Noël Etienne Henry

RESUMEN. Noël-Etienne Henry (1769-1832), un farmacéutico Francés, que estuvo a cargo de la Farmacia Central de los hospitales de Paris, trabajó principalmente en las áreas de química extractiva y química de los alimentos. Llevó a cabo un detallado análisis cualitativo de la composición y del principio activo presente en cinamomo, aceite de ricino, fedegoso, genciana, ipecacuanha, muérdago, nuez moscada, paratodo, ruibarbo, azafrán, vetiver, gorgojo del trigo, etc.

ABSTRACT. Noël-Etienne Henry (1769-1832), a French pharmacist, who most of his life was in charge of the Central Pharmacy of the Parisian hospitals, worked mainly in the areas of extractive chemistry and food chemistry. He carried on a detailed qualitative analysis of the composition and active principle present in, cinamomo, castor oil, fedegoso, gentian, ipecacuanha, mistletoe, nutmeg, paratodo, rhubarb, saffron, vetiver, wheat weevil, etc.

LIFE AND CAREER

Noël-Etienne Henry, was born in Beauvais on November 26, 1769, the son of a modest local merchant. After finishing his primary education at the local school, he was awarded a government scholarship to study in Paris. In 1793, he entered the Collège de Navarre (one of colleges of the University of Paris) and after finishing his basic studies he begun to study medicine, at the Hôtel-Dieu (the oldest hospital of the city of Paris), while simultaneously taking all the courses in chemistry and natural sciences given at the Jardin des Plantes and the Collège de Pharmacie. In 1794, he was admitted member of the Collège de Pharmacie and in 1797, he was appointed sub-director of the Pharmacie Centrale des Hôpitaux de Paris (Central pharmacy of the Parisian hospitals), directed by Jean-François Demachy (1728-1803). In 1803, after Demachy’s death, he was promoted to director of the institution, serving in this position until his death (1832). During his tenure he assembled a very rich teaching collection of samples in the areas of botany, zoology, and mineralogy. In 1804, he was appointed adjunct professor of chemistry at the École de Pharmacie (created in 1803), position he kept until 1826. Noël-Etienne Henry was one of the nine pharmacists appointed full members of the Académie Royale de Médecine, when it was
reestablished by the King Louis XVIII in November 1820. He was also member of the Société Philanthropique de Paris and secretary of the Commission des Remèdes Secrets, serving as one of the editors of the Codex Medicamentarius.1,2

Noël-Etienne Henry died in 1832 during the cholera epidemics that affected Paris [1].

Henry worked mainly in the areas of extractive chemistry and food chemistry. In addition to the subjects described below he also investigated the preparation of ethyl acetate and ethyl ether,4-6 of iodides and iodates and medicines based on them,7,8 and of strychnine,9, the properties of horse-chestnut (Aesculus hippocastanum);10 the extraction of castor (Ricinus communis) oil,11 of the oil in eggs,12 and in the seeds of camelina sativa (Myagrum sativum);13 the composition of palm oil14 and nutmeg,15 the analysis of the bark of parobo,16 pari-parobo,17 and vetiver;18 and the action of quinine sulfate on the color of wines.19

**SCIENTIFIC CONTRIBUTION**

Noël-Etienne Henry wrote over 45 papers and three books.2,20,21 Here the author describes the ones related to extraction and qualitative analysis of vegetable and animal principles.

**Ipecacuanha**

The first paper of Henry was devoted to a study of the emetic properties of the bark of gray ipecacuanha (Carapichea ipecacuanha) and the analysis of its root.22 Henry remarked that among the several scientists that had referred to this plant, only Joseph Marie François de Lassone (1717-1778) and Claude-Melchior Cornette (1744-1794) had analyzed the root and shown that the ligneous part was as nearly as emetic as that which was separated from it, and that the extractive portion also had this property, although with less violence and energy.23 According to Henry, in spite of the experiments of Lassone and Cornette, it seemed that the ligneous part of the plant had never been used for medical purposes, and for this reason, as a first stage, he decided to carry experiments in the hospitals of Paris, using gray ipecacuanha as the starting material (the color of the material, gray, red or brown, depends on the age of the plant, the drying process, etc.). He carefully separated the ligneous from the cortical part of the root and sent samples to the chief pharmacists at the Hôtel Dieu, Hôpital Saint Antoine, and Hospice de la Maternité; all of them reported that the ligneous material was equally emetic and purgative as the cortical one.

