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Some Characteristics of Segregation in Hybrids of *Hordeum spontaneum* C. Koch emend. Bacht. × *H. vulgare* (L.) emend. Vav. et Bacht.

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Summary. The analysis of hybrid generations, that had arisen from crosses of various forms of *H. spontaneum*, as well as comparison of the results of crossing representatives of *H. spontaneum* with two and six-row forms of *H. vulgare* warrant the following statements:

1. When various morphological races of *H. spontaneum* were intercrossed, no morphologically new types arose among the progeny of hybrid generations as a result of these crosses. Various morphological hybrid groups, eight up to F_3, remained strictly within the variability of the system of the species *Hordeum spontaneum* C. Koch emend. Bacht.

2. When various morphological races of *H. spontaneum* were hybridized with two- and six-row forms of *H. vulgare*, marked dominance of characters of the wild parent were observed, nevertheless even in F_3 occasional hybrid individuals with a nonbrittle ear have been obtained. This fact is an evidence that cultivated barley may take part in the formation of such hybrids.

In the fourth generation of the above interspecific crosses besides individuals which had inherited the characters of one or the other of the parents new morphological types arise. The latter are characterized by new combinations, inherited from both parents. In studies reported previously such casual hybrid individuals were provisionally named by us "sessiliproskowetzii". At first glance, the latter seemed not to differ from *H. spontaneum* v. *proskowetzii*, but more thorough observation showed that such hybrids differ from genuine individuals of v. *proskowetzii*: their sterile lateral spikelets are sessile, i. e. deprived of pedicels.

In a published paper of the writer's "Experimental data on the inheritance of some taxonomic characters in *Hordeum spontaneum* C. Koch emend. Bacht." (1965a, 1965b) Tables 1 and 2 were presented, giving characteristics of the parental forms used for crossing, along with a list of the hybrid matings investigated. Of the ten matings in the above-mentioned paper the following three crosses are considered in the present report:

1. h8-*Hordeum spontaneum* v. *spontaneum* I × *H. spontaneum* v. *lagunculiforme* D

2. h30-*H. spontaneum* v. *ischnatherum* × *H. vulgare* v. *nutans* cultivar Viner

3. h88-*H. vulgare* v. *pallidum* cultivar Pirkka × *H. spontaneum* v. *lagunculiforme* D.

This material was chosen with an aim of carrying out preliminary studies on the nature of inheriting a wild and a cultivated habitus of parental forms, the most contrasting examples being taken. In the author's opinion the three above-mentioned matings represent such material.

Results of experimental studies

The behaviour of the hybrid progeny h8. As seen in Table 1, the first generation of the intraspecific cross under analysis in contrast to its parental individuals turned out to be similar to *H. spontaneum* v. *ischnatherum* — the intermediate form between them.

As expected all the 384 F_2 ears under analysis*, were, without exception like *H. spontaneum* and were distributed among the four established varieties (Table 1) in approximately a ratio of 4:9:1:6. The greatest number of ears was found to be v. *ischnatherum*, the second v. *lagunculiforme*, the third v. *spontaneum* and the smallest one v. *proskowetzii*. No new morphological types outside the range of *H. spontaneum* were discovered, however, there were present lateral sterile spikelets characteristic of a heterozygous morphological type v. *ischnatherum* I and II, being observed in the same ear, as well as ears with heterozygous spikelets characteristic of a v. *ischnatherum* II and v. *proskowetzii* I hybrid type. The ratio of ears of a two-row to a six-row type (v. *lagunculiforme*) was approximately 2.5:1.

In F_3 a segregation of the progeny of ears of the type *ischnatherum* I and II as well as those of the type *proskowetzii* was observed. In the first case (*ischnatherum* I) 216 ears under analysis were distributed among the varieties of *H. spontaneum* i.e. v. *spontaneum*, v. *ischnatherum*, v. *proskowetzii* and v. *lagunculiforme* (Table 1) approximately in a ratio of 22:13:1:7. In the second case (*ischnatherum* II) 393 ears likewise turned out to belong to corresponding varieties of *H. spontaneum*, approximately in a ratio of 5:8:1:5. Finally, 106 ears of the individuals of the

* Due to a marked brittleness of the ears as these ripened it was necessary to harvest the ears rather, than the plants. Therefore our calculation may represent only approximations of the ratios of the characters studied.

