

CHROMOSOME COUNTS AND TAXONOMIC NOTES ON
DRABA (BRASSICACEAE) OF THE INTERMOUNTAIN WEST. 1:
UTAH AND VICINITY

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ABSTRACT

Of the 350+ species ascribed to *Draba*, nearly one quarter occur in the Intermountain Region of the western United States. Most of these *Draba* species have not been examined cytologically. This paper presents a total of 18 chromosome counts for 11 different taxa occurring in Utah, Wyoming, and Arizona. The chromosome numbers of *D. juniperina*, *D. kassii*, *D. maguirei* var. *maguirei*, *D. rectifructa*, *D. sobolifera*, *D. spectabilis* var. *spectabilis*, and *D. subalpina* are reported here for the first time. Counts differing from published reports are documented for *D. asprella* var. *stelligera* and *D. cuneifolia* var. *cuneifolia*. The taxonomic significance of the new chromosome counts is discussed for each species. Counts of $n = 11$ and $n = 13$ appear to be the first reports of those numbers in the genus, and they complete the continuous series of aneuploid base numbers extending from 8 to 16. It is suggested that the Intermountain West may be a center of diversity for aneuploid *Draba*, and that this assemblage of species provides a unique opportunity to study chromosomal evolution and speciation.

Species assigned to *Draba*, considered to be the largest genus in the Brassicaceae (Rollins 1993), occupy a variety of habitats and occur on all continents except Australia and Antarctica. The group achieves its greatest diversity in topographically complex, mountainous regions where the disjunct occurrence of suitable habitats seems to favor isolation and speciation (Payson 1917). A prime example of this is seen in the Intermountain Region of the western United States, broadly defined here as the territory extending from the continental divide to the Pacific Crest (Sierran-Cascade axis). Of the 350+ species attributed to *Draba* by Rollins (1993), nearly one quarter occur in this region and more than 50% of those are endemic to it.

The Intermountain West is *terra incognita* as far as the cytology of *Draba* is concerned. Of the 57 taxa confined to this region, only 11 have been examined chromosomally. Half of these are known from single counts, and none can be considered adequately sampled. By comparison, 37 of the 40 *Draba* species found in Canada and Alaska have been studied cytologically, thanks in large part to the diligent efforts of G. A. Mulligan (1966, 1970a, b, 1971a, b, 1972, 1974, 1975, 1976).

Mulligan's work on the high-latitude North American species of *Draba* (summarized in the 1976 paper) led to major advances in our taxonomic understanding of the genus. In addition to clarifying species boundaries in several groups, his data provided the basis for the only modern infrageneric classification of North American *Draba*. Setting aside *Draba* (*Erophila*) *verna* L., a Eurasian introduction unrelated to the native species, Mulligan (1976) recognized three informal groups based on

a combination of chromosome number, flower color, breeding system, and hybridization studies.

All 17 of the white-flowered species studied by Mulligan exhibit euploid chromosome numbers based on $x = 8$. They clearly are related to Eurasian boreal species assigned by Schulz (1927) to the section *Leucodraba* DC. Another nine Canadian species were assigned to his yellow-flowered euploid alliance, which also frequents boreal habitats and has representatives in Eurasia. The remaining 13 Canadian taxa were placed in a yellow-flowered group characterized by aneuploid chromosome numbers of $n = 9, 10, 12, 14, 15$, and 37 (Mulligan 1976). Apparently restricted to North and South America, this assemblage of species appears more tolerant of the warm/dry conditions that prevail in much of the western United States.

Mulligan's (1976) informal classification of North American *Draba* is a vast improvement over the patently unnatural sections proposed by Schulz (1927). However, it can neither be used nor evaluated phylogenetically until the chromosome numbers of local *Draba* species have been determined. The goals of this study were: 1) to collect crucial chromosome data for Intermountain *Draba* species, 2) to critically assess current taxonomic treatments for the species sampled, and 3) to develop a set of chromosomally vouchered samples for a DNA analysis (Beilstein and Windham in prep.) designed to test the monophyly of Mulligan's (1976) informal species groups.

