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## SHORT COMMUNICATIONS

### SILICA AND ASH IN THE SALT MARSH RUSH, *JUNCUS ROEMERIANUS*

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**ABSTRACT** Silica content of living rhizomes from the perennial salt marsh rush *Juncus roemerianus* had values of 0.34, 0.20, and 0.60% of dry weight in three morphologically distinct populations along the Mississippi coast and was directly related to available silica content of the soil (29.7, 17.0, 169.6 mg/100g soil, respectively). On the other hand, living leaves had about the same average silica content (0.93, 0.87, 0.90% of dry weight). The silica content of living leaves varied from 0.142% in younger leaves to 1.520% in older ones. Similarly, rhizomes also increased in silica content with age, varying from 0.137% in younger portions to 1.030% for older ones. Mature leaves collected in October all had a higher average silica content (0.737%) than those collected in April (0.413%), indicating that silica content also increases over the growing season. Decomposed leaves (dead-standing) had a relatively high silica content of 1.81%, obviously reflecting a loss of organic matter and soluble minerals. Roots contain considerable silica, but reliable results were not possible as the soil could not be completely removed from them. Petrographic microscope studies showed that the silica was clear, colorless and isotropic with a refractive index of 1.43, all properties typical of the mineral opal. No  $\alpha$ -quartz was present, as occurs in some species of *Juncus*. The silica was deposited in a sheet made up of small, irregular phytoliths arranged in rows lengthwise in the leaves. Ash percentages were much higher than those for silica and no definite conclusions could be drawn from their variation. In comparison to the maximum silica content of leaves from *Juncus interior* (3.21%), the concentrations found in leaves of *J. roemerianus* were relatively low.

#### INTRODUCTION

Silica occurs in numerous vascular plants, including the rushes *Juncus interior* Weig. and *Juncus bufonius* L. Lanning (1972) showed that these rushes contained much silica and that the content of *J. interior* increased nearly eight-fold over the growing season. Both *J. interior* and *J. bufonius* contain opaline silica and  $\alpha$ -quartz as do other plants such as Lantana (Lanning et al. 1958). From an extensive review of the literature, Ishizuka (1971) states that the presence of silica increases the rigidity of the leaves of the rice plant, causing them to become erect. He also cites strong evidence that the presence of silica increases the resistance of plants to fungal diseases and insect attack.

*Juncus roemerianus* Scheele is a common rush of salt marshes throughout the coastal area of Mississippi, southeastern Louisiana and other parts of the Gulf and Atlantic coasts (Eleuterius 1975). The rush grows erect, with stiff terete leaves, that arise terminally from short stems near the surface of the marsh (Eleuterius 1975, 1976). The leaves are coarse, long lasting in some populations, resistant to fungal attack and infrequently grazed by insects. This knowledge of *J. roemerianus* led to the hypothesis that the presence of silica may account for the stiff, persistent and resistant leaves.

This study was designed to determine: (1) if present, the types and quantity of silica; (2) the ash (A) and silica (S)

contents of the various parts of *Juncus roemerianus* plants; (3) the A and S contents of plants from three morphologically distinct populations; (4) the silica content of the marsh soil in relation to concentration in the rush plants; (5) seasonal differences, if any; and (6) the A and S contents of young leaves and rhizomes in comparison to older ones.

#### METHODS AND MATERIALS

*Juncus roemerianus* plants were collected from several populations at different locations near Ocean Springs, Mississippi (Figure 1): Belle Fontaine Beach (BFB) marsh; Weeks Bayou (WB) marsh; Salt Flats (SF). Samples with long rhizomes (LR) and a single plant (SP) were taken from Simmons Bayou Spoil (SBS). Plants found at WB have mature leaves 3 to 5 feet in length, while those at SF and BFB have leaves 1 to 1.5 and 5 to 7.5 feet in length, respectively. Decomposed leaf material was collected from the peripheral and terminal portions of Simmons Bayou marsh. Specific dates of collections are given with the tables of results.

The plant materials were thoroughly washed and then air dried at 110°C. Whole plants were separated into above-ground parts, rhizomes and roots. All plant materials were ground in a Wiley mill before analysis. Silica content of plant material was determined by classical gravimetric techniques using platinum crucibles. The material was ashed at about 500°C and the ash treated repeatedly with 6N hydrochloric acid to remove other mineral impurities. The silica was filtered out and ignited. The silicon dioxide content

