α. *Chlorine* is the most powerful of these. It was first proposed by Riauz in 1822. It has been subsequently strongly recommended by Buchner, Simeon, and Orfila. It should be applied both internally and externally if possible. If chlorine water be at hand, this should be given in doses of one or two teaspoonsful properly diluted with water. In the absence of this, weak solutions of the chloride [hypochlorite] of lime, or the chloride [hypochlorite] of soda, may be administered. Nitro-hydrochloric acid, largely diluted, might be given where none of the above agents could be procured. The patient should be allowed to inhale, very cautiously, air impregnated with chlorine gas (developed by the action of dilute hydrochloric acid on chloride of lime.) Enemata, containing chlorine water, or a solution of chloride of lime, should also be employed.

β. *Ammonia.*—The spirit of sal ammoniac was proposed by Mead (*Mechan. Account of Poisons*, 5th edit. p. 275, 1756.) as an antidote for laurel-water. In 1822, ammonia was recommended by Mr. J. Murray as an antidote for hydrocyanic acid; and its value has been admitted by Buchner, Orfila, Dupuy, and Herbst: but it is certainly inferior to chlorine; and, therefore, should be used only in the absence of this. If the patient be able to swallow, the liquor ammoniæ, diluted with eight or ten parts of water, should be exhibited, and the vapour of ammonia or its carbonate inhaled: the latter practice is most important, and should not be omitted. Orfila says that ammonia is of no use when introduced into the stomach, but that the inhalation of the vapour will sometimes preserve life. Great caution is requisite in the employment of it (see p. 276.) In the absence of ammonia the inhalation of the vapour of burnt feathers might be employed. Ammonia cannot be useful, as an antidote, by its chemical properties merely, since hydrocyanate of ammonia is a powerful poison.

γ. *Cold Affusion* has been strongly recommended by Herbst, (*Archiv. f. Anat. et Phys.* 1828; quoted by Dr. Christison.) and is admitted by Orfila to be a valuable remedy, though he thinks it is inferior to chlorine. Herbst says that its efficacy is almost certain when it is employed before the convulsive stage of poisoning is over, and that it is often successful even in the stage of insensibility and paralysis.

δ. *Artificial respiration* ought never to be omitted. Of its efficacy I am convinced from repeated experiments on animals. I once recovered a rabbit by this means only, after the convulsions had ceased, and the animal was apparently dead. It is an operation easily effected, and will be found a powerful assistant to chlorine or ammonia, by enabling it to get into the lungs when natural respiration is suspended. To produce respiration, make powerful pressure with both hands on the anterior surface of the chest, the diaphragm being at the same time pushed upward by an assistant. Inspiration is effected by the removal of the pressure and the consequent resiliency of the ribs.

Other remedies (as turpentine) have been recommended, but they will not bear comparison (if, indeed, they possess any efficacy) with those now mentioned. Blood-letting has been advised, in vigorous subjects, when respiration has been established, and the skin is livid. (Devergie, *Méd. Lég.* t. ii. p. 825; also Lonsdale, *op. supra cit.*)

ORDER VIII. COMPOUND OF BORON AND OXYGEN.

AC'IDUM BORA'CICUM.—BORACIC ACID.

HISTORY.—Beccher (Thomson's *History of Chemistry*, vol. i. p. 248. Lond. 1830.) "was undoubtedly the first discoverer of boracic acid, though the credit of the discovery has usually been given to Homberg," who, in 1702, (*Histoire de l'Academie Royale des Sciences*, 1702; *Memoires*, p. 50.) obtained it in small shining plates, which have been called *Sedative* or *Narcotic Salt* (*Sal sedativum Hombergi.*) In the year 1776 it was discovered in the lagoons (*Lagoni*) of

Tuscany by Hoefer[1] and Mascagni,[2] and more recently by Mr. Smithson Tennant,[3] Dr. Holland,[4] and Mr. Lucas,[5] in the crater of Volcano, one of the Lipari Islands.

NATURAL HISTORY.—Boracic acid is peculiar to the inorganized kingdom. It is found both free and combined.

α. *Free Boracic Acid.*—The boracic acid *lagoons* of Tuscany are spread over a surface of about thirty miles. There are nine establishments for the manufacture of this acid; viz. at Monte Cerboli, Monte Rotondo, Sasso, Serazzano, Castelnuovo, San Frederigo, Lustignano, Lurderello, and Lago. They are the property of one individual (M. Tarderel, now Count de Pomerance,) to whom they are the source of great wealth. The earth (principally calcareous) of this part continually evolves aqueous and sulphurous vapours, which, when they burst with a fierce explosion, produce boracic acid.[6] The phenomena are explicable on the supposition, that water gains access to immense masses of sulphuret of boron contained in the interior of the earth. By the mutual reaction of these substances, great heat, boracic acid, and sulphuretted hydrogen, would be evolved. The latter taking fire would produce water, sulphur, and sulphurous acid. (Dumas, *Traité de Chimie*, t. i. p. 380. Paris, 1828.) In consequence of being found at Sasso, native boracic acid has obtained the name of *Sassoline*.

