Botanical Investigations into Gal-Lamziekte.

By Joseph Burtt-Davy, F.L.S., Government Agrostologist and Botanist.

During the latter half of the year 1911, the losses caused by Gal-Lamziekte were exceedingly heavy. The failure of all attempts to transmit the disease pointed to a possible botanical origin, and it was therefore considered necessary to conduct a thorough investigation of the flora of the Northern Lamziekte region. In the course of our field work it was soon found that the area affected by the disease was much larger than had been generally known, and it became necessary to extend the investigation into other phytogeographical regions of South Africa.

It was evident that this task would require practically the whole of my personal time and attention, as well as that of my staff. As far as possible, therefore, I temporarily laid aside all other lines of investigation and concentrated attention upon Lamziekte.

I accompanied Dr. Theiler on his extensive journeys through the affected area, studying the general character and detailed composition of the veld, and recording data obtained from farmers both in public meetings and at their private houses.

Special visits were also paid to selected spots of particular interest, and several thousands of specimens were collected, thoroughly representative of the different Lamziekte areas. This material is being worked up as fast as possible.

Several hundreds of suspected plants have been received from correspondents and have been identified, and data concerning them has been furnished to the Division of Veterinary Research. A large number of the plants thus brought to our notice as suspects have been tested upon cattle, but so far not one of the 60 odd species so tested has produced Lamziekte, even though many hundred pounds of the material has been fed; the arrangement and supervision of these tests at the several Lamziekte stations has devolved upon me, as also the arranging of the camping off experiments and of the transplanting of grasses for the grazing tests.

I have also been studying the literature on such subjects as cyanogenesis in plants and the corn-stalk disease of the United States at the same time that Dr. Theiler has been following up that on the pica disease of north Germany. Simultaneously, we were led to the conclusion that these diseases were more or less analogous with Lamziekte. Discussing together the various facts ascertained in our joint investigation we were led to the conclusion that Lamziekte is due to a cumulative poison developed in the grass under certain climatic and telluric conditions in which drought at certain temperatures plays an important part.

This gives us a working hypothesis, and it is now necessary to put it to a thorough test; we expect this will require a whole season's work. Our plans are laid and much of the preliminary work has been done, but we are now forced to wait for the Lamziekte season before the tests can be completed.

Theories.

In an investigation of this character many working hypotheses must pass under review only to be discarded in turn until the truth is realized. It was Pasteur, I think, who observed that "theories come into our laboratory by the bushel: when they have served their purpose they are thrown out of the window." Of the many theories which have been offered by correspondents or have occurred to us from time to time as fresh facts have come to light, it is my province to discuss only those which are associated with plants other than bacteria; Dr. Theiler is dealing with the remainder.

The plant theories considered here are four in number:—

1. The specific poisonous plant theory.
2. The cumulative plant poison theory.
3. The wilted grass theory.
4. The toxine genesis theory.

1. *The Specific Poisonous Plant Theory.*

The disease was first brought to my attention in 1906 by Mr. A. S. Pringle, who lost several cattle in the vicinity of Kaffraria, Christiana, and who wished me to investigate the flora to find out whether some poisonous plant was the cause of the trouble, as he was quite at a loss to account for it otherwise. Several of the commoner poisonous plants (*Crotalaria burkeana, Urginea Burkei, Datura Tatula, Solanums, Asclepias fruticosa* and *Geigeria passerinoides*) were found in that part of the veld in which the deaths occurred, but nothing which could be actually suspected as the cause. In reporting to the Director of Agriculture I pointed out that too little was yet known about the actual effects produced by these plants, to enable us to say definitely whether they were the cause of the trouble, and suggested that a series of feeding tests should be conducted with all of them in order to learn their effect on stock. I had not animals nor sufficient funds at my disposal to carry out this work myself, and in any case it was desirable that it should be done in co-operation with the Veterinary Division in order that the symptoms might be recorded by a qualified Veterinary Surgeon and complete post-mortems made. Unfortunately the Veterinary Division was at that time too fully occupied with such problems as East Coast fever, horse-sickness, etc., and the feeding tests had to be postponed.

In 1909 Lamziekte appeared to be spreading westward and northwards, and many more cases were brought to our notice. This may have been due to the fact that Bechuanaland and the Western Transvaal were becoming more closely settled and stocked, and it was natural that losses should become more noticeable.

However, this apparent spread of the disease suggested to many minds that it was infectious or contagious. Therefore as soon as the Division of Veterinary Bacteriology was able to take up the matter, this aspect of the problem was the first to receive investigation. It was only after the accumulation of negative evidence on the bacteriological side that it was deemed advisable to investigate the poisonous plant theory.

A Definite Phytogeographical Region.

In the earlier stages of the investigation it was considered desirable to treat as suspects only such plants as were restricted to the area to which the disease was then supposed to be restricted. This involved a careful comparative study of the flora of the gal-lamziekte area with that of adjacent areas in which the disease was not known to occur. This has been made; the results cover too much detail to be included in the present report, but will be published later. It will suffice to state here that the gal-lamziekte area of Bechuanaland is found to have a peculiar flora of its own, which synchronizes with the northern Lamziekte area, and which I have here called the Southern Bechuanaland region.

This flora is characterized by the dominance of the following (among other) plants:—

Trees and shrubs—

Blaauwbosch (*Royena pallens*).
Kameeldoorn (*Acacia giraffæ*).
Terraschibosch (*Acacia stolonifera*).
Vaalbosch (*Tarchonanthus camphoratus*).
Zuur-karree (*Rhus ciliata*).
Rozijntjebosch (*Grewia cana*).