MATERIALS AND METHODS

Chromosome counts were made from flower buds of wild plants fixed in Farmer's solution (3

parts 95% ethanol: 1 part glacial acetic acid). Fixed materials were stored at -20°C for up to five years and transferred to 70% ethanol immediately before making slides. Buds (or dissected anthers in larger-flowered species) were macerated in a drop of 1% acetocarmine stain, which was mixed 1:1 with Hoyer's solution prior to setting the cover slip and squashing. Slides were examined with an Olympus BH-2 phase contrast microscope, and representative cells were photographed using Kodak Technical Pan 2415 film. A full set of voucher specimens was deposited at the Garrett Herbarium, Utah Museum of Natural History (UT). Duplicate vouchers were deposited at the herbaria listed in Table 1. To guide the discussion, I produced a compendium of published chromosome counts for all taxa studied and their putative relatives. This list was assembled by running all accepted names and synonyms from Rollins (1993) and Kartesz (1994) through *Chromosome Numbers of Flowering Plants* (Federov 1974) and a complete set of the *Index to Plant Chromosome Numbers* spanning the period 1966–1995 (Omduff 1967, 1968; Moore 1973, 1974, 1977; Goldblatt 1981, 1984, 1985, 1988; Goldblatt and Johnson 1990, 1991, 1994, 1996 & 1998). The primary literature was consulted to verify critical taxonomic and geographic information for each North American count identified by this search.

RESULTS

My chromosome studies of Utah, Wyoming, and Arizona *Draba* species yielded a total of 18 counts for 11 different taxa (Table 1). Seven of these taxa have not been counted previously. These include *D. juniperina* Dorn ($n = 11$), *D. kassii* Welsh ($n = 11$), *D. maguirei* C. L. Hitchc. var. *maguirei* ($n = 16$), *D. rectifruca* C. L. Hitchc. ($n = 12$), *D. sobolifera* Rydb. ($n = 13$), *D. spectabilis* Greene var. *spectabilis* ($n = 10$), and *D. subalpina* Goodman & C. L. Hitchc. ($n = 13$). Counts for two of the remaining taxa, *D. asprella* Greene var. *stelligera* O. E. Schulz ($n = 15$), and *D. cuneifolia* Nutt. ex. T. & G. var. *cuneifolia* ($n = 15$), differ from numbers previously reported in the literature. Unexpected counts, especially those that disagree with the literature, are documented photographically in Figures 1–6. Determinations of $n = 11$ and $n = 13$ appear to be the first reports of those numbers in the genus, and they complete the continuous series of aneuploid base numbers extending from 8 to 16. In fact, this small sample of taxa includes every step in that aneuploid series except $n = 9$ and $n = 14$.

DISCUSSION

The plants herein referred to *Draba albertina* Greene originally were identified as *D. stenoloba* Ledeb. based on the treatment in *A Utah Flora* (Welsh 1993). Because *D. stenoloba* has a chromosome number of $n = 20$ (Mulligan 1975), I was

surprised when samples from two widely separated Utah populations yielded counts of $n = 12$ (Fig. 1) and $2n = 24$. These determinations agree with previous reports for *D. albertina*, including four counts from Alberta and one from the Northwest Territories (Mulligan 1975). An additional count of $n = 12$ from Wyoming originally attributed to *D. stenoloba* (Mulligan 1966) was reassigned to *D. albertina* in a subsequent paper by Mulligan (1975).

Prior to detailed studies of the group (Mulligan 1975), *Draba albertina* was treated as a synonym or variety (*nana*) of *D. stenoloba*. After discovering that the two taxa had different chromosome numbers, Mulligan recognized them as separate species based on correlated morphological and geographical differences. The decision to classify these taxa as species also is supported by artificial hybridization experiments (Mulligan 1975), which indicate that any hybrids formed are completely sterile.

