

History:—The left eye of a girl, aged 8 years, had become inflamed two weeks ago. No illness had preceded.

Findings:—The left eye showed a typical keratitis dendritica (Fig. 10) and a herpetic ulcer in the nasal and upper quadrant.

The first eye clinic kindly administered two treatments with Bucky rays in two weeks. During this time the lesions had progressed considerably, were extremely painful, and at the end of the second week occupied most of the pupillary area (Fig. 11). Immediately I employed the old and reliable method of cauterization with the copper stick, and within a few weeks the lesion was healed, leaving, however, a scar.

In this case the herpetic keratitis progressed relatively fast, and only the treatment with the copper stick arrested the process.

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THE EFFECT OF DIET ON THE NATURE OF THE OCULAR LESIONS PRODUCED BY NAPHTHALENE*

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SINCE Bouchard, in 1886, observed that the administration of naphthalene to rabbits caused cataract, a large number of ophthalmologists have been attracted to the possibilities of this substance as a means of producing cataract experimentally. Certainly, the knowledge of a means by which cataract could be produced at will in a laboratory animal would seem to provide an excellent opportunity for attack on the problem of the aetiology of cataract.

* This research was carried out for the Committee on the Physiology of Vision of the Medical Research Council.

But most workers, in common with ourselves, have encountered difficulties in the employment of this technique, the chief one being the remarkable variability of the effects produced by naphthalene dosing.

Our early experience served to demonstrate to us that the ingestion of naphthalene by a rabbit is by no means inevitably followed by the formation of cataract. Sometimes the death of our animals ensued without the appearance of any ocular lesion whatever; sometimes crystals were laid down on the retina while the lens remained perfectly clear in spite of repeated large doses; often, extensive exudates developed without any sign of lens changes. Only in a small percentage of cases were we able to bring about the series of lens changes leading to the production of complete cataract.

The lesions themselves have already been described by Adams (1930), who noted the irregularity of their appearance; but at that time no determining factor had been found.

In seeking to amplify our knowledge of the biochemical changes, particularly of the variations in blood-calcium, which might accompany the formation of cataract, it was obvious that little progress could be made unless we were able to find conditions under which naphthalene would produce cataract more regularly. We were therefore forced to search for fundamental factors which might influence the action of the drug.

We found, as Panico (1923), and Michael and Vancea (1927) had already pointed out, that the size of the dose and the state of nutrition of the animal are important; but the retinal crystals and the apparent immunity of the lens in those animals in which crystals were laid down, remained unexplained and proved to be phenomena unrelated to either of these factors.

As we had already observed the striking effect of diet on the calcium and phosphorus metabolisms of the normal rabbit (Bourne and Campbell, 1932), it occurred to us that diet might also be one of the factors influencing the action of naphthalene on the eye.

We were able to demonstrate to our satisfaction that diet is, in fact, of fundamental importance, and it is the purpose of this paper to present evidence that the nature of the ocular lesions produced by naphthalene is profoundly affected by the character of the diet.

Experimental

Pure crystalline naphthalene, dissolved in 15 c. c. of warm liquid paraffin, was administered to rabbits by means of an oesophageal tube. Buck rabbits were used exclusively; and doses of two or of three grams were given daily. The eyes were examined

each day by means of an ophthalmoscope, and a record kept of the ocular changes as they occurred. In a number of cases the animals were weighed at frequent intervals and changes in weight recorded. Certain of the animals were bled from the marginal ear vein at intervals of from three to seven days for the purpose of determining the serum calcium. The results of the calcium determinations are reported in a subsequent paper (page 220).

Three diets were used and in each case food was liberally supplied and the animals allowed to feed at will. The experimental animals are divided into three groups, according to the diet received :

Group I, six animals, received oats and cabbage.

Group II, six animals, received bran (moistened with water) and carrots.

Group III, six animals, received moist bran, carrots and oats.