In the next stage, he carried on a detailed study of the cortical and ligneous parts of the plant. Each one was treated separately with sulfuric acid, distilled alcohol, and cold and hot water. The ether and alcoholic extracts of the cortical and ligneous parts yielded, after evaporation, a resinous matter, inflammable, and insoluble in water. The water extracts yielded a citrine solid, having a slight bitter taste. Once again, these two fractions were tested in the hospitals and found to have the same emetic and purgative properties. Hence, it was easy to see that the both parts of the root had the same properties; the only difference was the amount of resin and extract they furnished.

The last tests were related to the action of water and several chemical reagents on both parts of the root. Henry’s observations indicated that the cortical part treated with boiling water, swelled like Bassora gum; treatment with nitric acid released a substantial amount of nitrous acid and left a residue of malic acid. These results indicated that this matter was not a resin but a particular gum mixed with resin and extract, which alone gave it emetic properties. Boiling the cortical fraction led to a turbid solution, which after filtration deposited a whitish matter having the properties of an elastic gum. The infusion reddened litmus paper; it did not become turbid when mixed with a glue solution but did when treated with sulfuric acid. It was precipitated by silver nitrate and ammonium oxalate and not precipitated by barium nitrate, potassium tartrate, and antimony tartrate. The infusion of the ligneous portion showed the same properties. This behavior indicated that both parts of the root contained a thermally unstable free acid of a vegetable nature, and different calcium salts.22

[1] Most books on thermodynamics mention that Sadi Carnot also died during this epidemic.
Rhubarb

In 1814, Henry published a long memoir comparing the properties of three commercial varieties of rhubarb, originating from China, Moscow, and France (Henry, 1814). He first gave a short historical summary of the different studies, which had been published in the literature, highlighting the facts that rhubarb had strong antiseptic properties and that its principal components were gum, resin, an astringent and tanning matter, and calcium oxalate. He then proceeded to describe the general properties of material available in the commerce. Chinese and Muscovite rhubarbs were sold as cylindrical or flat yellow pieces, having a pronounced odor, bitter taste, and tinting saliva orange yellow or saffron. Their powder was orange or yellow. The French material was more voluminous, had a strong nauseous and unpleasant odor, a very astringent taste, and tinted saliva pale yellow; in powder form it had a reddish color.

The next sections described in detail the different procedures employed to separate and identify the materials present in each rhubarb sample. These included preparation of aqueous and alcoholic extracts, separation of the solutions and solid residue, and their treatment with a large number of reagents. The main results were as follows: (A) Chinese and Muscovite rhubarb were found to contain at least 10 principles: (1) a yellow coloring bitter matter, insoluble in cold water, soluble in hot water, alcohol, and ether, vaporizing partly as a yellow odorous fume. It dissolved in aqueous KOH or ammonia yielding a red solution, from which it precipitated when treated with acids. It produced a yellow precipitate with acids and aqueous solutions of lead, tin, mercury, and silver salts; a green black precipitate with ferric sulfate, and a hard milky precipitate with gelatin. Nitric acid converted it into a bitter yellow principle; (2) a sweet fixed oil, soluble in ether and alcohol, and becoming rancid under the action of heat; (3) a small amount of gum; (4) a starchy substance; (5) woody material; (6) calcium malate; (7) calcium oxalate; (8) calcium sulfate, (9) a potassium salt; and (10) an insoluble iron salt; (B) French rhubarb differed from the Chinese and Muscovite ones in that it contained much more tannin and that this tannin was reddish instead of yellow. It had a stronger astringent taste, its alcoholic extract was more strongly colored, and its aqueous extract produced a larger amount of precipitate with gelatin. It also contained a much larger amount of starchy material.

