cases it was in diastole.

Liver.—In some cases the liver appeared to be somewhat enlarged. In the dog succumbing to ringhals bite, there was some hepatic congestion, but in all other cases the parenchyma was pale, and generally slightly yellow in hue; the lobulation was usually rather indistinct, and in most cases the tissue was softer and more friable than normal. The bile varied much in amount and character.

Kidneys.—These organs did not present any very noticeable alterations when examined macroscopically. In three cases there was some degree of congestion, but with these exceptions the renal tissue appeared normal, or, in some cases, rather pale.

Spleen.—In the majority of cases the spleen pulp appeared paler and softer than normal, and the trabeculæ and malpighian bodies did not stand out prominently.

Stomach.—There was some hæmorrhage from the mucosa in one sheep, which had been bitten by *Naia haie*, and the mucosa showed hyperæmic areas in three of the four animals bitten by *Naia flava*, and in the dog succumbing to the effects of ringhals venom.

Rumen and Reticulum.—In no case were any lesions noticeable in these organs.

Omasum.—A few hæmorrhagic streaks were noticeable on the leaves in one sheep, bitten by a *Naia haie*.

Intestines—small and large.—In the three animals dying from *Naia haie* bite, there were no very pronounced intestinal lesions; a few petechiæ were recorded in the horse and in one sheep, occurring in the jejunum, in the former case, and in the latter case in the caecum.

Of the four animals bitten by *Naia flava*, one sheep showed only a few slightly hyperæmic areas in the colon.

In the other three animals the lesions were better-marked and more extensive; in both small and large intestines the mucosa showed

hyperæmic areas, and, in parts, a few petechiæ, and in the horse there were small hæmorrhagic areas in the jejunum.

In the mule the mucosa of the colon was slightly thickened and oedematous, and in this animal there was evident swelling and hyperæmia of some Peyer's patches in the ileum.

In the animals which succumbed to the effect of *Sepedon hæmachates* venom, the large intestine was unaltered, and the small intestine presented lesions only in two cases.

In the dog the mucosa showed some small hyperæmic areas, and in one sheep there was some diffuse hyperæmia, with swelling and hyperæmia of Peyer's patches.

Action on the blood—Proteroglypha.

Blood was withdrawn at intervals from the jugular veins of the animals under observation, and examined in the manner described in the previous section (*Opisthoglypha*).

In some cases the number of erythrocytes was estimated by the use of the hæmocytometer, or of the hæmatocrite.

In no case was any diminution in the number of erythrocytes detected, and in no case was there any noticeable coloration of the plasma or serum, of blood taken during life.

In the case of one sheep, which succumbed to the effects of *N. haie* venom, blood taken some hours after death showed slight hæmolysis.

The process of coagulation occurred quite normally in the majority of cases, but in some instances it was delayed and incomplete. This was shown by a sheep and a guinea pig which died as a result of *N. haie* bites, the snake in the latter case being very small, and by the horse which succumbed to the effects of *N. flava* bite.

In the records of the *post-mortem* examinations, it will be noted that the blood was still fluid in those cases in which the autopsy was performed within an hour of death. Partial coagulation had occurred where the examination was made from one to three hours after death, and, in other instances, coagulation was more or less complete after a lapse of about five hours, or longer.

The absence of any hæmolytic action *in vivo* of *Sepedon* venom has been recorded by Fraser and Gunn, who describe, however, "a feeble and tardy hæmolytic action" *in vitro*.

EXPERIMENTS WITH VIPERIDÆ.

Of the ten species of this family recorded from different parts of South Africa, only two species, *Bitis Arietans* and *Causus rhombeatus*, have been available for experiment.

Experiments on similar lines with *Atractaspis bibronii* should yield interesting information, on account of the relatively enormous size of the fangs.

(1) *Bitis Arietans*, the Puff-adder.

The species has an extremely wide distribution, and the puff-adder is more or less common over the greater part of South Africa. Specimens could always be obtained without difficulty.

Puff-adders, all more or less full-grown, were allowed to bite a horse, a mule, a donkey, three sheep, and a dog, and of these seven animals, only the mule recovered.

One young puff-adder, less than eight inches in length, was allowed to bite two sheep, but neither of the latter was visibly affected.

The following examples will illustrate the general course of the affection produced, and the symptoms and lesions observed :

Horse 5900. 17th June, 1911. (*Vide* Plate 62.)

10.50 a.m. Temperature 98° F., Pulse 48. Erythrocytes (as determined by the haematocrite), 28 per cent.

10.55 a.m. The horse was bitten by a puff-adder at the base of the neck, on the left side.

11 a.m. Pulse 48, unchanged.

11.4 a.m. There were slight muscular tremors in the gluteal region.

11.7 a.m. There were pronounced muscular tremors affecting both hindlegs.

11.8 a.m. The horse lay down. The temperature was 98° F. The head was turned to one side, and the animal appeared dull and sleepy.

11.12 a.m. After some restless movements, the animal rose, and stood grinding his teeth, with the head swaying from side to side.

11.14 a.m. Defaecation occurred, in a normal fashion.

11.15 a.m. The horse again went down, and after two minutes rose once more; the muscular tremors were less marked, but the animal was very restless, and defaecation was again observed. The respirations were becoming more frequent (30 to the minute), and were deep. Slight swelling was visible over the bite.

11.20 a.m. The muscular tremors were more noticeable. There were deep respiratory movements, and the nostrils were dilated.

11.21 a.m. The horse went down on the knees, and immediately rose again; the hindlegs were then brought forward under the body.

11.23 a.m. Defaecation occurred. The respiration was deep, and slightly irregular.

11.25 a.m. The muscular tremors were more pronounced, and there was now, over the area surrounding the bite, a fairly well-marked tense and painful swelling.

11.40 a.m. The pulse was 52 and somewhat irregular in strength, the temperature was 99.8° F., and a haematocrite determination gave 28 per cent. erythrocytes.

11.50 a.m. Muscular tremors were only slightly marked. The pulse was 52, and the respirations were 32 to the minute.

Respiration was laboured, and the nostrils were dilated.

12 noon. The horse was restless, the temperature was 99.4° F. and the respirations were 40 to the minute.

12.25 p.m. No muscular tremors were shown; the animal was restless and grinding the teeth.

1 p.m. The horse was quiet, and no muscular tremors were shown; the respiration was rather hurried, but regular.

2.40 p.m. The animal was quiet, and was attempting to feed. The pulse was regular, and the respiration was regular, but rather laboured. The swelling at the site of the bite was less noticeable.

During the remainder of this day the animal was quiet, and ate well. At 7 p.m. slight swelling over the breast was noticeable, and this swelling increased rapidly in size, extending laterally and downwards.

18th June. In the morning the animal was quiet and dull, but occasionally took a little food; the pulse was rather infrequent and weak. There was an enormous swelling about the region of the breast, extending backwards along the length of the sternum, and down both the forelegs. The swelling was warm to the touch, fairly tense, and painful.

In the afternoon the animal was distinctly weaker, and more depressed. It died about midnight, some 37 hours after the bite.

Post-mortem examination, made about seven hours after death:

An aged grey mare, in poor condition. *Rigor mortis* present. There was a firm swelling extending from the pectoral region over the shoulders and down both forearms. Posteriorly it extended to the umbilicus, and laterally the false ribs were covered.

Subcutaneous tissue.—At the base of the neck, and over the area covered by the above-mentioned swelling, there was an abundant liquid exudate varying in colour from a dark red to black. The connective tissue, and part of the neighbouring muscular tissue, were infiltrated, dark red in colour, and almost of a gelatinous consistency.

Peritoneal cavity contained some reddish liquid.

Pleural cavities empty.

Pericardial cavity contained 35 c.c. blood-tinged liquid.

Lungs were not completely collapsed, and both showed slight oedema and hyperæmia. The left lung showed extravasation of blood under the pleura, and slight emphysema at the lower border.

Trachea and bronchi contained froth; the mucous membrane was injected.

Bronchial glands showed a slight degree of anthracosis.

Mediastinal gland normal.

Heart in systole. The cavities were empty.

The epicardium showed some petechiæ over the left ventricle, and both endocardia showed ecchymoses and petechiæ. The myocardium was pale and softened.

Liver.—The capsule had a mottled appearance, and showed a few calcareous nodules, and fibrous patches and filaments.

On section, the parenchyma was very pale-brown in colour, with fairly distinct lobulation, and there were a few extravasations of blood into the tissues.

