

A MORPHOLOGICAL AND CHEMICAL STUDY OF NICANDRA PHYSALODES (L.) PERS.*¹

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BOTANICAL STUDIES.

INTRODUCTION.

Among the various plants that have been placed under cultivation in the Medicinal and Poisonous Plant Investigations Gardens of the South Dakota State College of Agriculture and Mechanic Arts School of Pharmacy, has been that of *Nicandra Physalodes* (L.) Pers., commonly known as the Apple of Peru. This plant has been placed under cultivation in the gardens since 1918, seed having been received from Professor E. L. Newcomb, in the fall of 1917. He reports that the seed had been purchased from Haage and Schmidt, Erfurt, Germany, in 1914.

The writer has undertaken a morphological and chemical study of the plant in question, on account of his interest in the *Solanaceæ*, especially in regard to the peculiar group of alkaloids that are present in a number of plants in this family.

Synonymy: *Nicandra*, Adans. (*Calydermos*); *Physalodes*, Boehm; *Nicandra Physalodes*, (L.) Pers.; *Atropa Physalodes*, (L); *Atropa peruvianum*, Kuntze; *Physalodes physalodes*, Britton; *Nicandra physaloides*, (L) Gärt.

Common Names: Apple of Peru. Known as Belladonna de Pais in Mexico.

HISTORICAL.

The Apple of Peru is an old-fashioned garden herb, now rarely seen, adventive from Peru and sparingly naturalized in the United States. It is to be found at the present time in old gardens and waste places, being cultivated for its large, pale blue, showy flowers. Reported to be widely distributed in the tropics.

The plant is named in honor of Nicander† by Adanson, the specific name, *Physalodes*, being given by Boehmer, a German botanist.

It has been reported in literature to possess diuretic and narcotic properties. Pammel states that it is a poisonous plant and is used in some parts of the United States as a fly poison. Dujardin-Beaumez, in their "Plantas Medicinales," states that a decoction of the plant is used in some of the tropical countries. The fruit is said to possess diuretic properties.

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¹ Acknowledgment.—The author wishes to take this opportunity of expressing his thanks to Prof. E. J. Petry and to Prof. E. R. Serles for aid in the preparation of this paper.

† Nicander (L. fr. Gr. Νικάνδρος, Nikandros) was a Greek physician and hereditary priest of Apollo in his native city. Nicander was born in Claros near Colophon, in Ionia, 150 B. C. He was also a grammarian and a poet. Among his numerous works in verse and prose, two poems are extant. The first deals with remedies which were used for wounds inflicted by venomous animals, and the second on poisons and the treatment of poisons. Nicander was especially noted for his great work along toxicological lines, having been frequently quoted by Pliny, Galen and other ancient writers.

DESCRIPTION OF PLANT.

The Apple of Peru is a coarse, tall-spreading annual, which attains a height from 3 to 8 feet. The stem is distinctly ribbed and hollow; glabrous. The leaves are alternate, ovate or elliptic, blunt-pointed, from 2 to 12 inches in length and from 1 to 8 inches in width. Numerous multicellular non-glandular hairs are present

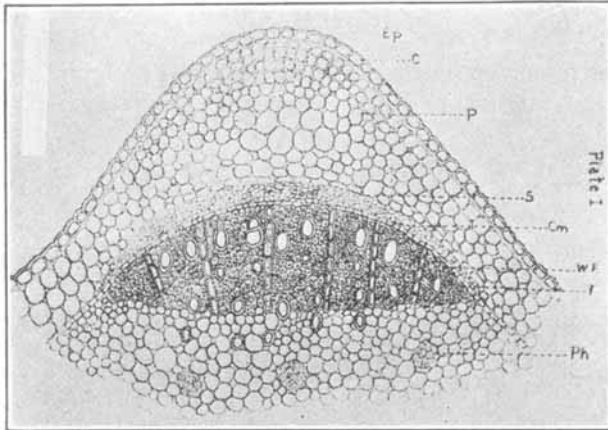


Plate I.—Transverse section through rib of young stem: Ep, epidermis; C, collenchyma; P, parenchyma; S, sieve; Cm, cambium; M, medullary rays; WF, wood fibers; T, tracheae; Ph, intraxylary soft bast; Pi, pith.

