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Research Articles

Translations of Roscoe's Chemistry Books into Japanese and Hebrew - Historical, Cultural and Linguistic Aspects

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Abstract. This research studies two translations of Henry Enfield Roscoe's chemistry book of 1872 into Japanese (1873) and Hebrew (1929). Roscoe's original chapter on candle burning is presented, in which he manifested his attitude to chemical experiments. The Japanese and Hebrew historical backgrounds of the translations, as well as their cultural and linguistic aspects are discussed. Roscoe's relations with Japanese scholars are presented. The study moves between events in three countries, England, Japan and Israel. The importance and complexity of translation of science and its later results are discussed.

Keywords: translation of chemistry, Henry E. Roscoe, Japanese language, Hebrew language, candle burning.

TRANSLATION OF SCIENCE

Transferring knowledge from one culture and language into another target language that does not yet have a suitable vocabulary for the subject studied is an intensive human endeavor; creating new, appropriate vocabulary in order to look at the behavior of nature is the topic of this research. Inventing language in a new scientific discipline depends on contemporary knowledge in that field. Within the process of translation, the subject matter changes some of its features to suit the culture, the beliefs and understanding of the target people and their language. As Bensaude-Vincent stated in her article "The Language of Chemistry": *Language plays a key role in shaping the identity of a scientific discipline* (Bensaude-Vincent 2003).[1] The new thought and new terminology serve to augment the discussion and practices of the scholars and people using the target language. Later, the new terms go on to infiltrate and fertilize the daily language of the people. According to Montgomery,

> In rendering technical knowledge mobile between peoples and through the centuries, translation has been a crucial force behind both the creation and the continual refertilization of science (Montgomery 2000).[2]

Following are translations into Japanese and Hebrew of Roscoe's *Science Primers Chemistry* for school. Roscoe's explanation about the candle burning experiment highlights the historical and cultural background of the translations, the chemical terminology of the languages and what translation of science may lead to.

ROSCOE'S LIFE AND HIS EARLY CHEMISTRY BOOKS

Henry Enfield Roscoe (1833-1915) was an English chemist who spent a few years in the laboratory of Robert Bunsen in Heidelberg before returning to England in 1857. The same year he moved to Manchester, organized and revived the chemistry department of Owens College, which was incorporated into Victoria University in 1880. His main fields of research were Vanadium and photochemistry. After retirement from Victoria University in 1887 he moved to London and became a Member of Parliament, devoting time to several scientific committees. He was elected president of the Chemical Society in 1881 and was a founder-member and first president of the Society of Chemical Industry in 1881 (Roscoe 1906).

The early chemistry books by Roscoe were *Lessons in Elementary Chemistry* (Roscoe 1866) and *Lessons in Elementary Chemistry: Inorganic and organic* (Roscoe 1868). Roscoe's book *Chemistry* in the *Science Primers Series* was published in London by MacMillan addresses the following topics: Fire; Air; Water; Earth; Non-Metallic Elements; Metals; Results (Roscoe 1872). *Science Primers Chemistry* (1872) was a part of a series that included physics, geology, logic, botany etc.[3] It was also published in the United States of America by D. Appleton and Company, New York 1872. Editions of the book are still being republished. Those books have been translated into more than nine languages. The book *Lessons in Elementary Chemistry* was translated into Russian, Italian, Hungarian, Polish, Swedish, Modern Greek, Japanese and Urdu.[4] Translations of *Science Primers Chemistry* appeared in German, Icelandic,[5] Polish, Italian, Japanese, Bengali, Turkish, Malayan, Tamil[3] and Chinese.[6] As Osawa stated, *it is a proof to the excellence of the small book* (Osawa 1978).[7]

A short, original English text of Roscoe (Roscoe 1872) and its Japanese (*kogaku* 1873) and Hebrew (Oirbach 1929) translations are presented and studied in the following chapters. A copy of Roscoe's book in Japanese was given to the current author by Kida Akiyoshi in Kyoto in 2014; this led to the following research.

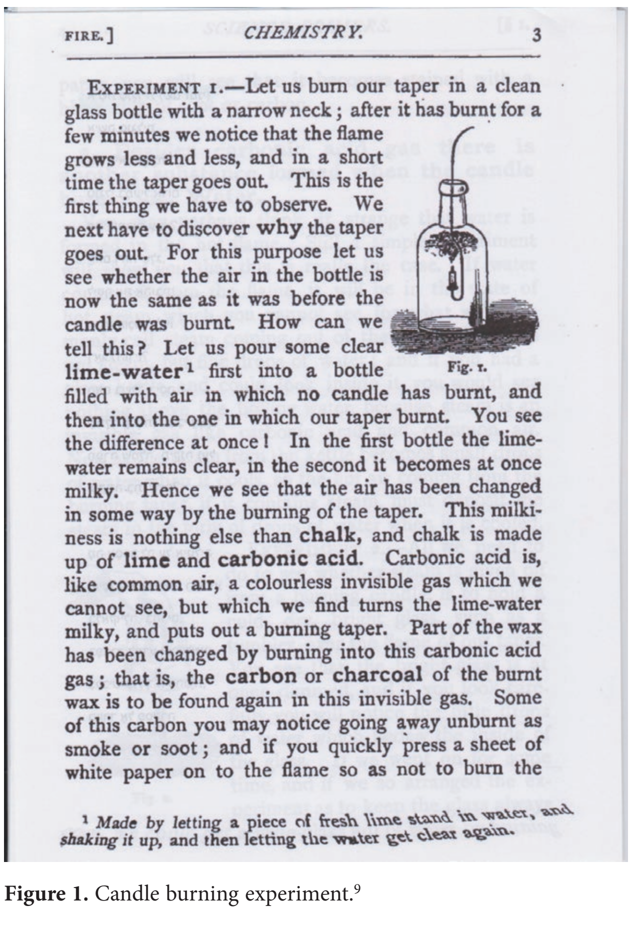
The experiment of the burning candle is the first experiment presented and explained by Roscoe and his translators. In addition to the observation of the chemical phenomena, Roscoe explained what a chemical experiment is and its importance.

ROSCOE: SCIENCE PRIMERS CHEMISTRY

The first chapter discusses the chemistry of air, water, earth and starts with fire.