Kidneys.—The capsule was easily detached. On section, the kidneys appeared pale-brown in colour, and bloodless, with a "washed-out" appearance. They were soft and friable.

Spleen.—Normal in size. The capsule showed a few fibrous filaments. The pulp was dark red in colour and slightly softened, and the trabeculæ showed up distinctly.

Stomach.—At the fundus the mucosa was slightly thickened, and showed brownish-red patches.

Duodenum contained a few *Gastrophilus equi* larvæ.

Jejunum.—The mucosa appeared to be slightly thickened.

Ileum.—The mucosa generally appeared to be thickened, and there were a few hæmorrhages and petechiæ.

Caecum.—The mucosa showed well-marked hyperæmia in patches, and some hæmorrhages and petechiæ.

Colon.—The serosa showed patches of slight hyperæmia; there were slate-coloured patches on the mucosa.

Bladder contained turbid brown-coloured urine.

Mule 4696.

This animal was the only one which recovered, in our experiments, from the effects of the bite of an adult puff-adder.

The mule was subjected to further bites on five subsequent occasions, and the results of such bites are of sufficient interest to merit recording in detail.

(1) *10th August, 1911.*

11 a.m. The mule was bitten on the shoulder by a large puff-adder. During the afternoon the animal was restless, and showed symptoms of pain. At 4 p.m. a small painful swelling around the punctures was noticeable, and this swelling increased noticeably in size during the evening.

11th August. Throughout the day the mule was very dull and depressed, and it frequently lay down for considerable periods. The pulse was rather weak and frequent, and respiration was hurried.

The swelling was hardly noticeable in the region of the bite, but there was considerable swelling, hot, tense, and painful, over the sternum.

12th August. The mule was very dull and depressed, and when observed was generally lying quietly on the breast; the respirations were rather infrequent, but normal in character, and the pulse was weak.

The swelling over the breast and sternum was larger and more extensive.

13th August. The general health had much improved, but the pulse was not strong, and the swelling extended considerably towards the abdomen.

During the following four days the swelling steadily extended, reaching the umbilical region, but the general health improved rapidly.

24th August. The swelling was noticeably smaller. From this date the swelling diminished rapidly in size, and the general health was excellent.

28th August. The mule was active, and feeding well, and the swelling was hardly noticeable.

(2) *21st December, 1911.*

2.40 p.m. The mule received four bites, from two full-grown puff-adders, on the left side of the neck and on the breast.

Blood trickled slowly from the punctures for several minutes.

3 p.m. Slight swelling was noticeable around each of the four bites. The mule was standing quietly, but the respiration was rather hurried.

4 p.m. The mule was feeding quietly; the swellings were increasing in size.

5 p.m. The mule was rather depressed; the swellings had increased considerably in size, especially over the breast.

9 p.m. The mule was dull and depressed, but the respiration was normal. There was now one large swelling, extending by gravitation to the sternal region; it was tense and warm to the touch, and the mule resented any palpation of this region.

22nd December. The swelling had increased in size, but the mule was feeding well.

23rd-25th December. The swelling continued slowly to extend, and palpation caused the mule to evince signs of pain. The animal was feeding fairly well, but was dull and depressed.

26th December. The swelling was rather smaller in size. From this date it diminished steadily in size, and the general depression was not so marked.

30th December. Some reddish liquid was escaping from the swelling through two small ruptures in the skin.

31st December. The swelling was considerably smaller, and reddish liquid was still exuding through the two openings.

1st January, 1912. The discharge dried up, and the two cutaneous orifices were closed; the swelling was very much smaller in size, and appeared now as several more or less discrete bosselated swellings.

2nd January. Much yellow liquid was escaping from the swelling by an opening in the skin, in the form of an irregular slit more than two inches in length. The general health was now excellent, and no further general disturbance was observed.

3rd January. The wound was now some four inches in length, and there was considerable serous yellow discharge.

This copious discharge continued for a week; movements of the muscles of the left shoulder caused the profuse expulsion of serous yellow liquid.

The discharge then diminished considerably, and the wound began to close.

On *23rd January*, a large inspissated yellow mass was expelled by two cutaneous openings, and during the following two weeks the local lesion healed, leaving only a very small cicatrix.

(3) *23rd January, 1912.*

12.40 p.m. The mule was bitten once by a puff-adder on the right side of the neck.

The general health was not visibly affected, but at 2 p.m. a small swelling was visible. The swelling continued to increase in size, and to gravitate down to the breast and right forearm, and on the following day it was very large.

During the following four or five days the swelling disappeared without complication of any kind, and the general health remained undisturbed.

(4).—*31st January, 1912.*

3 p.m. The mule was bitten once on the right shoulder by a puff-adder. As on the previous occasion, there were no general symptoms whatever.

At 11 p.m. there was very slight swelling over the bite, and by the following morning there was a large oedematous swelling situated on the right shoulder and the right side of the neck, and extending down to the sternum. After about 36 hours the swelling began to diminish in size, and it gradually disappeared.

(5).—*20th February, 1912.*

4 p.m. The mule received three bites, inflicted by two very large puff-adders, on the neck, and on each shoulder.

Within five minutes one could distinguish slight oedematous swelling around the punctures.

At 5 p.m. there was a large area of oedematous swelling over the left shoulder, and smaller patches on the right shoulder and the neck.

The mule was uneasy, but continued to eat readily.

21st February. The mule was rather dull, but exhibited no well-marked symptoms of general disturbance.

There was a very large, tense, and sensitive swelling extending over both shoulders, around the inferior aspect of the base of the neck, and down to the sternum.

22nd February. The swelling was gravitating down the forelegs, and along the sternal region.

23rd February. A portion of skin, measuring about 6 x 4 inches, sloughed from the left shoulder, and there was much serous yellow discharge. The mule was dull and depressed, but not to a marked degree.

The sloughed area was subjected to daily treatment with an antiseptic and astringent dry dressing, and within three days showed distinct signs of healing. The general health was excellent.

Six weeks later there remained only a comparatively small cicatrix.

(6). *7th May, 1912.*

The mule was again bitten on the right shoulder by a large puff-adder. Within a short time the mule became restless, "pointing" with the left foreleg, but this soon passed off, and the general health remained unimpaired.

About 45 minutes after the bite was inflicted, there was a distinct swelling, hot and sensitive, and during the following two days the swelling increased in size, and gravitated down between the forelegs.

On the third day there was some serous discharge through an opening in the skin, and on the following day the swelling was hardly noticeable.

By the 14th May the swelling had disappeared, and the discharge had dried up.

Donkey 6953, 23rd February, 1912.

(Previously bitten by *Naiia haie* on two occasions).

3.40 p.m. The donkey was bitten twice on the right shoulder by a puff-adder.

4 p.m. The shoulder was much swollen, and the donkey was lame. The head was hanging, the pulse was hard and frequent, and the animal was perspiring freely.

4.15 p.m. The animal made several attempts to lie down, but eventually remained standing.

4.45. The donkey was restlessly moving around the box; it was lame, and was staggering slightly.

5 p.m. The animal was dull, and made several attempts to lie down; the head was hanging, the respiration was rather frequent, and the pulse was frequent and fast.

There was a large tense swelling, hot and sensitive, extending over both shoulders, more especially the right shoulder, and along the lower aspect of the neck.

7 p.m. The donkey was standing in a corner of the box, swaying from side to side. The respirations were frequent and jerky, and the pulse was fast, but less frequent than formerly.

The swelling was increasing in size.

8.30 p.m. The animal was found dead, less than five hours after the bite was inflicted.

Post-mortem examination, made about eleven hours after death.

An aged dark brown donkey gelding, in fair condition. Blood not coagulated.

A swelling was prominent over the right shoulder, less so over the left shoulder, and it extended under the breast, and along the right side of the lower border of the neck almost to the head.

Subcutaneous tissue. There was haemorrhagic infiltration over the right shoulder region from the spine to the elbow joint, and this extended on to the neck.

Around this haemorrhagic zone there was an area of infiltration with a clear yellow serous liquid, corresponding with the swollen area above-described. Over the shoulder the infiltration penetrated to a depth of $1\frac{1}{2}$ inch from the skin, involving the deep fascia, the inter-muscular fascia, and the superficial portions of the subjacent muscles.

Pleural and peritoneal cavities empty.

Pericardial cavity contained 15 c.c. clear liquid.

