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Agropyron arizonicum (Gramineae: Triticeae) and a natural hybrid from Arizona

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AGROPYRON ARIZONICUM (GRAMINEAE: TRITICEAE) AND A NATURAL HYBRID FROM ARIZONA

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ABSTRACT.— The new hybrid X *Agrositanion pinalenoensis* (Gramineae: Tribe Triticeae) is found in disturbed, forested areas of higher elevations in southern Arizona. In the Pinaleno Mountains where logging has been heavy, numerous disturbed habitats have permitted frequent hybrid populations to persist. Intermediate phenotype, chromosome behavior, lack of seed set, and pollen sterility were used to interpret the status of this hybrid derivative. Introgression and/or segregation are not apparent.

Of the many natural and experimental intergeneric hybrids reported in the Triticeae, none have been reported between *Agropyron arizonicum* Scribner & Smith and *Sitanion hystrix* var. *brevifolium* (J. G. Smith) C. L. Hitchcock. The present paper describes extensive hybridizations between these two taxa.

Agropyron arizonicum has flat leaves, distinct flexuous spikes, one spikelet per node, and more or less ascending awns (although they are somewhat divergent at maturity). *Sitanion hystrix* has long been recognized as an extremely variable species; however, erect spikes, very long awns on the glumes and lemmas, and 2 spikelets per rachis node are typical. The variation in Arizona has been treated by Wilson (1963) as *S. longifolium.*

Although *Sitanion hystrix* has very extensive distribution in western North America, it is limited to higher elevations of isolated mountain ranges in the southwestern United States and northern Mexico. On these isolated mountain ranges, the range of this species frequently overlaps that of *Agropyron arizonicum,* a species of high elevations restricted to west Texas, southwestern New Mexico, and southeastern Arizona (Fig. 1). In the Pinaleno Mountains, Graham Co., Arizona, and the Santa Catalina Mountains, Pima Co., Arizona (Fig. 2), where extensive areas have been disturbed by logging (Fig. 3), recreation, summer home development, and road building, numerous hybrids between *Agropyron arizonicum* and *Sitanion hystrix* var. *brevifolium* are formed. Eleven hybrid

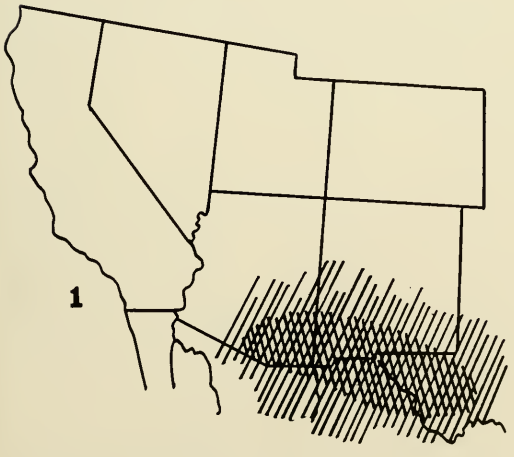

Fig. 1. Cross-hatched area represents sympatric range of *Sitanion hystrix* var. *brevifolium* and *Agropyron arizonicum.*

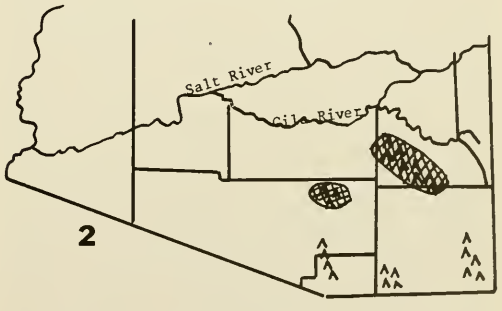

Fig. 2. Cross-hatched areas represent the distribution of X *Agrositanion pinalenoensis* Pyrah in Arizona. (Larger area is the Pinaleno Mountains, smaller area is the Santa Catalina Mountains).

