

The Pharmacognosy of Domestic Rye and Wheat Ergots*

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The problem forming the subject of this paper is threefold: first, to analyze pharmacognostically certain characters present in the morphology of four domestic ergots; second, to report on the chemical assaying of these domestic ergot samples; third, to compare these findings with those already established for rye ergot U. S. P. XI. The domestic ergots used in this study include those from various rye, wheat and wheat hybrid plants of Minnesota and neighboring states. The domestic grass plants used as sources include rye, *Secale cereale* L., durum wheat, *Triticum durum* Desf., and the hybrid wheat, *Triticum durum* Desf., crossed with a wild rye plant, *Elymus condensatus* Presl.

Reports in available literature on the comparative morphology and chemical assay of American ergot are meager. The United States Dispensatory (1) recognizes the similarities in properties and characters of ergot from many of the *Gramineæ* and *Cyperaceæ* families. Teperdriel (2) has described an ergot from a wild rice, *Zizania aquatica* L., of northwestern United States. Denniston (3) has mentioned the differences in morphology between ergot from wild rice and ergot of rye, *Secale cereale* L. Over 250 species of the *Gramineæ*, 10 species of Sedges and one species of the *Juncaceæ* have been cited by Barger (4) as sources for domestic and European ergots. In Europe, Tulasne (5) has found that the ergot sclerotia fructifications of more than twelve different grasses, most of which are found growing in this country, are identical botanically with *Claviceps purpurea* (Fries) Tulasne from rye. Munch (6) has offered a plausible explanation for the evident infrequent use clinically and experimentally of domestic

ergots other than from rye plants. This explanation is based in part on the fact that rye ergots are larger than wheat ergots.

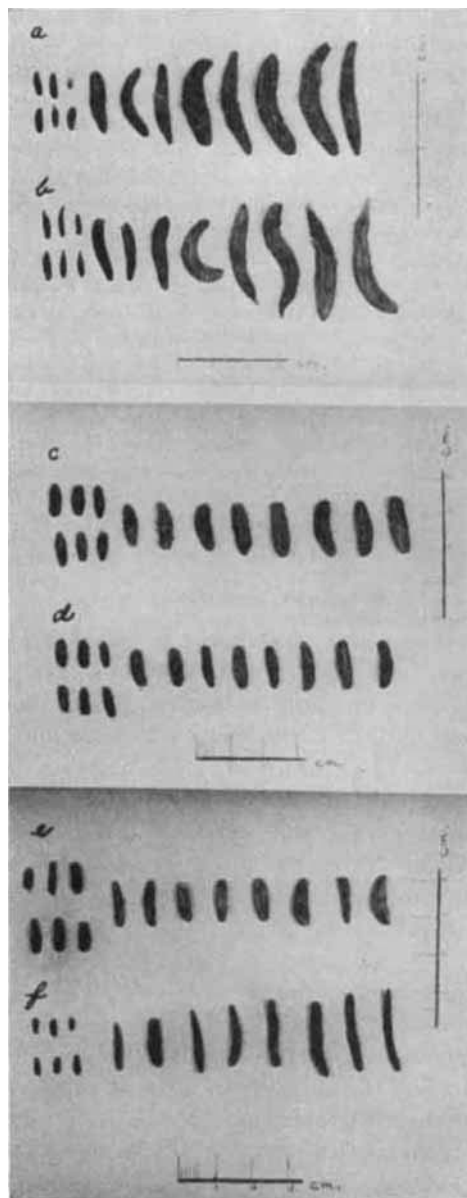


Fig. 1.—*a*, Spanish rye ergot U. S. P. XI. *b-f*, Domestic ergots: *b*, Minnesota rye; *c*, common wheat; *d*, durum wheat; *e*, "striated" durum wheat; *f*, wheat hybrid ($\times \frac{1}{2}$).

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EXPERIMENTAL

MORPHOLOGY

Studies of the comparative macroscopic and microscopic morphology of domestic rye and wheat ergots were made in the following manner: Several lots of domestic ergots obtained from fields of Minnesota¹ and neighboring states were examined first macroscopically and comparisons made with commercial samples of Spanish and Russian rye ergots U. S. P. XI. Anatomical sections of this material were then prepared. Material was properly fixed, dehydrated, using the Zirkle normal butyl alcohol method (7), imbedded in paraffin blocks, and sectioned. Sections from dry material were also made. The most suited reagents used in performing coloration tests included 50% sulfuric acid, chloral hydrate T. S., chloro zinc iodide and aqueous eosin. Stain reagents such as safranin, fast green and hæmatoxylin were used for permanent mounts. Of these, the use of a 0.3% iron alum mordant and 0.5% Heidenhain's Hæmatoxylin stain was found best for photomicrographs. Powdered ergots were treated in a similar manner.

