

SCIENTIFIC SECTION

BOARD OF REVIEW OF PAPERS.—*Chairman*, F. E. Bibbins; Glenn L. Jenkins, John C. Krantz, Jr., Heber W. Youngken, L. W. Rowe, L. W. Rising, C. O. Lee, E. V. Lynn, W. G. Crockett, Frederick V. Lofgren.

STUDIES ON POPLAR BUD.*

BY GERSTON BRUCH AND ELMER H. WIRTH.¹

While the first American monograph of Poplar Bud appeared as recently as 1916, (1) the use of Poplar Bud in medicine dates into antiquity. It is probable that Dioscorides (2) refers to the bud when he says of *Populus nigra*, "Aigerios. . . the seed (?) thereof being dranck with vinegar is good for the epileptical." Dalecampi (3) mentions *Populus nigra* as being used by both Dioscorides and Theophrastus. John Gerarde (4) states in his Herbal that "the buds of the black poplar which show themselves before the leaves spring out, are of a reasonable good favor, of which is made that profitable ointment called Unguentum Populeon." Joannis de Renou in his "Three Books of Medicinal Materials," published some twenty-five years after the Herbal says, "the first buds this tree emits, which are the rudiments of future leaves, are long and acute, full of some fat, oleous and resinous matter, which is subsalve and adheres to the fingers of the Tangents. Apothecaries call them *oculus populi*, which excerpe in the beginning of the spring, bruise, and recond in a figuline with swines grease till June for the confecture of the popular Unguent." A century after this they appear in the Unguentum Populeum of the Wirttemberg Pharmacopœia (5).

The virtues of the poplar buds, says the United States Dispensatory of 1834, are similar to those of the turpentine and balsams being used in tinctures, liniments and ointments for nephritic and rheumatic complaints. Ointments made with poplar bud occur frequently in the 19th century, examples of which are the Pomatum Populeum of the Paris Codex of 1837, the Unguentum Populi of the German Pharmacopœia of 1872 and the Unguentum Populeum of the Russian Pharmacopœia of 1880.

Balm of Gilead Buds appear as an ingredient of compound syrup of white pine in the National Formulary of 1896 but not until the 1916 edition do they appear as a crude drug. In connection with the sixth revision of the National Formulary, Chairman Gathercoal requested that the authors make a study of Poplar Bud, particularly as to the establishment of standards. A search of the literature revealed that very little in the way of investigation of poplar bud had been published. It was therefore decided to make an anatomical study as well.

Eleven commercial samples of Poplar Bud were obtained from various sources. Certain of the samples were sent to Dr. H. W. Youngken who identified them by means of authentic specimens collected at the Arnold Arboretum. Through his courtesy we were able to establish the identity of the buds for histological study. This study, in turn, enabled us to check the identity of the eleven commercial sam-

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ples. It is interesting to note that eight of the samples were *Populus canadensis*, Ait., two *Populus balsamifera* L. and one *Populus nigra* L., which would seem to indicate that the most prevalent species appearing on the American market was *canadensis*.

MACROSCOPIC STUDIES.

Several representative buds (Fig. 1.) from each sample were selected, measured, dissected and studied. The results of these studies have been condensed into the following macroscopical descriptions.

Leaf Buds.—The leaf buds are conical or pyramidal, pointed, up to 25 mm. in length (in all varieties) and up to 15 mm. in thickness in *Populus canadensis*, and up to 5 mm. in thickness in *Populus balsamifera* and *Populus nigra*. Externally they are reddish brown to dark reddish brown and when fresh glossy and glutinous and often covered with a resinous exudation. This resinous exudation is usually very prominent on *P. canadensis* and less prominent or absent on *P.*

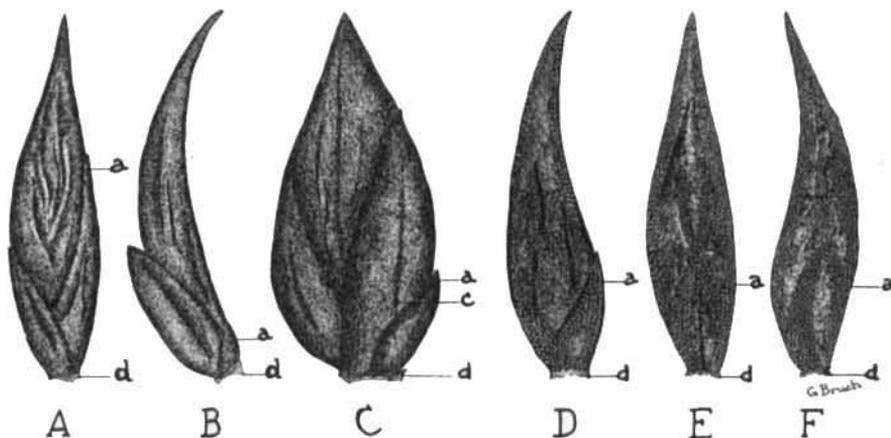


Fig. 1.—Entire Poplar Buds ($\times 2$). *Populus nigra*: A, leaf bud, a, outer scale, d, stem scar. B, flower bud, a, outer scale, d, stem scar. *Populus canadensis*: C, leaf bud, a, outer scale, c, second scale, d, stem scar. D, flower bud, a, outer scale, d, stem scar. *Populus balsamifera*: E, leaf bud, a, outer scale, d, stem scar. F, flower bud, a, outer scale, d, stem scar.

