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A Study in the Identification
of
Quack Grass.

A thesis submitted to the faculty of the Graduate
School of the University of Minnesota by Jane Nisbit in
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Introduction

Of all the plants which supply man and his domestic animals with food, the Grass family (Gramineae) is the most important. Though it ranks fifth^x in size it probably contains more individual plants than are included in any other plant family. That it includes such field crops as wheat, oats, barley, rye, corn, millet, sorghum, and rice is evidence of its value. Some grasses have developed such effectual devices for self preservation and distribution that their presence is a menace to cultivated crops, hence they are termed "weeds". One of the latter - *Agropyron repens*, Beauv. (quack grass)-is undoubtedly the worst weed in Minnesota and it is with this grass (*Agropyron repens*, Beauv.) that this paper has to deal.

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Statement of Problem.

The damage it has caused by reducing crop yields and depreciating land values amounts to millions of dollars in this state alone. Its noxious nature is due to the tenacious hold which it gets on the land which makes it very difficult and expensive to eradicate it. Quack grass

^xGrasses of N. A., Beal - Vol. I, p.67.

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is, moreover, particularly insidious because of the difficulty in distinguishing between its "seeds" and those of other species of *Agropyron*. Many farmers of this state have not realized the danger from this weed pest until the grass has become established in their fields and many more do not yet understand that the same prospect confronts them. The first trouble lies in the introduction of the weed into clean land. The matter of eradicating it when once established is a farm management problem which is not discussed here. To successfully avoid the introduction of the pest upon his land a farmer must recognize the plant in all of its phases. Other grasses so closely resemble *A. repens* in rootstalk, leaf and "seed", that close discrimination is necessary to identify the species, especially if only one phase of the plant is present. Even seed experts do not seem to have satisfactorily distinguished certain seed characters so that quack grass can be unhesitatingly determined.

The specific object of this paper is therefore a study of *Agropyron repens* in order to point out such botanical features as shall aid in more accurately and expeditiously identifying *A. repens* in its various forms.

Distribution of Quack Grass in Minnesota.

This weed is distributed pretty well over the cultivated land of Minnesota. It is especially bad in the southern half of the state and is becoming equally so in the Red River Valley. The following map shows the distribution as reported by farmers in attendance at the Short Course of the School of Agriculture in January 1910.



These reports were obtained from 127 farmers repre-

senting 49 counties in the state. The following table shows the importance placed by these representative and progressive farmers on this weed:

106	reported	quack	grass	the	worst	weed	in	his	locality
14	"	"	"	"	"2nd	"	"	"	"
4	"	"	"	"	"3rd	"	"	"	"
1	"	"	"	"	"4th	"	"	"	"
2	"	"	"	"	"6th	"	"	"	"

Introduction into Minnesota.

Quack grass is a native of the Eastern Hemisphere, ranging from Iceland through Siberia and from Lapland to North Africa and the Himalayas. It was first introduced many years ago into the United States along the Atlantic Coast and has spread westward until it is admitted to be a bad weed in the states of California and Washington. The exact date of its introduction into Minnesota is not determined but it occurred a good many years ago. The writer saw small patches of the weed at Rochester, Minn. in 1886. These patches were in Olmsted county and came from seed in hay raised on a farm in that locality.

The method of introduction into Minnesota is not known. It may easily have been introduced in seeds of commerce or along railroads or natural highways.

It has in some instances been introduced in Russian

Brome grass seed from the east upon land known to have been free from quack previously.^x In this case at least it developed into a bad weed.

During its migration from the Atlantic to the Pacific Coast the plant has acquired many local names. The following is a partial list:

Couch grass	Durfee grass	Quick grass
Chandler "	Dutch "	Quitch "
Creeping wheat	Fins' "	Scutch "
Devils' grass	Goose "	Squitch "
Dog "	Quack "	Twitch "
Durfa "	Quake "	Witch "

The term "goose grass" was popular among the New Englanders fifty years ago and the now common term "quack grass" has a related reference. "Quack"grass is the most common name applied to the grass in Minnesota, although other names are found locally popular.

Agricultural Features of Quack Grass.

