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Scientific results of the BRYOTROP expedition to Zaire and Rwanda
7. Life strategies of epiphytic bryophytes from tropical lowland and montane forests, ericaceous woodlands and the *Dendro-senecio* subpáramo of the eastern Congo basin and the adjacent mountains (Parc National de Kahuzi-Biega/Zaire, Forêt de Nyungwe/Rwanda)

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Abstract: Life strategies of epiphytic bryophytes are studied along an altitudinal gradient from the eastern Congo basin (tropical lowland zone) to the mountains of the East-African graben (tropical subalpine/alpine Zone; BRYOTROP III-transect). Three strategies, Colonists, Perennial shuttle species and Perennial stayers can be observed, which are further subdivided according to their reproduction tactic (high sexual reproductive effort, high asexual reproductive effort, moderately or low sexual and asexual reproductive effort). Of these, only taxa with a long life span (perennials) are of importance, indicating the unchanging and constant ecological conditions and long-lasting microsites, provided by the epiphytic habitats.
The basis for the life strategy pattern analysis along the altitudinal gradient were plant sociological investigations and the determination of the mean percentage cover values for the different life strategy categories. By this, the distribution and occurrence of the different strategies within the communities and the altitudinal zones can be shown.

Typical for the epiphytes of the primary rain-forests of the tropical lowland and lower montane zone are Perennial shuttle species and Perennial stayers with moderately or low sexual and asexual reproductive effort. This strategy obviously is favoured by the well balanced, high temperature and humidity regime of these zones and typical of most of the liverworts, dominating the epiphytic communities. They are replaced in the montane rain-forests and cloudy moss forests of the upper tropical montane zone by Perennial shuttle species with high asexual reproductive effort, regenerating mainly by propagules and clonal growth. Within the secondary woodlands of this zone and the unique ericaceous woodlands and subpáramo of the African volcanos, Perennial shuttle species and Perennial stayers with high sexual reproductive effort reach a maximum, building regularly sporophytes under the already xeric and strong diurnal climatic conditions of the subalpine/alpine zone. This reproduction strategy is typical of epiphytic communities of xerophytic woodlands. The frequent change within the life strategy spectra of the different altitudinal zones indicates, that life strategies can be seen as a set of co-evolved adaptive traits, which grow and evolve within different taxa under similar ecological conditions.

Zusammenfassung: Aufbauend auf einer pflanzensoziologischen Analyse wurden die Lebensstrategien epiphytischer Bryophyten entlang eines Höhenstufentransektes im östlichen Kongobecken (Tieflandstufe) bis zum zentralafrikanischen Grabenrand (tropisch subalpine/alpine Stufe; BRYOTROP III-Transekt) aufgezeigt und in Beziehung zu den verschiedenen Moosgesellschaften und dem ökologischen Gradienten gesetzt. Grundlage für die Interpretation ist der mittlere Gruppenmengenanteil. Drei Lebensstrategien, Besiedler (Colonists), Ausdauernde Pendler (Perennial shuttle species) und Ausdauernde (Perennial stayers) können unterschieden werden, die aufgrund ihres Reproduktionsverhaltens [hohe generative Reproduktion, hohe vegetative Reproduktion, niedere generative und vegetative (passive) Reproduktion] weiter unterteilt werden können. Von diesen erreichen nur die beiden Strategien, die durch langlebige (perennierende) Sippen gekennzeichnet sind, hohe Wertigkeiten in den Gesellschaften. Dies deutet auf konstante Umweltbedingungen und für lange Zeit verfügbare Mikronischen hin. Kennzeichnend für die Epiphytengesellschaften primärer Regenwälder der tropischen Tiefland- und der unteren Bergwaldstufe sind Ausdauernde Pendler und Ausdauernde mit passivem Reproduktionsverhalten. Dieses Reproduktionsverhalten wird durch die sehr ausgeglichenen hohen Temperatur- und Luftfeuchtigkeitsverhältnisse in dieser Stufe gefördert und ist typisch für die meisten der in diesen Epiphytengesellschaften dominierenden Lebermoose. Im tropischen Bergregen- und Nebelwald der oberen montanen Stufe wird diese passive Strategie durch Ausdauernde Pendler mit vegetativem Reproduktionsverhalten ersetzt, die sich v.a. aus vegetativ gebildeten Diasporen und einem ausgeprägten klonalen Wachstum regenerieren. Innerhalb der sekundären, offenen Bergwälder dieser Höhenstufe und in den auf die zentralafrikanischen Vulkane beschränkten Heidebuschwäldern und der Subpáramo-Vegetation erreichen Laubmoose mit der Lebensstrategie Ausdauernde Pendler und Ausdauernde mit generativem Reproduktionsverhalten hohe Anteile. Sie bilden in der bereits trockeneren und durch Frostwechselklima gekennzeichneten subalpinen/alpinen Höhenstufe regelmäßig Sporogone und vermitteln mit dieser Strategie bereits zu den Epiphytengesellschaften xerophytischer Offenwälder. Dieser auffallende Wechsel im Lebensstrategienspektrum entlang des Höhenstufengradienten zeigt, daß Lebensstrategien einen Komplex gemeinsam erworbener Anpassungsmerkmale darstellen, die sich unter ähnlichen bzw. gleichen Umweltbedingungen herausbilden.

Introduction

Life strategies in bryophytes can be envisaged as a system of co-evolved adaptive traits (Stearns 1976, During 1979, 1992, Frey & Kürschner l991a) implying numerous adaptations to the environmental conditions. Their classification can be very useful for making comparisons of the ecology of species and communities in different habitat sites and geographical regions. A general concept of a life strategy system to bryophytes has been applied by During (1979), consisting of six life strategy categories (Annual shuttle species, Fugitives, Colonists, Short lived shuttle species, Perennial shuttle species, Perennial stayers, Tab. 1). It is based on several characters, among which life span, reproductive effort [potential life span of the gametophyte, which is negatively correlated with the reproductive effort; avoidance strategy (discarding the gametophyte, and survival of the difficult season as spores only) versus tolerance strategy (survival of the gametophyte)] and dispersal mechanisms (few large spores with decreasing long-distance dispersal versus many small spores with chance dispersal) are of great importance (During 1979, 1992). This provisional system was further subdivided by Frey & Kürschner (1991a) with respect to the dominating reproductive tactic and completed by a seventh category, the geophyte life strategy (Tab. 1).

Despite of often incompletely known aspects like life history, the importance and potential adaptive value of asexual reproduction (clonal growth and propagules) and the dispersal capacity of the diaspores, within the last years different bryophyte communities of various habitat sites and geographical regions have been analyzed (During l981, During & ter Horst l985, Frey & Kürschner l991a,b,c, l995a,b, Kürschner l994) demonstrating key factors and interactions between plants, communities and environment.

With this study, for the second time we present an analysis of life strategies of tropical epiphytic bryophytes and their life strategy distribution pattern along an altitudinal gradient of the tropics (eastern Congo basin and adjacent mountains, BRYOTROP III-transect).

