Seasonal Changes In The Proximate Composition Of Some Common Aquatic Weeds[1]

CLAUDE E. BOYD[2] AND ROBERT D. BLACKBURN[3]

INTRODUCTION

The potential of freshwater vascular plants as feedstuffs has been emphasized (1, 2, 3). A few species appear to be suitable raw material for leaf protein extraction. Leaf protein concentrate can be used as human or non-ruminant animal food in the tropics (5). Leaf protein is not a suitable protein concentrate for use in the United States. However, probably a number of aquatic species could be dehydrated for use as fodder. Additional sources of fodder would be valuable in certain regions.

The nutritive value of a particular species of aquatic weed varies with the fertility of the water in which it is growing (3). Preliminary results also indicated that the chemical composition of aquatic plants change as the plants mature. The component that appears to exhibit the most drastic variation both between sites and with stage of maturity is crude protein. Protein is usually considered the most valuable constituent of feedstuffs, so careful attention must be given to protein content if aquatic weeds are to be used as feedstuffs. Crude protein overestimated the true protein content (sum of amino acids) of four species of aquatic plants by a factor of 1/4 to 1/5 (3,4). However, crude protein and true protein usually follow similar trends, so crude protein levels reveal useful information about true protein content.

The large moisture content will be a major problem associated with the utilization of aquatic plants (2), so the relationship between moisture content and plant age should be ascertained. Seasonal variation in other nutritive components should also be considered.

The present study was initiated to obtain information on seasonal changes in the proximate composition of alligatorweed (*Alternanthera philoxeroides*), eelgrass (*Vallisneria americana*), Florida elodea (*Hydrilla verticillata*), spatterdock (*Naphar advena*), southern naiad (*Najas guadalupensis*), water hyacinth (*Eichhornia crassipes*), and water lettuce (*Pistia stratiotes*). Such data are needed to determine if particular care must be taken in timing the harvest of aquatic weeds for fodder.

METHODS AND MATERIALS

Plant infestations were located in the vicinity of Fort Lauderdale, Florida. The plant parts harvested were as follows: entire plants—*E. crassipes* and *P. stratiotes,* entire shoots—*A. philoxeriodes, V. americana, N. guadalupensis,* and *H. verticillata,* leaves and portions of petioles—*N. advena.* A number of samples were taken from each stand and combined to make a sample for chemical analysis (1). These samples were weighed and then dried at 50°C for dry matter determination. The dried material was pulverized to pass the 20 mesh screen of a Wiley mill. Chemical analyses were made in duplicate according to methods previously described (1).

RESULTS AND DISCUSSIONS

Crude protein results are presented in Fig. 1. On a dry weight basis, no general trend of change by all species in crude protein with maturity was obvious. In some species there was a decline in crude protein, i.e. *A. philoxeroides* and *N. advena.* Fluctuations in crude *protein* levels occurred in other species, but no trends could be discerned. These findings are in agreement with other studies (4, 6, 9) which indicate that the nitrogen content (crude protein is nitrogen x 6.25) of emersed aquatic plants declines with age, which the nitrogen levels of submersed plants may increase, decrease, or remain constant as the season progresses. The nitrogen increase of submersed plants may be related to continual new growth or to the production of periphyton on leaf surfaces. The number of plants in a stand of emersed plants apparently changes only slightly during the year. Net nitrogen ab-