In its earlier stages, quack grass gives good pasturage and is recommended in some places, e.g. in semi-arid regions as forage for stock.* It is described by Lyon and Hitchcock[⊕] as "a pestiferous weed in the Eastern

* Carmichael of Farmington, Dakota county at the Minnesota Field Crop Breeders' Association, Jan. 11, 1910. St. Paul

* Richardson, U.S. Dept. of Agr. - Chem. Analysis - Report 32 1884, p 128

⊕ U.S. Dept. of Agr., B.P.I. Bul. #59, p 38 - 1904

States, yet for Nebraska it shows many qualities which recommend it as a hay grass. The grass is nutritious, palatable, drought resistant, and thickens up readily to form a good stand. It is true that it may tend to spread where it becomes established, but in the semi-arid regions such a quality in an otherwise desirable grass would be readily overlooked." "It is a valuable hay grass." "It is excellent for binding railroad and other embankments subject to wash, and can be recommended for this purpose", "As to the matter of protecting gullies or washouts in fields, there is no better grass than quack grass." "Its weedy nature should prevent its introduction as a forage plant."

X The rootstocks have been used in Europe and in the United States for medicinal and nutritive purposes but such use is slight in this country.

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- X { Lamson-Scribner, U.S. Dept. of Agr., Div. of Agros., Bul. #3
Iowa Exp. Sta. Bul. #83, July 1905, p 420
Grasses of Iowa, Part II, p 323
Hackel, *The True Grasses*, p. 177.
U.S. Pharmacopeia { Humphrey Davy
Sowerby (*Grasses of Great Britain*) p. 163 { Boerhaave
Kramer, *Botany and Pharmacognosy* - p. 227.

For Minnesota, however, it can only be described as a very bad weed and is not to be recommended for planting under any circumstances, but must be considered as a distinct and dangerous menace to agriculture in the state.

Quack grass is a perennial grass which thrives well in Minnesota and grows in cultivated land almost to the exclusion of any common farm crop unless methods of eradication are used. It may be introduced on the farm in various ways -

In seed - e.g. bromus, oats, timothy - chiefly unclean seed.

In manure -

By natural spreading from roads and other fields. Ordinary methods of farming will not get rid of the pest and in wet seasons even special methods fail.

Once present in a field the most persistent portion of quack grass is the creeping underground stem or rhizome. Cultivation of the soil cuts this system of underground stems which carry buds at each node. Absence of these buds would abolish the quack grass problem. The severing of these rhizomes allows the new plants a chance for spreading by the separating into many plants. Frequent tillage of the land aerates the soil and makes the growth

of the weed more vigorous. An interesting experiment performed at the North Dakota Experiment Station to show the possibilities of reproduction inherent in the rhizomes of quack grass plants is described in Bulletin 62, N. Dak., 1904.

"A square foot of quack grass sod was excavated to the depth of the rootstocks - about five inches. The soil was carefully washed away from the rootstocks and their length measured. This proved to be a total of 86 feet. The culms or stalks with heads arising from that area numbered ninety. Each rootstock has a joint on an average of every two inches and is capable of sending up a stalk at that place, hence the rootstocks of one square foot of sod are able to produce over five hundred plants."

The cost of eradication varies - often costing from \$10 to \$20 per acre to get rid of the weed. The depreciation in value of farming land in so many counties of southern Minnesota has been very great. The presence of the weed has made the raising of small grains unprofitable and many desirable tenant farmers have left those communities. Data concerning depreciation are not freely given by real estate dealers.

The following are probably authentic:-

1. ^x A quarter section of land in Freeborn county is rented for taxes only, because of the quack grass upon it, all attempts at eradication having proven futile. It is termed unsaleable - if free from quack grass it would bring \$75 per acre.

2. ^{*} "In the southwestern part of the state, Pipestone county, tracts of quack grass land have had other grass sown in with the quack to make them available for grazing purposes - so hopeless was the task of eradicating the quack grass."

3. There are localities as yet comparatively free from quack. [⊕] "There is so little real "quack" in this region that I have never heard the matter mentioned in connection with land deals."

4. Mr. George Welsh, Commissioner of Immigration of Minnesota, wrote to Mr. W. L. Oswald of the Seed Laboratory at the Experiment Station, Jan. 26, 1909, "Many farms in the southeastern section of our state have had their producing value lessened to an almost inconceivable degree by the ravages of this weed and it now becomes one of the serious

^x Field Crop Breeders' Assn., Jan. 1910
^{*} F. E. Older, College of Agriculture, May 13, 1910
[⊕] L. R. Moyer, Montevideo, April 24, 1910.

problems confronting the people of that locality, how to destroy the evil and prevent its spreading. Without a constant campaign against it these farms will be rendered valueless for anything unless it be possible pasture."