balsamifera and *P. nigra*. The buds of *canadensis* are therefore usually darker after aging than those of the other species. The bud (Fig. 2) consists of one to three small immature leaves located centrally and toward the base of the bud. These are enclosed by about 15 oblong, pointed, concave, closely imbricated scales in *P. canadensis* and about 10 scales in *P. balsamifera* and *P. nigra*. The buds of *P. canadensis* exhibit up to 5 shorter, outer imbricated scales; those of *P. balsamifera* up to 4 shorter outer scales and those of *P. nigra* up to 3. The scales are agglutinated with a sticky resinous substance containing numerous microscopic prisms of salicin which display colors in polarized light. When viewed with a lens the scales of *P. canadensis* exhibit hairs along the margin, those of *P. balsamifera* exhibit hairs on the dorsal surface and those of *P. nigra* exhibit no hairs.

Flower Buds.—The flower buds (Fig. 1) are thin, conical, up to 25 mm. in length and up to 15 mm. in thickness in *P. canadensis*, and up to 5 mm. in the other species. They are more or less curved and consist of one very short, small outer scale (occasionally a second outer scale) and three to four large inner scales enclosing a catkin of immature flowers (Fig. 2.). Externally the buds are reddish brown to dark reddish brown and less glossy and glutinous than the leaf buds. Both leaf and flower buds have a peculiar, agreeable and somewhat balsamic odor and an aromatic bitter taste.

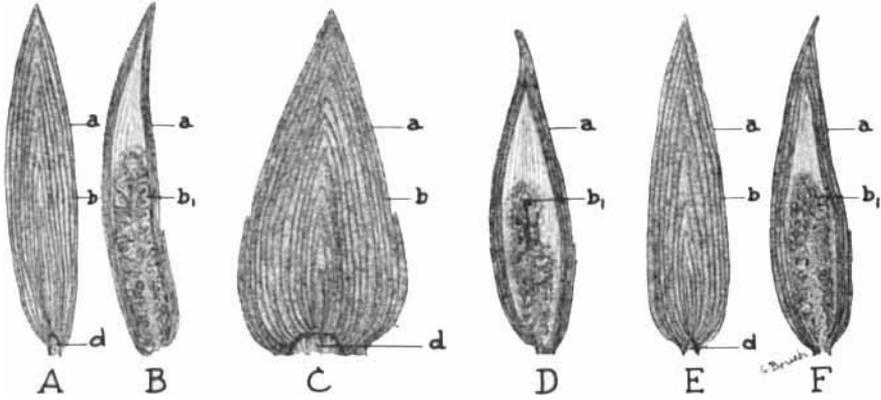


Fig. 2.—Poplar Buds in longitudinal section ($\times 2$). *Populus nigra*: A, leaf bud, a, outer scale, b, resinous exudation, d, stem scar. B, flower bud, a, outer scale, b₁, catkin of flower. *Populus candicans*: C, a, outer scale, b, resinous exudation, d, stem scar. D, flower bud, a, outer scale, b₁, catkin of flower. *Populus balsamifera*: E, a, outer scale, b, resinous exudation, d, stem scar. F, flower bud, a, outer scale, b₁, catkin of flower.