Lungs.—Collapsed normally. On section, the tissue appeared pale and bloodless.

Trachea and bronchi.—Normal.

Bronchial and mediastinal glands.—Normal.

Heart.—In systole. The cavities were empty.

The epicardium was normal, the left endocardium showed extensive ecchymoses, and the right endocardium showed petechiae.

The myocardium was softened.

Liver.—The capsule showed numerous white spots, irregular in shape, and of the size of a pin's head.

The parenchyma was pale yellow in colour, and soft.

Kidneys.—On section the renal tissue was pale and soft.

Suprarenal glands.—Normal.

Spleen.—Enlarged (39 x 22 cms.). The pulp was swollen and moist, and the trabeculae were fairly distinct.

Stomach contained normal food; the fundus contained one spiroptera "tumour." The mucosa of the fundus showed a few small hyperaemic patches.

Jejunum.—The mucosa showed slate-coloured patches.

Ileum.—The mucosa was pale.

Caecum contained *S. armatum*. The mucosa showed petechiae.

Colon.—Normal.

Sheep 3045, 21st September, 1911.

3.35 p.m. The sheep was bitten on the right thigh by a puff-adder.

3.45 p.m. The animal lay down, and was panting.

3.47 p.m. The animal rose and stood with the right hind leg raised from the ground. The eyes were closed, and the respirations were very frequent.

3.50 p.m. The sheep was walking slowly around the box, a short distance at a time; the right hind leg was sometimes dragged, sometimes carried.

In two minutes the animal again went down, and the respiration was hurried, the nostrils were working, and the whole body was shaking.

At 4 p.m. the sheep rose, and stood dully in a corner.

There was now very marked swelling over the right thigh. From 4 p.m. until 4.40 p.m. the animal was very restless; it would stand, or limp around the box, for two or three minutes, or even less, and would then lie down. After remaining recumbent for a few minutes, or even for less than a minute, the sheep would rise, and shortly afterwards go down again.

The respirations were very frequent, and the nostrils were working rapidly. The swelling was increasing noticeably in size.

When not recumbent, the animal either limped slowly around the box, dragging the right hind leg, or stood near the wall; on several occasions the sheep, when standing still, separated the hind legs widely, and appeared to be straining, and at 4.26 p.m. there was marked quivering of the muscles generally.

When recumbent the animal appeared to be very dull and depressed, and the corneal reflex was rather slow. At times the head was stretched far forward, and the muzzle was resting on the floor; at other times the head was stretched up, and the upper lip was turned up.

4.40 p.m. The sheep was lying on the breast, with the muzzle resting on the floor, and the eyes closed.

Respirations were less frequent. The animal moved very little, when approached and touched.

4.45 p.m. The animal was stretching the head upwards and forwards, and there was a slight discharge of mucus from the nostrils. The respiratory movements were jerky in character, and the corneal reflex was elicited only at very short distances.

4.46 p.m. Eructations were noticeable.

4.48 p.m. The animal rose and stood swaying, with the head turned to the chest wall. There were occasional strong spasmodic contractions of the abdominal muscles, and the respiration was becoming stertorous.

4.49 p.m. The sheep went down and lay on the side, with the head stretched forward. The corneal reflex was elicited only when the eye was actually touched.

Spasmodic contractions of the abdominal muscles were noticeable.

Respiration was accompanied by loud groaning, and the respiratory movements were rapid and deep, with a double expiratory effort.

4.52 p.m. The animal rolled on to the back, with the legs kicking, and one minute later fell again on to the side.

The respiratory movements were spasmodic and irregular.

4.54 p.m. All the muscles were tense, and the animal appeared to be dead. After half a minute the head was raised and shaken violently, and the right foreleg was kicking vigorously, but respiration had ceased.

4.55 p.m. All four legs were kicking, the jaws were working slightly, and the head was stretching gradually on the neck.

4.56 p.m. The heart stopped and death occurred, one hour and twenty minutes after the infliction of the bite.

Post-mortem examination, performed 5 minutes after death.

An aged merino ewe, in fair condition. Rigor mortis absent, blood dark red in colour, not coagulated.

Externally there was noticeable a tense swelling in the region of the right thigh, and extending down to the hock joint.

The skin on the inner side of the right thigh showed three livid areas, about 1 cm. in diameter, and around these distinct marks a diffuse area of slight livid discoloration.

Subcutaneous tissue.—Removal of the skin over the right thigh exposed a gelatinous exudate intermixed with oedematous fluid, both deeply blood-stained. This lesion extended from the pubis to the patella, and in this latter region had spread laterally to envelop the leg on all sides. On the external aspect of the leg it had reached the region of the hock joint, anteriorly and posteriorly it had spread over the proximal extremities of the metatarsal bones, and on the inner aspect it had attained the middle portion of the metatarsal region.

The posterior muscles of the thigh were infiltrated with blood-stained liquid.

Peritoneal and pleural cavities empty.

Pericardial cavity contained 5 c.c. clear colourless liquid.

Lungs.—Not completely collapsed. On section they appeared pale and bloodless, and there was slight oedema.

Trachea and bronchi.—Normal.

Bronchial glands.—Normal.

Heart.—In systole. The cavities were empty.

The epicardium showed a few petechiae, and the right endocardium showed ecchymoses and petechiae; there was extensive haemorrhage under the left endocardium. The myocardium was pale, and rather flabby in consistency.

Liver appeared to be somewhat enlarged. The parenchyma was rather pale, with indistinct lobulation, and it was friable.

The gall-bladder contained liquid yellow bile.

Kidneys.—Normal.

Spleen.—Normal in size. The capsule showed petechiae. On section, the pulp was dark and moist in appearance, the trabeculae were indistinct, and the malpighian bodies were distinct.

Abomasum.—The mucosa showed numerous very small petechiae.

Omasum, Rumen, Reticulum.—Normal.

Jejunum.—Normal.

Ileum.—Normal.

Caecum.—Normal.

Colon.—A few parasitic nodules (*Oesophagostomum*), in the sub-mucosa.

Sheep 3464.

On the 1st of February, 1912, this animal was bitten by a very young puff-adder, less than eight inches in length; no general nor local symptoms developed.

3.45 p.m. 8th February, 1912. The sheep was bitten in the right thigh by an adult puff-adder.

4 p.m. The animal was lame, and lay down; respiration was rather hurried.

4.5 p.m. The respiration was very hurried and deep.

4.10 p.m. The animal ignored any movements or noise in its vicinity.

4.19 p.m. The general condition was better, and respiration was less hurried.

4.21 p.m. The animal was restless, repeatedly raising the right hind leg, and occasionally limping around the box.

4.23 p.m. The sheep, was staggering around, panting, and blundering into obstructions. After a minute it went down heavily.

4.27 p.m. The panting was pronounced. The animal rose and staggered backwards for a few steps, and fell; the head was shaking. Death occurred at 4.35 p.m. 50 minutes after the bite.

Post-mortem examination: performed within 20 minutes of death.

A young (six incisors) merino hamel, in poor condition.

Rigor mortis absent, blood not coagulated.

Skin.—On the inner aspect of the right thigh there was a livid area, four centimetres in diameter.

In this region there was a swelling which extended down the leg, but it was not very noticeable.

Subcutaneously there was haemorrhagic infiltration over the inner aspect of the thigh, and this extended down and around the leg to the upper portion of the metatarsal region.

The muscles on the inner side of the right thigh were deeply infiltrated with blood-stained liquid; the external muscles of this region showed some superficial infiltration.

Pericardial cavity contained 10 c.c. clear liquid.

Lungs had collapsed normally. The lung tissue was pale.

Trachea and bronchi.—Normal.

Bronchial glands.—Normal.

Heart.—In systole; the cavities contained a little uncoagulated blood. The epicardium was normal, but both endocardia showed extensive ecchymoses. The myocardium appeared normal.

Liver.—The parenchyma was pale and soft, with fairly distinct lobulation. The gall-bladder contained thin green bile.

Kidneys.—Normal.

Spleen.—The pulp was rather pale.

Abomasum contained a few *H. contortus*. Mucosa normal.

Omasum, Rumen, Reticulum.—Normal.

Jejunum.—Normal.

Ileum.—Parasitic nodules (*Oesophagostomum*), otherwise normal.

Caecum.—Parasitic nodules (*Oesophagostomum*), otherwise normal.

Colon.—Parasitic nodules (*Oesophagostomum*), otherwise normal.

Sheep 2993, 21st December, 1911.

