Proc. Indian natn. Sci. Acad. B47 No. 5 pp 768–773 (1981)

Population Dynamics of *Scleria tessellata* Willd. — A Shade-Tolerant Secondary Successional Species in Slash and Burn Agriculture (Jhum) Fallows

S P S KUSHWAHA, P S RAMAKRISHNAN and R S TRIPATHI
Department of Botany, School of Life Sciences, North-Eastern Hill University, Shillong 793014

(Received 10 April 1981; after revision 22 October 1981)

Scleria tessellata Willd. is a sedge coming up in 5–20 years old secondary successional communities, developing after slash and burn agriculture (Jhum) in north-eastern hill region of India. The present study deals with the survivorship and population flux of this species in the Jhum fallows. While the clone populations in all the fallows remained considerably stable throughout the study period, the shoot populations had high turnover rates. The vegetative vigour and the seed output by the clones increased with the increase in the fallow age. The seed output in general was very low, the reproductive strategy being directed towards vegetative regeneration.

Key Words: **Population dynamics, Vegetative regeneration, Secondary succession, Slash and burn agriculture, Jhum, Weed Biology**

Introduction

Recruitment of new genets is often rare among plants and the dynamics of their populations is dominated more by birth and death of clonal modules than that of the whole genets. The ability of a single genotype to form fragmented phenotypes is just one of the variants in the life history patterns of modular organism (Harper & Bell 1979).

The life histories of shoot modules have been studied on spaced populations of several agriculturally important grasses (Lamp 1952, Langer et al. 1964, Robson 1968). These studies have shown a definite seasonal pattern of shoot births and deaths ultimately culminated by flowering. Some studies (Gorham & Somers 1973, Bernard & Mac Donald 1974, Bernard, 1976, Noble et al. 1979) have also been made on the longevity and reproductive performance of shoot modules.

Scleria tessellata Willd. (Cyperaceae) is a rhizomatous, perennial sedge found in 5–20 years old secondary successional communities coming in fallows after slash and burn agriculture (Jhum) in north-eastern India. This species makes its appearance in jhum fallows older than 5 years and increases in density in older fallows. The production is very low and vegetative growth is common with iterative production of shoot modules. The orthotropic shoots are produced from plagiotropic underground rhizomes. The apical and axillary buds of the rhizomes are protected by dense scale leaves. May to September is the active growth period when maximum shoot recruitment occurs. Shoots start flowering from July onwards with a maximum is September–October though some flowering shoots occur throughout the year. Seed setting is maximum in November. The large size of seeds does not facilitate its dispersal to far-off places. The present study is an attempt to investigate the dynamics of the clonal and shoots populations in *S. tessellata*.

Materials and Methods

Fallows after slash and burnagriculture located at similar exposure (south facing slope) and topography but of different ages, viz., 5, 10 and 15 years, were selected as study sites at Burnihat in Meghalaya (26° 02′N latitude and 91° 52′E longitude) at an altitude of about 100 m. The vegetation analysis of the different associated plant species in the fallows for determining the density, frequency and cover was done using $1m^2$ quadrats for herbaceous species and $100m^2$ quadrats for shrubs and trees. Importance value index was calculated using relative frequency, relative density and relative basal area of the species (Mishra 1968, Kershaw 1973). A total of 20 quadrats were examined on each site.

Demographic studies on *S. tessellata* were carried out in $1m^2$ permanent quadrats with four replicates in each of the fallows. The fate of the individual clones and shoots of established plants were followed at one month interval over a two-year period from May 1978 to May 1980. Much of the shoot recruitment occurred in June and the fate of these shoots and the others which came afterwards, was followed till the end of the study period. The shoots already present at the start of the study were considered as more than two years old, those coming in 1978 as two years old and those coming in 1979 as one year old. Monthly records of maximum and minimum temperature and rainfall were kept for the entire study period. The number of seeds produced per plant was estimated by counting in 1978 and 1979. The seeds were tested for viability (using trichloro-tetrazolium chloride solution) and germinability in petridishes at an alternating temperature regime of 25°/15°C to simulate the field condition with alternating light and dark periods for 12 hr.

The climate at Burnihat could be divided into three distinct seasons. The dry and windy summer extends from mid February to May with average maximum temperature of 32.2°C and minimum temperature of 24.1°C. The rainy season includes the period from May to September during which annual rainfall of 2200 mm takes place. This is warm period with high humidity. The month of October represents the transition from rainy to winter seasons. The mild winter with an average maximum temperature of 24.8°C and minimum temperature of 12.4°C extends from November to mid February. This period is practically rainless except for a few winter showers (figure 1).