Leaving out of consideration the problem of eradication of quack grass from land already infested - a distinct problem of farm management - and considering only those farms which are not badly infested, the chief danger which the farmer has to combat is in the introduction of the pest. When present in only a few small patches a careful farmer easily destroys the grass by well known methods of smothering it with tar paper or a heavy mulch. But the farmer must be able to recognize quack grass when he sees it. In the second place the weed may be introduced by seeds and to avoid this the farmer must be sure not to plant quack grass seed. These two points are of great importance to the farmer in stopping the spread of quack grass - viz:

1. To know quack grass in the field
2. To know it in the seed.

To assist in clearing up these points some of which are not at present clear even to trained botanists, the botanical studies described below were undertaken.

Quack Grass and Seed Legislation.

The matter of pure seed legislation has been agitated for many years in America as well as in Europe. ^x Canada has a Seed Control Act passed in 1896.

* Several states have seed laws which are directed toward the eradication of bad weed seeds from commercial seeds and seed mixtures. These laws have been enacted because the serious danger of the spread of weed pests through commercial seeds has been very evident. No federal seed law exists in the United States, but the U. S. Department of Agriculture through its Seed Laboratory has been able by publishing the results of the examination of seeds sold in the market to assist very materially in lessening the weed seed danger.

However efficient or inefficient any seed law may be, the object of all is to promote the cause of good seed and pure seed. It is obvious that first of all methods must be known whereby the weed seeds can be distinguished from

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- x Seed Control Act, Canadian Dept. Agr., Bul. No. S, I, July 1907
 - { Maine, Nul. 36, Aug. 1897
 - { Kentucky, Bul. 127, Sept. 25, 1906
 - * Iowa
 - { Wisconsin Circ. 4, Aug. 1909
 - { N. Dak. Special Seed Bul. I, July 1909

other seeds even if they differ from the latter only in a slight degree.

As pointed out above, quack grass is considered a bad weed over a large part of the United States and Canada. It therefore follows that it is of great importance that methods of distinguishing quack grass seed from commercial seeds and also from closely related grass seeds which may not be weed pests be devised. State and federal seed laws may diminish the spread of *Agropyron repens* through prohibition of distribution of unclean seeds. Large supplies of commercial seeds are raised in localities where there are indigenous species of *Agropyron*.

That these seeds shall not be pronounced unclean because of the presence of *Agropyron* seeds demands that the seed of the introduced *A. repens* shall be recognized as distinct from the others.

Botanical Study of Minnesota *Agropyrons*.

Common species of *Agropyron* in Minnesota.

There are several species of *Agropyron* common in Minnesota:

1. *Agropyron Smithii*, Rydb. Blue joint or
(" *occidentale*, Scribn.) Western
(" *spicatum*, Scribn. and J.G.Sm.) wheat-grass
2. *Agropyron tenerum*, Vasey- Slender wheat grass

3. *Agropyron caninum*, Beauv., Awned wheat grass
4. *Agropyron Richardsonii*, Schrad.
5. *Agropyron biflorum*, R & S Purplish wheat grass
 Agropyron violaceum, Lange

Of these *A. Smithii* has creeping rootstocks which are usually not so great in diameter as those of *A. repens* - the introduced species. In spite of its rhizomes, *A. Smithii* has not yet been reported as a noxious weed. The other species are distinguished by lack of creeping rootstocks.

* "Wheat grass is in fact one of the most promising of our native hay grasses. The seed is produced in abundance and is easily gathered". "The rootstocks soon fill the soil and the field may require rejuvenating. This can be done by disking or harrowing to cut up the rootstocks as is often done upon the native meadows."

"Western wheat grass (*A. occidentale*) is commonly found in the western portion of the Great Plains, extending into the mountains. It propagates by stout creeping rootstocks, but does not form a close sod." It grows on bench or bottom land, and though the yield per acre is not

* Lyon & Hitchcock - B. P. I. Bul. #59, p. 37.

large it furnishes more hay than any other common grass of this region. The foliage is stiff and harsh, but the quality of hay is good and it is readily eaten by stock."

A. occidentalis and *A. tenerum* are common in the semi-arid lands of North and South Dakota and grain shipped into Minnesota may contain spikelets of these *Agropyrons*. The spikelets so greatly resemble those of quack grass that it has been impossible by ordinary methods to distinguish one from the other. A purchaser of seed grain may be required at the elevator where he obtains the seed to sign a "release". This relieves the proprietor from further responsibility regarding the weed seeds contained therein. The inability of either party to identify *Agropyron* seeds has left the purchaser to assume the whole risk.