3.40 p.m. The sheep was bitten in the left nostril by a half-grown puff-adder. For eight minutes the punctures were bleeding freely, and the animal was moving about restlessly, tossing the head, and swinging it from side to side.

3.48 p.m. The animal was standing dully, with the legs widely separated, the head swaying from side to side, and the eyes closed.

The respiratory movements were frequent and abrupt.

3.55 p.m. The animal was standing as before-described, or occasionally walking a short distance. Respiration was accompanied by very audible nasal râles; there was very distinct swelling of the left side of the muzzle, and blood clots were hanging about two inches from the left nostril.

4.10 p.m. The animal defaecated and went down, lying on the breast with the head stretched out. The respiratory movements were less frequent, but more abrupt and audible, and the swelling had increased, forming now a large soft pendulous mass under the jaw and throat, and situated especially to the left side. Sometimes the head was hanging, at other times it was raised, and turned towards the chest.

4.25 p.m. The animal sneezed, expelling blood clots from the left nostril, and mucus and froth from the right nostril.

4.35 p.m. The animal rose, and stood with the head held obliquely to the right. Occasionally the head was shaken quickly from side to side, and now and again the sheep would walk a few steps.

The respiration was becoming more frequent, and very jerky.

4.55 p.m. The animal was again lying on the breast, with the head forward, and the muzzle resting on the floor.

Respiration was hurried, and accompanied by nasal râles.

5.15 p.m. In the same position and condition.

7 p.m. In the same position and condition.

9 p.m. The position was the same, except that the head was raised. Respirations were less frequent, but râles were still audible. The animal was quite conscious of any sound or movement. The swelling had increased considerably, extending under the jaw and down the throat, and affecting both sides of the head.

11 p.m. The respiration was less hurried and abrupt, but nasal râles were pronounced. The swelling was increasing in size, and blood was exuding from both nostrils.

22nd December. The animal was standing or walking about, and took notice of any approach, sound, or movement; a little food was taken. The respirations were regular, and of normal frequency, but were accompanied by audible râles.

23rd December. There was general improvement.

24th December. The animal was lying down, and appeared weak. The respiration was stertorous but regular.

From the 25th to the 27th the animal improved; the swelling was diminishing in size, and the animal was standing.

28th December. The animal, although standing, was very weak.

29th December. The weakness increased, and about noon the animal went down on the breast; the respiration was slow and laboured.

At 5 p.m. the sheep was lying on the side, and was very weak.

It was found dead the following morning at 7 a.m.

Death occurred about $8\frac{1}{2}$ days after the infliction of the bite.

Post-mortem examination, made within a few hours of death.

An aged merino hamel, in poor condition.

Rigor mortis present, blood coagulated.

Externally a swelling was visible under the jaw, and over both cheeks. The swollen region showed an infiltration of the subcutaneous tissue with a blood-stained liquid.

Pericardium contained 5 c.c. clear liquid.

Lungs.—Only partially collapsed. There was extensive hepatisation of the right lung, and a small hepatised area in the left lung; the lung tissue not affected by hepatisation was oedematous.

Trachea and bronchi contained froth.

Bronchial lymphatic glands.—Hyperaemic.

Heart in diastole.—The cavities contained coagulated blood.

The endocardium and myocardium were normal, and the epicardium presented two small ecchymoses.

Liver was enlarged. The parenchyma was pale and soft, with indistinct lobulation. The gall-bladder contained viscid yellow bile.

Kidneys.—The cortex was rather pale in colour, and the medulla was slightly hyperaemic.

Spleen.—Normal in size. The pulp was dark in colour, and the trabeculae and malpighian bodies were distinct.

Abomasum.—The mucosa showed diffuse hyperaemia.

Omasum, Rumen, and Reticulum.—Normal.

Jejunum.—The mucosa presented hyperaemic patches; a few parasitic nodules were present.

Ileum.—Similar to the jejunum.

Caecum.—The mucosa showed a few hyperaemic patches, and there were numerous parasitic nodules.

Colon.—Similar to the caecum.

Dog 1211. 11th April, 1912.

12.5 p.m. The dog was bitten in the left thoracic region by a large puff-adder.

12.10 p.m. The dog defaecated and micturated freely. A small oedematous swelling was visible around the punctures.

12.12 p.m. The animal stood with the back arched, straining to a marked degree. The respiration was deep, and rather fast, and the muscles generally were trembling.

The animal lay down unsteadily, and the head was moved restlessly from side to side; the dog ignored movements, noise, etc.

12.18 p.m. The dog rolled over on to the right side; the muscles generally were quivering, respiration was very deep and laboured, and the anus was everted. The corneal reflex could still be obtained.

The local swelling was now more diffuse, and less noticeable.

12.20 p.m. The respiration was stertorous, deep, and laboured; inspiration was accompanied by general trembling of muscles.

12.23 p.m. The respirations were becoming less frequent; there were occasional regurgitations in the throat. Temperature 100.6° F. The corneal reflex was elicited only by actual contact.

12.25 p.m. The respiratory movements were very fast and abrupt: there were eight respirations per minute, with long intervals, and they were no longer very audible.

The muscles of the trunk generally were quivering; the corneal reflex, produced by actually touching the eyeball, was now feeble.

The heart-beats were 70 to the minute, and there was slight intermittence.

12.35 p.m. The legs were extended fully, and were rigid.

12.40 p.m. The respirations were nine to the minute, and both inspiration and expiration were laboured. Salivation was noticeable, there was pronounced quivering of the body muscles, and the legs were very rigid. The animal appeared to be unconscious of noise, movement, and manipulation, but a feeble response to touching the eyeball was still elicited.

12.50 p.m. There were occasional spasmodic contractions of the body muscles generally, and of those of the throat region, causing the mouth to open widely, and producing shallow inspirations.

These movements became less frequent, and more shallow, until only the muscles of the throat and jaw contracted.

1 p.m. All respiratory movement ceased.

The heart-beat at this time was frequent but irregular; it became progressively more irregular, slower, and weaker, until it ceased at 1.3 p.m. A very feeble corneal reflex, produced by actually touching the eyeball, persisted until 1.3 p.m. also.

Death occurred about 58 minutes after the bite was inflicted.

Post-mortem examination, conducted about two hours after death.

A large mongrel dog, male, of the hound type; condition rather poor. Rigor mortis absent, blood partially coagulated.

A very small, and barely noticeable, soft swelling was present on the left chest wall. Subcutaneously there was an area of haemorrhagic infiltration about eight inches in diameter.

Peritoneal cavity.—Empty.

Pleural cavities contained about 20 c.c. partially coagulated blood.

The mediastinum was infiltrated with blood, and there was extensive haemorrhage under the costal pleura; blood coagula adhered to the pericardial sac.

Pericardial cavity contained 3 c.c. slightly blood-tinged liquid.

Lungs.—Collapsed more or less normally. There were numerous subpleural haemorrhages, varying in diameter up to 3 cms., and some emphysema was noticeable.

Trachea and bronchi.—Normal.

Bronchial glands.—Normal.

Heart.—In systole, and appeared normal in all respects.

Liver.—The parenchyma was pale and somewhat softened, with indistinct lobulation. The gall-bladder contained viscid yellow bile.

Kidneys.—There was some hyperaemia of the medulla and boundary zone.

Spleen.—The pulp was rather paler than normal.

Stomach contracted, and contained much mucus.

The mucosa showed a few hyperaemic patches.

Jejunum contained much mucus. There was diffuse hyperaemia of the mucosa.

Ileum.—The mucosa presented patches of well-marked hyperaemia.

Caecum.—A few hyperaemic streaks.

Colon.—Well-marked hyperaemic streaks and patches.

2. *Causus Rhombatus*, the Night Adder.

This species has a wide distribution, but it was difficult to obtain living specimens, and snakes forwarded as night-adders proved as a rule to be *Dasypeltis scabra*.

I was able to procure two living night-adders from Mr. F. W. Fitz Simons, however, and these were allowed to bite:—

One horse, which developed a slight local re-action only.

Two sheep, of which one died and the other recovered.

One dog, which recovered.

The detailed records of the cases are as follows:—

Horse 5093. 11th April, 1912.

12 noon. The animal was bitten on the neck by a night-adder. Within 20 minutes a small oedematous swelling appeared around the bite, but it increased very little in size.

At 3 and 4 p.m. the horse appeared to be rather dull, but this was quite transitory.