Grasses—

Besomgrass (*Eragrostis betschuanus*).
Woolgrass (*Anthephora pubescens*).
Creeping carrot-seed (*Tragus koelerioides*).
Sand-quick (*Schmidtia bulbosa*).
Holub's Panic-grass (*Panicum Holubii*).
Kalk-grass (*Fingerhuthia africana*).

Other herbaceous plants—

Urginea Burkei.
Crotalaria burkeana.
Crotalaria virgultalis.
Gazania longifolia.
Lycium oxycladum.
Lycium tenue var. *Sieberi.*
Commelina karooica.
Hermannia brachypetala, etc.

In defining the Southern Bechuanaland region as a distinct phytogeographical area, I have not ignored the fact that some of the characteristic plants extend their range part way into the other regions. On the other hand many of the species are endemic to this region, and many others appear to have their centre of distribution here.

Though many of the species met with in the Southern Bechuanaland region are also found elsewhere, the flora, as a whole, is quite distinct from that of the phytogeographical regions which surround it, viz., the *Bushveld* of the Limpopo basin region to the north, the *Tsama veld* of the Kalahari to the west, the *Composite Karroo* to the

south, and the *High grassveld* of the central and eastern Transvaal and Orange Free State to the east. Its general aspect may be described by the phrase *Bush Grassveld.*

Investigations at the Coast.

When it was found by Dr. Theiler that the disease known in Bechuanaland and the Western Transvaal as Gal-lamziekte was the same disease as the Lamziekte of the coastal belt of the Cape Province, which was known to have a flora distinct from that of southern Bechuanaland, it became necessary to investigate the flora of the coastal Lamziekte area. Although the latter is comparatively familiar, the relative abundance and local distribution of species are but little known.

This investigation enabled me to exclude a number of species which, though common to the two areas, do not occur on certain farms on which the disease occurs. This so reduced the number of plants common to the two areas, but not occurring outside those areas, that I could no longer confine attention to such species.

Possibility of the cause occurring also outside the Area.

Our first working hypothesis was based on the supposition that if some specific poisonous plant were the cause of the disease, such plant would be limited to the region in which Lamziekte occurred, otherwise it would be difficult to explain the restriction of the disease to a limited area.

But during the progress of the investigation fresh "outbreaks" occurred beyond the supposed limits of the disease; we also received reports of cases (none of which have, however, been verified) in the eastern parts of the Transvaal and Orange Free State and on the uplands of Natal; these facts led us to the theory that the plant might be widely distributed, but that it only became poisonous under certain climatic and telluric conditions. The pronounced increase in the number of cases in seasons of drought harmonises with this view; investigations conducted in other parts of the world into the genesis of toxines, under certain conditions, in plants which are normally innocuous, emphasized this possibility.

We must not, therefore, exclude from consideration plants which occur outside of the known Lamziekte area; it may easily be a fact that a plant which is innocuous in the Eastern Free State may become poisonous in the Boshof District under different climatic and telluric conditions.

May be due to more than one Plant.

In view of the now known fact that the same poison may be developed in several species of plants, under similar conditions, the view is no longer tenable that a plant must be excluded as a possible factor because it is found in only one of the two or more regions in which the disease occurs.

These several factors have made it necessary to study a much larger number of species than was originally anticipated.

For a while we were side-tracked by the fact that Lamziekte had been known for years on a certain farm, or a portion of a farm, while no cases occurred on an adjacent farm or in a certain camp

separated only by a wire fence. Careful comparative studies were therefore made of the "infected" and "clean" areas in a number of cases; this necessarily involved an enormous amount of work and took a great deal of time. As a result, I was unable to find any one factor common to all Lamziekte farms or camps, which was at the same time absent from the areas supposed to be clean. Moreover, with the continuance of the "drought" and the increase of cases of the disease most of the areas formerly considered healthy became "infected." We are impelled to the conclusion that within the Lamziekte region proper there is no farm which is really safe.

Lack of Unanimity of Opinion as to Cause.

I invited the assistance of farmers by sending information and specimens from known Lamziekte spots. Hundreds of letters have been received and scores of specimens; the information, other than that relating to specific plants has been handed over to Dr. Theiler for incorporation in his report.

It is significant that in spite of all the material sent in as suspicious, there has been no unanimity of opinion as to the cause of the disease. In the case of the Stijfziekte bosje, Vomeer-bosje, Tulp, Slang-kop, etc., these plants were known to the veeboer or schaapboer as the cause of the troubles they produce, long before any scientific investigation of their properties had been made. There was general unanimity of opinion in these cases, but it is not so with Lamziekte.

Feeding Tests.

Feeding experiments have been carried out at Schoonheid, Smitskraal, Armoed's Vlakte, Bester's Put, Grahamstown, Skinner's Court, and Onderstepoort, with the various suspected plants sent in by correspondents or found by the writer.

