

**On the fatal cases of inhalation of chloroform ... Read at the Westminster Med. Soc. March 31, 1849 / [John Snow].**

**Contributors**

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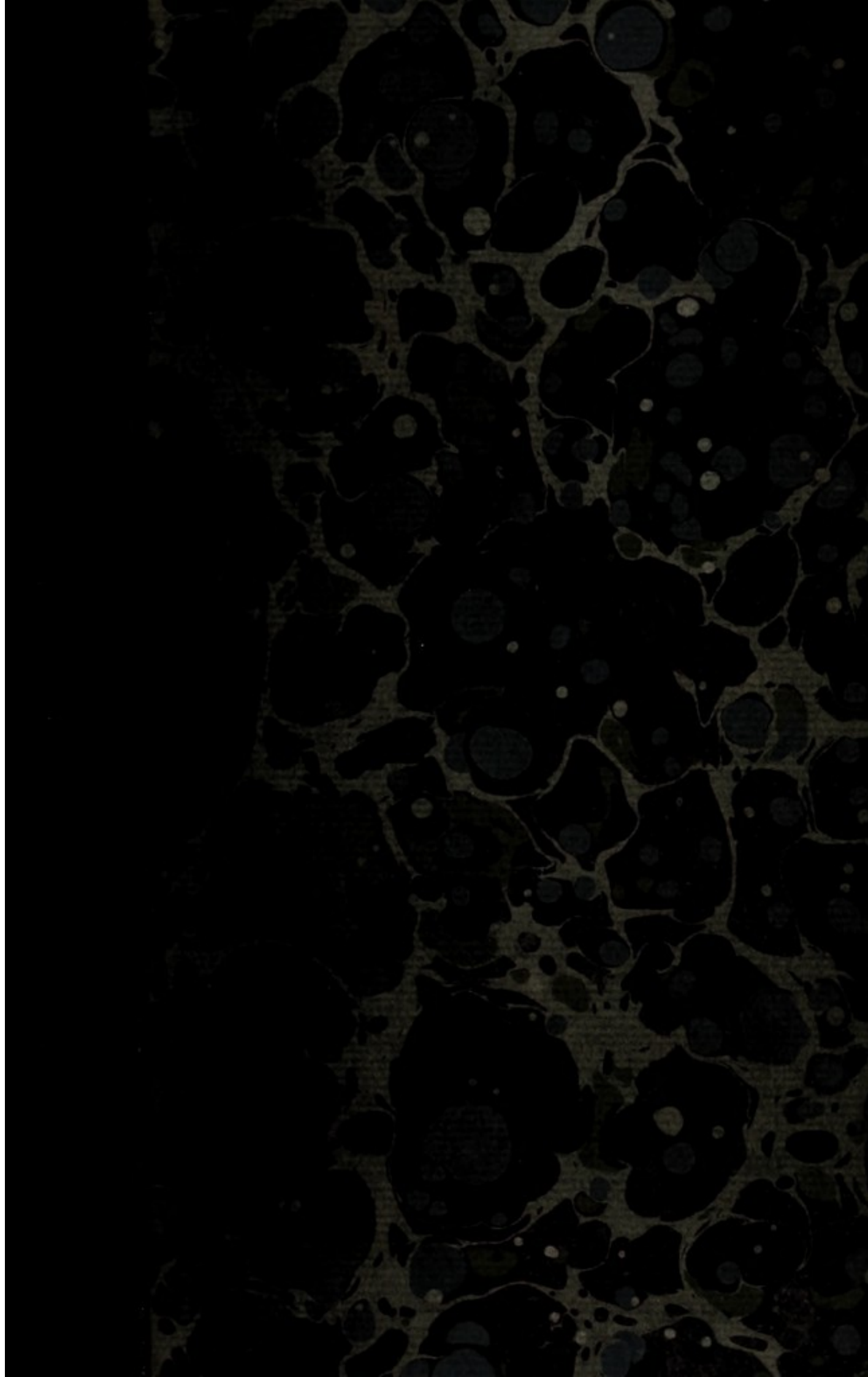
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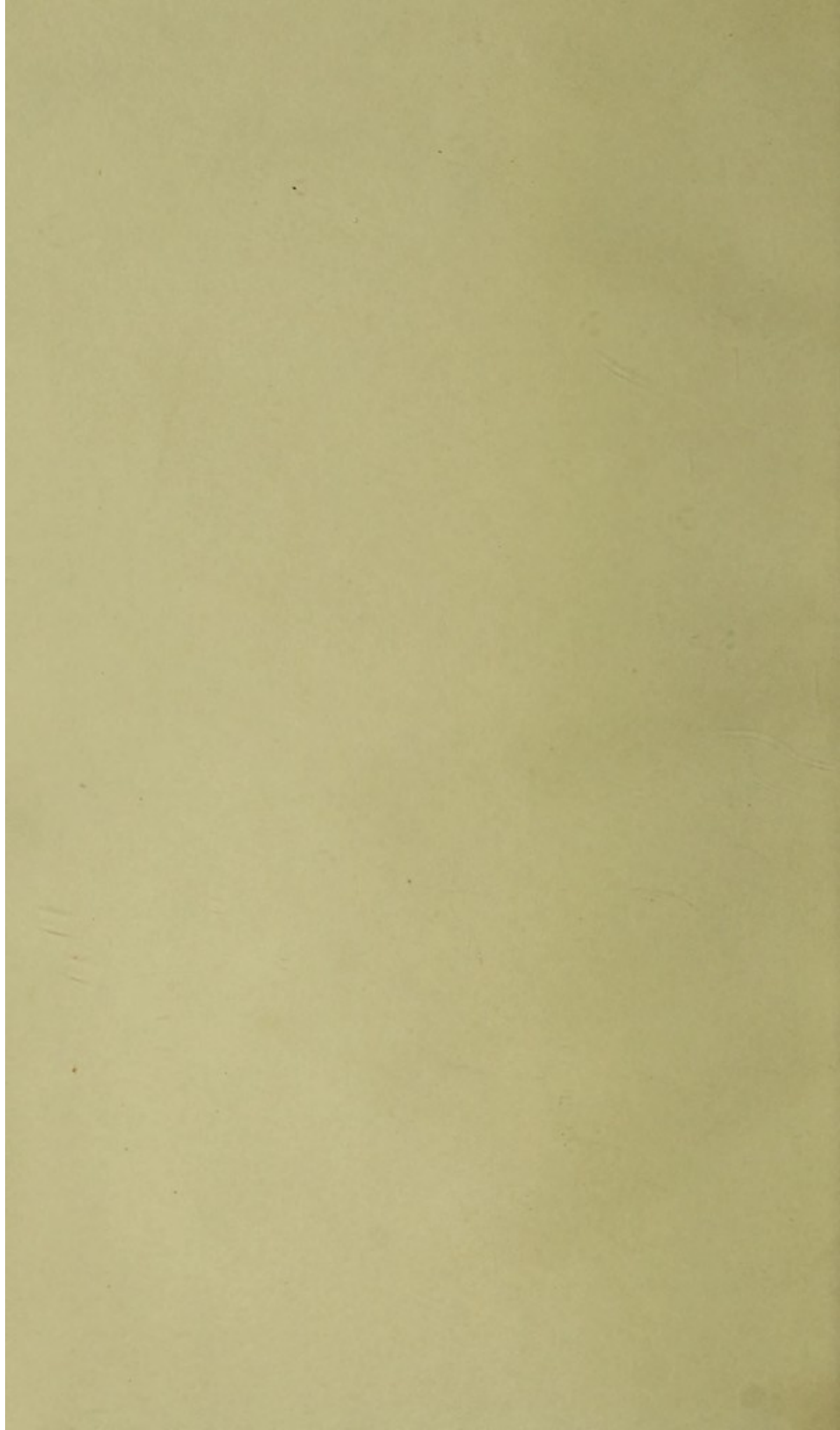


