DESTRUCTION OF THE VECTORS.

A. Methods Tried.

In order to devise the most effective and yet economical method of destruction of these animals, the following methods were investigated:—

1. Gassing the burrows with poisonous gases.
2. Trapping.
3. Destruction of the burrows and their inhabitants by means of explosives.
4. Baiting.

Gassing the Burrows with Poisonous Gases.

The effects of the following poisonous gases were investigated:—

(*a*) Hydrogen Cyanide.

(*b*) Carbon Monoxide.

(*c*) Sulphurous gases.

(*d*) Heavy gases.

(*a*) *Hydrogen Cyanide.*

Preliminary experiments with gassing were conducted on colonies, both large and small, selected at random, which meercats were seen to enter.

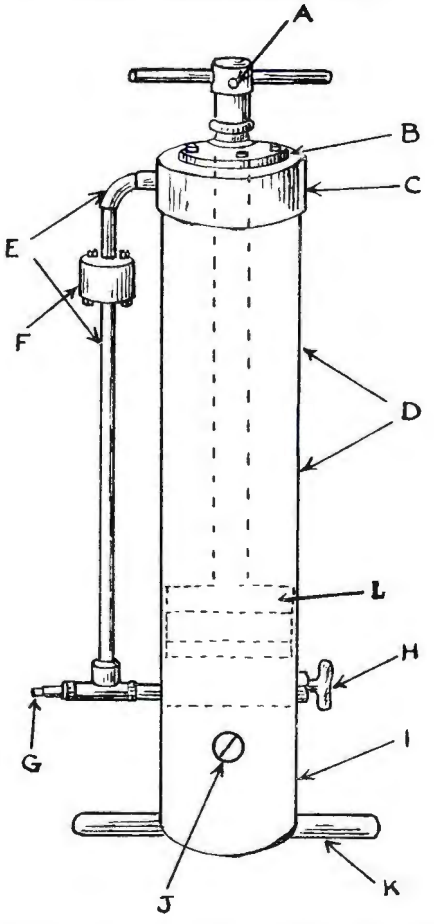
The gassing consisted of blowing finely powdered calcium cyanide dust (Cyanogas) with a hand-pump into the borrows. When this dust comes into contact with air it gives off hydrogen cyanide, leaving a residue of inert calcium hydroxide and impurities contained in the powder.

Two types of pumps were used, a single and a double action one. The single action pump works like an ordinary bicycle pump, but it is much larger, being about 3 inches in diameter. The air is blown through a chamber containing the powder, which is forced out in clouds.

The double action pump, known as the Schoeman pump (see Figure 1 and Illustration 8) forces the air on the downward stroke through a chamber containing the powder, which escapes from this chamber into the outlet in cloud-form. On the upward stroke pure air is forced into the outlet, thus giving additional force to the current of air created on the downward stroke. Both types of pumps have a control valve to regulate the cloud of dust blown out.

This pump has the advantage over the other pump, in that it not only works quicker, thus saving time, but that the powder-laden air is forced deeper into the burrows. The importance of this will be described later.

FIGURE 1.
Schoeman Double-action Pump.



A. Is the handle with an air-inlet for supplying the Cylinder D with air on the downward stroke of the piston.

B. Is a brass plate which compresses and expands a rubber ring on the inside which forms an air seal at the top of the cylinder, and is also fitted with an air slot through which air is sucked in on the downward stroke and forced into pipe E on the upward stroke.

E. Is the pipe and fittings which convey the upstroke air to the outlet G. and is fitted with a non-return valve, housed in F.

C. Is a brass strengthened bush.

G. Is the outlet nozzle to which a half inch hose is fitted.

H. Is the handle which controls a valve in the chamber I which regulates the powder supply to the outlet G.

J. Is an inlet fitted with an air tight cap for filling the chamber I with powder.

K. Is a footrest.

L. Is the piston, fitted with rubber piston rings, which expand when pressure is applied.

The principle on which the pump works is shortly as follows:—

On the downward stroke air is forced into the powder chamber I, where it disturbs the powder, which escapes through the valve controlled by H, into the outlet G. By turning the handle H, the amount of powder blown out can be either decreased or increased as required. On the upward stroke clean air is forced into the outlet G, through E, so as to provide some force behind the powder laden air forced out on the downward stroke.

(i) Method of Operations.

The powder control valve was adjusted so that a fairly heavy cloud of gas was blown out, but not so heavy as to allow a deposit of powder immediately in front of the loose end of the hose connected to the outlet.

The free end of the hose is inserted as far as possible into a hole, which is clean and well open. After insertion of the hose, the hole is filled up with earth, so as to prevent the escape of the gas. Pumping is then proceeded with. As soon as a perceptible cloud of powder emerges from a hole this is closed with earth. Pumping is continued through one hole until no more gas emerges. The hose is then inserted into another hole still open, and the process is repeated until all the openings in the colony are closed. The holes should be closed only when gas emerges, to allow free circulation of the gas and so avoid creating air pockets in the burrow.

Before any digging operations were commenced, the openings at which the gas was pumped into the colony were marked on the graph paper, adopting the same technique as was described in the previous chapter. The openings from which the dust was seen to emerge are indicated in the order in which it occurred, thus 1a, 1b . . .. 11a, 11b, etc., represents the order in which the holes were closed while pumping proceeded.

Digging operations were started, and the tunnels were traced in the same manner as described before.

Results of Experiments.

The results of the experiments are more easily followed when reference is made to the respective sketch plans of the colonies.

Colony 1. *(Sketch* 1.)

The colony was a fairly recently established one, situated in turf soil intermixed with lime pebbles. A single action pump was used and the gassing lasted for 15 minutes. The colony was dug up 4¾ hours after the gassing was completed. A dead *Geosciurus* male was found at the point XI, and a live female in a somewhat dazed condition at the point X2.

Colony 3. *(Sketch* 3.)

As indicated in the sketch this was a fairly simple colony, which was dug up immediately after gassing. A live *Cynictis* was found in the cul-de-sac at the top of the illustration.

Colony 15.

This was a fairly large colony. Several meercats were seen to enter the burrows It took about thirty minutes to complete the gassing, using a double action pump. Excavations were started immediately after gassing. Dead mongooses were found at two points while live ones were located at two other places. The one live mongoose was in a semi-conscious condition. Two dead squirrels were dug up in different parts of the colony.

Colony No. 122.

This experiment was conducted by the Zoological Survey Staff on a colony on the farm Beestekraal, Hoopstad district, on 3rd December, 1937. The colony was between 15 and 20 years in existence according to the owner of the farm. This was a very large and complicated colony, measuring 105 ft. by 80 ft. Five squirrels were seen to enter into the warrens previously. Before

gassing, all the old and disused openings were reopened to allow for better circulation of the gas. The dusting operations lasted 70 minutes, one double action pump being used.

When the colony was dug up seven dead squirrels were found. The depth of the tunnels ranged from 1 to 3 feet.

Colony No. 112. (*Sketch* 4.)

Date 16.12.37. (By curtesy of the Zoological Survey). On this occasion Colony No. 112, Beestekraal, Hoopstad district, was selected. It was formerly a springhare (*Pedetis caffer*) colony, but at the time of gassing inhabited by meercats. The soil is of a deep sandy nature and was somewhat moist, ·56 ins. of rain having fallen on the 14th. The disused and fallen-in openings were found reopened. The actual times of dusting were: A.—7 min., B.—5 min., C.—3 min., D.—3 min., E.—4 min., F. -2 min., G.—2 min., H. 3 min. Total time, 31 minutes.

The depth ranged from 1 to 4 feet. Six dead mongooses were found, one each at points X1, X4, X5 and two juveniles at X2. At points G1 and G2 dead squirrels were found.

Colony 39. (*Sketch* 5.)

An experiment was conducted on a "trassiebos" colony No. 39 Beestekraal, Hoopstad district 30.11.37. The colony measured 30 ft. in diameter. Two meercats were seen to enter the colony before the gassing operations. On excavations two dead *Cynictis* were unearthed at the points indicated.

Discussion of Results.

Ten colonies, ranging from very simple ones to the most complicated imaginable including a trassiebos mound, were gassed with Cyanogas and dug up at various intervals after gassing. The results obtained were on the whole satisfactory and encouraging. In all cases, except in three, all the meercats dug up were dead. In two of the three cases live meercats were found in comparatively small and simple colonies. Of the four animals, that were still alive, three were found in blind tunnels or cul-de-sacs. It is obvious, that in such cases the force of the air current is not strong enough to force gas into the blind passages. In the case of the *Geosciurus* (Colony 1) found in a dazed condition in an open tunnel, its escape may be due to the fact that insufficient gas penetrated to the point X2 when gassing took place from A; and when gassing was commenced at B, a blind tunnel was actually formed as the openings on the far side from B had been closed.

Conclusion.

(1) It is possible to destroy all the meercats in a colony even in very large and complicated ones by means of Cyanogas fumigation.

(2) In some instances when the burrowing animals have taken refuge in blind tunnels or cul-de-sacs, the gas fails to reach and destroy them. Especially is this the case in those tunnels which extend for great distances up to 30 feet.

(ii) *The Minimum Lethal Concentration (M.L.C.) of Hydrogen Cyanide for Meercats.*

At this point it became necessary to find out what minimum concentration of HCN was best suited to the purpose in view, and also to determine for what length of time such a concentration could, or had to, be maintained in warrens.

For this purpose a lethal box of wood was constructed, with inside dimensions of 52·1 by 61 by 26·7 cms., with a small inlet door. About two-thirds of one side was cut away and replaced with ordinary clear glass plate. On the top of the box, a hole 1½ in. in diameter, fitted with a tight-fitting rubber stopper, was made through which the Calcium Cyanide was to be introduced.

The testing and controlling of the HCN concentration was done as follows: A table later published by Steyn (1939) was used, showing the sensitivity of the picrate paper test (Guignard Test) for Hydrocyanic acid, i.e., the time taken to discolour picrate paper in various concentrations of HCN. From the data contained in this table a graph was drawn of the concentration against the time taken to discolour the paper. See graph No. 2.

For the purpose of the experiment a number of *Cynictis* were caught alive, some in a net placed over an open warren while the colony was smoked or dug up, others by means of traps.

To determine the effect of various concentrations of HCN on the animals, an animal was introduced into the box through the opening for the purpose, and measured amounts of Cyanogas dust were lowered with a spoon into the box and distributed into the air by giving a sharp blast of air on the spoon with an ordinary motor-tyre pump. The amounts of Cyanogas dust used were measured approximately in an ordinary graduated 10 c.c. cylinder—for three very good reasons: (*a*) no scale was available in the field, and (*b*) even if available it would have been unwise to expose the powder to the air for any length of time while it was being weighed, and (*c*) since the concentration of HCN was being estimated by the picrate method, the exact amount of dust was not of immediate importance.

Experiments on the Minimum Lethal Concentration (M.L.C.) of Hydrogen Cyanide for Meercats.

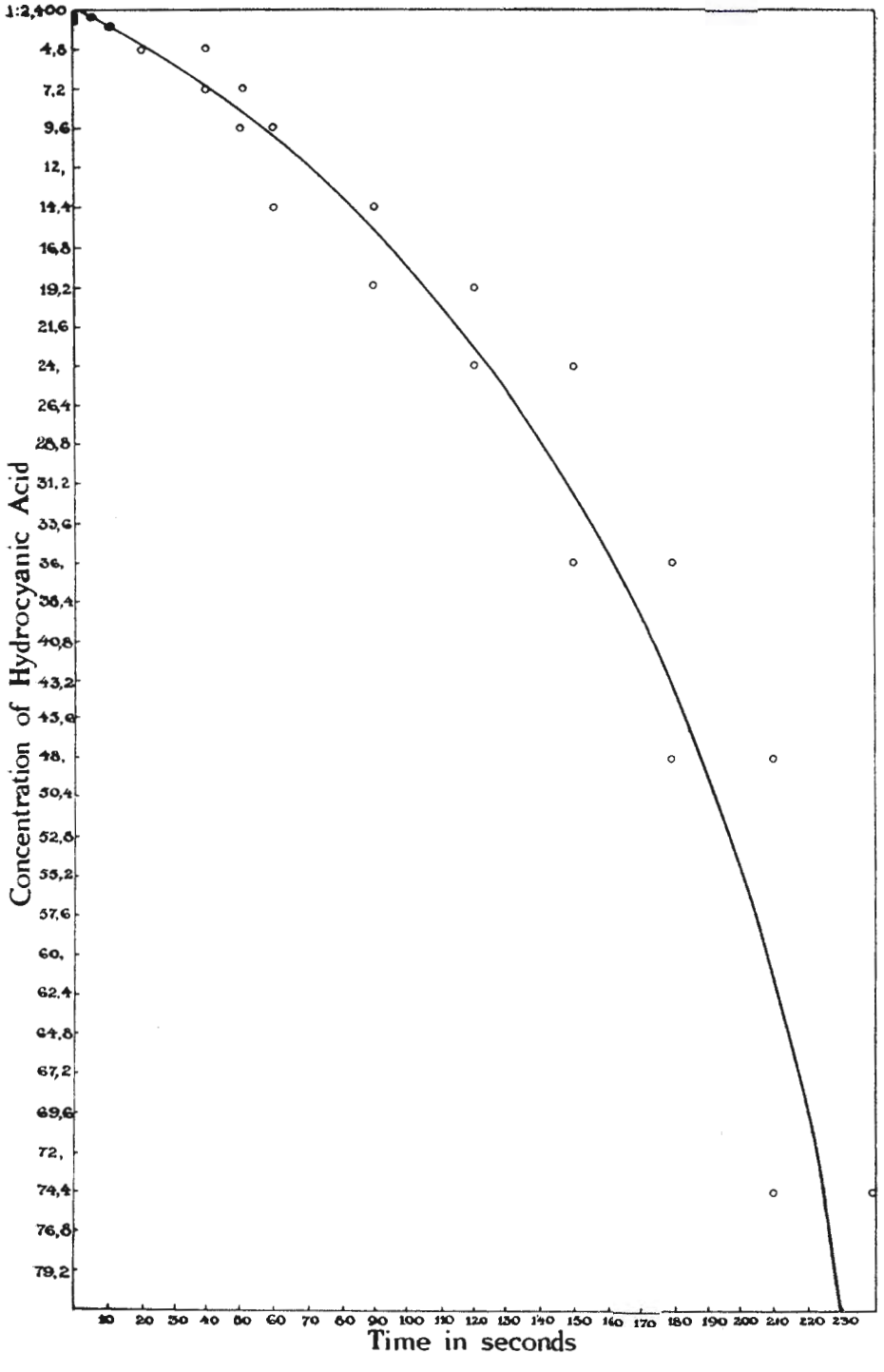
The lethal chamber, described above, was used throughout these experiments, its capacity was 84,852 cub. cms.

Experiment I.—Beestekraal, 14.1.38.

Object.—To determine the reaction of a *Cynictis* to a concentration of 1 : 7,680 of HCN.

Amount of Ca $(CN)_2$ introduced.—Approximately 4 c.c. of loose powder.

