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Ephemeral flush vegetation on inselbergs in the Ivory Coast (West Africa)

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ABSTRACT

DÖRRSTOCK, S., S. POREMBSKI & W. BARTHLOTT (1996). Ephemeral flush vegetation on inselbergs in the Ivory Coast (West Africa). *Candollea* 51: 407-419. In English, French and English abstracts.

A detailed description of floristic aspects and of the ecology, biogeography and species diversity of the ephemeral flush vegetation on West African granite inselbergs is given. Due to stressful environmental conditions inselbergs bear a highly distinct vegetation.The ephemeral flush vegetation is a seasonal, low growing herb community which occurs over shallow soils on inclined rocky slopes. Floristically the high number of carnivorous species (e.g. *Utricularia* spp., *Genlisea stapfii*) is remarkable. Species diversity of this habitat increases from the rainforest towards the savanna region of the Ivory Coast. With up to 35 species per relevé the ephemeral flush vegetation is the most speciose community on West African inselbergs.

RÉSUMÉ

DÖRRSTOCK, S., S. POREMBSKI & W. BARTHLOTT (1996). Végétation des micro-marécages temporaires des inselbergs de Côte-d'Ivoire (Afrique de l'Ouest). *Candollea* 51: 407-419. En anglais, résumés français et anglais.

Une description floristique, écologique et biogéographique avec considération de la diversité de la végétation des micro-marécages sur les inselbergs granitiques en Afrique de l'Ouest est présentée. La végétation des micro-marécages est un groupement de petites herbes sur sol très mince qui se forme pendant la saison des pluies au pied des pentes rocheuses. L'ensemble floristique de ce groupement se distingue par un grand nombre d'espèces carnivores (e.g. *Utricularia* spp., *Genlisea stapfii*). La richesse floristique de cette association augmente, en Côte-d'Ivoire, de la zone forestière vers la région des savanes. Avec un maximum de 35 espèces par relevé, c'est l'habitat le plus riche en nombre d'espèces sur les inselbergs de l'Afrique de l'Ouest.

KEY-WORDS: Carnivorous species – Climatic and latitudinal gradient – Ephemeral flush vegetation – Inselbergs – Ivory Coast – Seasonality – Species richness.

Introduction

The term "inselberg", created by BORNHARDT (1900), characterizes granitic and gneissic, mostly dome-shaped rock outcrops which are geomorphologically old (frequently more than 20 million years). A detailed survey of the geomorphology of inselbergs is given by BREMER

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& JENNINGS (1978). Inselbergs are widespread in many parts of the tropics and subtropics. Due to the lack of substrate and extremes of microclimate they bear a vegetation that is distinctly different from the surroundings.

Most inselbergs harbour a highly seasonal plant community of tiny hydrophytes which occurs on slightly inclined slopes in small seepage zones below patches of vegetation (e.g. *Afrotrilepis pilosa*-mats) where water seeps continuously during the rainy season. Following RICHARDS (1957) the term "ephemeral flush vegetation" will be used for this community. Only marginally mentioned in literature (e.g. ADJANOHOUN, 1964; BONARDI, 1966; GUILLAUMET, 1967; HAMBLER, 1964; MILDBRAED, 1922; POREMBSKI & BARTHLOTT, 1993; RICHARDS, 1957; VILLIERS, 1981) this vegetation type has not been examined in detail so far. The intention of this study is to present a first description of floristical, ecological and biogeographical details of this nearly unknown habitat.

Study area

The Ivory Coast is situated between 4°25'-10°40'N and 2°30'-8°40'W. Floristically Guineo-Congolian elements are dominating, but in the north of the country Sudanian affinities exist. The climate of the Ivory Coast is influenced by the shift of the ITCZ (intertropical convergence zone). The south of the country is mainly covered by lowland rain forest, secondary grassland and cultivational areas. Precipitation lies between 1600 to 2300 mm per year with a weakly expressed dry season in July/August and a more severe dry season during December/January. The northern part of the country is covered by several types of woodland respectively savanna. Annual rainfall is between 900-1500 mm/year with a dry season from November to March/April. Detailed descriptions of climate, flora and vegetation of the Ivory Coast are given by AKÉ ASSI (1984), ANHUF (1994), ELDIN (1971) and GUILLAUMET & ADJANOHOUN (1971).

Inselbergs in the Ivory Coast consist of granite and gneiss (LENEUF, 1959). They occur all over the country, with a higher number in the savanna region than in the rain forest zone. Inselberg size ranges from several 100 m^2 and a few metres in height ("shield inselbergs") up to an area of 7 km^2 and a height of 300 m above the surroundings. The microclimate of inselbergs is characterized by extremes of temperature and insolation. Even on inselbergs situated in rain forest, temperatures on the rock regularly exceed 60°C and relative air humidity falls below 30%. High wind speeds can be recorded on inselbergs which are caused by thermic convection.

Inselberg vegetation

The vegetation of inselbergs can be subdivided into characteristic habitats, e.g. cryptogamic crusts on rock surfaces, rock crevices, shallow depressions, seasonally water-filled rock pools, monocotyledonous mats, ephemeral flush and wet flush vegetation. Cryptogamic crusts on Ivorian inselbergs mainly consist of lichens (in particular *Peltula* spp.). Narrow rock fissures are colonized by short-lived herbs (many Poaceae and Cyperaceae), whilst crevices may be occupied by shrubs (e.g. *Hymenodictyon floribundum*) and trees (e.g. *Ficus* spp.). *Afrotrilepis pilosa*, a poikilohydric stem producing Cyperaceae dominates mat communities of West African inselbergs. *Afrotrilepis*-mats offer growing sites for a number of geophytes, such as *Albuca nigritana*, *Ceropegia deightonii* and *Eriospermum abyssinicum*. A wet flush community develops on inclined rocky slopes with water steadily running down during the rainy season. Typical are crusts of cyanobacteria which offer establishment sites for tiny vascular plants, like *Utricularia subulata*. For a more detailed description of habitats on inselbergs it is referred to BARTHLOTT & al. (1993). In the following, ephemeral flush vegetation is abbreviated to EFV. General descriptions of the Ivorian inselberg vegetation have been provided by ADJANOHOUN (1964), BONARDI (1966), POREMBSKI & BARTHLOTT (1992, 1993), POREMBSKI & al. (1995) and POREMBSKI & BROWN (1995).