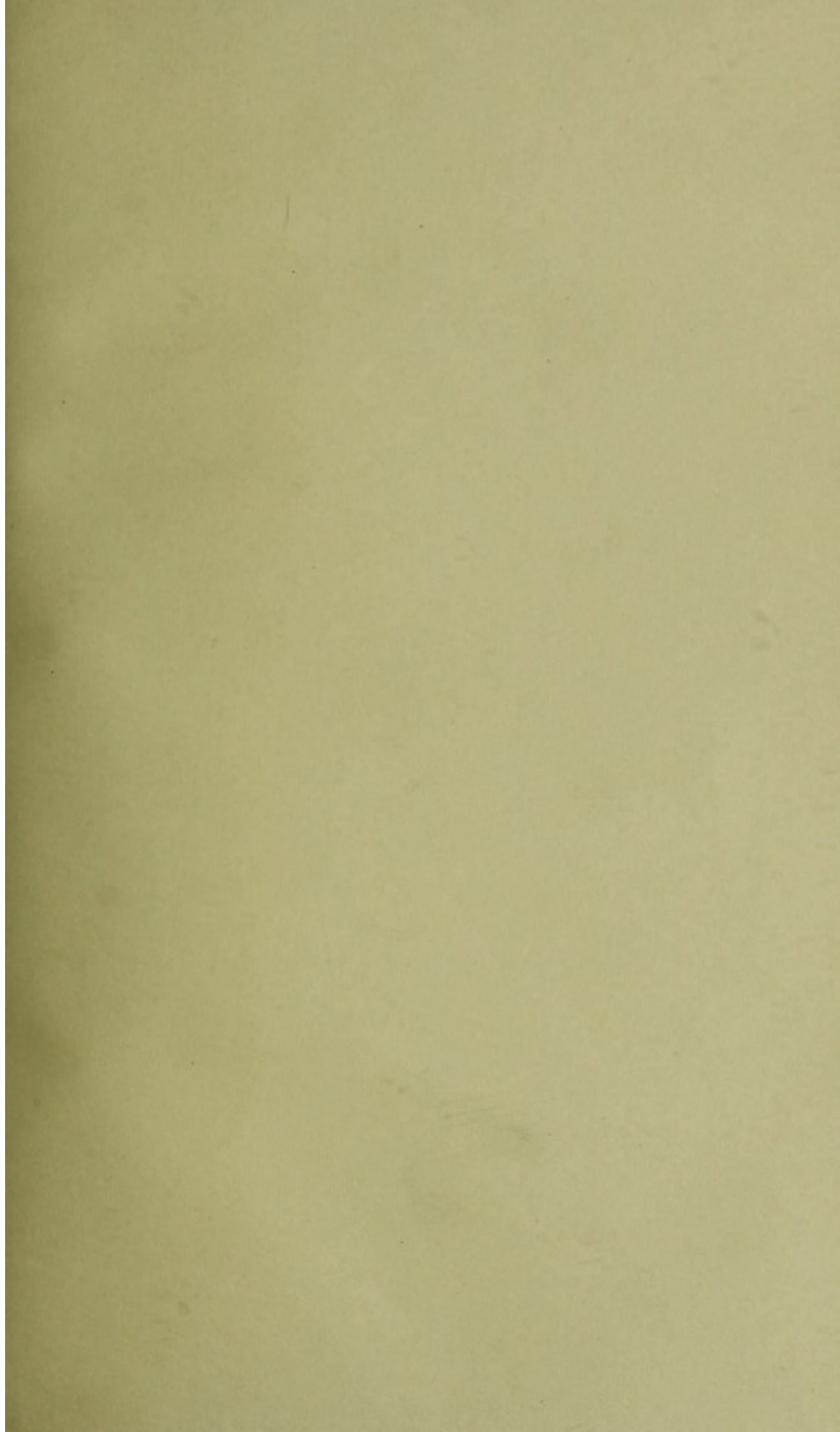
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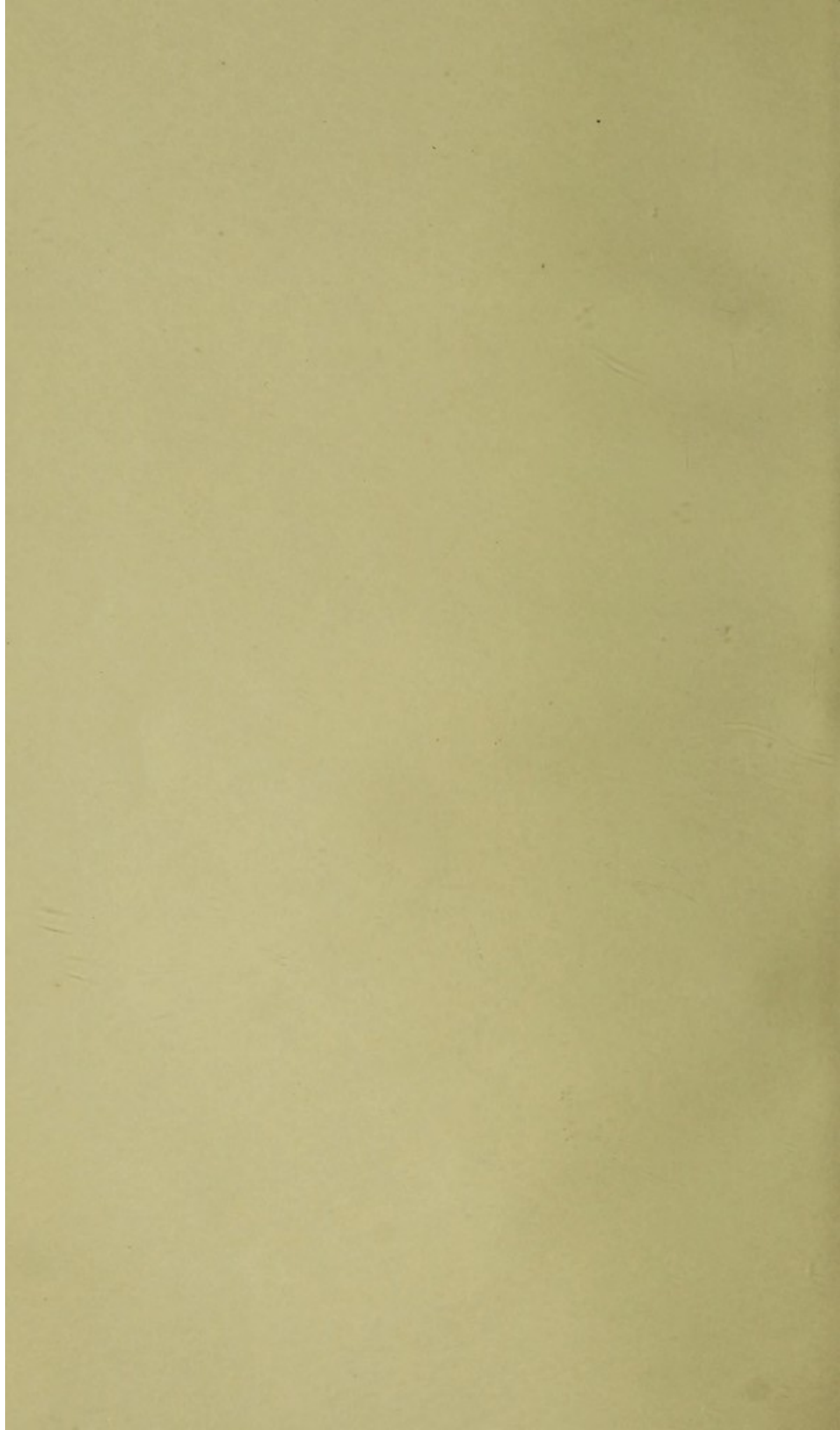