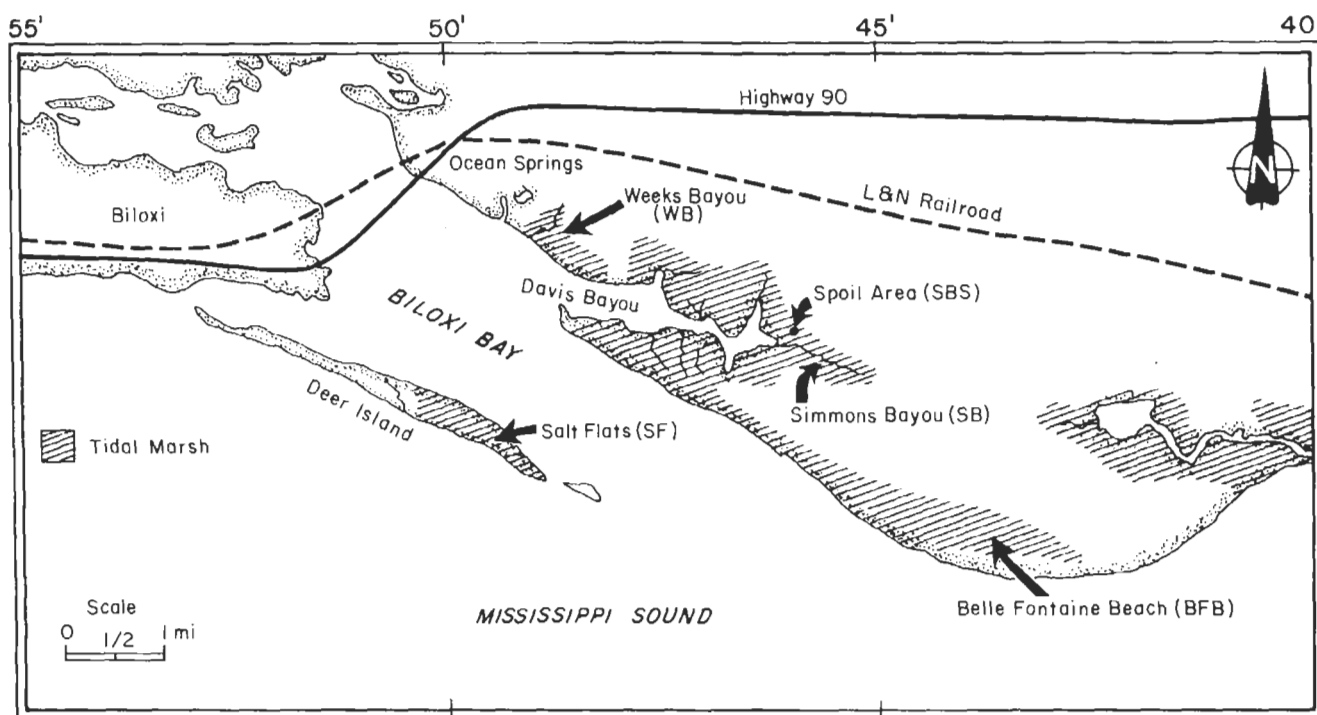


Figure 1. The study areas of the tidal salt marsh rush, *Juncus roemerianus*, were located at Belle Fontaine Beach; Weeks Bayou, and Salt Flats. The rush formed monotypic stands at each location.

was determined as the difference of weights before and after treatment with hydrofluoric acid.

Available silica in soil was determined as acetate soluble silica according to the Imaizumi and Yoshida (1958) modifications of Kahler's method (1941). A 10-gram sample of soil was extracted by 100 ml of 1N acetate buffer of pH 4.0 for 5 hours at 40°C. To a 10-ml aliquot of extract, 5 ml of 0.60N hydrochloric acid and 5 ml of ammonium molybdate (102 grams per liter) were added. After the mixture had stood for 3 minutes, 10 ml of sodium sulfite (170 grams per liter) were added. This mixture was allowed to stand 10 minutes, and then absorbance at 634 nm was measured with a Bausch and Lomb Spectronic 20. The pH of the soil was determined with a Coleman pH meter. Mixtures of equal volumes of soil and water were used for the pH determinations.

Spodograms were prepared by the Ponnaiya (1951) modification of the Uber (1940) method. The material to be examined was placed between microscope slides, and then ashed in a muffle furnace at 450° to 500°C. The ash was prepared for microscopic examination and photography by removing the upper slide, adding Canada balsam directly to the mass and covering with a cover glass. A petrographic microscope was used to study the nature of silica deposits. Several specimens from each location were examined.

#### RESULTS AND DISCUSSION

Petrographic microscope studies of silica from ash of *Juncus roemerianus* showed it to be clear, colorless and

isotropic with an index of refraction of 1.45. These properties are characteristic of the mineral opal (Lanning et al. 1958). No  $\alpha$ -quartz was present although it occurs in *Juncus interior* Weig. and *Juncus hufonius* L. The silica is deposited in sheets which are made up of rows of small irregular phytoliths arranged lengthwise in the leaves. Some fibers are also present (Figure 2).

The soils differed considerably between the three marshes. The soil for SF plants was sandy, had a pH of 9.10 and an acetate-available silica content of 29.7 mg/100g of soil. The BFB and WB soils were a clay type and had pH values of 5.77 and 7.00, respectively. The acetate-available silica contents of BFB and WB soils were quite high, 17.0 and 169.0 mg/100g soil, respectively.