Original texts from Roscoe's book:

> 2. What happens when a candle or a taper burns?
> The wax as well as the wick of the taper gradually disappears as the taper burns, and at last all is gone – wick, wax, and all. What has become of the wax? It has disappeared. Is it lost? So far as our eyes are concerned certainly it is lost, but so is the ship which sails away on the sea, and yet we know that the ship still exists though we do not see it; and so the lump of sugar appears to be lost when we put it into a cup of hot tea, and yet we know that the sugar is not really lost, because the tea is made sweet. Now we must look for the wax of our taper in another way; we must put a question to Nature for her to answer, and we shall always find that our question, if properly asked, is always clearly and certainly answered. We must



FIRE.] CHEMISTRY. 3

EXPERIMENT I.—Let us burn our taper in a clean glass bottle with a narrow neck; after it has burnt for a few minutes we notice that the flame grows less and less, and in a short time the taper goes out. This is the first thing we have to observe. We next have to discover **why** the taper goes out. For this purpose let us see whether the air in the bottle is now the same as it was before the candle was burnt. How can we tell this? Let us pour some clear **lime-water**[1] first into a bottle filled with air in which no candle has burnt, and then into the one in which our taper burnt. You see the difference at once! In the first bottle the lime-water remains clear, in the second it becomes at once milky. Hence we see that the air has been changed in some way by the burning of the taper. This milkiness is nothing else than **chalk**, and chalk is made up of **lime** and **carbonic acid**. Carbonic acid is, like common air, a colourless invisible gas which we cannot see, but which we find turns the lime-water milky, and puts out a burning taper. Part of the wax has been changed by burning into this carbonic acid gas; that is, the **carbon** or **charcoal** of the burnt wax is to be found again in this invisible gas. Some of this carbon you may notice going away unburnt as smoke or soot; and if you quickly press a sheet of white paper on to the flame so as not to burn the

Fig. 1.

[1] *Made by letting a piece of fresh lime stand in water, and shaking it up, and then letting the water get clear again.*

Figure 1. Candle burning experiment.[9]

> make an Experiment, and if this is properly made we shall never fail in the end to get the information we want.[8]
> […] and if you quickly press a sheet of white paper on to the flame so as not to burn the paper, you will see that it becomes stained with a black ring of soot or carbon.
>
> 3. Besides carbonic acid gas there is another substance formed when the candle burns, viz. Water.[10]

In the experiment described above the taper in the bottle was burnt, the fire was stopped, and (some of) the material disappeared from sight. The question Roscoe asked is what happened to the material of the candle, did it disappear completely? He addressed the question to Nature and the answer he gave after performing more experiments is that the carbon of the wax was turned into colorless carbonic acid and water. In a further experiment adding lime to the bottle in which the candle burnt it changed color to turbid white by forming calcium carbonate. The calcium of the lime (calcium hydroxide) reacted with the carbonic acid gas to produce calcium carbonate.

Roscoe didactically stresses the aim of the experiment and its result:

> We want to know what happens when a candle burns. We have learnt –
> 1. That a candle soon goes out if it be burnt in a bottle of air.
> 2. That a colorless invisible gas called **carbonic acid** is formed in the bottle after the candle has burnt.
> 3. That the carbonic acid gas comes from the carbon or soot contained in the wax.
> 4. That the **water** is also formed when the candle burns.[11]

The experiment gave answers to the question, thus Roscoe emphasized that chemistry is an **Experimental Science** [bold letters are in the original book]. However, Roscoe's statement that we shall always get the right answer if we ask the proper question is open to debate. The English text can be seen on-line in the Web.[12]

THE JAPANESE TRANSLATION OF ROSCOE'S TEXT

The Japanese translation of Roscoe's *Chemistry* book was published by the Ministry of Education 文部省 *mombusho* in 1873, translated by Ichikawa Seizaburou 市川盛三郎, titled *kogaku kagakusho hyoumoku* 小學化學書標目 *Chemistry Book for Elementary School*. The author of this article possesses a hand bound volume 1 of 1873. Its title page is presented in Fig. 2. There are many holes made by worms during one hundred and forty eight years since it was wood block printed, but still, in spite of the holes and the brownish background of the pages, it is clearly readable. The full translation was published in 1874 (Osawa 1978, Yamaguchi 2017). Japanese book can be seen on-line in the Web.[13]

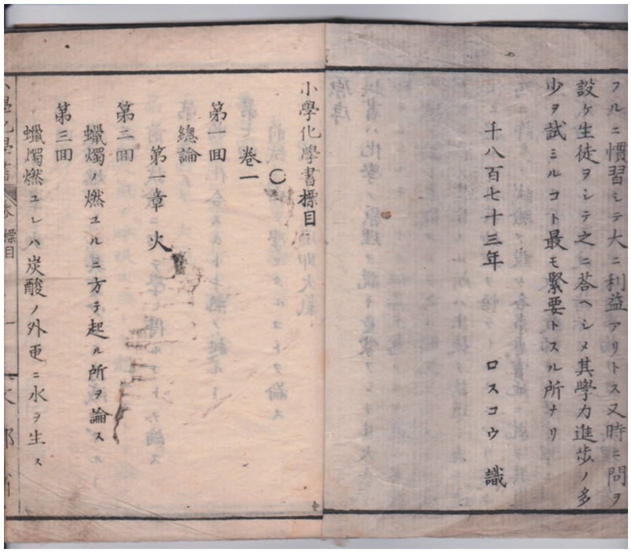

フルニ慣習ヒテ大ニ利益アリトス又時ニ問ヲ設ケ生徒ヲシテ之ニ答ヘシメ其學力進歩ノ多少ヲ試ミルコト最モ緊要トスル所ナリ
十八百七十三年　ロスコウ　識
小學化學書標目
巻一
第一回 總論
第一章 火
第二回 蠟燭ノ燃ユルニ方テ起ル所ヲ論ス
第三回 蠟燭燃ユレハ炭酸ノ外更ニ水ヲ生ス

Figure 2. Front page of Roscoe's book 十八百七十三年 ロスコウ 小學化學書標目 1873 Roscoe kogaku kagakusho hyoumoku *Chemistry Book for Elementary School*.

The experiment of candle burning in its Japanese translation is presented in Fig. 3. The figure of candle burning is the first of 36 figures, shown and discussed by Roscoe in his book. The Japanese translation of the English text is written in kanji, Chinese characters that convey meaning, and also in katakana, the phonetic square Japanese script.

This style is different from current use of kanji and hiragana, the phonetic cursive syllabaries. (B. Frellesvig).[14] The old writing style and some old characters will be discussed below. The pronunciation of the text in Romaji, adapted to today's writing and reading is presented in note.[15]

The Japanese text follows the English description in the paragraph on candle burning and running an experiment. According to Sato Shin it cannot be considered a good text by today's standards.[16] This is understood as we know that understanding chemistry and the language of chemistry have developed since 1873, examples follow.