Material and methods

Altogether 38 ephemeral flush communities, from inselbergs all over the Ivory Coast (Fig. 1) were investigated during September/October 1993, 7 sites were studied in 1991/1992. The description of the vegetation was carried out according to the Braun-Blanquet relevé method (BRAUN-BLANQUET, 1964) with a modification in cover abundance scale following BARKMAN & al. (1964) and WILMANNS (1984). The plots were randomly located with a size of 4 m^2. Relevé size was based on a minimal area analysis.

Life-form spectra were compiled in accordance with the RAUNKIAER (1934) classification, the classification of pollination modes according to syndromes follows FAEGRI & VAN DER PIJL (1979). Dispersal modes were classified according to syndromes after VAN DER PIJL (1982) with certain modifications following BERG (1983) and JENNY (1994).

For water pH-analysis, Merck indicator test-sticks were used. Soil analyses were carried out at the Pedological Institute of the University of Bonn: pH was determined by a glass electrode in a 0.01 M $CaCl_2$-solution, the nutrient content was determined by CAL-extract, quantitative analysis of the organic matter was determined by measuring the ash content. The soil type was determined by hand, the soil fraction >2 mm diametre was determined by electronic scales. Water analysis by the Wahnbachtalsperrenverband (using the Inductively Coupled Plasma (ICP)-method).

For germination experiments soil samples were dried for 3 months and subsequently heated (75°C) in a heat box for 3 hours. Afterwards the soil was put out in pots (which were kept in a greenhouse at 25-30°C air temperature) over a layer of granite fine cherts. For control unheated soil samples were hold under the same conditions.

Results

Abiotic factors

The ephemeral flush communities studied occurred at the feet of rocky slopes below *Afrotrilepis*-mats and other water-holding vegetation types (Fig. 2) or on sandy soils in transition zones between shield inselbergs and the surrounding vegetation. The degree of slope inclination was mostly between 1-10°, sometimes up to 25°. The sites studied occurred at altitudes between 100 and 620 m asl. and up to 300 m above the surrounding plains. Size of the communities studied ranged between 4 (narrow fringes bordering *Afrotrilepis*-mats) and 200 m^2.

Soil depth ranged from shallow to very shallow (0.5-12 cm) with lowest values at the community margin towards the rock. Characteristic was a mosaic of different soil depths occurring close together. The soil had a sandy or sandy-loamy texture and a high humus content (5-12% organic substance). The soil fraction >2 mm diametre reached 11-28.5%. The soil can be classified as lithosol or ranker (FAO-UNESCO, 1988). Soil pH varied between 4 to 5.5.

Apart from direct precipitation the sites studied were supplied with seepage water (nutrient content was low, s. Table 1). Depending on the water-holding capacity of the vegetation situated above the ephemeral flush communities seepage water was available for 1-14 days after rainfall. If the supply of seepage water comes to an end, the soil dries out within 2 weeks.

Physiognomy of the vegetation

The EFV is a low growing (5-70 cm) herb community. Frequently the vegetation cover is interrupted by bare rock. Usually 3-4 intergrading zones can be distinguished according to soil depth (Figs. 3, 4, 5): a transitional zone against the rock, a marginal zone, a central zone and an