The swelling persisted, without increasing in size, for about 36 hours, and then disappeared.

Sheep 3678. 3rd April, 1912.

3 p.m. The sheep was bitten on the right thigh by a night adder.

3.5 p.m. The animal was leaning to the left side.

3.10 p.m. The hind quarters were raised, and the right hind foot was resting on the toe, and was raised occasionally with a jerking movement.

3.25 p.m. The condition was unchanged; a livid mark was noticeable around the punctures, but there was no visible swelling.

3.30 p.m. The animal was depressed; the back was arched, and the head was hanging low. Respiration was rather frequent.

At times the jaws were working, and occasionally the right hind leg was raised from the ground.

No change was noted during the remainder of the day.

4th April. The leg was much swollen throughout its length, and was very sensitive to palpation. The sheep was depressed, and was recumbent during the greater part of the day, but when disturbed, it was able to stand, the swollen leg being raised from the ground.

5th April. The general health had improved, and the animal was feeding better. It was lying down throughout the day, however, and the swelling was as pronounced as before.

6th April. The swelling had diminished considerably in size, but the animal would not stand, nor put any weight on the leg affected. The general health was good, and the animal was feeding well.

After this the animal improved little for several days, on account of its inability to rise or move far to get food, but, with special attention paid to this difficulty, the weakness disappeared, and the swelling diminished rapidly in size.

Recovery was complete.

Sheep 3632. 7th May, 1912.

3.10 p.m. The sheep was bitten twice on the right thigh by a night adder; the bites were well delivered.

3.16 p.m. Respiration was rather hurried (excitement?)

3.18 p.m. The animal was leaning to the left side, and there were restless movements of the right hind leg.

3.40 p.m. The animal was staggering about, and at other times the right hind leg was moved restlessly. Respiration was hurried.

4 p.m. Around the site of the bite there was slight oedematous swelling, with a little diffuse dark discoloration of the skin.

8th May. The sheep was dull, but there were no marked general symptoms. The swelling had increased, and the leg was very sensitive, and was generally carried.

9th May. The sheep was somewhat dull and depressed. The leg, which was carried, was much swollen down to the foot.

10th May. The leg throughout its whole length was enormously swollen, hot, and painful. The skin over the swelling was tense, and showed extensive livid discoloration inside the thigh.

If recumbent, the animal was unable to rise unassisted, but when aided to rise it was then able to stand and walk.

The animal was dull, but displayed no very noticeable general symptoms.

At 8 p.m. the sheep was found to be down, and to be unable to stand. It was conscious of its surroundings, but very much depressed, and apparently in pain. The pupil of the eye was dilated, and the respirations were frequent.

At 11 p.m. the respirations were frequent and stertorous. The sheep showed no signs of being conscious of approach or manipulation, but the usual reflexes could be stimulated.

11th May. At 7 a.m. the animal was found dead, death occurring about $3\frac{1}{2}$ days after the bite was made.

Post-mortem examination, made at 7 a.m. 11th May

A young (six incisors) merino hamel, in fair condition. Rigor mortis present, blood coagulated.

The right hind leg was much swollen throughout its length.

The subcutaneous connective tissue of this leg was infiltrated with an oedematous liquid, dark red in colour. The inter-muscular fascia was also infiltrated, but the muscular tissue was not affected.

Pericardial cavity contained 5 c.c. blood-tinged liquid.

Lungs were only half collapsed. On section the tissue was oedematous, and congested to a slight extent.

Trachea and bronchi contained froth. The mucosa was hyperaemic.

Bronchial glands were enlarged, oedematous, and contained haemorrhages.

Heart in diastole. The cavities contained coagulated blood.

The epicardium and left endocardium presented extensive ecchymoses; the myocardium and the right endocardium appeared normal.

Liver. The parenchyma was pale and friable; the gall-bladder contained much thin green bile.

Kidneys.—The cortex was somewhat yellow in colour; the medulla was slightly congested, and of soft consistency.

Spleen.—The pulp appeared to be somewhat swollen, soft, and moist; the trabeculae and malpighian bodies were fairly distinct.

Abomasum contained mucus. The mucosa showed diffuse hyperaemia, and small haemorrhagic spots.

Omasum, Rumen, Reticulum contained little food. The mucosa was normal.

Jejunum.—A few parasitic nodules.

Ileum.—A few parasitic nodules. The mucosa presented hyperaemic patches.

Caecum presented a few parasitic nodules, and small hyperaemic patches.

Colon.—Similar to the caecum.

Dog 1200. 3rd April, 1912.

3 p.m. The dog was bitten on the right thigh by a night adder, immediately after the latter had bitten sheep 3678. Temperature 102.2°F .

3.5 p.m. The animal was depressed, and leaning the weight on the left hind leg; the respiration was deep, and rather frequent.

3.10 p.m. The animal was restless; the head was hanging low, and the right hind foot was raised from the ground. Respiration was normal.

3.15 p.m. The right hind leg was drawn back, and there was a warm and painful local swelling. The animal was depressed, the head was hanging, the respiratory movements were fast, and the pulse was 112 beats to the minute.

3.25 p.m. The eyes were closed, and respiration was rather laboured; the forelegs were stretched forward, and the right hind leg was projected back.

3.40 p.m. The animal was leaning to the left side; it went down, and lay with the affected limb fully extended.

3.50 p.m. The dog was lying with both hind legs extended and rigid.

3.55 p.m. There was noticeable quivering of the body muscles.

4 p.m. The respiratory movements were less frequent, but were somewhat fast and abrupt.

4.35 p.m. The dog rose, and immediately lay down again.

4.40 p.m. The animal rose on the fore limbs; the body muscles were quivering.

At 5 p.m. the dog was standing quietly, with the right hind foot raised from the ground. The temperature was then 102.4°F.

The condition was unchanged during the remainder of this day.

4th April. The right hind leg was moderately swollen, and the skin of the thigh showed a small livid area around the punctures. The animal was feeding well, and there were no signs of depression; at times it lay with the affected limb rigidly extended, and at other times the dog stood with the foot raised from the ground.

5th April. The general health was excellent; the swelling had markedly diminished in size, and some weight was supported by the affected leg.

6th April. The dog stood and walked well, and the swelling was hardly noticeable.

SUMMARY OF THE SYMPTOMS DUE TO VIPERINE VENOM.

(1). *Local lesion.*

Some local swelling was present in all cases.

In a sheep and a dog, both of which succumbed to *Bitis arietans* bites, the local swelling was not very noticeable, although *post-mortem* a comparatively extensive lesion was observed, and in the horse bitten by *Causus rhombeatus* the swelling remained quite small.

In all other cases, however, the swelling assumed large dimensions, and in some instances it was truly enormous.

In the majority of cases, the swelling was first noticeable from five to twenty minutes after the bite was inflicted, but in some cases it was not observed until an hour or more later.

When first seen, the swelling took the form of a more or less circular elevated area of skin, over and around the punctures, which at first was rather soft, but which rapidly became tense, warm to the touch, and sensitive to palpation.

This swelling, in most cases, increased very rapidly in size, and showed a well-marked tendency to gravitation to lower regions.

Ultimately there was generally a very large tense swelling extending under the breast, or down a limb, and this swelling was warm to the touch, and very sensitive.

In cases of recovery, the swelling eventually became softer and less sensitive, and then decreased in size; in the one case of recovery from *Bitis arietans* bite this process was first noticeable on the fourteenth day, and after bites from *Causus rhombeatus* it was first observed on the second or third day.

The reduction in size usually occurred somewhat slowly; discharge of liquid through rupture of the skin, and sloughing, were seen only in one animal (the mule) when, subsequent to its recovery from puff-adder bite, it was subjected to further bites from this species of snake.

Livid discoloration of the skin around the punctures was noticeable in two sheep bitten by puff-adders, and in a sheep and a dog bitten by a night-adder.

(2) *Symptoms Directly due to the Position of the Bite.*

The symptoms of this nature recorded in cases of bites by proteroglyphous snakes, were also present as a result of viperine bites, but in the latter case they were far more pronounced, owing to the more constant occurrence, and greater degree, of pain and swelling.

In one case, that of a sheep bitten in the nostril by *Bitis arietans*, the symptoms usually observed were complicated and obscured by the early onset of dyspnoea, owing to haemorrhage into the nasal cavities, and local swelling.

