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Seasonal succession in a small isolated rock dome plant community in western Nigeria

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On the slopes of one of the inselbergs within the Univ. of Ife Campus, Western Nigeria (7°32′N, 4°31′E) are islands of vegetation completely separated from each other by expanses of bare rock.
The pattern of seasonal succession in one small vegetation island was studied by weekly estimation of species importance. Species importance was estimated by censusing all individuals and by measurements of cover.
At the beginning of the growing season the island is dominated by ephemerals which are later replaced by drought enduring perennials. The number of individuals and species and species diversity and abundance patterns on the island over the growing season show a specific pattern which probably occurs every season.

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На склонах одной из островных гор на территории Университета Иф Кампус (Зап. Нигерия 7°32′ с.ш., 4°31′ в.д.) сформировались островки растительности, полностью изолированные друг от друга голыми скалами. Исследовали характер сезонной сукцессии в одном маленком островке путем еженедельной оценки видовых статусов в сообществе. Статус вида оценивали по учетам всех особей и измерениям покрова. В начале вегетационного сезона на островке доминировали эфемеры, позднее заменяющиеся многолетниками, переносящими иссушение. Число особей и видов, а также видовое разнообразие и динамика обилия отдельных видов на островке в течение вегетационного сезона показали специфические особенности, которые очевидно проявляются каждый сезон.

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Introduction

The seasonal succession here described occurs in an isolated plant community small enough for all the species to be identified and counted. The community is located on one of the inselbergs south of the Univ. of Ife, Nigeria (7°31'N, 4°31'E, where there is eight months growing season, March to October). These islands are established in spots of the rock dome where barriers prevent flow of water leading to deposition of material and establishment of pioneer plants with a community building up around them.

The ages of such islands on the Ife hills cannot be firmly established but Oke (1982) has shown that the communities behave like real islands in that the number of species in 100 such islands he studied had a log-linear relationship with area with a regression slope of 0.26 which is within the range found in island studies (MacArthur and Wilson 1967).

Richards (1957) and Hambler (1964) document the species composition of islands on inselbergs in Western Nigeria. *Cyanotis* spp. and *Afrotrilepis pilosa* are typical perennial drought enduring plants found on the Ife inselbergs. Oke (1982) gives a list of 70 species for the rock dome communities of the Ife inselbergs. The list of species found in the present community is given in the Appendix.

The island used for the present study has an area of 5.15 m^2 and a circumference of 7.75 m with a mean soil depth of 5.44 ± 0.70 cm.

Materials and methods

Seasonal successional changes in the community were estimated by measuring two aspects of species importance:

(1) Population size of each species was determined by censusing. This was done weekly from the beginning of the rainy season (1 March 1981) until 17 May; then bi-weekly to the middle of June. From the middle of June until the end of the growing season in late October, counts were made fortnightly. A summation of all the individuals in a species and in all species was made and the percentage of the total number contributed by each species recorded. Based on these, species diversity was calculated using the Shannon-Weaver formula:

$$H' = \sum_{1=i}^{st} Pi(\ln Pi),$$

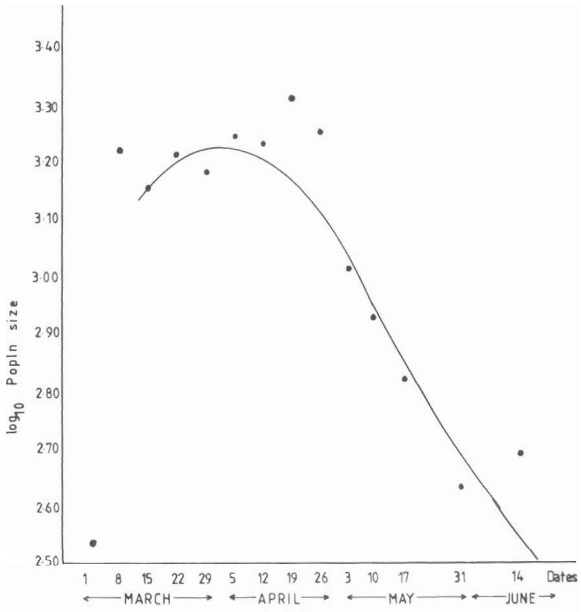

Fig. 1. The trend in the number of individual plants in an isolated rock dome community, Univ. of Ife, Western Nigeria, from the beginning to the middle of the growing season 1981.