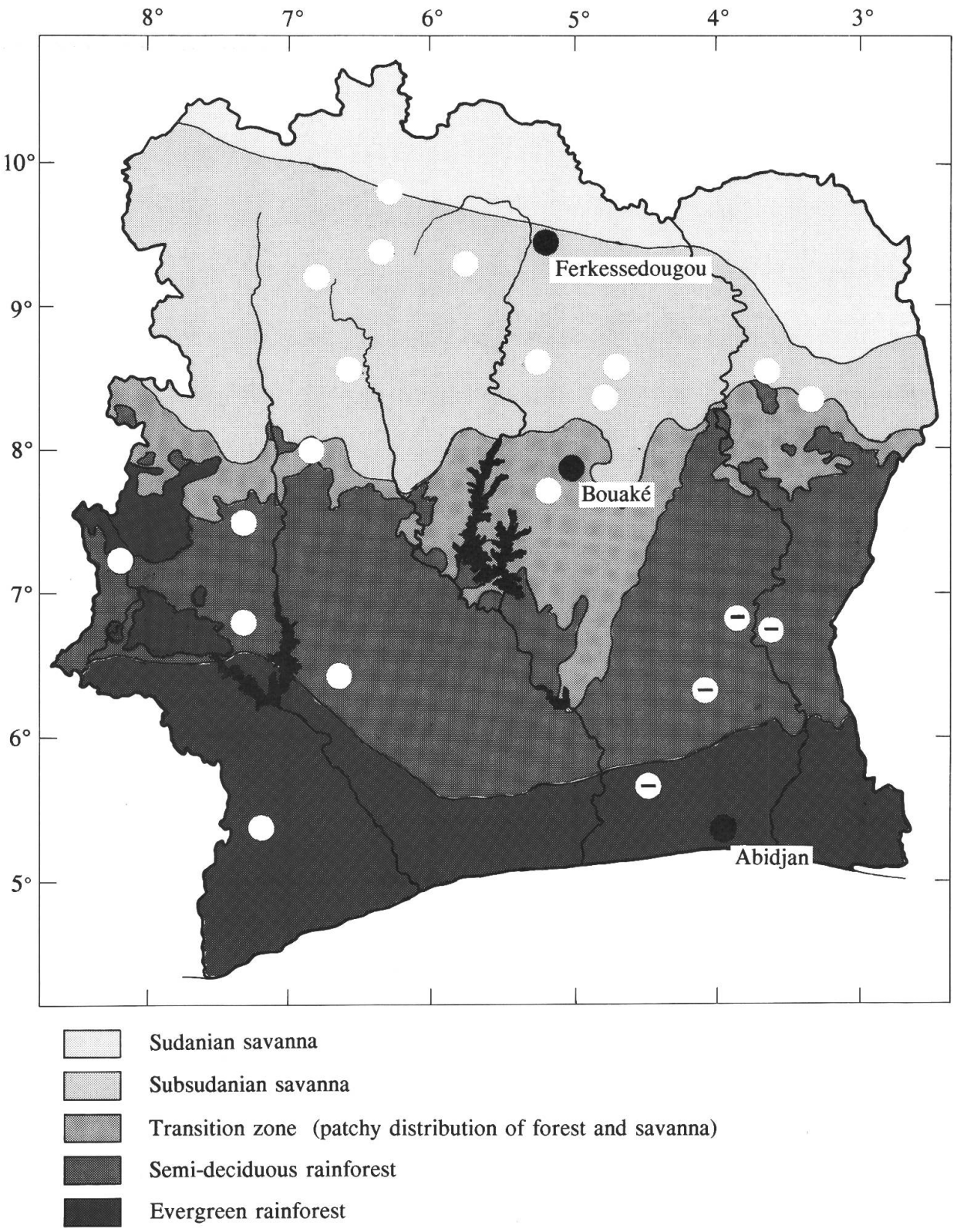

Fig. 1. – Map of the Ivory Coast showing natural vegetation zones (modified after MONNIER, 1993). Inselbergs studied indicated by white dots. The absence of ephemeral flush communities is marked by a bar.

Fig. 2. – Ephemeral flush vegetation (EFV) at the feet of a rocky slope on Mt. Niangbo. White bars indicate the border of this community. BR = bare rock, GM = grass mats.

Fig. 3. – Central zone of an ephemeral flush community on Mt. Niangbo with *Nemum spadiceum*, *Panicum lindleyanum* and *Utricularia juncea*.

Fig. 4. – Marginal zone of an ephemeral flush community with *Aeollanthus pubescens*, *Burmannia madagascariensis*, *Drosera indica*, *Panicum lindleyanum* and *Utricularia micropetala*.

Table 1. – Analyses of water sampled in ephemeral flush communities.

From relevé n°		1	2	3	4	8	9	10	12	13
Conductance	mS/m	1	3	11.6	1.8	2.1	3.4	2.7	1.8	0.6
NO2	mg/l	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NO3	mg/l	1	1	1	1	2	2	1	1	1
NO4	mg/l	0.109	1.067	10.147	1.174	0.042	0.025	0.684	0.458	0.155
P	mg/l	0.02	0.03	0.03	0.02	0.02	<0.02	0.02	<0.02	0.03
0-PO4-P	mg/l	<0.005	<0.005	<0.005	0.011	<0.005	<0.005	<0.005	<0.005	<0.005
K	mg/l	0.2	0.5	1.9	0.5	0.4	0.6	0.6	0.4	0.1
Mg	mg/l	<0.1	0.1	0.41	<0.1	0.1	0.4	0.1	0.1	<0.1
Ca	mg/l	0.4	1.6	1.7	0.2	0.9	1.5	1.5	0.9	0.2
Na	mg/l	1	2.3	4.8	1.3	3.1	5.5	2.4	1.8	0.5
Mn	mg/l	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Al	mg/l	0.015	0.013	<0.005	0.024	0.018	1.036	0.005	0.04	0.031
Fe	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	0.214	<0.005	<0.005	<0.005
Si	mg/l	1.6	3.1	5.4	1.6	1.8	7.7	2.2	1	0.3
SO4	mg/l	0.1	0.3	0.6	0.1	0.1	0.1	0.1	0.2	0.1

upper transitional zone (sometimes lacking) towards habitats, like *Afrotrilepis*-mats. The transitional zone against the lichen covered rock is dominated by cyanobacteria. The marginal zone (soil depth 0.5-3 cm) is characterized by the scattered occurrence of tiny annuals (5-20 cm in height) with a high percentage of carnivorous species. Within the central zone (soil depth 3-10 cm) Cyperaceae and Poaceae (20-50 cm in height) dominate. Tall grasses are typical for the upper transitional zone. This zonation may become obscured due to the patchy distribution of different soil depths. Most species recorded were not restricted to a single zone, however, they occurred preferentially in a particular one.

Floristic composition and phytosociological aspects

One hundred fifteen species out of 29 families were found (s. Table 2). Most species belong to the Cyperaceae (26 species), Poaceae (21 spp.), Lentibulariaceae (10 spp.), Scrophulariaceae (10 spp.) and Eriocaulaceae (6 spp.). Most speciose is the genus *Utricularia* (9 spp.), followed by *Cyperus* (7 spp.) and *Eriocaulon* (6 spp.). Many genera occurred with only one species (e.g. *Xyris*).