The lapse of time from the time of insertion of Animal into Box.	Time taken for Picrate Paper to Discolour.	Equivalent Concentration of HCN.	Remarks on condition of Animal.
1 min. 6 secs.	45 secs....	1 : 7,680	Falls over.
2 min. 41 secs.	—	—	Shallow breathing.
3 min. 26 secs.	—	—	Stopped breathing. Dead.



Graph No. 2.

The sensitivity of the Picrate Paper test (Guignard Test) for Hydrocyanic Acid.

Experiment II.—Beestekraal, 14.1.38.

Object.—To determine the reaction of a *Cynictis.*

Amount of Ca $(CN)_2$ introduced : 1·1 c.c. were added, which increased the concentration to 1 : 3,840.

The lapse of time from the time of insertion of Animal into Box.	Time taken for Picrate Paper to Discolour.	Equivalent Concentration of HCN.	Remarks on condition of Animal.
1 min. 30 secs.	15 secs....	1 : 1,840	Yawns, vomiting movements, dazed, falls over.
1 min. 35 secs.	—	—	Twitching of eyelids, and spasms of hind legs.
2 min. 45 secs.	—	—	Gasps at 15 sec. interval.
3 min.....	45 secs....	1 : 7,680	Shallow gasps, last 15 sec. before death.
3 min. 45 secs.	—	—	Dead.

Experiment III.

Object.—To determine the reaction of a *Cynictis* to a concentration of 1 : 15,600 HCN.

Amount of Ca $(CN)_2$ introduced : Nil.

The lapse of time from the time of insertion of Animal into Box.	Time taken for Picrate Paper to Discolour.	Equivalent Concentration of HCN.	Remarks on condition of Animal.
45 secs.....	90 secs....	1 : 15,600	Yawns.
1 min.....	—	—	Salivation.
2 min.....	—	—	Profuse salivation and masticating movements.
3 min.....	—	—	Uneven gait ; leaning against side of box.
4 min.....	—	—	Staggering movements and lies down.
5 min.....	—	—	Respiration accelerated and occasional deep inspiration.
6 min.....	—	—	Convulsions, slow breathing and occasional deep inspirations ; movements at 35 sec. intervals.
7 min.....	—	—	Hair on tail rises, shallow gasps.
9 min.....	2 min.....	1 : 22,800	Hair subsiding on tail, feeble gasps.
9 min. 30 secs.	—	—	Dead.

Experiment IV.

Object.—To determine effect of a low concentration of HCN on a *Cynictis*.

Amount of Ca $(CN)_2$ introduced.—The box was cleaned of all obvious dust. The Picrate paper took 10 minutes to discolour; i.e., a concentration of 1 : 5–800,000.

The lapse of time from the time of insertion of Animal. into Box.	Time taken for Picrate Paper to Discolour.	Equivalent Concentration of HCN.	Remarks on condition of Animal.
3 min.....	—	—	Sneezing.
5 min.....	—	—	Sleepy appearance.
6 min.....	—	—	Sits on hind-quarters like a dog.
8 min.....	—	—	Apparently no effect.
10 min.....	—	—	Apparently no effect.
13 min.....	—	—	Apparently no effect.
		·2 c.c. of Ca	$(CN)_2$ blown into box.
1 min.....	—	—	Salivation.
2 min.....	—	—	Sneezing, salivating, and masticating movements.
3 min.....	—	—	Shakes head. Salivating.
6 min.....	—	—	Profuse salivation; lies down.
8 min.....	—	—	Gets up and lies down again.
9 min.....	—	—	Inco-ordinated movements; respiration accelerated. Sneezes and rolls over.
11 min.....	—	—	Dyspnoea.
12 min.....	—	—	Twitching of the muscles. Cheyne–Stokes respiration gasps at intervals of 8, 5, and 3 secs., irregularly.
15 min.....	—	—	Shivering of head; hair rises on tail.
16 min.....	—	—	Pupils dilated; shallow gasping, at 18–16–22–18 to 30 secs.
19 min.....	2 min. 30 sec.	1 : 31,200	Hair subsiding on tail; shallow gasps at 30–40 secs.
22 min.....	—	—	Pupils dilated ¾; dead.

Experiment V.

Object.—To test effect of HCN on *Geosciurus.* (Animal was bleeding from nostrils).

Amount of Ca $(CN)_2$ introduced.—None added, Picrate test, 3 minutes, i.e., a concentration of 1 : 43,600.

The lapse of time from the time of insertion of Animal into Box.	Time taken for Picrate Paper to Discolour.	Equivalent Concentration of HCN.	Remarks on condition of Animal.
5 min.....	—	—	Apparently no effect.
6 min.....	—	—	Slight uneasiness.
9 min.....	—	—	Attempts to lie down.
14 min.....	—	—	Apparently no effect.
		·2 c.c. Ca ($CN)_2$ introduced.	
1 min.....	—	—	Salivation.
2 min.....	—	—	Convulsive movements.
3 min.....	—	—	Lying on side and making running movements. Breathing spasmodically.
4 min.....	—	—	Frequent deep gasps, salivation stopped. Testes retracted. Hair on tail raised fanwise.
5 min.....	—	—	Occasional prolonged inspiration. Hair on tail subsides.
6 min.....	—	—	Hair smoothes down; heart beats fast; gasps at 30 secs. intervals.
7 min.....	—	—	Gasps at irregular intervals.
10 min.....	2 min.....	1 : 22,800	Heart beat slower; inspiration prolonged.
11 min.....	—	—	Heart beat hardly perceptible; inspiration slow.
13 min.....	—	—	Faint shallow gasps.
14 min.....	—	—	Heart-beat stopped. Dead.

Experiment VI.—Philip, 25.5.38.

Object.—To observe reactions of two animals under approximately identical conditions. Two *Cynictis* were introduced, marked A and B.

Also the effect of moisture: About two ounces of water were poured into the box, and air from a motor tyre pump was played over it, to evaporate it.

Amount of Ca $(CN)_2$ introduced.—Not measured. The Picrate test was 5 minutes, i.e., 1 : 180,000.

The lapse of time from the time of insertion of Animal. into Box.	Time taken for Picrate Paper to Discolour.	Equivalent Concentration of HCN.	Remarks on condition of Animal.
9 min.....	5 min.....	1 : 180,000	Apparently no effect.
		More $Ca(CN)_2$	blown into box.
1 min.....	—	—	Apparently no effects.
3 min.....	—	—	A.—Sneezed; uneasy, walking about. Fell down on undispersed powder. B.—Apparently no effect. In far corner of box.
4½ min.....	—	—	A.—Deep respirations. B.—Apparently no effect.
5 min.....	—	—	A.—Violent spasms and kicking. Hair on tail rising slowly. Accelerated gasps. B.—Apparently no effect.
7 min.....	—	—	A.—Occasional deep inspirations. B.—Twitching of abdomen. Respiration accelerated; walks about. Comes near to the gas. Unsteady, gets up. Short shallow inspirations.
11 min.....	1½ min....	1 : 16,100	A.—Pupils dilated. B.—Down, but still able to lift itself.
14 min.....	—	—	A.—Intermittent breathing, shallow. B.—Respiration shallow and accelerated; intermittent deep inspiration.
17 min.....	2 min.....	1 : 23,000	A.—Hair on tail subsiding. Dead. B.—Same as before.
24 min.....	—	—	B.—Taken out of box and put in fresh air. Corneal reflex absent.
2 minutes after being taken from the box	—	—	B.—Deep gasp. Respiration accelerated, corneal reflex faint.
10 min.....	—	—	Pulse accelerated; twitching of toes; forced expiration.
12 min.....	—	—	Opening and closing of eyelids. Muscula control gradually being regained.
21 min.....	—	—	Comes to a sitting position. Falls over again. Violent spasms.
26 min.....	—	—	Eyes closed. Respiration deep and forceful. Pulse accelerated.
30 min.....	—	—	Able to rise, looks round, very weak.
31 min.....	—	—	Attempts to run, but falls over. Gets up. Animal recovering rapidly.

Experiment VII.—Beestekraal, 26.1.38.

Object.—To test effect of a higher concentration of HCN on a *Cynictis*, under same conditions as previous experiment.

Amount of Ca $(CN)_2$ introduced.—·1 c.c. loose dust.

The lapse of time from the time of insertion of Animal into Box.	Time taken for Picrate Paper to Discolour.	Equivalent Concentration of HCN.	Remarks on condition of Animal.
5 min.....	—	—	Sleepy appearance. Head between forelegs.
10 min.....	—	—	Sneezing; eyes rolling. Expiration forced.
15 min.....	—	—	Respiration regular, but shallow.
20 min.....	6 min.....	204,000	Same as before.
25 min.....	—	—	Unsteady in sitting position. When box tilted falls over, but rights itself.
30 min.....	—	—	Sits with head hanging, as if sleeping.
		$Ca(CN)_2$ introduced ·7 ccs.	
1 min.....	1 min.....	1:10,300	Head sinking.
2 min.....	—	—	Spasms; stretching of limbs; gasps.
3 min.....	—	—	Respirations imperceptible. Dead.

Discussion of Results.

The concentration of Hydrogen Cyanide which gave the optimum result, killing the experimental animals in less than four minutes were 1 : 7,700 and higher. Desired effects were obtained with concentrations of 1 : 12,000 to 1 : 24,000 killing the experimental animal in 9 to 10 minutes. A concentration of 1 : 31,200 killed the experimental animal in slightly over 19 minutes, while a concentration 1 : 43,700 failed to have the desired effect.

It is estimated that a concentration of Hydrogen Cyanide of 1 : 31,200 would kill meercats in a confined air space, but for practical purposes in warrens the aim should be to obtain concentrations of between 1: 30, – 24,000 or higher, and that concentrations of 1 : 36,000 or lower would not be sufficiently strong to kill the animals in their burrows. Theoretically therefore the concentration to be aimed at both from the point of view of economy and of rapid destruction of the animal must lie between the ranges of 1 : 24,000 and 1 : 30,000.

(iii) *The Concentration of Hydrogen Cyanide in the Burrows of Meercats.*

In view of the fairly high concentration of Hydrogen Cyanide, which is fatal to meercats and the comparatively big length of tunnelling in the maze constituting the colony, it is obvious that success in fumigation depends largely on the concentration of Hydrogen Cyanide attained in the burrows, and on the length of time this concentration is maintained in the burrows.

In order to investigate this, suitable colonies of different types were selected for the purpose. The openings were marked on graph paper in the usual way. The openings on which the tests were to be performed were selected in such a way as to be representative of the colony and as evenly distributed as possible. These openings were opened up to a depth of about 18 ins. to make sure that single tunnels were being dealt with, and to obtain their representative perimeter. This was also an advtange in the operations as the firm and damp soil facilitated the insertion of the apparatus.

Into these selected and prepared holes white glass cylinders 3 ins. in diameter and about 12-18 inches long were inserted, being as near as possible to the diameter of the tunnels. These cylinders resembled long winchester bottles, with the bottom knocked out, and in fact such bottles had to be pressed into service also. The open end was pushed into the burrow and the neck end, with the rubber stopper, protruded out and enabled one to insert the test-paper and see it turn colour. The cylinders were securely packed with damp soil so as to prevent any escape of gas. The rubber stoppers were withdrawn, and the positions of the cylinders were marked on the ground plan with Roman numerals.

Gassing operations were then begun in the usual way. As soon as puffs of dust emerged from a cylinder the rubber stopper was replaced, the opening being thus sealed up in the same way as if it were closed with earth. The sequence in which the dust emerged from the cylinders was recorded in the usual manner..

At definite intervals and more or less in rotation the concentration of Hydrogen Cyanide in the cylinders was tested, by inserting picrate test papers, fixed on thin pieces of wire through the stoppered openings and thus visible through the glass. Care was taken to insert the papers and to replace the stoppers as quickly as possible so as to prevent the escape of gas. The time taken to discolour the picrate papers was recorded for each cylinder. The interval between testing was fixed arbitrarily at 15 minutes, as this interval allowed just sufficient time to do the round of tests and to obtain the greatest number of tests for a definite period.

The corresponding concentration of Hydrogen Cyanide was obtained from the curve by reading the length of time in which the picrate test paper took to discolour. This information was recorded for each cylinder in a colony. Graphs, for each colony, were then plotted of the Hydrogen Cyanide concentration against the time interval, after the gassing had been completed.

The colonies were then dug up and details as to inhabitants, etc., recorded in the usual way.

Samples of soil were collected at the depth of the tunnelling, to determine the moisture content of the soil. This was done in the following way. About 500 grams of sand were weighed and heated in an oven at a temperature of approximately 230° F. until constant weight was attained, when the percentage loss of weight taken to be moisture, was calculated.

Experiment I.

This was conducted on a "Trassiebos" colony on the farm Wintershoek, which adjoins Beestekraal in the Hoopstad district. The gassing took 14 minutes to complete. The glass cylinders, after the tests were completed, were left in position over night, and a test on each on the following morning revealed a trace of Hydrogen Cyanide. Incidentally a dead *Cynictis* was found in cylinder No. 11 in the morning, and a warren closed with sand was found reopened.

Experiment II.

The colony selected was a typical colony in soft sandy soil on the sandbult at Beestekraal. Seven meercats were chased into the colony. The gassing took place from five different holes, and the times of dusting from the different holes were 13, 10, 6, 8 and ½ minutes.

On excavating the colony six dead suricates and one dead mongoose were recovered. A live *Cynictis* was discovered in a blind tunnel four feet long. The soil could be moulded by hand with fairly hard pressure. The moisture content was 2·6 per cent.

Experiment III.

Colony No. III on Beestekraal was selected for this experiment. The colony was of the same nature and soil as the preceding one. Three yellow mongooses entered the colony. The times of gassing were 9, 13, 1, and 9 minutes respectively. One hole was found to be closed. From Cylinders Nos. III and VII no Cyanogas emerged, and on excavations the warren of No. III was found to be partly filled with loose sand, while for No. VII no obvious cause could be found. Two dead mongooses were found.

The moisture content of the soil was 2·8 per cent. The soil could be moulded with the hand on pressure.

Gassing with Compressed Air.

The rate at which an air current flows through a tunnel is resisted by opposing forces created by :–

(*a*) the length of the airway;

(*b*) the perimeter of the airway;

(*c*) the degree of roughness of the surface;

(*d*) and the number and angles of the turns in the airway.

It is perfectly clear, that the comparatively small force created by an ordinary double action hand-pump is soon reduced to a negligible amount by diffusion in the length of tunnelling formed by the network in a colony. The comparatively small perimeter of the outlet pipe to that of a tunnel and the numerous turns sometimes at acute angles, combined with the roughness of the surface of the warrens, would further retard the force of the air current created by the pump.