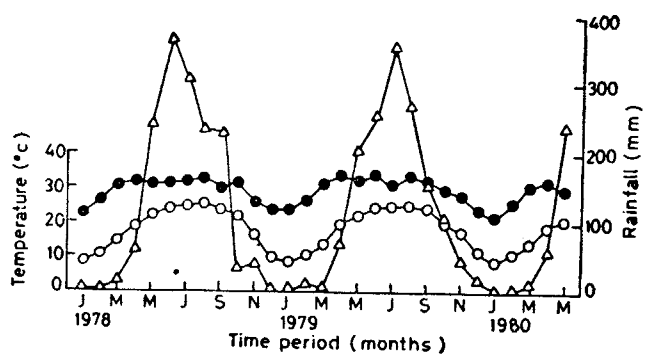

Figure 1 Ombrothermic diagram for the study area. Monthly maximum (●) and minimum (O) temperatures; monthly rainfall (△)

Table 1 *Importance value indices of commonly associated plant species in the fallows of different ages*

Species	Age of the fallows (years)		
	5	10	20
Ageratum conyzoides L.	—	—	—
Arundinella bengalensis (Spreng) Druce	11.6	—	—
Borreria hispida (L.) K. Schum.	—	—	—
Bauhinia variegata L.	7.2	16.9	—
Cyperus globosus Allioni	11.1	15.7	15.8
Carex cruciata Nees	7.9	15.8	16.8
**Careya arborea* Roxb.	—	15.2	17.1
**Callicarpa arborea* Roxb.	6.6	10.4	18.8
**Cedrela toona* Roxb.	4.2	5.7	12.0
**Combretum decandrum* Roxb.	3.5	7.5	8.8
Desmodium triquetrum DC.	6.5	—	—
Dendrocalamus hamiltonii Nees & Arn.	29.4	45.7	55.8
**Dillenia indica* L.	11.2	—	30.5
Eupatorium odoratum L.	62.1	8.1	5.4
**Eugenia communis* Wight	5.3	9.5	12.5
Ficus hispida L.	—	15.9	15.9
Grewia elastica Royla	—	—	—
Imperata cylindrica (L.) Beauv.	15.2	—	—
**Litsaea assamica* Hk. f.	—	7.8	—
Mikania micrantha H. B. & K.	—	—	—
Macaranga denticulata Muell.	12.2	—	23.5
**Melia azadirachta* L.	3.9	4.2	—
**Machillus khasiana* Meissn.	—	—	5.3
**Maesa indica* Wall.	5.2	10.0	—
Osbeckia crinata Benth.	—	—	—
Panicum maximum Jacq.	12.4	14.3	17.8
P. khasianum Munro	10.6	—	—
Setaria glauca Beauv.	15.0	—	—
Scleria tessellata Willd.	3.2	—	—
**Schima wallichii* (DC) Korth	7.1	16.3	16.6
**Sapium baccatum* Roxb.	—	7.8	11.8
Thysanolaena maxima Kuntze	11.4	—	—
**Vitex peduncularis* Wall.	11.7	42.1	—
**V. glabrata* Br.	10.6	30.1	31.0

*Stump sprouts

Results

Vegetation

The early stages of secondary succession up to five years had a number of woody species like *Imperata cylindrica*, *Eupatorium odoratum*, *Thysanolaena maxima*, *Arundinella bengalensis*, *Grewia elastica* and stump sprouts of many woody climbers, shrubs and trees. *Dendrocalamus hamiltonii* is one of the important species coming up in 5-year old fallows, and attains maximum density in 20-year fallows, along with a few dicot shrubs and trees. The importance value indices for various species are given in table 1.

Population flux and survivorship of clones

During the study period, *S. tessellata* maintained its population of clones in 5 and 10-year fallows. However, in the 20-year fallow there was a loss of one plant/m^2. No seedling recruitment could be noted during the study period (table 2).

Table 2 *Population flux of the clones of* S. tessellata

Species	Age of the fallows (year)		
	5	10	20
(a) No. of plants/m^2, May 1978	1.3	4.0	7.0
(b) No. of plants/m^2, May 1980	1.3	4.0	6.0
(c) Net change (b–a)	0.0	0.0	−1.0
(d) Rate of increase	1.0	1.0	0.9
(e) No. of plants arrived between May 1978 and May 1980	0.0	0.0	0.0
(f) No. of plants lost between May 1978 and May 1980	0.0	0.0	1.0
(g) Plants present May 1978 alive by May 1980	1.3	4.0	6.0
(h) % survival of plants in (a) (g/a × 100)	100.0	100.0	85.7
(i) Expected time (years) for complete turnover (2/100–h × 100)			14.0
(j) Total plants recorded during study	1.3	4.0	7.0
(k) % mortality of individuals (f/j × 100)	0.0	0.0	14.3

Population flux and survivorship of shoots

An addition of 3.4 and 3.0 shoots/m^2 was noted in 5-and 10-year fallows during the two-year period whereas 16 shoots were eliminated from the 20-year fallow. Shoot recruitment increased with increase in the age of the fallow. Mortality of the pre-existing shoots was 100% in the 5-year fallow. The mortality amongst the new arrivals was less than the total mortality of the population. The mortality of shoots was generally high with a maximum in a 20-year fallow. The data are significant at 0.1% level (table 3). Survivorship of shoots showed age-specific mortality with Deevey Type II (Deevey 1947) curve (figure 2).

