125TH ANNIVERSARY OF THE DISCOVERY OF MORPHINE BY SERTÜRNER.*

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When it is recalled that the practice of medicine is practically impossible without morphine, that directly or indirectly morphine has promoted scientific discovery in medicine, that morphine led in the development of pharmaceutical chemistry and of experimental pharmacology, and hence of rational therapeutics, the significance to Medicine of Sertürner's achievement 125 years ago becomes apparent. From the fact that morphine has been the sovereign pain-killer during these past 125 years, the humanitarian side of Sertürner's discovery achieves distinction. Yet, if one is to judge from the scanty mention of the subject in the literature of medicine, the significance of Sertürner and his achievement has been relegated to almost complete obscurity.

Fig. 1.—Friedrich Wilhelm Adam Sertürner, 1783–1841.

It is probably true that alongside of such glorified products as the endocrines, the vitamines and the synthetic medicinals, the isolation of morphine was a comparatively humble achievement. It required no munificent grant, no extensive laboratory equipment, no highly organized institute or factory; in fact, it required nothing but the ordinary equipment of a pharmacy and the self-determination of a man. Nevertheless, there is a charm, if not a lesson, in the very simplicity and the directness of this signal achievement.

In presenting this résumé on Sertürner and his achievement, I venture to recall the circumstances attendant upon the discovery of the first alkaloid, and to refresh our memories of the obscure pharmacist of Paderborn, who achieved by his own unaided efforts. The discovery of morphine was no insignificant event in Sertürner's day, and its significance has not diminished in importance during a lapse of 125 years, which merely testifies to its permanence and should excite both our curiosity and admiration. In Germany, the worthiness of Sertürner and his achievement had already been recognized, and recently again attention has been drawn to the subject by Dr. H. Coenen, Dean of the Medical Faculty, and Prof. H. Freund, professor of pharmacology, in the University of Münster; but in other countries, including our own, notice of the event has been conspicuous by its absence. This, therefore, may serve as an additional reason for this presentation.

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BIOGRAPHICAL.

Friedrich Wilhelm Adam Sertürner (Fig. 1) was born in Neuhaus near Paderborn, Germany, June 19, 1783 (Fig. 2). He was apprenticed at 16 years of age to the Royal Pharmacist Cramer at Paderborn and there (Fig. 3) he discovered morphine in 1803 at the age of 20 years. To Cramer, his preceptor, he dedicated 25 years later his newly founded "Annalen."

The details of Sertürner's personal life are scant, but apparently he was of Italian or French descent, the original family name being Serdinier, from Sardinia. His education appears to have been limited, about average for a boy of his station; but he proved himself a worthy apprentice. It appears that he was rather imaginative, this quality being tempered with practical common sense. In later years he become a hypochondriac, had gout, and led a miserable existence, being fully aware of the great benefits his discovery conferred on humanity. He was a

Fig. 2.—Sertürner's birth-place at Neuhaus, Westphalia, Germany. Proposed Museum.

Fig. 3.—Cramer's Pharmacy at Paderborn, where Sertürner discovered Morphine, in 1803.

man of noble character, a patriotic and charitable citizen. Sertürner died at the early age of 57 years in Hameln on February 20, 1841, an unhappy and ridiculed man. Nolte (*Archiv der Pharmazie*, 4, 29 (1842), 1), states that his death occurred after taking a second cup of tea with his family. He had suffered from convulsions (uremic?) shortly before death. The cause of the sudden death was ascribed to "a gush of water into the spinal canal and infiltration of water into the brain" (apoplexy?). In 1917, 76 years after Sertürner's death, Prof. Stich of Leipzig identified Sertrüner's casket in the family grave in Bartholomew's Chapel at Einbeck. This event undoubtedly stimulated further recognition of Sertürner in his own country. In 1921, or 80 years after his death, there appeared on the German emergency notes (Fig. 4) of that year a picture of Sertürner's birth-place and his portrait with these words;

"Deine Hütte verfallen, Dein Grab verwest,
Dein Werk wird bleiben, so lange die Erde steht."

In Cramer's pharmacy at Paderborn, a memorial tablet has been placed with this inscription: "In diesem Hause entdeckte 1803 Fr. W. Sertürner das Morphium." This tablet was unveiled in 1921, or 118 years after the discovery. Another memorial tablet was unveiled for Sertürner at Hameln in 1905 by the president of the German Pharmaceutical Society, and a plaque was placed on the Pharmacological Institute of the University of Münster in 1928 (Fig. 5).

