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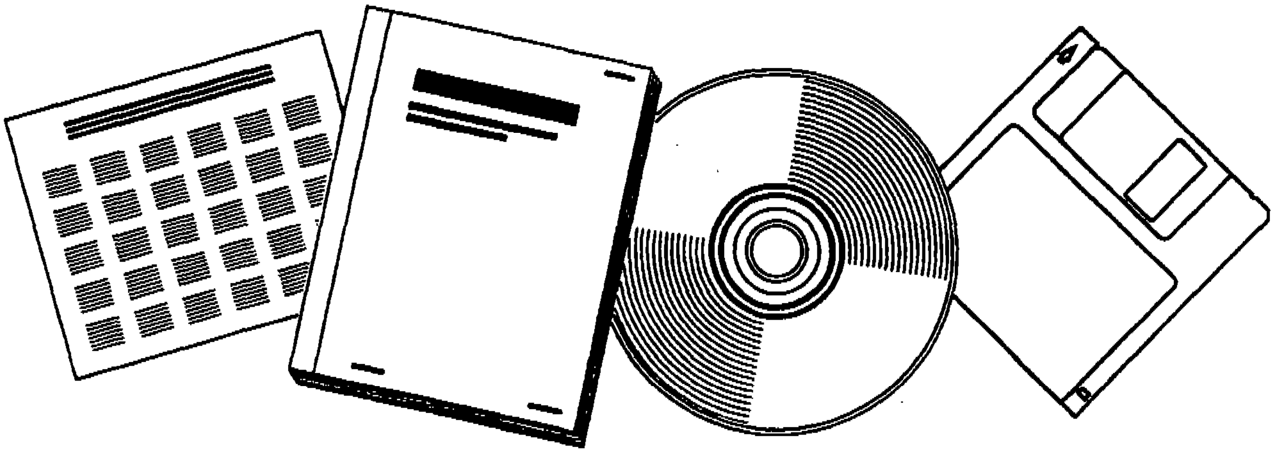
DETERMINATION OF 'IN SITU' BIOMASS AND ENERGETICS IN SEAGRASS BEDS ON THE WEST COAST OF FLORIDA. TOPICAL REPORT, MAY 1982-JANUARY 1984

UNIVERSITY OF SOUTH FLORIDA, TAMPA

JAN 1984



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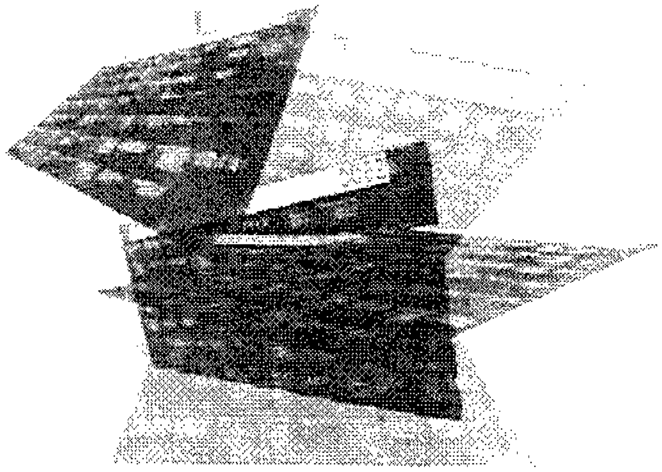

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The Determination of *in situ* Biomass and Energetics in Seagrass Beds on the West Coast of Florida.

TOPICAL REPORT

(May, 1982 to January, 1984)

Gas Research Institute
8600 West Bryn Mawr Avenue
Chicago, Illinois 60631

The Determination of In Situ Biomass and Energetics in Seagrass Beds on the West Coast of Florida

TROPICAL REPORT

(May, 1982 to January, 1984)

Prepared by

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For

GAS RESEARCH INSTITUTE

Contract No. 5080-323-0423 (G)

GRI Project Manager
Dr. Kimon Bird
Research Advisor

January, 1984

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16. Abstract (Limit: 200 words)

The 1 month mean biomass and energetics of the macroalgal and seagrass components of Thalassia testudinum beds along the west coast of Florida was 229 g dry wt $^{-1}$ m^{-2} which is similar to that reported for a number of other Florida and Caribbean seagrass communities. The highest mean standing stock occurred at Homosassa River Bay ~~(656 g dry wt $^{-1}$ m^{-2} or 2.41 tons dry wt $^{-1}$ acre $^{-1}$)~~ when means of 7 sites are compared. The mean overall standing stock in seagrass beds from Anclote Key to Cedar Key, Florida is estimated to be 2.28 $\times 10^9$ metric tons or 3.4 $\times 10^6$ US tons. Means of the available energetics over the 15 month study ranged from 244 (Weeki Wachee River Bay) kilocalories $^{-1}$ m^{-2}. The biomass and energetics of seagrass beds, the individual components including drift and attached seaweeds and seagrasses, and the totals are compared to terrestrial crops and found to be 4 to 9 times lower per unit area.

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RESEARCH SUMMARY

Title	The Determination of *in situ* Biomass and Energetics in Seagrass Beds on the West Coast of Florida.
Contractor	University of South Florida, Tampa. GRI Grant Number: 5080-323-0423(G)
Principal Investigator	C. J. Dawes
Report Period	May, 1982 - January, 1984 Final Report
Objective	Determination of the available biomass and energetics of the naturally occurring populations of seagrasses and seaweeds in Tampa Bay and along the west coast of Florida.
Technical Perspective	The Gulf Coastal region of Florida supports extensive grass beds that almost continuously cover the shallow (1-5m) depths from Apalachicola Bay to Anclote Bay and in Tampa Bay. Attached and drift benthic seaweeds occur as well and may have higher energetic yields than the seagrasses. The shallow and continuous beds offer a possible source for plant biomass use in methane production, if sufficient material is available throughout the year and the energetics are high enough.
Results	Triweekly samplings at three sites around Tampa Bay and bimonthly samplings at four sites along the west coast of Florida showed highest biomass occurring during the spring through fall months. The available biomass of combined attached and drift seagrasses and seaweeds was lower than that predicted when compared with terrestrial crops. Naturally occurring seagrass and seaweed beds do not have sufficient biomass to justify harvesting for biogass production, although energetics levels are high.
Technical Approach	Square meter samplings at all sites revealed biomass (g dry wt per meter squared) levels that were not equal to 1/2 that obtained in harvests of sorgham or aquatic plants in Florida. The low fiber content and moderate ash levels in both seagrasses and seaweeds did support the use for biogas production. Seasonal variation in biomass at all sites and the wide variation in biomass from the various sites indicate difficulty in obtaining sufficient amounts for sustained biogas production. Available energetics were similar for most collections on a g dry wt basis but reflected the loss of biomass in the winter.

Project Implications	The evaluation of natural and extensive seagrass communities as a source of biomass first requires the determination of the available standing stock and energetics of the seagrass and seaweed components. The possible use of the communities in biogas production will be dependent on such analyses.

Dr. Kimon Bird
Project Manager
Marine Biomass

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Introduction

a) Overall project objective. It was proposed to determine the standing crop and available organic matter of drift and benthic seaweeds and attached seagrasses in Tampa Bay and along the Gulf Coast of Florida. This information was to be obtained over a 15 month period (May, 1982 to July 1983) to determine seasonal biomass and energetic levels for biogas production.

b) Brief description of project. Two seagrass sites were selected in Tampa Bay and one near Tampa Bay and sampled every 3 weeks while four other sites were sampled bimonthly on the west coast of Florida from Anclote Key to Cedar Key, Florida. Each sampling included five square meter (m^{-2}) quadrats to determine amounts of attached seagrasses and seaweeds and drift seaweeds. The species in all samples were separated, identified and weighed with subsamples of each species from each side dried for chemical analysis. Analyses included determination of dry weight, ash, protein. soluble carbohydrate, lipid, ash, hemicelluloses, cellulose, lignin (seagrasses), and kilocalories were calculated. Biomass (g dry wt.$^{-1}$ m^{-2}) and energetics (kcal.$^{-1}$ m^{-2}) were determined for each site over a period of 15 months for the major plant components of the seagrass communities.

c) Rationale for undertaking the project. The west coast of Florida contains extensive shallow (1-5m) seagrass meadows that cover an area of at least 10 km wide by 200 km long, stretching from Tampa Bay northward around Apalachicola Bay (Dawes, 1974). Attached and drift benthic seaweeds are abundant in these regions. No data is available regarding seasonality, the extent of the biomass, or available energetics of the marine plants except for restricted studies (Dawes _et al._, 1979); Dawes and Lawrence, 1979, 1980). These extensive seagrass meadows with at least some year around biomass could be a source for biogas production, particularly in the light that marine plants appear produce little residue after anaerobic digestion for methane production. The proposal was designed to sample a number of well defined and discreet seagrass communities over a period of 15 months and to determine seasonal biomass and energetics.

d) Projected benefits to gas consumers. If sufficient biomass and high levels of kilocalories were found in the extensive seagrass meadows a pilot harvesting project could be initiated on the west coast of Florida to determine the feasibility of collection, drying, and digestion of marine plants for methane production. The relatively easy access to the seagrass communities makes them attractive as a biomass source. The potentially high levels of kilocalories per gram dry weight suggests that the seagrasses and seaweeds would be excellent material for digestion.

Technical Section.

a) Work plan. The three seagrass sites sampled every third week around Tampa Bay were at the mouth of Cockroach Bay (27°41.5'N, Lat., 82°31.5'W Long.), in the northern region of Anna Maria Island Sound (27°30.0'N Lat., 82°42.5'W Long.) and off Indian Bluff Island (28°06.0'N, 82°47.5'W). The four west coast seagrass sites sampled bimonthly were in the Anclote River anchorage (28°11.0'N, Lat., 82°48.0'W Long.), Weeki Wachee River Bay (28°32.0'N,82°39.0'W), Homosassa River Bay (28°45.0'N Lat., 82°44.0'W Long.), and off Seashore Key channel at Cedar Key (29°05.0'N Lat., 83°04.0'W Long.).

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 species from each site were dried, reweighed (percent dry wt.) and ground for analysis. Ash (500°C for 4 hr), protein (colorimetric Folin reagent), soluble carbohydrate (colorimetric, phenol-sulfuric acid procedure), lipid (gavimetric procedure), hemicelluloses, cellulose and lignin (deterent and sulfuric acid procedures, gavimetric) were used and kilocalories calculated from the organic constituents as described by Dawes (1981).

b) Work performed. Twenty one samplings were made at three week intervals at the three local sites (mouth of Cockroach Bay, Anna Maria Island Pass, Indian Bluff Island) on the following dates in 1982: 17 May, 13 and 25 June, 16 July, 6 and 27 August, 17 September, 8 and 29 October, 11 November, 10 and 31 December; and in 1983: 21 January, 11 February, 4 and 28 March, 15 April, 6 and 27 May, 7 June and 8 July. Seven samplings were taken at approximately bimonthly intervals for the four west coast sites (Anclote River anchorage, Weeki Wachee River Bay, Homosassa River Bay, and Cedar Key at Seahorse Key channel) on the following dates in 1982: 30 June, 24 September, 20 November; and in 1983: 29 January, 1 April, 23 May, and 29 July. In addition, 2 transects were run at Homosassa River Bay to 30 km offshore (7m deep) on 18 February and 15 July, 1983. A total of 434 algal and seagrass samples were analyzed for ash, protein, and soluble carbohydrate, 211 samples for lipid levels, and 108 pooled samples for hemicellulose, fiber, and lignin content.

c) Results. Seagrasses. 1. Biomass and energetics around Tampa Bay. Based on triweekly collection at the three local sites (Fig. 1-3, Tables 1-3), the seagrass bed at the mouth of Cockroach Bay (CRB), in

Tampa Bay has the lowest biomass and energetic levels as shown by bimonthly means (Fig. 1) with the highest biomass occurring on 25 Mar. 1983 (seagrass 402 g dry wt.$^{-1}$ m^{-2}, Table 1). A small peak occurred during the fall and a large peak in the spring and early summer of 1983 (Fig. 1). Dominance changed at CRB shifting from _Halodule wrightii_ in the summer and winter months to _Thalassia testudinum_ in both spring periods (solid line, Fig. 1). The higher biomass and resulting energetics in the spring of 1983 (dashed line, Fig. 1) appeared related to the warm early spring months although an almost complete dieback occurred in January after low water temperatures in December.

Thalassia testudinum at Anna Maria Island Sound (AMI) at the mouth of Tampa Bay also showed variations in biomass and energetics with dominance shifting from _Syringodium filiforme_ in the spring and summer of 1982 to _T. testudinum_ in the winter and spring of 1982-83 (Table 2, Fig. 2). A fall regrowth of turtle grass blades was evident in Nov.-Dec., 1982. Biomass peaked as with CRB in the spring of 1983 following the warm winter although highest biomass occurred on 27 May (38 g dry wt.$^{-1}$ m^{-2}, Table 2). A complete dieback did not occur at this site, perhaps due to the stable salinity and constant water flow (Table 10). Energetics (dashed line, Fig. 2) closely paralleled the biomass when expressed on a m^{-2} basis.

The highest energetic and biomass levels for the three local sites was found at the open coast site off Indian Bluff Island (IBI, Table 3, Fig. 3). _Thalassia testudinum_ usually accounted for over 50% of the seagrasses in the mixed bed except on 25 June, 16 July, 17 Sep., and 8 Oct. Seasonal spring and early summer growth with a major winter dieback of the blades were evident and coincided with the low midwinter temperatures (Table 10). Salinity reflected the stable and high open Gulf of Mexico influence at the site (Table 10).

Seagrasses. 2. Biomass and energetics on the west coast. Thalassia testudinum dominated all four seagrass beds sampled bimonthly on the west coast of Florida (Fig. 4-7, Tables 4-7). A seasonal cycle in biomass and energetics, similar to IBI was present at the southern most site, Anclote River anchorage (ANR, Table 4, Fig. 4) and at the northern most site in the study, Seahorse Key channel off Cedar Key (CDK, Table 5, Fig. 5). The seagrass biomass was lower at CDK (max. 580 g dry wt.$^{-1}$ m^{-2}, Table 5) while at ANR (max. 605 g dry wt.$^{-1}$ m^{-2}, Table 4) it was similar to that found at IBI. At both sites there was a clear seasonal shift with almost complete dieback in the winter. Syringodium filiforme dominated at CDK during the fall and spring months (Table 5) and reached about 40% of the biomass at ANR in the spring and early summer of 1983 (Table 4). Both sites showed relatively stable salinities although a drop occurred in the summer with temperatures paralleling that at IBI (Table 10).

The seagrass biomass at Weeki Wachee River Bay (WWR, Fig. 6, Table 6) and Homosassa River Bay (HSR, Fig. 7, Table 7) did not show typical seasonal cycling, perhaps due to the effect of the spring fed rivers that dominated the two bays (Table 10). A narrow bladed form of Thalassia testudinum was the only seagrass present in the low salinity waters of WWR and the biomass level was the lowest of the seven sites (max. 233 g dry wt.$^{-1}$ m^{-2}, 29 Jan. Table 6). A large amount of dead leaves made up the attached seagrass biomass during the winter months, thus a dip in energetics is evident but not in biomass for the Jan.-Feb. plot (Fig. 6).

At HSR, a consistently high biomass was found (max. 1086 g dry wt.$^{-1}$ m^{-2}, 29 June, Table 7) with only a limited winter dieback (321 g dry wt.$^{-1}$ m^{-2}, 28 Jan., Table 7). Syringodium filiforme dominated the seagrass component at HSR during the spring and fall months and accounted for 2/3 of the biomass. Due to some growth even during the winter at this more protected site, caloric sand biomass levels were the highest of all seven sites and remained highest even in the winter.

Seagrasses. 3. Proximate composition. The biochemical components of *Thalassia testudinum* blades from the five coast sites (IBI, ANR, WWR, HSR, CDK) and AMI at the mouth of Tampa Bay did not differ significantly (Fig. 8 and 9). Similarities were highest for *T. testudinum* collected at IBI and ANR. Levels of ash varied but were usually highest in the winter, the period of dieback or low growth. Lipid never accounted for more than 2% of the dry weight in seagrass blades and snowed no seasonal variation. Protein was maximum usually in the spring during the period of blade regrowth except at CDK where high levels of protein occurred during the fall as well. *Halodule wrightii* at CRB (Fig. 8) had high protein levels in the winter corresponding to a period of active growth. Soluble carbohydrate was highest in *H. wrightii* at CRB (Fig. 8) in the spring (1983) and generally high in the summer for *T. testudinum* at all other sites. Lower levels of soluble carbohydrate occurred in the winter for both seagrass species at all sites.

The mean level of kilocalories (g dry wt.$^{-1}$) of *Thalassia testudinum* at IBI was 2.9 +/-0.8, 2.3 +/- 0.5 at AMI and 2.0 +/- 0.6 for *Halodule wrightii* at CRB. Mean levels of kilocalories for *T. testudinum* at the other four sites were 2.4 +/0.6 at ANR, 2.4 +/0.2 at WWR, 2.6 +/-0.6 at HSR, and 2.4 +/0.6 at CDK. Thus there were no significant differences in kilocaloric levels for *T. testudinum* blades when expressed terms of dry weight. There was a significant difference between the caloric levels in *T. testudinum* of all sites and *H. wrightii* from CRB. The latter species had the lowest energetics and biomass when compared to any of the turtle grass dominated sites.

