

was tall and the veld overgrown.

From the above it may be concluded, that drought or scarcity of vegetation to some extent at least influence the number of outbreaks of rabies that are recorded. This would not necessarily mean, that epizootics occur during such periods. The larger number of outbreaks recorded during such periods, is probably due to the fact that meercats traverse larger areas searching for food, and when they become rabid they are easily seen, or the scanty vegetation allows such animals to wander further afield than when the grass is high and tall. It is therefore concluded that the increase in the incidence rate of rabies during such periods is only apparent and does not constitute an actual increase in the number of cases that occur normally.

(6) Epizootics in Rabies.

In view of the above can these be called epizootics.

Graph 1 indicates that the outbreaks of rabies occur in waves or epizootics. Three such epizootics are evident, viz. one during the period May 1932 to August 1933; the second from August 1935 to September 1936 and the last one during the period November 1937 to December 1938.

The First Epizootic.

The whole of the period during which this epizootic occurred coincided with a period of a severe drought when vegetation was very scanty. The climax was reached during the last three months of the period, when it terminated very suddenly.

The Second Epizootic.

In contrast to the former outbreak, there is a gradual rise in the curve until a peak is reached, but although there is a sudden drop from the peak, the curve is still regular until the final peak is reached, when there is again the sudden drop. This epizootic coincided with a comparatively wet period, when the rainfall was from 14 to 20 per cent more

than the average, resulting in abundance of vegetation and food for all three varieties of meercats.

The Third Epizootic.

Although there is some fluctuation in the initial stage, yet there is a gradual rise in the curve which, in contrast to the two former, shows a sharp but welldefined termination. The epizootic started after a summer marked with copious rains in the first part of the season, but which ended with a fall below the average and continued through an exceedingly dry summer.

In all three instances the epizootic terminated prior to any rains having fallen, which clearly indicates, that the termination in each case can not be described to drowning of the meercats, or overgrown vegetation obscuring rabid animals.

If all three cases are regarded as definite epizootics then they are very wide spread over the whole of the infected areas of the Union, occurring in each instance over the Western O.F.S., Western Transvaal and the Eastern portion of Bechuanaland.

Owing to the widely distributed nature of the epizootics occurring over such a large area at the same time it is difficult to conceive that they can be regarded as true epizootics, in the light that the disease started from one centre and swept over the country like the outbreak of rabies that occurred at Port Elizabeth in 1893. The epizootics must rather be regarded in the light of some factor or factors common to the whole of the area causing a "flare up" of the disease in the various centres of infection, where the disease was smouldering. NB

The fact that all three epizootics terminated equally suddenly may be regarded as proof that the common factor or factors ceased to act over the whole of the area affected (simultaneously).

Beyond speculation, it is impossible at this stage, with

our meagre knowledge, to state what factor or factors influenced these epizootics. It is only with intensive study of the life history and migratory habits of the vectors of rabies that knowledge concerning of the epizootology of the disease would be gained

(7) Incidence of Rabies in Domestic Animals.

Theiler (1934) stated that biological and histo-pathological investigations proved that the disease encountered in South Africa was identical with rabies of Europe.

It is peculiar, therefore, that the dog which plays the most important rôle in the epizootology of the disease in Europe, ^{apparently} should only play a secondary rôle in this country. Of the twenty-one cases in dogs, only two can be accounted for by the bites of rabid dogs, and thrice only did it cause rabies in other animals. See Table VI (a)

Several explanations have been suggested for this, amongst which the following may be regarded as contributory factors.

(1) The dog population in this country is comparatively small especially in the Orange Free State, owing to the heavy tax of ten shillings per head and the severity with which the tax is imposed. During the later half of each financial year, all policemen in the Province have a standing order, by Administrator's Ordinance, to destroy on sight any taxable dogs without the necessary dog licence. Further the whole of the rabies infected area falls within the sheep farming area of the country. Farmers here are loathe to keep too many dogs and natives are practically forbidden to keep dogs, owing to the fear of marauding dogs chasing and killing sheep. Sheep-owners are continually on the look out for dogs trespassing on their properties and any dog straying in the veld is shot and nothing said about it.

In one instance the author was told by a farmer, that

in six months he had destroyed fourteen dogs trespassing on his property.

