

VARIABILITY IN MORPHOLOGICAL CHARACTERS OF DIFFERENT TAXONS OF THE GENUS *Stylosanthes* Sw. (LEGUMINOSAE - PAPILIONOIDEAE)*

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ABSTRACT

The objective of the present study was to obtain basic information on intra- and inter-specific variability of different morphological traits in seven species and three varieties of the genus *Stylosanthes* Sw.

Nineteen taxonomically important morphological traits were measured and the data statistically analyzed.

The results showed that: 1) there is ample variability within and among species and varieties in terms of measurable vegetative, floral and fruit characters, indicating a considerable capacity of adaptation to different environments; 2) traits analyzed by numerical taxonomy provide a clearer differentiation of the species, establishing more precisely the evolutionary lines of the genus; 3) the variability of the varieties *microcephala*, *canescens* and *vulgaris* is as wide as that observed within and among the different species. Therefore, it is not possible to establish a differentiating criterion for species and varieties; 4) the dimorphism of the lomentum (one or two joints) is an adaptative character and indicates phylogenetic connection among species.

INTRODUCTION

The genus *Stylosanthes* Sw. belongs to the family Leguminosae which is one of the largest in the plant kingdom. Bogdan (1977) classified the genus *Stylosanthes*

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Sw. as one of the most important for pasture formation in tropical regions due to the wide natural species variability, a very important trait for breeding programs. According to Tuley (1968), Leitão Filho and Lovadini (1974), Barros (1978) and Barriga (1979), *Stylosanthes* species exhibit marked polymorphism in several traits such as growth habit, branch distribution, branch diameter, foliole shape, foliole size and color, number of flowers per inflorescence, seed color, dry matter yield, etc. Because of its wide intra- and interspecific variability due to genetic factors, the species has a great potential for environmental and ecologic adaptation, which makes it suitable for pastures in different geographical situations.

To obtain basic information on different species and varieties of *Stylosanthes* Sw., we estimated variability among and within different taxons by analyzing statistically measurements of vegetative, floral and fruit characters.

MATERIAL AND METHODS

The present study was carried out at the Experimental Station of ESALQ/USP, Genetics Department, Anhembi, Piracicaba, SP.

Seven species and three varieties of the genus *Stylosanthes* Sw. from different geographical and ecological regions of Minas Gerais, Rio de Janeiro and Goiás were used (Table I). A random block design was used, with 12 repetitions for each species and variety. Each plot was formed by two plants. Three measurements of the following traits were made on each plant: length and width of central foliole, right foliole, stipule, vexillum, wing, upper and lower articulate fruit; length of tooth, internode, peduncle, calyx and terminal appendix.

Table I - List of the species and varieties used.

Species	Origin
<i>S. capitata</i> Vog.	Itaguaí - RJ
<i>S. macrocephala</i> Ferreira e Costa	Betim - MG
<i>S. scabra</i> Vog.	Itaguaí - RJ
<i>S. grandifolia</i> Ferreira e Costa	Montes Claros - MG
<i>S. humilis</i> H.B.K.	Mozarlândia - GO
<i>S. gracilis</i> H.B.K.	Montes Claros - MG
<i>S. viscosa</i> Sw.	Uberaba - MG
<i>S. guianensis</i> (Aubl.) Sw. var. <i>microcephala</i> Ferreira e Costa	Santo Antonio do Monte - MG
<i>S. guianensis</i> (Aubl.) Sw. var. <i>canescens</i> Ferreira e Costa	Barbacena - MG
<i>S. guianensis</i> (Aubl.) Sw. var. <i>vulgaris</i> Ferreira e Costa	Divinópolis - MG

Analysis of variance was employed to estimate the degree of uniformity and diversification among species and varieties. Because number of plants is variable in each species (P), the mean number of plants (P_0) was estimated according to Snedecor and Cochran (1974).

For joint analysis of variance among plant traits within species, the data from the *microcephala*, *canescens* and *vulgaris* varieties were considered as from one species.

RESULTS AND DISCUSSION

The results in Tables II through VIII show that the traits studied vary widely among species and varieties. This supports the theory of Leitão Filho and Lovadini (1974), who concluded that *Stylosanthes* Sw. species are markedly polymorphic for different traits and also present wide intra- and interspecific variability due to genetic factors and environmental adaptation.