Seaweeds. 1. Drift Seaweeds. The seasonal biomass and energetics of the dominant drift seaweeds for the three Tampa Bay sites are shown in Tables 1,2,3 and Figures 10 and 11. The biomass (Fig. 10) was most pronounced for the common drift alga *Laurencia poitei* at IBI with the species accounting for 67% of the biomass in June of 1982. A mixture of drift seaweeds (*Spyridia filamentosa*, *Hypnea musciformis*, *Polysiphonia denudata*, *Gracilaria mammallaris*) occurred at the two sites in and near Tampa Bay (CRB,AMI), and this seaweed mixture comprised the largest component in May, 1982 (38%) at CRB (Table 1). Because of the low biomass, the drift seaweeds did not consistute a large portion of the kilocalories available in the various seagrass communities except at IBI (Fig. 11). The only site where drift seaweeds showed a clear seasonal cycle was at CRB where drift accumulated due to low currents and wave action so that populations remained entangled with the bases of seagrasses.

Proximate composition of the drift seaweeds showed some seasonality with ash being highest (40%) in the winter but varying when populations were compared (Fig. 12). Protein levels increased in the spring and carbohydrate (soluble portion) in the summer. Lipid levels were low and accounted for up to 5% of the dry weight in species of *Caulerpa* at CRB (Table 1) and IBI (Table 3) but showed no seasonal cycle. Mean kilocaloric levels for the drift seaweeds were lowest for *Laurencia poitei* at IBI (2.0 +/- 0.5) and higher for *Gracilaria verrucosa* at AMI (2.4 +/ 0.4) and at CRB (2.6 +/-0.5) when expressed on a g dry wt. basis.

Drift seaweeds did not constitute an important part of the biomass at the other four west coast sites (Tables 4-7) except occasionally at HSR and ANR (Jan. 1983), and WWR (May, June 1983). Drift algae accounted for 59% in May and 49% in July 1983 at WWR when Thalassia testudinum blades showed little growth.

Seaweeds. 2. Attached algae. Biomass of the attached algae was low and varied widely in the seven seagrass beds (Tables 1-7). The largest biomass occurred in CRB where the coenocytic green alga, Caulerpa prolifera, reached 83% on 27 Aug. (247 g dry wt.$^{-1}$ m^{-2}) and 45% on 27 May 1983 (133 g dry wt.$^{-1}$ m^{-2}) and where Enteromorpha intestinalis also accounted for 94% (372 g dry wt.$^{-1}$ m^{-2}) in Jan. 1983 (Table 1). A number of attached algae also occurred at IBI (Table 3) but only on 4 Mar. did a species (Halimeda incrassata) account for more than 15% of the total biomass. Because of the low seagrass biomass on 1 April at ANR, Caulerpa prolifera accounted for 45% of the total biomass and 38% of available energetics.

Total Biomass and Energetics. 1. Tampa Bay sites. Except for winter collections at CRB, the seagrass component accounted for the largest fraction (at least 45%) of the biomass and resultant energetics and the attached algae the least (Fig. 13, 14). Drift algae were the most significant component at IBI (up to 50%) in the spring of 1982 but usually drift seaweed biomass was variable, constituting 25% or less. The highest total biomass and energetic levels in the three seagrass beds around Tampa Bay was at the open coast site at IBI (429 +/-127 g dry wt.$^{-1}$ m^{-2}; 1052 +/-291 kcal $^{-1}$ m^{-2}) with AMI intermediate (406 +/246 g dry wt.$^{-1}$ m^{-2}; 997 +/-568 kcal $^{-1}$ m^{-2}) and CRB the lowest (254 +/-120 g dry wt.$^{-1}$ m^{-2}; 664 +/-336 kcal $^{-1}$ m^{-2}). Seasonally the highest total biomass occurred in the spring and summer at IBI and AMI and in the winter and spring at CRB (Fig. 13, 14).

Total Biomass and Energetics. 2. West coast sites. Thalassia testudinum accounted for the largest portion of the biomass and energetics in the four seagrass beds on the west coast of Florida (Fig. 15, 16). The total biomass for the seagrass beds at CDK (269 +/-212 g dry wt.$^{-1}$ m^{-2}) and ANR (333 +/-136 g dry wt.$^{-1}$ m^{-2}) were similar to that at IBI. The largest biomass for all seven sites was at HSR (582 +/-301 g dry wt.$^{-1}$ m^{-2}), possibly due to a continuous shore (southerly) current and protected conditions. The site with lowest salinities and highest temperature fluctuations, WWR, had the lowest biomass (163 +/-57 g dry wt.$^{-1}$ m^{-2}). Drift seaweeds contributed a significant portion to the total biomass only at ANR and WWR in the winter and spring months which were the periods of lowest seagrass biomass (Fig. 15). The southernmost site, ANR, had a lower drop in biomass in the winter than any of the other four west coast sites showing a similar seasonal cycle with IBI (Fig. 13 and 15).

Large fluctuations were evident for total kilocalories at all four west coast sites (Fig. 126) with the largest 15 month mean at HSR (1837 +/-949 kcal $^{-1}$ m^{-2}) and lowest at WWR (344 +/-68 kcal $^{-1}$ m^{-2}). No major differences occurred when biomass (Fig. 15) and energetics (Fig. 16) are compared although attached algae accounted for a greater amount of kilocalories at HSR and drift algae at WWR than the biomass levels would have suggested.

d) Discussion

The findings of the present study on the biomass and energetics of the macroalgal and seagrass components of seagrass beds along the west coast of Florida can be summed up with regard to four points. (1) The total biomass and resultant energetics in the seven seagrass beds was low when compared to terrestrial production. (2) There was a high degree of uniformity between populations of the same species in all the sites with regard to the ratio of energetics to biomass. (3) Seaweeds (attached and drift) showed a larger standing stock variation then the seagrasses and contributed about 20% of the total biomass. (4) This uniformity between populations suggests that the available biomass and energetics can be predicted on a seasonal basis for unknown sites.

Available standing stock in the seagrass beds varied considerably with regard to site and season (Table 9). The seagrass bed at Indian Bluff Island had the highest mean biomass (477 g dry wt.$^{-1}$ m^{-2} or 1.76 tons dry wt.$^{-1}$ acre, Table 9) with the highest level in the spring and early summer (635 g dry wt.$^{-1}$ m^{-2} or 2.3 tons dry wt.$^{-1}$ acre) for the three local sites (Fig. 1_3). The seagrass beds in Homosassa River Bay had the highest mean standing stock over all (656 g dry wt.$^{-1}$ m^{-2} or 2.41 tons dry wt.$^{-1}$ acre^{-1}) with the highest biomass also occurring in the spring (1202 g dry wt.$^{-1}$ m^{-2} or 4.45 tons dry wt.$^{-1}$ acre^{-1}, Table 9).

The 16 month mean standing stock (229 g dry wt.$^{-1}$ m^{-2}, Table 9) at the six sites dominated by <u>Thalassia testudinum</u> (ca 59% of TSS) was similar to that reported in previous studies on turtle grass standing stock (Table 10) in Texas (Odum, 1963), Biscayne Bay at Miami Florida (Jones, 1968, Zieman, 1975) sheltered sites in Cuba (Buesa, 1972, 1974) and the north coast of Jamaica (Greenway, 1976). None of the west coast sites had mean biomass levels (830 g dry wt.$^{-1}$ m^{-2}) reported for the same region by Bauersfeld et al. (1969, Table 10) although the extremes found at AMI, IBI, and HSR were similar if ranges are examined (Table 9). The very high biomass (Table 10) shown in ranges for Biscayne Bay by Jones (1968) and for Boca Ciega Bay by Taylor and Saloman (1969) are questionable and may be due to sampling error. There is no question that <u>T. testudinum</u> standing stock showed large fluctuations depending on the site and based on degree or exposure to wave action, salinity, and temperature ranges (Table 9).

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Similar ranges are evident in published data on the temperate seagrass Zostera marina (Table 11) although again a number of standing stock ranges are very high and open to question (e.g. Burkholder and Doheny, 1968; McRoy, 1970, Vozzhinshazy, 1964). Because of the temperature range, complete die off of the above ground portion of Z. marina occurred at all sites and thus the ranges reflect summer standing stock only.

Unlike previous studies, the present one also identified the standing weed component (Table 9). Mean total seagrass standing stock ranged from a low of 119 at WWR , a low salinity site, to a high of 535 g dry wt.$^{-1}$ m^{-2} at HSR and the same relationship occurred when total standing stocks are compared (159 at WWR vs 656 g dry wt^{-1} m^{-2} at HSR, Table 9).

The seaweed component (drift and attached macroalgae) was lower than that reported by Dawes et al. (1979) at a site near ANR and IBI but over all did account for about 18% of the total standing stock (Table 9). The highest mean drift and attached algal standing stock occurred at IBI (143 g dry wt.$^{-1}$ m^{-2}) and this accounted for 30% of the total standing stock. Seaweeds accounted for 39% at CRB and 26% standing stock at WWR, both sites where seagrass biomass was low. Only at IBI and ANR did seagrass standing stock not drop to zero during the winter months. Thus it appears that seaweeds to contribute a substantial portion to the overall standing stock of seagrass beds on the west coast of Florida.

Based on previous studies (Dawes and Lawrence, 1979), the average rate of blade regrowth after clipping is about 2 to 5 cm over a 2 week period. During May through October cropping studies indicated that seagrass regeneration required about 4 to 6 weeks (Dawes et al., 1979, Dawes and Lawrence, 1980) for seagrass beds near Tampa Bay. Thus a single seagrass bed could be harvested at least three times during the spring through the fall months and the average yield could be increased three times.

The extensive nature of the seagrass beds is apparent if the shallow subtidal west coast is considered. Seagrass beds occur at least 10 km offshore from Anclote Key to Cedar Key, Florida, an area of about 900 km^{-2} (900,000 ha). Based on aerial survey it appears that about 66% of that area consists of seagrass beds or about 594,000 hectars (240,468 acres). If the mean overall standing stock for the four west coast sites from Indian Bluff Island to Cedar Key is used (385 g dry $wt.^{-1}$ m^{-2} of 1.42 tons dry $wt.^{-1}$ $acre^{-2}$) then approximately 2.28×10^9 metric tons or 3.4×10^6 U.S. tons are present. These means include both summer and fall highs and winter lows in biomass and are less than those proposed by Bauersfeld et al. (1969). In that paper the seagrass beds of Apalachee Bay were included and an estimated 4×10^6 acres with a yield of 2.8 tons dry $wt.^{-1}$ $acre^{-2}$ (11.2×10^6 tons of dry leaves) calculated.

The above data is not so impressive when yields of Napiergrass (_Pennisetum_ _purpureum_) or water hyacinths (_Eichhornia_ _crassipes_) are compared. The annual yield for Napiergrass is 14 tons and 18 tons dry $wt.^{-1}$ $acre^{-1}$ in unfertilized and moderately fertilized fields. Water hyacinths yields range from 28 tons to 50 tons dry $wt.^{-1}$ $acre^{-1}$ on an annual basis for unfertilized and highly controlled population (Univ. Fla. Inst. Food Agri. Sci., 1983). The above annual yields of unfertilized populations are based on three harvests per year and thus are 4 to 9 times higher per unit area than seagrass bed also harvested three times each year.

The ratio of biomass to energetics (B:E) given in Tables 1-7 is actually the amount of kilocalories a dry wt.$^{-1}$ that were calculated according to Brody (1964) based on levels of protein, lipid, and carbohydrate (insoluble and soluble). The ratio can be used to determine the growth status of the plant (Dawes et al., 1974; Dawes et al., 1979; Dawes and Lawrence, 1980). The ratio for total energetics to biomass for each date were generally low in the winter months at all seven sites except at CRB where *Halodule wrightii* became the dominant seagrass in Nov. and Dec. The ratio was high in the spring and summer during the time of most active growth in the seagrasses and the highest ratio occurred in seagrass beds that were dominated by *Thalassia testudinum* (e.g. IBI in Oct. 1982; HSR in May, 1983).

The seaweeds as individual species had the highest B to E ratio: *Caulerpa* spp. (4.7, ANR 23 May 1983; 4.6, HSR 1 Apr. 1983), *Laurencia poitei* (4.8, HSR 23 May, 1983), *Gracilaria verrucosa* (4.3, AMI, 6 Aug. 1982). Seagrass blades had their highest ratios in the fall (*Thalassia testudinum*, 4.3, IBI 30 Oct. 1982) and in the early summer (*Syringodium filiforme*, 4.5, IBI, 8 July 1983. The kcal^{-1}g dry wt.$^{-1}$ of the seagrasses (2.0 to 2.9 kcal^{-1}g dry wt.$^{-1}$) are similar to those that can be calculated for terrestrial grasses based on levels of protein, lipid and carbohydrate. Dallis grass (*Paspalum dilatatum*) and Centipede grass (*Eremochloa ophiuroides*) have 2.4 and 2.2 kcal g dry wt.$^{-1}$ respectively (Neller and Daane, 1939), while Carpet grass (*Axonopus compressus*) had 2.2 kcal^{-1}g dry wt.$^{-1}$ (Neller, 1944). Thus per g dry wt little difference in levels of kilocalories is evident between seagrass blades and terrestrial grasses although chemical compositional differences have been noted (Dawes and Lawrence, 1983). With little chemical differences and the substantially lower biomass along the west coast of Florida there appears to be no advantage to harvesting seagrass beds over those of terrestrial grasses.

The uniformity of the biomass to energetics ratio between populations and the similar seasonal responses especially in the seagrass beds dominated by Thalassia testudinum on the open west coast sites suggests that seagrass biomass and energetics can be predicted. The greatest variation occurred at CRB and WWR, both sites where there was a strong depression in salinity and where air temperatures greatly influenced the water temperature due to large shallow areas. In most cases the seagrass beds at the seven sites showed a seasonal cycle with highest biomass and energetics and thus the highest ration occurring at time of growth, namely the spring through early fall months. The uniform B to E ratio (biomass to kilocal.) for the seagrasses, especially T. testudinum regardless of site supports the idea that seasonal predictions of biomass and resulting energetics can be made providing a single sampling is made to determine species dominance and biomass. Data from the present study can then be used to determine seasonal information for the site.

The biomass of seagrass beds dominated by Thalassia testudinum on the west coast of Florida is quite similar to previous studies near Anclote Key (Dawes et al., 1979) and at Indian Bluff Island (Dawes and Lawrence, 1979, 1980) and for beds in the Florida Keys and at Glover's Reef, Belize, C.A. (Dawes and Lawrence, 1983). The data is also similar to studies carried out in Cuba (Buesa, 1974, 517 g dry wt.$^{-1}$ m^{-2}) and earlier studies in Florida (Baursfeld et al., 1969, 700 g dry wt.$^{-1}$ m^{-2}) but higher than those reported for turtle grass beds in Texas (Odum, 1963, 363 g dry wt.$^{-1}$ m^{-2}). When the total biomass and energetics are compared to previous cropping studies near IBI and ANR (Dawes et al, 1979) the seaweed component can account for up to 50% of the total amount as shown earlier.

In summary, the mean standing stock of seagrass beds along the west coast of Florida was 229 g dry wt.$^{-1}$m^{-2} over a 15 month period at six sites dominated by Thalassia testudinum. The biomass was about 11 to 25% of yields obtained from such terrestrial crops as napiergrass or water hyacinths. Seaweeds accounted for about 20% of the biomass at most sites. Caloric values were similar when seagrasses and terrestrial plants were compared (2.0 to 2.9 kcal^{-1}g dry wt.$^{-1}$) and higher for the seaweed component (2 to 4 kcal^{-1}g dry wt.$^{-1}$). Because of the high degree of uniformity between sites for seagrasses and algae, the available biomass and energetics can be predicted on a seasonal basis for other west coast sites.

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Table 1. Mean and percent biomass (g dwt^{-1} m^{-2}) and energetics (kilocal.$^{-1}$m^{-2}) of the three plant components (seagrasses, attached algae, drift algae) of a seagrass bed at the mouth of Cockroach Bay in Tampa Bay, Florida. Ratio of energetics to biomass (E to B) is also given. Numbers in parentheses are ± 1 S.D. Sample size (n) is 10 x 10 cm^2 for seagrasses and for attached algae and 5 x 50 cm^2 for drift algae. Species code is as follows: 1. Seagrasses (1A = *Thalassia testudinum*, 1B = *Syringodium filiforme*, 1C = *Halodule wrightii*). 2. Attached algae (2A = *Caulerpa prolifera*, 2B = *Caulerpa ashmeadii*, 2C = *Enteromorpha intestinalis*, 2D = *Halimeda incrassata*, 2E = *Sargassum pteropleuron*, 2F = *Penicillus capitatus*). 3. Drift algae (3A = *Acanthophora spicifera*, 3B = *Amphoria rigida*, 3C = *Digenia simplex*, 3D = *Gracilaria verrucosa*, 3E = *Hypnea musciformis*, 3F = *Laurencia poitei*, 3G = *Polysiphonia denudata*, 3H = *Spyridia filamentosa*, 3I = *Ulva lactuca*, 3J = Mixture of species).