The following sixty-one plants have been tested by feeding or drenching; some of them have produced illness and some death, but none has produced Lamziekte:—

1. *Asclepias fruticosa* Linn. (Asclepiadaceæ).
2. *Cassia mimosoides* Linn. (Leguminosæ).
3. *Cassia obovata* Collad. (Leguminosæ).
4. *Chrysocoma tenuifolia* Berg. (Compositæ).
5. *Cissus* sp. (Vitaceæ).
6. *Cleome rubella* Burch. (Capparidaceæ).
7. *Clematis brachiata* Thunb. (Ranunculaceæ).
8. *Commelina karooica* C. B. Cl. (Commelinaceæ).
9. *Convolvulus ornatus* Engl. (Convolvulaceæ).
10. *Crotalaria burkeana* Benth. (Leguminosæ).
11. *Crotalaria capensis* Jacq. (Leguminosæ).
12. *Crotalaria virgultalis* Burch. (Leguminosæ).
13. *Dimorphotheca Zeyheri* Sond. (Compositæ).
14. *Elephantorrhiza Burchellii* Benth. (Leguminosæ).
15. *Euphorbia sanguinea* Hochst. (Euphorbiaceæ).
16. *Geigeria passerinoides* Harv. (Compositæ).
17. *Giesekia pharnaceoides* Linn. (Phytolaccaceæ).
18. *Grewia cana* Sond. (Tiliaceæ).
19. *Hæmanthus* sp. (Amaryllidaceæ).

20. *Hermannia brachypetala* Harv. (Sterculiaceæ).
21. *Homeria pallida* Baker. (Iridaceæ).
22. *Indigofera cryptantha* Benth. (Leguminosæ).
23. *Indigofera arrecta* Benth. (Leguminosæ).
24. *Lessertia tenuifolia* E. Mey. (Leguminosæ).
25. *Liliacea* (S78) (Liliaceæ).
26. *Limeum viscosum* Fenzl. (Phytolaccaceæ).
27. *Moraea polyanthos* Thunb. (Iridaceæ).
28. *Pentarrhinum insipidum* E. Mey. (Asclepiadaceæ).
29. *Pollichia campestris* Ait. (Caryophyllaceæ).
30. *Raphionacme* sp. (H.7117) (Asclepiadaceæ).
31. *Rhynchosia nervosa* Benth. (Leguminosæ).
32. *Rhynchosia Totta* DC. (Leguminosæ).
33. *Salvia stenophylla* Burch. (Labiatæ).
34. *Scilla lanceæfolia* Baker. (Liliaceæ).
35. *Solanum incanum* Linn. (Solanaceæ).
36. *Solanum supinum* Dunal (Solanaceæ).
37. *Tarchonanthus camphoratus* Linn. (Compositæ).
38. *Tephrosia capensis* Pers. (Leguminosæ).
39. *Thesium* sp. (S.208) (Santalaceæ).
40. *Urginea Burkei* Baker. (Liliaceæ).
41. *Vernonia Kraussii* Sch. Bip. (Compositæ).
42. *Walafrida densiflora* Rolfe. (Scrophulariaceæ).
43. *Ornithoglossum glaucum* Salisb. (Liliaceæ).
44. *Osteospermum muricatum* E. Mey. (Compositæ).
45. *Geigeria betschuana* Burtt-Davy. (Compositæ).
46. *Scirpus nodosus* Rottb. (Cyperaceæ).
47. *Cyperus marginatus* Thunb. (Cyperaceæ).
48. *Ipomœa argyrioides* Chois. (Convolvulaceæ).
49. *Listia heterophylla* E. Mey. (Leguminosæ).
50. *Cotyledon orbiculata* Linn. (Crassulaceæ).
51. *Cotyledon orbiculata* var. (Crassulaceæ).
52. *Kalanchoe thyrsiflora* Harv. (Crassulaceæ).
53. *Ranunculus pinnatus* Poir. (Ranunculaceæ).
54. Fungus on *Ornithoglossum glaucum* Salisb.
55. *Crassula turrita.* (Crassulaceæ).
56. Pumpkin pips.
57. *Senecio bupleuroides* DC. (Compositæ).
58. *Senecio serra* Sond. (Compositæ).
59. *Dichapetalum cymosum* (Hook.) Engl. (Dichapetalaceæ).
60. *Orthanthera jasminiflora* N.E. Br. (Asclepiadaceæ).
61. *Arctotis stœchadifolia* Berg. (Compositæ).

In addition to the above feeding tests were started with the following but were temporarily discontinued because the animals were falling off in condition too rapidly:—

62. *Anthephora pubescens.*
63. *Aristida uniplumis.*
64. *Cymbopogon excavatus.*
65. *Digitaria eriantha.*
66. *Themeda Forskalii* var. *Burchellii.*

Parasitic and Saprophytic Fungi.

Various species of fungi, parasitic or saprophytic on other plants, are known to be poisonous when taken in sufficient quantity, e.g. the poisonous properties of darnel were found by Freeman to be due to the existence of a mycelium in the seed-coats of the grass. Certain moulds, such as *Aspergillus*, have a poisonous action, and are found to contain enzymes and toxic bodies. The toxins of fungi are similar in character to the poisonous toxalbumens of the bacteria and of the higher plants, and the venenenes of snakes, and their poisonous actions in the paralysis of the nerve ends are found to be essentially the same. Certain features of Lamziekte suggested that the cause might be found among the fungi, and very careful search was made for anything of this nature.

It was found, however, that as compared with the more humid parts of South Africa, such fungi are extremely scarce in the Southern Bechuanaland Region. A few were found, such as *Ustilago cynodontis*, *Phyllachora graminis* (?), *Phyllachora cynodontis*, *Melampsora mixta*, and *Hyponectria* sp. nov. (all identified by Mr. Pole Evans), but they were in such small quantities, were so widely separated, and were absent from so many farms where Lamziekte occurs, that we cannot consider them to be in any way connected with the disease. Moreover, these fungi are least abundant in very dry seasons, which are the periods when the disease is most prevalent.

