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ANALYSIS OF THE VOLATILE OIL OF MONARDA PUNCTATA

A Contribution from the Chemical Laboratory of the Philadelphia College of Pharmacy.

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Read at the Pharmaceutical meeting, February 21.

Horsemint is a perennial herb, indigenous to the United States, and belonging to the natural order Labiatae; the leaves and tops being used in the preparation of the volatile oil. This volatile oil is described as having a yellowish or brownish-red color, lighter than water, and crystallizing below 5° C. It consists of an elaeopten, which has not been examined; and a stearopten, which is thymol  $C_{10}H_{14}O$ , identical with that obtained from oil of thyme.

Oil of horsemint, as far as could be found, has only been examined by Arppe (1846, Liebig's Annalen, lviii. 41), who separated an eltaeopten and a stearopten. The results of his experiments with the latter compound showed the following composition:

Calculated for  $C_{10}H_{14}O$ . Thymol. Arppe (mean).

C—80.00	78.88
H—9.33	9.42
O—10.67	11.70

He also gave the composition of the elveopten, which boiled at 224° C., as follows: C—86.41; H—9.85; O—3.74.

The analysis of this oil was conducted in the Chemical Laboratory of the Philadelphia College of Pharmacy, under the direction of Professor Trimble.

Three samples of the oil were used to experiment with.—Sample No I, was a specimen from the Museum of this College, which was presented some six years ago. It was contained in a ten pint bottle and about one-quarter of its volume was a crystalline deposit of thymol, having formed gradually by age. It was of reddish-yellow color, sp. gr. .926, strong mint-like odor and neutral reaction. Samples Nos. II. and III., were procured from reliable sources, had both a brownish-red color, sp. gr., .920 and .922 respectively, somewhat fragrant and minty odor, and neutral to test paper. These were subjected several times to a temperature of—15° to—20° C. for several hours, but no separation of thymol occurred. The process described in the National Dispensatory was then tried as follows:—The oils were subjected to fractional distillation; portions of the distillates obtained at above 200° C. were treated with solution of soda, the sodium compound separated and treated with HCl, but no thymol was obtained. The higher fractions obtained by fractional distillation from all three

samples (225°-245° C.), were also subjected to a temperature of below—15° C, but all without yielding crystals of thymol. It was concluded that samples Nos. II and III had either previously been treated for thymol and separated, or else being freshly distilled oils, had not become sufficiently changed to allow of the crystallization of that compound. This latter view, from further investigations, is probably the correct one.

Sample of oil No. I assumed with solution of ferric chloride a bright-red color, changing on long standing to near black. Samples Nos. II and III gave no reaction with this reagent. Solution of bisulphite of sodium gave no reaction with either of the samples of oil, indicating the absence of any aldehyde-like bodies.

Sample of oil No. I, after partial drying with calcium chloride, was subjected to fractional distillation. On redistillation 6 fractions were obtained as follows:

I. 170°-185° C.	III. 200°-230°.	V. 245°-255°.
II 185°-200°.	IV. 230°-245°.	VI. 255°+

Fractions V and VI had low boiling points, showing decomposition products. Fractions I and IV were the largest, and therefore were investigated. The former constituted about 25 per cent., and the latter 15 per cent. Fraction I (170°-185°) was redistilled over zinc dust, the largest portion distilling at 170°-173° C. This having a quite constant boiling point, several ultimate analyses were made of same. The results, however, showed from 2-4 per cent. still lacking to assume this body a hydrocarbon. The same portion was now redistilled over metallic sodium; three combustions of this distillate were made with results as follows:

Calculated for C <sub>10</sub> H <sub>16</sub> .		Found.		
		1.	2.	3.
C	88.23	88.10	88.35	88.28
H	11.77	11.20	11.30	11.45
	100.00	99.30	99.65	99.73

The above results would show the presence of a hydrocarbon in the oil, corresponding closely to C<sub>10</sub>H<sub>16</sub>. This fraction was colorless, sp. gr. .856, and of fragrant odor. The formula of this body was established by taking its vapor density, which will be given below.

Fraction IV (230°-245°) after redistillation gave a very large portion distilling at 230°-233° C. This was of slight yellow color, sp. gr. .968, quite viscid, and somewhat minty and camphoraceous odor. This was submitted to ultimate analysis, three combustion& giving following results:

Calculated for C <sub>10</sub> H <sub>14</sub> O.		Found.		
THYMOL.		1.	2.	3.
C	80.00	79.75	79.85	80.05
H	9.33	9.44	9.32	9.35
O	10.67	10.81	10.83	10.60

The above corresponds very close to the formula  $C_{10}H_{14}O$ , being that of thymol. The formula of this body was also calculated from its vapor density.

Sample of oil No. II was next submitted to fractional distillation, similar to that pursued with sample No. I. The oil began to boil at  $150^{\circ} C.$ , and after repeated distillation the following ten fractions were obtained :

I.  $160^{\circ}$  to  $175^{\circ} C.$  — II.  $175^{\circ}$  to  $180^{\circ}$  — III.  $180^{\circ}$  to  $185^{\circ}$  — IV.  $185^{\circ}$  to  $195^{\circ}$  — V.  $195^{\circ}$  to  $210^{\circ}$  — VI.  $210^{\circ}$  to  $220^{\circ}$  — VII.  $220^{\circ}$  to  $233^{\circ}$  — VIII.  $230^{\circ}$  to  $240^{\circ}$  — IX.  $240^{\circ}$  to  $250^{\circ}$  — X.  $250^{\circ}+$ .