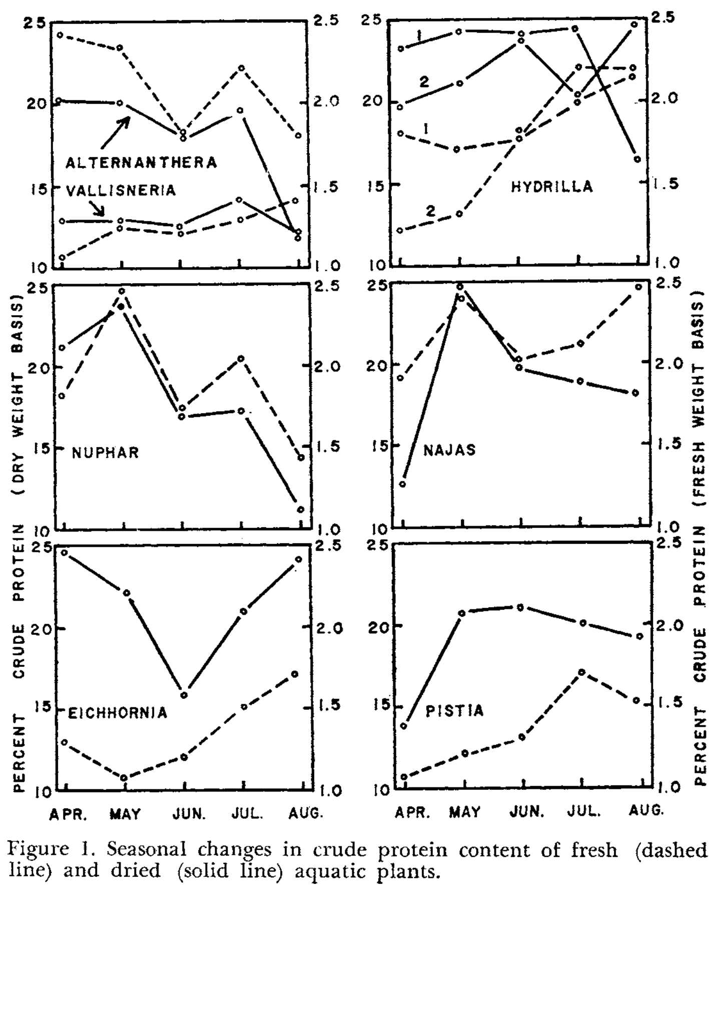

Figure 1. Seasonal changes in crude protein content of fresh (dashed line) and dried (solid line) aquatic plants.

[1]Cooperative investigations of Auburn University, Auburn, Alabama; Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture; the Central and Southern Florida Flood Control District and the University of Florida Agricultural Experiment Station, Fort Lauderdale, Florida.

[2]Assistant Professor, Agricultural Experiment Station, Auburn University, Auburn, Ala. Present address: Savannah River Ecology Laboratory, c/o U.S. Atomic Energy Commission, Savannah River Operations Office, P. O. Box A, Aiken, South Carolina 29801.

[3]Botanist, Crops Research Division, Agricultural Research Service, U.S. Dept. of Agriculture, Fort Lauderdale, Fla. 33314.

sorption is complete by the time about 75% of the total dry matter production has been obtained. Nitrogen is translocated from old to new growth during the final stages of growth with a corresponding decline in percentage nitrogen (4).

The relationship between dry matter standing crop and harvestable crude protein is important if the plants are to be utilized as a dehydrated feedstuff. The dried product should have as high a crude protein content as possible, but the maximum quantity of crude protein should be harvested from the stand. Data from a recent study (4) have been used to make calculations (Fig. 2) of harvestable crude protein and these values were compared to dry matter standing crop. The time of maximum harvestable crude protein was earlier than that of dry matter standing crop in both cases. The dehydrated product would contain a higher percentage of crude protein when harvested at the time of maximum crude protein standing crop. The percentage crude protein was considerably higher in May for both *Justicia americana* and *Alternanthera philoxeroides*, but the increase in amount of harvestable crude protein between May and June would compensate for the decline in percentage crude protein in the dehydrated product. Similar information is needed for additional species.

TABLE 1. Seasonal Changes in the Proximate Composition of Some Common Aquatic Weeds.

Date	% Dry Matter	% Dry Wt. Crude Protein	Ether Extract	Cellulose
Alternanthera philoxeroides				
April	8.2	14.1	5.05	18.0
May	8.5	17.6	4.41	20.4
June	10.0	14.6	5.33	23.7
July	11.4	15.6	4.50	21.5
August	15.0	11.1	2.33	20.9
Vallisneria americana				
April	8.0	27.0	2.04	24.0
May	10.0	23.8	2.86	32.3
June	9.5	19.4	2.92	30.5
July	9.2	17.6	3.44	34.5
August	12.0	17.6	2.17	28.7
Hydrilla verticillata Stand 1				
April	5.8	28.2	4.84	30.3
May	6.1	27.3	4.97	29.6
June	7.4	20.0	6.53	31.0
July	9.9	32.8	4.34	26.1
August	12.0	29.4	2.90	22.5
Hydrilla verticillata Stand 2				
April	7.8	30.3	4.68	28.6
May	6.8	22.4	5.84	32.6
June	7.5	19.8	5.33	32.1
July	9.0	28.7	599	29.2
August	13.5	43.3	2.96	21.9
Nuphar advena				
April	8.6	10.0	6.60	26.0
May	12.4	9.3	4.86	24.2
June	10.0	11.7	6.35	24.6
July	8.2	13.3	6.42	24.4
August	7.5	11.4	3.59	23.5
Najas guadalupensis				
April	14.3	39.8	3.11	19.5
May	8.8	17.4	4.44	34.6
June	10.0	18.3	6.45	28.1
July	11.D	41.6	5.23	28.8
August	14.2	26.8	3.83	22.5
Eichhornia crassipes				
April	5.0	22.0	5.29	25.7
May	5.0	23.5	5.60	26.7
June	8.0	18.2	3.75	22.8
July	7.3	15.7	5.11	21.6
August	7.0	19.4	3.84	20.4
Pistia stratiotes				
April	6.2	22.0	7.86	26.3
May	5.8	23.6	7.73	27.0
June	6.4	19.6	5.88	19.0
July	8.3	23.7	5.19	20.6
August	7.6	20.3	4.83	20.2

In some cases it will probably be desirable to utilize wet aquatic plants as a feedstuff. The dry matter content of most species increased with time (Table 1), so the crude protein content was expressed on both a fresh and dry weight basis (Fig. 1). Fresh weight data revealed that with the exception of *Nuphar advena* the percentage crude protein in fresh plants increased or remained relatively constant as the plants aged. Therefore, harvest of these species could be delayed until July or August when dry matter standing crop is generally near maximum for most species (8). Although there would possibly be a loss in harvestable crude protein, particularly with emersed species (Fig. 2), the increase in crude protein content would be advantageous. For example, the crude protein content of fresh *P. stratiotes* increased from 1.2% in May to 1.7% in July.