Table 3 *Shoot population flux of* S. tessellata

Species	Age of fallows (year)		
	5	10	20
(a) Shoots/m^2, May 1978	2.6	16.0	42.0
(b) Shoots/m^2, May 1980	6.0	19.0	26.0
(c) Net change (b–a) shoots/m^2	+3.4	+3.0	–16.1
(d) Rate of increase (b/a)	2.3	1.2	0.6
(e) No. of shoots arrived between May 1978 and May 1980	15.2	36.0	56.0
(f) No. of shoots lost between May 1978 and May 1980	11.8	33.0	72.0
(g) Shoot present May 1978 alive by May 1980	0.0	2.0	6.0
(h) % survival of shoots in (a) (g/a × 100)	0.0	12.5	14.3
(i) Expected time for complete turnover (years) (2/100–h × 100)	2.0	2.3	2.3
(j) total shoots recorded during study	17.8	52.0	98.0
(k) % mortality of all shoots (f/j × 100)	66.3	63.3	73.5
(l) % mortality of arrivals	60.5	52.8	64.3

Age distribution of dead shoots (figure 3a)

The shoots which flowered during September–November, died in November–January. The shoots recruited in June either flowered in the same year by October or remained vegetative until the flowering season (July–October) of the following year. Maximum shoot mortality followed flowering. In general mortality was higher in 1.5–2 year old shoots compared to that on 0.5–1year old shoots.

Age-structure of living shoot populations (figure 3 b)

At the end of the study period, one year old shoots were more frequent than 2-year old shoots. While there was a slight decline of one year old shoots in 10-and 20-year fallows compared to the 1-year fallow, the frequency of older shoots was higher in fallows of greater age.

Reproductive potential of the populations (table 4)

The percentage of fertile shoot population declined with the age of the fallow. However, because of the larger clone size in the 20-year fallow, the seed output per m^2 here was markedly higher.

Table 4 *Reproductive potential of* S. tessellata *in different fallows*

	Age of the fallows (years)		
	5	10	20
No. of clones/m^2	1.3 (1.3)	4.0 (4.0)	6.0 (7.0)
% fertile shoots/m^2	80.0 (100.0)	62.5 (68.7)	63.6 (83.3)
No. of shoots/m^2	5.0 (2.6)	16.0 (16.0)	22.0 (42.0)
No. of seeds per clone	20.0 (12.0)	15.0 (14.3)	18.0 (16.0)
No. of seeds/m^2	15.6 (26.0)	60.0 (57.0)	108.0 (112.0)

The values in parenthesis pertain to the values obtained in 1979

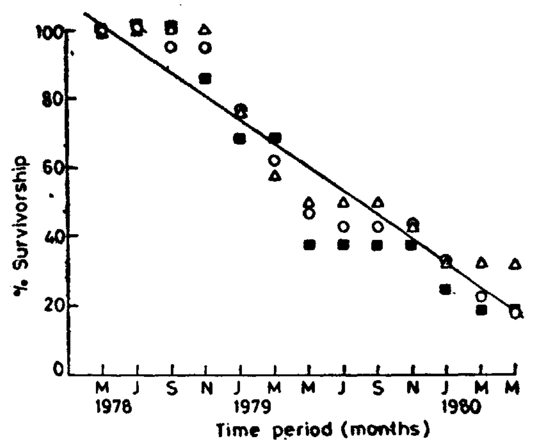

Figure 2 Survivorship of shoots of *S. tessellata* in different fallows. 5 year old fallow (O); 10 year old fallow (△); 20 year old fallow (●)

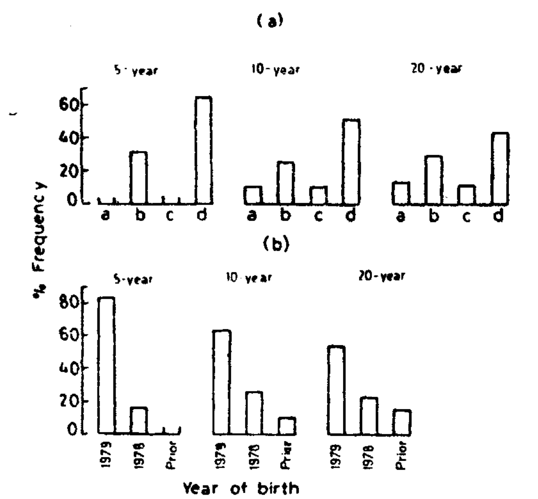

Figure 3a Age distribution of *S. tessellata* shoots born and died during the study period in different fallows