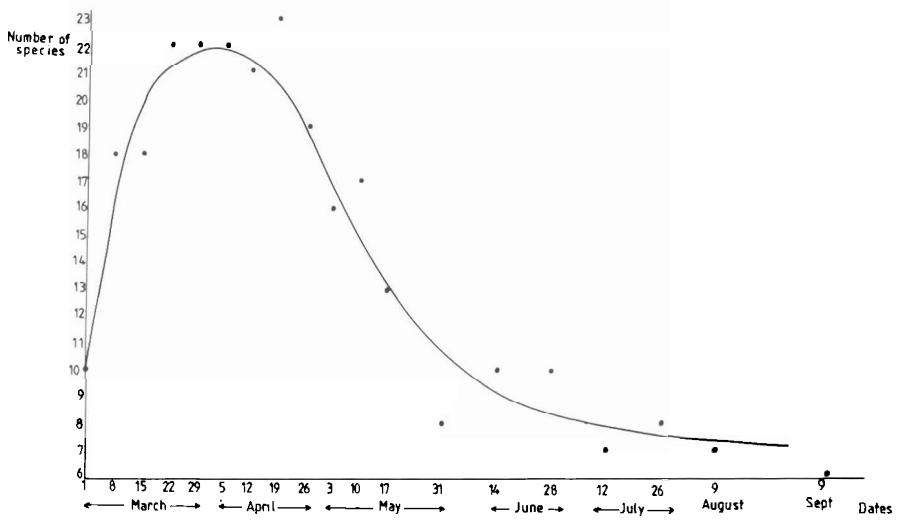

Fig. 2. The trend in the number of plant species in an isolated rock dome community in Western Nigeria over the 1981 growing season.

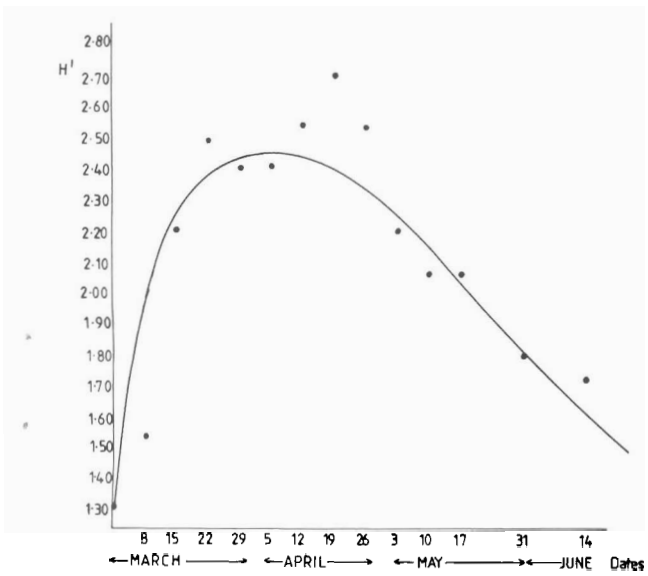

Fig. 3. The pattern of Shannon-Weaver species diversity index (H') in an isolated rock dome community in Western Nigeria from the beginning to the middle of the growing season 1981.

where H' = species diversity, st = total number of species and Pi = proportion of the total number of individuals contributed by the ith species.