SERTÜRNER'S EARLIEST RESULTS ON THE CONSTITUENTS OF OPIUM.

The first announcement of Sertürner's work with opium was in 1805, in Trommsdorff's *Journal der Pharmacie*, Vol. 13; at this time he described his discovery of meconic acid in two letters to the editor. There are no indications in these letters when he began working on opium, but he states that he had made observations before Derosne whose work had been reported in the *Journal der Pharmacie*, 12, (1804). From this it may be inferred that he had done work in 1803, and, in support of this inference, there is an intimation in his paper of 1817 to the effect that he made a successful isolation of the alkaloid in 1803. This date has been generally accepted as the date of the discovery.

Fig. 4.—Two-mark German emergency note of 1921, commemorating Sertürner, the Discoverer of Morphine.

In 1806, in Vol. 14 of the same *Journal*, he described the results of 57 experiments, detailed over 48 pages, with both opium acid and with a new substance which caused sleep and was morphine. Sertürner called it the "*Principium somniferum*" of opium. This paper has the appearance of a finished contribution although the 57 experiments are not really individual experimental trials, but merely successive steps in a relatively few experiments. The first 25 experiments may have been done early, perhaps in 1803, with the simple reagents that could be had in the drug store.

In these early experiments, all of which were carried out in Cramer's Pharmacy at Paderborn, Sertürner's most important reagent was ammonia. His object was to correct the irregular therapeutic results with the opium extracts used by the physicians of his day. It was an important problem. The chemical part of his work with the drug at this time (1803) was somewhat peculiar and quaint, but he made rather interesting and crucial experiments, the results of which encouraged him to pursue the subject. For those times the experiments were epoch-making. For one thing, he conceived of isolating the active constituent of a medicinal plant, then only a theoretical possibility; but Sertürner actually obtained results. He made experiments on 4 dogs with extracts before and after alkalization, and also with pure crystals, noting especially the narcotic effects. He found that, when the basic constituent of opium was removed by precipitation with ammonia and by filtration, the extracts did not cause narcosis in dogs. Hence, he believed that there was something important in the basic precipitate of the plant extract. Obviously, Sertürner confirmed his suspicion by animal experimentation, and thus, he was an early exponent of experimental pharmacology. In fact, he preceded by

53 years the founding of the first laboratory of experimental pharmacology by Buchheim (1856) in Dorpat, Russia (to-day, Tartu-Dorpat, Esthonia). Sertürner also tested the odoriferous portion of the extracts on a mouse and found it was inactive on inhalation over long periods. In the 53rd experiment, he summarized the constituents of opium as follows:

"Extractive with gummy portions, balsam-like matter, narcotic principle, mohn acid (opium acid), resin, gluten, rubber, calcium sulphate, aluminium silicate (earth), volatile odoriferous constituent, which appears to be composed mostly of hardened plant protein, fibres and impurities."

In the paper of 1806, Sertürner drew definite conclusions. These were that the great activity of opium was not due to the resin and extractive, but to the crystalline constituent, which he designated the narcotic constituent as against the current hypothetical narcotic substance; and that it was improbable the odoriferous

Fig. 5.—Plaque in honor of Sertürner on the Pharmacological Institute, University of Münster.

Fig. 6.—Present Pharmacy at Einbeck, formerly Sertürner's Pharmacy in 1809–1820.

constituent and resinous extractives possessed medicinal virtues. He recommended the use of strong alcohol as the choice menstruum for opium instead of weak alcohol or water; for, by so doing, physicians would no longer get irregular results with opium. Sertürner concluded further that his work gave new light on the action of opium, but that it would have to await the final decision of physicians. This indeed was a healthy attitude for the therapeutics of his day, and could with advantage be emulated to-day. The editor (Trommsdorff) of the *Journal* appended a note stating that the experiments reported by Sertürner contained many interesting suggestions for which the chemical public was much indebted. However, he warned that there had been so many pieces of work on opium that one should not regard the matter closed, and he hoped the new claims would be further investigated and many obscure features elucidated.

Sertürner now (in 1806) left Paderborn and established himself at Einbeck where from 1811 to 1817 he continued the work with opium in his own laboratory

(Fig. 6). His later papers were published from Einbeck. Two papers appearing in 1817 are important; for, in these, Sertürner gives the details of his method of isolating morphine and meconic acid and fully describes their physical and chemical properties and actions on man and animals. The details are as interesting as are the methods he employed.

