Chemical Matters Found in the Bible

Lecture for the Benefit of the Scholarship Fund

of the *Lehranstalt für die Wissenschaft des Judentums*

[Academy for the Study of Judaism]

Held on March 21, 1904

By

Privy Councillor to the Government

Prof. Dr. A. Pinner

Separate Printing from the "Allgemeine Zeitung des Judentums"

Translated by Katherine Elena Wolff, Aug. 2005. Published in http://www.math.rutgers.edu/~zeilberg/family/PinnerChemBible.pdf

Printed by Rudolf Mosse in Berlin

Ladies and Gentlemen:

When I received the honorable task of giving a lecture on a topic from my field of work for the benefit of the Scholarship Fund of the *Lehranstalt für die Wissenschaft des Judentums* [Academy for the Study of Judaism], I called the topic: "Chemical Matters Found in the Bible." The public announcements turned this into: "Chemistry in the Bible". That is too much, of course. For there is no room for chemistry in the Bible, even if in times long past, when the individual parts of the Bible were written, chemistry had played a greater part than it actually did. There are only a very few hints – and these are very superficial - that allow one to draw some kind of conclusion as to how much the Israelites knew of the then small store of knowledge in the chemical domain. And so I shall be able to tell you only very little.

In general, chemistry is considered to be one of the most recent sciences, and in fact, the ideas we now have about chemical transformations of substances began to develop hardly more than a century ago. But already in most ancient times, the Egyptian priests dealt with chemical problems, and in particular, they tried to change the metals into one another, for example copper into silver or gold. And the name "chemistry" itself means nothing other than Egyptian art or Egyptian science, that is to say, the art of the Hamites or Chamites, which is to say, the Egyptians. However, as is known, the Egyptian priests kept their knowledge in all areas very secret so that the people would not become too enlightened, and we can assume that hardly anything of the little that they themselves had learned about chemical matters over the course of time seeped through to the people and became common knowledge. Thus, even at the time when the Israelites had lively contact with Egypt, so during the period of the kings, probably just about nothing of the Egyptian priests' chemical knowledge would have trickled through to Palestine. So aside from the fact that the Bible is not meant to be a scientific textbook, this is another reason why we have to relinquish finding something of significance in the Bible where chemistry is concerned.

In addition, during the period of the Jewish State, the Israelites were a purely agricultural people, a people of small farmers, and they had no opportunity to make inventions of their own in the chemical domain. The two most powerful and essential sponsors of art and science, that is trade and industry, could not prosper in Palestine, because at no time did the Jews succeed in gaining the Mediterranean shores. You all know that between the State of the Judean and the Israelite kings and the sea, there was a long, narrow strip which was inhabited by the Phoenicians and the Philistines, who were perhaps identical. It was not possible to conquer the Philistines. There were already battles with them before the time of the historical Jewish kings, as can be gathered from the stories about Samson. The first king, Saul, also fought his wars mainly against these enemies, who were preventing the development of the Jewish community. But unfortunately, Saul's two successors did not follow his example. Both David and Solomon, so precisely the two rulers who represent the period at which the Jewish State was at its peak, were closely linked with the most outstanding Phoenician prince, Hiram, and they sought to expand their kingdom towards the north and the south, but not towards the west. And later, when the most powerful tribe, Juda, separated from the kingdom as such and two dwarf States were created that wasted their strength in mutual jealousies, there could be no thought of conquering the sea coast. The impressive development of power in the two coastal cities Sidon and Tyre shows us how significant this omission was.

At that time, art and industry were held in low esteem among the Israelites. When King Solomon wanted to build a palace for himself and the Temple, he did not find the competent people in his own country. He had to ask his friend Hiram in Tyre both for the architects and for the stone masons, and he also had to get woodcutters and blacksmiths from Tyre to decorate the two State edifices. And three centuries later, at the time of Ezekiel, the Jews still could contribute nothing to the world market except agricultural products. No industrial products and even less art creations, for in his prophecy against Tyre (chapter 27), Ezekiel mentioned many different peoples who supplied the world market in Tyre with their

countries' products, and he also named Juda and Israel. And what could they contribute to the world market? Wheat, honey, oil and two different kinds of resin or balsam – גנפ, which Luther translated as balsam, and ירצ, which he translated as mastix [Translator's Note: the King James Version translates the two words as "Pannag" and "balm"] – so nothing but agricultural products.

