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# Professor Georg Dragendorff (1836–1898) as a toxicologist

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The professor of pharmacy, Johann Georg Noel Dragendorff (1836–1898) is primarily known in the history of pharmacy as a pharmacognosist and forensic chemist, so far he has been less described as a toxicologist. He worked for 30 years (1864–1894) at the University of Dorpat (Tartu) in Estonia, and had been invited from Germany, developing here one of the pharmaceutical research centers in all of Europe. Dr. Dragendorff supervised 90 theses of Master of Pharmacy and 87 theses of Doctor of Medicine in Tartu/Dorpat. Dragendorff's supervised master's theses reveal his particular interest in phytochemistry. Of the 87 doctoral dissertations supervised by Dragendorff, are related to forensic chemistry (26 works), and toxicology with pharmacology (21). This work introduces Dragendorff as a toxicologist, discusses the theses supervised by him and his textbooks. Dragendorff's development as a toxicologist was logical considering his extensive scientific activities and the drugs characteristic of the 19th century. These, especially alkaloids and mercury preparations, are introduced in more detail in this study.

## 1. Introduction

Toxicology is a scientific discipline overlapping with biology, chemistry, pharmacology, and medicine, that involves the study of the adverse effects of chemical substances on living organisms, and the practice of diagnosing and treating exposures to toxins and toxicants (Schrager 2006). The relationship between dose and its effects on the exposed organism is of high significance in toxicology. It arose initially on the basis of observations, as a result of which it was established that the course and consequences of a disease can be related to the effect on the body of substances extracted from certain plants or animals, as well as substances of mineral origin.

Important observations about the action of poisons allowed ancient physicians to direct their efforts to combat poisoning and to search for antidotes. Thus, the works of Hippocrates (V-IV century BC), Galen (II century AD), Ibn Sina (Avicenna) (X-XI century AD) contributed to the formation of ideas about the effects of poisons and antidotes, contained attempts to classify toxic substances. Dioscorides, a Greek physician in the court of the Roman emperor Nero, made the first attempt to classify plants according to their toxic and therapeutic effect (Hodgson 2010). A work attributed to the 10th century author Ibn Wahshiyya called the Book on Poisons describes various toxic substances and poisonous recipes that can be made using magic (Levey 2017).

However, it should not be forgot about those who made a huge contribution to the approach of the formation of toxicology. Theophrastus Phillipus Auroleus Bombastus von Hohenheim (1493–1541) (also referred to as Paracelsus) is considered "the father" of toxicology (Krieger 2001). Paracelsus was the first to define poisons precisely as chemicals, and established the pattern of their action from the dose (Toxicology of the Middle Ages 2021). He is credited with the classic toxicology maxim, „Alle Dinge sind Gift und nichts ist ohne Gift; allein die Dosis macht, dass ein Ding kein Gift ist" which translates as, „All things are poisonous and nothing is without poison; only the dose makes a thing not poisonous." This is often condensed to: „The dose makes the poison" or in Latin „*Sola dosis facit venenum*" (Ottoboni 1991).

In the 19th century, the second stage in the development of toxicology began – the period of its formation as a science. The key person at this stage is the Spanish doctor Mathieu Orfila, who had singled out toxicology from pharmacology, and, most importantly, gave a complete definition of the word „poison" and classified all known toxic substances of his time, described their sources, mechanisms of action, and also gave methods for their identification in the biomaterial. All this was reflected in the book „Treatise

