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NEW GRASSES FOR CALIFORNIA, I

PHALARIS STENOPTERA HACK.

BY
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A survey of the soil and climatic conditions of California soon revealed the fact that most of our grasses, the seed of which is now procurable on the market, could not establish themselves and produce a strong sod on lands not susceptible of irrigation. Over large areas of the state there are good soils receiving moisture only in the form of rain on which there is no green pasturage for stock soon after the rains cease. This condition may set in as early in the season as May 1, and may continue during some seasons into November or even December. Therefore a perennial grass that will withstand the winter temperatures as well as the long, dry season in the great central valleys would be of great value to the live-stock industry of California. Recent investigations and experiments lead me to believe that I have found such a grass.

Several years ago an illustration of a grass in a trial plot in a seedsman's catalogue from South Africa attracted the author's attention. The report of its behavior under conditions of heavy frosts and long droughts made it appear that it might prove valuable under California conditions. Sufficient seed was purchased to sow one-twentieth of an acre only, as it was too costly to be considered in larger quantities. It was called perennial canary grass, or Toowoomba grass, *Phalaris bulbosa*. Perhaps the most authentic account of the introduction of this grass is to be found in the following letter received from Mr. R. R. Harding, curator of the botanic gardens, Toowoomba, Queensland.

In 1883 I received twenty-one packets of seeds from Italy. These I put in the nursery. All germinated, but the frost killed all except this wonderful grass, *Phalaris commutata*. In two years it had taken possession of nearly the whole plot of ground in the nursery from the seed self-sown.

It is a perennial. We had to remove the grass, so we dumped the root-clumps in a corner on hard ground, but it still grew to five feet in height. This was during the drouth and frost, and although it was cut it grew again.

Mr. Harding also concludes with the statement that it was distributed by him to all the Colonies, Africa, and even Italy. As will be pointed out later, neither *Phalaris bulbosa* nor *Phalaris commutata* is the correct scientific name for this grass, as those names belong to other and distinct species.

The seed secured from South Africa under the name of *Phalaris bulbosa* proved to be a strong perennial and to be pure, but not true to name. In the same year we planted a twentieth-acre plot with seed also called *Phalaris bulbosa* secured from seedsmen in Australia. It proved for the most part to be an annual *Phalaris* and not the same species as that from South Africa, although received under the same name. That there were a few seeds in this lot of the perennial species corresponding exactly to the grass from South Africa was evident, as some fifteen or twenty plants in the plot sown to the Australian seed lived throughout the next winter and summer, finally forming strong clumps.

The following year I noticed a sack of seed exhibited by the New Zealand Government at the Panama Pacific International Exposition. This, too, was labeled *Phalaris bulbosa*. The seed was so similar in appearance to the South African lot that at the close of the Exposition we arranged for its purchase. When grown, however, it proved to be an annual and not the desirable perennial grass called *Phalaris bulbosa* as received from South Africa.

A large number of packets from this sack were secured with permission from the New Zealand authorities by representatives of many experiment stations and by the United States Department of Agriculture. We desire simply to call attention to this to avoid further confusion and to make plain the fact that *Phalaris bulbosa* as distributed at the Exposition is not the same as the perennial *Phalaris bulbosa* (?) from South Africa. It is the latter grass that we desire to introduce into California, as the annual species do not offer any especial characteristics that would make them any more valuable either as pasture or hay than the cereal hays now so extensively and

satisfactorily utilized. That much, if not all, of the seed of *Phalaris* now on the markets of New Zealand and Australia is hopelessly mixed seems to be certain; and also that a selection of the perennial species will have to be made before one can recommend the purchase of seed from those countries.