All species and varieties showed more variability in the vegetative than in the floral or fruit traits. However, the quantitative traits of these species and varieties were considerably similar, indicating past phylogenetic interrelationships.

The three varieties of *S. guianensis* (*microcephala*, *canescens* and *vulgaris*) showed reasonable variability in most of the measurable traits studied. All the other traits were significantly different among varieties, suggesting the occurrence of a gradual differentiation process.

When an attempt was made to differentiate species from varieties based on collected data, problems arose with respect to the criterion to be used for species differentiation, because of the wide variability of all measurable traits.

Particularly interesting is the lomentum with one or two joints. *S. macrocephala*, *S. humilis*, *S. guianensis* var. *microcephala*, *S. guianensis* var. *canescens* and *S. guianensis* var. *vulgaris* only have one upper joint per lomentum, whereas Ferreira and Costa (1979) have reported two joints per lomentum for *S. macrocephala*, and Bogdan (1977) and Barriga (1979) found two joints per lomentum for *S. humilis*. This trait is variable within species and also has adaptive value. *S. humilis* exhibits a lomentum with a well developed and terminal appendix that probably plays an important role in species distribution by adhering to the body of animals.

CONCLUSIONS

There is wide variability within and among each species and varieties for all measurable vegetative, floral and fruit traits, suggesting a considerable capacity for environmental adaptation.

Table II - Individual analysis of variance and joint analysis of variance of some vegetative traits of the species *S. capitata* (E₁), *S. macrocephala* (E₂), *S. scabra* (E₃), *S. grandifolia* (E₄), *S. humilis* (E₅), *S. gracilis* (E₆), *S. viscosa* (E₇) and *S. guianensis*.

Sources of variation	Leaves																	
	Internodes				Central foliole				Right foliole				Stipule		Tooth			
	length (mm)	DF	MS	DF	MS	length (mm)	DF	MS	DF	MS	length (mm)	DF	MS	DF	MS	length (mm)	DF	MS
Plants/E ₁	4	146.40	6	136.44**	6	20.71**	6	76.41**	6	20.38**	6	7.24	4	1.62	4	1.62	6	7.81**
Plants/E ₂	26	418.73**	26	72.18	26	9.01**	26	52.26**	26	7.47**	26	5.15**	16	1.22**	16	1.22**	26	4.00**
Plants/E ₃	15	26.08	4	105.83**	4	21.07**	4	67.23**	4	10.50**	4	11.15*	4	2.35	4	2.35	4	8.85*
Plants/E ₄	1	16.67	3	26.78	3	3.86*	3	15.86*	3	4.31**	3	5.46*	3	1.12	3	1.12	3	1.12
Plants/E ₅	29	117.17	30	44.91**	30	1.62**	30	39.63**	30	1.26**	30	1.95**	30	0.96**	30	0.96**	30	1.27**
Plants/E ₆	30	63.72*	30	152.75**	30	17.28**	30	135.37**	30	16.86**	30	13.35**	30	1.89**	30	1.89**	30	3.81**
Plants/E ₇	36	69.83	36	35.17**	36	4.97**	36	27.28**	36	3.97**	36	2.72**	36	1.40**	36	1.40**	36	2.01**
Among/species	7	16278.61**	7	3237.05**	7	300.29**	7	2760.77**	7	228.18**	7	461.43**	7	37.86**	7	37.86**	7	66.82**
Among/plants/ species	232	138.12**	226	71.72**	226	8.81**	226	54.92**	226	6.47**	226	5.51**	226	1.58**	226	1.58**	226	489.36**
Among/measur./ plants/species	484	68.85	472	10.95	472	4.51	472	9.87	472	1.02	236	1.04	236	0.53	236	0.53	236	156.50

*Significant at the 0.05 level; **significant at the 0.01 level.

Table III - Individual analysis of variance and joint analysis of variance of some floral traits of *S. capitata* (E₁), *S. macrocephala* (E₂), *S. scabra* (E₃), *S. grandifolia* (E₄), *S. humilis* (E₅), *S. gracilis* (E₆), *S. viscosa* (E₇) and *S. guianensis*.