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Fig. 3. Typical disturbed forest with dense stands of *Agropyron arizonicum* and *Sitanion hystrix* var. *brevifolium*.

populations were found and studied in the Pinaleno Mountains at elevations generally between 7000 and 10,000 ft.

Materials and Methods

Eleven hybrid populations in the Pinaleno Mountains and two hybrid populations from the Santa Catalina Mountains were studied. Prepared herbarium specimens from each are deposited in the Southwest Missouri State University herbarium. Five additional mature inflorescences were obtained from each hybrid and four parent specimens from the High Peak population. These were put in envelopes and used for comparative measurements of length of glume, lemma, awn, and rachis joint, and also determination of the number of spikelets per rachis node.

A few late-flowering inflorescences were fixed in a solution of one part glacial acetic acid to three parts absolute ethyl alcohol. These were stored in 70 percent ethyl alcohol and used for cytological studies.

Pollen grains were obtained from mature spikes and viewed with the scanning electron microscope to determine viability. Soil pH was determined by sampling five sites each for parental species and the hybrid. The soil sample was carefully obtained by taking soil from the entire soil profile of 0 to 5 inches and mixed. A soil-water slurry was prepared and the pH determined by a standard pH meter.

In an attempt to assess the pollen parent and the seed parent and hybrid success, a large population near High Peak was studied in the following way. A circular area 6 m in diameter was marked around each of 25 hybrids. The number of specimens of each parental species as well as other hybrids within this circle were recorded.

Results and Discussion

Pure stands of *Sitanion* typically grow in rather open, unshaded, shallow soil, with topsoil and litter depths from 1 to 3 inches and clay with scattered rock constituting the remaining root zone. Soil pH range is 5.4 to 5.8. *Agropyron arizonicum* grows in richer soils, with the topsoil and litter occupying

the upper 10 inches and only a limited amount of clay and rock toward the bottom of the root zone. Soil pH range is 5.9 to 6.4. Characteristically, this species is more vigorous in partially shaded areas, but it also grows in open sun. Nearly all combinations of the above soil conditions and other habitat requirements have been created by logging and road building, resulting in numerous disturbed habitats, as well as habitats for each parental species in very close proximity. In many of these situations, plants of both species either touch each other or are within only a few inches. Since flowering occurs over the same time period, this allows for showers of pollen to accomplish hybridization. In nearly all these situations hybrids are found.

The frequency of hybridization between these species is difficult to assess, since a mature hybrid plant is the only indication that hybrid pollination occurred. A circular area (6 m in diameter) around each of 25 hybrids near High Peak was examined and the number of associated parental and hybrid plants was counted (Table 1). It is suggestive from the columns opposite hybrids 8, 9, 10, 11, and 13 that hybrid success is dependent upon the density and proximity of both parents. Although this may appear to be obvious, there are situations in some dicots in which hybridization is abundant but one parent is rare (Stutz 1964, Pyrah 1965). A series of artificial hybridizations would be necessary to determine whether or not *Agropyron* or *Sitanion* is more important as the seed or pollen parent of the natural hybrids.

Hybrid plants are readily recognized because of their robust size and slightly nodding spikes (Fig. 4), and most are growing in disturbed habitats (Fig. 3). Soil pH ranges from 5.7 to 6.5. Of the 11 populations studied, nearly every hybrid specimen fell within an intermediate range in morphological features and fragility of the rachis. A diagramatic illustration (Fig. 5) of *Sitanion hystrix* var. *brevifolium* and *Agropyron arizonicum* with their putative hybrids shows average lengths of the glume, lemma, awn, and rachis joint

TABLE 1. Comparison of the number of parental and hybrid plants within an area (6 meters in diameter) around 25 hybrids in a population near High Peak (see text).

