Contributions to the Ecology of *Dactylocte-nium aegyptium* (L.) P. Beauv.

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Abstract

***Dactyloctenium aegyptium*, which is a nutritious fodder, grows abundantly in the campus of University of Ibadan, Nigeria, under tropical climate and supported by reddish-brown loamy soil. The species shows morphological variations and three forms have been recognized. Form A is small sized, Form B medium, while Form C is large. Each form grows with different associated species, though some of them are common to all forms. The three forms behaved differently with respect to germination requirements, biotic disturbance, and water stress. Cultural experiments revealed germination lower on filter paper than on soil, a progressive decrease in germination with depth, no germination at 4 cm and 5 cm depths, and a general increase in germination from 10° C to 25° C. Form C did not germinate at all in total darkness but had the highest germination in glass-house and it was the only one that germinated in continuous light. Most of the results of various germination experiments showed that Form A had the least germination, followed by Form B, while Form C had the highest germination. Experiments on water stress revealed that Form B showed the best growth but it was only Form C that had flowered. There are persistent differences in three Forms with regard to growth habit, period of maturity, spike coloration, and germination behavior, which indicate that they are likely to be ecotypes.**

The superb job of nature in spreading the grasses and legumes on a considerable range of earth along with adaptations to different climates is a boon to mankind and livestock. A knowledge of their developmental physiology is, therefore, of the greatest importance, particularly in the management of grasslands and crops. Considerable work has already been done on different grasses and the present investigation on *Dactyloctenium aegyptium* is a general contribution to its ecology. This species is considered to be a nutritious forage plant in many parts of the world, as it is easily eaten by horses, cattle, sheep, and goats at all stages of growth. The species is a native of the Old World and occurs in tropics, subtropics, and warm temperate regions from sea level to 2000 m altitude, on roads, in fallow and waste land, as a common weed in cultivation and in pastures of relatively dry areas, where it can tolerate a considerable degree of salinity (Bogdan 1977). The species is an annual grass and is a troublesome weed in crops such as corn, cotton, sugarcane, and peanuts. Its principal range as a weed is from latitude 15° South to 15° North.

In West Africa *Dactyloctenium* is represented by only one taxonomic species—*Dactyloctenium aegyptium* (L.) P. Beauv. (Clayton 1972), though *D. giganteum* and *D. bogdenii* are common in South and East Africa respectively (Bogdan 1977). An attempt to study the biological variability of the Nigerian representative specimens was motivated by different descriptions of the species given by Townrow (1959) and Stanfield (1970). Townrow (1959) describes it as a mat-forming perennial, 30 to 40 cm high, rooting at the nodes with a maroon coloration. The attribute of maroon coloration has not been documented by other workers such as Britton and Millspauch (1962), Goodling et al. (1965), and Tadros (1973).

In the University of Ibadan campus, having an area of 1032 hectares (University of Ibadan Calendar 1978), *Dactyloctenium aegyptium* has been observed to have variations in morphology and other features. On comparing the various forms with specimens in the herbariums of the Botany Department and that of the Forestry Department, it has been found that they belong to the same species, *viz. Dactyloctenium aegyptium.* However, we have arbitrarily categorized them into three forms. Our interest centered in knowing the nature of ecological variations and this led to the planning of a number of experiments. It is hoped that this study would add to an understanding of some of the intricacies involved in the ecological variability of the species and hence allow one to assess, in relative terms, the success of the species as a weed. In addition, the information obtained in such a study is likely to stimulate thoughts on taxonomic differentiation which the forms might have reached. The three forms of *Dactyloctenium aegyptium* are recognized on the basis of morphological differences (Table 1, Fig. 1).

Climatic and Edaphic Factors

Climate and vegetation show a very close relationship. It is possible to regard vegetation as an indicator of climate and to utilize plant distribution for delimitation of climatic zones (Walter 1971). Some of the climatic data for the University campus are presented in Table 2. Data on temperature and precipitation are graphically shown in Figures 2 and 3. There appear to be two seasons—the wet season from March to October and the dry season from November to February. The relative humidity ranged from 32% at 1600 hours in January to a maximum of 95% at 0700 hours in May. The general monthly trend shows that it is lower during November to March. Similarly, the number of sunshine hours has been higher during the dry season. The importance of

Fig. 1. *Three forms of* Dactyloctenium aegyptium *(Linn.) P. Beauv.*

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Table 1. Morphological differences of the three forms of *Dactyloctenium aegyptium* (L.) P. Beauv. in the University of Ibadan Campus, Nigeria.