		Biomass		Energetics		Ratio
Date	Species	Component	Percent	Component	Percent	E to B
1982						
17 May	1A	25 (± 37)	20	66	19	2.6
	1C	31 (± 5)	24	128	36	4.1
	2A	23 (± 21)	18	67	19	2.9
	3J	49 (± 48)	38	95	27	1.9
	Total	128		356		2.8
13 June	1A	76 (± 117)	40	227	45	3.0
	1C	61 (± 45)	32	194	39	3.2
	2A	46 (± 61)	24	30	6	0.7
	3A	7 (± 6)	2	21	4	3
	3D	3 (± 2)	2	9	2	3
	3E	2 (± 5)	1	6	1	3
	3D	4 (± 2)	1	14	3	3.5
	Total	199		501		2.5
25 June	1A	131 (± 106)	79	406	82	3.1
	1C	17 (± 26)	10	17	3	1.0
	2A	17 (± 26)	10	61	13	3.6
	3A	1.7 (± 0.4)	0.6	4	1	2.4
	3I	0.2 (± 0.4)	0.4	0.5	1	2.5
	Total	166		493		2.9
16 July	1A	5 (± 12)	5	16	6	3.2
	1C	62 (± 27)	64	181	63	2.9
	2A	26 (± 35)	27	78	27	3.0
	3A	3 (± 2)	3	7	2	2.3
	3D	1 (± 1)	1	3	1	3.0
	3E	0.4 (± 0.5)	0	0.8	0.6	2.0
	3I	0.2 (± 0.5)	0	0.5	0.4	2.5
	Total	98		286		2.9

Table 1. cont'd

		Biomass		Energetics		Ratio
Date	Species	Component	Percent	Component	Percent	E to B
6 August	1C	58 (± 27)	30	222	31	3.8
	2A	136 (± 49)	70	500	69	3.7
	3A	0.8 (± 0.6)	0	1	0	1.3
	3D	0.2 (± 0.4)	0	1	0	5
	Total	195		724		3.7
27 August	1C	51 (± 39)	17	162	16	3.2
	2A	247 (± 148)	83	869	84	3.5
	3A	0.5 (± 0.5)	0	1.2	0	2.4
	3D	0.2 (± 0.1)	0	0.6	0	3.0
	Total	299		1034		3.5
17 Sept.	1A	242 (± 68)	100	702	100	2.8
8 Oct.	1A	1 (± 1)	6	3	5	3.0
	1C	2 (± 2)	12	5	9	2.5
	2A	13 (± 28)	82	50	86	3.8
	Total	17		58		3.6
30 Oct.	1A	69 (± 100)	22	171	25	2.5
	1C	239 (± 176)	77	520	75	2.2
	2A	0.6 (± 1)	1	2	0	3.3
	Total	309		693		2.2
19 Nov.	1A	39 (± 8)	93	99	95	2.5
	3A	1 (± 2)	2	2	2	2.0
	3D	2 (± 2)	5	3	3	1.5
	Total	42		104		2.5
10 Dec.	1C	80 (± 39)	93	263	85	3.3
	3A	19 (± 7)	3	43	14	2.3
	3D	.3 (± 5)	3	1	0.5	3.3
	3E	0.3 (± 0.6)	1	1	0.5	3.3
	Total	100		308		3.1
31 Dec.	1C	100 (± 46)	98	301	99	3.0
	2A	0.5 (± 0.7)	0.6	1	0.2	2.0
	3D	0.5 (± 0.7)	0.6	1	0.2	2.0
	3I	0.7 (± 1)	0.7	2	0.6	2.1
	Total	102		305		3.0

Table 1. cont'd

		Biomass		Energetics		Ratio
Date	Species	Component	Percent	Component	Percent	E to B
1983						
21 Jan.	2C	372 (± 76)	94	706	93	1.9
	3D	14 (± 22)	4	31	4	2.2
	3I	10 (± 15)	2	26	3	2.6
	Total	396		763		1.9
11 Feb.	1C	98 (± 37)	81	217	84	2.2
	2C	5 (± 8)	4	8	3	1.6
	3D	0.4 (± 0.6)	0.5	1	0.5	2.5
	3E	0.4 (± 0.8)	0.5	1	0.5	2.5
	3I	17 (± 16)	14	30	12	1.8
	Total	121		257		2.1
4 March	1C	216 (± 152)	82	476	68	2.2
	2C	74 (± 56)	11	157	22	2.1
	3D	11 (± 5)	1	31	4	2.8
	3E	3 (± 1)	0	8	1	2.7
	3H	2 (± 0.8)	0	3	1	1.5
	3I	15	6	31	4	2.1
	Total	321		698		2.2
25 March	1C	401 (± 238)	95	561	79	1.4
	3D	38 (± 17)	2	104	15	2.7
	3I	14 (± 13)	3	48	6	3.4
	Total	453		713		1.6
15 April	1C	322 (± 114)	96	451	91	1.4
	3D	5 (± 6)	0	17	3	3.4
	3E	1 (± 1)	1	4	1	4.0
	3I	9 (± 2)	3	24	5	2.7
	Total	337		496		1.5
6 May	1C	362 (± 208)	88	1521	85	4.2
	3D	25 (± 11)	1	70	4	2.8
	3E	8 (± 4)	1	31	2	3.9
	3I	52 (± 45)	10	177	9	3.4
	Total	459		1799		3.9
27 May	1A	151 (± 65)	52	661	66	4.4
	2A	133 (± 55)	45	306	30	2.3
	3A	8 (± 7)	1	20	2	2.5
	3D	3 (± 2)	1	9	1	3.0
	3I	7 (± 5)	1	21	1	3.0
	Total	304		1021		3.4

Table 1. cont'd

Date	Species	Biomass		Energetics		Ratio
		Component	Percent	Component	Percent	E to B
17 June	1A	27 (± 29)	17	110	26	4.1
	1C	75 (± 54)	48	198	47	2.6
	2C	38 (± 28)	25	77	18	2.0
	3A	15 (± 25)	10	33	8	2.2
	Total	155		418		2.7
8 July	1A	211 (± 141)	50	395	32	1.9
	1C	113 (± 51)	5	192	15	1.7
	2A	136 (± 148)	32	256	21	1.9
	3A	207 (± 93)	10	332	27	1.6
	3D	45 (± 20)	3	68	5	1.5
	Total	712		1243		1.7

Table 2. Mean and percent biomass (g $dwt^{-1}m^{-2}$) and energetics ($kilocal.^{-1}m^{-2}$) of the three plant components (seagrasses, attached algae, drift algae) of a seagrass bed in Anna Maria Island Sound at the mouth of Tampa Bay, Florida. See Table 1 for sample sizes, standard deviations, code to species and ratio.

		Biomass		Energetics		Ratio
Date	Species	Component	Percent	Component	Percent	E to B
1982						
17 May	1B	59 (± 44)	11	249	27	4.2
	1C	151 (± 50)	70	468	50	3.1
	3J	110 (± 53)	19	221	23	2.0
	Total	320		938		2.9
13 June	1A	174 (± 49)	72	557	73	3.2
	1B	10 (± 21)	4	31	4	3.1
	1C	21 (± 42)	9	65	9	3.1
	3D	5 (± 7)	2	10	1	2.0
	3H	6 (± 11)	2	17	2	2.8
	3J	25 (± 6)	11	78	11	3.1
	Total	241		758		3.1
25 June	1A	29 (± 65)	24	97	29	3.3
	1B	32 (± 38)	26	51	16	1.6
	1C	60 (± 48)	49	176	53	2.9
	3D	0.4 (± 0.4)	0	1	1	2.5
	3J	1 (± 2)	1	4	1	4.0
	Total	122		329		2.7
16 July	1A	98 (± 88)	60	306	62	3.1
	1B	10 (± 11)	6	30	6	3.0
	1C	53 (± 100)	32	154	31	2.9
	3D	1 (± 3)	1	3	2	3.0
	3J	2 (± 5)	1	2	1	1.0
	Total	164		495		3.0
6 August	1A	136 (± 73)	60	369	54	2.7
	1B	16 (± 17)	7	52	8	3.3
	1C	69 (± 105)	31	249	36	3.6
	3D	4 (± 8)	2	17	2	4.3
	Total	225		687		3.1
27 August	1A	220 (± 54)	98	747	98	3.4
	1B	3 (± 5)	1	9	1	3.0
	1C	1 (± 2)	1	3	1	3.0
	3A	<0.1	0	0.1	0	1.0
	3D	0.6 (± 1)	0	2	0	3.3
	Total	224		761		3.4

Table 2. (Cont'd)

		Biomass		Energetics		Ratio
Date	Species	Component	Percent	Component	Percent	E to B
17 Sept.	1A	107 (± 44)	61	300	84	2.8
	1B	3 (± 5)	2	10	2	3.3
	1C	15 (± 119)	35	43	12	2.9
	3A	2 (± 5)	1	4	1	2.0
	3D	2 (± 1)	1	2	1	1.0
	Total	131		359		2.7
8 October	1A	132 (± 66)	42	246	49	1.9
	1B	23 (± 26)	7	70	14	3.0
	1C	144 (± 165)	46	156	31	1.1
	3A	0.2 (± 1)	2	0.4	0	2.0
	3D	12 (± 21)	4	31	6	2.6
	3I	0.2 (± 0.5)	1	0.5	0	2.5
	Total	312		504		1.6
30 October	1A	117 (± 157)	53	413	60	3.5
	1B	41 (± 67)	19	116	17	2.8
	1C	48 (± 64)	22	125	18	2.6
	3A	0.7 (± 2)	1	1	0.5	1.4
	3D	6 (± 10)	3	14	2	2.3
	3H	5 (± 12)	3	13	2	2.6
	3J	1 (± 2)	1	1	0.5	1.0
	Total	219		683		3.1
19 Nov.	1A	172 (± 52)	88	499	88	2.9
	3D	22 (± 25)	11	62	11	2.8
	3J	2 (± 4)	1	3	1	1.5
	Total	196		564		2.9
10 Dec.	1A	206 (± 74)	48	475	62	2.3
	1B	20 (± 18)	6	54	7	2.7
	3D	203 (± 216)	46	242	31	1.2
	Total	429		771		
31 Dec.	1A	814 (± 167)	96	1710	95	2.1
	3A	1 (± 2)	0	1	0	1.0
	3D	26 (± 28)	3	65	3	2.5
	3I	8 (± 12)	1	19	1	2.4
	Total	849		1795		2.1
1983 21 Jan.	1A	192 (± 167)	78	422	85	2.2
	1B	40 (± 64)	16	41	8	1.0
	3D	5 (± 5)	2	13	2	2.6
	3H	8 (± 7)	4	19	4	2.4
	Total	245		495		2.0
11 Feb.	1A	117 (± 112)	65	282	64	2.4
	1B	42 (± 41)	23	118	27	2.8
	3D	7 (± 6)	6	16	5	2.3
	3H	6 (± 6)	6	13	4	2.2
	Total	179		444		2.5

Table 2. (Cont'd)

		Biomass		Energetics		Ratio
Date	Species	Component	Percent	Component	Percent	E to B
4 March	1A	115 (± 128)	45	378	50	3.3
	1B	47 (± 47)	18	140	19	3.0
	3D	95 (± 75)	37	237	31	2.5
	Total	256		755		2.9
25 March	1A	110 (± 93)	67	329	59	3.0
	1B	30 (± 20)	11	95	17	3.2
	1C	15 (± 10)	3	48	9	3.2
	3D	5 (± 3)	1	14	3	2.8
	3H	29 (± 9)	18	68	12	2.3
	Total	191		554		2.9
15 April	1A	405 (± 134)	81	1057	70	2.6
	1B	91 (± 41)	4	256	17	2.8
	3H	77 (± 32)	15	190	13	2.5
	Total	573		1503		2.6
6 May	1A	793 (± 97)	100	952		1.2
27 May	1A	838 (± 447)	84	2850	77	3.4
	1B	231 (± 127)	15	831	22	3.6
	3A	3 (± 1)	0	4	0	1.3
	3D	6 (± 6)	1	16	1	2.7
	Total	1078		3701		3.4
17 June	1A	748 (± 124)	100	1496		2.0
8 July	1A	808 (± 136)	99	1616	99	2.0
	3A	5 (± 2)	0	10	0.5	2.0
	3D	6 (± 9)	1	7	0.5	1.2
	Total	819		1633		2.0

Table 3. Mean and percent biomass (g dwt^{-1} m^{-2}) and energetics (kilocal.$^{-1}$m^{-2}) of the three plant components (seagrasses, attached algae, drift algae) of a seagrass bed off Indian Bluff Island on the west coast of Florida. See Table 1 for sample sizes, standard deviation, code to species and ratio.

Date	Species	Biomass Component	Biomass Percent	Energetics Component	Energetics Percent	Ratio E to B
1982						
17 May	1A	270 (± 126)	70	738	62	2.7
	1B	2 (± 4)	0.5	6	2	3.0
	1C	2 (± 5)	0.5	3	1	1.5
	2D	22 (± 31)	5	71	6	3.2
	3F	91 (± 144)	24	363	31	4.0
	Total	387		1181		3.1
13 June	1A	346 (± 120)	44	1115	59	3.2
	1B	49 (± 66)	6	79	4	1.6
	1C	16 (± 26)	2	55	2	3.4
	2B	7 (± 4)	1	21	1	3.0
	2D	5 (± 91)	6	10	1	2.0
	2F	6 (± 8)	1	8	1	1.3
	3F	312 (± 168)	40	592	31	1.9
	Total	734		1880		2.6
25 June	1A	207 (± 73)	10	558	28	2.7
	1B	30 (± 31)	4	90	5	3.0
	1C	40 (± 58)	5	88	4	2.2
	2D	18 (± 41)	3	47	2	2.6
	2E	81 (± 46)	11	80	4	1.0
	3C	1 (± 2)	0	3	0	3.0
	3F	496 (± 514)	67	1092	56	2.2
	Total	873		1958		2.2
16 July	1A	185 (± 163)	22	574	43	3.1
	1B	25 (± 37)	6	80	6	3.2
	1C	35 (± 60)	8	97	7	2.8
	2B	7 (± 12)	2	27	2	3.9
	2D	44 (± 39)	10	61	5	1.4
	2F	27 (± 28)	6	38	3	1.4
	3F	200 (± 259)	46	443	34	2.2
	Total	523		1320		2.5
6 Aug.	1A	322 (± 208)	68	965	77	3.0
	1C	12 (± 24)	3	41	3	3.[illegible]
	2B	18 (± 17)	4	52	4	2.9
	2D	39 (± 48)	8	55	4	1.4
	3F	86 (± 161)	18	147	12	1.7
	Total	477		1260		2.6

Table 3. cont'd

Date	Species	Biomass		Energetics		Ratio
		Component	Percent	Component	Percent	E to B
27 Aug.	1A	383 (± 393)	69	1302	76	3.4
	1B	45 (± 78)	8	145	8	3.2
	1C	45 (± 100)	8	143	8	3.2
	2B	2 (± 4)	0	4	0	2.0
	2D	62 (± 65)	11	100	6	1.6
	3F	18 (± 28)	3	30	2	1.7
	Total	555		1724		3.1
17 Sept.	1A	210 (± 197)	48	671	56	3.2
	1C	157 (± 261)	36	373	31	2.4
	2C	4 (± 7)	1	8	1	2.0
	2D	21 (± 20)	5	74	6	3.5
	2F	8 (± 17)	2	11	1	1.4
	3F	36 (± 38)	8	68	6	1.9
	Total	436		1205		2.8
8 Oct.	1A	135 (± 109)	48	443	55	3.3
	1B	27 (± 25)	10	61	8	2.3
	1C	47 (± 82)	17	152	19	3.2
	2D	37 (± 33)	13	36	4	1.0
	2F	9 (± 20)	3	12	1	1.3
	3F	25 (± 42)	10	97	12	3.9
	Total	280		801		2.9
30 Oct.	1A	296 (± 90)	83	1279	91	4.3
	1B	14 (± 30)	4	37	3	2.6
	2B	3 (± 6)	1	7	0.5	2.3
	2D	20 (± 24)	6	28	2	1.4
	2F	4 (± 10)	1	6	0.5	1.5
	3F	21 (± 24)	6	46	3	2.2
	Total	358		1403		3.9
19 Nov.	1A	161 (± 153)	70	402	72	2.5
	1B	15 (± 5)	0.7	45	8	3.0
	1C	1 (± 3)	0.3	4	1	4.0
	2D	13 (± 29)	6	23	4	1.8
	3F	52 (± 42)	23	83	15	1.6
	Total	242		557		2.3
10 Dec.	1A	250 (± 237)	45	385	39	1.5
	1B	35 (± 52)	6	37	4	1.0
	1C	2 (± 4)	0.3	6	1	3.0
	3F	264 (± 240)	48	459	46	1.7
	3H	4 (± 8)	0.7	8	1	2.0
	Total	555		795		1.8

Table 3. cont'd

Date	Species	Biomass Component	Biomass Percent	Energetics Component	Energetics Percent	Ratio E to B
31 Dec.	1A	438 (± 359)	75	875	76	2.0
	1B	24 (± 34)	4	59	5	2.5
	1C	5 (± 11)	1	10	1	2.0
	2D	34 (± 51)	6	38	3	1.1
	3F	68 (± 43)	12	137	12	2.0
	3H	12 (± 26)	2	25	2	2.1
	Total	581		1144		2.0
1983 21 Jan.	1A	275 (± 66)	66	664	61	2.4
	3F	139 (± 81)	34	432	39	3.1
	Total	414		1096		2.6
11 Feb.	1A	156 (± 129)	77	280	73	1.8
	1B	9 (± 21)	4	26	7	2.9
	1C	14 (± 32)	7	23	7	1.6
	3F	23 (± 29)	11	54	13	2.3
	Total	202		383		1.9
4 March	1A	176 (± 103)	72	549	58	3.1
	1B	9 (± 4)	1	25	3	2.8
	2B	19 (± 8)	3	52	6	2.7
	2D	26 (± 117)	21	288	31	1.1
	3F	10 (± 8)	4	25	2	2.5
	Total	476		939		2.0
25 March	1A	213 (± 130)	81	342	48	1.6
	1B	83 (± 54)	10	257	36	3.1
	1C	9 (± 4)	1	24	3	2.7
	2D	42 (± 30)	6	85	12	2.0
	3F	4 (± 5)	2	11	2	2.8
	Total	351		719		2.0
15 April	1A	234 (± 55)	56	468	60	2.0
	1B	63 (± 37)	6	144	18	2.3
	3F	157 (± 181)	38	168	22	1.1
	Total	454		780		1.7
6 May	1A	576 (± 24)	73	639	56	1.1
	1B	99 (± 220)	13	200	18	2.0
	2B	22 (± 26)	3	88	8	4.0
	2D	56 (± 126)	7	124	11	2.2
	3F	38 (± 18)	4	91	8	2.4
	Total	791		1142		1.4

Table 3. cont'd

Date	Species	Biomass Component	Biomass Percent	Energetics Component	Energetics Percent	Ratio E to B
27 May	1A	399 (± 240)	64	955	65	2.4
	1B	36 (± 16)	11	111	7	3.1
	2B	19 (± 11)	3	42	3	2.2
	2D	41 (± 50)	7	49	3	1.2
	2F	14 (± 7)	1	27	2	1.9
	3F	151 (± 66)	24	363	23	2.4
	Total	660		1547		2.3
17 June	1A	136 (± 202)	56	517	66	3.2
	1B	84 (± 20)	3	76	10	1.0
	1C	44 (± 86)	21	44	6	1.0
	2B	15 (± 15)	5	58	7	3.9
	2D	16 (± 7)	1	14	2	1.0
	3F	38 (± 34)	13	76	10	2.0
	Total	345		785		2.3
8 July	1A	218 (± 149)	69	559	59	2.6
	1B	49 (± 105)	16	219	23	4.5
	1C	12 (± 22)	4	52	5	4.3
	2B	18 (± 29)	6	70	7	3.9
	3F	18 (± 26)	6	48	5	2.7
	Total	315		948		3.0

Table 4. Mean and percent biomass (g dwt^{-1}m^{-2}) and energetics (kilocal.$^{-1}$m^{-2}) of the three plant components (seagrasses, attached algae, drift algae) of a seagrass bed in Anclote River anchorage on the west coast of Florida. See Table 1 for sample sizes, standard deviations, code to species and ratio.