In all four the Provinces of the Union the Ordinances relating to the keeping of dogs and the dog-tax authorize the owner or occupier of any land on which stock is kept to destroy any dog found trespassing thereon and not being under the control or custody of any person.

(ii) The general fear of mad dogs, will cause the majority of owners to destroy their pets on the slightest suspicion of madness. Such drastic steps are taken easily as the majority of dogs have very little more than sentimental value, and another mongrel is easily obtained to replace the one that has been destroyed.

It is realised, that in view of rabies having spread in dogs to a considerable extent on a previous occasion in South Africa (Port Elizabeth 1893) that the peculiarity of the disease is not entirely due to the above, but that the explanations given must only be regarded as probable contributory factors, and that the peculiarity is similar in nature to that of rabies in the vampire bat of Trinidad and certain South American states, and "Oulou-fato" of French West Africa and the Congo.

(iii) As regards the rôle the other domestic animals play, very little need be said, except that the rabid ox is always a potential source of danger to human beings. The practice in this country amongst farmers to diagnose any obscure disease as gallsickness and to dose such animals by pulling out the tongue exposes many to the dangers of rabies. In nearly all cases where the animal affected was a bovine, preventive inoculation had to be resorted to, and in one case as many as twenty natives had to be treated. There is, one fatal case in a farmer ascribed to this practice, see Olievenbos, Brandfort district in Table I.

THE VECTORS OF RABIES IN SOUTH AFRICA.

Du Toit (1936) summarizes the outbreaks of rabies in the Union according to the species of animals, in which the disease had been diagnosed.

In 1937 the author in a discussion on the epizootology of rabies in South Africa pointed out that taking into account the many outbreaks of rabies in cattle associated with a history of a mad mongoose, and the number of human cases in which the vector is definitely known to be Cynictis, together with the number of cases of rabies diagnosed in the Cynictis itself, then it is obvious that this specious of animal is by far the most important carrier.

Table VI gives a summary of the incidence of rabies in the various species of animals in which it has been diagnosed by laboratory methods. Some 20 cases in humans and 24 in animals have been added in which a laboratory examination was not made, but the history and clinical symptoms were such that rabies could not be excluded. These cases are bracketed in each instance. During 1937 the author dealt with 34 suspected outbreaks of rabies in the Orange Free State. In these 34 outbreaks material for laboratory examination was not available in ten instances owing to the animals concerned having been shot through the head or the material being too decomposed to be of any diagnostic value. Of the remaining 24 cases in which a clinical diagnosis of rabies was made, in two instances only was the diagnosis not confirmed. The inclusion of the cases of rabies, which were not confirmed in Table VI would therefore not materially affect the data.

Table VI.

for what purpose

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The Incidence of Rabies in the Various Species
of animals.

Species of animal	Province				Total
	O.F.S.	Bechu- analand	Cape	Trans- vaal	
Man	6+(11)	1+(1)	4+(2)	6+(6)	17+(20)
<u>Cynictis penicillata</u>	44+(6)	4	1+(3)	11+(3)	60+(20)
<u>Suricata suricatta</u>	1	-	2	-	3
<u>Myonax pulverulentus</u>	-	-	1	-	1
<u>Geneta felina</u>	1	6+(1)	1	-	8+(1)
<u>Felis spp.</u>	2	-	1	-	3
<u>Geosciurus capensis</u>	1	2	-	-	3
<u>Ictonyx orangiae</u>	1	-	-	-	1
<u>Cynalopex chama</u>	1	-	-	-	1
Dog	12+(2)	4	2	3	21+(2)
Cat	5+(2)	5	-	4	14+(2)
Cattle	23+(6)	6+(2)	-	18	47+(8)
Sheep	3	-	-	-	3
Pig	2	-	-	1+(1)	3+(1)
Equine	1	1	-	4	6
	103+(27)	29+(4)	12+(5)	42+(8)	191+(44)

Table VI(a).

X

The known Vectors implicated.

Species of animal	<i>Vectors</i>				
	of man	of dog	of cat	of cattle	of pig
<u>Cynictis penicillata</u>	21	3	-	5	
<u>Geneta felina</u>	3	1	1	-	
<u>Felis spp.</u>	2	-	-	-	
Dog	4	2	1	1	1
Cat	2	-	-	-	
Ox	1	-	-	-	
<u>Geosciurus capensis</u>	1	-	-	-	
Doubtful	3				
Total	37	6	2	6	1

(a) Wild Animals.