A careful comparison of our perennial plant as grown at the University Farm with the original descriptions of *Phalaris bulbosa* and *Phalaris commutata* soon proved that it could be neither of those species. On further search of the literature, including descriptions of some twenty additional species, the author failed to find a description that would agree with our grass. I was about to describe it as a new species when a paper entitled "*Gramineae Novae*," by Eduard Haekel, was discovered, in a somewhat obscure publication, which described the species in question. In order that this original description may be made more readily accessible to agronomists, we are including it here. We have been distributing seed from our plot at the University Farm and more or less confusion is likely to occur, as it has been distributed under the incorrect name of *Phalaris bulbosa*. This grass is not described or mentioned in any American literature on grasses and forage plants.

The following description with the accompanying illustrations should aid in its identification.

GRAMINEAE NOVAE IV. Eduard Haekel in Fedde, *Repertorium novarum Specierum Regni Vegetabilis*, 5, 1908, p. 333.

***Phalaris stenoptera* Haek., nov. spec.**

Perennis, caespitosa, sine stolonibus. Innovationes extravaginales, squamis elongatis herbaceis purpurascensibus fultae. Culmi erecti, robusti, ultra 1.5 m. alti, teretes, glaberrimi, plurinodes, simplices, internodiis basalibus non incrassatis. Vaginae teretes, arctae, internodiis breviores, glaberrimae. Ligula rotundata v. subtruncata, 5-7 mm. lg., denticulata, siccando fissa, glabra. Laminae linearis, sensim acuminatae, innovationum longissimae (50 cm. v. ultra), 1.2-1.5 cm. latae, culmeae superiores abbreviatae, omnes flaccidulae v. rigidulae, glaberrimae vel margine et in pagina superiore versus apicem scaberulae, virides, tenui-nerves. Panicula spiciformis linearis vel lineari-oblonga, 6-16 cm. longa, circ., 1.5 cm. lata, densissima, haud interrupta, non vel obselete lobata, rhachi laevi, ramis appressis ramulosis multispiculatis, pedicellis quam spiculae plures v. multoties brevioribus scabris. Spiculae elliptico-lanceolatae, 5-6 mm. longa, albido-viridulae, marginibus viridi-striatae. Glumae steriles 2 inferiores aequales, naviculares, acutiusculae, carina in $\frac{2}{3}$ superioribus anguste (in gluma I, angustissime vel sub-obselete) alatae, ala integra in apicem sensim decurrente, scaberula, trinerves, nervus (uno in basi alae, duobus ad latera) saturate viridibus. Gluma III nulla, IV vacua 1 mm. longa e squamula callosa ovata 0.3 mm. longa et ex appendice membranaceo lanceolato 0.7-0.8 mm. longo infra apicem squamulae inserto apice penicillato-

ciliato constans. Gluma V (fertilis) 3.5 mm. longa ovato-lanceolata, acuta, chartacea, appresse pubescens, tenuissime 5 nervis. Palae glumam aequans, angustior, carina ciliolata. Antherae 3.5 mm. longae. Ovarium glabrum. *Caryopseos* macula hilaris fere dimidiam caryopsin aequans.

Patria ignota, culta in Australia sub nomine *Phalaridis commutatae*. Plantam et semina misit A. J. Ewart, Melbourne.

Es ist auffallend, dass diese gut unterschiedene Art, welche in Australien als Futtergrass gebaut und sehr gerühmt wird, bisher meines Wissens nirgends beschrieben wurde. In Australien wurde sie durch Mr. Harding, Kurator des Botanischen Gartens in Tuwumba, Queensland (unbekannt woher) unter dem Namen *Ph. commutata* eingeführt und unter diesem Namen von Samenhändlern in Melbourne verbreitet. Ein mir vorliegendes Reklameblatt zeigt die Darstellung eines dichten Rasens von angeblich 7 Fuss (2.2 m.) Höhe, der nach dem Schnitt in 46 Tagen wieder einen 41 Zoll (106 cm.) hohen Rasen hervorgetrieben hatte. Besonders wird sein wert als Wintergras hervorgehoben.