Gentian

The preparation of several extracts based on the dry root of gentian (Gentiana lutea), a plant growing in the Alps, Tyrol, the Pyrenees, and France, led Henry to carry experiments to determine the character and properties of the root. Previous researchers had noticed that extraction with water removed more material than with alcohol, but that the latter solution was more active and bitter; others had described the medical properties and uses of the extracts. Henry extracted the powdered root with ether and noticed that the extract had a yellow green color and bitter taste; distillation of the same left a semi-fluid bitter residue, smelling like gentian and which did not redden litmus paper and seemed to be composed of oil and a more solid substance. The oil was cleanly separated by extraction with cold alcohol. The remaining solid was treated with cupric oxide and shown to contain only carbon, hydrogen, and oxygen. Evaporation of the alcoholic extract left a red fatty solid residue, containing an odorant substance, which could be separate by distillation in the presence of water.

In the following set of experiments Henry submitted the solid remaining from the first ethereal extraction, to successive extractions with distilled alcohol and cold water, dried the extracts, and treated them with a variety of chemical reagents (e.g. barite, ammonia, ammonium oxalate, led acetate, iodine, nitric acid, HCl, etc.). The results of the different treatments led Henry to conclude that gentian contained: (a) a purely vegetable substance resembling bird-lime; (b) a resin combined with an oil, which gave to gentian its peculiar odor; (c) a bitter extractive principle, similar to the one extracted from quinine; (d) gum mixed with a coloring matter; and (e) calcium phosphate. The results showed that gentian did not contain starch, inulin, or alkaline substances.
Canella (Canella alba, and Canella winterana)

In 1819, Henry published a paper describing the experiments he had done in order to find if the two barks known under the names Canella alba and Canella winterana were significantly different. The white canella was a tree a tree originating from the Antilles whose bark had a smell analogue to that of coriander, although sweeter and more agreeable. The powder of the same was yellow white and had a hot piquant aromatic taste. It had recently been substituted by the bark of canella Winteriana introduced in Europe from South America by captain Winter, at the end of the 16th century, and used by him to prevent scurvy in the crew. This canella differed from the first one in having a stronger color, gray on the outside and red in the inside, a stronger smell, and its powder having a color similar to quinine.

To do so, Henry treated both barks with ether, alcohol, cold and hot water, and heat, and the pertinent extracts with a variety of reagents (e.g. platinum dichloride, silver and barium nitrate, ammonium oxalate, KOH, NaOH, ammonia, nut gall tincture, ferric sulfate, etc.). White canella was found to contain resin, a volatile oil, gum, starch, an extractive substance and an extractive color, albumen, potassium an calcium acetates, potassium and magnesium chlorides, and calcium oxalate. The extractive substance had a strong disagreeable odor, similar to animal gelatin, a salty bitter taste; it absorbed humidity from the air, it slightly reddened litmus paper, and seemed to contain about 50 % of the resin mentioned before. The Winterian canella was found to contain resin, a volatile oil, a coloring matter, potassium acetate and chloride, potassium sulfate, calcium oxalate, ferric oxide and, tannin. It did not contain starch or gum. The volatile oil was dark yellow, had a very hot and acid taste. An interesting property was that after left alone for about 15 days, this oil separated into two fractions, a supernatant liquid one, and another, lighter than water, having the consistency of a fat. The alcoholic extract of this bark contained tannin, potassium acetate, and a large amount of brown red coloring matter; the latter with easily separated with the help of aluminum and potassium sulfate.