Carnivorous species like *Drosera indica*, *Genlisea stapfii* and *Utricularia* spp. were the most conspicuous elements according to their high share in species number compared with other habitats on inselbergs. Carnivorous plants characterize the EFV and discriminate this community from other inselberg habitats. Moreover the high species number of small-sized Poaceae and Cyperaceae is typical for the EFV. *Xyris straminea* occurred with a high degree of constance (95.4%) and forms also an essential component of the EFV. Further species with a high degree of constance were *Drosera indica* (93%) and *Panicum lindleyanum* (90.7%). In particular the latter species is highly characteristic for the EFV since it usually occurs with high cover percentages and has only rarely been found in other communities. Other frequently recorded (> 50%) species were *Utricularia pubescens* (76.6%), *Utricularia subulata* (72.1%), *Aeollanthus pubescens* (69.8%), *Afrotrilepis pilosa* (67.4%), *Bulbostylis congolensis* (67.4%), *Ascolepis protea* (62.8%), *Scleria melanotricha* (62.8%), *Sporobolus pectinellus* (60.5%), *Nemum spadiceum* (55.8%) and *Cyanotis lanata* (51.2%). In comparison, 61% of the species were found in only 10% of the relevés. Therefore, the homotoneity of the relevés is low.

Affinities to similar habitats

No species found in the EFV is restricted to inselbergs. Forty nine out of the 115 species recorded mainly occur on inselbergs where they are restricted to the EFV (e.g. *Genlisea stapfii*). Floristic links exist with inselberg communities in shallow soil-filled depressions (32 species) with Poaceae dominating and seasonally water-filled rock pools (26 species). Eight species also occur in *Afrotrilepis*-mats, 6 species are colonizers of rock crevices and 5 species grow among rock debris.

Outside inselbergs many species observed within ephemeral flush communities occur on open places over wet sandy soil or on swampy respectively marshy sites as well as on ferricretes (locally known as "bowal"). ADJANOHOUN (1964) described a *Sporobolus pectinellus-Cyanotis lanata* community occurring on ferricretes that has strong physiognomic and floristic affinities with the EFV.

Phytogeography

More than 50% of the species found are distributed all over tropical Africa or are paleotropical respectively pantropical elements. Thirteen species are paleotropics, 9 species are pantropics, 6 species show a disjunct distribution between tropical Africal and the neotropics. *Utricularia juncea*, which hitherto was only known from the New World, has been found at two sites in the Ivory Coast during this study (DÖRRSTOCK & al., 1995). Fifteen species (e.g. *Eriocaulon plumale* ssp. *jaegeri*, *Genlisea stapfii*, *Lipocarpha filiformis*, *Loudetiopsis capillipes*) are restricted to the Upper Guinea province, 17 species occur in the Upper Guinea-Nigeria/Cameroon-provinces and further 17 species are widespread throughout the Sudano-Zambezian Region. No species is endemic to the Ivory Coast.

Phenology

The vegetation period starts 4-8 weeks after the begin of the rainy season with the germination of the first seeds. Experiments showed that for *Drosera indica* the germination rate is increased after heat treatment (3 hours at 75°C) of the seeds. The vegetation cover reaches its maximum at the end of the rainy season. At most sites a cover degree of 70-90% was attained,

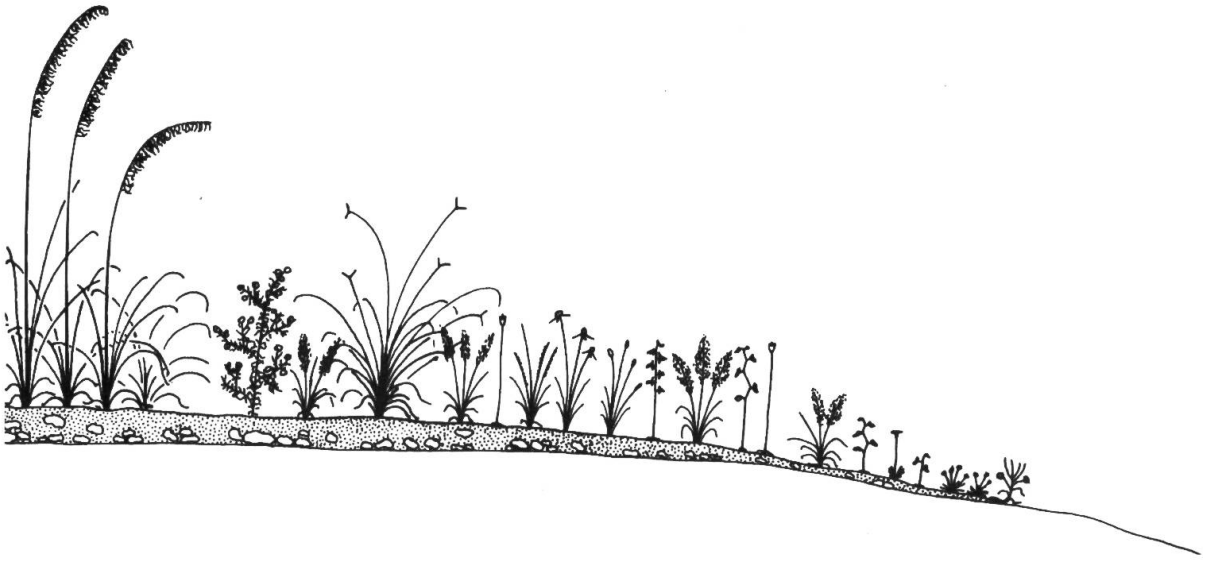

Fig. 5. – Schematic cross section of typical ephemeral flush vegetation.

however, at some sites the cover degree reached only 50%. On average the cover degree was higher in the rain forest region (70-100%) than in the savanna zone (50-90%).

The first flowers appeared 3-4 weeks after germination was observed (several Cyperaceae). The main flowering period lies at the end of the rainy season. At this time many fruit bearing individuals can be found too. Certain geophytes (e.g. *Eriospermum abyssinicum*) preferentially flower during the dry season. In the rain forest zone some species (e.g. *Utricularia* spp.) are able to complete their life cycle twice a year due to the prolonged vegetation period.

