

case died on the second day, while Meixner's never breathed. In older patients, beyond the interference with deglutition, the voice has been observed to alter in character, either assuming a high pitch with a nasal twang or becoming dull, muffled, and wanting in resonance. Free respiration is interfered with leading to functional troubles, such as snoring, or to actual dyspnoea of varying degrees. Occasionally ulceration of the surface has led to considerable hæmorrhages; this is regarded by Storrs as an important diagnostic characteristic but its occurrence is uncommon. The swelling itself possesses certain definite characters which make its diagnosis fairly easy. It is situated immediately behind and in intimate relation with the foramen cæcum; its surface is smooth, pale, and usually provided with numerous obvious large ramifying blood-vessels. It is practically median, although, as in the case just related, it may extend to one or the other side backwards. It is firm in consistence and non-fluctuant as a whole, although soft points corresponding to cysts may be present.

Certain negative points have been emphasised by Storrs and others as valuable in the diagnosis. Thus a dermoid is usually yellow in colour, more symmetrical in outline, non-vascular on the surface, and when it commences to enlarge does so more rapidly. An enlarged lingual tonsil has a whitish colour, the yellow openings of crypts are noticeable, it is often free from the foramen cæcum, and commonly is accompanied by the presence of adenoids in the nasopharynx. The surface of a papilloma is less even and it is pedunculated, not sessile. An angioma is softer, and dark bluish, violet, or nearly black in colour. Malignant growths are more rapid in their development and are accompanied by obvious and palpable infiltration of the surrounding area.

Prognosis and treatment.—Experience has shown that in the treatment of these cases we are sometimes on the horns of a dilemma. While the removal of the tumour is easy and safe, the operation may lead to the development of post-operative myxedema, or the leaving it, to the development of disagreeable or dangerous symptoms. The first point to try to determine is the presence or absence of the normal thyroid gland. If this is palpably present no difficulty arises; if doubt exists the lingual tumour should not be lightly interfered with. When, however, dysphagia and dyspnoea are prominent signs the growth must be removed and this is the more necessary since the advent of symptoms in many, if not in all, cases corresponds with the occurrence of degenerative changes in the gland tissue. Happily the effect of the removal of the gland can be in great measure neutralised by subsequent treatment by the administration of thyroid extract, while the effect of the operation itself may be diminished by leaving some portion of the thyroid tissue. In the latter relation it is interesting to note that such remnants of the gland have been noticed by Butlin and others to undergo considerable temporary enlargement subsequently to the performance of the operation. I have been unable to verify this observation in the case now under discussion, although I examined the patient several times during the first three months after the operation. This is perhaps to be explained by the fact that there is no reason to believe that the cervical thyroid is markedly deficient. In any case, however, it is no doubt advisable not to remove entirely the gland tissue from the base of the tongue, the more so that if it should happen to cause future trouble it is readily dealt with. The occurrence of post-operative myxedema, moreover, has been observed in a sufficiently large number of cases to oblige us to consider its development as a very appreciable possibility.

Lastly, as to the method of removal, there is no doubt that removal from the mouth, the head being placed on one side, and the tongue thoroughly drawn forward, is an efficient, safe, and the best method. The defect in the tongue may be sutured and heals readily. A preliminary tracheotomy can very rarely be necessary, and the supra-hyoid incision which has been sometimes adopted appears neither so convenient nor easy, while it has the grave disadvantage of leaving an unnecessary and disfiguring scar.

ENTERIC FEVER IN ABERSYCHAN.—In consequence of the outbreak of enteric fever in the Abersychan district the officials of the urban district have been examining the water-supply, and at the Pontypool police-court last week closing orders were made against the owners of several private wells. The analysis of the water from one of these wells showed that it was "practically diluted sewage."

FURTHER OBSERVATIONS ON ENDEMIC GOITRE.*

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I.—INTRODUCTION.

IN my last communication on this subject, read before the Royal Medical and Chirurgical Society,† the conclusion was arrived at that goitre is an infectious disease. Attention was also drawn to the following points: 1. That water, if it is the chief vehicle of infection, is not the only one. 2. That it is to no dissolved ingredient in water that goitre is due. 3. That the results of all experiments on dogs in Gilgit were constantly negative. 4. That the increased prevalence of goitre in the villages in the lower parts of the Gilgit fan was, in all probability, due to the increased impurity of the water lower down the fan. 5. That the people of Barmis, although living on the Gilgit fan, do not suffer from goitre. 6. That goitre is constantly associated with limestone rocks in Chitral and Gilgit. 7. That goitre can be rapidly acquired by susceptible individuals in goitrous districts; the minimum period of residence necessary being from three weeks to one month. 8. That in Nagar an epidemic of this disease is commencing and that children are first affected. 9. That there is considerable ground for the belief that in the indigenous inhabitants of the goitrous locality a natural immunity to the disease is produced after several generations. 10. That removal from a goitrous district causes a disappearance or reduction in size of symmetrical enlargements of the gland, the extent of the reduction being dependent on the age of the goitre and the presence or absence of secondary changes. 11. That the enlargement of the gland will disappear while the patient is still under goitrous influences if thyroid gland extract is administered by the mouth. It is the purpose of this communication to record such additional facts and observations as may, it is hoped, when taken in conjunction with those which I have already brought forward, remove any doubt as to the infective nature of endemic goitre.

Goitre exhibits a distinct "seasonal prevalence." The large proportion of new cases seen during the year in Gilgit develop during the early spring months (February, March, and April‡). Regarding the hot months of the year—namely, June and July—I know little, but quite a number of new cases have been observed to develop in the autumn or late summer. Of 90 young Hindustanis who arrived in Gilgit in August 17 were found to have enlarged thyroids when examined in November. During two winters here no new case of the disease has come to my notice—that is to say, no case has been shown to have developed during the winter months. The latter remark does not apply to an increase in size of already existing enlargements. Fresh enlargements of the thyroid gland are seen here with almost as much regularity in the spring months as are fresh enlargements of the spleen in autumn due to malaria. The seasonal prevalence of goitre will be again referred to when the relations of water to goitre are discussed. This "seasonal prevalence" leads up to the assumption that the virus of the disease requires a certain degree of "atmospheric temperature" to exert its maximum effect or favour its action. In my last paper I referred to the local reports in Chitral which incriminated the spring months.¹ It is only within the past year that I have had an opportunity of confirming them.

"Grief," "mental and physical depression," or "attacks of fever" markedly favour the production of the disease; indeed, they may be regarded as exciting or predisposing causes. Several cases have come to my notice where the swelling has made its appearance after "childbirth" or after the "menopause." At "puberty" also the gland not infrequently enlarges. These facts have been noted by observers in other parts of the world. Not only do new cases arise as the result of these exciting or predisposing causes, but previously enlarged glands undergo a further increase

* The superior figures refer to the bibliography at the end of the article.

† The paper referred to represented the progress made in my observation of this disease up to the beginning of July, 1905. The present contribution is the result of observations made since that date.

‡ In the water during these months no sediment is perceptible.

as a result of these influences. As a rule, such glands return to their former state of what may be called "thyroid equilibrium," when these influences are removed and the patient regains his normal state of health. It is not uncommon, in new cases, to hear that the enlarging gland has fluctuated to a noticeable degree, at times almost completely disappearing, before it becomes permanently enlarged. In adults, goitres may remain of the same size for years, increasing as a result of one or other of the causes mentioned, or diminishing as a result of treatment, but almost invariably returning to their original state of equilibrium when the causes which have produced the increase or the diminution are removed. Goitres in Gilgit are not as a rule large. It is a curious fact that a very high percentage of all enlargements of the gland contain tumours. Of 450 cases examined no less than 70 per cent. were found to be affected in this way.