This excellent detailed description agrees with our grass from South Africa in everything but the sterile florets. As these are used as the chief distinguishing characters in the genus to separate one species from another, a disagreement in regard to these particular structures makes a positive identification difficult. Our specimens show a variation in the sterile florets, one 1.5 mm. in length and the other much smaller, .7 mm. The latter may be reduced to a mere point protruding from the ovate scale (pl. 1, fig. 4).

Haekel's description is as follows:

Gluma III nulla, IV vacua 1 mm. longa...infra apicem squamulae inserto apice penicillato-ciliato constans.

That Haekel seemed convinced that there was constantly only one sterile floret is emphasized by the fact that in a discussion of the relationship of the new species, he writes "doch ist der Hüllspelzenflügel bei *Ph. stenoptera* noch schmaler als bei *Ph. nodosa* und es ist stets nur eine kleine Leerspelze (die glume IV) am Grunde der Vorspelze"; also "Ein merkmal aber, das sie von beiden genannten Arten (*Ph. arundinacca* and *Ph. bulbosa*) scharf trennt, ist das Fehlen der gluma III, das mir ganz Konstant zu sein scheint."

Through the kindness of Mr. Harding, who forwarded us some old seed from the Botanic Gardens at Toowoomba, Queensland, we were able to examine original material. There were present in the packet some spikelets with two sterile florets, others with one sterile floret, and another very minute one and still others with only one present. This same condition was found in our specimens grown at Davis and which may be seen under sheets nos. 5000, 5001, 5002, and 5003 of

the herbarium of the Division of Agronomy, Department of Agriculture, Berkeley. Among the seeds in the packet from Harding was an outer glume whose narrow wing showed distinctly the scaberulous margin characteristic of *Ph. stenoptera*.

Hackel mentions that he received the plants and seeds from which he drew up the original description of *Ph. stenoptera* from A. J. Ewart, of Melbourne. Since the seeds of at least two species are so hopelessly mixed in Australia, is it not just possible that the seeds sent to Hackel may have been the annual species which constantly has only one sterile floret and that the plants were those of *Ph. stenoptera*, the perennial species?

A most interesting fact in connection with this grass is that it should not have been described from Europe previous to its introduction to the Toowoomba Botanical Gardens by seed sent from Italy. Hackel in his description says "Patria ignota." This from such a renowned agrostologist who has traversed the whole of southern Europe many times, is of especial significance. Could it be a hybrid from other existing species?

ECONOMIC CONSIDERATIONS

The giving of a name to this grass which will be suitable for everyday agricultural usage deserves some consideration. Perennial canary grass is not desirable, as there are several "perennial canary" grasses. Toowoomba grass is too unwieldy. I propose to call it Harding grass, after the man who first grew it in Australia.

Our experiments demonstrate that the seed may be sown at Davis during the winter season so as to take advantage of the rains. The young plants, although very slender, almost like threads coming through the ground, are very hardy and were not harmed by severe frosts. At the same time cotyledons of such hardy species as *Melilotus alba* turned yellow and many seedlings were killed outright by the drouth and cold. The grass grows rapidly, stooling profusely, and producing large clumps the first season. A feature of great merit from a pasture standpoint is the large number of dense leafy shoots produced from the base. The first year these are much in evidence and comparatively few flowering culms are sent up. These are only about two to two and a half feet tall and bear short, somewhat ovate heads. The leafage is devoid of hairy coverings of any kind, thus tending towards a clean hay and palatable pasturage.

The roots are fibrous, radiating downwards to a depth of one or two feet. They are covered with a downy coating similar to that found on many desert grasses. That they are able to make use of slight amounts of hygroscopic moisture in the soil seems possible, as when a clump was dug up and placed upon the surface of the ground the grass continued to grow, although exposed to severe conditions of drouth with no rainfall for several months.

The plot of Harding grass attracted considerable attention during the hot summer months, with its long green leaves showing no tendency to wilt. It makes a decided contrast in July and August by its vivid green among the dry brown stubble of the cereals and other grasses given the same care and treatment. We also had occasion to observe its behavior during the winter. On the coldest morning, with ice everywhere, we visited the grass plot and observed the hoar frost on the leaves and the ground frozen, yet the foliage remained green. Even our generally recognized hardy grasses like Kentucky bluegrass, orchard grass, and red top had turned brown.