(2) Towards the end of the experiment, beginning from the end of June extending to early October, species percentage cover was determined by means of a pin (Greig-Smith 1964: 6). Cover measurements were used in place of plant numbers because unlike at the beginning of the experiment when plant numbers were important, biomass and cover were more important. Furthermore with such creeping plants as *Cyanotis* and *Ipomea* it is difficult or impossible to determine where one plant ends and another begins. Destructive sampling was not desirable in the community so biomass estimates could not be carried out.

Results

The trend in the number of individual plants in the community is shown in Fig. 1. There is an exponential rise in the first weeks of the growing season and a peak attained after seven weeks. Thereafter there is a drop which means that some species have already completed their life cycles and that the rate at which new individuals are added to the community is lower than the rate at which old ones are dying.

The trend in number of species (Fig. 2) is the same. Again there is an initial exponential rise and a peak attained at the seventh week. The rate of decrease is much slower and as late as the end of July new species were still germinating. An equilibrium seems to be established towards the end of the growing season in October and the few remaining species are mainly perennials such as *Cyanotis arachnoidea* and *Urena lobata*. These are the species that last on to the dry season.

Species diversity follows the same pattern (Fig. 3) as followed by numbers of individuals and number of species since it is dependent on both quantities. The initial increase in species diversity is related to the upshoot in number of individuals and species. The drop is also related to the drop in numbers of individuals and species but an additional factor is the increasing dominance of a few species which lowers the species diversity index (Moore 1976).

Fig. 4 shows the patterns of species abundance in the community. The cyclic pattern shown for number of individuals (Fig. 1), number of species (Fig. 2) and species diversity (Fig. 3) is repeated here with the pattern of abundance shown at the beginning of growth repeated at the middle and end of the growing season. At the point where species number is high (22 March–19 April), the pattern of abundance is close to lognormal. This is related to the relative large number of species.

When per cent contribution to the total number of individuals by each species as an importance value is plotted against species sequence at roughly monthly intervals, the patterns obtained are shown in Fig. 5. At the beginning of growth (1 March) the proportion of species number to the total follows the geometric series distribution which implies domination of the community by a few species.

The distribution of this species importance value tends towards the lognormal after one month (29 March) and two months (26 April) of growth. These patterns may be related to species numbers. By 31 May, during the period that may be described as the mid-growth, the number of species has fallen and the pattern observed at early growth is repeated.

Tab. 1 shows the percentage cover for each of the 11 species in the island from 31 May to first week in October. Towards the end of the season *Cyanotis arachnoidea* is a major dominant species in terms of cover followed by *Ipomoea heterotricha*.

Discussion

The early germinating plants are mainly ephemerals and r-strategists which have little influence on the future micro-environment of the community. In some cases they complete their life cycles in two weeks. The peak of species number and species diversity index occurs at the time these ephemerals are joined by late starting perennials, K-strategists, which later replace them. The fall in the diversity index is related to the fall in the number of species.

In relation to dominance and non-dominance, the early germinators (ephemerals) are dominant at the be-