(3). *Symptoms of Pain.*

No signs of pain were exhibited by the horse which was bitten by *Causus rhombeatus*, the animal being only very slightly affected by the bite, and the mule, which had recovered from *Bitis arietans* bite, evinced few if any symptoms of this nature when subjected to further bites.

In all other cases, however, the symptoms of local pain were very pronounced.

The symptoms were similar in character to those described in connection with the *Proteroglypha*, but they were very much more constant and intense.

(4). *Nervous Symptoms.*

All the symptoms of nervous excitation recorded in cases of bites from proteroglypha, were also shown as a result of puff-adder bite, with the exception of such cerebral symptoms as licking walls, and biting the air.

In the majority of cases, most of the symptoms of excitation could be ascribed to acute local pain.

In some animals twitching of muscles, defaecation, micturition, and straining, occurred apparently as manifestations of pain, but in a sheep and dog, both of which died in about an hour, there were spasmodic contractions of the abdominal and limb muscles, with the production of such secondary symptoms as defaecation and kicking, and these were seemingly due to the onset of asphyxia.

In cases of *Causus* bite, all the symptoms of excitation were evidently caused by pain.

Some depression was shown in all cases.

In the earlier stages, the animal was dull and depressed, the head was inclined to hang, and the eyes were sometimes closed.

The pulse was generally infrequent and rather weak, and the respiration laboured.

Later the animal would generally show increasing weakness, sometimes swaying from side to side, and would lie down; in some cases the muzzle was rested on the ground.

In fatal cases the weakness increased, the pulse and respiration became progressively weaker and less frequent, and the conjunctival reflex slower and less active.

Finally the animal would lie in a comatose condition, not responding to such stimuli as light, sound, and touch, with stertorous respiration and a weak infrequent pulse, until death supervened.

No symptoms of incoordination or paresis were observed.

This stage of depression was usually shown after that of acute pain had passed, but in some cases the pain appeared to be somewhat intermittent, and in these cases the animal, between two periods of acute pain, showed usually some dullness and depression.

The general course of the affection thus resembles that described for the *Proteroglypha*, the stages being:—

(a) A period of restlessness and excitement, which appears to be chiefly, if not entirely, due to local pain.

(b) In some cases the first stage is succeeded by a period during which the animal shows little abnormality, beyond the presence of a local lesion.

(c) In a few cases dyspnoea comes on, after less than an hour in the smaller animals, or after a few hours in equines, and the animal dies within a short period, after showing motor excitation, or even marked convulsions, followed quickly by depression, coma, and death.

(d) Animals succumbing after longer periods, pass through a final, and more or less prolonged, stage of depression, and this is seen in some cases ending in recovery. (In two cases of recovery from *Causus* bite, the stage of depression was not prolonged).

(5). *Respiration and Pulse.*

These were much affected by pain, and in the stage of depression they showed corresponding changes.

In a few cases respiratory paralysis, presumably of central origin, occurred early, and led rapidly to death, and in one case there was acute dyspnoea produced mechanically by haemorrhage into the nasal cavities, and by swelling in the region of the nostrils.

(6). *Temperature.*

In several of these cases the rectal temperature was taken at intervals, but no significant rise was noted; in the last stages the temperature was several times found to be sub-normal.

LESIONS OBSERVED POST-MORTEM—VIPERIDAE.

Rigor mortis was absent in cases in which the *post-mortem* examination was made within an hour of death; in other cases, where an interval of several hours had elapsed, it was present.

Subcutaneous tissue.—The local lesion produced by *Bitis arietans* bite, appeared as an infiltration of the subcutaneous areolar tissue, the deep fascia, and even of the neighbouring muscle.

The affected tissue was infiltrated with liquid and a gelatinous material, both being deeply blood-stained.

This lesion was very extensive in all cases except that of the dog, in which it took the form of a more or less circular area some eight inches in diameter.

In one case (a donkey) the haemorrhagic lesion was surrounded by an area of infiltration with a clear serous liquid, yellow in colour.

In the one fatal case of *Causus* bite, there was a very similar lesion in the form of an extensive area of haemorrhagic infiltration, and the inter-muscular fascia was involved, but the muscular tissue itself was not affected.

Serous cavities.—The peritoneal cavity contained some blood-tinged liquid in the horse which succumbed to *Bitis arietans* bite, but in all other cases it was normal.

The pleural cavities were empty, except in the dog which was bitten by *Bitis arietans*; in this case there was about 20 c.c. of blood free in the cavities, and the mediastinum was infiltrated with blood, which had apparently escaped through the pulmonary pleura, although no actual rupture was seen.

The pericardial cavity contained some liquid in all cases, but it was tinged with blood-pigment only in the horse and dog which succumbed to *Bitis arietans* bites, and in the sheep which died as a result of a bite from *Causus rhombeatus*.

Lungs.—In the horse and dog above-mentioned, there were sub-pleural haemorrhages, and some degree of emphysema was recorded.

In those animals (a donkey, a sheep, and a dog) which succumbed quickly to *Bitis arietans* bites, the lung tissue appeared pale and bloodless, and in one sheep, which survived for a slightly longer period, the tissue was pale but slightly oedematous.

In the horse and sheep which survived for considerably longer periods, and in the sheep which died (also after a considerable number of hours) from the effects of the bite of *Causus rhombeatus*, the lungs were oedematous and hyperaemic.

The lungs of one sheep which survived for nearly nine days, and which exhibited symptoms of respiratory distress mechanically produced, showed considerable areas of hepatisation; in this case there was probably complication by secondary infection.

Trachea and bronchi in a few cases contained froth. In two instances the mucosa was slightly hyperaemic.

Bronchial lymphatic glands.—These were generally quite normal, but in the sheep affected with pulmonary hepatisation, they were hyperaemic. In the sheep bitten by *Causus rhombeatus*, they were enlarged and oedematous, and contained haemorrhages.

Heart.—With the exception of the sheep which survived for nearly nine days, in all cases of *Bitis arietans* bite the heart was found *post-mortem* to have stopped in systole.

In the fatal case of *Causus* bite, the heart was found in diastole.

The epicardium and both endocardia showed petechiae or extensive ecchymoses, the number, and exact situation, of such lesions varying in the different cases.

Only in the dog were such lesions absent in cases of *Bitis arietans* bite, and they were well-marked in the sheep which was bitten by *Causus rhombeatus*.

The myocardium usually appeared rather pale, and soft or flabby in consistency.

Liver.—In two sheep, bitten by *Bitis arietans*, the organ was noticeably enlarged. The parenchyma in all cases was abnormally pale, and the lobulation was generally indistinctly shown; the tissue was somewhat softened or friable. In the horse there were a few extravasations of blood into the tissue.

Kidneys.—These organs in some cases were not visibly altered, but they were generally rather pale in colour, and of softer consistency than normally; in three cases the medulla was slightly hyperaemic.

Spleen.—In one sheep, bitten by *Bitis arietans*, the capsule showed petechiae. The organ was not very markedly affected, and there was considerable variation in the characters observed in different cases.

Stomach or Abomasum.—In one sheep, which succumbed to the effects of *Bitis arietans* bite, there was no noticeable abnormality, but in the other cases there were lesions of the mucosa, varying from slight hyperaemia to petechiae.

Omasum, Rumen and Reticulum.—Normal.

Intestines.—In some cases there was some degree of hyperaemia of portions of the mucosa, varying in intensity and extent in different cases.

In the horse there were haemorrhages and petechiae in the ileum and caecum, and the donkey also showed petechiae in the caecum.

ACTION ON THE BLOOD—VIPERIDAE.

Observations were made, at intervals of two or three hours, on the blood of the various animals bitten by *Bitis arietans* and *Causus rhombeatus*, the methods used being those already described in connection with the experiments with *Opisthoglypha* and *Proteroglypha*.

(1) *Causus rhombeatus*.

No traces of haemolysis were found, and in all cases the blood coagulated well.

(2) *Bitis arietans*.

(a) In no instance were any signs of haemolysis detected in the plasma or serum,

(b) Coagulation was not noticeably affected in the mule which recovered, nor in the sheep (2993) which died after eight and a half days, but in all other cases it was distinctly slow in occurring, or even absent.

Thus blood taken from Dog 1211, half an hour previous to death, showed only partial coagulation after a lapse of 35 minutes, and the process was not complete until 1½ hours after the blood was taken.

In the case of Sheep 3464, blood taken immediately after death showed no signs of coagulation five hours later, and on the following day the coagulation was only partial.