Up to the present I have been unable to show that difference of "race" plays any essential part in this affection. All the tribes of Gilgit and all the many foreign races residing there appear to suffer. There is, however, no case on record of a white man having contracted the disease in Gilgit, a fact which is doubtless due to the care which is taken with regard to food and drink, as well as to occupation and the situation of their dwellings.

"Occupation" is a factor of very considerable importance. It is noticeable that the landed classes both in Chitral and Gilgit suffer less than do the labouring classes. There are many families of educated Hindustani clerks in Gilgit. They have resided here for years. They do not suffer nor do their wives and children, although they daily drink water supposed to be capable of causing the disease, and live on an infected soil. The total population of this class in Gilgit amounts to 72. Further, none of the hospital staff, 24 in number, have ever developed goitre, while cases not infrequently arise among the Hindu dooly bearers who live on the same soil and drink the same water, but who, in addition, are constantly employed handling soil, either in the gardens or in plastering the mud floors of their rooms. Goitre is most common among the zamindars or land cultivators of Gilgit. The women of this class are more commonly affected than are the men. The troops in Gilgit suffer little; 20 per cent., however, of young recruits contracted the disease last year. It is a notable fact that in the garrison here it is only among those men who have access to the irrigation water that goitre is found. Goitre does not occur among those who drink only the pure water of the Gilgit river which is supplied to them. Large numbers of Balti coolies who come to Gilgit for employment contract the disease there.

The following is the result of the analysis of the Gilgit river water, which does not cause goitre:—

	Grains to gallon.
Total solids	7
Total hardness	4
Calcium	About 6.
Magnesium	Not found.
Iron	Trace.
Sulphates	3
Chlorides	Present in small amount.
Free NH ₃	Nil.
Organic matter	"
Other metals: lead, copper, and zinc ...	"
Nitrites	"

II.—GOITRE IN ANIMALS.

It appears to be generally agreed that in places where goitre is prevalent animals suffer as well as men.² This has not been my experience in Gilgit. All the dogs in the village of Kashrote were carefully examined (45 per cent. of the inhabitants of Kashrote have goitre) without encountering a single case of enlargement of the gland. Other animals, mules, sheep, goats, cattle, and ponies, have been examined in Gilgit, but I have come across no case of enlarged thyroid among them. The following is a detailed list of the animals examined.

Animals.	Number.	Goitrous.
Dogs	101	Nil.
Mules	116	"
Cows	150	"
Sheep and goats	100	"
Ponies	100	"

I have often observed that the hill dogs here present a fulness of the throat which is, on closer examination, found to be due to an excessive growth of hair.

These results would seem to indicate that the causes which operate to produce goitre in man fail in Gilgit to produce the affection in animals. It has been lately pointed out³ that the functions of the thyroid gland appear to differ very widely in different classes of animals—a fact which may have a very considerable bearing on the subject of the identity of the disease in man and animals. The fact that dogs do not suffer from this disease in Gilgit deprives me of the only animal available for experimental purposes. Cretinism, too, has never been observed in any of the lower animals in Gilgit. I find from recent physiological research that "although extirpation of the thyroid causes a temporary cessation of growth (in animals) we find that this is not necessarily accompanied by symptoms of a cretinoid nature."²

III.—WATER IN RELATION TO GOITRE.

I have pointed out that "it is to no dissolved ingredient in the water that goitre is due" and that "if water is the chief vehicle of infection, it is not the only one." It has been shown that, as far as the Gilgit water is concerned and assuming that water is the vehicle of infection, the more impure the water becomes and the larger the amount of matter in suspension, the higher is the percentage of goitre in places supplied by it. The question naturally arises, Can the water at its source, the pure water from the melting snows of the hills, take up on its way down a rocky nullah such ingredients as will give rise to goitre among the people drinking it in the valleys below? In answer to this question the case of the Nagar spring is to be remembered. The people of Nagar have begun to suffer from goitre during the past six years; the water-supply is the same. Goitre was introduced from without. Further, in Gilgit there is a small village called Napur which is supplied by water from its own nullah. The water irrigates the crops before the people drink it; there is 11 per cent. of goitre in the village. The same water runs along a water-course, cut in the side of the hill, for four miles till it reaches the village of Barmis, above which village it joins the Barmis spring and does, in fact, during the summer months make up more than half the total water-supply of the village. There is no goitre in Barmis. There never has been. Indeed, the people occasionally resort to the village to get rid of their goitre and yet the inhabitants drink the water which at Napur is supposed to cause at least 11 per cent. of goitre. It is true that they drink it in a diluted form, but if the water is goitre-producing it is necessary to assume: (1) that the dilution with the Barmis spring robs it of its goitre-producing properties; or (2) that the organism which produces goitre cannot live in running water for four miles; or (3) that the original water of the Napur nullah does not of itself produce goitre but only acts as a vehicle for the organism, which it picks up from the soil of infected localities. I have pointed out¹ how, where the Barmis spring joins the main supply of Gilgit, there is a slight fall in the percentage of goitre in the village of Majinpharri, as compared with the village above it, and suggested that the waters of Barmis "may possibly have a slight influence in causing this fall by diluting the more or less polluted waters of the main channel." In this way it is possible that the first of my three assumptions may be correct. With regard to the second, however, that the organism which produces goitre cannot live in running water for four miles, if this is true, neither could it live in the water of the nullah before it reaches Napur, and, therefore, Napur should be free from the disease, which it is not. I think that, bearing the case of Nagar in mind, it is more reasonable to fall back on the third assumption, that the original water is not in itself capable of producing the disease but that it only acts as a vehicle, picking up the organism which causes goitre from infected sites. This assumption is not incompatible with either of the others formulated. It is quite possible—certainly if the organism which produces goitre is shown to be a bacillus—that such organism cannot survive for four miles in running water. It is also possible that dilution with a purer supply may kill it. This fact has been commented on as far back as 1899 by Dr. Mackenzie.⁴

My experience of the disease in Chitral and Gilgit makes it necessary for me to admit that water is, as a rule, the vehicle for the organism of this disease. But there is no