Hybrid No.	*Sitanion*	*Agropyron*	Hybrids
1	8	0	0
2	15	0	0
3	14	0	2
4	15	0	2
5	10	7	0
6	20	4	1
7	20	1	1
8	8	8	5
9	8	8	5
10	8	8	5
11	7	9	5
12	5	2	1
13	6	6	5
14	15	1	0
16	15	0	1
17	15	0	1
18	20	0	0
19	9	1	1
20	15	0	1
21	13	0	0
22	1	2	0
23	5	0	1
24	5	0	1
25	8	3	0

Fig. 4. Spikes of *Sitanion hystrix* var. *brevifolium* (left), hybrid (center), and *Agropyron arizonicum* (right).

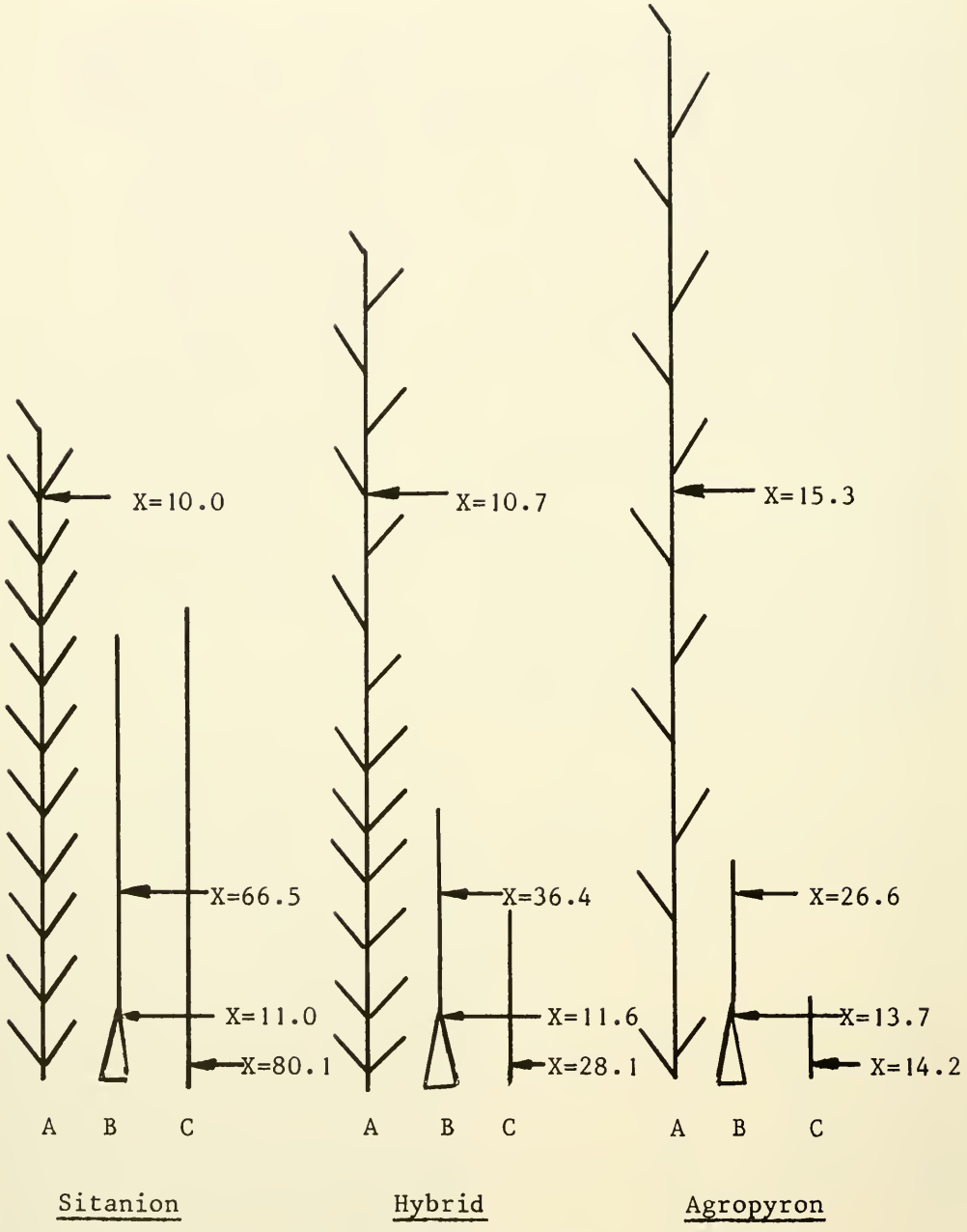


Fig. 5. Schematic representation of some spike and spikelet characters of *S. hystrix* var. *brevifolium*, *A. arizonicum*, and their natural hybrid. Measurements used in this figure are means ($\bar{X}$) from one population. A = Spike; center line between oblique lines (spikelets) represent the rachis joint. B = Lemma (triangle) with attached awn. C = Glume.

and the number of spikelet pairs per spike. Measurements were derived from a population near High Peak consisting of 25 hybrids and 4 parental specimens (Table 2). Field observation and examination of numerous herbarium specimens reveal clearly that the 2 parents are rather uniform with regard to the characters used and that where variation exists the range does not overlap that of the hybrid.