So what chemical products were they acquainted with? First of all, some metals: gold, silver, copper, iron, lead and tin. Of course, we have to be careful as regards the explanation of the Hebrew names for some metals. We won't even take into account that, for example in Genesis 4, Tubal-Cain, who was supposed to have lived long before Noah, is said to have worked on copper and iron, although during this early period no one was acquainted with iron and probably no one knew copper. But aside from this, the word לידב, which is supposed to mean tin, is to be found in Isa 1:25 in a context in which it can hardly mean that, but rather only a low-grade metal; in any case, it would fit better to lead, which is תרפוע and which is at various times named alongside of לידב. The two metals do look somewhat similar, and in ancient times, when only the external appearance of an object enabled one to recognize it, they were probably confused with one another often enough. So no wonder the authors of the individual parts of the Bible, who were surely no real experts in the metallurgical domain, didn't always choose the correct name for the substance they meant.

As already mentioned, during the time when the Bible was written, the Jews knew six kinds of metal. But it was the Phoenicians who brought them these metals. There was no mining in Palestine. Gold and silver and to a small extent copper do exist in nature in the metallic state. The former two, the precious metals, only need to be cleaned, purified, so that they can be worked on some more. And the Jews must have known how to purify the precious metals and in particular how to separate them from the low-grade metals, since the refining fire, ךרצ, is mentioned repeatedly in the most varied parts of the Bible, as are also the waste products produced in the purification process, which are called םיגיס. On the other hand, copper for the most part, as well as all iron, tin and lead can be found in nature in the form of a chemical compound with oxygen or sulphur, and they have to be brought to a metallic condition by means of a particular process. This production of the metals from the compounds in which they occur in nature was not done in Palestine, but rather in the countries, where these compounds were mined. And it was precisely the Phoenicians who not only mined the ore in the various countries and worked them into metals, but who also transported them on their ships to the various countries along the Mediterranean.

You all know from the Bible that King Solomon equipped fleets in Etsion Geber, the port on the Red Sea, so as to get gold and ivory, etc. from Ophir, which was in Southeast Africa. But the ships were built by Phoenician ship builders, and it was mainly Phoenician captains and sailors who brought Africa's treasures to the king, as is emphasized explicitly (1 Kings 9:27).

Besides Ophir, gold came to Tyre from Uphas; the Phoenicians got silver, as well as lead and iron from Spain, they separated copper in Cyprus, and they brought tin home from Britain. If the Israelites themselves were not able to produce the metals that were known at the time, neither could they reach a higher quality by working them. For they lacked the most powerful incentive for developing work on metals, which was the production of artistic images or sculptured utensils for religious purposes. On the contrary, they were strictly forbidden to make images. In Solomon's temple, the various copper and bronze utensils were made by Hiram, the artist from Tyre.

We shall now come to a second point: to what extent did the Israelites know how to look after their living quarters and clothing. Here again we have only weak hints that let us deduce what they were able to do. At the time when Genesis was written, they not only knew how to form

bricks and to dry them in the air, as was common in ancient times, so as to use them; they also knew how to burn them in order to harden them. In the story of the Tower of Babel, it is said in a nice play on the Hebrew words, which it is not possible to give in the translation: "'Come, let us make bricks, and burn them thoroughly.' And they had brick for stone, and bitumen for mortar." There are three Hebrew words for clay, טיט, which corresponds more or less with the German word *Lehm* [English clay] and means the raw, not immediately usable, soft, not very valuable mass which makes things dirty; then הנבל, the clay used for bricks, and רמח, the clay used by potters, which is really the clay that can be formed and used to make various utensils. I don't want to miss pointing out that הנבל, which really means the white mass, so the white clay, was used exclusively to make bricks, whereas רמח, the red mass, so the red clay, was considered to be the more precious material and was valued more. Now, we consider the white clay, that is the clay which remains white when burnt, to be far more valuable. It is the pure clay, the clay used for porcelain, whereas the reddish clay owes its color to the presence of foreign substances, in particular of iron compounds. We are not told why the Israelites used the white clay only to make bricks; probably this clay, which was to be found in Palestine at the time, could not be formed easily enough to make ceramic utensils out of it.

