XXIX.—*Lines of Discovery in the History of Ozone, with an Index of its Literature, and an Appendix upon the Literature of Peroxide of Hydrogen.*

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Read January 12th, 1880.

LINES OF DISCOVERY IN THE HISTORY OF OZONE.

I.—ITS ORIGINAL DISCOVERY, SOURCES AND PROPERTIES.

The history of ozone begins with the clear apprehension, in the year 1840, by Schönbein, that in the odor given off in the electrolysis of water, and accompanying discharges of frictional electricity in air, he had to deal with a distinct and important phenomenon. Schönbein's discovery did not consist in noting the odor; that had been done by Van Marum, more than half a century before, but in first appreciating the importance and true meaning of the phenomenon. For while Van Marum, Cavallo, and others who followed them, connected the odor with the electricity, calling it the "electrical odor," or "aura electrica," and thus made it the property of an imponderable agent, Schönbein ascribed it to the peculiar form of matter operated upon.

The hypothesis of Van Marum necessarily remained barren of fruits; that of Schönbein speedily enriched chemical science with a host of acquisitions.

Clinging tenaciously to the doctrine that there could not be a variety of origin for one and the same odor, and that the kind of matter producing it in every case must be identical, Schönbein fixed his discovery by giving to that one and certain kind of matter, the name of Ozone. By adhering to this guiding clue, he added as a third source of ozone, the action of moist phosphorus upon air (1840–1843); and since that time, besides electrolysis, electrical influence, and the action of air upon moist phosphorus, no other sources of ozone of practical utility have been discovered.

The fact that Schönbein so stoutly insisted, and eventually so triumphantly established, the *identity* of the ozone from whatever

source derived, must not be lost sight of in any estimate of his merits as a discoverer. The earliest attack came from De la Rive, who attributed the odor to metallic oxides set free from the metals used as electrodes, or as terminals in electric discharges. But Schönbein pointed out, that besides the improbability of an odor arising from solid bodies, this hypothesis required that solid bodies should have the property of indefinite suspension in the atmosphere, instead of being deposited, or washed down by water (1840–1843).

The next attacks came from Fischer, who regarded Schönbein's ozone as probably peroxide of hydrogen, and from Williamson, who thought there were two kinds of ozone, one the ozone given off in electrolysis, and which he regarded as a higher oxide of hydrogen, differing from the previously well-known peroxide, and the other formed by the action of phosphorus on moist air. But Schönbein disposed of both objections ;—of the first, by showing that the chemical and physical properties of ozone are not the properties of peroxide of hydrogen ; and of the second, by demonstrating that, whatever might be the true nature of ozone, the gaseous matter obtained in the electrolysis of water, was in all respects identical with that formed by the action upon air of moist phosphorus (1844–1845).

During these first five years, Schönbein was busily engaged in ascertaining the properties of ozone. Since no peculiar methods were employed in the furtherance of these discoveries, they need not detain us here, further than briefly to summarize them, and to point out what corrections have been rendered necessary by the labors of subsequent investigators.

They are :—1st. Its eminent oxidizing powers, as shown by its ability to transform most metals into their higher oxides, and to raise the lower oxides into the condition of peroxides. Certain of the non-metals—phosphorus, chlorine, bromine, and iodine—are similarly oxidized. Schönbein's statement that it does not unite with nitrogen under ordinary circumstances, but enters into combination when alkali is present, has been abundantly disproved ; among others, by Berthelot (1877), who has shown that no combination occurs, even when alkali is present. It oxidizes sulphites and nitrites into sulphates and nitrates,

and many sulphides into their corresponding sulphates. It destroys (as has since been more elaborately demonstrated by Houzeau, 1872) many gaseous compounds of hydrogen, like those with sulphur, selenium, phosphorus, iodine, arsenic, and antimony. It discharges vegetable colors and powerfully attacks many organic bodies. The nature of its action in the latter case has been more extensively studied by Gorup-Besanez (1863), and he has described the products of the reactions which occur when ozone is allowed to act upon organic substances, alone or in presence of alkali.

2d. According to Schönbein, ozone is insoluble in water. The observations of subsequent experimenters conflict on this point, but there appears to be much evidence to show that it is soluble in water, though only in small degree.

3d. Schönbein pointed out that atmospheric air strongly charged with ozone, acts powerfully on the mucous membranes, and produces symptoms of catarrh. This, and his analogous statement that ozone is present in the atmosphere and plays there a very important role, attracted to the subject not only great popular attention, but enlisted as observers a multitude of students of medicine the world over, who hailed the newly discovered body as an invaluable therapeutic agent, and rushed forward to establish, by sufficiently numerous observations, the relations between its presence or absence in the atmosphere, and the kind and prevalence of disease. Thirty years have passed away, and neither anticipation has been realized. Indeed, at the present hour, the possible value of ozone as a therapeutic agent, is obscured by its having fallen into the hands of empirics ; and the multiplication of inexact observations, and the crude and hasty generalizations therefrom, have covered with a sort of scientific opprobrium the whole subject of Atmospheric Ozone.

What causes have led to these lamentable results in the past ? what prospects are there that both subjects can be reinstated in good scientific standing in the future ?

And first, with regard to ozone as a therapeutic agent. Without considering at present the unsettled questions of a medical

character, as to the proper mode or amount or propriety of application, we apprehend that there have been hitherto three grave instrumental difficulties. 1st. To obtain ozonized air or oxygen, of known strength and of adequate purity. 2d. It is doubtful whether in one form, in which the attempt has been made to employ ozone in medicine,—that of "ozonized water,"—any ozone whatever has been present. Such was the case with the "ozone water" of Krebs, Kroll & Co., in which Rammelsberg found *chlorine*. Since ozone is so slightly soluble in water at common temperatures, that it is extremely difficult to demonstration the fact of solution, the proposition to employ "ozonized water" as a remedial agent opens a wide door to quackery. 3d. It is certain, that from the mixture of potassium permangat nate and sulphuric acid, which has been and is recommended as a convenient source of ozone for medical use, no ozone, bumerely chlorine and oxides of chlorine (due to impurities in the permanganate) are derived.

These errors have been exposed and the difficulties overcome. There is no obstacle to having in the office of the physician, the sick-room of the patient, or the wards of the hospital, ozonizers suitable to each place, and adequate to supply ozonized air or oxygen of known strength and purity. This being the case, it remains for the therapeutist to do his part of the work, and to discover when and how ozone is to be employed in legitimate practice.

Second, to detect the amount of ozone present at any time or place in the atmosphere, and the role this atmospheric ozone plays as a disease-excitant or prophylactic. The objections which vitiate the observations hitherto made, are two in number: 1st. The ozonoscopes hitherto employed, Houzeau's and the Thallium test included, are all affected by some one of the gaseous bodies possibly present in the atmosphere, as well as by ozone. 2d. The method of conducting the observations is in its nature inexact, and variations in wind, temperature, humidity, etc., are allowed to increase the resultant errors.

Advance in this direction is to be looked for, only when the methods at present in use are abandoned in favor of others more in harmony with those pursued in other branches of gas-analysis,

and when reagents are employed which will assign true values to the amount of ozone determined.

II. The nature of the constituent matter of ozone.

In his speculations upon the nature of ozone, Schönbein was far less fortunate than in his multiplied inquiries into its sources, properties and applications. The difficulty at that time of procuring air or oxygen containing more than a minute percentage of ozone, and of manipulating it when obtained, was very great, so that precise quantitative investigations were attended with formidable obstacles, and probably for that reason were rarely instituted by Schönbein. He brought forth a variety of hypotheses, thus introducing great uncertainty into a confessedly difficult subject, and necessitating the labors of chemists during nearly a quarter of a century for their complete overthrow.

His earliest hypothesis was, that ozone is a compound, consisting of hydrogen and oxygen. This, in 1844, he abandoned in favor of the theory, that ozone itself is elementary, and along with hydrogen enters into the composition of nitrogen, which is a compound substance.

The following year he reverted to his original hypothesis, and while maintaining strenuously that ozone is not peroxide of hydrogen, he nevertheless upheld the view that it is composed in certain unknown proportions of hydrogen and oxygen.

The second hypothesis was overthrown by the experiments of Marignac and De la Rive, who showed that ozone could not be derived from the decomposition of nitrogen, inasmuch as they obtained it by passing electric sparks through perfectly pure and dry oxygen. They proved the resultant body to be ozone, by causing it to react on moist silver and potassium iodide, with the formation of argentic peroxide and iodate of potassium. They explained these reactions by supposing that, under the influence of the electric discharge, the oxygen had acquired an electrified condition, with exalted chemical properties,—in other words, that ozone is oxygen and oxygen only, but oxygen in an electrified state. Plausible as was this explanation, there was nothing in the experiments, water having been present in the reaction upon silver and potassium iodide, to confute the different inter-

pretation brought forward by Schönbein : that ozone was oxygen, to which in some way was added the elements of water. Nor was this point settled by a more elaborate experiment of the same nature, instituted by Fremy and Becquerel in 1853, who demonstrated that when a certain volume of oxygen is confined over an aqueous solution of potassium iodide, moist silver or mercury, *all* of the oxygen undergoes absorption by the reagent, under the influence of a sufficiently prolonged series of electric sparks.

The first to abandon the theory that hydrogen is a constituent of ozone, was Schönbein himself (1849). He employed air, ozonized as strongly as possible by moist phosphorus, and afterwards dried by passage through a sulphuric acid drying-tube. That water was employed in tho generation of the ozone, was not from Schönbein's point of view an essential element in the problem : it was whether this ozone, after drying, still contained the elements of water or hydrogen.

Three hundred liters of the desiccated air were passed through a narrow glass tube heated to redness, in order to decompose the ozone, and then through a second sulphuric acid drying-tube. Since the latter, in repeated experiments, showed no increase of weight, Schönbein regarded the absence of hydrogen in ozone as conclusively proven. At the same time he did not accept the views of Marignac and De la Rive, declaring that to him the existence of an allotropic modification of a gaseous body was inconceivable.

For a long time, however, the theory that ozone was a compound of hydrogen and oxygen prevailed. It derived great weight from the experiments, which had been made by Williamson in 1845. He prepared ozone by electrolysis, and to avoid obtaining along with the electrolytic oxygen any hydrogen, used oxide of copper dissolved in sulphuric acid as the electrolyte. The gas was dried over calcium chloride, and then passed over ignited copper turnings into a second drying tube. This uniformly showed an increase of weight. The copper previous to ignition had been reduced by carbonic oxide, and not by hydrogen, in order to prevent the possibility of any occluded hydrogen being given up, on ignition, to the stream of ozonized oxygen.

These views were apparently confirmed by Baumert's experi-

ments (1853). He passed the electrolytic oxygen evolved in such a manner as to exclude the presence of hydrogen, through a very long sulphuric acid drying tube, and thence into an absorption apparatus containing potassium iodide, and provided with a sulphuric acid bulb-apparatus, to condense evaporated water. In case the matter of ozone and oxygen were identical, the weight of oxygen equivalent to the weight of iodine set free by the ozone, should have been equivalent to the total gain in weight by the absorption apparatus. But, according to the experiments, this weight was less, and the numbers apparently assigned to electrolytic ozone, the formula $H_2 O_3$. And since Baumert found that ozone prepared by the electric charge, could not be made to yield up the elements of water on strong heating, while that prepared by electrolysis could, he regarded the two as different bodies, the former as allotropic oxygen, the latter as teroxide of hydrogen.

Thus, the old hypothesis, against which Schönbein had so long striven, that there were two (and possibly more) bodies of the nature of ozone, was rehabilitated. It was finally overthrown by Andrews (1856), who showed that the preceding experiments on electrolytic ozone had been vitiated by the presence of a small but appreciable quantity of carbonic acid, which, unless very great precautions be taken, is always present in the evolved gas. In very numerous experiments, he showed that the weight of active oxygen was equivalent to the weight of the iodine set free in the absorption apparatus, and therefore no hydrogen as well as could have been present; also, that the properties of electrolytic ozone, and that obtained by the action of the electrical spark on pure and dry oxygen, were identical. More especially, it was shown that both were converted into ordinary oxygen, at a temperature of about 237°C.; and from the whole investigation the author drew the conclusion, which was confirmed by the still more elaborate experiments of Soret, in 1863, and is now universally adopted, "that ozone, from whatever cause derived, is one and the same substance, and is not a compound body, but oxygen in an altered or allotropic condition."

III. The exact nature of the relations existing between ozone and ordinary oxygen.

We have seen that Marignac and De la Rive, as the result of their experiments performed in 1845, had enunciated the view that ozone was oxygen, rendered allotropic by its passage into a peculiar electric state. They proposed to abandon the name "ozone," which assumed an independent chemical existence for this body, and to call it merely "electricized oxygen." This view of ozone was not readily susceptible of investigation by usual chemical methods. But the case was different with the hypothesis, which was shortly afterwards advanced by Dr. T. Sterry Hunt, in 1848. Since his intuition of a truth, not fully demonstrated until twenty years later, is of a very striking character, it will be interesting to quote it as originally announced. In a paper on the anomalies presented in the atomic volume of sulphur and nitrogen, Dr. Hunt says :—"In considering such combinations as SO_2 and SeO_2, which contain three equivalents of the elements of the oxygen group, it was necessary to admit a normal species which should be a polymere of oxygen, and be represented by $O_3 = (OOO)$. The replacement of one equivalent of oxygen by one of sulphur, would yield sulphurous acid gas (OOS), and a complete metalepsis would give rise to (SSS). The first compound is probably the *ozone* of Schönbein, which the late researches of Marignac and De la Rive have shown to be in reality only oxygen in a peculiarly modified form," etc. The hypothesis herein stated, that ozone is triatomic oxygen, necessarily involved the assumption of a corresponding difference in density and other physical properties—differences admitting of exact quantitative proof or disproof. Such were the experimental difficulties in the way, however, that it was not until 1860, that an investigation was made into the volumetric relations of ozone to oxygen. The experiments of Profs. Andrews and Tait then resulted in establishing, that where perfectly pure and dry oxygen is converted into ozone, under the influence of the silent electric discharge, it becomes more dense, the amount of contraction being proportional to the quantity of ozone produced. Also, that when ozone, thus condensed, is exposed for a short

time to a temperature of 270°—300°, it expands to its original volume. That the increase in density is exactly proportional to the amount of ozone formed, was proven by an analysis of the contracted gas by means of potassium iodide. The amount of iodine in every case set free, was precisely equivalent to the weight of a volume of oxygen equivalent to the volume of the contraction, which the oxygen had experienced in the process of ozonation. The same laws were demonstrated to hold good with regard to electrolytic ozone, not only by these authors (1860), but also by Von Babo and Claus, and by Soret (1863).

Andrews and Tait found great difficulty in reconciling the theory of the allotropism of ozone, with their experiments, inasmuch as the oxidation of a body like mercury, potassium iodide, etc., was effected without any diminution in the volume of the contracted gas. In other words, the density of the allotropic oxygen concerned in this oxidation was apparently infinite. They sought, therefore, to explain the origin of ozone by the assumption of a decomposition of the oxygen.

But in 1861, Odling put forth the interpretation, that ozone was a compound of oxygen with oxygen, the combination being attended by a contraction. Hence, if one portion of the combined or contracted oxygen were absorbed by an oxidizable body, the other portion would be set free, and by its liberation might expand to the initial volume. He likewise suggested that this contraction might consist in the condensation of three volumes of oxygen into two volumes, not because this ratio was the only one which would explain the volume and density relations, so far as then known, but because, on the hypothesis of the dual nature of oxygen, this was their simplest possible explanation.

Four years later, Soret discovered that a very remarkable reaction occurs when electrolytic ozone is allowed to act upon oil of turpentine. Its volume is diminished by a volume equivalent to twice that of the oxygen, corresponding to the iodine set free on passing the ozonized oxygen into a solution of iodide of potassium. The latter, it will be remembered, is the same as the diminution in volume, which the oxygen undergoes in ozonation, and may be called the contraction-volume. Hence the two volumes of ozonized oxygen, absorbed in Soret's experiments, contained not only their own volume of oxygen, but

also that contained in the contraction-volume, or, in all, three volumes of ordinary oxygen. The density of ozone, therefore, was to the density of oxygen, as three to two, or 1.6584; the density of ordinary oxygen being 1.1056.