Fractions I, VIII and IX being the largest, constituting about 15 per cent., 25 per cent. and 20 per cent. respectively, were therefore only investigated. The fractions obtained between  $180^{\circ}$  to  $225^{\circ} C.$ , were taken to be mixtures of these larger ones; the distillate coming over regularly and gradually until  $230^{\circ}$  was reached, when the largest fractions were obtained. The portion distilling above  $250^{\circ}$  was viscid, of dark-brown color, empyreumatic odor; this being a decomposition product was disregarded.

Fraction I ( $160^{\circ}$  to  $175^{\circ}$ ), after redistillation of several times over metallic sodium, the largest portion distilled at  $160^{\circ}$  to  $163^{\circ} C.$  This corresponded to the lightest portion obtained from sample No. I, although the boiling point of, the former was a few degrees higher than that of this body. This was colorless, of fragrant odor, sp. gr., .854.

Five combustions of this compound, of which the first three are those after once redistilling over sodium, the other two after another such treatment, gave the following results:

Calculated for $C_{10}H_{16}$ .		Found.				
		1.	2.	3.	4.	5.
C	88.23	87.02	87.08	87.20	88.20	88.25
H	11.77	11.40	11.52	11.61	11.55	11.70
	100.00	98.42	98.60	98.81	99.75	99.95

In composition this body agrees with that obtained from sample of oil No. 1, and with very close figures to the formula  $C_{10}H_{16}$ , as noted above.

Fraction VIII ( $230^{\circ}$  to  $240^{\circ}$ ), after redistillation distilled at  $230^{\circ}$  to  $232^{\circ} C.$  This corresponded to the same fraction obtained from sample of oil No. I at this temperature. This was almost colorless, becoming yellow on standing, sp. gr. .964, of a mint-like odor. Three combustions of this compound showed it to have the same composition as the former body found in the oil No. I.

Calculated for $C_{10}H_{14}O$		Found.		
THYMOL.		1.	2.	3.
C	80.00	79.90	80.10	80.05
H	9.33	9.45	9.40	9.85
O	10.67	10.65	10.53	10.60

Fraction IX. (240°-250°), when redistilled, yielded a very large portion at 240°-242° C. This was an oily liquid, similar to the foregoing, slight yellow color, specific gravity 9.72, mint-like and empyreumatic odor. Four combustions of this compound gave the following results:

CALCULATED FOR C <sub>10</sub> H <sub>18</sub> O		FOUND,			
		1.	2.	3.	4.
C	77.92	77.47	77.57	77.89	77.96
H	11.69	11.91	11.55	11.62	11.73
O	10.39	10.62	10.88	10.49	10.31

The above results would show the presence of a higher oxygenated compound besides thymol in the oil. The formula of this body C<sub>10</sub>H<sub>18</sub>O, was also established by taking its vapor density.

Sample of oil No. III. was submitted to partial redistillation only, the object being to obtain a larger quantity of the hydrocarbon. After redistillation a similar body as that obtained from the other samples distilled at 160°-175°, and upon further treatment with metallic sodium, two fractions were obtained, (I.) at 160°-163°, and (II.) at 163°-165° C. Six ultimate analyses of these compounds gave the following results:

CALCULATED FOR C <sub>10</sub> H <sub>16</sub>	I. 160°-163° C.			II. 163°-165° C.		
	1.	2.	3.	1.	2.	3.
C 88.23	88.18	88.20	88.27	87.85	87.97	88.02
H 11.77	11.52	11.68	11.70	11.40	11.45	11.35
100.00	99.70	99.88	99.97	99.25	99.42	99.87

The above results show without doubt the presence of a hydrocarbon in oil of horsemint. To establish the correct formula of this body the molecular formula was arrived at by taking the vapor density of this compound.

From the hydrocarbon obtained it was tried to form a substitution product with hydrochloric acid. The terpene was treated with dry hydrochloric acid gas, at both cold and warm temperatures, but no crystalline compound separating. The resulting liquid though assumed a violet-red color, changing to dark-red.

*Vapor Density.* The vapor densities of the compounds found in the oil were ascertained. The method used was that of V. and C. Meyer.

The results of six experiments with the hydrocarbon found are as follows:

- 0.100 gram of substance vaporized replaced 17.6 cbc. of air.
- 0.090 gram of substance vaporized replaced 16.2 cbc. of air.
- 0.057 gram of substance vaporized replaced 10.1 cbc. of air.
- 0.068 gram of substance vaporized replaced 12.2 cbc. of air.
- 0.089 gram of substance vaporized replaced 15.6 cbc. of air.
- 0.117 gram of substance vaporized replaced 20.6 cbc. of air.

These figures with the observation of the barometric pressure, the temperature of the water, and also the tension of vapor of water, gave on calculation the following vapor densities:

<i>Calculated vapor.</i>	<i>Found.</i>					
Density for $C_{10}H_{16} = 4.71$ .	1.	2.	3.	4.	5.	6.
	4.81	4.65	4.74	4.73	4.82	4.75

These all correspond sufficiently close to that of  $C_{10}H_{16}$

The vapor densities of the oxygenated compounds are as follows:

#### I. Thymol, $C_{10}H_{14}O$ .

<i>Calculated vapor.</i>	<i>Found.</i>		
Density for $C_{10}H_{14}O = 5.19$	1.	2.	3.
	5.22	5.14	5.16

These figures correspond also very well with  $C_{10}H_{14}O$ , and upon calculation that formula was arrived at.