The second year from the seed it still maintained a dense leafy growth from the base of about three feet, the flowering culms extending about two feet higher, making a total height of five feet. This is a growth rarely reached by any of the cultivated perennial species of grasses known at the present time.

We did not wish to be understood that the Harding grass will withstand a lower or as low a temperature as our common hardy grasses and that it is adapted to regions with severe winters as in parts of the east or middle west. As yet we do not know its cold-resistant qualities. The fact that it remains green during the comparatively mild winters at Davis, Yolo County, California, does not indicate the minimum temperature the roots may withstand. Information as to its latitudinal and altitudinal tolerance is not at hand.

In order that some comparison may be made as to the probable adaptability of this grass to other states and to different parts of California, we give the following conditions for Davis.

According to S. H. Beckett, of the United States Department of Agriculture, "the mean annual rainfall is 16.54 inches, the greater part of which comes in December, January, February, and March, while from May to October very little rain falls." There is considerable variation in the amount of rainfall in different years. Frequently it amounts to 20 inches, but occasionally only 8.74

inches is precipitated. It is the so-called dry years that cause a shortage in all farm crops not under irrigation, and interfere seriously with the pasturage on the ranges. The mean annual temperature is 62.7° F, with a known maximum of 112° F, and a minimum of 16° F. Intense sunshine prevails throughout the summer.

Technically the soil is known as Yolo silt loam. Professor C. F. Shaw describes it as follows:

A fine, smooth-textured brown soil at the surface, grading at about three feet to a light brown subsoil containing slightly more clay loam or clay. It is usually free from gravel. The soil when wet has a tendency to run together and become puddled, preventing the free downward percolation of water. On drying it tends to form a crust on the surface. If plowed when wet it forms hard clods and lumps. When handled in the proper condition of moisture, however, it becomes loose and mellow. It has good moisture-holding capacity, is very productive, and adapted to a wide range of crops.

That the soil has exceptionally good moisture-holding capacity, especially at the lower depths, is shown by the following furnished us by Professor B. A. Madson. The figures represent an average of several plots believed to be similar in all essential details to that on which the Harding grass was grown.

MOISTURE CONTENT OF SOIL, 1916, DAVIS

| Depth, feet | Per cent Moisture, April 1 | Per cent Moisture, May 25 | Per cent Moisture, July 7 | Per cent Moisture, August 24 |
|----------------|----------------------------------|---------------------------------|---------------------------------|------------------------------------|
| 1 | 17.35 | 10.34 | 10.32 | 7.44 |
| 2 | 21.91 | 12.31 | 12.66 | 11.12 |
| 3 | 27.39 | 20.75 | 19.47 | 17.00 |
| 4 | 27.98 | 19.84 | 20.21 | 16.87 |
| 5 | 28.60 | 25.44 | 21.19 | 22.01 |
| 6 | 34.44 | 27.64 | 28.98 | 27.65 |

The land on which the experiment with Harding grass was conducted had for many years previous been cropped to grain. No manure, artificial fertilizer or irrigation were given the plot, nor could it have been affected by moisture from any adjacent irrigation.

A strip six by eighteen feet was cut from the plot on May 25, 1916, the second year (pl. 7). The estimated green weight of forage per acre was twenty tons and of cured hay three tons. There still remained on the ground a dense aftermath which would have furnished good pasturage. The average yield under field conditions can not be ascertained until the grass has been grown on a larger area.

The remainder of the twentieth-acre plot was allowed to go to seed. From this we harvested seventeen pounds of seed, 43 per cent

of which germinated. This somewhat low viability was due to the fact that we had no fanning-mill that was suitable for cleaning grass-seed, so that much chaff remained.