In Donkey 6953 and Sheep 3045, blood taken immediately after death remained liquid in the test-tube for days, and ultimately putrefied.

In this connection it is of interest to note that, at the autopsies, the blood was found fully coagulated only in the somewhat atypical case of Sheep 2993; in Dog 1211, when examined about two hours after death, the blood had only partially coagulated.

It is, therefore, apparent that the venom of *Bitis arietans* exercises a distinct anti-coagulative action on the blood.

This is of particular interest in that viperine venom generally actively promotes coagulation of the blood, although an anti-coagulative action has been demonstrated with the venoms of *Ancistrodon cortortrix* and *Ancistrodon piscivorus*, two North American *Crotalinae* (*vide* Calmette, "Les Venins").

GENERAL CONCLUSIONS AND COMPARISONS.— PROTEROGLYPHOUS COLUBRIDAE AND VIPERIDAE.

(1) *Action of the venom on the tissues at the point of introduction.*

Viperine venom exerts a strong and almost constant effect, in producing local infiltration and pain, with all the consequent symptoms. The lesion is generally extensive, and haemorrhagic in character, and the deeper structures (muscle and intermuscular fascia) are usually involved.

The action is much less marked with the venom of the proteroglyphous snakes tested, for in a considerable proportion of cases no noticeable local swelling developed, and the lesions, when present, were generally smaller, more superficial, and not haemorrhagic in character. Moreover, even very large swellings, produced by the action of colubrine venom, may not give rise to any appreciable symptoms of pain.

Calmette has stated: "Il est remarquable de constater combien l'importance des désordres locaux est grande lorsque le reptile venimeux appartient au groupe des Solénoglyphes (Viperidae), tandis qu'ils sont presque nuls avec les Protéroglyphes (Colubridae et Hydrophiidae)" ("Les Venins," p. 175), and again "La morsure d'un cobra, même de grande taille, n'est pas très douloureuse" (*idem*, p. 176).

He mentions, however, the occurrence of a local lesion (apparently not of large size, nor of painful character) in cases of recovery from the bite of a colubrine snake such as a cobra (*id.*, p. 185).

It will be seen that the results obtained in these experiments are in general agreement with the position as stated by Calmette, for the local lesion produced by viperine venom was very considerably larger, and more serious and painful in character, than that associated with colubrine venom.

It would appear, however, that colubrine venom (or at least that of the three species mentioned) has frequently a considerably more pronounced local action than is indicated in the passages quoted above.

(2) *Action on the Nervous System.*

Apart from manifestations of pain, animals bitten by vipers do not, as a rule, exhibit pronounced symptoms of nervous origin. In a few cases there are convulsions which appear to be due to respiratory

distress, brought on presumably by the action of the venom on the respiratory centres, but as a rule the animal, in the later stages, shows general depression.

With Proteroglypha, the nervous symptoms are generally better marked. There is a great tendency to the production of asphyxial convulsions, especially in smaller animals (a question of dose, presumably,) and distinct symptoms of cerebral disturbance may be shown.

In cases surviving for longer periods, the final stage of depression is generally very pronounced, and incoordination of movement, and local and progressive paresis and paralysis, may be prominent symptoms.

(3) *Action on the blood.*

The venoms of *Naia haie* and *Naia flava*, and of *Sepedon haemachates*, appear to exert very little action on the blood *in corpore*, in spite of the haemolytic and anti-coagulative actions, *in vitro*, which have been described in connection with venoms of many proteroglyphous colubridae (compare Fraser and Gunn).

Some diminution in the coagulability of the blood was noted in a small proportion of cases.

With *Bitis arietans* venom, there was a very distinct anti-coagulative action exercised *in corpore*, and this species must, therefore, be classed with the small number of exceptions to the rule, that members of the family Viperidae secrete a venom possessing active coagulative powers. (It is of interest to note that a similar anti-coagulative action, *in corpore* was recorded with the venom of the opisthoglyphous boomslang).

(4) *Action on the heart.*

With Colubridae, the heart of the subject was generally found to have stopped in diastole; with Viperidae, it was usually in systole.

(5) *The production of haemorrhages.*

The tendency to the production of haemorrhagic lesions, and extravasations in the heart, the gastro-intestinal tract, etc., is more pronounced with viperine than with colubrine venom, and, as has already been remarked, the local subcutaneous infiltration is usually haemorrhagic in the former case.

(On the other hand, this action is very much more evident with the venom of *Dispholidus typus* than with that of either of the two vipers tested).

(6) *Rapidity of action.*

Judging from the time which elapsed from the delivery of the bite until the first symptoms were observed, and until death occurred, there is no marked difference between the two classes of venom in this respect.

(7) *Lethality.*

In order to form an accurate estimate of the comparative lethality of the venoms of these species for the various domesticated animals, it would be necessary to have access to reliable records of a considerably larger number of cases than are here available, but such information could best be obtained by the determination, in each case, of the minimum-lethal dose.

As far as one can judge from a limited number of cases of the kind recorded in this paper, the following conclusions may provisionally be drawn :—

(1) *Proteroglypha.*

Of the three species tested, *Naia flava* appears to be the most highly venomous, while *Sepedon haemachates* is apparently considerably less dangerous, to equines in particular.

It is of interest, in this connection, to note that Fraser and Gunn, comparing *Sepedon* venom with that of the Indian cobra (*N. tripudians*), have found that the scale of comparative lethality for small laboratory animals is very similar in the two cases, but that *Sepedon* venom possesses a lower absolute toxicity.

(2) *Viperidae.*

Bitis arietans is evidently highly dangerous to equines, sheep, and dogs. The absolute toxicity of the venom may possibly prove not to be very high, as compared with that of some other species, but the poison glands are well developed, and the volume of venom available for ejection is generally very considerable.

Causus rhombeatus is popularly considered to be extremely venomous, but this view is not supported by the experiments recorded here. In four experiments only one death (of a sheep) occurred, but it should be noted that the dog which recovered was bitten by a snake which, immediately previous to this, had bitten a sheep, the latter also recovering.

Mr. F. W. Fitz Simons, as a result of biting experiments on rabbits and fowls, has also concluded that this species is not very dangerous to life.

It is probable, however, that the majority of the sheep bitten by this species, under natural conditions, would ultimately die from starvation, on account of the interference with feeding by the large and painful local swelling.

IMMUNITY IN CASES OF SNAKEBITE.

In practically all cases, animals which failed to succumb to the effects of a snakebite, were subsequently subjected to further bites from the same or some other species of snake.

In a number of cases, the animal, on the first occasion, had exhibited no symptoms of venom intoxication; the reasons for such results have been suggested in the records of the individual cases. When subsequently tested these animals, as was to be expected, showed no noticeable degree of resistance to the same or other venoms.

(1) *Immunity to the venom of the same species.*

Donkey 6953, which recovered after severe illness arising from a bite by *N. haie*, showed only a slight local reaction when subjected, 13 days later, to a second bite from this species.

There were two other cases, however, which deserve special mention.

In one case the subject of the experiment, Mule 4696, was bitten by *Bitis arietans*, and eventually recovered, after undergoing a very severe reaction, both local and general.

The mule was subjected to puff-adder bites on five subsequent occasions, and in some instances the test was very severe, the animal receiving as many as four full bites from large and vigorous puff-adders. The general health was never seriously affected by these further bites, but the *local* reaction was very marked; within a short time a swelling was noticeable in the region of the bite, and this swelling increased rapidly in size until it attained large dimensions.

Moreover, on two occasions there was considerable discharge through cutaneous orifices, and on another occasion extensive superficial sloughing occurred.

In the other case a baboon, which had exhibited signs of very serious illness as a result of boomslang (*Dispholidus typus*) bite, succumbed within a short time to the effects of a second bite, inflicted after an interval of 25 days.

(2) *Immunity to the venom of another species.*

Two of our cases are of interest in this connection. The donkey which had acquired a strong immunity towards the venom of *Naia haie*, as was shown by the insignificant reaction to the second bite, was subjected, after an interval of one month, to the bite of a puff-adder, and died within the comparatively very short period of five hours.

This result was not unexpected, as it is a well-established fact that an immunity acquired towards the venom of a colubrine snake, affords little protection against the venom of a viper.

In the second case, however, the result was more remarkable, for a sheep (Sheep 2803) which had recovered from serious disturbance provoked by *Naia haie* bite, succumbed in about one hour to the effects of a bite by *Naia flava*, inflicted 19 days after the first bite.