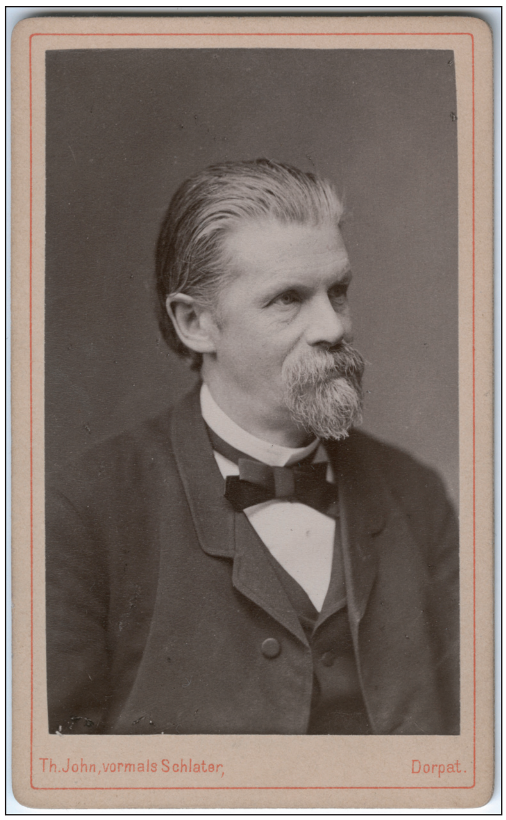


Fig. 1: Professor Georg Dragendorff

on Poisoning, which he created" in 1814. This work marked the birth of a new science. After Orfila, Claude Bernard and François Magendie, the founders of endocrinology and experimental medicine, will conduct a lot of research, advancing the development of toxicology (Status of Toxicology..., 2021; Biography of Mathieu... 1787–1853).

In 1850, Jean Stas became the first person to successfully isolate plant poisons from human tissue. This allowed him to identify the use of nicotine in the Bocarmé murder case, providing the evidence needed to convict the Belgian Count Hippolyte Visart de Bocarmé of killing his brother-in-law (Wennig 2009). Such doctors as E. V. Pelikan, I. M. Sorokin, N. D. Zelinsky and many others also contributed a lot to toxicology science.

Also must be mentioned here German professor Johann Georg Noël Dragendorff (1836–1898), who made a significant contribution to the development of modern toxicological science. He worked as a pharmacy professor at the University of Tartu (Dorpat, Estonia), extensively described elsewhere (Tankler et al. 2002; Hinrikus et al. 2005; Raal et al. 2009, 2020; Kapp et al. 2012). This paper focuses on Professor Dragendorff's work in the field of toxicology.

## 2. A short biography of Professor Dragendorff

Johann Georg Noel Dragendorff was born on April 20, 1836 in Rostock, Germany. He passed the pharmacy exam at the University of Rostock in 1858. University studies at the universities of Rostock and Heidelberg followed. In 1861 he defended his doctoral dissertation „Effects of phosphorus on some carbonic and boric acid salt". Dragendorff gained research experience in the field of plant analysis, plant physiology and agrochemistry, while working as an assistant in the laboratory of Franz Schultze, a professor at the University of Rostock, from 1860 to 1862. In 1862 he was invited to edit the journal "Pharmaceutische Zeitschrift für Russland" of the St. Petersburg Herbal Society. There he continued his paedagogical work in the teaching of pharmacy and pharmacognosy to St. Petersburg pharmacy students. In May 1864, Dragendorff passed the examinations for a master's degree in pharmacy at the University of Tartu (Dorpat), and in September of the same year he was awarded a master's degree for his dissertation „Chemical study of mushrooms in white birch and related species".

From 1864–1894 he was the head of the Institute of Pharmacy of the University of Tartu, a professor, in 1882-1887 the vice-rector of the University of Tartu and in 1890-1892 the dean of the Faculty of Medicine. He was the president of the Estonian Society of Naturalists from 1890 to 1893. He published research in the fields of forensic chemistry, pharmacognosy, food analysis, environmental chemistry, pharmacology, toxicology and others. After thirty years of work in Tartu, Dragendorff moved back to Rostock in 1894, where he died of heart disease on March 26, 1898. Dragendorff is buried in his hometown, his grave is covered with a four-meter-high obelisk made of black granite (Tankler et al. 2002; Hinrikus et al. 2005; Kapp et al. 2012).

In the history of phytochemistry, Dragendorff has a definite place as the creator of a reagent of his own name. To prepare Dragendorff's reagent, the basic bismuth nitrate is dissolved in 30% nitric acid and mixed with aqueous potassium iodide. After standing for a few days, the solution is filtered. This reagent can be used to demonstrate the presence of alkaloids in plants, medicines, foods, body fluids, and the like. Often, several alkaloid precipitation reagents are used in parallel in such assays, in which the reagents developed by and named after Mandelin, Marquis, Mayer, and others are better known. Addition of a few drops of reagent to the alkaloid-containing solution results in the formation of a colored precipitate (Raal et al. 2020).