DESCRIPTION OF DOMESTIC RYE ERGOT

Ergot from domestic rye (Fig. 1) measured in length from 5.5 mm. to more than 42 mm. The thickness ranged from less than 3 mm. to more than 7 mm. In outline, individual grains appeared lanceolate, cylindrical, angular and tapered to blunt or pointed ends. Several grains occurred twisted, but most were straight or curved. The surface consisted of deep furrows running longitudinally, some extending the entire length of the grain. Transverse fissures were numerous and deep in some sclerotia, giving each a rough and scaly appearance.

The color varied from purple to purple-brown, with lighter brown areas caused by deep furrows sometimes showing conspicuously. The inner areas upon fracturing showed grayish white to pink tints. Striations extended from the central region and followed along to the outer zone. When dried, the odor was free from mustiness and much like that of drying cereal. The fracture was sharp and waxy, the taste oily and acrid.

Histology.—Cross sections made through many thicknesses showed three regions of pseudoparenchymatous cells (Fig. 2). The outermost region consisted of the "rind" and was continuous, excepting for an occasional interruption caused by a furrow or fissure. Its width measured from less than 16 μ to about 38 μ . Test solutions of 50% sulfuric acid and chloral hydrate colored this "rind" layer red or scarlet.

Individual cells cleared of coloring matter measured in width up to 12 μ (Fig. 2); a few measured

14 μ . In length these cells ranged from 3 μ to 14 μ . Few cells were found to be collapsed and all possessed brown thickened walls.

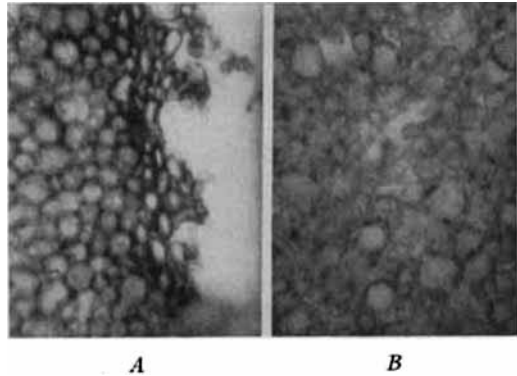


FIG. 2 (Photomicrograph $\times 950$).—Domestic rye ergot. A, Transverse section of outer zone of hyphal cells; B, transverse section of innermost zone of hyphal cells.

Layers of closely compacted pseudoparenchyma cells were found immediately within the outer "rind." Cells of this region measured in width up to 12 μ , and in length up to 14 μ . In longitudinal section the arrangement of these pseudoparenchyma cells appeared to be as in chains, many filaments paralleling one another. In surface view the chain-like arrangement was modified from parallel to perpendicular in direction of growth. Some coloring matter was present and fixed oil globules and protein substances were abundant. An innermost region (Fig. 2) of the transverse section, and largest region, consisted of colorless cells with numerous oil cells measuring up to 25 μ in diameter. These cells were irregularly arranged with an occasional short chain of hyphæ scattered in the more central regions. Inter-cellular air spaces were numerous with large cells mixing profusely with smaller compact pseudoparenchyma cells. A central zone within this area was variously marked with stellate patterns by tightly compressed fungous cells.

DESCRIPTION OF DOMESTIC DURUM WHEAT ERGOT

Sclerotia of domestic durum wheat ergot were found to measure in length from 6 mm. to 15 mm., and in width from 2 mm. to occasionally more than 5 mm. Most grains of wheat ergot were straight (sometimes slightly curved) and the outline appeared cylindrical to ovate. End regions were generally blunt and rounded. Only very small sclerotia appeared to have tapered extremities.

Surface markings exhibited characteristic furrows running longitudinally the entire length of some sclerotia with smaller fissures paralleling these. Transverse fissures were not found to be conspicuous (Fig. 1).