Life-forms and vegetative strategies

Most species found were therophytes (79%), followed by hemicryptophytes (9.6%), geophytes (6%), meso-phanerophytes (4.3%) and one chamaephyte (*Afrotrilepis pilosa*). The number of perennials increases in the rain forest region. The high percentage of carnivorous species is indicative of the nutrient deficiency of the sites studied. Remarkable is the occurrence of carnivorous "climbers", such as *Utricularia micropetala*, *U. spiralis* and *U. tortilis*. Using grasses as support these species may expose their flowers more conspicuously.

Pollination biology

Entomophilous species (57%) dominate over anemophilous taxa. Concerning the number of entomophilous flowers the ephemeral flush community is much richer than other inselberg habitats (own data). However, it is conspicuous that only a very small number of pollinating insects (e.g. *Apis mellifera adansonii*) could be observed. Autogamy seems to be an important factor. Cleistogamous forms of *Utricularia juncea*, *U. pubescens* and *U. subulata* (s. KILLIAN, 1953;

relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
latitude (N)	7°45´	8°35´	8°42´	8°49´	8°49´	8°49´	8°49´	9°27´	9°36´	9°32´	9°15´	7°45´	6°45´	8°35´	8°35´	8°35´	8°35´	8°35´	8°35´	8°35´	8°35´	8°35´	8°35´	8°35´	8°35´	8°35´	8°25´	8°49´	8°49´	8°49´	8°49´	8°49´	8°49´	8°49´	8°49´	8°49´	8°49´	8°49´	8°36´	9°40´	6°29´	7°15´	7°25´	7°25´	5°25´	6°45´
longitude (W)	5°10´	4°40´	3°35	5°11´	5°11´	5°11´	5°11´	5°38´	6°55´	6°29´	6°40´	6°40´	7°21´	4°40´	4°40´	4°40´	4°40´	4°40´	4°40´	4°40´	4°40´	4°40´	4°40´	4°40´	4°40´	4°40´	4°32´	5°11´	5°11´	5°11´	5°11´	5°11´	5°11´	5°11´	5°11´	5°11´	5°11´	5°11´	3°46´	6°30´	6°35´	8°1´	7°35´	7°35´	7°10´	7°22´
height above sea level [m]	370	410	310	540	530	530	530	470	460	430	410	300	200	340	340	380	400	420	420	440	450	500	460	455	430	400	360	450	450	550	620	600	570	490	490	500	500	280	525	220	370	240	270	260	240
inclination [°]	10	11	3	6	8	5	8	17	2	12	2	2	8	3	2	3	21	12	2	7	6	3	4	8	3	7	14	6	17	3	3	6	2	2	3	9	5	3	3	7	5	3	5	7	3
exposition	SE	SE	SW	SE	S	S	S	S	S	SSE	E	E	E	W	W	N	N	N	N	N	N	W	NE	E	S	E	S	N	N	W	NE	N	E	S	SW	S	S	N	E	S	W	SW	SW	SE	NW
cover degree (%)	80	70	75	70	75	65	75	50	60	85	60	90	90	75	50	50	70	85	70	60	50	80	70	80	70	50	80	90	70	70	50	60	60	60	70	70	80	40	70	100	85	80	90	80	90
species number	22	31	34	30	10	10	29	14	32	28	22	19	11	18	26	35	20	23	33	25	32	31	16	21	15	18	8	20	21	23	23	15	18	10	27	8	16	24	17	8	11	15	9	5	7
site area [m²]	20	120	40	60	25	20	25	15	120	65	30	50	50	8	110	25	50	200	70	60	120	100	100	40	25	100	20	80	25	20	40	10	120	60	150	40	30	40	25	40	10	15	10	4	4
Xyris straminea	1	1	1	2m	1	.	2m	1	2m	2m	.	2m	1	2m	2m	2m	2m	1	2m	2m	2m	2a	2m	1	2m	2m	1	1	2m	1	2m	2m	2m	.	2m	.	1	1	1	p	1	1	1	1	1
Drosera indica	.	p	1	1	1	1	1	1	1	1	.	2m	.	1	1	1	1	2m	1	1	1	2m	1	1	.	2m	1	1	2m	2m	2m	2m	1	1	1	.	1	1	1	p	1	1	1	1	1
Panicum lindleyanum	.	2b	3	2b	4	4	3	.	2b	2b	.	.	.	3	2a	2b	3	4	4	3	3	3	3	3	1	2b	4	3	3	4	2b	4	3	3	3	3	3	3	.	4	3	2b	2b	5	3
Utricularia pubescens	1	1	1	1	1	p	1	p	1	1	.	1	2a	1	1	2m	1	1	1	1	1	1	2m	2m	2m	2m	2m	1	1	2m	1	.	.	.	1	.	.	.	1	.	1	.	.	.	.
Utricularia subulata	1	2m	1	1	.	.	1	1	2m	2m	.	.	1	2m	1	2m	1	1	1	1	1	1	1	1	.	.	1	1	1	.	1	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.
Aeollanthus pubescens	.	1	.	2a	1	p	1	.	.	.	.	.	.	1	1	1	1	2a	1	1	1	1	1	1	1	2a	1	.	1	1	1	1	1	1	1	1	1	2a	2a	1	.	.	.	.	.	.
Afrotrilepis pilosa	1	1	.	2a	.	.	1	.	p	p	.	2a	2a	.	2a	2a	1	1	1	1	1	1	1	2b	3	1	2b	2a	.	1	2a	1	1	.	1	.	.	.	3	.	.	.	.	.	.	.
Bulbostylis congolensis	2a	2a	.	2a	.	p	1	p	p	1	.	4	.	1	1	p	1	1	.	2a	1	2a	2b	1	2a	1	.	1	.	1	1	1	1	1	.	1	.	.	.	.	.	.	2a	.	.	.	.
Scleria melanotricha	.	1	.	1	1	3	1	.	1	2a	.	.	.	1	1	.	1	1	1	1	1	1	1	1	2a	1	.	1	1	1	1	.	.	.	.	1	.	.	.	2a	.	2a	2a	2a	.	.
Ascolepis protea	.	p	.	1	.	1	p	1	1	1	1	.	.	2m	p	1	p	2m	1	1	p	1	.	p	1	1	.	1	1	2a	1	.	.	.	p	.	.	1	2b	.	.	.	.	.	.	.
Sporobolus pectinellus	1	1	.	1	.	.	1	1	1	1	2a	2a	1	.	1	1	.	1	1	.	.	p	.	1	1	1	.	1	.	1	1	1	2a	1	2a	.	.	.	.	.	.	.	.	.	.	.
Nemum spadiceum	.	1	.	1	1	.	2a	.	.	1	.	.	4	.	.	.	1	1	2a	2a	1	1	1	1	.	.	.	3	3	.	1	.	2a	2b	2a	.	2b	.	.	2a	2b	2a	2a	.	.	.
Cyanotis lanata	p	r	p	1	.	.	1	.	1	p	2a	1	.	2b	1	1	.	.	p	.	.	1	.	1	.	.	.	.	.	.	1	1	1	1	p	.	.	2a	.	.	.	.	.	.	.	.
Lipocarpha filiformis	1	p	1	1	.	.	1	.	p	1	.	.	.	2m	1	1	.	.	1	1	1	1	.	p	.	.	.	1	1	.	1	1	.	.	1	.	.	1	.	.	.	.	.	.	.	.
Eriocaulon plumale ssp.jaegeri	.	2a	2m	2m	.	.	2m	.	1	.	.	.	.	.	.	1	1	2m	1	2a	2a	.	.	.	.	2a	.	.	.	2a	.	.	.	.	2a	.	.	1	.	p	1	1	.	1	.	1
Eriocaulon afzelianum	.	.	1	.	.	p	p	1	1	1	1	.	.	2m	1	1	.	.	1	.	1	1	.	2a	.	1	.	.	1	2a	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Neurotheca loeseliioides	.	1	.	1	.	1	.	.	p	.	.	.	1	.	.	.	2m	1	1	2a	1	1	1	.	.	.	1	.	.	.	.	1	p	1	.	.	.	.	.	1	.	1	.	1	.	2a	.
Lindernia exilis	1	p	1	1	.	.	1	1	.	1	1	1	1	.	.	p	1	.	.	1	p	1	1	.	.	1	.	.	.	1	1	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.
Ophioglossum costatum	.	p	p	.	.	.	.	1	.	p	1	.	.	1	p	.	.	1	p	1	1	.	p	.	1	.	.	.	.	1	.	.	.	.	.	.	.	2a	1	.	1	1	.	.	.	1
Loudetiopsis capillipes	.	.	.	2a	2a	.	2a	.	.	2a	.	.	.	.	.	.	.	2a	p	p	2b	.	p	.	.	.	.	2a	2a	.	2b	2a	2a	.	2b	2b	.	.	.	.	2a	2b	.	.	.
Lindernia schweinfurthii	.	1	.	1	.	.	1	.	1	.	.	.	.	2m	1	2m	.	.	1	1	1	.	1	1	1	1	.	.	.	1	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.
Panicum griffonii	1	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	2a	.	1	1	2a	.	2a	.	.	.	.	1	.	.	.	p	3	3	.	.	.	.	.	2b	2a	2b	.	3
Bacopa floribunda	p	1	1	.	.	.	.	.	.	1	1	1	.	1	1	2m	p	.	1	.	.	.	.	.	.	1	.	.	2a	.	.	.	.	.	.	1	.	.	.	1	.	2a	2a	.	2a
Andropogon africanus	5	.	.	.	.	.	.	.	.	.	2a	.	.	.	2a	.	2a	1	2a	.	.	.	.	.	.	.	.	2a	.	1	2b	.	2a	2b	2b	2a	1	.	.	1	.	2a	2a	.	2a
Borreria scabra	p	r	p	.	.	.	.	p	.	p	p	.	.	.	p	p	p	.	p	p	.	.	p	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.
Burrmannia madagascariensis	.	1	.	1	.	.	1	.	.	.	.	.	.	.	.	.	2m	2m	2m	2m	2m	.	.	.	1	.	1	.	1	1	.	.	2m	.	.	1	.	.	.	.	.	.	.	.	.	.
Utricularia micropetala	.	.	.	2a	2m	.	1	.	.	2m	.	.	.	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	2m	2a	1	.	1	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.