## 3. Medicine in the 19th century: toxicological aspects

### *3.1. Toxic plants and preparations in the medicine of the 19th and 20th centuries*

Toxic plants and their galenic preparations were commonly used in medicine during the 19th and the first half of the 20th centuries. Many of these medicines were made from plants that contained alkaloids, which could accumulate potent substances that caused poisoning and severe side effects. Opium was one of the most popular drugs during this time. Prescription books from the beginning of the 19th century revealed that 10-20% of medicines contained opium, and some doctors prescribed opium in up to 40% of their prescriptions. Opium (*Opium purum*) was often prescribed in various forms, including opium tincture (*Tinctura Opii crocata*) with saffron, clove, cinnamon, and wine, as well as ethanol-based opium *Laudanum liquidum.* Opium preparations were prescribed not only to adults, but also to children (Gudienė and Šimaitienė 2014). The 19th century, medical manuals indicate that opium has analgesic, cough suppressant and nervous system effects, has also been used to control diarrhea, vomiting, and for the treatment of dysentery (Shprengel 1820). Morphine began to replace opium in medical practice during the mid-19th century. However, in the early 20th century, doctors still frequently prescribed galenic opium preparations. Despite the potential for addiction and abuse, opium and its preparations continued to be a common ingredient in medications even in the 20th century. In the pharmacopeias of the Baltic countries, Estonia, Latvia, and Lithuania, published between 1938 and 1940, there were several paragraphs describing opium and its preparations (Estonian Pharmacopoeia 1937; Lithuanian Pharmacopoeia 1938; Latvian Pharmacopoeia 1940). For example, various preparations of opium were described in the Lithuanian pharmacopoeia and a monograph on *Caput Papaveris* can be found in the Estonian Pharmacopoeia. There were monographs devoted to *Opium, Dover's Powder, Tinctura Opii crocata* in the Latvian Pharmacopeia

Another frequently prescribed alkaloid-accumulating plant was Ipecacuanha (*Carapichea ipecacuanha*). Ipecacuanha is a plant whose roots were used to produce a powder that can induce vomiting, and it was used as an emetic medication. It is commonly referred to as "vomiting root". Sometimes Ipecacuanha was prescribed with opium. For example, Dover's powder *Pulvis Doweri*, also called *Pulvis Ipecacuanhae opiatus*. Dover's powder was commonly used for pain, fever, and respiratory problems such as coughing (Pharmacist Theodor Geldner's... 1830)

Henbane (*Hyoscyamus niger*) was a common component of medicines in the 19th century. It contains several alkaloids, including hyoscyamine, scopolamine, and atropine. These alkaloids have anticholinergic properties and can cause various effects on the central nervous system, such as sedation, and hallucinations. Henbane has been used as an analgesic, diuretic, expectorant, or antitussive medicine (Hager 1893). Sometimes *Extr. Hyoscyami* was prescribed with sugar syrup, and sometimes as part of a multi-component composition.

A Vilnius University Pharmacy prescription book records recipes prescribed by Prof. Jan Lobenwein (1758–1820) in 1801 and 1802. The dean of the Faculty of Medicine (Vilnius University) prescribed to his patients not only the extract and oil *Oleum Hyoscyami*, but also the toxic plants *Cicuta virosa,* and *Aconitum napellus* which contain highly toxic alkaloids (Vilnius University Pharmacy... 1801).

The most popular herbal remedies for fever were cinchona (*Cinchona* spp.) bark powder and its extract. However, they were gradually replaced by the alkaloid quinine isolated from the bark in 1820 by French scientists Pierre-Joseph Pelletier (1788–1842) and Joseph Bienaimé Caventou (1795–1877. In 1830 prescription books, quinine sulfate was recorded, but it was about ten times more expensive than than Cinchona tree bark powder. Quinine proved to be more effective and could be dosed more accurately, but galenic preparations were still prescribed for a long time (Gudienė and Šimaitienė 2014; Kondratas and Gudienė 2020). Patients may have been poisoned by drugs made from potent substances that were not accurately dosed. Pills were dosed more accurately, but doctors often prescribed liquid forms of medicine and instructed patients to take them by spoonful or cupful, which carried a high risk of overdose.

Gradually, there was an increasing focus on both the research and the toxicity of excreted alkaloids. As late as 1921, injectable solutions of alkaloids such as quinine, morphine, codeine, and others were being produced in small pharmacy laboratories under primitive conditions (Advertisement of a pharmacist... 1921). Alkaloid preparations were also imported. For example, in the 1924 issue of the professional Lithuanian pharmacy journal "Pharmacy News," various chemical materials were offered for purchase, with special attention paid to alkaloids such as morphine, codeine, caffeine, strychnine, emetine, theobromine, and pilocarpine. In the advertisement (Fig. 2), alkaloid names were written in bold (Smith and Smith 1924).