SERTÜRNER'S METHOD OF ISOLATING, AND RESULTS WITH, MORPHINE IN 1817.

Sertürner prefaced this paper by stating that the Parisian pharmacist, M. Derosne, undertook the isolation of the constituent 14 years prior to the time of his first successful isolation of morphine, but their results were so different and contradictory that the problem remained as dark as ever. He stated further that his original contribution went unnoticed; that it had been quickly gotten together and the quantity of morphine he had worked with was too small, and some could not repeat his results. In this paper Sertürner stated that he desired to present science not only with a remarkable plant constituent, but also with the discovery of a new alkaline principle (basic).

Gilbert, the editor of the *Annalen der Physik*, criticized the paper in a long foot-note, justifying himself for accepting Sertürner's somewhat un-chemical paper, and stating that Sertürner apparently overlooked the work of Thénard and Chevreul, who had previously found that acids unite with many plant constituents to form true compounds, and advised Sertürner to study this work. Gilbert said further, that, if Sertürner's body from opium—his morphine—was a true plant constituent and consisted of carbon, hydrogen and oxygen, the chemists had something to learn from this plant constituent in being a base, as claimed, and behaving like an alkaline earth. Gilbert thought that morphine could be a base without being an alkaline earth. It appears that no one recognized the importance of the nitrogen in the morphine as being the real clue to the basicity, although Sertürner claimed he found this element occasionally.

Details of the Method and Results.—Eight ounces of dry opium were repeatedly extracted with small portions of distilled water until the extracts remained colorless. The combined extracts were clear, but, on addition of more water, precipitation occurred and the precipitate redissolved with more water. The watery extract was now supersaturated with ammonia. Crystals appeared and these were washed with water until clean; they consisted of morphine. Some extractive and meconic acid adhered to the morphine. The total yield of crystals was 16 drachms, or about 25 per cent. The crystals were next treated with dilute sulphuric acid, precipitated again with ammonia, and the newly-formed dry crystals were rubbed with alcohol and dissolved. This treatment left much brown extractive behind. The yield now was 8 drachms, or about 12.5 per cent. The morphine was next dissolved in alcohol, and allowed to re-crystallize, this process being repeated several times to purify the product. The final crystals were parallelopipeds, while Derosne's crystals were prismatic and gave a strong red color with iron.

The properties of Sertürner's pure morphine were as follows: It was colorless, slowly and slightly soluble in boiling water and easily soluble in alcohol and ether. Its taste was bitter. It turned red litmus blue, and turmeric, brown. There was no ammonia in the crystals, which were soluble in acids with neutral reaction and formed the bicarbonate, sulphate, hydrochloride, nitrate, meconate, acetate and

tartrate salts, all of which were prepared by Sertürner. Elementary analysis showed the crystals contained carbon, hydrogen and oxygen, and perhaps nitrogen. The crystals were easily oxidized and melted at a low temperature. Sertürner stated he employed a competent chemist to help him with the elementary analysis. Obviously, Sertürner had described all properties of morphine correctly, except that he did not establish its nitrogen content.

Actions on Human Body.—Sertürner used three young men as subjects, and described his own sensations after taking $^1/_2$-gr. doses of the pure crystals, each dose being taken in $^1/_2$-fluid drachm of alcohol and several ounces of water. He warned against taking the drug by mouth, unless dissolved in alcohol or little acid, because he thought it would not be dissolved in the gastric juice and absorbed. Sertürner described the symptoms as follows: after the first $^1/_2$-gr. dose, there were facial redness and apparent increased body activity; after the second $^1/_2$-gr. dose, one-half hour later, the previous states were increased and there were nausea, dullness in the head and general numbness; after the third $^1/_2$-gr. dose a quarter of an hour later, depression was marked, and there were loss of power, general numbness, narcosis, with a dreamy state, and small spasms in the legs and arms which coincided with the pulse beats. The latter effects Sertürner declared to be poisoning, and he concluded that the drug was very effective in small doses. He concluded further that, *since no other constituent of opium produced these peculiar actions of narcosis, etc., the valuable medicinal properties of the drug opium were due to the morphine.* Sertürner added that the morphine abolished toothache. At this time (1817), he named his product *Morphine*, from *Morpheus*, the *God of Sleep.* Thus was Sertürner remarkably correct in his description of the narcotic and analgesic actions of the newly-discovered morphine.

