to Dr. Salmon,* in his year book, Department of Agriculture, 1900, no case had occurred in Berlin since 1883. The same report states that in Sweden previous to 1870 there were 8 or 10 deaths annually from hydrophobia. Laws were then enacted and enforced, and there have been no deaths since.

Literature on the disease in the United States would not indicate that its seriousness or frequency has been properly appreciated by the medical profession. For the year ending May 31, 1890, there were found among incomplete records 143 deaths from hydrophobia in the United States. Twenty-one died here in Massachusetts and 16 in Georgia. Incomplete records of 73 cities between 1890 and 1899, including in some cases the first half of 1900, show 230 human deaths after eliminating doubtful ones.

In Massachusetts, between 1857 and 1880, I have found records of 54 deaths and during the last 20 years there have been at least 60 more with many exposed cases under observation and treatment at present. At least 100 persons have been bitten by rabid animals in Massachusetts during the past year. At a later date I shall be able to present to you more complete data on the prevalence of the disease in this country.

It is true that the layman would need a good deal more information on the subject to support legislation for the eradication of the disease, just as it has been necessary to educate them regarding the infectiousness and rational treatment of tuberculosis. It is a duty incumbent upon us to furnish them with such knowledge that they may assist us in obtaining proper laws for its eradication, and it is upon us, who have in the past secured the many sanitary laws for the public welfare, that the duty devolves of actively guiding into existence such national and state laws as the following: *

1. Control of the disease in the United States to be placed under the supervision of the Chief of the Bureau of Animal Industry at Washington, as are other epizootic diseases, such as foot-and-mouth disease, according to the Act of Congress of May 29, 1884.

2. Full authority vested in the state cattle or other appointed commission to act as may be necessary for the eradication of the disease, in conjunction with the United States Bureau of Animal Industry at Washington, whenever rabies appears in the state.

3. All licensed dogs to wear collars and metal plate of special form, that they may be readily recognized.

4. Prompt capture of all dogs not properly tagged, with subsequent humane destruction, unless properly licensed within a short time.

5. Efficient muzzling of all dogs unrestrained in public places for a period of at least one year.

* Since this paper was read, these six suggestions for legislation were presented in the form of resolutions at the fifty-eighth session of the American Medical Association at Atlantic City, through the courtesy of Dr. Richard C. Cabot, delegate from Massachusetts. They were favorably acted upon by the House of Delegates and are now in the hands of the Legislative Committee, which will do what it can to carry out the declared wishes of the American Medical Association in national and state legislation.

6. Dogs imported from countries other than those from which rabies is excluded to be quarantined for six months.

As Massachusetts is not isolated, and our dogs at the borders of the state are often infected by or infect dogs in contiguous states, interstate regulation under the supervision of the chief of the Bureau of Animal Industry at Washington seems to me to be the only efficient method of eradicating the disease in this and other states.

In Berlin its eradication was made effectual by conjoined action on the part of Prussia, and in Great Britain by like action of England, Scotland and Wales.

Dr. Peters⁹ in his excellent address on "Rabies" before the Massachusetts Board of Health at a recent meeting quotes Dr. Cope, Chief Veterinary Officer of British Board of Agriculture, as saying: "It may truly be said that the board has never undertaken a duty which has rendered so great a service to the community of this country from the point of view of human health as the extinction of rabies in the dogs." Dr. Cope died recently. The protection he gave to man and dog against rabies can never die. Let us furnish our citizens that same protection. Let us answer now that question that was asked fifty years ago and promise those that trust us as their sanitary guardians that both human and canine life shall be protected by theegis of the law.

