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Contributors

Hoggan, Frances Elizabeth.
Hoggan, George.
Royal College of Physicians of Edinburgh

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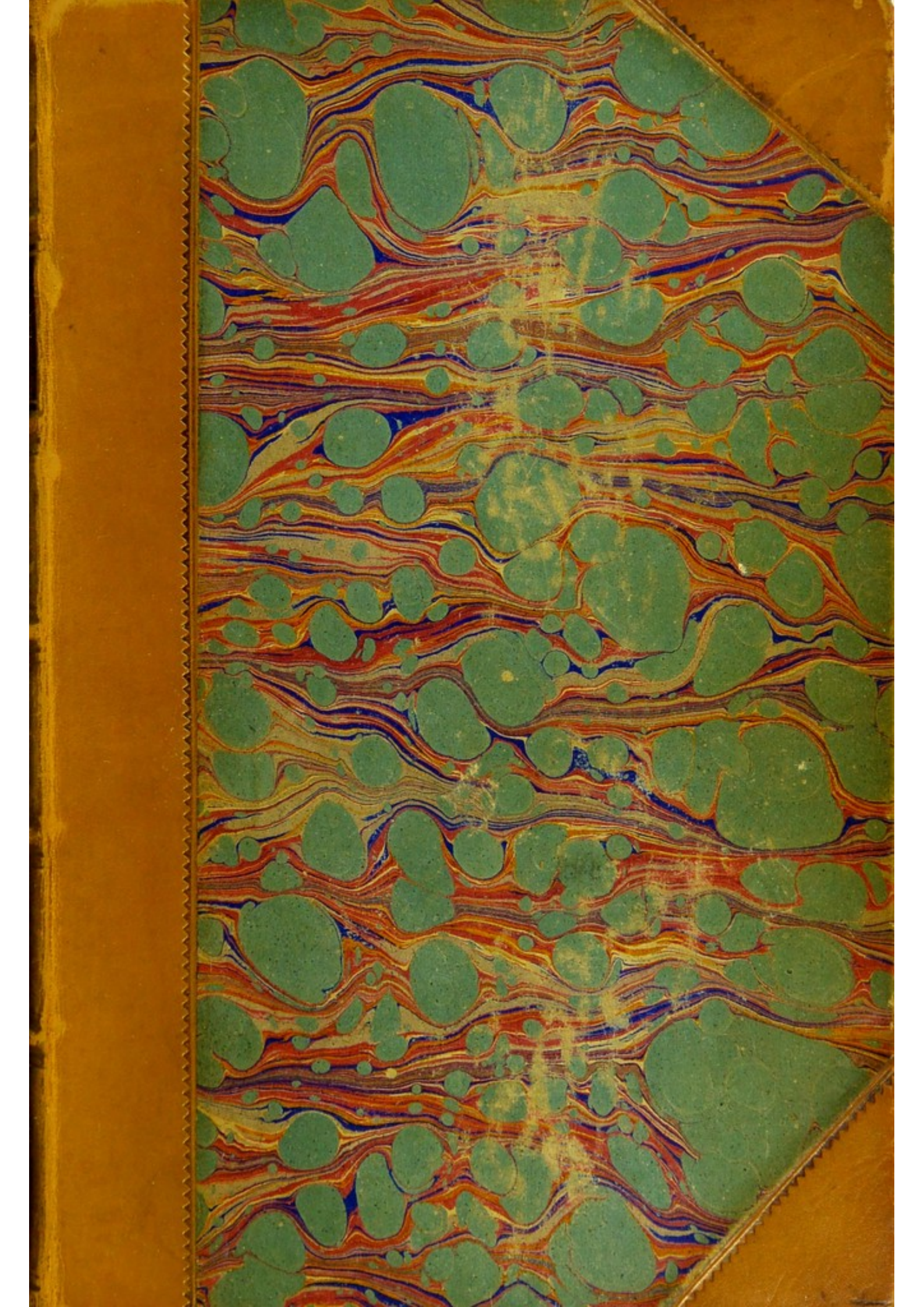

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ALCOHOL

ITS FUNCTION AND PLACE

A LECTURE

Delivered before the University Temperance Society

By THOMAS R. FRASER, M.D., F.R.S.

PROFESSOR OF MATERIA MEDICA IN THE UNIVERSITY OF EDINBURGH

WITH DIAGRAMS AND TABLES

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ALCOHOL: ITS FUNCTION AND PLACE.

GENTLEMEN—When I was invited by our Chairman—the Honorary President of the Edinburgh University Temperance Society—to address you on the subject of alcohol, I complied with the request with a greater readiness than further consideration perhaps justified, for at the time I hardly apprehended the fact that the Society adopts as a distinctive principle, total abstinence from alcoholic beverages. I am, therefore, now obliged to claim your indulgence when I make the confession that that distinctive principle is not one which has been adopted by me. Notwithstanding this serious blot in my character, I feel sure that I may claim to be so far in harmony with all of you, that I fully recognise the evils of immoderation. May it not also be that the personal acquaintance which I believe I almost daily make with that which the members of this Society daily shun, has given me a greater knowledge of, and therefore, perhaps, some greater justification than I otherwise would have in venturing to address you on the subject whose title has been admirably suggested for me, *viz.* "*Alcohol, its function and place*"?

We are all only too familiar with some of the effects of alcohol, and we easily and quickly recognise these effects. They prompt us, for example, to give a wide berth to persons exhibiting them on the street, during our New Year's carnival; to treat with kind compulsion, or it may be

equivocation, the inebriate who is only too ready to imitate the Donnybrook custom of inviting a pugilistic encounter; and to esteem at its proper value the gushing, or rather hesitating assertion of everlasting friendship which the amiable inebriate attempts to persuade us is worthy of our acceptance.

But, gentlemen, the recognition of these and other gross manifestations of the effects of alcohol teaches us very little of its action. Each manifestation, each symptom as we say, is the result of some change in the normal function of the structures and organs of which the body is composed, and unfortunately there are a number of modifications of great importance which cannot be recognised by mere symptoms, or by merely examining, as closely as we are capable of doing so, the conduct or appearance of any one under the influence of alcohol.

In short, the problem is a complicated one, and like all other complicated problems, it requires, before it can be solved, that the conditions of the experiment should be simplified and varied. The explanation of each symptom may be found in a number of possible actions of alcohol, and in order to arrive at the real one, it is necessary to eliminate those by which the symptoms are not produced. Well, it is asserted for alcohol that it is a food. If it be a food, it must have certain chemical properties, and it must produce certain effects on nutrition. Experiments are required to determine these necessary conditions, such as chemical examinations of alcohol, and of the changes of a chemical nature which take place in the body after it is swallowed. We all know, also, that alcohol, in a remarkable manner, modifies the ability to walk steadily—the motor function of the individual. Now, to illustrate the difficulties of the problem, let me say that this impairment of motor function may result from any one of at least five possible and different actions—an action upon

the sensory nerves, or upon the spinal cord, or upon the brain, or upon the organs of vision, or of hearing. It is of the highest importance to determine which of these actions is the cause of the symptom : for, in the first place, the determination results in the acquisition of a fact ; and in the next place, that fact would materially influence our notion of the danger likely to follow the action. If it were an action on the brain, for example, we would be inclined to regard alcohol as a more dangerous substance, or this symptom as a more dangerous symptom, than if it were merely produced by an action on some of the sensory nerves in the lower limbs. Unfortunately, the most careful scrutiny of the individual presenting alcoholic unsteadiness of gait will not lead us to the solution of this or of similar problems ; and those who are interested in their solution—whose duty, indeed, it is to try to arrive at a solution—must adopt methods of inquiry in which, as I have already stated, the conditions are more simple than in the complex experiment which we have only too frequently an opportunity of observing.

Now, gentlemen, as a result of observation, and of chemical and physiological experiment, a number of facts have been ascertained with regard to the action of alcohol, although many problems still remain for further investigation.