Date		Biomass		Energetics		Ratio
1982-83	Species	Component	Percent	Component	Percent	E to B
29 June	1A	326 (± 94)	91	914	78	2.8
	1B	26 (± 30)	7	78	7	3.0
	2B	56 (± 7)	1	179	15	3.2
	3J	2 (± 1)	1	6	0	3.0
	Total	410		1177		3.3
10 Sept.	1A	45 (± 62)	17	139	13	3.1
	1B	170 (± 152)	63	443	40	2.6
	1C	176 (± 78)	20	527	47	3.0
	3F	0.3 (± 0.5)	0	1	0	3.3
	Total	391		1110		2.8
20 Nov.	1A	206 (± 103)	81	536	81	2.6
	1B	18 (± 18)	7	68	10	3.8
	3F	14 (± 9)	5	32	5	2.3
	3J	17 (± 32)	7	28	4	1.6
	Total	255		644		2.6
28 Jan.	1A	155 (± 74)	56	404	64	2.6
	1B	44 (± 47)	16	63	1	1.4
	1C	11 (± 24)	4	35	6	3.2
	3F	67 (± 36)	24	128	29	1.9
	Total	277		630		2.3
1 April	1A	29 (± 34)	16	124	17	4.3
	1B	49 (± 43)	26	175	25	3.6
	1C	9 (± 21)	9	118	17	4.1
	2B	84 (± 54)	45	270	38	3.2
	3F	5 (± 7)	3	21	3	4.2
	3J	0.8 (± 0.4)	0	2	0	2.5
	Total	197		710		3.9
23 May	1A	255 (± 122)	68	766	59	3.0
	1B	82 (± 73)	13	269	21	3.3
	1C	8 (± 6)	1	27	2	3.4
	2B	32 (± 42)	9	151	12	4.7
	3B	29 (± 27)	8	57	4	2.0
	3F	140 (± 9)	2	31	2	2.2
	Total	420		1301		3.1
29 July	1A	342 (± 240)	57	444	53	1.3
	1B	116 (± 70)	19	175	21	1.5
	1C	113 (± 118)	19	161	19	1.4
	3F	34 (± 10)	6	50	6	1.5
	Total	605		830		1.4

120e

Table 5. Mean and percent biomass (g dwt^{-1}m^{-2}) and energetics (kilocal.$^{-1}$m^{-2}) of the three plant components (seagrasses, attached algae, drift algae) of a seagrass bed off Seahorse Key channel near Cedar Key, on the west coast of Florida. See Table 1 for sample sizes, standard deviations, code to species and ratio.

Date 1982-83	Species	Biomass		Energetics		Ratio E to B
		Component	Percent	Component	Percent	
29 June	1A	386 (± 63)	79	926	78	2.4
	1B	94 (± 60)	19	225	19	2.4
	1C	9 (± 19)	2	28	3	3.1
	3J	0.4 (± 0.1)	0	1	0	2.5
	Total	489		1180		2.4
24 Sept.	1A	105 (± 65)	31	220	30	2.1
	1B	212 (± 128)	63	446	62	2.1
	3D	0.5 (± 1)	0	1	0	2.0
	3E	19 (± 21)	6	55	8	2.9
	3F	1 (± 1)	0	2	0	2.0
	Total	338		724		2.1
20 Nov.	1A	52 (± 68)	47	115	38	2.2
	1B	52 (± 51)	47	145	48	2.8
	1C	0.3 (± 0.7)	0.4	1	0.5	3.3
	3D	0.5 (± 0.6)	0.6	1	0.5	2.0
	3F	19 (± 6)	5	39	13	2.1
	Total	124		301		2.4
28 Jan.	1A	34 (± 11)	62	100	60	2.9
	1B	20 (± 9)	36	64	39	3.2
	3F	0.3 (± 0.5)	1	0.6	0	2.0
	3J	1 (± 2)	1	1	1	1.0
	Total	55		166		3.0
1 April	1A	18 (± 8)	37	56	35	3.1
	1B	31 (± 14)	63	106	65	3.4
	Total	49		162		3.3
23 May	1B	256 (± 102)	100	819	99	3.2
	3E	1.0 (± 0.5)	0	3	1	3.0
	Total	256		822		3.2
29 July	1A	409 (± 151)	71	1189	65	2.9
	1B	171 (± 220)	29	647	35	3.8
	Total	580		1836		3.2

Table 6. Mean and percent biomass (g dwt^{-1}m^{-2}) and energetics (kilocal.$^{-1}$m^{-2}) of the three plant components (seagrasses, attached algae, drift algae) of a seagrass bed in Weeki Wachee River Bay on the west coast of Florida. See Table 1 for sample sizes, standard deviations, code to species and ratio.

Date 1982-83	Sepcies	Biomass Component	Biomass Percent	Energetics Component	Energetics Percent	Ratio E to B
29 June	1A	83 (± 39)	72	267	75	3.2
	2B	4 (± 9)	3	10	3	2.5
	2E	10 (± 21)	9	32	9	3.2
	3J	18 (± 8)	16	46	13	2.6
	Total	115		355		3.1
10 Sept.	1A	101 (± 62)	99	275	99	2.7
	1C	0.5 (± 1)	0.7	2	0.7	4.0
	3F	0.4 (± 0.2)	0.3	0.7	0.3	1.8
	Total	103		278		2.7
20 Nov.	1A	130 (± 135)	99	311	99	2.4
	3C	0.2 (± 0.4)	1	1	1	5.0
	Total	130		312		2.4
28 Jan.	1A	187 (± 78)	80	242	86	1.3
	2A	7 (± 16)	3	12	4	1.7
	3C	5 (± 11)	2	10	4	2.0
	3F	6 (± 13)	2	14	5	2.3
	3G	4 (± 37)	12	9	3	2.3
	Total	209		282		1.3
1 April	1A	167 (± 86)	74	434	91	2.6
	3C	2 (± 1)	1	6	1	3.0
	3F	49 (± 37)	23	133	7	2.7
	3H	5 (± 6)	2	6	1	1.2
	Total	223		579		2.5
23 May	1A	51 (± 29)	41	152	42	3.0
	3C	1 (± 3)	1	18	5	3.0
	3F	72 (± 30)	58	191	53	2.7
	Total	125		361		2.9
29 July	1A	108 (± 49)	51	237	70	2.2
	3J	102 (± 42)	49	103	30	1.0
	Total	210		340		1.6

Table 7. Mean and percent biomass (g dwt^{-1}m^{-2}) and energetics (Kilocal.$^{-1}$m^{-2}) of the three plant components (seagrasses, attached algae, drift algae) of a seagrass bed in Homosossa River Bay on the west coast of Florida. See Table 1 for sample size, standard deviations, code to species, and ratio.

Date		Biomass		Energetics		Ratio
1982-83	Species	Component	Percent	Component	Percent	E to B
30 June	1A	345 (± 502)	32	1103	28	3.2
	1B	560 (± 306)	52	1849	47	3.3
	2A	132 (± 12)	1	464	12	3.5
	3C	3 (± 7)	0	8	0	2.7
	3J	162 (± 106)	15	487	12	3.0
	Total	1202		3911		3.3
10 Sept.	1A	282 (± 248)	50	816	49	2.9
	1B	259 (± 183)	46	804	48	3.1
	3A	10 (± 15)	2	32	2	3.2
	3J	9 (± 13)	2	22	1	2.4
	Total	560		1674		3.0
20 Nov.	1A	200 (± 379)	49	514	43	2.6
	1B	206 (± 63)	50	660	56	3.2
	3F	3 (± 6)	1	7	1	2.3
	Total	409		1171		2.9
28 Jan.	1A	180 (± 123)	40	448	41	2.5
	1B	141 (± 130)	31	286	26	2.0
	2A	76 (± 58)	17	234	21	3.1
	3C	0.7 (± 1)	1	2	0	2.9
	3F	50 (± 65)	11	133	12	2.7
	Total	448		1103		2.5
1 April	1A	418 (± 52)	41	955	61	2.3
	1B	137 (± 76)	48	467	30	3.4
	2A	19 (± 23)	7	88	6	4.6
	3C	2 (± 2)	0	7	1	3.5
	3F	11 (± 10)	4	20	1	1.8
	3G	9 (± 3)	0	21	1	2.3
	Total	596		1558		2.6
23 May	1A	147 (± 123)	16	485	28	3.3
	1B	270 (± 213)	73	1078	62	4.0
	2A	18 (± 25)	5	71	4	3.9
	3C	4 (± 2)	0	6	1	1.5
	3F	11 (± 13)	3	53	3	4.8
	3G	11 (± 8)	3	34	2	3.1
	Total	462		1727		3.7
29 July	1A	632 (± 204)	59	1075	63	1.7
	1B	148 (± 349)	28	296	17	2.0
	2A	129 (± 101	12	322	19	2.5
	3F	3 (± 5)	1	14	1	4.7
	Total	912		1707		1.9

Table 8. Water temperature, T, and salinity, S, for seven seagrass beds on the west coasts of Florida (see Fig. 8 and 9 for code to sites).

	SITES													
	CRB		AMI		IBI		ANR		WWR		HSR		CDK	
	T	S	T	S	T	S	T	S	T	S	T	S	T	S
1982														
17 May	26	30	26	36	28	33								
13 June	29	27	30	34	30	33								
25 June	27	24	28	34	28	28								
29 June							32	26	32	14	30	26	28	25
16 July	29	25	30	35	29	34								
6 Aug	27	22	28	32	29	32								
27 Aug	29	24	30	32	32	29								
10 Sep							27	28	27	7	25	16	27	27
17 Sep	29	26	29	33	28	32								
8 Oct	30	21	28	32	28	29								
29 Oct	22	24	21	29	20	26								
19 Nov	-	27	-	31	-	28								
20 Nov							23	28	24	14	22	18	20	30
10 Dec	22	28	22	31	20	32								
31 Dec	18	28	21	34	20	31								
1983														
21 Jan	19	26	15	32	15	30								
28 Jan							16	30	14	21	14	18	12	28
11 Feb	17	21	17	32	15	28								
4 Mar	20	20	18	32	17	28								
25 Mar	17	27	15	31	12	25								
1 Apr							19	25	19	12	17	20	16	23
15 Apr	25	28	23	33	22	30								
6 May	24	22	21	32	19	28								
23 May							29	33	28	16	26	16	28	27
27 May	28	30	28	35	26	31								
17 June	28	26	28	32	27	32								
8 July	30	25	29	34	30	32								
29 July							30	31	28	11	28	26	29	27

Table 9. The mean standing stock ± 1 standard deviation (SS ± S.E.) expressed as grams dry weight^{-1}m^{2}, percent of the total standing stock (TSS) and seasonal ranges (highest and lowest dry wt^{-1}m^{2}) of *Thalassia testudinum*, all seagrasses, all seaweeds (drift and attached algae), and total biomass over the 14 month study (May, 1982 to July, 1983) of seven seagrass beds on the west coast of Florida. The seven west coast sites were Cockroach Bay (CRB) in Tampa Bay, Anna Maria Sound (AMI) at the mouth of Tampa Bay and 5 open coast sites: Indian Bluff Island (IBI), Anclote River Anchorage (ANR), Weeki Wachee River Bay (WWR), Homosassa River Bay (HSR), and at Seahorse Key off Cedar Key (CDK).

Site	*Thalassia testudinum*				All Seagrasses				All Seaweeds				Total Standing Stock		
	Mean SS	± SE	Percent of TSS	Seas. range	Mean SS	± SE	Percent of TSS	Seas. range	Mean SS	± SE	Percent of TSS	Seas. range	Mean TSS	± SE	Seasonal range
CRB	47	75	20	242-0	156	124	677	401-0	89	12	39	396-0	231	174	712-17
AMI*	302	297	78	838-0	357	296	92	1069-121	37	50	9	110-0	386	297	1078-122
IBI*	266	112	56	576-135	321	123	67	411-62	143	135	30	596-23	477	178	873-202
ANR*	194	125	53	342-29	311	155	85	571-87	69	65	19	201-31	365	136	605-191
WWR*	118	47	74	187-51	119	47	76	187-51	41	38	26	102-0	159	52	223-103
HSR*	315	170	48	632-147	535	242	82	905-321	95	102	14	297-3	656	294	1202-409
CDK*	180	168	67	409-0	264	212	98	580-49	6	9	2	20-0	270	210	580-49
*Mean of Thalassia Dominated Sites.	229	77	59		320	136	83		69	46	18		389	171	

Table 10. Means and seasonal range of standing stock (SS g dry $\text{wt}^{-1}\text{m}^{2}$) of <u>Thalassia</u> <u>testudinum</u> as reported in previous studies.

Site	Mean SS	Seasonal Range	Reference.
Texas	373	(summer only)	Odum (1963)
Florida			
west coast	700	(summer only)	Bauersfeld et al. (1969)
Boca Ciega Bay	81		Pomeroy (1960)
Boca Ciega Bay	80	1198-320 (Aug.)	Taylor and Saloman (1969)
Tarpon Springs		820-601	Dawes et al. (1979)
Bear Cut, Miami	830	1800-700	Jones (1968)
Biscayne Bay, Miami	126(inshore)	230-30	Zieman (1975)
Biscayne Bay, Miami	280(offshore)	650-80	Zieman (1975)
Cuba	340(sheltered)	517-240 (Aug.)	Buesa (1972,1974)
	80(exposed)	80-76 (Aug.)	Buesa (1971-1974)
St. Croix	77		Zieman et al. (1979)
Jamiaca	249	330-170	Greenway (1976)
Puerto Rico	80		Burkholder et al. (1959)

Table 11. Means and seasonal range (summer only) of standing stock (SS g dry wt^{-1}m^{2}) of *Zostera marina* as reported in previous studies.

Site	Mean SS	Seasonal Range	Reference
Denmark, Vellerup Vig		226 (Aug.)-58 (Mar.)	Sand-Jensen (1975)
		226 (Aug.)-12 (Apr.)	Sand-Jensen (1983)
		920-272	Peterson (1914)
		487-210	Grøntved (1957)
Russa-Bering Sea		895-31	Vozzhinskaya (1964)
Russa-Black Sea		550-166	Zenkevitch (1963)
France, Roscoff		260-92	Jacobs (1979)
North America			
Massessuchtus		29-5	Conover (1958)
Rhode Island		175 (Aug.)-2 (Apr.)	Thorne-Miller et al. (1983)
Chesapeake Bay		225 (July)-50 (Apr.)	Wetzel and Penhale (1983)
New York		2445-133	Burkholder and Dohney (1968)
New Jersey		426-110	Moeller (1964)
North Carolina	172	335-50	Thayer et al. (1977)
Japan		235-70	Kitz and Harada (1962)
Alaska	466	1840-62	McRoy (1970)
California		421-32	Keller and Harris (1966)

Figures 1-7. Bimonthly means of seagrass biomass (solid line, g dry wt.$^{-1}$ m^{-2}) and energetics (dashed line, kcal^{-1} m^{-2}) for seven sites on the west coast of Florida. Circles are equal to no more than 1/2 a S.D., the white portion of the circle shows percent of the dominant seagrass and the black portion the percent of other seagrass species.

Figure 1. *Halodule wrightii* at Cockroach Bay (CRB) mouth in Tampa Bay Florida based on means of triweekly collections. Another seagrass, *Thalassia testudinum* was dominant in May and June, 1982 and again in July, 1983.

Figure 2. *Thalassia testudinum* at Anna Maria Island Sound (AMI) at the mouth of Tampa Bay, Florida based on means of triweekly collections. *Syringodium filiforme* beds occurred intermixed with *T. testudinum* and these beds were randomly sampled in the spring and fall of 1982.