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THE UTERO-SACRAL LIGAMENTS.*

BY DANIEL H. CRAIG, M.D., BOSTON,
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In accepting your kind invitation, so graciously extended to me through Dr. Greenwood, to talk to you this evening, I was influenced to utilize this theme by two considerations: first, the decided importance of the subject itself; and second, by the surprising and very gratifying interest

* Read by invitation before the Waltham Clinical Club.

manifested when I demonstrated the technique of their shortening in a case of retroversion at the Free Hospital for Women last June, before members of the American Medical Association during its Boston session. I am, perhaps, still further influenced by the fact that all definite knowledge of these ligaments seems to be very strictly confined to the gynecologists, and by no means all of these latter appreciate them at their full significance. For example, to show the position not only of the general practitioner, but also of others, not a great while ago one of Boston's leading surgeons of the younger generation referred a patient to my Out-Patient Clinic at the Free Hospital for Women and I returned her with a diagnosis of chronic inflammatory thickening and shortening of the utero-sacral ligaments and advised, in connection with other operative treatment, their section. The patient was promptly returned to me, with the request to operate and a frank avowal that he knew nothing about operations on these ligaments.

Their anatomy is either misunderstood or not understood at all. I have found by repeated conversations that most physicians regard the utero-sacral ligaments as very vague, inconsequent, peritoneal folds, which they have never seen outside of text-books, and possibly the dissecting-room, and have never felt. The first portion of this postulate is entirely wrong. They are very definite, not peritoneal, and very efficient under proper circumstances. While Bovée has gone very elaborately into their complete and minute description for general purposes of usefulness, I prefer Deaver's description, which is as follows: "The utero-sacral ligaments are flat, muscular bands, which extend from the uterus at the level of the internal os, beneath the layers of the recto-uterine ligaments, to the sides of the sacrum, opposite the lower borders of the sacroiliac articulation. In the first part of their course they are in relation with the lateral walls of the pouch of Douglas, and finally run on either side of the rectum, near the junction of the sigmoid flexure and the upper portion of the rectum."

In this description he very properly emphasizes the distinction between the true muscular utero-sacral ligaments and the false peritoneal portion, which he describes as the above-mentioned recto-uterine ligaments in the following words: "The false posterior or recto-uterine ligaments are composed of peritoneum, are two single serous layers which pass backward from the posterior surface of the uterus and vagina to the upper portion of the rectum, where they are continuous with the peritoneal coat of the rectum. These folds of peritoneum form the lateral boundaries of the pouch of Douglas. External to each of these false ligaments are found the true, or muscular, utero-sacral ligaments, extra-peritoneal connective tissue and anastomosing branches of the uterine and hemorrhoidal vessels."

Deaver's language is too plain to leave any doubt as to the actual muscular structure of these ligaments and physiology has taught us that muscular tissue is not furnished anywhere throughout

our bodies, without definite purpose and definite actions.

I believe that I am doing you no injustice when I express the belief that very few of you have ever considered the true utero-sacral ligaments as an entity apart from the very unimpressive peritoneal folds, which become visible from above when the uterus and rectum are widely separated. Realizing their muscular structure necessarily modifies our entire conception of their physiology.

Furthermore, the opinions of Testut, in France, and of Nagel, in Germany, fully confirm and even emphasize the correctness of Deaver's and Bovée's descriptions.

In the light of this anatomy and recent gynecologic surgery the physiology of these ligaments has become definitely known and indubitable. They certainly play an important rôle, not only in the support of the uterus, but also in the maintenance of its proper axis. As this latter point will come up later we will consider it at that time.

The pathology of these structures, considered individually, is changed from that of the peritoneum to that of muscular tissue, but since, as a matter of fact, the line should not, arbitrarily, be so strictly drawn between the true and the false as is done anatomically, we have a mixed pathology in practically all inflammatory lesions of these structures, and I shall endeavor to convince you later that at least one condition which has for years been considered pathological is in reality but a fine example of the physiology of the muscles comprising these ligaments.

The pathology should be divided into the congenital and the acquired. They are relatively frequently the subject of developmental arrest, and I am unable to say whether the arrest is pre-natal or post-natal, — whether in a given case the original norm never obtained, or whether at birth the anatomy was normal but an arrest occurred at the pubital development of the other allied structures. The developmental lesion which is most commonly met and of the greatest practical importance is an improper insertion into the uterus, being attached to the uterus above or below the level of its normal attachment.