One fact, which it seems to me cannot admit of doubt, is that the effects differ widely in accordance with the quantity that is taken. It would, indeed, be wonderful if this were not so, for alcohol would then be an exception to every known substance capable of modifying function, or even nutrition. A small quantity of any of our medicines renders it a valuable modifier of function when disease exists ; a large quantity renders it so pernicious a modifier that it may produce death. A moderate quantity of a food, or a substance that modifies nutrition, renders it an essential to life ; a large quantity renders it a substance that most injuriously and

uncomfortably modifies the process of nutrition. Nor is this simply or always a difference of *degree*, it may also be a difference of *kind* of action. A few drops of sulphuric acid mixed with water will produce certain changes in the stomach which may result in improved digestion of food; a table-spoonful of sulphuric acid, on the other hand, will produce totally different changes, as a result of which the stomach will no longer be able to digest food.

Action on the Stomach and Digestion.—This elementary but nevertheless most important fact is exemplified throughout the entire range of the special actions of alcohol. When a small quantity is introduced into the stomach, it increases the amount of blood in the walls of that organ, it causes the gastric juice to be poured out abundantly, and it stimulates the muscular fibres to contract, so that the movements of the stomach are increased. The effect of all this is that the digestion of food is rendered more rapid and complete. To produce these effects, which I venture to regard as beneficial, it is necessary, however, not only that the quantity should be small, but also that this small quantity should be diluted sufficiently, either before it is taken, or afterwards by the food in the stomach, and the diluting material must be equal to at least 50 per cent. of the alcohol.

If the quantity be a large one, or if it be taken in a more concentrated form than that of a dilution of 50 per cent., the effects are very different from those which I have described. The small cells, known as epithelium cells, which line the interior surface of the stomach, lose their translucency and become dim or opaque, the flow of gastric juice is impeded, and from any gastric juice that may be present in the cavity of the stomach, there is thrown down, or precipitated, in a condition that is useless for digestion, a substance which is termed pepsin, and which constitutes the most efficient digesting ingredient in that juice. Dyspepsia

is thus apt to be produced, and it becomes an uncomfortable and familiar monitor, whose warnings are, however, only too frequently neglected by those who habitually or frequently partake of alcohol in a concentrated form—as nips for example—in the intervals between meals.

The frequent repetition of doses of alcohol in too concentrated a form results, further, in changing the structure of the stomach. Inflammation is originated, the cells and glands of the interior surface become deteriorated, only an insufficient quantity of gastric juice can be secreted, and, as a consequence, food is no longer properly digested. There is reason to believe that when excessive quantities of alcohol are taken for a considerable period—even if in a diluted state—the same pernicious effects are produced. And to add to this category of evils which fall upon the unfortunate stomach, Dr. Richet has shown that large quantities greatly increase the acidity of the gastric juice, and thereby entail the sufferings of acid dyspepsia upon the immoderate consumer of alcoholic beverages.

Action on the Circulation.—When a substance that is volatile and capable of passing through membranes is introduced into the stomach, it almost instantly commences to diffuse into the small blood-vessels that ramify on the walls, and is quickly carried to the heart, and thence to every part of the body. As alcohol is both volatile and diffusible, its entrance into the blood from the stomach is extremely rapid, and the general effects of its action soon show themselves. Among the earliest of the effects subsequent to absorption, is that upon the circulation. I daresay most of us are familiar, at any rate from observation, with several of these effects. Some of us may have experienced an increased beating of the heart, or a degree of throbbing of the arteries ; and all of us may have observed the flushing of the face, neck, or hands, which follows the drinking of even moderate quantities of

alcohol. These effects result from a double action upon the circulation. Nearly simultaneously, after small or moderate quantities, the heart is quickened and contracts more forcibly, and the small blood-vessels, everywhere present on the surface of the body, become dilated. If the pulse be counted before and after a small quantity of wine is taken, a slight increase in the number of pulsations will be discovered, and each pulse-beat will be found to be more strong and full than before the wine was taken. Now, we have a small instrument, invented a few years ago by a Frenchman, Marey, and called a sphygmograph, by means of which the movements of the arteries, or what we call the pulse, are written upon paper by the pulse itself, and so a permanent graphic record is obtained, and errors on the part of the observer are avoided. I show you such writings made by the pulse in three experiments I recently made with alcohol.

In each experiment, half an ounce of absolute alcohol, diluted with two ounces of water, was taken after the person who kindly formed the subject of experiment had been in bed for a short time. The pulse writings or tracings were obtained while the recumbent posture was continuously maintained, and without removing, or in any way changing the position of the sphygmograph on the wrist.

The series of tracings in the first experiment (Figures 1 to 6) was obtained from a man, 30 years of age and in good health. You will observe that the effects produced by the alcohol are very marked and obvious, the tracing of the pulse before alcohol was taken (Fig. 1) being very different from the tracings subsequent to alcohol (Figs. 2 to 6). There is an obvious increase in the amplitude of each pulsation, indicating both a diminished resistance to the flow of the blood through the artery, the result of dilatation of blood-vessels, and a greater strength in the contractions of the heart. The man who was the subject of experiment had been for years a hard drinker,

FIG 1.—WILLIAM W.—5 minutes *before* alcohol.—Pulse, 66 per minute.

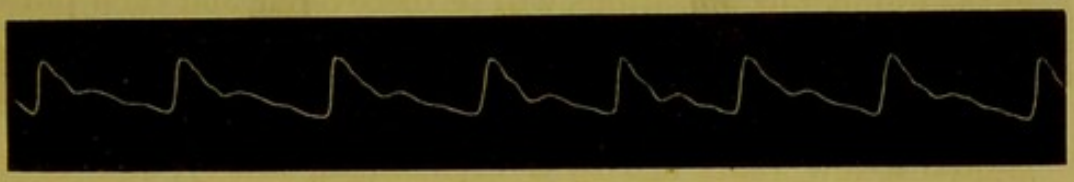

FIG. 2.—5 minutes after alcohol.—Pulse, 70 per minute.

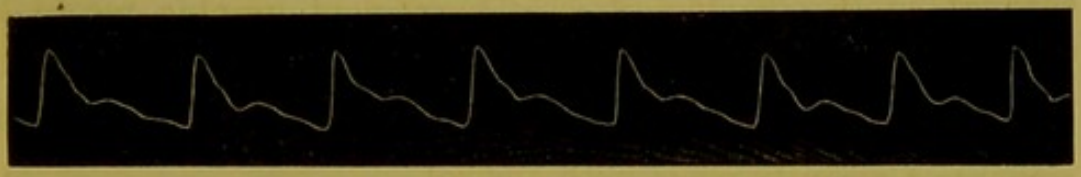

FIG. 3.—25 minutes after alcohol.—Pulse, 74 per minute.

FIG. 4.—40 minutes after alcohol.—Pulse, 72 per minute.

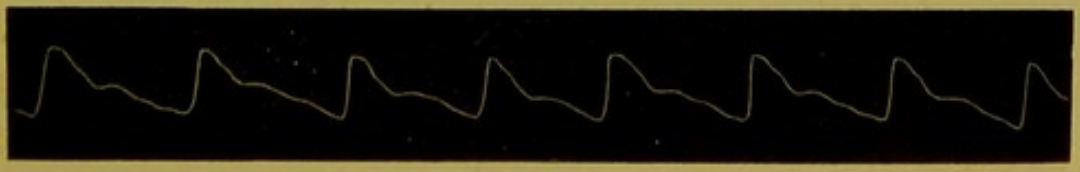

FIG. 5.—1 hour 50 minutes after alcohol.—Pulse, 73 per minute.