Table 1. *Segregation of the progeny h8 — Hordeum spontaneum v. spontaneum I × H. spontaneum v. lagunculiforme D*

Generation	Segregation			
	v. *spontaneum*	*v. ischnatherum*	v. *proskowetzii*	v. *lagunculiforme*
F_1 = *H. spontaneum* v. *ischnatherum*		2 plants		
F_2 (ears)	79	174	19	112
F_3 (ears): v. *ischnatherum* I	109	66	5	36
v. *ischnatherum* II	107	168	20	98
v. *proskowetzii* I	26	45	8	27

progeny v. *proskowetzii* I were distributed among the varieties of *H. spontaneum* roughly as 3:6:1:3.

Consequently, segregation in F_3 of the hybrid forms of F_2 under tests in all three cases shows a marked dominance of forms of the v. *spontaneum* and v. *ischnatherum* types. On further analysis the hybrid form v. *ischnatherum* I produces in its progeny predominantly v. *spontaneum*, whereas in the progeny of v. *ischnatherum* II individuals of the parental type, i. e. v. *ischnatherum*, are predominant. The F_3 progeny of the hybrid form *proskowetzii* also consisted mainly of individuals of v. *ischnatherum* and v. *spontaneum* types; whereas the individuals of the parental hybrid type itself, (i. e. v. *proskowetzii*) were in the minority. Individuals of the *lagunculiforme* type greatly outnumbered those of v. *proskowetzii* in the material under test (Table 1).

The analysis of experimental material of a h30 cross (Table 2) showed complete dominance of the wild parent *H. spontaneum* in F_1 and F_2. The first generation, being represented by 5 plants, was similar to *H. spontaneum* v. *ischnatherum*. Segregation in F_2 likewise did not transgress beyond the morphological form of the wild parent: 262 ears were distributed among the varieties *spontaneum*, *ischnatherum* and *proskowetzii*, approximately in a ratio of 5:9:1.

Corresponding ear material, which had been selected to be sown for F_2 was represented by the extreme forms belonging to varieties: *spontaneum* I, *spontaneum* II, *proskowetzii* I, II, III and IV. Among the F_3 progeny of the first three hybrid forms a strong dominance of the wild-growing type was observed but a few individuals were discovered which were similar to the variety of cultivated barley v. *nutans*, except that these were very rough and did not even resemble the Viner ecotype. In general, there is an obvious predominance of wild barley forms in the products of segregation.

Further studies of F_4 and F_5 hybrids were mainly directed towards elucidation of the degree of constancy manifested by individuals of the *nutans* type, and towards observing a possible occurrence of new morphological formations. For this purpose 13 families of the *nutans* type , 1 family of the type *spontaneum* II, 8 families of the type *ischnatherum* I, 13 families of the type *ischnatherum* II, 11 families of the type *proskowetzii* I and 9 families of the type *proskowetzii* V—VII were tested in F_4.

Among 13 F_4 families classified as being of the type *nutans*, 4 turned out to be constant (i. e. breed true), but differed widely from cultivated barley with respect to the roughness of all the parts of their ears.

Table 2. *Segregation in families derived from crosses h30 — Hordeum spontaneum v. ischnatherum × H. vulgare v. nutans cultivar Viner*

Generations	Families Total	Segregation				New formations
		v. *spontaneum*	v. *ischnatherum*	v. *proskowetzii*	v. *nutans*	
F_1			5 plants			
F_2 (ears)		87	158	17		
F_3 (ears):						
spontaneum I		14	1		1	
spontaneum II		34	29	8	3	
proskowetzii I		3	103	169	4	
proskowetzii II			1	35		
proskowetzii III—IV			3	41		
F_4 (ears):						
nutans	13	+	+	+	+	
spontaneum II	1	+	+	+		*sessiliproskowetzii*
ischnatherum I	8	+	+	+	+	*sessiliproskowetzii*
ischnatherum II	13	+	+	+	+	*sessiliproskowetzii*
proskowetzii I	11			+		
proskowetzii V—VII	9			+		
F_5 (ears):						
nutans					+	

