Bob Harms
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Sporobulus compositus var. *drummondii*

Sporobulus clandestinus

Survey of collections of the *Sporobolus compositus* complex and the *Sporobolus vaginiflorus* complex in the TEX/LL herbaria

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In the text of my report, I adapt the USDA abbreviations (by deleting final digits) for the four main components of the *S. compositus* (SPVO) complex and the three components of the *S. vaginiflorus* (SPVA) complex simply for convenience, without implying species or variety status.

SPCL	***Sporobolus clandestinus* (Biehler) A.S. Hitchc.**
SPCO	***Sporobolus compositus* complex**
SPCOC	***Sporobolus compositus* (Poir.) Merr. var. *compositus***
SPCOD	***Sporobolus compositus* (Poir.) Merr. var. *drummondii* (Trin.) Kartesz & Gandhi**
SPCOM	***Sporobolus compositus* (Poir.) Merr. var. *macer* (Trin.) Kartesz & Gandhi**
SPNE	***Sporobolus neglectus* Nash**
SPVA	***Sporobolus vaginiflorus* (Torr. ex Gray) Wood (var. vaginiflorus)**
SPVAO	***Sporobolus vaginiflorus* (Torr. ex Gray) Wood var. *ozarkanus* (Fern.)**

1. Background, perspectives and personal opinions.

My field experience with the SPCO complex at this writing has been limited to two areas of the eastern Edward's Plateau: (1) the Barton Creek Greenbelt c. 1 mile upstream from Zilker Park, and (2) northern Hays Co. just east of Pedernales Falls State Park. In both locations distinct populations of SPCL and SPCOD occur in close proximity (represented in the Herbarium by Harms 18-21). In these locales SPCL, with pubescent lemmas, forms small tufts, with erect culms that persist from late summer until early spring; its grain pericarp loosens, but does not become gelatinous when wet. SPCOD forms large clumps, often several feet in diameter (resembling giant *Carex planostachys*), with lax leaves and long culms that soon become prostrate at anthesis (in early fall); its grain pericarp becomes gelatinous when wet. This prostrate habit of SPCOD does not match the current literature, which indicates 'erect culms' (even 'stiffly erect', Hatch et al 1999).

To gain some perspective into the nature of my survey of the SPCO complex and SPVA complex, I suggest the following purely hypothetical taxonomic exercises for each complex:

Plants to be classified:

Mounted herbarium specimens determined (by experts) to constitute a closely related set of possibly (1) one or more species and/or (2) one or more varieties. The specimens are not otherwise identified, nor are any notes present on the sheets. The specimens represent different stages of maturity from pre-anthesis to disarticulation of mature spikelets.

Factors to be considered are limited to the following (based on Gould 1975):

For the SPCO complex:

C1. Lemma pubescence consisting of appressed hairs.
C2. Length of spikelet, glumes, lemma, palea.
C3. Relative length of glumes, lemma, palea.
C4. Width of culm base.
C5. Rhizomes present.
C6. Width of terminal sheath when folded.
C7. Number of primary panicle branches.
C8. Whether panicle branches are crowded or lax.
C9. The grain pericarp becomes gelatinous when moistened.

For the SPVA complex:

V1. Floret pubescence consisting of appressed hairs.
V2. Lemma has/lacks (faint) lateral nerves:
  a. all lemmas have 3 nerves;
  b. one or more (but not all) lemmas have 3 nerves:
  c. no lemmas have 3 nerves.
V3. Lower sheaths are papillose-pilose.
V4. Relative length of glumes and floret
V5. Floret length/width ratio.

Based upon my familiarity with the current holdings I would expect the results – given unlimited time for examination of the specimens – to be rather limited and indecisive.

For the SPCO complex the only clear result would be that the grain pericarp will not become gelatinous (C9) only if the lemma is pubescent (C1), and vice versa – grounds for at least varietal status [i.e., some but not all of the SPCL specimens]. All other factors would produce a continuous scale from one extreme to the other with no clear boundaries. Even C5 (presence of rhizomes) would not provide a clearly categorical result.

For the SPVA complex, if the floret is glabrous (V1), then no lemmas will have 3 nerves (V2c), sheaths will not be papillose-pilose (V3), and floret length/width ratios will be among the lowest for the group (V5) – again support for variety/species recognition [all and only SPNE specimens]. Other factors would lack nonarbitrary boundaries.

Obviously this is not how I proceeded, and I doubt whether anyone has approached problems of classification in this fashion. After a limited but intensive examination of those characteristics I considered both feasible and relevant – not restricted to those in the standard keys – I have nonetheless formed a number of personal opinions:

(1) I was unable to find necessary and sufficient criteria for the separation of SPVA and SPVAO, but SPNE is clearly distinct.
(2) SPCOD and SPCOC differ as two extreme poles of size and stoutness of morphological features.
(3) SPCL is a distinct species, cooccurring with SPCOD without intergradation (based on field experience).
(4) The single clear specimen in the collection doesn't support a distinct rhizomatous SPCOM.

2. Methods and problems.

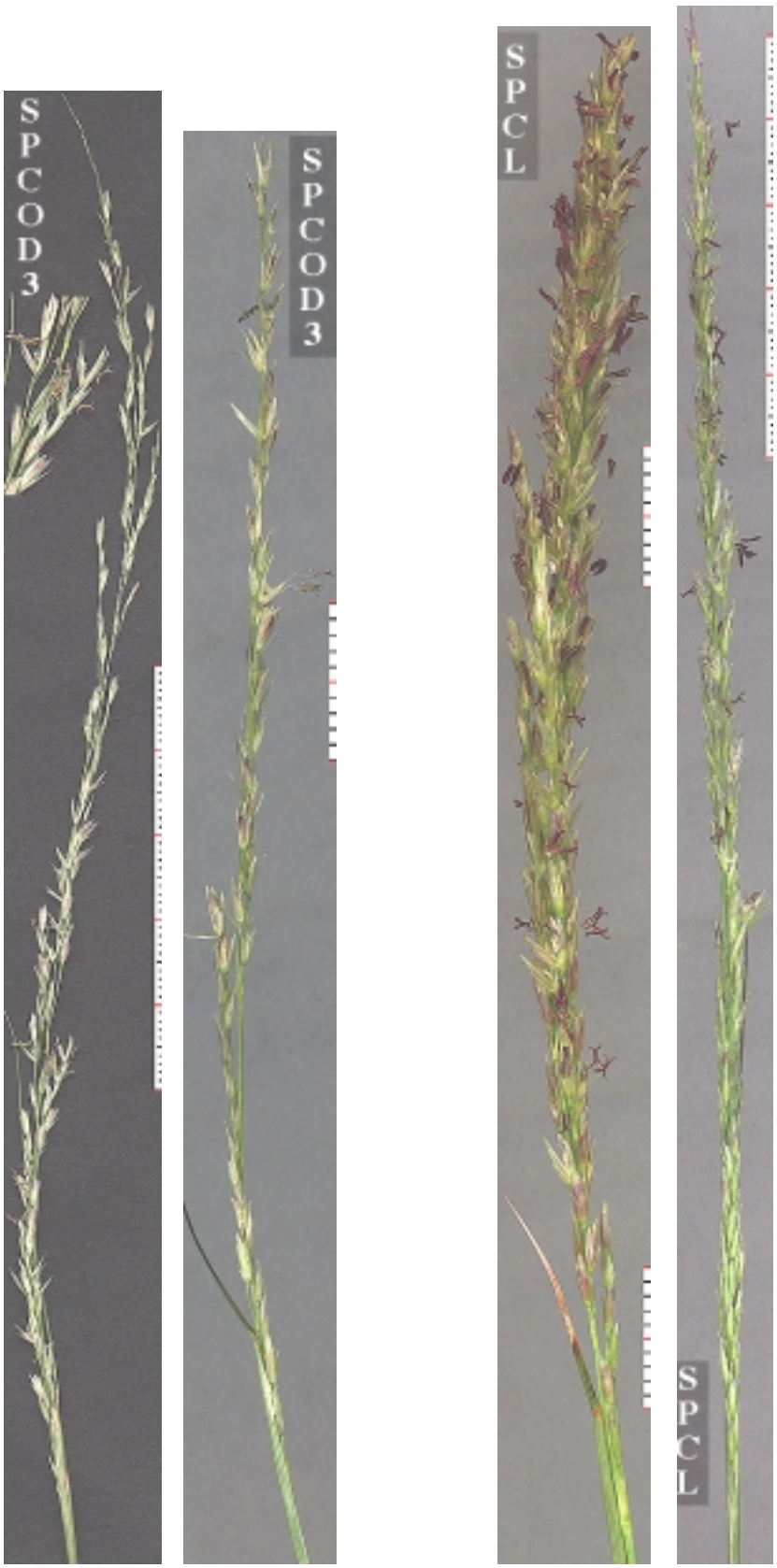
Before attempting my survey of the Herbarium's Texas Sporobolus holdings for these two complexes I familiarized myself with the published keys and descriptions (cf. References) to determine those features deserving special attention. Upon starting my scan of the holdings I learned that three specialists - i.e., R. Riggins, R. L. McGregor, S. L. Hatch - had earlier worked through much of the collection, making determinations for distinct species/varieties – i.e., SPCL, SPCOC, SPCOD, SPCOM. and SPVA, SPVAO, SPNE. There was a remarkable lack of agreement among their determinations; Riggins did not recognize the separation of SPVA and SPVAO. And for some specimens even assignment to complex proved contentious – one reason why I decided to survey both groups.