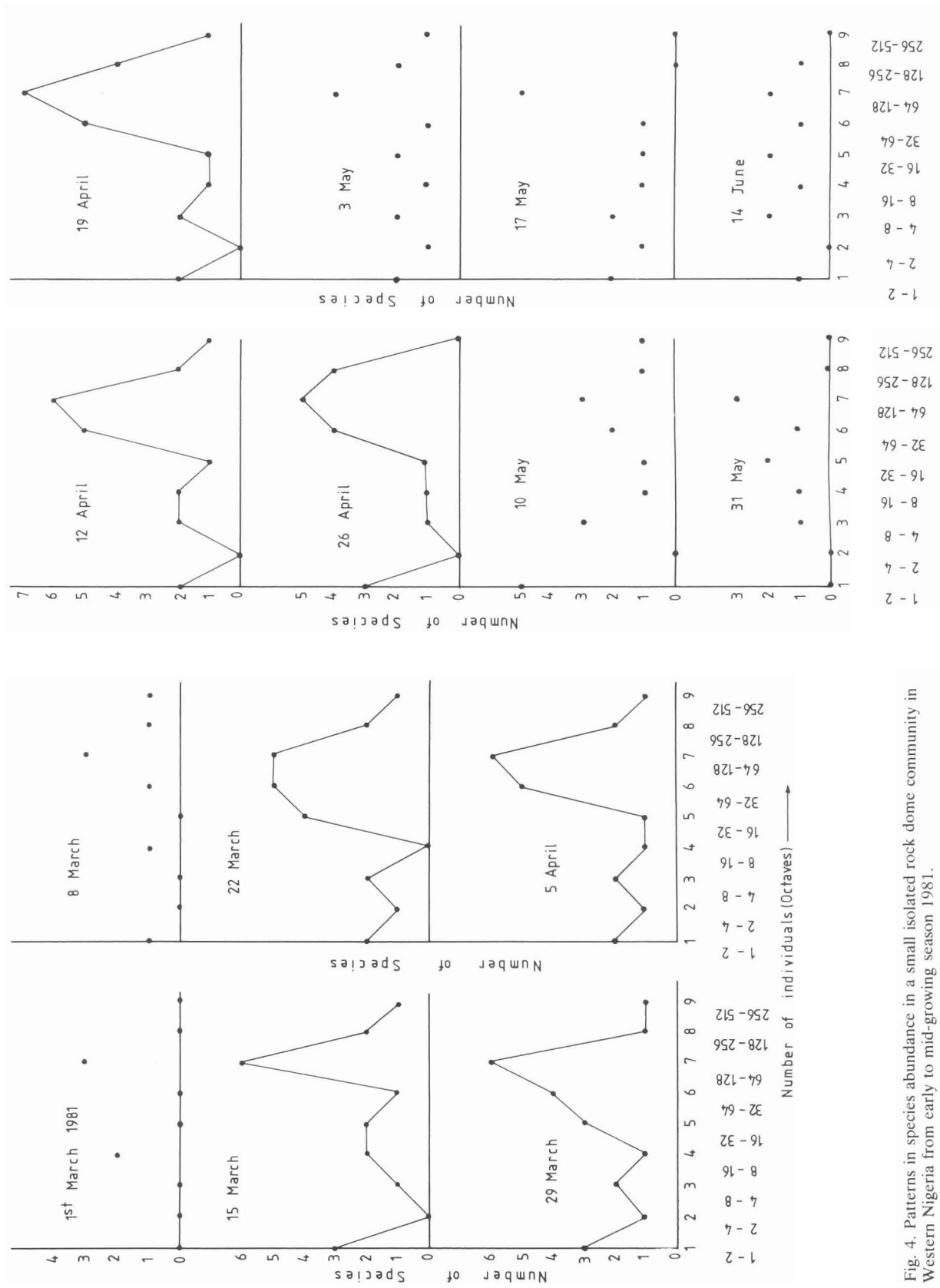

Fig. 4. Patterns in species abundance in a small isolated rock dome community in Western Nigeria from early to mid-growing season 1981.