The acquired forms of pathology almost invariably originate in inflammatory processes reaching the ligaments by extension from contiguous structures, which structures may normally belong in contiguity with the ligaments, or which may have become adjacent to them only by antecedent pathological displacement, as for instance in the case of a prolapsed ovary or tube.

The principal gross manifestations of such inflammation are tumefaction and rigid muscular contraction, the tumefaction being due in part to edema and in part to the thickening consequent upon the muscular foreshortening.

To proceed from generalizations to more specific consideration of individual lesions, let us first consider contraction.

CONTRACTION OF THE UTERO-SACRAL LIGAMENTS.

(a) *Inflammatory contraction* is well understood and has been repeatedly described by vari-

ous observers. It is due to an extension of contiguous inflammation usually from an inflamed ovary, which, through its tumefaction and consequent increased weight, has prolapsed and so come into close apposition with the ligament. And there is a very intimate relationship between a prolapsed ovary and the utero-sacral ligament of the same side. The most immutable attachment of the ovary is by its ligamentum proprium to the cornu of the uterus, and in the downward course of the prolapsing ovary this ligament must form the radius of the arc through which it descends, and the length of this ligament is such that, the uterus remaining in anything like a normal position, the ovary will impinge upon and often rest upon the outer aspect of the recto-uterine fold and its subjacent utero-sacral ligament. If then the ovary be inflamed, or later become inflamed, the recto-uterine fold becomes the seat of a localized peritonitis, in which commonly the subjacent connective tissue and the true ligament become involved. This localized peritonitis, of course, results in an adherent ovary. Should the uterus be more or less retroverted, the approximation of the fundus to the sacrum permits the ovary to fall deeper into the pelvis, and it thus reaches the cul-de-sac of Douglas and rests upon the median aspect of the recto-uterine fold instead of the outer aspect as above, but the advance of the process is in no way affected.

The same sequence of events is also possible in those forms of sacro-salpinx in which, through adhesive inflammation, a collection of fluid, either pus, blood or serum, becomes sacculated in or near the fimbriated end of the tube. The proximal portion of the tube forms the radius of the arc in this instance. Moreover, digital differentiation of these two lesions, per vaginam, I have always found impossible, unless the other organ could be distinguished in another location. Of course the two very commonly co-exist.

In cases in which the inflammatory processes in tube or ovary are still active, the contraction of the utero-sacral ligaments can merely be considered as a complication and no special individualized treatment can be administered, and coincident treatment seems advisable only when it is felt that the inflammatory disorganization has reached such a degree that spontaneous resolution cannot take place on the removal of its cause.

A cause of contraction which, so far as I know, has never been mentioned by any one until I last month submitted a paper entitled, "Contraction and Shortening of the Utero-Sacral Ligaments. A Suggestion as to Etiology and Treatment," is what I like to term:

(b) *Defensive contraction.* — In this paper I explained at length the nature of this form of contraction to which I wish to refer briefly here. This form of contraction came to my attention in perfecting a treatment for chronic endotrachelitis and depends entirely upon a correct realization of the relatively strong muscular structure of these ligaments. By the contraction of their muscular fibers the cervix, and to a lesser extent the lower portion of the uterus, is strongly drawn backward

and upward into the hollow of the sacrum and immobilized. I have many times observed this position of the uterus, commonly referred to in the text-books as retrocession, retroposition, in my observation of cases of endotrachelitis, and finally began to realize that the uterus returned to a normal position, owing to a relaxation of these ligaments very promptly after the cure of the endotrachelitis. In other words, the ligaments, although much shortened and thickened, rigid, readily palpable and very sensitive, were in reality never the seat of a true inflammation at all, but were merely contracted, following the natural law of immobilization in the defense of an inflamed cervix.