TABLE 2. Summary of measurements of spike characters used from one population to distinguish *Agropyron arizonicum*, *Sitanion hystrix* var. *brevifolium*, and their natural hybrid.

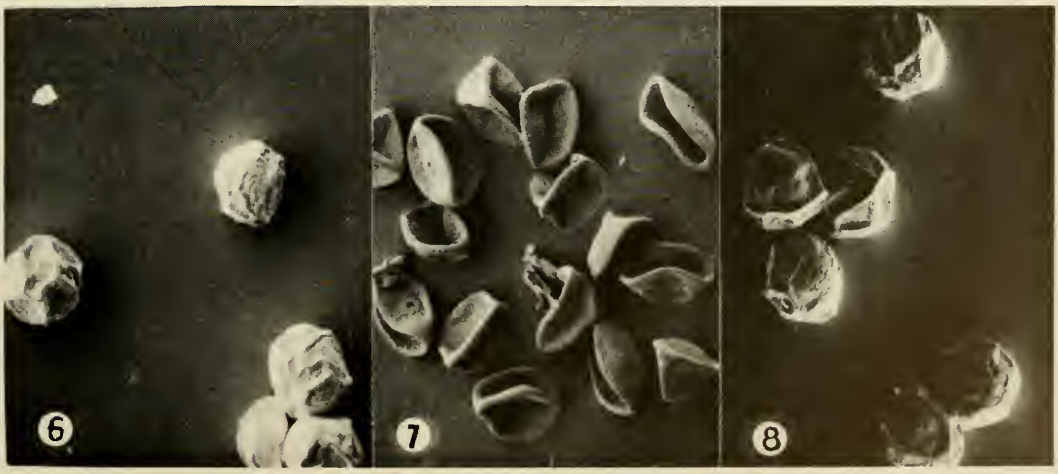
		No. nodes per spike	No. single spikelets	No. double spikelets	Glume length	Lemma awn length	Lemma length	Rachis joint length
Agropyron	$\bar{X}$	11.900	11.600	0.300	14.156	26.588	13.739	15.349
	N	40.000	40.000	40.000	109.000	119.000	119.000	109.000
	S^2	2.329	2.318	0.648	2.290	4.758	9.122	3.059
	$\bar{X}SE$	0.368	0.367	0.103	0.219	0.436	0.836	0.293
Sitanion	$\bar{X}$	10.900	1.900	9.000	80.091	66.505	11.037	10.020
	N	40.000	40.000	40.000	99.000	109.000	109.000	99.000
	S^2	1.236	0.709	1.013	11.639	8.759	0.849	2.162
	$\bar{X}SE$	0.195	0.112	0.160	1.170	0.839	0.081	0.217
Hybrid	$\bar{X}$	13.360	8.730	4.630	28.071	36.372	11.609	10.737
	N	400.000	400.000	400.000	1236.000	1336.000	1336.000	1236.000
	S^2	2.380	2.888	2.733	4.741	7.441	1.220	1.969
	$\bar{X}SE$	0.119	0.144	0.137	0.135	0.204	0.033	0.056