#### II. Higher compound $C_{10}H_{18}O$ .

<i>Calculated vapor.</i>	<i>Found.</i>		
Density for $C_{10}H_{18}O = 5.33$ .	1.	2.	3.
	5.30	5.35	5.37

On calculation with these results, this showed also the formula of that body to be  $C_{10}H_{18}O$ .

*Polarization.* The action of polarized light upon the compounds obtained was noted; that of the hydrocarbon and of the oxygenated compounds. With a 200 mm. tube the following readings were made:

$C_{10}H_{16}$ —Fraction I. (160°-163°)	gave	-34°.50.
$C_{10}H_{16}$ —Fraction II. (163°-165°)	gave	-32°.40.
$C_{10}H_{14}O$ —Thymol (230°-232°)		+ .60.
$C_{10}H_{18}O$ —	(240°-242°)	+ 1°.10.

From the above will be seen that the hydrocarbon turns the plane of polarization strongly to the left, while with the oxygenated compounds it is slightly turned to the right.

*Acids obtained by saponification.*—100 grams of the oil from sample No. III were treated with a solution of 10 grams of caustic potash in 100 grams of water, and boiled for eight hours in a flask with an upright condenser. The alkaline liquid was separated from the oily layer, which was then acidified with sulphuric acid. This produced two layers, (I) a yellowish aqueous liquid, and (II) a dark brown oily layer, floating on the surface; the former was separated from the latter by means of a wet filter.

The dark brown oily liquid (II) was exposed to a temperature of  $-15^{\circ}$  C, which then became solidified. This was dissolved in alcohol and mostly decolorized by means of animal charcoal; but on exposure again to the above degree of cold nothing crystallized out, neither from alcohol nor from ether.

The aqueous filtrate (I) from this oily liquid was diluted with water and distilled as long as the distillate had an acid reaction. The distillate was colorless, of peculiar odor, and gave the following reactions :

1. With conc.  $\text{H}_2\text{SO}_4$  and ethyl alcohol produced the odor of some fruit ethers, prominently that of butyric ether.
2. With  $\text{HgCl}_2$  on boiling for some time produced white precipitate of  $\text{Hg}_2\text{Cl}_2$ , which was blackened by ammonia.
3. On addition of  $\text{H}_2\text{SO}_4$ , a rod moistened with  $\text{NH}_4\text{OH}$ , produced white fumes when held into the tube.
4.  $\text{Fe}_2\text{Cl}_6$  caused a violet-pink color on addition of a few drops, when more of the reagent was added became brownish, and on boiling a light-brown precipitate formed.
5. With  $\text{AgNO}_3$  caused a reduction of the salt on boiling for some time.

A lead salt was formed from this acid distillate by digestion with lead carbonate. The filtrate was evaporated to dryness and the residue treated with 95 per cent. alcohol.

The filtrate (I) from this was then tested for *acetates*, the residue (II) not soluble in alcohol for *formates*.

The alcoholic solution (1) was evaporated to dryness, redissolved in water and then gave the following characteristic reactions for *acetates*:

1. With  $\text{AgNO}_3$  a white precipitate formed, which changed not until after some time.
2. On heating the residue obtained by evaporation of a small quantity of the liquid with  $\text{As}_2\text{O}_3$  the odor of kakodyl was produced.
3. With  $\text{Fe}_2\text{Cl}_6$  a dark red color was produced, and on boiling a brownish precipitate formed.

4. With concentrated  $\text{H}_2\text{SO}_4$ , and ethyl alcohol, the odor of fruit; ethers was produced, prominently that of butyric ether.

The residue (II) not soluble in alcohol was dissolved in water and then gave the following reactions for formates:

1. With  $\text{AgNO}_3$ , a white precipitate formed, which on boiling darkened and became black.

2.  $\text{Fe}_2\text{Cl}_6$  produced a dark-red coloration.

3. With concentrated  $\text{H}_2\text{SO}_4$  and ethyl alcohol the odor of formic ether was developed.

4.  $\text{HgCl}_2$  produced on boiling for some time a white precipitate of  $\text{Hg}_2\text{Cl}_2$ , which was blackened by  $\text{NH}_4\text{OH}$ .

From the above reactions the presence of acetic and formic acids were indicated, but both existing in small quantity; also the presence of a small quantity of butyric acid. The oil itself having a neutral reaction, the above acids exist probably as compound ethers.

*Summary of results.*—From these investigations the following are the most important constituents of the oil:

I. A hydrocarbon, of the formula  $\text{C}_{10}\text{H}_{16}$ , which has not previously been examined. It is laevogyrate, and is present to the amount of about 50 per cent.

II Thymol,  $\text{C}_{10}\text{H}_{14}\text{O}$ , present to the extent of about 25 per cent., which is dextrogyrate. This body it seems is present in the freshly distilled oil in a condition which will not crystallize, even at a low temperature; but by age gradually becomes crystalline and separates, without, as far as appears, any change in chemical composition.

III. Higher oxygenated compounds, comprising  $\text{C}_{10}\text{H}_{18}\text{O}$ , and probably others. This portion is also dextrogyrate.

IV. *Formic acid.*—1. Its silver salt was reduced on boiling the solution 2. Its lead salt was insoluble in alcohol, and gave characteristic reactions. 3. The free acid reduced  $\text{HgCl}_2$  to  $\text{Hg}_2\text{Cl}_2$  on boiling.