THE HEBREW TRANSLATION BY PESACH OIRBACH, *HIMIA*, CHEMISTRY

Figure 4 presents Oirbach's Hebrew translation of Roscoe's arguments on the disappearance of things and

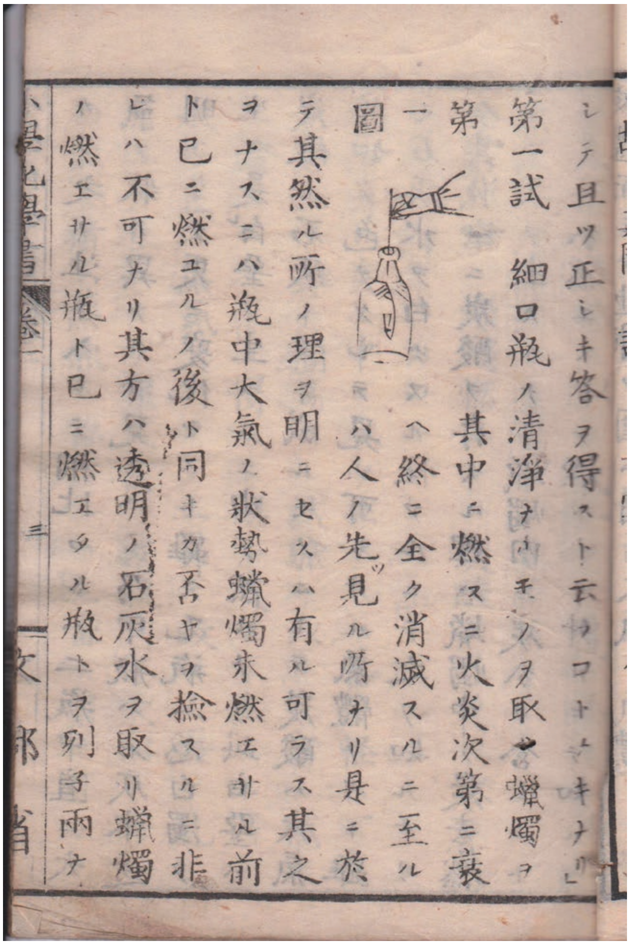


Figure 3. Candle burning experiment in Japanese, 1873.

Figure 4. Candle burning experiment in Hebrew, 1929.

the explanation about setting an experiment. The full Hebrew text of Experiment 1 on candle burning is presented in note 17.[17]

The Hebrew content follows faithfully the English original. It is written with somewhat elevated language, adding explanatory details that are discussed below.

In the following section, history, culture and linguistic aspects of the texts and the significance of its translations are presented and discussed.

HISTORICAL, CULTURAL, AND LINGUISTIC ASPECTS OF THE TRANSLATIONS

Historical background

In 1873 Japan and in 1929 Palestine-Israel, processes of the nation's revival evolved. The Japanese people shortly after Meiji Restoration of 1868, which moved the Tokugawa feudal rule and put the Emperor back to its seat, strived to reform and to unite the country. The Jews since late nineteenth century, started returning and renewing life in their ancient, Biblical motherland. These processes of nation building formed the need for updated scientific knowledge including chemistry. Hence, the motives to translate Roscoe's chemistry teaching book in both countries.

The Japanese translation of Roscoe's book

By 1873 the Ministry of Education of the new regime in Japan published the Japanese translation of Roscoe's *Science Primers Chemistry* book under the title *Chemistry Book for Elementary School*. How come the Ministry of Education decided to translate Roscoe's book, rather than a book by any other author? Three potential reasons are presented in notes.[18, 19, 20] However the Iwakura Mission is the only one of those three that might have had Roscoe's *Science Primers Chemistry* book.

Thus, Griffis holding Roscoe's book Elements in Chemistry, Inorganic and Organic, Kume Kunitake Diary emphasis on chemistry education during the travel of the Iwakura Mission, specifically during the visit in Manchester, at Roscoe's laboratory in Owens College, and Ichikawa's-Ritter's copy, might have influenced the Ministry of Education to order the translation of Roscoe's latest book.

Cultural aspects of the translations

Looking at the differences between the original English text and its Japanese and Hebrew translations, how faithful are they to the original text, are there any changes and what might be the reasons for these changes?

In order to explain the disappearance of the candle wax during burning, Roscoe presented two cases for the disappearance of items out of our sight and yet we are aware of their existence. Those cases serve to emphasize the fact that although the burning candle in the bottle has disappeared, its material is present in other forms. In the first case, a ship is going away and we do not see her any longer; nevertheless, we are sure of its existence. The Japanese translation tells about a ship, *fune*, 舟, that cannot be seen, without any additional information. The Hebrew translation broadens the description, telling about a ship with masts and sails, sailing beyond the horizon. This description is more figurative, adding more features to the original text.

The second case tells about material that disappears and actually changes its state. Roscoe told of a lump of sugar that enters into a cup of hot tea. The sugar disappeared, yet we are aware of its effect since the hot tea became sweet. This example tells about an English custom in which a lump of sugar is introduced into the tea. The Japanese translation of hot tea changed it into water, *mizu*, 水, not even hot water that has a different character *yu* 湯. The water becomes sweet therefore we are aware of the sugar dissolving effect. Since the Japanese do not sweeten their tea, in order to make the description closer to the Japanese experience, the English tea description is replaced by water. The Hebrew translator went even further: instead of hot tea the description is of a piece of sugar put into coffee. The reason for this change is not clear. Was coffee more popular than tea in Israel in 1929? There is no evidence for that. It can be said in general that the Hebrew translation uses a more elevated linguistic style than the English does, New Hebrew terms are used, and in an elaborate style. Oirbach wrote improved examples and a somewhat more detailed story. The vocabulary is widened, the style is new and the existing culture affects the terminology chosen for the translation.