A Myxomycete (*Physarum cinereum*), was sent as a suspect by a farmer near Leeuwdoorns, and I subsequently found a small patch of it at Kaffraria, but its occurrence seems to be much too infrequent to have any connection with the disease.

2. The Cumulative Plant Poison Theory.

Certain peculiarities of Lamziekte suggest the idea that the poison may not be sufficiently plentiful in a limited quantity of the plant-material to produce the disease, but that it accumulates in the animal system until sufficient has been acquired to produce the characteristic symptoms; in short, that it is a cumulative poison. If this hypothesis be correct it might account for some of the negative results obtained where only small quantities of certain plants were fed; we have tried to meet this contingency by feeding as nearly as possible up to 100 lb. of material of the various suspected plants. It would also account, in part, for the beneficial effect of the frequent movement of animals from one farm to another, by causing a temporary check in the accumulation of the poison. Also, perhaps, for the fact that animals which get the disease and recover are usually the first to get it again next season by the addition of poison to that already accumulated in the system.

3. The Wilted Grass Theory.

Certain farmers in the Southern Bechuanaland Region have expressed the firm opinion that Lamziekte is due to eating wilted grass. This idea seems to have originated among the Batlapings, some of whom associate the disease with the fine quick grass (*Cynodon incompletus*). Many farmers have observed that cases are most numerous

shortly after rain which has been sufficient to cause a new growth of grass but not sufficient to keep it growing; Lamziekte cases become numerous as soon as this grass begins to wilt away.

At first sight this theory seems entirely untenable. Wilted grass is found all over South Africa; but Lamziekte is limited in its distribution; and we have evidence that it occurs when the grass is not wilted, *i.e.* when it is green and vigorous and at its best, and also when it is dormant.

This theory does not explain all the known facts of the case.

4. The Toxine Genesis Theory.

The plants which cause plant poisoning are of two sorts, those which are characterized by the normal presence of some toxic substance, and those which are normally innocuous but which, under certain conditions, develop a definite toxine.

Of the latter an increasing number have been brought to notice in recent years, including plants belonging to several distinct families. Among them may be mentioned dhourra and kaffir corn (*Sorghum vulgare*) and sweet sorghum (*Sorghum saccharatum*) of the Gramineæ; the lima bean (*Phaseolus lunatus*) and khuther (*Lotus arabicus*) of the Leguminosæ; the almond (*Prunus Amygdalus*) of the Rosaceæ and *Pangium edule* of the Flacourtiaceæ.

In these particular cases the toxic substance is hydrocyanic (or "prussic") acid. In several cases which have been investigated it has been found that this substance does not exist as such in the plant, but that it occurs in some state of combination such as a cyanogenetic glucoside which, owing to the simultaneous occurrence in the cells of the plant of a hydrolitic enzyme, undergoes hydrolysis (under favourable conditions), producing hydrocyanic acid as one of the products of hydrolysis.*

Prussic acid may be produced by all parts of the plant; the khuther plant is most poisonous in the earlier stages of growth, especially just before the ripening of the seeds; the mature plant and the seeds are innocuous. In the case of *Sorghum vulgare* the amount of cyanogenetic glucoside contained in the stem and leaves increases until the seeds are ripe, after which it rapidly diminishes until the glucoside finally disappears. In the case of *Phaseolus lunatus*, however, the glucoside is most plentiful in the ripe seed itself.

Mr. Brunnich, chemist to the Department of Agriculture, Brisbane, Queensland, finds that cultivation of *Sorghum saccharatum* on land heavily manured with *sodium nitrate* leads to an increased production of the cyanogenetic glucoside in the stem and leaves.

The poisonous action of hydrocyanic acid is well known, and the symptoms are different from those of Lamziekte. But the fact that a poison may be generated in a plant which is normally innocuous is highly suggestive. There appears to be nothing against the theory that under certain climatic and telluric conditions a toxic substance may be developed in certain plants, which produces the disease Lamziekte.

---

* Dunstan and Henry, Cyanogenesis in Plants, Part III; in Proc. Roy. Soc. vol. 72, pp 286-294.

Such a poison may be developed in one of the native grasses of the region, and in more than one species of grass. And it may also be found in some other plant, such as a legume.

Sorghum Poisoning.

In the case of sorghum poisoning due to cyanogenesis, it has been found that after periods of extreme drought, or when growth is stunted from other causes, the leaves of the sorghum plants often contain a large amount of prussic acid, whereas plants of normal growth seldom contain prussic acid in appreciable quantities; it largely disappears in the process of curing, so that cured sorghum may be fed with little danger (Warburton). But frosted sorghum is said to be especially injurious.

Deaths in cattle frequently occur when, on account of the failure of rain, the sorghum plants which have reached a certain size become stunted and withered. The toxic principle appears simultaneously over a wide area, but soon disappears if a rainfall occurs (Crawford).

Pammel states that it appears more than probable that the sorghum plant under different climatic conditions and different conditions of growth may produce varying amounts of prussic acid.

Kaffir Corn Poisoning.

Kaffir corn also contains a cyanogenetic glucoside and becomes poisonous under certain conditions. In Australia it is believed that this plant becomes more poisonous when attacked by an insect during a drought. A similar observation has been made with dhurra in the Sudan (Crawford).

In some cases, at any rate, the development of poisonous properties in plants which are normally innocuous only occurs under special conditions which are, as a rule, somewhat abnormal for that particular plant. An illustration may be taken from the common mustard.

Mustard Poisoning.