Source of variation	Vexillum			Wing			Peduncle			Calyx		
	length (mm)		width (mm)	length (mm)		width (mm)	length (mm)		length (mm)		length (mm)	
	DF		DF	DF		DF	DF		DF		DF	DF
Plants/E ₁	6	0.48	6	0.57	6	0.64*	6	0.40*	6	2.24*	6	0.40
Plants/E ₂	17	6.22**	17	3.12**	17	2.06**	17	0.90**	17	1.22	17	1.30*
Plants/E ₃	3	0.67*	3	1.12*	3	0.67*	3	0.12	2	0.50	3	0.12
Plants/E ₄	4	0.35	4	1.15*	4	0.00	4	0.40	4	0.75	4	0.00
Plants/E ₅	11	0.64	11	1.31**	11	0.40*	11	0.41*	11	0.95**	11	0.26
Plants/E ₆	27	0.56**	27	0.57**	27	0.28*	27	0.31**	27	1.21	27	0.46
Plants/E ₇	30	0.49**	30	0.65**	30	0.83**	30	0.48**	30	0.76**	30	0.07
Among/species	7	164.06**	7	31.31**	7	46.66**	7	5.73**	7	47.61**	7	28.10**
Among/plants/ species	189	1.40**	189	1.10**	189	0.74**	189	0.42**	188	1.82**	189	0.40**
Among/measur./ plants/species	199	0.73	199	0.22	199	0.14	199	0.09	198	0.70	199	0.25

*Significant at the 0.05 level; **significant at t

Table IV - Individual analysis of variance and joint analysis of variance of some fruits traits of the species: *S. capitata* (E₁), *S. macrocephala* (E₂), *S. scabra* (E₃), *S. grandifolia* (E₄), *S. humilis* (E₅), *S. gracilis* (E₆), *S. viscosa* (E₇) and *S. guianensis*.

Source of variation	Upper article			Lower article			Terminal appendix			
	length (mm)		width (mm)	length (mm)		width (mm)	length (mm)			
	DF	MS	DF	MS	DF	MS	DF	MS	DF	MS
Plants/E ₁	4	0.43	5	0.00	5	0.35	5	0.2222	4	0.60**
Plants/E ₂	20	0.35**	20	0.55**	-	-	-	-	18	0.61**
Plants/E ₃	27	0.6**	27	0.15	16	0.68**	16	0.18	27	1.49**
Plants/E ₄	5	0.27	5	0.00	5	0.22**	5	0.50	5	0.37
Plants/E ₅	17	0.36**	17	0.45**	-	-	-	-	10	0.02
Plants/E ₆	24	0.36*	24	0.24	25	0.62**	25	0.16	23	0.30
Plants/E ₇	21	0.13**	21	0.08*	15	0.48**	14	9.77	13	1.10**
Among/species	7	12.38**	7	13.34	4	14.77**	4	1.75**	6	187.51**
Among/plants/ species	202	0.26**	209	0.26**	66	0.55**	65	2.28**	100	0.77**
Among/measur./ plants/species	438	0.13	438	0.14	142	0.17	140	2.04	214	0.18

*Significant at the 0.05 level; **significant at t

Table V - Joint analysis of variance of some vegetative traits of 3 varieties of *S. guianensis*: *S. guianensis* var. *microcephala*, *S. guianensis* var. *canescens* and *S. guianensis* var. *vulgaris*.

Source of variation	Leaves																
	Internodes			Central foliole			Right foliole			Stipule			Tooth				
	length (mm)			length (mm)	width (mm)	width (mm)	length (mm)	width (mm)	width (mm)	length (mm)	width (mm)	length (mm)					
	DF	MS		DF	MS	DF	MS	DF	MS	DF	MS	DF	MS				
Among/ varieties	2	15456.83**		2	1767.80**	2	295.25**	2	550.78**	2	46.71**	2	75.94**	3	123.03**	2	11.81**
Among/ plants/ varieties	91	135.6**	91	63.88**	91	8.69	91	44.45**	91	4.45**	91	4.94**	91	1.83**	91	1.06**	
Among/ measur./ plants/ varieties	188	72.63	188	7.30	188	9.11	188	9.23	188	0.89	188	1.0	94	0.44	94	0.74	

*Significant at the 0.05 level; **significant at the 0.01 level.