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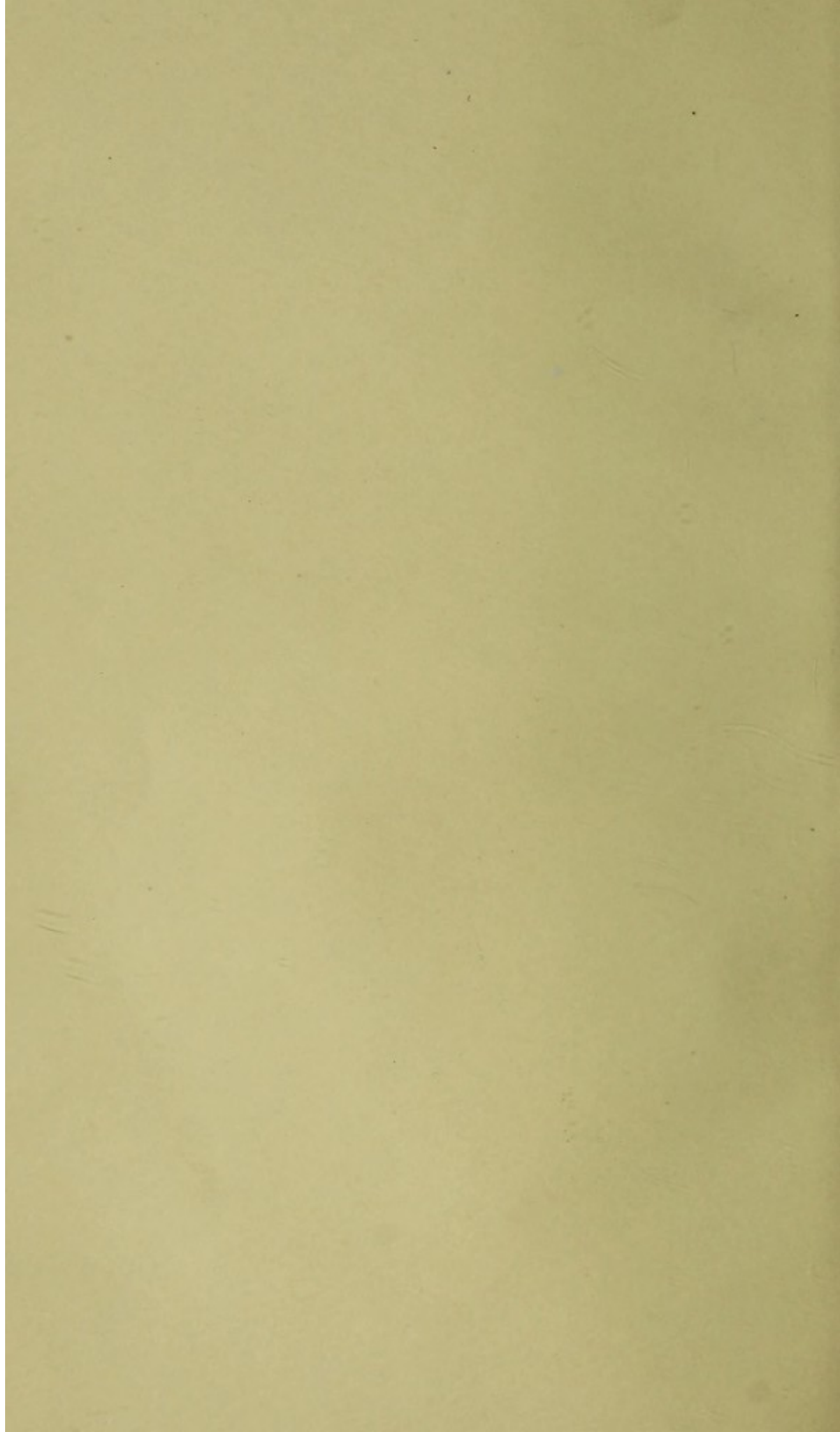