For each complex I surveyed the specimens in the alphabetical zone (B to P) and numerical county order as organized in the collections, noting the collector's identification and any determinations by the above specialists, notations on the specimen sheet and certain critical details of each specimen.

Many specimens seemed to be immature, lacking spikelets with mature grains. Disarticulation of early abortive florets may have given the impression of maturity when the plant was collected. My own experience with SPCL indicates that mid-summer florets commonly do not set seed, and disarticulate above the glumes. For given specimens McGregor noted immaturity as an obstacle to making a determination; Hatch always identified these.

2.1 The SPCO complex.

For each specimen I measured the length of glumes, lemma and palea for a representative range of the available spikelets. I also examined visible lemma surfaces under high magnification (40X) for evidence of pubescence or other nonglabrous features. Using the drawings in Riggins 1977 as a basis for my judgments, inflorescences were assigned an impressionistic ranking for width, spikelet density and rigidity, ranging from 'a' (for 'asper': wide, dense, rigid) to 'd' (for 'drummondii': narrow, sparse, flexuous), with 'c' (for 'clandestinus') in between. Attempts to measure or guess the width of the culm base - a distinctive feature in several keys - proved futile, especially with herbarium materials; and ultimately seemed irrelevant to determinations made on other grounds.



SPCOD3 and SPCL panicles.

SPCL and SPCOD panicle detail.

2.1.0. Problems and observations associated with making determinations.

2.1.1. Lemma pubescence.
Presence of (appressed) lemma pubescence (cf. Gould 1975, Riggins 1977, Hatch et al 1999) is a reliable indicator when present, but was not discernible for a number of specimens deemed by one or more of the specialists to be SPCL.

The use of this feature presents a number of difficulties. (1) Pubescence is especially difficult to observe at stages prior to full maturity (a significant portion of the collection), (2) the hairs when present are often concealed under glume 1, on the lower third of the lemma and (3) the appressed hairs are only sparsely distributed over the lemma – Hitchcock's 1935 (418) description notes 'lemma **sparsely** [bold by RTH] appressed pubescent'. Even with a strong hand lens, field identification may not be possible.

In a sampling of SPCL specimens collected in early August, with numerous empty glumes and several having set seed, with florets separated from the spikelet, not all lemmas revealed hairs; some lemmas showed hairs on only one side; and when present, pubescence was often restricted to the bottom portion of the lemma. These same observations seemed to be borne out by the herbarium specimens as well.

Lemma pubescence also seemed to vary by position on the inflorescence, with spikelets higher on the panicle less likely to reveal any hairs, again perhaps also a function of maturity.

All lemmas with even limited pubescence showed scattered scale-like scabridity on their upper portions; these surfaces differ in 'texture' from the 'truly glabrous' lemmas of SPCOD/SPCOC specimens agreed upon by all three experts. Indeed, in several instances I was forced to conclude that Riggins had based the determination of SPCL solely on this 'scabridulous' texture; and conflicting judgments among the experts tended to involve just those specimens which were not truly glabrous. In a number of cases, I found that I could use this feature as an indicator that actual pubescence would be found on at least some lemmas of a specimen that otherwise might not have clearly visible hairs on lemmas of the most easily scanned spikelets.

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2.1.2 Quantitative comparison of vegetative features.

Once a specimen has been determined to have a non-pubescent lemma – i.e., SPCL has been excluded, the keys utilize various quantitative measures of vegetative features to distinguish SPCOC and SPCOD. These include culm base width, terminal sheath width, width of leaf blades, number of primary panicle branches and their density/laxness.

Culm base width was particularly difficult to ascertain from mounted specimens. My attempts to guestimate culm width produced a continuum with no clear boundaries of taxonomic import. Although an impressionistic stoutness–of–culm index did seem to distinguish the two extremes of the

SPCOD/SPCOC specimens, it did not help with the many intermediate cases that were the source of most conflicts among the experts.

With SPCL the culm base width varies enormously. Riggins 1977 gives the following ranges for the complex:

SPCL	0.7 – 3.0 (3.8) mm
SPCOD	1.0 – 2.0 (2.5) mm
SPCOC	(1.2) 2.0 – 4.0 (5.0) mm

The range for SPCL thus overlaps those for SPCOD and SPCOC; and thus cannot be used to distinguish SPCL from SPCOD, and not generally to differentiate it from SPCOC.

My own measurements of a representative sampling of SPCL plants gathered from a small population of relatively young plants at anthesis are consistent with Riggin's measurements, with a range of 0.7 – 2.2 mm for culm base widths. Typical values are given in Table 1.

Table 1. Ten typical SPCL culms with inflorescences, collected Aug. 4, 2002 (N. Hays Co.):

	culm height cm	culm width mm	infl. length cm	spikelet lengths
1	122	2.2	34	5.5 – 8.0
2	91	1.8	24.5	3.3 – 6.2
3	56	1.5	14	5.0 – 5.9*
4	52	0.7	10	6.2
5	51	1.1	15	5.3 – 6.8
6	48	1.4	9	6.2 – 6.5
7	47	1.2	7.5	5.3
8	47	1.0	10.5	8.3
9	39	1.4	8	6.0 – 8.2
10	39	1.0	9	4.5

*with mature grain

Although culm base width is clearly correlated with culm height, and both are probably a function of plant age; spikelet length and maturity are not correlated with either culm width or height. Panicle size, however, is significantly reduced in breadth and width on shorter culms.

I develop this issue because I strongly suspect that the difficulties in discerning SPCL lemma pubescence together with the wide range of culm base width and panicle density of SPCL conspire to produce incorrect determinations of SPCL as SPCOD (with spikelet lengths exceeding the expected range for SPCOD); i.e., if it appears that a specimen lacks pubescence, the culm features will seem to determine it as SPCOD.

I found the other vegetative features said to distinguish SPCOD and SPCOC equally unfeasible for the purpose of this survey.

SPCOD3 and SPCL – Sections of single culm.

2.2 The SPVA complex.

For each specimen I noted the above factors V1–V4. I also examined the lemma surface for evidence of nonglabrous features other than pubescence. The apparent wide overlap in floret length/width ratios in the holdings and as reported in Gould 1975 did not seem to justify making detailed measurements of this feature beyond impressionistic observations.

2.2.0. Problems and observations.

2.2.1. Floret pubescence of SPVA/SPVAO is much more evident and more widely distributed over the floret surfaces than was the case with SPCL lemma pubescence. In addition to pubescence, with all unambiguous SPVA/SPVAO florets I observed a distinctive minutely papillate surface texture (using 40X magnification). This texture was absent from the lemmas (and paleas) of SPCL.

2.2.2. Lateral lemma nerves.
The presence of a lateral lemma nerve was often noted on the specimen sheets– i.e., 'lemma 3-nerved' – and these specimens were always among those determined to be SPVAO. I found no specimens in which the lateral lemma nerve was always present. SPVAO determinations with most lemmas lacking a lateral nerve seemed to be as common as those with most lemmas showing 3 nerves. Lateral nerves, not surprisingly, were also common among SPVA determinations. The keys contrast '3-nerved' with 'lemmas with 1 or 3 nerves.' An exact reading of the Gould 1975 key (pp. 286-7) would indicate that specimens with only 1 nerve on at least one lemma are SPVAO, although the intended reading is uncertain.