To clear up this difficulty a special study has been made of the two species of *A. repens* and *A. tenerum*. When it became evident that *A. Smithii* was also important on account of its seed similarity to *A. repens* it was also included in part in this study.

Prevalence of different species in Minnesota Seed Samples.

By means of the methods and characters discovered by the writer and which are described below, the following

data were obtained in regard to the presence of Agropyron species in seed samples of Minnesota:

Samples received in 1909 to 1910 at the Minnesota Experiment Station (Division of Botany and Plant Pathology) for purity tests showed the following results-

No.	Sample	From		
3	Wheat	Hugo, Minn.	Quack	(A. repens)
6	"	Farmington	"	"
10	Oats	"	"	"
44	Brome	Watson	Quack	"
80	Timothy	Hanley Falls	Slender wheat	(A. tenerum)
112	Wheat	Lakeville	"	"
113	Oats	"	Quack	(A. repens)
164	Wheat	Webster	"	"
165	Barley	"	"	"
167	Oats	"	"	"
191	Wheat	Stillwater	"	"
195	Eng. bluegrass	Worthington	Slender wheat	(A. tenerum)
221	Brome	A seed Co.	"	"
296	Wheat	Mapleton	Quack	(A. repens)
305	Brome	A seed Co.	Slender wheat	(A. tenerum)
443	Oats	Litchfield	Quack	(A. repens)
448	Wheat	Wilton, N.D.	Quack	"
			Slender wheat	(A. tenerum)

Most of these were probably home grown seeds. Two of the brome grass samples came from large seed companies who reported that they purchased their brome seed in North and South Dakota and in Russia. Upon inquiry the other seed companies of the Twin Cities reported that their brome seed came from practically the same localities. Since brome grass seems to be likely to contain quack grass seed and since it is in this seed that quack is most difficult to

detect, nine samples of fairly well known origin were obtained from Twin City seed firms. These were examined for *Agropyron* species with the following results:

Samples of *Bromus inermis* containing seed of *Agropyrons*

No.	Source	Species of <i>Agropyron</i> found
534	Dakota	<i>A. tenerum</i>
547	Imported-probably from Russia	<i>A. repens</i> (probably)
548	Dakota	<i>A. tenerum</i>
549	Dakota	<i>A. tenerum</i>
550	Dakota	<i>A. tenerum</i>
551	Dakota	<i>A. tenerum</i>
552	Dakota	<i>A. tenerum</i>
553	Dakota	<i>A. tenerum</i>
578	Minnesota	<i>A. tenerum</i>

The number of samples was not large enough to give a basis for generalization but shows nevertheless that *A. tenerum* is very common in brome grass samples.

Description of species.

Since the two common species, *A. repens* and *A. tenerum*, have been frequently described in European and American botanical literature, the descriptions are not included here. A partial bibliography containing the most important American references on this phase is appended to this paper.

Rootstock studies.

The stem of *A. repens* is differentiated into two

areas.

1. An aerial tract which elongates to support the leaves and their sheaths. Its advancing apex rises to a height of two or three feet and usually bears an inflorescence in the form of a spike. Mechanically this stem is strong and light, being composed of from four to six solid nodes and hollow internodes. Adventitious buds developing near the node at the surface of the earth produce a grouping of stems known as stooling which gives the grass a slightly tufted habit but the groups are too small to form a bunch-grass tuft.

2. A subterranean tract - the lower end of which gradually dies away. This is white and contains reserve food. In all Minnesota specimens examined no ^x"bright greenish yellow" color could be observed. Roots are borne at the nodes. In front of each node is a large scale in the axil of which is a bud. These underground buds have distichous arrangement and each nourished by the roots of its adjacent node may develop into an independent plant if severed from adjoining parts of the rhizome. Each rhizome has a sharp conical apex that will penetrate clods of earth and ob-

*Gray's New Manual of Botany (7 ed.), p.166.

jects which have considerable power of resistance. This device of the advancing rootstock facilitates migration into adjoining tracts of soil where fresh supplies of plant food may be obtained. Some of the buds borne by the rhizome produce branches to locate the new plant at a distance from the parent plant. ^x "The formation of new rootstocks begins about the time of blossoming."