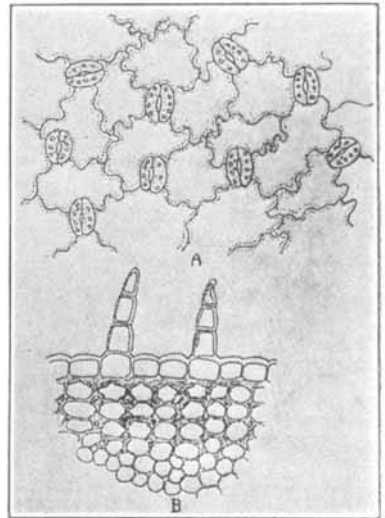


Plate III.—A, epidermal cells of leaf, showing stomata; B, transverse section petiole, showing epidermis, collenchyma and non-glandular hairs.

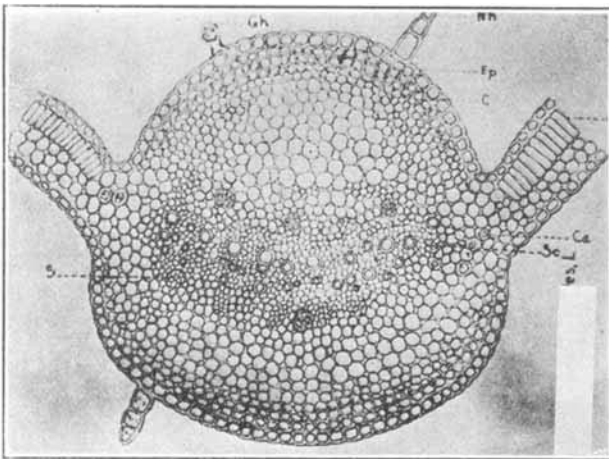


Plate II.—Transverse section, petiole: Ep, epidermis; Gh, glandular hair; Nh, non-glandular hair; C, collenchyma; T, tracheae; S, sieve; Ca, calcium oxalate; P, parenchyma; Pa, palisade tissue; Sc, sclerenchyma tissue.

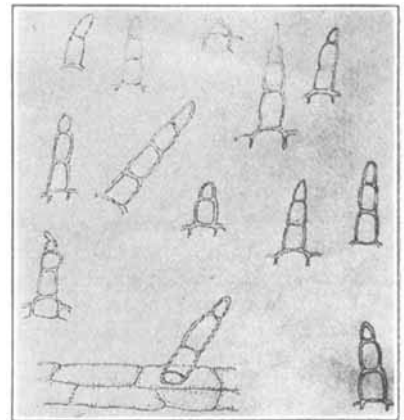


Plate IV.—Various types of non-glandular hairs.

on upper surface and along the margin of the leaf. The plant is grown for its large blue showy flowers, which are broadly campanulate, about an inch in length. Stamens 5, inserted on the corolla; anthers oblong; stigma 3- to 5-parted. Calyx

5-parted and which is much inflated in the fruit, loosely surrounding the latter. The fruit is a dry or nearly dry globular berry, about one-half inch in diameter. The fruit wall is thin and membranous, enclosing numerous small, brown seeds; 3- to 5-loculed, which differentiates the Apple of Peru from that of *Physalis*, the latter possessing a 2-loculed fruit. The Apple of Peru resembles that of a large *Physalis* and is often mistaken for the ground cherry and the winter cherry.

STRUCTURE OF STEM.

As pointed out by Solereder, an important character of the axis is to be found in the presence of intraxylary soft bast, which has been demonstrated by various

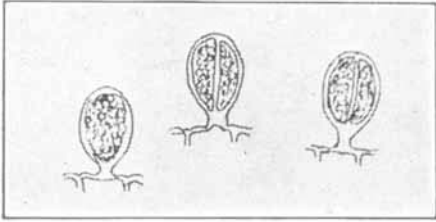


Plate V.—Various types of glandular hairs.

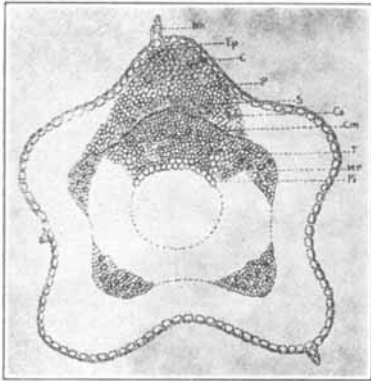


Plate VI.—Transverse section of young stem: Ep, epidermis; Nh, non-glandular hairs; Gh, glandular hairs; C, collenchyma; P, parenchyma; Cm, cambium; Ca, calcium oxalate; WF, wood fibers; T, tracheae; Pi, pith.