The seed of the mustard plant contains a valuable oil, and after this oil has been expressed the residue, or "mustard-cake," is used for feeding stock. Under certain conditions this cake becomes poisonous,* so that it is found necessary to feed it with discretion and only in small quantities until the animal becomes accustomed to it. The optimum temperature for the production of toxic substances in mustard cake is about 37° C. (93.6° F.). The enzyme may be destroyed by treating the cake with boiling water.

The American Cornstalk Disease.

In the central maize districts of the United States many farmers continue to follow the old practice of picking by hand the ears from the standing stalks and turning the cattle into the stalk fields to gather the stray ears left by the huskers, and to eat what they like of the maize leaves and stalks and the weeds found among them.

* This is the more remarkable because the mustard plant belongs to the Cruciferæ, a family which is considered destitute of toxic properties under normal conditions.

"Not infrequently, within a day or two after turning the cattle into the fields, they suddenly sicken and die. Thousands of cattle are lost each year in this way, and the subject has attracted much attention and elicited several theories as to the cause."† This disease is commonly known as "cornstalk disease." Moore concludes that "the disease is probably due to some poisonous principle in the dried cornstalk or its leaves."‡

Moore (*loc. cit.*) points out that animals which are fed with shocked maize, or maize stover, do not get corn-stalk disease.

A correspondent in the south-western Transvaal, Mr. Fred. H. Robinson, writes as follows:—

"I have been reading with much interest yours and Dr. Theiler's investigation into the cattle disease, Lamziekte.

"About ten or twelve years ago, while I was cattle ranching in North-Western Nebraska, U.S.A., there was an exceptionally dry year and thousands of cattle were lost in the cornfields of Western Nebraska.

"For a long time the investigation of a very large staff, both of the United States, and State Departments, proved fruitless; at last they found that on account of the very dry season the corn stalks carried a very large per cent. of prussic acid (I am not positive if I am correct in the poison), but it had much the same effect that kaffir corn fodder has when grown in a dry country. The Nebraska State Department, also the U.S.A. Department, issued very extensive pamphlets on the subject. The symptoms of death were very like lamziekte.

"I did not have cases of it myself, for I was ranching in a sandy country with water near the surface, with the result that we had plenty of green grass. I am getting along very well with our irrigation scheme and hope in a few years to prove that the absence of green food for so many months out of the year is one of the chief causes of a great many of the stock diseases in the Western Transvaal."

Brimhall (1902) considered that so-called cornstalk disease is, in a large percentage of cases, to be included under *hemorrhagic septicaemia*, which he traces to *Bacillus booisepticus*. See Exp. Sta. Rec. xiv., 201 (1902-3); xvi., 603-4 (1904-5); Report of the Vet. Dept. of the Minn. State Bd. of Health, 1903, St. Paul, 1903.

Price (1904) reported the presence of an enzym in cornstalks from a field where cattle had died of cornstalk disease; this peroxydase had the properties of catalase; it lost its power of splitting up glucosides when subjected to a temperature of 78° C. The proteolytic enzyme was broken up at 68° C. The cornstalk enzyme appeared to have the same resisting power toward heat as that obtained from bitter almonds. Negative results were obtained from attempts to find either prussic acid or a glucoside which might break up into prussic acid. Although not conclusive, Price believes that his investigations indicate the presence of an enzyme in maize stalks which may give rise to the formation of prussic acid by the splitting up of glucosides, and that this

† U.S.D.A. Bur An. Ind. Bull. 10. See also Bull. 58 Kansas Station.
‡ Henry: Feeds and Feeding p. 175.

would account for a certain percentage, at least, of the cases of cornstalk disease. See U.S.D.A. Bur. Anim. Ind. Rep. 1904, pp. 66-75, E.S.R. xviii., 676-7, 1906-0.

Craig (1906) notes that a disease referred to by this name appeared quite extensively in Indiana during 1902 and 1906. After summarizing the theories held by different observers he concludes that there are probably several diseases referred to under the same name. While the symptoms resemble those of toxic poisoning, it is by no means certain that potassium nitrate in the maize is the cause of the trouble. He suggests that prussic acid may at times be developed in the corn. See Indiana Sta. Circ. 3, pp. 10, 1906, and E.S.R. xviii., 676-7, 1906-07.

Alway and *Trumbull* (1909) report failure to find even a trace of prussic acid in cornstalks or suckers from a field in which several cattle had just died, though subjected to a thorough test. Feeding tests to calves gave negative results. Similar tests with sorghum confirmed Brunnich's findings of prussic acid (E.S.R. 15, p. 355) so that the negative results with maize appear not to be due to any fault in the method adopted.

Further information on the cornstalk disease may be found in the following publications:—

Price, T. M.: Enzymes in Cornstalks and their Relation to Cornstalk Disease. U.S.D.A. Bur. Anim. Ind., Circular 84, 75; Rep., 1904, pp. 66-75; E.S.R., xvii., 702.

Craig, R. A.: Cornstalk Disease. Purdue Univ. Agr. Exp. Sta. Cir. 3, 10.

Craig, R. A.: Silage Poisoning. Purd. Univ. Agr. Exp. Sta. Suppl. to Bull. 147, 628.

Alway, F. J., and *Peters, A. T.*—Losses from Cornstalk Disease in Custer Co., Nebraska, during the winter of 1906-07. Nebraska Agr. Exp. Sta. Press Bull., 27, 4.

Billings, F. S.: Corn Fodder Disease Investigations, Nebraska Sta. Buls., 7, 8, 9, 10, and 22 and 23 (1892); E.S.R., vol. 4, p. 843.