Age-c; asses-0-0.5 year (a); 0.6–1.0 year (b); 1.1–1.5 years (c); and 1.6–2.0 years (d)

Figure 3b Age structure of the living shoots of *S. tessellata* in May, 1980 in different fallows

Discussion

Clonal growth is a common feature in the life of herbaceous perennials and helps in the extension of the shoot population from a single genet in time and space. We found that the population size of *S. tessellata* at the clonal level was relatively stable in different fallows but it varied at the sub-population level (i.e. shoots). The number of clones present at the beginning of the study varied in the three fallows; this could mean either a differential clonal spread or a variable seedling recruitment. However, since no seedling could be detected on the sites throughout the study period, it is probable that seeds have little significance in maintenance and spread of the population of present species, as aslo reported by Major and Pyott (1966)for certain other species. In *S. tessellata* most of the seeds are non-viable lacking properly developed embryo. Herberd (1967) too, demonstrated the significance of vegetative growth for the persistence of the populations in older successional communities. According to him, seeds have very little chance of survival in a closed community of perennials and the role of the sexual reproduction may be obscure in such communities.

The changes at sub-population level (shoots) are particularly significant when the species turnover is slow. The survivorship of shoots showed constant mortality risk with seasonal fluctuations. The period with comparatively higher mortality mostly coincided with post-flowering events. The flowering shoots withered after seed production. Some mortality was also noted in 1 month old shoots which might be due to their susceptibility to interspecific competition afforded by the associated vegetation. Thus the shoot mortality in this species seems to be age-dependent giving a Deevey Type II negative exponential curve.

The seed output in this species is exponentially low with a still lower (about 5%)

seed viability. None of the seeds germinated in the laboratory under temperature and light conditions simulated for those occurring in nature indicating that possibly they require some after-ripening period for germination or some more exacting requirement. Seeds are heavy and do not possess any morphological specialization for their wide dispersal and thus dispersal is confined around the parent plant. The absence of seedlings at the sites colonized by *S. tessellata* implies that the seeds are either predated upon or they become non-viable. In contrast, individuals produced asexually, have the advantage of belonging to the genotypes already tested for suitability in the environment and of obtaining from the parent a good material start in life.

Acknowledgements

This research was supported under 'Man and Biosphere' programme sponsored by the Department of Science and Technology, Government of India. We extend our thanks to Mr A K Das and K G Saxena, for their help during the preparation of this manuscript.

References

Bernard J M and MacDonald J G 1974 Primary production and life history of *Carex lacustris*; *Can. J. Bot.* **52** 117–123

_____1967 The life history and population dynamics of shoots of *Carex rostrata*; *J. Ecol.* **64** 1045–1048

Deevey E S 1947 Life tables for natural populations of animals; *Q. Rev. Biol.* **22** 283–314

Gorham E and Somers M G 1973 Seasonal changes in the standing crop of two montane sedges; *Can. J. Bot.* **51** 1097–1108

Harper J L and Bell A D 1979 The population dynamics of growth form in organisms with modular construction; in *Population Dynamics* ed. R L Anderson (Oxford: Blackwell Scientific Publications)

Herberd D J 1967 Observations on natural clones in *Holcus mollis*; *New Phytol.* **66** 401–408

Kershaw K A 1973 *Quantitative and Dynamic Ecology* (London: Edward Arnold)

Lamp H F 1952 Reproductive activity in *Bromus internis* in relation to phases of tiller development; *Bot. Gaz.* **113** 413–438

Langer R H M, Ryle S M and Jewiss O R 1964 The changing plant and tiller population of timothy and meadow fescue swards. I. Plant survival and the pattern of tillering; *J. appl. Ecol.* **1** 197–208

Major J and Pyott W T 1966 Buried viable seeds in two California bunchgrass sites and their bearing on the definition of flora; *Vegetatio* **13** 253–282

Misra R 1968 *Ecology Work Book* (New Delhi: Oxford and IBH Publishing Company)

Noble J C, Bell A D and Harper J L 1979 The population biology of plants with clonal growth. I. The morphology and structural demography of *Carex arenaria*; *J. Ecol.* **67** 993–1008

Robson M J 1968 The changing tiller population of spaced plants of S 170 tall fescue (*Festuca arundinacea*); *J appl. Ecol.* **5** 575–590

Salisbury E J 1942 *The Reproductive Capacity of Plants*. (London: Bell)