EXPERIMENTAL RESEARCHES CONCERNING TRICHOPHYTON TONSURANS, (THE RINGWORM FUNGUS).

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THE fact that it is possible to grow *trichophyton tonsurans* in several animal substances, and more particularly in Koch's nutrient gelatine, makes it possible to solve experimentally certain interesting problems. Indeed, the extent to which this field of investigation may be cultivated is indefinitely large, and if I now publish the results of only a few experiments, it is not merely because I think they are interesting in themselves, but because I hope they will induce other observers and practitioners to follow up a line of investigation which is calculated to extend our scientific knowledge, as well as help us to treat that most obstinate affection, ringworm of the scalp.

Experiments of this kind yield us important information regarding the vitality of the spores of the fungus. The spores of trichophyton certainly retain their vitality for a very considerable time after they have been detached from their host, as will be seen by a glance at the following table. The data are extracted from my notes regarding cultivations of the fungus, the experiments not being intentionally designed to show how long the spores live outside the body. The cultivations were made with hairs which, after being extracted from the scalp of the patient, were folded in white paper and kept in a box in my laboratory, in which the temperature was that of an ordinary London house.

TABLE I.—Having reference to the length of time the spores of *trichophyton* retain their vitality.

NEGATIVE.	POSITIVE.
1. Hairs extracted July, 1882; sown in nutrient gelatine January 5th, 1885. Up to January 22nd no growth.	Hairs extracted December 21st, 1884; sown April 5th, 1885. Growth.
2. Hairs extracted July 3rd, 1882; sown in nutrient gelatine January 22nd, 1885. Up to January 28th no growth.	Hairs extracted April 19th, 1887; sown November 22nd, 1887; examined November 26th. Growth.
3. Hairs extracted in the summer of 1882, sown in nutrient gelatine June 21th, 1885. Up to June 29th no growth of trichophyton.	Hairs extracted April 19th; sown December 14th, 1887; examined December 17th. Growth.
4. Hairs extracted September 21st, 1882; sown in nutrient gelatine July 9th, 1885. Up to July 30th no growth.	Hairs extracted April 19th; sown November 30th, 1887; examined December 2nd. Growth.
5. Hairs extracted January 9th, 1883; sown in nutrient gelatine July, 1885; examined July 13th. No growth.	Hairs extracted April 19th; sown December 3rd. Growth. Hairs extracted April 19th, 1887; sown February 9th, 1888. Growth. Hairs extracted April 19th, 1887; sown March 10th, 1888; examined March 13th. Growth.

Microscopical examination showed that the hairs in all these cases contained the fungus.

It would appear from these notes that after two years and a half the spores have lost their power of growth, but I do not wish to lay absolute stress on these negative experiments. Although the nutrient gelatine and method of cultivation were the same as those used in other experiments which had a positive result, I do not consider that they are sufficiently numerous to settle the point. The question is one which it would be easy to determine. All that is necessary is to put aside packets of hairs, and after an interval of, say, six months begin to cultivate them at comparatively frequent intervals until it is found that they cease to grow. It is quite certain, however, from the positive experiments that the fungus can live exposed to the ordinary room temperature of a London house for eleven months. I am under the impression that the vitality is retained after a considerably longer period than this, the impression being derived from a series of cultivation experiments carried on with other objects in view, and of which I have now no notes.

The data given under the positive table are selected from others in my possession. They may be relied upon as absolutely correct. Six hairs at least were sown in nearly all the experiments, and all doubtful experiments, and those in which adventitious fungi were present have been rejected.

I come now to the chief object of the paper, which is to describe

a series of experiments which were made with different substances, in order to ascertain whether and to what extent they exercise a destructive effect on the vitality of the fungus. I shall present these in a set of tables.