Saffron

In 1811 Edmée Bouillon- Lagrange (1764-1844) and Heinrich August von Vogel (1778-1867) published a paper about the constitution of saffron, a spice derived from the flower of *Crocus sativus*, and used mainly as a seasoning and coloring agent. Little information was available on the subject; it was known that one kilogram of saffron distilled with water yielded one ounce 12.5 g of golden-yellow heavy oil smelling strongly as saffron. The alcoholic extract was precipitated by ether, indicating that saffron was mainly composed of a soapy principle and did not contain gum, resin, or mucilage.

Bouillon- Lagrange and Vogel found that saffron placed inside a glass bell deprived of air, lost its color completely when exposed to sunlight. Cold water became instantly yellow by the addition of saffron, and of a deep red on standing twenty-four hours. The solution was slightly bitter and turned yellow litmus paper; the color was not eliminated by water washes but was bleached immediately by chlorine. Digestion of the water extract with boiling alcohol of density 0.798 dissolved all the coloring matter forming a deep yellow tincture and leaving a colorless and tenacious mucilage having all the properties of gum. When saffron was distilled with water the first fraction was milky, bitter, aromatic water, slightly acid. Two oils appeared at the same time, one swimming in the distilled liquor and the other sinking at the bottom. The latter had the same smell and taste as that of the first fraction, and was readily soluble in water.

To obtain the coloring matter of saffron separately, Bouillon- Lagrange and Vogel macerated it in alcohol and evaporated the resulting tincture to dryness. The resulting yellow red solid residue absorbed humidity from the air and became viscous. The coloring matter was purified by evaporating the aqueous infusion to the consistence of honey, followed by extraction with alcohol and evaporation to dryness. The extract was found to be insoluble in fixed and essential oils and to possess a very intense degree of coloring power compared to its quantity. For this reason
Bouillon-Lagrange and Vogel decided to name it *polychroite* (also called crocin and safranin). They summarized their results indicating that 100 g of saffron contained 10 g of water, 6.50 of gum, 0.50 of albumin, 65.0 of polychroite, 0.50 of waxy matter, 10 of vegetable debris, and an unknown amount of volatile oil. In 1821 Henry decided to study polychroite in more detail to verify was claimed about its properties and add more information. He treated well-dried saffron with ether and noted that the pale yellow solution evaporated spontaneously leaving a residue composed of volatile oil, wax, and an acid. The latter appeared to be malic acid; it was deliquescent, did not crystallize, and with acid generated salts that seemed to be malates. According to Henry, the alcoholic extract of saffron that Bouillon-Lagrange and Vogel regarded as the pure coloring matter mixed with a small amount of volatile oil, actually owed its large solubility in water and other properties to the combination of these two substances. This was easily justified by the fact that adding a little of KOH or NaOH to the alcoholic extract dissolved in a small quantity of water resulted in the formation of a large amount of yellow flakes, which could be separated by filtration. The filtrate was found to contain a very small amount of coloring matter and volatile oil combined with the alkali. Heating the filtrate led to separation of the volatile oil diffusing a bitter piquant odor that provoked lacrimation. A similar result was obtained if the alkali was neutralized with an acid. Other alkaline oxides, such as magnesia, baryta, and ammonia acted with less intensity, or not at all.

To extract the coloring matter, Henry exhausted saffron with boiling water, concentrated the extract to the consistency of a thick syrup, followed by extraction with concentrated alcohol. Employment of concentrated alcohol was indispensable to separate the gum and albumen present. The alcoholic extract was distilled to eliminate about three quarters of the solvent. The residual liquid was the coloring matter combined with the volatile oil, having an acid and piquant taste. This substance was separated by addition of a small amount of KOH or NaOH, followed afterwards by addition of an excess of an acid such as acetic. The mixture was split by neutralization of the alkali, followed by successive washes with water.