There is a large time gap between the Japanese translation of 1873 and the Hebrew translation of 1929: understanding chemistry had progressed in the world between those almost sixty years. Moreover, the main difference is related to the translators. The Japanese translator had very little to rely on. Earlier chemistry translation in Japan were the seven volumes of *Seimi Kaiso*, Introduction to Chemistry, by Udagawa Youan published during 1836-1847 (Udagawa 1836-1847, Tanaka 1975, Siderer 2017). Udagawa Youan studied more than twenty books in Dutch on chemistry before he composed *Seimi Kaiso* (Dōke 1973, Azuma 2015, Siderer 2021). Perhaps Udagawa Youan's *Seimi Kaisou* books on chemistry might have been good sources for chemistry vocabulary if the translator Ichikawa Seizaburou had access to them. In distinction, the Hebrew translator Pesach Oirbach was born in Kishinev, Moldova, in 1877 and died in Tel-Aviv, 1945. He was a teacher, school principle, an author, researcher of nature and wrote books for teaching natural sciences. He immigrated to Palestine-Israel in 1908 (Wikipedia, 21.4.2021 Oirbach's biograph).[21]

Oirbach had the advice from Engineer M. Vinik (1886-1966) and other experts on the officially chosen and invented terms by a large group of scholars. Moreover, members of the Hebrew Language Committee in Mandatory Palestine-Israel had earlier studied chemistry in the countries they immigrated from, and they had already learnt chemistry in Russia and Germany (Simchoni 1949, Leibovitch 1951, Shapiro 1959). So when they came to coin Hebrew chemistry terms their scientific basis was much better than that of the Japanese translator Ichikawa. It enabled the Hebrew translator Oirbach to choose terms and to present a more elaborate translation. Nevertheless, we see in the next section that not all the terms Oirbach used has survived, and they were replaced by other, more appropriate terms. An example can be seen in Yizhak Klugai, a professor of the Technion, Israel Institute of Technology, who translated *General Chemistry* by Linus Pauling in 1965.

JAPANESE CHEMISTRY LANGUAGE AND TERMINOLOGY

The first English-Japanese chemistry dictionary was published in 1891 by Tokyo Chemical Society that later became the Chemical Society of Japan. It has English alphabetic order of the terms and the Japanese term opposite it. Some of the terms in the text above were modified during several changes of rules for writing kanji. During the years there were several committees that considered, omitted, added and modified kanji writings and kanji usage (Gottlieb 1995). The text under study itself has very few periods to mark the end of a sentence. Also, several of the syllables in the text like *ha, sa, su, ki, ku* are nowadays pronounced *ba, za, zu, gi, gu* respectively and are written with inverted commas (") at the right top of the character, not present in the old text, (e.g. は>ば、き>ぎ、く>ぐ) . Following are examples of few of the words written in kanji in the text and their modernized character (Denshi Jisho, 2017):

- 燈 (*tou*), lamp, an old kanji is replaced today by 灯 (*tou*) meaning lamp, and also in a combination: instead of 燈心 (*toushin*) it is now written 灯心 (*toushin*), meaning (lamp)/wick.
- 蠟燭 (*rousoku)* in the text, now an obsolete term, was changed into its variant 蝋燭 (*rousoku),* meaning wax, candle. The old term 蠟 (*rou*) having 25 brush strokes was modified to 蝋 (*rou*), having 14 strokes only.
- 氣體 (*kitai)* meaning vapor, gas, nature, atmosphere, was modified to 気体 (*kitai).* 気 (*ki*) stands for spirit, mind, air, atmosphere, mood. 体 (*tai*) means body, substance, object, reality. In this case both characters were modified: 氣 > 気, 體 > 体.
- 大氣 (*taiki*); 大 (*tai*) large, simplified letter 気 (*ki*) air, atmosphere. 大気 (*taiki*) atmosphere. In the text, talking about the atmosphere in the bottle.
- 石灰水 (*sekkaisui*), limewater, the term is formed by combination of three characters: 石 (*seki*) stone, 灰 (*hai*) ashes, 水 (*sui*, *mizu*) water.
- 造化 (*zouka*) creation/nature/the universe. 造 (*zou*) create, 化 (*ka*) change, take the form of, -ization. It is a word that is used in Shinto faith: 造化 の三神.[9]

Other chemistry related terms:[22]

- 燭 *(akari*) light, candlepower. Also written 灯 (*hi*)
- 炎上 (*enjou*) blazing/destruction
- 壓 (*ats*u) pressure. Its variant 圧 has 5 strokes instead of 17 in the old term.
- 環 *(wa, kan)* ring/circle
- 玻璃 (*hari*) glass / quartz (Buddhist term)
- 盃 (*sakazuki*) glass, cup
- 実地試験 (*jichchi shiken*) practical experiment, 実地 (*jichchi*) practice.

The language of chemistry is a specific topic in language planning. Chemistry and other sciences as well have to adapt to international rules for naming. The Japanese text of the chemistry book of the nineteenth century is written in a combination of kanji characters and katakana phonetic syllabaries. Current chemistry is written using Kanji, hiragana replace katakana; katakana is used for foreign names. The chemical elements and compounds have their Japanese names but chemical formulas and equations are written according the Western conventions. The Japanese names of the elements have either a Japanese word, e.g. iron, 鉄 (*tetsu*), or are written by katakana following foreign words, e.g. manganese, マンガン *mangan*, or use a combination of kanji character and katakana, e.g. iodine, ヨウ素 (*youso).*

HISTORY OF WRITING CHEMISTRY BOOK IN HEBREW

After the Hebrew people were exiled from their biblical Land of Israel the Hebrew language was not a daily spoken language. However, for many hundreds of years it was kept for reading the Bible, in prayers, and in writing and reciting religious services. Since the eighteenth century, when Jewish people started returning to and living in the Land of Israel then under Ottoman (Turkish) rule, that was followed by the League of Nations British Mandate for Palestine (1920-1947), there arose a gradual need to define, revive, restore and renew the spoken and written Hebrew language. In 1890 the *Committee of the Language* was established in order to plan the language. In 1953, after the 1948 Independence of the State of Israel, the *Committee* became the Academy for the Hebrew Language (Iair G. Or 2016).