Relaxation. — This is a subject regarding the etiology and pathology of which I am able to learn practically nothing either by observation of the great number of cases seen or by reading. We all realize that it is an important factor in every case of retroversion and retroflexion and prolapse, but know practically nothing of its antecedents. I say in retroversion and retroflexion, because it is largely the degree of relaxation of these ligaments which determines the difference. When the ligaments are freely relaxed retroversion results, but when this relaxation is slight or absent, the fundus may be forced backward, but the cervix cannot move forward and so the uterus becomes flexed.

One fact regarding this relaxation is important, and that is that in cases of retroversion known to be of very long standing and of extreme degree I have never yet failed to find them sufficiently firm and of sufficient caliber to permit of their comparatively easy manipulation. This is a fact which I think many who have not had personal experience in their operative manipulation have failed to realize. Everyone seems to regard these ligaments as an operative bugaboo.

The diagnosis of lesions of these ligaments is usually very easy. The only difficulty is encountered in the purely inflammatory cases, in which the prolapsed tube or ovary and the recto-uterine fold as well as the utero-sacral ligaments are all inextricably coalesced into a tender mass behind and beside the cervix, but fortunately it is only in those exceptional cases in which the ligaments require coincident section while operating for the more serious and primary condition that such differentiation is necessary, and it can thus be made most advantageously after the obscuring adhesions have been broken up and the ligament so exposed as to be amenable to inspection, as well as direct palpation.

In those cases of inflammatory contraction, in which the original causative inflammation has resolved, leaving the chronic condition in the ligaments and in those in which the causative lesion does not mask the true condition of the ligaments, the diagnosis is relatively easy. The first thing which attracts attention is the retraction of the cervix far back into the hollow of the sacrum and to a variable extent upward. The first impression is as to the lessened accessibility of the cervix. Generally deep insertion of the examining finger with strong upward forcing

of the perineum is required to reach to the full depth of the posterior vaginal fornix, while at the same time the uterus is being forced downward by the external hand over the hypogastrium. Having reached the apex of the posterior fornix, pressure made upward and forward with the tip of the finger, in such a way as to draw the cervix out from the sacrum, will be found to cause an altogether unusual degree of pain; while at the same time, if the tip of the finger is carried outward about one-half inch from the median line, a cord-like structure will be felt, which is very firm, very tender and in diameter may vary from one-eighth to one-half inch or even larger. Its antero-posterior linear feel as well as its characteristic resilience instantly distinguish it from prolapsed appendages, neoplasms or fecal masses in the rectum or sigmoid.

The pain spoken of above upon drawing the retrocessed uterus away from the sacrum deserved fuller mention. The finger-tip should be placed against the posterior aspect of the cervix so low down that in the manipulation no pressure can be made directly upon the suspected ligament, and by the flexion of the finger the cervix drawn sharply forward. If the ligament is diseased this traction causes intolerable pain and the patient will involuntarily exclaim and raise the entire hips off the examining table in her efforts to lessen the tension on the ligaments. On the other hand, such traction is either inoffensive or only mildly painful in adnexal lesions.

Furthermore, inasmuch as it is no more possible to distinguish the normal utero-sacral ligaments than it is the normal broad ligaments, the mere fact of being able to distinguish them on palpation is evidence of some pathological condition.

One further lesion is seldom recognized and is yet easy of diagnosis. This is the too high insertion of these ligaments with the resultant retroversion. The axis of rotation of the uterus in its antero-posterior versions is very nearly at the level of the internal os, but in reality a little above it at the point of insertion of the strong musculo-fibrous base of the broad ligament, which the Germans so wisely designate the "cardinal ligaments of the uterus." Normally the utero-sacral ligaments are inserted below this axial point, keeping the cervix behind the axial point and hence the fundus anterior to this point, or in what is commonly characterized as normal anteversion. The contraction of the utero-sacral ligaments draws the cervix backward at the same time that the round ligaments draw the fundus forward after the fundus has been displaced backward; as, for example, by distention of the bladder. In those cases, therefore, in which, through arrest of development, faulty development or faulty growth, their attachment is above the axial point, they as inevitably produce retroversion by drawing the body instead of the cervix backward. Usually in such cases the anterior vaginal and vesical attachments with the utero-vesical folds are correspondingly low, still further tending to a forward position of the cervix, with the consequent retroversion of the fundus.