Bromus inermis: In this locality the rhizomes most likely to be mistaken for those of *A. repens* are those of *Bromus inermis* (Awnless Brome grass). They are greater in diameter than those of *A. repens* but they do not average so long nor are there so many of them. Cross-sectioning shows the *A. repens* rhizomes to be hollow while *Bromus inermis* (though in some cases the internal cylinder showed torn cells at its center) presented no definite cylindrical opening.

Agropyron tenerum (Slender Wheat Grass) - in this locality has rhizomes only four or five inches long, 1 mm. in diameter, and not branched. The terminal bud from each of the rhizomes coming to the surface of the ground develops into a plant. The resulting cluster of plants forms a

x Proceedings of the Society for the Promotion of Agricultural Science, 1908.

group, hence it is known as a bunch grass.⁺

Agropyron (*occidentale*, Scribn.) *Smithii*,[⊗] (*Bluejoint*) has branching rhizomes - hollow like the other *Agropyrons* - but of less diameter ($1\frac{1}{2}$ mm.) than *A. repens* (2 mm.). This species grows in this locality on soil with a high percentage of sand and gravel - hence the tenacity of the rootstocks is highly developed. Their small diameter may be in part due to lack of water because of xerophytic environment.

Muhlenbergia species.

Agropyron repens is distinguished from members of the genus *Muhlenbergia* in its subterranean area by cylindrical scales closely enveloping the internodes of the rootstock while the scales of *Muhlenbergia* are broad, imbricated, and conspicuous. None of the rootstocks of *M. glomerata* or *M. Mexicana* observed in Minnesota specimens exceeded 3 inches in length.

A. repens - The Root.

The roots of *A. repens* are found at the nodes of the rhizome and especially at the node where the terminal bud

⁺ B. P. I., Bul. #59, p 38
[⊗] Gray's New Manual of Botany (7 ed.), p 166.

becomes an aerial tract. At each subterranean node only 4 or 5 roots appear, all of which are not necessarily well developed. Their origin is the tissue of the node at the base of a bud. Then if the rhizome is broken the bud develops as an aerial stem with leaves; and in proportion as it is necessary for fixation and vegetative function the fibrous, branching roots increase in number and length at the node which marks the division between subterranean and aerial tracts of the stem. *A. repens* does not produce so large nor so matted a tuft of these roots as is produced by *A. Smithii* under like conditions.

The Leaf.

The leaves of *A. repens* are of a peculiar glaucous, bluish green. They lack the pale distinctly bluish effect of the leaves of *A. Smithii* and have more of an emerald hue than the darker bluish leaves of *Bromus inermis*. They are not so dark nor are they of the same green as *A. tenerum*.

The leaves of *A. repens* consist of two tracts- a sheath and a blade. The terete sheath is split on the side opposite the blade. When new buds develop above ground in the spring the base of the leaf sheaths is apt to be purple. The outer surface of the sheath bears rows of hairs.

The inner is membranaceous. There may be a collar of hairs on the outside where the sheath and blade unite. On the inside the scarious wall projects as a short lac-
erate ligule. The upper surface of the blade is ridged. On each side of the ridge is a definite row of stomata and on the summit - when the leaf is young - is a row of hairs. The lower surface of the blade is smooth and has neither so many stomata nor so many hairs as the upper surface. The scarious margin bears a row of modified hairs, giving it a serrate appearance. The blades are from 10 to 20 cm. long and about 1 cm. wide.

Bromus inermis.

This grass has coarser, longer, darker-colored leaves of which the upper surface many be destitute of hairs or have much shorter hairs than the average sample of *A. repens*. Many leaves showed closed^x sheaths, but the area on the inner side of some sheaths was weak and there was a tendency to split. The ligule is about 1 mm. long and truncate. Almost invariably there is a mark somewhat resembling an inverted W about 1/3 of the distance from the tip of the blade to the ligule. This is probably due

^xBeal, Grasses of N. A., Vol. I, p 10

to constriction before being freed from the sheath. A like mark appears about an inch from the tip of quack grass leaves in spring but is hard to distinguish later in the summer.

Agropyron tenerum and *A. Smithii*.

The leaf tracts of these species because of their adaptation to semi-arid localities expose much less surface to the air than *A. repens*. Those of *A. tenerum* are smaller than *A. Smithii* and in the spring their sheaths like those of *A. repens* are sometimes tinged with purple.

The Inflorescence.