Peters, A. T. and *Avery, S.*—Nebraska Sta. Rep. for 1902, pp. 63 and 94, E.S.R. 15, p. 514.

Peters, A. T.—Cornstalk Disease of Cattle, Nebraska Board, 52, January, 1898, E.S.R. 10, p. 494.

Mayo, N. S.—Cornstalk Disease of Cattle. Kansas Bul. 58, June, 1896, E.S.R., vol 8, 522.

Notes on Suspected Plants.*

Acacia stolonifera Burch. (Leguminosæ).—"Terraschi-bosch"; leaves received which had been taken from the pharynx of an ox which died of lamziekte. A common and characteristic bush of the Bechuanaland region, but absent from many farms where lamziekte occurs.

Argyrolobium uniflorum Harv. (Leguminosæ).—From J. A. Whiting, Annarth, Ixopo, Natal; supposed to have caused lamziekte; We have not yet been able to obtain sufficient material for a feeding test. This plant is also found in the Albany Division.

* These plants have been reported as suspects, but in a few cases the supposed poisonous property is not necessarily associated with lamziekte.

Asclepias fruticosa Linn. (Asclepiadaceæ).—Melkbosch, milkweed, wild cotton, wilde-kapok. One of the suspected plants on Mr. A. S. Pringle's farm. An exotic weed widely distributed in the Bechuanaland region, and spreading. One beast was killed by feeding this plant; it acts as a purgative, but the symptoms produced are not those of lamziekte.

Bouchea pinnatifida Schauer (Verbenaceæ) (H6800).—Received from Mr. Burnet Wilson, Hamburg, Geluk, from a "particularly poisonous spot" on his farm. A not uncommon and characteristic plant of the Bechuanaland region.

Buphane toxicaria Thunb. (Amaryllidaceæ).—Reported as poisonous. Widely distributed outside the Lamziekte area.

Cassia mimosoides Linn. (Leguminosæ).—Sent by Mr. D. J. E. Erasmus, Grootfontein, Pretoria District, as one of the causes of stiff-sickness. A feeding test gave negative results. A widely distributed species, common in the Pretoria District, less plentiful in Bechuanaland.

Cassia obovata Collad. (Leguminosæ).—A common and characteristic species of the Bechuanaland region, where it is known as "zwart-storm"; the root is used medicinally. Feeding tests proved that it possesses laxative properties, as might be expected, but no symptoms of lamziekte were produced.

Chenopodium anthelminticum Linn. (Chenopodiaceæ).—From Mr. C. G. Dennison, Vryburg, 14th June, 1911 (H.6535). "This herb is known here as the gall-ziek bosje, and is supposed to be a remedy for gall-sick. I have not tried it so do not know." Not likely to be poisonous; properties tonic and anthelmintic; a strong-smelling weed, often sent to us under the name "galziekte bosch," and considered by many farmers to be a cure for galziekte.

Chrysocoma tenuifolia Berg. (Compositæ).—A "Bitter Karroo"; common in the Composite Karroo Region, and also in parts of the Bechuanaland Region, where it appears to be spreading. Feeding tests gave negative results.

Cissus sp. (Vitaceæ).—Frequently met with in the Bechuanaland Region; drenched at Armoed's Vlakte; results negative.

Cleome rubella Burch. (Capparidaceæ).—From Mr. C. G. Dennison, Vryburg, 14th June, 1911 (H.6537), under the name "Wild Bosganna." Mr. Dennison states that it was "given me by a farmer near Genesa, whose ploughed lands had a quantity of the herb growing. This farmer stated that whenever his cattle grazed in these lands gall-lamziekte was the result, and that he had reason to believe it was caused by eating this herb." Not likely to be poisonous. Feeding tests at Onderstepoort gave negative results.

Cleome rubella has rather small, purplish pink flowers with long stamens, leaves divided into 5-7 narrow leaflets, and very narrow pods about an inch long; the whole plant is more or less covered with a glandular pubescence.

Cleome rupestris. Sond. (Capparidaceæ).—From Mr. D. J. Odendaal, Viljoenshof, P.O. Bultfontein, Orange Free State, through the Principal Veterinary Surgeon, Bloemfontein, with the statement that it is alleged to be the cause of lamziekte. Not likely to be poisonous.

Clematis brachiata Thunb. (Ranunculaceæ).—Not uncommon, climbing over bushes, and occasionally browsed; an acrid plant. Drenched at Armoed's Vlakte; results negative.

Cluytia ? (Euphorbiaceæ).—Material incomplete and unfit for identification, consisting of leaves from the rumen of a cow which died at Smitskraal in the paralytic stage of lamziekte.

Commelina karooica C.B. Cl. (Commelinaceæ).—Characteristic of the Bechuanaland Region. At Armoed's Vlakte 91 lb. 11 oz. was given (by drenching) to two cows (Nos. 2106 and 2157), No. 2157 passed offensive faecal matter, but no symptoms of lamziekte were produced. Discontinued drenching 8th June, 1912, because no more of the plant could be found.

Convolvulus ornatus Engl. (Convolvulaceæ).—Mr. Van Aswegen, Ganspan, Border Siding, per Mr. Sargent, of Vryburg. Mr. Van Aswegen states that when on Ganspan there was one part of the farm with a lot of this bush, and that whenever cattle went there they got sick. Drenching tests at Armoed's Vlakte gave negative results.