Soret inferred rather than demonstrated these relations, inasmuch as in his first set of five experiments, the ratio of the total volume of ozonized oxygen absorbed by the turpentine, to the contraction-volume, was 2.4, and in his second set of seven experiments, 1.81; both of these results being far from 2, the theoretical number.

However, in 1872, Sir Benjamin Brodie, by the introduction of methods of exact volumetric character, supplied a rigorous experimental demonstration. He obtained in a set of eight concordant experiments made with oil of turpentine, for the ratio between the whole diminution in the volume of the original oxygen, to the diminution in volume of the ozonized oxygen, as a mean result, 3.02 to 2.02. Operating in the same manner with a neutral or slightly alkaline solution of sodium hyposulphite, he obtained as a mean result of 27 concordant experiments, the ratio 3.02 to 2.02. In these experiments, the actual weight of the oxygen absorbed, could not be determined otherwise than by calculation from the alterations in volume. But by the oxidation of stannous chloride, under proper conditions, he effected a direct determination, and found that the weight of the oxygen absorbed from the ozonized oxygen by the stannous chloride, was almost exactly three times the weight absorbed from the same gas by potassium iodide. At the same time the volume in the first case was almost exactly twice the contraction-volume, as determined by the latter reagent.

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1785	VanMarum	Quoted by Cahours, Compt. Rend. (1870), LXX, 369. "Report upon the labors of Houzeau relative to Ozone."	"Electrical Odor" acquired by oxygen through which electric sparks have been passed. Its chemical properties are also exalted, acquiring the property of oxidizing mercury at ordinary temperatures.
1840	Schönbein	Basel, Ber., IV, p. 66; Bibl. Univ., XXVIII, p. 342; München, Abhandl, 1837–1843, III, p. 265; Pogg., Ann., L, p. 616; Arch. de l'Elec., t. iv, p. 333.	Observations on the odor given off by the electrolysis of water and by ordinary electricity.
		Compt. Rend., X, p. 706; Froriep. Notizen, XIV, p. 292.	Researches on the nature of the odor given off by certain chemical reactions.
		R. Soc. Proc., IV, p. 226.	On the odor accompanying electricity and the probability of a new substance.
	De la Rive	Pogg., Ann., LIV, p. 402.	Platinum, silver and copper as electrodes—their effects on evolved gases.
1841	Schönbein	Sturgeon, Ann. Elec., VI, p. 108.	Research on the odor manifested by certain chemical reactions.
1843	"	Pogg., Ann, LIX, p. 240; Arch. de l'Elec., III, p. 295; München, Abhandl., 1837–1843, p. 587.	On the odor accompany ing the electrolysis of water and ordinary electricity. Opposes De la Rive's hypothesis that the odor arises from metallic oxides.
1844	"	Arch de l'Elec., IV, p. 333 and 454;	"Production of Ozone by chemical means."
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	"	Pogg., Ann., LXIII, p. 520.	Ozone distinct from nitrous acid.

1844	Fischer	Berl. Jahrb. f. wissensch. Kritik, 1844.	Critique of Schonbein's pamphlet "Ueber die Erzeugung des Ozons auf chemischen Wege." Ozone produced by the action of electricity on pure oxygen.
1845	Schönbein	Arch. de l'Elec.. V, p. 556; Chem. Soc. Mem., 1845, p. 62; Phil. Mag., XXVII, p. 336; Brit. Ass. Rep., p. 91; R. Soc. Proc., V, p. 565; Pogg., Ann., LXV, p. 69.	"On the nature of Ozone." Reverts to his original hypothesis that it is a compound of oxygen and hydrogen, and instead of nitrogen being essential, this body does not contribute in any way to the production of Ozone.
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	"	R. Soc. Proc.., V, p. 565.	Letter to Faraday on Ozone.
	"	Pogg., Ann., LXVI, p. 593.	Nature of Ozone.
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	Fischer	Schles. Gesel. Uebersicht, pp. 98 and 107; Pogg., Ann., LXVI, p. 163; J. pr. Chem., XXXV, p. 351.	On the Ozone discovered by Schönbein. Probably a peroxide of hydrogen.
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1845	Schönbein	J. pr. Chem., XXXIV, p. 492.	Action of dilute acids on iodide of potassium.
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	Williamson	Chem. Soc. Mem., II, p. 395; Liebig, Ann., LIV, p 127; Phil. Mag., XXVII, p. 372; Compt. Rend., March.	Researches on Ozone. Its solubility in water. Supposes the ozone obtained by electrolysis and from phosphorus are different.
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	Williamson	Liebig, Ann., LXI, p. 13.	On the Ozone theory. Advises the use of little phosphorus and a slow current in the ozonation of air.
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1850	Schönbein	Schweiz. Gesel. Verhandl., p. 126.	Oxidizing power of Ozone.
	"	Bibl. Univ., Arch. XV, p. 89; Schwz. Ges. Verhan. p. 44; J. pr. Chem., LI, p. 267.	Influence of the light on the chemical activity of oxygen.
	"	J. pr. Chem., LI, p. 321; J. de Pharm., XIX, p. 385.	On Ozone.
	"	Schweiz. Gesel. Verhandl., p. 120.	The slow oxidation of ether in the air and oxygen.
	Schwartzbach	Verhandl. der physik. med. Gesellsch. zu Würzburg, VI, p. 322.	Action of Ozone upon animals.
	Osann	J. pr. Chem., L, p. 209.	The nature of Ozone, its density and action.
	Becquerel	Compt. Rend., XXX, p. 13.	Schönbein on Ozone.
1851	Schönbein	J. pr. Chem., LIII, p. 321.	The equivalency of Ozone.
	"	J. pr. Chem., LIII, p. 501, and LV, p. 11; Basel, Bericht., X, p. 30.	Influence of phosphorus on the chemical power of ordinary oxygen.
	"	J. pr. Chem., LIV, p. 65; Basel, Bericht., X, p. 32.	Influence of the noble metals on the chemical power of oxygen.
	"	Phil. Mag., II, p. 32; J. de Pharm., XX, p. 258.	Influence of light and oxidizing substances on oxygen.
	"	Basel, Bericht., IX, p. 10.	The preparation of Ozone in pure oxygen by means of phosphorus.
	"	J. pr. Chem., LVII, p. 135.	Upon the peculiar behavior of ether and some etherial oils.
	"	Basel, Bericht., IX, p. 10.	Oxidation of silver and other noble metals by means of Ozone.
	"	J. pr. Chem., LIII, p. 72.	Decomposition of iodide of potassium in the dry way by Ozone ; similarity of the peroxide of lead to Ozone ; on nitrification and guiacum.
	"	J. pr. Chem., LIII, p. 80.	Influence of light and oxidizing substances on the chemical power of oxygen.
	Osann	Pogg., Ann., LXXXII, p. 158.	Ozone in the atmosphere.
	"	Pogg., Ann., LXXXII, p. 531, and LXXXIII, p. 137.	On the nature of Ozone.
	"	Pogg., Ann., LXXXII, p. 537; J. pr. Chem., LIII, p. 51.	On Ozone-oxygen.
	Schönbein	J. pr. Chem., LIII, p. 248.	The atomic weight of Ozone.
1852	Schönbein	Basel, Bericht., X, p. 15.	Some properties of Ozone.

1852	Schönbein	Basel, Bericht., X, p. 50; J. pr. Chem., LV, p. 135.	Excited oxygen in iron oxide and nitrous acid.
	"	J. pr. Chem., LVI, p. 343; Basel, Bericht., X, p. 82.	On the name and nature of Ozone.
		J. pr. Chem., LVI, p. 349.	Quantitative estimation of Ozone.
	"	Polli, Ann. di Chim., XIV, p. 276.	On Ozone.
	Osann	J. pr. Chem., LVII, p. 257; Würzburg Verhandl., II, p. 54.	On Ozone-oxygen.
	"	Würzburg Verhandl., III, p. 234; J. pr. Chem., LVIII, p. 92.	Description of an ozonometer.
	Fremy and Becquerel	J. pr. Chem., LVI, p. 124; Ann. d. Chem. u. Pharm., LXXXIV, p. 204; Ann. de Chim. et Phys. [3 S] XXXV, p. 62; J. de Pharm., XXI, p. 325.	On excited oxygen. Production of Ozone by means of the Ruhmkorff coil. Electro-chemical researches on the properties of electrified bodies.
	Faraday	Proc. R. Inst., Vol. I, 1851—1854, p. 94.	On Schönbein's Ozone.
1853	Schönbein	Neufchatel, Bull. III, p. 216.	Remarks on Ozone.
	Baumert	Breslau, Sches. Gesel. Verhandl. Uebersicht., 24; Ann. de Chim. et Phys., XXXIX, p. 477; J. pr. Chem., LIX, p. 350; J. de Pharm., XXIV, p. 381; Phil. Mag., VI, p. 51; Ann. d. Chem. u. Pharm. LXXXVIII, p. 221; Pogg.,, Ann., LXXXIX, p. 38.	A new oxide of hydrogen and its relation to Ozone.
	Leblanc	Compt. Rend., XXXVIII, p. 444.	On the electro-chemical decomposition of water.
	Clemens	Henle's Zeitschrift für die Staats arzneikunde, 1853.	Malaria and Ozone.
	Soret	Compt. Rend , XXXVIII, p. 445.	The development of Ozone at low temperature.
	Williamson	J. pr. Chem., LX, p. 254.	The ozonizing of turpentine and citron oils.
	"	J. pr. Chem., LIX, p. 504.	Action of Ozone on lead compounds.
	Fremy and Becquerel	Quar. Jour. Chem. Soc., V, p. 272; Compt. Rend., XXXIV, p. 399; J. de Pharm., XXXI, p. 321.	Electro-chemical researches on oxygen and the so-called principle Ozone. All of a certain volume of oxygen can be converted into Ozone, when a body like potassium iodide solution, moist mercury or silver, is present to absorb the Ozone formed.

1854	Schönbein	Ann. der Pharm., III, pp. 180 and 242 ; Ann. der	On Ozone and various conditions of oxygen.
	"	Chem. und Pharm., LXXXIX, p. 257.	
	Soret	Bibl. Univ., XXV, p. 263; J. pr. Chem., LXXII, p. 40 ; Pogg. Ann., XCII, p. 304.	Production of Ozone at low temperature.
	Osann	J. pr. Chem., LXI, p. 500.	Active modifications of hydrogen and oxygen.
	"	J. de Pharm., XXVI, p. 68.	Carbon anodes, charged with electrolytic oxygen and immersed in potassium iodide solution, liberate iodine.
	Glaisher	Report on the Meteorology of London during the epidemic of cholera in 1854.	The occurrence of cholera is coincident with the absence or diminution of Ozone.
	Karlinsky	Pogg , Ann., XCIII, p. 627.	Ozone observations in Cracow.
	Schönbein	Pogg., Ann., XCI, p. 625.	First mention of Ozone.
	Baumert	Quar. J. Chem. Soc., VI, p. 169.	A new oxide of hydrogen and its relation to Ozone.
1855	Schönbein	Actes de la Soc. Helvetique, p. 214.	On various conditions of oxygen.
	"	J. pr. Chem., LXVI, p. 286; Basel, Verhandl., I, p. 252.	Ozonized oxygen.
	"	München, Gelehrte Anz., XLI, p. 108 ; J. pr. Chem., LXVI, p. 280.	Preparation of ozonized oxygen from peroxide of silver.
	"	J. pr. Chem , LXVI, p. 272; München, Gelehrte Anz. Bull., XIV. p. 115.	Behavior of ozonized turpentine oil and ether with antimony and arsenic.
	Houzeau	Compt. Rend., XL, p. 947 ; J. pr. Chem., LXV, p. 96.	Researches on nascent oxygen.
	"	J. pr. Chem., LXV, p. 499; J. de Pharm., XXVII, p. 413; Pogg., Ann., XCV, p. 484.	Its production from barium dioxide and sulphuric acid. The odorous gas thus obtained, different from the ozone of Schönbein, instantly converting ammonia into nitrate and nitrite, and being decomposed at a lower temperature.
	Wolf	Compt. Rend., XL, p. 419.	On the variations of Ozone in the atmosphere, considered relative to themselves and to the hygienic state of the place of observation.
	"	Compt. Rend., XL, p. 909.	Influence of Ozone on the health of man.
	Bineau	Compt. Rend., XL, p. 702.	Atmospheric Ozone.

1855	Berigny	Compt. Rend., XLI, p. 426.	Meteorological observations with ozone paper.
	Schönbein	J. pr. Chem., LXV, p. 96.	Existence of oxygen in two conditions.
	Osann	J. pr. Chem., LXVI. p. 105; Pogg. Ann., XCVI, p. 498; Würzburg Verhandl. VI.	Characteristics of the oxygen separated from water galvanometrically.
	Andrews	R. Soc Proc., VII, p. 475.	On the constitution and properties of Ozone.
1856	Meidinger.	Quar. J. Chem. Soc., VII, p, 251.	On Ozone and hydrogen dioxide in the electrolysis of water.
	Robert	Gaz. Méd. de Strasbourg. Nov., 1855.	Relation between Ozone and epidemic of cholera at Neudorf.
	Pettenkoffer	Ueber die Cholera, 1855.	The Ozone does not fall below its summer minimum during epidemics of cholera.
	Schönbein	J. de Pharm., XXIX, p. 316.	Ozone, a means to distinguish between arsenic and antimony stains.
	"	Phil. Mag., XI, p. 137; J. pr. Chem., LXVII. p. 496.	Ozone and ozonic action in mushrooms.
	"	Ann. de Chim., XLVIII, p. 193; Pogg., Ann., XCIX. p. 473.	Ozone contained in acids formed by the slow oxidation of phosphorus in the air.
	Andrews	Phil. Trans., 1856, p. 1; R. Soc. Proc., VII, p. 475; Ann. de Chim., XLVII, p. 181; J. de Pharm., XXX, p. 3; Ann. der Chem. u. Pharm., XCVII, p. 371; Pogg., Ann., XCVIII, p. 435.	"Constitution and properties of Ozone." Ozone obtained by electrolysis does not contain hydrogen. It is identical in weight with the active oxygen present, and does not yield water on heating. Properties of Ozone the same from whatever sources derived.
	Baumert	Pogg., Ann., XCIX, p. 88.	The Ozone question. Reply to Andrews.
	Cloëz	Compt. Rend., XLIII, p. 38; Bull. Soc. Chim., [2] 3, 86; Ann. de Chim., L, p. 80.	Iodide of potassium as a reagent for Ozone. The presence of vapors of nitrous and nitric acids, etherial oils, and in moist air the light as well, can bring about the bluing of Ozone papers.
	Houzeau	Compt. Rend., XLIII, p. 34.	"Researches on nascent oxygen." It is identical with Ozone. Circumstances affecting production of Ozone by electrolysis.