Material and methods

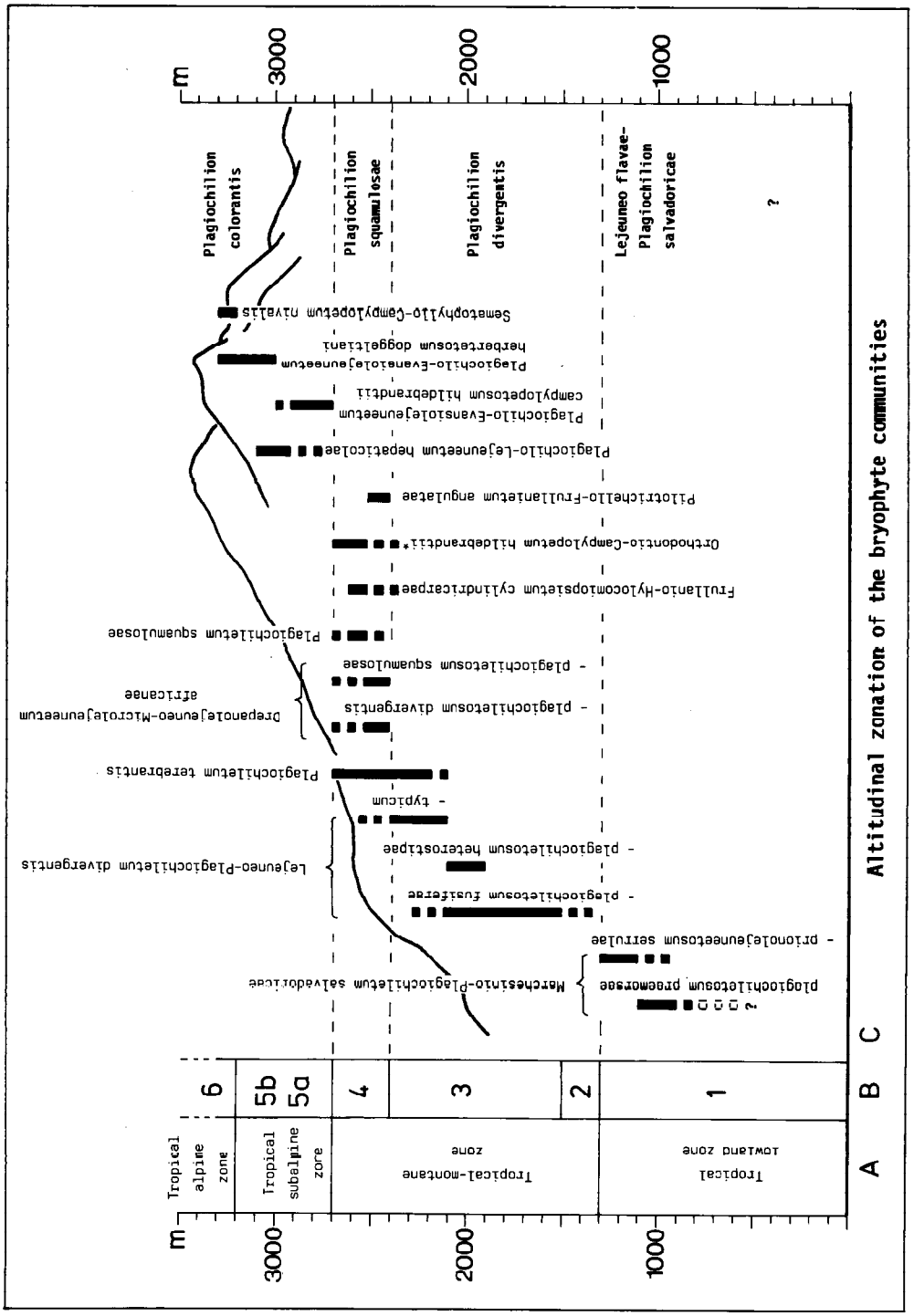
The life strategy analysis of the epiphytic bryophytes (shade epiphyte synusia) is based on a plant sociological analysis (Kürschner l995a), which was carried out along an altitudinal gradient from the eastern Congo basin [Irangi (850)-900 m, upper tropical lowland zone] to the mountains of the East-African graben [Mt. Biega (2790 m), Mt. Kahuzi (3308 m), tropical subalpine/alpine zone; BRYOTROP III-transect]. Within this altitudinal gradient, comprising the upper tropical lowland zone (Caesalpiniaceae lowland forests, Pluviisilvae Klötzli 1958, forêt ombrophile Prioul & Sirven l981), the lower and upper tropical montane zone (montane rain-forests, Laurisilvae, forêt ombrophile de montagne and bamboo-forests), the tropical subalpine zone (ericaceous woodlands, Ericifruticeta, étage des bruyères) and the tropical alpine zone (*Dendrosenecio*-subpáramo, Frigorideserta), 11 associations and 9 subassociations occur (Fig. 1), which synhierarchically can be classified into 4 alliances. The vertical distribution of these 4 alliances corresponds well with the altitudinal zonation at the eastern Congo basin, the distribution of the different forest types, as well as the ordination of the different bryophytes (ecological groups, Kürschner l995b) characterizing the transect.

For the analysis itself, the plant material collected during the field trip, older collections from Central Africa (B) and some few data from literature (Correns l899, Fleischer l900-1922, Schuster l988) were available. Data concerning the asexual and sexual reproductive effort often were sparse, thus making the classification to the different life strategy categories more difficult. The quantitative calculation of the life strategy spectra is based on the mean percentage cover value of each species and category (Frey & Kürschner l991a,b) within the different altitudinal zones and the different bryophyte associations. By this, the biological relevance of each life strategy within the entire spectrum, as well as the different life strategy patterns of each zone can be shown, which are strongly related to and influenced by the ecological gradient.

		Life span				Reproduction								Innovations		Distribution of gametangia		
						Sexual reproduction			Spores		Asexual reproduction							
		ephemeral, winter annual, summer annual	pauciennial	perennial	with subterranean stems	age of first reproduction low, normally less than 1 year	frequent from 2.-4. year	rare or absent or very variable, taking at least several years	large (≥ 25 µm), long-range dispersal limited	small (≤ 25 µm), long-range dispersal possible	rare or absent	frequent		rare or absent	frequent	monoecious	dioecious	
Annual shuttle species Einjährige Pendler		●				●			●		●			●		●		P_e
Fugitives Kurzlebige		●				●				●	●			●		●		K
Colonists Besiedler	Colonists with high sexual reproductive effort		●				●			●	●			●		●		B_g
	Colonists with high asexual reproductive effort		●					●		●		●		●			●	B_v
	Colonists with sexual and asexual reproductive effort		●				●			●		●		●		●	●	$B_{v,g}$
	Colonists with basitone innovations		●				●			●	●				●	●	●	B_i
	Pauciennial colonists			●			●			●	●			●		●		B_a
Short lived shuttle species Kurzlebige Pendler			●				●		●		●			●		●	●	P_k
Perennial shuttle species Ausdauernde Pendler	Perennial shuttle species with high sexual reproductive effort			●			●		●		●			●		●		P_g
	Perennial shuttle species with high asexual reproductive effort			●				●	●	●		●		●			●	P_v
	Perennial shuttle species with sexual and asexual reproductive effort			●			●		●	●		●		●		●	●	$P_{v,g}$
	Perennial shuttle species with moderately or low sexual and asexual reproductive effort			●				●	●		●			●			●	P_p
Perennial stayers Ausdauernde	Perennial stayers with high sexual reproductive effort			●			●			●	●			●		●		A_g
	Perennial stayers with high asexual reproductive effort			●				●		●		●		●			●	A_v
	Perennial stayers with moderately or low sexual and asexual reproductive effort			●				●		●	●			●			●	A_p
Geophyte Geophyt				●	●				●		●				●			Geo

Tab. 1. Life strategy categories of bryophytes (after During 1979, Frey & Kürschner l991a).