Table 3. *Segregation in the progeny of the cross h88 — Hordeum vulgare v. pallidum cultivar Pirkka × H. spontaneum v. lagunculiforme D*

Generations	Families Total	Segregation					New formations
		prosko-wetzii	*lagunculi-forme*	*agrio-crithon*	*pallidum*	*pallipodum*	
F_1			4 (plants)				
F_2 (ears):		14	108	+	9		
F_3 (ears):							
lagunculiforme			1010	431	20	10	
pallidum			11	73			
agriocrithon			125	304			
proskowetzii		1	48	5			
pallipodum			119	25	1	5	
F_4 (ears):							
agriocrithon	1						
pallipodum	10				114	114	
pallidum	18				194	105	
proskowetzii VII	1		2				*proskow-fertillum*
F_5 (ears):							
pallidum	33			7	1220	407	
pallipodum	28			3	491	1045	
agriocrithon	1			60	2		

The other 9 families continued to segregate into forms similar to v. *spontaneum*, v. *ischnatherum*, v. *proskowetzii* and v. *nutans*. In two cases the ratio between a wild and a cultivated type was close to 1:1.

The F_4 family of the *spontaneum* II type segregated into forms close to v. *spontaneum*, v. *ischnatherum* and v. *proskowetzii*. Among the latter group new types were observed, which, in general, could be classified as the new formation v. *proskowetzii*, but which in contrast to v. *proskowetzii* had sessile lateral sterile spikelets, therefore the provisional name of forma "*sessiliproskowetzii*" has been assigned to them.

All but one of the 8 families of the type *ischnatherum* I continued to segregate into hybrid forms similar to the varieties *spontaneum-ischnatherum* and *proskowetzii*. In addition *sessiliproskowetzii* forms were discovered in the progeny of two of the families. Among 8 families only one proved to be constant as regarded toughness of ears, the hybrids themselves remained very coarse, as is characteristic of individuals of *H. spontaneum*. In some families, segregation for this character continued, with brittle forms obviously predominating there.

13 families of F_4 were grouped before sowing according to their morphological similarity. In the majority of cases these manifested a similar nature of segregation as did *ischnatherum* II: from v. *spontaneum* through *proskowetzii* in one family the form *sessiliproskowetzii* was predominant. In only one family was a hybrid individual similar to *nutans* observed, however it had not even a remote resemblance to the parent form Viner. Judging by the character brittle or non-brittle ear two families remained constant as regards firmness of their ears, though morphologically all of them remained within the range of *H. spontaneum*. In other families the ratio between the individuals with brittle and non-brittle ears proved to be nearly 1:1.

The next 11 families in F_4, classified as *proskowetzii* I, continued to segregate within the morphological limits of v. *proskowetzii*. Among them only one family was found to be tough-eared, the other ones were similar to their wild parent in this respect.

Nine families in F_4, structurally resembling *proskowetzii* V—VII, did not vary beyond the morphological differences of *proskowetzii* I—*proskowetzii* VII as regards their polymorphism. They had brittle and coarse ears, though in F_3 in the majority of cases they had been selected for being tough-eared.

For studies in F_5 very few plants of a *nutans*-type were selected, they turned out to breed true, but had nothing in common with the parent from *nutans* (Viner) except for taxonomic similarity. Nevertheless, with respect to a number of economical characters all of them are doubtless of interest for further observations.

Combination h88. As had been reported (Bakhteyev, 1965) the morphology of the paternal form *lagunculiforme* was predominant in F_4. In F_2 along with 108 ears of the *lagunculiforme*-type, 14 were of the *proskowetzii*-type, and only 9 ears were similar to the maternal parent *pallidum*. Along with these, a single new formation of the *H. agriocrithon* E. Åberg-type had arisen. The ears were outwardly similar to *pallidum*, but differed from the latter by the presence of lateral fruit-bearing spikelets with a pedicel, they were provisionally named "*pallipodum*".