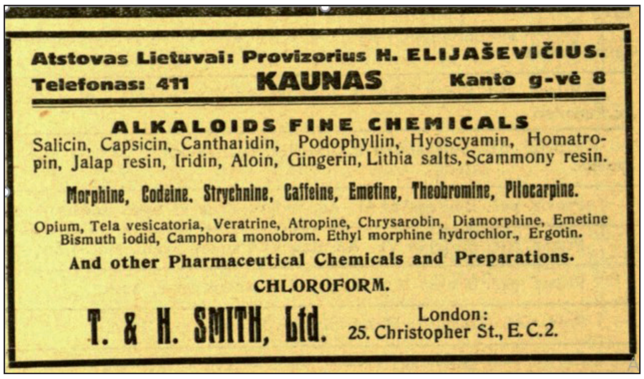


Fig. 2: Advertisement for alkaloids by T. and H. Smith (1924)

The alkaloids quinine, codeine, caffeine, cocaine, and morphine were mentioned in all national pharmacopoeias of the Baltic countries (Kondaratas et al. 2015). Pharmacopoeias set standards for the purity and strength of these alkaloids. The Lithuanian Pharmacopoeia (1938) describes only a few injection solutions, two of them with alkaloids: *Solutio Coffeini sodium-benzoici 10% sterilisata pro injectionibus hypodermicis and Solutio morphii hydrochloridi 1% sterilisata pro injectionibus hypodermicis*.

Plants accumulating alkaloids were very popular medicines in the 19th and the first half of the 20th century. They were used to treat a variety of ailments such as pain, coughs, diarrhea, and fever and could cause adverse effects such as respiratory failure, cardiac arrest, and even death if not properly dosed. The lack of standardized dosing also made it difficult to predict the effects of the plant extracts on patients.

Taking into account the wide use of poisonous plants in medical and pharmaceutical practice, cases of poisoning occasionally arose, so this posed new and new challenges to the scientists of that time. Thus, Dragendorff and his students very intensively carried out research in these directions.

### 3.2. Some terms related to toxicology

The first user of the term 'side effects' is considered to be Louis Lewin, who mentioned it in his book 'The Side Effects of Drugs' (1881), but this is not true (Helmstädter and Schneider 2016). The term 'side effects' has been used in various languages already in the scientific literature of the 18th century. By Helmstädter and Schneider (2016) the use of the term side effects' of drugs can be traced back to at least 1752, described in the Latin-language medical dissertation. The Swedish physician Daniel Ludwig Agricola mentioned the term 'biverkningar' ('side effects' or 'side meaning') in his book 'Description of the New Opium' (1764). Also, the French physician Francois Magendie used the term 'secondary effects' in the book 'Formulary for the Preparation and Employment of Several New Remedies' (1827).

On the other hand, Dragendorff did not use the term 'side effects' in his more famous books. For example, in his book 'Contributions to the forensic chemistry of individual organic poisons' (1872), where he described properties, effects on the human body, and methods for their analysis in biological samples of toxic compounds, this term is missing. However, he uses the terms 'physiological effect' and 'narcotic effect' here, but not 'toxic effect or dose'. Also, the author shows that the toxic effect of the drug depends on its dose. Hence his logic: the toxic effect can be reduced by minimizing the dose.

In the book 'The forensic-chemical determination of toxins in food, air mixtures, leftovers, body parts, etc' (1895), published in several editions, Dragendorff used the terms 'small, large and lethal doses', and in the case of fast-acting poisons, the expression 'energic effect' ('wirkt energisch'), but does not write about side effects. In his widely known herbal book 'The medicinal plants of different peoples and times' (1898) he does not discuss the various effects but uses the term 'therapeutic properties'. Thus, as a toxicologist, Dragendorff does not stand out as a creator of important new basic terms, but his strength is expressed in the analysis of toxic substances.

## 4. Supervising of students and colleagues

The award work of the pharmaceutical students, supervised by Professor Dragendorff, won 23 gold and two silver medals. "Many of his former students described him in his memoirs as an excellent lecturer, a demanding teacher and research supervisor, a well-meaning and responsive, sociable person who, despite his workload, took part in joint events between students and teachers," (Otter and Kalnin 1996). An overview of these prize works and their authors can be found in R. Wallner's writing (1932).