The hybrid did not set seed and no viable pollen was produced because the pollen grains were collapsed and empty (compare Figs. 6, 7, and 8). Preliminary cytological examination of one hybrid showed 14 bivalents at metaphase; however, some bivalents show irregular pairing of chromosome segments that could cause cryptic structural hybridity (Fig. 9; arrows indicate conspicuous asynaptic and synaptic pairing within two bivalents). Morphology of spike characters was generally intermediate. These evidences strongly suggest that the plants studied are first generation hybrids and that little or no introgression occurs. These hybrid plants conform to the generic description of X *Agrositanion* as reported by Bowden (1967).

DESCRIPTIONS OF THE HYBRIDS

X *Agrositanion pinalenoensis* Pyrah, Hyb. nov. (*Agropyron arizonicum* Scribner & Smith X *Sitanion hystrix* var. *brevifolium* (J. G. Smith) C. L. Hitchcock).

Hybrida sterilis, inter *Sitanion hystrix* var. *brevifolium* et *Agropyron arizonicum* probabiliter sed differt ab utroque spica moderate nutanti et inferioribus sex nodis spicae cum binatis vel binatis singulisque spiculis et superioribus nodis spicae cum singulus spiculus; differt a prima articulis rhachis et lemmatibus longioribus et glumis et aristis lemmatum brevioribus; differt a secunda articulis rhachis et lemmatibus brevioribus et glumis et aristis lemmatum longioribus.



Figs. 6, 7, and 8. Electron micrographs (SEM) of pollen from *Sitanion hystrix* var. *brevifolium* (Fig. 6), hybrid (Fig. 7), and *Agropyron arizonicum* (Fig. 8). ca 600X.

Fig. 9. Meiotic metaphase I of hybrid. Arrows indicate two pairs of chromosomes with synaptic and asynaptic regions.

Sterile hybrids differing from both parents by having moderately nodding spikes and usually having the lower 6 to 8 spike nodes with paired spikelets or a combination of paired and single spikelets and only single spikelets at the upper nodes; differing from *Sitanion* by having longer rachis joints and lemmas but shorter glumes and lemma awns; differing from *Agropyron* by having shorter rachis joints and lemmas but longer glumes and lemma awns.

TYPE.— Open grassy meadows of disturbed forests along State Rt. 366 near mile marker 141 on Mt. Graham, Pinaleno Mountains, Graham Co., Arizona, 13 Aug. 1975, Grant L. Pyrah 3051 (SMS).

DISCUSSION

The classification of genera, species, and hybrids in the Triticeae is still open to question. Many taxonomists question the validity of recognizing all the genera now published, although Gould (1947) and Church (1967) are two of only a few who have initiated some consolidation. Widespread hybridization, similar chromosome behavior, and several variable spike characteristics were the primary bases for consolidating *Sitanion*, *Agropyron*, and *Hystrix* with *Elymus*. Hitchcock et al. (1969) defend the retention of established separate generic names for this agronomically important tribe, primarily on the basis of practicality. *Agropyron arizonicum* is probably closely allied to *A. spicatum* and there are still conflicts about the variation found in *Sitanion hystrix*. Wilson (1963) treats the plants of this region as *Sitanion longifolium*, but Hitchcock et al. (1969) prefer *S. hystrix* var. *brevifolium*.

Confusion is now arising in the literature for numerous named hybrids because of the lack of agreement as to the generic status of each of the parents involved. If a consolidation of genera were accepted, hybrids would bear the appropriate specific designation within the genus *Elymus*. However, Bowden (1967) recognized the classical treatment of this tribe and made appropriate nomenclatural designations for intergeneric hybrids in conformity with the International Code of Botanical Nomenclature. Hybrid naming in this case had resulted in such generic combinations as *Agroelymus*, *Agrohordeum*, *Agrositanion*, *Elyhordeum*, and *Sitordeum*. I have chosen to use the classification of Bowden and to create the binomial X *Agrositanion pinalenoensis* Pyrah.

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