Table VI - Joint analysis of variance of some floral traits of 3 varieties of *S. guianensis*: *S. guianensis* var. *microcephala*, *S. guianensis* var. *canescens* and *S. guianensis* var. *vulgaris*.

Source of variation	Vexillum			Wing			Peduncle			Calyx		
	length (mm)		width (mm)	length (mm)		width (mm)	length (mm)		width (mm)	width (mm)		MS
	DF	MS	DF	MS	DF	MS	DF	MS	DF	MS	DF	MS
Among/ varieties	2	0.51105	2	52.2524**	2	16.8302**	2	5.3484**	2	29.4571**	2	7.4287**
Among/ plants/ varieties	91	1.2724**	91	1.0415**	91	0.6945**	91	0.3639**	91	2.4220**	91	0.3645
Among/ measur./ plants/ varieties	94	0.6153	94	0.2014	94	0.1436	94	0.1190	94	0.7766	94	0.2647

*Significant at the 0.05 level; **significant at the 0.01 level.

Table VII - Joint analysis of variance of some fruit traits of three varieties of *S. guianensis*: *S. guianensis* var. *microcephala*, *S. guianensis* var. *canescens* and *S. guianensis* var. *vulgaris*.

Source of variation	Article			
	Length (mm)		Width (mm)	
	DF	MS	DF	MS
Among/varieties	2	12.12**	2	0.65
Among/plants/varieties	91	0.12**	91	0.26**
Among/measur./plants/varieties	188	0.08	188	0.17

**Significant at the 0.01 level.

Trait analysis by numerical taxonomy provides a clearer differentiation of the species and helps establish the evolutionary lines of the genus in a more precise manner.

The variability of the varieties *microcephala*, *canescens* and *vulgaris* is as wide as that observed within and among the different species. Therefore, it is not possible to establish a differentiating criterion for species and varieties.

The dimorphism of the lomentum (one or two joints) is an adaptative trait and indicates phylogenetic connection among species.

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RESUMO

O objetivo deste trabalho foi obter informações básicas sobre a variabilidade intra- e interspecífica em diferentes caracteres morfológicos de sete espécies e três variedades do gênero *Stylosanthes* Sw.

Dezenove caracteres, considerados importantes para a taxonomia, foram medidos e analisados estatisticamente.

Os resultados permitiram concluir: (1) existe uma considerável variabilidade dentro e entre as espécies e variedades para os caracteres mensuráveis vegetativos, florais e do fruto, indi-

Table VIII - Evaluation of means (\bar{X}) and standard deviation (S).