sufficient evidence to show that the original water is in itself capable of producing goitre. Many investigations have been carried out by me to demonstrate, if possible, the effect of boiling and filtering waters supposed to be capable of causing goitre. The experiments on dogs recorded in my first paper¹ were obviously without result owing to the fact that dogs do not suffer from goitre in Gilgit. In Appendix I. I give the results of a series of observations on men, carried out in Chitral, which I have not hitherto published; these are now recorded, because further observations on man have given similar results in Gilgit. It has been shown that symmetrical goitres diminish in size when the patient leaves the infected area, in the case of young goitres, and in young people the subjects of goitres of considerable standing in which no secondary changes have taken place; this diminution is very rapid indeed. Men in the garrison here tell me that their necks become, at the time of the bi-annual reliefs, normal in size, before they reach Kashmir, a march of only 15 days. Now remembering these facts, it must be admitted that if water is the only cause of the disease, boiling and filtering it would necessarily place the patient in a similar position with regard to goitrous influences as removal from the district. My observations (see Appendix I.) have failed, both in Chitral and Gilgit, to demonstrate that such is the case. So long as the subjects of the disease live on the infected site no markedly beneficial results are observed to occur as the result of boiling and filtering the waters of that site. These observations were carried out with the greatest possible care so as to insure that only boiled or filtered waters were used by the subjects of the observations. I believe that the men under observation did not drink other waters, and this for two reasons, first, owing to the loathsome nature of the disease, which no soldier or well-to-do young Chitrali cares to be burdened with, and is, therefore, anxious to be rid of; and, secondly, owing to the penalties imposed for infringement of the orders given. I propose again to put this point to the test, but up to the present time I must admit that no beneficial results have been observed in treating the water either by boiling or filtering. From this I do not conclude that boiling or filtering suspected waters may not be beneficial, but that, if such treatment of the waters is beneficial, these measures alone will not prevent or cure the disease; at most they will only lessen the chance of infection. It is a very noticeable fact that new cases of goitre arise at a time when irrigation is at its height and coincident with its commencement in February and March when the degree of impurity of irrigation water used for drinking purposes must be very considerable. It is curious, too, that no new cases should have come to my notice during the winter months when irrigation is not practised. In this connexion the observations of Macnamara² in the Brahmaputra and Chenab valleys are of importance. This observer found that it is during and after the rains when the waters, so far as their mineral ingredients are concerned, must be in the state of greatest dilution, that the disease most commonly commences and most rapidly develops. It appears to me, therefore, that the organism may possibly be washed into the drinking water channels from the soil of the infected locality, or that the added impurity of the water favours its action. The marked increase in the percentage of goitre in the lower parts of the Gilgit fan, as compared with the upper parts, favours this view, the water becoming more and more infected, more and more impure on its way down.

IV.—SOIL IN RELATION TO GOITRE.

There would appear to be three factors having some greater or lesser causal connexion with the endemic occurrence of goitre in Gilgit. These are, the geological origin of the soil, the dampness of the soil, and the slope of the ground.

It has been pointed out that goitre, in Gilgit and Chitral, is invariably associated with limestone rocks; that the water supplying goitrous localities is invariably so associated. The sites of the villages are the alluvial fans, which have at one time been formed by the stream which now serves the people as a water-supply. The limestone is found in the nullah at the mouth of which is the alluvial fan. Limestone, therefore, enters largely into the composition of the soil on which the villages stand. It has been demonstrated that water is not in itself the cause of goitre; it is, therefore, reasonable to suppose that whatever the

causal connexion which exists between the endemic occurrence of goitre and the limestone may be, it is through the soil that it exerts its influence. The goitre-free village of Barmis is in marked contrast to the rest of Gilgit in this respect. It is not situated on a soil into the composition of which limestone enters. It is situated on clay. The village lies at the base of a hill in which there is no limestone; the soil of the village is the accumulation of detritus at the base of this hill. This is a fact of much importance and one which may explain to a large extent the absence of the disease in Barmis.

With regard to dampness of the soil as a factor in the causation of goitre, it is to be observed that in Gilgit the most goitrous villages are those which are dampest, where from their situation or the slope of the ground the surface drainage is bad and where in consequence the subsoil water is near the surface. The village of Kashrote lies in a hollow which is practically waterlogged at the height of the irrigation season. Barmis, on the other hand, is situated on a slope, as well as on a clayey soil; the surface drainage is good, the subsoil water low.

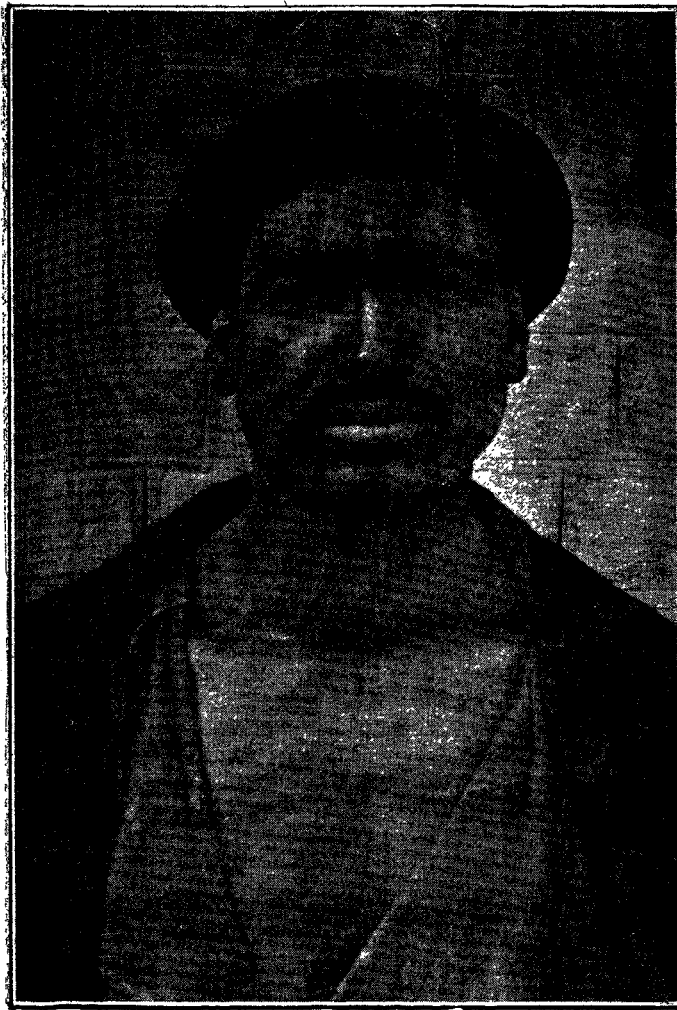
I consider that the dampness of the soil is a factor which cannot be overlooked. Observers in other countries have frequently drawn attention to the fact of the greater prevalence of the disease in narrow valleys possessing a damp or marshy soil. Goitre is known to occur in soils which are dry but there is no reason why a certain degree of moisture may not be of importance. Malaria was formerly named "marsh fever" from the fact of its prevalence in marshy places; it occurs none the less in places which are far from marshy; the mosquito does not require a marsh in which to develop, a water-pot serves its purpose equally well. Also, the beneficial effect of the introduction of good drainage has been commented upon by observers in other countries.⁴ A damp soil in association with goitre would appear to be the rule, its occurrence on a dry soil the exception. Exceptional conditions must, therefore, be sought for to account for its occurrence on exceptionally dry soils. It is necessary to find the equivalent of the water-pot of the mosquito. I have dealt with this point at some length because I find that its probable importance is likely to be ignored; one prominent text-book, indeed, goes so far as to say that dampness of the soil cannot seriously be regarded as an etiological factor, a view which I consider to be a narrow one considering the present state of our knowledge of this disease. The following facts appear to me to indicate that the soil is the natural habitat of the organism of goitre:—1. The epidemic outbreak of goitre in Nagar after the introduction of the disease from without. 2. The fact that water in itself does not cause the disease. 3. The fact that those whose occupation brings them into close contact with the soil suffer most. 4. The absence of beneficial results from boiling and filtering waters while the subjects of the experiment still live on an infected site. 5. The fact that the disease is confined to very limited areas. 6. The fact that even in infected areas groups of houses, or even whole communities, escape the disease.

V.—THE BLOOD IN RELATION TO GOITRE.