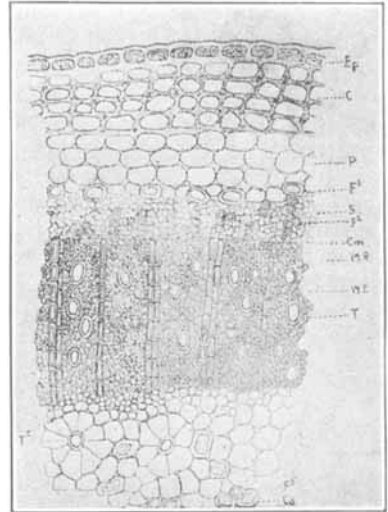


Plate VII.—Transverse section of mature stem: Ep, epidermis; C, collenchyma; P, parenchyma; F¹, bast fibers; F², bast fibers; S, sieve; Cm, cambium; Mr, medullary rays; WF, wood fibers; T, tracheae: T¹, tracheae (surrounded with stellate parenchyma); F³, sclerenchyma fibers; Ca, calcium oxalate.

authors (Vesque, Radlkofer, Solereder, Schepegrell, Fedde) and which has been verified by the writer.

Sections of the mature stem present the following characteristics: a layer of uniform epidermal cells, with heavily thickened, cutinized outer walls and with thin radial walls; 3 to 6 layers of collenchyma, with distinct thickenings at the corners; cortex of parenchyma, in which are noted irregular-shaped crystals (prisms) of calcium oxalate, occurring singly or in the form of crystal fibers, associated

with the bast fibers; scattered elongated bast fibers; sieve area of characteristic form, among which is scattered a different type of bast fiber, the latter much shorter than those scattered throughout the cortical area; cambium, not clearly defined; xylem, consisting of heavily lignified wood fibers with thickened walls, tracheae of the simple and bordered pore type; medullary rays, 1 to 2 cells in width; pith composed of parenchyma cells, tracheae of single and double spiral type, around which are stellate groups of parenchyma cells; scattered sclerenchymatous .

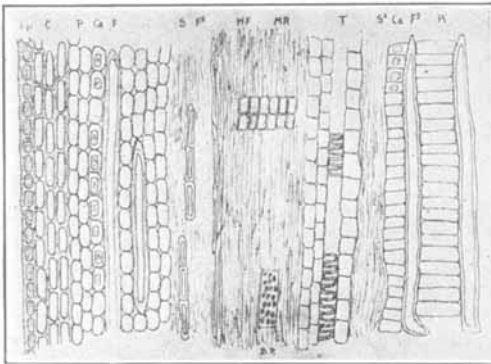


Plate VIII.—Longitudinal section of mature stem: Ep, epidermis; C, collenchyma; P, parenchyma; F, bast fibers; Ca, calcium oxalate; S, sieve; F², bast fibers; Cm, cambium; WF, wood fibers; T, tracheae; MR, medullary rays; S², intraxylary soft bast; F³, sclerenchyma fibers; Pi, pith; BP, bordered pore tracheae.

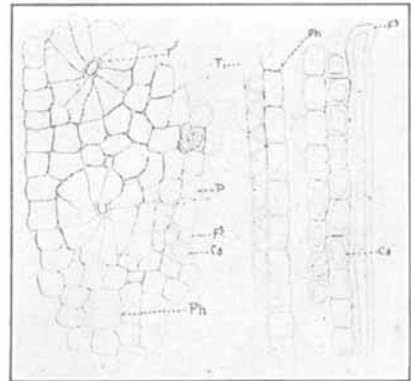


Plate IX.—A, transverse section of pith (mature stem); B, longitudinal section (same); T, tracheae; T¹, tracheae with stellate parenchyma; F³, sclerenchyma fibers; Ph, intraxylary soft bast; Ca, calcium oxalate; P, parenchyma.

fibers, of the type found in the cortical region, and with which are associated crystal fibers; scattered patches of sieve (intraxylary soft bast—Solereeder); central portion of stem hollow.

CHIEF STRUCTURAL CHARACTERISTICS OF LEAF.

Leaf bifacial; numerous multicellular non-glandular hairs on upper surface and along margin of leaf; the hairs being 2-4-5-celled in addition to the 3-celled hair as reported by Solereeder; few small multicellular non-glandular hairs on both the upper and lower surfaces; stomata of usual shape, generally being surrounded by four neighboring cells; fibrovascular tissue of bicollateral type; irregular-shaped prisms of calcium oxalate in the parenchyma cells.