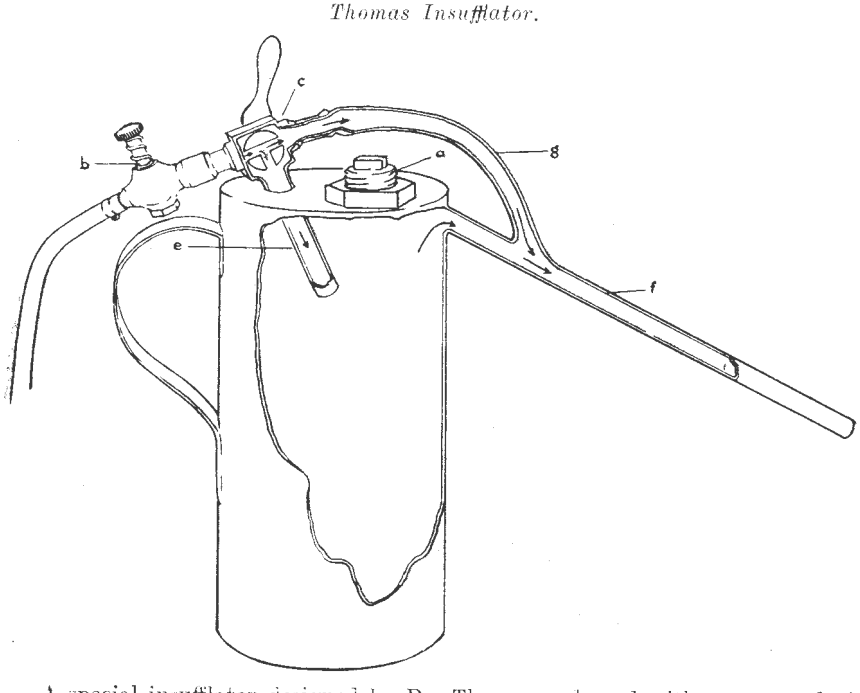
It was considered that the failures in many instances were due to poor distribution of the dust along the deeper tunnels, and that this might be overcome by using a jet of compressed air, which would create greater force and volume to overcome some of the retarding influences. Further, that in the case of blind tunnels or cul-de-sacs the greater velocity of the air-current would create a partial vacuum in them, and that when the air current ceased, air laden with cyano-gas powder would be sucked into them, and so kill meercats which might have taken refuge in these.

A small Curtiss Pneumatic compressor, driven by a " Mar-vil " two stroke engine, mounted on a cylindrical pressure tank 30 ins. long and with a diameter of 14 ins. was acquired. The tank was tested to a pressure of 150 lbs. per sq. in. This plant was mounted on a donkey cart for transport purposes on the veld.

A special insufflator designed by Dr. Thomas was used in connection with the compressed air outfit.

FIGURE 2.

Thomas Insufflator.



A special insufflator designed by Dr. Thomas and used with compressed air for gassing meercat burrows.

For description see text.

Description of the Thomas Insufflator.

(See Figure 2 and Illustration 9.) The insufflator consists of a can, 10 ins. deep, with a diameter of 5 in., fitted with a handle similar to the ear of a cup. On the top of the can is an opening (*a*) fitted with a screw cap for filling the insufflator with powder. The insufflator is connected to the pressure tank by

ten yards of pressure hose-pipe, which is connected at the point (*b*), where a spring release-stopper is fitted. At the point (*c*) a bifurcation exists in the air-supply tube into which a three-way stopcock is housed with a hand-lever. One tube (*e*) leads into the can for about 3 inches at an angle, while the other (*g*) forms a deviation which joins the outlet tube (*f*). A short length of hose-tubing is connected to the outlet (*f*) for insertion into the warren.

When the spring release-stopper is pressed (*b*), compressed air enters along the tube, and by manipulating the lever of the three-way stop-cock (*c*) the air-flow into the can can be regulated, while the rest of the air escapes along the bye-pass (*g*) into the outlet tube (*f*). The air laden with powder escapes into the outlet (*f*). The concentration of powder blown into the warrens can therefore be very accurately regulated.

Plan of Experiments.

The following two experiments were planned to serve a double purpose, (*a*) to serve as a repetition of the Hydrogen Cyanide concentration test conducted on Beestekraal, and (*b*) to compare the efficiency of the compressed air outfit for fumigation purposes with that of the ordinary double action hand-pump.

The procedure adopted with the compressed air outfit was exactly as that adopted with the hand-pump.

Experiment IV.

For the purpose of this experiment a colony (A) was selected on Bestersrust adjoining Philip in Hoopstad District. The colony was situated on a high bank on the side of a pan. The soil, although sandy in nature and fairly moist, was hard lower down owing to clay. On the morning of 23rd of May, 1938, after the usual preliminaries of plotting and insertion of the cylinders, etc., the colony was gassed with compressed air, and the necessary picrate tests were performed. After the tests had been completed, the cylinders were taken out and the openings filled in with earth.

The following morning all the holes were reopened by hand and the cylinders were inserted in the same positions as the previous day. Tests were taken in the cylinders. When these proved negative for HCN, two squirrels distinctively marked were introduced, one each from two different holes. The gassing with the hand-pump was then proceeded with from the same two holes and in the same sequence as the previous day.

Gassing was commenced at 9 a.m. and was completed at 9.30 a.m. The picrate tests were then repeated as on the previous occasion, and lasted until 1 p.m. At 10.50 a.m. two more squirrels with one injured foot each, having been caught in a trap, were inserted through cylinder I.

The colony was dug up when all the cylinders except No. I gave negative tests.

Results of the Experiment.

(1) On the morning of the second day before the gassing with the hand-pump was undertaken, two holes in the colony were found open. (2) When the two squirrels were introduced through cylinder I at 10.50 the picrate test paper took 30 seconds to discolour, and

after the introduction the time elapsed was only 20 seconds. (3) Spent Cyanogas powder was found at a point between one opening and cylinder VII, and loose sand was found at a point near the cylinder, and partially obliterating the tunnel. This explained the negative test at cylinder VII, where only a trace of Hydrogen Cyanide was recorded. (4) The following dead animals were found: At cylinders I and III stiff carcases of *Cynictis* were found, while at cylinder II a fresh carcase of the same species of animal was discovered. It must be remembered that no *Cynictis* were introduced. Four carcases of *Geosciurus* were found.

The carcases of the two marked squirrels were found near the openings, through which they were introduced, those introduced through cylinder I at 10.50 a.m. were found near the cylinder. A fresh unmarked carcase of a *Geosciurus* was also found.

Experiment V. 3.5.38.

The previous experiment was repeated in every detail on the same farm, on a very large colony (B) of which only a portion seemed to be inhabited. As the openings in that portion had fallen in and showed no signs of meercat activity, to save unnecessary digging, a trench, 40 inches deep, was dug right across the colony separating the used from the unused section. Several tunnels were found opening into the trench, all at more or less the same level, from 12 to 18 inches from the top of the trench. The trench thus completely intersected all tunnels leading into the disused section. These holes were plugged with clay. Three *Cynictis* caught in traps were introduced into an opening. The gassing and testing were completed at 5.37 p.m. The cylinders were left in position over night. At 8.30 the following morning two *Geosciurus* were introduced. None of the openings was found reopened during the night.

After all the openings had been carefully reopened by hand, gassing was repeated with the hand-pump and the picrate tests were made.

Results.

The following carcases were recovered:—

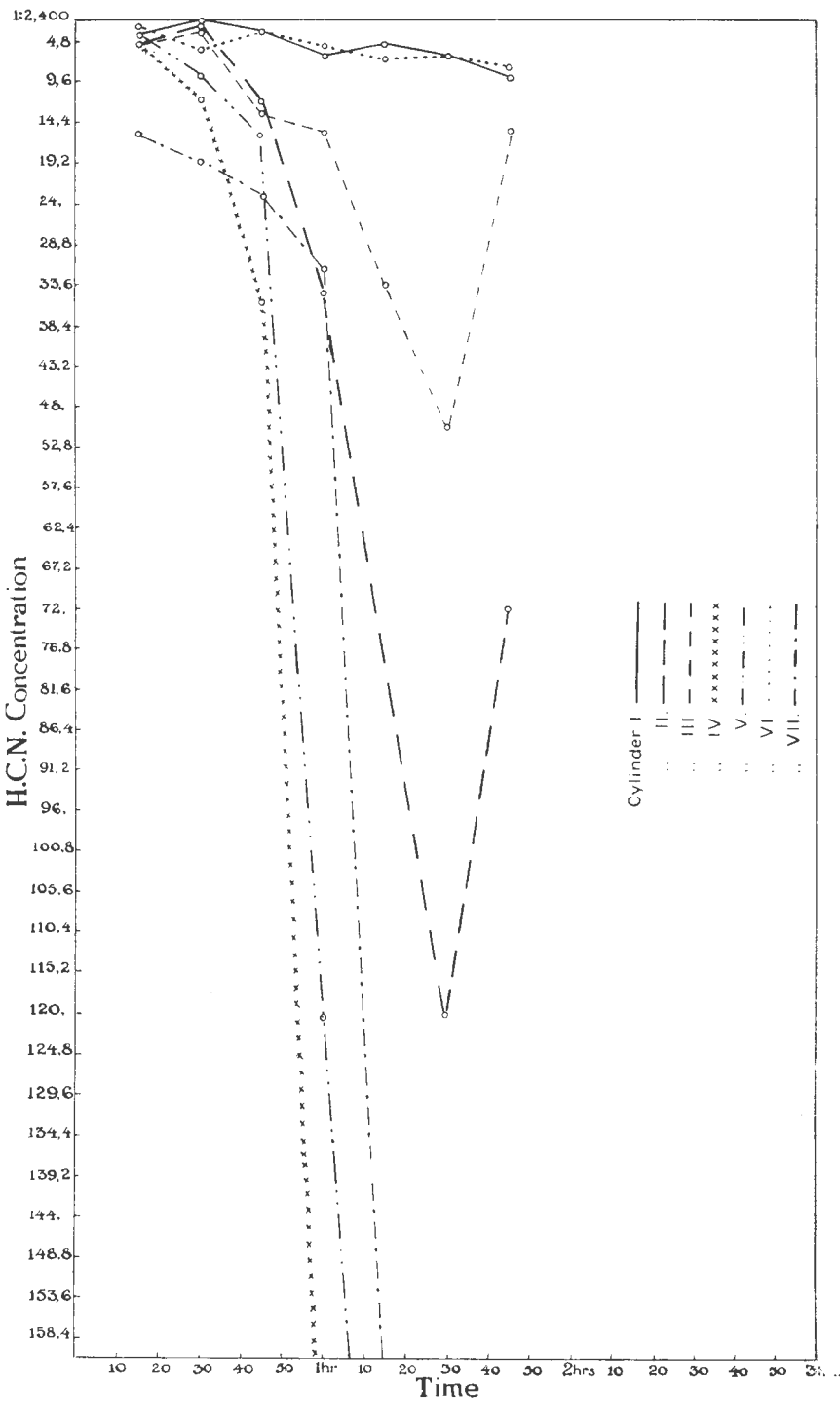
1. Two *Cynictis*, both stiff and marked.
2. Three *Geosciurus* carcases, two of which were fresh and marked, while one was stiff and unmarked. The carcase of the third *Cynictis* which had been introduced the previous day was not recovered.

Discussion of the Results on the HCN Experiments.

Experiment I, "Trassiebos". Graph 3.

(*a*) High concentrations of Hydrogen Cyanide were maintained in openings I and IV for at least $1\frac{3}{4}$ hours.

(*b*) Within 1 hour from the time of completion of gassing the concentration in four openings dropped to below 1 : 30,000.



Graph No. 3.

Experiment I.

Colony in a "Trassiebos" mound on Beestekraal: 14.1.38.

HCN concentration in the warren using a hand-pump.

(*c*) In two openings, II and III, the concentration increased at the same time, in No. III the concentration reached 1 : 15,600.

The colony was unfortunately not dug open to see the results of the gassing. The explanation for the discovery of the *Cynictis* in Cylinder No. II can only be speculative. It is thought, that the *Cynictis* was prevented from escaping into the colony by our presence, and that soon after we had departed, and everything seemed safe it opened one hole and entered, and disturbed some of the Cyanogen powder that had settled. In its endeavours to escape the *Cynictis* was trapped in the cylinder. This explanation is quite acceptable, for as can be expected, from the structure of a "Trassiebos" colony consisting of big chambers (even if the animal had travelled through chambers connected with openings I and VI, where the concentration remained high 1 : 7-9,000) it could still have reached the place where it was found, for such a concentration is fatal in 105 seconds only.

Experiment II. Graph 4.

(*a*) In cylinder III a negative test was recorded, in spite of the fact that it was the first hole from which the gas emerged when dusting. The gas emerged after 1 minute.

(*b*) A concentration of 1 : 30,000 was maintained in five of the test tunnels for 2½ hours after completion of gassing of the colony. In one tunnel, No. V, the comparatively high concentration was maintained for 3¼ hours. The high concentration was the result of a large amount of calcium cyanide deposited in the vicinity of the test cylinder.

(*c*) The fact that a live *Cynictis* was found in the blind tunnel, was evidently due to the animal having escaped contact with the gas while there.

Experiment III. Graph 5.

(a) The sudden decrease in the Hydrogen Cyanide concentration in the opening I was due to the small amount of cyanogen that was precipitated at that point, on account of its distance from where the dusting took place.

(b) A negative test was recorded at cylinder III as can be expected, as the tunnel was partially filled with sand. The negative test in VII cannot be explained.

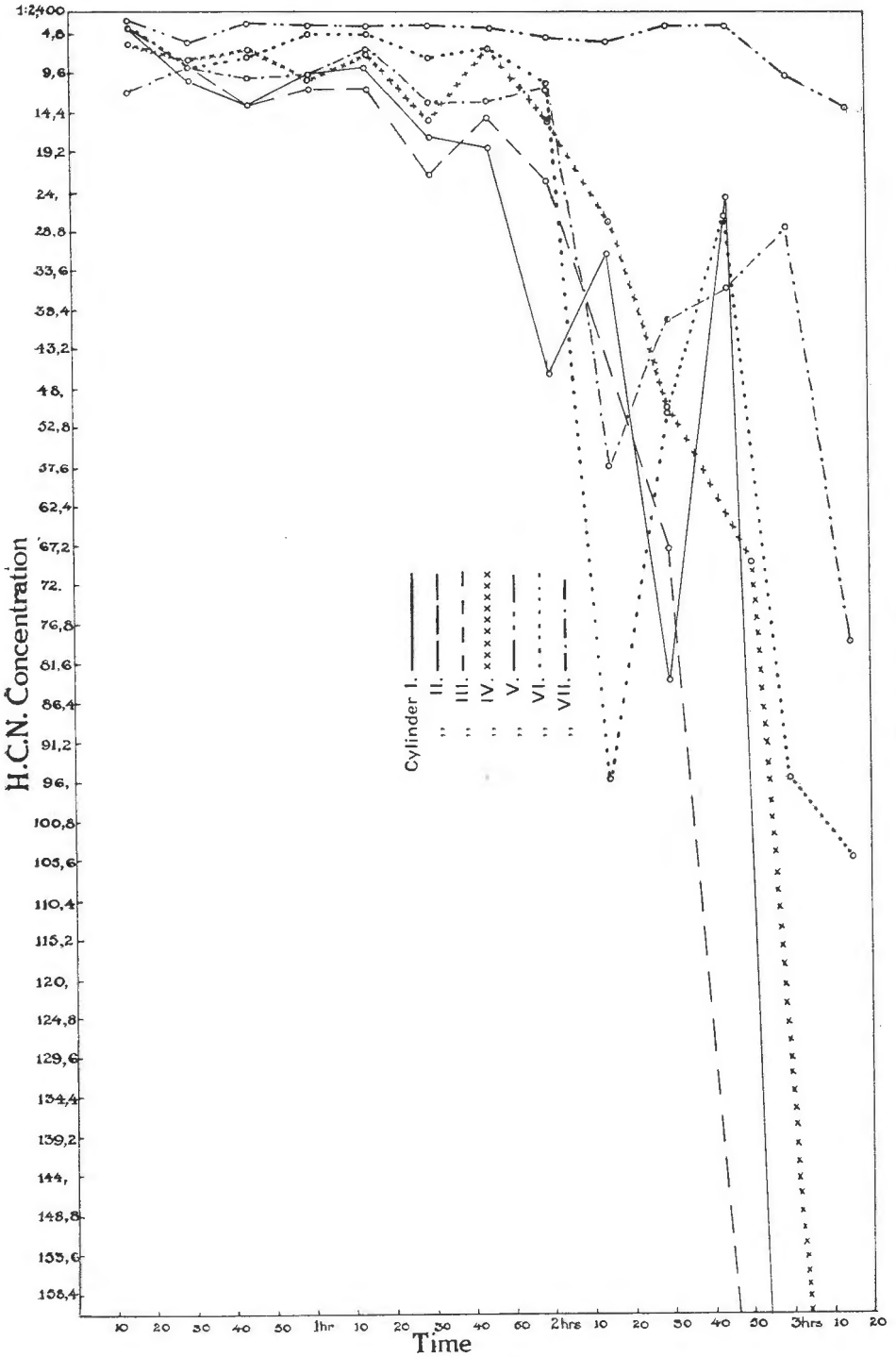
(*c*) The test was not continued for a long enough period.