The editorial preface by the publisher of the Hebrew translation of Roscoe's book presented his motivation in the beginning of the book:

> Textbooks for the studying youngsters and for everyone who seeks knowledge, this is a need that is felt every day in the life of the Hebrew school in the Land of Israel and outside of it....Chemistry book is the first in this series of books.…"*Daat*" [knowledge] books are meant not only for the younger ones needs, but also for the people, mainly those young ones who devote their days to labor and the evenings for studying (Torah). (Oirbach 1929, pp. 3-4).[23]

A study by Noach Shapiro (1900-1964) surveyed the historical development of the Hebrew terminology for chemistry. It shows the long various periods in which scholars of the Hebrew language paid attention to Nature and gave names to physical materials. Shapiro pointed at biblical names of six metals that remained unchanged in modern time, those are gold, silver, copper, iron, tin and lead; he added names of different forms of gold and silver. Shapiro emphasized that chemistry teachers among

Jewish immigrants to the Land of Israel in the 1920s felt the absence and need for Hebrew vocabulary and teaching books (Shapiro 1959, Shapiro1 1964). Leibovitch explained the discussion, dispute and agreement between the members of *Vaad HaLashon* committee and the committee for chemistry terms of the chemistry teachers organization concerning the construction of the names of chemical compounds (Leibowitch Y. 1951).[24] Interestingly, those metals of the ancient world have their names in Chines-Japanese kanji, since they were also known in ancient Asia. Those are: gold 金, silver 銀, copper 銅, iron 鉄, tin すず (金属 metal, old time's name) and lead 鉛 Sugahara 1990). Hebrew terms were also changed, as is shown in Table 1. Names of the elements in Hebrew carry biblical names in Hebrew, e.g. iron, ברזל *barzel*, or foreign name in Hebrew, like neon, ניאוןneon, or modified foreign names to adapt to the Hebrew sound, e.g., manganese, מנגן *mangan*.

THE STYLE OF THE LANGUAGE OF OIRBACH'S *HIMIA*

Looking at titles of the scanned page on Fig. 4: title 1. **הָאֵשׁ** The fire (*HaEsh*) and the following subtitle **ב.** מַה מִתְחַזֶּה כְּשֶׁדּוֹלֵק נֵר שֶׁל חֵלֶב**?** What is presented when a candle of tallow is burning? (*Ma mitchaze keshedolek ner shel chelev?*) Those two lines and the last sentence in that paragraph are written with what is called *nikud*, punctuation, small marks that serve as vowels to facilitate and clarify the reading. Most of the rest of the text is written without those. Currently the *nikud* is used mainly for writing children books, poetry, and to help reading words that might have more than one meaning when it is differently pronounced and punctuated. In the text, the words **בַּקָּפֶה** in the coffee (*bakafe*) and **הַקָּפֶה** the coffee (*hakafe*) are also punctuated, to make their reading clear.[25] (Incidentally, an interesting panel discussion for the Japanese term for "coffee" is described in: Okayama Dutch Learning Group, 2016).[26]

Hebrew terms in Oirbach's translation were those accepted by the committee for chemistry terms near *Vaad HaLashon*, Language Committee. The list has some eighty one terms. Fifty two of the terms are in use today, by chemists and by the general public. Twenty nine terms are not in use today, replaced by other words. A few examples of terms not in use today and their recent alternatives are listed in Table 1 and discussed below.

This author does not remember using the word retort or *abik* while working in the chemical laboratory, even though one finds them in the Hebrew dictionary, meaning a tool for distillation; the foreign name *kolba* was used. The Concise Hebrew Dictionary by A. Ben Shoshan *HaMilon Ha'ivri HaMerukaz*, (HaMilon Ha'ivri HaMerukaz, 1972) divides the literary sources of the vocabulary presented into five categories: the Bible, Talmud and ancient scrolls from Judea Desert, medi-

Table 1. Oirbach's *Himia* terms translated from English and German[27] and recent Hebrew terms.

English	German	Hebrew term in *Himia*	Hebrew reading	Hebrew term today	Hebrew reading
Retort	*Retorte*	אביק	*abik*	אביק	
Lunar Caustic	*Höllenstein*	אבן-התופת	*Even-HaTofet*	כסף חנקתי	Kesef chankati $AgNO_3$
Alkali	*Lauge*	בורית	*Borit*	1.אלקלי 2. בסיס	1. alkali 2. basis
Galena(Lead Sulphide)	*Bleiglanz*	ברק עופרת	*Brak Oferet*	עופרת גופריתית	Oferet gofritit PbS
Marsh-gas	*Sumpfgas*	גז ביצה	*Gaz bitza*	מתאן	Methan CH_4
Fire damp	*Grubengas*	גז מחפורת	*Gaz machporet*	גז מיכרות: מתאן, פחמן דן-חמצני, פחמן חמצני, חמצן, חנקן	Gaz michrot: Mines gas: CH_4, CO_2, CO, O_2, N_2
Prussian Blue	*Berlinerblau*	כהל ברליני	*kohel Berlini*	כחול פרוסי	Kachol prussi $Fe^{III}_4[Fe^{II}(CN)_6]_3$.
Magnesium	*Magnesium*	מגנון	*Magnon*	מגנזיום	Magnezium
Ferrycyanide	*gellbes Blutaugensalz*	מלחת	*Malachat*	פריציאניד	Ferricianid
Gold leaf	*Blattgold*	רדי זהב[01], עלי זהב	*Radey zahav, Aley zahav*	עלה זהב	Aley zahav

eval literature, new literature since the Haskalah (Age of Enlightenment) including press and spoken language and terms from foreign languages.[28] The word "Borit" comes from the Talmudic literature, a name of a wild plant that contains Saponin, which dissolves in water to produce emulsion with oil, like soap. Borit is also a synonym for soap, *sabon*. Hebrew uses the foreign word gas, pronouncing "gaz", but gives the chemical names of methane and other gases for "Gaz Bitza" and "Gaz machporet". Prussian blue is translated today to "Kachol prussi", meaning Prussian blue. Magnesium and Ferry-cyanide are pronounced similar to their foreign names, not using Oirbach's term. "Aleh Zahav" meaning golden leave remained in use today.

ROSCOE'S INFLUENCE ON CHEMISTRY STUDIES IN JAPAN

How much was Roscoe involved in the education of Japanese chemists? After Meiji Restoration, 1868, the Japanese authorities invited foreign teachers to teach chemistry. The ministers felt the need to start modern technology and modern industry for the benefit of the people and the country's prosperity. Moreover, they sent students to study abroad, supported by the Ministry of Education. A few students were sent to Owens College, Manchester. Other students were sent to University College, London.

The connection of Japanese scholars with Roscoe did not end with the 1873-1874 translation of *Science Primers Chemistry*. In his autobiography Roscoe mentioned his Japanese chemistry student Sugiura Shigetake 1877-1879, and Y. Kiraga 1878-1879 and wrote with appreciation his recollections of his Japanese students.[29]

The Japanese who studied abroad were influenced by what they saw, by the cultures they were exposed to and what they learned in foreign countries. After their return to Japan some of them were appointed as school teachers, others had government and prefectural administration positions and a few others became professors in the new universities. They introduced what they have absorbed into the scientific thought, teaching and administration of their own country.