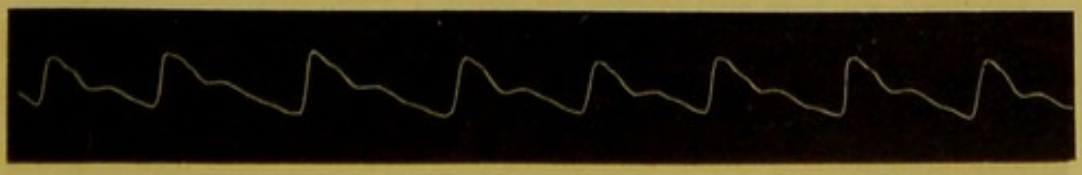

FIG. 6.—4 hours 25 minutes after alcohol.—Pulse, 72 per minute.

FIG. 7.—ALFRED G.—10 minutes *before* alcohol.—Pulse, 90 per minute.

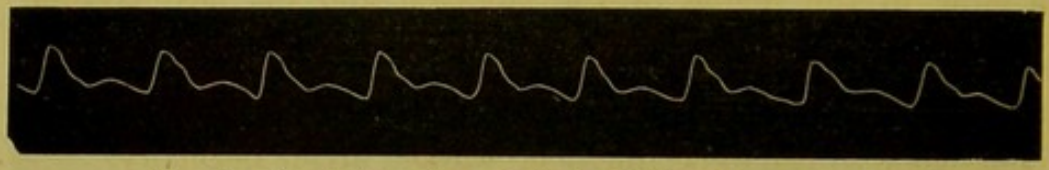

FIG. 8.—5 minutes after alcohol.—Pulse, 96 per minute.

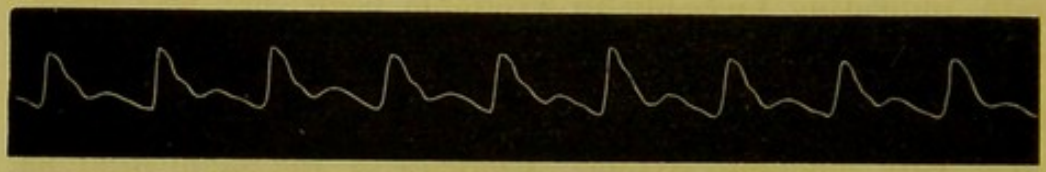

FIG. 9.—20 minutes after alcohol.—Pulse, 92 per minute.

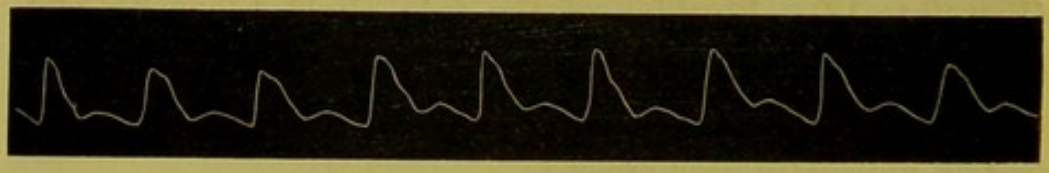

FIG. 10.—30 minutes after alcohol.—Pulse, 90 per minute.

FIG. 11.—55 minutes after alcohol.—Pulse, 86 per minute.

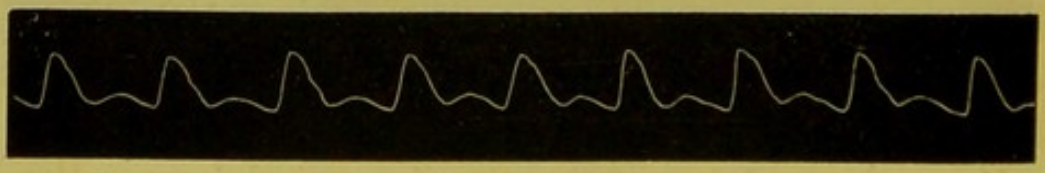

FIG. 12.—1 hour 30 minutes after alcohol.—Pulse, 84 per minute.

FIG. 13.—1 hour 50 minutes after alcohol.—Pulse, 82 per minute.

but had not taken any alcoholic beverage for nearly three months. He considered himself exceptionally insusceptible to the influence of alcohol, and, indeed, boasted that he could drink a very large quantity without any sympton of intoxication being induced. Soon after drinking the alcohol, he felt a glow in the region of the stomach, and his face became flushed at about the same time; but neither confusion of ideas, nor difficulty of articulation was produced, and at the conclusion of the experiment he walked about normally.

The subject of the second experiment had a rapid pulse-rate, indicating probably an excitable heart, but was otherwise in a perfectly normal condition. He is 20 years of age, and weighs rather more than 10 stone, and he drinks alcohol to a very moderate extent. Changes of the same kind as those in the first experiment were produced in his pulse (Figs. 7 to 13). Flushing of the face, slight headache, and drowsiness, were produced by the half ounce of absolute alcohol; he slept well at night, and on the following morning had an unusually good appetite.

The subject of the third experiment had also a rapid pulse and easily excited circulation. She is 19 years of age, weighs 6 stone 13 pounds, and has not drunk alcohol in any form for more than three months. The changes produced in the pulse by half an ounce of alcohol are even more decided than in the two previous experiments, although undoubtedly of the same kind (Figs. 14 to 20). Flushing of the face and throbbing of arteries were accompanied with a full bounding pulse. Marked drowsiness was induced, and she suffered from headache, nausea, and loss of appetite, for several hours. Her sex, light weight, and easily excited circulation, rendered her more susceptible to the influence of alcohol than the subjects of the two former experiments.

The tracings accordingly show that alcohol in moderate quantity dilates the blood-vessels and increases the number

FIG. 14.—ANNA M.—2 minutes *before* alcohol.—Pulse, 102 per minute.

FIG. 15.—10 minutes after alcohol.—Pulse, 126 per minute.

FIG. 16.—15 minutes after alcohol.—Pulse, 126 per minute.

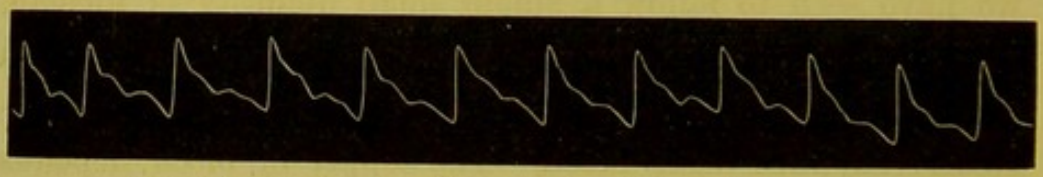

FIG. 17.—40 minutes after alcohol.—Pulse, 111 per minute.

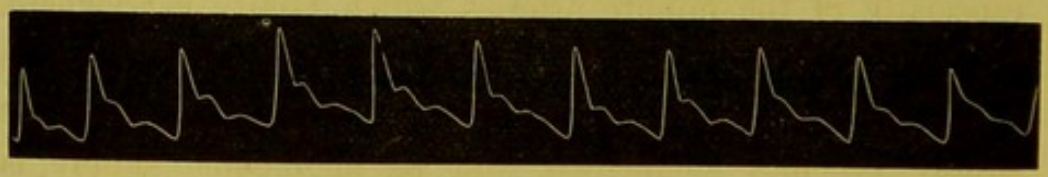

FIG. 18.—65 minutes after alcohol.—Pulse, 111 per minute.

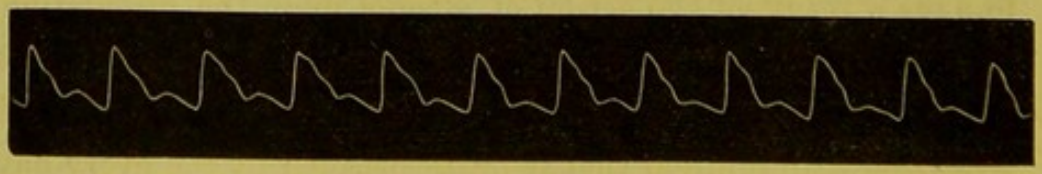

FIG. 19.—3 hours 5 minutes after alcohol.—Pulse, 120 per minute.