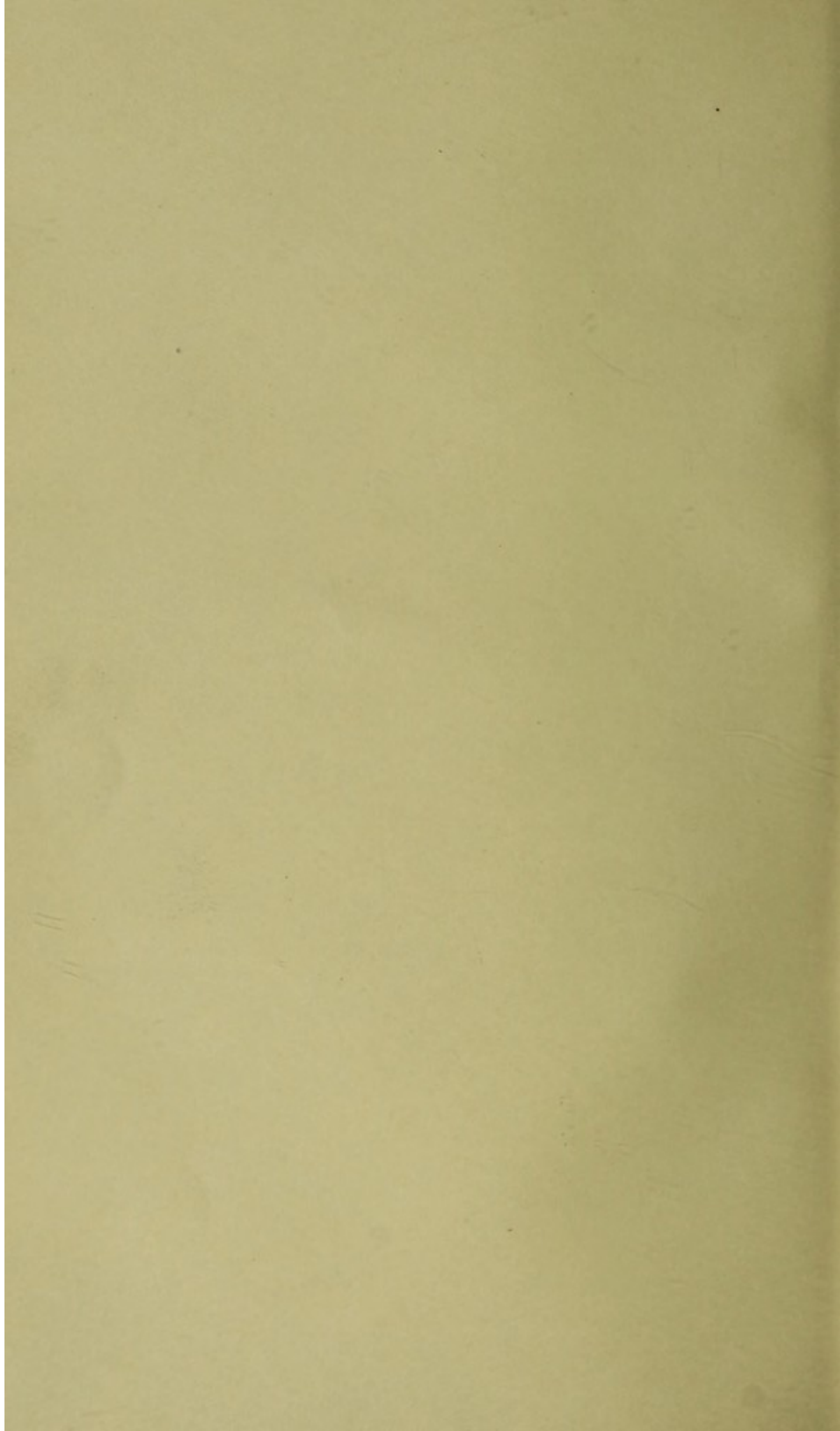


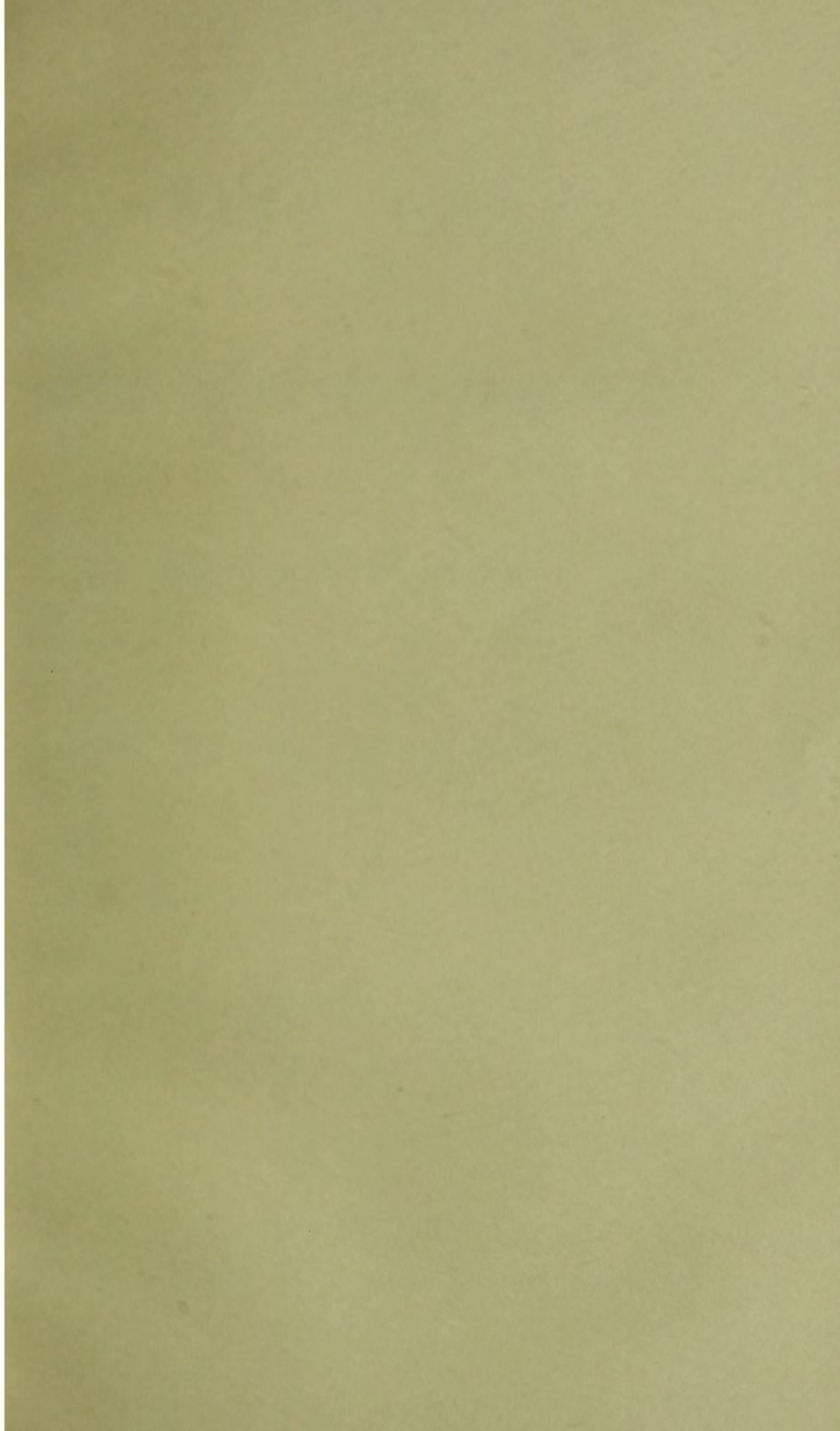


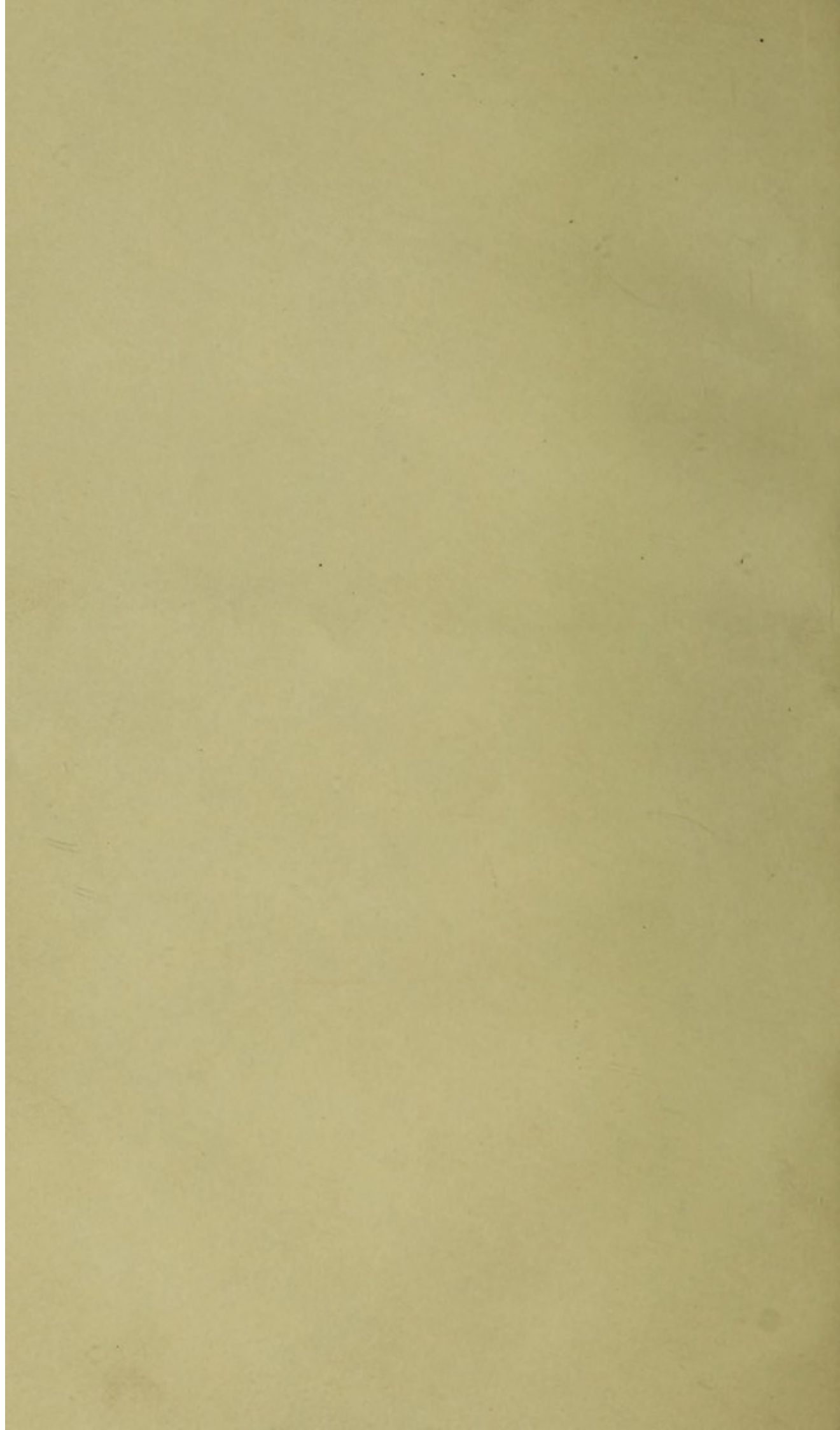












ON THE  
FATAL CASES  
OF  
INHALATION OF CHLOROFORM.

BY JOHN SNOW, M. D.

READ AT THE WESTMINSTER MEDICAL SOCIETY,  
MARCH 31, 1849.

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*(From the Edin. Med. and Surg. Journal, No. 180.)*

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(LONDON: PRINTED BY J. JOHNSON, ST. PAUL'S CHURCH-YARD, 1848.)





## ON INHALATION OF CHLOROFORM.

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SOON after the introduction of the inhalation of ether, two or three cases occurred in which it was rumoured that fatal effects had followed the practice; and in one case, that of Mrs Parkinson at Grantham, a coroner's jury returned a verdict to that effect, without much inquiry; the cause of death being taken for granted by the coroner in his charge. However, as the physiological effects of ether became generally known to the profession, it became evident that these deaths, which occurred two or three days after severe operations, could not be attributed to the inhalation. I know only one case where death was occasioned by the inhalation of ether.\* This occurred in France, and the process was continued for ten minutes, without intermission, although alarming symptoms existed a considerable part of that time, and the result was probably as much due to defective admission of air as to the influence of the vapour.

At the time at which the inhalation of ether was introduced, two solutions of chloroform in spirit were in occasional use as medicines,—one of them bearing the name of chloric ether, and the other being called terchloride of carbon. The former of these preparations was used occasionally for inhalation, in St Bartholomew's Hospital and elsewhere, soon after the employment of sulphuric ether was introduced; but, besides being expensive, it was uncertain in its effects,—partly from its variable strength, but chiefly because the chloroform evaporated in largest quantity at first, leaving the spirituous solution weaker and weaker as the process continued. The composition of this so-called chloric ether was not generally known to the profession; but in the latter

\* See Gazette Medicale, Mars 4, 1848.



part of the year 1847, Mr Waldie of the Apothecaries' Hall of Liverpool, being in Edinburgh, made known its nature, and recommended the chloroform, to which it owed its virtues, to Dr Simpson, who was at that time in search of new anæsthetics. Dr Simpson tried the chloroform in its separate state, as recommended by Mr Waldie, found it to answer, and introduced it into general employment, as is well known; and in a short time it almost superseded the use of ether throughout Europe, and became employed also, to a great extent, in America.

Chloroform is much more powerful than ether, and this is one reason why it is, in some respects, more convenient. Its greater potency depends, as I showed on a former occasion,\* on its being more sparingly soluble in the blood than ether. The quantity of chloroform required to induce insensibility is less than one-tenth as much by measure, as in the case of ether. Viewed in this manner, it is more than ten times as strong; but to ascertain their comparative physiological power, when inhaled in a similar manner, their volatility requires to be taken into account. In order to perceive the relative strength of these two medicines, we may suppose that the air which a patient breathes is saturated at 60°,—the ordinary temperature of a dwelling room,—with one or other of the vapours, and see how much air he would have to breathe in either case, in order to be narcotized to the third degree,—the extent of insensibility usually required in a surgical operation. Thirty-six minims is about the average quantity of chloroform required to produce this degree of narcotism in the adult, and this would saturate 257 cubic inches of air at 60°, making it expand to nearly 300 cubic inches, which would be breathed in 12 