2.2.3. Lower sheath and blades as papillose-pilose.
My inspection of lower sheaths indicated that essentially all SPVA/SPVAO specimens had papillose-pilose lower sheaths; only the sheath hairs of SPNE never being papillose.

2.2.4. Relative glume/floret length.
Relative glume/floret length is one of the key features for the SPVA/SPVAO distinction. Here again, where a specimen sheet has notations such as 'glumes (mostly) longer than floret' they were determined to be SPVAO. This characteristic was not consistently applied – even specimens with 3-nerved lemmas and glumes longer than florets were determined to be SPVA (Table 8, #27–28); specimens with glumes both longer and shorter than the floret were determined as SPVAO (#9–17).

3. Specific results and opinions.

3.1 SPCO complex.

Apart from B. L. Turner's decision not to make distinctions within either complex, a comparison of my own views in with the most recent determinations in the collection made by Riggins (1972), McGregor (1988), Hatch (1996), or by the collector (if not reviewed by the experts) is given in Table 2.

Major disagreement lies, with two exceptions, in the status of the putative SPCL and SPCOD specimens, roughly 40% of specimens most recently determined to be SPCOD .

A somewhat less radical perspective of my differing opinions emerges from a comparison of my IDs with those of Riggins for those specimens we both examined, a 10% difference – less than the 20% difference between Hatch and Riggins.

Table 2. IDs made by Harms in comparison with the most recent ID for 123 specimens.

	No. of	No of IDs – most recent determination for each type			
Harms' ID	IDs	**SPCOD**	**SPCOC**	**SPCOM**	**SPCL**
SPCOD	30	30	-	-	-
SPCOC	12	1	11	-	-
SPCOM	1	-	-	1	-
SPCL	79	20	3	2	54
SPVA	1	-	-	-	-

Table 3. IDs made by Harms in comparison with Riggins' IDs, for 48 specimens.

Harms		No. of Riggins' IDs for each type				
	IDs	**SPCOD**	**SPCOC**	**SPCOM**	**SPCL**	**SPVA**
SPCOD	15	13	-	-	1	1
SPCOC	6	1	5	-	-	-
SPCOM	1	-	-	1		-
SPCL	48	3	1	-	41	3
SPVA	1	-	-	-		1

3.1.1. Spikelet length and pubescence.

Tables 4-6 show the values I obtained for maximum spikelet length and degree of pubescence for the 123 specimens in the Herbarium's Texas collection. The entries in each sub-table are given in order of increasing spikelet length. Entries are numbered 1 to 123 from the first entry in Table 4 to the last entry in Table 6. Reference to an entry in the text will be simply as '#' plus the entry number; e.g., in Table 4a only #30 was determined by Riggins as SPVA. For the collector and collection number of an entry number, a key associating these is provided in Appendix A; e.g. #30 is Lundell 12020.

3.1.1.1. Specimens with glabrous lemmas.

Specimens with glabrous lemmas are shown in Table 4, in two sets by spikelet length: (1) less than 4.2 mm. and (2) greater than 4.4 mm. Specimens in group (1) were deemed to represent SPCOD by the experts, with one exception, #30 (just above the boundary line); those in group (2) as SPCOC or SPCOM, with one exception, #32 (just below the boundary). Although the boundary might seem arbitrarily selected from a continuous scale, when mature specimens are compared specimens in

group (1) differ from those in group (2) in their notably different panicle morphology – rather sparsely distributed spikelets along a flexuous axis. Although my interpretation of #32 (as immature SPCOC) differs from that given by Riggins in 1970, it is more in accord with her 1977 article, where she gives maximum glume and lemma lengths of 4.2 mm. (p. 314).

Abbreviations used in data tables.

Col.	Collector
MG	R. L. McGregor
SLH	S. L. Hatch
RR	R. Riggins
RTH	R. T. Harms
d, h	SPCOD
a	SPCOC
c	SPCL
vag, v	SPVA
o	SPVAO
n	SPNE
crpt	*S. cryptandrous*
pil	*S. pilosus*
fil	*S. filiformis*
can	*S. canovirens*
trid	*Tridens*
im	too young/immature for determination
pub	pubescence (+ = strong, - = minimal)
S^{max}	maximum spikelet length
im	too young for determination

3.1.1.2. Specimens with pubescent lemmas.

Specimens with pubescent lemmas, those for which I found one or more appressed hairs on the lemma are listed in Table 5. I assigned impressionistic rankings of lemma pubescence as strong, clearly present (but not necessarily discernible on all spikelets, and minimal (difficult to find, limited to very few hairs).

With strong pubescence (5a) came near unanimous accord in determining the specimen as SPCL, with only one exception, #51, as SPVA. The widespread distribution of pubescence over the lemma for #51 is more typical of SPVA, but perhaps the strongest support for SPVA may be seen in the unique SPVA papillate texture of the lemma surface (cf. 2.2.1 above). I don't consider #51 a close call.

Table 4. Specimens with glabrous lemmas, in order of maximum spikelet length.

#	County	Col.ID	MG	SLH	RR	RTH	Smax
Spikelet length less than 4.2 mm.							
1	K13	h	d	d	-	d	3.2
2	J4	a	-	d	-	d	3.4
3	K10	h	-	d	d	d	3.4
4	G10	a	d	d	d	d	3.5
5	J4	a	d	d	-	d	3.5
6	J7	h	d	d	d	d	3.5
7	O13	a	d	d	-	d	3.5
8	P12	h	d	h	d	d	3.5
9	K1	crpt	-	d	-	d	3.6
10	M6	d	-	-	-	d	3.6
11	M13	a	d	d	d	d	3.7
12	K10	a	-	-	d	d	3.8
13	K13	a	d	d	d	d	3.8
14	M13	h	d	d	-	d	3.8
15	M5	-	d	h	c	d	3.8
16	K13	h	d	d	d	d	3.9
17	K8	h	-	d	d	d	3.9
18	L2	d				d	3.9
19	M6	d	-	-	-	d	3.9
20	G7	a	d	d	d	d	4
21	G8	a	d	d	d	d	4
22	G9	a*	-	d	-	d	4
23	K13	a	d	d	d	d	4
24	K13	d				d	4
25	K9	h	-	h	d	d	4
26	M13	a	d	d	-	d	4
27	M13	a	d	d	-	d	4
28	M6	d	-	-	-	d	4
29	F3	a	d	d	-	d	4.1
30	M13	a	im	d	vag	d	4.1
Spikelet length greater than 4.4 mm.							
31	J2	a	a	a	a	a	4.5
32	M2	a	d	d	d	aim	4.9
33	J9	a	a	a	a	a	5
34	L5	m	m	m	m	m	5
35	P9	d	a	a	a	a	5.1
36	O10	a	a	a	-	a	5.2
37	K6	a	-	a	-	a	5.4
38	K6	a	-	a	-	a	5.4
39	J8	a	a	a	-	a	5.5
40	H4	m	a	a	a	a	5.7
41	B20	a	a	a	a	a	6
42	M13	a	a	a	-	a	6.2
43	C17	a	a	a	-	a	6.4

*determined by W. R. Carr

Table 5. Specimens with pubescent lemmas (hairs present):