Fig. 1. (p. 133) Zonation of epiphytic bryophyte communities (C) in eastern Zaire (Mt. Biega, Mt. Kahuzi) and Rwanda (Forêt de Nyungwe). [A altitudinal zonation; B forest formations (cf. Hedberg 1951, Klötzli 1958, Prioul & Sirven 1981; 1 Caesalpiniaceae lowland forests, forêt ombrophile, Pluviisilvae; 2 *Julbernardia-Ocotea* transition forest, forêt de transition; 3 montane rain-forest, forêt ombrophile de montagne, Laurisilvae; 4 bamboo-forest, étage à *Arundinaria alpina*; 5a *Podocarpus-Syzygium-Psychotria* forest; 5b ericaceous woodlands, étage à bruyères, Ericifruticeta; 6 *Dendrosenecio*-subpáramo, páramo à *Senecio* et *Lobelia*, Frigorideserta. * synhierarchical position uncertain]. (After Kürschner l995a).


Altitudinal zonation of the bryophyte communities
m
3000
2000
1000
Plagiochilion colorantis
Plagiochilion squamulosae
Plagiochilion divergentis
Lejeunea flavae-Plagiochilion salvadoricae
?
Sematophyllo-Camptochaetum nivalis
Plagiochilo-Evansiolejeuneetum herbertetosum doggeltiani
Plagiochilo-Evansiolejeuneetum camptochaetosum hildebrandtii
Plagiochilo-Lejeuneetum hepaticolae
Pilotrichello-Frullanietum angulatae
Orthodontio-Camptochaetum hildebrandtii*
Frullanio-Hylocomiopsietum cylindricarpae
Plagiochiletum squamulosae
- plagiochiletosum squamulosae
- plagiochiletosum divergentis
Drepanolejeuneo-Microlejeuneetum africanae
Plagiochiletum terebrantis
- typicum
- plagiochiletosum heterostipae
- plagiochiletosum fusiferae
Lejeuneo-Plagiochiletum divergentis
- prionolejeuneetosum serrulae
plagiochiletosum praemorsae
Marchesinio-Plagiochiletum salvadoricae
A
B
C
1
2
3
4
5a
5b
6
Tropical lowland zone
Tropical-montane zone
Tropical subalpine zone
Tropical alpine zone
m
3000
2000
1000

Results and discussion (Tab. 2-4, Figs. 2-5)

The epiphytic bryophytes of the BRYOTROP III-transect (Parc National de Kahuzi-Biega/Zaire, Forêt de Nyungwe/Rwanda), together with their main characters (e.g. life form, sexual and asexual reproductive effort, dispersal strategy, distribution of gametangia and life strategy) are listed in Tab. 2. Altogether, only three categories of life strategies, Colonists (3 taxa), Perennial shuttle species (48 taxa), Perennial stayers (99 taxa) occur, indicating the more or less stable ecological conditions within the different epiphytic bryophyte communities of each altitudinal zone.

1. Colonists

Species with the Colonists' strategy are characterized by a moderately short life span of only a few years (pauciennial-pluriennial taxa), a high sexual and/or asexual reproductive effort, small spores (less than 25 µm) indicating long-range dispersal with spores and short-range dispersal with asexual diaspores. In tropical epiphytic communities, taxa with this life strategy consist of truly colonizing species with a pioneer-character, appearing in early succession series or mainly disturbed communities (Frey & Kürschner l991b). In the transect analyzed, this strategy is confined to the tropical lowland (900 m) and tropical montane zone (1900 m, 2300 m, Tab. 3), but reaching here only very low mean percentage cover values (less than 1%). According to the reproductive tactic, the Colonists can be subdivided into Colonists with asexual and sexual reproductive effort ($B_{v,g}$; only *Octoblepharum albidum*), Colonists with high sexual reproductive effort (B_g; only *Aneura pseudopinguis*) and Colonists with high asexual reproductive effort (B_v; only *Syrrhopodon gardneri*), all being of less importance within the life strategy spectra and their distribution pattern (the Colonists' strategy is not shown in a separate figure).

2. Perennial shuttle species

The life strategy Perennial shuttle species comprises taxa with a long life span (pluriennial-perennial taxa), a moderate, sometimes low to absent or high sexual and/or asexual reproductive effort, a normally rather high age of first sexual reproduction (more than 5 years), and rather large spores (> 25 µm) in regularly sporulating species. In accordance with During (1979), Frey & Kürschner (1991a,c), Miles & Longton (1992) and Stoneburner et al. (1992), the probable dispersal distance rapidly decreases by spores larger than 25 µm, indicating short-range dispersal and an atelechorous tendency. This, and the relatively high number of taxa belonging to this strategy (48 taxa, Tab. 1) is in contrast to Grime et al. (1990), who postulate small spores with long-range dispersal as an important regeneration strategy of epiphytic bryophytes. The Perennial shuttle strategy is typical of unchanging and constant ecological conditions and long-lasting microsites, as it is provided by many epiphytic habitats.

The further subdivision of the category clearly shows an altitudinal zonation (Fig. 2), which is reflected also by the different proportions within the ecological groups (Fig. 4) and the different proportions within the epiphytic communities (Fig. 5).

The epiphytic communities of the tropical lowland zone (Caesalpiniaceae lowland forests and *Julbernardia-Ocotea* transition forest) are dominated by species of the life strategy Perennial shuttle species with moderately or low sexual and asexual reproductive effort (P_p, Tab. 3, Fig. 2). Most of the species characterizing syntaxonomically the Marchesinio-Plagiochiletum salvadoricae and the Lejeuneo-Plagiochiletum divergentis plagiochiletosum fusiferae, like *Marchesinia excavata*, *M. moelleriana*, *Plagiochila fusifera*, *P. salvadorica*, *Porella subdentata*, *Radula appressa*, *R. boryana* and *Syrrhopodon armatus* belong to this strategy, showing a low or nearly absent asexual and sexual reproduction. Their dominance on the phorophyte and within the epiphytic communities mainly is a result of clonal growth of the often unisexual populations (dioecious species), which is supported by the balanced climatological conditions (isothermie, high and stable humidity) of this altitudinal zone.

In contrast, Perennial shuttle species with high sexual reproductive effort (P_g) reach their maximum within the epiphytic communities of the upper tropical montane zone (montane rain-forests and bamboo-forests, Tab. 3, Fig. 2). This strategy is typical for *Plagiochila divergens* and *P. squamulosa*, the leading species of the Lejeuneo-Plagiochiletum divergentis typicum, the

Plagiochiletum squamulosae and the two subassociations of the Drepanolejeuneo-Microlejeuneetum africanae of the primary rain-forests of this zone (Tab. 4, Fig. 5). Also various mosses like *Brachymenium nepalense*, *B. rigidum*, *Hylocomiopsis cylindricarpa*, *Neckera platyantha*, *N. remota*, *Macrocoma abyssinica* and *Syrrhopodon incompletus* fall into this category, which is typical of the more or less open, secondary montane forests (*Nuxia floribunda-Agauria salicifolia* community, *Hagenia abyssinica* fragments), dominated by the Frullanio-Hylocomiopsietum cylindricarpae (Tab. 4, Fig. 5). Obviously, the more open and already xeric conditions in these forests favoured regularly sporulating species. Their relatively large spores have a low dispersal capacity, but probably better chances of successful establishment and a longer life span in the diaspore bank (During 1992).

Perennial shuttle species with high asexual reproductive effort (P_v) mainly are restricted to the tropical subalpine/alpine zone (*Podocarpus-Syzygium-Psychotria* forest and ericaceous woodlands, Tab. 3, Fig. 2). In contrast to the previous category, the sexual reproduction in this group is low to absent, but asexual diaspores (mainly flagellae, gemmae, breaking-off of leaf tips and shoots) are regularly produced in large amounts. To this strategy, some of the most conspicuous afro-alpine epiphytes belong, e.g. *Anastrophyllum auritum*, *Andrewsianthus bilobus*, *Herbertus doggeltianus*, *H. lobatus* or *Plagiochila barteri* ssp. *colorans*, which are typical components of the humid Plagiochilo-Lejeuneetum hepaticolae and the Plagiochilo-Evansiolejeuneetum roccatii (Tab. 4, Fig. 5). This group shows a strong tendency towards reduced sporophyte production and increased reliance on asexual propagules for population maintenance.