Experiment IV.

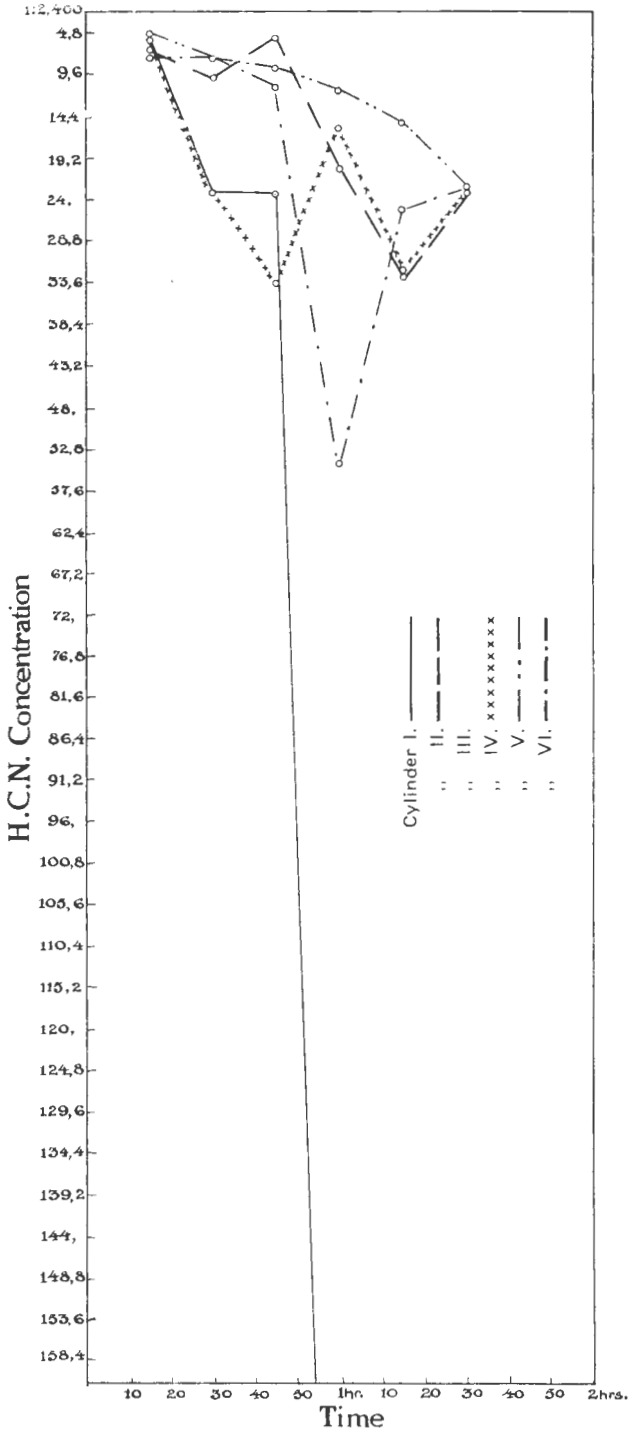
(1) *Gassing with hand-pump.* Graph 6. Colony A.

(*a*) In three of the cylinders a high concentration was maintained for more than two hours.

(*b*) In two cylinders No. VI and VII only a trace of Hydrogen Cyanide was recorded.



Graph No. 4.
Experiment II.
Colony in sandbult on Beestekraal.
HCN concentration in meerat burrows using a double action pump.

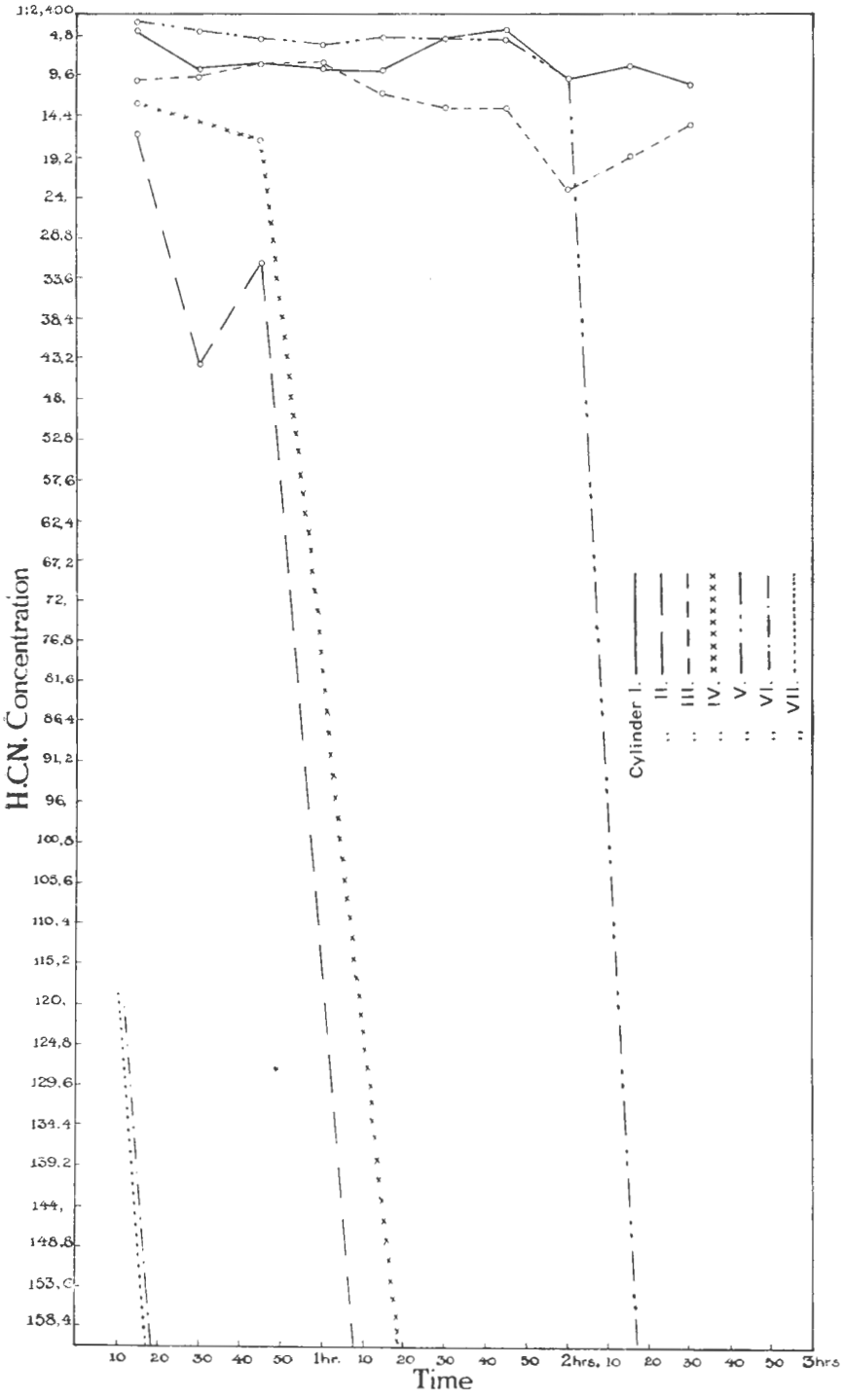


Graph No. 5.

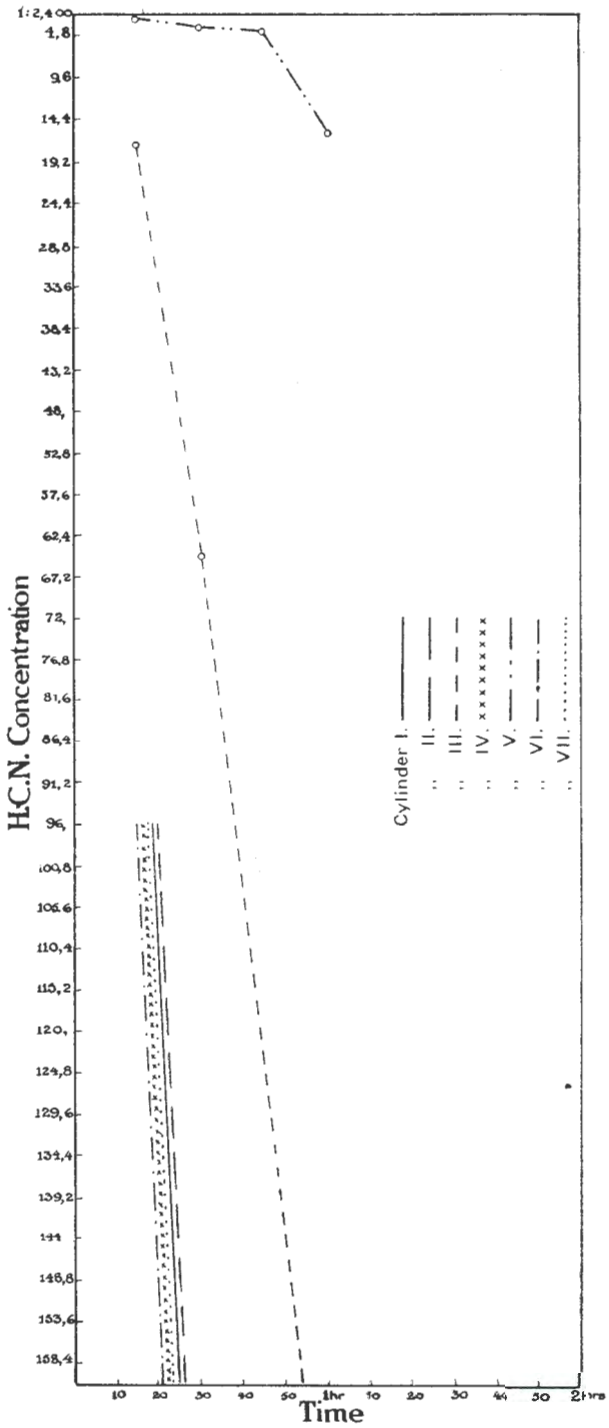
Experiment III.

Colony III: Beestekraal: 15.1.38.

HCN concentration in peercat burrows using a hand-pump.



Graph No. 6.
Experiment IV.
Colony A: Bestersrust: 1.5.38.
HCN concentration in burrow when hand-pump was used.



Graph No. 7.

Experiment IV.

Colony A.: Bestersnst: 3.5.40.

HCN concentration in burrow when compressed air was used.

(*c*) A slight rise in the concentration was recorded in No. I after the two squirrels had been introduced. The rise in concentration was obviously due to disturbance of the precipitated cyanogas by the animals.

(2) *Compressed Air.* Graph 7.

(*a*) In contrast to the high concentration produced in 5 cylinders when using the hand-pump, concentrations of lower than 1 : 96,000 were produced in five cylinders.

(*b*) In two cylinders only was a concentration of higher than 1 : 24,000 recorded. In No. III it was maintained for 20 minutes only, and in one, No. V, a high concentration was maintained for more than $1\frac{1}{4}$ hours.

(*c*) It was further noticed that the gas did not emerge from the same openings and in the same sequence, when gassing was done from the same hole and using the hand-pump and compressed air. While gas emerged when the compressor was used at an opening, it would not emerge from the same opening when the hand-pump was used, so that gassing had to be resumed at a different opening.

The same is noticed to a lesser extent in Experiment V. It is doubtful whether this variation in air currents produced had any effect on the HCN concentrations in the warrens.

Experiment V. Colony B, Bestersrust, Graph 8. Hand-pump.

(*a*) In 5 cylinders a high concentration of HCN was maintained for $2\frac{1}{2}$ hours.