β. *Combined with bases.*—Boracic acid is found native combined with soda (forming *Tincal*,) (See *Sodæ Biboras.*) and with magnesia (constituting *Boracite.*) It is also found in the minerals called *Datholite*, *Botryolite*, *Schorl*, *Apyrite*, and *Axynite*.

PROCESS OF MANUFACTURE.—Boracic acid is obtained in Tuscany in the following manner:—"Round the more considerable fissures a circular basin is dug, about four feet deep, and usually three or four yards across. These basins, which are called *lagoni*, being situated at different levels, the water of a rivulet is admitted into them, which, mixing with the black mud at the bottom, is made to boil up violently by the issues of vapour within its circuit. The water is generally confined in each basin for twelve [twenty-four, *Payen*] hours at a time, during which period it becomes saturated to a certain extent with acid from the steam which has passed through it. It is then drawn off from the higher basin to one beneath it, where it remains an equal length of time, till at length it reaches a building at the bottom of the hill, in which the process of evaporation is conducted." Here it enters a reservoir or cistern, where it is allowed to repose till it has deposited the mud which it held in suspension. Having cleared itself of impurities, the water is then drawn off from the cistern into flat leaden pans, under which some of the natural steam is conducted by brick drains about two feet under ground, and by this heat is evaporated. This process requires about sixty hours, the water passing successively from the pans at the upper extremity into others at the centre, and from thence into others at the lower extremity of the building, by means of leaden siphons.

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[1] *Memoria sopra il sale sedativo di Toscana ed il Borace*, &c. Firenze, 1778. Uebers von B. F. Hermann: Wien. 1782.

[2] *Memorie della Societa Italiana*, viii. 487.

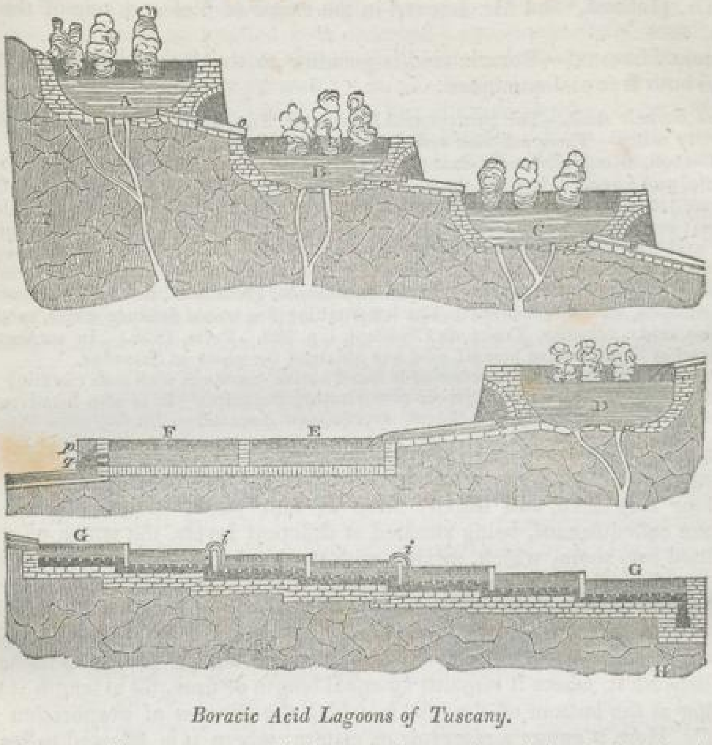
[3] *Transactions of the Geological Society*, vol. i. p. 388. 1811.

[4] *Travels in the Ionian Islands, Albania, Thessaly, Macedonia, &c. during the years* 1812 and 1813, p. 9. Lond. 1815.

[5] *Ann Chim. et de Physiq.* t. ii. p. 443. 1819.

[6] For farther details consult Tancred, *On the Collection of Boracic Acid from the Lagoni of Tuscany*, in the *Transactions of the Ashmolean Society*, vol. i., Oxford, 1837; Dr. Bowring, *On the Boracic Acid Lagoons of Tuscany*, in *The Lond and Edinb. Philosoph. Magazine*, vol. xv. p. 21. Lond. 1839; and Payen, *Ann. Chim. et Phys.* 1841.

Fig. 56.



Boracic Acid Lagoons of Tuscany.