In F_3 (Table 3) the nature of the further segregation within each of the morphological groups is recorded, these groups having been established in F_2. Thus, the progeny of the group *lagunculiforme*, consisting of 1471 ears was found to include the varieties *pallidum*,

langunculiforme, *H. agriocrithon* and *pallipodum*, their ratio being approximately 2:101:43:1.

The group of hybrid individuals of the *pallidum*-type was distributed correspondingly between *H. spontaneum* v. *langunculiforme* and *H. agriocrithon*, 11 ears and 73 ears respectively, or in ratio close to 1:7.

The progeny of a hybrid group of the *H. agriocrithon*-type separated into the same morphological categories as did the former group, v. *langunculiforme* and *H. agriocrithon*, approximately in a ratio of 1:2,5.

The group *proskowetzii* was represented in F_3 by only one ear of this type, by 48 ears of *langunculiforme* and by 5 of *agriocrithon*.

The *pallipodum* type segregated in its progeny into *pallidum*, *langunculiforme*, *agriocrithon* and *pallipodum*.

As may be seen in Table 3, the further generation of the cross h88 under test comprised: one true breeding family *agriocrithon*, 10 families of *pallipodum*, 18 families of *pallidum* and one family of *proskowetzii*. Among the *pallipodum* families two were constant, whereas the other 8 continued to segregate into forms similar to *pallidum* and *pallipodum* in approximately equal ratios. Of the 18 families of the *pallidum*-type 8 proved to be constant, and 10 families were heterozygous, the later segregated into variants of the *pallidum* type, individuals of a *pallidum*-type being roughly twice as frequent as the other form. In the family of a *proskowetzii* VII-type of 17 only three were retained, two of them were of a *langunculiforme*-type and one plant was a new morphological type: "*proskowfertillum*".

F_5 of combination h88 was represented by families of *pallidum*, *pallipodum* and by one family of *agriocrithon*; among them 11 and four families respectively were found to breed true, whereas in the family *agriocrithon* a few individuals similar to *pallidum* were discovered. Segregation in heterozygous families of *pallidum* and *pallipodum* yielded forms similar to: *H. agriocrithon*, v. *pallidum* and *pallipodum* (Table 3). In the families of the *pallidum* and *pallipodum* types the respective parental forms of the same name were predominant in the progeny.

Zusammenfassung

Untersuchungen der Hybridgenerationen, die sich aus Kreuzungen verschiedener Formen von *Hordeum spontaneum* ergeben haben, und die Ergebnisse von Kreuzungen von *H. spontaneum* mit zwei- und sechszeiligen Formen von *H. vulgare* berechtigen zu folgenden Feststellungen:

1. Bei der Kreuzung morphologisch verschiedener Formen von *H. spontaneum* untereinander entstanden in den Hybridnachkommenschaften keine morphologisch neuen Typen. Morphologisch verschiedene Hybridengruppen blieben bis zur F_3 deutlich innerhalb der Variabilität des Speziessystems *H. spontaneum*.

2. Bei der Kreuzung morphologisch verschiedener Formen von *H. spontaneum* mit zwei- und sechszeiligen Formen von *H. vulgare* konnte zwar eine ausgeprägte Dominanz der Merkmale des Wildelters beobachtet werden, doch sind gelegentlich, auch in der F_3, Individuen mit nichtbrüchiger Ähre aufgetreten. Diese Tatsache ist ein Hinweis dafür, daß Kulturgerste an der Bildung solcher Hybriden beteiligt sein kann.

In der 4. Generation der erwähnten interspezifischen Kreuzungen entstehen neben Individuen, die Merkmale des einen oder anderen Elters geerbt haben, morphologisch neue Typen. Sie sind durch von beiden Eltern ererbte neue Merkmalskombinationen gekennzeichnet. In früheren Berichten waren solche zufällig aufgetretenen Hybridindividuen von uns vorläufig „*sessiliproskowetzii*" benannt worden. Auf den ersten Blick schienen sie sich nicht von *H. spontaneum* v. *proskowetzii* zu unterscheiden, aber eine eingehende Beobachtung ergab, daß diese Hybriden doch von den echten Individuen von v. *proskowetzii* verschieden sind: ihre sterilen Seitenährchen sind sitzend, d. h. sie haben kein Stielchen.

References

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