This combination of abnormalities is surprisingly easily recognized and equally surprisingly seldom recognized. This is the one class of movable retroversions which can never be cured by Alexander's operation alone, and which through improper attempts to do so has brought that operation into an undeserved disrepute, just as its improper employment in adherent or otherwise complicated cases of retroversion has.

The recognition of this form of retroversion depends upon the realization of an abnormally deep posterior vaginal fornix, with usually a very high attachment of the vagina to the uterus posteriorly, together with a very short anterior portion vaginalis reaching in some extreme cases almost to an entire absence of any anterior lip to the cervix, the vaginal wall seeming to start from the very border of the os externum. On replacing the uterus it is much easier to distinguish these characteristics, and unless there are or have been inflammatory complications resulting in adhesions, such replacement is easily effected bimanually, but the uterus will return promptly to its abnormal position. As would be expected, pessaries are not well tolerated. This form of retroversion is spoken of as "congenital retroversion."

The diagnosis of defensive as distinguished from inflammatory contraction depends upon the realization that it is only a symptom of some more serious condition, most commonly endotrachelitis, and especially upon the recognition of this original lesion, of which it is a symptom, and finally upon the exclusion of the inflammatory form of contraction through the lack of evidence of past or present contiguous inflammation.

The treatment may be palliative or operative, according to the individual case. In those cases in which an inflammatory contraction is consequential to a mild inflammatory condition in the appendages, which is itself amenable to non-operative measures, the complicating contraction will often, if not of too long duration, yield *pari passu* with the adnexal lesion. In such cases no special treatment need be instituted until the adnexal lesion has been cured, since the packings with or without medication, which best serve to cure the adnexal conditions, also relieve the ligaments. After-treatment is no longer needed by the original condition if, as often happens, a certain degree of contraction persists. I have seen most benefit from a dressing which I call an ichthyol T. A firm roll of non-absorbent cotton two inches long and one inch in diameter is thoroughly smeared with a mixture of ichthyol and glycerin and placed transversely behind the cervix in the posterior vaginal fornix and sustained in this position by a similar roll, about four inches long, which vertically fills the vagina down to the bulbo-cavernosus muscles. Threads are attached to each roll, so that they may be removed by the patient after about seventy-two hours.

The treatment of defensive contraction, since it is itself a symptom, resolves itself into the removal of the disease, of which it is a symptom. In the vast majority of cases, then, our problem is

the cure of an endotrachelitis, and I have found no treatment so prompt and permanently efficacious as the little operation with the specially designed instruments which I described last year.

The operative treatment of contraction of the utero-sacral ligaments is confined to a very small number of cases of such long standing that all manner of palliative treatment must fail, as the ligaments have become so infiltrated by fibrous tissue that relaxation is a physical impossibility. It rarely occurs in such cases that operation should be undertaken for their relief alone. Usually grave and long-standing antecedent or complicating lesions demand operative intervention, in which case the simple cutting of the ligaments either from above, during a celiotomy, or from below in a vaginal section, is very simple. In those infrequent cases in which their section is indicated, a simple vaginal cutting through an ample transverse vaginal incision is very easy, without invading the peritoneal cavity at all. It must be borne in mind that in this class of cases the ligaments are much larger than normal and hence more obvious and more easily manipulated. The cervix should be kept well forward for two or three days following the section of the ligaments. The opening of the abdomen for the section of these ligaments is entirely unnecessary, and for this alone seems to me unjustifiable.

The above small class of cases represents the easiest possible operations upon the ligaments.