V. *Acetic acid.*—1. Its iron salt dissolved in water with bright red color, and was precipitated on boiling. 2. Its lead salt, when heated with  $\text{As}_2\text{O}_3$ , gave the kakodyl reaction. 3. The free acid caused the formation of white fumes with  $\text{NH}_4\text{OH}$ .

VI. *Butyric acid.*—Was detected by its odor, and exists in very small amount.

The oil having a neutral reaction, these acids probably exist as, compound ethers; but are present in small amount only.

## ANALYSIS OF THE LEAVES OF EUPATORIUM PURPUREUM.

A contribution from the Chemical Laboratory of the Philadelphia College of Pharmacy.

By FRANK M. SIGGINS.

Read at the Pharmaceutical meeting, February 21.

Fifty grams of the drug in No. 60 powder were exhausted with, petroleum ether, the solid extract of which amounted to 6.99 per cent. of the weight of the drug. This extract had a pale greenish color, with the odor of the drug, and an insipid, greasy taste. On heating in an air-bath at 110° C. it lost .186 per cent. of its weight, representing the volatile portion. It was slightly soluble in cold alcohol, and wholly so in hot alcohol, but precipitated on cooling. On filtering this solution and allowing it to evaporate spontaneously, a white granular wax was obtained which was not examined.

The drug after thorough evaporation of the petroleum was exhausted with ether. The solution thus obtained had a bright-green color by transmitted light, but brownish-red by reflected light, showing abundant evidence of chlorophyll. The solid extract obtained with the ether amounted to 2.97 per cent. of the weight of the drug. This extract had a dark-green or blackish-green color, was hard when cold, but became soft at 80° C.; was insoluble in cold water, but partly so in hot water, to which it imparted its bitter taste, and which the water retained on cooling. With this aqueous solution, potassio-mercuric iodide gave no precipitate, but potassium tri-iodide gave a bulky brownish-red precipitate, which slowly changed to a light-yellow and indicated the probable presence of an alkaloid; other reactions, however, showed that this bitter principle is not an alkaloid but a glucoside.

The drug was then exhausted with alcohol, to which it yielded an extract of 2.14 per cent. of its original weight; it had a dark-green color, was sparingly soluble in water, and had a slightly bitter taste. The aqueous solution gave a light precipitate with potassium tri-iodide, but as this was due probably to only a small part of the bitter principle which had escaped solution in the ether it was not further examined.

The drug was then exhausted with distilled water and yielded 14.20 per cent. of extractive matter. 20 cc. of this aqueous solution were treated with 60 cc. of absolute alcohol, and the precipitate representing The mucilage was collected, dried and weighed, yielding 4.8 per cent. The filtrate was evaporated to syrupy consistency, and treated with four volumes of absolute alcohol, the precipitate collected as before, and representing the dextrin, amounted to 4.75 per cent. The filtrate, representing sugar, evaporated to dryness, yielded 3.8 per cent.

The drug was then exhausted with a 2 per cent. aqueous solution of sodium hydrate, and yielded to it 16.30 per cent. of its weight. This solution, acidified with acetic acid and precipitated with alcohol, yielded 7.20 per cent. of albuminoid matter.

Exhaustion of the drug with a 2 per cent. aqueous solution of hydrochloric acid yielded 6.91 per cent. extractive. On treating the solution with sodium hydrate and collecting the precipitate representing calcium oxalate, 1.8 per cent. was obtained.





containing a few crystals. The aqueous solution of the extract, tested with ferric chloride and gelatin, gave evidence of the presence of tannin, and after precipitating this with lead acetate, Fehling's solution showed glucose. A much larger precipitate of cuprous oxide was obtained from the aqueous solution which had been previously boiled with diluted sulphuric acid, thus indicating the possible presence of a glucoside. Precipitates were also obtained with tannin and potassio-bismuth iodide, but an alkaloid could not be observed in the aqueous or acidulated solution, which had a bitter taste, an unpleasant odor and, on vigorous agitation, a decided foamy appearance.

About 200 gm. of the root were now treated with strong alcohol, and the extract boiled with a small quantity of absolute alcohol, from which, on standing, some acicular crystals separated. The aqueous solution of the extract freed from tannin as before, was acidulated with sulphuric acid and agitated successively with petroleum spirit, benzol and chloroform; then rendered alkaline and the same treatment repeated; but no residue was obtained from these solvents.

The powdered root exhausted with alcohol yielded to water about 15 per cent. of soluble matter. After precipitating the gum with alcohol (66 per cent.), the filtrate was evaporated, the residue treated with chloroform and this solution evaporated; the residue thus left gave, with sulphuric acid, a reddish color, which may be due to saponin.

## OLIVE CULTURE IN CALIFORNIA.

By JAMES E. C. BELL.

Read at the Pharmaceutical Meeting, February 21st.

The extent to which foreign olive oil is now adulterated is a matter that would justly cause serious apprehension were it not for the fact that, we have within our own country the means of relief. California has for several years past produced a limited supply of pure olive oil of very superior quality. The olive tree was introduced at the time of the founding of the Missions by the Jesuit priests during the twenty or thirty years beginning with 1769. Orchards of from a dozen to one or two hundred trees were planted for the use of the Padres, and many of those trees still survive, adding much by their graceful proportions and striking foliage to the picturesqueness of the surroundings of the Missions, which, with few exceptions, are in ruins. The writer has often rested in the shade of some of these trees planted more than one hundred years ago. It will thus be seen that the introduction of the olive tree is coeval with the founding of the Missions. The latter received their death blow in 1833 by reason of the confiscation of their lands by the Mexican Government, while the former still flourishes in more than pristine vigor. It was not until 1872, however, that olive orchards were planted with a view to extensive oil production. In that year Mr. Ellwood Cooper, of Santa Barbara, planted the nucleus of what is now one of the finest olive orchards in the world. Having demonstrated that the industry could be made profitable, his example has been followed by others, so that now there are productive orchards in San Diego county (Mr. Frank A. Kimball of National City), near San José (Mr. Edward E. Goodrich of Quito Olive Farm), and at several other places in the State. The trees are now being extensively planted, and the day is not

far distant when the difficulty of getting pure olive oil will not be as great as it is now. The climate and soil of California are peculiarly adapted to olive culture, the chief difficulties now in the way being the high price of land and labor. These obstacles will doubtless be gradually overcome, and then pure olive oil will be obtainable at a much lower price than at present.