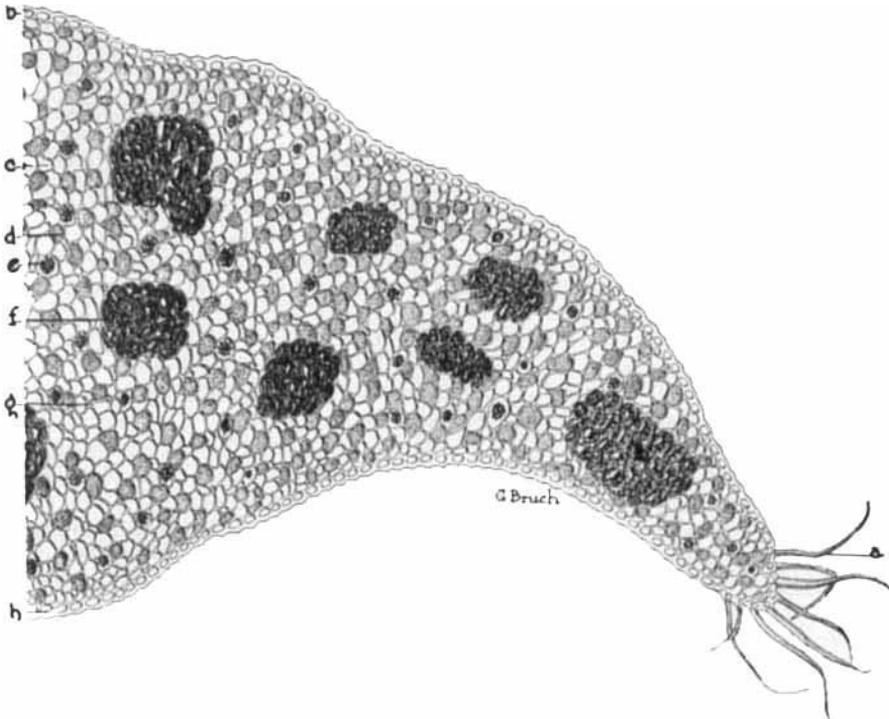


Fig. 3.—*Populus candicans*, transverse section of the outer bud scale ($\times 100$). a, hair; b, outer epidermis; c, mesophyll parenchyma; d, yellowish brown cell content; e, rosettes of calcium oxalate; f, stone cells; g, intercellular space; h, inner epidermis.

MICROSCOPIC STUDIES.

Several representative buds were selected from each sample. These were dissected and sections were cut from the various scales comprising each bud. Studies from these sections have been condensed into the following histological descriptions.

POPULUS CANDICANS. OUTER BUD SCALE. (FIG. 3.)

Outer Epidermis.—A single row of nearly isodiametric cells with comparatively thin inner and lateral walls and a heavily cutinized outer wall; up to 0.015 mm. in diameter. The epidermal cells are occasionally modified into narrow conical unicellular hairs with thick lignified walls, up to 0.230 mm. in length and up to 0.015 mm. in diameter at the base. These hairs usually occur only at the margin but in rare instances have been found to occur on the dorsal surface.

Mesophyll.—The mesophyll consists of from 30 to 40 rows of isodiametric parenchyma cells with more or less thickened walls; up to 0.025 mm. in size and occasionally separated by intercellular spaces. Many of the cells exhibit a yellowish brown content.

Numerous rosettes of calcium oxalate up to 0.020 mm. are scattered throughout the mesophyll. Stone cells up to 0.025 mm. in size and occurring singly or in groups are scattered through-

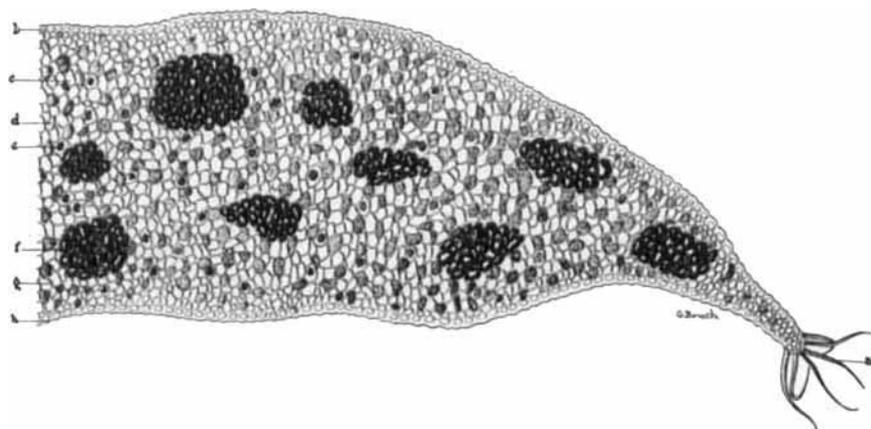


Fig. 4.—*Populus candicans*. Transverse section of inner bud scale ($\times 75$). *a*, hairs; *b*, outer epidermis; *c*, mesophyll parenchyma; *d*, yellowish brown cell content; *e*, calcium oxalate rosette; *f*, stone cells; *g*, intercellular space; *h*, inner epidermis.

out the mesophyll. (The groups of stone cells do not occur in a horizontal row as in *P. balsamifera*.) Starch is absent.

Inner Epidermis.—A single row of slightly elongated cells up to 0.020 mm. in size, having cutinized outer walls.

INNER BUD SCALES. (FIG. 4.)

The inner bud scales are similar in structure to the outer bud scale except for the following differences: The mesophyll is somewhat narrower varying between 15 and 30 cells in thickness and the cells of the inner epidermis are usually isodiametric (instead of slightly elongated) and up to 0.015 mm. in size. No appreciable histological difference is apparent between the scales of leaf and flower bud.

POPULUS BALSAMIFERA. OUTER BUD SCALE. (FIG. 5.)

Outer Epidermis.—A single row of isodiametric cells up to 0.015 mm. in size. The inner and lateral walls of the cells are comparatively thin but the outer wall is heavily cutinized. Many of the cells of the dorsal epidermis are modified into long, narrow, conical, unicellular, non-glandular hairs with thick lignified walls. These hairs range up to 0.260 mm. long and up to 0.020 mm. wide at the base.