APPENDIX I.

SOME OBSERVATIONS OF A GENERAL NATURE.

(1) *Behaviour when approached or attacked.*

It appears to be the rule with all South African snakes, with the exception of the mamba during the breeding season, that when attacked by man their first instinct is to escape.

When they are unable to do so, however, on account of confinement, or of mechanical restraint, some species become very fierce and aggressive, while others show little of this tendency.

There is, moreover, considerable difference in this respect between individuals of the same species.

The python is well-known to bite very fiercely when cornered, and our one specimen was no exception to this rule.

With regard to the Colubridae, it is our experience that, as a rule, the aglypha and opisthoglypha are timid snakes, only attempting to bite when actually held tightly, and frequently not even when so held.

The proteroglypha, on the other hand, are generally fierce when approached closely, and usually bite readily when touched even very lightly.

This difference is not absolute, for *Leptodira hotamboeia* (an opisthoglyphous colubrine) when actually cornered or confined in a cage, has, in our experience, proved invariably to be exceptionally fierce and aggressive; even in this species the resentment to approach or handling is to a great extent lost after prolonged captivity.

The Boomslang is generally a timid snake, and when touched or seized, it seeks by very quick movements to escape, and evinces little or no inclination to bite.

When manipulating the boomslang with the pole and cord previously described, it may be held some distance behind the head, an arrangement which allows the snake to strike with greater freedom.

The majority of the other large species of snakes cannot be so held, as they will at once bite fiercely at the pole.

On the other hand, it was not difficult, as a rule, to induce the boomslang to bite a living animal, against which its head had been pressed or rubbed.

In one case a boomslang behaved very differently to all the others which had been under observation; the snake was fierce and aggressive, and attempted to bite at anything passing close to its cage. When enraged, the snake showed a peculiar inflation of the pharyngeal region, producing an increase in the antero-posterior diameter of the neck, with lateral flattening.

The "schaapstekers" (*Trimerorhinus*) were generally timid, and very great difficulty was experienced in inducing them to bite such animals as sheep or dogs, but, when held with the hand or forceps, they readily bit small animals such as guinea pigs and rabbits.

The *Psammophis* and *Tarbophis* snakes were also timid, and disinclined to bite larger animals, but, as previously stated, Herald snakes (*Leptodira*), when first caught were always very aggressive.

Of the proteroglyphous colubridae kept under observation, *Naia haie* was always aggressive, and actively resented any approach and handling; this was well shown by both adults and young individuals, of which many specimens were procured from the immediate vicinity.

Naia flava, of which two specimens were procured at Onderstepoort, behaved somewhat differently, awaiting close approach, or actual handling, before attempting to bite, and then biting very quickly.

Both of these specimens had possibly been in captivity for some time (they were procured from Mr. F. W. Fitz Simons, of Port Elizabeth), and the two individuals which I have encountered in the natural state were very fierce, although more eager to escape than to bite.

Of the ringhals, *Sepedon haemachates*, one adult and ten newly-born individuals were under observation.

The young ringhals were always aggressive, and resented any approach, but the adult displayed repeatedly a remarkable instinct for feigning death.

The snake would lie with the mouth open, and the neck twisted on the body through a wide angle, and in such a position it would remain motionless for many minutes, in spite of actually rough treatment with a stick. Sometimes a period of such feigning would terminate in a sudden fierce bite at the stick, but this was not always the case.

This ringhals showed well the habit of distant projection of venom, and the motor-glasses worn by the observer were several times freely bespattered.

On one occasion the venom was projected almost vertically to a height of about four feet, the greater part of the venom, on this occasion, falling short of the eyes and entering the mouth of the observer. No particular taste was noted, and no ill-effects whatever resulted.

Naia flava has been included among the "spitting snakes," but no attempt to project venom was witnessed in this species.

(2) *The Mode of Biting.*

In this respect a very distinct difference between the proteroglyphous and opisthoglyphous snakes was observed.

In the former case, the bite is delivered very rapidly; the fangs are driven well home, and are withdrawn almost immediately.

The snake may bite several times in succession, if much enraged, and particularly when tightly secured close behind the head, as in most of our experiments, but it is rare for such a snake to retain its hold for many seconds.

With the opisthoglypha, on the other hand, the snake darts forward quickly, with jaws widely separated, and endeavours to raise a large fold of skin, which is held as far into the mouth as possible.

This grip is retained for a considerable time, during which the jaws are slowly worked through a small angle, and with a slight but constant forward movement, evidently intended to extend the jaws as far as possible over the fold of skin.

We have observed boomslangs to continue this process for more than five minutes; the position of the jaws is generally moved slightly, in a lateral direction, once or twice during the process.

Finally the grip of the jaws is relaxed, and the snake frequently remains with the hanging head, and jaws separated, as if fatigued. The aglypha usually retain a hold, once taken, until the victim is swallowed.

(3) *Feeding in Captivity.*

Of the snakes mentioned in these records, a number were kept in captivity over considerable periods, and at different times living rats, mice, lizards, frogs, birds, and chameleons were placed in the cages.

The only snakes which fed voluntarily, however, were some of the striped schaapestekers (*Trimerorhinus tritaeniatus*), which swallowed a number of mice.

All the snakes drank much water. One *Leptodira hotamboeia* was kept alive in a cage for fifteen months, during which period it moulted several times.

Throughout the fifteen months, the snake drank water eagerly at intervals of a few days, but refused all food (no artificial feeding was performed).

On one occasion a female puff-adder, which was kept in a large cage with two males of the same species, gave birth to about twenty-five young. Two days later, only four (dead) young snakes were found in the cage, the others having presumably been swallowed by one or both of the adult males.

(4) *The Age at which Active Venom is Developed.*

On this subject we were able to make some observations on *Sepedon haemachates*, ten young snakes being born in one of our cages.

Within twenty-four hours of birth, three of these snakes were allowed each to bite a guinea-pig; two of the guinea-pigs died, one hour and forty minutes, respectively, after the infliction of the bites.

When twelve days old, two of these snakes killed a rabbit in eighteen minutes, and at the age of one month, a ringhals (then less than six inches in length) killed a large mongrel Irish terrier in forty-five minutes.

APPENDIX II.

LIST OF THE SNAKES RECEIVED, WITH THE DISTRICT IN WHICH THEY WERE CAPTURED.

<i>Typhlops bibronii</i>	Pretoria District.
<i>Python sebae</i>	Pretoria District (Rietfontein).
<i>Ablobophis rufulus</i>	Pretoria District (Onderstepoort).
<i>Lamprophis aurora</i>	Pretoria District (Onderstepoort).
<i>Boodon lineatus</i>	Pretoria District (Onderstepoort, Pienaar's River).
	Barberton District (Hector Spruit).
<i>Simocephalus capensis</i>	Pretoria District (Pienaar's River).
	Barberton District (Hector Spruit).
<i>Dasypeltis scabra</i>	Pretoria District (Onderstepoort Pienaar's River).
	Barberton District (Hector Spruit).
<i>Tarbophis semiannulatus</i>	Pretoria District (Pienaar's River).
<i>Leptodira hotamboeia</i>	Pretoria District (Onderstepoort, Pienaar's River).
	Barberton District (Hector Spruit).
<i>Trimerorhinus tritaeniatus</i>	Pretoria District (Onderstepoort, Pienaar's River).
<i>Psammophis furcatus</i>	Pretoria District (Onderstepoort, Pienaar's River).
<i>Dispholidus typus</i>	Pretoria District (Pyramids, Pienaar's River).
	Barberton District (Hector Spruit).
<i>Calamelaps</i> (? Species)	Barberton District (Hector Spruit, one dead specimen).
<i>Naia haie</i>	Pretoria District (Onderstepoort, Pienaar's River).
	Barberton District (Hector Spruit).
<i>Naia flava</i>	Steynsburg (Cape, dead specimens).
<i>Aspidelaps scutatus</i>	Barberton District (Hector Spruit, one dead specimen).

Dendraspis angusticeps	Barberton District (one dead specimen).
Bitis arietans	Pretoria District (Onderstepoort, Pienaar's River). Barberton District (Hector Spruit).

A number of species, such as *Causus rhombeatus*, *Trimerorhinus rhombeatus*, *Dispholidus typus*, *Naia flava*, and *Sepedon haemachates*, were procured from the Cape Province through the kind assistance of Mr. F. W. Fitz Simons, Director of the Port Elizabeth Museum.

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