Virgin olive oil in full sized bottles now sells on the Pacific Coast at two dollars a bottle wholesale. Mr. Cooper and Mr. Goodrich, both state that the demand for their respective products is much greater than the supply. The cost is a serious bar to its general use at present, but not to those who wish pure oil.

The limits of this article preclude more than a mere outline of olive culture in California. Much interesting matter must therefore be left out and only the main points mentioned.

The trees are propagated from cuttings, taken from sound growing trees, during the months of December and January, and carefully trenched in a loose, sandy soil in a shady place. The ground of the intended orchard is thoroughly prepared by proper cultivation, and in February or March the cuttings are permanently planted about twenty feet apart. Theoretically the trees should be propagated from the seeds as they would be better rooted and more symmetrical, but in practice this method has not proved successful. The trees usually produce some fruit the fourth year from planting, and thenceforward the yield increases, alternating a light with a heavy crop. A few trees at four years have produced over two gallons of olives, and at eight years thirty gallons. The average yield is, of course, much smaller than this. A tree in the San Diego Mission orchard has produced 150 gallons of berries in a year. The fruit is generally ready for picking in November, but sometimes is not sufficiently matured before the middle of January. The oil made from olives picked before fully ripe and just after they become purple, is lighter in color and more fragrant than that from riper fruit. The picking is done by means of ladders attached to wagons which are driven from tree to tree. This method is preferable to that employed in Europe, where the fruit is knocked with poles and picked from the ground.

After picking, the fruit is freed from leaves and imperfect berries by passing it through a winnowing mill, when it is either dried in the sun for about two weeks, or exposed to artificial heat at a temperature of 110° to 130° F. When the moisture has been sufficiently evaporated the fruit is crushed by stone rollers, and pressed out in a manner almost identical with that used in the old-fashioned beam cider-press. The cheeses are three feet square and three inches thick, enveloped in coarse linen cloth, about ten cheeses being put in at one pressing. The expressed liquid is allowed to stand in tanks from two to three months by which time the oil rises to the top and is drawn off. The pomace is re-crushed, treated with hot water, and, on pressing, a second quality of oil is obtained. The oil is clarified by being passed through a filtering column composed of five or six compartments with sieve bottoms on which cotton batting is placed. Heat facilitates this process, but is liable to injure the oil, and hence is not used in filtering the best oil. The oil is finally bottled, kept in a moderately cool place, not exposed to sunlight, and agitated as little as possible.

Pickled olives are prepared in various ways. In general, the process is to deprive them

of bitterness by steeping them in brine, or in water containing lye, for varying periods, thoroughly washing to free from alkali, and preserving in a strong solution of the best Liverpool salt.

From what I have said it appears that if pharmacists and other consumers of olive oil are willing to pay the price necessary for an absolutely pure oil, they can obtain it of unsurpassed quality in California. The price given is unusually high, owing to a short crop last year, and the excellent reputation that the oil has gained on the coast. A prominent producer of oil informs me that the prices will probably be greatly reduced when the new product now in process of manufacture is placed on sale. It is earnestly to be hoped that this new addition to our home industries will receive the encouragement and support it so well deserves.

## HONEY PRODUCTION IN CALIFORNIA.

By J. E. S. BELL.

Read at the Pharmaceutical Meeting, February 21.

Southern California is justly celebrated for the quality and variety of its fruits, but comparatively few persons on this side of the Rocky Mountains are aware of the extent to which honey is produced there, and the excellence of the product. Believing that pharmacists and other consumers will be interested in knowing where they can procure honey of unsurpassed quality in any desired quantity at a reasonable price, I have been led to prepare this brief account of its production on the Pacific coast.

The honey producing district includes San Diego, Los Angeles, Ventura, Santa Barbara and San Bernardino counties, together with portions of those adjacent. The primary requisites for an apiary are a suitable location, plenty of "bee-feed" and convenient water. The apiaries, or "bee-ranches," as they are commonly called, are mostly located in canyons of the Coast Range Mountains, whose slopes are, in many places, densely covered with several varieties of wild sage and other honey-bearing shrubs and trees. In addition to these sources of honey supply, the so-called grasses commonly known as *wild alfalfa* (*Medicagosativa*, Linné) and *alfilaria* or pin grass (*Erodium cicutarium*, L'Heritier), are much utilized by the bees in gathering in their supplies. Usually from one hundred to three hundred colonies are kept in one place, the number depending chiefly upon the extent of the range. The hives are made in two compartments, the upper one, called a super, being removable.