Crotalaria spp. (Leguminosæ).—Various species of Crotalaria are suspected of causing stiffness and *C. burkeana* has been proved to produce one of the forms of stijfziekte met with in the Transvaal and Bechuanaland. The following species occur in South Africa:—

Crotalaria angustissima E. Mey.—Sandy hills near Ebenezer, Stellenbosch.

Crotalaria aspalathoides Lamk.—On the Grasberg River in the Onder Bokkeveld.

Crotalaria burkeana Benth.—From Mr. P. G. Oertel, Kameelfontein, Bloemhof (H.7098), and sent by other farmers as suspected of causing lamziekte. Feeding tests show that this plant produces one form of stijfziekte, but the symptoms are not those of lamziekte.

Crotalaria capensis Jacq.—Commonly met with on some lamziekte farms near Grahamstown. At Grahamstown three ostriches were each fed daily with two ounces of this plant for thirty-one days; results negative. Also fed to a young ox with negative results.

Crotalaria distans Benth.—Lay Spruit and Tal River.

Crotalaria Ecklonis Harv.—Clanwilliam Division, in rocky places near the Oliphants River.

Crotalaria effusa E. Mey.—Found on the sands near Krakeelskraal.

Crotalaria elongata Harv. is found in the Karroo.

Crotalaria globifera E. Mey.—Natal. There is a variety *glabra* Harv. with nearly glabrous leaflets, shorter petioles and smaller flowers, also found in Natal. Also a variety *brachycarpa* Harvey, found along the Magaliesberg, Transvaal.

Crotalaria grantiana Harv.—Near Durban.

Crotalaria humilis E. and Z.—Common near Capetown and Paarl. Also occurs on the Oliphants River, Clanwilliam Division.

Crotalaria lanceolata E. Mey.—Kaffraria and Natal.

Crotalaria lotoides Benth. is commonly met with on lamziekte farms in the south-western Transvaal and southern Bechuanaland; It also occurs near Grahamstown and Pretoria.

Crotalaria macrocarpa (E. Mey), occurs in marshy places in Kaffraria.

Crotalaria mollis E. Mey.—Found on dry hills and islands at the mouth of the Orange River.

Crotalaria natalitia Meisn. is a coast species from Natal.

Crotalaria obscura DC.—The coastal belt analogue of *C. burkeana*, to which it bears a close resemblance, differing chiefly in having only three leaflets and fewer flowers, which differ in colour. This species occurs in the Eastern Province and Kaffraria, from the Uitenhage and Albany Divisions eastward.

Crotalaria platysepala Harv. is found near Lake N'Gami.

Crotalaria purpurea Vent. is found in moist, sub-alpine places from Caledon to Uitenhage, near George, Genadendal and on the Zwarteberg.

Crotalaria sparsiflora E. Mey.—Occurs in the neighbourhood of Verleptpram, on the Orange River.

Crotalaria spartioides DC.—Found at the Rhenoster River, Orange Free State, and in Zululand.

Crotalaria sphœrocarpa Pers. var. *angustifolia* Hochst. (Syn. *C. nubica* Benth.).—From G. Pilditch, Davel, Ermelo District (H.6431), as a suspect.

Crotalaria striata DC.—Near Durban.

Crotalaria virgultalis Burch.—Common on certain farms in southern Bechuanaland where both gal-lamziekte and stijfziekte are very bad, and being related to *C. burkeana* has been suspected of causing one or other (if not both) diseases. It occurs as far west as Verleptpram on the Orange River.

Feeding tests conducted by Mr. Casewell, of Geluk, near Vryburg, under the direction of Government Veterinary Surgeon Elphick, were entirely negative; in fact the animals got fat on it. Mr. Burnet Wilson, of Geluk, writes under date 29th November, 1911:—"I do not for a moment think it is harmful, as on Mr. Potgieter's farm (next to this) there is a great quantity round his fountain, which his cattle are keeping short at the present time, and he is not losing cattle."

Aspalathus acuminata Lam. H.7241 (Leguminosæ).—From P. K. Albertyn, Zeekoe Vlei, Bredasdorp, 18th February, 1912. "A thorny bush, which experienced farmers—my overseer for instance—think causes lamziekte in stock. . . Arrangements have been made with Mr. Albertyn to collect and forward sufficient material for a feeding test.

H.7026 (Cucurbitaceæ).—From A. G. Rose, Kingsheath, Klipnek, Orange Free State, 4th January, 1912. This plant was found by Mr. Rose where he has had several deaths from what other farmers call lamziekte, but what he believes to be irritant poison.

Cymbopogon excavatus (Hochst.) Stapf. (Gramineæ).—One of the turpentine grasses; a "sour" grass, common in parts of the southern Bechuanaland region. Found in the pharynx of an ox that died of lamziekte. Feeding tests are not yet complete.

Cynanchum spp. (Asclepiadaceæ).—Several species occur in South Africa, and are generally believed to be poisonous, but need further investigation.

Cyphocarpa angustifolia Lopr. (Amarantaceæ).—Common in the Southern Bechuanaland Region. A case of poisoning has been reported from another part of the country, which has been attributed to a native medicine made from this plant and applied to sores.

Dichilus gracilis E. & Z. (Leguminosæ).—Mr. V. de Villiers, Matjes Kloof, Beaufort West, reported as follows, in January, 1912:—"It grows on my farm, and wherever it is found I can't let small stock graze. I lost eight sheep to-day through eating this bush, and during the year I have lost many from the same cause. . . . I may add that this farm is situated in the Nieuweveld Mountains, and I'm told that some years ago the previous owner lost stock from lamziekte." More material is required for feeding test.