Dragendorff was one of the most prolific supervisors, if not the most prolific, among the lecturers of the University of Tartu – he helped to compile 178 dissertations. It is good to monitor the scientific activity of a capable researcher on the basis of his or her scientific publications, including specially supervised dissertations. During 30 years, professor Dragendorff, who had been invited from Germany, supervised 90 theses of Master of Pharmacy and 87 theses of Doctor of Medicine in Tartu/Dorpat. While the master's theses were written by pharmacists, the authors of the doctoral dissertations were persons with a medical degree. The scientific degree of Doctor of Pharmacy did not yet exist at that time (Tankler et al. 2002; Hinrikus et al. 2001). Dragendorff compiled a list of scientific papers written by the Institute of Pharmacy and published in the journals Pharmaceutische Zeitschrift für Russland (Dragendorff 1988) and Фармацевтическій журналъ (Dragendorff 1885) in 1888 and 1885. 168 dissertations have been added to these lists, including 88 doctoral and 80 master's degrees.

### 4.1. Master's dissertations

The vast majority of Dragendorff-supervised master's dissertations (84%) are devoted to pharmacognostic and phytochemical studies of various medicinal plants. More than a third of them concern alkaloids, to a lesser extent anthracene derivatives, tannins, as well as various glycosides, saccharides and acids have been analyzed (Tankler et al. 2002). This is also understandable, because the era of phytochemistry that began in the early 19th century laid the foundation primarily for long-term research into alkaloids (Raal 1989). It is relatively easy to prove and isolate alkaloids from plants, and their medical significance, both in terms of potential efficacy and danger, is very high (Raal 2010).

Studies in the field of pharmaceutical chemistry (4 works) have dealt with the synthesis and preparation of some substances, as well as their properties, salts, etc. Although Dragendorff is also known worldwide as a forensic chemist, there are only a modest number of such works on our list (5). Some single ones were dedicated to food (3 works) and environmental chemistry (1) (Tankler et al. 2002). Thus, Dragendorff's supervised master's theses introduce the professor primarily as a phytochemist.

### 4.2. Doctoral theses

Of the 87 doctoral dissertations supervised by Dragendorff, 26 can be classified as related to forensic chemistry, 21 to toxicology and pharmacology, 10 to physiology and pathophysiology, 9 to environmental research, 8 to bacteriology, 7 to pharmacognosy and 6 to food research (Hinrikus et al. 2005).

### 4.2.1. *Forensic chemistry*

Alkaloids were studied in more than half of his dissertations. The main problem was to prove their presence in animal body fluids and tissues, as well as to identify poisoning in both the living and the dead. In addition to chemical analyzes, a large number of animal experiments were performed during these works. Alongside the toxicological aspect, there is no need to search for the application of alkaloids for therapeutic purposes, to elucidate their mechanisms of action, metabolic possibilities, etc. Atropine, morphine, papaverine, codeine, physostigmine, quinidine, cinchonidine, etc., which are still widely used today, as well as virtually discarded drugs, thebaine, narcissus, brucine, emetin, etc., and the highly toxic conine, and colchicine, have been studied. The Institute of Pharmacy of the University of Tartu has an excellent collection of drugs thanks to the research work of that time.

In addition to alkaloids, various substances of plant origin such as thimble active substances (cardiosteroids), santonin (terpenoid), resorcinol, arbutin, hydroquinone (phenolic substances) and others were studied. The third group of works dealt with the research of several new synthetic drugs at that time (eg antipyrine, tallow, etc.). Household poisonings caused by sulfuric acid were also studied.