On a dry weight basis, most of the species in Fig. 1 were equal to or superior to conventional forages in percentage crude protein. However, when this comparison was made on a fresh weight basis, all species were somewhat inferior to high quality forages (7). For efficient use of aquatic feedstuffs, careful attention will have to be given to the moisture content—crude protein content and dry matter standing crop-harvestable crude protein relationships.

Seasonal changes in other components are given in Table 1. Ash content declined with age in *A. philoxeroides* and *V. americana*. The ash content of other species fluctuated, but there were no general trends of increase or decrease. Ether extract levels were at a maximum in April or reached a maximum by May or June and then declined during the remaining months. In general, cellulose values remained fairly constant or decreased with time.

All species were much higher in ash than forage species, but on a wet weight basis the values would probably be similar to those of most forage crops (7). The individual mineral nutrient components of the ash should be examined if the plants are to be dehydrated since toxic quantities of certain nutrients may be present. In this event, the plants could be used as a component of a ration in order to dilute the levels of certain nutrients. Some species might even have value as a mineral supplement.

Ether extract values exceed those for most dehydrated forages and cellulose values are about the same as for forages (7).

Another problem that will be encountered with some species is that certain parts of plants may have a much higher nutritive value than other parts. To illustrate this point, data for the proximate composition of entire *Justicia americana* plants (4) were compared with unpublished values for the aerial shoots of this same stand (Table 2).

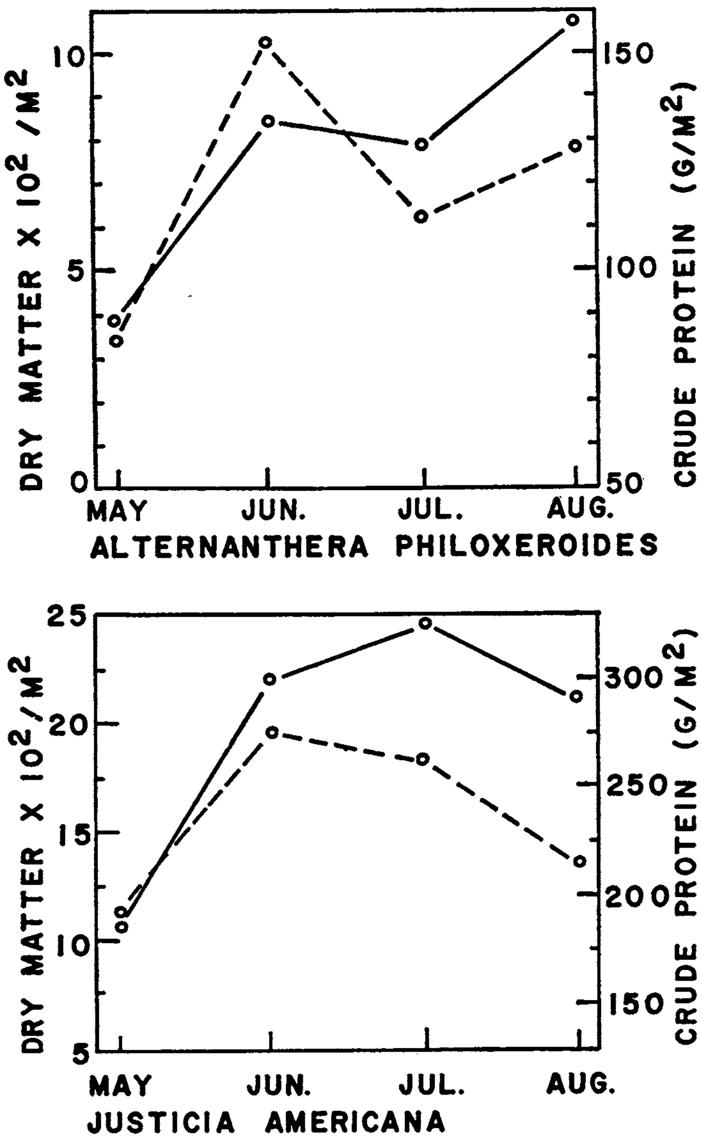

Figure 2. Seasonal changes in dry matter standing crop (solid line) and harvestable crude protein (dashed line) in *Alternanthera philoxercides* and *Justica americana.*

Dry matter and ash values were similar in magnitude, but the aerial shoots contained higher percentages of crude protein and ether extract than entire plants. Similar examples will undoubtedly be found for other species and it may be desirable to adjust harvesting methods to obtain plant parts with the highest nutritive value.

TABLE 2. Proximate Composition of Aerial and Entire *Justicia americana* shoots.

		% Dry Wt. Basis		
	% Dry Matter	Ash	Crude Protein	Ether Extract
Aerial shoots	13.3	17.47	20.66	4.75
Entire shoots	15.3	16.07	12.62	3.95

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