The color graded in intensity from purple to purplish black. The inner surface was whitish to pinkish white and faint markings extended in a

¹ The authors are indebted to C. H. Bailey of the College of Agriculture, University of Minnesota, for the several samples submitted.

dendritic manner from the center. The odor was noticeably free from mustiness and rancidity. The fracture was sharp and waxy, the taste oily.

Histology.—Transverse sections were made through the greater diameters of domestic durum wheat ergots and showed from periphery to the center: (a) a narrow zone, up to $32\ \mu$ in width, of purplish brown cells containing coloring matter; (b) a middle region of closely compacted hyphal cells; (c), a wide innermost zone of loosely arranged large and small thin-walled pseudoparenchyma cells (Fig. 3).

Cells of the outermost narrow or "rind" zone stained red to scarlet with 50% sulfuric acid or chloral hydrate solution. Upon decolorizing, this "rind" consisted of thickened brown-walled cells closely appressed together. Individual cells measured up to $7\ \mu$ in thickness and up to $10\ \mu$ in length. Many cells were collapsed; all possessed thickened brown suberose walls and formed a continuous outer "rind."

An inner region of regularly rounded closely compacted pseudoparenchyma cells appeared of varied thicknesses and with many globules of fixed oil. Coloring material occurred in the very outermost cells. In width these cells measured up to $10\ \mu$, and in length up to $12\ \mu$. Characteristic chains of hyphal cells appeared in longitudinal sections. Most of these ran in parallel fashion. Examination of the innermost (central) regions of transverse and longitudinal sections (Fig. 3) revealed the presence of colorless cells which were loosely arranged but less so than those of rye sclerotia. Many of these contained fixed oil. Large and small cells were scattered, and intercellular air spaces frequently separated these. Large cells measured up to $20\ \mu$ in width. Short chained hyphal cells were scattered throughout in longitudinal section. In the center of this region closely grouped fungous cells formed stellate markings. Many sections of durum wheat ergot appeared to be more uniform as to size and arrangement of the cells than were those of rye ergot.

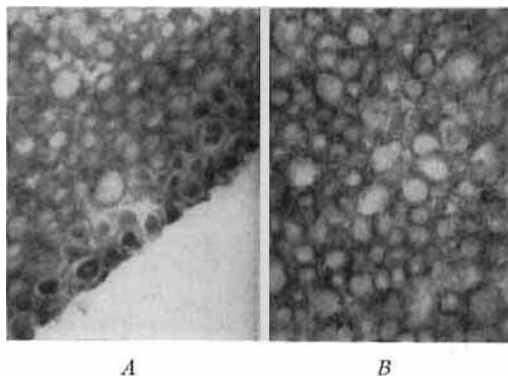


Fig. 3 (Photomicrograph $\times 950$).—Domestic wheat ergot. A, Transverse section of outer zone of "striated" durum wheat ergot; B, transverse section of innermost region showing hyphal cells in durum wheat ergot.

DESCRIPTION OF DOMESTIC DURUM WHEAT "STRIATED" ERGOT

Ergot grains obtained from some durum wheat stock were found to be variously marked with striations of purplish black color and various tints of rose (Fig. 3). These sclerotia measured in length from 6.5 mm. to over 15 mm., and in thickness from 2 mm. to 5 mm. The outline was conspicuously cylindrical, lanceolate and terminated usually at both extremities in blunt, obtuse points. Grains appeared to be straight with only an occasional slight curving to be noted. Outline of the diameter was angular and waxy.

The smooth, waxy surface appeared marked with numerous longitudinal shallow furrows, some extending the entire length of the sclerotia; transverse fissures were not often found.

Fractures made of the sclerotia were hard, short and waxy. The internal fractured surface varied in appearance from white to pinkish white. The odor was free from being ammoniacal or rancid upon treatment of several sclerotia with hot water. With untreated grains, a noticeable "ergot" odor was conspicuous. The taste was oily and somewhat acid.

Histology.—Transverse sections made through various diameters of striated domestic durum wheat ergots showed, from periphery to center, an outermost interrupted zone (up to $20\ \mu$ in thickness) of suberose (brown-walled) cells, which take a red to scarlet stain with 50% sulfuric acid or chloral hydrate T. S. Cells of this purple to purplish brown layer measured individually up to $10\ \mu$ in diameter and up to $12\ \mu$ in length. The suberose walls were thickened and in many cases the cells were tightly pressed together.