A large number of blood examinations have been made in cases of goitre at all stages of the disease. It may be stated at the outset that although blood examinations have been made in over 100 cases of this disease, the hæmatozoon described by Professor Grasset⁵ has never been met with. The cases shown in the first table of differential counts are all of less than three months' standing, which would appear to be recent enough infections for the detection of blood parasites. Cases of such recent origin as those of Professor Grasset have not been examined. Examination in 10 recent cases of blood obtained by thyroid puncture has also given negative results. The number of white blood corpuscles is within normal limits in goitre.

For tables of differential counts see Appendix II. It will be observed from these tables that in many cases there is a marked "eosinophilia," and this even in cases where examinations of the fæces for intestinal parasites have been negative. It will be seen that an eosinophilia is not a constant feature of this disease. A more constant feature is the relative diminution in the numbers of the polymorphonuclear leucocytes and the relative increase in the mononuclear elements of the blood. Analogy between these results and the blood conditions characteristic of other diseases suggests the probability of a microbic or parasitic

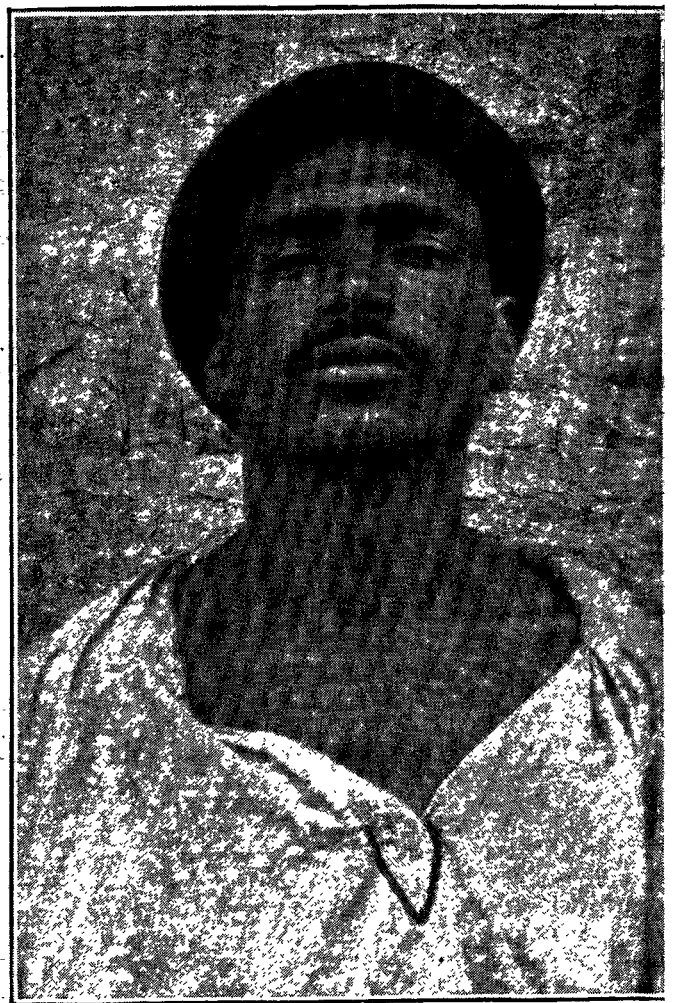
FIG. 1.



Before treatment. Treatment of goitre by thymol. Gi'giti. Three months' case. Duration of treatment 17 days.

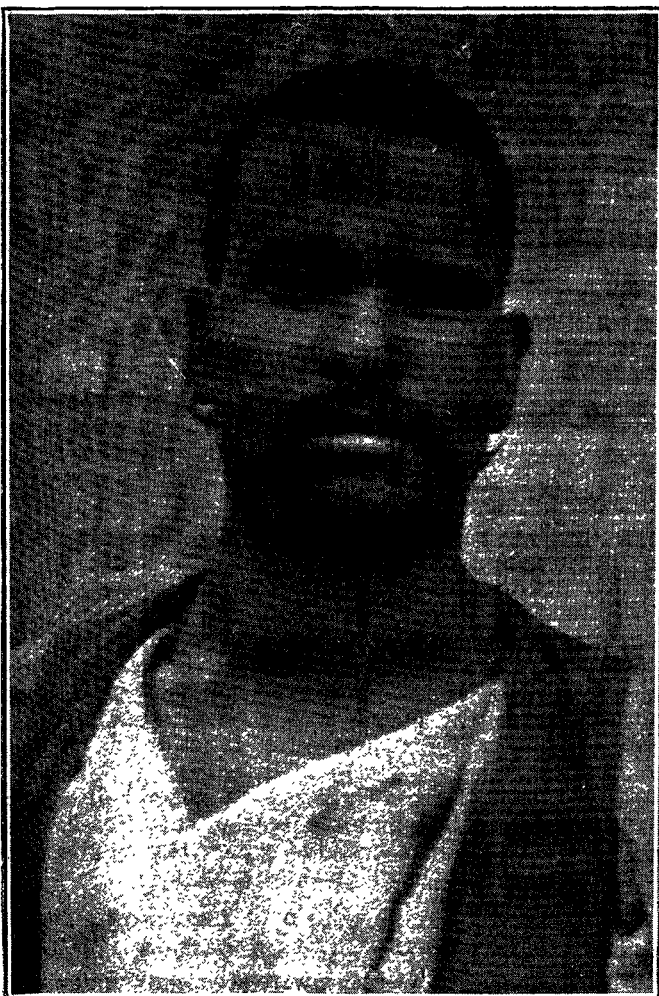
FIG. 3.

FIG. 2.



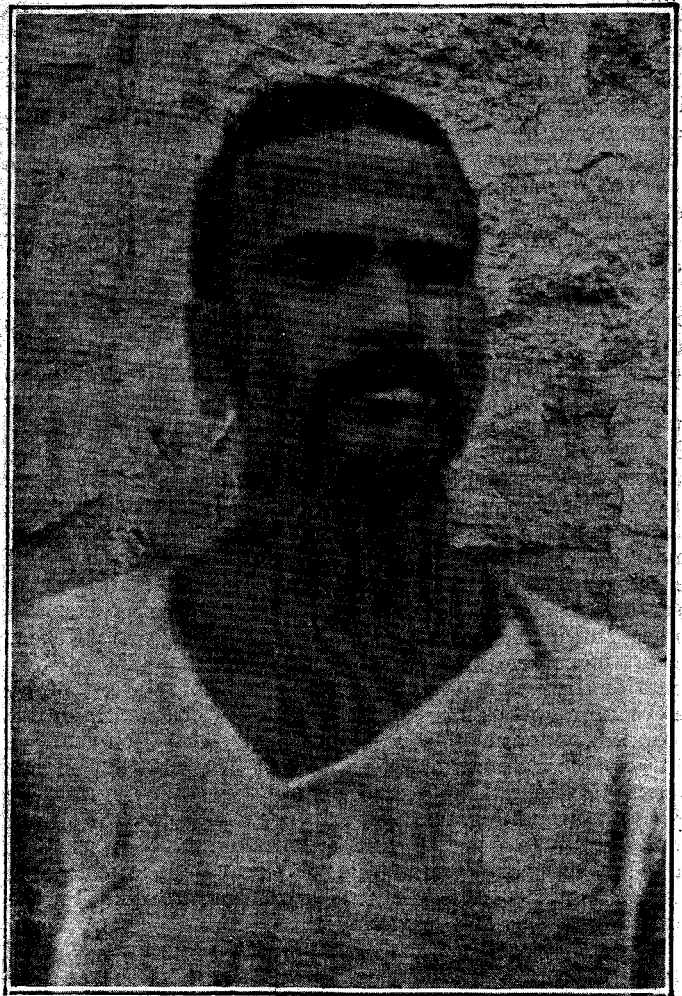
After treatment.