ordinary respirations of 25 cubic inches each. The quantity of ether usually required to produce the same amount of insensibility in the adult, is about  $7\frac{1}{2}$  fluid drachms; this would saturate 440 cubic inches of air at 60°, and increase its volume to rather more than 800 cubic inches, which would require 32 ordinary respirations to breathe it. We see, therefore, that 12 inspirations of air charged with vapour of chloroform are equal to 32 similar inspirations of air charged with vapour of ether, at the same temperature; and that, consequently, chloroform is nearly three times as strong as ether. In actual practice the difference in strength is generally greater than this, for ether abstracts much more caloric than chloroform during its evaporation, thereby reducing the temperature of the air passing over it, and the sponge or whatever contains it, and limiting its own evaporation, in a greater degree. It follows, therefore, that the fact of accidents not occurring under the use of ether, could be no guarantee that they would not happen during the employment of chloroform.

\* See Med. Gaz., March, 1848.



Having, on a previous occasion, described the ordinary effects of chloroform, I shall now proceed at once to the consideration of the circumstances under which it is capable of causing death. When an animal, after it has become completely insensible, is allowed to continue breathing air charged with the vapour, the respiration shortly ceases; but if the air do not contain more than about five per cent. of the vapour, the heart continues to pulsate for some time after the breathing has ceased, and the circulation is finally arrested for want of the respiration, as in all other cases when death takes place by apnœa. I have heard the pulsations of the heart, by means of the stethoscope, several times, for one or two minutes after the breathing has ceased, in cats and rabbits under the influence of chloroform. During this interval, life is easily recalled by means of artificial respiration; indeed, more than once, moving the animal, or pressing on its chest, whilst using the stethoscope, has apparently been the means of resuscitating it. This persistence of the heart's action, as I have elsewhere shown,\* does not arise from any incapacity of chloroform to paralyze it, but from the circumstance that the sensibility of that part of the nervous system on which the motions of respiration depend, is abolished by a somewhat smaller quantity of the narcotic than is requisite to suspend the action of the heart. When, however, an animal is made to breathe air containing a greater quantity of the vapour, ten per cent. or upwards, death takes place rapidly in from half a minute to about two minutes, and the respiration and circulation cease about the same time. The reason of this is, that there is sufficient vapour in the lungs, at the moment when the breathing stops, to paralyze the action of the heart as soon as it is absorbed, and added to that already contained in the blood. Under these circumstances, it is evident that artificial respiration can be of no avail; and this is the manner in which, there is every reason to believe, the greater number of the fatal cases of inhalation of chloroform have occurred.

In order to give as clear an idea as possible of the cause of the accidents from chloroform that have happened in different parts of the world, I must direct attention to some considerations of the quantity of it, in the blood and in the lungs, under different circumstances. I have stated that the average quantity of chloroform required to be inhaled, by an adult, to induce the usual amount of insensibility required in an operation, is 36 minims; but about half of this is expired again without being absorbed, so that 18 minims is about the quantity existing in the blood. Indeed, about a year ago, I related to this Society† the result of some experiments, undertaken to ascertain the exact proportion in the blood, in the different degrees of narcotism, by which it was shown

\* *Med. Gaz.*, Vol. xlii. p. 415.