Henry described the coloring matter as follows: when dried it was pulverulent and had a scarlet color; when humid it was yellow, odorless, had a slight bitter taste, and colored saliva yellow. It was sparingly soluble in cold water, a little more soluble in hot water, completely soluble in distilled alcohol and fixed or volatile oils, and in alkalis at room temperature. It was slightly soluble in organic acids producing strong red solutions. Calcination in a platinum crucible left a very small residue of ferric oxide; treatment with cupric oxide yielded water, CO₂, and no traces of nitrogen.

In order to separate the volatile oil Henry distilled a mixture of one part of dried saffron with eight parts of saturated brine, and one half part of aqueous caustic; the oil came over into the receiver, and left the coloring matter in the retort, which could be precipitated from the alkaline solution by an acid. The oil had a very intense yellow color, a bitter taste, and an agreeable smell. It was soluble in water and in alcohol; and the solution, by exposure to light, gradually lost its color, which was destroyed instantly by chlorine. A few drops of sulfuric acid changed the color to a beautiful blue; and nitric acid, added in like manner, to green.

From the above results, Henry concluded that (a) polychroite should be considered a combination of volatile oil and coloring matter; (b) the separation of the two components could only be achieved with the help of an alkali; (c) saffron contained 42 % of coloring matter and 10 % of volatile oil; (d) the properties of the coloring matter, separated from the volatile oil, were different from those of the mixture; (e) the properties of the volatile oil were very similar to those of saffron; (f) saffron contained malic acid, as claimed by Bouillon-Lagrange and Vogel; and (g) alkalis and acids were able to precipitate part of the coloring matter present in aqueous extracts and alcoholic extracts (diluted or concentrated), by destroying the combination of fatty material and polychroite.
Mistletoe (Viscum album)

At some time, Joseph-Louis Proust (1754-1826) requested from Henry to carry on some experiences on the fruit of mistletoe, a semi-parasitic plant growing in the branches of hardwood trees like oak and apple. The fruit is a white berry containing its seeds in a viscous sticky and tasteless juice, having a nauseous smell. Henry remarked that the viscosity of the berries made it very difficult to extract its juice. For this reason he tried two methods, one exposure of the fruit to the steam from boiling water, and the other, to soften it by heating with a little water at the temperature of a water bath.29

The juice of mistletoe, contacted with boiling water, turned into an opaque viscous fluid, surmounted by a flocculent deposit. The filtrated deposit, heated with a little water, became viscous as the original liquid. This characteristic became more pronounced if it was first mixed with alcohol and then precipitated with water. The filtrate of the first operation was yellow, slightly viscous, and produced a white precipitate with lead sub acetate and a while gray one with mercurous nitrate, and did not react with nutgall tincture. Treatment of the juice with rectified alcohol turned it into a gray viscous mass, while the alcoholic extract became yellow. Distillation of the latter passed colorless alcohol smelling like mistletoe; the remaining residue was soluble in alcohol and insoluble in ether. Treatment of mistletoe juice with ether extracted a yellow fatty matter, more solid than tallow, having a strong aromatic odor like rancid fat, completely soluble in ether, and not reacting with nitric acid.29

After additional treatment with non volatile oils (olive oil and turpentine), concentrated acetic acid, alkalis, distillation with nitric acid, etc. led Henry to conclude that the pulp material of mistletoe berries contained parenchyma and a viscous substance of particular nature, as well as an extractive substance and a solid non volatile fat; and did not show the presence of starch. The viscous substance was insoluble in water, alcohol, ether, fixed and volatile oils, and acetic acid. It formed with water an opaque viscous mass, insoluble in cold and hot water; which nitric acid transformed into oxalic acid. It was constituted by carbon, oxygen, and hydrogen, and did not contain nitrogen.29

In a following publication Henry indicated that since old days mistletoe was used as an anti-epileptic and his berries known to act as a strong purgative, although birds and many animals avidly ate it. The seeds were not digested and were thus spread by the birds. The peasants used the sticky gelatinous properties of the fruit to prepare a material to catch small birds (birdlime). Henry indicated that this viscous material was actually contained in all parts the plant, and could be separated by simple mechanical means from the bark or the berries. If the resulting juice was kneaded with water, birdlime became attached to the fingers as a white opaque mass, while leaving the filaments as residue.30

