POLYTECHNIC ASSOCIATION OF THE AMERICAN INSTITUTE.

At the regular meeting of the Polytechnic Association of the American Institute, on Thursday evening, May 8, 1862, the Chairman, Prof. Joy, announced the subject for the evening to be

THE MANUFACTURE OF SOAP,

and opened the discussion with the following remarks :—

It is not known when the manufacture of soap was first introduced. We find mention of it in our earliest classical writers and in the Old Testament; in Jeremiah, ii. 22, is found the expression, "Though thou wash thee with niter and take thee, much soap;" and in Malachi, iii. 2, "for he is like a refiner's fire and like fuller's soap:" but it is doubtful whether the soap here alluded to was made of the same materials as are at present employed.

The niter mentioned in Scripture was notour saltpeter, but an impure sesqui-carbonate of soda, procured from certain lakes in Egypt. Solomon was acquainted with the action of an acid upon this salt, as he says in Prov. xxv. 20: "As he that taketh away a garment in cold weather and as vinegar upon niter, so is he that singeth songs to a heavy heart." Pliny calls it *nitrum* and relates the circumstances attending the discovery of glass by its accidental fusion with silica on the shore where the sailors were using it to support their kettles while cooking their dinner.

The difference between soda and potassa was not known to the ancients and this was first recognized by Duhamel in 1735. The alchemists were of the opinion that the alkali of plants was produced by the burning, and it was not until 1764 that it was shown to be present in the living plant.

According to Pliny, the Romans learned the art of soap making from the Gauls.

Pliny says: "Soap is an invention of the Gauls and is used for giving a reddish tint to the hair. It is prepared from tallow and ashes, the ashes of beech and elm being preferred; there are two kinds of it, the hard and the liquid, both of them much used by the people of Germany, the men in particular more than the women."

The city of Pompeii contained a complete soap-boiling establishment. It was near the sea shore, conveniently placed for the importation of the blocks of soda (niter) from Syria and next door to the Custom house. The works were uncovered after having been buried more than 1,700 years and found in a tolerable state of preservation.

The first room contained lime soap. In the second were five oval vessels made of cement and coated with hard stucco, which had been used in the manufacture of soap. It is a curious fact that the pumice stones which were rained down upon Pompeii and drove out the soap boiler of that day, are now ground up and used by our manufacturers in the preparation of sand soaps. Whatever may have been the origin of this manufacture, it is clear that it was carried on in a thoroughly empirical manner for many centuries. We are indebted to a man still living for our knowledge of the scientific principles which lie at the foundation of this important industry. The French chemist Chevreul first announced to the Academy of Sciences in Paris, in a paper dated July 5, 1813, his discovery of the compound nature of the fatty bodies. Previous to that time, fat had been regarded as an unmixed organic substance—Chevreul showed it to be composed of several salts, which he called stearine, margarine and oleine. These bodies will be described by the gentleman who is to follow me.

The influence of Chevreul's discovery upon the manufacture of soap and candles was immense, and so great has the industry become that all parts of the world have been laid under contribution for the supply of the raw material. There is an oft quoted sentence in Liebig's Letters on Chemistry :—"*Die Seife ist ein Massstab fuer den Wohlstand und die Cultur der Staaten.*" (Soap is a measure of the prosperity and civilization of a people.)

Liebig refers to the endless threads of manufacture which are bound up with this industry.

The extensive supply of soda ash, has suggested its use in the manufacture of glass and in the preparation of soap. Sulphuric acid was necessary in its manufacture and the supply of this acid became so great that its application increased in proportion. To make sulphuric we need nitric, and for nitric we send to explore and civilize South America, and obtain nitrate of soda, and thus diminish the demand for salpeter and render that available for gunpowder. Hydrochloric acid is an incidental product in the manufacture of soda ash, and this acid being remarkably cheap is extensively used in the preparation of bleaching powders, and in many manufactories; and thus one discovery ramifies in every direction and tends to the civilization of people in remote countries. In this respect, the manufacture of soap is a measure of the prosperity of a people.

I shall leave the practical operations of soap making to gentlemen who are familiar with the subject.

It is known that when a great number of bodies are buried in trenches under certain conditions, a peculiar change takes place. The oleine and glycerine are often removed, and pure acids (stearic and palmitic with ammonia) remain behind. The body retains its natural shape.

During the removal of the bodies of the victims of the cholera buried in Potters-field on Forty-ninth street, numerous examples of this decomposition were observed, and a body is now preserved in the Museum of the College of Physicians and Surgeons on Twenty-third street. This fat is called adipocere, from *adeps*, fat and *cera*, wax. It has been thoroughly investigated by Dr. Wetherill, of Philadelphia. The specimens on the table are from the Potters-field, and the soap and candles were prepared from the adipocere in the course of some scientific experiments.

The Chairman concluded by giving a detailed account of soda ash, illustrated by diagrams and by specimens taken from each step in the process.

He then called upon a German chemist, Mr. Engelhard, of St. Xavier College, to take up another branch of the subject.

Mr. ENGELHARD—Mr. President, The fats and fixed oils, used in the manufacture of soap, of different qualities and properties, are taken both from the animal and vegetable kingdoms. Chemically pure fats have neither taste, smell nor color, and leave a grease spot on paper. They are lighter than water, having generally a specific gravity of .91 to .94. All of them are soluble in ether; a few in alcohol, and none in water. Heated by themselves they will resist a temperature of 500° Fah., but above that decompose; hence their name, fixed oils, in contradistinction to volatile oils, which may be distilled without alteration.