† *Ib.* xli., p. 850.



that about 12 minims is the quantity in the second degree, or the stage when the mind wanders and voluntary motion is unsteady; about 18 minims in the third degree of narcotism; about 24 minims in the fourth degree,—the stage of complete insensibility, with relaxation; a little more than 30 minims, the quantity that would be required to suspend the respiration; and about 36 or 37 minims to arrest the action of the heart, supposing the vapour to be equally diffused through the whole of the blood. Now, let us ascertain what proportion of this latter quantity of chloroform may be present in the lungs at once, provided the air breathed by the patient be saturated at 60°. The quantity of air usually present in the lungs is about 250 cubic inches; this would contain 30 minims before it entered the lungs, but, as absorption and inhalation go on together, it is probable that, during ordinary respiration, only from half to two-thirds of this quantity would be present in the lungs at once, or from 15 to 20 minims; and, if the chloroform were removed from the patient's mouth, part of this would be expired again, and not more than from 10 to 15 minims would be absorbed into the blood after the discontinuance of the inhalation. But, supposing 12 minims were thus absorbed, they might cause a fatal result; for if the patient were narcotised to the third degree, and about 18 minims had been absorbed, when the inhalation was discontinued, the additional 12 minims would make half a drachm, which might suspend respiration; or, if the patient were already in the fourth degree, and twenty-four minims had been absorbed, twelve minims more would complete the quantity which I have estimated would be sufficient to arrest the action of the heart. These numbers are only approximations to the exact quantities; but the subject itself is not one of speculation, for that the effects of chloroform continue to increase during about twenty seconds after the inhalation is left off, owing to the further absorption of the vapour present in the lungs, may be observed daily in practice, even when the chloroform is largely diluted with air, and, of course, the greater the quantity of vapour in the air, the more formidable must be this increase of the narcotism. It will be recollected that I called the attention of the society to this increase or accumulation of the effects of chloroform, early in January last year,\* before any fatal case had happened from its use, and recommended that the vapour should, by means of some suitable apparatus, be so diluted, that its effects should be gradually induced in not less time than about two minutes.

Sometimes a patient begins all at once to breathe deeply during the inhalation; and, under these circumstances, if the vapour be not largely diluted, it will be inspired with dangerous rapidity.

\* See *Med. Gaz.* Vol. xli. p. 75, and *Lancet*, Feb. 12, 1848.



The first incision by the surgeon's knife, when the patient is unconscious, but not totally insensible, sometimes has the effect of causing him to draw a deep inspiration, and to hold his breath at the end of it, retaining the air in his lungs: now, an inspiration of this kind might, on a moderate computation, introduce 100 cubic inches of air; and, if this were charged with vapour of chloroform, by passing over a handkerchief or sponge, it might contain ten or twelve minims; if the air or the handkerchief were warm, it might, indeed, contain much more; but this quantity, added to that already in the circulation, might cause a fatal accident.

It must be sufficiently evident, from these considerations, that, unless some means were used for regulating the strength of the vapour, fatal accidents would be liable to occur from the employment of chloroform. Unfortunately, Dr Simpson, to whom we are indebted for its introduction, recommended it to be used on a handkerchief, and even held it out as one of the advantages of the new anæsthetic, that it did not require any apparatus. This advice, coming from so high a quarter, could not fail to meet with numerous followers; and to this circumstance, many of the accidents that have occurred must, in my opinion, be partly attributed. It is not asserted, by the advocates of the handkerchief, that it affords any accurate means of regulating the strength of the vapour. This they seem to think unnecessary. They appear to consider that all that is required is, that the patient should inhale the chloroform till he is made insensible, and then leave off;—that the practice is not attended with danger; and that the deaths which have occurred, either were not caused by the chloroform, or depended on some idiosyncrasy, or the presence of organic disease. In order, however, to show the different effects of the vapour, according to the quantity of air with which it is diluted, I will make two experiments; in the first of which, a bird will die in about half a minute, although having sufficient air for purposes of respiration; and, in the second, another bird will become gradually insensible, and will as gradually recover, after its removal from the vapour.

Twelve grains of chloroform were poured into a glass jar holding 100 cubic inches, and covered with a plate of glass; the jar was moved about till the chloroform was converted into vapour, and equally diffused amongst the air, when a brown linnet was introduced. It made an attempt to escape, then appeared in distress; shortly afterwards it fell down, and it was taken out dead half a minute after its introduction. The same quantity of chloroform was then put, in a similar way, into a jar holding 600 cubic inches, and another linnet introduced. After a short time, it began to stagger as it walked, and soon afterwards was unable to keep on its legs; in about two minutes it appeared insensible,



but was allowed to remain a minute longer, when it was taken out and laid on the table. It shortly began to move, and in two or three minutes had quite recovered.

The jar employed in the first experiment holds enough air to support the respiration of a small bird, for ten or fifteen minutes, without distress. The chloroform introduced formed about nine cubic inches of vapour, displacing as much air, and leaving about 91 cubic inches; but the same quantity of vapour of ether would have acted much more mildly, gradually causing insensibility; and the same quantity of some vapours,—that of wood spirit, for instance,—would have scarcely had an appreciable effect on the bird in several minutes. Vapour of the strength employed in these two experiments does not act so rapidly on larger animals, but, by increasing its strength, it acts as quickly, and there is the same difference in its effects, with a similar difference in the proportion of vapour and air.

The first fatal case of inhalation of chloroform was that of Hannah Greener, which occurred near Newcastle, on the 28th of January last year. The patient was a girl 15 years of age, who required to have her toe nail removed. About a teaspoonful of chloroform was put on a cloth, which was applied to the mouth and nostrils. In about half a minute the patient's arm was rigid, and she appeared insensible. The operation was at this time commenced; she gave a kick, as if not quite insensible; at this time the lips became suddenly blanched, and she spluttered at the mouth, as if in epilepsy. The breathing continued for upwards of half a minute after the cloth was removed from the face, but the patient was quite dead in two minutes from the first commencement of the operation.\* The spasm that occurred in this case at the moment of death, resembles what is often met with when animals are suddenly killed by vapour of chloroform not well diluted with air.† The most prominent appearance, found on inspection of the body, was a highly-congested state of the lungs. Sir John Fife attributed the death to this, but it ought rather to be attributed to the narcotic effects of an over-dose of chloroform on the brain and nerves. Both chloroform and ether, when in too strong a state, cause a temporary congestion of the lungs, as is evidenced by a momentary smallness of the pulse; but it may fairly be doubted whether this would cause death, and especially in so rapid a manner; whilst, on the other hand, the undoubted narcotic effects of the vapour explain it fully. There is no evidence to determine whether the action of the heart continued in this case after the respiration had ceased or not. There was dark fluid blood in its right cavities, and a very little in the left.

\* See Dr Meggison's Letter, *Med. Gaz.*, Vol. xli. p. 254.

† For a full account of the case of Hannah Greener, see the *Edinburgh Medical and Surgical Journal*, Vol. lxi. p. 498. April 1848.