In this new publication Henry reported the result of addition experiences carried on to determine in more detail the composition of birdlime. Birdlime was obtained by extracting the crashed berries with ether, followed by spontaneous evaporation. The resulting soft mass was insoluble in water, ethyl acetate, slightly soluble in alcohol, and very soluble in cold or hot ether. The first ether extract contained a mixture of green waxes and birdlime and evaporated to a green residue; additional extracts contained birdlime more and more pure, and their evaporation yielded whiter birdlime. The green waxes were easily eliminated by extraction with alcohol. The juice obtained from the berries was able to absorb a large quantity of water, like a sponge, without a significant change in its consistency. Addition of a considerable amount of water transformed it into an almost non-viscous liquid, which on filtration left a small amount of a solid residue. These two fractions were subjected to the action of several reagents and solvents, among them, alkalis, acids (nitric, sulfuric, HCl, and acetic), ether, alcohol, fixed and volatile oils; as well as calcinations of some of the solids obtained. The results indicated that the berries of mistletoe contained (a) an abundant amount of waxes, birdlime, and gum; (b) an insoluble viscous material; (c) chlorophyll; and (d) potassium calcium, magnesium, and iron salts.30
Paratodo

In 1823, Henry reported a qualitative analysis of the bark of paratodo, a plant growing in Brazil (most probably, *Gomphrena officinalis*). According to Henry, it was possible to distinguish three layers in it, the most internal one composed of fibrous cortical strata forming the phloem, an external one built of cellular spongy and soft tissue and epidermis, and the middle one, which seemed to be formed or a set of very old granular hard cortical layers. The bark was first extracted repeatedly with refined alcohol and the solution distilled to eliminate the solvent. The resulting residue was brown, extremely bitter, and having the odor or the bark. After being powdered it was extracted repeatedly with ether and the resulting colored solution left to evaporate spontaneously; the resulting brown residue was found to be insoluble in water and highly bitter. Henry assumed it was a fatty material similar to the one found in a large number of vegetable analyses, but combined with a number of immediate principles of paratodo. The solid remaining after the ethereal extraction was colorless and tasteless. It was macerated with cold water, yielding a yellow bitter extract. The latter was mixed with magnesium hydroxide, concentrated by heating in a water bath, and then filtrated. The resulting liquid kept its color and flavor. After being treated with lead neutral acetate and hydrogen sulfide, it was evaporated to dryness in a water bath. The resulting solid was considered to be the bitter principle of paratodo. According to Henry it was a yellow brown translucent solid, very bitter, soluble in water and alcohol, deliquescent, not influenced by barite water, KOH, ferrous sulfate, and lead neutral acetate; producing a white flocculent precipitate with silver nitrate, and a white precipitate with mercuric chloride and nutgall tincture. After additional testing, including calcination, Henry concluded that the bark of paratodo contained a particular bitter principle, resin, fatty material, coloring matter, starch, potassium acetate, salts of calcium and magnesium, and woody material.

Fedegoso

In 1817, Charles-Louis Cadet de Gassicourt (1769-1821) reported the analysis of a sample of the ligneous part of the roots of fédégose, a plant growing in Brazil, which had been sent to him by the French Ambassador. The local inhabitants used this root as a general-purpose medicine. Cadet Gassicourt wrote that he had been unable to find this plant described in any modern botanical publication. The results of the analysis indicated that the root was slightly resinous and contained an astringent principle. Its aqueous extract was bitter and slightly aromatic, reddened litmus paper, gave a black precipitate with iron and a white one with silver nitrate, it was not precipitated by gelatin, and contained chlorides and potassium. Cadet de Gassicourt speculated that the coloring of litmus paper was due to the presence of gallic acid.