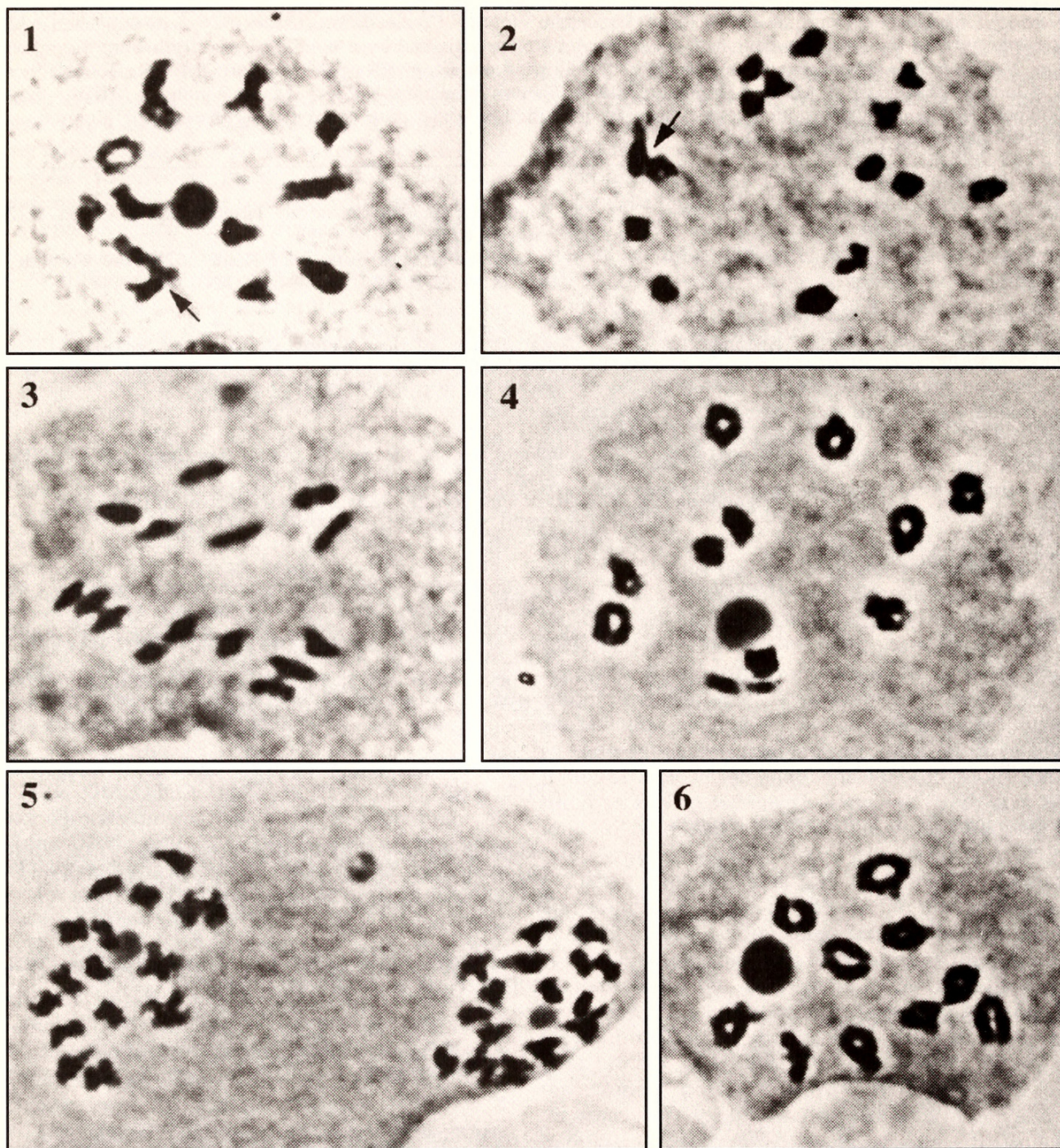
According to Mulligan (1975) and Rollins (1993), *D. stenoloba*, with a chromosome number of $n = 20$ and mostly dendritic trichomes on the upper leaf surfaces, is rarely encountered south of the Canadian border. They assign most collections identified as *D. stenoloba* from the western United States to *D. albertina*, characterized by a chromosome number of $n = 12$ and simple or once-forked adaxial leaf trichomes. My morphological studies of Utah specimens concur that typical *D. stenoloba* is not present in the state, and all collections identified as such represent *D. albertina*. Both taxa belong to Mulligan's (1976) yellow-flowered aneuploid group.