Between the discontinuous brown-walled cells which circle the periphery, areas of thickened colorless-walled, closely compacted hyphal cells were present. These cells did not stain as brilliantly red with sulfuric acid or chloral hydrate test solutions. However, they appeared to be filled with a fungous, waxy material which was insoluble in alcohol, xylene or petroleum ether. In width some cells measured up to $10\ \mu$, and in length up to $12\ \mu$.

Directly beneath the discontinuous outer suberose "rind" layers were noted several layers of colorless and compactly arranged cells (Fig. 3). In longitudinal sections many of these cells were found to form in long chains. Some coloring material was noted in the outer cells of this region. Cells measured up to $10\ \mu$ in length and up to $12\ \mu$ in width. Fixed oil was present.

The innermost pseudoparenchymatous region consisted of large and small, loosely arranged cells, but more compactly arranged than rye ergot. These cells measured from $2\ \mu$ to $21\ \mu$ in diameter. Fixed oil was also abundant. Short chains of hyphal cells and stellate markings were evident. The latter appeared to have been formed by closely appressed small fungous cells. Often beaked cells were observed to be present.

DESCRIPTION OF HYBRID WHEAT ERGOT

Sclerotia obtained from a hybrid wheat, *Triticum durum* Desf., crossed with a giant wild rye, *Elymus condensatus* Presl., measured from 3.5 mm. to 30 mm. in length, and from 1.5 mm. to 4 mm. in width (Fig. 1).

The outline of most grains was lanceolate, linear-lanceolate, and tapered to sharp fine points at either end. Little curving was visible, grains were mostly straight in length. In transverse view, outlines appeared angular to ovate. Transverse fissures and longitudinal furrows appeared shallow. Usually the latter extended the entire length of the sclerotia.

The color was observed to be purplish to purplish brown. Fractured surfaces were pinkish white and cream colored with thin stellate markings emitting from the center. Odor was free from rancidity and somewhat sweet. The taste was pungent and oily.

Histology.—Transverse sections cut at various diameters through hybrid wheat ergots exhibited an outermost region of a few layers (up to 24 μ in extent) of "rind" cells which retained a red or scarlet color upon the application of 50% sulfuric acid or chloral hydrate T. S. When dissolved of any coloring material the individual cells of this zone measured up to 10 μ in width and up to 12 μ in length. Each possessed a thick brown wall with a narrow lumen. The brownish layer of suberose cells circles the sclerotium and is rarely interrupted.

Immediately within the outermost region of cells were found closely compacted pseudoparenchyma cells. Some measured in width up to 10 μ and in length up to 13 μ . Outermost cells of this region possessed slight amounts of coloring matter and an alcohol-insoluble material. Fixed oil globules occurred in the larger cells. Occasional air spaces were observed in this region.

In the central area of the cortex are large pseudoparenchyma cells, some of which measure up to 18 μ in width. Most cells are loosely arranged. Smaller fungous cells (less than 4 μ in width) are scattered throughout. Globules of fixed oil were present in large numbers, especially among the larger cells. Coloring matter in this region appeared to be absent, or if present, was water-soluble. Short chain-like hyphal cells extended in irregular directions as seen in longitudinal view. Inter-cellular air spaces were numerous and stellate markings consisting of tightly appressed small fungous cells extended in finger-like fashion from the center of the sections.

POWDERED DOMESTIC RYE AND WHEAT ERGOT

Several samples of a No. 40 powder were examined. Striking resemblances were noted upon comparing all domestic rye and wheat ergot in this form with U. S. P. XI rye ergot. In general the following pseudoparenchymatous tissue fragments were noted: fragments of the purple-colored outer "rind" cells which appeared red to scarlet with

50% sulfuric acid or chloral hydrate T. S.; strands of colorless hyphae, some of which appeared broken and others entire; fragments of compact fungous tissue with many fixed oil globules; and small pieces of irregularly shaped waxy cells, thought to be portions of the sclerotium wall. Powdered rye, durum wheat and hybrid wheat ergots were gray-brown to purple in color. Powdered durum wheat "striated" ergot exhibited a gray-pink color. The presence of "striated" wheat ergot of this kind could be detected by the presence of fragments of cells with a pink-colored content and rather glistening waxy appearance quite unlike other ergot powders (Fig. 3).

