Cytology, Morphology, and Amino Acid Characterization of the Putative Inter-Generic Hybrid, Agroelymus palmerensis, and Its Presumed Parents

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During the summer of 1949 vigorous but sterile grass plants atypical of any known species were observed in the vicinity of Palmer, Alaska. These were described as Agroelymus palmerensis Lepage and Agroelymus hodgsonii Lepage (8, 9). The putative parents were thought to be Elymus canadensis L. and Agropyron sericeum Hitch. and E. canadensis and A. repens (L.) Beauv. for the respective combinations. Since 1949 these hybrids have been observed in many additional locations and in considerable abundance. The presumed parents of Agroelymus palmerensis were observed at all locations but at some all three parent species were present.

A. sericeum is indigenous to Alaska and is found throughout much of the state (Hulten, 6; Wiggans and Thomas, 17). A. repens is an exotic found throughout most settled areas of the southern half of the state.

The species of Elymus involved was regarded by Anderson (2) and Lepage (8) as the exotic E. canadensis. Hodgson (5) concluded that this 28-chromosome Alaskan Elymus was not E. canadensis and because of its distinctive features and its occurrence in indigenous communities described it as E. pendulosa Hodgson, Bowden and Cody (3) collected this species at Port Simpson, District of Mackenzie, and later relegated it to E. sibiricus L. The author has accepted this interpretation of the Alaskan Elymus.

The cytology, morphology and amino-acid characterization of the hybrids and the putative parents are considered in this paper.

Materials and Methods

Spikes selected for cytological examinations were fixed in acetic alcohol (3:1) or Carnoy's (6:3:1) or aceto-carmine smears. Slides containing desirable figural features were made and stored at 3.5 °C.

Vegetative pieces of 5 hybrid plants were rooted in vermiculite in May 1953. When roots were 1 to 2 inches long, about 1 cm. of the root tips were cut off and the remainder of the roots wereimmersed for 2 hours in a 0.2% colchicine solution. After treatment the roots were washed and returned to vermiculite. This treatment was repeated the following day after which the rooted plants were placed in soil in flats. Well-established plants were transplanted to the field. These were examined for seed formation in 1953 and 1954. C4 generation plants arising from seed produced on colchicine-treated plants in 1953 were established in the spring of 1954 and fertility data were compiled that fall.

Attempts to produce the hybrid by hand emasculation and hot water emasculation (Keller, 7) were unsuccessful. Plants of A. sericeum and E. sibiricus were grown in isolation in the greenhouse to determine their levels of self-fertility.

Variation and estimates of population means for morphological characters were determined from mass collections. The data were compiled from single culms from randomly selected plants of the three associated species and from all hybrid plants encountered. Specimens were deposited in the herbaria of Iowa State University and the University of Alaska. Measurements of floral parts were made with an eye-piece micrometer. Means, ranges, and standard deviations were calculated for all characters measured quantitatively. Descriptive notations were recorded for other characters. The numbers of plants represented in the mass collections were as follows: Agropyron sericeum 54, A. repens 18, Elymus sibiricus 47, and Agroelymus 57.

Analyses of A. sericeum, A. repens, E. sibiricus and Agroelymus were analyzed for their content of amino acids. The tissues used were (1) leaf blades harvested when growth was 6-8 inches tall and again when plants were in the boot stage, (2) rhizomes and tillers collected in late fall, (3) mature dry seed, and (4) germinating seed. Leaves and rhizomes were placed in polyethylene bags and frozen as soon after harvest as possible. Germinating seed was frozen when the coleoptiles averaged ⅔ to ½ inch in length.

Leaves, rhizomes, and germinating seed were removed from the freezer and dried. Dry seed was ground to pass through a 40-mesh screen. Two and one-half grams of each tissue of each species were homogenized in 25 ml. of acetate buffer at a pH of 5.6. The homogenate was decanted and centrifuged at approximately 18,000 times gravity to remove suspended materials such as plastids, mitochondria, and other cellular fragments. The supernatant liquid was stored at 3.5°C.

Descending chromatographic analyses were made for free amino acid content (McFarren and Mills, 10). Solvents used were phenol at pH 12.0 and m-cresol at pH 8.4. Chromatograms were developed at 21.0 °C ± 1 °C. Whatman No. 1 filter paper strips were air dried and dipped in a solution of 1.4% ninhydrin in water-saturated n-butanol to which was added 4% acetic acid for strips that were to be developed with phenol and 2% acetic acid for strips developed with m-cresol. Strips were dried at 60°C for 15 minutes. Each tissue test was made in duplicate. Amino acids were identified by comparison of Rf values to those of known acids, as reported by McFarren and Mills (10). Quantitative values were determined by measuring the percent light transmission through the amino acid spot with a densitometer. Curves were constructed for known concentrations of each amino acid. Milligrams per gram of fresh weight for each amino acid in an unknown was determined from its respective curve.

Results

Fertility. Average self-fertility levels for 3 plants each of E. sibiricus and A. sericeum under greenhouse isolation were 30 and 86%, respectively. Smith (14) found self-fertility levels for the former to be 37 and 75% under bag and greenhouse isolation, respectively, and an open-pollinated fertility of 67% under field conditions. In Alaskan material of E. sibiricus and A. sericeum open-pollinated fertility was very high. It appears, therefore, that while self-fertility levels in both species may be considered reasonably high, the possibility of some natural cross pollination exists. This would seem especially true in the case of E. sibiricus.

Fertility in the natural hybrid was essentially zero. No seeds were found though hundreds of spikes were threshed and the florets examined for seed.