Form A	Form B	Form C
1. Root system: 8–10 roots per tiller; Average rooting depth 10 cm.	Rooting at nodes of stolons; 10–15 roots at each node; average rooting depth 15 cm	15 roots per tiller; rooting at node also; average rooting depth 25 cm
2. Culms: 10–15 cm. high, occasionally 30 cm.	30–35 cm, occasionally 50 cm	45–50 cm. high, occasionally 60–80 cm; 1m according to Holm et al. (1977)
3. Growth pattern: Matforming tendency, diffused type	Stoloniferous type	Upright form in tufts with a little tendency to form stolons.
4. Leaf: Longest leaf is 20 cm	Longest leaf is 25 cm	Longest leaf is 35 cm
5. Spikes: Dark brown above and light green below, maroon coloration (Townrow, 1959); max. length 3 cm.	Slight brownish coloration but mostly dark green with short extended rachis; maximum length 4 cm.	Mostly green color Maximum length 6 cm.
6. Seed color: Reddish brown	Reddish brown	Greyish brown

sunshine hours is considerable since, as Wilsie (1962) has shown, light intensity at seedling stage may determine the success or failure of grasses.

The temperature curve goes higher in February, gradually declining with a minimum in July and again increasing until December. The total annual rainfall was 1578.5 mm with nil amount in December and the highest (305.2 mm) in April. The rainfall shows two peaks, one in March-April and another in September.

The soil in the area is reddish-brown loam. It is permeable and strongly leached. The soil profile does not show visible stratification. The soil reaction is acidic to neutral, varying from 6.47 to 6.93. Wilsie (1962) is of the opinion that grasses grow well in such a pH range. The soil moisture during the dry season was quite low (0.02%) while the organic matter, as determined by loss on ignition, varied from 2.03 to 2.32%.

Materials and Methods

Specimens of various forms were carefully collected in polythene bags and brought to the laboratory for a detailed study with the help of local flora (Hutchinson and Dalziel 1963; Lowe and Stanfield 1974; Stanfield 1970; Townrow 1959). Seeds of each form were collected at the proper time and sterilized by treatment with a solution of 0.1% mercuric chloride for germination studies. Twenty such seeds were placed on sterilized filter papers over sterilized cotton wool in sterilized petri dishes. All germination experiments were carried out as replicates of three. Various cultural experiments conducted were as follows:

1. Germination on different substrates such as vermiculite, soil, and filter paper.
2. Germination at different temperatures from 10° C to 45° C.
3. Germination at different soil depths from surface to 5 cm depth.
4. Germination in different environments such as glasshouse, orchid house, total darkness, continuous light.
5. Experiment to show effect of biotic disturbance under the following conditions.
   a) Five plants of each form uprooted and left on soil without watering.
   b) Five plants of each form uprooted, left on soil surface and watered daily with 100 ml tap water.
   c) Five plants of each form uprooted, replanted and watered daily with 100 ml tap water.
6. Effect of water stress by watering daily, alternate day, twice a week, fifth day, and tenth day. The volume of water provided on each occasion was 500 ml

Results and Discussion

Variation is a feature of common occurrence in plants. The pattern and extent of variation of weed species is of immediate

Table 2. Climatic data for the University of Ibadan Campus, Nigeria, for the year 1978-79.