3. Perennial stayers

As in the Perennial shuttle strategy, the life strategy Perennial stayers also is characterized by species with a long life span (perennial taxa), but in contrast to the shuttle strategy, the spores are small (less than 25 µm) and long-range as well as short-range dispersal is possible (chance dispersal). This strategy is typical of most of the epiphytic species analyzed in the transect (99 taxa, Tab. 1) and most frequent in later successional and climax stages (permanent habitats).

Two species, *Metzgeria australis* and *Plagiochila terebrans* belong to the Perennial stayers with high sexual and asexual reproductive effort ($A_{g,v}$, Tab. 2). Their mean cover percentage value within the life strategy spectra normally is low (Fig. 3), except in the tropical montane zone (montane rain-forests), where this strategy reaches a high value in the Plagiochiletum terebrantis (Tab. 4, Fig. 5), due to the high cover abundance of *Plagiochila terebrans*.

Perennial stayers with high sexual reproductive effort (A_g) reach higher maxima especially in the more xerophytic, secondary woodlands of the upper tropical montane zone and in the tropical subalpine/alpine zone. Various mosses like *Brachymenium speirocladum*, *Campylopus hildebrandtii*, *C. nivalis*, *Chrysohypnum frondosum*, *Hypnum cupressiforme* var. *townsendii*, *Leptodontium viticulosoides*, *Orthodontium gracile*, *Pyrrhobryum spiniforme* or *Sematophyllum stylites* belong to this strategy, which is highly dominant in the Frullanio-Hylocomiopsietum cylindricarpae and the Orthodontio-Campylopetum hildebrandtii of the *Nuxia floribunda-Agauria salicifolia* woodlands and the *Hagenia abyssinica* fragments, as well as in the Sematophyllo-Campylopetum nivalis of the *Dendrosenecio* subpáramo (Tab. 4, Fig. 5). These mosses sporulate regularly, but the age of the first reproduction is variable, taking at least several years. The small spores often are produced in large numbers, to make sure that many of them will reach the distant phorophytes and seem to serve for the occasional establishment of new populations. Within the liverworts, *Lejeunea confusa*, *L. flava*, *L. helenae*, *L. tabularis* and *Metzgeria consanguinea* show this strategy, and therefore have a wider distribution within the communities and along the altitudinal gradient. In general, this strategy is typical of epiphytic communities of more open, xeric sites and woodlands with high light intensities and a high diurnal variation of temperature and humidity (Frey & Kürschner l995a). In the transect, one can observe an increasing number of Perennial stayers characterized by regularly sporulating species in higher altitudes and already xeric woodlands.

Perennial stayers with high asexual reproductive effort (A_v) by means of flagellae, stoloniferous

	Life-form	Sexual diaspores: Relevé	Sexual diaspores: Other samples	Sexual diaspores: Literature	Monoecious/dioecious	Sexual reproduction	Spores (ø in µm)	Asexual diaspores: Relevé	Asexual diaspores: Other samples	Asexual diaspores: Literature	Asexual reproduction	Others	Life-strategy
Hepaticae													
Adelanthaceae													
Adelanthus decipiens	Ma	-	-	+	D	a	(23-30)	+	-	fD	h	Fl	A_v
Adelanthus lindenbergianus	tT	-	-	+	D	a	(12-16)	-	-	[Ge]	a		A_p
Aneuraceae													
Aneura pseudopinguis	Ma	+	-	-	M	h	13-16	Ge	-	-	l		B_g
Riccardia amazonica	Ma	+	-	-	D	a,l		-	-	-	a		A_p
Riccardia compacta	Ma	+	-	-	M,D	a,l	12-22	[Ge]	-	-	l,m		A_v
Calypogeiaceae													
Calypogeia fissa	Ma	-	-	+	Mat	l,m	8-17	-	-	fD,Ge	l		A_g
Geocalycaceae													
Chiloscyphus cuspidatus	Ma	+	-	+	Mat	h	14-16	-	-	-	a		A_g
Chiloscyphus difformis	Ma	+	-	-	D	a,l		[Bl],Bs	-	-	a,l		A_p
Chiloscyphus fragrans	Ma	-	-	+	Mat	a		-	-	-	a		A_p
Chiloscyphus martianus	Ma	-	-	-		a		-	-	-	a		A_p
Chiloscyphus muricatus	Ma	+	-	-	M	a,l		+	-	-	l,m	Fl	A_v
Leptoscyphus infuscatus	Ma	-	-	+	D	a		+	-	-	a,l	Fl	A_p
Herbertaceae													
Herbertus dicranus	We	-	-	+	(D)	a		fD	-	-	m	Fl	P_v
Herbertus doggeltianus	tT	-	-	+	D	a		fD	-	-	l,m	Fl	P_v
Herbertus lobatus	tT	-	-	+	D	a		fD	-	-	m	Fl	P_v
Herbertus subdentatus	We	-	-	+	D	a		fD	-	-	h	Fl	P_v
Jubulaceae													
Frullania angulata	Pe	+	-	+	D	m	(40-50)	-	-	-	a		P_p
Frullania apicalis	Ma	+	-	+	D	a,l	(40-50)	Bl	-	Bl	m		P_v
Frullania arecae	Ma	+	-	+	Mat	m	(40-50)	-	-	-	a		P_g
Frullania depressa	Ma	+	-	+	Mat	h	(40-50)	-	-	-	a		P_g
Frullania ericoides	Ma	-	-	+	D	a	(40-50)	-	-	Ge	l		P_p
Frullania obscurifolia	Ma	+	-	+	D	a.l	(40-50)	-	-	Ge	l		P_p
Frullania serrata	Ma	+	-	+	M	m	(40-50)	-	-	-	a		P_g
Frullania variegata	Ma	+	-	+	D	m	(40-50)	Bl	-	-	m		P_v
Jungermanniaceae													
Anastrophyllum auritum	We	-	-	-		a		Bl,Bs	-	-	h	Fl	A_v/P_v
Andrewsianthus bilobus	We	-	-	-		a		Bl,fD	-	-	h	Fl	P_v
Chandonanthus hirtellus	tT	-	-	-	D	a		-	-	-	[a]	[Bs]	A_p/P_v
Lejeuneaceae													
Aphanolejeunea exigua var. exigua	Ma	-	-	+	D,M	a		-	-	Ge	l		A_p
Cheilolejeunea krakakammae	Ma	-	-	+	D	l		Ge	-	-	a,l		A_p
Cheilolejeunea pluriplicata	Ma	+	-	+	M	a,l		-	-	-	a		A_p
Cololejeunea zenkeri	Ma	-	-	+	M	a		-	-	Ge	l		A_p