FIG. 20.—8 hours 35 minutes after alcohol.—Pulse, 102 per minute.

and strength of the heart's contractions, the latter being indicated not only by the greater amplitude of the chief up-stroke, but also by its more perpendicular direction.

With larger quantities, these effects are more marked, and with repeated quantities, not necessarily excessive in amount, the dilatation of some of the vessels becomes permanent. They seem to forget to contract again to their normal smaller, and less obvious size, or it may be that the frequent repetition of the dose prevents an opportunity being given to them to contract; and the result is the tell-tale rubicund complexion or ruddy nose which one occasionally sees.

Before describing the action upon the circulation of a large quantity, let us consider what effects are produced on the individual by the changes in the circulation which we have seen to follow a single small quantity of alcohol. The body is composed of organs and structures which do their work properly only so long as they are sufficiently supplied with blood. The supply of blood depends upon the state of the heart and the blood-vessels, and especially of the minute arteries which ramify everywhere. When the minute arteries are dilated, and at the same time the force of the heart's contractions is increased, this supply becomes augmented, and as augmented supply is *the* condition required for greatest functional activity, so we find, as a result of the action of alcohol upon the circulation, that organs and structures do more work. It is this action which has led to the common opinion that alcohol is a *stimulant*—an opinion that is quite justified by the every-day observation of its effect on the brain, upon appetite, upon digestion, and upon that general state of the body which we speak of as fatigue.

Let me ask you to allow your imaginations to have play to the extent of fancying that in place of being in this warm and close atmosphere, you are inhaling the invigorating

breezes of one of those Highland mountains over which my esteemed colleague Professor Blackie delights to roam. I ask you to imagine that in place of *roaming* you have been *walking hard* for ten or twelve hours, and have at length reached your destination in the thoroughly tired state which somewhat excessive physical work is sure to produce. You have eaten little, and I hope, for the sake of comfort, have drunk less, and kind friends have prepared for you the substantial repast which they properly suppose you much require. Many of us, I hope, have experienced circumstances of this kind, and do not require an effort of imagination, but only one of memory to realise the disappointment produced by their inability to do justice to the refreshment placed before them.

Now, why should this be so? Why, in the very circumstances in which food is most required, should there be a distaste for food? The answer is to be found in the fact that over exertion is followed by fatigue; and among the organs and structures fatigued the heart and blood-vessels are included. It follows from this, that any food which may be swallowed fails to excite the circulation, fails to cause a sufficient increase in the blood-supply of the stomach, and accordingly fails to produce that flow of gastric juice which is required for the digestion of the food, and without which there is no relish for food. Before the last requirement of digestion can be produced, one of two plans must be adopted, we must either allow a sufficient period of rest to permit the fatigue of the circulation to pass off, or we must excite the circulation; and there is no more effectual method of accomplishing the latter object than by drinking a small quantity of alcohol, which, as we have seen, will increase the heart's contractions, and dilate the blood-vessels, and so allow the requisite amount of blood to be supplied to the stomach.

This action of alcohol may be more clearly understood by a reference to the diagram (Fig. 21).

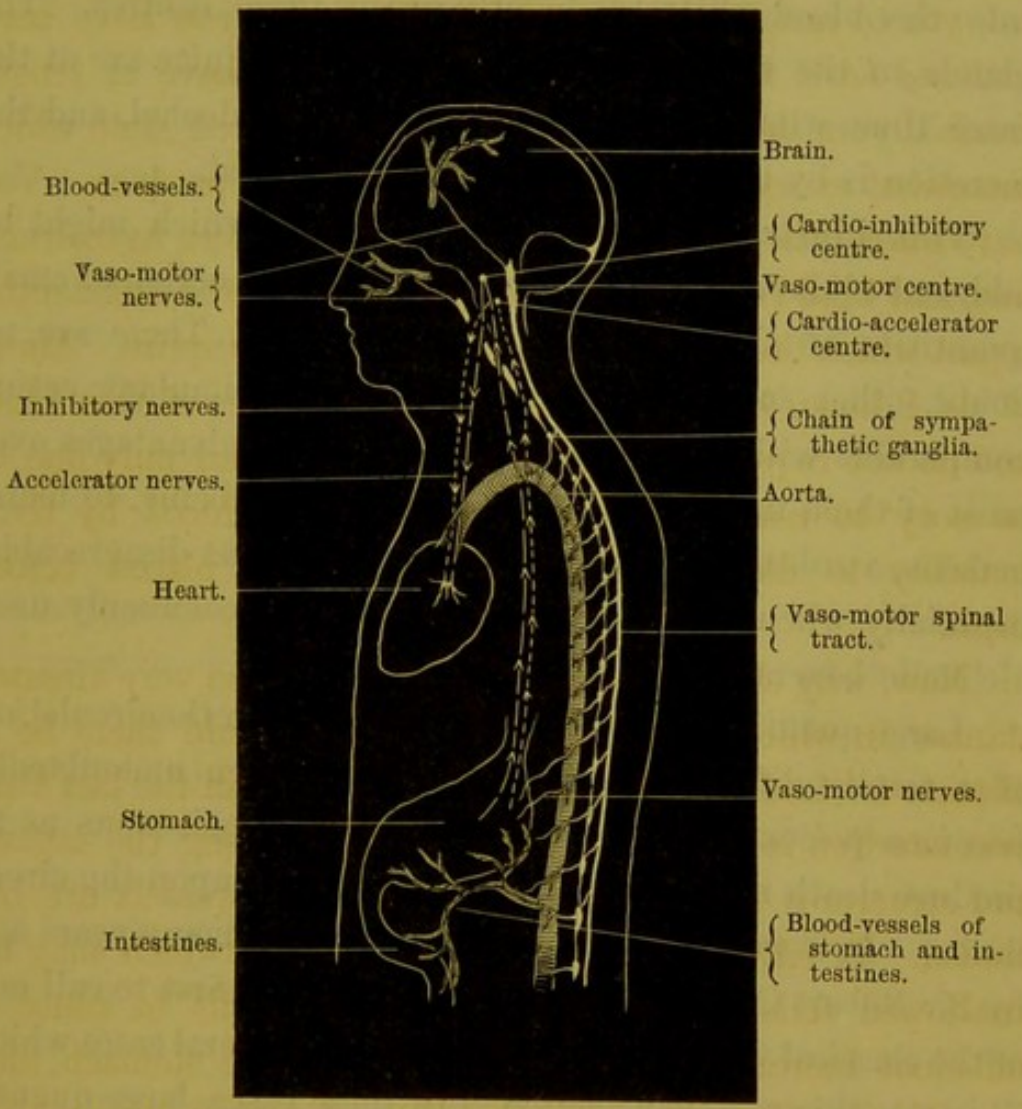

FIG. 21.—Diagrammatic representation of the nerve-connections between the Stomach, Heart, and Blood-vessels.

When the alcohol has entered the stomach, it stimulates nerve-fibres which are distributed over its inner surface. By some of these nerve-fibres impressions are carried to a cardio-accelerator centre at the base of the brain, and by others to vaso-motor centres either at the base of the brain or in the spinal cord. The cardio-accelerator and vaso-motor centres are in this way acted upon, and from them impressions are reflected to the heart, increasing its contractions, and to the stomach, dilating its blood-vessels, with the result that the

quantity of blood supplied to the stomach becomes increased. It is probable also that any alcohol which has been absorbed into the blood will act directly upon these centres. The glands in the stomach which secrete gastric juice are at the same time stimulated by mere contact with alcohol, and the secretion is by this action still further increased.

This illustration is only one of several which might be adduced of the results following the stimulant action of small quantities of alcohol upon the circulation. There are, no doubt, other substances which produce a stimulant action comparable with that of alcohol, but it has advantages over most of them in being rapid in action, and in being, to many persons, a substance whose taste is by no means disagreeable, especially when in the form of one of the commonly used alcoholic beverages.