	Relative humidity %					
Month	0.700 hr	1000 hr	1600 hr	1800 hr	Lowest	Sunshine hours
1978						
January	89	68	32	43	11	247.6
February	91	74	38	47	27	212.4
March	93	80	53	62	34	208.5
April	94	82	66	74	54	168.3
May	95	80	67	74	54	205.6
June	94	86	69	78	59	166.6
July	94	85	74	71	57	118.5
August	93	85	71	77	60	116.0
September	94	85	73	80	61	106.6
October	94	85	72	78	62	166.1
November	93	76	52	69	30	171.6
December	94	79	47	60	25	219.4
1979						
January	93	81	43	52	21	206.1
February	92	74	34	44	8	208.7
March	92	75	44	54	25	192.8
April	93	79	56	65	40	190.5

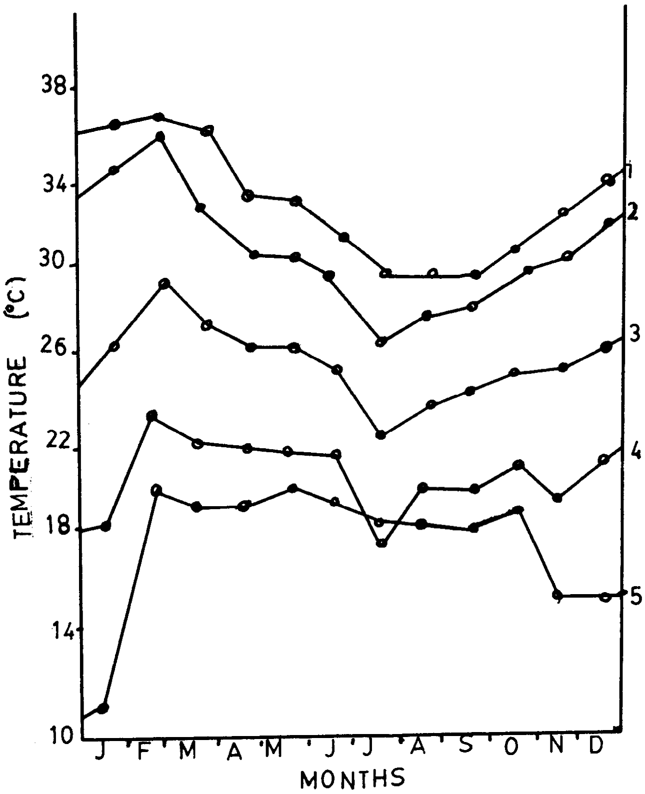

Fig. 2. *Temperature curves for the University of Ibadan Campus, 1978. 1=Extreme maximum. 2=Mean daily maximum. 3=Average daily mean. 4=Mean daily minimum. 5=Extreme minimum.*