Results

The results are summarized below, while protocols giving details of experiments on separate animals are appended (page 217).

Group I, oats and cabbage diet :—All the animals in this group laid down crystals on the retina and all showed a high degree of resistance to the toxic effects of naphthalene. The lens in each case either remained perfectly clear, or, if any lens changes occurred (as in rabbit number 40), they did not progress beyond the stage of early peripheral striae.

Rabbits number 7 and 15, receiving three grams of naphthalene daily for 24 days, remained perfectly healthy, and, except for an initial anorexia, persisting only during the first week of dosing, seemed undisturbed by this large dose. The lens in both cases remained perfectly clear, although the retinae became covered with crystals. In number 15 a few small patches of retinal exudate appeared during the first week, but these never enlarged or became confluent.

Rabbit number 40 suffered some slight toxic effects. The loss of appetite was more prolonged; there was slight diarrhoea on the 16th day, and an initial loss of 100 grams in weight. But, after the first two weeks, the tolerance of the animal to naphthalene seemed to increase. Weight was recovered, and at the end of the experiment the animal was in excellent condition. In this case also the retina was covered with crystals. Some retinal exudates appeared during the first two weeks of dosing, but these did not progress to the confluent stage. There was some evidence of lens damage, but it was slight and the changes did not advance beyond the stage of early peripheral striae.

In rabbits number 36 and 48 the deposition of retinal crystals was unaccompanied either by retinal exudates or lens changes of

any kind. In rabbit number 136, a few discrete patches of retinal exudate appeared in addition to the crystals, but the lens was unaffected.

The maintenance of weight, the lively and healthy appearance at the end of a prolonged period of dosing, suggest that on this diet the animals were able to combat successfully any toxic products that might have been formed from the naphthalene. The internal organs, when inspected at autopsy, appeared to be in a healthy condition. The histological examination of the tissues in one animal (number 40) showed that the stomach, liver, spleen, intestines and kidneys were normal. The lens also was immune from the damaging effects of any toxic substance which might have been present in the blood. The retina, however, had not been completely protected, for crystals were laid down on the surface and in the nuclear and ganglion cell layers, and there were patches of exudate.*

Group II, moist bran and carrots diet:—In the animals on this diet retinal crystals never appeared; extensive retinal and lens lesions were developed; loss of weight and the signs of a general toxaemia were present as a rule.

Of the six animals in this group, two developed complete cataract; three developed extensive retinal exudates and lens striae and died as a result of the toxic effects of the dose; the remaining animal developed no ocular lesion, but became severely ill and died within a short time.

On this diet the larger doses, three grams daily, produced a severe toxaemia. Loss of appetite was marked; weakness and loss of power in the hind legs developed; and signs of fluid in the lung were often present. These animals succumbed rapidly, within five to fourteen days after the first dose. Post-mortem examination showed a severe inflammation and congestion of the gastrointestinal tract; the intestines were full of bile and mucus; there was an accumulation of mucus in the stomach, and numerous bleeding ulcers in the gastric mucosa. The heart muscle showed areas of degeneration with ante-mortem clots affixed. In these cases the retinal and lens lesions, as a rule, developed rapidly; although in the case of one animal, number 27, no lesion except a slight haziness of the lens was produced.

The ocular lesions cannot be attributed to the moribund condition even in those cases of severe and fatal toxaemia; for with smaller doses (2 grams daily) where the toxic effects were much less marked, similar lesions were produced although the initial stages were less rapid in their development. Rabbit number 41 survived 35 two-gram doses of naphthalene and developed complete

* In histological character these and all other ocular lesions referred to conformed to the description given by Adams (1930).

cataract; the toxic effects in this animal were limited to a rapid loss of weight, the profuse shedding of hair, and the development of the cataract.