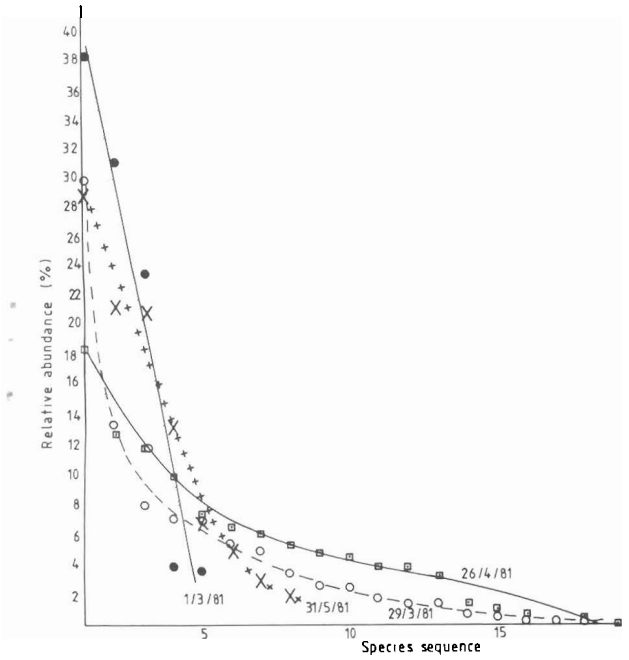

Fig. 5. Distribution of relative abundance of species in an isolated rock dome community in Western Nigeria at various dates in the 1981 growing season. ●——● 1 March, ○---○ 29 March, ⊡——⊡ 26 April, ×+++++× 31 May.

ginning of the growing season. Later, as the rains come and the season progresses, more plants germinate and the rate of appearance of new individuals and species exceeds the rate at which those already present disappear. Toward the end of the season some species and individuals are eliminated and a few perennials assume dominance. This trends is related to the exponential rise in the species diversity index at the early part of the growing season until the seventh week of growth, then a peak and a fall as the perennials assume dominance. Diversity then remains low because of low species richness and evenness – two components of the diversity index. At the end of the growing season (October), one species, *Cyanotis arachnoidea*, forms over 50% of the cover in the community.

Species abundance in the community tends towards the lognormal at least at the middle of the growing season. No discernible form of distribution can be ascribed to the patterns shown at the beginning and at the end of the growing season. The trend is clearer when the contribution to the total number of individual plants is used as an importance value. Here niche pre-emption by the early germinators results in a geometric series distribution. When, however, more plants join the community a near equitable distribution of individuals (the lognormal) is shown. Later stages are similar to the early ones.

Overall, the distribution of number of individuals and species over time as well as species importance show that major changes involving species replacement and increase in numbers occur within the months of March, April, May and June. No rapid changes in species occur during the rest of the growing (season (July–October). The largely perennial drought enduring species increase their respective covers until *Cyanotis arachnoidea* and *Ipomea heterotricha* remain the only species at the tail end of the growing season.

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Tab. 1. Percentage cover of plants found in a seasonal community af various dates from the middle to the end of the growing season 1981.

Plant species	Dates and percent cover							
	31 May	14 Jun	28 Jun	12 Jul	26 Jul	9 Aug	9 Sep	9 Oct
Borreiria spp.	16	2	2	0	0	0	0	0
Bulbostylis congolensis	0	4	4	2	2	2	0	0
Cassia minosoides	0	2	5	3	5	4	3	0
Monocymbium ceresiiforme	4	3	4	2	4	5	2	3
Desmodium ramosissimum	5	3	9	1	3	2	5	2
Ipomea heterotricha	13	11	21	34	25	24	10	28
Mariscus sp.	1	3	3	0	2	0	0	0
Cyanotis arachnoidea	43	48	48	56	48	46	76	60
Sida sp.	18	24	4	2	11	17	4	7

Appendix. Species found in a seasonal rock dome community in Western Nigeria

All plant names are according to The Flora of West Tropical Africa, Hutchinson and Dalziel, Keay and Hepper, 1953–1973, Crown Agents for Overseas Governments, Millbank, London.

Andropogon gayanus
A. tectorum
Borreiria radiata
B. scabra
Bulbostylis congolensis
Cassia mimosoides
Cyanotis arachnoidea
C. lanata
Desmodium ramosissimum
Eragrostis tremula
Ipomea heterotricha
Loudetia arundinacea
Mariscus sp.
Monocymbium ceresiiforme
Mucuna pruriens
Sida sp.
Talinum triangulare
Tephrosia elegans
Urena lobata
Urginea ensifolia
Vigna gracilis