1856	Houzeau	J. de Pharm., XXX, p. 342; Pogg., Ann., XCIX, p. 156.	Proves that Ozone is not a compound of oxygen with hydrogen, or with nitrogen.
	Osann	Pogg., Ann., XCVIII, p. 181.	On Ozone hydrogen.
	Dumas	Compt. Rend., XLIII, p. 38.	Remarks on Houzeau's article.
	Scoutetten	Compt. Rend., XLIII, pp. 93, 216, and 450.	Formation and sources of atmospheric Ozone.
	Brame	L'Institut, 1856, 282.	Plants as well as water furnish Ozone during day; not during night.
	Bineau, Cloez, and Scoutetten	Compt. Rend., XLIII, pp. 162, 762, and 863.	Remarks on Scoutetten's preceding article.
	Billiard	Compt. Rend., XLII, p. 885.	Source of organic Ozone.
	Scoutetten	Compt. Rend., XLII, pp. 941, 943.	Source of Ozone in the atmosphere.
	Wolf	Compt. Rend., XLII, p. 944.	Influence of Ozone on health.
	Berigny	Compt. Rend., XLII, p. 1115.	Observations at St. Cloud.
	Luca	Compt. Rend., XLIII, p. 865.	Oxygen given out by plants is ozoniferous.
	Andrews	J. pr. Chem., LXVII, p. 494	Composition of Ozone.
	Hiss	Virchow's Ann. der Phys. und Anatom., 1856, p. 348.	Relations of the Blood to active Oxygen.
	Campani	Cimento, IV, p. 112.	Influence of various bodies upon potassium iodide papers.
	Van der Willigen	Pogg., Ann., XCVIII, p. 511; Ann. de Chim., L, p. 126; Amsterdam, Verslag. Akad. IV, p. 280.	Formation of Ozone at positive pole of a platinum wire, rendered red-hot in an electric current.
	Bunsen	Quar. J. Chem. Soc., VIII, p. 232.	Volumetric estimation of Ozone.
1857	Schönbein	Basel, Verhandl., I, pp. 237, 246 and 252.	Behavior of ozonized ether and turpentine oil with antimony and arsenic, Ozone from dioxide of silver and ozonized oxygen.
	"	Basel, Verhandl., I, p. 3.	The excitation of oxygen by ferrous salts.
	"	Basel, Verhandl., I, p. 339.	Ozone in the vegetable kingdom.
	"	Basel, Verhandl., I, p. 355.	Influence of heat on the chemical activity of oxygen.
	"	München, Nat. Tech. Comm. Abhl., I, p. 173.	Relation of Ozone to practical chemistry.
	Andrews and Tait	R. Soc. Proc., VIII, p. 498; Ann. de Chim., LII, p. 333; Ann. der Chem. u. Pharm., CIV, p. 128; Chem. Gaz., p. 319; Pogg. Ann., CII, p. 625.	Density of Ozone.
	Baumert	Ann. der. Chem. u. Pharm., CI, p. 88.	Ozone developed by electricity.

1857	Houzeau	J. pr. Chem., LXX, p. 340; Compt. Rend., XLV, p. 873.	"Analytical method to detect and estimate nascent oxygen." Absorption by acid solution of potassium iodide, elimination of the iodine set free, and estimation of the potash produced.
	Osann	J. pr. Chem., LXXI, p. 355; Würzburg. Verhandl., VII. p. 171.	Ozone-hydrogen.
	Berigny	Compt. Rend., XLIV, p. 1104.	Researches on ozonometric papers.
	Billiard	Compt. Rend., XLV, p. 1100.	Relation of Ozone to cholera.
	Baumert	J. pr. Chem., LXX. p. 446.	Active oxygen.
	Cloez	J. pr. Chem., LXX. p. 319; Ann. de Chim. et Phys., May, 1857.	Iodide of potassium as reagent for Ozone. Denies that oxygen evolved by plants in sunlight contains Ozone.
	Erdmann	J. pr. Chem. XXI, p. 209.	Preparation of Isatin by the action of Ozone on the sulphate of indigo.
	W. Siemens	Pogg., Ann., CII, p. 120.	An Ozonizer. Two glass tubes with an annular space between, and their inner and outer surfaces oppositely electrified.
	———	Greenwich Observations, pp. CLXVI—CCX.	Influence of the sun's hour-angle on the production of Ozone.
	Schönbein	Pogg., Ann., C, p. 4.	Various experiments with Ozone, its density, specific heat, &c., &c.
	"	Pogg., Ann. C, p. 292.	Capability of ordinary oxygen to change nitrous to nitric acid.
	"	J. pr. Chem., LXX, p. 129.	"A peculiar mode of preparing Nitrous Acid." Not only Ozone but platinum-sponge, agitated with oxygen, causes the oxidation of ammonia.
	Neumann	J. pr. Chem., CII, p. 614.	Relation of atmospheric Ozone to pressure and electricity.
	Baumert	Ann. der Chem. u. Pharm., CI, p. 88.	Review of Andrews' article on the composition of Ozone.
	Andrews	Quar. J., Chem. Soc., IX, p. 168.	Constitution of Ozone.
	Schönbein	J. pr. Chem., LXXV, p. 88.	Formation of peroxide of lead from the acetate by means of hydrogen dioxide or Ozone.

1858		Phil. Mag., XV, p. 24; XVI, p. 178.	Various conditions of oxygen.
	W. B. Rogers	Edinburgh New Philosophical Journal, January.	On Ozone observations. Does not think the oxygen evolved by growing plants is ozonized.
	Andrews & Tait	R. Soc. Proc., IX. p. 606.	Density of Ozone.
	Clausius	Pogg., Ann., CIII, p. 644; Bibl. Univ. Arch., II, p. 150; Phil. Mag., XVI, p. 45.	On the nature of Ozone.
	Houzeau	J. de Pharm., XXX, p. 115.	Method to discover nascent oxygen.
	"	Compt. Rend., XLV, p. 89; J. pr. Chem., LXXV, p. 110.	Proof of the presence of Ozone in the atmosphere.
	Houzeau and Zantedeschi	Firenze, Il Tempo, I, p. 181.	Scientific value of ozonometric observations.
	Osann	Würzburg, Verhandl., VIII. p. 180.	Ozone-hydrogen.
	Becquerel	Compt. Rend., XLVI, p. 670.	Report of a commission on Houzeau's communications on Ozone.
	Berigny	Compt. Rend., XLVI. p. 237.	On ozonometry.
	Billiard	Compt. Rend., XLVI, p. 98.	Relation of Ozone to hygiene.
	"	Compt. Rend., XLVI, p. 138.	The oxygen secreted by plants is not from Ozone.
	Berigny	Compt. Rend., XLVII, p. 947.	Ozonometrical observations in camp in the Crimea.
	Regnault	Compt. Rend.. XLVI p. 673.	On the term "Ozone."
	Schönbein	Pogg. Ann., CV, p. 258.	Researches on oxygen.
	"	J. pr. Chem., LXXIV, p. 329; Ann. der Pharm., CII, p. 129.	Oxidations occurring in the air due to the ozonization of oxygen.
	Tripe	Report of Council of Eng. Meteorological Society, 1858, pp. 7 and 36.	Air is deprived of Ozone by passing over densely populated towns..
1859	Schönbein	Amer. J. Sci., XXVII, p. 19.	Various conditions of oxygen.
	"	München, Gelehrte Anz., XLVIII, p. 73; J. pr. Chem., LXXVII, p. 257; Pogg., Ann., CVI, p. 307.	Chemical condition of the removable oxygen in ozonized turpentine oil.
	"	München, Gelehrte, Anz., XLVIII, p. 563; J. pr. Chem., LXXVII, p. 271.	Nascent oxygen.
	R. B Smythe	Austral. Med. Jour., IV, p. 1.	Observations on Ozone.
	Gorup-Besanez	Ann. der Chem. u. Pharm., CX, p. 86; Erlangen, Mitt. Phys. Med. Soc., I, p. 13; J. de Pharm., XXXI, p. 65.	Action of Ozone on various organic compounds, as urea, uric acid, albumen, &c.
	Andrews & Tait	R. Soc. Proc., X, p. 427; Ann. der Chem. u. Pharm., CXII, p. 185.	The volumetric relations of Ozone.
	"	Ann. de Chim., LVI, p. 333.	Density of Ozone.
	Schafhaütl	J. pr. Chem., LXXVI, p. 129.	Upon the Wölsendorf Fluor Spar—cause of its odor.

1859	Houzeau	J. pr. Chem., LXXVI, p. 164	Method of discovering nascent oxygen.
	Osann	J. pr. Chem., LXXVI, p. 435, and LXXVIII, p. 93; Würzburg Verhandl., IX, p. 182.	Ozone-oxygen and ozone-hydrogen.
		Würzburg Verhandl., p. 197; Pogg., Ann., CVI, p. 326.	Reply to Magnus in regard to the preceding.
	Bérigny	Compt. Rend., XLIX, p. 391.	Ozonometric observations during the Aurora Borealis.
	Schönbein	Pogg., Ann., CVIII, p. 472.	Polarization of neutral oxygen by the slow oxidation of phosphorus and of ether.
	Löwenthal	J. pr. Chem., LXXIX, p. 473.	Change of inactive to active oxygen.
	Smith	Quar. J. Chem. Soc., XI, p. 208.	Absence of Ozone in the neighborhood of large towns.
1860	Schönbein	Basel, Verhandl., II, p. 139.	Chemical condition of the removable oxygen in ozonized turpentine oil.
	"	Basel, Verhandl., II, p. 155.	Nascent oxygen.
	"	München Gelehrte Anz., L, p. 446; J. pr. Chem., LXXX, p. 275.	Active positive oxygen.
	"	J. pr. Chem., LXXXI, p. 1.	Continuation of the contributions to a knowledge of oxygen.
	"	Basel, Verhandl , II, p. 9.	Formation of the peroxide of lead from the acetate by means of hydrogen dioxide or Ozone.
	Andrews	J. de Pharm. [1860], p. 161.	Density of Ozone.
	and Tait	J. Chem. Soc , XIII, p. 344; R. Soc. Proc., X, p. 427; Phil. Trans., p. 113.	Volumetric relations of Ozone.
	Weltzien	Ann. der Pharm., CXV, p. 121.	Polarization of oxygen : Ozonides and Antozonides.
	Houzeau	Pogg., Ann., CIX, p. 180.	Method of discovering nascent oxygen.
	"	Compt. Rend., L, p. 829; J. pr. Chem., LXXXI, p. 117.	Absence of free Ozone in terebenthine oxide.
	Schrötter	Pogg., Ann., CXI, p. 561.	Upon the occurrence of Ozone in the Mineral Kingdom.
	Osann	Pogg , Ann., CXI, p. 20; Würzburg Verhandl., X, p. 111; Würzburg Naturw. Zeitschr., I, p. 241.	Ozone-oxygen and ozone-hydrogen.
		Würzburg, Verhandl., X, p. 3.	Reply to Magnus.

1860	Gorup-Besanez	Chem. News, I, p. 38.	Action of Ozone on some organic substances.
	Andrews	Chem. News, I, p. 222.	Density of Ozone.
	Schrötter	Sitzung. der Acad. zu Wien, XII; Chem. News, II, p. 298.	Ozone in the Wölsendorf fluorspar.
	Lowe	R. Soc. Proc., X, p. 531.	A new Ozone box.
	Le Roux	Compt. Rend., L, p. 691.	Production of Ozone by a platinum wire rendered incandescent in the electric current.
	Bérigny	Compt. Rend., LI, p. 643.	Ozonometrical observations.
	Riche	Bull. Soc. Chim , 1860, 178.	Ozoniferous oxygen obtained by the action of concentrated sulphuric acid upon hydrogen peroxide.
	Mitchell	Edinburgh New Phil. Jour. [N. S], July, 1860.	"Remarks on Ozone." Bleaching of altered ozonoscopes independent of light and moisture
1861	Odling	Manual of Chemistry (publ. 1861), p. 94.	Phenomena consequent upon the contraction of ozygen in its conversion into ozone, explained upon the hypothesis that ozone is triatomic oxygen.
	St. Edme	Compt. Rend., LII, p. 408.	No ozone, but one of the higher oxides of nitrogen, formed at positive pole of a platinum wire ignited in electric current.
	Schönbein	J. pr. Chem., LXXXII, p. 231.	Behavior of oxygen to ammonia agitated in contact with oxides.
	"	München, Sitzungsbericht, p. 22 ; J. pr. Chem., LXXXII, p. 86.	Positive active Ozone.
	"	J. pr. Chem., LXXXIV, p. 193.	Chem. Contributions.—Behavior of the three modifications of oxygen to the nitrites.
	"	München, Sitzungsbericht, p. 546 ; Pogg., Ann., CXII, p. 281.	Behavior of Ozone, Antozone, and oxygen, with the nitrates.
	"	Phil. Mag., XXI, p. 88.	Insulation of Antozone.
	"	Presse Scient., II, p. 244.	Memoir on oxygen and Ozone.
	Gorup-Besanez	Ann. der Chem. u. Pharm., CXVIII, p. 232.	Action of Ozone on organic substances.
	Andrews	Pogg., Ann., CXII, p. 249.	Volumetric relations of Ozone.
	Houzeau	Ann de Chim., LXII, p. 129.	Researches on nascent oxygen.

1861	Osann	Chem. News, IV, p. 74.	Ozone-hydrogen.
	T. S. Hunt	Amer. J. Sci., XXXII, p. 109: Chem. News, IV, p. 193	Ozone, nitrous acid, and nitrogen.
	Eöttger	Chem. News, IV, p 69; J. pr. Chem., LXXXVI, p. 377; Zeitschr. f. Chem. u. Phys., III, p. 718.	Ozone from sulphuric acid and permanganate of potash.
	Moffat	Chem. News, IV, p. 166.	Atmospheric Ozone.
	Gorup-Besanez	Chem. News, V, p. 110.	The removal of stains from engravings by means of Ozone.
	Andrews & Tait	Quar. J. Chem. Soc., XIII, p. 344.	Volumetric relations of Ozone.
	Sylvestri	Compt. Rend., LIII, p. 247; Pisa, Ann. Univ. Tosc. Cosm., V, p. 147.	Ozone observations ot Pisa.
	Sauvage	Compt. Rend., LIII, p. 544.	Ozone a simple element.
1862	Schönbein	Basel, Verhandl., III, p. 155.	Positive active oxygen.
		München, Sitzungsbericht, p 166; J. pr. Chem., LXXXVIII, p. 65.	Allotropic condition of oxygen.
		J. pr. Chem., LXXXVI, p. 70; München, Sitzungsbericht, p. 171; Chem. News, V, p. 350; Phil. Mag., XIV.	Chemical preparation of Ozone.
	Moffat	Proc Meteor. Soc., June 18, 1862.	When ozone is most prevalent, phosphorus is most luminous, and *vice versa*.
	Heldt	Chem. Centr., 1862, pp. 695, 886.	Action of various bodies upon potassium iodide papers.
	Pfaff	Henle's Zeitschrift für die Staatsarzneikunde, 1862. No. 2.	Much atmospheric ozone unfavorable to diseases of the respiratory organs.
	von Babo	Freiburg, Ber., II, p. 331.	An apparatus to make Ozone,
	Lowe	Chem. News, VI, p. 186.	An Ozone-box.
	Böttger	Pogg., Ann., CXVII, p. 188; J. pr. Chem., LXXXVI, p. 377; Zeitsch. für Chem. und Pharm., III, p. 718.	Formation of Ozone from sulphuric acid and permanganate of potash.
	Lichtenstein	Compt. Rend., LIV, p. 1198.	Direct application of Ozone in medicine.
	Kosman	Compt. Rend., LV, p. 731.	Researches on Ozone given off by plants.
1863	Schönbein	J. pr. Chem., LXXXIV, p. 196; Basel, Verhandl., III, p. 196.	Behavior of Ozone and Antozone with the nitrates.
	"	Basel, Verhandl., III, p. 299.	Allotropic condition of oxygen.
	"	Basel, Verhandl., III, p. 305.	Chemical preparation of Ozone by means of $H_2SO_4 + KMO_4 + BaO_2$.