Large quantities of alcohol produce effects on the circulation of a totally different kind, for the action then undoubtedly becomes poisonous, and may be so violently poisonous as to produce death merely by the changes induced upon the circulation. In a work on Poisons, written a good many years ago by Sir Robert Christison—which I am not the first to call one of the classical works in Toxicology—I find several cases which illustrate this poisonous action. In these cases, large quantities of alcohol were swallowed by foolish persons, who perhaps had made wagers that they could drink a bottle of whisky right off; and the result has been that they have become insensible, and sometimes have died. Sudden deaths in these circumstances are to be explained by the violence of the irritation of large quantities of alcohol upon the nerves of the stomach. Some of these nerves convey impressions to a ganglion at the base of the brain (cardio-inhibitory centre), whose function it is to slow or inhibit the contractions of the heart; and if a very strong impression is conveyed, then the inhibition is sufficient to stop the heart, and the person dies (see Fig. 21).

Action on Respiration.—Changes in the circulation are usually accompanied by changes in the respiration. Nearly every substance which modifies the former also modifies the latter. Alcohol is no exception to this rule. In small and moderate quantities it increases the respiratory movements, and in large quantities it diminishes them.

Action on the Nervous System.—I have already shown that alcohol is quite entitled, on account of some of its actions on the circulation, to be regarded as a stimulant; because, by exciting the circulation, when taken in the proper quantity for doing so, it supplies the increased amount of blood to many organs and structures which is requisite for their increased action. The popular idea of this stimulant action is founded also on the effects that are observed upon the nervous system, and especially upon the functions of the brain. Opportunities, indeed, are not infrequently presented for observing that a moderate quantity produces gaiety, self-satisfaction, courage, affection, loquacity, and many evidences of emotional excitement; that larger quantities produce delirious excitement; and that still larger, or poisonous quantities, produce loss of sensibility, coma, and other manifestations of paralysis of the brain. I am inclined to think that the mental phenomena caused by even moderate quantities result from the combination of a stimulant with a paralysing action, and that the higher faculties of the brain are usually enfeebled or paralysed, while the emotions and other faculties of a lower order are stimulated. To this general statement I would make the exception that in the existence of fatigue, the intellectual faculties may be strengthened and refreshed by a small quantity of alcohol. This beneficial effect is, I believe, only a temporary one, greatly resulting from the effects upon the circulation, and is of short duration, if the cause of fatigue be continued.

Food Value.—But, it may be asked, might not the repeated administration of small quantities, even in the protracted

existence of conditions productive of fatigue, result in prolonging the increased activity of the intellect over considerable periods of time? The answer to this enquiry is, to some extent, to be derived from the solution of the much discussed problem of the *food value of alcohol.*

In order to act as a food, a substance must, in the first place, either have the same composition as a component part of the body, so that after its absorption it may assist in forming the structures of the body ; or it must be capable of such transformation after absorption that some results of the transformation are available for forming tissues, or that active energy is supplied to the body by the transformation.

As the composition of alcohol ($C_2 H_6 O$) is not that of any substance which enters into the structure of the body, it cannot act as a food by becoming a component part of the body. In order to determine if it so acts after absorption as to fulfil the second requisite of a food, it is necessary to consider the history of alcohol after it has been introduced into the stomach. The chief means at our disposal for constructing such a history are to search for evidence of its decomposition, and to ascertain if it produces any effect upon the excretions or upon the nutrition of the body.

Its decomposition in the blood was a long time ago assumed by Liebig, who regarded it as a typical respiratory food, yielding carbonic acid and water by decomposition in the blood; and this view was adopted by nearly every physiologist until 1860. At that time, Lallemund, Perrin, and Duroy, published a most important work, for the purpose of proving that alcohol is eliminated from the body unchanged. This assertion, however, was not warranted by the evidence they supplied, for the effect of that evidence was only to show that in certain circumstances minute traces of alcohol could be detected in the excretions, while the greatest portion was not accounted for. Since that time, many investigations have

been performed by Baudot, Schulinus, Dupré, Anstie, Binz, and others, which have very clearly proved that extremely little alcohol—indeed only a very minute trace—passes out of the body unchanged, after small quantities have been swallowed. After large quantities, however, a more considerable elimination takes place; a fact which is not at all remarkable, for it is observed also in the case of several undoubted foods, such as white of egg and grape sugar. Alcohol must, therefore, undergo some transformation in the body, but the nature of that transformation has not yet been discovered.

It is reasonable to suppose, from its composition and from the transformations observed in the laboratory of the chemist, that it might be decomposed into carbonic acid and water, or that it might so subdivide itself as to form aldehyde, acetic acid, oxalic acid, and, finally, carbonic acid. Each of these substances has been carefully searched for, but there is only some doubtful evidence of the water in the expired air being increased, and, at times, an odour like that of aldehyde may be detected in the breath after continued indulgence in large quantities.

The search for carbonic acid has led to the discovery that in place of being increased it is diminished in quantity in the excretions, at any rate after small or moderate quantities of alcohol. This discovery acquires a very considerable importance when it is considered in connection with another fact which has been tolerably well established—namely, that alcohol lessens also the excretion of urea and of other solids. For these two facts show that alcohol has the property of lessening the destruction of the tissues, and that to its other valuable properties we must add a conserving power by which it diminishes the waste of the body.

So far, therefore, the evidence appears to be in favour of its being a food. In that case the results of its transforma-

tion—which, I have pointed out, are not yet ascertained—should become manifest in increase of function or of nutrition.

Action on the Temperature.—Looking to the chemical composition of alcohol—to the fact that it is a compound of carbon, hydrogen, and oxygen—it would be natural to expect that as a food it should elevate the temperature of the body. This anticipation, however, has not been altogether confirmed. It seems to be the case that when small quantities are taken a very slight and temporary rise of temperature takes place,[1] but this slight rise may be accounted for by the increase in the flow of blood which even small quantities produce. The observations of Duméril, Demarquay, Binz, Anstie, Ringer, Bouvier, Parkes, and many others, have shown that in moderate quantities it slightly, and in large quantities more distinctly, lowers the temperature. At first sight this result seems to contradict the supposition that alcohol is a food. But there is really no contradiction. As a food it may produce active force of a different kind from mere elevation of temperature, and while doing so it may lower the general temperature. Even if, during its consumption in the body, it produces an elevation of temperature corresponding to that

[1] Temperature observations were made in the experiments from which the pulse-tracings already considered were obtained. The results in two of the experiments were as follows:—

	William W.	Alfred G.
Before alcohol	98·8 deg.	98·9 deg. F.
10 min. after alcohol	98·6 ,,	—
15 ,, ,,	—	98·9 ,,
25 ,, ,,	99· ,,	—
35 ,, ,,	—	99·1 ,,
40 ,, ,,	99· ,,	—
55 ,, ,,	—	99·1 ,,
1 h. ,,	98·6 ,,	—
1 h. 30 m. ,,	—	98·8 ,,
1 h. 45 m. ,,	—	98·6 ,,
1 h. 50 m. ,,	98·4 ,,	—
4 h. 25 m, ,,	98·4 ,,	—

consumption, it may nevertheless lower the general temperature by the restraining influence of the yet unconsumed portion upon the transformations of the tissues, or of substances present in the blood. The lowering of temperature, while it is mainly caused by lessened tissue changes, is no doubt also caused by the effect produced on the blood-vessels, which has before been described.

Let me remind you that the superficial blood-vessels become very obviously dilated, and the rate at which the blood flows through them becomes accelerated. Now, the blood in the superficial vessels is exposed to the cooling influence of the surrounding air. We should therefore expect that the greater the quantity of blood thus exposed to the influence of a temperature lower than that of itself, the greater will be the reduction of temperature in the blood throughout the body.