The wild animals which so far have been proved to carry and transmit rabies are the following in order of their relative importance:

1. Cynictis penicillata.
2. Genetta felina.
3. Felis ocreata and Felis negripes.
4. Suricata suricatta.
5. Geosciurus capensis.
6. Myonax pulverulentus.
7. Ictonyx orangiae.
8. Cynalopex chama.

In addition to the several species of animals named above, cases of rabies in the jackal and hyena have been reported from the neighbouring territories of Rhodesia and Angola. The other species of carnivora such as the other two species of jackal, the Cape Hunting Dog, the Aardwolf, etc., in fact all of our numerous species of wild carnivora must be regarded as potential carriers of rabies.

(1) Cynictis penicillata.

It has already been shown, that the species most commonly concerned with rabies transmission is Cynictis penicillata. This animal has been responsible for the death of some 21 human-beings and five head of cattle, besides causing some 80 known outbreaks of rabies. That the disease is more prevalent in this animal, is not to be ascribed to any greater susceptibility to the virus of rabies, nor does the animal become any more ferocious when rabid than other species of carnivora. The reason is rather to be found in the fact that it is very abundant, living in small colonies near to each other, thus increasing the chances of contact for transmission much more than in the other animals, which are comparatively less abundant, and with a more solitary mode of living.

A very large proportion of the cases reported in human-beings are children, who through ignorance and their fondness for pets, are bitten in their endeavours to catch what appears to them to be a tame meercat, but which is actually rabid.

2. Genetta felina.

It is interesting to note that the greater number of cases of rabies reported in this species of animal were in the Bechuanaland area, i.e. Vryburg and Mafeking districts, where this animal also has been suspected for years by the natives as the cause of a fatal disease.

If one takes into consideration that the spotted genet is nocturnal and solitary in its habits then the few cases on record, especially those reported from the Bechuanaland area where it is probably more prevalent than in areas affording less shelter, one may assume that the disease is equally as prevalent in this animal as in the yellow mongoose.

3. Felis spp.

Although this animal has a wide distribution over the whole of South Africa it occurs only in isolated families. The few cases of rabies reported in this animal are therefore commensurable with the smaller chances of contact among this species of animal.

4. Suricata suricatta.

The few cases reported in this species probably do not reflect the true state of affairs, if one takes into consideration its wide distribution, gregarious habits, and its close association with Cynictis penicillata often occupying the same burrows. Possibly the fact that these animals are more inclined to wander over large areas in troops may have something to do with this.

5. Geosciurus capensis.

While this animal is not a carnivore but a rodent, living in close association with Cynictis, cases of rabies in it

could be expected. In fact it is surprising more have not been observed. In *one* case only is there evidence of it having caused the death of a child.

6. Myonax pulverulentus.

This animal being limited in its distribution and occurring in an area where rabies is not very prevalent, it does not play a major rôle in the dissemination of the disease.

7. Ictonyx orangiae.

Owing to its nocturnal habits, this animal is seldom encountered, but several members of this species have been trapped at the warrens of Cynictis. On the farm Riverside in Edenburg district, where the only case of rabies in a polecat has thus been discovered, meercats are scarce. It is not suspected, that the polecat will play a big rôle in the dissemination of the disease.

8. Cynalopex chama.

The jackals have long been suspected carriers of rabies. In 1934 a European died of hydrophobia contracted by the bite of a dog, which had fought with a jackal three weeks previously at a native kraal. On the 21st September 1939, the dogs killed a Silver jackal on the farm Rooidam, Jacobsdal district. The brain proved positive for rabies. The skin of a similar animal ~~of-a-similar~~ was identified by Dr. Roberts of the Transvaal Museum as that of Cynalopex chama.

In Northern Rhodesia where the jackal still abounds in great numbers several cases of rabies have been reported in them, in fact they seem to be the principal vectors there.

In the Union the sheep farmers in their persistent endeavours to exterminate the destructive Black-backed

Jackal, have succeeded in reducing the numbers of all three species to a minimum, and over large areas they have been exterminated altogether. In the Karoo, Southern Free State and Griqualand West where the jackal still persists, jackal-proof fencing has been erected at great expense to check their raids on small stock.