Group III, oats, bran and carrots diet:—The results obtained with the six animals on this diet are almost identical with those of Group II (bran and carrots). Again the eye lesions were extensive and, with larger doses of naphthalene, the signs of toxæmia marked. Complete cataract developed in one animal and lens opacities in a second. Two others showed extensive retinal exudates and lens striae, but died before further development of the lesion could take place. One animal developed no ocular lesion of any kind, but rapidly became very ill and died on the third day; another showed retinal exudates and lens striae.

In those animals of this group which succumbed to the toxic effects of the naphthalene, symptoms such as loss of appetite, weakness, diarrhoea or pneumonia preceded death; in all there was a striking diminution in weight, amounting in one case to 700 grams and in another to 650 grams. At post-mortem examination severe inflammation of the gastro-intestinal tract was evident; gastric ulcers were usually present; the heart muscle seemed to be affected, as there were degenerate areas in the ventricular walls with ante-mortem clots affixed; usually there was a more or less extensive congestion of the lungs.

Rabbit number 52, which successfully resisted the generally toxic effects of the dose, developed extensive lens and retinal lesions, including complete cataract. It is interesting to observe that in this case the lens lesions continued to develop even after the dosing had been discontinued.

Discussion

Although the number of our experimental animals is comparatively small, six in each group, the results are so clear cut that there can be no doubt about the primary effect of diet.

A rabbit, feeding on oats and cabbage, is able to tolerate large doses of naphthalene; at the same time the lens is almost completely protected; and retinal exudates, if they appear, are limited in extent. The only noteworthy ocular lesion is the copious deposit of retinal crystals.

Contrast this with the result obtained with animals on a bran and carrots diet. Here large doses of naphthalene, three grams daily, proved very toxic and usually fatal. With smaller doses, two grams daily, although the generally toxic effects were less marked, there was considerable loss in weight and extensive ocular changes were produced. Retinal crystals were never seen. Large retinal exudates and lens striae appeared in all of the experimental

animals except one; and in two cases where the resistance to the toxicity of the naphthalene was most successful the lens changes proceeded to the development of complete cataract.

No effect can be attributed to the addition of oats to the bran and carrots diet. If due allowance is made for individual variation, and for probable differences in state of nutrition, the results obtained on Group III (oats, bran and carrots) are identical with those on Group II (bran and carrots). The addition of oats did not cause the retinal crystals to appear, and it did not prevent the rapid and extensive development of retinal exudates. It supplied no antidote to the toxic effects of the naphthalene; experiments in this Group frequently terminated in the death of the animal, and complete cataract developed if the animal survived.

Therefore, the protection which the diet afforded to the animals of Group I must be attributed to the cabbage; and the laying down of retinal crystals must also be associated with the presence in the diet of this foodstuff.

The more striking variations in the ocular lesions developed by naphthalinized rabbits, which we and other workers experienced may be explained on the basis of variations in diet. Our own early experiments were not controlled from the point of view of diet; some of our animals were given bran and oats plus a small amount of cabbage, while others received oats plus large feeds of cabbage. It is probable that the food given to rabbits varies greatly in different laboratories, and even in the same laboratory at different seasons of the year. No doubt this explains why some of the older workers obtained crystals (Panas, 1887 and Kolinski, 1889), while others never observed them (Hess, 1887; Salfner, 1905; Panico, 1928).

It is probably not impossible to produce cataract in a rabbit even if cabbage is included in the diet, provided that the dose of naphthalene is sufficiently large, or that the effect of the initial doses on the gastro-intestinal tract is severe enough to bring about loss of appetite. In such cases the protective effect of the cabbage might be overwhelmed and the lens changes produced. But in our experience the optimum conditions for the production of cataract by naphthalene are: The administration of daily doses (not exceeding one gram per kilogram of body weight) to healthy rabbits feeding on a diet (such as bran and carrots) from which cabbage has been excluded. If there is severe loss of appetite dosing should be suspended until the animal recovers.