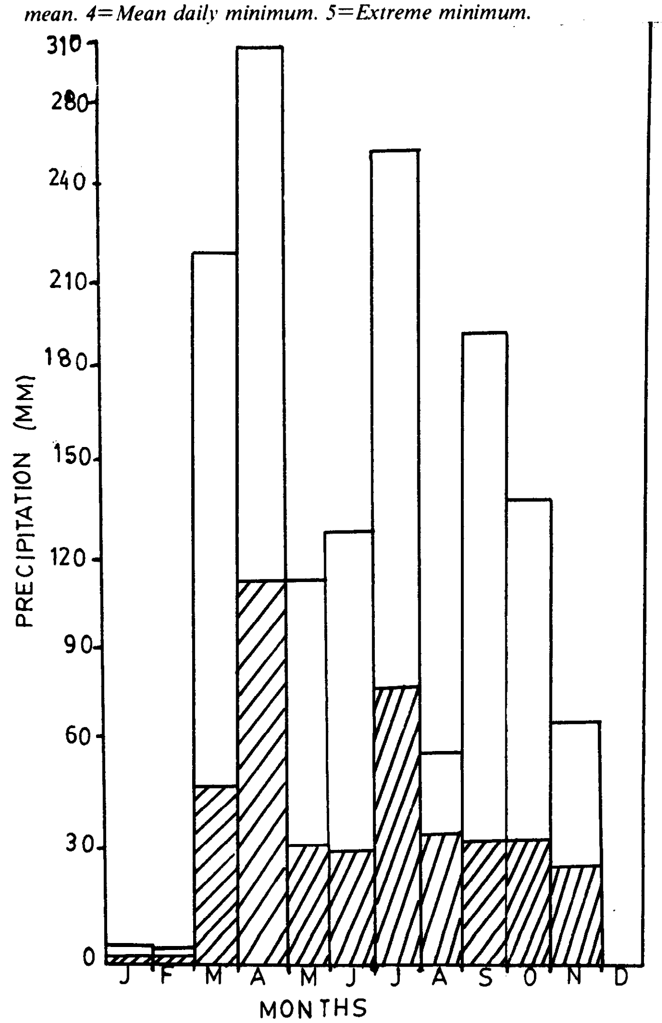

Fig. 3. *Precipitation at the University of Ibadan Campus, 1978.*

concern both to the ecologist and taxonomist, who aim at understanding the pattern and direction of species differentiation in order to delimit the forms and studies in ecotypic differentiation as a priority. Turesson (1922) by his transplant experiments has conclusively shown that variations may be either habitat determined and genotyically fixed, being called ecotypes or the manifestations of the phenotypic plasticities of the same genotype. The variations characterized by simple somatic plasticity in response to the habitat result in ecads (Ashwanii 1968) or ecophenes (Daubenmire 1947). The morphological variations occur during the course of evolution and there is the formation of ecotypes, depending on circumstances determined by soil, climate, and methods of management. The important biotic factor operating on the campus populations is the constant cutting and shearing of the weeds and it is very much likely to produce changes in plants thereafter, as can be seen in *Dactyloctenium aegyptium* adopting three forms. Various cultural experiments conducted with the three forms to establish whether they are ecotypes, are discussed.

Germination Studies

Table 3 shows the results of germination for three forms under different conditions. It is seen that percentage germination ranged from nil for all forms on vermiculite to 65% on soil for Form C. On the soil medium, the least germination was in Form A (20%), followed by Form B (35%). Germination on filter paper was rather low compared to that on soil. Here too, the least germination was in Form A (5%), followed by Form B (15%) and finally Form C (35%). The higher germination on the soil for each form might be due to the fact that soil has a high infiltration capacity, adequate aeration, and there is a close contact between soil particles and seeds.

There was a progressive decrease in germination with depth (Fig. 4). Germination was nil at 4 cm and 5 cm depths. This might be explained due to the fact that seeds are very small, weighing 0.00025 to 0.00027 g, and the little food reserve is inadequate to allow proper development of the plumule. There was a significant negative correlation between germination and soil depth. The value of r for Form A and Form C is -0.94 while for Form B is -0.95.

Table 3. Germination hebavior of *Dactyloctenium aegyptium* (L) P. Beauv.

Parameter	% germination of each form					
	A		B		C	
I. Substrate	X[1]	Y	X	Y	X	Y
Filter paper	5	10	15	15	35	30
Vermiculite	0	0	0	0	0	0
Soil	20	15	35	50	65	55
II. Soil Depth (cm)						
Surface	25	65	35	70	45	80
1	10	35	10	55	30	50
2	5	20	10	25	25	30
3	5	10	5	10	10	30
4	0	0	0	0	0	0
5	0	0	0	0	0	0
III. Temperature (° C)						
10	5	0	5	0	10	5
15	15	5	10	15	25	30
20	20	25	35	40	40	45
25	20	25	25	30	30	30
30	5	5	5	15	10	15
35	5	5	5	5	10	10
40	5	0	5	0	10	0
45	0	0	0	0	5	0
IV. Environment						
Continuous light	0	15	0	5	10	40
Total darkness	10	5	5	0	0	0
Orchid house	45	55	30	45	30	40
Glass house	30	65	45	70	55	80

[1]X—Germination soon after seed collection (November, 1978).
Y—Germination after 4½ months.