I may state once for all the method which was employed. A number of hairs were taken from a packet marked with the date of extraction, and placed in the medium the effect of which was to be tested. These hairs, after a given time, were removed from this medium and sown on the gelatine, a corresponding number of hairs being then taken from the same packet and sown on slides prepared from the same tube of gelatine which was used for the hairs that had been in the medium. These I called the "dry hairs," so that the medicated hairs, if I may so term them, and the dry hairs, were extracted at the same time from the same patient, and were cultivated at the same time, in gelatine from the same tube, at the same temperature, the conditions being in every respect the same, except that the medicated hairs had been subjected to the action of the medium, the effect of which it was desired to investigate. The number of dry hairs and medicated hairs was usually six or more respectively. Whenever a growth of adventitious fungi tended in the slightest degree to endanger the accuracy of the experiment, the series was rejected.

First of all I will deal with the action of common water on trichophyton, the effect of which will be seen by a glance at the following table:¹

TABLE II.—Common Water.

Time of Contact with the Medium before being Sown on Nutrient Gelatine.	Result.
32 days	Sterilised
16 "	"
7 "	"
2 "	Growth
2½ hours	"
2 "	"
1 "	"
Half an hour	"

The experiments recorded in the above table may be taken as "clean," and it appears from them that trichophyton is sterilised by being placed in common water for seven days, while it survives soaking for two days. It is, of course, evident that there is room for a further experiment in the interval of time which elapses between two and seven days. The temperature of the water was not recorded. The time of the experiments was summer. The practical application of this series is in the fact that mere washing with water of the head or of clothes or dressings leaves the vitality of the spores untouched.

A series of experiments were made with oil and fats. In Table III the effect of soaking the fungus in olive oil is shown to be nil.

TABLE III.—Olive Oil.

Time of Contact with the Medium before being Sown on Nutrient Gelatine.	Result.
27 days	Growth
13 "	"
4 "	"
3 "	"
25 minutes	"

It is, of course, understood that in these cases the growth has nothing to do with a supposed growth in olive oil. The spores did not develop until placed in the nutrient gelatine, but, as is evident from the above table, soaking in olive oil for as long as twenty-seven days had no effect on the vitality of the fungus. It grew as luxuriantly as if it had been planted in the gelatine immediately after extraction. Experiments with lard and one experiment with vaseline gave a like result.

TABLE IV.—Fat.

Time of Contact with the Medium before being Sown on Nutrient Gelatine.	Result.
4 days	Growth
3 hours	"
2 "	"
1 "	"

¹ Water that had been boiled was used for the experiments, but otherwise no special precautions were taken to exclude germs. The vessels, for example, in which the boiled water was placed were not sterilised. In using unboiled water the growth of adventitious fungi is usually so great that the experiments are worthless. Even in using boiled water with unsterilised vessels the growth of adventitious fungi is often somewhat embarrassing.

TABLE V.—*Vaseline.*

Time of Contact with the Medium before being Sown on Nutrient Gelatine.	Result.
8 days	Growth

It appears, therefore, from Tables III, IV, and V that olive oil, lard, and vaseline exercise no injurious effect on the vitality of trichophyton. Contact with olive oil for twenty-seven days, with fat for four days, and with vaseline for eight days had no effect in checking the development of the fungus after it was placed in nutrient gelatine.

From the practical, if not from the scientific, side, the action of ordinary soap-lather or soapsuds is of interest, the question of whether the head should be washed or not with common soap and water being one that is frequently asked by the parents of children suffering from ringworm. The soap-lather that was used for these experiments was obtained from ordinary soap sold in shops for toilet purposes.

TABLE VI.—*Soapsuds.*

Time of Contact with the Medium before being Sown on Nutrient Gelatine.	Result.
3 days	Sterilised
25 hours	"
24 "	Three hairs sterilised; a little growth in two
6 "	Sterilised
30 minutes	Slight growth
30 "	Almost complete sterilisation

It will be seen from the above table that a comparatively short period of contact with soapsuds destroys the vitality of the fungus.