Mesophyll.—The mesophyll consists of from 15 to 20 rows of more or less polygonal and approximately isodiametric parenchyma cells with rather thickened walls. The cells are up to 0.020 mm. in diameter and are occasionally separated by intercellular spaces. Many of the cells contain a yellowish brown content. Rosettes of calcium oxalate up to 0.020 mm. in size are scattered throughout the mesophyll. Groups of isodiametric stone cells are interspersed throughout the mesophyll, each group consisting of from a few to about 80 stone cells, with porous lignified walls, the individual cells varying up to 0.025 mm. in diameter. These groups of stone cells are usually located in a horizontal row nearer to the inner epidermis. Starch is absent.

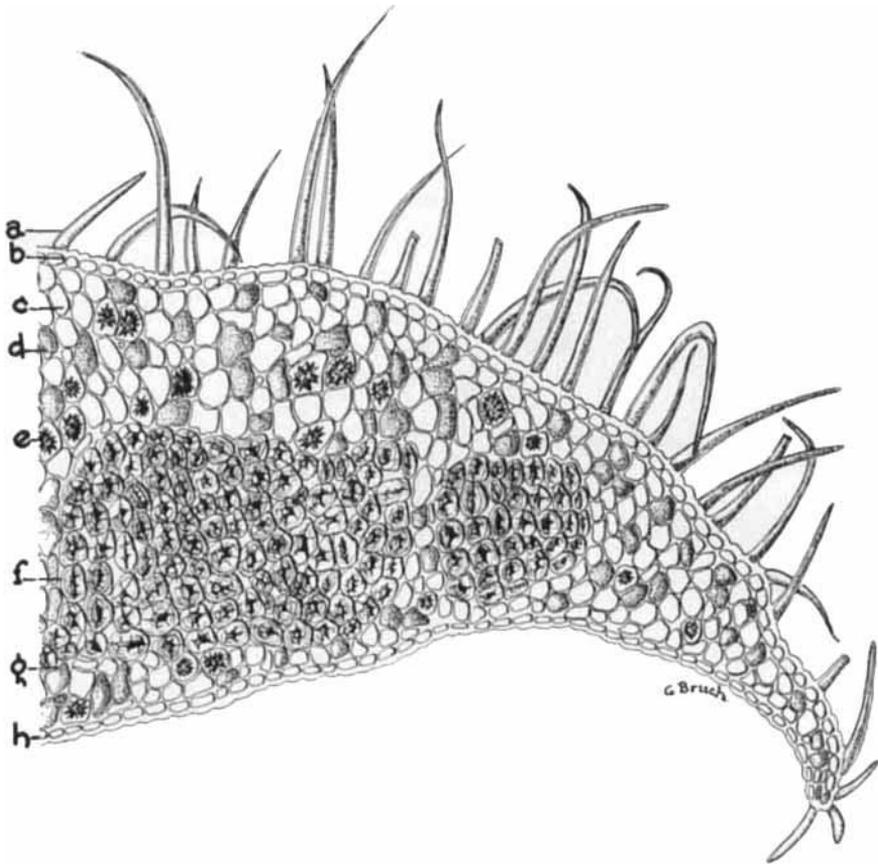


Fig. 5.—*Populus balsamifera*. Transverse section of the bud scale ($\times 100$). *a*, hairs; *b*, outer epidermis; *c*, mesophyll parenchyma; *d*, yellowish brown cell content; *e*, calcium oxalate rosettes; *f*, stone cells; *g*, intercellular space; *h*, inner epidermis.

Inner Epidermis.—A single row of somewhat laterally elongated cells with cutinized outer walls. The cells vary in length up to 0.025 mm.

Inner Bud Scales.—The inner bud scales exhibit a structure similar to that of the outer bud scales except that they show a less complete development, are thinner (up to 15 rows of mesophyll cells), exhibit fewer stone cells and show less pubescence. No appreciable histological difference is apparent between the flower and leaf bud.

POPULUS NIGRA. OUTER BUD SCALE. (FIG. 6.)

Outer Epidermis.—A single row of isodiametric cells with comparatively thin inner and lateral walls and heavily cutinized outer walls, up to 0.015 mm. in size.

Mesophyll.—The mesophyll varies in thickness from 15 to 25 rows of cells. The parenchyma cells are approximately isodiametric, up to 0.025 mm. in diameter and are occasionally separated by intercellular spaces. The cell walls are more or less thickened, those cells nearer the outer epidermis usually exhibiting the greater thickening. Many of the cells exhibit a yellowish brown content. Rosettes of calcium oxalate up to 0.020 mm. in diameter are scattered throughout the mesophyll parenchyma. Groups of stone cells, usually located in a horizontal row nearer the inner epidermis consist of, from a few to 75 individual cells. The individual stone cells show thick, porous, strongly lignified walls and vary in size up to 0.040 mm. Starch is absent.

Inner Epidermis.—One row of isodiametric cells with relatively thin inner and lateral walls and a more or less heavily cutinized outer wall.