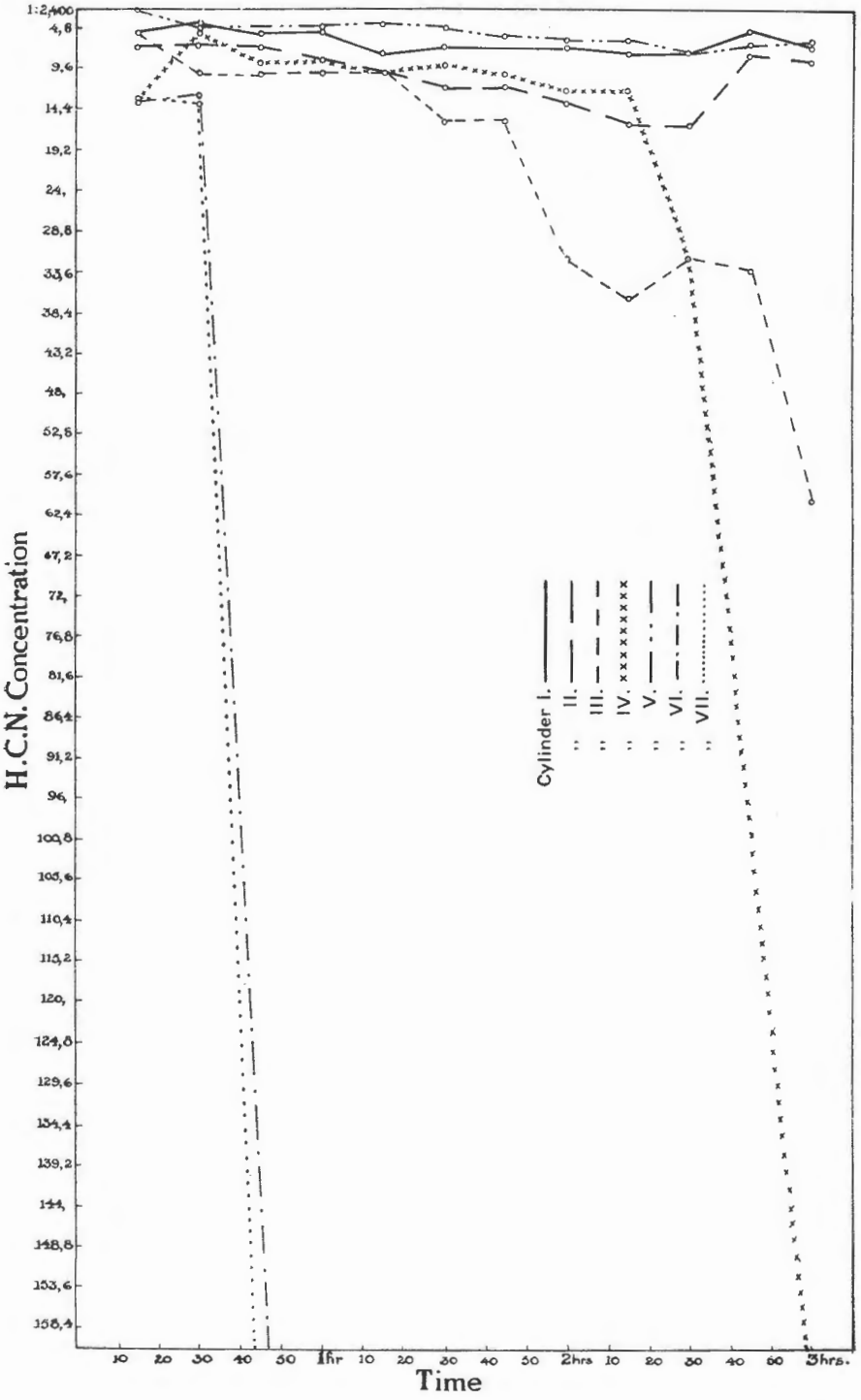
(*b*) In two cylinders (VII) and (VI) a concentration of 1 : 24,000 was maintained for 30 minutes only. This is obviously due to a small deposit of dust in the corresponding tunnels, owing to the distance away from the openings where the dusting took place.

Compressed Air. Graph 9.

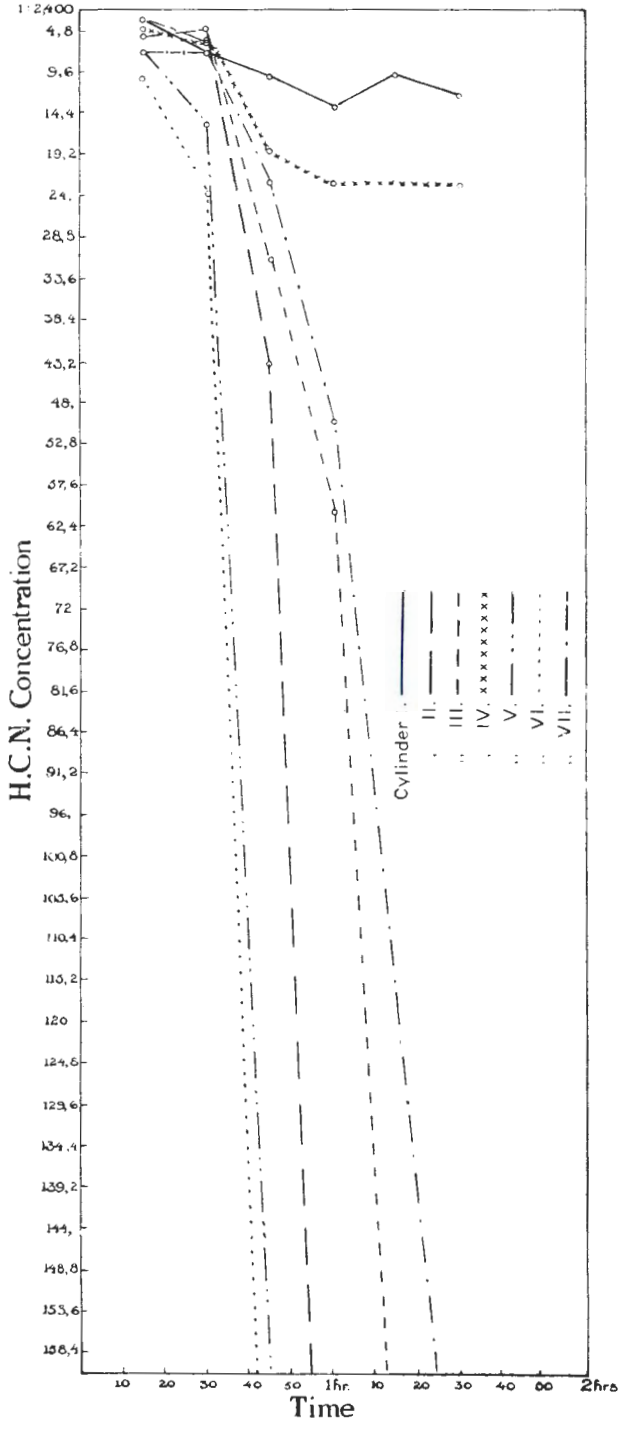
(*a*) Better results were obtained in this case with compressed air than in the previous experiment. The longer interval, which elapsed between the beginning of the gassing and the testing in the previous experiment, was a contributory factor. The colony in the previous experiment was very much larger than in this experiment.

(*b*) In two cylinders, I and IV, a high concentration was maintained for some time. This was obviously due to large amounts of deposits of cyanogen in the corresponding tunnels. Gassing was done through cylinder I and IV (which although situated some distance from the hole where gassing took place) were connected with this hole by a number of tunnels, and so had a combined effect.

(*c*) In the remainder of the cylinders a high concentration was maintained for a comparatively short period only.



Graph No. 8.
Experiment V.
Colony B on Bestersrust.
HCN concentration in meerat warrens, when using a double-action hand pump.



Graph No. 9.
Experiment V.
Colony B: Bestersrust: 3.5.38.
HCN concentration in burrow when compressed air was used.

General Discussions.

(1) It is observed in all cases where the hydrogen cyanide concentration was recorded until negative tests or very low concentrations were obtained that the concentration with minor fluctuations remained fairly constant, until a point was reached when it decreased very rapidly. This indicates that the hydrogen cyanide is as rapidly absorbed into the soil as it is given off from the calcium cyanide, when the moisture content ranged from 2·6 to 3·05 per cent.

(2) The length of time the concentration of hydrogen cyanide remained at, or above, a concentration of 1 : 30–24,000 depends on the amount of calcium cyanide deposited. This is particularly well illustrated in Colony B, Experiment V, where the gassing took place in both instances with compressed air and the hand pump through cylinder I.

(3) Discarding the minor fluctuations in the hydrogen cyanide concentrations as probable experimental errors in judging the intensity of the colouration of the picrate test papers, the major fluctuations in cylinders II and III Experiment IV (Graph 6), II and III Experiment V (Graph 8); II and VI in Experiment I (Graph 3) can only be explained as probably due to air currents in the burrows.

(4) The greatest concentrations in HCN in the burrows were recorded from those openings through which gassing took place, or in openings close to those through which powder was blown into the colony.

(5) Comparison of the efficiency of the gassing by means of compressed air and using a hand-pump:

(*a*) If the maintenance of the concentration of hydrogen cyanide may be taken as being dependent on the amount of Cyanogas blown into the colonies through the different openings, then less cyanogas is used with compressed air than by using a hand-pump.

(*b*) By comparing the results obtained on the animals found dead after excavations, it is found that the two methods employed are equally effective, in spite of the fact that very much less powder is used when gassing with compressed air. In both experiments IV and V the carcases recovered could be accounted for. The only carcases that could not be accounted for were the one of a *Cynictis* and the one of a *Geosciurus* in Experiment IV. But if it is remembered that two holes were found re-opened after the gassing with compressed air had taken place, and the positions where these carcases were located, it is thus likely that these animals entered after the gassing with compressed air had taken place.

(6) The only occasion on which a live animal was found after the colony had been dug up was in Experiment II. In this instance the section of the colony in which the *Cynictis* was found was gassed from an opening which connected with the test cylinders II, VI and VII. In the latter two cylinders high concentrations of HCN

were recorded for 2 hours, while in the first a negative test was given. Apart from the fact that the Cynictis had taken refuge in a blind tunnel, his chances of escape were further increased by the very small amount of Hydrogen Cyanide which circulated in that section of the colony. The amount was so small that a negative test was recorded at cylinder III.

(7) From these results obtained in gassing colonies with compressed air and using a hand-pump, it is clear that the effectiveness of gassing meercat burrows with Hydrogen Cyanide does not entirely depend on large amounts of dust being blown into the warrens, so as to maintain high concentrations for long periods, but that it rather depends on a thorough distribution of lethal concentrations of HCN, even for short periods, in the warrens.

Conclusions.

Assuming that the meercats are in their burrows, factors which influence successful gassing can thus be summarised as follows:—

(1) *Distribution of the Dust.* Of the greatest importance is a thorough distribution of dust in all the warrens of a colony. This can be obtained by using a double-action pump in perfect working order and pumping with continuous forceful strokes, or using a jet of compressed air. A good length of tubing inserted into the burrow as deeply as possible will further assist in blowing the gas to the deeper sections. Before commencing work the operator should satisfy himself that the pump is in good working order, and that none of the parts or the nozzle is choked. The pressure and the cloud of dust should be tested at frequent intervals.

(2) *Quantity of Dust.*—The cloud of dust which is blown out should be first regulated, so that it is easily perceptible and not too thick. It is essential to test this at intervals by one or two strokes of the pump with the nozzle in the open, as the dust sometimes cakes or openings in the dust reservoir may become blocked.

(3) *Quality of Dust.*—Only fresh dust, of good quality, in fine powdery form should be used. The dust should be supplied in the original containers, provided with a press-in lid covered with a screw-on top. The container should always be tightly closed after each filling, since exposure to air deteriorates the powder. Good dust is of a bluish slate colour, and spent dust which is of a brownish colour and is useless, should be discarded. Any dust remaining in the pump after use should always be returned immediately to the container, and the pumps should be cleaned out every morning before operations start.

(4) *Humidity of the Soil.*—A very dry atmosphere retards the liberation of the poisonous gas Hydrogen Cyanide, while on the other hand the gas is readily absorbed into the moisture in the soil. The optimum conditions in the burrows are when the soil can be moulded by hand on applying some pressure. During the rainy season good results will only be obtained if gassing is postponed till the dry spells, when the soil is not saturated with water.

(5) *Looseness or Gas-absorbing Properties of Soil.*—Gas diffuses very easily into loose soil of a porous texture, thus limiting the period for which lethal concentrations are maintained.

(6) *Volume and Intricacy of Tunnel Maze.*—Efficiency in gassing a colony does not so much depend on the size of the colony as on the intricacy of the tunnel maze. The airflow usually takes the line of least resistance, with the result that the gas does not circulate in side tunnels and by-passes.

(7) *Presence of Blind Ends or Air Locks in the Tunnel System.*—In nearly every instance where live meercats were found after gassing, they were recovered from blind-ends or where air-locks existed. On no account should holes be closed before dust has emerged from them.

(8) *Presence of Obstruction in Tunnel.*—Very frequently an animal or caved-in earth forms an obstruction to the passage of the gas. The latter obstruction frequently happens in winter before rains have fallen, and the burrows have not been cleaned out by the inhabitants. Gassing should be commenced at those holes which show fresh activities and recent occupation or excavations.

(*b*) *Carbon Monoxide.*

The next gas tested was Carbon Monoxide. An easy, but not the least economical way to obtain the gas, or a mixture of it and Carbon Dioxide, is from the exhaust pipe of a motor-car. A long hose-pipe was connected to the exhaust-pipe, and the free end inserted into the openings of the burrows, while the engine was running at a speed corresponding to 10-15 miles per hour in top gear. As a test to see if the gas emerged from an opening, an ordinary lighted safety match was used. The lighted match was lowered as far down the opening as the hand could reach. If the light was extinguished the hole was closed. Repeated check tests were made at the same hole. The hose-pipe, as in the case of dusting with a pump, was inserted into successive openings until all the openings had been closed.

The first test was performed at Beestekraal, 2.2.38. Two *Cynictis* were seen to enter a colony, which was then gassed. Five days later the openings were still closed; one can assume, therefore, that they were killed.

The second test was on a colony at Bestersrust on 5.5.38 into which two *Cynictis* were seen to enter. The gassing lasted 25 minutes. On partial excavation 1 dead *Cynictis* and 1 dead *Geosciurus* were recovered, from which one can conclude that the gas is effective It has since come to my notice that there is a small portable CO generator on the market. If it should prove efficient there is little doubt that the cost of gassing would, therefore be greatly reduced.

(*c*) *Sulphurous Gases.*

Various makes of gas-cartridges or fumigators are found on the market, guaranteed to be effective in eradicating small burrowing animals.

On account of their economy, only requiring one man to operate, these fumigators were tested on the Vryburg Commonage during November, 1938.

The fumigators used are designed to generate on burning, Hydrogen Sulphide, Carbon Monoxide, Carbon Disulphide and small quantities of Sulphur Dioxide. The lethal gases are only generated if the cartridges are burnt under the proper conditions, i.e., in a restricted space. If burned in the open the gases formed are Sulphur Dioxide and Carbon Dioxide. Each cartridge gives off one cubic foot of gas. The lethal properties of the gases in the burrow will persist for ten minutes. If the soil is damp, Hydrogen Sulphide will dissolve in the soil moisture.

The fumigators were used according to directions and under ideal conditions, no rain having fallen since the previous summer. The holes that were not to be charged were closed according to directions, and from one to two cartridges were ignited and inserted into the other holes, which were immediately closed.

On the day following the first test, it was found that all the colonies had been reopened. Consequently, in the next colony as many as five cartridges were inserted in one hole, and in many instances cartridges were inserted in every hole of the entire colony. Even this gave disappointing results. It was then decided to establish definitely the effect of these gases on two colonies. One of a very simple construction, and the other of a more complicated structure, were selected. (See sketch 2.)

As a test for the sulphuretted Hydrogen, Lead Acetate papers freshly prepared were used, and employed in the same way as the picrate test for Hydrogen Cyanide.

It was noticed that the fumes, liberated from the ignited cartridge on insertion in the hole, were drawn in, and advantage was taken of this as the cartridges were too big to be inserted through the stoppered openings in the test cylinders. The ignited cartridges were inserted and the cylinders were placed in position as quickly as possible. The actual times, when the cartridges were inserted, were noted.

Experiment I.

This was conducted on a colony of simple structure, consisting of five openings only, connected by straight tunnels without branches. One cartridge was inserted into each hole. Lead Acetate tests were not conducted. See Sketch No. 2.

Results.—On excavation of the colony two dead squirrels were found at the places indicated on the sketch. In all five live suricates were found at the places indicated. At hole No. III one suricate escaped and ran away. The other two in the same burrow were prevented just in time from escaping, by one of the labourers placing his foot on the opening. The hole was closed and a cartridge was inserted at the point indicated on the sketch. The tunnel was then

about three feet long. After three minutes of interruption the excavations were continued, and both suricates were found dead. The other two suricates were killed in the same way.