DESCRIPTION OF POWDER (LEAF MATERIAL).

Dark green; consisting of numerous large multicellular non-glandular hairs, which are from 2- to 5-celled, conical; a fewer number of smaller conical multicellular, non-glandular hairs; glandular hairs, club-shaped with short stalks, consisting of 1 to 2 cells, with vertical walls; calcium oxalate in the form of individual crystals and also in crystal fibers, the individual crystals in the form of irregular-shaped

prisms; stomata with fragments of accompanying epidermal cells; fragments of sclerenchymatous tissue; spiral and close annular tracheae; fragments or groups of cells filled with chlorophyll grains.

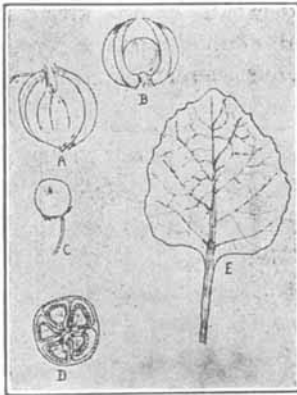
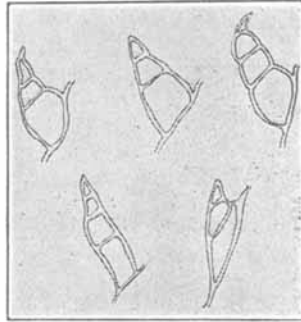


Plate X.—A, mature fruit; B, mature fruit with part of calyx removed; C, fruit with calyx removed; D, transverse section of fruit; E, leaf, 1/2 natural size.



Part XI.—Types of multicellular non-glandular hairs from leaf.

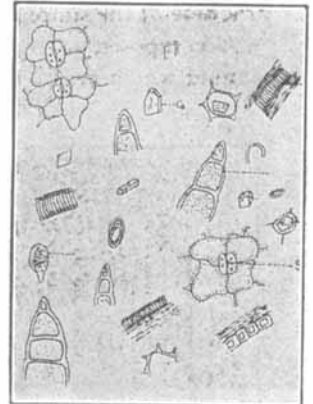


Plate XII.—Powdered leaf material; T, tracheae; Nh, non-glandular hairs; Ca, calcium oxalate; Cf, crystal fiber; Gh, glandular hairs; St, stomata.

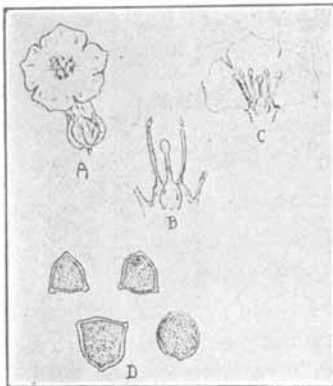


Plate XIII.—A, entire flower; B, C, longitudinal sections through flowers; D, pollen grains.

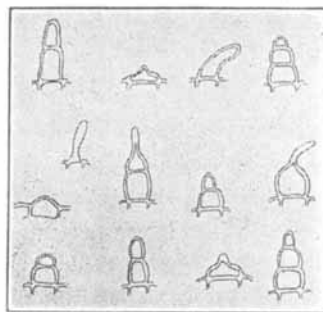


Plate XIV.—Types of multicellular, non-glandular hairs (from seedlings).

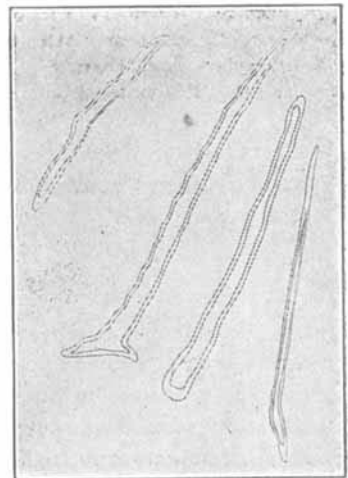


Plate XV.—Types of sclerenchymatous fibers from pith of mature stem.

CHEMICAL EXAMINATION.

The writer became interested in a study of *Nicandra Physalodes* (L) Pers., through the question of the alkaloids of the *Solanaceæ*. No reference has been noted in literature cited, in regard to the chemistry of this plant.

The present work only includes a preliminary investigation of the alkaloids of the Apple of Peru, the work to be continued, and reported upon at a later date, on the question of the Chemistry of the Alkaloids of *Nicandra Physalodes* (L.) Pers.