When oils in vats are heated with the hydrated alkalis, such as lime, potash, soda, a process called saponification takes place.

To count up all the different constituents of the known fats and fixed oils would require too much time, and therefore I shall speak of those only which constitute lard, suet, palm oil and olive oil. All fats are mixtures of two, three or four closely-allied substances, namely, stearine, palmatine, margarine—solid at ordinary temperatures—and one liquid, olein. The more olein a fat contains in proportion to the other constituents, the less solid is it. [The speaker then described in detail the four substances named. They are all composed of carbon, hydrogen and oxigen, in the following proportions :—

Stearine....C_{114} H_{110} O_{12}
Palmatine..C_{102} H_{98} O_{12}
Margarine..C_{108} H_{104} O_{12}
Oleine.....C_{111} H_{104} O_{12}]

If a fat or fixed oil is heated with a caustic hydrated alkali the following decomposition takes place:—
Stearine +6HO=glycerine+3 stearic acid and 3 water.

Stearine C_{114} H_{110} O_{12} + 6 Water H_6 O_6 = 3 Stearic acid { C_{36} H_{35} O_3 ; C_{36} H_{35} O_3 ; C_{36} H_{35} O_3 } + 1 Glycerine.. C_6 H_8 O_6 + 3 Water..... H_3 O_3 = C_{114} H_{116} O_{18}

Stearine, palmatine, margarine and olein consists, therefore, of stearic, palmitic, margaric and oleic acids, with the base glycerine. In soap making the following decomposition takes place :—

C_{114} H_{110} O_{12} + 6(HO) + 3(KO) = 3(KO) + 3(C_{36} H_{35} O_3) + C_6 H_8 O_6 + 3 (HO)

The stearate of glycerine is decomposed and the stearate of potash is formed. We substitute for the base, glycerine, in the original combination, a new, stronger base, potash, and form the new salt known as soap.

[The speaker next described the several acids mentioned, and pointed out the proper methods of detecting the various adulterations used in the manufacture of soap.]

The PRESIDENT—There is a gentleman present who will give us some information in relation to vegetable soaps.

Mr. AUSTIN—In some countries the natives use the seeds of some plants as substitutes for soap, of some plants the bark is used, and of others the root. Such plants are found to abound in an acrid, narcotic principle—a vegetable alkali, called saponin; but whether their virtues as purifiers of linen depend upon chemical or mechanical action is a question I believe not yet settled. These plants are confined to a very few widely-diverse natural orders of the vegetable kingdom, and frequently to a very few genera of those orders. However, it is, no doubt, contained in many plants where it is not at present suspected to exist. I will mention briefly a few of the more important plants containing saponaceous secretions. The seeds of many plants of the soap-berry family, as the horse chestnut, contain this matter to a great extent. The fruits of these latter lather freely in water, and "a few of them will cleanse more linen than sixty times their weight of soap." Pounded and thrown into water they stupefy fish.

There are two or three genera belonging to the natural order—Rosaceæ and the tribe Guillaiæ—remarkable for their saponaceous secretions. Guillaia saponaria yields one of the barks called Guillaia, used as a substitute for soap. "Two ounces of this bark are sufficient to wash a dress," and it is said to give a remarkable luster to wool. It contains a substance which occasions violent sneezing, and which is allied to saponin.

The California soap plant belongs to the natural order—Liliaceæ, and to the Scillæ or onion tribe. It is used by the natives as a substitute for soap. This plant produces a thick bulb, which is inclosed in a remarkably large and thick bundle of black, coarse fibers—the remains of the nerves of former leaves.

All plants secreting saponaceous matter (and I have mentioned only some of the more important ones) contain also an acrid, narcotic, and often highly poisonous principle, and, no doubt, the two principles are identical—saponin or an allied vegetable alkali. These plants also furnish many useful medicines, and not unfrequently highly nutritious food. The poisonous principle is readily expelled by heat, as in the manihot or jatropha, whence the cassova and tapioca are derived.

Dr. STEVENS—This is the bread fruit of Brazil, and I have seen the natives preparing it for use. The plant resembles very closely our sassafras; it has the same rough bark and the same palmate leaf. The food is derived from the root, and it probably produces a larger amount of food from a given area of ground than any other plant. A yield of 3,000, 4,000, and 5,000 bushels to the acre is not uncommon, and the cultivation is of the roughest kind. In fact, it has no cultivation except planting. The universal South American knife, the machete is used to cut a hole in the sod, the plant is inserted, and left to take its chance. It is sure to take its chance, however. It will root out all other plants, and it cannot itself be destroyed. The root is grated in mills, the milk flows away, and the pulp is dried for food. The milk is wasted by the hogshead; I have seen a river white with it for a long distance below the grating mill. This milk is poisonous, and it contains the saponaceous principle. The women use it freely for washing their persons, and I am bound to say, that during the bread fruit harvest is the only time of year that they are clean.

Prof. SEELY—I will say a word in regard to soft soap. Genuine soft soap, such as I knew in my boyhood, is not now to be found. This was made by the farmers from the ashes of their wood fires. The ashes were placed in a barrel, and leached by pouring water upon them from time to time, and then the lye was boiled with grease to make soft soap. Now farmers come into the city and buy something under the name of soft soap; but it is nothing but a little hard soap with a great deal of water and a little sal-soda. It would be much more economical to buy the hard soap without the water.