The tip of the aerial stem of *A. repens* is extended into an inflorescence which takes the form of a spike. The part of the stem which becomes the rachis is laterally compressed and upon it are located 2 - 6 flowered, flattened, sessile spikelets. The flower consists of the floral glume, terete or laterally compressed, enclosing a flat, 2 nerved, hyaline scale with inflexed edges and two minute lodicules. Alternate with and within these are 3 stamens having versatile anthers and slender filaments. The anthers are 2 celled, linear, and pendulous and the pollen yellowish white.

The mature spikelet consists of -

(a) Two distichous, chaff-like, concave scales or bracts (glumes) with their concave faces toward the axis (rachilla).

These two lower glumes and often one or more of the uppermost glumes are empty. The lower empty glumes are unsymmetrical, 7 - 11 mm. long, with about 5 - 7 nerves, scarious margined, widest below the middle, acute at the tip with the midrib sometimes prolonged into a short awn.

(b) Above the empty glumes are four or five mature florets, distichously imbricated along the rachilla. ^xBeal states that there may be two - eight flowers in a spikelet but in the material examined from many sources the writer has not found more than five mature fruits and seldom more than three in *A. repens* spikelets. The floral glume or lemma is about 1 cm. long, scabrous outside and may be awned. Within is a 2 keeled glume, the palea. This is scarious, has minute scattered hairs, with hispid hairs on the keels. The inner surface of the palea adheres to the caryopsis. The florets at the middle of the spike may overlap for three-fourths of their length or more.

Appearance of Spikelets.

The spikelets of *A. repens*, *tenerum*, and *Smithii* containing immature fruit strongly resemble each other but

^xGrasses of N. A. II, p 636

in autumn after dissemination has begun there is a marked difference. When *A. repens* spikelets are awned the awns are neither so long nor stiff as those of *A. Smithii*. *A. repens* shows a tendency to retain the whole spikelets all winter.

A. tenerum spikelets assume an angle toward their rachis which gives the spike a cylindrical appearance and distinguishes it immediately from *A. repens* and *A. Smithii*.^x In the spikelet of *A. Smithii* the rachilla is so long and the texture of the plant so brittle that several of the upper florets often break from the tip leaving only three or four at the base. The spikelets diverge from the rachis at a considerable angle; this character combined with the broken spikelet marks the appearance of patches of *A. Smithii* as seen in winter (above the snow) and also in spring. Whole spikelets are not often found in seed grain, as they are usually injured in transportation. If present they are easily seen and serve as a warning of the presence of broken ones. When any *Agropyron* spikelet breaks up the groove of each lemma retains at its base a conical portion of hollow rachilla bearing on its surface minute hairs.

^xGray's New Manual of Botany, p. 166.

The Caryopsis.

The caryopsis is exposed by the removal of the lemma and palea. It is pubescent at the apex, oblong, has a convex outer surface and a grooved surface next to the palea. The testa is membranous and the endosperm farinaceous. The embryo is located at the base. Cotyledon scutellate; plumule well developed; radicle thick, obtuse, endorhizal (with a sheath).

The caryopsis is columnar, longitudinally grooved on one side and approaches a cylinder in form.

These dry caryopses are difficult to remove, without injury, from the glumes, especially from the adhering palea.

Characteristics by which the caryopses of the three species of *Agropyron*, - *repens*, *tenerum*, and *Smithii* may be distinguished.

(a) By the dry fruit when glumes are removed-

A. repens; color - dull brown, variable, slight groove on inner surface; length 3 to 5 mm.; width $1\frac{1}{2}$ to 2 mm.;

A. tenerum; color - very pale with slight brown tinge; length, 6 mm., width $1\frac{1}{2}$ mm.; shape - convex on back and so thin that the inner surface is grooved the entire length.

Vascular tract - medium brown.

A. Smithii; color - reddish brown; length 3.5 mm.; width

1.5 mm; grooved the entire length.

The hairs at the apex of *Agropyron* fruits are usually broken off when the dry palea is removed. If present they are of a whitish color.

(b) When caryopses were placed in boiling water for five minutes, the color of *A. repens* usually showed a golden tinge, *A. tenerum* was nearly colorless and *A. Smithii* was dark brown. The vascular tracts showed clearly.

(c) When caryopses were kept in boiling water for ten minutes they began to show translucent tracts near the edges. The endosperm absorbed enough water so that the differences of shape were marked. The hairs at the apex of most of the *A. repens* specimens were of a yellowish shade.

(d) When soaked in cold water for twenty four hours, the caryopses assumed the normal form of mature fruit before they became shriveled by drying.