Sopubia parviflora	.	p	.	p	.	.	.	.	p	r	r	.	.	p	r	r	.	.	r	.	.	r	.	r	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Utricularia juncea	.	2a	.	2a	1	.	1	.	.	.	.	.	.	.	.	.	.	2a	2a	2a	2a	.	.	.	.	.	.	.	2a	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.
Loudetiopsis keretingii	.	1	.	.	.	.	.	.	.	.	.	.	.	2a	p	2b	.	.	p	p	1	2a	.	.	2b	2b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Andropogon curvifolius	.	.	.	.	.	.	.	.	.	.	.	.	2b	.	.	.	.	.	.	1	1	1	2a	2a	1	.	2a	.	.	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	.	.	.
Genlisea stapfii	.	2m	.	.	.	.	.	.	1	1	.	.	.	.	.	.	2m	2m	.	2m	2m	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pandiaka heudelotii	.	.	p	p	.	.	p	.	.	p	.	.	.	.	.	.	.	.	.	r	p	.	.	.	.	.	.	.	r	.	.	.	.	p	p	.	.	.	.	.	.	.	.	.	.
Fimbristylis alboviridis	p	.	1	.	.	.	p	.	p	.	.	1	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Borreria cf.filifolia	.	.	p	.	.	.	.	.	p	.	.	.	.	.	.	.	p	p	p	p	p	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygala arenaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	p	.	p	p	.	p	.	.	.	.	p	.	.	p	.	.	.	1	.	p	.	.	.	.	.	.	.	.	.	.	.
Eriocaulon togoense	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	1	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pycreus capillifolius	.	p	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	p	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyanotis longifolia	.	.	p	.	.	.	.	.	.	.	p	.	.	.	.	p	.	.	p	.	.	.	.	p	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Loudetia simplex	.	.	p	.	.	.	.	.	.	.	2a	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	2a	.	.	.	.	.	.	.	.
Ophioglossum gomezianum	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.
Rotala tenella	.	.	1	.	.	.	.	.	1	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Kyllinga sp.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	p	p	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.
Pancratium trianthum	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.
Cassia mimosoides	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	r	.	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.
Isoetes nigritiana	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Fimbristylis dichotoma	.	p	1	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Sporobolus infirmus	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2b	.	.	.	.	.	.	.	.
Microchloa indica	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.
Cyperus squarrosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Utricularia spiralis	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygala sp.	.	.	.	p	.	.	.	.	.	.	p	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eriospermum abyssinicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera sp.	.	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	p	r	.	.	.	.	.	.	.	.
Ascolepis capensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.
Ascolepis pusilla	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Digitaria leptorhachis	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
cf.Schizachyrium sp.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eleocharis atropurpurea	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Djaloniella ypsilostyla	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Eriocaulon remotum	.	.	.	.	.	.	.	.	1	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygala lecardii	.	.	p	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sebaea pumila	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Alectra basserei	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	p	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Commelina sp.	.	.	.	.	.	.	.	.	p	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Loudetia togoensis	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sporobolus festivus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2b	.	.	.	.	.	.	.	.
Aristida diminuta	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crepidorhopalon debilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus cuspidatus	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus dubius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus haspan	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus pustulatus	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Cyperus tenuispica	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diheteropogon hagerupii	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis gangetica	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis scotelliana	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eriocaulon pulchellum	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Leersia drepanothrix	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Utricularia prehensilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Utricularia stanfieldii	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Bulbostylis abortiva	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bulbostylis pusilla	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crinum sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.
Cyperus tenuiculmis	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbiaceae sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.
Lepidagathis anobrya	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lobelia cf. djurensis	.	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Murdannia simplex	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phyllanthus maderaspatensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.
Polygala multiflora	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Portulaca foliosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.
Pycreus pumilus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Utricularia tortilis	.	.	.	.	.	.	.	.	p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Crotalaria ochroleuca	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Rhytachne rottboellioides	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Solenostemon graniticola	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stylochiton sp.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