This action on temperature is certainly not in accordance with general or popular notions. The street porter who disappears occasionally in cold weather into the convenient public-house, the coachman who seems to make it a matter of duty to take a drink at each inn before whose door his coach draws up, will tell you that a glass of whisky makes him warm. Why should widespread popular opinion be opposed to the truth ? The explanation is to be found in the different methods pursued by the porter and coachman on the one hand, and the man of science on the other. The latter uses an instrument of precision, the thermometer, and its indications show him that alcohol somewhat lowers temperature in moderate and large quantities. The porter and the coachman judge merely from their sensations, and as the glass of whisky produces a sensation of warmth in the stomach by dilating the gastric blood-vessels, and a comfortable glow over the surface of the body by dilating the superficial blood-vessels, they naturally conclude that it makes them

warm. This conclusion is, however, not only an erroneous but a dangerous one. The dilated vessels permit of a rapid cooling of the blood when the surface is exposed to a low temperature; and therefore the street porter soon fancies that another glass of whisky would do him good, and the coachman is only too impatient to see the sign-post of the next inn. The dilated vessels also permit of a *sudden* cooling of the blood to take place, and internal congestions and inflammations are thereby caused; and so it is that the diseases of the kidneys, of the liver, of the brain, which are of frequent occurrence in those exposed to vicissitudes of climate, are not altogether to be explained by climatic influences. So it is also that the drunkard, lying helpless on the roadside, may have his temperature lowered to a dangerous point, and may even die of cold, while the thermometer indicates that he has been exposed to only a moderate temperature.

At the same time, rational and useful applications may be made of the effect which alcohol produces on the distribution of temperature. It may even in certain circumstances promote elevation of temperature. When the body is thoroughly cooled in a healthy person, we all know how slowly a comfortable degree of warmth is restored to it, even when the heat of a warm fire is used for this purpose. The cold has contracted the superficial vessels, and reduced the action of the heart. The fire warms the surface of the body nearest to it, but the other surfaces remain cold, for their contracted vessels only slowly relax. If, in these circumstances, a small quantity of alcohol be taken, the superficial vessels all over the body will dilate, and warm blood will find its way everywhere, and will do so all the more rapidly, because the alcohol at the same time excites the heart. In these actions, also, we have the explanation of the benefit to the cold benumbed wayfarer, who is revived from his starved, unconscious condition by alcohol.

Action on Nutrition.—Let us now consider if the nutrition of the body is in any more obvious manner affected by alcohol. That it is obviously affected must have been frequently observed by each of us. It is notorious that many drinkers of alcohol grow stout, and even uncomfortably fat. They do not so much put on more flesh as more fat. The explanation of this influence upon nutrition is to be found in some of the statements I have already placed before you. We have seen how alcohol lessens the excretion of carbonic acid and of urea. Physiologists know that this implies a reduction in the process of oxidation, and therefore a reduction in the waste of substances in the body, whether of the nature of food or of formed tissues. Let me say here, that some experiments made by George Harley of London, by Bonwetsch of Dorpat, and by Schmiedeberg of Strassburg, have rendered it probable that a part, at least, of this action is caused by alcohol so affecting the red corpuscles of the blood, that their power of giving off oxygen is lessened. This retarding influence upon the destruction of substances in the body produces, among other effects, an imperfect consumption of fat, and hence the fat in the body increases in amount. This increase is favoured by the action alcohol possesses of facilitating the solution and absorption of the fatty portions of the food in the stomach. We accordingly see why those who take alcohol even moderately, especially if at the same time they consume food rich in fat, or (what leads to the same result) in sugar or starch, are apt to become stout from a deposit of fat taking place under the skin ; and why those who take alcohol immoderately are, in addition, very likely to have fat deposited in some of the organs of the body, where its presence constitutes the disease, fatty degeneration.

These actions, no doubt, indicate decided effects upon nutrition ; and while an extreme degree of them produces

disease, a slight degree may be beneficial, and may entitle alcohol to be regarded as a food. This title would, however, be more fairly won if it could be shown that alcohol is able to maintain the nutrition of the body while an insufficient amount of ordinary food was being taken, and still more, that it is able to do so while absolutely no ordinary food was being taken.

Now data exist for testing its claims to be regarded as a food in both of these conditions.

In regard to the first condition, the most satisfactory data have been supplied by an eminent physiologist and physician of America, Dr. Hammond, in a series of experiments made upon himself, the importance of which in the decision of this question can, I think, hardly be exaggerated. Dr. Hammond's experiments were performed for the threefold purpose of ascertaining (*a*), the influence of alcohol while the body was maintained at a nearly uniform standard by a sufficiency of food ; (*b*), its influence *while the body lost weight from a deficiency of food ;* and (*c*), its influence while the body gained weight from an excess of food. In each series of experiments, the quantity of alcohol taken was one ounce and a half, diluted with an equal bulk of water, and divided into three equal quantities, which were taken during breakfast, luncheon, and dinner. The following are some of the results obtained from these experiments :—The weight of the body increased, and a diminution occurred in the elimination of carbonic acid and urea, whether the food was sufficient, deficient, or excessive in amount. When the food was sufficient, and when it was excessive in amount, the addition of alcohol to the diet produced disturbances in the health, such as excitement of the circulation, dyspepsia, general lassitude, and indisposition for exertion of any kind, the disturbance of health being greatest during the days in which an excessive amount of food was taken ; but *when the food*

was deficient in amount, the addition of alcohol seemed very clearly to supplement this deficiency, for not only was the weight of the body more than maintained, but the insufficient amount of food fully satisfied the appetite, the intellectual faculties were clear, and all the functions of the organism were performed with regularity.

Assuming, as I believe we are entitled to do, that these experiments are entirely trustworthy, and connecting them with the statements I have previously brought before you, I do not see how we can avoid the conclusion that alcohol is a food which increases the weight of the body by "retarding the metamorphosis of the old tissues, promoting the formation of new, and limiting the consumption of the fat."

The remaining test which I have suggested for deciding the claim of alcohol to be so regarded, is its ability to maintain the nutrition of the body while absolutely no ordinary food is being taken. Such a test can be applied only within certain limits, for very few food-substances are able alone to nourish the body for more than a brief period of time. Evidence on this point is not very easy to obtain. Perhaps the chief source from which it can be obtained, in a trustworthy form, is the experience of medical practitioners who have been called upon to treat cases of illness in which the stomach was unable to retain any ordinary food. I shall content myself with mentioning that several cases of this description have been recorded, in which life appeared to be maintained solely by the administration of alcohol. Four of these are described in the well-known work on *Stimulants and Narcotics*, by the late Dr. Anstie. Alcohol was the only substance besides water administered for from six to twelve days, and the recovery of weight and of bodily and intellectual strength was conspicuously rapid during convalescence.

But if alcohol be a food, as, I think, the evidence entitles

us to conclude, its applications as a food are apparently very limited. It may, possibly, supplement with advantage an insufficient dietary where insufficiency is an inevitable condition, and illustrations of this advantage are to be found in the records of sieges, as in that of Paris during 1870-71. It may also supplement insufficiency of food arising from poverty, but in this case there is little advantage to be gained from the use of so expensive a food as alcohol, and undoubted disadvantage is likely to result from the opportunity that is given for the consumption of too large quantities.

Its applications as a food are further limited by the fact that while it acts as a food, it likewise impedes the transformations and combustions in the body, which are necessary for the production of force. Men undergoing great and prolonged physical exertion work as well without alcohol as they do with it. The experience of recent campaigns which have been successfully conducted on total abstinence principles, have proved that men *in a healthy condition and supplied with a sufficient amount of food*, retain their health and are capable of performing the most arduous labour, in every variety of climate, without alcohol. And, further, in some of these campaigns, opportunities were afforded for observing that the addition of alcohol to the diet may actually diminish the capability for prolonged physical exertion.