Diplasiolejeunea cornuta	Ma	+	-	+	M	l		-	-	Ge	l		A_p
Diplasiolejeunea kraussiana	Ma	-	-	+	M	a		-	-	Ge	l		A_p
Diplasiolejeunea runssorensis	Ma	+	-	+	D	a,l		Ge	-	Ge	m		A_v
Drepanolejeunea physaefolia	Ma	+	-	+	D	a		Bs	-	-	h		A_v
Evansiolejeunea roccatii	We	+	-	+	D	a		[Bl]	-	-	a	[Fl]	A_p
Lejeunea caespitosa	Ma	-	-	+	D	a		-	-	Bl,Ge	l		A_p
Lejeunea capensis	Ma	-	-	+	D	a		-	-	-	a		A_p
Lejeunea confusa	Ma	+	-	+	D	l,m		-	-	-	a		A_g
Lejeunea cystheorum	Ma	+	-	+	Mat	m		-	-	-	a		A_g
Lejeunea eckloniana	Ma	[+]	-	+	Mat	h		-	-	-	a		A_g
Lejeunea flava	Ma	+	-	+	Mat	h	14	-	-	-	a		A_g
Lejeunea flavovirens	Ma	-	-	+	M	a		-	-	-	a		A_p
Lejeunea helenae	Ma	-	-	+	D	a		-	-	[Bs]	a		A_p
Lejeunea hepaticola	Ma	+	-	+	M,D	m		-	-	-	a		A_g
Lejeunea isophylla	Ma	+	-	+	D	a		-	-	-	a		A_p
Lejeunea tabularis	Ma	+	-	+	M	m		-	-	-	a		A_g
Leucolejeunea xanthocarpa	Ma	+	-	+	Mat	[m]		-	-	-	a		A_p
Lopholejeunea spec.	Ma	-	-	-		a		-	-	-	a		A_p
Marchesinia excavata	Ma	-	-	+	D	a	(35-40)	-	-	-	a		P_p
Marchesinia muelleriana	Ma	-	-	+	M	a	(35-40)	-	-	-	a		P_p
Microlejeunea africana	Ma	+	-	+	D	a,l		+	-	-	l	[Fl]	A_p
Microlejeunea kamerunensis	Ma	+		+	D	m,h		+			a		A_g
Prionolejeunea serrula	Ma	-	-	+	M	a		-	-	-	a		A_p
Ptychanthus striatus	Ma	+	-	-	D	a,l		-	-	-	a		A_p
Rectolejeunea rhodesiae	Ma	+	-	+	D	a,l		Bl,fD	-	Bl	l,m	Fl	A_v
Schiffnerolejeunea altimontana	Ma	+	-	-	D	a		[Bl]	-	-	a,l		A_p
Lepidoziaceae													
Bazzania decrescens	We	+	-	+	D	a,l	(15-20)	Bl	-	+	l	[Fl]	A_p
Bazzania pumila	Ma	-	-	+	D	a	(15-20)	Bl	-	+	l	[Fl]	A_v
Bazzania roccatii	We	-	-	+	D	a	(15-20)	Bl	-	+	h	[Fl]	A_v
Lepidozia cupressina	We	-	-	+	D	a	(11-15)	Bs,fD	-	+	h		A_v
Lepidozia stuhlmannii	We	-	-	+	D	a	(11-15)	Bs,fD	-	+	l		A_p
Metzgeriaceae													
Metzgeria australis	Ma	+	-	+	D	l,m	16-24	Ge	-	Ge	h		$A_{g,v}$
Metzgeria consanguinea	Ma	+	-	+	D	l,h	20-26	+	-	-	l	aT	A_g
Metzgeria leptoneura	Ma	+	-	+	D	a,l	15-24	+	-	+	l	aT	A_p
Metzgeria limbato-setosa	Ma	-	-	+	D	a	(>30)	+	-	-	m	aT	P_v
Metzgeria musicola	Ma	-	-	-		a	(>30)	+	-	-	h	aT	P_v
Plagiochilaceae													
Plagiochila barteri ssp. colorans	Fa	-	-	+	D	a,h	(15-28)	Bl	-	Bl	m		P_v
Plagiochila corniculata	Ma	-	-	+	D	a	(15-28)	Bl,fD	-	Bl,fD	h		P_v
Plagiochila divergens var. divergens	Fa	+	-	+	D	h	(15-28)	-	-	[+]	a		P_g
Plagiochila divergens var. myriocarpa	Fa	+	-	+	D	a,l	(15-28)	[Bl],fD	-	[+]	a,l	Fl	P_g
Plagiochila ericicola	Fa	-	-	-	D	a	(15-28)	-	-	-	a		P_p
Plagiochila fusifera	Fa	+	-	+	D	a	(15-28)	fD	-	Bl	l		P_p

	Life-form	Sexual diaspores: Relevé	Sexual diaspores: Other samples	Sexual diaspores: Literature	Monoecious/dioecious	Sexual reproduction	Spores (ø in µm)	Asexual diaspores: Relevé	Asexual diaspores: Other samples	Asexual diaspores: Literature	Asexual reproduction
Plagiochila heterostipa	Fa	-	-	-		e	15-22	-	-	-	e
Plagiochila integerrima	Fa	-	-	-		a	(15-28)	-	-	-	[1]
Plagiochila praemorsa	Fa	-	-	+	D	a	(15-28)	-	-	-	a
Plagiochila salvadorica	Fa	+	-	+	D	l	(15-28)	-	-	Ge	a,l
Plagiochila squamulosa var. sinuosa	Fa	-	-	+	D	h	(15-28)	-	-	-	e
Plagiochila squamulosa var. squamulosa	Fa	+	-	+	D	m,h	(15-28)	-	-	-	a
Plagiochila subalpina	Ma	-	-	-		a	(15-28)	Bl,fD	-	Bl	h
Plagiochila terebrans	Fa	+	-	+	D	l,m	20-22	fD	-	Bl,Be	l,m
Porellaceae											
Porella subdentata	Ma	-	-	+	D	a	(24-80)	-	-	-	a
Radulaceae											
Radula appressa	Ma	-	-	+		a	(15-55)	Bl	-	Bl	a,l
Radula boryana	Ma	+	-	+	D	a,l	30-35	[Bl,Ge]	-	-	a,l
Radula comorensis	Ma	+	-	+	D	a,l	(15-55)	Bl	-	Bl	a,l
Radula flaccida	Ma	-	-	+		a	15-18	Ge	-	Ge	h
Radula holstiana	Ma	-	-	+	M	a	18-22	-	-	Bl,Ge	a,l
Radula javanica	Ma	-	-	+	D	a	(15-55)	Bl	-	Bl	a,l
Radula quadrata	Ma	-	-	+	D	e	(15-55)	Ge	-	Ge	h
Musci											
Brachytheciaceae											
Brachythecium salebrosum	We	-	-	+	Mat	a	12-18	-	-	-	a
Brachythecium velleream	We	+	-	+	D	m		-	-	-	e
Bryaceae											
Brachymenium nepalense	sT	+	-	+	D	h	25	-	-	-	a
Brachymenium rigidum	sT	+	-	+	D	h	19-27	-	-	-	a
Brachymenium speirocladum	sT	+	-	+	D	h	15-20	-	-	-	a
Orthodontium gracile	sT	+	-	+	M	h	10-18	-	-	[Ge]	a
Calymperaceae											
Syrrhopodon armatus ssp. insularum	sT	-	-	+	D	a	(15-35)	-	-	(Ge)	a
Syrrhopodon gardneri	sT	-	-	+	D	l	13-18	Ge	-	(Ge)	m
Syrrhopodon gaudichaudii	sT	-	-	+	D	a	(15-35)	Ge	-	(Ge)	h
Syrrhopodon incompletus	sT	-	-	+	D	a	(15-35)	-	-	(Ge)	a
Dicranaceae											
Bryohumbertia flavicoma	sT	+	-	+	D	a,l	14-15	-	-	-	a
Campylopus hildebrandtii	tT	+	-	+	D	h	11-14	-	-	-	a
Campylopus nivelis	tT	+	-	+	D	h	13-16	-	-	-	a
Campylopus perichaetialis	sT	-	-	+	D	a		-	-	Ge	a,l
Dicranum johnstonii	tT	-	-	-	D	a		Ge	-	-	a,l
Leucoloma holstii	We	-	-	+	D	a		-	-	-	a