Roscoe had an influence on Japanese researchers and chemistry education since 1872 and later. The translated chemistry books were edited and republished in later editions. Osawa lists eleven books related to Roscoe between the years 1874-1889. There were several translators and reviewers, and different books titles. Kaji mentioned Ira Ramsen's popular book *The Elements of Chemistry: A Textbook for Beginners*. Originally published in 1887, it included a classification of elements based on valency but made no mention of the periodic law. Kaji listed its Japanese translations.[30, 31, 32]

FURTHER PROMOTION FROM THE WEST TO JAPANESE CHEMICAL EDUCATION

Western chemistry education in Japan was achieved from two directions. The Japanese students who studied abroad and returned to Japan after spending some months or years in European countries or in America. After returning to Japan they could get positions in industry, in governmental and prefectural administration, or as teachers in schools and in the developing universities. Gradually they developed the Japanese chemical and technological terminology. There is a list of more than one hundred and fifty Japanese who studied chemistry abroad during Meiji era 幕末明治海外渡航者総覧 *Bakumatsu Meiji kaigai tokō-sha sōran* (published 1992). The list includes their birth year, the countries they went to, the year(s) of their return to Japan, the positons they held after returning.[33]

Another source of studying chemistry came from the foreign chemistry teachers in Japan and the translation of their courses by their Japanese students. Discussed above are Griffis and Gratama. Other teachers like William Robert Atkinson, a British chemist who taught at *Tokyo Kaisei School* during the Meiji Period,[34] and the American teacher D. Penhallow teaching in Hokkaido, included in their curriculum to their Japanese students local Japanese materials and what is available in the Japanese environment for teaching natural sciences, including chemistry and botany. Penhallow later wrote about his experience in Japan.[35]

David Wright in his thorough study on *Translating Science, the Transmission of Western Science into Late Imperial China 1840-1900*, looks at various aspects of translation (Wright 2020). Wright explains the subtitle Transmission. His study concentrates on China, but the more general view he developed can apply to Japan, even though the methods and approach for translation science were different between China and Japan. In China, in the official translation offices, the translation was carried out by collaboration between Chinese translators and a Western scholar, whereas the Japanese translated mainly by themselves. Wright looks at translation model of transmission that "includes the political, social, economic and historical matrices within which the translation is conducted, affecting not only the nature of the process but also its velocity and acceleration."[36] We have looked in this study into aspects of culture, linguistic, history and politics. After Meiji Restoration, there was a change from the reluctance of the Edo era feudal rule to the spread of Western knowledge among the common people, and there evolved the recognition of the new regime in the need for modern knowledge in order to modernize Japan. That recognition caused the support for translation and publishing a basic chemistry teaching book by the Ministry of Education in 1873, as a part of the general new rules for basic education.

HIGHLIGHTS OF WORLD RECOGNITION IN CHEMISTRY IN JAPAN AND ISRAEL

For early twentieth century international collaboration on nomenclature see *Japan's Engagement with International Chemistry (1900-1930)* (Kikuchi 2017). A Japanese-English Chemistry Dictionary presents the current rules for Japanese chemistry nomenclature (Gewehr 2007). The Japanese Society for the History of Chemistry (*Kagakushi Gakkai*) published a comprehensive Encyclopedic Dictionary on the History of Chemistry that is now available to the Japanese readers (Encyclopedic Dictionary 2017).

Both Japan and Israel developed prosperous chemical industries. There have been Nobel Laureates from both countries in recent years, their history deserves another study.

In 2016, the superheavy synthetic element 113, discovered by Kyushu University professor Kosuke Morita, head of a team of scientists, was officially given the name nihonium, after the Japanese name of their country Nihon or Nippon. Nihonium is the first element to be discovered in an Asian country. It might be said that the translation of chemistry from the West into Japanese in the nineteenth century, and all the educational, theoretical, experimental, technological and industrial chemistry that followed, culminated into these Japanese achievements.

SUMMING UP

The practice of chemistry and chemistry teaching were involved in carrying knowledge across continents from the eighteenth to the twentieth century. The chapters above presented the transformation of the original English book in chemistry (1872) from England to America, then to Asia in 1873, to Finland in Northern Europe, and to the Middle East in 1929. Within the translations new terminology for the specific discipline chemistry was required and invented. Later authors of chemistry texts used the old terms, changed them, or rejected and replaced them with more appropriate terms. Those translations were the building blocks for increasing the number of people that have access to chemistry and its theory, to deepen modern knowledge in the respective countries, supporting modern approach to chemical manufacturing industry.

What conclusions the reader can draw from this comparison as a whole? This comparison reflects the dynamics of language movement between people and thru time. This is true for languages in general, and in this study for the case of the science of chemistry in Japan and Israel.

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NOTES

1. Bensaude-Vincent **2003**, 174.
2. Montgomery **2000**, 270.
3. Roscoe's Autobiography **1906**, 151.
4. Roscoe Autobiography **1906**, 150.
5. Icelandic Efnafrædi **1879**, cited by Morris **2015**, 174.
6. Chinese translation of Roscoe's *Science Primers Chemistry* **1886**. Received with thanks from Chang H. 2017.
7. Osawa **1978**. The book size is 18x12 cm, including 16 drawings of experiments in 35 folded pages. *Mr. Roscoe's Chemistry* 羅斯珂氏化学 was co-translated by Sugiura Shigetake 杉浦重剛 and Miyazaki Michimasa 宮崎道正, one of the first three graduates of Tokyo University Department of Chemistry (Kikuchi, correspondence of 23 April 2017). This is probably a translation of Roscoe's 1866 book *Elements of Chemistry* (Osawa **1978**).
8. Roscoe **1872**, 2.
9. Roscoe **1872**, 3.
10. Roscoe **1872**, 4.
11. Roscoe **1872**, 5.
12. Roscoe's *Science Primers Chemistry* book is available on line at: https://archive.org/details/bub_gb_8RsNAAAAYAAJ/page/n3/mode/2up

13. The chemistry book in Japanese is available on line at: https://archive.wul.waseda.ac.jp/kosho/ni04/ni04_03127/ni04_03127_0001/ni04_03127_0001.html
14. Frellesvig **2011**, 14 sec.1.1.2.5 *manyōgana;* pp. 158-162 sec. 6.1.2, Kana (hiragana, katakana, hentaigana). The hiragana and katakana developed as reduced shapes of *man'yōgana*. Kanji letters as they are read phonetically, not logographically. There are two sets of fifty kana letters: hiragana stands for the cursive set, katakana are the square shaped letters set. Mixed writing of kanji and kana started in the middle of Heian period (794-1185).
15. Professor Shin Sato is acknowledged for providing the following Romaji transcription for reading the text of the candle burning experiment in Fig. 3.