Draba asprella, a species endemic to Arizona and southern Utah, is represented by few herbarium collections and a confusing chromosome literature. A single count of $n = \pm 16$ appears in the primary literature and the Indexes to Plant Chromosome Numbers. This count derives from a population in Coconino Co., AZ studied by Rollins and Rüdénberg (1971), which was not identified to variety in the original paper. Rollins (1993) attributes this count to var. *asprella* and reports an additional, apparently undocumented count of $n = 16$ for var. *stelligera*. The latter count is critical because it seems to place *D. asprella* in Mulligan's (1976) yellow-flowered euploid assemblage, whereas my count of $n = 15$ (Fig. 2) would suggest an affiliation with his aneuploid group. I am confident of my determination, which is based on at least 40 cells from eight individuals. At this point, I am inclined to discount the undocumented euploid report and assign *D. asprella* to the yellow-flowered aneuploid group. In the upcoming field season, I hope to obtain accurate counts for all four varieties and determine whether var. *stelligera* is truly polymorphic with regard to chromosome number.

The available literature provides two chromosome counts for *Draba cuneifolia*. Rollins and Rüdénberg (1971) report a count of $n = 16$ from Pecos Co., TX. Although not identified to variety, this col-

TABLE 1. CHROMOSOME COUNTS ON *DRABA* FROM UTAH AND VICINITY. Counts differing from previously published reports are marked by an asterisk. Apparent first counts for a taxon are marked by a double asterisk following the relevant name. Letters before collection numbers identify the following collectors: ER = Eric Rickart; RS = R. Douglas Stone; JT = James Therrien; W = Michael Windham; TW = Theresa Windham; MEW = Maria Windham; MKW = Molly Windham. Herbaria housing voucher specimens are identified by upper case abbreviations (based on Holmgren et al. 1990) following the collection numbers.