Entodontaceae													
Entodon adyris	Ma	+	-	+	Mat	h	17-23	-	-	-	a		A_g
Entodon vulcanicus	Ma	+	-	+	D	h	(17-23)	-	-	-	a		A_g
Fissidentaceae													
Fissidens borgenii	sT	+	-	-	D	a,l		-	-	-	a		A_p
Fissidens glauculus	sT	+	-	+	M	m	8-9	-	-	-	a		A_g
Fissidens microcarpus	sT	-	-	-		a		-	-	-	a		A_p
Hookeriaceae													
Callicostella lacerans	Ma	+	-	-	D	h		-	-	-	a		A_g
Daltonia mildbraedii	Ma	+	-	-	D	h	15-17	-	-	-	a		A_g
Lepidopilidium theriotii	sT	-	-	-		a		-	-	-	a		A_p
Lepidopilum lastii	sT	-	-	-		a		-	-	-	a		A_p
Lopidium hemiloma	Fa	-	-	-	D	a		Ge	-	(Ge)	m		A_v
Hypnaceae													
Chrysohypnum frondosum	Ma	-	-	+	Mat	m		-	-	-	a		A_g
Hypnum cupressiforme var.cupressiforme	Ma	-	-	+	D	m	12-18	fD	-	fD	m	Fl	A_g
Hypnum cupressiforme var.townsendii	Ma	-	-	+	D	m	12-18	fD	-	fD	m	Fl	A_g
Isopterygium mbangae	We	-	-	-	Mat	a		-	-	-	a		A_p
Mittenothamnium reptans	Fa	-	-	-	Mat	a		-	-	-	a		A_p
Rhacopilopsis kilimandscharica	We	+	-	+	D	a,l		-	-	-	a		A_p
Rhacopilopsis transvaaliensis	We	-	-	-		a		[fD]	-	-	a	Fl	A_p
Rhacopilopsis trinitensis	Ma	-	-	-		a	(17)	-	-	-	a		A_p
Hypopterygiaceae													
Hypopterygium laricinum	Fa	-	-	-	D	a		-	-	(Ge)	a	Sc	A_p
Hypopterygium mildbraedii	De	-	-	-	D	l		-	-	(Ge)	a	Sc	A_p
Leskeaceae													
Hylocomiopsis cylindricarpa	We	+	-	+	Mat	h	40-50	-	-	-	a		P_g
Leucobryaceae													
Leucobryum cf.acutifolium	sT	-	-	+	D	a	15-17	-	-	-	a		A_p
Octoblepharum albidum	sT	+	-	+	Mat	h	17-20	Bl,Bs	-	+	h		$B_{v,g}$
Leucophanaceae													
Leucophanes angustifolium	sT	-	-	+	D	a	15-20	-	-	Ge	a		A_p
Leucophanes molleri	sT	-	-	+	D	a	10-15	-	-	Ge	a		A_p
Meteoriaceae													
Floribunderia floribunda	Pe	-	-	-	D	a	15-22	-	-	-	a		A_p
Pilotrichella profusicaulis	Pe	+	-	-	D	a,l		Bl	-	-	m		A_v
Neckeraceae													
Calyptothecium hoehnelii	Fa	-	-	+	D	a	16-42	fD,Ge	-	Ge	m	Fl,Hs	P_v
Homaliodendron piniforme	Fa	-	-	+	D	a	(12-25)	fD	-	(fD)	m	Fl	A_v/P_v
Neckera platyantha	Fa	+	-	+	Mat	m	35-45	fD	-	(fD)	a,l	Fl	P_g
Neckera remota	Fa	+	-	+	Mat	m,h	20-33(45)	fD	-	(fD)	l	Fl	P_g
Porothamnium stipitatum	Fa	+	-	+	D	l	9-17	fD	-	(fD)	l	Fl	A_p
Porotrichum elongatum	Fa	+	-	+	D	l		fD	-	(fD)	l	Fl	A_p
Porotrichum molliculum	Fa	+	-	+	D	a	13	fD	-	(fD)	a,l	Fl	A_p
Orthotrichaceae													
Macrocoma abyssinica	Ma	+	-	+	D	h	31-56	-	-	(Ge)	a		P_g
Macromitrium bequartii	sT	-	-	-		a		-	-	(Ge)	a		P_p
Schlotheimia cf. bequartii	Cu	-	-	-	M	a		-	-	(Ge)	a		P_p

	Life-form	Sexual diaspores: Relevé	Sexual diaspores: Other samples	Sexual diaspores: Literature	Monoecious/dioecious	Sexual reproduction	Spores (ø in µm)	Asexual diaspores: Relevé	Asexual diaspores: Other samples	Asexual diaspores: Literature	Asexual reproduction	Others	Life-strategy
Zygodon intermedius	Cu	+	-	-	D	a,l	15-19	Ge	-	(Ge)	h		A_v
Zygodon roccatii	sT	+	-	-	D	l,h		-	-	(Ge)	a		A_p/P_p
Pottiaceae													
Leptodontium viticulosoides	tT	+	-	+	M,D	h	17-20(25)	-	-	-	a		A_g
Rhizogoniaceae													
Pyrrhobryum spiniforme	tT	+	+	+	M	h	14-16	-	-	-	a		A_g
Sematophyllaceae													
Acroporium prionophylax	Ma	+	-	+	M	a,l	(15)20-22	-	-	-	a		A_p
Donnellia matutina	We	-	-	+	Mat	a		-	-	-	a		A_p
Sematophyllum brachytheciiforme	Ma	+	-	+	M	h	22-28	-	-	-	a		P_g
Sematophyllum nebulosum	Ma	-	-	+		a		-	-	-	a		A_p/P_p
Sematophyllum stylites	Ma	+	-	+	Mat	m	14	-	-	-	a		A_g
Trichosteleum percilleanum	Ma	-	-	-	Mat	a		-	-	-	a		A_p
Wijkia trichocolea	We	-	-	-		a		-	-	-	a		A_p
Thuidiaceae													
Thuidium chenagonii	Ma	-	-	-		a		-	-	-	a		A_p
Thuidium versicolor	We	+	-	-	D	m		-	-	-	a		A_g

Tab. 2. Characters and life strategies of the taxa of the epiphytic bryophyte communities of eastern Zaire (Mt. Biega, Mt. Kahuzi) and Rwanda (Forêt de Nyungwe). [+ present; - absent; [ ] data uncertain; ( ) character of the genus; empty field: no data available; a absent, not observed; aT adventive shoots/ thalli; Bl breaking-off of leaf tips; Bs breaking-off of shoots; Cu cushion; D dioecious; De dendroid; Fa fan; fD flagelliform diaspores (stoloniferous shoots or branches with a gradual attenuation from ordinary leaves at the branch base to vestigial-leaved branch tips); Fl flagellae; Fr fragmentation; Ge gemmae; h high; Hs heterospore; l low, M monoecious; m middle; Ma mat; Mat autoecious; Pe pendant; Sc shoots creeping, rhizome-like; sT short-turf; tT tall-turf; We weft; A_g-P_v life-strategies, cf. Tab. 1.]. For author's names of the taxa cf. Kürschner 1995a.