The generally toxic effect of naphthalene, particularly the irritative action on the gastro-intestinal tract, has not been emphasized by previous workers, although it was observed and recorded by some. Curatulo (1889) reports that there was a high mortality among his animals, most of them dying within two or three

days, and that the survivors were much emaciated; at autopsy he found haemorrhage and catarrh of the gastro-intestinal tract, and intra-muscular and sub-cutaneous abscesses. Kolinski (1928) noted the loss in weight of his naphthalinized animals, and, at autopsy, hyperaemia, secretion of mucus, and small punctiform haemorrhages of the gastro-intestinal tract. Such effects are important and indicate either that the naphthalene is acting as a local irritant of the surfaces of the stomach and intestines, or that it is giving rise to some toxic derivative which, when absorbed into the bloodstream is not only damaging to the tissues of the eye, but is poisonous to the organism as a whole.

There still remains a small group of animals whose reaction to naphthalene is exceptional and unexplained. On a bran and carrots diet these developed no ocular lesion, except a slight swelling of the lens, but succumbed rapidly to the toxic effects of the dose. If, before the death of the animal, the diet was changed to oats and cabbage, and, after a period of recovery, the naphthalene dosing resumed, retinal crystals were laid down.

Summary

The type of ocular lesion produced in rabbits by naphthalene was found to depend upon the diet.

In animals feeding upon oats and cabbage, crystals are laid down on the retina; retinal exudates sometimes appear, but are limited in extent and never become confluent; the lens is either completely protected, or if affected, the changes do not advance beyond the stage of early peripheral striae. The protective effect is believed to be due to the cabbage.

On diets of bran and carrots, or of oats, bran and carrots, extensive retinal exudates and lens changes leading to complete cataract are produced. Retinal crystals were never observed on this diet. In a few cases there was rapid death of the animal without the occurrence of any lesion except a slight swelling and haziness of the lens.

The toxic effects of naphthalene, in the absence of cabbage, are described; and the results of post-mortem examination are given.

The optimum conditions for the production of cataract by naphthalene are suggested.

I am indebted to the Committee on the Physiology of Vision for grants, to Professor Drummond for his advice and helpful criticism, and to Dr. Muriel Bell for assistance with the pathological examinations.

Protocols

Group I. Oats and Cabbage Diet

(a) Rabbit number 7:—Grey, weight 2,745 grams. Received three grams naphthalene daily for 22 days. Crystals appeared on the retina on the third day and gradually increased in size and number until, by the 18th day, the retina was practically covered. No retinal exudates were seen, and the lens remained clear throughout. The animal refused food during the first five days of the experiment but subsequently recovered its appetite, and remained in good condition during the experiment and for a period of 20 days afterwards, when it was killed.

(b) Rabbit number 15:—Grey, weight 1,725 grams. Received three grams of naphthalene daily for 24 days. A few very small patches of retinal exudate appeared at the periphery of the retina on the second day. Crystals appeared on the third day, and increased in size and number until the 18th or 19th day. The areas of retinal exudation increased slowly in size until the 10th day, after which no further increase occurred; they never became confluent, but remained as small, discrete, white, atrophic patches with retinal pigment heaped up around the edges. There was a temporary loss of appetite during the first six days of the experiment, but no other sign of general toxaemia. The animal remained healthy until the end of the experiment and for 20 days afterwards, when it was killed.

(c) Rabbit number 36:—Dark brown, weight 2,570 grams. Received two grams of naphthalene daily for 19 days. There was no evidence of ocular lesion until the 11th day, when crystals appeared on the retina. On the 12th day a few small patches of retinal exudate appeared; these enlarged slightly, but did not become confluent. The crystals increased in size and in number while naphthalene was being given. The lens remained entirely clear.

In this case the loss of appetite was more marked than in the two preceding, but the animal remained healthy, and showed no loss of weight at the end of the experiment. It survived for several months, apparently healthy, and the crystals and atrophic patches remained in the same state as at the end of the experiment.