A. repens:- fruit varied in color from golden yellow to reddish brown. Vascular tract brown, usually with a dark stripe on each side. Groove on inner surface nearly obliterated. Thickness of fruit .5 mm.

A. tenerum:- translucent throughout with a faint yellowish - seldom a bluish tinge. Brown vascular tract distinct and the fruit scale-like because it was so thin -

(.4 to .5 mm. in thickness).

A. Smithii:- dark brown, grooved and of an obovate shape - Thickness, 1 mm.

Special Characteristics of Seeds Soaked in Cold Water.-

	Color	Length	Width	Thickness	Appearance
A.tenerum	Almost colorless	6 mm.	1.5 mm.	.5 mm.	Scale-like
A.Smithii	Brown	3.5 mm.	1.5 mm.	1.1 mm.	Approaching obovate
A.repens	Golden-yellow to brown	4.5 mm.	1.55 "	.75 "	Approaching cylindrical

Considering the length and width of A. Smithii the fruit is proportionally the thickest of the three species. The width of the A. repens fruits averaged twice the thickness-of A. tenerum the width averaged three times its thickness.

Summary.

I. Introduction.

(a) Grasses are important as food plants and as weeds. The species Agropyron repens - doubtless the worst agricultural pest in Minnesota - needs attention to check its spread into the few parts of the state where it is yet unknown.

(b) A. repens Beauv. or quack grass - native of the Eastern Hemisphere - has migrated to our country and of

late years has appeared in Minnesota. Unclean seed was the medium by which part of it was brought here.

(c) ^x"Its weedy nature should prevent its introduction as a forage plant." It is a menace to a farming community and should not be tolerated as it

1. Depletes the soil
2. Depreciates the value of the land because of cost of eradication.

(d) To combat the spread of the weed the farmer must know it

1. In the field.
2. In the seed.

(e) Since it is spread by commercial seed, laws have been enacted prohibiting the sale of unclean seed. That these laws may be efficient it is demanded that inspectors shall recognize seeds of noxious weeds and distinguish them from closely related species which are harmless.

II. Botanical Studies.

(a) There are several species of *Agropyron* common in Minnesota. *A. tenerum* and *A. Smithii* are found in the prairie region of the western part of the state; *A. repens* is the most important introduced species. Seed samples examined for purity tests at the Minnesota Ex-

^xGrasses of Iowa, Vol. II, p. 323.

periment Station show *A. tenerum* to be commonly present; also show *A. repens* to be prevalent and wide-spread.

(b) Rootstock characteristics.

	Color			Avidiameter
<i>B. inermis</i>	White	Usually solid	Creeping	3 mm.
<i>A. tenerum</i>	Whitish	Hollow	Non "	1 mm.
	Forming bunch-grass tufts			
<i>A. Smithii</i>	Whitish	Hollow	Creeping	1 $\frac{1}{2}$ mm.
<i>A. repens</i>	White	Hollow	Creeping	2 mm.
	Forming extensive branched systems.			

(c) The leaves of *A. repens* are of a characteristic bluish green, with distinct rows of stomata on both surfaces. Though variable, when young, they bear longer hairs than *A. tenerum* or *Smithii* or *B. inermis*. The sheaths are split in contrast to the usually closed sheaths of *B. inermis*. The blades are not so stiff as the blades of *A. Smithii* nor of so distinct a pale blue color. Though in the early stages the constriction mark resembling that of *B. inermis* is found within an inch of the tip, it is not usually recognizable later.

(d) The spikelets of the inflorescence do not diverge from the rachis at so great an angle as do those of *A. Smithii* nor do they approach the rachis to give the cylindrical appearance of *A. tenerum*.

(e) The glumes of *A. repens* are not so stiff, nor do

they bear such long awns as *A. Smithii*. They may be awned and their arrangement gives the spikelet a broader appearance than that of *A. tenerum*.

(f) The "seeds" of the three species may best be distinguished after : (a) soaking them for twenty-four hours in cold water; or (b) by boiling them in water for five or ten minutes. In all authentic material examined, which had been soaked for twenty-four hours in cold water, the caryopses were distinguishable with certainty by means of the following characters:

A. tenerum: Color - pale brown, occasionally bluish. Vascular tract, brown - Average dimensions: length, about 6 mm.; width $1\frac{1}{2}$ mm.; .5 mm. Scale-like in appearance because of dimensions.

A. Smithii: Color - brown. Vascular tract usually of the same color as the rest of the fruit. Average dimensions: length about 3.5 mm.; width 1.5 mm.; thickness 1.1 mm. Approaching obovate in shape. Thick in comparison with *A. tenerum* and *A. repens*.