Figure 3. *Thalassia testudinum* at Indian Bluff Island (IBI) on the west coast of Florida based on means of triweekly collections. Although a mixed bed occurred, *T. testudinum* dominated throughout the study.

Figure 4. *Thalassia testudinum* at Anclote River anchorate (ANR) on the west coast of Florida based on means from biomonthly collections. The seagrass bed is a mixture of the three species.

Figure 5. *Thalassia testudinum* at Cedar Key on the Seahorse Key channel(CDK) on the west coast of Florida based on means of bimonthly samplings. *Syringodium filiforme* is a codominant at the site.

Figure 6. Thalassia testudinum at Weeki Wachee River Bay (WWR) on the west coast of Florida based on bimonthly samplings. The low salinity site supports pure stands of the seagrass.

Figure 7. Thalassia testudinum at Homosassa River Bay (HSR) on the west coast of Florida based on bimonthly collections. Syringodium filiforme occurred as well.

Figure 8 and 9. Proximate constituents of the dominant seagrass from seven sites on the west coast of Florida expressed as bimonthly means. Ash (A), soluble and insoluble carbohydrate (C), protein (dark portion of circle) and lipid (line) are expressed as percents of the circle and kilocalories are given in parentheses below for each bimonthly mean.

Figure 8. Proximate constituents of the dominant seagrasses for three sites near Tampa Bay: Indian Bluff Island (IBI) on the west coast, Anna Maria Island Sound (AMI) at the mouth of Tampa Bay, and Cockroach Bay mouth (CRB) in Tampa Bay. Data is based on means of triweekly collections.

Figure 9. Proximate constituents of the dominant seagrasse, Thalassia testudinum, for four sites on the west coast of Florida: Anclote River anchorage (ANR), Weeki Wachee River Bay (WWR), Homosassa River Bay (HSR), and Seahorse Key channel at Cedar Key (CDK). Data is based on means of bimonthly collections.

Figure 10 and 11. Bimonthly means of the dominant seaweek biomass (Fig. 10, g dry wt.$^{-1}$ m^{-2}) and energetics (Fig. 11, kcal^{-1} m^{-2}) at three sites near Tampa Bay (see Fig. 8 for code to sites). Circles are no more than 1/2 a S.D. and the bimonthly means are based on triweekly samplings.

Figure 12. Proximate constituents of the dominant drift seaweeds from the three sites near Tampa Bay, Florida. See Fig. 8 for code to graph and sites.

Figure 13 and 14. Mean biomass (Fig. 13, g dry wt.$^{-1}$ m^{-2}) and energetics (Fig. 14, kcal^{-1} m^{-2}) of all macrophytic components for the three seagrass beds near Tampa Bay, Florida based on means of triweekly collections. Seagrass (S), drift seaweeds (D), and attached algae (dark portion of circle) are presented as percent of the circle with mean total biomass (Fig. 13) and energetics (Fig. 14) given in parentheses below each mean. See Fig. 8 for code to sites.

Figure 15 and 16. Mean biomass (Fig. 15, g dry wt.$^{-1}$ m^{-2}) and energetics (Fig. 16, kcal^{-1} m^{-2}) of all macrophytic components for four seagrass beds on the west coast of Florida. See Fig. 13 and 14 for code to circles and Fig. 9 for code to sites.

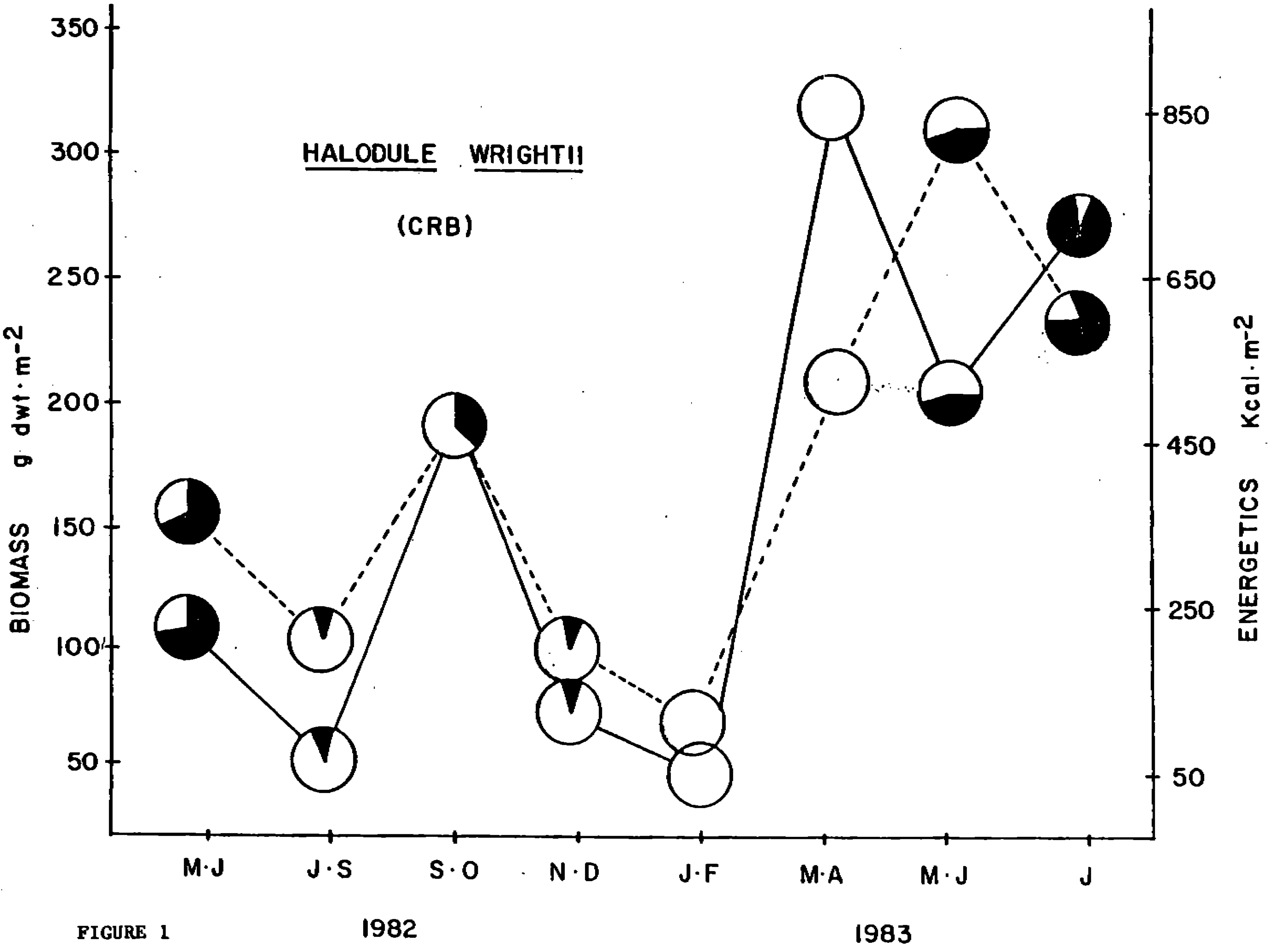
HALODULE WRIGHTII
(CRB)
BIOMASS g dwt·m-2
ENERGETICS Kcal·m-2
350
300
250
200
150
100
50
850
650
450
250
50
M·J
J·S
S·O
N·D
J·F
M·A
M·J
J
1982
1983

FIGURE 1

20F/

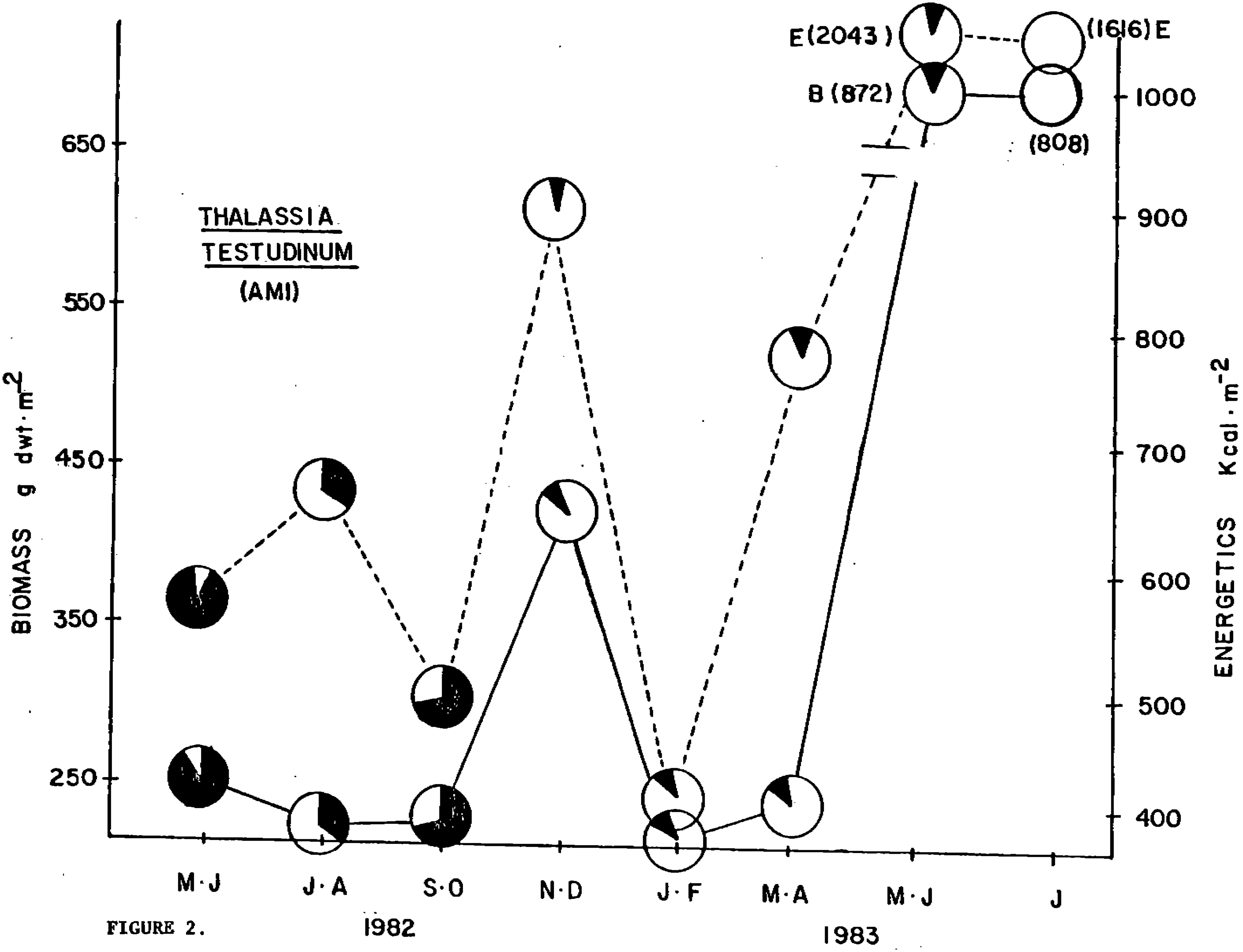
THALASSIA
TESTUDINUM
(AMI)
BIOMASS g dwt · m^{-2}
650
550
450
350
250
ENERGETICS Kcal · m^{-2}
1000
900
800
700
600
500
400
E(2043)
B (872)
(1616) E
(808)
M · J
J · A
S · O
N · D
J · F
M · A
M · J
J
1982
1983

FIGURE 2.

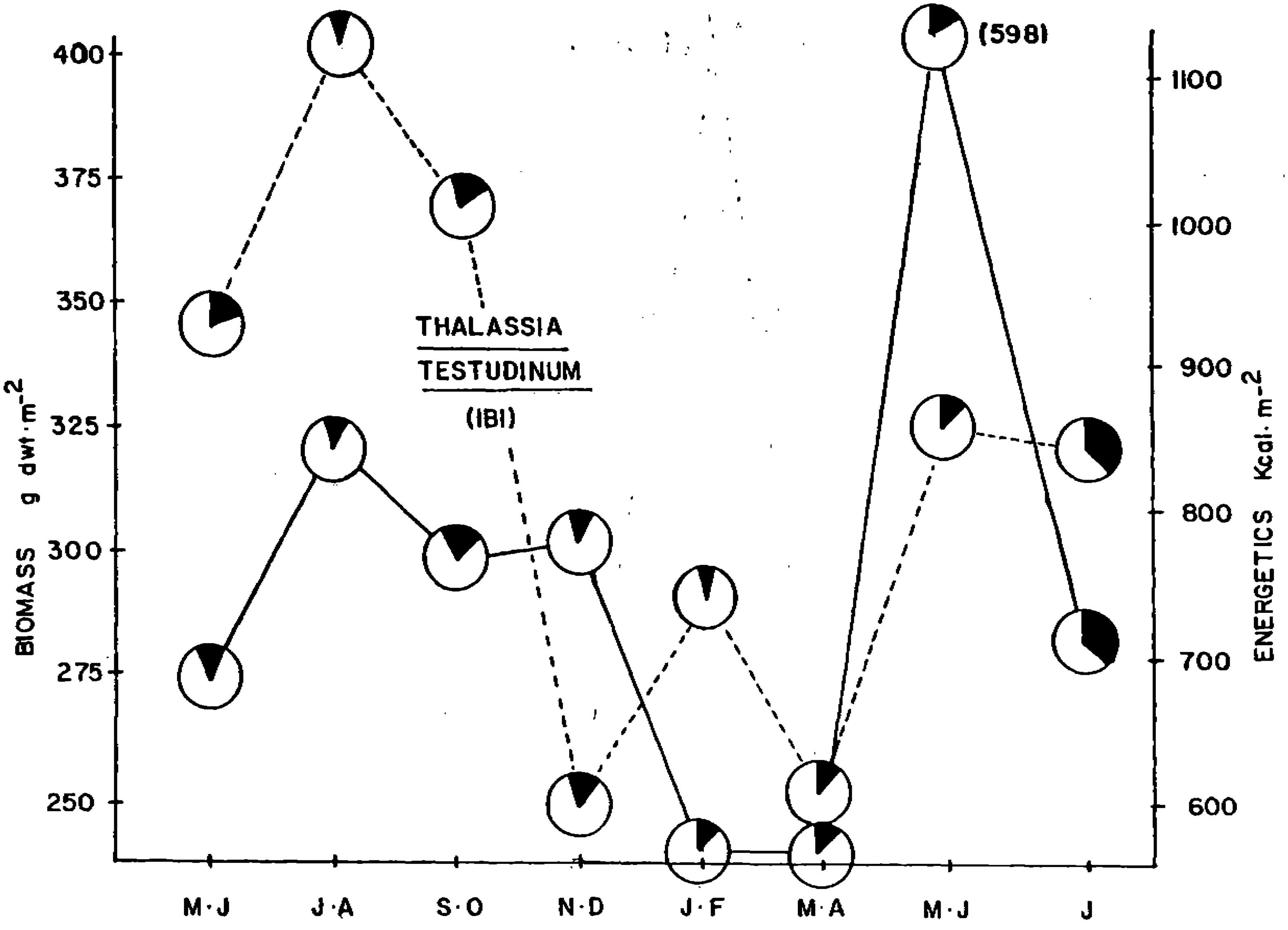
BIOMASS g dwt·m^{-2}
400
375
350
325
300
275
250
ENERGETICS Kcal·m^{-2}
1100
1000
900
800
700
600
THALASSIA
TESTUDINUM
(IBI)
(598)
M·J
J·A
S·O
N·D
J·F
M·A
M·J
J
1982
1983

FIGURE 3

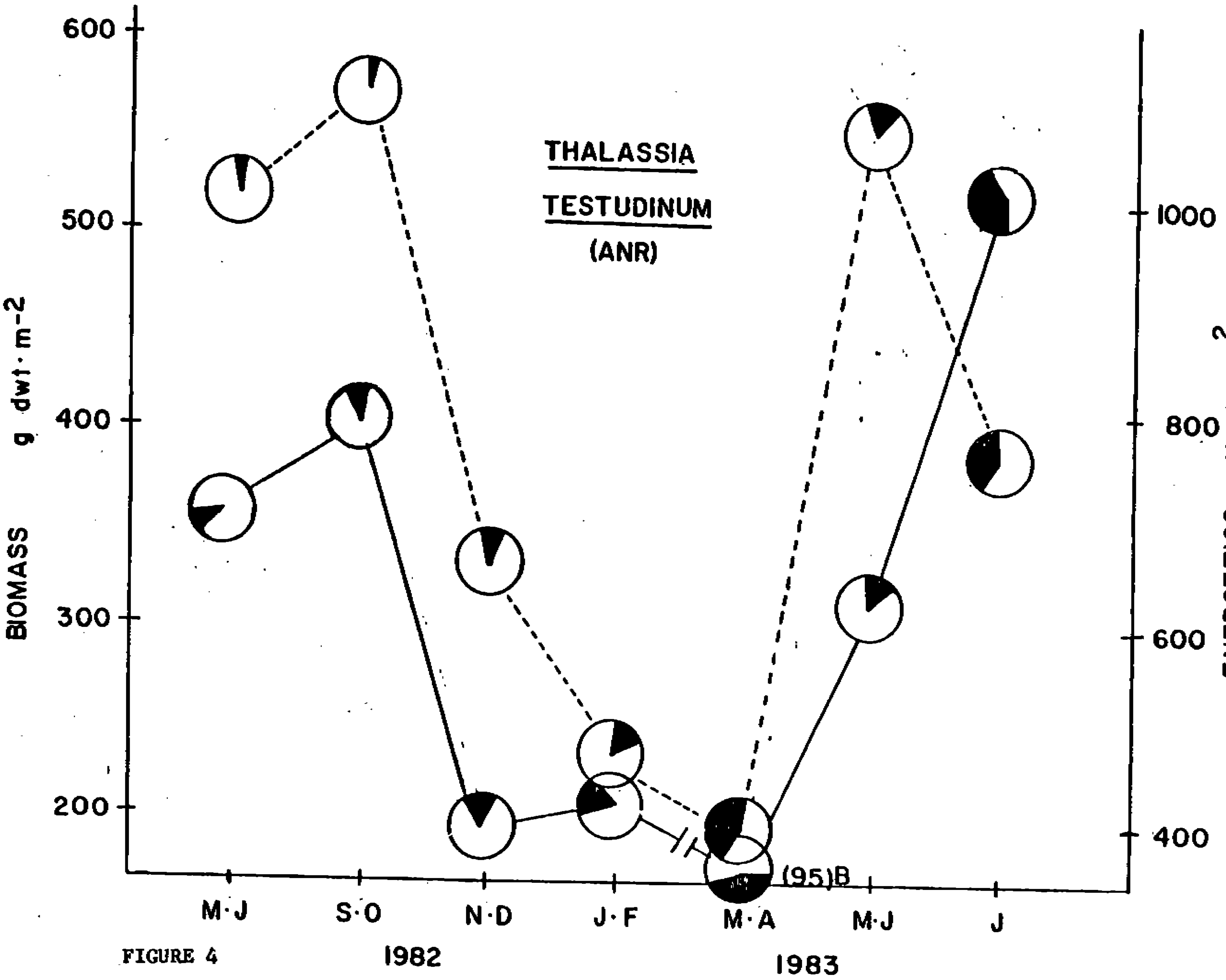
THALASSIA
TESTUDINUM
(ANR)
600
500
400
300
200
BIOMASS g dwt · m-2
1000
800
600
400
ENERGETICS Kcal · m-2
(95)B
M·J
S·O
N·D
J·F
M·A
M·J
J
1982
1983