From this home-grown seed we have sown an acre in rows mainly for seed increase purposes. In addition we have distributed a large number of packets to co-operative experimenters in different parts of the state in order to find out the range of soil and climate in which it might prove valuable.

In regard to its palatability, I have not yet had sufficient personal experience to determine this with certainty. Nor do we know its chemical composition or nutritive value. We fed some of the hay to work-horses accustomed to alfalfa and they ate it readily. Reports from other sources would lead us to believe that it is well liked by stock. The following excerpt from the catalogue of a branch of the well-known and reliable British seed firm, George Carter and Company, located at Pietermaritzburg, South Africa, speaks for itself.

A magnificent winter grass for fairly good lands. This is our sixth season of experience with this grass, and we have had no reason as yet to alter our high opinion of its value. For farms where the land is of a poor, light, sandy nature, we do not recommend it. But on good, fairly heavy loams (say wherever a good crop of Mealies can be grown), or on deep veldt lands, *it is magnificent.* The yield of luscious feed is tremendous all the year round, and it is particularly valuable for the winter and early spring months, growing even during heavy frost and long droughts. The rooting system is very large and deep. In seed the plants reach the height of over five feet, while the ordinary growth without seed-stems is about three feet high, and just like a permanent crop of rich green barley. It can be cut continually, growing at the rate of an inch per day. While growing with great success on dry lands, it will well repay both good manuring and irrigation.

For dairy farms we can not praise it too highly, particularly for producing milk during the colder months, when other food is so scarce; while it is just the grass to grow near the homestead for cutting for calves, horses, or indeed any animal which eats grass. There is no need to say that the cattle relish it—it is a difficult matter to keep them fenced out at all from a crop of this grass.

I refrain from quoting the praiseworthy accounts of it in the public press of Australia, as we are unable to determine whether the comments are attributed to *Phalaris commutata* or *Phalaris stenoptera*, both of which (as previously explained) are indiscriminately mixed on the seed market of that country.

Even if the Harding grass should not prove to be adaptable to a wide range of territory in California and elsewhere, the immense stretches of land between the foothills on the east and west in the great central valley, where in many instances only a poor crop of

grain is secured every other year, would be sufficient to warrant its thorough investigation.

A system of pasturing cattle and sheep on Harding grass for a period of years would be most profitable as well as beneficial to the soil.

Much, however, remains to be investigated, particularly as to its ability to withstand grazing without injury, its carrying capacity, nutritive value, longevity, and the quality of beef and mutton that it will produce.

Transmitted March 30, 1917.

PLATE 1

Phalaris stenoptera, Hack.

- Fig. 1. Root system. *A.* Velvety covering on roots. *B.* Short stolons.
- Fig. 2. Portion of sheath, blade, and culm. *A.* Ligule.
- Fig. 3. Spikelet. *A.* First empty glume. *A'*. Wing of glume. *B.* Second empty glume. *B'*. Wing of glume. *C.* The lemma. *D.* Palea. *E.* Stamens.
- Fig. 4. Lemma and sterile florets. *C.* Lemma. *F.* Ovate scales. *H.* First sterile floret. *G.* Second sterile floret.