Experiment II.

A fair sized colony was selected for this experiment. Two *Cynictis* were seen to enter it, and later the suricate that escaped from the colony above also entered into one of the burrows. In some of the openings two cartridges were inserted while in others only a single cartridge was inserted. The Roman numerals indicate the identification numbers of the test-cylinders. The other holes were closed up before the cartridges were inserted. Lead-Acetate-tests were performed at fifteen minute intervals.

Results.

The details of the Lead Acetate test are recorded in the Table 5.

TABLE 5.

Large Colony. Experiment II. Vryburg 16.11.38.

Lead Acetate Test; Gas Cartridges, Liberating Hydrogen-Sulphide and other Sulphurous Gasses.

Time of Test, at 15 Minutes Interval.	Cylinder No. I, Loaded.	Cylinder No. II, Loaded.	Cylinder No. III, Loaded.	Cylinder No. IV. Unloaded.
10 a.m.....	Instantaneous..	Instantaneous..	Instantaneous..	Some delay.
10.15 a.m.....	Instantaneous..	Instantaneous..	Instantaneous..	Negative.
10.30 a.m.....	Slight delay....	Slight delay....	Instantaneous..	Negative.
10.45 a.m.....	Slight delay....	Slight delay....	Instantaneous..	Negative.
11 a.m.....	Delayed.....	Weak.....	Instantaneous..	Negative.
11.15 a.m.....	Weak.....	Weak.....	Instantaneous..	Negative.
11.30 a.m.....	Weak.....	Weak.....	Delayed.....	Negative.

On excavation both the *Cynictis* were found alive, as well as the *Suricata*. One *Cynictis* was killed with a gas cartridge when only 24in. of tunnel was left.

Experiment III.

An experiment with fumigators was repeated on a " Trassiebos " colony on the Hoopstad commonage a week later. Four *Cynictis* were seen to enter the colony. Out of the ten openings, seven were charged. On excavations two adult *Cynictis* escaped, while two young ones about six weeks old were found dead at a place 24 inches from where two cartridges were inserted.

Conclusions.

The fumigators, that were used, are ineffective on meercats under ordinary circumstances, and effective only in short tunnels, in which an exceedingly high concentration of gases can be obtained.

The slow rate of diffusion, which is dependent solely on the density of the heavy gases and not assisted by any air currents in the tunnels, coupled with the quick rate of absorption of the lethal gases into the soil, renders the use of such fumigators impracticable.

On account of disappointing results, the use of gas-cartridges liberating lethal gases cannot be recommended for the eradication of meercats.

(*d*) *Heavy Gases.*

(1) It was considered that if heavy poisonous gases could be liberated in the warrens, they would gravitate to the deeper sections and so reach the animals, which could otherwise not come in contact with the gases used in the previous experiments.

Carbon Bisulphide gas was thought to be suitable. Before the experiment was begun, the M.L.C. was established. This was done the following way. A *Geosciurus* was introduced into the lethal box described above. Five c.c. of CS_2 were poured on cotton wool and introduced into the box.

Results.—After six minutes the animal showed no effects beyond coughing during the first minute. A further 10 c.c. were introduced. Two minutes afterwards the animal scratched its nose and fell over. The respirations became shallow and slow, and eventually it died 22¼ minutes after introduction of the further 10 c.c. of Carbon Bisulphide

As a result of the large amount of Carbon Bisulphide which had to be used, and which proved fatal, only after 22 minutes, the experiment was abandoned.

Heavy war gases like Chloropicrin and mustard gas, which are five times as heavy as air, were also considered, but not being procurable locally they could not be tried. On account of their expense and danger in handling, it is doubtful whether their use could even become a practical proposition.

(2) *Granulated Calcium Cyanide.*—Hydrogen Cyanide is liberated very slowly from granulated Calcium Cyanide. Advantage was taken of this to create, in the opening of the warrens, chambers in which the air was charged with Hydrogen Cyanide, the idea being that such chambers would form a trap, and so gas the animal entering it.

Colony 162 at Beestekraal was selected for this experiment. Two Cynictis were seen to enter the colony. The lethal chambers were constructed as follows:—

The warrens were closed at arm's length on the inside with earth. A heaped-up teaspoonful of granulated Calcium Cyanide was deposited in a heap, and the opening was finally closed with earth.

Another unnumbered colony was treated in the same way.

The following morning on inspection one hole was found open, through which the meercats evidently had escaped. The other holes were opened by hand to find the chambers intact. In the other colony all the chambers were intact.

Further trials were not carried out.

2. Trapping.

All three species of animals are very easily trapped with ordinary three-inch gin-traps. (Illustration 10.)

Setting of Traps.—The methods which gave the most success are shortly as follows: After the hole at which the trap is to be set has been selected, sand is pushed into it until about a third of it is filled up, care being taken to fill only so much as will allow free action of the jaws of the trap, and avoid contact with the roof or the sides of the hole. This partial filling of the opening prevents the animal from avoiding the trap and compels it to crouch when entering, thus putting more weight on the catch. The trap is set in position and the catch covered with soft paper to prevent the sand, with which the whole trap is covered up, from getting under the catch and so preventing it from being released. The chain is staked to the side of the entrance. The sand is then smoothed over with the hand, and brushed lightly with a twig to obscure signs of human interference.

Selecting of the Burrows at which to set Traps.

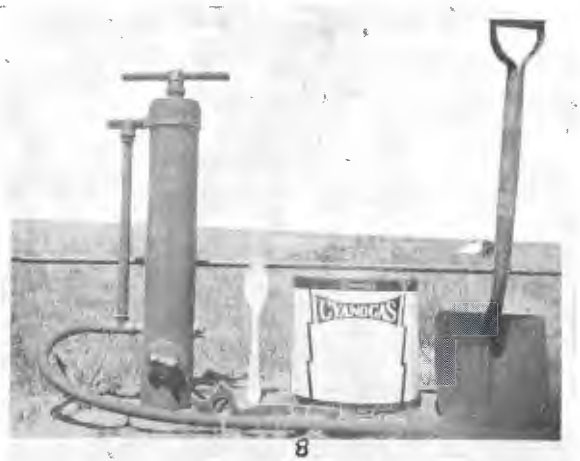
As will be described later, traps were set at those colonies which became reoccupied after gassing, or in which gassing had failed to kill all the inhabitants. In these cases traps were set at all the burrows that had been reopened.

The system of trapping and its effectiveness are described more fully later.

By way of demonstration, experiments to ascertain to what extent the inhabitants of a colony can be exterminated by trapping, were carried out at Sannahspost on 28th February and 2nd March, 1939. Traps were set at different colonies in the burrows, which were in use. The other openings were closed up with earth and trampled down. In the first case 40 traps were set at seven colonies and 35 meercats were trapped, and in the second 31 traps were set and 24 meercats trapped. On both occasions all the inhabitants were caught, since no further holes were opened up.

3. Explosives as a means of Destruction.

When it was decided to undertake experiments to investigate the effect of explosives, African Explosives and Industries Ltd. of S.A. was approached with a view to obtaining some information regarding the use of explosives to the best advantage on meercat warrens. The Company kindly placed the service of one of its experts, Mr. E. A. Hendry of the Explosives Service Station, at our disposal.



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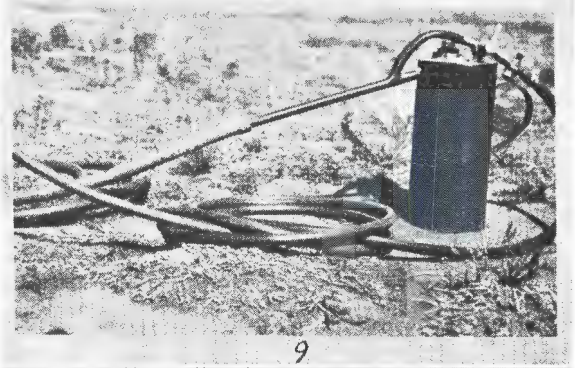

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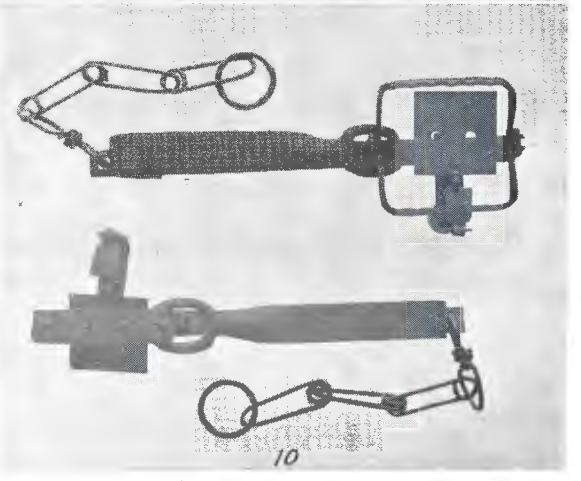

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Illustration 8.—(Top.) Gassing equipment, consisting of Schoeman double-action pump, spanner for opening the dust chamber, and a spoon for filling it; a supply of Cyanogas and a spade for closing the holes where the gas escapes.

Illustration 9.—(Middle.) Thomas insufflator.

Illustration 10.—(Below.) 3 inch Metal gintraps, used for trapping meercats.

This gentleman personally supervised all the trials conducted, and failure cannot, therefore, be attributed to amateurish and inefficient use of explosives.

(a) In loading up a colony, charges varying from ½ to 2 lb. of explosives were used. The cartridges were pushed as far down each of the burrows as possible, before filling up the holes behind with sand. The electric detonators, with which the charge was to be exploded, were connected up in series and fired with an 80 shot electric-exploder through 100 yards of cable. A certain amount of difficulty was experienced in loading as the majority of the burrows twisted considerably, and it was only possible to push the charges down for about 2-3 feet, although in certain cases the charges could be pushed down three or four feet with a stick.

In all cases the holes which were not charged were filled in with soil.

The time of charging up, including making up of primers, varied from half an hour for small "Trassiebos" colonies to two hours for a large underground colony.

Both 40 per cent. dynamite and 40 per cent. Ammon. Gelignite were used.

Altogether 11 colonies were blasted for which 150 lb. of explosives and 151 electric detonators were required.

After the explosions had taken place, the surface effects were noted before the colony was completely dug up to examine the effect of the blasting.

The results of the trials are summarised in Table 6.

Remarks.

In one instance three holes were put down with a jumper in a "Trassiebos" colony, but owing to the dry, sandy nature of the soil, on withdrawal of the jumper the holes became partly filled with sand. An attempt was also made to chamber one of the holes, but on one ⅞ in. by 4 in. cartridge being fired inside it became completely filled up with sand.

It was suggested that holes should be put down in underground colonies by means of jumpers, to increase the blasting effect, but even if the difficulty of sand filling the holes was overcome, this method was regarded as impracticable, as a very large number of holes would be required to cover a colony and, even then, there would be no certainty of the explosion reaching meercats in long blind tunnels.

From the table it will be seen, that in spite of the large amount of explosives used in some colonies, the results were very disappointing. As many meercats survived the explosion as were killed. Even in cases where half the sand-mound was blown away, live meercats were found.

TABLE 6.

Summary of the Trials with Explosives i

No. of Colony.	Type of Colony.	Approximate Size of Colony.	Total No. of Holes.	No. of Holes Charged.	Amount and Grade of Explosive used.	Effect of Explosion.
1 (1).....	Underground...	20′ diameter	16	6	3 lb. of 40 per cent. Dynamite	Slight upheavel.....
2 (73).....	Underground...	24′ × 30′	19	9	10½ lb. of 40 per cent. Dynamite	Fairly violent upheavel
3 (60).....	Underground...	90′ diameter	68	25	22½ lb. of 40 per cent. Dynamite	Violent upheavel. Stones thrown up
4 (45).....	"Trassiebos"..	20′ diameter	11	11	9 lb. of 40 per cent. Dynamite	Sand thrown into the air and roots of bushes loosened
5 (41).....	"Trassiebos"..	12′ diameter	Not counted.	1	5 lb. of 40 per cent. Dynamite	Half the mound blown away
6 (46).....	"Trassiebos"..	21′ diameter	Not counted.	10	7 lb. of 40 per cent. Ammon. Gelignite	Mound incompletely demolished
7 (50).....	"Trassiebos"..	35′ × 25′	25	18	20½ lb. of 40 per cent. Ammon. Gelignite	Spectacular effect. Roots of bushes well loosened
8 (14).....	"Trassiebos"..	18′ diameter	12	9	12½ lb. of 40 per cent. Ammon. Gelignite	Sand well scattered, and bushes torn up
9 (127).....	Underground...	90′ × 45′	50	22	26 lb. of 50 per cent. Ammon. Gelignite	Considerable upheavel, especially in rocky portion
10 (123).....	Underground...	60′ × 45′	41	15	18 lb. of 40 per cent. and 50 per cent. Ammon. Gelignite	Ground well disturbed near the charges
11 Trompsburg	Underground...	75′ × 45′	Not counted.	25	20 lb. of 50 per cent. Ammon. Gelignite	Fairly well disturbed.

85-86b →

TABLE 6.

th Explosives in Meercat Colonies. 23.11.37.

Nature of Soil.	No. of Meercats Chased In.	No. of Meercats Killed.	No. of Meercats Found Alive.	REMARKS.
Dry loam.....	4	Nil	11	5 Meercats were found in one blind tunnel 3 feet underground and 15 feet away from the surface burrows, and 1 female and 5 young were found in another blind tunnel also 3 feet underground and about 30 feet away from the central colony.
Dry turfy loam.....	4	1	3 (escaped during the night)	Here again what appeared to be long blind tunnels were located and digging was stopped.
Sand, rock and gravel	—	4	—	Diggings was not completed. It is surmised that one meercat escaped at night.
Sand.....	1	4	1	On returning after blasting one meercat was observed to crawl out and stagger away.
Sand.....	1	2	—	It is not known how many meercats were in this Colony. It is possible that one escaped alive.
Sand.....	—	—	—	Indefinite result. An attempt to put down jumperholes was made here, but was unsuccessful on account of the sandy nature of the soil.
Sand.....	3	1	2 (escaped)	Portions of the mound were not affected by the blast.
Sand.....	2	2	—	No evidence was found of any meercats having escaped between the time of blasting and the time of digging up.
Hard yellow soil, and rocks	—	1	—	The total number of meercats in the colony at the time of the blast is not known. The deepest crater formed was 3 feet deep.
Red soil.....	—	3	—	Several portions of the colony away from the charges were left intact.
Very rocky.....	—	—	1	Local shattering. The meercat found crawled out after the blasting.
	TOTAL.....	18	18	

← 85-86a

The following reasons for the disappointing results were deduced.

In underground colonies, charges cannot be pushed down to any depth owing to the winding of the tunnels, and consequently only local shattering results.

The explosion does not appear effectively to penetrate the lower levels of the burrows, and it would appear that meercats in the ends of blind-tunnels, about 3 feet underground and well away from the surface burrows, are practically immune from the effects of the blast.