The usual size is fourteen by nineteen inches, inside measurement, and ten inches deep, the size of the super being the same. Each compartment is supplied with eight or ten frames placed longitudinally, and supported upon the rabbeted upper edge. A movable horizontal partition separates the two compartments, by which the bees are confined to the lower part of the hive, which is often necessary. The season opens usually about the beginning of March, and continues until the close of July. When fully at work a large apiary presents a scene of activity not often seen elsewhere, for in addition to the storing of honey, swarming occurs frequently to the extent of fifty swarms a day. In a good season it is not uncommon for the number of colonies to be doubled. The method of extracting honey, while familiar to many, may not be without

interest. The frames containing the filled combs are taken to the extracting room, where the ends of the cells are sliced off with a long flat-bladed knife. The frames are then placed in the extractor, which consists of an upright tank with a vertical shaft and from four to eight radial arms, supporting hinged wire cages of sufficient size to admit the frames and support the combs. By means of a simple or geared crank the shaft is rapidly revolved alternately to the right and to the left, and in a few minutes the contents of the comb are thrown out against the sides of the tank and collect at the bottom, whence the honey is drawn off into storage tanks, to be kept until canned and shipped. The emptied combs are then replaced in the hives to be refilled, which process is repeated a number of times with the same comb, being continued until the comb is destroyed. When it is understood that the amount of bee energy required for one pound of wax will produce twenty pounds of honey, the object of the above mentioned process will be apparent. "Comb foundation" is largely used in order to save unprofitable energy. It is made by passing thin sheets of wax between metal rollers whose surfaces are so arranged as to produce an exact reproduction of the central partition of a honey comb. This is fastened into the frame with a little melted wax, and the bees build out the cells just as if they had made the entire comb.

The refuse combs, fragments of combs, scraps, etc., are put into the "sun-extractor," in which, by exposure to the sun's rays, the honey is rendered less viscid and slowly drains off. This product is of course inferior, and is not mixed with the centrifugally extracted honey, being reserved for the bees to forestall a possible honey-famine, which, owing to unfavorable seasons and improvident extraction, sometimes occurs.

It is said that glucose is used not only to feed bees but also to adulterate honey. I do not know to what extent this practice obtains elsewhere, but a long residence in the honey districts of California, and frequent visits to a large number of apiaries, confirms me in the belief that glucose is not used for either of these purposes there. I have never seen any glucose at an apiary, and the fact that it would be quite as expensive as the honey itself, would preclude its use.

California honey is usually very light colored, which fact leads many people to believe that it is not pure, but to those who thoroughly understand the circumstances under which it is produced this seems to be an entirely unfounded prejudice. The amount of honey turned out in a single apiary seems to those unaccustomed to such things, enormous. Thirty tons of extracted honey have been produced in a single season in an apiary of three hundred colonies. Indeed, three hundred pounds per colony is not uncommon, a super often being filled once in seven days. This large yield depends to some extent upon the assistance given the bees by the apiarist, but chiefly upon the season. If the preceding winter has been dry, or if there is much fog during the period of honey production, the yield will be greatly lessened, and sometimes is barely sufficient to tide the bees over until the next season. Formerly much loss was occasioned in this way, but now a sufficient portion of honey is always held in reserve to keep the colonies in a strong healthy condition.

The bulk of California honey is shipped in cans varying in size from twelve to sixty pounds. It can also be obtained in smaller cans and glass jars if desired; about one-tenth of the entire amount is shipped in the comb. During 1887 there were shipped to the East from Los Angeles 1,256,210 pounds, and from San Francisco 1,090,000

pounds, together with 250,000 pounds of comb honey. Canned honey usually sells at the apiaries at from four to six cents per pound. I have frequently bought honey of superb quality for five cents per pound. In car load lots it can be laid down in any eastern city at from two to three cents a pound for freight. It could be sold with profit by retail dealers at ten to twelve cents. Last season was unfavorable for honey production, and in consequence the quality is not up to the standard although the price is higher than usual. In view of the figures given above as to quantity and price it would seem that there is no sufficient reason why all persons who use honey for domestic and other purposes cannot be fully supplied. The honey of California is unsurpassed by any in the world, and nowhere else can honey of equal quality be procured in such large amount. There are reliable merchants in each of the counties named who can supply honey of the best flavor and purest quality in any desired quantity from a single can to a car load, at prices entirely within the reach of all who are accustomed to the use of pure articles of food.

## THE HOME OF THE CINCHONAS.

By DR. H. H. RUSBY.<sup>1</sup>

Leaving out of the question the cold, stormy and little known region of Cape Horn, South America is divided by the Andes into two portions, having almost nothing in common. The Cordilleras which extend along the eastern verge of the great Andean table land, while only a few miles in width, mark differences in soil, climate, productions and general appearance as great as any that are to be observed upon the globe, and present an obstacle to the interchange of organic beings far more effectual than the broadest ocean could constitute. Upon the Pacific coast rain is in many regions almost unknown, and the air is so destitute of humidity that it is said that the inhabitants never die, but dry up and are subsequently blown away in some gale of wind. Upon the other side rain is so constant that weeks may pass when the sun is seen for scarcely an entire hour, and the humidity of the atmosphere is sometimes so great that the clouds of rising vapor obscure the view of even the nearest objects. The west Andean region is marked over its greater extent by a total absence of trees, or even of large shrubs, many sections being destitute of even a vestige of green. The east Andean region on the contrary presents a scene of impenetrable verdure, reaching from near the summit of the mountains to the Atlantic Ocean, three thousand miles away. With the former region we have nothing to do. Except for a small portion of Chili it produces no important drug. The portion of Chili referred to yields soap bark, chequen and boldo, and it was here that I discovered the properties of the *Fabiana imbricata*, or pichi, a drug that is meeting with a remarkably uniform success in the treatment of cystitis. I have stated that the eastern Cordillera forms a barrier to the interchange of species between the two regions. The barrier is not a direct one. It is perfectly easy for birds to fly, for quadrupeds and insects to migrate, and for seeds to be carried across this region at many points, but if they do so they