The reddish clay, the רמח, also seems to have been the only material out of which they were able to make more shapely objects. For the word for potter is רצוי, that is, the one who forms, the epitome of the one who forms, the one who brings forth a shape. That means nothing other than that they were wont to use only clay to form various shapes. They could not or did not want to use any other materials that could be used for this purpose: wood and ivory, stones, marble, metals.

It is quite doubtful whether they knew the potter's wheel, the oldest aid in forming clay, in the biblical period. In Jeremiah 18:3 it says: "I went to the potter's house and he was working on the two stones." Those are the two stones that were also used in the handmill to grind the grain; they could only serve to knead the clay, not to form it.

They used the reddish clay not only to make pottery products, but also as bitumen, although it is not unlikely that they were acquainted with real bitumen, a mixture out of slaked lime and sand. For in Isaiah 27:9 it says: "when he makes all the stones of the altars like limestones crushed to pieces." If the translation of the Hebrew word used there, רג, as lime is correct, the Israelites must have known about burning lime. For in nature, we can find limestone, which is as hard as rock and which remains hard and firm, and marble, both – as also chalk – a compound of lime with carbon dioxide. The lime containing carbon dioxide is decomposed by means of intensive heating, through burning, und what remains is the baked lime. However, by lying in the air, this gradually takes on humidity and carbon dioxide and thereby disintegrates. When water is poured over it, the burnt lime becomes very hot and bloated and combines to become slaked lime. So when Isaiah says that it is characteristic of lime to disintegrate easily, he can only mean the burnt lime, and burnt lime could only be used to make bitumen. Since people knew how to burn clay, we don't have to be too surprised that they could also burn lime.

Incidentally, let us also mention that people did know how to burn clay at the time when the Bible was written, but they did not know how to make it water-tight at the same time. Thus, clay vessels could not be used to keep liquids. The production of water-tight vessels belongs to a much later period.

A text in Jeremiah 2:22 is interesting for a chemist. It says: "For though you wash yourself with רתנ and take much תירב, yet the stain of your iniquity is before me." What is *neter* and what is *borit*? In any case, they must have been strong cleansers. Luther translated this verse

as: “And if you washed yourself immediately with salt solutions (*Laugen*) and took much soap as well, your vice would blaze all the more before me.” [Translator’s note: the King James Version translates this verse as: “For though thou wash thee with nitre, and take thee much soap, yet thine iniquity is marked before me.”] So *neter* would be a salt solution and *borit* soap. But the ancient Israelites were just as ignorant of soap as the ancient Greeks. Soap began to be produced much later and was probably invented by the Teutons.

The word *neter* can be found again in the Bible in a very interesting connection. There, the first vowel is somewhat changed and it says *nater* instead of *neter*. But as we know, in ancient times the vowels were not very important. In the Book of Proverbs 25:20 it says: “Like one who takes off a garment in cold weather, and like acid upon nitre, is he who sings songs to a heavy heart.” [Translator’s Note: the King James Version has: “As he that taketh away a garment in cold weather, and as vinegar upon nitre, so is he that singeth songs to an heavy heart.”] Here, Luther translated the word *nater* as chalk, so very different to the previous text. Nevertheless, Luther understood quite well what the sentence meant. For it is supposed to characterize wrongdoing, absurd action. If you pour vinegar onto chalk, it fizzes up, as you probably all know; the sour taste of vinegar gradually vanishes and the chalk disintegrates. Both become useless for their purpose, they are spoiled.

The word *neter* or *nater* is very old and still exists. In Egypt and on the northern coast of Africa, particularly in Tunis, so where in times past the city founded by Tyre or its “new city”, Carthage, extended its rule, two externally similar substances that are often confused with one another can be found. The Greek and Roman authors sometimes called them *natron* and sometimes *nitron*. The word probably originated in Egypt.

One of these two substances is identical with Chilian saltpeter, which has been found in huge quantities on the northern border of that country, and of which great masses are now being brought from Chili to Europe and used mainly as fertilizer. When people had finally learned how to distinguish it from other substances, it was called *nitrum* (niter); however, the real saltpeter, which is only very slightly different from it, was then also called *nitrum* (niter).