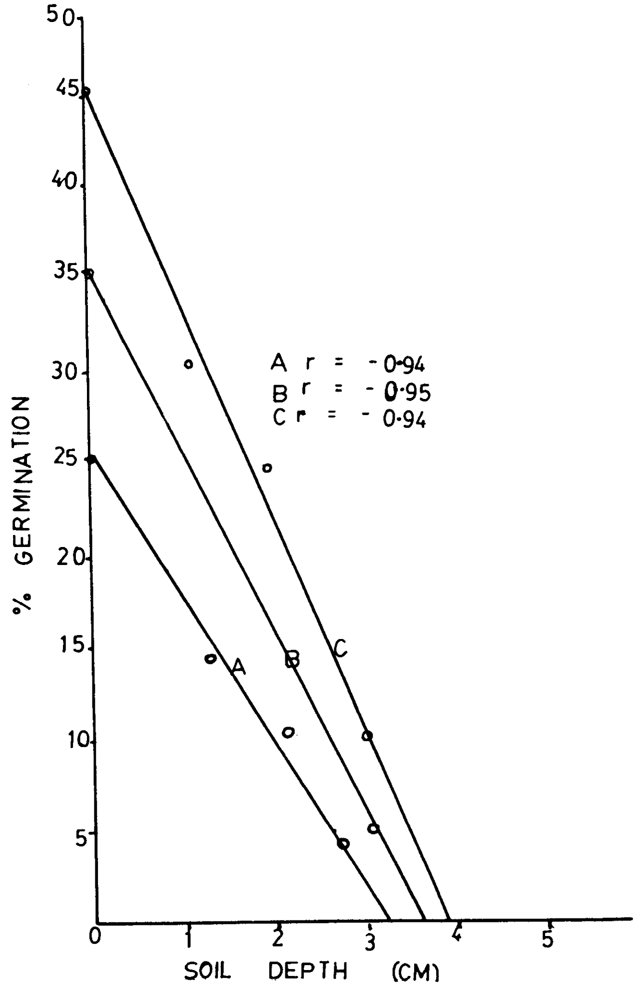

Fig. 4. *Correlation between soil depth and germination.*

There was germination in all forms between 10° C and 40° C. However, only Form C germinated at 45° C. There was a general increase in the percentage from 10° C to 25° C (Fig. 5). However, germination was maximum at 20° C (Form A-20%, Form B-35%, Form C-40%). It decreased after 30° C. This observation agrees with that of Holm et al. (1977), who reported maximum germination of 80% at 20° C. Low germination at lower and higher temperatures might be due to the inactivation and destruction of enzymes, respectively. Statistically, the correlation is not significant as is clear from Figure 6. The value of *r* for Form A is -0.21, Form B -0.45, and for Form C it is -0.65.

Considering the germination of various forms in different environments, it was seen that Form C did not germinate at all in total darkness but had the highest germination in glass-house and it was

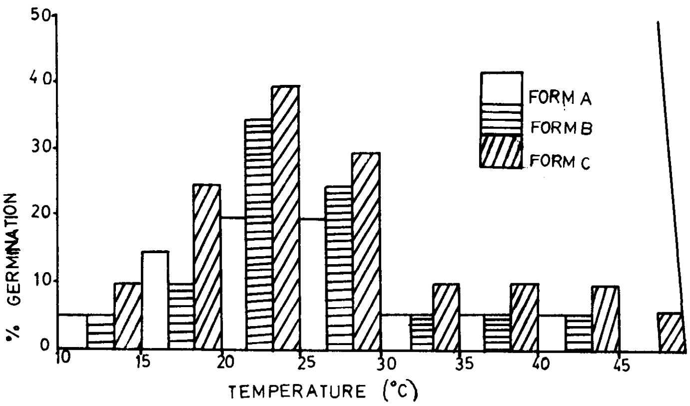

Fig. 5. *Germination at different temperatures.*

Table 4. Results of field experiment on *Dactyloctenium aegyptium* (L.) P. Beauv on disturbance at pre-flowering conditioning (November, 1978).

No. of days	Forms								
	A			B			C		
	X_1	Y_1	Z_1	X_2	Y_2	Z_2	X_3	Y_3	Z_3
1	+	+	±	+	+	±	+	±	+
2	+	+	±	+	+	–	+	±	–
3	+	±	±	+	+	–	+	±	–
4	+	±	–	+	±		+	±	
5	+	±	–	+	±		+	–	
6	+	±		+	±		+	–	
7	+	±		+	±		+		
8	+	–		+	±		+		
9	+	–		+	±		+		
10	+			+	±		+		
11	+			±	±		+		
12	+			±	–		+		
13	+			±	–		±		
14	+			±			±		
15	+			–			±		
16	±			–			±		
17	±						–		
18	±						–		
19	±								
20	±								
21	±								
22	–								

X_1, X_2, X_3 = Uprooted, replanted, watered daily.
Y_1, Y_2, Y_3 = Uprooted, watered daily
Z_1, Z_2, Z_3 = Uprooted, unwatered.