(d) Rabbit number 40:—Brown, weight 2,070 grams. Received two grams of naphthalene daily for 36 days. A few small patches of retinal exudate appeared on the third day; these increased in size until the 10th day, but never became confluent, and remained as atrophic white patches with pigmented edges. The crystals, which first appeared on the fourth day, increased in size and number during the whole period of naphthalene administration, eventually covering the whole retina. The lens was in this case slightly affected; it was slightly swollen and contained a few peripheral striae on the second day. The striae were somewhat more marked by the 10th day; after this they did not develop further, but showed, instead, some tendency to retrogress. At the end of the experiment lens striae were still present, but they had not progressed beyond an early stage and the lens was still transparent. There was an initial loss of appetite accompanied by a loss of 50 grams in weight. Normal appetite was not fully recovered until about the 20th day of the experiment, after which there was a slight gain over the initial weight (30 grams). When killed at the end of the experiment, the animal was very healthy and robust. At autopsy it was found to have large deposits of sub-cutaneous and body fat; all the organs of the viscera appeared by inspection and by subsequent histological examination to be in normal condition. Histological examination of sections of the retina showed large deposits of crystals on the surface and in the ganglion cell layer of the retina. (Cf. protocol (f) Group II, Rabbit 41 on bran and carrots diet.)

(e) Rabbit number 136:—Brown, weight 2,490 grams. Received six two-gram doses of naphthalene. Crystals appeared on the second day and continued to increase in size during the dosing period. There were no retinal exudates, and the lens was unaffected. The animal did not lose weight during the experiment, and 15 days after the last dose was found to be perfectly healthy and to weigh 2,820 grams. At this time the crystals were still present on the retina, and no further change in the eye had taken place.

(f) Rabbit number 48:—Brown and white, weight 2,230 grams. A month prior to the beginning of this experiment, this animal, then on a diet of oats, bran and carrots, had received four two-gram doses of naphthalene; no ocular lesions, except a slight swelling and haziness of the lens, were developed at this time, but there were signs of general toxaemia and complete loss of appetite. The diet was then

changed to oats and cabbage, and a month later the present experiment was begun. This time the animal again received two grams of naphthalene daily for four days. There were no signs of general toxæmia, the loss of appetite was temporary, and the weight was maintained. Crystals appeared on the retina on the third day and increased on the fourth and fifth days. There were no retinal exudates. The lens, still a little swollen and hazy as a result of the first dosing, showed no sign of any additional damage. Thirty-five days after the last dose the animal was still apparently healthy, the crystals were still present on the retina, and the lens condition showed no change.

Group II. Bran and Carrots Diet

(a) Rabbit number 21 :—Grey, weight 2,125 grams. Received three grams of naphthalene daily for six days. Retinal exudates were present at the periphery of the retina on the second day; they increased rapidly and had become confluent by the third day. Peripheral lens striae were present on the second day and these also developed rapidly, extending to the centre of the lens on the fifth day. A general haziness of the lens accompanied the development of striae and by the fifth day it was impossible to see the retina clearly with the ophthalmoscope. The animal suffered complete loss of appetite after the first dose; showed marked weakness and loss of power in the hind legs; became lethargic and obviously ill. It was found dead on the morning of the sixth day.

When examined post-mortem, the stomach was found to be full of food, although the animal had eaten nothing for about five days. The stomach contents smelled strongly of naphthalene, although 24 hours had elapsed since the last dose. There were numerous ulcers in the gastric mucosa; the intestines were congested and inflamed, the kidneys also appeared to be congested and inflamed.

(b) Rabbit number 27 :—Grey, weight 2,500 grams. Received three grams of naphthalene daily for five days. A slight haziness of the lens developed on the third day, but there was no other ocular lesion. The animal refused all food after the second day, but drank a little water. It was lethargic but not obviously weak or ill, and died on the 14th day.