The second of the two substances to be found in North Africa can be observed in particular during the annual drying up of the many flat lakes, the so-called bulkheads, that form during the rainy season. It then forms a salty crust and is the actual detergent, the “*neter*”. It has been called *natron* (sodium carbonate) and is chiefly nothing other than our soda. In chemical terms we call it sodium carbonate (*natron* or *natrium*), whereas the Chilian saltpeter is called saltpeter *natrium*. Of course, it was the Phoenicians who brought the Israelites the *neter* or *natron* from Africa. By the way, throughout the entire Middle Ages this *natron* (sodium carbonate) was also brought from Africa to Europe, but the Berbers distorted its name by turning the two syllables around and calling it *trona* instead of *natron*. Now that we are artificially producing the biggest possible quantities of soda , we no longer need the *natron* found in nature.

It is interesting that the people of Antiquity already knew that by pouring vinegar onto sodium carbonate, both the sour taste of the vinegar and the sodium carbonate’s very unpleasant taste of salt solution disappear and that the liquid that is created takes on a salty taste. They must also have known that pouring vinegar onto sodium carbonate caused it to fizz up, but of course that is not mentioned.

So much on *neter*. Now what does the word *borit* mean? This word can be found again in the Bible, in Malachi 3:2, where it says: “and like the washers’ *borit*” [Translator’s Note: the King James Version has: “like fuller’s soap”], which Luther here also translated as soap. In addition, the word רב, which means the same, can be found several times. Thus it is mentioned a number of times as a cleansing substance in the book of Job: 9:30: “if I cleanse my hands with *bor*”; Job 22:30: “your hand will be cleansed with *bor*”; finally Isaiah 1:25: “I

will purge away your dross as with *bor*." It is also used repeatedly in a figurative sense: רבכ ידי – "like the purity of my hands". The more recent translators of the Bible appropriately render it as "salt solution". In the past, this was the name given to the substance gained by washing out wood ash with water, filtering the liquid from what remains undissolved and evaporating it. When this is done, what remains is a solid mass, which gradually dissolves in the air and which is very similar to soda. We now call it potash, a name which comes from the Middle Ages and which resulted from the fact that through the mediation of the North German Hanseatic cities, in particular Lübeck, this substance was exported from Eastern Europe by way of Novgorod to the West in odd raw pots. Potash is exactly what the name says: the ash of a pot.

Like soda or sodium carbonate, it is very likely that at the time of Jeremiah the Jews already knew potash, the chemical name of which is potassium carbonate; its cleansing effect is even stronger than that of soda. But it is not at all likely that the Jews also knew how to make potash at that time. Aside from the fact that they then would hardly have given it a special name derived from ררב, "to cleanse", the Bible does not contain even the slightest hint indicating that the ash was put to any kind of use. Rather, ash, רפא, is always used in the Bible as a symbol of what is debased, worthless. Job complains that he is "considered as dust and ashes". That is why the person in mourning sits on ashes or scatters ashes on his head so as to humble himself, to lower himself. If people had known then that it was possible to obtain תירב, which at that time was considered to be very valuable, from the ashes remaining after having burned wood (and wood ash contains about 50% of potash), they would not have treated this material with scorn. תירב probably came out of Egypt, where they had learned very early how to produce various substances by chemical means.

So the text in Jeremiah would be: "And if you washed yourself with soda and added potash, your iniquity would remain as stains before me." These stains of shame, this dirt cannot be removed with soda or potash.