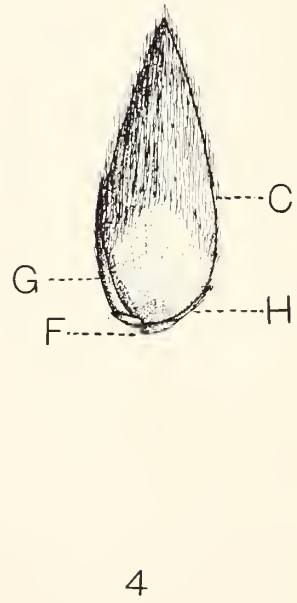
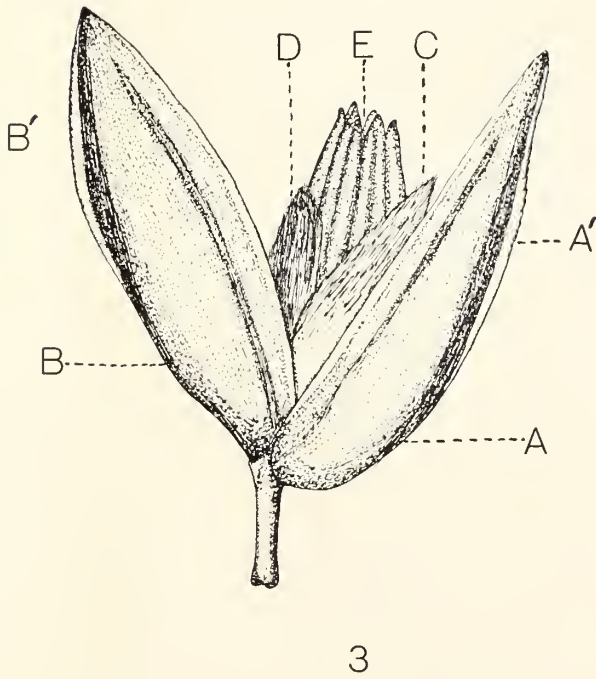
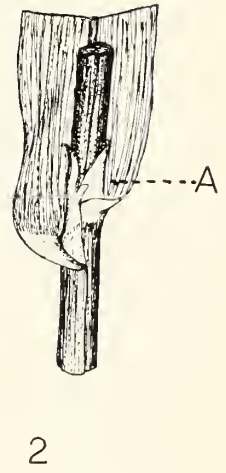
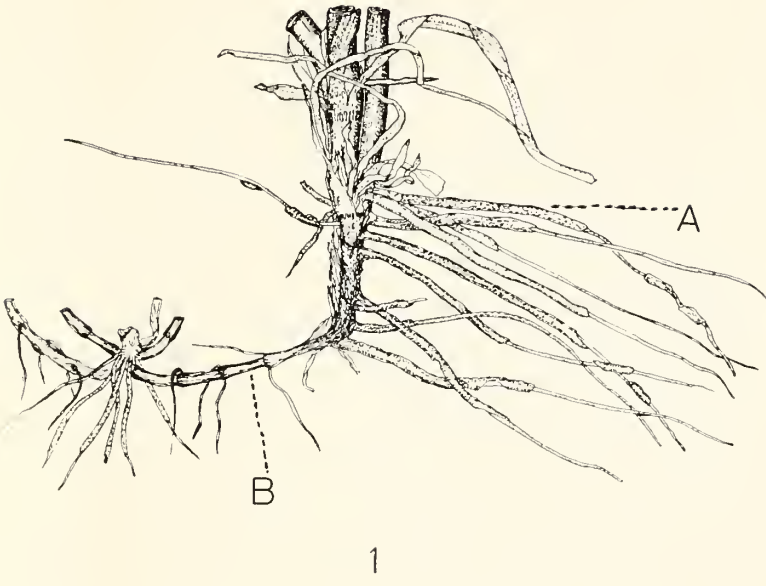


PLATE 2

Spike-like panicles of *Phalaris stenoptera*, showing different stages of development.



PLATE 3

Young plant of *Phalaris stenoptera*, showing stooling habit and character of roots.



PLATE 4

First-year growth of *Phalaris stenoptera*, dense tender leafage in January, 1916.



PLATE 5

Phalaris stenoptera in full bloom, second year from seed. Photo taken at University Farm, May 25, 1916. Height of plant, five feet.



PLATE 6

Phalaris stenoptera, showing strip cut across plat and dense aftermath. Photo taken May 25, 1916.



PLATE 7

Phalaris stenoptera--sheaves from experimental plot, University Farm, May 25, 1916.



PLATE 8

Lodged plants represent the annual species, the so-called *Phalaris commutata* with an erect perennial clump of *Phalaris stenoptera*. Seed came to us from Australia under name of *Phalaris bulbosa*.