#	County	Col.ID	MG	SLH	RR	RTH	S^{max}
a. lemmas with strong pubescence:							
44	L5	c	c	c	c	c	4.1
45	N8	m	c	c	c	c	4.5
46	O5	trid	c	c	c	c	4.7
47	L5	c	c	c	c	c	4.8
48	N5	can	c	c	c	c	4.8
49	M11	a	c	c	-	c	4.9
50	K13	a	c	c	c	c	5
51	M24	vag	vag	c	vag	vag.	5
52	O10	a	c	c	c	c	5.1
53	L5	c	c	c	c	c	5.2
54	L5	c	-	-	-	c	5.2
55	M2	h	c	c	c	c	5.3
56	O10	h	c	c	c	c	5.6
57	O5	c	c	c	c	c	5.6
58	N8	vag	c	c	c	c	5.7
59	O13	c	c	c	-	c	6.1
b. lemmas with discernable pubescence:							
60	G9	h	c	c	c	c	3.6
61	G9	a	-	c	-	c	3.8
62	K3	a	-	-	c	c	4.2
63	K13	h	c	c	c	c	4.3
64	K13	h	im	c	c^{im}	c	4.8
65	M3	-	c	c	c	c	4.8
66	P7	c	c	c	c	c	4.8
67	K13	a	-	-	-	c	4.9
68	L8	c	c	-	c	c	4.9
69	F19	d	-	-	-	c	5
70	K13	a	-	d	-	c	5
71	K7	a	c	-	c	c	5
72	M1	a	c	-	-	c	5
73	P13	a	c	c	-	c	5
74	K13	m	a	a	a	c	5.1
75	K13	a	c	c	c	c	5.2
76	O11	a	-	d	-	c	5.2
77	O7	h	c	-	c	c	5.2
78	G7	pil	c	c	c	c	5.25
79	L2	c				c	5.4
80	K13	c				c	5.5
81	K13	a	-	d	-	c	5.6
82	N3	a	-	-	-	c	5.6
83	L8	a	im	d	vag	c	5.7
84	P1	a	-	d	-	c	5.7
85	O17	a	c	c	-	c	5.8
86	P12	a	c	c	-	c	5.8
87	G6	c	c	c	-	c	6
88	H10	a	c	c	c	c	6
89	N8	m	m	m	c	c	6
90	G6	c	c	c	-	c	6.4
91	O11	a	c	c	-	c	6.6
92	M4	fil.	c	c	c	c	-

Table 5. Specimens with pubescent lemmas
(continued)

c. lemmas with minimal pubescence:							
#	County	Col.ID	MG	SLH	RR	RTH	S^{max}
93	M4	h	c	c	c	c	4.6
94	G9	a	-	d	-	c	4.8
95	J10	vag	c	-	c	c	4.9
96	J5	a	c	c	c	c	4.9
97	K13	a	im	d	vag	c	4.9
98	M1	a	d	d	-	c^{im}	4.9
99	G9	a*	-	d	-	c	5
100	J9	d	c	c	c	c	5
101	K10	a	c	-	-	c	5.1
102	O13	c	c	c	-	c	5.1
103	G3	a	c^{im}	c	c	c	5.2
104	K9	a	d	h	c	c	5.2
105	M13	c	d	d	-	c^{im}	5.2
106	K10	a	c	c	c	c	5.4
107	M24	m	c	c	c	c	5.4
108	P9	c	c	c	-	c	5.5
109	P6	c	-	-	-	c^{im}	6.1

* determined by W. R. Carr

With reduced pubescence, as in Table 5b, conflicting opinions increase to c. 30% of the group. I carefully reexamined those items for which my views were in conflict with one or more of the experts or with the collector (if not reviewed by an expert). My findings conflict with those of Riggins in only two instances, #74 – her SPCOC and #83 – her SPVA. Although #74 has an inflorescence type similar to that of SPCOC, I found unmistakable pubescence at the base of the lemma. The lemma surface of #83 lacks the papillate texture typical of SPVA and, in addition to weak pubescence almost concealed by the first glume, has the angular scabridity of SPCL.

My conflicts with Hatch were more numerous (seven, including #74) and for most (five) of these Hatch determined SPCOD, which in addition to pubescence have maximum spikelet lengths 5.0-5.7 mm. and a panicle type more typical of SPCL.

Item #89, SPCOM or SPCL, with no easily seen spikelets, required teasing open a sheath to examine a lemma. Since SPCL is known to have rhizomatous forms, a determination of SPCOM requires positive evidence that lemmas lack pubescence. Perhaps a bias in this instance resulted from the notation on the specimen sheet 'lemmas and palea glabrous.'

With minimal pubescence (5c) the number of type of conflicts closely parallel those with 5b: my one conflict with Riggins, #97 – her SPVA and five with Hatch – #94, #97-99, #105, his SPCOD.

3.1.1.3. Specimens with neither pubescent nor glabrous lemmas.
Specimens with neither pubescent nor glabrous lemmas are listed on Table 6. These have lemmas I considered to have some degree of scabridity on the upper portion of the lemma, most often triangular and antrorse, sometimes lengthened. To see this feature requires a relatively high magnification – I used 40X – and an appropriately directed light source. This scabridity is typical of virtually all SPCL lemmas, in addition to any actual pubescence. The extent of the scabridity (as well as pubescence) is a function of spikelet maturity (cf. 2.1.1 above).

Examination with a good hand lens is not sufficient, and would most likely lead to a determination of SPCOD or SPCOC depending upon general morphological characteristics such as culm base width. See my discussion of the interaction of inconspicuous pubescence and culm base width in section 2.1.2 above.

In short, I interpret all specimens in Table 6 to be SPCL. Although I was in agreement with the experts with only 3 of the 14 items, I note that at least one expert shared my view in five additional items.

Ideally the definitive wet-grain test might be applied to the specimens in this set, if any mature grains could be found.

Table 6. Specimens with neither pubescent nor glabrous (i.e., scabridulous) lemmas, in order of increasing maximum spikelet length.

#	County	Col.ID	MG	SLH	RR	RTH	S^{max}
Not striking, but clear nonglabrous lemma surface.							
110	M1	a	d	d	-	c^{im}	4.3
111	K13	a	a	a	d	c	4.5
119	M13	a	d	d	-	c^{im}	4.6
112	H4	h	d^{im}	d	c	c	4.8
113	K10	a	d	d	c	c	4.8
114	K13	h	d	d	d	c	5
115	K10	h	im	d	vag	c	5.2
116	L5	h	m	m	c	c	5.2
117	K13	a	c	c	c	c^{im}	6.1
118	J10	d	-	-	-	c	6.9
Lengthened scabridity on lemma surface.							
120	K13	pil	c	c	d	c	4.5
121	K13	h	c	c	c	c	4.5
122	L2	h	c	c	c	c	4.8
123	K10	a	d	d	c	c	5.2

3.1.2. Relative Palea/Lemma Length.

A palea longer than the lemma is one characteristic sometimes used to distinguish SPCL. For those SPCL specimens with strong pubescence (Table 5a), the palea was nearly always longer than the lemma, although the difference was sometimes negligible. This was valid for most specimens without strong pubescence (for those agreed by all experts to be SPCL), but not for all. Conversely, for SPCOC specimens (Table 4b), most but not all specimens exhibited longer lemmas.

I do not consider relative palea/lemma length to have decisive significance in the identification of individual specimens.

3.1.3. Lateral lemma nerves.

A faint lateral lemma nerve was observed with a few SPCL specimens, consistent with Riggins 1977 finding (p. 317). A collection of fresh SPCL culms in August (cf. Appendix C) had several lemmas with strong lateral nerves. When present this would seem to be a clear but not very practical indicator of SPCL.

3.2.1. SPVA complex.

I did not succeed in determining any basis for distinguishing SPVA and SPVAO, but SPNE was clearly distinct in having a glabrous floret, floret size and shape, the hairs of lower sheaths were not papillate. There was no serious conflict among the experts on the SPNE determinations, as indicated in Table 7.

Table 7. Results for glabrous (SPNE) specimens.

#	Loc. Code	Col.ID	RR	MG	SLH
1	F14	n	n	*S.sp.*, im	n
2	J4	v	-	n	n
3	J4	n	n	n	n
4	H4	n			
5	M13	n	n	n	n

The determinations for SPVA and SPVAO alongside my findings for lateral lemma nerves and relative glume/floret lengths are shown in Table 8.

4. General Discussion and Speculation.

Prior to B. L. Turner's 2001 decision to eliminate all distinctions of species/varieties within the SPCO complex, the Herbarium's holdings represented a chaotic set of conflicting determinations based upon unclear criteria. They could not reliably serve to provide identification of new material below the SPCO complex level, or even, in several instances, to discriminate between SPCO and SPVA specimens. Although I disagree with that decision as an issue of 'determination,' it was virtually demanded by the opinions and materials in the collection. Analogous problems exist for SPVA/SPVAO determinations, not however for SPNE, within the SPVA complex.

To some extent the existing confusion is the result of specimens that are insufficiently mature to permit clear intersubjective interpretation. Without mature spikelets and grains, the two discriminating features of SPCL will not permit a high degree of certainty.

The apparent confusion may also account for the fact that a high percentage of the most recently collected specimens are those that seem to have the least reliable determinations – i.e., identification possibly derived by matching a plant with some previously determined specimen in the holdings.

