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Seasonal Proximate Constituents and Caloric Values in Seagrasses and Algae on the West Coast of Florida[1]

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ABSTRACT

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Levels of ash, protein, carbohydrate, and caloric values of blades of three species collected at seven sites on the west coast of Florida were similar. Blades of *Thalassia testudinum* had the highest ash content (41%) and those of *Syringodium filiforme*, the highest level of soluble carbohydrate (16%). Winter caloric levels were low at the time of low growth rates and dieback in the two seagrass species (2.4 to 2.8 kcal g dry wt^{-1}), while late spring levels were high (3.1 to 3.2 kcal g dry wt^{-1}) at the time of new growth. Caloric levels were similar to terrestrial grasses. Hemicellulose and cellulose content in blades of the three seagrasses ranged from 1 to 15% and 18 to 32%, respectively, while lignin was almost undetectable (1-3%), and thus the structural components were less than that found in terrestrial grasses. The proximate constituents in dominant seaweeds common to seagrass beds were similar to previous studies and non-calcified seaweeds had caloric levels which were similar to those found in seagrass blades. A complete random block ANOVA and the Student-Newman-Keul's test found no significant differences in levels of proximate constituents and caloric values between sites for the seagrasses or the drift red alga, *Laurencia poitei*.

ADDITIONAL INDEX WORDS: *Algae, energy biomass, Florida seagrasses, seagrass biomass, seaweed,* Thalassia.

INTRODUCTION

The proximate composition of seagrasses and seaweeds, particularly seasonal changes, is poorly known (DAWES *et al.*, 1979; DAWES and LAWRENCE, 1983). Studies of seasonal changes in ash, protein, lipid, and carbohydrate levels have been carried out on some marine algae such as *Ulva* (ABDEL-FATTAH and EDRESS, 1973), *Macrocystis* and *Nereocystis* (WORT, 1958), *Laminaria* and *Alaria* (HAUG and JENSEN, 1954), *Pterocladia* (ABDEL-FATTAH *et al.*, 1973), *Eucheuma* (DAWES *et al.* 1974), and *Hypnea* (SOLIMABI *et al.*, 1980; DURAKO and DAWES, 1980). Similarly, seasonal studies of proximate constituents have been carried out in seagrasses (DAWES and LAWRENCE, 1980; 1983) with no information available on cellulose and hemicellulose content in seagrasses.

The ecological importance of seagrass communities on the west coast of Florida has been emphasized (HUMM, 1973; DAWES, 1974) and a high level of production has been suggested (BAUERSFELD *et al.*, 1969; DAWES *et al.*, 1979). The uniformity in levels of proximate constituents and energetics in discrete seagrass communities along the west coast of Florida is not known. This paper presents data suggesting that proximate constituent levels are similar for a given species of seaweed or seagrass regardless of site on the west coast of Florida and that predictable seasonal changes in proximate constituents occur in both the seagrass component and in the attached and drift macroalgae associated with seagrass communities.

Materials and Methods

Three seagrass sites were sampled tri-weekly from 17 May 1982 to 8 July 1983 in the vicinity of Tampa Bay. The sites were located at the mouth of Cockroach Bay (27°41'N Latitude 82°31.5'W Longitude), in the northern region of Anna Maria Island

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Sound (27°30.0'N Latitude 82°42.5'W Longitude) and off Indian Bluff Island (28°06.0'N Latitude 82°47.5'W Longitude). Four west coast seagrass sites were sampled bi-monthly from 30 July 1982 to 29 July 1983. These sites were located in the Anclote River anchorage (28°11.0'N Latitude 82°39.0'W Longitude), Weeki Wachee River Bay (28°32.0'N Latitude 82°39.0'W Longitude), Homosassa River Bay (28°45.0'N Latitude 82°44.0'W Longitude). and off Seahorse Key channel at Cedar Key (29°05.1'N Latitude 83°04.0'W Longitude).