FIXED OIL, MOISTURE, AND ALKALOID DETERMINATIONS

Fixed oil, per cent of moisture, and a chemical assay of the total alkaloid content of several samples of domestic ergot were determined as follows: Fixed oil determinations were carried out using sufficient quantities of a No. 40 powder of each of the four domestic ergots. Extractions with petroleum ether were made and the solvent afterward removed by evaporation. The residue remaining was dried, weighed, and percentages of oil computed.

Moisture determinations were made by using the U. S. P. XI toluene method (8).

Total alkaloid determinations were obtained according to the Hampshire-Page (9) and British Pharmacopœia (10) colorimetric methods. These results were then compared with the determinations by Hampshire and Page (9) for rye ergot from foreign sources.

Results of the above assaying are shown in Table I.

TABLE I

Source	Fixed Oil, %	Moisture, %	Total Alkaloid, % (as Ergotoxine)
1. Domestic rye ergot	Av. ^a 20.47	5.57	0.348
	30.68	5.73	0.306
	25.20	5.72	0.386
	Total average	25.67	5.67
2. Domestic durum wheat ergot	Av. ^a 25.75	3.00	0.058
	24.82	3.45	0.057
	30.67	4.20	0.064
	26.42	5.19	0.044
	21.32	4.13	0.066
Total average	25.79	3.99	0.058
3. Domestic durum wheat "striated" ergot	Av. ^a 29.63	5.63	0.102
	24.71	5.60	0.014
	21.24	3.05	0.087
	29.08	4.33	0.086
Total average	26.66	4.65	0.072
4. Domestic hybrid wheat ergot (durum wheat \times giant wild rye)	Av. ^a 29.80	4.14	0.115
	20.04	5.21	0.105
	24.62	3.15	0.106
	Total average	24.82	4.13

(Table I continued on p. 140)

Source	Fixed Oil, %	Mois- ture, %	Total Alkaloid, % (as Ergo- toxine)
5. Spanish rye ergot			Av. ^b 0.116
			0.245
			0.223
			0.235
			0.223
Total average			0.208
6. Russian rye ergot			Av. ^b 0.060
			0.063
	Total average		0.0615

^a An average for not less than three different samples.
^b An average for not less than two different samples as reported by Hampshire and Page (9).

SUMMARY

A pharmacognostic examination has been made of four ergots from grasses of north-western United States. Cell size determinations have been recorded and cell characteristics described. A form of "striated" wheat ergot has been described and a means for determining its identity in commerce suggested. The following salient facts have been observed:

1. The variations that occur in structural characteristics between foreign rye ergot and domestic rye ergot are mainly in size of cell forms. They are practically negligible.

2. Sclerotia of domestic and foreign rye ergots were generally larger in size than those of wheat ergot. The pseudoparenchyma cells of domestic wheat ergots, how-

ever, are more compactly arranged than are those of rye ergots.

3. There were no appreciable differences in the results of microchemical coloration tests, fixed oil determinations and moisture content for ergots of domestic rye and wheat.

4. A chemical assay indicated that total alkaloid content (as ergotoxine) of domestic rye ergot was greater than of foreign rye ergot. On the other hand, ergot from domestic wheat was in most cases found to be lower in total alkaloid (as ergotoxine) than ergot of rye.

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Nomenclature Confusion of *Populus candicans* Aiton*†

By Kenneth Redman‡

The genus *Populus* has long been known to show variation in the shape of the leaves, not only in those from different trees of the same recognized species, but also in the various leaves from the same tree.

The leaf variation, especially, has led to a difference of opinion among taxonomists

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as to whether certain plants in the genus *Populus* should be given specific or merely varietal ranking. This is particularly true in the case of the plant now commonly called "Balm-of-Gilead Poplar." This was first given a specific rank, *Populus candicans* by Aiton (1) in 1789, commonly called the "Heart-leav'd Tacamahac Poplar Tree" which had previously been listed by Hope (2) as *Populus tacamahaca* Miller in 1778.

Aiton did not have long to wait to have his specific ranking challenged, however, for Brisseau-Mirbel (3) in 1800-1806 stated that "*Populus balsamifera* Linné or *Populus tacamahaca* Miller, and *Populus candicans*