The method in which these experiments with soapsuds were carried out was ill fitted to lead to a very exact result as regards time. When it was found that the results were somewhat unequal, it occurred to me that I had not taken sufficient precautions to remove the soap from the hairs before placing them in the gelatine. The excess of soapsuds was removed by the hairs being rolled over on the smooth surface of the solidified gelatine at a little distance from the grooves that were made for the reception of the hairs. It is evident that if any soap lather is left in contact with the root of the affected hair, the action will continue to be exerted on the spores for some time after the hair has been placed in the groove on the gelatine, so that the action may have been continued longer than might appear from the notes.

If I were to repeat these experiments I should carefully wash out the soapsuds from the hairs before sowing them. The experiments, however, show that the ordinary soapsuds had exerted a destructive influence on the vitality of the fungus. That that influence is not immediate may be partly explained by the fact that it will naturally take some time before the action of the soap penetrates to the centre of the hair. In those cases in which I have noticed "slight growth," "a little growth," and "almost complete sterilisation," it was seen that, instead of the abundant straight growth of mycelium which is observed after two to three days' contact with the gelatine, only a few short isolated mycelial buds were observed on several points of the hair. This was probably due to the fact that the spores which had been fertile were situated in the centre of the hair, had therefore not been so much acted on by the soap, and from their position had taken more than the usual time to grow beyond the margin of the hair.

A quicker result took place when the hairs were immersed in soft soap (*sapo mollis* of the *Pharmacopœia*). It will be seen that while contact of the hairs with soft soap for half an hour resulted in complete sterilisation, a contact of thirteen minutes did not destroy the vitality of the spores. Again, this result was probably due to the fact that the contact did not last sufficiently long to enable the soft soap to penetrate the centre of the hair. In any case, the important fact stands recorded that a ringworm hair may be in contact with soft soap for thirteen minutes at least, and the vitality of all the spores not be destroyed.

TABLE VII.—*Soft Soap.*

Time of Contact with the Medium before being Sown on Nutrient Gelatine.	Result.
4 days	Sterilised
2 "	"
6 hours	"
5 "	"
1 hour	"
30 minutes	"
13 "	Growth

Contact with 1 per cent. acetic acid was found to sterilise the fungus. On the other hand, as will be seen from Table IX, its vitality survived the contact for three days with 1 per cent. solution of carbonate of soda.

TABLE VIII.—*1 Per Cent. Acetic Acid.*

Time of Contact with the Medium before being Sown on Nutrient Gelatine.	Result.
13 days	Sterilised
3 "	"

TABLE IX.—*1 Per Cent. Carbonate of Soda.*

Time of Contact with the Medium before being Sown on Nutrient Gelatine.	Result.
13 days	Sterilised
3 "	Growth

The fact that trichophyton is uninjured by prolonged contact with simple fat renders it of more than usual interest to ascertain the effect of ointments with simple fat as their basis. The following table gives the result of sulphur ointment of various strengths, the unity of strength being taken from the *Pharmacopœia*.

TABLE X.—*Sulphur Ointment.*

Time of Contact with the Medium before being Sown on Nutrient Gelatine.	Result.
4 days (half strength)	Sterilised.
21 hours (whole strength)	"
24 " (half strength)	"
6 "	"
2 " (quarter strength)	"
1 hour "	Of three hairs growth in one hair, none in two

It will be seen that sulphur ointment in comparatively feeble strength soon exerts a destructive effect on the ringworm fungus, contact with a quarter strength of the *Pharmacopœia* for two hours having proved destructive, and for one hour to a large extent sterilised the spores. Of course it must be borne in mind that both in this and the following experiments with ointments a certain amount of ointment would be conveyed on the hair when it was placed in the groove on the gelatine, although I tried to obviate this as much as possible by wiping the hair on the surface after it was removed from the ointment.