Sampling procedures included the use of square meter quadrats divided into 10 cm^{-2} subdivisions. Five random square meter samples were taken at each site each time on a line transect through the seagrass meadow. One-fourth of each meter was allotted for drift seaweed collection and three 10 cm^{-2} subunits were used in each quadrat for seagrass and attached seaweed collection. All samples were kept separate, and in the laboratory the species of each sample were separated, identified, and weighed. Subsamples of all algae and blades of seagrass species from all sites were dried in a vacuum desiccator over concentrated sulfuric acid at room temperature, ground to a fine powder using a Wiley Mill and a #40 mesh, and stored in vials for analysis.

A grand total of 434 subsamples of all algae and the blades of three seagrass species from all sites were processed for chemical analysis (ash, protein, carbohydrate, lipid) according to DAWES and LAWRENCE (1983). Pooled samples of seagrasses were analyzed for levels of hemicellulose, cellulose (acid and neutral detergent extraction) and lignin (sulfuric acid method) as detailed by GOEING and VAN STOESH (1970). Kilocalories were calculated according to the ratios of BRODY (1964) based on gram dry weight equivalents of protein, lipid, and carbohydrate.

Results

Distribution

All three species of seagrasses occurred at least in 5 of the seven sites (Table 1). Of the three species, *Thalassia testudinum* (turtle grass) occurred at all seven sites, although complete dieback of the blades was evident at the Cockroach Bay (CRB) site in the winter and at the Cedar Key (CDK) site in the spring. *Syringodium filiforme* (manatee grass) did not occur in the seagrass communities at CRB or Weeki Wachee River Bay (WWR). *Halodule wrightii* (shoal grass) occurred in patches at all seven sites.

Of the 30 species of seaweeds collected in the seven seagrass sites in sufficient quantity to justify analysis, there were 11 species of green algae (chlorophyta), 2 species of brown algae (Phaeophyta), and 17 species of red algae (Rhodophyta, Table 1). A red algae, *Laurencia poitei* was the most common species, occurring as drift plants throughout the 14-month study at all sites but CRB and Anna Maria Island Sound (AMI). The only other species of drift alga that was collected throughout the year at 2 or more sites (CRB, AMI, occasionally at CDK) was the red alga, *Gracilaria verrucosa* (Table 1).

Of the attached seaweeds, species of the coenocytic green algal genus, *Caulerpa*, particularly *C. prolifera*, and the calcified coenocyte, *Halimeda incrassata* were collected at 2 or more sites including Indian Bluff Island (IBI), CRB, Homosassa River Bay (HRS) and Anclote River Anchorage (ANR). Usually the attached algae were found in only one site and then infrequently (Table 1).

Caloric Values

Mean caloric values of the seaweeds, calculated according to BRODY (1964) and based on levels of protein, carbohydrate, and lipid ranged from a low of 1.3±0.2 kcal/g dry wt in the calcified green alga *Halimeda incrassata* to a high of 3.0±0.6 kcal/g dry wt in the green alga coenocyte *Caulerpa prolifera* (Table 1). Calcified species (footnote #2, Table 1) generally had the lowest levels of kilocalories. Highest caloric values for most seaweed species occurred in the spring or summer months, although some cool water species such as *Ulva lactuca* showed high caloric values in late winter and early spring (Table 1). The overall mean caloric values of non-calcified drift and attached seaweeds were similar to those obtained for blades of the three seagrass species.

Overall mean caloric values in the blades of the three seagrass species from all sites ranged from 2.6 in *Thalassia testudinum* to 2.9 kcal/g dry wt in *Syringodium filiforme* (Table 1). Highest caloric values occurred in the spring and summer in all three species. *Thalassia testudinum* blades had the highest degree of variability due to the presence of calcified epiphytes.

Proximate Constituents

The overall mean ash levels of seagrass blades were usually lower than those of non-calcified seaweeds (Table 2A). The seagrass blades (Table 2A, species 1-3) usually had high ash levels in the winter (November-December; January-February), a period of blade dieback or low growth and in the late summer (September-October) when epiphytization was most intense. No common seasonal pattern in ash level was evident in seaweeds. The calcified species

Table 1. Kilocalories per gram dry weight are given for bimonthly means ±1 standard deviation of seaweeds and seagrasses collected in seven seagrass communities on the west coast of Florida.