(c) Rabbit number 45 :—Silver Grey, weight 2,380 grams. Received three grams of naphthalene daily for 22 days. Numerous watery exudates appeared on the retina on the second day; these rapidly enlarged and became confluent, covering almost the whole retina by the fourth day. Lens striae were present on the third day; these showed a progressive development, extending from the periphery towards the centre of the lens; their development was accompanied by a gradually increasing haziness of the lens. By the 12th day it was almost impossible to see the retina, and by the 22nd day true lens opacities were present. By the 37th day there was complete cataract of both eyes.

There was an almost complete loss of appetite during the first five days of dosing. However, the animal recovered and remained healthy and without loss of weight. When killed three months later it was apparently perfectly healthy, weighed 2,660 grams, and the cataracts, now fully mature, had assumed a yellowish tinge.

(d) Rabbit number 25 :—Grey, weight 2,200 grams. Received three grams of naphthalene daily for five days. Retinal exudates were present on the second day, and they enlarged and rapidly became confluent. Lens striae and generalized haziness of the lens were present on the third day.

The animal developed complete loss of appetite after the second dose, became weak and ill, and died on the sixth day.

At autopsy the stomach was found to be full of food, in spite of the fact that nothing had been eaten for three days; the stomach contents smelled strongly of naphthalene; a large amount of mucus was present in the stomach and there were many ulcers in the gastric mucosa; the intestines were congested and inflamed and there were patches of necrosis high up in the duodenum and jejunum; there was evidence of a slight pneumonia at the base of one lung; the heart muscle was very pale, and the wall of the right ventricle contained adherent ante-mortem clots; the kidneys were pale and the cortex appeared enlarged.

(e) Rabbit number 35 :—Brown, weight 2,520 grams. Received two grams of naphthalene daily for 13 days. Numerous discrete, watery exudates appeared on the retina on the second day; these increased in size and had become confluent by the fourth day. Lens striae were present on the third day, and by the 13th day had

become very marked. There was a general haziness of the lens, but no definite opacities. On the 22nd day (9 days after the last dose of naphthalene) the lens was still hazy, but no further development of the lens lesion had taken place. The retina in the exudative areas had become atrophic.

The animal died on the 44th day, no further development of the lens lesion having taken place. Post-mortem examination showed a number of bleeding ulcers in the gastric mucosa; the intestines were inflamed and filled with bile-stained mucus; the liver was congested, but otherwise appeared normal; the kidneys were definitely congested and seemed inflamed; the urine contained in the bladder was acid in reaction and contained albumin; the lungs were congested and oedematous; there was an area of degeneration in the right ventricle of the heart with an ante-mortem clot affixed.

(f) Rabbit number 41:—Brown, weight 2,070 grams. Received two grams of naphthalene daily for 35 days. Retinal exudates and lens striae appeared on the second day. The retinal exudates continued to increase a little in size until the eighth day; one or two new exudative spots appeared on the 12th day; the exudates never became confluent, but remained as atrophic patches as long as the retina was visible; by the 20th day the lens had become so hazy that the retina was no longer clearly seen. The lens changes showed a continuous progression; the striae increased and extended from the periphery to the centre of the lens by the 12th day; from this time on the lens became increasingly hazy, until by the 20th day it was impossible to see the retina through it. On the 21st day definite opacities appeared in the right lens and by the 26th day had progressed to the stage of immature cataract. Opacities appeared in the left lens on the 29th day. On the 36th day there was complete cataract of the right lens and immature cataract of the left lens. The animal was then killed.

This animal showed no striking loss of appetite and no signs of general toxæmia. At the end of the experiment it was lively and had a healthy appetite. There was, however, a progressive loss of weight, 170 grams being lost during the 35 days. A sore developed on the tip of the left ear, which was treated and eventually healed. About the 10th day the hair began to fall out; the flanks and hind quarters soon became almost completely bare.

Inspection of the viscera at autopsy, and their subsequent histological examination, revealed no evidence of any lesion, except a slight congestion of the left lobe of one lung. (*cf.* protocol. (d) Group I, rabbit 40, oats and cabbage diet.)