The leaves of plants in the sandy alkaline soil (SF) grew from 1 to 1.5 feet tall. The leaves from other locations (see Methods section) were much taller (WB = 3 to 5 feet; BFB = 5 to 7.5 feet).

Results from samples collected in January (Table 1) show that silica concentration is much higher in the leaves than the rhizomes. The leaves of plants from all three locations had about the same silica percentage. The WB rhizomes growing in the soil with high available silica content had a much higher percentage of silica than rhizomes from the other locations. Ash concentrations were much higher than the silica concentrations and were lowest in SF plants.

Living leaf material from the three locations (Table 1) all showed a considerably higher silica percentage in samples collected in October than those collected in April. This



Figure 2. Spodogram of silica deposited in a *Juncus* leaf (100 X). Note the small, irregular phytoliths (P) and some fibers (hyaline streaks, F).

TABLE 1.

Ash and silica content of living *Juncus roemerianus* from Belle Fontaine Beach (BFB) marsh, Weeks Bayou (WB) marsh, and Salt Flats (SF) on Deer Island. Collections were made during January 1977. Composition of living leaves taken in April (A) and October (O) 1976 from the same three populations are also shown.

Sample No.	Leaves		Rhizomes	
	% Ash	% Silica	% Ash	% Silica
BFB-1	4.13	0.93	3.53	0.21
BFB-2	4.28	0.83	5.10	0.21
BFB-3	4.39	0.79	4.47	0.28
BFB-4	5.12	0.80	4.20	0.23
BFB-5	4.75	0.94	3.24	0.08
BFB-6	5.25	0.94	4.43	0.18
Average	4.65	0.87	4.16	0.20
WB-1	4.93	0.95	5.34	0.40
WB-2	5.40	1.24	5.31	0.93
WB-3	4.90	0.86	4.74	0.43
WB-4	5.35	0.89	5.02	0.36
WB-6	4.70	1.11	6.55	1.28
Average	5.10	0.90	5.50	0.60
SF-1	4.26	0.90	3.57	0.22
SF-2	4.36	1.22	5.12	0.37
SF-3	3.80	0.88	3.64	0.43
SF-4	4.15	1.03	4.03	0.37
SF-5	3.98	0.83	4.27	0.42
SF-6	3.85	0.71	4.02	0.23
Average	4.07	0.93	4.11	0.34
BFB-A	4.93	0.56		
BFB-O	4.47	0.69		
WB-A	4.69	0.34		
WB-O	4.40	0.83		
SF-A	3.95	0.34		
SF-O	3.68	0.69		

increase over the growing season corresponds with results obtained by Lanning (1972) for other *Juncus* plants and Lanning and Linko (1961) for *Sorghum* plants.

The results of studies on plants to compare the silica concentrations of younger and older plant materials are shown in Table 2. For this study the rhizomes were cut in two, and the older halves analyzed separately from the younger. In all cases older leaves and rhizomes had considerably higher silica percentages than younger ones. Decomposed leaf material had a much higher silica percentage than the living material analyzed. Loss of organic matter and soluble mineral matter obviously resulted in this higher silica percentage. Silica constitutes a small fraction of the mineral matter in the plants since the ash percentages were much higher. Root analyses were not accurate since it was not possible to remove all the soil. Ash content of the roots was abnormally high indicating that silica must also be too high to be accurate.

TABLE 2.

Ash and silica contents of young and old leaves, rhizomes and leaves of a single clump [clone or single plant (SP)] about 45 cm in diameter, of *Juncus roemerianus* collected from Simmons Bayou Spoil (SBS). Long rhizomes (LR), 30 to 45 cm in length, bearing intact shoots and roots were dug from a larger clump located at SBS and separated into younger and older parts. Comparative samples were also taken from three populations: Belle Fontaine Beach (BFB) marsh, Weeks Bayou (WB) marsh and Salt Flats (SF) at Deer Island. Composition of decomposed (dead-standing, BFB) leaf material is also shown. All samples were taken during June 1977.

Plant Part	% Ash	% Silica
Single plant (small clump) -- SBS-SP		
Young leaves	4.85	0.142
Old leaves	4.99	0.599
Dead leaves	4.63	0.783
Rhizomes	6.15	0.317
Roots	10.40	1.25
Long rhizomes with intact shoots and roots -- SBS-LR		
Younger half of rhizomes	3.97	0.270
Older half of rhizomes	3.30	0.441
Leaves on younger half of rhizomes	4.94	0.960
Leaves on older half of rhizomes	4.47	1.520
Roots	15.36	2.53
Long rhizomes with intact shoots and roots from three populations		
BFB:		
Rhizomes - younger half	7.35	0.137
Rhizomes - older half	9.92	0.506
Roots	13.30	0.632
WB:		
Rhizomes - younger half	8.95	0.418
Rhizomes - older half	9.10	0.447
Roots	15.90	1.18
SF:		
Rhizomes - younger half	7.78	0.705
Rhizomes - older half	9.63	1.03
Roots	14.09	1.82
Decomposed leaf material -- BFB	3.93	1.81

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