Date:	Source[1]	1982 May-June	July-Aug	Sept-Oct	Nov-Dec	1983 Jan-Feb	Mar-Apr	May-June	No. of Samples	Overall Mean	±1 S.D.
Chlorophyta											
Batophora oerstedii[2]	A	2.2							(1)	2.2	
Caulerpa ashmeadii	A	3.1±.2	2.7±.3	1.7			3.0±.3	2.3±.6	(12)	2.6	±0.6
C. cupressoides	A		2.8	2.9				2.2	(3)	2.6	±0.4
C. paspaloides	A	2.8				1.8			(2)	2.3	±0.7
C. prolifera	A	3.3±.4	3.3±.3	3.3±.2	3.0	3/1	3.6	2.4±.8	(16)	3.0	±0.6
Cladophora sp.	A/D						2.8		(1)	2.8	
Entermorpha intestinalis	A					1.8±.1	2.1		(3)	1.9	±0.2
Halimeda incrassata[2]	A	1.3±.2	1.4±.1	1.3±.1	1.4±.2		1.1±.1	1.4±.1	(16)	1.3	±0:2
Penicillus capitatus[2]	A		1.4	1.4±.1*				1.8	(3)	1.5	±0.2
Udotea conglutinata[2]	A	2.0							(1)	2.0	
Ulva lactuca	A/D		2.7		2.3	2.6±.0	3.0±.4	3.0±.4	(10)	2.8	±0.4
Phaeophyta											
Dictyota dichotoma	A			2.6±.3					(2)	2.6	±0.3
Sargassum filipendula	D	3.0±.6			2.7				(3)	2.8	±0.3
Rhodophyta											
Acanthophora spicifera	A	2.3±.6	2.6±.4	2.0±.3	1.9±.3			1.9±.5	(16)	2.2	±0.5
Amphora spp.[2]	A/D				1.6			1.2	(2)	1.4	±0.3
Champia parvula	A					2.0			(1)	2.0	
Chondria littoralis	D					2.0			(1)	2.0	
Digenia simplex	A/D	2.7±.4		3.0	1.3	2.4±.5	2.6±.0	2.2±.1	(12)	2.4	±0.6
Gracilaria compressa	D	2.6±.8	2.1						(4)	2.5	±0.7
G. foliifera	D						2.7		(1)	2.7	
G. mammillaris	D	2.6±.3	2.2		2.2				(4)	2.5	±0.4
G. verrucosa	D	2.7±.2	3.0±.6	2.4±.2	2.3±.3	2.4±.1	2.8±.2	2.5±.3	(35)	2.6	±0.4
Hypnea musciformis	A/D	2.5±.0	2.3	2.5	2.7	2.4	2.5±.2	3.3±.8	(11)	2.6	±0.4
Laurencia intricata	D				2.4				(1)	2.4	
L. obtusata	D						2.3		(1)	2.3	
L. poitei	D	2.1±.2	1.8±.1	1.9±.3	2.1±.3	2.3±.4	2.2±.3	2.4±.5	(40)	2.1	±0.4
Lomentaria baileyana	A/D				1.5				(1)	1.5	
Polysiphonia hapalacantha	D	2.6					2.3	2.6	(3)	2.5	±0.2
P. ramentacea	D					2.2	2.8		(2)	2.5	±0.4
Spyridia filamentosa	D	2.5±.4		2.6±.1	2.1±.0	2.4±.1	2.3±.2		(11)	2.4	±0.2
Seagrasses											
Thalassia testudinum	A	2.9±.4	3.2±.1	2.7±.5	2.5±.3	2.4±.3	2.4±.4	2.4±.7	(79)	2.6	±0.5
Syringodium filiforme	A	3.1±.7	3.1±.2	2.7±.3	2.8±.3	2.8±.4	2.9±.3	3.2±.3	(54)	2.9	±0.5
Halodule wrightii	A	3.2±.4	3.2±.2	2.5±.4	2.8±.4	2.4±.8	2.3±.9	3.0±.9	(49)	2.8	±0.6

The number of samples ( ), overall mean and ± standard deviation are also given. [1] Source of sample: A = attached, D = drift. [2] Species of seaweeds that are calcified.

such as *Halimeda incrassata* (Table 2A, species 5) always had 50% or more ash per gram dry weight.