1863	Schönbein	Basel, Verhandl., III, p. 317; München, Sitzungsbericht, p. 181; J. pr. Chem., LXXXVI, p. 80; Phil. Mag., XXIII, p. 466.	Change of the allotropic condition of oxygen.
	"	München, Sitzungsbericht, p. 274; Basel, Verhandl., III, p. 408; J. pr. Chem., LXXXIX, p. 323.	Antozone in the Wölsendorf fluorspar.
	Tyndall	"On Heat," etc., London, 1863, p. 333.	Electrolytic oxygen has 136 times the capacity for absorption of the dark heat-rays, as ordinary oxygen.
	Soret	Compt Rend., LVI, p. 390; Bibl. Univ. Arch., XVI, p. 208; J. pr. Chem., XC, p. 216; Heidelberg, Verhandl. Nat. Med., III, p. 20; Ann. der Chem. u. Pharm., CXXVII, p. 38; Pogg., Ann., CXVIII, p. 623; Roma, Atti, XVI, p. 638.	Production of Ozone by electricity, and the nature of that body.
	"	Phil. Mag., XXV, p, 208; Chem. News, VII, p. 248.	Experiments on Ozone. Best methods of obtaining it by electrolysis. So prepared, it contains no hydrogen.
	Lawes, Gilbert and Pugh	Jour. Chem. Soc., 1863, p. 100.	"On the Sources of the Nitrogen of Vegetation, etc." Ozone near vegetation due to action of oxygen of the air upon hydrocarbons evolved by the plants, and not to any action within the cells.
	Soret	Compt. Rend., LVII, p. 604; Chem. News, VIII, p, 191; Bibl. Univ. Arch, XVIII, p. 65; Heidelberg, Verhandl. Nat. Med., III, p. 82.	Volumetric relations of Ozone.
	Meissner	Unters. über d. Sauerst., Hannover, 1863.	Water in contact with ozone acquires its properties.
	Gorup-Besanez	Ann. der Pharm., CXXV, p. 207; Chem. News, VIII. p. 222.	Action of Ozone on some organic substances.
	Morin	Compt. Rend.. No. 18, 1863.	Pulverization of water always accompanied by development of ozone.
	von Babo	Ann. der Pharm., Suppl., II, p. 265.	"Contributions to a knowledge of Ozone." Influence of temperature,

1863			pressure, electrical intensity. Contraction of volume. Maximum of ozonation.
	von Babo and Claus	Ann. der Chem. u. Pharm., Suppl. II, p. 297.	"Volumetric relations of Ozone." The amount of contraction is equal to the volume of oxygen corresponding to the iodine liberated from potassium iodide solution.
	Clausius	Zürich, Vierteljahrs., VIII, p. 345.	Difference between active and ordinary oxygen.
	Atkinson	Proc. Meteorological Soc., January, 1863.	Effect of light on ozonoscopes.
	Houzeau	Ann. de Chim., LXXVII, p. 466.	Method of determining nascent oxygen.
	Ireland	Chem. News, VII, p. 118; Edinburg, Med. Jour., VIII, p. 729.	Action of ozonized air on animals.
	De Luna	Chem. News, VIII, p. 39; Ann. de Chim. et Phys., [1863] p. 182.	Production of Ozone. States that hydrogen gas decolorizes ozonoscopes.
	Lawes et al.	Quar. J. Chem. Soc., I (N. S.), pp. 144 and 153.	Promotion of the formation of nitrogenous compounds in plants by Ozone.
	Lowe	R. Soc. Proc., XII, p 518.	Precautions in Ozone observations.
	Poey	Compt. Rend., LVII, p. 344.	Giving off of Ozone by plants.
	Bérigny	Compt. Rend., LVII, p. 846.	Influence of moisture on Ozone in air.
	Kosman	Compt. Rend., LVII, p. 979.	Researches on the relative quantity of Ozone in plants and atmosphere.
1864	Begeman	Arch. Pharm., CXIII, p. 1.	Action of various bodies on ozonoscopes.
	Meissner	Quar. J. of Science, IV, p. 670.	Ozone and Antozone; reply to von Babo.
	Kaiser	Brit. J. of Photography, 1864, p. 392.	Ozone said to possess the property of converting the insensitive variety of iodide of silver into one that is highly sensitive to light.
	M. Carey Lea	Amer. J. Sci. [2] XXXVII; Quar. J. Science, III, pp. 509–523.	"On the influence of Ozone and some other Chemical Agents on germination and vegetation." Effects of respiring.

1864	M. Carey Lea	Quar. J. Science, I, p. 116.	Ozone from evaporation.
	"	Quar. J. Science, I, p. 531.	Generation of Ozone from leaves of plants.
	"	Quar. J. Science, I, p. 263.	Researches on Ozone.
	Soret	Pogg , Ann., CXXI, p. 268.	On the volumetric deportment of Ozone.
	Clausius	Compt. Rend., LVIII, p. 283.	Difference between ordinary and active oxygen.
	Saintpierre	Compt. Rend., LVIII, p. 420.	Production of Ozone by the mechanical action of ventilation apparatus.
1865	Bérigny	Chem. News, XI, p. 224; Compt. Rend., LX, p. 903.	Ozonometrical observations during a period of nine years.
	"	Compt. Rend., LXI, p. 937.	Ozonometrical observations.
	———	Quar. J. Chem. Soc., [1865] p. 277.	Ozone researches.
	Soret	Compt. Rend., LXI, p. 941; Chem. News, XII, p. 275.	Researches on the density of Ozone.
	Jean	Compt. Rend., LXI, p. 995; Chem. News, XII, p. 288.	Preparation of Ozone. Decomposition of carbonic acid into carbonic oxide and Ozone, by electricity.
	Houzeau	Chem. News, XIII, p. 5; Compt. Rend., LXI, p. 1113.	Remarks on atmospheric Ozone.
	St. Claire-Deville	Compt. Rend., LXI, p. 1115.	Remarks on atmospheric Ozone.
	Poey	Compt. Rend., LXI, p. 1107.	Ozonograph.
	Fremy	Compt. Rend., LXI, p. 939.	Uncertainty of atmospheric ozonometry.
	Schönbein	J. pr. Chem., XCIII, p. 25.	On Ozone and antozone.
	"	J. pr. Chem., XCIII, p. 45.	Action on Pb and PbO.
	"	J. pr. Chem., XCII, p. 154.	Ozone in contact with urine.
	"	J. pr. Chem., XCIII, pp. 65 and 53.	Action of Ozone on cobalt and its hydrate: on nickel.
	"	J. pr. Chem., XCIII, pp. 24, 25 and 35.	Formation of Ozone by slow oxidation of phosphorus and of turpentine oil in presence of Antozone.
	"	J. pr. Chem., XCIII, p. 459.	Action of Ozone on photocyanin.
	"	J. pr. Chem., XCII, p. 146.	Ozone in contact with H_2S.
	"	J. pr. Chem., XCII, p. 165.	Formation of Ozone in urine.
	Bérigny	Compt. Rend., May 1, 1865.	Ozone observations at Versailles Observatory for 1864.

1865	Osann	J. pr. Chem., XCII, pp. 20, 210 and 30.	Ozone - hydrogen and structure of Ozone.
	Soret	Ann. de Chim. et Phys., [4 S.] IV, p. 197, and VI, p. 235.	Density of Ozone and its mechanical energy.
	Andrews	Ann. de Chim. et Phys., [4 S.] VI, p. 245.	Influence of the seasons on the quantity of Ozone in the atmosphere.
	"	Ann. de Chim. et Phys., [4 S.] VI, p. 247.	Relation of Ozone in the atmosphere to the barometric height.
	St. Claire-Deville	Compt. Rend., LX, p. 909.	Remarks on atmospheric Ozone.
	Richardson	Chem. News, XII, p. 181; Brit. Assoc. Report, 1865.	Physiological experiments with Ozone. Its existence in the atmosphere discussed.
	Boeckel	Ann. de Chim. et de Phys., [3], VI, 235.	Ozone as an element in meteorology. The ozone-percentage of the air is greatest in spring.
	Moffat	Lancet, September 9, 1865.	Cholera is accompanied by a minimum quantity or complete absence of Ozone.
	Seitz	Catarrh and Influenza, 1865.	No relation observed during the cholera epidemic of 1854 in Munich, between it and the amount of Ozone.
1866	St. Edme	J. pr. Chem., XCIV, p. 507.	Production of Ozone by means of electricity.
	Lea	J. pr. Chem., XCV, p. 312.	Action of Ozone on the iodide and bromide of silver.
	Woods	J. pr. Chem., XCV, p. 311.	The action of Ozone on NO.
	Boussingault	J. pr. Chem., XCIV, p. 336.	Production of Ozone from phosphorus.
	Schönbein	J. pr. Chem., XCV, pp. 470 and 469; and XCIII, p. 36.	Action of Ozone on thallium and its oxide, and the influence of water on the chemical action of Ozone.
	"	Ann de Chim. et Phys., [4 S.] VII, p. 103, and VIII, p. 465.	Action of platinum, iridium, and rhodium on ozonized oxygen,
	"	Ann. de Chim. et Phys., [4. S.] VII, p. 462; J. pr. Chem., XCV, p. 285.	Action of Ozone on cyanine.
	Gentele	J. pr. Chem., XCVI, p. 306.	Chemical structure of Ozone.
	Soret	Ann. de Chim. et Phys., [4 S.] VII, p. 113.	Density of Ozone.
	"	Ann. der Chem. u. Pharm., CXXXVIII, p. 45.	Volumetric relations of Ozone and its density.

1866	v Babo & Claus	Ann. der Chem. u. Pharm., CXL, p. 248.	Researches on the constitution of Ozone.
	Daubeny	Paper read at meeting of English Chemical Society, Nov. 15,1866.	At Torquay, ozonoscopes were most affected during S. W., W. and S. winds; least with N. winds.
	"	Brit. Ass. Rep., 1866.	Atmospheric ozone due to the green parts of plants; but flowers do not generate ozone.
	Houzeau	Compt. Rend., February 26, 1866.	Relation between the chemical activity of the air and certain atmospheric perturbations.
	Böttger	J. pr. Chem., XCV, p. 311.	Recommended thallous oxide papers as ozonoscopes, since they were not affected by nitrous acid.
	Weltzien	Compt. Rend., LXXII, pp. 640 and 757; Ann. der Chem. u. Pharm., CXXXVIII, p. 162; Chem. News, XIII, pp. 159 and 355.	Researches on Ozone and peroxide of hydrogen. Nitrogen and Ozone.
	Montani	Compt. Rend., LXII, p. 538.	Ozone observations at Constantinople during the cholera.
	Laborde	Compt. Rend., LXII, p. 307.	Diminution of Ozone during epidemics showing want of electricity.
	Planté	Compt. Rend., LXIII, p. 181.	On the production of Ozone. Lead electrodes yield more ozone by electrolysis than those of platinum.
	Hermary	Compt. Rend., LXIII, p. 645.	Study of Ozone in its relation to cholera.
	Osann	J. pr. Chem., XCV, p. 55; Chem. News, XIII, p. 109.	On Antozone.
	Poey	Chem. News, XIII, p. 5.	Ozonograph.
1867	Smythe	Compt. Rend., LXIV, p. 724.	Significance of atmospheric indications of Ozone.
	Soret	Compt. Rend., LXIV., p. 904; Pogg., Ann., CXXXII, p. 165; Chem. News, XVI, 49.	Density of Ozone.
	Poey	Compt. Rend., LXV, p. 708; Chem. News, XVI, p. 312.	Remarks on ozonoscopic observations.
	Verrier	Compt. Rend., LXV, p. 711.	Remarks on the preceding.
	Chevreul	Compt. Rend., LXV, p. 712.	Remarks on the preceding.
	Bérigny	Compt. Rend., LXV, p. 982.	Reply to Poey.
	Cossa	Chem. News, XVI, p. 37; Zeitsch. f. anal. Chem., VI, p. 24.	Ozonometry.

1867	W. F. Moffat	Brit. Ass. Report, 1867.	Amount of Ozone in different degrees of latitude and longitude at sea.
	Schönbein	J. pr. Chem., XCVIII, pp. 269 and 288.	Production of Ozone from camphene and by slow evaporation. Production of the same from phosphorus.
	"	J. pr. Chem., XCVIII, p. 83.	Action of Ozone on platinum black.
	"	J. pr. Chem., XCVIII, p. 71.	Hydrogen peroxide on the test paper for Ozone.
	Schmid	J. pr. Chem., XCVIII, p 416.	Production of Ozone from phosphorus.
	Houzeau	Ann. de Chim. et Phys., 4 S., XII, p. 60.	Oxidation of thallium test paper.
	Weltzien	Ann. der Chem. u. Pharm., CXLII, p. 107.	Influence of pressure on the formation of Ozone. Bichromate of potash and sulphuric acid yield ozoniferous oxygen.
	Soret	Ann. der Chem. u. Pharm., Suppl. V, p. 148.	Density of Ozone.
	———	Quar. J. Science for 1867, p. 552.	Protoxide of thallium as test for Ozone.
	———	Quar. J. Science for 1867, p. 392.	Density of Ozone.
	Andrews	Pogg. Ann., CXXXI, p. 659.	The Ozone in the atmosphere.
	Hoffman	Pogg. Ann., CXXXII, p. 607.	Amounts of Ozone and antozone given off by the electrolysis of water.
	Daubeny	J. Chem. Soc. [2], V.	Influence of light on ozonoscopes.
1868	Schönbein	J. pr. Chem., C, p. 474.	Formation of Ozone from camphene.
	"	J. pr. Chem., CII, p. 154.	Action of Ozone on guaica resin, quinone, olefiant gas, and other organic substances.
	"	J. pr. Chem., C, p. 472.	Formation of Ozone from turpentine oil in presence of antozone.
	"	Ann. de Chim. et Phys., XIII, pp. 57 and 475.	Atmospheric Ozone.
	Andrews	Ann. de Chim. et Phys., XIII, p. 474 ; Ann. der Chem. u. Pharm., Suppl. VI, p. 125.	Identity of the body in the atmosphere that reacts on the starch papers, with Ozone.
	Wyrobouff	J. pr. Chem., C, p. 59.	Non-occurrence of Ozone in fluorspar.
	Soret	Ann. de Chim. et Phys,, XIII, p. 257.	Determination of the density of Ozone by diffusion.
	Houzeau	Ann. de Chim. et Phys., XIV, p. 30.	H_2O_2 not the cause of the turning of test paper in the atmosphere.

1868	Houzeau	Compt. Rend., LXVI, p. 1329.	Action of ether in contact with iodide of potassium.
	Denza	Compt. Rend., LXVI, p. 105; Chem. News, XVII, p. 70.	Power of electricity and Ozone during cholera.
	Blondlot	Compt. Rend , LXVI, p. 351.	Ozone and phosphoric acid produced by the slow combustion of phosphorus. Recommends temperature of 12° to 13°.
	Houzeau	Compt. Rend., LXVII., pp. 44, 314, and 491.	Method of collecting and examining small quantities of H_2O_2. Presence of Ozone in air.
	"	Compt. Rend., LXVII, p. 714.	Action of sulphuric acid on iodide of potassium.
	Sauvage	Compt. Rend., LXVII, p. 633.	The same.
	"	Compt. Rend., LXVII, p. 1138.	Reply to Houzeau.
	L'Hote and St. Edme	Compt. Rend., LXVII. p. 620.	Production of Ozone in air and oxygen influenced by the "spark of condensation" of an induction coil.
	Lippincott	Chem. News, XVII, p. 48.	Agreement between the iodized starch tests and those of moistened silver leaf.
	Andrews	Chem. News, XVII, p. 32.	Identity of the atmospheric body decomposing potassium iodide with Ozone.
	F. Wohler	Göttinger Nach. (1868), 139; Chem News, XVIII, p. 189.	Formation of silver peroxide by Ozone in electrolysis.
	Hollman	Arch. neerland. des sciences ex. et nat., 3,260.	1 gram. Ozone evolves 355.5 heat-units in its conversion into ordinary oxygen.
	Klebs	Bern. naturf. Verh., 1868, 13.	Many of the fluids of the human body are ozoniferous.
	———	Bulletin de Statisque Munipale, February, 1878.	Daily observations of ozone in Paris, 1866 and 1867.
	Jevons	Chem. News, XVIII, p. 245; Manchester, Lit and Phil. Soc., III, p. 11.	Remarks on Baxendell's laws of atmospheric Ozone.
1869	De la Sagro	Compt. Rend., LXVIII, p. 100.	The condensator as producer of Ozone.
	"	Zeitsch. f. anal. Chem., VIII, p. 179.	Detection of Ozone in the atmosphere,
	Soret	Chem. News, XIX, p. 104.	Density of Ozone.
	Grotowski	Chem. News, XIX, p. 260.	Ozonation of hydrocarbon oils.
	Böttger	Ber. Bericht., II, p. 612.	Ozone ether is only ether containing H_2O_2.
	Andrews	J. pr. Chem., CIV, p. 55.	Ozone in the atmosphere.