FIG. 4.



Before treatment.

Treatment of goitre by thymol. Hindustani newcor. e. Three months' case. Duration of treatment 17 days.



After treatment.

infection of the alimentary tract of man, as the etiological feature of the disease.

VI.—THE FÆCES IN GOITRE.

The following experiment was undertaken before it was discovered that dogs in Gilgit do not suffer from goitre. The results were negative, but the experiment is worthy of record. On Nov. 17th, 1905, five puppies, average age four months, were confined in a pen on ground near the village of Barmis where goitre does not occur. To these five puppies Barmis water, contaminated by the fæces of goitre patients, was given; their food also was contaminated in the same way. As a control five other puppies were confined in a similar pen, on the same ground, and to these pure Barmis water was given. At the conclusion of the experiment, on March 1st, 1906, only one dog was alive in each pen; the others had died in February owing to mange. No enlargement of the gland occurred. The experiment was undertaken to put to the test the view that possibly the organism which causes goitre is contained in fæces. A large number of microscopical examinations of the fæces have been made. There are up to the present time no definite results to record.

VII.—INTESTINAL ANTISEPTICS IN GOITRE.

The possibility of the intestine being the seat of infection in this disease having occurred to me, and the blood counts appearing to support such a view, I was led to try the effect of intestinal antiseptics in selected cases. The cases selected were those in which no secondary changes had taken place in the gland. The drug selected was thymol. The good effect of this line of treatment was immediately apparent. Cases of recent origin react at once and in some the enlargement of the gland disappears with extraordinary rapidity. The swelling in the course of the first week of treatment becomes soft and gradually disappears after a longer or shorter period depending apparently on the age of the goitre. Reproductions of photographs are here shown of cases in which the drug was administered (Figs. 1, 2, 3 and 4). Attention is directed to the duration of the treatment in each case shown. I have now cured 25 cases of goitre by means of thymol, the most rapid disappearance having taken place in 17 days, while the longest period over which the drug has been employed was 60 days. My practice is to administer 30 grains on the morning of the first day of treatment followed by a purge the same evening, after which ten grains night and morning are given in cachets. A large dose of 30 grains is administered twice a week, followed by a purgative. The treatment is kept up without intermission till the swelling disappears. No ill-effects have been observed to follow the use of thymol administered in this way. For the most part the cases cured by thymol have been of about three months' standing. In several instances, however, the duration of the disease has been one year and over.

Beta-naphthol also appears to act beneficially, though it has not been given the same extended trial as thymol. I notice that Woakes successfully used hydrofluoric acid in the treatment of goitre.⁷ I conclude that the beneficial effect of these drugs is due to their intestinal antiseptic action.

Not only is thymol beneficial in early cases but it is so in all cases in which the swelling is progressing. Among the troops here it is not uncommon to see men on arrival in Gilgit, who have served here before, who have a small unilateral enlargement of the gland which even removal from the district had not caused to disappear. The thyroid in these cases invariably enlarges again in Gilgit, and thymol has rapidly reduced it in all the cases in which I have adopted this line of treatment. In old-standing cases the seat of adenomata, the gland around the nodular masses becomes softer and retreats from the tumours, so that these latter are more readily visible or palpable.

Occasionally distressing symptoms are complained of by sufferers from goitre, such as feelings of suffocation, inability to sleep, &c., though these are more rarely met with than we might expect. Symptoms of this sort are relieved, in the two cases in which I have had an opportunity of trying the drug, in a marked degree and that very rapidly by the use of thymol. I have observed, also, in some early cases that even in as short a time as two or three days a noticeable difference is detected by the surgeon, as well as by the sufferer, in the size of the gland.

It is, as I have said, as common to see new cases of enlarged thyroid here in the spring as it is to see new

cases of enlarged spleen in the autumn. I now approach the treatment of the former by means of thymol with as much confidence as I do the latter with quinine. Most enlarged thyroids (those in which the gland is itself diseased and altered by secondary changes excepted) disappear with as much rapidity under thymol as do most spleens under quinine. I say "most thyroids" and "most spleens" advisedly, for there is no more reason for assuming that all enlarged thyroids are due to an infection of the intestine than for attributing all enlargements of the spleen to the hæmamoeba of malaria. Exophthalmic goitre is so rare in Gilgit that I have not had an opportunity of trying thymol in this disease. I would suggest its use in this affection.

It will be interesting now to marshal the facts which have been accumulated in such a way as to bring this disease into line with other diseases of an infectious nature. 1. Goitre is caused by an organism invading the body of man. All the evidence so far accumulated points to the intestine as the seat of infection. 2. In nature it lives in the soil of infected localities and is very limited in its distribution. 3. It is conveyed to man in the drinking water, by contact with soil, or by other means yet undetermined. 4. It requires a calcareous soil to enable it to flourish and produce goitre. 5. It can be conveyed by man to places where the disease has not hitherto prevailed and, if the conditions are favourable there, it can produce the disease. 6. The virus is, therefore, given off by persons suffering from the disease, in some way as yet undetermined, but not unlikely by means of the fæces. 7. The fact that it requires peculiar conditions of soil, &c., suggests a stage of development outside the body of man. 8. There is reason to believe that it is destroyed by admixture with pure water. 9. The organism flourishes best where there is a certain degree of moisture. 10. The organism requires a certain temperature, in all probability, to favour its development. 11. Where it gives rise to an epidemic the most susceptible individuals suffer most and first—namely, the children. 12. There is reason to believe that where the disease has prevailed for years a natural immunity is developed. 13. Those who come into close contact with the soil in their daily occupations suffer most. 14. Newcomers to a district acquire the disease very rapidly, from three weeks to one month being the minimum incubation period of this disease—20 per cent. of newcomers suffer. 15. Goitre shows a marked seasonal prevalence. 16. Goitre disappears when the patient leaves the infected area and cannot arise in the new area to which the patient goes unless the above conditions for the growth of the organism are present—calcareous soil, moisture, virus of the disease, and susceptible individuals. 17. The duration of life of the organism in the body of man is not great, as shown by the fact that the gland diminishes in size when the patient leaves the infected area. 18. An organically impure water may favour the spread of the disease. 19. All races suffer. 20. Women suffer more than men. 21. Certain conditions, such as emotional disturbances, attacks of fever, &c., act as predisposing or favouring causes. 22. Boiling and filtering the water alone do not prevent or cure the disease so long as people live on the infected site. 23. Domestic animals do not suffer from goitre or cretinism in Gilgit. 24. Large communities living on the infected site often escape; groups of houses also escape the disease. 25. Certain blood changes occur in goitre of an uncertain nature, but suggesting, from analogy with other disease, a parasitic or bacterial invasion of the intestine. 26. Goitre is rapidly cured by the administration of intestinal antiseptics.