Although a case of rabies has been discovered in a Jackal, it is not suspected that any of the three species play a major rôle in the dissemination of the disease, as not a single case of rabies has been reported in hunting packs, in spite of the large number of jackals hunted by them.

Description of the Vectors of Rabies.

As the epizootology of rabies in South Africa is very closely associated to the habits, mode of life, migration, food, distribution, burrows and colony formation of the various wild carnivora, a brief description of each of the species of animals concerned with the dissemination of rabies will be given.

The descriptions which follow are based on those given by Solater(1900), Fitzsimons (1919), Roberts (1935), Shortridge (1935), Snyman & Thomas (1939), and supplemented by the observations of the officers of the Zoological Survey Section and by personal observations.

The sketch map of the Union of South Africa shows in the different shades the estimated population density of Cynictis penicillata and its distribution.

The Position of the viverridae amongst the wild carnivora in South Africa.

All wild carnivora have always been regarded as inimical to man, consequently the larger and the less elusive species

have been exterminated in closely settled areas. They are today only found in the sparsely populated or uninhabited parts of the country. The smaller and more elusive species have survived in settled areas, even in the vicinity of towns and villages.

It stands to reason, therefore, that the Lion (Leo leo), the leopard (Panthera pardus), the cheetah (Acinonyx jubatus), the hyenas (Hyaena brunnea and Crocuta crocuta) and the wild dog (Lycaon pictus) play no rôle in the rabies problem of this country, but may become of considerable importance, especially the Lycaon, which still goes about in large troops and sometimes invades settled areas, should the disease spread to the outlying areas and the game sanctuaries. On the other hand the smaller species composing the Viverridae and some of the smaller members of the Felidae and Canidae, e.g. the Jackals and wild Cats which have survived in the settled areas and live in close association with man, are greatly concerned with the spread of rabies.

Cynictis penicillata.

English : Yellow mongoose, yellow meercat, red meercat.

Afrikaans : Rooimeerkat, witkwasmeerkat, witpuntstertmeerkat, geelmeerkat.

Xosa : Igola.

Sotho : Mosa, moswe.

Sechuana : Mushi, musha.

Zulu : N'caciti (Paracynictis?)

The genus Cynictis belongs to the sub-family Herpestinae of the family Viverridae, it contains a number of geographical varieties, of which Roberts lists some twelve.

Distribution.

The distribution of Cynictis extends from the Uitenhage and Alexandria districts in the Cape Province, Northwards through Kaffraria where its most Eastern distribution is

Kingwilliamstown, thence through the highveld of the Orange Free State and the Transvaal as far as the Drakensberg mountains. From here it extends westward through the Karoo, Namaqualand Griqualand West, Bechuanaland and Ngamiland into South West Africa, Damaraland (excluding the Namib) up to the Kaokoveld as far as Okovosame, then into western Ovamboland and to the Etosha pan. It does not occur as far North as Grootfontein, S.W.A., and the Caprivi Zipfel. The most thickly populated region is undoubtedly the sandveld of the Western Free State and Transvaal, extending into Vryburg district in Bechuanaland.

Although it has always been regarded as not occurring to the East of the Drakensberg into Natal I have found a pair in the mist-belt in the Nqutu district about seven miles north of the village. From information obtained from the local natives the Cynictis, although very scarce, is known to them and its flesh is relished by piccanins.

In the vast area described above, islands occur in which this species of animal is very scarce or totally absent. One such island appears to be the Eastern slopes of the Gaap mountains up to the Hartz and Vaal rivers, and to some extent on the plateau. I have never seen a yellow mongoose in this area and this is confirmed by local inhabitants.

Habitat.

The areas selected by Cynictis are governed by a combination of various factors such as food supply, occurrence of Geosciurus capensis, soft or sandy soil, spruits and water courses, open country devoid of dense bush, etc.

(a) Food supply.

As Cynictis is primarily insectivorous, one usually finds it plentiful in areas where harvesting termites (Hodotermes) which form its principle food occur in abundance.

The food supply being the limiting factor of all wild life, one often finds the greatest concentration of these animals near farm yards, especially near cattle kraals and the lairs of cattle, where in addition there is an abundance of dung beetles and their larvae. It is not uncommon to find a few colonies near the gates on grazing commonages and outspans where cattle usually congregate. Very frequently on approaching a gate, one sees a creature disappearing into the stone walls protecting the gate-posts, so familiar in some districts of the Free State. The above is well illustrated with a glance at the maps of Trompsburg Commonage and ^{Philip} ~~Beete-~~ kraal.