A. repens: Color - varying from a very light brown with a golden tinge to dark brown. Vascular tract brown, conspicuous on light colored seeds. Often with a dark stripe on each side of the vascular tract. Average dimensions:

length, 3 to 5 mm.; width 1.5 mm.; thickness .75 mm.;
shape approaching cylindrical.

- Triticum repens*, L., Sp. Pl. 86, 1753
Agropyron repens, Beauv., Agrost., 146, 1812
- Watson and Coulter, Gray- Man. Bot. 671, 1890 (6 ed.)
- Scribner - Grasses of Tenn., Bull. Univ. Tenn. Agr.
Exp. Sta. 7 f 178, 1894
- Shear, Bull. U. S. Dept. Agri., Div. Agros. 4, 35
- Agropyron repens* (L) Beauv. - Beal, Grasses of N. A.
Q - 636, 1896
- Scribner - Bull. U. S. Dept. Agr., Div. Agros. 7, 304
f 298 - 1900 (3 ed.)
- Grasses of Iowa - Part II, 1903, Pammel, Ball, Lamson-
Scribner
- Rydberg - Flora of Colorado - 1906 - terms all *Agropy-*
ron sp - Wheat grass - Quack grass
- Flora of State of Washington - Piper - 1906, p 149

- A. tenerum* - Vasey - Coulter - Bot. Gazette 10-258, 1885
- Rydberg - Bull. 100, Agr. Exp. Sta. of Col., Agr. Col. 1906
- Piper - Fl. of Wash. p 147
- Watson & Coulter
- Shear - Bull. U.S. Dept. Agr., Div. Agros. 4:29, 1897
- Nash in Britton and Brown, Ill. Fl. I 227 f 527, 1896
- Scribner, Bull. U.S. Dept. Agr., Div. Agros. 17; 297 f 593, 1899
- A. repens* - var. *tenerum* (Vasey) Beal - Grasses of N. A.
II, 636 - 1896

Description of Plates.

Plate I. Magnification, X 15 .

Figures 1, 2, 3, 4, and 5 are diagrams of cross sections of five quack grass seeds from five different localities. The average width of these seeds equals twice their thickness.

Figures 6, 7, 8, 9, and 10 are diagrams of cross sections of *Agropyron tenerum* seeds from five different localities. The average width of these seeds equals three times their thickness.

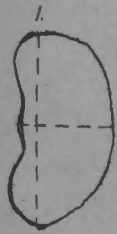
Plate II. Magnification, X 25.

Figure 1. Typical color and shape of *A. repens*.

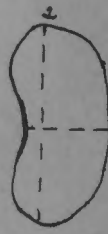
Figure 2. Typical color and shape of *A. tenerum*.

Figure 3. Typical color and shape of *A. Smithii*.

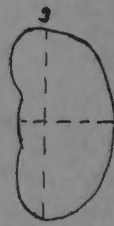
Plate I.



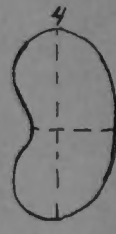
13mm X 25mm.



12 X 26.5



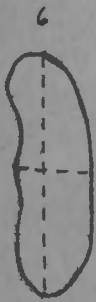
13 X 24.5



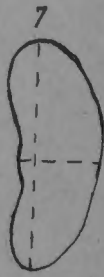
12 X 24



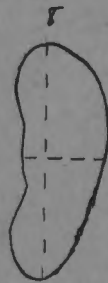
12 X 23



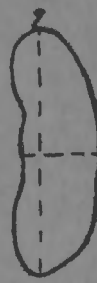
9 X 32



10 X 30



11 X 31



10 X 32

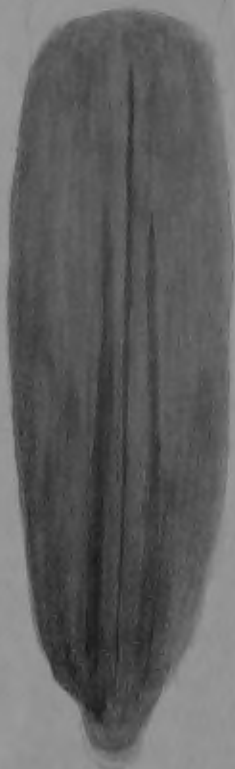


11 X 32.5

Plate II.



3.



1.



2.