FIGURE 4

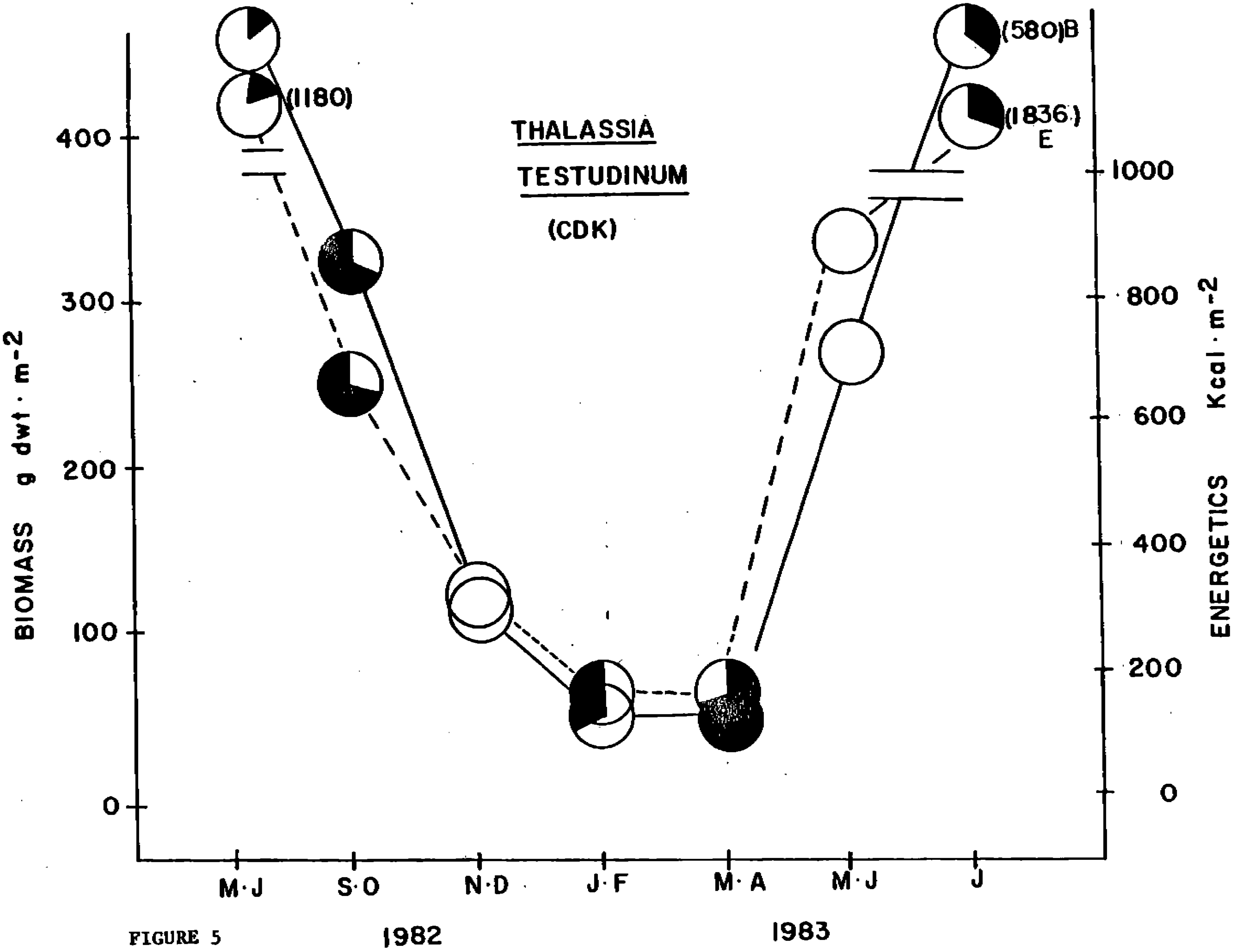
THALASSIA
TESTUDINUM
(CDK)
(1180)
(580)B
(1836)
E
BIOMASS g dwt · m^{-2}
0
100
200
300
400
ENERGETICS Kcal · m^{-2}
0
200
400
600
800
1000
M·J
S·O
N·D
J·F
M·A
M·J
J
1982
1983

FIGURE 5

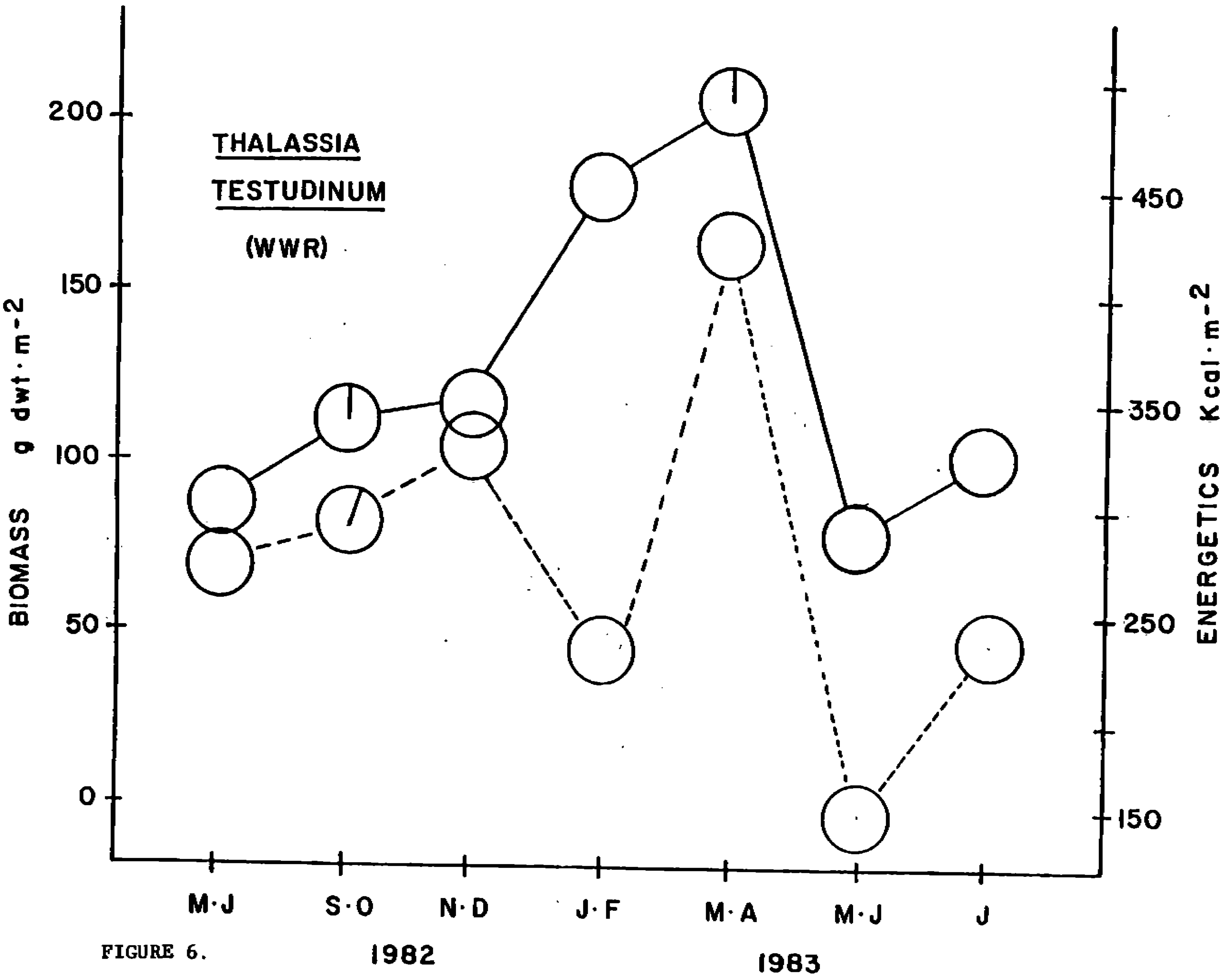
THALASSIA
TESTUDINUM
(WWR)
BIOMASS g dwt · m-2
200
150
100
50
0
ENERGETICS Kcal · m-2
450
350
250
150
M·J
S·O
N·D
J·F
M·A
M·J
J
1982
1983

FIGURE 6.

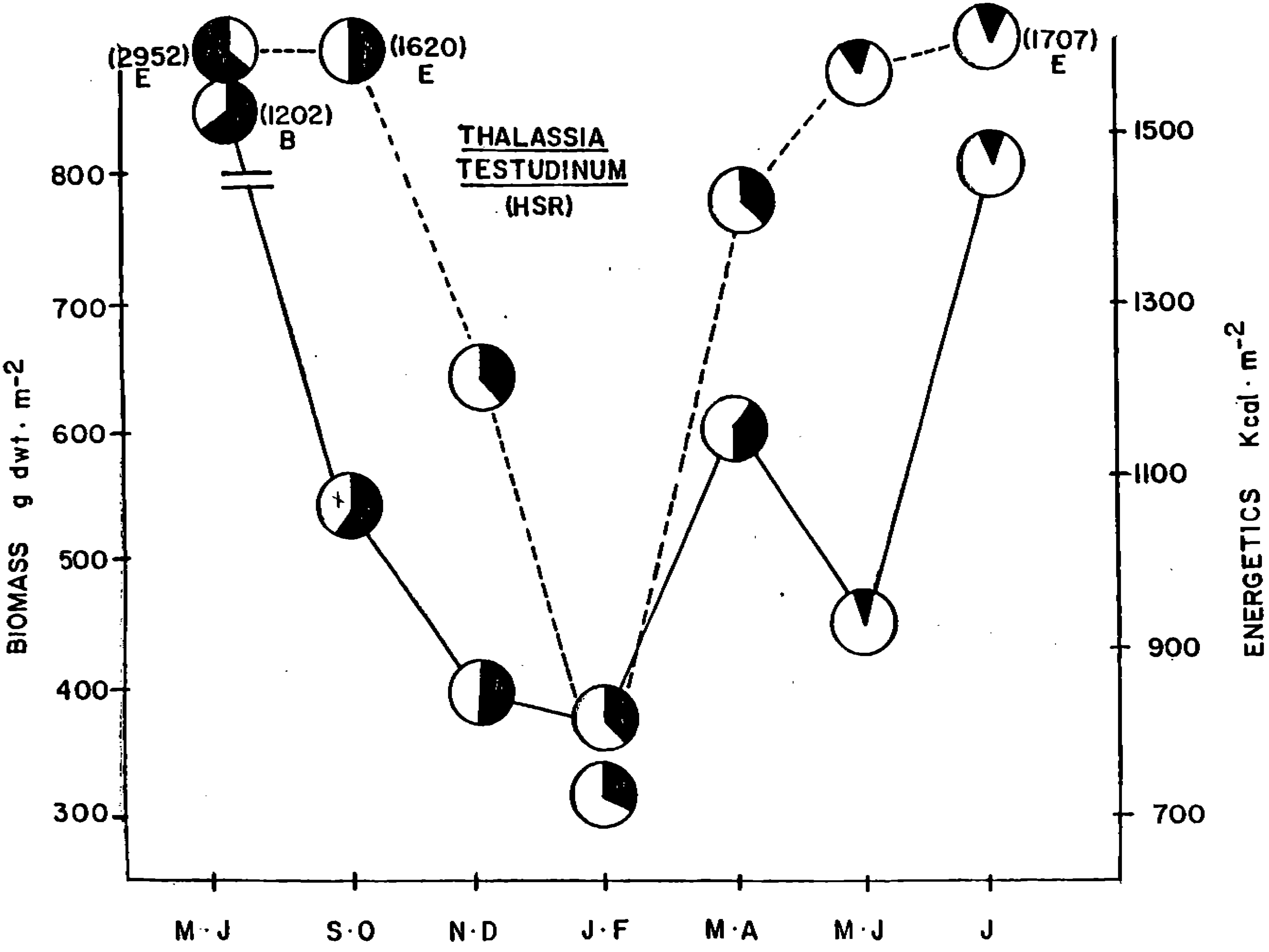
THALASSIA
TESTUDINUM
(HSR)
(2952)
E
(1620)
E
(1202)
B
(1707)
E
800
700
600
500
400
300
BIOMASS g dwt · m^{-2}
1500
1300
1100
900
700
ENERGETICS Kcal · m^{-2}
M · J
S · O
N · D
J · F
M · A
M · J
J
1982
1983

FIGURE 7.

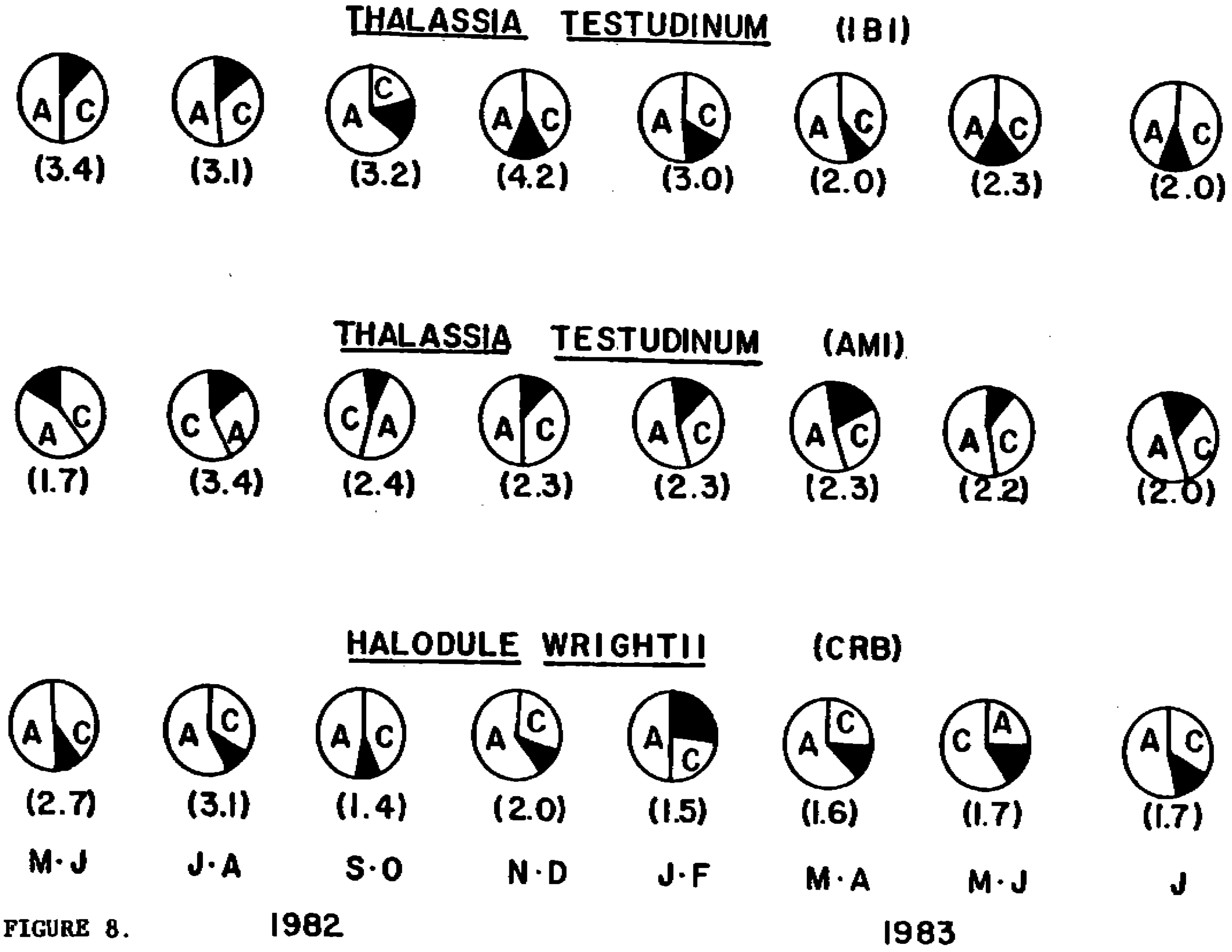
THALASSIA TESTUDINUM (IBI)
A
C
(3.4)
(3.1)
(3.2)
(4.2)
(3.0)
(2.0)
(2.3)
(2.0)
THALASSIA TESTUDINUM (AMI)
(1.7)
(3.4)
(2.4)
(2.3)
(2.3)
(2.3)
(2.2)
(2.0)
HALODULE WRIGHTII (CRB)
(2.7)
(3.1)
(1.4)
(2.0)
(1.5)
(1.6)
(1.7)
(1.7)
M·J
J·A
S·O
N·D
J·F
M·A
M·J
J
1982
1983

FIGURE 8.