Qualitative tests for the presence of alkaloids were performed as follows:

1. Twenty-five grams of powdered leaf material were triturated with sufficient water during ten minutes and then filtered. Mayer's reagent was added to one portion and phosphomolybdic acid to another portion of the filtrate. No precipitate was produced in either case.

2. A like quantity of the material was triturated in a similar manner with sufficient dilute sulphuric acid ($\frac{1}{2}$ per cent.) and then filtered. A precipitate was produced in both cases with Mayer's reagent and with phosphomolybdic acid, apparently showing the presence of alkaloids.

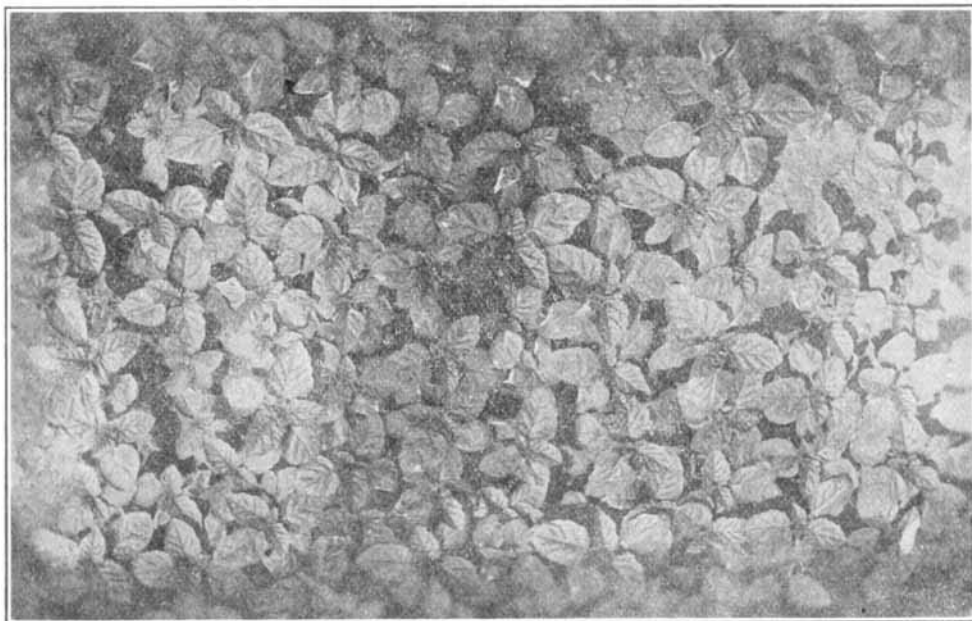


Plate XVI.—Flat of seedlings, *Nicandra Physalodes* (L.) Pers., infected with *Pythium De Baryanum*.

3. Two hundred grams of powdered leaf material were extracted with $\frac{1}{2}$ per cent. sulphuric acid, filtered, made alkaline with ammonia water and then extracted with chloroform. The chloroform extract was evaporated and recrystallized several times.

The finally purified alkaloidal material, when dissolved in $\frac{1}{2}$ per cent. sulphuric acid solution, gave a distinct test for the presence of alkaloids with Mayer's reagent and also with phosphomolybdic acid, as well as a number of other alkaloidal precipitants in general use in the laboratory. The purified material was crystalline in nature and possessed the characteristic tobacco-like odor which is so generally noted in the assay of Solanaceous plants.

When assayed according to the method outlined in the United States Pharmacopœia, Ninth Decennial Revision, for *Belladonnæ Folia*, the leaves were found to contain 0.1 per cent. of total alkaloids. This has been verified by other workers in Drug Assaying Laboratory of the School of Pharmacy.



Plate XVII.—Seedling, *Nicandra Physalodes* (L.). Pers.

2. Chemical study revealed the presence of alkaloids to the extent of 0.1 per cent. in the powdered leaf material.

SUMMARY.

1. A morphological study of *Nicandra Physalodes* (L.) Pers. has been made and the following characteristics noted:

(a) Bicollateral type of fibrovascular tissue.

(b) Presence of 2-4-5-celled non-glandular hairs, in addition to the 3-celled type as reported by Solereder.

(c) The presence of an elongated type of sclerenchymatous fiber in the cortical and pith regions.

(d) The presence of calcium oxalate in the form of individual prisms of irregular shape and also in the form of crystal fibers.

(e) The presence of 1-2-celled non-glandular hairs with vertical walls.



Plate XVIII.—*Nicandra Physalodes* (L.) Pers. in Garden of Many Herbs, Medicinal and Poisonous Plant Investigations Gardens.

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