### 4.2.2. *Toxicology and pharmacology*

The doctoral theses that form the second largest group are closely related to toxicology in particular and refer to Dragendorff's good working relationships with professors of pharmacology (H. Meyer, R. Kobert et al.). At the same time, a connection with forensic chemistry research topics becomes apparent. In several studies, we find points of contact with the topics studied in the master's theses. Nearly half (10) of pharmacological doctoral dissertations are again related to alkaloids. One of the largest (115 pages) dissertations defended in this field was the study on cantharidine poisoning submitted by R. F. Radeck (1866). The study describes 69 animal experiments on mammals, birds and amphibians (frogs). The effect of cantarin was determined by determining various urinary parameters (amount, color, reaction, specific gravity, albumin, urea, uric acid, creatinine, etc.) (Tankler et al. 2003; Hinrikus et al. 2005). The source of cantarin is the infamous emerald beetle with a metallic luster of emerald green, known as the Spanish fly (*Lytta vesicatoria*). The beetles are 1.2-2 cm long and 0.5-0.6 cm wide and contain 0.7-1% cantarin. The Spanish fly is known as a sex-enhancing agent that is now only used in veterinary medicine. Externally, it has been used to treat warts and other skin diseases, but its hydrofuran derivative, cantaridine, causes reddening of the skin and blisters. When used internally, it impairs liver and kidney function. The lethal human dose of cantarin is 40-80 mg. Due to the image associated with this sexual desire, products are now offered on the internet and in sex shops that allegedly contain "Spanish flies", but the connection with the famous beetle is hopefully limited to what is printed on the package (Raal 2010b).

The effects and toxicity of curarin, cinchonine, caffeine, theobromine, morphine, strychnine, cocaine, as well as some other but less known alkaloids have been studied in numerous animal experiments. All these works have been done worthy of the cradle of Tartu as an experimental pharmacology. The synthetic substances, such as chloral hydrate, phenol, aniline, ortho- and para-toluidine and picric acid, were extensively studied.

In addition to alkaloids, three natural products with a glycosidic structure were studied, namely aloin, convolvulin, and jalapin. The study of toxins in purulent blood was directly related to practical medical work. The field of exotics can be considered the study of fish venom from Africa. One of the merits that brought Dragendorff great fame is the identification of arsenic poisoning found in the wallpaper pattern. These wallpaper samples have been preserved in the History Museum of the University of Tartu to this day (Tankler et al. 2003; Hinrikus et al. 2005).

### 4.2.3. *Foodstuff*

Food research was based on Dragendorff's work as an expert as well as his great interest in agriculture. This activity was also related to the scientific interests of the professor as the founder of sanitary control. The assessment of food quality was based primarily on the detection of counterfeits, and the results of practical work were also published in the local press. For example, the composition of tea and coffee was studied by determining caffeine and other ingredients, and methods for determining milk quality were improved. The research of W. Kubick (1873) and H. Jundzill (1873) was devoted to the study of counterfeit substances added to beer. Namely, the counterfeiters tried to save on hops by adding bitter-tasting substances to the beer, which could have been toxic in the worst case. O. Klemm (1890) studied the bush content of vodka varieties sold in Tartu, so the issue was the toxicity of the alcohol sold. His work can be found in today's place – reducing the number of taverns is one of the most effective tools in the fight against drinking disease.

### 4.2.4. *Bacteriology*

The first thesis in the field of bacteriology was defended by L. Bucholtz (1876), who studied the behavior of bacteria in the presence of some antiseptics. The dissertant determined in which dilutions sublimate, thymol, sodium benzoate, thyme oil, etc. inhibit the development of bacteria and which substances (chlorine, iodine, bromine, etc.) destroy their fertility. Such an approach to this topic can also be observed in other similar doctoral dissertations supervised by Dragendorff. There was also work on the study of bacterial biology, mold research, etc.

### 4.2.5. *Environmental research*

In addition to purely scientific research, Dragendorff's activities also involved the practical organization of life. This type of research concerned the carbon dioxide content of Tartu air (3 works) and the carbon dioxide content of soil (2 works). V. Feldt (1887), who wrote a dissertation on carbon dioxide in Tartu air, mentions in the introduction of his work that Dragendorff had received a call to study the carbon dioxide content of Tartu air from America. The first work to study the bacterial content of carbon dioxide-containing waters was to move from carbon dioxide analysis to well water research. Dragendorff divided the study of well water between three dissertants, Th. Zimmermann, E. Seegrön and A. Brasche, the results were presented for defense in 1893. They studied the well water of different regions of Tartu chemically and bacteriologically. The ideal drinking water should also be discussed. The most radical was Brasche's claim that the water of the two artesian wells he studied should not be drunk. These works also talk about the supervisor as an environmental chemist (Tankler et al. 2003; Hinrikus et al. 2005).