When we direct our attention to mental work, I believe the same conclusion must be arrived at. The stimulant action on the brain, resulting from a direct action of alcohol, and from an indirect one produced by the increased blood supply which it induces, is accompanied with a paralysing action which seems, unfortunately, most rapidly and powerfully to involve the higher faculties. In the existence of fatigue, a temporary advantage is no doubt gained. In the normal condition, the capacity of the brain to perform real work does not appear to be increased. The shy man acquires

some self-confidence, the taciturn becomes loquacious, and society thereby gains some advantage. Mental work may seem to be rendered more easy, but facility is gained at the expense of quality. The editor of a newspaper will tell you that he cannot with confidence write a leading article, if he has been dining out, until he has allowed sufficient time to elapse for the effects of the wine he has drunk to pass away; and even the novelist, whose brain-work is in the regions of emotion and imagination, will relate a similar experience.

I think, gentlemen, I have now sufficiently considered the functions or actions of alcohol, which constitutes the first and greater portion of my subject.

That consideration appears to me clearly to confirm experience derived from many sources,—derived, for example, from the mere existence of the University Temperance Society, —that alcohol is not necessary to enable a healthy individual to lead a useful and happy existence. It seems to me also to show that the use of alcohol *in moderation* is attended with some advantages. Its action on the brain produces effects that are not invaluable to society; and by employing the word society, I am led to remark that the mere existence of civilised societies is at present attended with many conditions that make it extremely difficult for a normal and perfectly healthy individual to exist. Fatigue, mental and physical, will occur, our digestive functions will become disordered, our appetites will occasionally fail; and for each of these conditions alcohol in moderation is occasionally a valuable remedy. The extensive, nay, almost universal employment of substances capable, in varying degree, of removing these abnormal conditions, seems to prove that in both civilised and uncivilised communities the human organism is rarely maintained in so perfect a state of health as to be altogether independent of their assistance. The Mussulman employs for this purpose tobacco, coffee, or opium; the Hindoo, opium

or Indian hemp; the Peruvian and Brazilian, coca; the Arabian, coffee; the Central Australian, pituri; and there is probably no race, whether civilised or barbarian, which does not expend labour or money in satisfying what appears to be a universal craving. In many respects, each of the substances so used produces effects resembling those of alcohol; and an exception cannot be made to this statement in the case of even the commonly used beverage, tea. Its action on the pulse is depicted in the illustrations to which I now direct your attention (Figs. 22 and 23).

FIG. 22.[1]—Pulse tracing *before* tea was taken.

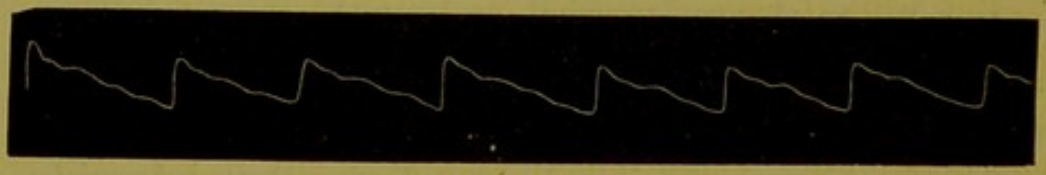

FIG. 23.—After tea was taken.

On comparing these tracings with those obtained in the experiments with alcohol, you will detect, I have no doubt, a general resemblance between the action of the two substances upon the circulation. It is probable that in this action we may discover a part of the explanation of the now fashionable indulgence in the cup of tea, which cheers, while it does not inebriate the fatigued drinker in the afternoon succeeding the occupations of the earlier part of the day.

The title of my subject, as well as the necessity for

[1] Figures 22 and 23 are copied from Dr. Moréno y Maiz, *Recherches sur l'Erythroxylum Coca*, p. 57. Figure 23 represents the pulse after a cold infusion of half an ounce of tea in three ounces of water was taken. This infusion increased the pulse-rate from 60 to 70 per minute.

avoiding interminable complexities, has obliged me, to some extent, to understate, by omission, the advantages of alcohol. I have not described many of its valuable applications in disease. I have not been able to point out the special advantages of many of the forms in which it is used, which, among their other constituents, possess ethers, volatile oils, and nourishing ingredients, which have important actions, and which confer upon some of them flavours that to many persons are agreeable. If it be justifiable to cultivate the appreciative powers of the palate by savoury foods, I see no reason—assuming that the moderate use of alcohol is not improper—why the flavours generated in the juice of the grape should not have equal consideration. Were alcohol used as a beverage only in the form of ethylic alcohol, it is not improbable that the quantity consumed would be diminished, and the number of total abstainers would be increased.

But while I have somewhat understated the advantages that may be obtained from the use of alcohol in moderation, I have by no means fully stated the evil consequences of its immoderate use. These, indeed, require no detailed description. They may be summarised in the production of mental and physical deterioration and of premature death.

In order to exhibit the pernicious consequences of intemperance in a concise and readily appreciable form, I have placed before you several Tables extracted by Dr. Parkes from Neison's "Vital Statistics" (see Appendix, Tables II. III. and IV.) In one of these Tables (Table IV.) you will observe that the kind of beverage indulged in has an influence, apart from mere intemperance, upon the production of the evil effects. This influence seems to depend, to a great extent, on the differences that exist in the composition of the beverages. The alcohol they contain is not always solely the ethylic alcohol which is the subject of my remarks. Other alcohols are found in many of them, such as propylic, butylic, and

amylic alcohols. Their action has been investigated by Pelletan, Rabuteau, Richardson, Dujardin-Beaumetz, and Audigé; and it has very clearly been shown that they differ greatly in poisonous activity, amylic alcohol, for example, being more poisonous than propylic alcohol, and the former eight times as poisonous as ethylic alcohol. Now, the purest alcoholic beverages are those which contain the smallest quantity of alcohols other than ethylic; and as very little of these other alcohols is produced during the fermentation of the grape-juice, so the beverages derived from it are, in respect to their alcohol, the most wholesome. If derived from other sources, such as corn, beetroot, or potato, they are apt to contain propylic, butylic, and amylic alcohols, and to be more hurtful in proportion to the amount of any of them that may be present.

These facts, gentlemen, have a most important bearing upon the production of the evils which are justly attributed to alcohol. The disease termed alcoholism attains its greatest intensity among those nations who chiefly consume alcohol derived from the fermentation of substances which produce the more poisonous alcohols. This has been abundantly established by statistics; and when the relationship between the crimes resulting from the abuse of alcohol, and the nature of the chief alcoholic beverages consumed, is examined, it becomes equally apparent that ethylic alcohol is a much less pernicious substance than the other alcohols I have mentioned. M. Lunier, for example, has shown that, in France, such crimes are less frequent in the wine-growing districts, and most frequent in the districts where the alcoholic beverages are derived from other sources than the grape; the only exceptions occurring in the large towns in the wine-growing districts, where, however, a ready explanation is found in the fact that beverages derived from other sources than the grape are there largely consumed. I do not think

we are unwarranted in entertaining the supposition that the differences in the pernicious effects produced by alcoholic beverages, when used in too large quantity, are in this country, also, to some extent explainable by the composition of the beverage. The greatest evils are met with among the poorer inhabitants of our large towns; and it is notorious that the most impure beverages, or those containing the largest quantity of the more poisonous alcohols, are supplied to them. The baneful effects of immoderation, accordingly, are increased by the poisonous action of impurities which their poverty supplies them with.

Now, are we able to define the terms moderation and immoderation when applied to the quantity of alcohol? We cannot do so exactly, for obviously individual characteristics must be taken into account. The late Dr. Parkes, to whom we owe much of our present knowledge regarding alcohol, has shown that in the case of a healthy, well-fed man, undergoing moderate physical exertion, two ounces of absolute alcohol, taken during the day, produced uncomfortable and disagreeable effects, and was a greater quantity than the body was able to consume. One ounce and a half seemed to be entirely consumed, and did not produce any disagreeable effects. These observations were made upon a man selected because of his exceptionally healthy state; and it may be assumed that in a less healthy and strong person, undergoing but little physical exertion, even one ounce and a half of alcohol would produce some undesirable effects. I am, therefore, inclined to adopt, as a general standard of moderation, one ounce only of absolute alcohol in the twenty-four hours, and I do not think this quantity is usually exceeded by moderate drinkers. What such a quantity represents in some of the ordinary alcoholic beverages, is shown in the Table to which I now direct your attention (Table I.):—

TABLE I.—Percentage by volume of absolute Alcohol in several common Alcoholic Beverages, with the quantity of the Beverage representing about one ounce of absolute Alcohol.