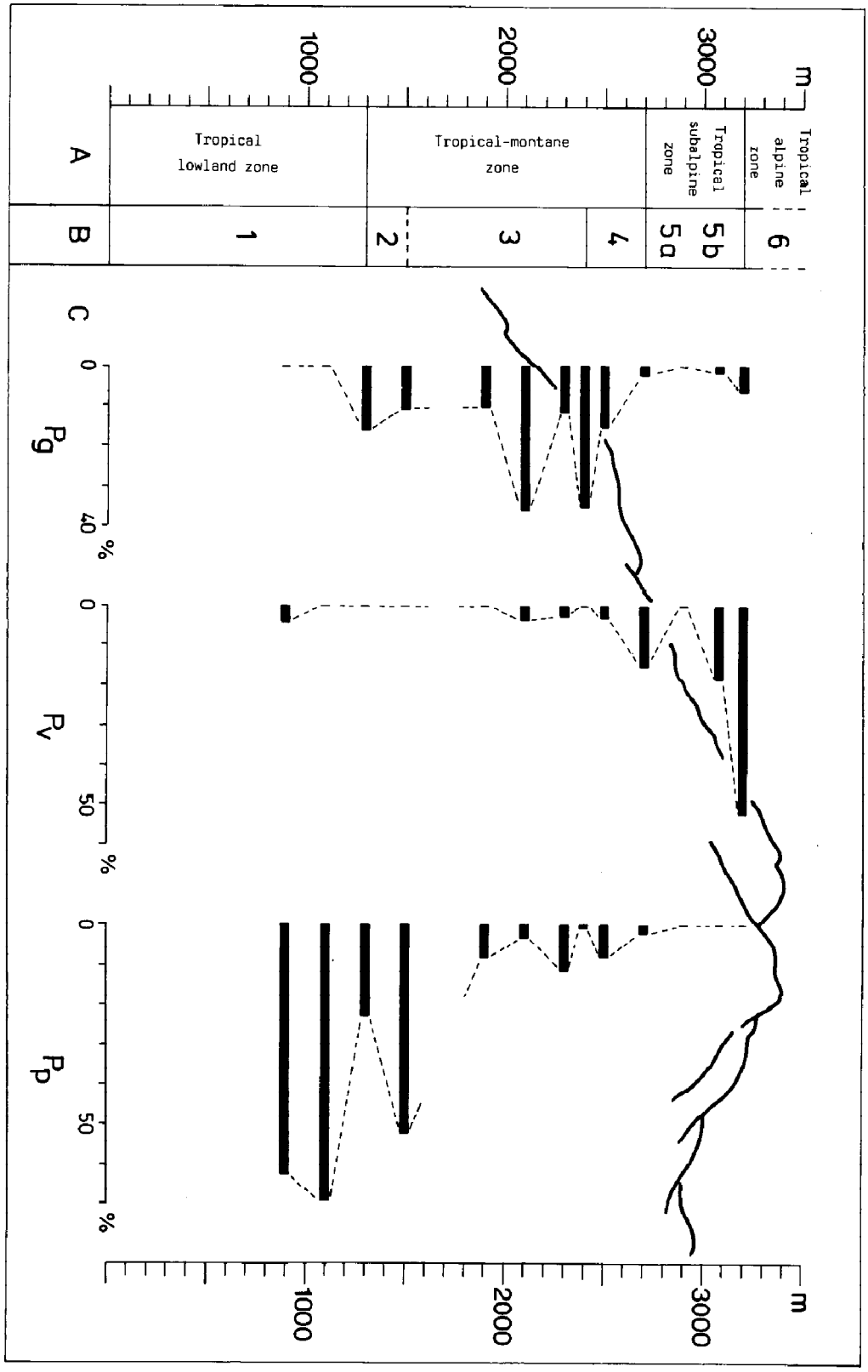
Tab. 3. (p. 141) Life strategies and mean percentage cover values (%) within the altitudinal gradient of eastern Zaire (Mt. Biega, Mt. Kahuzi) and Rwanda (Forêt de Nyungwe) (for abbreviations see Tab. 1).

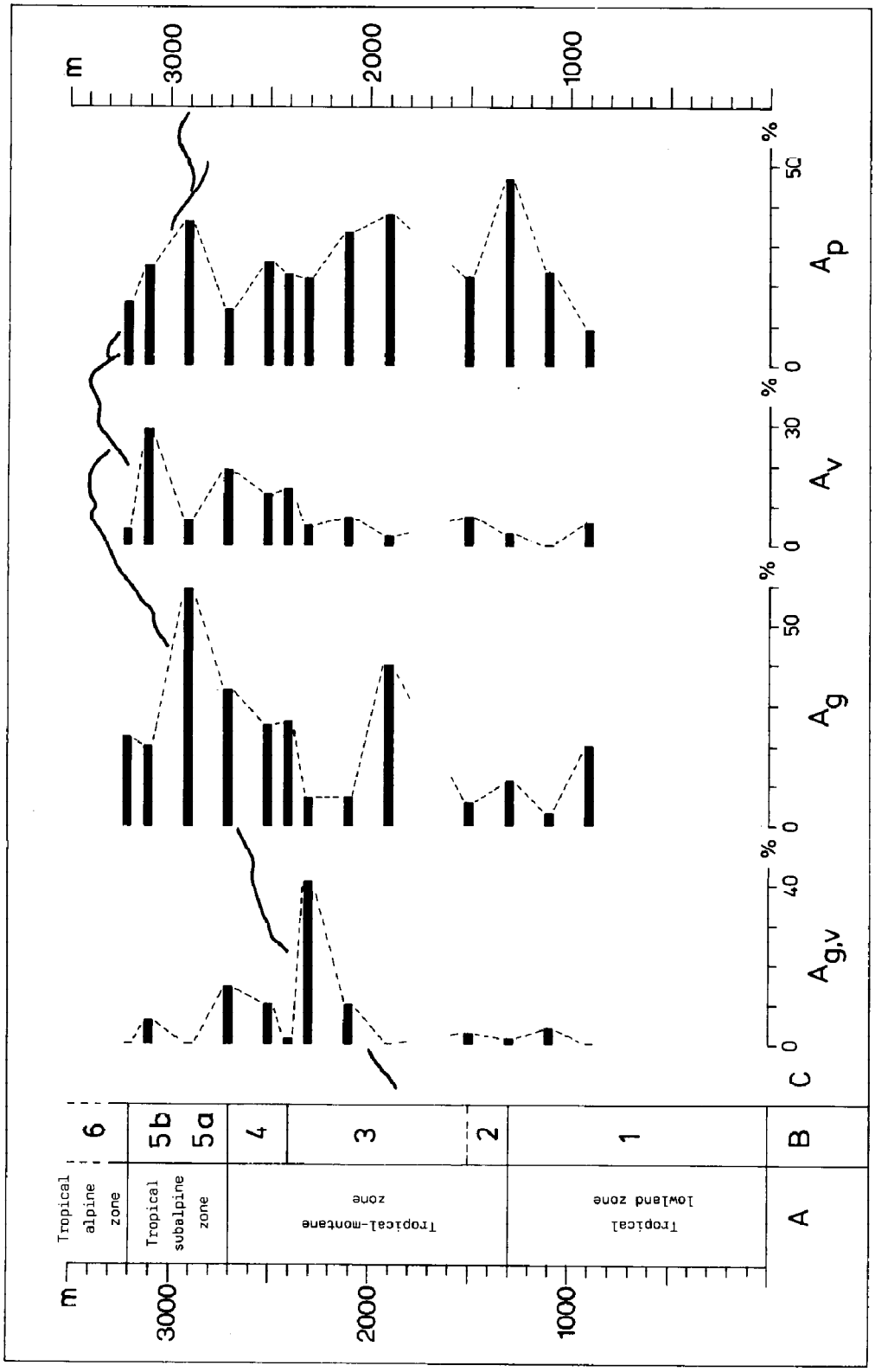
Fig. 2. (p. 142) Life strategies (P_g, P_v, P_p for abbreviations see Tab. 1; mean percentage cover values in %) and their distribution in the altitudinal gradient (200 m-isohypse intervalls, C) of eastern Zaire (Mt. Biega, Mt. Kahuzi) and Rwanda (Forêt de Nyungwe) (for A, B see Fig. 1).