In the appendix of the same paper, Sertürner described an improved method for isolating morphine. He now advised rubbing 8 ounces of opium with 2 to 3 ounces of acetic acid and some distilled water, the whole to be diluted with 2 or 3 pounds of cold water and strained. The slightly colored extract contained morphine acetate and opiate. The morphine was then precipitated with ammonia; the mixture was concentrated somewhat and filtered to separate the morphine crystals, which were then treated with barium acetate. This treatment gave morphine acetate and barium opiate, the latter a precipitate, which was filtered off. In this way, Sertürner claimed, the morphine was obtained pure.

Meconic Acid.—In the same year (1817), Sertürner published another paper in Vol. 57 of Gilbert's *Annalen*, the object being to describe what he called "Eine der fürchterlichsten Gifte der Pflanzenwelt" (one of the most horrible poisons of the plant kingdom), referring to meconic acid, which he now compared and contrasted with morphine. He stated that morphine, in small doses, gave an agreeable sensation and sleep, while meconic acid caused poisoning in every man, being dangerous to life. Previously he had held that meconic acid was harmless, but now he wanted this impression corrected, saying that it belonged to the most terrible poisons. His evidence was as follows: 3 grs. of sodium meconate given to a dog by mouth caused vomiting, loss of leg control, paralysis of hind legs, and deepened and slowed respiration. Eventually, weak spasms occurred and there was a "feeling of anxiety," but the dog recovered. Sertürner himself took $^1/_{10}$ gr. and experienced the "feeling of great anxiety." A dog was given 1 gr. of barium

meconate with resulting increased excitability, emesis and expulsion of tapeworms.

From this evidence Sertürner concluded that meconate acted oppositely to morphine. We know now that many of the effects of meconate described by Sertürner occur also with morphine. Many physicians reported to him that meconate was ineffective as analgesic in toothache and cramps, while morphine was effective. Moreover, he observed that roosters and cats did not react to meconate, and also that 10 grs. of opium administered to a rooster gave no results. Another difference cited by Sertürner was, that meconate gave a deep color with iron while morphine did not; it gives a blue color. He concluded this paper by pointing out that morphine was a base of the plant and had the advantage over opium in that the meconate of the latter was harmful to animal life. Thus, by isolating morphine, the purified substance was free from the injurious one. He made the deduction that it was characteristic of all products of the animal kingdom to be basic in nature whereas those of plants were acid, *i. e.*, in combination with acid, as was morphine in opium. The latter was a fairly clever distinction for that time, although it would not be accepted now.

In commenting on Sertürner's work, Robiquet stated that the surprising thing to chemists was that morphine should be an alkali, *i. e.*, a base, and that the opium extracts should be acid. From this, Robiquet inferred that the morphine of the opium extract was in the form of a salt, which, on alkalinization, liberated the base, but he questioned Sertürner's contention that morphine existed in opium as morphine meconate. Nevertheless, Sertürner called morphine the correct thing and recognized an important property of alkaloids, *viz.*, their basicity; he showed also that alkaloids did not exist as bases in plants, but in combination with acid radicles.

PRIORITY OF DISCOVERY OF MORPHINE ("SEL DE DEROSNE").

Sometimes the priority of the discovery of morphine has been ascribed to the French pharmacist, Derosne, who used alcohol to extract opium. Derosne's extracts at best were crude extracts and contained besides morphine all the other constituents of opium. "*Sel de Derosne*" was the name of the crude extract. Sertürner did not believe Derosne had isolated morphine. He proved that isolation was only possible by making the extract alkaline first, and showed that the resulting precipitate, and not the supernatant fluid, caused narcosis. Derosne employed neither of these steps. Derosne's contemporaries at the Institut de France settled the matter by voting a prize of 2000 francs to Sertürner instead of to their countryman. The prize was voted to Sertürner for having recognized the basic nature of morphine and for having discovered a method which had produced great medical discoveries.

Recognition of Sertürner's Work.—The Institut's recognition did not come before Gay-Lussac's opinion. Gay-Lussac read a French translation of Sertürner's work in the *Annales de Chimie*, 5 (1817), 121 and expressed surprise that the extremely important discovery in Germany had remained unnoticed in other countries. In that year the University of Jena conferred the degree of Doctor of Philosophy on Sertürner and he was elected to membership in scientific societies in Marburg, Berlin, Paris, Batavia, St. Petersburg and Lisbon.