It appears, then, that the disease, of which the enlargement of the thyroid gland is the external indication, differs little from other diseases of an infectious nature. The enlargement of the thyroid is not in itself the disease. In its beginning it is a pure hypertrophy, a protective increase in size, comparable to that of the spleen in certain other infectious diseases, and, like the spleen, it returns to its normal size when the causes which have stimulated the exercise of the gland's protective function have been removed.

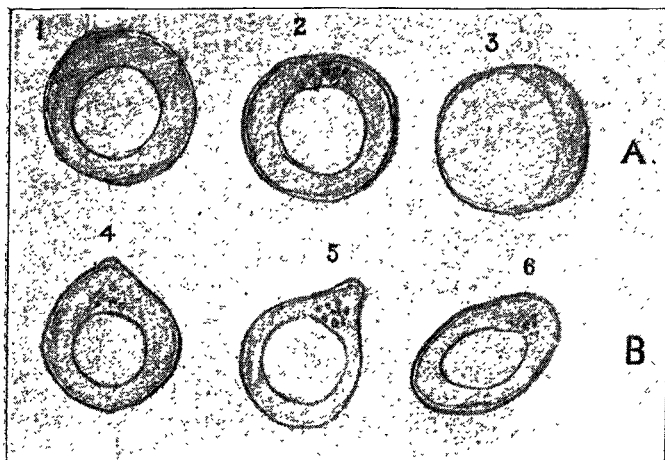
To sum up, then, I regard goitre as a general disease of an infectious nature in which the seat of infection is most probably the intestinal tract and of which the enlargement of the thyroid gland is the dominant symptom.

DESCRIPTION OF ORGANISMS FOUND IN FÆCES OF PERSONS SUFFERING FROM GOITRE. (*Examined under* $\times 800$.)

1. In fresh fæces two varieties were seen most frequently

—A, spherical; B, pear-shaped or oval. Colour, brownish-yellow; doubly contoured. Contents, central clear area surrounded by thin membrane, external to which is the protoplasm of the organism. In the latter coarse granules are frequently seen massed together at one pole of the central spherical body or nucleus (?). The central clear area varies in size, sometimes almost filling the whole organism. The size of the spherical and pear-shaped variety of the organism is fairly constant. I make it 18μ . The accompanying diagrams illustrate the above. (Fig. 5)

FIG. 5.



B, This variety usually possesses granules at one pole.

2. Spherical bodies also are seen in which the whole cell contents appear to be finely granular and in which the central clear space is not apparent or is obscured.

3. Occasionally on carefully focusing the surface of the sphere shown in drawing A a network faint in outline can be made out. This network appearance is confined, I am convinced, to the wall of the organism. It can only be seen when the surface which is nearest the observer is thrown into and out of focus. Whether this is a young form of the body described in paragraph 5 I do not know. I suspect it is.

4. The next most common form or stage of the organism to be seen is that in which the cell contents are undergoing division. This division is confined to the central clear spherical body already described. The protoplasm does not take part in it. Many appearances have been observed.

FIG. 6.

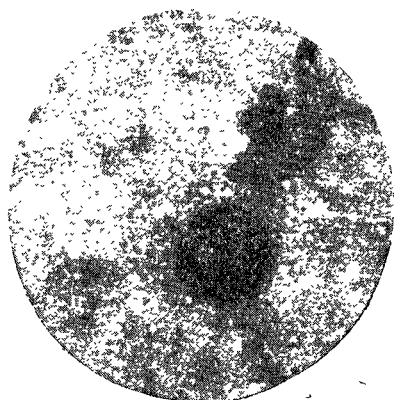


Fig. 6 shows the appearances presented beautifully; in this the rounded divisions are clearly seen on looking into it closely.

5. In addition to these organisms, which are all forms of the spherical, oval, or pear-shaped varieties, the following is observed. A perfectly spherical body slightly larger than the above and provided with prickles. This form is seen with great frequency. It presents different appearances according to the focus. When the surface of the sphere is in focus it is seen to be possessed of a network of clear spaces. See reproductions of micro-photograph (Figs. 7 and 8. Concerning Fig. 9 see paragraph 6). When, however, the body of the organism, the equator of the sphere, is in focus it is seen to be provided at intervals with prickles, while the cell contents may appear granular simply or divided into portions. On

bringing the distal pole of the sphere into focus the reticulated appearance of the cell wall is again seen. That this network is confined to the cell wall (shell) is shown by the facts noted in the next paragraph.

FIG. 7.

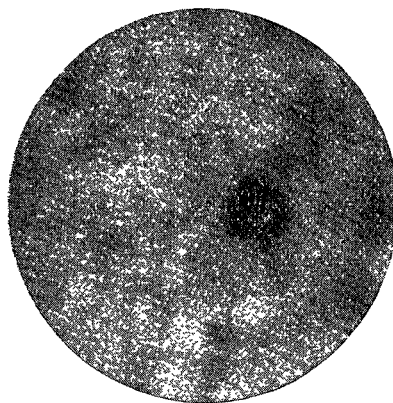


FIG. 8.

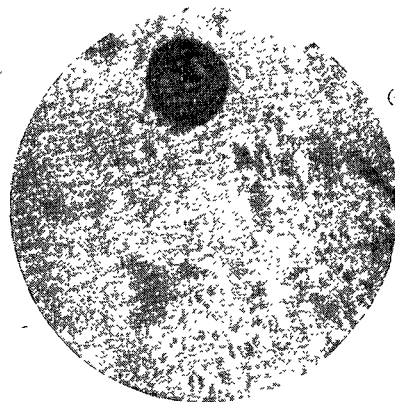
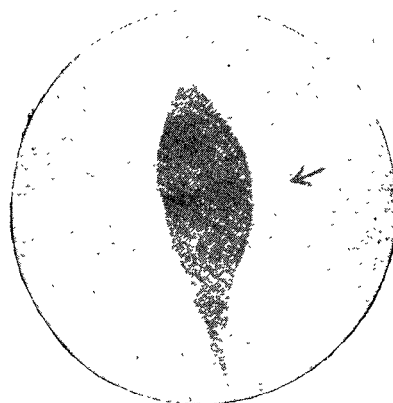
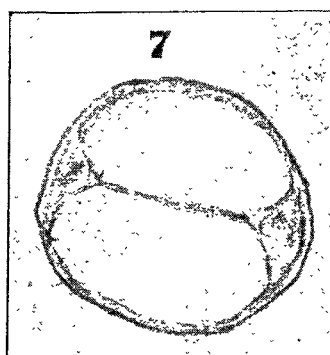


FIG. 9.



6. Portions of shell are frequently met with. In Fig. 10 a crack may be seen running across the organism and in the prickly variety a crack at some portion of the surface is

FIG. 10.



commonly observed. In addition fragments of shell of all classes shown are frequently met with (Fig. 11). In no case

APPENDIX I.

Experiments showing the Result of Boiling and Filtering Water Supposed to Cause Goitre.

Series I., Sonoghar, Chitral, July-August, 1904. The subjects of experiment were young men of better classes, residents in Chitral valley, not residents of Sonoghar. Period of observation, 60 days. Percentage of goitrous individuals in Sonoghar = 41·8.

A. Filtered water.—1. Six individuals, subjects of considerable goitre; drank only filtered water for two months. Four increased; one was conscious of it and two showed no appreciable difference. Average increase in size = 1·6 centimetres. 2. Seven individuals not sufferers from goitre. Four showed increase after two months, three no appreciable difference. Average increase in size of the four = 1·65 centimetres.