Dr Simpson attributed the death in this instance to suffocation, by a small quantity of brandy given to the patient whilst she was dying, and which she swallowed, though with difficulty; but I believe that few medical men agree in this opinion. Some persons,—and there are medical men of eminence amongst them,—whilst they admit that the chloroform was the cause of death in this and similar cases, suppose that it acts mechanically, by excluding the air; but they do not distinguish between a vapour and a gas. Chloroform, when not admitted to mix with air, remains liquid until it is raised to the temperature of  $140^{\circ}$  Fah., unless the pressure of the atmosphere be partially removed from it, by means of the air-pump. I have already alluded to the real cause of the accident, viz. that the air breathed by the patient contained too much vapour,—probably 10 or 15 per cent., when it ought to contain only about 5. There are others who think that the handkerchief applied too closely has caused death, by obstructing the respiration; but where death has happened so suddenly, this explanation is quite untenable. When ether was first introduced, I believe that some disagreeable symptoms were occasionally caused by obstructed respiration, from breathing for several minutes through a very narrow tube; and I have alluded to one case, in which this process being continued for ten minutes without ceasing, probably contributed to a fatal result. But the accidents from chloroform are of a different nature, and it must be borne in mind, that with this medicine air is required to dilute its vapour considerably over and above what would be merely required for the purposes of respiration.

The next accident from chloroform happened to Mrs Simmons, of Cincinnati, U. S., on Feb. 23, 1848. The limits of a paper will not allow of the cases being read in detail, consequently I can allude only to their chief features. The patient in America was 35 years of age, and in pretty good health. She required some stumps of teeth removed, and inhaled from a glass globe containing a large sponge saturated with chloroform. I believe that this is the only fatal case in which any kind of apparatus was used, and the dentists who employed it were not medical men, and their only endeavour appears to have been to make the patient insensible as quickly as possible. When the patient had drawn from twelve to fifteen inspirations, she appeared insensible, and the roots of teeth were extracted; she turned pale during the inhalation; groaned as the teeth were removed; and as the last root came out, her head turned to one side, her arms became rigid, and the body was drawn backwards. Mrs Pearson, a friend who accompanied the patient, at this moment placed her finger on the pulse and found it feeble, and that it shortly ceased to beat; the respiration ceased, she says, about the same time. She and



another female friend considered that the patient died at this time, about two minutes from the commencement of the inhalation,—the dentists thought that she lingered a little longer. Artificial respiration was performed after a time, and galvanism was also applied, which caused contraction of the voluntary muscles, but had no effect on the heart. In a medical inquiry which took place respecting this case, it was estimated that one-fourth part by measure of what the patient inhaled, might be vapour of chloroform; but this is evidently an over-calculation, for there could not be this quantity, unless the interior of the glass globe were maintained at a temperature of 80°; however, half the amount supposed might have caused the result.

At the *post mortem* examination, the blood-vessels of the head were moderately distended; some fluid blood mixed with air flowed from the sinuses of the *dura mater*,—this air had no doubt entered the blood-vessels during the artificial respiration. The lungs were considerably, but not intensely, congested; the heart was flaccid, and all its cavities were quite empty, but its lining membrane was stained with blood,—it had been emptied after death, either in opening the head, or else by the artificial respiration. Dr Sibson, in commenting on this case, last year, in the Medical Gazette, stated that he had seen the heart emptied after death, during experiments with artificial respiration in the human subject. The blood was very fluid in this case.

The next case occurred at Hyderabad in Hindostan, in the person of a young woman, who had the distal phalanx of one of her fingers removed. A drachm of chloroform was put on a handkerchief and inhaled. The patient coughed a little, and then gave a few convulsive movements. The operation was then performed, but scarcely a drop of blood flowed, and no signs of life remained. The practitioner is inclined to think that death was almost instantaneous; for, after the convulsive movements, the patient was not observed to breathe or stir. There was no examination after death.

The next fatal case happened at Boulogne, in May last. The patient was a female, aged 30 years, in good health, but she had previously been in a state of anæmia. In the first account of the case, it was stated that only fifteen to twenty drops of chloroform had been put on the handkerchief; but a judicial examination of the bottle from which it had been taken, showed that from a drachm and a quarter to two drachms had been used,—five to eight grammes. “Scarcely had the patient taken several inspirations, when she tried to remove the handkerchief, and cried, ‘I choke.’ Immediately the face became pale; the countenance changed; the breathing embarrassed; and she foamed at the mouth; at the same instant (and certainly less than a minute



after the beginning of the inhalation), the handkerchief moistened with chloroform was removed," and the operation was performed by M. Gorré, his colleagues, in the meantime, trying in vain to remedy the state of the patient. Artificial respiration was kept up for a long time, and with such force as to cause permanent dilatation of the air-cells.

At the inspection of the body, the lungs were found visibly engorged in the lower lobes. The heart was quite empty, as in the American case, in which artificial respiration had been employed. The vessels of the head were not engorged, but air was found in the venous sinuses. It was met with also in the pulmonary veins (where no doubt it first entered by minute ruptures of the air cells and vascular tissue), in the heart, in the right carotid artery, and in the veins generally.

The members of the Academy of Medicine of Paris, attach great importance to the air in the veins; most of them attributing the death to it; some supposing that it was due to an unknown action of chloroform on the blood, and others thinking that it was spontaneously and suddenly developed. It is alleged that the air in the veins could not have been introduced by the artificial respiration, as the left ventricle had already ceased to act. But so soon as an opening was made into the pulmonary veins, the air would be urged forward, in the course of the circulation, by the forcible inflation. Moreover, the arteries possess the power of forwarding their contents after death, as is proved by their generally being found quite empty. The blood, in the case under consideration, was very fluid and black.

There was a statement in the Glasgow Herald at the beginning of the year, which was copied into the Medical and other Journals, that a gentleman inhaled chloroform, preparatory to having his toe-nail removed, by a surgeon in Govan, and expired almost instantly. As no account of this case has been given to the profession, we cannot discuss it; but there are two other cases which it is necessary to notice. The first of these occurred in the practice of Dr Barrier, at the Hotel Dieu at Lyons. The patient was a boy aged 17, on whom it was intended to perform amputation of the finger. A thin compress was placed on the face, and chloroform was dropped on gradually; in four or five minutes he was still speaking, and conscious of pain in the injured finger; a minute afterwards, he spoke again, and showed a little agitation. By this time, from one drachm and a half to two drachms had been poured on the lint, and it is to be supposed that a great deal of it went off by evaporation. The pulse had all the while been perfectly normal. All at once the patient rose suddenly, and threw about his limbs, but he was soon brought down again by the assistants. This excitement did not altogether last more than a quarter of a



minute, when it was found that the artery at the wrist had ceased beating. The cloth was immediately taken off from the face, which looked haggard. The heart ceased to beat, and no pulse could be detected. Respiration was, however, carried on, but soon became weak, slow, and ceased completely in about half a minute. On the employment of very energetic restorative means, the breathing began again, with a certain amount of vigour; the pulse, however, could not be felt, and the respiration soon ceased again. Artificial respiration was employed amongst other means. After death, the heart was found empty. The lungs were collapsed, and of a slate colour.

It was especially noticed in this case that the heart ceased to beat before the respiration entirely left off. Dr Sibson made last year a suggestion which is particularly applicable to this case, viz., that the blood passing from the lungs to the heart, and through the coronary arteries, is more highly charged with the vapour than that in any other part of the body, and may cause paralysis of the heart, before even general insensibility is induced. Some experiments of mine on frogs and other animals\* have shown that the vapour of chloroform has the power of acting locally on the heart, and suspending its action. It is therefore possible that, by means of very strong vapour, the blood passing through the lungs might be so impregnated with chloroform as to paralyze the heart, before the functions of the nervous system generally were abolished. To prevent this occurring, all that is required is that the vapour be uniformly and sufficiently diluted with air. In the case at Lyons, it appears that the patient got but little vapour into his lungs for several minutes, and then suddenly inhaled a considerable quantity, either from taking a deep inspiration, or some other cause.