SERTÜRNER'S LATER WORK AND DECLINE.

The year 1817 was undoubtedly the high point of Sertürner's scientific career; after that came the decline. It was in the short space of 14 years (between 1803 and 1817), and between the ages of 20 and 34, that Sertürner did his best work. After the discovery of morphine, he busied himself with numerous things. In fact, his energies were too diffuse. He was a many-sided man of a restless, impatient, and perhaps impulsive, nature. He seemed somewhat impatient with the chemists of his time, accusing them of lack of vision and of interest in practical problems, but unfortunately he himself became merely an arm-chair critic. This was quite in contrast with his early life. Many of his later ideas had been nourished from his earliest work with opium.

Among various items, which very early claimed his attention, were questions of benzoic acid in fennel water, nitrate, active constituents of drugs, animal charcoal, borax, nut-galls, tannins and explosives. In 1838, he tells of experimental work which had occupied his attention from youth on. From the results obtained he held that the caustic alkalies (hydrates), then as yet regarded as elementary substances, were composed of oxygen and a metallic element similar to hydrogen. This conception was ridiculed by Gehlen to whom he had sent his manuscript in 1806; and shortly thereafter, Davy announced his discovery of the same thing in another way.

In Sertürner's time terrible epidemics of cholera raged in European countries and he directed his thoughts to the control of this scourge. He pleaded with scientific men of his day to give attention to this all important problem. He anticipated Koch in the matter of treatment, though without knowing the rational basis. Sertürner conceived of cholera as a gastric disturbance and was supported in this by an English physician, Henderson. Together they proposed to cure cholera with magnesium oxide, castor oil and laudanum. One reason for the choice of magnesia was the reported presence of acetic acid in the mouth and rectum of dying victims. The other reason was an assumed benefit from alkaline earths in disease in general. The proposed remedy was never put to a test. Sertürner's most important advice for the prevention of cholera was to purify (boil) the drinking water, and fifty-three years later Koch discovered the cause and confirmed Sertürner's hunch on the preventive measure.

Nolte has discussed at length Sertürner's conceptions of body functions and diseases. Most of these conceptions were erroneous; for example, he proposed to use alkali earths in the treatment of nearly all diseases just as he explained body processes on the basis of changes in alkaline earths. It might be contended that he was not far from the truth about physiological and disease processes. For, does not modern physiology recognize the importance of a proper acid-base equilibrium for health and medicine, the disturbances in this equilibrium for disease, *viz.*, the clinical acidosis of the dysenteries, cholera, etc.?

During this period Sertürner founded a system of Chemical Physics (modern Physical Chemistry). He also founded, and published during three years, the "*Annalen für Universalsystem der Elemente.*" In these publications he discussed the life element "Zoön," the cold nature of light, atmospheric heat, various drugs, the art of gunnery and many other things, all of which were speculative. He

began to show his weakness, and for all these things he was ridiculed and attacked. He complained in his *Annalen*, saying, "As a result of my work with opium, von Sternberg called me a pupil and later another distinguished German chemist called me a quack." In his necrology of Sertürner, Buchner said, "Sertürner made a notable beginning in the realms of Chemistry and Pharmacy, and indicated the greatest hopes, but he failed to realize a beautiful and fruitful promise because of his speculations in physics and medicine and of his controversies."

VALUE OF SERTÜRNER'S ORIGINAL WORK.

There is no doubt that Sertürner was not a well-read or scientifically trained man, but that makes his work and conclusions all the more remarkable. Considering this lack of training he possessed the power of making remarkably correct deductions. His discovery of morphine was accomplished rather simply and cleverly, in fact, under exceedingly humble circumstances. He worked intuitively and later became a speculative philosopher. To-day he might be regarded as a man of "good hunches." He worked alone, and, instead of being given advice, was showered with rebuke and bitter criticism. He was reproached for not being more scientific, though his critics were no supermen; some did not accomplish as much as he, but, secretly, made use of much that Sertürner discovered.