B. Boiled water.—1. Six goitrous individuals. Four showed increase; two cases conscious of it, two no appreciable difference. Average increase was 1·85 centimetres. 2. Four individuals; no goitre. Two increased, two showed no appreciable difference. Average increase = 1·45 centimetres.

C. Ordinary water of Sonoghar.—1. Twelve individuals, subjects of goitre. Nine increased; three showed no appreciable difference. Average increase = 1·75 centimetres. 2. 12 individuals, not subjects of goitre. Four increased; eight showed no appreciable difference. Average increase = 1·25 centimetres.

D. Control observations.—The subjects were natives of the village of Sonoghar. 1. Six individuals, subjects of goitre living under ordinary conditions of life and observed for two months. Three increased; three showed no appreciable difference. Average increase = 1·44 centimetres. 2. Two individuals, subjects of goitre, given boiled water for two months. One increased, 2·7 centimetres; one showed no appreciable difference. 3. One individual, subject of goitre, given filtered water for two months; no appreciable difference. 4. Six men, not subjects of goitre given ordinary water. Three increased; three showed no appreciable difference. Average increase = 1·2 centimetres.

The above experiments were carried out at the “Chitral Scout” Camp of Exercise, the men were under strict discipline, taking hard exercise daily, and having the ordinary sepoy’s ration. Allowing for all possible sources of error, increase in size of neck owing to fat, congestion, &c., or errors of measurement, it will be observed that no cases benefited by the use of boiled or filtered water. 20 per cent. of newcomers contracted goitre in two months in Sonoghar.

Series II.—Gilgit, autumn, 1905. The subjects of experiment were newcomers, Hindustanis, arrived Gilgit August, 1905. Period of observation 60 days.

A. Filtered water.—Four cases, small goitres. Two increased; patients conscious of increase. One unilateral swelling diminished; one showed no appreciable difference.

B. Boiled water.—Seven cases, small goitres; no appreciable difference could be detected.

C. Controls, no restrictions.—14 individuals, small goitres. 12 showed no appreciable difference, in one the gland was considerably larger, in one it was slightly smaller.

APPENDIX II.

Differential Blood Counts in Endemic Goitre.

A.—Cases of goitre of recent development (three months).

—	Polymorpho-nuclears.	Large mono-nuclears.	Small mono-nuclears.	Eosinophiles.	Remarks: Faeces.
1	59·3	7·0	25·7	8·0	—
2	36·9	10·3	32·8	20·0	Gland blood. Ascaris oxyuris in faeces.
3	32·0	15·0	39·0	14·0	—
4	46·2	12·6	34·0	7·2	Total leucocytes, 7800 per cubic millimetre.
5	40·0	13·6	35·0	11·4	Ditto. Ascaris in faeces.
6	45·0	14·0	30·0	11·0	Total leucocytes, 6250 per cubic millimetre.
7	50·5	12·3	30·0	7·2	—
8	39·2	14·2	30·0	16·7	—
9	43·0	17·0	30·0	10·0	Nil in faeces.
10	39·0	10·0	31·0	20·0	Ascaris in faeces.
11	44·0	18·0	30·0	8·0	”
12	40·0	10·0	35·0	15·0	Nil in faeces.
13	40·0	15·0	37·0	8·0	”
14	45·6	10·6	30·8	13·0	”
15	59·0	12·0	21·0	8·0	—
16	49·0	11·0	27·0	13·0	—
17	56·0	9·0	28·0	7·0	—
18	50·0	10·0	18·0	22·0	—
19	46·0	6·2	40·0	7·8	—
20	44·4	8·5	43·6	3·5	—
21	52·8	8·0	34·0	5·2	—
22	44·0	6·0	39·0	11·0	—
23	59·0	8·0	30·0	3·0	—
24	40·0	8·0	36·0	16·0	—

B.—Cases of former infection. The patients had suffered from goitre before, but the swelling had, in part or wholly, disappeared on leaving Gilgit, and reappeared on arrival again in the infected locality.

—	Polymorpho-nuclears.	Large mono-nuclears.	Small mono-nuclears.	Ecsinophiles.
1	61·2	9·0	22·5	7·3
2	59·0	9·0	20·0	12·0
3	67·6	6·6	18·8	7·0
4	60·0	7·0	28·0	5·0
5	53·4	10·0	30·0	6·6
6	30·0	15·5	42·0	12·5
7	44·0	20·0	33·5	2·5
8	54·7	9·0	30·0	6·3

C.—Cases supposed to be of about one year’s standing.

—	Polymorpho-nuclears.	Large mono-nuclears.	Small mono-nuclears.	Eosinophiles.
1	37·0	18·3	41·5	3·2
2	48·4	9·8	30·0	11·8
3	42·0	11·2	30·0	16·8
4	53·8	7·4	34·0	4·8
5	40·0	11·2	32·4	16·4
6	53·4	9·5	32·3	4·8

D.—Old-standing cases.

—	Polymorpho-nuclears.	Large mono-nuclears.	Small mono-nuclears.	Eosinophiles.
1	58·4	8·3	20·5	12·8
2	37·7	8·8	48·0	5·5
3	40·2	19·0	34·0	6·8
4	58·4	6·3	32·8	2·5
5	58·9	7·4	30·0	3·7
6	50·5	15·0	30·0	4·5
7	40·0	16·2	38·0	5·8
8	49·5	11·3	32·8	6·4
9	44·8	14·0	32·0	9·2
10	37·0	15·8	43·4	3·8
11	58·0	13·0	28·0	1·0
12	44·0	9·6	36·8	11·6

E.—Differential counts of cases of three months’ standing and at five months; no treatment.

—	Polymorpho-nuclears.	Large mono-nuclears.	Small mono-nuclears.	Eosinophiles.	Number of count.
1	40·0	13·6	35·0	11·5	First.
	49·5	10·0	32·3	8·2	Second.
2	39·2	14·2	30·0	16·6	First.
	47·0	10·0	37·0	6·0	Second.
3	43·0	17·0	30·0	10·0	First.
	47·8	5·2	33·7	13·3	Second.
4	39·0	10·5	31·5	20·0	First.
	32·0	7·0	45·0	16·0	Second.
5	46·0	10·5	33·0	10·5	First.
	57·8	8·1	27·3	6·8	Second.
6	40·0	10·0	35·0	15·0	First.
	45·3	9·6	3·0	14·1	Second.
7	59·0	12·0	21·0	8·0	First.
	65·0	7·0	21·0	7·0	Second.
8	56·0	9·0	28·0	7·0	First.
	42·7	7·8	37·8	11·7	Second.
9	30·0	15·5	42·0	12·5	First.
	36·5	5·0	44·1	14·5	Second.

Bibliography.—1. Endemic Goitre in the Chitral and Gilgit Valleys, Royal Medical and Chirurgical Society, April 10th, 1906. 2. Berry: Diseases of the Thyroid Gland and their Surgical Treatment, 1901. 3. Some Observations upon the Functions of the Thyroid and Parathyroid Glands, Journal of Physiology, Dec. 30th, 1904, vol. xxxii., No 1. 4. Glasgow Medical Journal, January, 1899. 5. Theory and Practice of Hygiene, Nottter and Firth, second edition. 6. Hamatozoon in Goitre, Brit. Med. Jour., Sept. 24th, 1898, p. 915. 7. Whitla: Materia Medica, THE LANCET, vol. i., 1881, pp. 443, 497, and 537. Gilgit, Kashmir, India.