## 5. Textbooks written by Dragendorff

Dragendorff's prolific scientific work with students, doctoral students and colleagues led to the creation of several scientific books that are still relevant in the study of pharmacognosy and toxicology. He published several textbooks, which were printed in St. Petersburg and in different cities in Germany (Stuttgart, Göttingen) and used in various European universities. The usage of numerous literature sources and the research results of his students and staff in his textbooks was typical. One of the world-famous works by Dragendorff, "The Forensic Chemical Determination of Poisons in Food, Air Mixtures, Leftovers, Body Parts etc." appeared in four editions in the years 1868–1895 (Göttingen, Vandenhoeck and Ruperecht's Verlag) and was translated into Russian, French and English. This manual is intended for doctors and pharmacists for the practical implementation of forensic chemical examinations. Here the more important forensic chemical methods are set out which were then used to prove various types of poisoning, their advantages and disadvantages as well as the level of reliability in practice was described. In addition to vegetables, the poisons originating from the inorganic environment are characterized (heavy metals and their toxic compounds, acids, bases, colors, etc.) (Wallner 1936; Raal et al. 2009; 2010a).

The textbook "The role of some organic poisons in forensic chemical analysis" (St. Peterburg, 1872) was a manual containing detailed overviews of poisons of vegetable origin – alkaloids and glycosides. Dragendorff's lectures on forensic chemistry, which he incorporated into the curriculum of the University of Tartu in the late 1860s, were based on this material. Materials from the master's and doctoral theses defended in Tartu are used in the work by referring to their authors.

The book "The chemical determination of the value of some powerful drugs and the medicinal products made from them" (St. Petersburg, 1874) was translated into French and was published in 1874 under the title "Analyze chimique de quelques drogues actives: et de leurs préparations pharmaceutiques" (Dragendorff 1876). The book provides precise instructions for evaluating the quality of the herbal drugs and the pharmaceutical forms produced by them. Also, there are sub-chapters as *Aconitum, Belladonna, Datura, Hyoscyamus, Ipecacuanha, Conium, Nicotiana, Strychnos, Colchicum, Opium, Cantharidin*, etc. The book is provided with a bibliography and references to studies written at the Pharmaceutical Institute of the University of Tartu. In the foreword, the author, who had great practical experience, emphasizes the importance of research at universities and the need to establish appropriate laboratories.

Dragendorff's "The qualitative and quantitative analysis of plants and plant parts" was published in Göttingen (1882) and was quickly translated into other languages. It was published in Paris in 1885 under the title "Analyze chimique des végétaux ..." and in London in 1884 under the title "Plant analysis: qualitative and quantitative."

The book "The medicinal plants of the different peoples and times" (Dragendorff 1898) was Dragendorff's last work and was published posthumously. The compilation was based on medical books, calendars and other writings published in Estonia since the 18th century (Sõukand and Raal 2008). The second edition was published in Munich in 1967. Dragendorff added synonyms to the Latin plant names, including popular names. The representation is based on the plant systematics, more precisely on genera. He briefly describes different plant species according to families. The author counts over 12700 plants and if the relationship to pharmacognosy is known, he gives the composition and/or the effect and the area of application (Raal et al. 2010a).

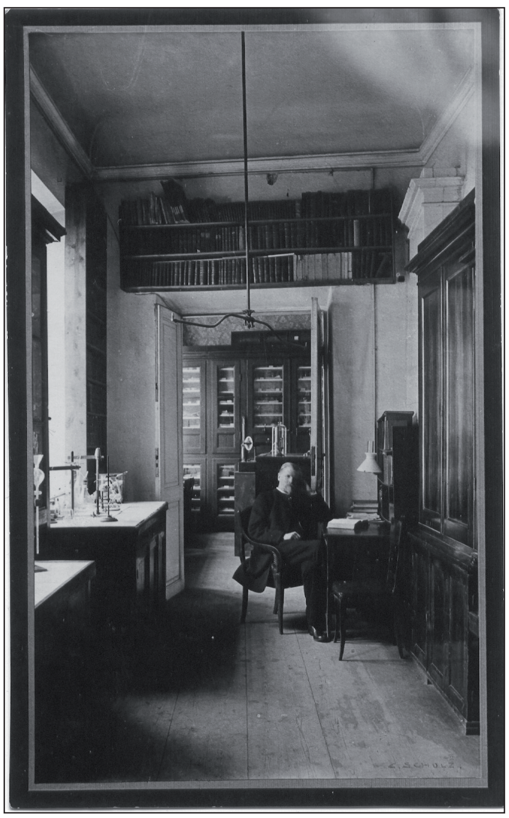

Fig. 3: Professor G. Dragendorff at the Institute of Pharmacy, University of Tartu/Dorpat, Estonia.