Overall mean protein levels in the seagrass blades at all sites were identical (10%, species 1-3, Table 2B) with highest levels occurring in March-April (12-15%). Blades of *Halodule wrightii* showed high levels of protein in the winter (January-February, 13%, Table 2B) corresponding to a period of growth. Protein levels in seaweeds were lower than seagrass blades and were high in the spring as shown by the four selected species most common to seagrass communities (Table 2B).

Blades of *Syringodium filiforme* and *Halodule wrightii* had similar overall mean levels of soluble carbohydrate (16%, species 2 and 3, Table 2C) and blades of all seagrasses showed peak soluble carbohydrate levels in late summer (July-August) and early fall (September-October). Non-calcified seaweeds generally had high carbohydrate levels in early summer (May-June) and spring (March-April) with highest levels found in phycocolloid-bearing seaweeds such as *Gracilaria verrucosa* (species #6, Table 2C).

Overall mean lipid levels were low in blades of all

Table 2A. Percent ash levels in three species of seagrasses and four seaweeds found in seagrass communities on the west coast of Florida.

	1.	2.	3.	4.	5.	6.	7.
1982							
May-June	(12) 37 ±9	(8) 31 ±4	(10) 31 ±6	(4) 27 ±9	(3) 74 ±3	(7) 36 ±5	(6) 52 ±6
July-Aug	(7) 33 ±6	(5) 34 ±2	(8) 34 ±4	(4) 31 ±7	(3) 74 ±3	(6) 43 ±8	(3) 61 ±11
Sept-Oct	(13) 38 ±10	(8) 33 ±5	(9) 42 ±10	(3) 28 ±4	(3) 71 ±3	(4) 42 ±5	(8) 55 ±7
Nov-Dec	(11) 43 ±9	(7) 35 ±8	(6) 38 ±10	(1) 36	(2) 71 ±4	(7) 51 ±10	(6) 53 ±7
1983							
Jan-Feb	(8) 43 ±20	(6) 34 ±4	(3) 49 ±18	(1) 39		(4) 45 ±3	(6) 52 ±6
March-April	(10) 49 ±11	(9) 34 ±8	(6) 46 ±20	(1) 20	(2) 79 ±1	(5) 35 ±6	(6) 50 ±7
May-June	(11) 40 ±9	(7) 33 ±7	(4) 29 ±5	(3) 45 ±14	(2) 71 ±1	(3) 42 ±8	(6) 46 ±4
Overall	(72) 41 ±12	(50) 34 ±7	(46) 36 ±12	(16) 33 ±11	(15) 72 ±5	(36) 43 ±9	(41) 53 ±4

The number of samples ( ), mean and ±1 standard deviation are given for each bimonthly period for 7 sites. 1. = *Thalassia testudinum*, 2. = *Syringodium filiforme*, 3. = *Halodule wrightii*, 4. = *Caulerpa prolifera*, 5. = *Halimeda incrassata*, 6. = *Gracilaria verrucosa*, 7. = *Laurencia poitei*.

Table 2B. Percent protein in three species of seagrasses and four seaweeds found in seagrass communities on the west coast of Florida.

	1.	2.	3.	4.	5.	6.	7.
1982							
May-June	(12) 12 ±3	(8) 9 ±2	(10) 12 ±3	(4) 8 ±1	(3) 6 ±0	(7) 4 ±1	(6) 5 ±2
July-Aug	(7) 13 ±5	(5) 10 ±4	(8) 12 ±6	(4) 7 ±2	(3) 5 ±2	(6) 5 ±2	(3) 5 ±1
Sept-Oct	(13) ±3	(8) 5 ±3	(9) 6 ±2	(3) 5 ±2	(3) 5 ±2	(4) 3 ±1	(8) 4 ±3
Nov-Dec	(11) 8 ±3	(7) 8 ±1	(6) 10 ±1	(1) 7	(2) 8 ±4	(7) 6 ±3	(6) 5 ±2
1983							
Jan-Feb	(8) 10 ±4	(6) 14 ±7	(3) 13 ±5	(1) 8		(4) 7 ±1	(6) 9 ±1
March-April	(10) 12 ±3	(9) 15 ±5	(6) 12 ±5	(1) 9	(2) 6 ±1	(5) 7 ±3	(6) 7 ±2
May-June	(11) 9 ±3	(7) 11 ±3	(4) 9 ±4	(3) 8 ±3	(2) 6 ±3	(3) 9 ±2	(6) 8 ±3
Overall	(72) 10 ±2.4	(50) 10 ±5	(46) 10 ±4	(16) 7 ±2	(15) 6 ±2	(36) 5 ±3	(41) 6 ±3

