Decomposition of *Spartina alterniflora* in Different Seasons and Habitats of a Northern Massachusetts Salt Marsh, and a Comparison With Other Atlantic Regions

**ABSTRACT:** Packets of freshly harvested live *Spartina alterniflora* were placed on the marsh surface, in a tidal ditch, in a pool contacting sides and bottom, and in the center-bottom of the same pool in September 1972. Rates of loss were the same for all four sites through day 242. After that packets on the marsh surface decomposed slower. A second experiment was begun in July only at the marsh surface and pool side sites. These lost dry weight much more rapidly than packets started in September.

Populations of bacteria, fungi, diatoms, flagellates, ciliates and nematodes within the packets peaked within 60 days then decreased proportionally with the loss of dry weight in packets through day 242. After this, bacterial numbers decreased more rapidly presumably in response to a qualitative change in the packet material. Populations of flagellates and ciliates also declined rapidly after day 300. This decline occurred in new packets at around this date as well.

In a limited set of samples 12 taxa were analyzed for date or detritus-age dependent occurrence. Of these, eight were date dependent, two were dependent on packet age, and two could not be determined from the data.

**Introduction**

For a number of years we have been studying various aspects of the ecology of the Rowley Marsh (Montagna 1975; Deegan 1976; Gillis 1977; Murray 1978; Ruber and Murray 1978; Ruber, Gillis and Montagna, unpublished). The present study had two sets of objectives, (1) To compare rates of decomposition of *Spartina alterniflora* with those obtained previously to the south of us (Burkholder and Bornside 1957; Odum and de la Cruz 1967; Ustach 1969; Kirby 1971; Gessner and Goos 1973); (2) To determine rates at different sites on our marsh; and to compare rates of material loss from packages established at different seasons. (2) To determine abundance patterns of major organismic groups on these decaying plants, in order to assess whether there was a sequential invasion of species, and whether such colonization was primarily regulated by the qualitative content of the packet, or by the season.

**Materials and Methods**

The study was conducted at the Parker River National Wildlife Refuge (Rowley, Massachusetts) about 60 km north of Boston. The salt marsh drains into Broad Sound which is the lagoon-like portion of the Parker River Estuary, formed by Plum Island (72°45'N, 70°48'W).

Live, clean, dwarf *Spartina alterniflora* leaves were collected, wet-weighed (15.00 g/packet) and sealed in plastic bags of a diamond shaped mesh (4.5 mm × 11 mm). We used five leaves because these give consistent ash-free dry weights while dead materials were variable (Ruber, Gillis, and Montagna, unpublished). Five randomly selected bags were oven dried at 90 °C for 48 hours to establish an appropriate wet weight to dry weight conversion factor. Fifty such bags were placed in each of 4 locations: on the surface of the marsh in the original *Spartina* stand (SS), in an adjacent tidal ditch (TD), and in contact with the side and bottom of a salt marsh pool (PS), and in the center-bottom in the same pool (PC). Bags were loosely packed in hardware cloth boxes (mesh of 10 mm²) for protection.

The bags were placed in the field on 8 September 1972, and pairs were collected on 20 subsequent dates, 19 over the first year and one after two years had elapsed. Similar studies were begun in July 1973 and again in July 1974, but packets were placed only in the SS and PS habitats.

On each date replicate samples from each site were censused in three ways. Bacteria and fungi were sampled by the following method modified from Witkamp (1963). The decomposing grass was placed in an erlenmeyer flask with 1,000 ml of sterile artificial sea water made from Rila Marine Mix at a salinity of 25%. The grass was agitated by magnetic stirrer for 20 minutes to suspend all organisms. Colony densities were determined by serial dilution plating on Difco nutrient agar for bacteria and Difco Saboraud agar for fungi, again using artificial sea water. The second phase of censusing began by concentrating the 1,000 ml supernatant with organisms down to 25 ml. Densities of protozans, diatoms, and nematodes were determined by live counts from the concentrate. At the beginning of the study the grass was subjected to 2 stirring cycles. The second stirring resulted in increased population estimates of only 1–5% giving us confidence that the organismal separation from the grass and subsequent census was accurate. During the third and last census phase macroinvertebrates were hand-picked from the grass remnants, after which the grass was recovered by filtration through plankton netting of 178 μm mesh, oven dried at 90 °C and weighed.

**Results**

In the first experiment, begun in September, packets from all 4 sites lost weight at about the same rate except SS which lost weight more slowly after 242 days. The
average monthly loss rates could be divided into three phases (Fig. 1). Decomposition was rapid the first 3 months (12%). The rate of loss decreased the next 5-6 months (7%) and then increased the following 3 months (2%) and then increased the following 3 months (2%). After 342 days, 30% of the original dry weight remained. Only one-half of this was lost during an additional year in the field.

In the experiments begun in July, site differences were again slight. Early loss rates were much greater (23% per month for the first 3 months). Only 30% of the original material remained after this interval, compared with 65% in the first experiment (Fig. 1).

In order to assess whether the presence of a taxonomic group was related to season or to sample age the co-occurrence of 12 taxonomic categories was compared with 65% in the first experiment (Fig. 1).

Fig. 1. Remaining dry weight of Spartina alterniflora litter for experiments begun Sept. 8, 1972, July 13, 1973, and July 9, 1974. Each point is the mean for all 4 sites. Standard errors range from 1 to 4% of the mean for all but 3 data points of the 1972 and 1973 runs; data were insufficient to assess the 1974 run statistically.

Discussion

We had expected that the different sites would yield different loss rates as reported by Kirby (1971). It may be that the placement of SS bags, which was expected to yield the lowest rates was too close to the tidal ditch (3 m) and the pool (1 m). This would permit a greater effect by migrating invertebrates such as Palaemonetes pugio which Welsh (1975) found to be important in the fragmentation of Spartina, and which was probably present in Burkholder and Bornside’s (1957) crates. Such proximity also resulted in flooding during mean high tides, which affects breakdown rates (Teal 1962; Blum 1968; and Kirby 1971).

The difference between the summer and autumn series is striking. Odum and Fanning (1973) and Hardisky and Reimold (1977) have shown that there is a continual loss of leaves from the culms of Spartina species during their growing season. Such early losses are probably subject to much more rapid degradation at all latitudes studied than is the main crop in autumn. However, since we used healthy leaves and the continued loss is of senescing leaves, we cannot be certain of this.

Despite the differences in latitudes and in packaging of materials in these studies two patterns of loss seem to occur. First, a slow group characterized by studies done in Louisiana, Georgia, Rhode Island, and Massachusetts and which began in the autumn, winter, or spring, and second, a fast group done in Louisiana, North Carolina, and Massachusetts which began in the summer (Fig. 3).

It appears that when experiments are begun in the summer, the high prevailing temperatures result in a rapid loss of material (70% after 3 months). Those begun in other seasons are exposed to more moderate temperatures in the early stages of the experiment resulting in a slower loss of material (35% after 3 months),...