TAYLOR, 1989) were found. Presumably, autogamy occurs in *Aeollanthus pubescens* (RYDING, 1986), Eriocaulaceae (STÜTZEL, 1981) and many Cyperaceae. The latter observation was made in the greenhouse where isolated (i.e. wrapped with plastic bags) specimens of Cyperaceae (*Bulbostylis* sp., *Fimbristylis* sp.) showed a high fruiting rate.

Dispersal biology

Most species (54.8%) possess dehiscent capsular fruits. The number of diaspores per individual is frequently very high (up to several thousands, e.g. *Utricularia* spp., *Burmannia madagascariensis*). Among the diaspores the following groups can be distinguished: dust seeds (less than 0.5 mm in size), granule seeds (0.6-2 mm in size) and small fruits (e.g. nutlets). Dust seeds were dominating and characteristic for small annuals (e.g. *Drosera indica*, *Utricularia* spp., *Xyris straminea*). Micromorphological testa characters, like raised anticlinal walls (e.g. *Utricularia spiralis*), columnlike projections on anticlinal walls (*Eriocaulon togoense*) and epicuticular waxes (*Drosera indica*) reduce the sink velocity and enhance the water-repellance of the sometimes nauto-hydrochorous seeds (RAUH & al., 1975). Granule seeds and fruits (nutlets, caryopses) were the typical diaspores of many Poaceae and Cyperaceae.

Anemochory (75%) is the most frequent mode of dispersal. In contrast to tiny dust seeds the nearly smooth and relatively heavy granule seeds can probably only be dispersed by strong winds which occur on inselbergs due to upwinds and turbulences. Zoochory is often found as epiornithochory, e.g. diaspores lying in wet ground stick to the feet of visiting birds. Myxospermy occurs in *Rotala* spp. and *Aeollanthus pubescens*. Certain Poaceae and Cyperaceae may be endozoochorous.

Most species (77%) use several dispersal modes ("polychory"): dust seeds can be dispersed by wind, animals or water (28% of all species). Granule seeds can be dispersed by animals and wind (49%). Purely zoochorous were 19% of the species, 4% were purely anemochorous.

Discussion

Abiotic factors

The existence of the EFV depends both on more or less continuous water supply from surrounding vegetation types (size of catchment area and storage capacity influence the area of the ephemeral flush community) during the rainy period and on the occurrence of a prolonged dry season. The shallowness of the soil in connection with its sandy or sandy-loamy texture results in a very low water storage capacity of the EFV-sites. Without water supply the soil dries out quickly. Therefore an essential prerequisite for the existence of this habitat is seepage water running down from other plant communities.

Dry periods of 1-2 weeks (sometimes even longer) during the rainy season occur more frequently in the savanna region than in the rain forest zone of the Ivory Coast. The risk of local extinction due to catastrophic drought is therefore higher for ephemeral flush species growing on savanna zone inselbergs. Surprisingly the EFV is often lacking respectively poor in species on inselbergs situated in the rain forest zone with their relatively high and more regularly distributed annual rainfall. Presumably a few perennial species outcompete a large number of annuals under these more favourable growth conditions. In contrast to this the harsher climatic conditions on savanna zone inselbergs favour the co-existence of less competitive annuals and thus increase the species richness of the EFV.