As white precipitate and citrine ointments have been and still are largely used in the treatment of ringworm, the following experiments were made.

TABLE XI.—*White Precipitate Ointment.*

Time of Contact with the Medium before being Sown on Nutrient Gelatine.	Result.
24 hours (full strength)	Sterilised
2 " "	Sterilisation almost complete
24 " (half strength)	Sterilised
6 " "	"
2 " "	Growth
2 " (quarter strength)	"
1 hour "	"

From this it appears that, whilst contact for six hours with half the pharmacopœial strength sterilised the spores, they survived the contact of a hair with half strength for two hours. We must again bear in mind the probability that the ointment would not in a short time penetrate to the centre of the hairs, and in reasoning from these experiments as to the effect of similar strengths of the ointment on the scalp it is not to be forgotten that at the temperature of the scalp the ointment would be almost fluid in consistence.

As appears from the following table, citrine ointment appears to exercise a more destructive effect on the fungus than the white precipitate ointment.

TABLE XII.—*Citrine Ointment.*

Time of Contact with the Medium before being Sown on Nutrient Gelatine.	Result.
24 hours	Sterilised
21 "	"
24 " (half strength)	"
2 " (quarter strength)	"
1 " "	"

It will be seen from the above table that when a ringworm hair had been in contact for one hour with quarter strength (*pharmacopœial*) the spores were sterilised. In this, as in all the other

cases, the control hairs which had not been in contact with the ointment had developed trichophyton freely.

Clinical experience makes it very interesting to note the effect on the spores of trichophyton of contact with croton oil.

TABLE XIII.—*Croton Oil.*

Time of Contact with the Medium before being Sown on Nutrient Gelatine.		Result.
7 days	29 hours	
...	...	Growth
...	...	..

The two experiments recorded in Table XIII are not the only ones I have made with croton oil. Before these cultivations were carried out I had made several others, and although I had acquired from them the conviction that croton oil had no injurious effect on the spores, yet as I could not be certain from the profuse growth that there was no admixture of adventitious fungi, I waited until I could get results in which the question of mixture with outside fungi could be entirely excluded, as was the case in the experiments recorded in this table. It will be seen that after hairs had been plunged for seven days in croton oil the vitality of trichophyton was in no way injured.

It will, no doubt, have struck the reader that these experiments might have been more exhaustive in character. It will seem to him, for example, that it would have been so easy to determine the point at which the action of common water sterilises trichophyton, or to find out the exact length of time that was required by a given strength of sulphur or mercurial ointment or any other of the common applications in ringworm of the scalp in order to effect sterilisation; that I might have waited, before publishing, until I could get more exact information on these points; but, easy as these experiments are, particularly to those who are familiar with the process, they still require a considerable amount of time. The experiments that I have now recorded were mostly finished in the summer of 1887; and, as I have since not been able materially to extend them, I have thought it better to publish them as they stand, hoping, I trust not in vain, that other workers, who have perhaps more time at their disposal, may see what a rich field there is here for experiments which are so interesting from the clinical side, and may take up the thread which for the time being I have let fall.

Something may be learned from these experiments that may be useful to us in practice. We may gather, for example, that the action of soap and water on the scalp, unless prolonged to a much greater extent than is at all likely, will not destroy the power of growth of such spores as may happen to be living amongst the scales on the surface. Secondly, we now know with definite certainty, what was fairly well understood before on clinical grounds, that the action of simple fat is not sufficient to destroy the vitality of the spores. Although the scalp were smeared thickly with fat or vaseline, the vitality of all those spores that were lying in the epidemic scales or in the mouths of the follicles would remain uninjured, although I have little doubt that they would cease to grow until the fat had been removed. On the other hand, we learn that an ointment which contains a comparatively small proportion of the ordinary antiseptic preparations that are used in the treatment of ringworm is destructive to all the spores that come in contact with it if the contact is prolonged for a comparatively short time. If the scalp, for example, is smeared in a weak strength of sulphur ointment, there is no doubt that all the spores are destroyed except those that are deeper in the hair-follicle than the ointment can penetrate.