<i>Draba albertina</i> Greene			
2n = 24	UT	Emery Co.	in South Hughes Canyon on the Wasatch Plateau (T14S, R7E, S30); W & ER 95-185 (UT)
n = 12	UT	Salt Lake Co.	E of Guardsman Pass along State Route 152 in the Wasatch Mts. (T2S, R3E, S25); W 98-320 (MO, NY, UT)
<i>Draba asprella</i> Greene var. <i>stelligera</i> O.E. Schulz			
n = 15, 2n = 30*	AZ	Coconino Co.	along tributary of Bear Wallow Canyon E of Sedona (T17N, R6E, S10); W 95-250 (ASU, BRY, COLO, UT, UTC); W, TW & MKW 98-002 (MO, NY, UT)
<i>Draba cuneifolia</i> Nutt. ex Torr. & A. Gray var. <i>cuneifolia</i>			
n = 15*	AZ	Yavapai Co.	WNW of Sedona on the SW side of Fay Canyon (T18N, R5E, S30); W, JT & MEW 97-005 (MO, UT)
n = 15*	UT	Washington Co.	NE of Pinto on low hills overlooking road to Cedar City (T37S, R15W, S26); W 99-008 (MO, UT)
<i>Draba juniperina</i> Dorn**			
n = 11	UT	Daggett Co.	along Browns Park-Clay Basin road in upper Jesse Ewing Canyon (T2N, R24E, S1); W 96-152 (MO, NY, UT)
n = 11	UT	Daggett Co.	along State Route 44 on N side of Spring Creek (T2N, R20E, S19); W 99-073 (COLO, MO, UT)
n = 11	WY	Sweetwater Co.	just E of Richards Gap at S edge of Red Creek Basin (T12N, R105W, S22); W 00-012 (ASU, BRY, MO, UT)
<i>Draba kassii</i> Welsh**			
n = 11	UT	Tooele Co.	in Goshute Canyon on E slope of the Deep Creek Range (T10S, R18W, S36); W 98-211 (ASU, COLO, MO, NY, UT)
<i>Draba maguirei</i> C.L. Hitchc.** var. <i>maguirei</i>			
n = 16	UT	Cache Co.	SE slope of Mt. Magog in the Bear River Range (T14N, R3E); W95-161 (ARIZ, ASU, BRY, COLO, CPH, DAO, ISTC, MO, NY, OGDF, UC, US, UT, UTC)
<i>Draba nemorosa</i> L. var. <i>nemorosa</i>			
n = 8	UT	Summit Co.	N base of Windy Ridge on NE slope of the Uinta Mts. (T2N, R19E, S24); W 99-072 (COLO, MO, NY, UT)
<i>Draba rectifructa</i> C.L. Hitchc.**			
n = 12	UT	Juab Co.	N of Mount Nebo near head of Gibson Creek (T11S, R2E, S19); W 96-204 (UT)
<i>Draba sobolifera</i> Rydb.**			
n = 13	UT	Piute Co.	S side of Bullion Canyon in the Tushar Mts. (T28S, R5W, S11); W & RS 95-201 (ASU, BRY, COLO, MO, NY, OGDF, UT)
<i>Draba spectabilis</i> Greene var. <i>spectabilis</i> **			
n = 10	UT	San Juan Co.	SE of Gold Basin in the La Sal Mts. (T27S, R24E, S15); W95-170 (ASU, BRY, COLO, CPH, MO, NY, OGDF, UT, UTC) W & ER 97-188 (ISTC, UT)
n = 10	UT	San Juan Co.	NW slope of South Peak in the Abajo Mts. (T34S, R22E); W95-182 (ASU, BRY, COLO, CPH, MO, NY, OGDF, UT, UTC)
<i>Draba subalpina</i> Goodman & C.L. Hitchc.**			
n = 13	UT	Garfield Co.	along tributary of Red Canyon on the Paunsaugunt Plateau (T36S, R4½W, S1); W & MKW 92-037 (COLO, MO, UT); W 96-036 (DAO)
n = 13	UT	Garfield Co.	near headwaters of Coyote Hollow on the Paunsaugunt Plateau (T36S, R4½W, S1); W 98-129 (MO, NY, UT)
n = 13	UT	Iron Co.	NW slope of Blowhard Mtn. on the Markagunt Plateau (T37S, R9W, S15); W 92-135 (BRY, MO, NY, UT, UTC)



FIGS. 1–6. Meiotic chromosome squashes for various *Draba* species. Solid spherical bodies in Figs. 1, 4, and 6 = nucleoli. Arrows identify overlapping pairs. 1. Diakinesis in *D. albertina* ($n = 12$). 2. Late diakinesis in *D. asprella* var. *stelligera* ($n = 15$). 3. Metaphase I in *D. cuneifolia* var. *cuneifolia* ($n = 15$). 4. Diakinesis in *D. juniperina* ($n = 11$). 5. Late prophase II in *D. maguirei* var. *maguirei* ($n = 16$ at each pole). Faint spherical body near the center of each cluster = nucleolus. 6. Diakinesis in *D. spectabilis* var. *spectabilis* ($n = 10$).