Succession

Although not directly observed, there are hints which indicate successional processes. On inselbergs situated in the rain forest zone ephemeral flush communities mostly occurred as small fringes around *Afrotrilepis*-mats respectively other open plant communities (e.g. shallow depressions, rock pools). It is conceivable that the EFV under these conditions forms a stage in a successional sere which will lead to an *Afrotrilepis*-community. In the savanna region, succession within the EFV towards a community dominated by perennials is regularly thrown back because of disturbing effects (i.e. unpredictable droughts, occasional fire). On average the species richness of ephemeral flush communities is higher on savanna zone inselbergs (up to 35 species per relevé) than on those in the rain forest region (up to 15 species per relevé). In addition in the savanna zone the area of ephemeral flush communities is generally larger in combination with an increased heterogeneity in soil depths within individual stands. We suppose that the higher species richness of ephemeral flush communities on savanna zone inselbergs is due to the combined effect of a certain degree of disturbance and a greater habitat heterogeneity than on rain forest inselbergs. A similar gradient in species richness has also been reported for plant communities in shallow depressions on Ivorian inselbergs (POREMBSKI & al., 1995).

Phytosociology

Remarkable is the high number of species with low constance, i.e. the unpredictability of the species inventory of ephemeral flush communities which indicates a considerable amount of stochasticity.

For an exact phytosociological classification of the EFV more fieldwork is necessary. Preliminary data indicate that the EFV is floristically relatively uniform and may be unified as single phytosociological unity in West Africa (from Guinea to Nigeria). Close affinities exist to certain other communities, such as those on ferricretes. SCHNELL (1952) described an *Utricularieto-Eriocauletum pumili*-community from ferricretes in the Nimba Mountains (Guinea) which has a similar species inventory than many ephemeral flush communities. Presumably, the EFV belongs to the class *Eriocaulo-Utricularietea* which has been described from wet to shallowly inundated rock depressions on West African inselbergs respectively ferricretes (KNAPP, 1966). Moreover relations seem to exist to the class *Drosero-Xyridetea* described by SCHMITZ (1988) from Rwanda, Burundi and Zaïre. Even in the temperate zone ecologically similar therophyte-rich pioneer communities, like the class *Isoeto-Nanojuncetea* (MOOR, 1936; PIETSCH, 1973) occur. POTT (1992) characterizes them as small, often unstable pioneer communities on open soil and disturbed places.

Life-forms and life-strategies

Obviously tiny annuals and to a much lesser extent hemicryptophytes respectively geophytes are particularly well adapted to cope with the environmental conditions (e.g. nutrient deficiency, unpredictable droughts during the rainy season) typical for ephemeral flush communities. Most other habitats on Ivorian inselbergs are also characterized by the dominance of therophytes (POREMBSKI & al., 1995; POREMBSKI & BROWN, 1995) what is indicative of extreme environmental conditions.

Therophytic species occurring in ephemeral flush communities are r-strategists which are weak competitors with a short life cycle and a high reproduction rate. This is in strong contrast to *Afrotrilepis*-mats where highly competitive and long-lived K-strategists dominate (POREMBSKI & al., 1995).

Pollination and dispersal biology

The rarity of pollinator visits recorded in ephemeral flush communities could be an artefact of observation (i.e. time span of observation too short) or an effect of the comparatively small size and patchily distribution of this habitat which results in a decreased attractivity for flower visitors. Perhaps the presence of autogamous and agamospermous species is a direct consequence of a low frequency of pollinator visits.

The nutrient deficiency within ephemeral flush communities favours the production of very small diaspores. These, however, are produced in huge numbers which enhances the probability of dispersal over larger distances. Most ephemeral flush species seem to be relatively effective dispersers what is characteristic for colonizers of patchily distributed growing sites. In particular the production of polychorous dust seeds with combined anemochory, zoochory and nautohydrochory seems to be of importance concerning the effectiveness of dispersal.

Germination

Diaspores of many ephemeral flush species seem to have a dormancy, which prevents them from germination during the last weeks of the rainy season. Supposedly the diaspores need high temperatures during the dry season and subsequently a definite duration of permanent moisture (see HINTIKKA, 1990; MEYER & KITCHEN, 1992). This strategy prevents germination after sporadic rainfall in the dry season.

Phytogeography and floristic affinities

Supposedly there is a relation between the large distributional area of many species found in ephemeral flush communities and their good dispersal ability. Phytogeographical affinities of the EFV are similar to those of other habitats on Ivorian inselbergs. Striking is the absence of endemics which is quite different from the situation in other tropical regions (for a discussion of possible reasons s. POREMBSKI & BROWN, 1995). In West Africa the EFV seems to be floristically uniform from Guinea to Nigeria (RICHARDS, 1957; HAMBLER, 1964; POREMSBKI & al., 1994) with minor differences on the species level. According to JAEGER & WINKOUN (1962) and KEITA & al. (1993), the EFV on ferricretes and rock outcrops on the plateau of Bandiagara (southern Mali) is floristically very similar to the Ivorian EFV. On inselbergs in the rain forest zone of Cameroon many characteristic annuals (e.g. *Drosera indica*, *Utricularia* spp.) are missing (LÉTOUZEY, 1968; VILLIERS, 1981; E. FISCHER, Bonn, pers. comm.), sometimes the whole community is absent (e.g. in Gabon, REITSMA & al., 1992). Similar ephemeral flush communities are also known from Malawi (POREMBSKI, 1996), Zimbabwe (R. SEINE, Bonn, pers. comm.), Madagascar (RAUH, 1973; E. FISCHER, Bonn, pers. comm.), India (BHARUCHA & ANSARI, 1963) and Australia (ORNDUFF, 1987). Own preliminary data from the neotropics indicate that ephemeral flush communities are poorer in species compared to their paleotropical counterparts.

No species recorded during this study is strictly restricted to the EFV. Most species occur in other seasonally available habitats, like marshy or swampy places and even ruderals (e.g. *Fimbristylis dichotoma*) are regularly present.

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