The remaining case occurred very recently in Westminster, in a dispensary patient under the care of Mr Nunn's dresser. The subject of it was a labouring man who had his great toe amputated, on account of gangrene, following an accident. Half an ounce of chloroform was used on a handkerchief, with the effect of causing only excitement; insensibility was not induced; and a delay of two hours took place before fresh chloroform was procured. The second time the same quantity was employed as before. I understand that it was not all poured on the handkerchief at once, but was dropped on by portions; but of course it cannot be determined how much of the whole quantity was on the handkerchief at one time. In the account in the *Lancet* by Dr Arlidge, it is stated that, "after a period of excitement lasting two or three minutes, insensibility was induced, and the breathing, at first rather hurried, became now slower and rather sterto-

\* *Med. Gaz.*, vol. xlii., p. 415.



rous; the eyelids quivered on the approach of an object to the eye; the pupil became somewhat dilated; the pulse was at about 70, moderately strong. As soon as anæsthesia was produced the operation was proceeded with, and occupied not more than two minutes." I understand that the inhalation was continued during part of the time occupied by the operation. "At the close of the amputation no blood escaped when pressure was removed from the arteries. In the meantime the breathing became slower and less full, and a pallor with coldness diffused itself over the body, and showed itself in the lips, &c. The pulse receded in strength and frequency, and very shortly ceased at the wrist. The features assumed a ghastly expression, and everything betokened impending dissolution. A few respirations were noticed after the pulse ceased at the wrist, but in ten minutes (the time is probably greatly over-estimated) from the time of the inhalation respiration altogether ceased, and the chin dropped." The lungs and bronchial membrane were congested; the heart was rather large but flabby. There was an ounce of semi-fluid blood in the right ventricle, and a little in the left (artificial respiration had been employed). The contents of the head were natural.

This case shows in a striking manner the uncertainty of the employment of the handkerchief. In the first attempt to make the patient insensible, nearly all the chloroform was wasted by evaporation into the air of the apartment, and but little entered the lungs; whilst, on the second occasion, he at some moment got an overdose, and was no more. The coroner's jury returned a verdict of death by chloroform properly administered, which is tantamount to an assertion that the inhalation of it is attended with danger, however well managed, than which nothing can be more untrue. I have no desire to blame the parties in whose hands this unfortunate case happened, and who had sufficient precedents for the way in which they proceeded, but I cannot admit that chloroform is properly administered when it leads to the death of the patient.

There have been two accidents from persons inhaling chloroform whilst no one was present; but I shall confine this paper to the cause and prevention of accidents occurring during its professional administration. There was an alleged death from it, which must be fresh in the minds of the fellows of the society, to which I have not alluded. I mean that which occurred in the practice of Mr Robinson, but which, I believe, was not caused by chloroform, for the following reasons. In the first place, the patient could have had but an extremely small quantity of the vapour, since, according to the evidence at the inquest, the face-piece, of which Mr Robinson's inhaler consists, was not fitted to the face, but held at a little distance from it; the air would



therefore pass into the mouth and nostrils by the side, instead of going through the sponge it contained, and would consequently be but just flavoured with the chloroform. In the next place, the patient never exhibited any symptoms of the action of the vapour. He was talking one moment, and showing no signs of its effects, and the next moment his head and hand dropped, and he was dead. There was no convulsive action as in the cases in India and America, and that near Newcastle. No frothing at the mouth, as in the case at Boulogne, nor any exclamation respecting the strength of the vapour, such as, "I choke;" but, on the contrary, he was observing that the vapour was not strong enough, which, assuredly, he would not have done, if there had been a quantity of it in the lungs capable of causing sudden death. The decease of this patient seems to belong to a different class of deaths from those under consideration, viz. to those instances in which patients have suddenly expired when an operation was about to commence,—a kind of death from which patients are safe as soon as they become unconscious from the effects of chloroform. I look on Mr Badger's case as one of syncope, through fear of the operation or of the inhalation, concerning which he had been led to entertain apprehensions; and I believe that the syncope proved fatal from the fatty degeneration of the heart and the enlargement of the liver, which greatly encroached on the space of the thorax.

The death of a medical gentleman of Birkenhead, last year, was attributed to chloroform. He died of an attack of hæmoptysis, which came on two days after he had inhaled the vapour for the removal of a tooth. It is not surprising that, amongst the thousands of persons who have inhaled chloroform, one of them should have done so, a little time before he was about to have an attack of hæmoptysis. As the vapour has never caused hemorrhage from the lungs at the time of its employment, there is no reason to suppose that it could do so at an after period. There are other cases besides this, in which the death of patients, at periods more or less remote from an operation or confinement, have, by some persons, been attributed to chloroform. There is not time to consider these cases *seriatim*. I can only state generally my conviction, that the dangers, even of the mismanagement of chloroform, are chiefly confined to the moment when it is administered, and do not develop themselves afterwards.

The fatal cases we have been considering bear a considerable resemblance to each other. We have no particulars of the Glasgow case; but in four out of the other six the insensibility was produced very rapidly, proving that the vapour must have been inhaled of great strength from the first; and in the other two cases, as well as in these, the dangerous symptoms set in very suddenly.



From the sudden paleness observed in most of the cases, it is probable that the circulation was arrested at once, by the direct action of the chloroform on the heart.

The appearances met with on dissection do not differ from those that are found in many other cases, especially of sudden death. There was no particular congestion of the head in any of the five bodies that were examined. The lungs were much congested in two of them, and somewhat congested in the other three. The heart was quite empty in three cases, in which inflation of the lungs had been made after death. The blood was generally fluid, —in two of the cases very much so. I think that this is mainly attributable to the sudden nature of the death; the blood in the human subject very often remaining liquid after sudden death. In animals, such as cats and rabbits, the blood is generally partially, if not well coagulated, after they have been killed by chloroform; and if a portion is allowed to flow by a wound made just after death, this coagulates very firmly, showing that, even if this medicine have the power of interfering with the coagulation of the blood in the vessels, it is not by effecting an alteration in that fluid.

As regards the treatment for an overdose of chloroform, I believe that artificial respiration, carefully performed, is all that could be done; it would save the patient in any case in which the heart is not paralyzed; and, in such a case, I believe that nothing would be of service.

The points which I have endeavoured to impress on the Society are, that, whilst chloroform is perfectly safe when carefully regulated, by means of a suitable instrument, it is not so under other circumstances. In the inhaler which I employ, the compartment containing the chloroform is surrounded with cold water to limit the quantity of vapour taken up by the air, and the expiratory valve of the face-piece is so adapted as to admit additional air to any extent to dilute the vapour still farther.

It will perhaps be asked, how it is that accidents are not more numerous from the use of the handkerchief, if it be really so dangerous, for it is still employed to a considerable extent, though much less frequently, in this metropolis at least, than the various kinds of inhalers which are in use. I think that the skill and adroitness of medical practitioners are the chief causes of this; but I have heard of several cases, such as one that I lately related to the Society, through the kindness of Mr Henry Smith, in which the patient has had a narrow escape from impending dissolution during the use of the handkerchief.