(b) Occurrence of Geosciurus capensis.

Where other warrens are available the yellow mongoose very seldom digs its own. It finds it more convenient to take up quarters in the warrens dug by the ground squirrel and lives side by side with the latter in the same colony. In places where both species abounds, the ground squirrel determines where they should live. The squirrel, being dependent on bulbs and grass roots for its food, usually elects to dig its warrens near pans, vleis, and water-courses. The Cynictis, although preferring higher ground, takes refuge in such places when suitable. The localities of the colonies marked on the map of the Trompsburg Commonage illustrate this point very well. On the farm Philip in the Hoopstad district the majority of colonies inhabited by the yellow mongoose were situated along the shallow panlike depressions and many mongooses were also found along the slopes of the big pan.

(c) Soft or Sandy Soil.

As has been stated before, the Cynictis very seldom digs its own warrens, but it will do so in soft or sandy soil. The actual digging and most of the cleaning up of

Burrows takes place usually after good rains when the soil is moist and easily worked. Where "trassie-bos" mounds i.e. mounds resulting from wind-blown sand accumulating around Acacia stolonifera bushes occur, nearly every mound is excavated to form a place of refuge. In these mounds the warrens ^{never} penetrate below the ground level but remain above it. On the farm Sunnyside near Bloemfontein, over which the pipe-line for the town water supply passes, the loose soil over the whole length of the pipe-line is riddled with holes and occupied mostly by Cynictis. Whether the pioneer was the squirrel, or not, is difficult to say, but there is no reason to doubt that yellow mongooses were responsible for some of them. On the Trompsburg commonage in the "refuse camp" the refuse heaps are honey-combed with warrens.

Sometimes colonies belonging to Cynictis are found on the slopes of very stony hills. On first appearance one is inclined to think that they have burrowed in very hard soil, but on excavation it is found that they have burrowed in between and underneath the large rocks, where the soil consists of soft mould. These warrens are usually not very deep, so that reliance for shelter is placed in the overlying heavy rocks.

(d) Open Country Devoid of Dense Bush.

Fitzsimons states that contrary to the statement that these animals are never found in the bush veld, he has frequently observed them in the bush-veld provided that it is not too dense.

In Vryburg district I have met them in the bush, but invariably found their burrows in the more open spaces, but amongst taller trees like Acacia giraffae devoid of dense shrub. In the Hoopstad district they occur on the sand-bults covered with Acacia giraffae and other trees.

Except for very dry seasons Cynictis avoids flat low lying plains, and prefers to inhabit colonies on higher

ground on slope or ridges. This presumably is done to avoid the water logging, that is likely to occur in vleis and other low lying territory.

The Cynictis, although primarily an insectivorous animal, has retained its carnivorous habits. Where the harvester termite Hodotermes is plentiful, ~~as~~ it forms an easily accessible and inexhaustible food supply during the greater part of the year. During the autumn days when these termites are particularly active, the yellow mongoose consumes tremendous quantities of them. In several individuals that have been shot on such days, the stomach was found loaded with Hodotermes to almost bursting capacity. At other times or when termites do not occur every other type of insect e.g. grasshoppers, spiders, caterpillar and grubs are preyed upon.

The eggs and the young of ground birds are devoured when found. Cynictis are often very troublesome near farm yards where fowls are kept, in that they take a liking to eggs and chickens and will show great cunning in regularly plundering the fowls nests. It is also interesting to see how this animal solves the problem of crashing the eggshell by repeatedly rolling the egg against a stone until it is broken.

Lizards, toads and frogs are also eaten. The Cynictis to a certain extent is also a scavenger. A bird, which had been shot and thrown near a colony was first regarded with suspicion, but was eventually eaten. On one occasion a Cynictis was seen eating a springhare carcass, killed by a motorist during the previous night. On another occasion a Cynictis was disturbed gnawing at the lips and muzzle of a dead ox.

Food is carried to their young in the mouth. Occasionally fur of rodents (rats and mice) is seen in their dung but contrary to popular belief they rarely prey on them, except when found dead or sick and thus ^{easily} caught.