In relaxation of these ligaments I am skeptical of any form of palliative treatment accomplishing anything except in very recent cases. In such recent cases my method of palliative treatment is by means of a systematic packing of the vagina so as to sustain the replaced uterus in its normal axis and at the same time avoid all tension upon the ligaments. Thus pessaries I do not use in these cases for mechanical reasons. The pessary sustains the uterus in normal anteversion by so forcing upward and backward the vaginal wall that, through its attachment, the cervix is thus drawn backward and, of course, the fundus thrown forward. But in order to accomplish this the transverse bar of the pessary must push a roomy vagina so far upward that the utero-sacral ligaments are stretched over this bar and hence have no opportunity for resolution to their normal length and strength. On the other hand, with the packing installed as I have elsewhere described, the cervix is held properly back, and yet the posterior vaginal fornix is empty and the ligaments have all possible chance of recovery of their normal tone. To briefly repeat this method of packing, it is as follows: One of the wool segments of the "kite-tail" dressing is placed in each lateral fornix and one in front of the cervix, and then the vagina is systematically packed down to the level of the bulbo-cavernosus muscles, where the last layer is displaced as a transverse bridge, thus leaving the bladder and rectum free and the perineum free from the downward pressure of the dressing.

Massage, other than that passively performed

by such a packing, has not proved satisfactory in my experience.

The operative shortening of these ligaments is intermediate in difficulty between their easy section and their difficult transplantation when faultily inserted. The difficulty lies in their softness and attenuated diameter, while these difficulties are compensated by the free mobility of the cervix. Here, as in shortening, it cannot be too emphatically stated that no justification exists for the opening of the abdomen for any operation involving these ligaments alone, while it is equally true that all these operations can be done from above when the abdomen is already open for other reasons.

In order to shorten these ligaments a free transverse incision is necessary at the cervico-vaginal junction. Through this incision, after working upward through the loose connective tissue between the uterus and the rectum, the ligaments are very readily detected by the finger, especially if they are intermittently tightened by traction upon the cervix. They are then transfixed by a tenaculum and readily drawn into sight. Some operators advise resection of a piece of the requisite length and approximation of the distal segment to the uterus by suture. This I do not like, but prefer to transfix the ligament at the proper point to give the requisite shortening with a suture, and then with the same suture take up a firm hold on the cervix just below the normal insertion. Before tying the first suture, similarly place the second in the opposite ligament, thus saving the advantage of the free mobility of the cervix. Finally, tie both sutures. By this technique three things are accomplished. If the sutures fail of their purpose the patient is at least no worse off than originally, which may not be true if the ligaments were cut. The folded ligament forms adhesions and becomes stronger than originally, and lastly the attachment being slightly below the normal attachment gives them a little greater leverage in drawing the cervix backward.

In transplanting the faultily inserted ligaments the same technique is followed up to the point of inserting the sutures. It is very seldom that the ligaments are so short as to need cutting at their uterine insertion in order to get sufficient length to reach to the new attachment. I have never seen such a case. The ligaments being as freely as possible exposed, which is much less than in the preceding class of cases, because of the less mobility of the cervix, estimate the distance between the point of faulty insertion upon the back of the uterus and the lowest point to which they can be sutured and transfix them with the suture at this distance from their uterine ends. Pass the sutures deeply into the cervical tissues at the elected point for the new attachment, and finally tie after both sutures have been placed.

In addition to the above transplantation some form of plastic work is almost always necessary in these congenital retroversions, such as making a deep transverse incision and closing it vertically, thus shifting the cervico-uterine attachments upward. Shortening of the round ligaments by one

technique or another is often a wise or necessary coincidental treatment.

In the close watching of these congenital retroversions after operating as above, some very interesting anatomical data have been observed. We have all heard of the strong influence exerted by the strong pelvic fascia in determining the normal axis of the uterus. That is, the uterus has been spoken of as pushed down through these fasciae at a certain angle, which their attachment tends to perpetuate. These cases illustrate that point beautifully. The cervix was originally "pushed down through" at a wrong angle. On examining these cases six weeks to two months after operation I have invariably found the fundus forward; but the cervix still showing a decided tendency to a forward position, in many cases almost a true antelexion and without any treatment, in five or six months the cervix comes down to its normal relation to the body in every case.