	Leaves						Flowers						Fruits							
	Central foliole		Right foliole		Stipule		Tooth		Internodes		Vexillum		Wing		Calyx Peduncle		length (mm)		width (mm)	
	length (mm)	width (mm)	length (mm)	width (mm)	length (mm)	width (mm)	length (mm)	width (mm)	length (mm)	width (mm)	length (mm)	width (mm)	length (mm)	width (mm)	length (mm)	width (mm)	length (mm)	width (mm)	length (mm)	width (mm)
<i>S. capitata</i>	\bar{X}	18.79	8.62	15.26	6.76	7.93	7.64	4.71	39.00	4.79	4.57	3.71	1.93	2.57	6.43	3.07	3.23	1.30	2.04	2.45
	S	6.38	2.63	4.89	2.48	1.90	0.90	1.98	6.77	0.49	0.53	0.57	0.45	0.45	1.06	0.28	0.39	0.46	0.11	0.51
<i>S. macrocephala</i>	\bar{X}	15.50	5.75	14.25	4.59	7.63	4.88	4.13	29.50	4.40	4.20	4.00	1.70	2.00	7.00	3.67	-	1.50	2.00	-
	S	2.98	1.13	2.38	1.20	1.65	0.75	0.75	1.65	0.42	0.76	0.00	0.45	0.00	0.61	0.30	-	0.35	0.00	-
<i>S. scabra</i>	\bar{X}	15.25	6.52	12.65	4.83	6.82	5.37	3.15	38.51	3.84	4.26	3.02	1.76	2.41	4.07	2.93	2.97	1.65	2.21	2.13
	S	7.18	2.63	6.69	2.38	2.58	0.97	1.38	4.68	0.52	0.54	0.31	0.37	0.48	0.76	0.33	0.44	0.30	0.29	0.19
<i>S. grandifolia</i>	\bar{X}	32.17	10.12	29.46	8.83	14.48	6.15	6.69	56.82	10.20	6.53	6.36	2.58	4.81	5.86	3.10	3.89	0.93	2.53	2.56
	S	5.02	1.73	4.32	1.60	1.84	0.82	1.46	11.63	1.78	1.31	1.03	0.67	0.81	1.05	0.35	0.27	0.22	0.42	0.35
<i>S. humilis</i>	\bar{X}	17.63	5.27	15.40	4.27	6.20	4.40	4.10	20.47	3.50	3.38	2.50	1.13	2.63	4.50	3.48	-	5.11	2.07	-
	S	5.98	2.66	4.74	1.88	1.89	1.08	1.29	2.86	0.58	0.75	0.58	0.25	0.95	0.50	0.46	-	0.72	0.22	-
<i>S. gracilis</i>	\bar{X}	23.15	3.65	20.20	3.19	12.29	7.03	5.44	40.90	4.50	4.21	3.54	1.75	2.58	4.04	2.83	2.42	0.15	2.02	1.95
	S	3.87	0.13	3.43	0.68	0.99	0.69	0.78	5.40	0.56	0.81	0.45	0.45	0.36	0.69	0.38	0.48	0.12	0.31	0.22
<i>S. viscosa</i>	\bar{X}	12.97	5.49	11.24	4.34	6.53	4.80	39.10	33.00	3.89	3.52	2.97	1.39	2.08	3.10	2.06	2.16	0.66	1.94	1.84
	S	3.42	1.29	3.10	1.15	1.17	0.86	0.99	4.68	0.50	0.57	0.63	0.49	0.18	0.63	0.33	0.40	0.60	0.17	0.28
<i>S. guianensis</i> var. <i>microcephala</i>	\bar{X}	19.60	4.67	16.08	3.72	8.69	4.35	4.63	30.99	3.65	3.78	3.15	1.65	2.32	4.18	2.94	-	1.71	-	-
	S	3.73	0.93	3.07	0.87	1.23	0.91	0.73	6.74	0.57	0.50	0.52	0.46	0.48	0.91	0.18	-	0.27	-	-
<i>S. guianensis</i> var. <i>canescens</i>	\bar{X}	26.41	8.20	21.57	6.36	9.99	6.94	4.29	41.24	5.29	5.15	3.87	2.10	2.98	5.37	3.00	-	0.92	1.67	-
	S	6.64	1.83	4.47	1.45	1.89	0.96	0.84	6.61	1.00	0.85	0.89	0.64	0.36	1.27	0.11	-	0.40	0.33	-
<i>S. guianensis</i> var. <i>vulgaris</i>	\bar{X}	20.45	7.29	16.49	5.71	7.87	5.90	3.62	40.49	4.35	3.72	3.48	2.00	2.68	4.46	2.89	-	1.83	-	-
	S	4.00	1.46	3.15	1.12	1.51	1.12	0.62	7.73	0.64	0.60	0.52	0.42	0.54	0.98	0.26	-	0.24	-	-

cando capacidade de adaptação em diferentes meios ambientes; (2) a análise dos caracteres pelo uso da taxonomia permite uma distinção mais nítida das espécies, possibilitando estabelecer com mais clareza as linhas evolutivas do gênero; (3) as variedades *microcephala*, *canescens* e *vulgaris* apresentam grau de variabilidade tão amplo quanto aquele observado nas diferentes espécies, impossibilitando estabelecer critérios diferenciais entre espécies e variedades; (4) o dimorfismo exibido pelo lomento com um ou dois artículos, encontrados nas diferentes espécies e variedades, sugere que, além de ser um caráter adaptativo, os grupos taxonômicos semelhantes estão filogeneticamente relacionados.

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