* *
*

A very important area of chemical activity which began to be practiced early on, was dyeing. It goes without saying that at the time we are talking about, there were not yet any artificial dyes, and instead of the many thousand dyes produced by chemists in every possible shade over the last half century, there were only very few in ancient times. In the Bible, three are mentioned alongside of one another: ינש־תעלת ,ומגרא ,תלכת. --- תלכת is definitely the reddish-brown color that was obtained in ancient times from a snail (crimson snail) and which we still call crimson today. ומגרא, which is usually translated as crimson, is probably the red color which we now call alizarine. The madder plant is indigenous to Central Asia and was already used for dye in very ancient times. The alizarine dye (from madder), which in the past was also called Turkey red, is characterized by its beauty and authenticity and is still used today to a very large extent. However, it is no longer obtained from the plant, but is produced artificially. ינש־תעלת comes from עלות, worm, and is the "worm red", but not, as more recent translators believe, cochineal or crimson, that is to say, the red dye from *coccus cacti*, the cochineal insect (mealybug). For that scale insect is indigenous to Mexico and Central America and was brought to Europe from there. Thus, the Israelities could not yet have known it. It is rather the so-called kermes, a yellowish-red color that comes from an insect that is indigenous to Asia. So the only three colors with which it was possible to dye were all red and only varied in their nuances. And we can be sure that the Israelites did not dye things themselves with these colors, but rather that they bought the already dyed materials or threads; for during the period from the 10th to the 6th centuries BCE, which is the time when most of the Old Testament was written, the Phoenicians were considered to be masters in the

difficult art of dyeing and the only ones who possessed it, and they sold their dyed threads and fabrics to the various peoples, for example also to the Greeks, who called materials dyed red φοῖνιξ, "Phoenicians". Moreover, there is no allusion to dyeing in the Bible.

So the Israelites only knew ware that was dyed red. Other dyes were not known, and they didn't even always have specific names for the infinitely many colors of flowers. They only had the expressions בוהצ for the golden yellow color of hair, ןנער for the leaf green of the trees, קורי for the yellow-green of herbage, and מודא for red. But they did not have a name for blue, for example, which they saw every day in the sky.

Finally, a makeup that was used at that time is also of interest to a chemist. In the Second Book of Kings we are told about Jezebel, the Israelite king Ahab's wife of bad repute. After Ahab's son and successor Yehoram was dethroned and killed in a military revolt through Yehu, Jezebel awaited the new ruler at the window and she was wearing makeup. There it says: "And she treated her eyes with דופ." Pukh is translated as στιβιον, and that is a strange makeup. For it is mentioned in various places as a grey-black mineral, which today we call antimony. This is easy to crush and its powder was used by the ancient Egyptian women, or rather by the young ladies of those ancient times, to emphasize more the white of the eye and to make their eyes look larger. That is why it says in a verse in Jeremiah 4:30: "for even if you enlarge your eyes with pukh." The antimony powder was drawn on the eyebrows and in a fine line unter the eyes as well.

Antimony powder is a compound of the metal antimony and sulphur. During the Middle Ages it was used very much as a medicine, and because it contains a lot of arsenic, it caused much damage. Now it is used mainly to obtain the metal from which, melted together with lead, the printing types are made; and melted together with tin it is called britannia metal and is used to make many different kinds of containers. So today antimony is used for nobler and more useful purposes than in more ancient times.

The same word דופ also means a greatly valued precious stone, and in this sense it is used in Isaiah 54:11, where it says: "I will lay your stones with pukh and lay your foundations with sapphires." When the objects contained in David's treasury are listed, דופ ינבא, "pukh stones" are mentioned in 1 Chronicles 29:2. Here the word certainly means something other than antimony. For precious stones have to be hard and shiny, and in the verse in Isaiah mentioned above, the stones are to be covered with pukh to make them harder and more lasting. However, antimony is easy to crush, as was already mentioned. Perhaps דופ is to be understood here as dark smoky topaz. By the way, in the Bible there are quite a few names for precious stones and they are mentioned quite often; with most of them, it is not known what they are called now.

A very important chapter, and one that greatly interests a chemist, is the production of food and luxury articles. However, precisely this area I only want to touch on very briefly, because it is too closely connected to the religious precepts of the Bible, and it goes without saying that I do not in the least want to criticize these in any way. I only want to touch on a small branch of this extensive subject, and that is the area of fermentation, which in many kinds of food is begun deliberately, or which commences spontaneously.