Table 8. SPVA/SPVAO Determinations

(v = SPVA, o = SPVAO, c = SPCL, d = SPCOD, g = glumes, f = floret)

#	Loc. Code	Col.ID	RR	MG	SLH	lem. nrvs	glume / floret length
6	L2	v	v	im	v	3	f>=g
7	H3	v	v	v	v	3	f>g
8	O5	v	v	v	v	3	f>g
9	G12	v	-	o	o	3	g<=>f
10	K9	n	v	im	o	3	g<=>f
11	K13	n	v	o	-	3	g<=>f
12	O11	v	-	o	o	3	g<=>f
13	K10	v	v	im	o	3	g<>f
14	K12	v	v	v	v	3	g<>f
15	K13	n	v	o	o	3	g<>f
16	K13	-	-	v	v	3	g<>f
17	L5	v	v	o	o	3	g<>f
18	G8	v	-	o	o	3	g>=f
19	K13	v	v	o	o	3	g>=f
20	K13	v	v	o	o	3	g>f
21	K13	v	v	im	o	3	g>f
22	K13	v	v	o	-	3	g>f
23	K13	n	v	o	-	3	g>f
24	K13	n	v	o	o	3	g>f
25	K13	v	v	o	o	3	g>f
26	L7	v	v	o	o	3	g>f
27	L1	v	-	-	v	3	g>f
28	L2	v	-	-	v	3	g>f
29	M18	n	v	o	o	3	g>f
30	H3	n	v	im	o	3	g>f
31	K13	v	-	-	-	3	g>f
32	L5	v	v	o	o	3	g>f
33	K13	c	v	v	v	3	g2>f
34	H4	v	v	im	o	?	f>g
35	J10	v	-	-	-		f>=g
36	J1	v	v	v	v		f>g
37	J9	v	v	v	v		f>g
38	M13	v	-	-	v		f>g
39	N8	v	v	v	v		f>g
40	O7	c	v	v	v		f>g
41	K6	n	-	-	-		g<>f
42	K9	v	v	v	v		g<>f
43	K13	n	v	v	v		g<>f
44	H3	n	-	-	v		g>=f
45	B13	v	-	v	v		g>f
46	G9	v*	-	-	v		g>f
47	G10	v	-	-	v		g>f
48	J6	v	v	v	v		g>f
49	K12	v	v	im	v		g>f
50	K13	n	v	v	v		g>f
51	O11	v	-	-	v		g>f
52	K13	d	v	im	n		

*determined by W. R. Carr

References

Correll, D. S. & M. C. Johnston 1970, *Manual of the vascular plants of Texas*, Renner.

Diggs, G. M., B. L. Lipscomb & R. J. O'Kennon 1999, *Shinners' and Mahler's illustrated flora of North Central Texas*, Fort Worth.

Gould, F. W 1975, *The grasses of Texas*, College Station.

Hatch, S. L., J. L. Schuster & D. L. Drawe 1999, *Grasses of the Texas Gulf prairies and marshes*, College Station.

Hitchcock, A. S. 1951, *Manual of the grasses of the United States*, Washington, D.C.

Riggens, R. 1977, "A biosystematic study of the *Sporobolus asper* complex (Gramineae)," Iowa State Journal of Research 51:287-321.

Appendix A: Specimen Numbers from Tables 4-6 and Corresponding Collection Information.

#	Loc. code	County	Collector	Col. No.
1	K13	Travis	Higdon	34
2	J4	Grayson	Correll&Correll	26648
3	K10	Bell	Gould	8878
4	G10	Kerr	Gould&Roy	11778
5	J4	Grayson	Correll&Correll	26647
6	J7	Denton	Gould	10293
7	O13	Walker	Correll	38113
8	P12	Brazoria	Rogers	6570
9	K1	Comanche	Hill	9266
10	M6	Hunt	Sanders	3915
11	M13	Dallas	Killian	
12	K10	Bell	York	53080
13	K13	Travis	Warnock	W-1026
14	M13	Dallas	Lundell	12012
15	M5	Collin	Tharp	40
16	K13	Travis	Moon	130
17	K8	McLenno	Gould	10273
18	L2	Hays	Harms	19
19	M6	Hunt	Sanders	3908
20	G7	Kimble	Gould	9684
21	G8	Gillespie	Barkley	14510
22	G9	Blanco	Oefinger	285
23	K13	Travis	Brown	3476
24	K13	Travis	Harms	21
25	K9	Burnet	Webster & Rogers	6466
26	M13	Dallas	Lundell	11978
27	M13	Dallas	Lundell	12020
28	M6	Hunt	Sanders	3916
29	F3	Wilbarger	Correll	30391
30	M13	Dallas	Lundell	12020
31	J2	Montague	Gould&Roy	11747
32	M2	Lamar	Brown	3449
33	J9	Parker	Tracy	8234
34	L5	Bastrop	Silveus	2397
35	P9	Aransas	Tharp	7921
36	O10	Angelina	MCJohnston	7130
37	K6	Lampasas	Hatch	5810
38	K6	Lampasas	Hatch	5826
39	J8	Palo Pinto	Correll&Correll	24119
40	H4	Bexar	Silveus	2151
41	B20	Collingsworth	Gould&Thomas	7735
42	M13	Dallas	Fleetwood	9952
43	C17	Dickens	Correll &Johnston	24186
44	L5	Bastrop	Silveus	2395
45	N8	Brazos	Parks	s.n.
46	O5	Anderson	Marsh	37
47	L5	Bastrop	Tharp	49005
48	N5	Robertson	Gould	11047
49	M11	Morris	Correll	26335
50	K13	Travis	Higdon	15
51	M24	Gregg	York	
52	O10	Angelina	Gould	12444
53	L5	Bastrop	Duval	359
54	L5	Bastrop	Duval	359
55	M2	Lamar	Tharp & Brown	3452
56	O10	Angelina	Gould	7299
57	O5	Anderson	Marsh	312
58	N8	Brazos	Parks	s.n.
59	O13	Walker	Correll	31957

60	G9	Blanco	Silveus	5456
61	G9	Blanco	Dunlap	35
62	K3	Hamilton	Gould	12436
63	K13	Travis	Hidgon	
64	K13	Travis	Tharp	5119
65	M3	Red River	Tharp	
66	P7	San Patricio	Jones	4295
67	K13	Travis	Carr	14917
68	L8	Fayette	Ripple	51-1038
69	F19	Brown	Carr	14222
70	K13	Travis	Carr	3516
71	K7	Coryell	Gould	7698
72	M1	Fannin	Correll	37873
73	P13	Galveston	Waller	3269
74	K13	Travis	Brown	3397
75	K13	Travis	Tharp	43242
76	O11	San Augustine	Orzell&Bridges	8402
77	O7	Nacogdoches	Brown	3432
78	G7	Kimble	Silveus	741
79	L2	Hays	Harms	18
80	K13	Travis	Harms	20
81	K13	Travis	Edwards	
82	N3	Freestone	Do	282
83	L8	Fayette	Ripple	51-1058
84	P1	Victoria	Mayfield	1574
85	O17	Tyler	MCJohnston	7005
86	P12	Brazoria	Fleetwd	10696
87	G6	Llano	Butterwick & Lamb	3366
88	H10	Karnes	Johnson	988
89	N8	Brazos	Parks	s.n.
90	G6	Llano	Butterwick & Lamb	3366
91	O11	San Augustine	Correll	26257
92	M4	Bowie	Letterman	[1894]
93	M4	Bowie	Tharp	4777
94	G9	Blanco	Lemke	707
95	J10	Tarrant	Tracy	8209
96	J5	Jack	Gould	10286
97	K13	Travis	Brown	3470
98	M1	Fannin	Correll	23496
99	G9	Blanco	Oefinger	340
100	J9	Parker	Tracy	8226
101	K10	Bell	Silveus	6418
102	O13	Walker	Correll	31948
103	G3	San Saba	Gould	8439
104	K9	Burnet	Silveus	6418
105	M13	Dallas	Lundell	12044
106	K10	Bell	York	53149
107	M24	Gregg	York	s.n.
108	P9	Aransas	Fleetwd	9316
109	P6	Liberty	Brown	18202
110	M1	Fannin	Correll	23495
111	K13	Travis	Tharp	51-523
112	H4	Bexar	Silveus	315
113	K10	Bell	York	53147
114	K13	Travis	Tharp	
115	K10	Bell	Allen	
116	L5	Bastrop	Boy	
117	K13	Travis	Brown	3474
118	J10	Tarrant	Carr	14817
119	M13	Dallas	Correll	22583
120	K13	Travis	Gould	5333
121	K13	Travis	Tharp	3078
122	L2	Hays	Gould	6697
123	K10	Bell	Gould	12417

Appendix B: Specimen Numbers from Tables 7-8 and Corresponding Collection Information.