    小学化学書巻一 *shougaku* (orally: sho-gaku) *kagakusho kan ichi*

    p.1

    Roscoe shi sen
    Ichikawa Morisaburo yaku

    [Skipped]

    The Japanese description of the candle burning, Experiment 1:

    Dai ichi shi hosokuchibin no seijou naru mono wo tori, rousoku
    sono naka ni moyasu ni (sono naka de moyasu to) kaen shidai ni otoro e
    shimai ni mattaku shoumetsu suru ni itaru wa hito no mazu miru tokoro nari.
    Kore ni oite sono shikaru tokoro no ri wo akiraka ni sezuba aru bekarazu.
    Sore wo nasu ni wa binchuu taiki no jousei, rousoku imada moezaru mae
    to sude ni moyuru no nochi to onaji ki ka inakaya wo kensuru ni arazareba fuka nari. Sonohou wa toumei no sekkaisui wo tori, rousoku no moezaru bin to sude ni moetaru bin to wo narabete hakari na
    p.4
    Gara kore wo sosogi irete ai kurabureba ni binchuu tadachi ni taiki
    no jou no koto naru wo miru beshi. sunawachi koubin wa sekkaisui
    toumei ni shite sara ni henka sezu to iedomo otsubin wa tachimachi
    hakudaku wo shouzu. kore hakua wo shouzuru ni yorite shikaru nari.
    kono hakua wa tansan to sekkai to yori naru mono ni shite, tansan wa
    taiki no gotoku iro wa naku shite miru bekarazaru kitai nari to iedomo
    sekkaisui wo shiroku suru sei aru nite kore wo shiru nari.
    ima, sono binchuu ni tansan no son suru ri wa rousoku chuu no tanso mo
    ete kore wo shozuru nari. rousoku nai ni tanbun wo fukumu koto
    wa sono ichibu moezu shite kemuri to nari masaru nite shiru beku, mata
    sumiyaka ni hakushi wo motte honoo ue yori ooi asseba
    sono tanso kuroki wa to narite tsuku wo miru nari.
    dai san kai
    rousoku moyuru wa tansan no hoka sara ni mizu wo shouzuru koto.
16. Sato S. comments in correspondence of 1 April 2017.
17. The full text of Experiment 1 on candle burning is presented in Hebrew:

    נסיון א' – נכניס נר דולק בבקבוק נקי של זכוכית בעל צואר צר. כעבור שעה קלה נראה את השלהבת פוחתת והולכת עד שתדעך ותכבה. דבר זה מיד יעורר בנו את החפץ לדעת **מדוע** כבה הנר. לתכלית זו נבדוק את האוויר הנמצא עתה בתוך הבקבוק, למע[ן] דעת אם עודנו כזה שהיה מתחלה, טרם דלק הנר בבקבוק. וכיצד נבדוק? – ניצוק מעט מי סיד צלולים* בשני בקבוקים, שאחד מהם יהיה מלא אויר אשר נר לא דלק בו, והשני יהא זה שהנר דלק בו וכבה. מיד נכיר את ההבדל: בבקבוק הראשון יהי המים **צלולים** ובשני – **עכורים**. מכאן ראיה, כי ע"י בעירת הנר חל שינוי באויר. מהו שנוי זה – תסביר לנו עכירות המים (מי הסיד). המים לא נעכרו אלא על ידי קירטון, וזה עשוי **מסיד חי ומחומצה-פחמנית**. החומצה הפחמנית היא גז חסר צבע, זך ושקוף וסמוי מן העין, ממש כאויר, אלא שהוא עוכר מי סיד צלולים ומכבה נר דולק. נמצא שחלק מן החלב נהפך והיה לחומצה-פחמנית, כלומר, הפַּחְמָן או הפחם הכבוש בחלב שנשרף נתגלגל בגז סמוי מן העין. חלק מפחם זה נראה לנו בדמות עשן או פיח: אם שקע לרגע פסת ניר לבן בשלהבת הנר נראה, כי הניר לא יאוכל באש אלא כעין כתם שחור ועגול של פיח יוטל בו. ופיח זה אינו אלא פחם שלא הספיק להשרף.

    ג. מִלְּבַד חֻמְצָה-פַּחְמָנִית מוֹלִידָה הַבְּעִירָה עוֹד חוֹמֶר אַחֵר מָיִם.
18. Potential source for the awareness of the Japanese Ministry of Education was the copy of the book ordered to Japan by William Elliot Griffis (1843-1928), an American graduate (1869) of Rutgers University at New Brunswick, who was invited to teach chemistry to youngsters in remote Fukui in Japan and started teaching there in May 1871. In a letter of 15th July 1871 to his sister Margaret in Philadelphia he wrote: "… Send one copy of Roscoe's Chemistry, latest American edition, by mail, it costs $1.50…" (Yamashita 1965). Uchida mentioned Griffis reading to his students in Fukui from a copy that used to belong to Kusakabe Taro, who studied in Rutgers and died there. When Griffis came to Japan shortly thereafter, he brought with him Kusakabe's personal effect. It is possible that after reading to his students in Fukui from Kusakabe copy on 12th July, Griffis

wrote the request cited above. After moving to Tokyo in January 1872 Griffis was involved in preparation of curriculum for a new university and in 1872-74, he taught chemistry and physics at *Kaisei Gakkō* (the forerunner of Tokyo Imperial University).

The three chemistry books that are noted by Griffis in the Library of Fukui are:

1. H.L. Roscoe, Lessons in Elements of Chemistry: Inorganic and Organic (New York, 1868).
2. W.A. Miller, Elements of Chemistry: Theoretical and Practical, 4th edition (London, 1867).
3. J.E. Bowman, An Introduction in Practical Chemistry, Including Analysis, 5th edition (London, 1866) (cited by Uchida p. 247, and by Edward R. Beauchamp p. 33, both in Edward R. Beauchamp and Akira Iriye Eds. in *Foreign Employees in Nineteen Century Japan*, 1st edition **1990**.

After returning to America Griffis published and lectured about Japan. His book *The Mikado's Empire*, 1895 edition, had a new edition in 2007 and printed on-line in 2015.