The inner bud scales exhibit a similar structure to the outer scales. There is no appreciable difference in structure between the scales of leaf and flower buds.

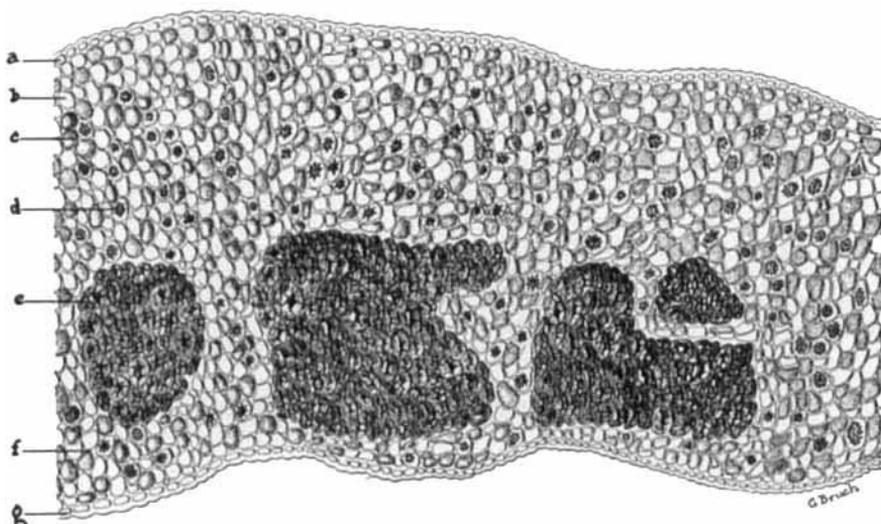


Fig. 6.—*Populus nigra*. Transverse section of the bud scale (× 100). *a*, upper epidermis; *b*, mesophyll parenchyma; *c*, yellowish brown cell content; *d*, calcium oxalate rosettes; *e*, stone cells; *f*, intercellular spaces; *g*, inner epidermis.

The difference between the three poplar buds official in the N. F. V may be tabulated as follows:

| | <i>P. canadensis.</i> | <i>P. balsamifera.</i> | <i>P. nigra.</i> |
|----------------------|---------------------------------|--|--------------------------|
| Size | | | |
| Length | Up to 25 mm. | Up to 25 mm. | Up to 25 mm. |
| Breadth | Up to 15 mm. | Up to 5 mm. | Up to 5 mm. |
| Resinous exudation | Prominent | Less prominent or absent | Less prominent or absent |
| Number of scales | Up to 15 | Up to 10 | Up to 10 |
| Shorter outer scales | Up to 5 | Up to 4 | Up to 3 |
| Hairs | At the margin of scale only | Interspersed over outer surface of scale | Absent |
| Hairs | | | |
| Size | | | |
| Length | Up to 0.230 mm. | Up to 0.260 mm. | |
| Breadth | Up to 0.015 mm. at base of hair | Up to 0.020 mm. at base of hair | |

| | | | |
|-------------------|-----------------------------|--|--|
| Mesophyll, | | | |
| Outer scale | 30-40 cells wide | 15-20 cells wide | 15-25 cells wide |
| Inner scale | 15-30 cells wide | 15-20 cells wide | 13-25 cells wide |
| Stone cells | Single or in groups | Single or in groups | Single or in groups |
| Number in a group | Up to 25 cells | Up to 80 cells | Up to 75 cells |
| Occurrence | Scattered thruout mesophyll | Horizontal row closer to inner epidermis | Horizontal row closer to inner epidermis |
| Size | Up to 0.025 mm. | Up to 0.025 mm. | Up to 0.040 mm. |

OTHER POPLAR BUDS.

Farwell (6) has called attention to the appearance on the market of buds whose source was *P. Tacamahacca*. Through the courtesy of Dr. Youngken we were able to obtain authentic buds of *P. Tacamahacca*, Mill. and *P. Trichocarpa*, Torr. and Gray (8). These were examined histologically, the observations being condensed into the following descriptions.

POPULUS TACAMAHACCA.

The leaf buds are pyramidal, pointed, up to 20 mm. in length and up to 6 mm. in diameter. Externally they are reddish brown to dark reddish brown, glossy and glutinous. The bud consists of from one to three small immature leaves located centrally at the base of the bud and surrounded by about 7 oblong, pointed, concave, closely imbricated bud scales agglutinated with a resinous substance. These are surrounded at the base by from 2 to 3 shorter outer scales. The flower buds are up to 20 mm. in length and up to 5 mm. in thickness. They consist of a single short outer scale and up to 3 larger inner scales enclosing the catkin. Microscopically they show the following characteristics:

Outer Epidermis.—A single row of isodiametric cells, the outer walls of which are heavily cutinized. The inner wall is thin but the lateral walls show considerable thickening. A few unicellular non-glandular hairs are found at the margin of the scale only. These vary up to 0.125 mm. in length and up to 0.015 mm. in breadth at the base.