Other factors tending to reduce the efficacy of the blasts are, that charges cannot be properly stamped in the burrows owing to the size of the latter, and that sand in the burrows has a damping effect on the explosion. In rocky ground where concussion should be greater, it was found that quite large cavities exist under the boulders, and also that burrows are more widely spaced, tending to reduce the effect of the blast.

In " Trassiebos " colonies a good deal of the sand is scraped out, this, combined with the fact that the mounds are composed of sand, would have the effect of reducing the concussion to a very great degree. It was thought that, in those colonies where meercats were found dead, they had been partly stunned and then suffocated by the fallen sand and explosive fumes.

Conclusion.

Owing to the large amount of explosives necessary to blast a colony and the time required to charge up, coupled with expense and poor results, it was concluded that the use of explosives for the destruction of meercats and their burrows is not a practical proposition.

4. Poisoning with Bait.

One of the commonest methods of eradicating vermin is by means of poisoned bait.

On preliminary trials it was found that the yellow mongoose would devour the fresh carcases of birds, which were shot and placed near their warrens. Experiments were then carried out to test the efficacy of Strychnine sulphate.

Experiment 1.

$\frac{1}{8}$ Grain of strychnine sulphate was fed in a piece of meat to *Cynictis* (juvenile) at 2.48 p.m. At 6.40 p.m. the animal showed signs of inco-ordination of movements, and died during the night.

Experiment 2.

$\frac{1}{4}$ Grain of strychnine sulphate dissolved in 5 c.c. of water was injected subcutaneously into the left thigh of a *Geosciurus*. The animal died after two minutes, showing violent convulsions and arching of the back.

Remarks.

Poisoning the yellow mongoose on a large scale is not recommended, owing to the danger of large stock getting access to the bait, especially in pica areas.

The danger to native piccanins is even more real, as piccanins may pick up and eat the bait if birds are used.

When an owner wishes to kill off a few chicken-thieving mongooses, poisoning on a small scale may be practicable; but the method is obviously involved, uncertain, and dangerous for general use.

B. Attempts at Large Scale Eradication of Meercats.

The best method of destroying the yellow mongoose having been determined, experiments were planned to investigate the possibilities and the technique of exterminating it in large areas, and to observe the extent to which migration back into the areas, of the yellow mongoose would take place

For this purpose, two adjoining farms, Beestekraal and Middagson in the Hoopstad District, were chosen, on account of (*a*) being infected with rabies (an outbreak in a dog having occurred there on 27th March, 1937) and (*b*) their situation in typical mongoose country.

General Description of the Farms Beestekraal and Middagson.

The two farms mentioned are rectangular in shape, about $1\frac{3}{4}$ miles wide by 4 miles long, bordering the Vet River on the south.

They stretch northward from the Vet River, on which they have about three miles frontage, into a sand-hillock for approximately three miles. Both farms are ring-fenced, and subdivided into several fenced camps. The farms Beestekraal and Middagson are about 1,400 and 1,000 morgen respectively in extent. About 400 head of cattle, including a few horses, had been kept at Beestekraal for the previous three years, and there were 100 head of cattle at Middagson.

Both farms can be divided topographically into two distinct parts, viz. a low lying area adjoining the Vet River, and the higher part in the sandbult-hillock. The Bloemhof-Hoopstad main road running from East to West, incidentally corresponds to a line separating these two parts.

That part of the low-lying area immediately adjoining the Vet River is flooded in the rainy season, when the river overflows its banks. The water disappears soon after the river has subsided. The soil, which becomes very hard when dry, is a black clay. This area is marked by tall trees, mostly *Acacia karroo*. From the low land the ground rises very gradually to the main road, where it merges into the sand-hillock in a sharp rise. The soil here consists of clay in the deeper layers and sand in the superficial layers. The vegetation

is sparse, but characterized by "Trassiebos" mounds (*Acacia stolonifera*) which average 10-20 yards in diameter and are spaced from 20 to 100 yards, with an occasional *Acacia karroo* between.

The sand-hillock portion starts with a sharp rise from the main road, and rises steadily until the northern boundary is reached. The soil is of a very loose sandy nature and easily blown away when dry. The vegetation consists of various species of tall grasses and Camelthorn trees (*Acacia giraffae*) which forms the climax stage.

The altitude of the farms is 4,100 feet.

Observations Made.

The two farms together were treated as one area, and, to facilitate plotting as well as systematic covering of the ground, was paced off and marked into squares of approximately 400 yards a side.

After the outer boundaries had been traced on squared paper, the flagged squares were also marked in.

Each flagged area was carefully searched for meercat colonies, which were marked and numbered for identification purposes, and the site recorded with a corresponding number on the sketch-plan. Detailed remarks, as to the size of the colony, whether there were signs of inhabitants, were made. The latter observations were made as meercats, when disturbed, usually rushed back into their colonies to take refuge.

It was generally possible to determine the species of meercat inhabiting a colony by the tracks, and the fact that *Cynictis* usually selects a spot near its colony to the leeward of some bush or stone, or in a hollow to defaecate, and fresh faeces in such a spot near the colony indicates the presence of *Cynictis*.

During the excursions to locate the colonies, notes were made on the nature of the soil in which the colonies were located, the habits of the meercats, the occurrence of food. A general survey of the flora and fauna was also done at the same time. The diet of the different species of animals and birds found in the area was established by examination of the stomach contents of those shot or trapped.

It was realised at the outset that, in order to exterminate the yellow mongoose and the suricate, those colonies occupied by the squirrels had to be gassed as well, as the latter live in very close association and often congregate in the same colonies. It was also obvious that, unless all colonies were closed, one would not be able to judge whether all the mongooses and suricates had been destroyed. In any case the squirrel is regarded as vermin on account of the destruction to mealie fields, and one thus felt quite justified in including it in the campaign against the other two species.

As soon as the task of locating and flagging off the colonies was completed, which took about a month of fairly continuous work, gassing operations were started.

The technique of gassing a colony with Calcium Cyanide dust has already been described.

The routine adopted at the commencement of the operations was shortly as follows: Early in the morning before the meercats had dispersed, natives were sent out to watch the inhabited colonies in a given area. They were instructed to chase back into their warrens any meercats seen to emerge, and then to keep guard pending the arrival of the gang armed with the gassing apparatus.

All the natives including those of the advance party carried spades with which to close all uninhabited colonies, and to fill in any odd holes they came across in the veld.

This was continued until about 11 a.m., as it was found that after that time and until late in the afternoon very few meercats were seen. The operations were resumed at about 4 p.m., and continued until dusk.

Periodic inspections were made of the colonies that were gassed, and any that were found reopened were regassed.

It was soon found that several colonies had to be gassed repeatedly; e.g. Colony 61, inhabited by *Geosciurus*, was gassed five times without any conclusive results. It was found in many instances that only a single warren had been reopened and in order to save dusting powder, time, and labour, gin-traps were set at these burrows.

On account of this experience the routine was then changed somewhat. Instead of gassing reopened colonies, traps were set at the warrens reopened, until the animals responsible had been trapped.

Two natives were then detailed to make periodic inspections of the areas treated, and at any warrens found open they had to set traps. If a trap remained unsprung for two days, it was removed and the hole closed.

On or about the 5th February, 1939, the routine was again changed. Instead of having advance parties, all the natives with the gassing outfit set out together, and walked in extended rank formation spaced at from 50 to 150 yards according to the density of the grass. This procedure proved very effective for rounding up the meercats, and so chasing them into their warrens, which were then gassed. This procedure had the further advantage in that the work could proceed uninterruptedly. In the area so traversed all colonies were fumigated, unless they were obviously not inhabited, when they were merely closed.

A complete record of each colony was kept, giving the dates of subsequent visits and regassing, whether any warrens were found reopened, the number of traps set, and the results.

The following is a brief summary of the histories of the colonies found and treated at Beestekraal and at Middagson:

(*a*) In all, 150 colonies were located.

(*b*) 35 colonies were unoccupied; but 6 became occupied later, after the first summer rains.

(*c*) 65 colonies of those gassed remained closed until the 2nd of March, 1938, when the operations were completed.

(*d*) 50 colonies were reopened by meercats subsequent to the initial gassing. Of these, in 13 instances meercats were actually seen to inhabit them again, and eleven of these were regassed. In the other 39 the inmates were not seen, but numerous spoors were seen and seven animals trapped.

(*e*) 29 colonies were not revisited until some time afterwards, when they were found to have been reopened.

(*f*) 21 colonies were still closed on a re-inspection some days after the gassing, but were found reopened at a subsequent inspection.

Remarks.

(*a*) In all, some 150 colonies were found on the two farms. In some instances two to four colonies existed very close to one another, especially in the " Trassiebos " area. These were collectively given one number, but were identified separately with alphabetical letters, e.g. Col. 68: a, b and c.

(*b*) 35 colonies were marked as uninhabited or abandoned colonies, which were not gassed but closed in; of these, 6 were later found to be inhabited, viz., Nos. 32, 66, 81, 98, 150 and 152. No. 32 was found inhabited on 3.1.38. It was then gassed and was still closed on 5.2.38. On 9th February some holes were found reopened and traps were set, with the result that 2 squirrels were trapped. The holes were then closed again, and were still closed on the 2nd of the following month.

The history of two of these colonies is given in detail, to indicate to what extent they became occupied and how they were treated.

Colony 98.—The colony appeared uninhabited on 11th January, 1938. On the 25th one warren was found reopened, and was closed again as no signs of its being inhabited were seen. On 1st February several warrens showed fresh excavations. The colony was gassed and the holes were closed. On the 14th it was still closed, but five warrens were found to have been reopened on the 21st. The colony was again gassed and remained closed until the 28th. On 1st March two warrens were found reopened and traps were set, but again removed after two days as they were not sprung.

Colony 150.—On 28.1.38 the colony appeared as if it had been vacated and was visited repeatedly until 22nd February, when seven warrens were found open. Numerous fresh spoors were present. The colony was gassed, and remained closed until 2nd March.

The other two colonies, 66 and 152, remained closed when they had been gassed.

(*c*) Out of the total number of colonies found inhabited and gassed, 65 remained closed after only one gassing. In 38 instances of these, either one or more were yellow mongoose or squirrels, and in three instances both species of animals were seen to enter immediately prior to gassing.

(*d*) Of the total number of colonies gassed 50 were reopened by meercats or other animals, subsequent to the gassing. Of this number 21 colonies were closed on reinspection at different times, while 29 colonies which were not visited for some time were found open at the subsequent inspection.

In 13 cases of the 50 which were found reopened, meercats were actually seen to enter and inhabit these, and eleven of these remained closed on regassing, while the other two had to be regassed several times. In the other colonies traps were set, and in seven instances the new inhabitants were trapped.

In order to indicate the difficulty experienced in some instances in destroying the inhabitants of the colonies, and to show how they became reoccupied, the history in detail of a few colonies is given.

Colony 63.—On 30th December, 1937, two squirrels entered the colony, whereupon it was immedately gassed. On 3rd January it was still closed. On the morning of the 11th January several warrens were found open, and two squirrels and two mongooses were trapped, whereafter the colony remained closed until 28th February.

Colony 87.—On the 11th January, three *Cynictis* were seen to enter whereupon the colony was gassed. It remained closed until the 14th, when two warrens were found to have been reopened. The colony was regassed after the other holes had been re-opened to allow the free circulation of gas.

On 3rd March one warren was found re-opened, and a trap was set but remained unsprung for two days.

Colony 101.—On 9th November, four *Cynictis* and five *Geoscirurus* entered the burrows. On 4th December one *Cynictis* was trapped. On 4th January four *Geosciurus* and three *Cynictis* were seen to enter the colony, whereupon it was gassed. On the 12th there were signs of its being inhabited again, and one *Cynictis* was trapped. The colony then remained closed till 28th February.

Colony 110.—On 10th January as fresh tracks and faeces were found, the colony was gassed at 12 noon. On the 27th five warrens were found open showing fresh excavations. The colony was again dusted.

On 21st February two warrens were opened and fresh tracks were found. The colony was regassed. On the 24th it was still closed, but one warren was found reopened on the following day, when a trap as set and a *Cynictis* trapped. On 1st March it was still closed.

Colony 131.—On 12th January a *Geosciurus* entered the colony which was then gassed. On the 21st it was still closed. On the 7th a *Cynictis* and a *Geosciurus* entered, and two traps were set. A *Geosciurus* was trapped on the 10th, and a *Cynictis* on the 15th. On 21st February a *Myonax* was trapped in the same colony. On the 23rd another *Cynictis* was trapped. The colony then remained closed.

Colony 140.—On 12th January 4 Suricates, 5 *Geosciurus* and 4 *Cynictis* emerged from the colony but were chased back, whereupon the colony was gassed. On the 28th five warrens were found to have been reopened, fresh tracks and faeces being present.

On the 28th the colony was regassed. On 9th February six warrens were found reopened, whereupon the colony received a further gassing. It then remained closed until the 23rd when 3 warrens were once more found reopened, and two *Cynictis* were trapped. It then remained closed until 2nd March.

Philip-Hoopstad District.

On 10th April, 1938, experiments were arranged on the farm Philip, firstly to follow up the gassing of colonies with systematic trapping of the meercats that had escaped gassing, and of those which had filtered into the ground already treated and which were responsible for reopening colonies treated; and secondly to repeat some of the hydrogen cyanide concentration experiments in colonies.

General Description.

The farm Philip is situated seven miles to the south of Wesselsbron at an altitude of 4,350 ft., and is 1,400 morgen in extent. The average annual rainfall is 15·20 in.

The larger part of the farm consists of a sand-hillock with numerous small pan-like depressions. The sand-hillock slopes down to a large pan, typical of that part of the country. The soil on the hillock is of a deep sandy nature, in which mealies are extensively cultivated. The whole farm is devoid of trees, except for a small patch of young *Acacia karroo* near the northern boundary.

The sandy soil gradually changes on the slopes near the pan into a brown turf, with lime subsoil. The pan contains water during the rainy season, but soon dries up leaving a level and caked bed.

Vegetation.

The vegetation consists mainly of a mixed variety of grasses, with *Arastida*, *Themeda* and *Chloris spp.*, *Cynodon* and *Aristida* being dominant on uncultivated land. The "stand" of mealies in the different fields was good owing to abundant rains.

Fauna.

The majority of the meercat colonies were situated along the slopes of the big pan, and mostly inhabited by *Geosciurus*, although *Cynictis* was fairly prevalent as well. The owner informed us that a large family of Suricates periodically inhabited various colonies along the pan.

The colonies on the hillock were usually close to the mealie-fields and along the slopes of the pan-like depressions. The former were predominantly occupied by *Geosciurus*, while *Cynictis*, which favoured the hillock, occupied the colonies along the pan-like depressions.

One was struck by the scarcity of Korhaan and other ground birds. Very few springhare (*Pedetes caffer*) inhabited colonies were seen. The few that did exist were inhabited by individual animals only. This was explained by the owner, who stated that a Springhare club existed in the area aiming at total eradication, by systematic hunts, etc., as the animals cause considerable damage to the mealie crops.

Hodotermes were plentiful and very active. An outbreak of rabies occurred on this farm in an ox on 7th November, 1937, and, on 23rd May while the experiments were in progress, a rabid *Cynictis* was found in the same camp, where the ox became ill.

Procedure.