There is no doubt that Sertürner laid the foundation of alkaloidal chemistry. After his discovery and the isolation of morphine, came the following important alkaloids; emetine (Pelletier and Magendie, 1817), strychnine (Pelletier and Caventou, 1817), quinine (Pelletier and Caventou, 1820), caffeine (Runge, 1820), atropine (Mein, 1833), aconitine (v. Planta, 1850), veratrine (Merck, 1855), cocaine (Wöhler, 1860), eserine (Jobst and Hesse, 1864), muscarine (Schmiedeberg and Koppe, 1870), pilocarpine (Hardy, 1875), pelletierine (Tanret, 1878), nicotine (Liversedge, 1881), ephedrine (Nagai, 1887) and ergotoxine (Barger and Carr, 1906). Accordingly, a span of 103 years elapsed before the isolation of these 15 alkaloids was accomplished. These discoveries were for the greater part only repetitions of what the obscure Paderbornian pharmacist had done under difficulties. He recognized the principles which govern the isolation of these important plant constituents. In fact, his work was the starting point for the discovery of all active constituents, which were destined to play an important rôle in the development of experimental pharmacology and of rational therapeutics. For it is only by using definite and pure constituents that accurate doses can be given and their effects scientifically studied. His discovery came at the zenith of the nihilistic period in therapeutics, and thus served as a starting point for the period of reconstruction which followed and still continues.

Besides isolating morphine, as the first alkaloid, Sertürner determined its chemical nature and showed that the effect of opium on man was essentially due to this constituent. His work has been amply confirmed and has stood the test of time, but it cannot be said that it has been greatly extended along chemical lines. For instance, the structural formula of this most important alkaloid has not been definitely established; nor has the alkaloid been synthesized. These deficiencies exist despite the tremendous resources of present-day chemistry.

Humanity owes Sertürner a permanent debt of gratitude for his contribution to the alleviation of suffering. His discovery is not limited in application to one

disease as is insulin to diabetes or diphtheria antitoxin to diphtheria, but it is widely applicable to the relief of that distressing symptom—pain—in all kinds of conditions. As a matter of fact there is hardly a branch of medicine which is not indebted to Sertürner's discovery for making it possible to serve mankind. This beneficence extends even to animals of the lower orders. Considering that this discovery led directly to the discovery of such important alkaloids as quinine, cocaine, emetine, ephedrine and others, it is not too much to say that Sertürner promoted not only the conquest of pain, but also of disease prevention, and thus facilitated the conquest of continents and of uncivilized peoples. Thus, Sertürner's discovery stands well alongside of the greatest discoveries which have benefited the human race. No wonder that it was hailed as an important one.

Now, on the 125th anniversary of this important discovery, we reaffirm our gratefulness for the timely effort and native talent of the once obscure pharmacist of Paderborn. There is indeed a lesson in his achievement. In it we have an example of drug store research 125 years ago. Would it be too much to expect of American Pharmacy to draw a fresh inspiration for higher and better things from Sertürner and his discovery? Could this happen, it would contribute to her a life element of inestimable worth.

AUTHOR'S NOTE: My acknowledgments are due to the University of Wisconsin Library, Madison, Wisconsin, for a loan of the journals containing the papers by Sertürner; and to Prof. Dr. H. Freund of the University of Münster, Germany, for certain cuts, which have been used in this paper, and a pamphlet by Dr. Krömeke, previously unknown to me, all of which were received after completion of this paper.

REFERENCES TO RECENT LITERATURE.

(1) H. Coenen: *Med. Klinik*, 24 (1928), 357.

(2) H. Freund: *Ibid.*, 24 (1928), 398.

(3) F. Krömeke: Friedrich Wilhelm Sertürner, der Entdecker des Morphiums. Lebensbild und Neudruck der Original, Morphiumarbeiten. Gustav Fischer, Jena (1925), 93. This contains a biographical sketch by Dr. Krömeke, with references to older literature on Sertürner, and reprints of the five papers on opium and morphine by Sertürner.

SYRUP OF FERROUS IODIDE AND THE OFFICIAL HYDRIODIC PREPARATIONS.

BY H. V. ARNY, BENJAMIN VENER AND LESLIE C. JAYNE.

(*Concluded from p. 268, March Issue*).

Part II.

SYRUP OF FERROUS IODIDE.

(Work performed with Leslie C. Jayne, Ph.Ch., B.S.)

Three samples of this syrup were prepared:

A. Exactly as directed by U. S. P. X. The fresh sample assayed 5.1793 per cent ferrous iodide.

B. As directed by U. S. P. X with omission, however, of the hypophosphorous acid. The fresh sample assayed 5.4116 per cent ferrous iodide.

C. As directed by U. S. P. X except that the sugar is replaced by the same