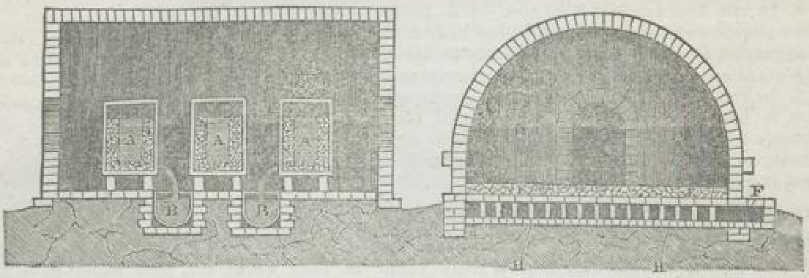
A, B, C, D. Lagoons.—The vapours enter at the bottom, and escape through the water into the air. When the water in the upper lagoon, A, is sufficiently charged with acid, it is allowed to run through the tube, *o*, into the lower lagoon, B. In this way it passes successively from B to C, from C to D, and from D into the reservoir, E.

E, F. Reservoirs or Cisterns.—In these the solution is allowed to rest, and deposite mechanical impurities. By the removal of the upper plug, *p*, the solution escapes into the upper evaporating pan, G.

G, G. Leaden Evaporating Pans.—They are supported by rafters, and are heated by the aqueous vapours, which enter at H and are confined in drains. The acid solution is conveyed from one pan to another by means of leaden siphons, *i i*.

Having arrived at a proper state of concentration, it is then conducted into wooden tubs, in which it cools for about five days, during which the crystallization of boracic acid takes place on the sides of the tubs, and on the stick in the centre. The acid having been removed from the tubs is placed in a basket to drain, and is then spread on the floor of a closed chamber, heated by vapour, to dry. The acid, thus prepared, is sent in casks to Leghorn. (Tancred, *op. supra cit.;* also Bowring, *op. supra cit.;* and Payen, *op. supra cit.*)

Fig. 57.



Crystallization and Drying Chambers.

A, A, A. Wooden tubs lined with lead, in which the acid crystallizes.
B, B. Mother liquor.
C. Basket in which the crystallized acid is placed to drain before it is conveyed to the drying chamber.
D, D. Drying chamber.
E, E. Boracic acid drying on the floor (F,) between which and the lower floor (H) the hot vapour circulates.

Boracic Acid may also be obtained by dissolving borax in hot water, and adding half its weight of oil of vitriol. As the solution cools, crystals of boracic acid (retaining a little sulphuric acid) are deposited, which must be well washed. Or borax may be decomposed by hydrochloric acid, by which a purer boracic acid is procured.

Properties.—Crystallized boracic acid occurs in the form of white, transparent, pearly, hexagonal scales, which are odourless, have a weak, scarcely acid, taste, and communicate a wine-red tint to litmus. At 60° the crystallized acid requires 25·66 times its weight of water to dissolve it, but only 2·97 times at 212.° It dissolves readily in spirit of wine. When sufficiently heated it evolves its water of crystallization, melts, forming a transparent liquid, which, by cooling, becomes a brittle glass (*vitrified boracic acid.*)

Characteristics.—An alcoholic solution of boracic acid burns with a beautiful green flame. A hot aqueous solution of the acid renders turmeric paper brown, like the alkalis. (Faraday, *Quarterly Journal of Science*, vol. ix. p. 403.) Before the blowpipe, boracic acid fuses, and forms a glass which may be tinged blue by chloride of cobalt, and rose-red by the terchloride of gold. A mixture of one part of vitrified boracic acid, finely pulverized, two parts of fluor spar, and twelve parts of oil of vitriol, evolves, by heat, the fluoride of boron, recognised by its forming dense white fumes in the air, and by its charring paper, wood, &c.

Composition.—The following is the composition of boracic acid:—

	Atoms.	*Eq. Wt.*	*Per Ct.*	*Berzelius.*
Boron	1	10	29·41	31·18
Oxygen	3	24	70·59	68·82
Dry Boracic Acid	1	34	100·00	100·00

	Atoms.	*Eq. Wt.*	*Per Ct.*	*Berzelius.*
Dry Boracic Acid	1	34	55·74	56
Water	3	27	44·26	44
Crystallized Boracic Acid	1	61	100·00	100

Physiological Effects and Uses.—Though sedative properties were formerly ascribed to this acid, it is probably inert, or nearly so. Cullen (*Materia Medica*, p. 341.) gave it in large doses without observing that it produced any effect on the human body. It is, therefore, not employed in medicine; but it is extensively used in the manufacture of borax. (See *Sodæ Biboras.*)

Order IX. PHOSPHORUS AND PHOSPHORIC ACID.

1. PHOS'PHORUS, *L.*—PHOSPHORUS.

History.—This substance was discovered, in 1669, by Brandt, an alchymist at Hamburgh; and received its name from being luminous in the dark (from φως, *light*, and φερω, *I carry.*)