#	Loc. Code	County	Collector	Col. No.
1	F14	Taylor	Tolstead	7747
2	J4	Grayson	C&C	26643
3	J4	Grayson	Riggins	396
4	H4	Bexar	Edwards	
5	M13	Dallas	Hynes	
6	L2	Hays	Johnson	412-B
7	H3	Medina	Silveus	2465
8	O5	Anderson	Marsh	
9	G12	Bandera	Silveus	7271
10	K9	Burnet	Rogers & Webster	6466
11	K13	Travis	Higdon	114
12	O11	San Augustine	Correll	26252
13	K10	Bell	York	53079
14	K12	Williamson	Gould	8127
15	K13	Travis	Warnock	W1028
16	K13	Travis	Tharp	-1927
17	L5	Bastrop	Riggins	483
18	G8	Gillespie	Barkley	14511
19	K13	Travis	Young	
20	K13	Travis	Allen	
21	K13	Travis	Normand	5118
22	K13	Travis	Lynch	
23	K13	Travis	Moon	172
24	K13	Travis	Gould	6698
25	K13	Travis	Young	
26	L7	Gonzales	Tharp et al	49006
27	L1	Comal	Lemke	755
28	L2	Hays	Dunlap	138
29	M18	Van Zandt	Kral	290
30	H3	Medina	Silveus	1592
31	K13	Travis	Carr	6155
32	L5	Bastrop	Riggins	481
33	K13	Travis	Gould	5334
34	H4	Bexar	Silveus	323
35	J10	Tarrant	Carr	14846
36	J1	Clay	Deam	2460
37	J9	Parker	Tracy	8225
38	M13	Dallas	Lundell	11970
39	N8	Brazos	Parks	
40	O7	Nacogdoches	Goss	61
41	K6	Lampasas	Hatch	5824
42	K9	Burnet	Gould	8373
43	K13	Travis	Brown	3402
44	H3	Medina	Silveus	3640
45	B13	Carson	MCJ, Walker	6808
46	G9	Blanco	Oefinger	338
47	G10	Kerr	Hatch	4712
48	J6	Wise	Gould	11736
49	K12	Williamson	Gould	8366
50	K13	Travis	Rogers	6521
51	O11	San Augustine	Orzell & Bridges	8398
52	K13	Travis	Painter	

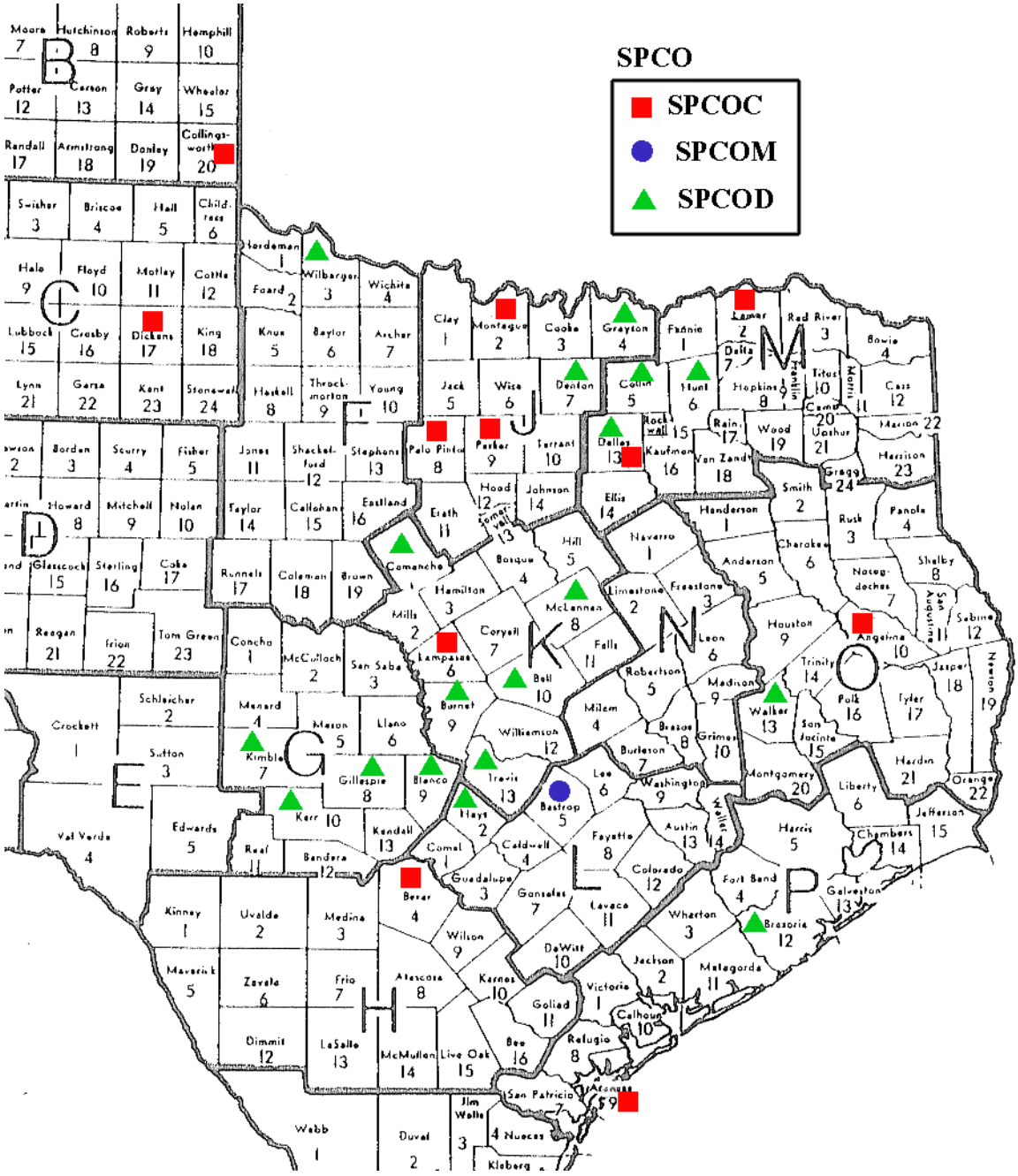
Appendix C. Survey of SPCL culms with inflorescences collected on 8/4/02 in N. Hays Co.

hght cm	wdth mm	infl lngth cm	spikelet lengths mm	notes
-	-	14.5	4.3, 4.5 (some smaller)	pub at base mostly on one side only, many fl disart, most brown, no l have green mid nrv 1 longer spikelet - 4.4 - reddish l, s1 at top, clear pub at mid, less at bot second longer spikelet (4.5) is sim.
-	-	37	5.2	1 loose spikelet, pub only at bot, essentialy only on 1 side (few on other) - also had ovary lower spikes had set im. seeds low spike had fl with stigma fresh and anthers old 1 spikelet: s1 at top with pub under g1/g2 1 has clear (not green) lat nerve (mid nerve also tan) top spike & most of next spike down had only dry aborted spikelet (c. 15 cm)
37	1.6	5	5.7	most disart, s1 over whole l, min pub on one side only, central
39	1.4	8	7.2, 6.0, 8.2	very long spikelet - to 8.2, spikelet min scab at top, glabr. below
39	1.0	9	4.5	clear p at base, s2 top -> mat. grain
46	1.1	8	4.5	bot sparse pub, top s3
47	1.2	7.5	5.3	few ap. pub at base, fine grainy scabr textr, at top, pub is vis at 1X, pal. totally enclosed pre-anthesis- anthers only beg. to form on lower spikelet, l has clear granular textr, esp in mid to lower - at 1X no pub vis. (perhaps one tiny hair), textr appears as minute scab. role of lighting was significant - if strong, seems completely glab.
47	1.0	10.5	8.3	tiny circular s1 at top, few hairs at edge of g1 at bot
48	1.4	9	6.5, 6.2	s1 at top, sparse hairs at mid, pub at base
48	1.4	8	8.9	min s1 at top, pub at base
51	1.1	15	5.3. 6.8	spikelet@5.3, glab @ top 2/3, min s1 at bot max spikelet 6.8, mid 5.3, term!= 3.5 -> virtually glab most have disart. one l has a few hairs at top - most l are glab with widely scattered weak s1
52	1.4	8.5	6.0 term	very heavy pub on pal nerve - same for #17 term spikelet has lat nrv, pre-anth, ap pub on only one side in central, not top/bot - no clear scabr at top - pretty glab.
52	0.7	10	6.2	prior to anth, l has lat nrv, s1 at top 1 l has clear green lat nrv, s1 at top, else glab.
56	1.7	8.5	8.1	s1+ at top, sparse hairs at bot.
56	1.5	14	5/9, 5.5, 5.0 (w. mat.grain)	pub at base
91	1.8	24.5	4.4, 5.6, 6.2, 4.0, 3.3 (shth)	min scab/pub
91	1.8	21		
122	2.2	34	5.5, 8.0	pub. lower 2/3, s1- at top/ pal nrvs very pub one 8.0 l had very strong lat nerve, no sign of pub, min s1 at top