The distinct antiparasitic effect of weak strengths of white precipitate and citrine ointments, notably of the latter, is also experimentally shown to be certain.

But very interesting it is indeed to note the result of the plunging of ringworm hairs in croton oil. Croton oil (as most readers who have given any attention to the literature of the subject are aware) has been greatly lauded in the treatment of ringworm. The method has not been generally adopted in France, where it was originally suggested, and I hardly think that the support which it has found in this country has led to its being much used. I have nothing to add to what I have expressed on this subject in my book on *Ringworm*. That it is a powerful, although not a certain, remedy in ringworm of the scalp is certain; but the inflammation that it produces and the impossibility of being certain that baldness will not follow its use are drawbacks which,

in my opinion, are sufficient to prevent its being used at all by practitioners who are careful that neither the health of the patient nor the permanent vitality of the hairs of the scalp should be injured. However, the fact remains that in a certain number of cases ringworm of the scalp can be removed by croton oil. What, then, is the action of croton oil? Certainly not that of a parasiticide. Spores that have been soaked in croton oil grow luxuriantly as soon as they are placed in a proper medium. The curative effect of croton oil, then, must depend on the inflammation that it produces, and we are led back to the doctrine which I have maintained for a considerable number of years, that the remedies which cure ringworm of the scalp do so, not in virtue of their parasitic effect, but in virtue of the inflammation which they produce. It is the products of inflammation that cure ringworm of the scalp. The wise practitioner is he who chooses the methods suitable for each individual case—such methods as will produce a certain amount of congestion and no more, a congestion that, if steadily maintained for a sufficient length of time, will gradually lead to the destruction of the vitality of the spores, but which is never allowed to reach a point that will either injure the skin superficially or destroy the hair-follicle.

I may be pardoned for reiterating the expression of my opinion that there is no fixed formula to produce these results. The practitioner must, in accordance with the peculiarities of each individual case, select both his remedies and the strength of his remedies, and, above all things, take care that, whether the disease lasts a longer or shorter time, neither the health nor the scalp of his patient shall be allowed to suffer.

ON THE

OPERATION OF OPENING THE SHEATH OF THE OPTIC NERVE FOR THE RELIEF OF PRESSURE.

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MR. PRESIDENT.—It may possibly be within the knowledge of some of my audience that, on March 21st, 1887, I read before the Medical Society of London a detailed account of a case in which I had incised the sheath of the left optic nerve, behind the eyeball, for the relief of great swelling of the disc—swelling which, in that case, was monocular only. The patient made a good recovery, and my paper was printed *in extenso* in the number of *Brain* for July of last year, and also in the tenth volume of the *Proceedings of the Medical Society*. I have since performed the same operation in three other cases, the histories of which I am desirous briefly to relate.

The first of these was that of a man about 45 years old, who was under the care of Dr. Ferrier in the National Hospital for the Paralysed and Epileptic. In addition to some obscure symptoms of intracranial disease, there had been swelling of both optic discs, which was apparently passing into atrophy. The vision had for some time been failing. In the right eye it amounted to $\frac{1}{3}$ ths; in the left it was recorded by Dr. Hull, the house-physician, as being bare perception of light. I opened the nerve-sheath of the left eye; and, in testing vision a few days afterwards, I thought at first that perception of light existed, but, on careful blocking up of the right eye, I found that it did not. I could not feel quite sure whether Dr. Hull had been deceived, as I was myself for a time, or whether perception of light had been lost subsequently to the operation, either by the natural progress of atrophic change, or by some injury inflicted upon the nerve. I did not think the latter explanation could possibly be the true one; although, from the shape of the orbit and other circumstances, the operation had been difficult of performance. In consequence of the doubt, I decided not to touch the other eye unless its vision