The number of samples ( ), mean and ±1 standard deviation are given for each bimonthly period for 7 sites. 1. = *Thalassia testudinum*, 2. = *Syringodium filiforme*, 3. = *Halodule wrightii*, 4. = *Caulerpa prolifera*, 5. = *Halimeda incrassata*, 6. = *Gracilaria verrucosa*, 7. = *Laurencia poitei*.

seagrasses (species 1-3, 1.2-1.5%) and seaweeds (species 4-7, 0.8-3.8%, Table 2D) with highest overall means occurring in species of *Caulerpa* as shown by *C. prolifera* (species 4, Table 2D). No seasonal fluctuations were evident for any of the seagrasses or seaweed species.

Highest levels of cellulose in seagrass blades occurred in the summer and fall for all three species

Table 2C. Percent soluble carbohydrate in three species of seagrasses and four seaweeds found in seagrass communities on the west coast of Florida.

	1.	2.	3.	4.	5.	6.	7.
1982							
May-	(12) 9	(8) 17	(10) 13	(4) 19	(3) 4	(7) 48	(6) 20
June	±3	±4	±4	±2	±1	±19	±6
July-	(7) 15	(5) 22	(8) 20	(4) 21	(3) 8	(5) 46	(2) 15
Aug	±6	±10	±8	±4	±4	±10	±4
Sept-	(13) 17	(8) 19	(9) 18	(3) 30	(3) 11	(4) 27	(8) 24
Oct	±13	±6	±4	±9	±7	±18	±11
Nov-	(11) 9	(7) 12	(6) 15	(1) 7	(2) 7	(7) 33	(6) 19
Dec	±2	±5	±4		±1	±11	±5
1983							
Jan-	(8) 11	(6) 17	(3) 15	(1) 24		(4) 30	(6) 25
Feb	±3	±5	±4			±10	±5
March-	(10) 10	(9) 15	(6) 13	(1) 24	(2) 7	(5) 28	(6) 20
April	±1	±4	±4		±4	±11	±9
May-	(11) 9	(7) 15	(4) 22	(3) 17	(2) 4	(3) 35	(6) 19
June	±3	±4	±10	±3	±1	±12	±6
Overall	(72) 11.1	(50) 16	(45) 16	(15) 20	(15) 5	(35) 34	(40) 21
	±3.2	±6	±6	±5	±4	±9	±7

The number of samples ( ), mean and ±1 standard deviation are given for each bimonthly period for 7 sites. 1. = *Thalassia testudinum*, 2. = *Syringodium filiforme*, 3. = *Halodule wrightii*, 4. = *Caulerpa prolifera*, 5. = *Halimeda incrassata*, 6. = *Gracilaria verrucosa*, 7. = *Laurencia poitei*.

Table 2D. Percent lipid in three species of seagrasses and four seaweeds found in seagrass communities on the west coast of Florida.