lection is presumed to represent var. *cuneifolia* based on geographic location. Hartman et al. (1975) also report $n = 16$ for a collection of the typical variety from Dallas Co., TX. Given this history, I was surprised to obtain clear preparations of $n = 15$ (Fig. 3) for two populations of *D. cuneifolia* var. *cuneifolia* from Arizona and Utah. These counts were confirmed in at least five cells from three different plants in each population, so it seems likely that the apparent chromosomal polymorphism is

real. It is interesting to note that my counts derive from the northwestern portion of the species distribution, whereas the two reports of $n = 16$ represent the southeastern portion of the native range. Further sampling is needed to determine whether chromosome number truly is correlated with geography in *D. cuneifolia*. Such an investigation also should encompass *Draba reptans*, (Lam.) Fern. which is considered closely related (Hitchcock 1941) or intergradient (Welsh 1993) and apparently displays par-

allel variation in chromosome number (Mulligan 1966; Löve and Löve 1982). Although *D. reptans* is placed in the aneuploid group by Mulligan (1976), the taxon is white-flowered and probably should be assigned to a separate group (Beilstein personal communication).

Draba juniperina is endemic to pinyon-juniper woodlands at the northeastern edge of the Uinta Mountains near "Three Corners", the point where Utah, Wyoming, and Colorado meet. The taxon, long thought to be related to *D. oligosperma* Hook., because of the shared occurrence of doubly pectinate trichomes, has a complex nomenclatural history. It was first separated from the yellow-flowered *D. oligosperma* under the name *D. pectinipila* (Rollins 1953), a taxon typified on white-flowered specimens from alpine habitats in northwestern Wyoming. Dorn (1978) pointed out that the petals of *D. pectinipila* truly are white, but the flowers of populations from southwestern Wyoming and northeastern Utah are yellow when fresh. Additional morphological features were found to correlate with flower color, geography, and habitat, which led Dorn (1978) to describe the Uinta populations as a new species, *D. juniperina*.

Subsequent studies by Lichvar (1983) seemed to reinforce the distinctions among *D. oligosperma*, *D. pectinipila*, and *D. juniperina* but, in his most recent work, Rollins (1993) abandoned this taxonomy. Stating that designating "deviant types as independent taxa . . . has done little to clarify the nature of the species as a whole" (Rollins 1993), he once again synonymized the segregate taxa under *D. oligosperma*. Kartesz (1994) followed suit, though Welsh (1986a) maintained *juniperina* as a variety of *D. oligosperma* without further comment. There has been little use of this combination, however, because var. *juniperina* is described as having "petals evidently white" (Welsh 1993), a character state not found in Utah specimens.

The chromosome counts presented here for *Draba juniperina* (Fig. 4) provide valuable insight into the taxonomy of this contentious species complex. Studies at two widely separated localities in Daggett Co., UT and one site in Sweetwater Co., WY revealed that *D. juniperina* is a sexually-reproducing taxon with a chromosome number of $n = 11$. This is one of two numbers not previously documented in Mulligan's (1966, 1976) aneuploid series, and clearly establishes this taxon as a member of the yellow-flowered aneuploid group. *Draba oligosperma*, on the other hand, is an apomictic taxon (Mulligan and Findlay 1970) with three reported chromosome numbers: 1) $2n = 32$ from Alberta (Chinnappa and Chmielewski 1987), 2) $2n = \pm 60$ from Wyoming (Rollins 1966), and 3) $2n = 64$ from seven populations in Alberta and one in Yukon Territory (Mulligan 1972). These numbers indicate that *D. oligosperma* belongs to Mulligan's (1976) yellow-flowered euploid group.

The difference in chromosome base numbers be-

tween *D. oligosperma* ($x = 8$) and *D. juniperina* ($x = 11$) is not trivial. The former is not a simple polyploid derivative of the latter and, if Mulligan (1976) is right in his assessment of relationships, they may belong to different major lineages. The two taxa are easily distinguished using the characters listed by Dorn (1978) and Lichvar (1983), even where their ranges overlap. Even if they grew together, which they apparently do not, there would be no opportunity for hybridization because *D. oligosperma* is apomictic and apparently does not produce functional gametes (Mulligan and Findlay 1970). All of this provides a strong argument for maintaining *Draba juniperina* as a distinct species.