1870	Beanes	Quar. J. Chem. Soc., VII (N. S.), p. 124.	The decolorization of sugar by Ozone.
	Schönbein	J. pr. Chem., CV, pp. 198 and 223.	Role Ozone plays in respiration, and on its production from camphene.
	Clausius	Pogg. Ann., CXXXVI, p. 102.	Odling's Ozone theory.
	Houzeau	Chem. News, XX, p. 35; Bull. Soc. Chim., p. 120.	Ozone in the atmosphere.
	Cook	Brit. Ass. Report, 1869.	Presence of cholera attended by a relative deficiency of Ozone.
	Dubrunfaut	Chem. News, XXI, p. 57; Compt. Rend., LXX, p. 159.	The nature of Ozone.
	Cahours	Compt. Rend., LXX, p. 369.	Report on the works of Houzeau relative to Ozone.
	Jouglet	Compt. Rend., LXX, p. 539; Chem. News, XXI, p. 136.	Action of Ozone on nitroglycerine, dynamite, and other explosives.
	Martin	Compt. Rend., LXX. p. 611; Chem. News, XXI, p. 154.	Electro-chemical studies on Ozone.
	Houzeau	Compt. Rend., LXX. p. 1286; Chem. News, XXI, p. 298.	Experiments on the electrifying of air or oxygen as a means of obtaining Ozone.
	"	Chem. News, XXI, p. 118; Compt. Rend., LXXI, p. 20.	First mention of Ozone by van Marum at Haarlem. Action of Ozone on mercury. Preparation from $H_2SO_4+BaO_2$.
	Struve	J. pr. Chem., CVII, p.503.	A review on Schönbein.
	Wolffenstein	Pogg., Ann., CXXXIX, p. 32.	On Ozone density by Soret.
	Soret	Pogg., Ann., CXLI, p. 294; Arch. des. Sci. Phys. et Nat. Suisse, XV, p. 5.	Reply to the preceding.
	"T. B."	Chem. News, XXI, p. 204.	Ozone found in bottles where nitrogen was formed during the slow oxidation of iron filings.
	Loew	Zeitsch f. Chem. von Beilstein, VIII, pp. 13, 65; Chem. News, XXI, p. 107.	Formation of Ozone by blowing air through a Bunsen gas flame.
	"	Chem. News, XXI, p. 299; Zeitsch. f. Chem. von Beilstein, IX.	Reply to Böttger.
	"	Chem. News, XXII, p. 13; Am. J. Sci., XLIX, p. 369.	Formation of Ozone during rapid combustion.
	Böttger	Chem. Centr., 1870, 161.	Denial of Loew's statement, only ammonium carbonate and some hydrogen peroxide formed.
	Boeke	Chem. News, XXII, p. 57..	Reply to Loew.
	Than	Chem. News, XXII, p. 24; J. pr. Chem., [2] I, p. 415.	Formation of Ozone during rapid combustion of hydrogenous bodies.
	Engler & Nasse	Ann. der Chem. u. Pharm., May; Chem. News, XXII, p. 35.	Ozone and antozone.

	Moigno	Chem. News, XXII, p. 60; Les Mondes, VII, p. 7.	Explosion of picric acid in contact with Ozone.
1871	Tichborne	Chem. News, XXIII, p. 32; R. Irish Acad. Rep., IX, p. 1.	Formation of Ozone from resin under influence of air and light.
	Than	Quar. Jour. Chem. Soc., IX, (N. S.), p. 483; J. pr. Chem. (N. S.), I, p. 415; Zeitsch. f. Chem. [2] VII, p. 92.	Formation of Ozone during rapid combustion of hydrogenous bodies.
	Houzeau	Quar. J. Chem. Soc., IX (N. S.), p. 994.	Electrization of air and oxygen for the production of Ozone. A new apparatus.
	"	Compt. Rend., LXXIV, pp. 256 and 316.	Production of Ozone in a concentrated state.
	"	Compt. Rend., LXXIV, p. 712.	Ozone in the country and its origin.
	Soret	Ann. de Chim. et Phys., 4 S., XXII, p. 150.	Electrification of air or oxygen as a means of producing Ozone.
	"	Ann. de Chim. et Phys., 4 S., p. 152.	Continued production of Ozone in the air.
	Struve	Chem. News, XXIII, p. 203; Bull. de l'Acad. Imp. des Sci. de St. Petersbourg, XV, No. 3.	Studies on Ozone, peroxide of hydrogen, and nitrite of ammonia.
	Debus	Proc. Chem. Soc., I, p. 6; Chem. News, XXIII, p. 272.	History of Ozone. Lecture delivered before the English Chemical Society.
	Ruhmkorff	Chem. News, XXIV, p. 252; Rev. Hebd. de Chim., Nov 9, 1871.	A new Ozone generator. Air ozonized under the action of a large number of electric sparks.
	Pincus	Pogg., Ann., CXLIV, p. 480.	Formation of Ozone by burning hydrogen in the air.
1872	Houzeau	Chem. News, XXV, p. 82; Compt. Rend., LXXV, p. 349.	A new ozonizer. Its powers. Decolorizing power of concentrated Ozone.
	"	J. Chem. Soc., N. S., X, p. 976; Chem. News, XXVI, p. 144; Ann. de Chim. et Phys., 4 S., XXVII, pp. 5, 29 and 59.	Atmospheric Ozone. New test papers, consisting of litmus + KI + starch.
	"	Compt. Rend., LXXIV, p. 256; J. Chem. Soc., N. S., X, p. 220; Chemisches Centralblatt, 1872, p. 242.	A new ozonizer.
	"	J. Chem. Soc., N. S., X, p. 465; Chem. News, XXV, p. 178	Proportion of Ozone in country air, and on its origin.
	"	Ber. Bericht., V, p. 217.	Ozonizer.
	"	Ber. Bericht., V, p. 827; Compt. Rend., LXXVI, p. 317; Chem. News, XXVI, p. 82.	Formation of hydrogen peroxide when Ozone acts on indigo.

1872	Brodie	Phil. Trans., Vol. 162, p. 435.	Action of electricity upon gases.
	Buchan	J. Scottish Meteor. Soc., Jan. and Apr., 1872.	"Report on Ozone Observations."
	Houzeau	Chem., News, XXV, p. 166; J. de Phar. et Chim., March, 1872.	Action of Ozone on silver, on organic bodies, on H_2S, H_3P, etc.
	Kingzett	Chem. News, XXV, p. 242; Ber. Bericht , V, p. 485.	Oxygen obtained from whatever source is always accompanied by Ozone.
	Croft	Chem. News, XXV, p. 87; Am. J. Sci., III, p. 466; Canadian Jour., XIII, No. 3.	Anomalous production of Ozone from crystallizing iodic acid.
	Gorup-Besanez	Ann. der Chem. u. Pharm., February and March ; Chem. News, XXV, p. 202; J. Chem. Soc., N. S.. X, p. 384; J. der Pharm., CLXI, p. 232.	Large amount of Ozone in the neighborhood of gradation machines of salt works.
	A. Frentz	Chem. News, XXV, p. 118; Rev. Hebd. de Chim. Scient. et Industr., Jan., 1872.	Mellowing alcohol drinks by Ozone.
	Bellucci	Chem. News, XXV, p. 118; Gaz. Chim. Ital., I, p. 687; J. Chem. Soc., N. S., X, p. 515.	Action of Ozone on plants.
	Pincus	Chem. News, XXV, p. 70.	Formation of Ozone from a fine jet of hydrogen burning in the air or in oxygen.
	Lies-Bodart	Chem. News, XXV, p. 205; Rev. Scientif. de la France et de l'Etranger, Sept., 1872.	Action of Ozone on the albumen of the blood, and on white albumen. Its disinfectant qualities.
	Carius	Chem. News, XXVI, p. 23; Ber. Bericht., V, p. 520; J. Chem. Soc., N. S., X, p. 785.	Absorption of Ozone in water.
	Thenard, A. and P.	Chem. News, XXVI, p. 105; Compt. Rend., LXXV, p. 458; J. Chem. Soc., N. S., X, p. 977; Ber. Bericht., V, p. 828.	Action of Ozone on sulphate of indigo and arsenious acid.
	Phipson	Compt. Rend., August 26, 1872.	The increased phosphorescence of Noctilucine during S. W. winds due to the large amounts of Ozone contained therein.
	Le Blanc	Chem. News, XXVI, p. 118; Compt. Rend., LXXV, p. 537.	Ozone and peroxide of hydrogen.

1872	Wideman	Chem. News, XXVI, p. 118; Compt. Rend., LXXV, p. 538.	Application of Ozone to remove fusel oil from whiskey.
	Wright	Chem. News, XXVI, p. 113; Amer. J. Sci. [3], IV, p. 29; J. Chem. Soc., N. S., X, p. 1072.	Apparatus to produce Ozone by electricity of high tension.
	P. Thenard	Chem. News, XXVI, p. 70; Compt. Rend, LXXV, p. 174; J. Chem. Soc., N. S., p. 921; Ber. Bericht., V, p. 824.	Process of estimation of Ozone by absorption in arsenious acid and titrating with permanganate of potash.
	A. Thenard	Compt. Rend., LXXV, p. 118.	An apparatus to subject vapors and gases to electricity.
	Odling	Chem. News, XXVI, pp. 281 and 294.	History of Ozone.
	Boillot	Chem. News, XXVI, p, 312; Compt. Rend., LXXV, pp. 214 and 1712; J. Chem. Soc., N. S., X, p. 879.	A new Ozonizer—A double tube filled with gas-carbon.
	Struve	J. Chem. Soc., N. S., X, p. 35.	Research on Ozone, hydrogen peroxide, and nitrite of ammonia.
	Chabrier	Compt. Rend., LXXV, p. 484.	Tendency of certain gases to acquire an active condition under influence of electricity.
	Becquerel	Comp. Rend., LXXV, p. 1735.	Report on A. Thenard's last article.
	Andrews	Ann. de Chim. et Phys., 4 S. XXVII, p. 31.	Influence of the seasons on the quantity of Ozone in the atmosphere.
	Wright	Pogg., Ann., CXLVI, p. 426.	Action of Ozone on vulcanized india rubber.
	P. Rumine	Ber. Bericht., V, p. 123.	An apparatus for Ozone production.
	B. J. Angell	Ber. Bericht., V, p. 543.	Seetang, as a means of obtaining Ozone.
	Loew	Ber. Bericht., V, p. 740.	Ozone obtained by blowing air through a Bunsen's burner.
	Moffat	Ber. Bericht., V, p. 814; Brit. Ass. Rep., 1872.	Tube ozonometer.
1873	Boillot	Chem. News, XXVII, p. 256; Compt. Rend., LXXVI, p. 1132; J. Chem. Soc., N. S., XI, p. 865.	Action of Ozone on absolute alcohol.
	"	Chem. News, XXVII, p. 208; Compt. Rend., LXXVI, p. 1712; J. Chem. Soc., N. S., XI, p. 724.	Production of Ozone from air and oxygen by electric action.

1873	Boeke	Chem. News, XXVII, p. 303 ; Berlin Bericht., VI, p. 1031 ; J. Chem. Soc., N. S., XI, p. 486.	Action of Ozone on pyrogallol.
	"	Ber. Bericht., VI, p. 439 ; J. Chem. Soc., N. S., XI, p. 938.	Examination of various methods for the production of Ozone.
	C. B. Fox	Chem. News, XXVII, p. 82; London, J. & A. Churchill.	Ozone and antozone, their nature and history.
	Rammelsberg	Chem. News, XXVII, p. 322 ; Ber. Bericht., VI, p. 603 ; J. Chem. Soc., N. S., XI, p. 1103.	Insolubility of Ozone in water of ordinary temperature.
	Carius	Chem. News, XXVIII, p. 84 ; Ber. Bericht., VI, p. 809.	Solubility of Ozone in water of 1°—2.5° C.
	Houzeau and Renard	Chem. News, XXVII, p. 142 ; Compt. Rend., LXXVI, p. 572.	Concentrated Ozone as reagent for organic substances.
	Houzeau	J. Chem. Soc., N. S., XI, p. 610 ; Ber. Bericht., VI, p. 267.	Concentrated Ozone as reagent for organic substances.
	Bellucci	Chem. News, XXVII, p. 185 ; Gaz. Chim. Ital., Nos. 1 and 2 for 1873.	Alleged emission of Ozone from plants.
	David	Chem. News, XXVII, p. 34 ; Rev. Hebd. de Chim. Scient. et Indust., Dec., 1872.	Bleaching cotton rags, etc., for paper making, by means of Ozone.
	Wills	Ber. Bericht., VI, p. 769 ; Chem. News, XXVII, p. 292.	An improved ozonizer (Modification of Siemens's).
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	"	J. Chem. Soc., CLXXVI, May, 1878, p. 371; Compt. Rend., LXXXVI, p. 76; J. Chem. Soc., XXXIV, p. 371.	Stability of Ozone.
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The History of Antozone and Peroxide of Hydrogen.

(Read April 12th, 1880.)

I. ANTOZONE.

By far the most important fact in the long and perplexing history of Antozone, is the recent discovery that there is no Antozone. After giving rise to a very voluminous literature, filled with confused and contradictory statements, the mysterious body named by Schönbein Antozone, has disappeared from the pages of chemistry, and been added to that daily increasing host of defunct chemical elements, which, after a brief and troubled existence, have fallen into final oblivion. As it was, it never had a sturdy existence. It appeared to be a sort of chemical will-o-the-wisp, a matter of exhalations, connecting its existence with the formation and disappearance of clouds and similar phenomena, and ever resisting the attempts of the experimenter to obtain it in some tangible form. The ghost of Antozone, raised by Schönbein, and, together with its twin brother, Atmizone, expanded into great proportions by the labors of Meissner, was struck down by von Babo (in his Contributions towards a Knowledge of Ozone, 1863) and finally laid by the experiments of Nasse and Engler, on the phenomena attendant upon the action of oil of vitriol upon peroxide of barium (1870).

And when we consider for a moment the overwhelming host of acquisitions which are yearly made to our stores of veritable chemical knowledge, the mind experiences a sensation of actual relief in seeing so many questionable statements expunged from the history of chemistry, and in getting hold, so to speak, of an unexpected *tabula rasa* on which to write discoveries of permanent value. Such being the case, it would certainly be an unremunerated toil to weigh and ponder the great bulk of conflicting data concerning Antozone. The most we would feel willing to undertake would be, to inquire into the grounds upon which such mistaken views were originally built: further, into the experiments which appeared to confirm these views, and eventu-

ally to win for them the credence of philosophers in general: and finally, to examine narrowly into the validity of the experimental evidence, which is regarded as demonstrating conclusively the non-existence of Antozone.

The ground was prepared for the growth of a belief in the actual separate existence of Antozone, by the promulgation by Schönbein of his theory of Ozonides and Antozonides. Under the former class, he included the peroxides, which in their action upon other bodies manifested a strong likeness to Ozone, the typical body of this class being the Peroxide of Lead.

Without enumerating all the features in their deportment towards other bodies, an enumeration which would serve only to confuse us, it will be sufficient for our present purpose to note that the properties of ozonides that Schönbein regarded as most characteristic, were their power of liberating chlorine on contact with hydrochloric acid ; of being reduced by peroxide of hydrogen to lower oxides (water and ordinary oxygen at the same time being generated), and of causing the tincture of the resin guaiacum to turn blue.