The Israelites as well knew how to produce intoxicating drinks, just as almost all peoples learned already at a very early stage of their development how to produce liquids containing alcohol. For alcohol develops as an effect of a strange microscopic fungus (the yeast fungus) working on sugar. Now sugar is not only contained in grapes; it is also in many other plant

juices, for example in palm juice, and also in the juice of blossoms used by bees to make honey, etc. There is an immense number of various bacteria and fungi germs floating in the air, and if they fall on appropriate soil that is able to nourish them, for example in a liquid, they develop and cause the symptoms that are generally known and that we can observe every day. Thus, milk turns sour and clots because the germs of the lactic acid bacteria get into the milk and change the milk's sugar, which we call lactose, into a substance with a strong sour taste. When lactic acid develops, the milk not only turns sour, but it excretes a substance that is dissolved in milk, casein, and the milk thickens and clots. Or if we leave damp bread lying in the air, germs of the mold fungus fall on it and develop rapidly, and in a short time the bread is covered with a meadow of white or green mold. In the same way, among others, many germs of the yeast fungus get caught in the fine down covering grapes; when the grapes are pressed, they get into the grape juice, and after a short period of fermentation, they cause the glucose to turn into alcohol.

Among the many germs of various bacteria floating around in the air, the most frequent seem to be the bacteria causing decay, the lactic acid bacterium, and those of the yeast and the mold fungi. Which kind of bacteria develop first depends on the nature of the liquid. First of all, it will always be the kind that flourishes best in this specific liquid. Thus in milk, for example, the germs of the lactic acid bacteria develop first. But as soon as a small amount of lactic acid has been produced, the good conditions disappear for these bacteria's further development, because they don't flourish in sour liquids, and then the germs of the bacteria causing decay begin to develop.

The germs of the yeast fungus develop most easily in grape juice. But as soon as the glucose has more or less disappeared, so when there is no more of the substance that allows the yeast fungus to exist comfortably, if the other conditions are good, as for example if the new wine remains open to the air for a longer period, then other bacteria germs begin to develop, which change the alcohol and transform it to acetic acid. These are the germs of the acetic acid bacteria.

Sourdough is also nothing other than the breeding ground for a good number of various bacteria, in particular of the lactic acid bacteria and the bacteria causing decay. On the other hand, the chemical process that occurs when grain germinates is different and is not a fermentation process. The main component in the seed of grain is starch; in addition, it contains some other substances as well, in particular some that change easily and to which we give the collective name protein. When the shoot contained in the seed of grain begins to develop into a small plant, the seed's protein produces a strange substance that is able to gradually change the starch to sugar, which dissolves in water and which can easily be absorbed as nourishment by the young plant. This germination is brought about deliberately to produce malt from barley. For it was discovered that the yeast fungus can easily cause only a sugar solution to ferment and to be changed into alcohol. Therefore, malt is produced in order to obtain the substance that changes the starch into sugar. And malt is not only used to make beer but also spirits, by mixing malt with other substances containing starch, such as potatoes, and then transforming the entire mass of starch into sugar, because with the malt far more starch than that contained in the barley seed can be changed into sugar.

Now it is certain that the Israelites knew how to produce two alcoholic beverages, or at least that they were acquainted with them, wine and רכש, which must have had a much stronger intoxicating effect, so must have contained more alcohol than wine, since the words for "drunk, drunkenness" etc. are derived from it. We can hardly come to a decision as to whether this alcoholic beverage was mead, so wine made from honey, or possibly palm wine, as the word usually appears alongside of ויי, wine, and there is never a hint as to what the drink was made of.

They surely did not know how to make beer, nor following from that, malt. On the other hand, they of course were acquainted with vinegar, which would have been only wine vinegar.

So we can see that the Israelites at the time of the Bible were acquainted with a number of substances that were produced chemically, or at least that could be produced, and that are used very much in the present. But we almost always had to admit that they themselves did not produce these, but rather, that they received the substances ready to use from the Phoenician tradesmen. For a while, the tradespeople of Antiquity, the Semitic Phoenicians, along with the Egyptians of Ham, were the bearers of culture, that is to say, the bearers of that culture, which develops on the basis of trade and industry. During the period we are talking about, the Jews, who later showed that they certainly were not lacking in trading and industrial abilities, had a higher task, a task by which they gained the right to continue to exist for more than three thousand years up to the present day and still for unforeseeable times to come. That is the task of building and developing the pure concept of God as opposed to the raw fetishism and the immoral natural religion of the peoples surrounding them. In this sense, they were truly the people of God, and they have remained so.