+ = Alive and healthy ± = Withering – = Dry.

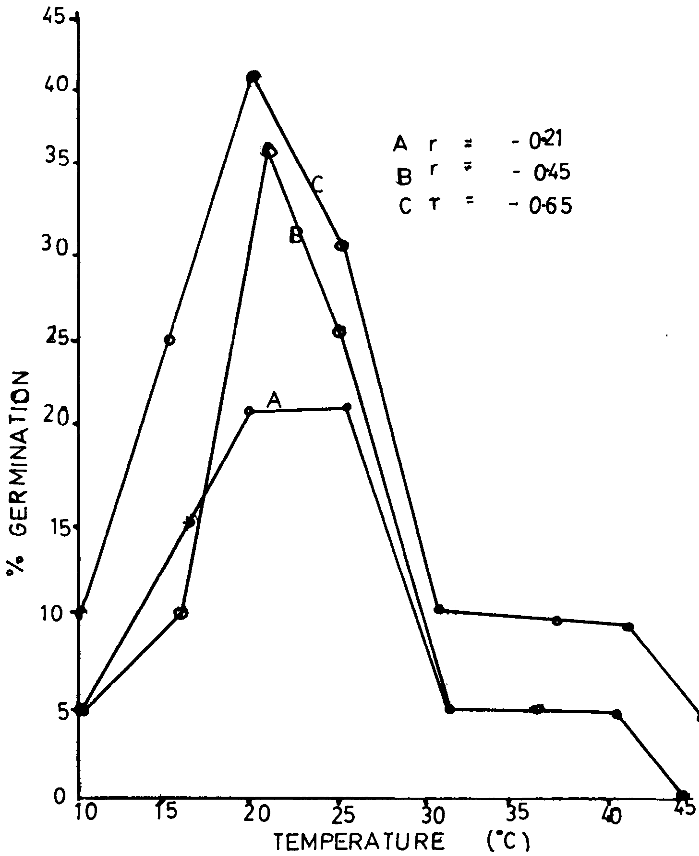

Fig. 6. *Relationship between germination and temperature.*

Table 5. Growth behavior of *Dactyloctenium aegyptium* (L.) P. Beauv. when watered daily.

Characteritic	Wk. 1	Wk. 2	Wk. 3	Wk. 4	Wk. 5	Wk. 6	Wk. 7	Wk. 8
Form A								
Number of leaves	4	7	12	15	16	13	14	15
Longest leaf (cm)	8.5	12	18	20	23	18	20	20
Number of tillers	1	1	2	3	3	3	3	3
Flowering period	–	–	–	–	–	–	–	–
Form B								
Number of leaves	4	9	21	28	23	26	26	29
Longest leaf (cm)	9.5	15	24	23	24	34	32	33
Number of tillers	1	1	3	4	4	4	4	4
Flowering period	–	–	–	–	–	–	fl*	fl
Number of spikes								
Form C								
Number of leaves	4	5	6	5	6	5	6	6
Longest leaf (cm)	10	16	18	21	20	21	21	21
Number of tillers	1	1	1	1	1	1	1	1
Flowering period	–	–	–	fl	fl	fl	fl	fl
Number of spikes				3	3	2	2	3

*fl = flowering.

Table 6. Growth behavior of *Dactyloctenium aegyptium* (L.) P. Beauv. when watered every alternate day.

Characteristic	Wk. 1	Wk. 2	Wk. 3	Wk. 4	Wk. 5	Wk. 6	Wk. 7	Wk. 8
Form A								
Number of leaves	4	7	10	9	9	9	14	9
Longest leaf (cm)	8	13	14	16	16	22	20	16
Number of tillers	1	1	2	3	3	3	3	3
Flowering period	–	–	–	–	–	–	–	–
Number of spikes	–	–	–	–	–	–	–	–
Form B								
Number of leaves	5	8	14	14	13	14	16	14
Longest leaf (cm)	9	15	24	28	26	26	25	28
Number of tillers	1	1	2	2	2	2	2	2
Flowering period	–	–	–	–	–	–	–	–
Number of spikes	–	–	–	–	–	–	–	–
Form C								
Number of leaves	5	7	6	6	6	6	9	6
Longest leaf	12	16	16	20	20	22	23	20
Number of tillers	1	1	1	1	1	1	1	1
Flowering period	–	–	–	fl	fl	fl	fl	fl
Number of spikes				2-3	2-3	2	3	3

Table 7. Growth behavior of *Dactyloctenium aegyptium* (L.) P. Beauv. when watered every third day.