19. The Iwakura Mission Diary, the Mission's accumulated oral and written information. The statesman Iwakura Tomomi (1825–1883) headed the Iwakura Mission (December 1871-1873) that was sent to America and Europe in order to introduce the new Japanese regime; to renegotiate the commerce treaties of 1859; and to observe and study Western systems of law, commerce, transportation, education and others ways of life in the countries they visited. In his Diary (*Nikki*) of the Iwakura Mission its historian Kume Kunitake observed chemistry studies and industry in several places. He wrote and emphasized the need of the Japanese to learn the fundamentals of chemistry (In Liverpool, Kume True Account 2002, vol. II p. 143). While in Manchester during 4th-9th October 1872 the Iwakura Mission visited the chemistry laboratory in Owens College (Kume True Account 2002 vol. II chapter 29 pp. 190-191, Japanese pocket edition 2009 p. 182). It is possible that the Mission's visitors have collected Roscoe's *Science Primers Chemistry* book during the visit and sent it to Japan. The book first edition was already mentioned in a letter by Huxley dated 11th April 1872 (Roscoe 1906, p. 148).
20. Ichikawa Seizaburou assistance to Hermann Ritter.
The translator Ichikawa Seizaburou (alas Morisaburou), later changed his name to Hiraoka Morisaburou (1852-1882), studied at University College London between 1866 - June 1868 when he had to return to Japan due to the fall of the Bakufu regime. He became a teacher of higher education for the Ministry of Education and an assistant of the German chemist Hermann Ritter (1827~1874). Ritter taught chemistry and physics in Osaka and Tokyo in English, and succeeded the Dutch chemist Koenraad Wolter Gratama (1831-1888). Gratama stayed in Japan for five years from 1866 to 1871 and taught chemistry in Osaka chemistry school, *seimikyoku*, which was built in 1869. Osaka chemistry school was closed in Meiji 3, 1871 and moved to Kyoto. Ichikawa saw Roscoe's earlier chemistry book that was used by Ritter. Ichikawa moved to Tokyo on May 1873 and about that time he made the translation that was published in 1873 and 1874 (Osawa 1978). Ichikawa went again to England and was in Manchester Owens College studying physics during 1877-8 and 1878-9 and published physics book under the name Hiraoka Morisaburou.
21. Oirbach assisted the renowned poet, translator and editor Chaim Nachman Bialik (1873-1934) when he came to Kishinev to write a report, and later famous poems, about the Kishinev Pogrom that took place there in 1903. Thanks to Dr. Ruhama Albag and Agnon House for the information concerning the acquaintance between Oirbach and Bialik.
22. 金箔 *kinpaku* Golden leaf. In Kanazawa city– *kinpaku* production survives to-date.
23. Oirbach, **1929**, pp. 3-4.
24. Leibowitz **1951** Vol. 18 (י”ח) p. 104-105.
25. Adding punctuation in order to distinguish between הקָפֶה *hakafe* meaning 'the coffee' and הַקָפָה *hakafa* meaning 'surrounding'.
26. The suitable characters for the word "coffee" were searched by the scholar Udagawa Youan (1798-1846), when he introduced the word コーヒー ko-hi- and 咖啡 written by *ateji*, phonetic pronunciation of the kanji, not its meaning. He wrote 27 kanji combinations and 6 katakana combinations before he chose the combination that satisfied him:
コーヒーの当て字
各比伊，歌兮，迦兮，可喜，哥非乙，哥兮，骨喜，架非，咖啡，黒炒豆，
可非，青喜，茶豆湯，架菲，豆の湯，和蘭豆，加非，雁喰豆，過
稀，可否，香湯，滑否，滑韭，骨非，茶豆，架啡，煎豆湯
コオヒー□ コーシー□ コーヒィ□ カウヒイ□ コヲヒ豆□ コツヒイ
27. Oirbach English and German in Word List. The Hebrew terms in this list were mostly accepted by *Vaad HaLashon* based on the suggestion of M. Vinik (1886-1966). pp. 111-114.

28. המילון העברי המרוכז *HaMilon Ha'ivri HaMerukaz*. Page facing inside front cover 1972.
29. Roscoe, 1906, pp. 113-115. Sugiura Shigetake 杉浦 重剛 (1855-1924), In Britain (1877-1879), and Y. Kiraga (1878-1879.) Roscoe wrote: "…Since that time I have had several letters from my Japanese friends and pupils, some of which are interesting:" A letter from Y. Kiraga 1878-1879, at the Technical Institute, Asakusa, Tokio, Japan, October 1st 1886. Kiraga (formerly known as Sadam Takamatsu) apologized for not writing since he returned to Japan and happily announced his appointment as a chair of Technical Chemistry in the established Technical Institute by the Ministry of Public Instruction, devoting himself to the chemistry of dyeing. Kiraga sent to Roscoe a copy of his "maiden work" on guidance of dyeing for the dyers.
30. Osawa, Table 2, pp. 857 (75), **1978**.
31. Osawa, vol. 29, No. 10, p. 72-79, (854-861), **1978**
32. Kaji **2015**, p. 287; notes p. 300 no. 13, lists several translations of Roscoe and Ira Remsen's books. p. 301 no. 15. Ira Remsen, *The Elements of Chemistry: A Textbook for Beginners*, London: Macmillan, **1887**.
33. After returning from studies abroad, Japanese chemists various field of research include: academic research on fertilizer, agricultural chemistry, applied chemistry, beer brewing, biochemistry, cement making, chemical education, chemistry of sake brewing, common salt production, components of oriental drugs, copper engraving- lithograph, dyeing, electrochemistry, gunpowder production, industrial gas, industrial pharmaceutical production, inorganic chemistry, internal medicine, isolation of glutamate – *ajinomoto* (the element of taste), manufacturing of window glass, meat-making, metallurgy, minting, paint manufacturing, paper making engineering, physical chemistry, plant physiology, oil and sugar manufacturing, organic chemistry, wine brewing, and more**.**
34. William Robert Atkinson, a British chemist. Atkinson stayed in Japan during September 9, 1874 - September 8, 1878 and February 3, 1879 - July 4, 1881. He taught agricultural studies at *Tokyo Kaisei School* and Faculty of Science, University of Tokyo. He concentrated on Natural produce of Japan, e.g. studying the brewing method of sake (Japanese liquor) and the dye that is used for dyeing cloths, indigo blue dye, that he called "Japan blue".
35. David P. Penhallow *Japan*, McGill University Magazine 3 (April **1904**), pp. 88-103.
36. Wright, **2000,** Chapter 12. The Translation of Western Science. P. 403.
37. Kikuchi **2017** p.17.

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