Antozonides, on the other hand, were those peroxides which under the circumstances detailed above, behaved in quite contrary fashion ;—under no circumstances liberating chlorine from a chloride, not decomposing peroxide of hydrogen, and not turning guaiacum tincture blue. The typical body of this class was Peroxide of Barium.

And inasmuch as Schönbein thought he had demonstrated that ozone is electro-negative oxygen, and that the ozonides were combinations of a lower oxide with ozone, he accordingly regarded the antozonides as combinations of a lower oxide with electro-positive oxygen. This electro-positive oxygen, he appears to have named Antozone to distinguish it from Ozone, and to indicate the function it performed in antozonides, without claiming, at least at the outset, that it had been or could be isolated in a free condition. The fact that an ozonide and an antozonide could mutually decompose one anothor, and both at the same time undergo reduction to the state of lower oxides, with liberation of ordinary oxygen, was regarded as lending great probability to the view that the oxygen in the two compounds existed in two opposed electro-chemical conditions.

This hypothesis of Schönbein was evolved at that epoch when the electro-chemical theories of Berzelius reigned paramount, and has the same general objection which is urged against the dualistic theory in general, that instead of regarding a chemical compound as a new individual in which for the time being the specific identity of its components is lost, it assumes that these components, though unrecognisable for the time, nevertheless still exist. In other words, that in an ozonide there is ozone in combination with a lower oxide, and, in an antozonide, antozone. The validity of this reasoning is denied, on the ground that a compound body may yield up its constituents in one form or in another form, according to the reagents, or according to the circumstances, etc., by which its decomposition is brought about. So with the bodies under consideration. It was pointed out by Brodie (1863), that the chemical differences in the deportment of the ozonides and antozonides, were to be attributed to the nature of the substances with which in each class of bodies the oxygen was united, and to the nature of the substances taking part in the reactions, rather than to the existence in them of two different modifications of oxygen. For example, taking the evolution of chlorine when a chloride is brought into contact with an ozonide, as the most characteristic of its properties, as was done by Schönbein, we certainly should not anticipate that peroxide of barium, which is the typical antozonide, in contact with a chloride should evolve chlorine. But it was shown by Brodie (1861) that it did so or not according to circumstances, with concentrated hydrochloric acid yielding chlorine; with dilute, peroxide of hydrogen.

In the same direction tended the still earlier observations of Lenssen, that peroxide of hydrogen (an antozonide) could add oxygen to, or subtract oxygen from, an oxidizable body, according as the circumstances of the reaction, or as naturalists at the present time are fond of saying, "the environment," are favorable to the formation of a higher or a lower stage of oxidation. Thus in alkaline solution, it oxidizes oxide of chromium to chromic acid, while it reduces chromic acid to oxide in the acid solution.

The above facts are irreconcilable with the hypothesis that an ozonide contained ozone as such, and an antozonide, antozone.

Consequently, the hypothesis, and with it the terms employed, have been abandoned.

But the existence or non-existence of ozone is not only independent of the truth or falsity of any such hypothesis, but its properties have been studied with a minuteness, an exactitude, that render it in fact a much better known body than either sulphur or phosphorus. It is questionable whether or no sulphur and phosphorus are elementary bodies; but no one doubts that the substance-matter of ozone and ordinary oxygen is identical, and the relations existing between these allotropic conditions of one and the same elemental substance are clearly and sharply defined. How does the case stand with *antozone?*

It is manifest that the theoretical speculations of Schönbein upon the existence of electro-negative and of electro-positive oxygen, in a state of combination with lower oxides in ozonides and antozonides respectively, would strongly incline him to the possibility of obtaining in a free state antozone, corresponding to the previously obtained modification of oxygen, ozone. Accordingly, we find later that Schönbein thought that the gas set free by the action of oil of vitriol on barium peroxide contained antozone. He likewise formulated a number of characteristics by which the presence of antozone could be recognized. Without pausing to enumerate all of these, it will be of service to us in obtaining a clear notion of Schönbein's conception of antozone, to specify the three most salient. They are, 1st.—That antozone, such as is made from barium peroxide, combines with water to form peroxide of hydrogen. Ozone, on the contrary, cannot oxidize water to the form of peroxide. 2d.—It does not turn manganous salts brown, while ozone does, a higher oxide of manganese in the latter case being formed. 3d.—It bleaches paper saturated with manganous and lead salts, after they have previously been turned brown by ozone.

Unfortunately, these matters of distinction were open to sources of mistake in their verification. But had the antozone been odorless, or incapable of turning iodo-potassium-starch paper blue, Schönbein would have stated grounds of difference, which would have rendered it possible readily to distinguish between it and ozone. On the contrary, in these two most striking

points, according to Schönbein, antozone and ozone were nearly alike.

Perplexing as the subject was rendered by the numerous, and, not unfrequently, the contradictory statements of Schönbein, it was enveloped in a far more disheartening nebulosity, and, it is hardly exaggeration to say, buried beneath a dense fog, raised around it by the indefatigable life-long labors of Meissner. Witness the following samples of Meissner's modes of conceiving and stating the nature of the problems under study, and ask yourselves whether, as he stated them, the problems were not too vague to admit of precise thinking or of crucial experimentation. Antozone, says Meissner, is identical with the gas which is set free by the action of sulphuric acid upon peroxide of barium, except in the two respects, that unlike this gas it does not decompose iodide of potassium, and it does not smell (in other words, it is identical with a gas, from which it differs in two essential characters). But (note how the accompanying qualification tends to clarify our ideas) this gas likewise loses its smell, clouds at the same time being formed on coming into contact with moist air.

According to Meissner, ozone could not oxidize nitrogen, and probably antozone alone could not do so either, but both together could bring it about, in case moisture were present and other oxidizable bodies were absent. As the peculiarly distinguishing characteristic of ozone, Meissner rated its power of forming clouds in contact with water. When the water was abstracted from the clouds, by contact with dessicating bodies, the dried antozone could form ozone again by transmission through water.

Finally, in opposition to Schönbein, Meissner held that antozone was not absorbed or acted upon by potassium iodide, so that if a mixture of ozone and antozone is passed through a solution of iodide of potassium, the ozone is absorbed, while the antozone escapes and passes on free.

I have endeavored to present above the views entertained by Schönbein, Meissner, and others, concerning antozone, as lucidly as the contradictory and oftentimes vague statements made concerning it would allow, and have brought its history down to the time of the publication by von Babo of the memoir before alluded to (1863), in which the weakness of the experimental

evidence brought forth in support of a belief in its existence, was for the first time clearly set forth. For Meissner, it will be recollected, saw in its power of generating a cloud in contact with water, the distinguishing property of antozone. Von Babo discovered that the formation of a cloud is always to be noted when, in any manner whatever, ozone is decomposed, water being present. Meissner believed that the clouds could not be due to peroxide of hydrogen, because, according to him, the latter is not volatile. If, then, peroxide of hydrogen was not concerned in these phenomena, there was left as the only other alternative under the circumstances, the hypothesis of a peculiar modification of oxygen capable of giving rise to them, and to this modification, which again was necessarily different from ozone, Meissner gave the name of atmizone. Later he identified it with, and called it by the same name as Schönbein's antozone. Von Babo, on the contrary, found that the clouds were only peroxide of hydrogen diffused through vapor of water, and capable of being transported along with it, and even passing with it through aqueous solutions, for long distances, without being deposited or absorbed.

Unfortunately, these results of von Babo were encumbered with certain vague and doubtful speculations concerning the mode of genesis of the peroxide of hydrogen, through the interaction of ozone and water in the presence of an oxidizable substance. That they were in reality conclusive against the existence of the so-called antozone, was not generally recognised until the labors of Nasse and Engler (1870), upon the gas set free by the action of sulphuric acid upon peroxide of barium, had confirmed their truth and illuminated their proper bearings and significance. Nasse and Engler, by simple but trenchant experiments, demonstrated that the gas evolved in this case was a mixture, containing not only ozone, but also water and peroxide of hydrogen.

When the escaping gas was passed through a series of tubes surrounded with a freezing mixture, the latter underwent condensation, and the permanent gas which passed on was ozone. The condensed product, when subjected to appropriate tests, proved to be merely a solution of peroxide of hydrogen. Carry the simple explanation thus afforded with you, and see with

what a flood of light it illuminates all the hitherto hopelessly obscure passages in the history of antozone, and enables one to give readily a natural explanation to phenomena which at the time of their original discovery perplexed mightily their discoverers, and led them to form many ingenious, but in the end harmful hypotheses.

For instance, examine with the aid thus given, Schönbein's first distinguishing characteristic of antozone: *i. e.*, as made from barium peroxide, it combines with water to form peroxide of hydrogen. Since the gas given off in this reaction consists not only of ozone, but of peroxide of hydrogen, the peroxide of hydrogen which Schönbein thought was formed on its coming into contact with water, really pre-existed. Consider his second test: that antozone does not turn manganous salts brown, while ozone does. This difference is likewise true of peroxide of hydrogen as compared with ozone. The same remark applies to his third test:—that it bleaches papers saturated with manganous salts, after they have been turned brown by ozone. The same effect precisely is produced by peroxide of hydrogen. Is there any adequate explanation of these agreements, short of conceding that Schönbein's antozone is disguised peroxide of hydrogen?

But what shall we say of those numerous cases, in which Meissner thought that a mixture of ozone and antozone was present, and that on removing the former by passing the mixture through a solution of iodide of potassium, the latter went on alone attended with its characteristic white cloud? The explanation is that afforded by von Babo, viz.—that when ozone decomposes potassium iodide solution, there is found in addition to free iodine, iodate of potassium and potassium peroxide, *peroxide of hydrogen.* If any one doubts the adequacy of this explanation, let him try the following experiment. Strongly ozonize some *dry* oxygen by an electrical ozonizer, pass the ozonized gas through a sulphuric acid wash-bottle, and then allow it to descend upon a potassium iodide solution. The ozone will undergo complete absorption, the solution becoming deeply colored by the liberated iodine. Resting upon the surface will be seen a dense white cloud. This white cloud may now be aspirated through many wash-bottles containing water,

and even a solution of chromic acid, and may stand for hours over water before it completely disappears. But on examining the waters used in washing it, they will be found to contain peroxide of hydrogen. Apply the same mode of solving the other statements made by Meissner, remembering always that the peroxide of hydrogen which is formed when ozone is decomposed by an aqueous solution, is attended by a white cloud through which the peroxide of hydrogen has diffused itself,—a white cloud of such permanence that it may be transmitted through many solutions before undergoing absorption,—and their explanation will be found both natural and easy.

In conclusion, why not make an end of the matter by stating that antozone is peroxide of hydrogen ? The objection to so doing is, that along with the term antozone there were attached many notions which are not true of peroxide of hydrogen, such as its being electro-positive oxygen, that it had the power of forming peroxide of hydrogen on coming into contact with water, etc.

Finally, the very name antozone implies a substance in its nature the opposite of ozone, and supposes the existence of a theory to account for the difference. For these reasons, I deem it more just to sum up the question by reaffirming the affirmation made at the beginning, that *there is not, and never was, antozone.*

II.—Peroxide of Hydrogen.

Though Peroxide of Hydrogen was discovered by Thénard more than half a century ago (1818), and has ever been a substance possessed of unusual interest in the eyes of chemists, yet the difficulties of its manufacture were so great, that only recently has it ceased to be a chemical curiosity and come into common use in the arts. Only a year ago a very dilute solution of the peroxide, imported from Europe, was sold in New York at the price of $16 per gallon. But to-day a solution containing .8 per cent. is retailed at about $1 per pound. At this high price, it is sold under fanciful names, and employed to bleach human hair. But there is much reason for believing that a

most important future is before it, and that alike in the chemist's laboratory and in the arts, as a most powerful oxidizing and reducing agent,—for it can act as both,—for bleaching purposes, etc., it is destined to play a great part. With its cheapening, many new uses will be found for it, and it is probable before very long, it will take its place, as Mr. G. C. Davis has strongly urged (Chem. News, XXXIX, p. 220), as an indispensable article upon the working-table of every chemist.

But it is not these considerations, which mainly interest us in connection with its scientific history. It is rather the accessions to our knowledge, which more especially of late have elucidated many obscure points connected with its sources and properties.

That the method of preparation from peroxide of barium and hydrochloric acid (Thénard, 1818), or from the same oxide and carbonic acid (Duprey, 1862 : Balard, 1862), is not used to obtain it on a commercial scale, is familiar to many,—the method of Pelouze, in which hydrofluoric or fluosilicic acid is used to effect the decomposition, being that employed in the arts.

That peroxide of hydrogen was formed in the electrolysis of water strongly acidulated with sulphuric acid, was stated by Meidinger (1853), and was apparently so well confirmed by the experiments of Bunsen (1854), C. Hoffmann (1867), and others, that until the researches of Berthelot (1878) were published, the production of peroxide of hydrogen in electrolysis was looked upon as a fully established fact. But the great French chemist showed that the body dissolved in the acid electrolyte, did not exhibit the reactions characteristic of peroxide of hydrogen: *i. e.*, it did not decompose potassium permanganate (Brodie's test), nor oxidize chromic to perchromic acid (Barreswil's test), nor convert calcium hydrate into an insoluble peroxide in alkaline solution (Berthelot's test?). He demonstrated that it contained in solution the same oxide of sulphur, which he had previously formed as a beautifully crystalline body by the long-continued exposure of dry ozone and dry sulphurous acid to the action of the silent electric discharge—Berthelot's persulphuric anhydride, $S^2 O^7$.

Finally, during the course of the year just passed, Schöne has demonstrated in his elaborate research upon the behavior of

peroxide of hydrogen towards the galvanic current (1879), that *in the electrolysis of water no hydrogen peroxide is formed.*

Will the same be found to be true of Schönbein's statement, that in the oxidation of phosphorus exposed to moist air, along with ozone, a by no means inconsiderable quantity of peroxide of hydrogen is formed? This point was investigated by the author in the course of a research into the by-products obtained in the ozonation of air by phosphorus, with the result of confirming Schönbein's observation. The amount of hydrogen peroxide was determined by analysis of the water employed in washing the ozonized gas, the iodine liberated by the washed gas being attributed entirely to the decomposition effected in a neutral solution of potassium iodide by the ozone. The proportion of hydrogen peroxide to the ozone, as determined by this method, was only one to four hundred. But later, the author has re-investigated the subject, estimating not only the hydrogen peroxide held back in solution, but the entire amount present in the ozonized gas, and has found that its proportion to that of the ozone may exceed one to three. The two substances, as Schöne has pointed out, may be present in the same vessel in quite a concentrated form for a long interval, without effecting a complete mutual decomposition, and when highly dilute, may co-exist for hours.

One question of very great interest still remains:—*is Peroxide of Hydrogen present in the atmosphere?* As yet, except as an inference from other meteoric phenomena, there is no evidence that it is. Meissner (1863), Schönbein (1868), Struve and Schmid (1869), and Goppelsröder (1871), believed that they had succeeded in demonstrating the presence of peroxide of hydrogen in rain. Houzeau, whose authority in matters of chemical climatology no one would feel disposed to question,—seeing that he gave a lifetime of arduous study to their elucidation,—made very numerous analyses of the atmospheric precipitates, at different seasons of the year, occurring in the vicinity of Rouen (1868). But he did not succeed in finding peroxide of hydrogen either in snow or rain-water, nor in natural or artificial dew.

But in the year 1874, Schöne made an elaborate investigation of the subject, and obtained results which established, that in that locality at least, and at the time his experiments were per-

formed, hydrogen peroxide was present in certain atmospheric precipitates. Of 130 samples of rain-water collected during the latter half of the year 1874, at Petrowskoje, near Moscow, he found only four in which hydrogen peroxide could not be detected. Of snow, of which 29 samples were examined, there were 12 in which the presence of hydrogen peroxide could not be proven. As to the amount, Schöne found that it varied in rain-water, between *one part in one million to one part in twenty-five millions.*

The problem, how to detect with scientific exactitude the presence of ozone, or peroxide of hydrogen, or of both, in the excessively dilute condition in which, if ordinarily they exist at all, they must be present in the earth's atmosphere, is still unsolved ; and while its importance, as a leading factor in chemical and medical climatology, is on all sides generally admitted, there appears to be scanty prospect of its speedy or satisfactory settlement.