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<sup>1</sup> On the evening of December 1, 1887, Dr. H. H. Rusby delivered before the students and Alumni of the Philadelphia College of Pharmacy a very interesting lecture, profusely illustrated with specimens, on subjects connected with the researches during a sojourn in South America. From a stenographic report of this lecture by Dr. C. R. Morgan, we select a portion relating to the Bolivian home of the cinchonas, and intend to publish in the following numbers of the JOURNAL several parts of the same lecture relating to other topics.-EDITOR.

immediately perish. It is the climatic condition which constitutes the direct barrier, and these conditions are the direct result of the mechanical obstruction constituted by the mountain chain referred to. The heated winds which sweep across the tropical Atlantic become surcharged with moisture. On striking the shore the changed condition disarranges the cloud equilibrium sufficiently to precipitate a portion of this moisture, But the clouds, thus lightened, as they sweep onward do not pass over a dry region, but one that is a perfect net-work of broad lakes and rivers; a surface that at certain seasons probably presents more water than land; so the little disarrangement that has been caused in the atmospheric conditions is at once atoned for by the soaking up of a fresh supply of vapor, which is again partially precipitated, and so on; so that the transit of these clouds across the Amazonian sylvas is a mere succession of partial unloadings and loadings, a journey of equalization, in the course of which those regions which are temporarily wanting in humidity, are fed from those which are better supplied. But that is not all; there is an additional and peculiar feature. The equalizing process is not only regional, but temporal as well, for at certain hours of the day there is in most sections a discharge of rain which is said to be almost as regular as the striking of a clock. For the most part these showers are comparatively gentle, as we should expect from the comparative uniformity of the conditions, but when these clouds have reached the mountains an entire change occurs in all their conditions. Up to this point they have, upon the whole, gained more than they have lost, and they reach the Andean foot hills like an M. D. who comes home from a meeting with his colleagues at five o'clock in the morning after hospitably entertaining some favorite guest, very top heavy with wetness.

What now are the conditions on which cloud precipitation depends? Only one, although it may be produced in a variety of ways; an increase of density. On striking the first range of hills, this increase of density is produced by compression of the clouds between the hills and other clouds that are pressing on behind them. They at once discharge great volumes of water upon the plains below. The cloud thus lightened endeavors to escape upward over the tops of the hills, but reaching the colder upper strata, there is another increase in density and fresh precipitation occurs. This operation is again and again repeated as the 250 miles of steadily increasing elevation are passed, until finally, the tattered remnants of the recent cloud dome find themselves among the jagged peaks of the highest ranges. From one or another of these peaks there is an almost constant discharge of electricity, and this completes the annihilation of the cloud-forces, the winds which cross to the other side carrying with them but the merest traces of moisture. Now there is a point upon this mountain slope where this strife among the elements seems more violent than elsewhere. A narrow belt of between three thousand and five thousand feet above the level of the sea where it seems that peak and forest have united in a resolution that no cloud shall pass without being broken to its centre. In the midst of this scene of vapory turmoil the cinchona has its home. Far to the northward, in the equatorial region, they creep up to a higher elevation, and in the Cochabamba region of Southern Bolivia the cinchona belt is limited upward to between five thousand and five thousand five hundred feet, and downward to two thousand five hundred or three thousand feet. The precise conditions of heat and moisture are hard to find, hence the small number of places where the cultivation of cinchona has been even partially successful. And hence the fact that the United States has no territory where the faintest hope of its production can ever be entertained. The water supply must be

abundant and constant. Irrigation, however abundant, is entirely inadequate in the cultivation of these trees. The aerial as well as the subterranean portion must be bathed in moisture. It is true that there is a period of several weeks when the rains almost entirely cease. But this occurs just at the close of the rainy season when the earth is saturated with water, so that up to the re-commencement of the rains there is no period when the atmosphere, by evaporation from the surface of the earth and the exuberant mass of foliage, is not sufficiently humid. It is to be remembered that the supply of water does not cease with the cessation of the rains. Ten thousand feet of mountain slope lie back of the cinchona belt, and conserve the rain-fall in the crevices of the rocks and in the tangled mass of roots and rootlets that for a depth of ten or fifteen feet almost constitute the soil, rather than ramify through it. This supply allows the water to trickle slowly along under the roots of the cinchona.

Just here we meet with a paradox. While the water supply must be constant, yet if it be unchanged disaster will certainly result. If the cinchona trees be planted upon a level tract where there is not sufficient drainage to immediately carry off the falling showers, they soon begin to droop and die. The temperature in this region seldom falls below 70 degrees, and is usually below 90 degrees. Under such conditions as these, the character of the vegetation may be readily inferred. Its luxuriance is nowhere exceeded. There are larger trees in Australia, but they stand independently of each other. The forests of Brazil are heavier, but there is not such a profusion of tender plants, parasites and gorgeous flowers. Here, however steep and high may be the cliff, there are sufficient large trees shooting upwards from its foot or supported upon its ledges, to form a frame for the dense net-work of vines that entirely conceal it from our view. Over the smaller mountain streams arch giant branches, concealing them from our downward view, and into the water droop gay festoons of flowering vines. Thus we gaze as it were upon a vast, irregular sea of verdure, and forget all the roughness of the surface below. Could these mountains be suddenly stripped of their verdant cloak of charity and exposed in all their roughness to our view, the scene of desolation would be appalling and pitiable, for nowhere does nature present such abrupt descents as here. Before us is a mountain side glittering with shining palms, whose tops alone are seen, and at its centre a slight depression, not noticeable but for a mountain stream that leaps out from the midst of its foliage and falls, a sheet of silver, among the lower tree tops, only to re-appear a hundred feet below.