Dimorphotheca Zeyheri Sond. (Compositæ).—"Bietouw." Common in parts of the Composite-Karroo of the north-western Orange Free State; said to be deadly to sheep, but not known to affect cattle. Feeding tests with partially dried material have given negative results. A recent consignment from Springfontein smelt faintly of hydrocyanic acid. Recently collected near Leeuwdoorns and Christiana, Transvaal.

Dimorphotheca nudicaulis DC. was also "presumed to be poisonous," according to the late Professor MacOwan.

Doria eriocarpa DC. (Compositæ).—"The plant is scarce and grows on the rocky parts of infected farms near, and is suspected by the Fingo natives of causing Lamziekte."

Elephantorrhiza Burchellii Benth. (Leguminosæ).—Sent as a suspect by several farmers.—Feeding tests at Armoed's Vlakte; results negative.

Emex australis Steinh. (Polygonaceæ).—Duiveltje Doorn. Believed by Cape Province farmers to be the cause of geeldikkop in sheep, when in a certain withered condition. See Journ. Comp. Anat. and Therap. xix, Pt. 1, pp. 5-8, Mch. 1906.

Epichloe (*typhina Tul.?*) Hypocreaceae).—Sometimes plentiful on grasses. Checks the growth of grass, and when in quantity does considerable injury. Prillieux states that grass containing much of this fungus is injurious to horses.

Eragrostis lehmanniana Nees (Gramineæ).—Scraps of what appear to be this grass have been obtained from the pharynx of an ox that died of lamziekte.

Euphorbia sanguinea Hochst. (Euphorbiaceæ).—Sent by Mr. Burnet Wilson, Hamburg, Geluk, near Vryburg, as a suspect, "growing in a particularly poisonous spot on this farm." (H.6801.)

Geigeria passerinoides Harv. (Cospositæ).—Vomeer bosje. Suspected of causing vomiting sickness in sheep, by Mr. C. S. Schikkerling, Trifaldi, Fauresmith District, Orange Free State. Suggested by several farmers as a possible cause of lamziekte in cattle. Drenching of cattle at Armoed's Vlakte produced vomiting, without the characteristic symptoms of lamziekte, and has been discontinued.

Mr. A. J. Polley, Ganna Vlakte, Windsorton Road, wrote in April last:—"Lately we have had splendid rains, the veld is in good condition. I notice that a lot of the Vomeer bush is growing, mostly in the hilly parts of the farm among the Vaal bush and thorn trees. I do not see any in the flats, which is mostly all ganna-bosch, and my

cattle mostly graze in the hills. For the last four years we have had but little rain, and I have not seen any of the Vomeer bosje during that time, and I had no lamziekte during the four years; yesterday one of my cows got lamziekte in a very bad form."

Giesekia pharnaceoides Linn. (Phytolaccaceæ).—Common in the Southern Bechuanaland Region. Many plants of this family are supposed to be poisonous. Cattle were grazed for some time on a patch of this plant at Bester's Put, and others were drenched with it, with negative results.

Grewia cana Sond. (Tiliaceæ).—One of the common and characteristic bushes of the Southern Bechuanaland Region; much browsed in the latter part of summer and early spring when green grass is scarce. The leaves have frequently been found in the rumen or pharynx of beasts which have died of lamziekte. Drenched at Armoed's Vlakte with negative results. Called Rozijntjie-bosch.

Harpagophytum procumbens D.C. (Pedaliaceæ).—Grapple Plant; Klaauwdoorns. Common in the sand-veld of the Southern Bechuanaland Region. The plant has a tuberous root, buried at some distance beneath the surface (see plate 30). The ripe fruits, called Klaauwdoorns, or grapple-thorns (see plate 29), are commonly met with lying about on the veld, and not infrequently get into the mouths of stock; when firmly hooked between the jaws, the animal finds it impossible to get rid of the obstruction, which in some cases has been known to cause fatal starvation. The specimen photographed was taken from the mouth of an ox which was starving for want of food and water, being quite unable to eat or drink owing to the obstruction.

Hæmanthus sp. (Amaryllidaceæ).—Material incomplete for determination. Drenching at Armoed's Vlakte gave negative results.

Haplocarpha lyrata Harv. (Compositæ).—Called Bietow in Kaffraria (Sim). Supposed to be poisonous.

Hermannia brachypetala Harv. (Sterculiaceæ).—Sent by J. Dalrymple, Sterkfontein Farm, P.O. Quaggashoek, Orange Free State, 2nd February, 1912 (H.7075). He states that it is the only green thing to be seen on his farm, and that removal of cattle away from that part of the land on which it is prevalent seems to stop lamziekte. In this connection it should be borne in mind that any movement of cattle has a tendency to check the disease. A common and characteristic plant of the Southern Bechuanaland Region. I have rarely seen it with signs of having been eaten by stock. Drenching tests at Armoed's Vlakte gave negative results.

Heteropogon contortus R. and S. (Gramineæ).—The sharp callus of the achene irritates the skin, which is inimical to the health and best development of the stock. A farmer near Douglas reported that it is the cause of Lamziekte, and also that he had noticed that where this grass grows the cattle suffer more from the disease than on bush veld (*i.e.*, Karroo veld).

Homeria pallida Baker (Iridaceæ).—Yellow tulp. One of the most common and characteristic plants of large areas of sandy soil in the Southern Bechuanaland Region; extends eastward to the Natal border. Very poisonous to stock when eaten, but usually avoided by animals brought up among it. The symptoms produced are not those of lamziekte.