WATER GAS, CARBURETTED WATER GAS, AND CARBON MONOXIDE POISONING.

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INTRODUCTION.

THE adoption in recent years by municipal and private gas companies of carburetted water gas as a substitute for, or as an admixture of, illuminating gas has given rise to some important questions from the public health and forensic points of view. These points, be it said at once, have reference mainly to increased risks of danger to health and life. The reasons which have prompted these companies to its use have doubtless much attraction from the standpoint of the gas-producer, not less probably from the economic side as from the comparative simplicity of production. These reasons may be briefly summed up as follows, viz.: (1) the plant required being more compact demands smaller ground space for its installation; (2) the product can be more quickly produced and therefore can be supplied more rapidly on occasions when a large supply of gas has suddenly to be provided in populous centres—as, for example, on sudden onset of fogs; (3) it requires fewer hands in its manufacture; and (4) it is cheaper, therefore, on the whole to produce. Whatever be the reasons, however, which have incited its adoption, the fact is established that in America, Great Britain, and other countries numerous cities have employed, and are now employing, it either as a substitute for ordinary coal gas or as a percentage admixture of coal gas.

It will be well at the outset to recall what is exactly meant by the gaseous compounds known as *water gas*, *producer gas*, and *carburetted gas*, and to contrast the composition of these with that of ordinary coal gas, as it is important, when the term "carburetted gas" is used, that its exact composition should be remembered. It should be understood that the two former are used for the motive power of gas engines and for heating purposes, whereas for public or domestic lighting purposes it is carburetted gas alone or carburetted water gas mixed with coal gas that is used. What are producer gas and water gas and how are they made? The former is made by passing air, or a mixture of air and steam, through incandescent coke or anthracite coal in a furnace generator or retort. The carbon ought to be about the temperature of 2000° F. in order to attain the point of maximum production of the gas. This is the mode by which it is made in the Dowson producer. The product consists of a mixture of hydrogen, nitrogen, marsh gas, and carbon monoxide, with carbon dioxide as its principal impurity. The latter, water gas, is manufactured essentially in the same way, except that steam only is passed through the incandescent coke, the product being chiefly carbon monoxide and hydrogen, in terms of the following equation: $C + H_2 = CO + H_2$. If, however, the temperature of the carbon be much lower than 2000° F. there is a relative increase of the CO_2 , thus: $C + 2H_2O = CO_2 + 2H_2$. Temperature of production, therefore, has an important influence on the percentage amounts of CO and CO_2 in the compound produced, and as the former gas is the desideratum, regulation of temperature of the carbon is of importance. According to Sachs¹ wood charcoal at 350° C. (662° F.) gives off 78·6 per cent. of CO_2 and 21·4 per cent. of CO, whereas at 1100° C. (2012° F.) it yields 1·3 per cent. of CO_2 only, and 98·7 per cent. of CO. Carburetted gas, or carburetted water gas as it is sometimes called, is a different product from both of the foregoing. It is manufactured by passing water gas, made as above, over a large superficies of heated refractory material charged with oils rich in hydrocarbons. The effect of this procedure is that the more volatile hydrocarbons are vapourised or rendered gaseous, and are thereby mixed with the water gas, the resultant product being what is called carburetted gas. The volatilised hydrocarbons thus incorporated are mainly benzene and benzene congeners, and they impart to the carburetted gas an odour similar in kind at least to the characteristic odour of illuminating gas made solely from coal.

The difference in composition between carburetted gas and olefiant or coal gas depends entirely on the mode of manufacture. Coal gas is a compound mixture of gases produced by the destructive distillation of bituminous or cannel coal in air-tight retorts by the agency of high temperature, which mixture, after having been purified by washing or scrubbing and by lime to rid it of objectionable ingredients, chiefly the sulphur compounds, is employed for municipal and domestic lighting and for power purposes. It is not necessary now to enter into details concerning the relative utility of these products further than to say that, in relation to coal gas, producer gas and water gas have low illuminating qualities and high heat-producing properties. From the public health point of view, however, it is important to note that the chief difference in the composition of producer gas, water gas, and carburetted gas, when contrasted with coal gas, is the relatively much higher proportional amounts of carbon monoxide which they contain. Coal gas, for example, may be said to contain on the average from 6 to 9 per cent. of carbon monoxide, whereas producer gas or water gas contains as much as from 25 to 50 per cent., and carburetted gas about 30 per cent. By reason, therefore, of the large increases of carbon monoxide in these last-named products, it will readily be perceived how, in certain circumstances of exposure to leakage, risks to health and danger to life will be substantially increased by the use of the former compared with the use of coal gas.

There can be no doubt whatever of the toxic effects of carbon monoxide gas when inhaled, and since this may be taken for granted no further elaboration of statement is at this stage needed. It has been argued by some, however, that the toxic influence following the inhalation of coal gas, or of carburetted gas, is not solely or entirely due to the carbon monoxide which each contains, but to the benzene and benzene congeners which each contains. Let us for a moment inquire if there be substantial ground for this belief, and if so, how far benzene present in the inhaled gas is a determining influence in the causation of death.

In a paper read before the Royal Society by Staehelin, in which were presented the results of a research into the action of coal gas on frogs, it was shown that on exposure of these animals to coal gas motor phenomena were produced which were not found if the coal gas had been previously purified by passing the gas through oil, and also that these motor phenomena could be reproduced if the purified gas were made to take up benzene vapour. Staehelin indicates that this research was initiated by reason of a statement by Vahlen that a difference does exist between the toxic action of common coal gas and that of carbon monoxide. It would appear from Staehelin's experiments that these differences depend on the presence of benzene in coal gas. Vahlen asserted that warm-blooded animals and frogs died more rapidly after exposure to coal gas than ought *a priori* to be expected from the amount of carbon monoxide which the gas contained. But Staehelin's experiments on warm-blooded animals with air containing a small percentage of benzene showed that no evil effects were observable. This, it was believed, is due to oxidation of the benzene within the body to an aromatic sulphate, in which form it is excreted from the body. The net result of these experiments by Staehelin seems to be that inhalation of benzene in coal gas does not produce definite appreciable toxic effects on man, and that the toxic effects produced must be held attributable to the contained carbon monoxide.² Moreover, the experiments made on behalf of the Departmental Committee on Water Gas, 1899, by Professor J. Lorrain Smith, showed that the evil effects of both coal gas and carburetted water gas are due to carbon monoxide alone and not to any other constituents, which are relatively harmless.³ From experimental evidence, therefore, as well as from experience, we are bound to consider the toxic influence of inhalation of these gases, apart from their general asphyxiating action, to be entirely due to carbon monoxide.

When pure, carbon monoxide is a colourless gas, with a very faint odour, and has a specific gravity of 0·9678. It is sparingly soluble in water, does not support combustion, burns with a pale blue light, and in burning unites with an additional molecule of oxygen from the air to form carbon dioxide. Producer and water gas have some, though slight, odour due to volatile products from the coke, while

¹ Die Kohlenoxyd-vergiftung in ihrer Klinischen, Hygienischen, und Gerichts-Aertztlichen Bedeutung, 1900.

² Transactions of the Royal Society, 1904; THE LANCET, Feb. 20th, 1904, p. 526.

³ Report of the Departmental Committee on Water Gas, 1899, Appendix vii., p. 127.