We are traveling upon a little ledge, which runs for miles along the sides of an otherwise inaccessible slope, four thousand feet in height. Upon the left the road is bordered by tree ferns, whose delicately divided fronds, a dozen feet in length, brush in our faces, alternating with graceful bamboos which arch over our pathway.

Upon our right rises the cliff, but all hidden by a mass of our hot-house favorites—begonias, fuchsias, amaryllas, calceolarias, ferns, mosses and orchids, a new species at every turn of the road. Beautiful little grottoes are formed where the cascades come down, one of which would make the fortune of any florist who could reproduce it here. Except where the pathway is kept open by constant travel, and the lopping off of the encroaching vegetation, the earth itself is never seen. No one travels through the “Monte,” as the tangled forest is called, without a machete, or enormous knife in his hand with which to cut away the undergrowth at every step, and allow him to examine well the ground upon which he is to tread, for a single careless step may



precipitate him to his death.

Such is the home of the cinchona. A full history of its search, collection, shipment and culture would be, virtually a history of the most enchanting regions in South America. But we can merely touch upon it. At first the collectors plied their trade in the vicinity of their own home. But soon the accessible supply became exhausted and the collector was obliged to make longer journeys into the forests, remaining weary days upon the journey, and bearing a thousand trials, privations and dangers. His scanty supply of food must all be carried with him, for contrary to the general impression, these forests yield almost nothing in the way of a regular food supply. We are accustomed to read in novels about the wonderful production in tropical forests of berries and roots. Whenever a traveler in the stories of fiction is lost, he is always saved by going to the forests and collecting some roots and berries. The traveler in reality never finds them. He may occasionally come upon a spot in the forest where they are abundant and again he may go several weeks without finding anything.

Even the savage tribes depend upon their plantation for their subsistence. If now the *cascarillero* became lost in the forest, suffered some injury preventing him from traveling, became hemmed in by a sudden rise in the mountain stream, or suffered some like injury, he was in imminent danger of starvation. But it was not these conditions which caused the high price of cinchona bark when it was three and four dollars a pound. It was the monopoly which existed in the trade. In Bolivia, a single individual, through intermarriage with the family of the President, whose actions were those of an absolute despot rather than of a Republican executive, and by aiding the latter in plundering the national treasury, secured the forcible monopoly of the bark trade.

The prices paid were as low as possible without removing the stimulus to collection, and those charged as high as the world could be forced to pay. The mode of operating by this gentleman was as follows: Whenever he heard that some rival firm had sent a man in for the purchase of bark so as to antagonize him in his business, he immediately reported that fact to the President, his near relative. The President would have this man seized by his soldiers, accuse him of fomenting treason, punish him, often with his own hands, and order him to leave the country on pain of death. It seems impossible to us that a President could act this way. But I assure you that this President is now living in Paris upon several millions of dollars which he stole from the treasury; not embezzled, but actually stole, sending it out of the country at night: robbing the treasury of silver, and sending it out of the country at night as merchandise. This man was so bold as to seize the British Minister, who remonstrated with him for some of his actions, beat him, tied him upon a mule like an ordinary pack, and sent him out of the country with orders to never return. England did nothing in return for this affront. She considered the country beneath her notice and she has never sent any representative to that country since, but has abandoned it as a savage country, and Englishmen who go there, go without protection.

The profits of this trade were enormous, millions of dollars being realized. Large towns sprang up in the wilderness devoted especially to this industry. All classes pursued it to the neglect of everything else. When the business finally collapsed, most of the inhabitants fell back into absolute indolence. Under the process above described it

soon became apparent that the supply of bark would become exhausted, and wise foreigners united in urging the producing governments to take steps towards perpetuating the native stock. But no adequate measures were taken, and finally the British themselves undertook the task. But the South American people, not satisfied with themselves neglecting these most important measures, forbade and obstructed the efforts of the foreigners, and even visited them with violent persecution. But in spite of all, the happy result was accomplished, and all of the most valuable varieties of cinchona were successfully introduced to cultivation in the British provinces.

It is to be noticed here that the result is not so much due to the British government as to a few earnest individuals. The government itself did only what was barely necessary to render the project possible, and it did this grudgingly. It must ever be a stain upon English history, that an accomplishment of so much economic value to England, and of such vast benefit to humanity, should so long have gone unacknowledged. But such is the fate which throughout all time has attended efforts of this class. The individual or association, who shall explore in new and so-called unpromising fields, must summon all their fortitude to endure the malicious persecution, the cowardly indifference and ignorant misconception which for the most part attend such efforts. He who engages in such a work must be buoyed up by a consciousness that he works for eternity, and that the best part of right is its righteousness. At about the time that the plants exported to India had begun to produce seeds, the native supply of South America had become exhausted, and those whose business had thus failed were obliged to invest their capital in the planting and culture of the tree. So it happens that at the present time no bark, except an occasional bale, reaches the market which is not the product of cultivated trees. I had men out for two months searching the forests for wild trees, and so scarce is it that I assure you I succeeded in obtaining only three.