Mesophyll.—A single row of what appears to be water-storage cells is found just below the outer epidermis in the outer scale only. The cells occur in palisade form and are devoid of contents. The balance of the mesophyll is from 15 to 25 cells in breadth being composed largely of isodiametric parenchyma cells up to 0.020 mm. in diameter. Calcium oxalate rosettes up to 0.020 mm. in diameter occur frequently. The stone cells occur singly or in small groups (up to 10 in a group) usually situated nearer to the inner epidermis, the individual cells being up to 0.075 mm. in diameter. The occurrence of stone cells is considerably less frequent than in the officially recognized varieties. Starch is absent.

Inner Epidermis.—A single row of isodiametric cells with cutinized outer walls.

POPULUS TRICHOCARPA.

The leaf buds are conical, pointed, up to 23 mm. in length and up to 8 mm. in thickness. Externally they are reddish brown to dark reddish brown. The bud consists of from one to three small immature leaves located centrally at the base and surrounded by about 8 oblong, pointed, concave, closely imbricated and agglutinated scales. These are surrounded at the base by 3 to 4 shorter outer scales. The flower buds are conical, up to 30 mm. long and up to 5 mm. thick. They are slightly curved and consist of a very short, small outer scale and about 3 larger inner scales enclosing the catkin. Cross sections show the following characteristics:

Outer Epidermis.—A single row of cells which are considerably laterally elongated. The cells are about 0.020 mm. long and have cutinized outer walls. Hairs practically absent.

Epidermis.—The mesophyll is up to 55 cells in breadth, the parenchyma cells being isodiametric and up to 0.025 mm. in diameter. Rosettes of calcium oxalate up to 0.020 mm. occur frequently. Stone cells up to 0.075 mm. in size are of frequent occurrence, usually being found in greater number nearer the inner epidermis. The stone cells occur singly or in groups up to 50. Starch is absent.

Inner Epidermis.—A single row of isodiametric cells with cutinized outer walls.

Buds from *P. deltoides*, Marsh, a frequently cultivated shade tree in northern Illinois were gathered by the authors. These buds exhibited the following characteristics.

POPULUS DELTOIDES.

The leaf buds are pyramidal, pointed, up to 23 mm. in length and up to 6 mm. in thickness at the base. Externally they are reddish brown and less glutinous than the official buds. The bud consists of an immature leaf located centrally near the base surrounded by about 8 oblong, pointed scales, the whole being surrounded at the base by up to four shorter outer scales. The flower buds are conical, up to 25 mm. in length and up to 7 mm. in thickness. They consist of a short outer scale and three inner scales surrounding the catkin. The bud scales show the following microscopical characteristics:

Outer Epidermis.—A single row of cells more or less radially elongated and up to 0.020 mm. in size. Hairs are absent.

Mesophyll.—The mesophyll is up to 20 cells in breadth, being composed largely of isodiametric parenchyma cells up to 0.020 mm. in diameter and containing calcium oxalate rosettes up to about 0.020 mm. in size. The stone cells occur singly or in small groups (up to 25), the individual cells being up to 0.025 mm. in size. The occurrence of stone cells is very frequent. Starch is absent.

Inner Epidermis.—A single row of cells with cutinized outer walls. The histological characteristics of *P. Tacamahacca*, *P. Trichocarpa* and *P. deltoides* buds may be summarized as follows:

| | <i>P. Tacamahacca.</i> | <i>P. Trichocarpa.</i> | <i>P. Deltoides.</i> |
|------------------------|---|--|-------------------------------|
| Epidermis | Cells isodiametric thick lateral and outer walls | Cells considerably elongated laterally | Cells elongated radially |
| Hairs | Present (at margin only) up to 0.125 mm. long up to 0.015 mm. broad at base | Absent | Absent |
| Water-storage palisade | Present (in outer scale only) | Absent | Absent |
| Mesophyll | Up to 25 cells broad | Up to 55 cells broad | Up to 20 cells broad |
| Stone cells | Few, up to 10 in a group | Frequent, up to 50 in a group | Frequent, up to 25 in a group |
| Stone cells | Up to 0.075 mm. | Up to 0.075 mm. | Up to 0.025 mm. |

The authors were unable to find buds agreeing with the characteristics of *P. Tacamahacca*, *P. Trichocarpa* or *P. deltoides* in the eleven commercial samples of Poplar Bud examined by them.

QUALITY STANDARDS.