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TO THE

Literature of Peroxide of Hydrogen.

1818	Thenard	Ann. de Chim. et Phys., IX, pp. 314, 441; Traité de Chim., 4me ed., IV, 2, 41; Paris, Mem. Acad. Sci., III, p. 385.	Discovery of oxygenated water (hydrogen dioxide), and experiments on some of its reactions.
1819	"	Ann. de Chim. et Phys., X, pp. 114, 335; and XI, pp 85, 208; Brugnatelli, Giornale, II, pp. 82, 126, 206, 313; Thomson, Ann. Phil., XIV, pp. 209, 274; Phil. Mag. and Jour. Sci., LIII, pp. 21, 109, 147, 462, and LIV, p. 76; Jour. de Phys., LXXXVIII, p. 455; Trommsdorf, N. Jour. de Pharm., III, p. 378; Compt. Rend., 1819.	Experiments on the reactions of H_2O_2, with a method for its preparation from barium dioxide and sulphuric acid.
1820	"	Trommsdorf, N. Jour. de Pharm., IV, p. 37; Quar. Jour. Sci., VIII, pp. 114, 154.	Experiments on hydrogen dioxide.
	"	Gilbert, Annal., LXIV, p. 1.	Liquid oxygen, or oxidized water.
1822	"	Thomson, Ann. Phil, III, p. 41.	Memoir on the preparation of H_2O_2.
1832	"	Ann. de Chim. et Phys., L, p. 80; Schweigger, Jour., LXV, p. 439 (= Jahrb. V).	Preparation of H_2O_2, and a study on some of its reactions.
	Pelouze	Pogg., Ann., XXV, p. 508.	Preparation of H_2O_2.
	Liebig	Ann. der Chem. u. Pharm., II, p. 22.	Property of pulverulent or angular bodies to liberate oxygen from H_2O_2.
1833	Thenard	Phil. Mag. and Jour. Sci., II, p. 403.	Preparation of H_2O_2.
1834	Vogel	J. pr Chem., I, p. 448.	H_2O_2 from MnO_2 or PbO_2 with H_2SO_4 diluted with 8 times the quantity of water.
1836	Kirchner	Ann. Chem. u. Phar., XVII, p. 40,	Peculiar formation of hydrogen dioxide from

			chlorine held in a bladder in a moist atmosphere.
1839	Lampadius	J. pr. Chem., XVII, p. 36.	A solution bleaching litmus obtained from PbO_2 and dilute H_2SO_4.
1843	Kirchner	J. pr. Chem., XXVIII, p. 250.	Use of H_2O_2 to purify foul air in rooms, &c
	Sondalo	Compt. Rend., XVII, p. 820.	Purification of foul air by means of H_2O_2.
	Barreswil	Compt. Rend., XVI, p. 1085.	Conversion of chromic into perchromic acid by H_2O_2.
1845	Schönbein	Pogg., Ann., LXV, p. 161.	Electrolysis of H_2O_2 containing H_2SO_4.
1850	Brodie	Phil. Trans., XI, p. 759.	Decomposition of H_2O_2 as affected by the chemical polarity of the atoms.
1851	Schönbein	J. Chem. Soc. (Memoirs), III, p. 358.	Action of metallic oxides, metals, and charcoal on H_2O_2.
1854	Bunsen	Pogg., Ann., XCI, p. 621.	Effect of heat on the formation of H_2O_2 in the electrolysis of acidulated water.
	Wöhler and Geuther	Ann. der Chem. u. Pharm., XCIV, p. 127; J. pr. Chem., LXII, p. 250; Pharm. Centr. für 1854, p. 752.	Equal amounts of oxygen are liberated from the MnO_2 and H_2O_2 by mutual decomposition in acid solution.
	Brodie	J. Chem. Soc., VII, p. 304; J. pr. Chem., LXIV, p. 474.	Did not find the preceding to be the case.
1858	Schönbein	Verhandl. der naturf. Gesell. in Basel, II, pp. 20, 113; J. pr. Chem., LXXV, p. 88; Chem. Centr., 1858, p. 951; Anzeige Philosophische Magazin, [4] XV, p. 24; Ann. der Chem. u. Pharm., CVIII, p. 157; Pogg., Ann., CV, p. 268; (See also Chem. Centr., 1859, pp. 19, 33); N. Arch. ph. nat., [4] XVI, p. 178; Amer. J. Sci., [2] XXVII, p. 19; Ann. Ch. Phys., [3] LV, p. 218.	Behavior of H_2O_2 with plumbic acetate, ozone, potassium manganate, chromic acid, etc. Considers the O in H_2O_2 and $KMnO_4$ for example, to be in opposite electrical conditions; in the former, electro-positive, in the latter, electro-negative.
	"	J. pr. Chem., LXVII, p. 263; Chem. Centr. für 1859, p. 741; Pogg., Ann., CVI, p. 313.	H_2O_2 obtained from potassium, sodium, and barium peroxides on mixing with H_2O. Evolution of O on mixing H_2O_2 with perchlorates.

1859	Schönbein	J. pr. Chem., LXXVII, p. 276; N. Jahrb. Pharm., XII, p. 209; Chem. Centr. für 1859, p. 763.	Behavior of H_2O_2 to manganese and iron salts.
	"	Pogg., Ann., CVIII, p. 471; N. Jahrb. Pharm., XII, pp. 214, 281; J. pr. Chem., LXXXVIII, p. 63; See also Chem. Centr. für 1860, p. 33); Ann. Chim. Phys., [3] LVIII, p. 479.	Chemical polarity of oxygen. Formation of H_2O_2 by slow oxidation of phosphorus in contact with water.
	"	Verhandl. der naturf. Gesell. in Basel, 1859; N. Jahrb. Pharm., XII, p. 291; Pogg., Ann., CIX, p. 134.	Behavior of H_2O_2 with ether.
	"	Phil. Mag. [4], XVIII, p. 510; J. pr. Chem., LXXIX, pp. 65, 71, 285; Chem. News, I, p. 12.	Formation of H_2O_2 by slow oxidation of metals in moist air.
	"	Verhandl. naturf. Gesell. in Basel, 1859; N. Jahrb. Pharm., XII, p. 288.	Catalytic decomposition of H_2O_2 by platinum.
	F. H. Storer	Proc. Amer. Acad. Arts and Sciences, IV, p. 338; J. pr. Chem., LXXX, p. 44; Rep. chim. appliquée, II, p. 155.	Reaction for chromium by means of H_2O_2.
1860	Böttger	J. pr. Chem., LXXX, p. 58.	Preparation of an etherial solution of H_2O_2.
	Schönbein	Verhandl. der naturf. Gesell. in Basel, II, p. 520; J. pr. Chem., LXXX, p 280.	Preparation of H_2O_2 from BaO_2 by means of hydrofluosilicic acid.
	"	Verhandl. der naturf. Gesell. in Basel, II, p. 455; J. pr. Chem., LXXX, p. 257; Rep. chim. pur., III, p. 36.	Behavior of chromic acid with H_2O_2 free from acid.
	"	Chem. News, II, p. 23.	Delicate tests for H_2O_2; 1st.—KI + starch + $FeSO_4$; 2d.—K_3FeCy_6 + a ferric salt; 3d.—$KMnO_4$; 4th.—Indigo + $FeSO_4$; 5th.—Chromic acid.
	"	Ann. Chim. et Phys., LVIII, p. 486; Pogg., Ann., CIX, p. 130.	Catalytic decomposition of H_2O_2 by platinum, and the cause.
	"	Verhandl., der naturf Gesell. in Basel, II, p. 507; J. pr. Chem., LXXXI, p. 265; Chem. Centr. für 1861, p. 165.	On the action of N_2O_4 on H_2O_2.
	"	Pogg., Ann., CIX, p. 134.	Preparation of a mixture of H_2O_2 and ether, and its characteristics.

1860	Aschoff	J. pr. Chem., LXXXI, pp. 487, 401 ; Arch. Pharm., [2], CV, p. 129 ; Chem. Centr. für 1861, p. 234.	Chloride of lime with H_2O_2 in acid solution, gives off four atoms of oxygen. Action on chromic acid.
	Riche	Chem. News, II, p. 107; Pogg., Ann., CIX, p. 346; Bull. Soc. Chim., 1860, p. 178.	Action of H_2SO_4 on H_2O_2 in liberating ozone. Liberation of oxygen by the alkalies.
	Lenssen	J. pr. Chem., LXXXI, p. 276.	Iodine is changed by H_2O_2 into HI in presence of alkaline carbonate.
1861	Schönbein	Pogg. Ann., CXII, pp. 281, 287, 446.	Tests for H_2O_2. Formation of H_2O_2 from H_2O and O in contact with Zn, Cd, Pb, Cu, and the other metals, except Au, Ag, Pt, etc., in a moist atmosphere.
	Brodie	R. Soc Proc., XI, p. 442.	Action of H_2O_2 on oxygenated bodies in solution.
	Aschoff	Chem. News, V, p. 129 ; J. pr. Chem., LXXXI, p. 401.	Action of H_2O_2 on the higher oxides, and the formation of perchromic acid.
	Böttger	Chem. News, IV, p. 57 ; Wittsb. V. Schr., IX, p. 546.	Preparation of an etherial solution of H_2O_2.
1862	Osann	Chem. Centr., 1862, p. 97.	H_2O_2 made from K_2O_2 and hydrofluosilicic acid.
	Chevreul	Compt. Rend., LV, p. 737.	Bleaching power of H_2O. upon organic coloring matters.
	Duprey	Compt. Rend., LV, p. 736; Chem. News, VII, p. 301; Institut, 1862, p. 365 ; Dingl., Polyt. Jour., CLXVII, p. 38 ; J. pr. Chem., LXXXVIII, p. 440 ; Zeitsch. Chem. u. Pharm., 1862, p. 695.	Preparation of H_2O_2 from Ba_2O_2, 8 H_2O and CO_2.
	Balard	Compt. Rend., LV, p. 738.	Uses same method of preparation as Duprey.
	Brodie	Phil. Trans., p. 834.	Decomposition of H_2O_2 by $KMnO_4$, K_3 $FeCy_6$, Ba $(ClO)_2$ and H_2CrO_4, and on the oxidation effected by H_2O_2.
	von Babo	Ann. der Chem. u. Pharm., Suppl. II, p. 265.	Ozone forms H_2O_2 with water, only in presence of nitrogen or an oxidizable body.
	Schönbein	Zeitsch. anal. Chem., I, p. 440.	Action of H_2O_2 on plumbic acetate, etc.
1863	Brodie	J. Chem. Soc., XVI, p. 320.	Decomposition of H_2O_2 by $KMnO_4$, etc.

1863	Schönbein	Ann. Chem. u. Pharm., Suppl. II, p. 211 ; J. pr. Chem., LXXXVIII, p. 469; J. Pharm., [3] XLIV, p. 83; Bull. Soc. Chim , V, p. 442.	Action of H_2O_2 on bromine and chlorine.
	"	J. pr. Chem., LXXXIX, p. 22 ; Bull. Soc. Chim., V, p. 548.	Formation of H_2O_2 in the blood by respiration, and its behavior to the constituents of the blood.
1864	Schönbein	J. pr. Chem., XCIII, p. 24; Bull. Soc. Chim., [2] III, p. 179; Chem. News, XI, p. 25.	Formation of H_2O_2 by slow oxidation of lead.
	"	J. pr. Chem., XCIII, p. 60, and XCII, p. 150 ; Institute, 1864, p. 399.	Delicate tests for H_2O_2 by means of KI and indigo.
	"	J. pr. Chem., XCII, p. 168; Zeitsch. anal. Chem., III, p. 245 ; Bull. Soc. Chim., [2] III, p. 147; J. Pharm., [3] XLVI, p. 313.	Presence of H_2O_2 in urine.
1865	C. Hoffmann	Ann. der. Chem. u. Pharm., CXXXVI, p. 188 ; Chem. Centr. für 1865, p. 1119 ; Phil. Mag., [4] XXXI, p. 143.	H_2O_2 made from potassium peroxide and hydrofluosilicic or tartaric acid.
	Giannuzzi	Zeitschr. Chem., VIII, p. 749.	Action of H_2O_2 on myosin, fibrin, blood-serum, albumen, etc.
1866	Schönbein	J. pr. Chem., XCVIII, pp. 257, 280 ; Zeitsch. Chem. für 1866, p. 658 ; Bull. Soc. Chim., [2] VII, p. 238 ; J. Pharm., [4] IV, p. 308 ; J. pr. Chem., XCIX, pp. 11, 19 ; Zeitschr. Chem., für 1867, p. 93.	Formation of H_2O_2 by the slow oxidation of organic substances in the absence of water, as ether, alcohol, etc.
	"	J. pr. Chem., XCVII, p. 76; Ann. Chim. Phys., [4] VII, p. 103 ; J. Pharm., [4] IV, p. 395.	Catalytic decomposition of H_2O_2 by Pt, Ru, Ir, Rd, etc.
	"	J. pr. Chem., XCVIII, p. 270.	Delicate test for H_2O_2— plumbic acetate, starch, potassium iodide or guaiacum and a solution of blood-corpuscles.
	"	J. pr. Chem., XCVIII, p. 65 : N. Repert. Pharm., XVI, p. 6; Zeitsch. Chem. für 1866, p. 445 ; Zeitsch. anal. Chem., VI, p. 114 ; J. Pharm., [4] IV, p. 306; Chem. News, XV, p. 123.	Stability of H_2O_2 in aqueous solutions.

1866	Schönbein	Chem. News, XIV, p. 107; Bull. Soc. Chim., V, p. 547.	Concentration of H_2O_2, and various reactions.
	Weltzien	Compt. Rend., LXII, p. 640; J. Pharm., [4] p. 254; Chem. News, XIII, p. 139, and XIV, pp. 1, 15, 39, 50.	Action on H_2O_2 of Fe, Al, ferrous salts, Mg, Tl, NH_3, Ag NO_3, KI, (KI + Fe SO_4), K Mn O_4, K_4 Fe, Cy_6, and K_3 Fe Cy_6.
	"	Ann. der. Chem. u. Pharm., CXXXVIII, p. 129.	Concentration of H_2O_2 by evaporation at the boiling point, etc.
	"	Compt. Rend. LXII, p. 757; Chem. News, XIV, pp. 1, 15; Bull. Soc. Chim., [2] V, pp. 261, 322.	Theoretical consideration of H_2O_2. Instability of the H in the molecule as compared with H_2O.
	Baudrimont	Compt. Rend., LXII, p. 829.	Experiments in H_2O_2.
	Hoffmann	Phil. Mag. & Jour. Sci., XXXI, p. 143.	Preparation of H_2O_2 from K_2O_3 and fluosilicic acid; also from K_2O_3 and tartaric acid.
	Harcourt and Esson	Proc. Roy. Soc., XV, p. 262.	On the reaction of H_2O_2 and H O.
		Ann. Chim. et Phys., 4me S., VIII, p. 465.	Action of platinum, iridium, etc., on H_2O_2.
1867	Schönbein	J. pr. Chem., CII, pp. 145, 155, 164; Zeitsch. Chem. für 1868, pp. 155, 178; N. Repert. Pharm., XVII, pp. 306, 321; J. pr. Chem., C, p. 469; Zeitsch. Chem., für 1867, p. 606; Bull. Soc. Chim., [2] IX, p. 74.	Formation of H_2O_2 from various substances, as in turpentine, alcohol, resins, etc.
	Harcourt and Esson	J. Chem. Soc., [2] V, p. 460.	Reaction of H_2O_2 and H I.
	Swiontowski	Zeitsch. Chem. für 1867, p. 179; Bull. Soc. Chim., [2] VIII, p. 404; Ann. der Chem. u. Pharm., CXLI, p. 205.	Action of H_2O_2 on potassium permanganate.
	Houzeau	Chem. News, XVII, p. 57; Compt. Rend., LXVI, p. 44.	Method of estimating quantitatively small amounts of H_2O_2 by means of KI and an acid.
	"	Compt. Rend., LXVI, p. 314,	Upon H_2O_2, considered as the cause of the alterations in Houzeau's test papers.
	Schönbein	N. Repert. Pharm., 18, 364; J. pr Chem., CVI, p. 270.	Occurrence of H_2O_2 in rain-water, air, etc.
	"	J. pr. Chem. CV, p. 219; Institute, 1869, p. 6.	H_2O_2 recognised by malt extract and guaiacum tincture.
	"	J. pr. Chem., CV, p. 241.	Stability of H_2O_2 on heating its aqueous solutions.