According to Henry, fedegoso belonged to the family of leguminous, was used in Brazil as a febrifuge, although it was not known how strong were its properties. When powdered, the ligneous material was yellow, similar to that of rhubarb, odorless, and had a slight nauseous bitter taste. Henry treated the root using two procedures. In the first one he extracted the powdered root with water, ether, etc, and in the second, he boiled it with water acidulated with sulfuric acid, followed by neutralization with calcium carbonate, filtration, and alcohol extraction of the precipitate.

The ether extract was yellow orange and evaporated to dryness left a large amount of orange coloring matter. The brown residue of the ether extraction was tasteless, insoluble in water, and soluble in hot alcohol. It was partially soluble in ammonia, leaving a gelatinous magma containing small pearly fibers. After decolorization it was shown to be a waxy material not containing nitrogen. Treated with first with alcohol and then with ether separated a sweet-tasting brown viscous substance, bitter and nauseous, and showing no action on litmus paper. Additional treatment showed it to be the bitter principle of the ligneous material of fedegoso, non-crystallizable and of resinous nature.

The results of further treatments (including calcinations) led Hendry to conclude that the ligneous material of fedegoso contained (a) a waxy material; (b) a resinous substance, bitter,
nauseous; (c) a yellow coloring matter, which turned red brown under the influence of ammonia or NaOH; (d) a small amount of gum, sugar, gallic acid, and woody material; and (e) potassium sulfate, potassium chloride, potassium acetate, calcium phosphate, calcium oxalate, silica, and ferric oxide. All these facts indicated that fedegoso was not particularly important as a medicine because its extractive principle showed a weak activity.³³

**Wheat weevil**

Previous researchers had shown that weevils contained an acid analog to gallic acid. Henry and Jean-François Bonastre believed that it was necessary to carry on more research about these insects.³⁴ For this purpose, they submitted them to the action of ether, alcohol, water, HCl, and heat (calcinations) and obtained the following results: (1) The ether extraction showed the presence of two oily substances, one clear yellow, the other, brownish. Both reddened strongly litmus paper, had a hot non-permanent taste, and smelled like yeast. The acidity was eliminated by water washes; the acid water produced a black precipitate with ferric sulfate. The results proved that the ether had removed three substances, an acid similar to gallic acid, a fatty material soluble in alcohol, and two fatty substances colored differently, and insoluble in alcohol; (2) The extract obtained with refined alcohol was colored gold yellow and slightly reddened litmus paper; it was partially soluble in water producing a strong yellow red aqueous solution. The latter was tested with different reagents: lead sub-acetate produced a flocculent green precipitate; silver nitrate, a white precipitate soluble in nitric acid, mercurous chloride, a white precipitate; ferric salts, a black precipitate, and albumen an abundant flocculent precipitate. No precipitate or change in coloration was observed with mercuric chloride, platinum dichloride, iodine tincture, soap water, barium salts, and gallnut tincture. These results indicate the presence of a particular acid, a substance similar to tannin, and a resin; (3) A boiling water extract of the material left after the alcoholic extraction, was colored gray black and weakly reddened litmus paper. It produced a gray black precipitate with lead sub-acetate, a green black precipitate with ferric sulfate, an abundant precipitate with albumin and ammonium oxalate; and did not react with silver nitrate, acids, and barium nitrate. Hence, this extraction had dissolved gallic acid, a substance similar to tannin, a bitter principle, and an animal matter, partly non-volatile, partly volatile when steam distilled; (4) the residue resulting from the above extractions was now boiled with water acidulated with HCl and shown to contain animal matter, sulfuric acid, ferric oxide, and phosphates; (5) the final residue was calcined at a high temperature and seen to release a fetid odor similar to burned corns and leave a white residue. Test of the latter showed the presence of silica, calcium and magnesium phosphates, ferric oxide, sulfuric acid, and a vegetable acid.³⁴

Experiments carried on with live weevils showed that they died promptly when exposed to hot sun, chloride vapors, and ammonia vapors.³⁴

**References**