Group III. Oats, Bran and Carrots Diet

(a) Rabbit number 23:—Brown, weight 1,375 grams. Received three grams of naphthalene daily for six days. Retinal exudates appeared on the fourth day, and rapidly became large, watery and confluent. Early lens striae were present. The animal developed loss of appetite and the signs of general toxæmia, and died on the seventh day. At post-mortem, the stomach was found to be full of food smelling strongly of naphthalene; there were numerous ulcers in the gastric mucosa; the intestines were inflamed and contained bile and mucus, but no faeces; the kidneys were enlarged and congested; the left lung was solid; there was an area of degeneration in the wall of the right ventricle and an adherent ante-mortem clot.

(b) Rabbit number 26:—Grey, weight 2,030 grams. Received two three-gram doses of naphthalene. No ocular lesion of any kind developed. The animal became rapidly very ill and died on the third day. At autopsy the stomach was found to be full of food smelling strongly of naphthalene. A great deal of mucus was present in the stomach, but no gastric ulcers were found. The intestines were congested and there were haemorrhages in the wall of the caecum; one lung was congested; the heart appeared normal; save for areas of degeneration in the wall of the ventricle and adherent ante-mortem clots.

(c) Rabbit number 55:—Brown, weight 2,645 grams. Received two grams of naphthalene daily for 13 days. Discrete retinal exudates appeared on the second day; these gradually enlarged, but never became confluent. The lens was not affected until much later. A general haziness of the lens was observed on the 17th day; on the 19th day a few peripheral striae appeared, which, during the following three days, extended towards the centre of the lens. The animal died on the 24th day, after having developed complete loss of appetite from which it did not recover. There was a rapid loss of weight amounting to 650 grams in 24 days.

(d) Rabbit number 52:—Fawn colour, weight 2,230 grams. Received two grams of

naphthalene daily for eight days. Retinal exudates and peripheral striae were present on the second day. The exudates rapidly enlarged and became confluent; by the ninth day the entire periphery of the retina had atrophied. The lens striae developed during 20 days; on the 24th true lens opacities were present; complete cataract of both eyes subsequently developed about one month after the last dose of naphthalene.

(e) Rabbit number 50:—Black, weight 2,010 grams. Received two grams of naphthalene daily for two days. The ocular lesions developed rapidly. Retinal exudates and peripheral lens striae were present on the second day; by the fifth day the exudates had become confluent and the lens striae were rapidly extending towards the centre; by the ninth day the lens striae had still further increased and the affected areas of the retina had become atrophic. The animal died on the 10th day after having manifested all the signs of severe toxæmia including loss of appetite, weakness, torpor, and severe diarrhoea. The sound of the breathing indicated the presence of fluid in the lungs. There was a very rapid decrease in weight, amounting to a total of 700 grams.

(f) Rabbit number 51:—Grey, weight 1,900 grams. Received five two-gram doses of naphthalene. The ocular lesions were extensive and developed rapidly. The retina was covered with large patches of watery exudate on the second day; these rapidly became confluent, and by the fifth day, the whole retina was atrophic. Peripheral lens striae were present on the second day; these increased and by the ninth day, had extended throughout the lens; on the 14th day true lens opacities were present. The animal died on the 19th day, having developed anorexia and having lost 350 grams in weight.

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THE RÔLE OF CALCIUM IN NAPHTHALENE CATARACT

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THE theory that a relationship exists between calcium and the production of cataract arises from two independent sources.

In the first place, a number of observers have found that the calcium content of cataractous lenses is higher than normal. Burge, in 1909, first reported an increased proportion of calcium in the ash of cataractous human lenses. This was confirmed by Adams (1929) who found that the calcium in the lens in human senile cataract is greater than normal. Recently, Mackay, Stewart, and Robertson (1932) also found the calcium in human cataractous