	1.	2.	3.	4.	5.	6.	7.
1982							
May-	(12) 1.4	(8) 1.5	(10) 1.0	(4) 4.6	(3) 1.7	(7) 0.6	(6) 0.6
June	±0.4	±0.3	±0.5	±1.3	±1.2	±0.2	±0.1
July-	(7) 1.5	(5) 1.7	(8) 1.6	(4) 4.3	(3) 1.4	(6) 0.7	(3) 0.8
Aug	±0.3	±0.2	±0.3	±0.2	±0.6	±0.2	±0.1
Sept-	(13) 1.5	(8) 1.5	(9) 1.3	(3) 3.9	(3) 1.0	(4) 0.8	(8) 1.0
Oct	±0.4	±0.4	±0.3	±0.8	±0.0	±0.2	±0.1
Nov-	(11) 1.4	(7) 1.4	(6) 1.3	(1) 4.9	(2) 1.0	(7) 1.0	(6) 1.0
Dec	±0.4	±0.4	±0.2		±0.0	±0.0	±0.1
1983							
Jan-	(8) 1.3	(6) 1.4	(3) 1.3	(1) 3.0		(4) 1.0	(6) 1.0
Feb	±0.4	±0.5	±0.3			±0.0	±0.1
March-	(10) 1.4	(9) 1.6	(6) 1.1	(1) 3.0	(2) 1.0	(5) 0.7	(6) 0.8
April	±0.4	±0.5	±0.2		±0.0	±0.2	±0.2
May-	(11) 1.3	(7) 1.4	(4) 1.0	(3) 3.6	(2) 1.7	(3) 0.7	(6) 0.8
June	±0.4	±0.5	±0.1	±1.0	±1.0	±0.0	±0.2
Overall	(72) 1.4	(50) 1.5	(46) 1.2	(16) 3.8	(15) 1.3	(36) 0.8	(41) 0.9
	±0.1	±0.2	±0.03	±2.0	±0.6	±0.3	±0.2

The number of samples ( ), mean and ±1 standard deviation are given for each bimonthly period for 7 sites. 1. = *Thalassia testudinum*, 2. = *Syringodium filiforme*, 3. = *Halodule wrightii*, 4. = *Caulerpa prolifera*, 5. = *Halimeda incrassata*, 6. = *Gracilaria verrucosa*, 7. = *Laurencia poitei*.

(Table 3). Hemicellulose extracted by weak acid hydrolysis and heating with detergents, varied between species and appeared highest in the pooled samples for summer and fall. Thus the cell wall constituents paralled soluble carbohydrate buildup. The blades of *Syringodium filiforme* had the highest levels of hemicelluloses, while *Halodule wrightii* blades had the highest cellulose fraction. Lignin

Table 3. Levels of cellulose, hemicellulose, and lignin expressed as percent of dry weight on pooled samples (m-2) of three seagrass species over a ten month period of two sites near Tampa Bay, Florida.

Species:	*Thalassia testudinum*		*Syringodium filiforme*		*Halodule wrightii*	
Site:	AMI	IBI	AMI	IBI	AMI	IBI
August-October 1983						
Cellulose	28.7	32.1	24.3	24.9	32.5	27.4
Hemicellulose	8.9	5.8	15.4	14.7	14.0	11.7
Lignin	0.2	1.9	1.2	2.4	3.2	3.1
November 1982-February 1983						
Cellulose	18.2	21.2	24.3	18.7	24.9	24.6
Hemicellulose	5.8	4.0	15.4	15.5	6.5	3.7
Lignin	2.3	1.7	1.2	2.5	2.3	0.0
March-April 1983						
Cellulose	17.9	19.4	19.9	20.1	—	—
Hemicellulose	3.4	2.8	11.0	13.3	—	—
Lignin	0.0	1.7	0.6	1.1	1.6	
May-June 1983						
Cellulose	24.7	22.5	—	25.7	30.4	—
Hemicellulose	1.3	6.7	—	10.4	8.2	—
Lignin	1.9	1.2	—	2.3	3.9	—

AMI = Anna Maria Island Sound IBI = Indian Bluff Island

content was low in all species (0.0 to 3.9%, Table 3).

DISCUSSION

Seagrasses

Levels of ash, protein, carbohydrate, and caloric values of blades of the three species of seagrasses were found to be similar to previous reports (BURKHOLDER *et al.*, 1959; BAUERSFELD *et al.*, 1969; WALSH and GROW, 1972; DAWES *et al.*, 1979; DAWES and LAWRENCE, 1979; 1983). Using ANOVA and the Student-Newman-Keul's test for variance, no significant differences in bimonthly caloric levels were found between sites or seasons for blades of the three species. Furthermore, the conservative Student-Newman-Keul's test showed no differences between bimonthly means for protein, lipid, carbohydrate, or ash levels for each species with relation to sites. Thus samplings of seagrass blades at CDK and IBI, 100 km apart, yielded similar levels of proximate constituents for a particular date.