THE CONTAMINATION OF THE AIR OF OUR CITIES WITH SULPHUR DIOXID, THE CAUSE OF RESPIRATORY DISEASE.

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THE importance of sulphur dioxide as an impurity of the air of our cities and its injurious effects upon the organs of respiration is a subject that has not received the attention in works on hygiene which it demands. Most of the works on hygiene give us but a very meager information or none at all of sulphur dioxide as an impurity of the atmosphere. They chiefly mention and describe its antiseptic and disinfectant properties. The writer has been studying the noxious effects of sulphur dioxide as an impurity of the atmosphere for the past ten years and he had arrived at the conclusion that it is one of the most potent causal factors of asthma. Some of his observations were published elsewhere in 1902. It is only within the most recent years, especially through the investigations of Kionka,¹ that the importance of the toxic properties of sulphur dioxide in the form of sulphites has been made apparent and established.

The atmosphere, being a mixture of gases, gives, according to the most recent investigations, the following average composition in one hundred volumes:

Oxygen	20.60	volumes.
Nitrogen	76.90	"
Argon	1.00	"
Carbon dioxide	0.04	"
Aqueous vapor (about)	1.46	"
Ozone, hydrogen dioxide	}	traces.
Nitrogen acids		
Marsh gas		
Sulphur dioxide (in towns and volcanic districts)		
Hydrogen sulphid		

Besides the three above-mentioned elements there are in the air hydrogen gas (according to Gautier 0.015%), neon, krypton, xenon, helium

and coronium, which have only a scientific interest. According to Mendeléeff's "Periodic Law" a number of other elements are believed to exist in the atmosphere, but remain to be discovered by the chemist in the near future. Dust, being a normal constituent, is found in the air at all times.

PRESENCE OF SULPHUR DIOXID IN SMOKE AND FOG.

Since the air is the great receptacle for all gaseous emanations, other substances, in the vapor or solid form, may be discovered in it by chemical and microscopical means. Sulphurous anhydride or sulphur dioxide, for instance, can often be traced in it, being derived from domestic, manufacturing or tellural sources. In the combustion of coal, which contains iron pyrites (FeS_2), and coal gas, which contains hydrogen sulphide and other gaseous sulphides, the sulphur is oxidized and converted into sulphur dioxide, which passes into the air in which it is rapidly diffused. The air of every large city, especially in the manufacturing districts, becomes polluted with free sulphur dioxide in variable proportions. To form even an approximate idea of the enormous quantity of waste matter poured into the air of a city like London, it is worth while mentioning the statement quoted by Egbert,² that "It has been calculated that for every ton of coal burnt in London something like three tons of carbon dioxide are produced," and as the city's coal consumption is over 30,000 tons per diem, we can see that its atmosphere must receive the enormous daily contamination of about 300 tons of soot and 90,000 tons of carbonic acid. From this calculation the writer has made another proportionate calculation from which he finds that at least 2,700 tons of sulphur dioxide are produced at the same time, helping to augment the further daily pollution of the atmosphere of that city.

Sulphur dioxide, after uniting with the oxygen and aqueous vapor of the air, is converted into sulphuric acid.

A portion of the sulphuric acid, says Thorpe,³ is probably derived from the oxidation of the iron pyrites, which is generally present in coal to the amount of 3%, although some coals contain much larger quantities of this substance. The amount of sulphur which it contains has an important bearing on the value of the fuel in nearly all its applications. When coal is burnt the sulphur escapes as sulphur dioxide. This gas exerts a very detrimental action on vegetation, and by its proneness to pass into the state of sulphuric acid in the atmosphere it brings about the rapid deterioration of the stone-work on which it may be precipitated. It has been calculated that as much as 20 tons of oil of vitriol (sulphuric acid), produced by the combustion of coal, are annually brought down by the rain in a large city like Glasgow or Manchester.

Dr. R. Angus Smith⁴ has shown that in large towns the amount of sulphates is largely increased, owing to the combustion of coal which contains iron pyrites. The nature of the sub-