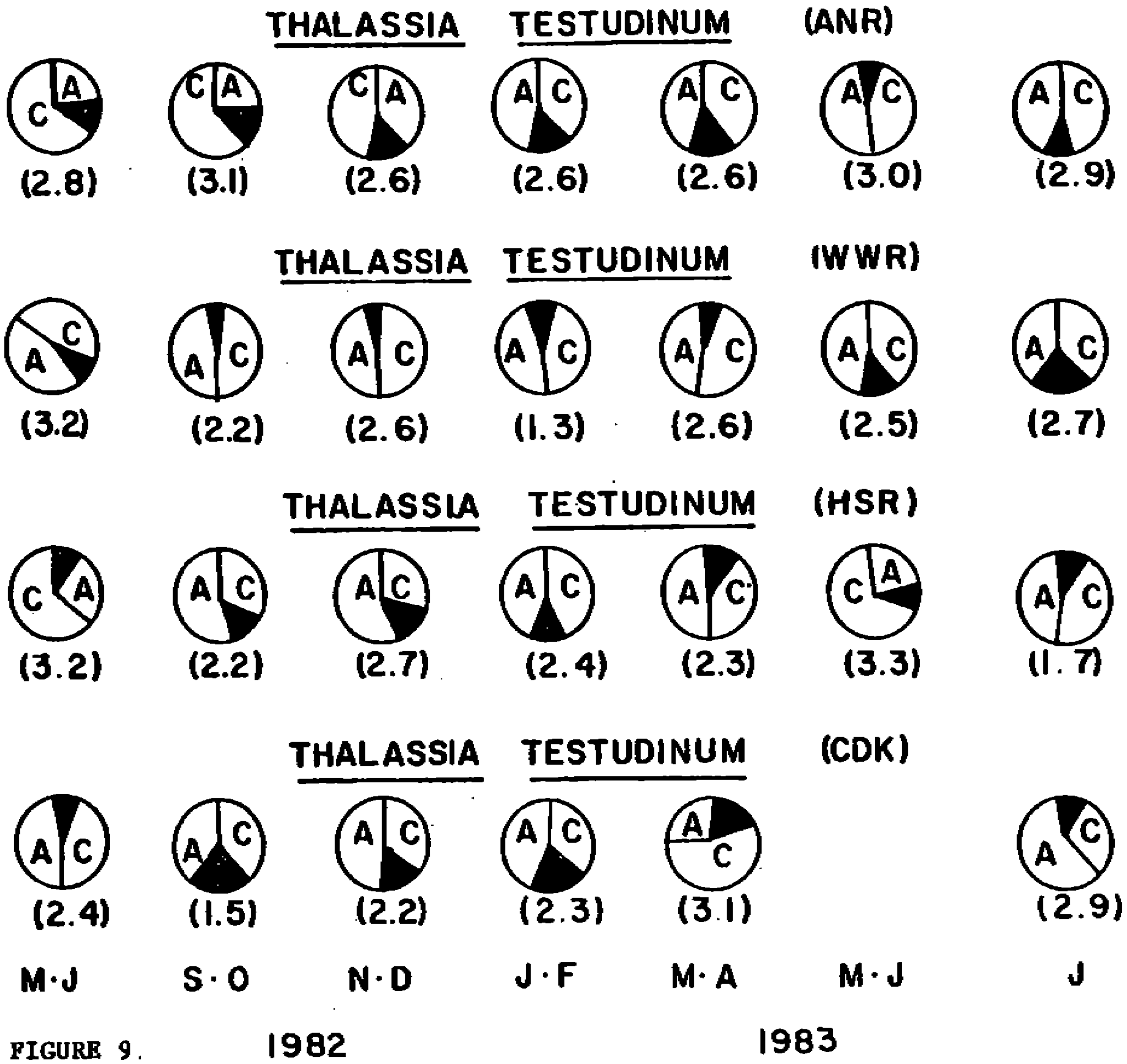
THALASSIA TESTUDINUM (ANR)
(2.8)
(3.1)
(2.6)
(2.6)
(2.6)
(3.0)
(2.9)
THALASSIA TESTUDINUM (WWR)
(3.2)
(2.2)
(2.6)
(1.3)
(2.6)
(2.5)
(2.7)
THALASSIA TESTUDINUM (HSR)
(3.2)
(2.2)
(2.7)
(2.4)
(2.3)
(3.3)
(1.7)
THALASSIA TESTUDINUM (CDK)
(2.4)
(1.5)
(2.2)
(2.3)
(3.1)
(2.9)
A
C
M·J
S·O
N·D
J·F
M·A
M·J
J
1982
1983

FIGURE 9.

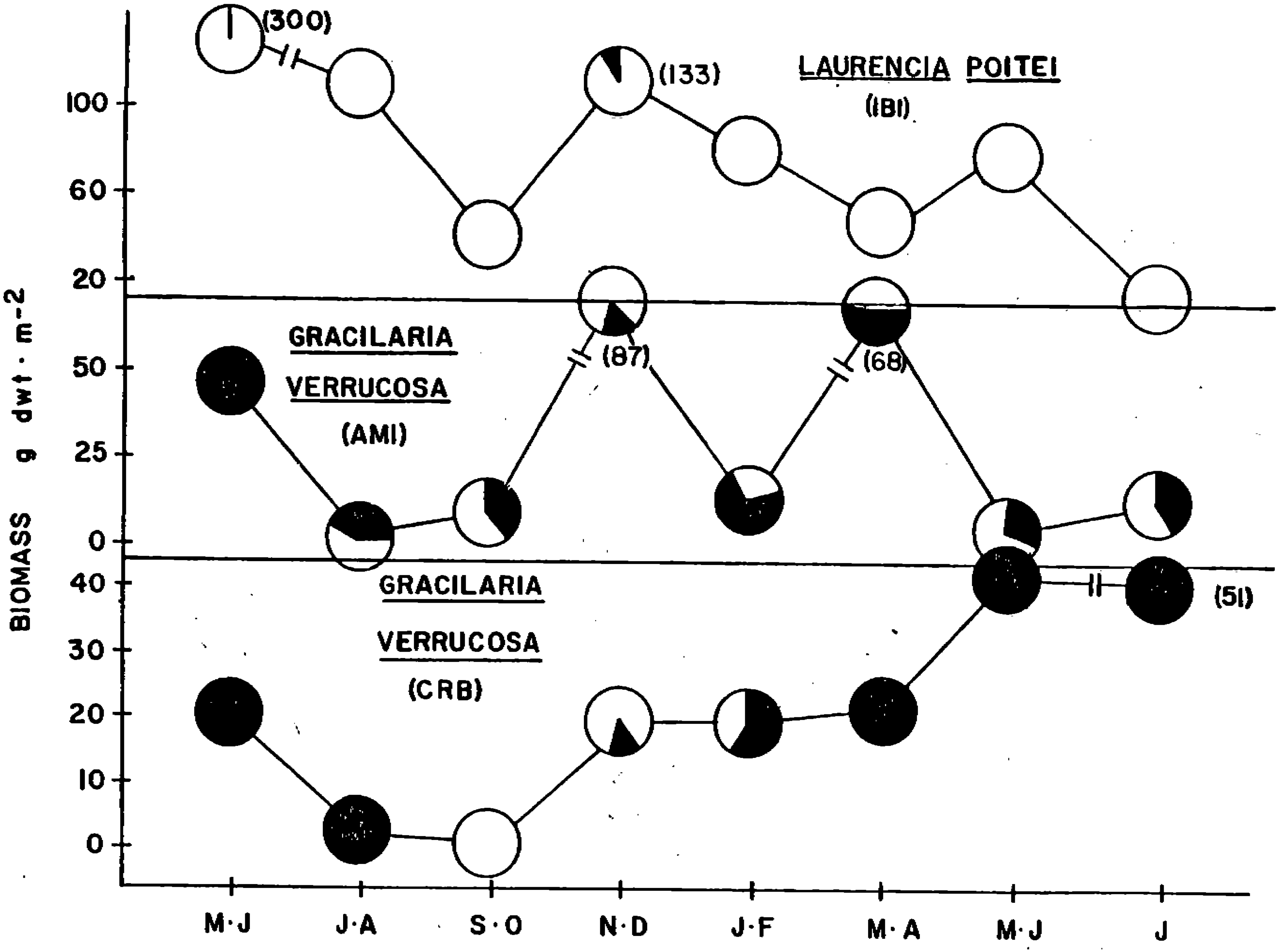
LAURENCIA POITEI
(IBI)
GRACILARIA
VERRUCOSA
(AMI)
GRACILARIA
VERRUCOSA
(CRB)
(300)
(133)
(87)
(68)
(51)
BIOMASS g dwt · m-2
100
60
20
50
25
0
40
30
20
10
0
M·J
J·A
S·O
N·D
J·F
M·A
M·J
J
1982
1983

FIGURE 10.

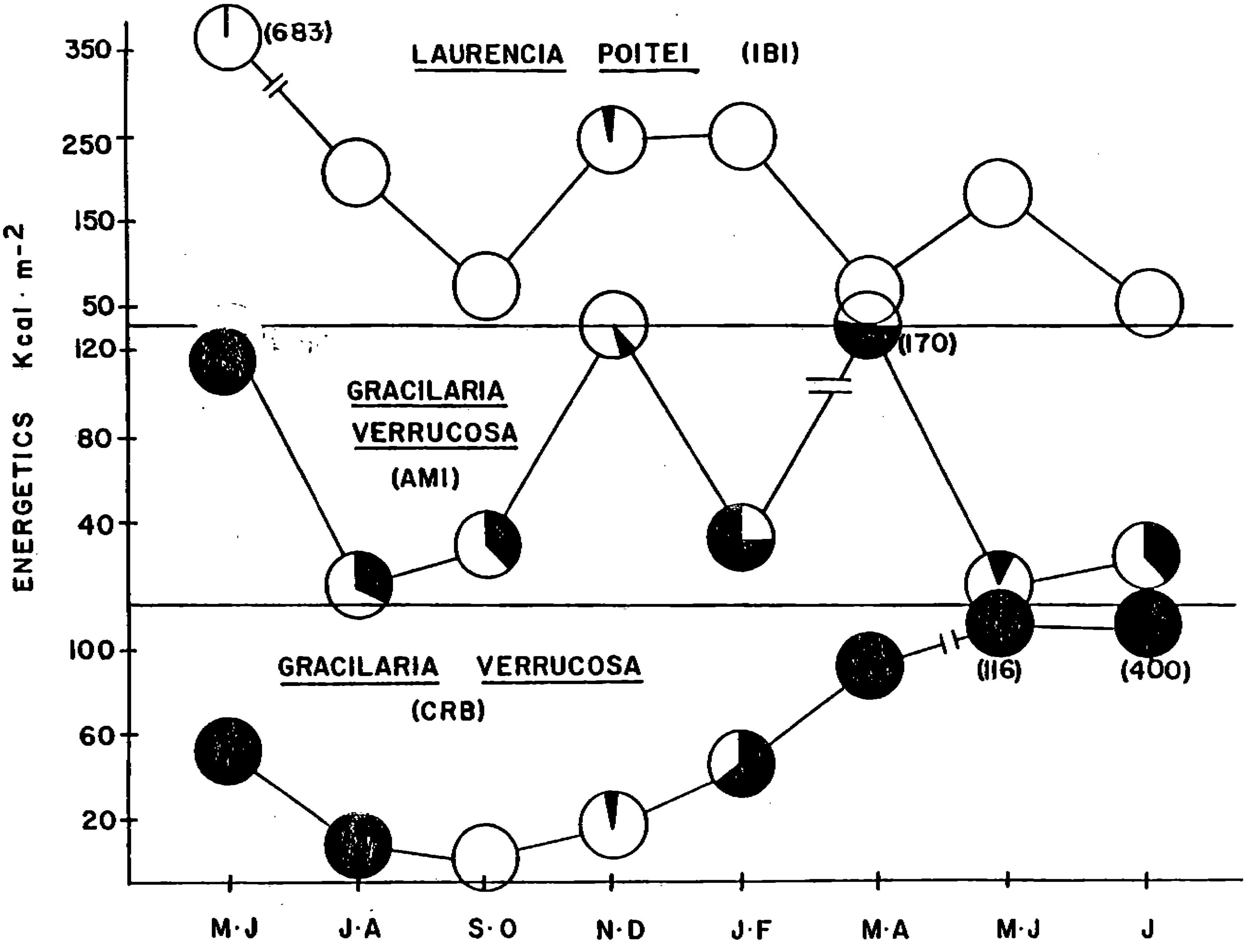

FIGURE 11.

1209

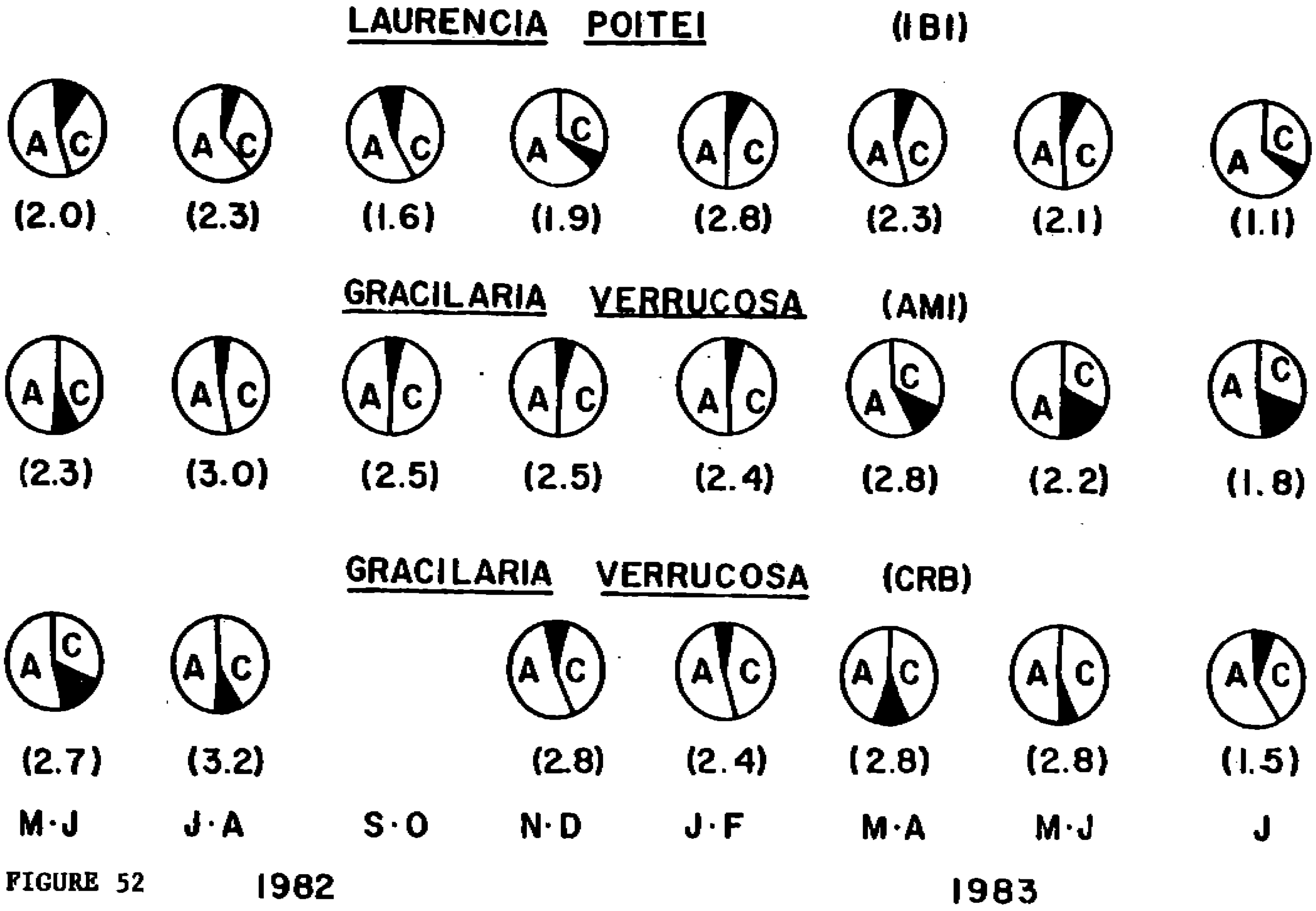
LAURENCIA POITEI
(IBI)
A
C
(2.0)
(2.3)
(1.6)
(1.9)
(2.8)
(2.3)
(2.1)
(1.1)
GRACILARIA VERRUCOSA
(AMI)
(2.3)
(3.0)
(2.5)
(2.5)
(2.4)
(2.8)
(2.2)
(1.8)
GRACILARIA VERRUCOSA
(CRB)
(2.7)
(3.2)
(2.8)
(2.4)
(2.8)
(2.8)
(1.5)
M·J
J·A
S·O
N·D
J·F
M·A
M·J
J
1982
1983