Since the principal constituents of poplar bud are more or less resinous in nature it was decided that a quantitative solvent extraction might best serve as an indication of quality. About 300 Gm. of Poplar Bud were reduced to a coarse powder by chopping. After thoroughly mixing, approximately 12-Gm. samples of this coarse powder were completely extracted in a Soxhlet extractor (48 hours) using a variety of solvents. After removing the solvent, the extractive was dried to constant weight, the percentage being calculated on the weight of the original sample. Averages for these extractive experiments are as follows:

| | |
|----------------------|-------|
| Ether | 45.0% |
| Chloroform | 49.1% |
| Alcohol | 62.3% |
| Benzol | 47.8% |
| Petroleum benzin | 4.3% |
| Carbon tetrachloride | 20.5% |

These results show alcohol to be the best solvent and with this fact established it was decided to endeavor to adapt an alcoholic extractive method. The alcohol-soluble extractive method of the United States Pharmacopœia (7) being an established method was selected as probably being suitable for adaption to Poplar Bud. Approximately 2-Gm. samples of the prepared drug, accurately weighed are macerated in about 70 cc. of alcohol in a suitable flask. The flask is shaken at 30-minute intervals during eight hours, and then allowed to stand for sixteen hours without shaking. The contents of the flask are then filtered into a 100-cc. volumetric flask, the flask and residue being washed with small quantities of alcohol until the filtrate measures 100 cc. A 50-cc. aliquot portion of the filtrate is evaporated to dryness on a water-bath and dried to constant weight at 110°, the percentage of anhydrous extractive being calculated from the weight of the drug taken.

Eight samples were selected from the various lots of commercial Poplar Bud at hand. Since Poplar Bud cannot be ground in a mill the samples were prepared by chopping as finely as possible in a chopping bowl and then mixing the chopped material on paper.

Results obtained by submitting the eight selected samples to the alcohol-soluble extractive method were as follows: 23.0%; 43.0%; 41.1%; 48.9%; 20.1%; 37.6%; 44.1% and 44.2%.

While the above results show considerable variation (20.1% minimum to 48.9% maximum) it will be observed that five of the eight samples run well over 40% and one sample approaches that figure. It therefore seemed that 40% might be tentatively selected as a suitable minimum standard. In order to establish the feasibility of selecting this standard a careful analytical study of the samples at our command was carried out. The questions arising were: Why do some samples run high and some low? Is there any relation between botanical source and the quantity of alcohol-soluble extractive? Is there any relation between appearance and alcohol-soluble extractive? Does a high content of flower buds affect the alcohol-soluble extractive?

A. A portion of each original sample was reduced to a coarse powder and submitted to the alcohol-soluble extractive method.

B. A second portion of each original sample was separated into leaf and flower buds, the percentage of flower buds (by weight) being determined.

C. The flower and leaf buds from each original sample were reduced to a coarse powder separately and each portion submitted to the alcohol-soluble extractive method.

This gave four results for each sample, *i. e.*, (1) The percentage of flower buds. (2) The average alcohol-soluble extractive of the sample as such. (3) The average alcohol-soluble extractive of the leaf bud portion of the sample. (4) The average alcohol-soluble extractive of the flower-bud portion of the sample. The results are tabulated in Table I.

TABLE I.*

| Sample Number. | Botanical Source. | % Flower Bud (by Weight). | % Alc.-Ext. of Sample. | % Alc.-Ext. Leaf Bud. | % Alc.-Ext. Flower Bud. |
|----------------|-----------------------|---------------------------|------------------------|-----------------------|-------------------------|
| I | <i>P. balsamifera</i> | 97.0 | 17.1 | 45.8 | 15.8 |
| II | <i>P. canadensis</i> | 16.1 | 43.1 | 43.8 | 16.8 |
| III | <i>P. canadensis</i> | 4.0 | 49.4 | 48.7 | 15.4 |
| IV | <i>P. canadensis</i> | 9.2 | 46.5 | 47.4 | 18.0 |
| V | <i>P. nigra</i> | 76.6 | 20.7 | 44.6 | 14.6 |
| VI | <i>P. canadensis</i> | 11.1 | 44.3 | 48.3 | 18.3 |
| VII | <i>P. canadensis</i> | 1.5 | 49.0 | 51.5 | 13.6 |
| VIII | <i>P. canadensis</i> | 2.6 | 50.1 | 51.3 | 28.4 |
| IX | <i>P. canadensis</i> | 20.2 | 48.9 | 51.0 | 23.4 |
| X | <i>P. balsamifera</i> | 74.7 | 20.8 | 45.8 | 16.1 |
| XI | <i>P. canadensis</i> | 15.4 | 57.9 | 58.8 | 22.8 |

* Samples I and II are museum samples of considerable age; Sample III was purchased about ten years ago and Samples IV to XI (incl.) were purchased from wholesale houses within the past two years.

COMMENTS.

The results exhibited in Table I seem to show:

(1) That the alcohol-soluble extractive of the flower buds, averages considerably lower than that of the leaf buds.

(2) Where the flower-bud content of a sample is high the alcohol-soluble extractive is usually proportionately low.

(3) That it is not uncommon to find a flower-bud content higher than 10%. (The N. F. V limit.)

(4) That while a high flower bud content usually indicates an inferior sample as to alcohol-soluble extractive (I, II, V and X) it does not always follow that a flower bud content of over 10% indicates a poor sample (Sample IX, for example, with a 20.2 flower bud content runs 48.9% alcohol-soluble extractive and Sample XI with a flower-bud content of 15.4% runs 57.9% alcohol-soluble extractive).