1868	Houzeau	Ann. Chim. Phys., [4] XIII, p. 111; Bull. Soc. Chem., [2] X, p. 242; J. Pharm., [4] VII, p. 268; Zeitsch. Chem. für 1868, p. 223; Zeitsch. anal. Chem., VII, p. 242; Chem Centr., für 1868, p. 315.	Estimation of small quanties of H_2O_2.
	"	Compt. Rend,, LXVI, p. 314; Ann. Chim. Phys., [2] XIV, p. 305.	No H_2O_2 in the air.
	Parnell	J. Chem. Soc., [2] VI, p. 356; Zeitsch. Chem. für 1868, p. 714.	Reducing action of H_2O_2 in presence of C_6H_6O.
	Rundspaden	Ann. Chem. u. Pharm., CLI, p. 306.	H_2O_2 from electrolysis of water.
1869	Tomlinson (Harcourt, in discussion of Tomlinson's paper.)	J. Chem. Soc., [2] VII, p. 145.	Effect of the state of surface in the rate of decomposition of H_2O_2.
	Struve	J. Pharm., [4] X, p. 356; Zeitsch. anal. Chem., VIII., p. 315; N. Rep. Pharm., XVIII, p. 753; Chem. Centr., für 1870, p. 148; Bull. Soc. Chim., [2] XIII, p. 39; Chem. News, XX, p. 23; Compt. Rend., LXVIII, p. 1551; J. pr. Chem., CVII, p. 503; Zeitsch. für Chem. von Beilstein, für 1869, p. 274.	Detection of H_2O_2 in rain, snow, &c., by means of KI, starch, and ammonio-ferrous sulphate.
	Schaer	Vierteljahrsschr. für pr. Pharm., XVIII, pp. 371, 497.	Action of H_2O_2 on emulsin and myrosin, spittle and milk.
	Schönbein	J. pr. Chem., CVI, p. 257; N. Rep. Pharm., XVIII, p. 28; Zeitsch. Chem. für 1869, p. 533; Zeitsch. anal. Chem., VIII, p. 81; Dingl., Polyt. Jour., CXCI, p. 499.	Behavior of H_2O_2 towards ferment.
	Schmid	J. pr. Chem., CVII, p. 60.	Occurrence of H_2O_2 in rain-water.
	Schonn	Zeitsch. anal. Chem., IX, p. 49; Zeitsch. Chem. für 1870, p. 446; Bull. Soc. Chim., [2] XIV, p. 42.	Action of H_2O_2 on molybdic acid and oxide, and upon titanic acid.
	Struve	N. Petersb., Acad. Bull., XV, p. 325.	Formation of H_2O_2, ozone, and ammonium nitrite, in combustion of hydrogen.
	Houzeau	Compt. Rend., LXX, p. 519; Bull. Soc. Chim., [2] XIV, p. 372; Institute, 1870, p. 74; Zeitsch. Chem., [2] VI, p. 255.	Absence of H_2O_2 in the snow fallen at Rouen.

1871	Struve	Chem. News, XXIII, p. 203; Bull. Acad. Imp. Sci., XV.	Presence of H_2O_2 in air and in vital processes.
		J. Chem. Soc., XXIV, p. 356.	Reducing action of H_2O_2 and phenole.
	F. Goppelsröder	J. pr. Chem. [2] IV, pp. 139, 383; Zeitsch. anal. Chem., X, p. 259 ; Moniteur Scientifique, [3] I, p. 912.	Presence and formation of H_2O_2 in the atmosphere.
1872	Struve	J. Chem. Soc., XXV, p. 35; Zeitsch. f. anal. Chem., X, p. 292.	Occurrence of H_2O_2 in combustion and in vital processes.
	Thenard	J. Chem. Soc., XXV, p. 921; Compt. Rend., LXXV, p. 177.	Action of KMO_4 on H_2O_2 under influence of a freezing mixture.
	Struve	J. Chem. Soc., XXV, p. 922 ; Zeitsch. f. anal. Chem,, XI, p. 25.	Determination of H_2O_2 by means of indigo.
	LeBlanc	Compt. Rend., LXXV, p. 537.	Production of H_2O_2 in the electrolysis of H_2SO_4.
	Thenard, A. and P.	Compt. Rend., LXXV, p. 458.	Formation of H_2O_2 by the action of ozone on sulphate of indigo.
	Houzeau	Compt. Rend., LXXV, p. 537.	The same.
1873	Al. Schmidt	J. Chem. Soc., XXVI, p. 186 ; Pflüger's Archiv., VI, pp. 413, 490; J. Chem. Soc., 1873, p. 180.	Decomposition of H_2O_2 by filter paper, ptyalin, and pepsin.
	LeBlanc	J. Chem. Soc., XXVI, p. 242.	Production of H_2O_2 in the electrolysis of sulphuric acid.
	Fudakowski	Ber. Bericht. VI, p. 107.	Presence of H_2O_2 in benzene.
	J. Thomsen	Pogg., Ann., CL, p. 31, and CLI, pp. 194, 225; Ber. Bericht., VI, pp. 223, 1434; Chem. Centr., 1873, p. 472.	Thermo-chemical researches on H_2O_2.
	Böettger	Dingl., Polyt. Jour., CCIX, p. 157.	Stability of H_2O_2.
	Struve	Wien. Akad. Ber., 2 Abth., LXVIII, p. 432.	Test for H_2O_2 by means of pyrogallic acid.
	Hamel	Compt. Rend.. LXXVI, p. 1023.	Estimation of H_2O_2 by $KMnO_4$.
	Radenowitsch	Dingl., Polyt. J., CCX, p. 476 ; Ber. Bericht., VI, p. 1208; J. Chem. Soc., 1874, p. 433.	Formation of H_2O_2 in the slow oxidation of turpentine oil.
1874	Thomson	Dingl., Polyt J., CCXI, p. 211 ; Ber. Bericht, VII, p. 73; J. Chem. Soc., 1873; p. 433.	Preparation of H_2O_2.
	Weith & Weber	Ber. Bericht., VII, p. 1745.	H_2O_2 and NH_4O give nitrous acid.

1874	A. V. Schrotter	Ber. Bericht., VII, p. 983.	H_2O_2 as a cosmetic.
	Schöne	Dingl., Polyt. Jour., CCX. p. 307; J. Chem. Soc., 1874. p. 601.	Tests for H_2O_2—titanic acid; cadmium iodide, starch, and ferrous sulphate.
1875	Schöne	Ber. Bericht., VII, p. 1693; J. Chem. Soc., 1875, p. 418.	Atmospheric H_2O_2.
	Clermont	Compt. Rend., LXXX, p. 1591; J. Chem. Soc., 1875, p. 1216; Ber. Bericht., VII, p. 981.	Presence of H_2O_2 in the sap of plants.
	Kingzett	J. Chem. Soc., [2] XIII, p. 210; Moniteur Scientifique, [3] V, p. 1020.	Formation of H_2O_2 from oxidation of turpentine.
	Thomsen	Pogg., Ann., CLI, p. 194; J. Chem. Soc., 1875, p. 223.	H_2O_2 as an oxidizing agent (Thermo-chemical Researches).
	Carius	Ann. der Chem. u. Pharm., CLXXIV. p. 31; J. Chem. Soc., 1875, p. 128; Ber. Bericht, 1874. p. 1481.	Formation in nature of nitrous acid, nitric acid, and hydrogen peroxide.
1876	Cohné	Chem. News, XXXIV, p. 4; J. Chem. Soc., 1876, vol. II, p. 539.	Formation of ozone by contact of plants with hydrogen peroxide.
	Kingzett	Report Brit. Assoc. for 1875 (2d Pt.), p. 43; Moniteur Scientifique. [3]. VI, p. 197.	Formationof H_2O_2 by incomplete oxidation of terpenes.
	Bellucci	Gazz. Chim. Italiana, V. p. 405; J. Chem. Soc., 1876. vol. I, p. 954.	Presence of H_2O_2 in the juice of plants.
	Griessmayer	Ber. Bericht., IX, p. 835.	Connection of H_2O_2 with the reduction of nitrates by bacteria, etc.
	Schaer	Ber. Bericht., IX, p. 1068.	The same.
1877	Fairley	J. Chem. Soc., 1877, vol. I, pp. 1. 125.	H_2O_2 and certain peroxides.
	Kingzett	Moniteur Scientifique, [3] VII. p. 715.	Disinfecting action of H_2O_2.
1878	Böttger	Chem. Centr., 1878, p. 574; J. Chem. Soc., 1879, p. 103.	Formation of H_2O_2 by explosion of a mixture of oxygen and hydrogen.
	E. Schöne	Ann. der Chem., Vol. 192, p. 257; J. Chem. Soc, 1878, p. 931.	H_2O_2. its preparation, products of.
	Schöne	Ber. Bericht., XI, pp. 482. 561, 874, 1028; J. Chem. Soc., 1878, p. 552.	Atmospheric H_2O_2.
	Berthelot	Compt. Rend., LXXXVI, p. 71.	Formation of hydrogen peroxide, ozone, and persulphuric acid during electrolysis.
	Boillot	Compt. Rend., LXXXVI, p 123.	Effect produced by a low temperature upon a mixture of H_2O_2 and H_2SO_4.
	Berthelot	Compt. Rend., LXXXVI, p. 277.	New observations on the chemical reactions of the silent electrical discharge.

1878	Bellucci	Gazz. Chim. Ital., Fasc. VIII and IX. 1878; Chem. News. XXXIX, p. 149.	Alleged existence of H_2O_2 in the organism of plants.
	E. Schöne	Ann. der Chem., Vol. 195, p. 228; J. Chem Soc., 1879. p. 353; J. Am. Chem. Soc., I. p. 250	H_2O_2 (3d paper). Behavior of H_2O_2 towards KI.
	"	Ann. der Chem., Vol. 196, p. 58; Chem. News, XXXIX. p. 164.	Behavior of H_2O_2 towards the oxygen compounds of thallium.
	"	Ann. der Chem., Vol. 196, p. 239.	Behavior of H_2O_2 towards ozone and chlorine.
	"	Ann. der Chem., Vol. 197, p. 137.	Behavior of H_2O_2 towards the galvanic current.
	Davis	Chem. News, XXXIX. p. 221.	Peroxide of hydrogen, its estimation. stability, and uses.
	Drechsel	J. pr. Chem., 2 S., XVIII. p. 303.	Catalytic decomposition of H_2O_2 by alkalies.
	Kern	Chem. News, XXXVII, p. 35.	H_2O_2 in the rain-water at St. Petersburgh. Less in rain coming with north winds, than in that coming with south winds.
	Berthelot	Bull. Soc. Chim., XXXIII, pp 342, 249.	Decomposition of H_2O_2 in presence of alkalies. Action of iodide of potassium on H_2O_2.

LIST OF ABBREVIATIONS.

Actes de la Soc. Helvétique.	Actes de la Société Helvetique des Sciences Naturelles,—Geneva.
Amer. J. Sci.	The American Journal of Science and Arts,—New Haven.
Ann. de Chim.	Annales de Chimie,—Paris.
Ann. der Chem. u. Pharm.	Annalen der Chemie und Pharmacie,—Leipzig and Heidelberg.
Ann. der Chem.	Justus Liebig's Annalen der Chemie,—Leipzig and Heidelberg.
Ann. of Pharm.	Annals of Pharmacy,—London.
Arch. de l' Elec.	Archives de l' Electricité,—Geneva.
Atti Scienz. Ital.	Reunione degli Scienziati Italiani.
Basel, Bericht.	Bericht über die Verhandlungen der Naturforschenden Gesellschaft in Basel.
Basel, Verhandl.	Verhandlungen der Schweizerischen Naturforschenden Gesellschaft bei ihrer Versammlung zu Basel.
Ber. Bericht.	Berichte der deutschen chemischen Gesellschaft, —Berlin.

Bibl. Univ.	Bibliothèque Universelle des Sciences, Belles-Lettres et Arts,—Geneva.
Bibl. Univ. Arch.	Supplèment a la Bibl. Univ.,—Geneva.
Breslau, Schles. Gesell. Jahresb.	Jahresber. des Academischen Naturwissenschaftlichen Vereins zu Breslau.
Breslau, Schles. Gesell. Uebersicht.	Uebersicht der Arbeiten und Veränderungen der Schlesischen Gesellschaft für vaterländische Kultur,—Breslau.
Bull. Soc. Chim.	Bulletin de la Société Chimique de Paris.
Chem. News.	Chemical News,—London.
Compt. Rend.	Comptes Rendus Hebdomadaires des Séances de de l'Academie des Sciences,—Paris.
Dingl. Polytech. Journ.	Polytechnisches Journal von J. G. Dingler,—Stuttgart
Edinb. Med. Journ.	Edinburgh Medical Journal,—Edinburgh.
Erlangen, Abhandl.	Abhandlungen der Physikalisch-medicinischen Societät in Erlangen.
Erlangen, Mitt. Phys. Med. Soc.	Wissenschaftliche Mittheilungen der Physikalisch-medicinischen Societät zu Erlangen.
Freiburg, Bericht.	Berichte über die Verhandlungen der Naturforschenden Gesellschaft zu Freiburg in Breisgau.
Froriep, Notizen.	Notizen aus dem Gebiete der Natur-und Heilkunde, Erfurt
Gazz. Chim. Ital.	Gazzetta Chimica Italiana,—Palermo.
Heidelberg. Verhandl. Nat. Med. Ver.	Verhandlungen des Naturhistorisch-medicinischen Vereins zu Heidelberg.
Il Tempo.	Il Tempo, Giornale Italiano di Medicina, Firenzi.
J. der Chem. u. Pharm.	Journal der Chemie und Pharmacie,—Heidelberg
J. pr. Chem.	Journal für praktische Chemie,—Leipzig.
J. de Pharm.	Journal de Pharmacie et des Sciences accessoires, —Paris.
J. Chem Soc.	Journal of the Chemical Society,—London.
J. Amer. Chem. Soc.	Journal of the American Chemical Society,—New York.
Les Mondes.	Revue Hebdomadaire des Sciences et de leur Applications aux Arts et à l'Industrie,—Paris.
München. Gelehrte Anz.	Gelehrte Anzeigen,—München.
München, Sitzungsber.	Abhandlungen der Naturwissenschaftlich-technischen Commission bei der Königl. Baierischen Academie,—München.
Phil. Mag.	Philosophical Magazine,—London.
Pogg., Ann.	Annalen der Physik und Chemie,—Leipzig.
R. Soc. Proc.	Proceedings of the Royal Society,—London.
Roma Atti	Atti dell' Accademia Pontificia dei Nuovi Lincei, —Rome.
Schweiz. Gesell. Verhandl.	Verhandlungen der Schweizerischen Gesellschaft für die gesammten Naturwissenschaften,—Basel.
Stockholm, Ofversigt.	Ofversigt af Kongl. Vetenskaps Academiens Handlingar.
Würzburg Verhandl.	Verhandlungen der Physikalisch-medicinischen Gesellschaft in Würzburg.
Zeitsch. f. Anal. Chem.	Zeitschrift für analytische Chemie,—Wiesbaden.