BEVERAGE.	Percentage of absolute Alcohol.	Average percentage of absolute Alcohol.	Quantity representing about one ounce of absolute Alcohol.
Spirits—			
Brandy	50 to 60	50	2 ounces, or 1 small wine glass.
Whisky	50 ,, 60		
Gin	49 ,, 60		
Rum	60 ,, 77		
Strong Wines—			
Sherry	16 ,, 25	20	5 ounces, or 2 wine glasses.
Port	16 ,, 23		
Madeira	16 ,, 22		
Marsala	15 ,, 25		
Light Wines—			
Bordeaux (Clarets)	6·8 ,, 13	10	10 ounces, or 4 wine glasses.
Rhone	8·7 ,, 13·7		
Champagne	5·8 ,, 13		
Malt Liquors—			
Beer, Ale, Stout, Porter	1·2 ,, 10	5	20 ounces, or 2 tumblers.

Whatever limitation may be considered essential, difficulties will always arise in causing this limitation to be adhered to, and the boundary line will then be passed which separates moderation from immoderation. When that occurs, evils which cannot be exaggerated are caused, and hardly any greater service could be rendered to humanity than the prevention of these evils. The existence of this Society shows how fully this fact is recognised, and how willing many of you are to undergo personal sacrifices in order to aid in producing this great result. Your anxiety to further it, will, I am confident, render you all the more desirous to consider

whether total abstinence is sufficient to meet the evils of immoderation in alcohol. There is no reason for doubting that it is sufficient to effect much good, if it were merely by directing attention to the grave mischiefs produced by immoderation, by producing examples of the fact that good work may be done, and good health enjoyed by abstainers, and by training a considerable portion of the community to such habits of self-control, as render them most unlikely to add to the number of the immoderate. But are those who are likely to become abstainers the persons who chiefly, or to any considerable extent, swell the ranks of the immoderate? Are they not more likely to be those whose powers of self-control have not become deteriorated, and upon whom the influence of social opinion can be successfully exerted? I much fear that total abstinence, although a most powerful, is still an inadequate, means of prevention. Thoroughly recognising it, however, as a powerful means, let us consider if by any other influences the progress of immoderation may not be checked.

Now, I believe that mistaken ideas with regard to the action of alcohol have much to do with its abuse. Even among intelligent and educated persons it is looked upon as an agent which greatly increases the capacity for work, decidedly elevates the temperature of the body, and gives strength to the feeble. Erroneous conceptions of this description have led to its habitual use in conditions where that use can result only in evil, and habits of drinking have thereby been most gratuitously originated. To exemplify this, I would only refer to its employment as an everyday article of consumption by young children *in good health*, upon whom the retarding influence upon tissue metamorphosis can only have a pernicious effect. If such results of error can occur among the intelligent and educated classes, how much more likely are the evils of ignorance to be prevalent among

the uneducated? Compulsory education will certainly be a powerful agency in reducing immoderation in alcohol.

Social opinion has already effected much good in some ranks of society. At the present time we can hardly realise the drinking habits of our ancestors. Lord Cockburn, describing the state of society in Edinburgh at the beginning of this century, informs us that "nothing was more common than for gentlemen, who had dined with ladies, and meant to rejoin them, to get drunk." He also informs us that the Judges "had always wine and biscuits on the bench when the business was clearly to be protracted beyond the usual dinner-hour." . . . "Black bottles of strong port wine were set down beside them on the bench, with glasses, caraffes of water, tumblers, and biscuits; and this without the slightest attempt at concealment."

The conditions in which the lower orders of society exist are undoubtedly a further cause of intemperance. Not only does the insufficient and badly cooked food on which they subsist engender a craving for alcohol, but this craving is increased by the bad hygienic conditions to which they are subjected; and as the largest number of the intemperate is produced among the poor, the greatest blow will probably be given to intemperance when these pernicious conditions are removed.

The influence of education, of public opinion, and of improved sanitary conditions cannot, however, be expected to remove or greatly reduce intemperance until many years have elapsed. Can we afford to wait, or is there necessity for waiting, till these tardy, but most effectual agencies produce their desired effect? The drunkard of even the best type is morally and mentally a child, in so far as his ability to resist alcoholic temptation is concerned. Now, when we have recognised that immoderation in the use of any substance is injurious to a child, do we wait the slow progress of education in strength-

ening the powers of self-control, so that the child may be able successfully to resist the temptations to immoderation? Let us take a very homely illustration. Children are fond of sweetmeats; in small quantities they do them some good, in large quantities they do them much harm. Recognising these facts, are we contented to await the progress of education in preventing the harm that indulgence in large quantities of sweetmeats is sure to produce? and further, Do we consider that it would be a wise course, to place numerous tempting heaps of sweetmeats in positions where they could most conveniently be reached? If we were to do so, we know that the child would suffer, and that we would suffer in augmented doctors' bills. Still, in connection with a much greater evil than that of immoderate indulgence in sweetmeats, I fear we, to some extent, adopt this unwise course. In those very districts of our towns, where the greatest number of the immoderate in the use of alcohol are to be found, we permit the greatest number of temptations to immoderation to exist. With all due regard for the liberty of the subject, I think there is room for prevention, in the form of restriction of the facilities for immoderation, to be brought into operation; and while prevention will not in itself eradicate the evils which we all deplore, it may confidently be expected to have a more immediate effect in diminishing these evils, than any of the other means to which I have made reference, and to whose more tardy influence we are to look for the radical cure of intemperance.

APPENDIX.

TABLE II.—Ratio per cent. from the undermentioned Causes to Deaths from all Causes.

Cause of Death.	1847.	Gotha Life Office.	Scottish Widows' Fund.	Intemperate Lives.
Head diseases . . .	9·710	15·176	20·720	27·10
Digestive organs (especially those of the liver)	6·240	8·377	11·994	23·3
Respiratory organs . .	33·150	27·843	23·676	22·98
Total of above three classes	49·100	51·396	56·390	73·38

TABLE III.—Expectation of Life among the Temperate and Intemperate. (Derived from rather limited data.)

A Temperate person's chance of living is—	An Intemperate person's chance of living is—
At 20 = 44·2 years.	At 20 = 15·6 years.
„ 30 = 36·5 „	„ 30 = 13·8 „
„ 40 = 28·8 „	„ 40 = 11·6 „
„ 50 = 21·25 „	„ 50 = 10·8 „
„ 60 = 14·285 „	„ 60 = 8·9 „

TABLE IV.—Mortality among Intemperate Spirit and Beer Drinkers.

Spirit drinkers . .	5·996 per cent.	(nearly 60 per 1000).
Beer drinkers . .	4·597 „	(nearly 46 per 1000).
Spirit and beer drinkers .	6·194 „	(nearly 62 per 1000).

TABLE V. — Comparison between the Expected and Actual Claims in the Temperance and General Sections of "The United Kingdom Temperance and General Provident Institution for Mutual Life Assurance," for the thirteen years, 1866-1878.

	Temperance Section.		General Section.	
	Expected Claims.	Actual Claims.	Expected Claims.	Actual Claims.
1866-1870 (5 years) .	549	411	1008	944
1871-1875 (5 years) .	723	511	1268	1330
1876-1878 (3 years) .	534	351	869	850
Total (13 years) .	1806	1273	3145	3124

The claims in the Temperance Section are about 30·5 per cent. below the expectancy, and in the General Section only about 0·7 per cent. below the expectancy.

(I am indebted to Professor Calderwood, the Honorary President of the University Temperance Society, for having procured for me the above Table from the secretary of the Institution.)