Characteristic	Wk. 1	Wk. 2	Wk. 3	Wk. 4	Wk. 5	Wk. 6	Wk. 7	Wk. 8
Form A								
Number of leaves	3	5	6	6	6	5	6	6
Longest leaf (cm)	10	15	18	24	23	26	24	24
Number of tillers	1	1	1	1	1	1	1	1
Flowering period	–	–	–	–	–	–	–	–
Number of spikes	–	–	–	–	–	–	–	–
Form B								
Number of leaves	5	6	6	13	12	14	12	13
Longest leaf (cm)	12	16	20	26	26	26	26	26
Number of tiller	1	1	2	2	2	2	2	2
Flowering period	–	–	–	–	–	–	–	–
Number of spikes	–	–	–	–	–	–	–	–
Form C								
Number of leaves	5	6	10	10	10	6	10	10
Longest leaf (cm)	14	18	20	22	20	22	22	22
Number of tillers	1	1	2	2	2	2	2	2
Flowering period	–	–	–	fl	fl	fl	fl	fl
Number of spikes	–	–	–	3	2	3	3	2

the only one that germinated in continuous light. Form A germinated well in orchid house, a cool and shady structure housing orchids and lower plants.

Most of the results of various germination experiments show that Form A had the least germination followed by Form B while Form C had the highest germination. The only exceptions were the germination under total darkness and orchid house.

Comparing the germination of seeds soon after collection and that after four and half months, it was seen that for all forms, there was a general increase in the percentage under the later condition. This shows that the species needs a period of after-ripening for the embryo to become more active. However, the exceptions were the germination at 10°C, 40°C, 45°C and total darkness. Bogdan (1977) has also pointed out that it is generally not recommended to sow seeds immediately after harvest but after 6 months of storage.

Biotic Disturbance

Table 4 shows results of the field experiment where plants were disturbed as explained under materials and methods. In all the three forms, the greatest effect was on the uprooted and unwatered plants. The plants dried very rapidly after remaining in withered stage for one to three days. Those that were uprooted and watered survived slightly longer, though in an unhealthy state. The period ranged from 4 days in Form C, followed by 7 days in Form A and 11 days in Form B. Form C is the most sensitive while a longer survival of Forms A and B might be due to the tendency to root at nodes when in contact with the wet soil. The uprooted, replanted, and watered plants survived the longest periods. The period of survival depended on the stage at which transplantation was done. Almost mature plants, if uprooted and replanted, do not survive longer. Death of plants was due to maturation, old age, and more so, due to the onset of dry season. However, Form A seems to have survived the longest under these conditions, probably because of the rhizomatous nature.

Tolerance of Water Stress

Tables 5, 6, and 7 show the results of experiments on water stress. The plants survived when watered every day, on alternate day, and every third day. Those plants that received water on every fifth and tenth day did not survive. Comparing the growth of three forms under the different conditions of water stress shows that Form B surpasses the other two, Form A being the least vigorous. However, Form C developed flowers and was capable of survival by sexual reproduction under water stress, even though the number of spikes was two to three in comparison to the normal five. Hagan (1957) also observed the reduction of plant organs under water stress.

Information from all available floras on West Africa and Nigeria in particular, indicates that there is only one species of *Dactyloctenium aegyptium.* The present investigation revealed persistent differences of growth habit, period of maturity, spike coloration and germination behavior in the proposed three forms. This fact leads to their behaving as three ecotypes, though it requires further confirmation. The effects of the interaction of environmental conditions on plant growth require to be well understood; but prior to the study of the interactions, effect of individual environmental factors should be understood (Downs and Hellmers 1975). This study has attempted to act in this direction and the results are likely to establish whether the three forms represent ecotypes. In any case, a part of an overall picture of basic plant behavior does emerge, which may be useful in guiding future work.

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