(5) No definite conclusion as to the relation between botanical source and alcohol-soluble extractive can be drawn from the samples examined. The two samples of *P. balsamifera* and the sample of *P. nigra*, the only samples of these varieties obtainable, all ran excessively high in flower buds and consequently low in alcohol-soluble extractive. If, on the other hand, we examine the alcohol-soluble extractive of the leaf buds only, in these samples we find them to run among the average. It therefore might not be amiss to conclude that a sample of either species, low in flower bud content would be acceptable as far as alcohol-soluble extractive is concerned. *P. candicans*, however, seems to run very acceptable both as to flower bud content and alcohol-soluble extractive.

(6) General appearance might be in a sense considered indicative of quality. Buds covered with an abundance of resinous exudation usually run high in alcohol-soluble extractive and those which are dry and brittle usually run low. In *P. candicans* the flower buds may easily be distinguished from the leaf buds by their shape. This is considerably more difficult in the other species, which fact may account for the higher flower bud content in the other species. In this connection Farwell (6) states that the proper time to collect the buds is in the spring when the trees are in full bloom and before the leaf buds have broken, so as to avoid gathering flower buds. It is doubtful whether this is ever carried out in practice as the interval between flowering and breaking into leaf is a relatively short one. It is also questionable whether leaf buds gathered just before breaking are as high in alcohol-soluble extractive as those gathered earlier in the season.

SUMMARY.

(1) Morphological studies of the three Poplar Buds official in the N. F. V have been made and histological means for their differentiation enumerated.

(2) Morphological and histological characters of some unofficial poplar buds are also described.

(3) A method for the determination of the quality of Poplar Bud based upon alcohol-soluble extractive is suggested.

(4) Forty per cent is tentatively advised as a suitable minimum standard for alcohol-soluble extractive.

(5) A comparative study of the alcohol-soluble extractive of leaf and flower buds shows the flower buds to be considerably inferior. It appears that the present (N. F. V) limit of not more than 10% is probably too restrictive,

BIBLIOGRAPHY.

- (1) National Formulary IV (1916).
- (2) The Greek Herbal of Dioscorides. Book I, No. 113 Goodyer-Gunther Translation, Oxford (1934).
- (3) Dalecampi, "Historia Beneralis Plantarum," Lond., 1587.
- (4) Gerarde, John, "The Herbal or General Historie of Plants," London, 1633 (Book III, page 1486.)
- (5) Pharmacopœia Wirtenbergica, Stuttgart, 1754.
- (6) Farwell, O. A., "Source of Balsam Poplar Buds," JOUR. A. PH. A., 11, (1922), 184.
- (7) United States Pharmacopœia X, page 466.
- (8) *P. Tacamahacca*, Mill. (Gard. Dict. et. viii) is the northern Balsam Poplar. This plant was described under the name of *Populus balsamifera* by Duroi, which has probably given rise to confusion with *P. balsamifera*, Linné. In connection with this it should also be pointed out that *P. balsamifera* Linné, the true balsam poplar has been referred to by the synonyms "Cottonwood" and "Tacamahac."
- (9) *P. trichocarpa*, Miller (Torrey and Gray ex Hook. Ic. Pl. t 878) is the Black Cottonwood ranging from California to Oregon, British Columbia and Alaska. It is sometimes known as the "Western Balsam Poplar."

MONARDA PECTINATA, NUTT., A PHYTOCHEMICAL STUDY.*¹

BY JOSEPH B. BURT.

II. THE VOLATILE OIL.

A. DISTILLATION OF THE VOLATILE OIL.

1152¹/₂ lbs. of the fresh flowering herb of *Monarda pectinata*, Nutt., collected near Signal Hill, Scottsbluff County, Nebraska, and distilled, in July 1932, in the field while fresh, yielded 2688 cc. (2552.65 Gm.) of oil, corresponding to 0.486 per cent. Cohobation being impractical in the field, all water-soluble oil was discarded.

The oil was dark reddish brown in color. $d_{25}^{\circ} = 0.9496$, $n_{D25}^{\circ} = 1.5070$. The optical rotation could not be ascertained because of the dark color. When the total phenols were determined in accordance with the assay process for Oil of Thyme (1), two samples showed 77 per cent by volume.

B. SEPARATION OF PHENOLS.

In order to avoid an excess of alkali, about one-half of the theoretical amount of sodium hydroxide, in 5 per cent solution, was used, and the process repeated, each succeeding portion being reduced progressively by one-half, until there was no further reduction in volume of the oil shaken with the aqueous solution of the alkali.

In the first experiment 224 cc. of the oil were treated in this manner with the following results:

* Scientific Section, A. PH. A., Portland meeting, 1935.

¹ A portion of a thesis submitted to the Graduate School of the University of Wisconsin in partial fulfillment of the requirements for the degree of Doctor of Philosophy. (Pharmacy as major.)