Draba kassii is a very rare species endemic to a few canyons in the Deep Creek Mountains of western Utah. Its relationships are obscure, with Rollins (1993) stating that it "is not closely enough related to any known species of *Draba* to allow inferences as to its phylogeny." Comparisons have been drawn to *D. asprella* (Welsh 1986b) and *D. standleyi* J. F. Macbr. & Payson (Rollins 1993), though both authors suggest that the similarities may be superficial. Chromosome numbers have the potential to play a crucial role in determining the relationships of this species. At least 20 cells from five different plants clearly establish that the chromosome number of *D. kassii* is $n = 11$ (Table 1). This number, which establishes the taxon as a member of Mulligan's yellow-flowered aneuploid group, would seem to rule out a direct phylogenetic link to *D. asprella* ($n = 15, 16?$). The possibility of a relationship to *D. juniperina*, the only other species known to have $n = 11$, is intriguing. However, the two taxa do not appear closely related morphologically, and any hypothesis of relationships will remain speculative until additional *Draba* species (including *D. standleyi*) have been sampled chromosomally.

The phylogenetic affinities of *Draba maguirei* are as contentious as those of *D. kassii*, and it appears that no recent author has ventured to discuss its possible relationships. On first describing the species, Hitchcock (1941) stated that it "is very striking and quite unlike any of the other *Drabas* from its immediate vicinity. Its closest relatives are probably those of the *ventosa* group . . .". Of the eight taxa comprising Hitchcock's *ventosa* group, chromosome counts have been published for two (*D. ventosa* Gray and *D. ruaxes* Payson & St. John) and a third (*D. sobolifera*) is reported here. All three belong to Mulligan's (1976) yellow-flowered aneuploid group with chromosome numbers based on $x = 12$ and 13. Thus, it is surprising to find that *D. maguirei* var. *maguirei* shows a euploid count of $n = 16$ (Fig. 5). Additional chromosome counts on *D. maguirei* and other members of Hitchcock's *ventosa* group are needed to resolve this apparent conflict.

Draba nemorosa L., a species of widespread occurrence in both North America and Eurasia, was

assigned by Mulligan (1976) to his yellow-flowered euploid group. All populations analyzed chromosomally have shown $n = 8$, regardless of geographic origin. In North America, there have been four counts from Alberta (Packer 1964; Mulligan 1966, 1975), one from Manitoba (Löve and Löve 1982), two from Ontario (Mulligan 1975), and two from Saskatchewan (Mulligan 1966, 1975). It appears that my determination of $n = 8$ (Table 1) from Daggett Co., UT is the first report for the United States. None of the previous North American reports specify variety, though most are surely var. *nemorosa*, the taxon to which my count is assigned following the taxonomy of Kartesz (1994). Although the glabrous-fruited form (var. *leiocarpa*) is considered taxonomically insignificant by many authors, there does appear to be some geographic integrity to its occurrence. Therefore, it seems wise to maintain the distinction until North American populations are studied adequately.

Although Hitchcock (1941) considers *Draba rectifracta* to be a close relative of euploid *D. nemorosa*, little evidence is cited to support such an association. Instead, it appears to be very closely related to *D. albertina*, distinguished from that species mainly by its pubescent upper stems and pedicels. Ongoing studies of populations in northern Utah suggest that *D. rectifracta* and *D. albertina* hybridize when growing in close proximity. Thus, it is not surprising to find that *D. rectifracta* has a chromosome number of $n = 12$ (Table 1), identical to that of its putative aneuploid relative.