Although the overall mean caloric values (Table 1) were lowest for blades of *Thalassia testudinum*, no significant difference between species was evident. Seasonally low caloric values occurred in the winter months and high values in the spring and summer months. This cyclic response corresponded to a winter dieback or slowdown of growth and a Summer peak in growth with continued buildup of photosynthates (DAWES and LAWRENCE, 1979; 1980). Caloric values for these hydrophytic angiosperms are similar to those calculated for terrestrial grasses. For example, dallis grass (*Paspalum dilatatum*) and centipede grass (*Eremochloa ophiuroides*) have 2.4 and 2.2 kcal g dry wt^{-1} (NELLER, 1944). Thus, little difference in caloric values g dry wt^{-1} is evident between seagrass blades and terrestrial grasses although chemical composition did differ (DAWES and LAWRENCE, 1983.

This study also included determinations of fiber and hemicellulose levels in seagrass blades. It is apparent that hemicelluloses can account for better than 15% if the dry weight of seagrass blades, cellulose for more than 30%, and lignin did not occur in any significant amounts. In comparison, the tropical forage grasses such as tal fescue (*Festuca arundinaceae*) and bermuda grass (*Cynodon dactylon*) had levels of 37% and 40% hemicellulose, 32% and 27% cellulose, and 10% and 6% lignin per g dry wt^{-1} respectively (THAREL, 1981). As suggested earlier (DAWES, 1981) the hydrophytic angiosperms, adapted to an aqueous medium do not require large amounts of structural carbohydrates in the cell wall. The almost complete lack of lignification in seagrass blades may reflect the short life span of the organ or limited grazing and fungal activity on the tissue.

Seaweeds

The macroalgal component of seagrass beds can account for up to 50% of the available energetics (DAWES *et al.*, 1979). The non-calcified seaweeds showed similar overall mean caloric values when compared with seagrass blades. Some species had caloric values as high as 4.3 (*Gracilaria verrucosa*), 4.7 (*Caulerpa prolifera*), and 4.8 (*Laurencia poitei*) in specific samplings.

Because of the ephemeral nature of most seaweeds, seasonal fluctuations in proximate constituents and caloric levels were difficult to ascertain. However a spring or early summer high in caloric values, protein, and carbohydrate levels were evident in most non-calcified species as shown by the dominant algae. Proximate constituent levels in seaweeds were similar to previous studies (DAWES *et al.*, 1979). Protein levels were lower and soluble carbohydrate levels higher in most non-calcified seaweeds when compared with seagrasses and this resulted in similar overall caloric values.

In summary, the levels of proximate constituents and caloric values in the seaweed and seagrass components of the hydrophytic angiosperm community on the west coast of Florida were similar and little variation between sites was noted. It appears that predictions of community energetics and levels of proximate constituents can be made for dominant species from one site to another with limited sampling. Further studies are needed to determine if hemicellulose, lignin, and cellulose levels in seagrasses are uniform among sites, particularly with relation to deep and shallow water populations. It is apparent that the structural components of seagrass cell walls are significantly lower than in terrestrial grasses.

Seasonally the seagrass community showed a peak in organic content in the fall following a period of rapid growth in the spring and preceeding a winter dieback. The seagrasses and dominant seaweeds showed similar patterns with highest levels of kilocalories occurring in the late summer through early fall (August-October) in both years. The seasonal winter decline in seagrass blades and macroalgae resulted in low caloric values in January and February. This is also evident with levels of proximate constituents (Tables 2A-D). Ash was usually highest in the winter, a period of heavy epiphytization and slow growth in both seagrass blades and macroalgae. Protein was highest in most samples in the early spring to early summer months (March-June), a period of rapid growth. Soluble carbohydrate was highest in the fall, a time of growth slowdown and increase in storage products (DAWES *et al.*, 1974). Thus the seagrass community as a whole reflected the seasonal pattern of the dominant species which showed a very similar response to the environment.

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