As the object of the experiment on Philip was to follow up the gassing with systematic trapping and so to exterminate the meercats on the farm, it was therefore arranged that a definite area be gassed each day. The day following the gassing of a particular area, it was covered again to set traps at any warrens that had been reopened. This was followed by periodic inspections at short intervals to set fresh traps, if necessary. The trapping was continued until no further holes were reopened.

For the purpose of working out a daily programme a survey of the farm was made, and the colonies located were roughly marked on a sketch-map. It was then very easy to divide the whole of the farm into areas, special consideration being given to localities where the colonies were more closely situated together, so as uninterruptedly to gas such an area in one day in order to minimize the chances of reinfestation from neighbouring colonies still untreated.

Results and Observations.

(*a*) In all 92 colonies were located on the farm, of which 13 were uninhabited and not gassed, but only closed.

(*b*) Of the 79 colonies gassed, 45 remained closed until 26th May, when the operations were completed, i.e. when it was considered that all the meercats on the farm had been exterminated. Thirty-four of the colonies were re-opened subsequent to the gassing.

(*c*) Eleven colonies were found re-opened once only.

(*d*) Seven colonies were found re-opened twice.

(*e*) Eight colonies were found re-opened three times or more.

(*f*) In 20 instances where colonies had been found re-opened, no meercats were trapped.

(*g*) Only one colony was found re-opened on the day following gassing.

(*h*) In only two instances were colonies found re-opened on the 2nd day following the gassing.

(*i*) In two out of the thirteen colonies regarded as unoccupied at the time of the general survey of the farm, warrens were re-opened. In one case a *Cynictis* was trapped, whereas the trap remained unsprung in each of the others.

(*j*) On 25th and 26th May, when the final inspection was made, only nine colonies showed meercat activity. In three cases the traps had not been sprung, while in four instances meercats had been trapped, viz. three *Geosciurus*, one *Cynictis* and one *Suricata*. In the remaining two cases no further observations could be made, owing to our departure from the farm.

(*k*) In twelve cases the colony was dug open by meercats between the 4th and 10th day after gassing.

Subsequent Inspections at Beestekraal, Middagson, and Philip.

In order to determine to what extent meercat migration will take place into areas in which meercats have been exterminated, subsequent visits were paid to the farms Beestekraal, Middagson, and Philip.

Beestekraal and Middagson.

Visits on the 7th, 8th and 13th April, 1938, i.e. 33 days after the operations had been suspended.—Out of 110 colonies visited, mainly on the area north of the Bloemhof-Hoopstad main road, 31 colonies were found re-opened, of which 18 only showed signs of being inhabited. The other 13 were abandoned. Colonies 113 and 110 each had 9 warrens re-opened; numerous fresh spoors were seen and the usual heap of fresh faeces of *Cynictis* was present. In colonies 63 and 68, eight and three warrens respectively, were re-opened and a *Cynictis* and a *Geosciurus* escaped into them.

Visits on 24th to 26th November, 1938, i.e. 10 Months afterwards.—Some 105 colonies were visited. While 32 colonies showed definite signs of being inhabited, 88 were still closed, or partially opened but abandoned. The extent to which the colonies were re-opened varied a great deal. In the smaller ones all the holes were found re-opened, whereas in the bigger ones only some of the holes on the periphery had been re-opened and occupied. It was found that the colonies near the boundaries of the farms showed more meercat activities than those near the centre of the farms, although some of the colonies towards the centre of the farms were also well attended.

The only area into which meercats had definitely not migrated was that in the vicinity of the farmyard.

An attempt was made to take a census of the meercats, but owing to the tall grass this had to be abandoned. Only twenty mongooses and ten suricates were seen. From the activities manifest at the various colonies, it was estimated that the reoccupation of the colonies was from one to three per colony, so that the total number, at a conservative estimate, was from fifty to sixty meercats on the farm.

Visits on 8th June, 1939.—An excursion was made to the farm Beestekraal only some fifteen months after the initial operations. On the sand-hillock all the colonies that were encountered had been re-opened, and showed signs of long habitation, viz. excavations and faeces observed. In the majority of cases the fresh excavations were on the periphery of the colonies, the rest of the warrens still being closed. The area in the vicinity of the farmyard showed very little activity. In the area immediately to the south of the Bloemhof-Hoopstad road, all the "Trassiebos" mounds had been excavated and were inhabited. Except for the small area near the farmyard, it was considered that meercat activity over the whole area had reached the same stage as before the trial eradication at the beginning of the previous year.

Philip.

Visit on 29th June, 1938, *i.e., 34 days after the meercats on the farm had been eradicated.*—Some 44 colonies were visited, of which 29 showed signs of being occupied by meercats. Fresh spoor, and/or faeces were found at each of the colonies. Several colonies had been completely re-opened; e.g., No. 105 had 24 warrens re-opened and was occupied by squirrels; No. 139 had 12 warrens re-opened. Thirteen colonies had been re-opened but no spoors or faeces were seen.

Visit on 27-29 November, 1938.—On this date 80 colonies were inspected with the following results: 21 colonies were reinhabited; five mongooses and three squirrels were seen. As in the cases of Beestekraal and Middagson, the number of warrens re-opened varied from one to ten per colony. Colony 66 had ten warrens re-opened.

Visit on 9th June, 1939.—The inspection of the colonies was confined to a portion of the hillock along the main road, the vicinity of the pan and the eastern portion of the farm. All the colonies encountered had been re-opened and showed signs of having been inhabited for a long time. The colonies in the hillock, which were inhabited by *Cynictis* had only a few warrens on the periphery re-opened, while those inhabited by *Geosciurus* had all the warrens re-opened. The distribution of the meercats was more or less even over the area visited.

Remarks on the Observations Made and Results Obtained at the Farms Beestekraal, Middagson, and Philip.

(1) In both the areas about half of the number of colonies gassed was found re-opened subsequently to being gassed. The re-opening of the colonies was ascribed to meercats that—

(*a*) had escaped the gas in the colonies and had dug themselves out;

(*b*) were away at the time of gassing, and had returned to dig themselves in;

(*c*) wander from colony to colony, probably looking for mates. They usually open a few holes, but not being attracted go away again.

(*d*) come from elsewhere, migrating into new hunting ground, where they find suitable shelter by merely opening up and cleaning out existing colonies.

These animals were all trapped.

(2) If an analysis is made of the results obtained at Philip, where the gassing of the colonies was followed up by repeated inspections, it is seen that some colonies become reoccupied at different intervals. In some instances this occurred as many as three times, e.g., colonies Nos. 6, 62, 115, etc.

The new inhabitants of a colony do not necessarily consist of the same species as the original ones, but they may consist of a different species of meercat, or of all three species.

Considering only those colonies where the new inhabitants were trapped, the analysis shows that nine colonies became reoccupied between the 6th and 10th days, six between the 11th and 15th, six between the 16th and 20th, three between the 21st and 25th, four between the 26th and 30th, and three after the 30th day following the gassing.

Migration of meercats, therefore, takes place to a greater extent soon after an area has been treated, but as the number of meercats available in the neighbourhood is being steadily reduced by gassing and trapping, the rate of migration becomes reduced, until finally a stage is reached when the infiltration becomes negligible.

After the extermination of meercats in any locality by the methods outlined above, it should be a comparatively easy matter if so desired to maintain effective control over such area with very small expenditure of time and money, by making frequent periodic inspections and setting traps at any warrens, that have been re-opened.

Especially would this be the case with *Cynictis*, the most important carrier of the disease. This animal, unlike *Geosciurus*, when occupying a new colony, only opens and uses a few warrens on the periphery.

(3) On the other hand, if no check is placed on the migration of meercats to such a farm, it soon becomes reinfested with meercats, as is clearly shown by the observations made on the subsequent visits to Beestekraal, Middagson and Philip. In both instances after an interval of 33 days on the first-mentioned farms, 18 out of 110 colonies visited, and in the latter 29 out of 44, were re-occupied by meercats, and some months later something near the normal density of population was restored.

(4) The migration of meercats to an area in which eradication had been carried out does not take place in the form of a general movement of a section of the population from the adjoining untreated ground, but it occurs in the form of a steady infiltration by individuals looking for new hunting-ground. Since the new hunting-ground affords adequate shelter by merely opening up and cleaning out existent burrows, the invaders prefer to remain in the new area.

(5) The distance over which *Cynictis* and *Geosciurus* may migrate is not known. In the case of *Suricata*, it is known that it migrates over long distances. But that migration of *Cynictis* and *Geosciurus* from colony to colony over short distances, normally occurs is obvious from the fact, that colonies left or abandoned by meercats of their own accord become inhabited again later. It seems also that constant movement by individuals or families takes place from colony to colony, even in the same hunting-ground, and that migration is not due entirely in the case of *Cynictis* and *Geosciurus* to exhausted food-supply.

(6) During the last visit to the two farms on which the experiments had been carried out, seven places, where colonies had been dug up and totally destroyed, were visited, and in not one instance had warrens been dug again on those sites.

In 1936 Dr. Thomas gassed, dug up, and completely destroyed all the colonies in an area about ten morgen in extent, near Odendaalsrust. On subsequent visits by him and myself it was found that the whole area was invaded by meercats, and that they had dug their warrens on the sites of the colonies that had been destroyed. The fact that this did not happen on either of the two farms Beestekraal or Philip is owing to the facts that the areas were big and that warrens were available by merely cleaning them out, whereas in the other case no such warrens existed, and advantage was taken of the loose soil of the old colonies in which to dig fresh burrows.

(7) An attempt was made to estimate the number of meercats on the farms Beestekraal and Middagson.

One can assume that in the 65 colonies, that remained closed up to 3rd March, and the 21 which were closed for a few days, the meercats in them at the time of gassing were killed. Only in 57 of these colonies were meercats seen to enter prior to gassing. The actual number of meercats seen to enter the colonies can thus be regarded as the minimum destroyed, i.e. *Cynictis* 97, *Geosciurus* 37, *Suricata* 7.

In addition to those the following meercats were either shot, trapped, or captured in some way: *Cynictis* 53, *Geosciurus* 58, *Suricata* 10.

To the above totals may be added the number of meercats seen to enter the colonies found reopened after the initial gassing, and prior to the revisit.

The totals are therefore:—

	Cynictis.	*Geosciurus.*	*Suricata.*
Assumed killed by gassing.....	97	37	7
Trapped, shot, etc.....	53	58	10
Escaped gassing.....	16	11	12
TOTAL.....	166	106	29

These totals of course represent the absolute minimum of meercats that were on the two farms, as no consideration was taken of those that were killed in the colonies into which no meercats were seen to enter. If one makes an allowance for these on a proportional basis, the following figures are obtained, viz.: the 86 colonies that remained closed may have harboured 146 *Cynictis*, 55 *Geosciurus* and 9 *Suricata*.

Likewise on the same basis then 29 colonies which were found reopened before being revisited, harboured about 25 *Cynictis*, 27 *Geosciurus* and 29 *Suricata*. Some of these, however, were trapped, so that some allowance must be made for that. It is estimated that seven *Cynictis* were trapped and already accounted for, so that the total for the *Cynictis* becomes 18. The grand total therefore becomes: *Cynictis* 184, *Geosciurus* 139, *Suricata* 58.

These totals may be regarded as a fair and still conservative estimate of the meercat-population on the two farms, cognisance being taken of the fact that more meercats were probably killed by gassing than were counted and seen to enter the colonies prior to gassing.

On the other hand again it may be that a certain percentage of those that escaped the gassing were probably trapped at some other colony.

If these totals are acceptable as a rough estimate, then the density on the two farms, 2,400 morgen in extent, works out at 1 *Cynictis* to 13 morgen, 1 *Geosciurus* to 17, 1 *Suricata* to 40 morgen.

C. Extermination of Meercats on Infected Farms, as a Practical Measure of Rabies Control.

As a consequence of the promising results obtained in the experimental destruction described above at Beestekraal and Philip, the Department of Agriculture was prevailed upon to undertake the extermination of meercats on infected farms as a practical control measure. Thus, this afforded a further opportunity of improving the technique, and making further observations under rigorous field conditions.

A Stock Inspector was appointed to undertake the work under the author's supervision. The labour and working-equipment consisted of eight natives, three Schoeman double-action pumps, the necessary supplies of Cyanogas, two hundred 3-in. gin traps, six spades and a motor-van. The party camped near the site of operations, so that there was a minimum of time lost going to, and coming back, from, work.

Procedure.

The localities in which outbreaks of rabies occur are treated in sequence. A preliminary inspection is carried out, to establish the probable extent of the infection and therefore the area to be treated. This is based on the occurrence of colonies, whether there is a break in their continuity or not, the topographical features, etc. These points will be more fully illustrated when the infected areas are described.

As soon as this is completed a programme is drawn up and the whole area is divided into sections, which are to be treated in sequence.

Operations are then started and carried on according to the method already explained. The area is traversed in strips to locate the colonies, and gas them. This is followed by systematic inspection and trapping, until no meercats are left.

A daily report is drawn up, and submitted, by the Stock Inspector. Certain essential data are extracted from this report and summarized in table-form, so as to show in column (1) the number of the sections, corresponding to the number on the sketch-map, of

the area to be treated; column (2) the date; (3) the number of colonies found and treated; (4) the total number of colonies opened by meercats on the day following gassing; (5) the number of traps set and the number of meercats caught; (6) the number of colonies in which warrens are found open on the second day following gassing, and (7) the number of traps set and the result; (8) the number of colonies inspected and found open at the periodic inspections, giving the dates on which these were gassed; (9) the number of traps set and the result, and finally (10) the result of a final inspection over the whole area with the number of colonies opened, the number of traps set, and the number of meercats caught.

The daily reports also include the number of meercats seen, particulars as to age, pregnancy, species, with stomach contents, etc., of the meercats trapped.

(1) Marah-Waaikraal Area: Bloemfontein District.

11.2.39-27.3.39.

The first destruction raid undertaken in this new campaign was the Marah-Waaikraal one. Rabies was diagnosed in a *Geosciurus* at Marah on 11.2.36 and at Waaikraal in a dog on 20.9.38. At the time of the outbreak at Marah, suspected cases were reported in yellow mongooses near the railway station of Sannahspost.

Description of the Area.

(Refer to Map No. 2).—The area borders on the Modder River. A weir across the river, situated near the railway line, causes damming of the water as far back as, and sometimes beyond, Besemkop and thus form an impassable barrier to meercats. Two spruits forming vleis run across the area to join each other on the farm Newlands. The whole area consists of rather flat hillocks, which rise gradually from the water courses. There are no hills except for a stony ridge on Valle.

The vegetation, consisting of mixed grasses, was dense on account of copious rains; 10 ins. was recorded during the latter half of January. The hillocks are extensively cultivated for mealies. Soil erosion is bad on the farms Woonhuis and Goupond.

Extent of the Infection.

The Modder River, which forms the Eastern boundary of Marah, where the first outbreak occurred, was considered to be the limit of the infection on that side, as the river at that part is impassable to meercats.

On account of the infection on Marah, and the suspected cases that were reported at Sannahspost railway station, and the outbreak at Waaikraal, the triangular area thus formed with Klipkraal in the centre, was considered the centre of the infection.