## 6. Dragendorff as the founder of sanitary control in Tartu

The interest of a professor of pharmacy in environmental research and bacteriology helps to understand the fact that on February 1, 1888, Dragendorff established a sanitary station in Tartu, which was located in the building of the Institute of Pharmacy. It was also the first sanitary institution in Estonia (Tankler et al. 2003). Dragendorff himself called it a food analytical station. The city administration received 400 rubles each year, which was intended for the maintenance of a chemist's assistant and for the purchase of reagents and other necessities. The professor's students worked as technical assistants. The need for effective sanitation was mainly due to the growing counterfeiting of foodstuffs and the introduction of consumer products containing toxins (eg wallpaper, fabrics, paints). Until now, food quality had been inspected at random, mainly on behalf of the city government or when complaints were received by the police, but was mainly limited to organoleptic assessments of food and beverage quality. In the first place, the new laboratory was supposed to detect food fraud, but it also examined beverages, water, soil and consumer goods. In addition to chemical analyses, microscopic and bacteriological studies were also performed (Saava 2008).

"In the first 22 months alone, a total of 1,172 surveys were conducted at the station, of which 518 were initiated by the police and city authorities, 427 at the initiative of Prof. Dragendorff, and 227 at the suggestion of institutions and individuals. It turned out that counterfeits of milk, butter, tea and vinegar often occurred in both Tartu and the county. Manufacturers often added a health-threatening amount of arsenic when painting wallpaper and fabrics," writes A. Saava (2008: 9). The activities of the laboratory gained momentum in connection with the hiring of a city sanitary doctor in 1891. Due to the risk of cholera, 147 wells in Tartu were chemically and bacteriologically tested in 1892 and 1893, whereas only 18 wells were declared to be of good quality. Due to Dragendorff's departure in Tartu, the work of the sanitation station also ceased and stopped for a while (Saava 2008). The establishment of the Food Analytical Station is an excellent example of how Dragendorff's theoretical knowledge and practical skills as a researcher were put into practice, literally beginning to protect the interests of the people and serve their health.

It is interesting to note that food was referred to in the pre-war Republic of Estonia as means of subsistence, which according to the relevant German law of 5 July 1927 was defined as follows: "All substances intended to be eaten and drunk in the unaltered, prepared or processed state not primarily to eliminate, alleviate

Fig. 4: The wallpapers studied by Dragendorff (University of Tartu Museum ÜAM_1618:1 AjM)

or prevent disease. Equivalent to means of subsistence are: tobacco, tobacco-containing and tobacco-like products intended for smoking, chewing or sniffing" (Toomingas 1937). The close link between food and medicine has been repeatedly emphasized (ibid.): "The close relationship between means of subsistence and medicine also means that they often have the same function, namely to keep the body healthy, to replace missing substances, to penetrate and influence the digestive system." As far as we know, Dragendorff and his colleagues also studied milk, tea, coffee, beer, cherries, plums, peaches, cinnamon, apples, cocoa, onions, yeast, saffron, water, eggs, fat, as well as chicory in coffee, hop substitutes and more (Toomingas 1937).

Hence the reason why pharmacists have been taught food analysis as one of the subjects was: the laboratories, tools and operations are very close in assessing the quality of both food and medicines. It was not until after World War II that this subject disappeared from the pharmacy curriculum. During and after the Dragendorff period, students were involved in forensic chemistry research. At the same time, Dragendorff consistently considered forensic chemistry to be the first in the world (Otter and Kalnin 1996). Forensic chemistry was replaced by toxicological chemistry in the curriculum for pharmacists during the Soviet era, and later disappeared.

## 7. Conclusions

Many 19$^{th}$ century medicines and household chemicals were poisonous. Professor Georg Dragendorff was known in Europe for his scientific works in the fields of pharmacognosy, phytochemistry, forensic chemistry, food chemistry, environmental chemistry, and pharmacology, therefore his involvement in toxicology was logical and expected. Since pharmaceutical laboratories were also suitable for food analysis in terms of their structure, tools and methods, under Dragondorff's leadership they also dealt with the analysis of nutrients, this subject remained in the pharmacy curriculum for decades.

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