FIGURE 52

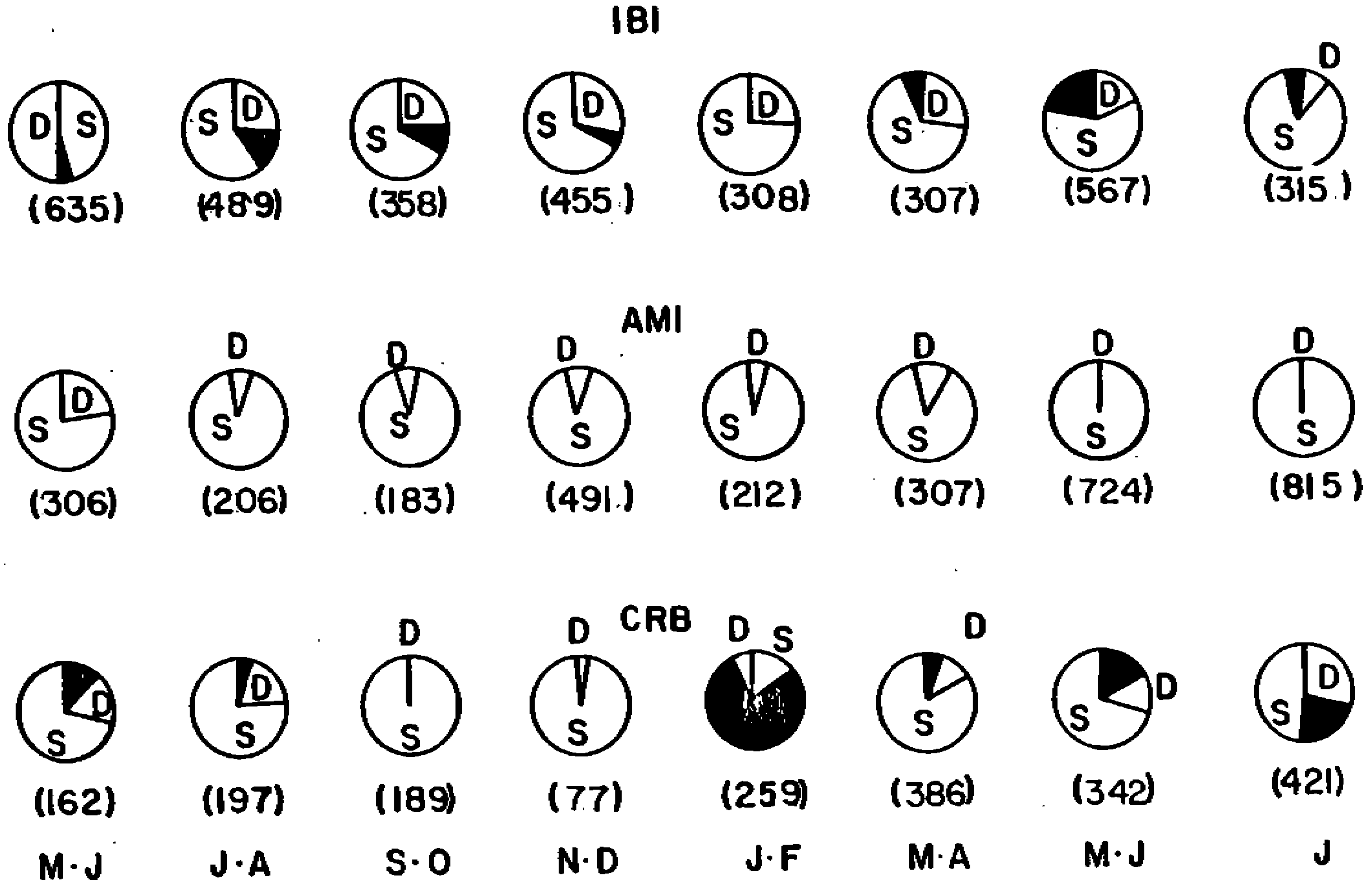
IBI
D
S
(635)
(489)
(358)
(455)
(308)
(307)
(567)
(315)
AMI
(306)
(206)
(183)
(491)
(212)
(307)
(724)
(815)
CRB
(162)
(197)
(189)
(77)
(259)
(386)
(342)
(421)
M·J
J·A
S·O
N·D
J·F
M·A
M·J
J
1982
1983

FIGURE 13

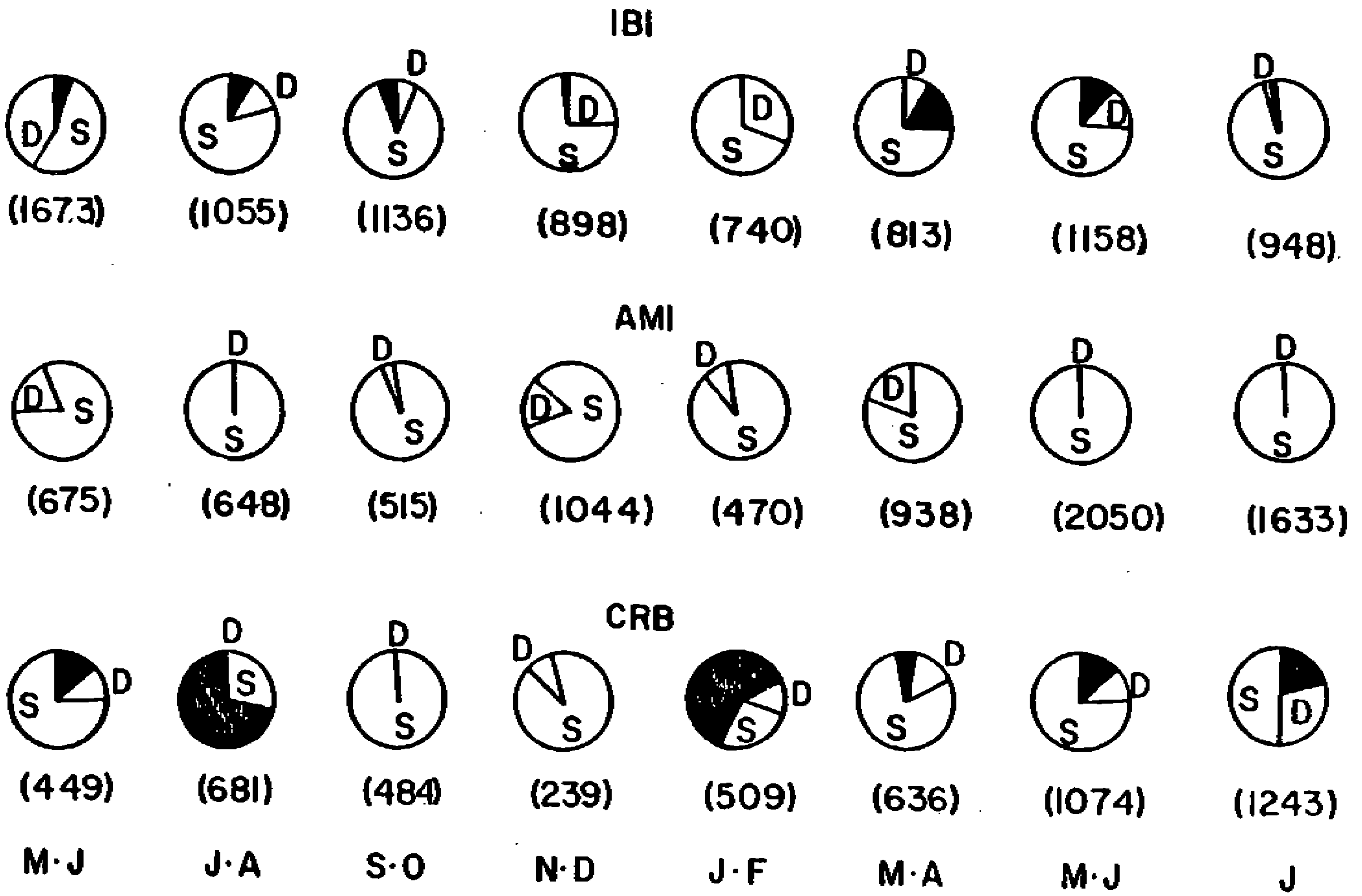
IBI
D
S
(1673)
(1055)
(1136)
(898)
(740)
(813)
(1158)
(948)
AMI
(675)
(648)
(515)
(1044)
(470)
(938)
(2050)
(1633)
CRB
(449)
(681)
(484)
(239)
(509)
(636)
(1074)
(1243)
M·J
J·A
S·O
N·D
J·F
M·A
M·J
J
1982
1983

FIGURE 14

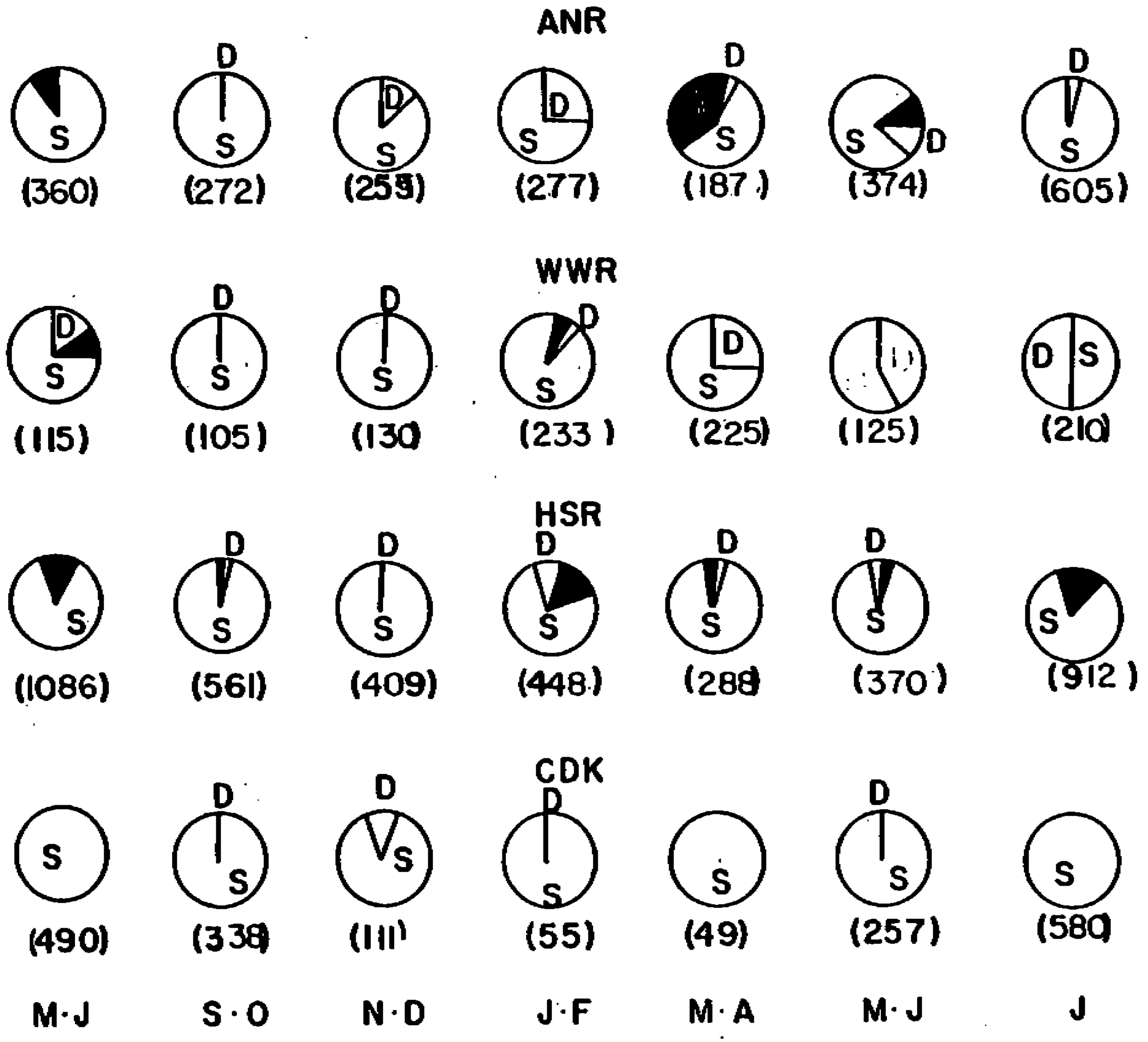
ANR
(360)
(272)
(259)
(277)
(187)
(374)
(605)
WWR
(115)
(105)
(130)
(233)
(225)
(125)
(210)
HSR
(1086)
(561)
(409)
(448)
(288)
(370)
(912)
CDK
(490)
(338)
(111)
(55)
(49)
(257)
(580)
D
S
M·J
S·O
N·D
J·F
M·A
M·J
J
1982
1983

FIGURE 16

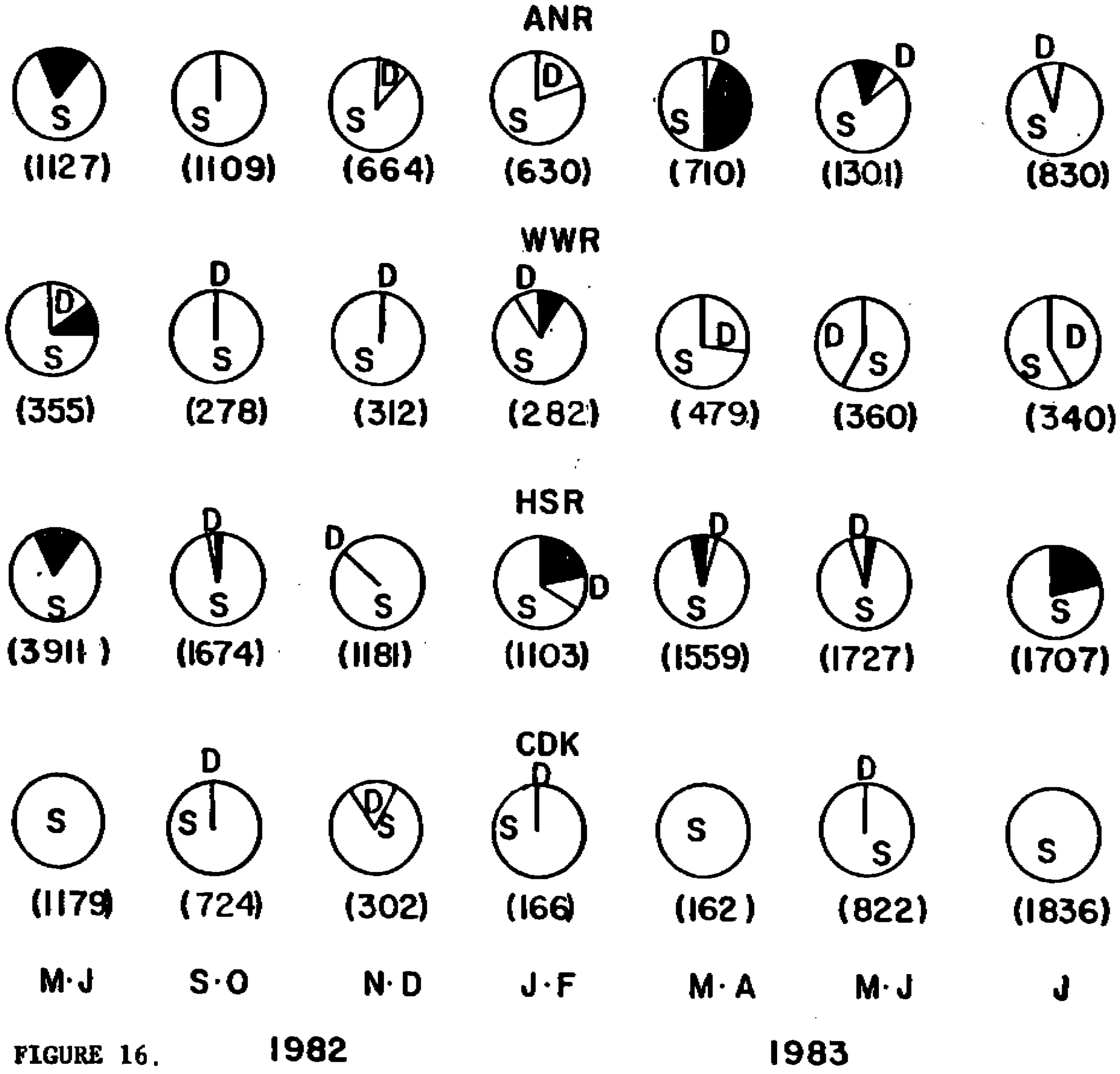
ANR
(1127)
(1109)
(664)
(630)
(710)
(1301)
(830)
WWR
(355)
(278)
(312)
(282)
(479)
(360)
(340)
HSR
(3911)
(1674)
(1181)
(1103)
(1559)
(1727)
(1707)
CDK
(1179)
(724)
(302)
(166)
(162)
(822)
(1836)
S
D
M·J
S·O
N·D
J·F
M·A
M·J
J
1982
1983

FIGURE 16.

Acknowledgements.

The author is indebted to Mr. Raymon K.Riechert and Ms Margaret O. Hall for their field and laboratory work on this project. Without these two persons the extensive field and laboratory analyses could not have been accomplished. The author also thanks Dr. Kimon Bird and Mr. Jim Frank of the Gas Research Institute and Dr. John Ryther, Dr. Dennis Hanisak, and Dr. Brian Lapointe. All of these offered advice and support in the research.