Draba sobolifera, endemic to the Tushar Mountains of southern Utah, is considered a member of Hitchcock's (1941) *ventosa* group with close affinities to *D. cusickii* Robinson & D. E. Schulz (Rollins 1993). The chromosome number of the latter species is unknown, but the two members of the *ventosa* complex previously reported, *D. ventosa* and *D. ruaxes*, show $2n = 36$ and $2n = 72$ (Mulligan 1971). They are considered to be triploid and hexaploid respectively, with a base number of $x = 12$. Cytological studies on a population of *D. sobolifera* from Piute Co., UT reveal that it is a sexually-reproducing taxon with a chromosome number of $n = 13$. This is the last number to be documented in Mulligan's (1966, 1976) aneuploid series, and it firmly establishes this species as a member of the yellow-flowered aneuploid group.

There are three previous chromosome counts for *Draba spectabilis*, all from Colorado and all assigned to var. *oxyloba* (Greene) Gilg. & O. E. Schulz by Price (1980). The earliest report (Mulligan 1966) of $n = 10$ seemed to indicate that the species belonged in the aneuploid group. However, two subsequent counts of $n = 16$ and $n = 16 \pm 2$ by Price (1980) suggest an affinity to the yellow-flowered euploid assemblage. My determinations, apparently the first for var. *spectabilis*, are from two widely separated populations in San Juan Co., UT (Fig. 6). They agree with Mulligan's (1966) report

of $n = 10$ and point out the need for further sampling to determine the relationships and proper taxonomy of *D. spectabilis*.

Draba subalpina generally is restricted to a single geologic stratum, the Claron Formation of Bryce Canyon National Park and vicinity. Although recent authors have said little regarding its probable relationships, Hitchcock (1941) states that its closest relative is *D. oreibata* J. F. Macbr. & Payson, a species under which it was subsumed prior to 1932. The latter taxon is endemic to central Idaho in its typical form, is similarly white-flowered, and shows a chromosome number of $n = 16$ (Henderson et al. 1980). In light of its proposed relationships and the assumption that *D. subalpina* was a member of the white-flowered euploid group, the actual chromosome number was unexpected. Based on at least ten cells from five individuals in each of three populations, the chromosome count of *Draba subalpina* proves to be $n = 13$ (Table 1). Whether *D. subalpina* belongs to a relatively rare, white-flowered aneuploid group or is more closely related to some of its yellow-flowered congeners remains to be determined. The close proximity (ca. 60 km) of *D. sobolifera*, the only other species known to exhibit $n = 13$, raises intriguing possibilities regarding the relationships of white- and yellow-flowered aneuploids in *Draba*.

Even with the small sample size of this nascent effort, it is clear that the taxonomic composition of the Intermountain *Draba* flora is quite different from the intensively studied assemblage of Canada and Alaska. In the latter, Mulligan (1976) assigned 17 species to his white-flowered euploid group, nine to the yellow-flowered euploid assemblage, and 13 to his yellow-flowered aneuploid group. In my sample from Utah, Wyoming, and Arizona, white-flowered euploids are not represented (unless *D. cuneifolia* belongs here) and yellow-flowered euploids are rare, comprising only *D. nemorosa* and possibly *D. maguirei*. Seven of the Intermountain taxa belong to the yellow-flowered aneuploid assemblage and the remaining taxon (*D. subalpina*) is a white-flowered aneuploid of uncertain affinity.

A growing number of chromosome counts for the region suggests that the Intermountain West may be a center of diversity for aneuploid *Draba*. With the discovery of both $n = 11$ and $n = 13$ among local endemics, a complete series of base numbers extending from 8 to 16 has been documented. Only $n = 9$ and $n = 14$ are missing from my sample, and those numbers have been confirmed in other taxa from the region. This means that every major step in the process of aneuploid evolution is preserved among the *Draba* species of the Intermountain West. In this assemblage of *Draba* species, we have an unprecedented opportunity to study the processes of chromosomal evolution and speciation in plants. With further cytological sampling and concurrent DNA studies of the group, we soon may be in a position to elucidate the evo-

lutionary history of this interesting and diverse set of organisms.

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