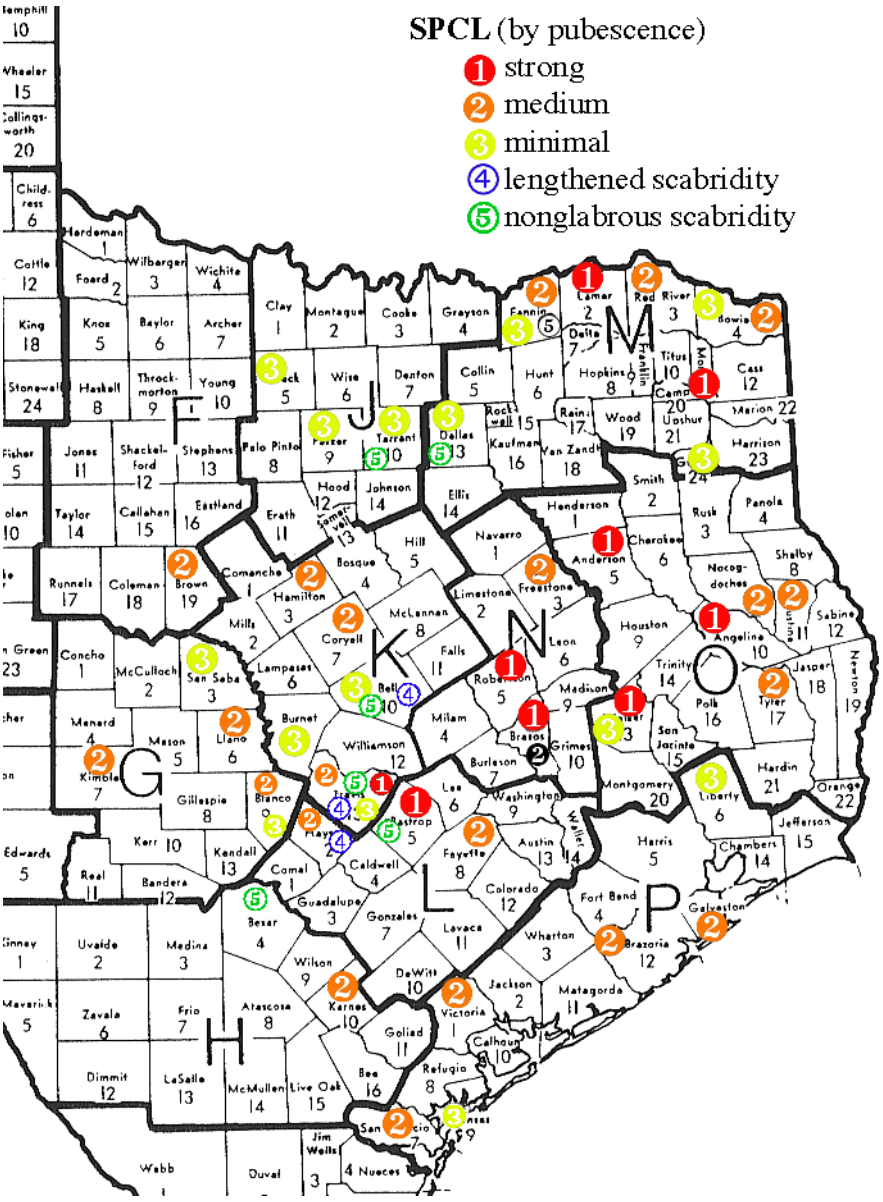
Note: Lemma scabridity was ranked from 's1' (smallest) to 's3'.

Appendix D. Distribution of Texas Specimens.

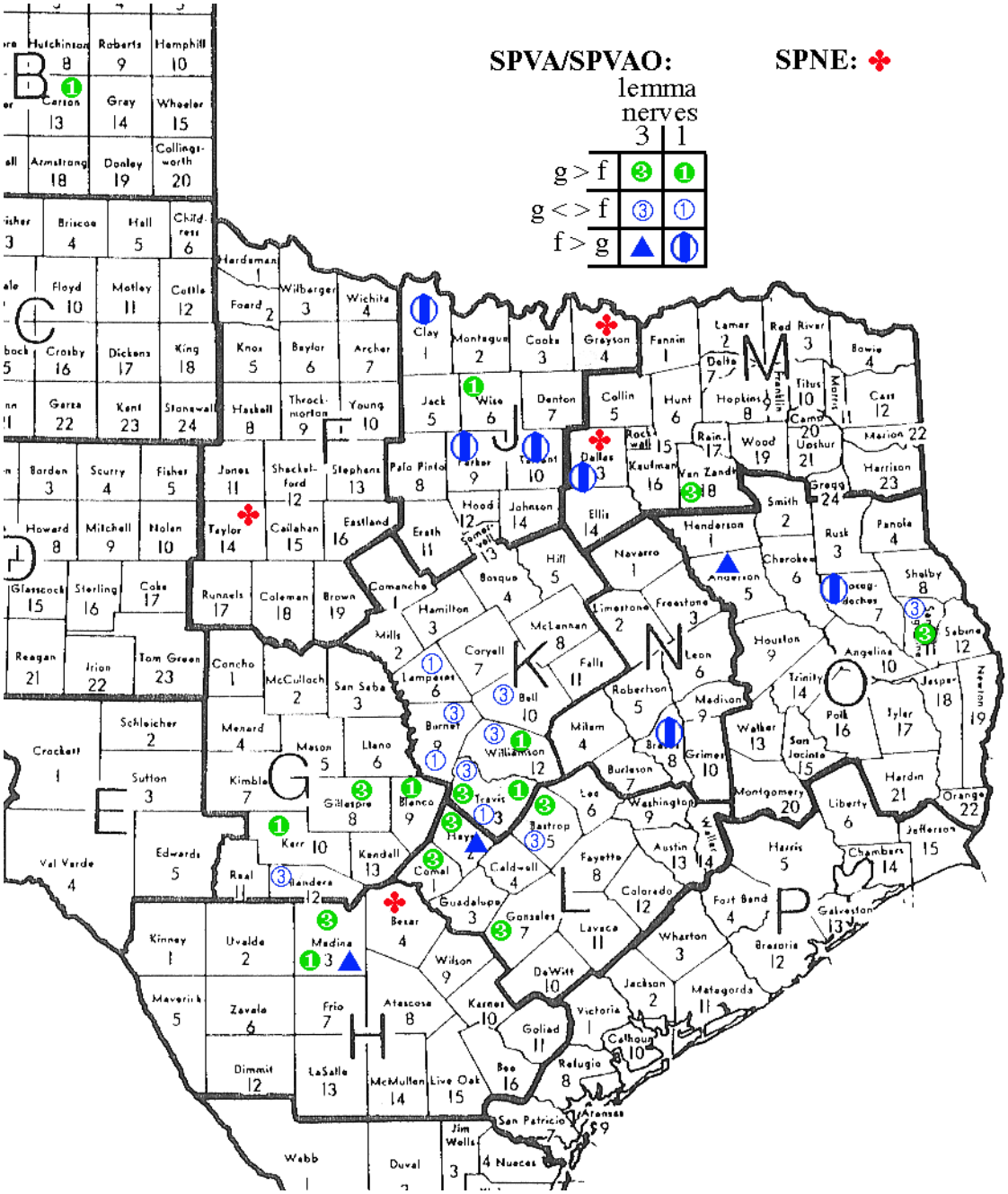
Map 1. Distribution of *Sporobolus compositus* by variety:



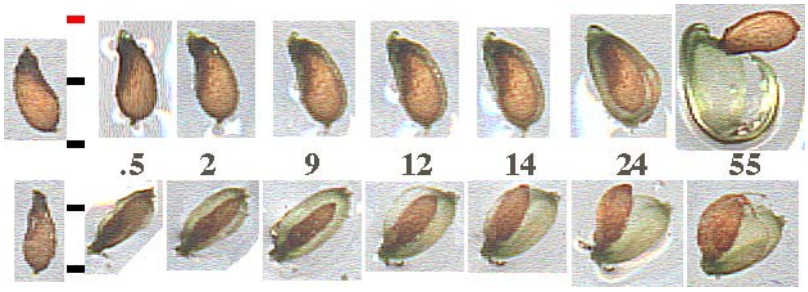
Map 2. Distribution of *Sporobolus clandestinus* by Pubescence Type:



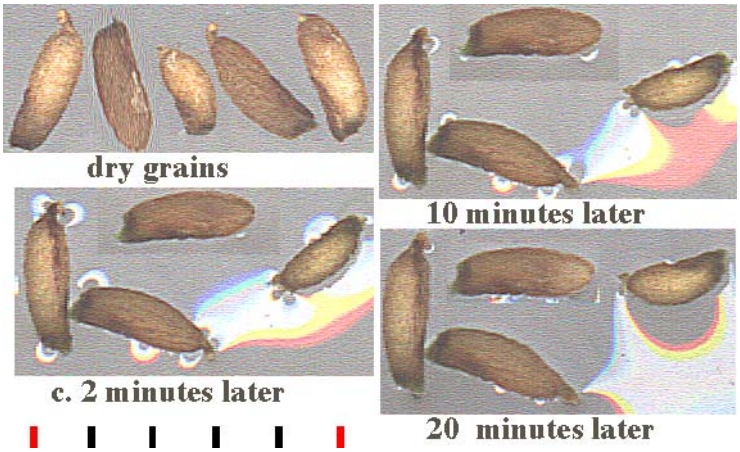
Map 3. Distribution of *Sporobolus vaginiflorus and Sporobolus neglectus*.
(g = glumes, f= floret)



Appendix E. The Wet Grain Test.



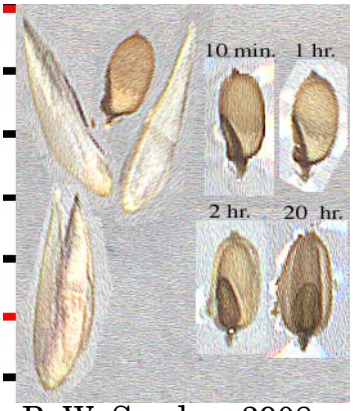
Sporobolus compositus var. *drummondii*, effect of water on two grains at intervals of 0.5, 2, 9, 12, 14, 24, and 55 minutes. The two grains shown were selected to illustrate extremes in variation of this process, the lower being more typical. Dry grains are shown at left. The pericarp of the lower grain has begun to become gelatinous after 30 seconds; the upper grain doesn't show significant change until nearly 9 minutes have passed. Although the grains were not agitated in any way, the gelatinous pericarps of both grains had slipped loose at the 55 minute point.



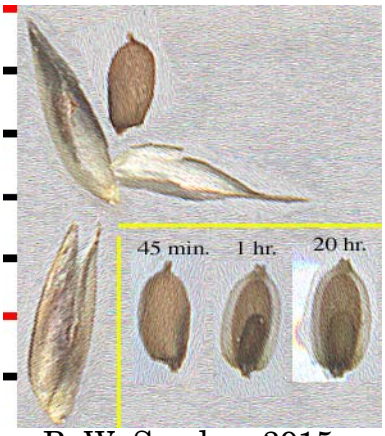
Sporobolus clandestinus, effect of water on four grains at intervals of 2, 10 and 20 minutes. No visible effect on the pericarp resulted. Left to imbibe, these same grains were germinating after 44 hours (below).

Appendix F. The Wet Grain Test with Older Specimens.

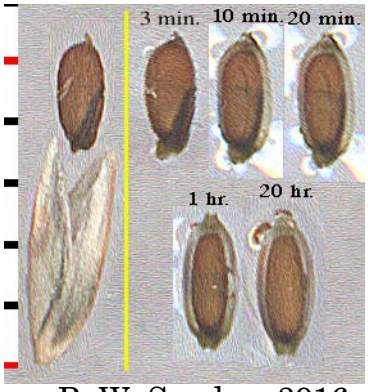
Swelling of the wetted pericarp for SPCOD3 and SPCOC2 diminishes with the age of the specimen. After 35 years it may no longer provide a reliable test for distinguishing SPCL from the SPCO complex..



R. W. Sanders 3908
SPCOD3



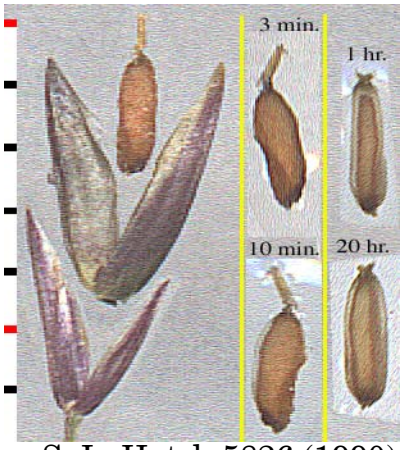
R. W. Sanders 3915
SPCOD3



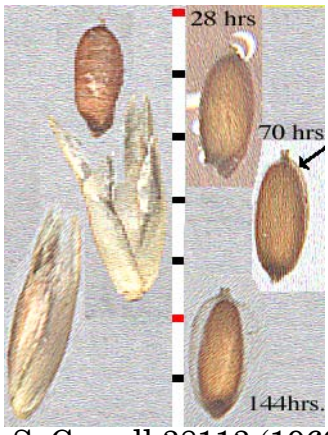
R. W. Sanders 3916
SPCOD3

The above SPCOD3 grains collected in 1995 and the SPCOC2 (1990) grain below clearly show the gelatinous transformation of the pericarp, although even after several days of immersion, the pericarp did not slip free as is noted with fresh and year-old specimens in Appendix E. After some 30 years the swelling effect is much reduced but still discernable, as with the SPCOD3 (1969) grain below (Correll 38113).

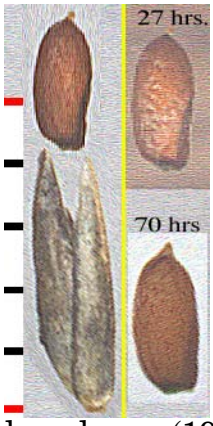
And the effect emerges much more slowly with older grains; first appearing with Sanders 3916 and Hatch 5826 after 10 minutes; Sanders 3915, one hour; Sanders 3908, two hours; and with Correll 38113, only after several days.



S. L. Hatch 5826 (1990)



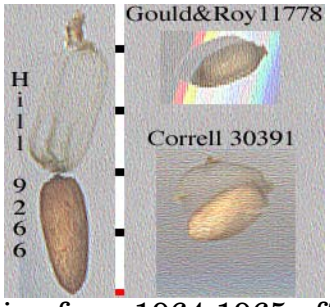
D. S. Correll 38113 (1969)



G. Edwards s.n. (1974)

If older grains do exhibit this feature, SPCL can safely be excluded; but if wetting produces no effect, SPCL may not so easily determined. Grains of Do 282 (1994), Carr 3516 (1981) and Edwards s.n. (1974; shown above) did not react to immersion in rainwater after 4 days. Given that specimens from 1964 (Correll 30391) and 1965 (Gould & Roy 11778, Hill 9266) exhibited both swelling and release of the pericarp after 3 days (shown below), I would feel confident assigning the above nonreactive cases to SPCL on this basis alone; but less so with specimens older than 35 years. [It is worth noting here that in my opinion

the above three holdings can also be assigned to SPCL on the basis of pubescence and spikelet size.]



SPCOD3 grains from 1964-1965 after 71 hours.

The lack of a reaction with the Correll & Correll specimens from 1961 and 1962 (below) after several days of immersion might seem to indicate 40 years as an upper limit.

Grains from 1961 and 1962,
collected by D. S. Correll & H. B. Correll
(SPCOC2: 24119, 7/27/1961; SPCOD3: 26648, 11/4/1962)