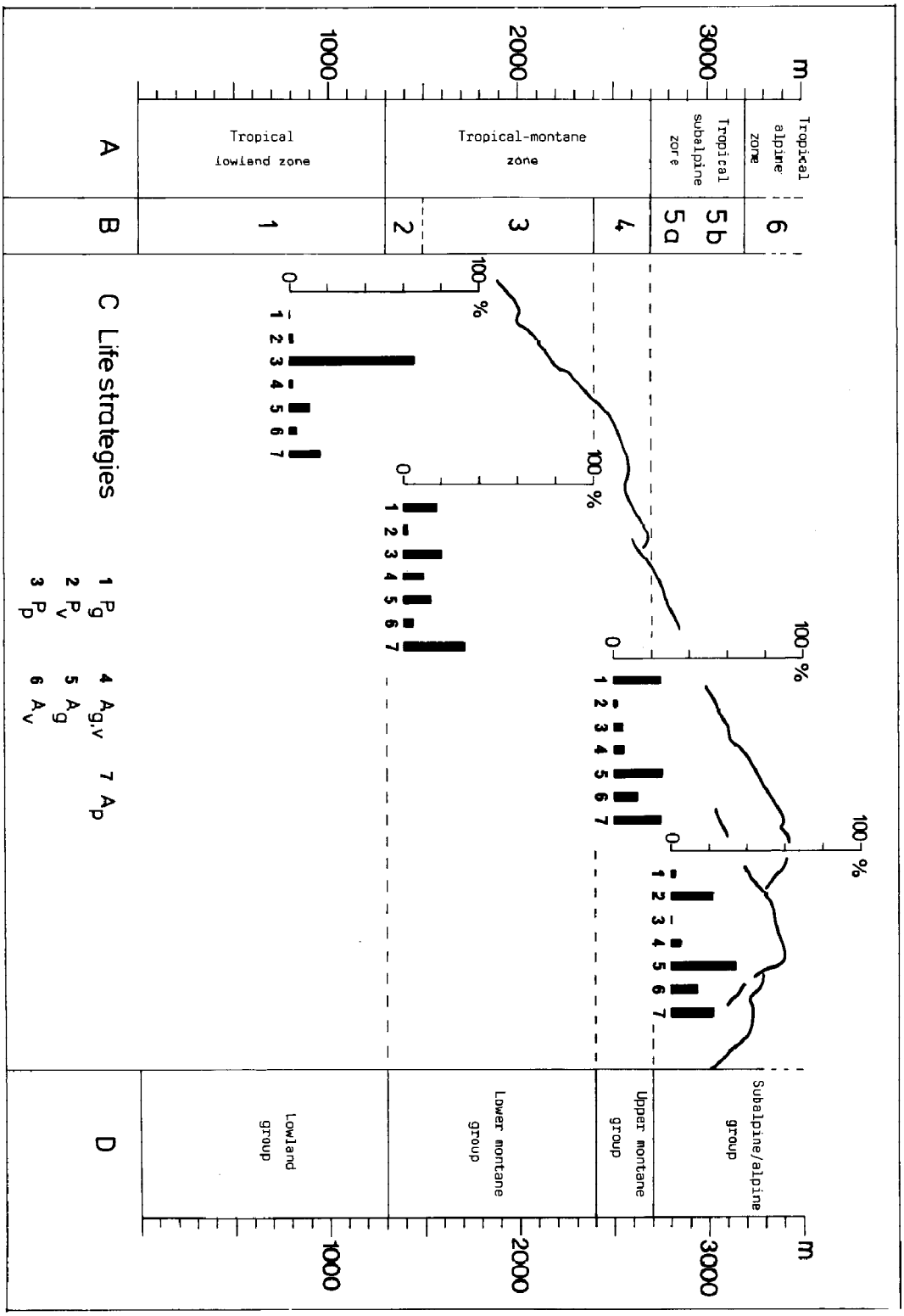
Fig. 3. (p. 143) Life strategies ($A_{g,v}$, A_g, A_v, A_p for abbreviations see Tab. 1; mean percentage cover values in %) and their distribution in the altitudinal gradient (200 m-isohypse intervalls, C) of eastern Zaire (Mt. Biega, Mt. Kahuzi) and Rwanda (Forêt de Nyungwe) (For A, B see Fig. 1).

Fig. 4. (p. 144) Life strategies (mean percentage cover values in %) confined to ecological groups (D, cf. Kürschner 1995b) and their distribution in the altitudinal gradient of eastern Zaire (Mt. Biega, Mt. Kahuzi) and Rwanda (Forêt de Nyungwe) (for abbreviations see Tab. 1, for A, B see Fig. 1, for C compare Tab. 3).

Altitude		900 m	1100 m	1300 m	1500 m	1900 m	2100 m	2300 m	2400 m	2500 m	2700 m	2900 m	3100 m	3200–3300 m				
Ecological group (Kürschner 1995b)		Lowland group (1)		Lower montane group (2)					Upper montane group (3)		Tropical subalpine/alpine group (4)				Ecological group			
															(1)	(2)	(3)	(4)
No. of species		21	16	21	24	12	30	29	26	56	42	11	18	19	$\bar{x}$			
Life strategy	$B_{g,v}$	0.2	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-
	B_g	-	-	-	-	0.7	-	-	-	-	-	-	-	-	-	0.1	-	-
	B_v	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	0.1	-	-
	P_g	0.2	-	15.2	10.5	10.6	35.9	11.6	37.5	14.9	2.1	-	1.2	6.2	0.1	16.8	25.3	2.4
	P_v	3.3	-	-	-	-	3.4	2.2	-	2.6	15.2	-	18.7	51.9	1.7	1.1	1.3	21.5
	P_p	62.5	69.9	23.1	52.3	8.3	3.3	11.5	0.5	8.6	1.6	-	-	-	66.2	19.7	4.6	0.4
	$A_{g,v}$	-	3.2	1.1	2.6	-	9.7	41.1	0.2	9.8	14.1	0.2	5.9	-	1.6	10.6	5.0	5.1
	A_g	19.8	3.2	10.3	5.6	40.0	6.9	6.1	26.4	25.6	33.8	57.8	19.6	21.9	11.6	13.8	26.0	33.3
	A_v	5.3	0.2	3.0	7.2	2.2	7.4	4.6	14.2	12.4	19.5	6.0	29.7	3.8	2.7	4.9	13.3	14.8
	A_p	8.7	23.5	47.3	21.8	38.2	33.4	22.3	23.0	26.1	13.7	36.0	24.9	16.2	16.1	32.6	24.6	22.7


m
1000
2000
3000
A
Tropical lowland zone
Tropical-montane zone
Tropical subalpine zone
Tropical alpine zone
B
1
2
3
4
5a
5b
6
C
Pg
0
40
%
Pv
0
50
%
Pp
0
50
%
1000
2000
3000
m


m
3000
2000
1000
Tropical alpine zone
Tropical subalpine zone
Tropical-montane zone
Tropical lowland zone
6
5b
5a
4
3
2
1
A
B
C
$A_{g,v}$
A_g
A_v
A_p
0
40
50
30
%


A
B
C Life strategies
D
m
3000
2000
1000
Tropical alpine zone
Tropical subalpine zone
Tropical-montane zone
Tropical lowland zone
6
5b
5a
4
3
2
1
100 %
0
1 2 3 4 5 6 7
1 Pg
2 Pv
3 Pp
4 Ag,v
5 Ag
6 Av
7 Ap
Subalpine/alpine group
Upper montane group
Lower montane group
Lowland group

shoots and gemmae and a rather low to nearly absent sexual reproduction (tendency towards reduced sporophyte production) also reach a maximum within the tropical subalpine/alpine zone (Fig. 3), but are confined to wetter sites. This strategy is typical of several liverworts (*Adelanthus decipiens*, *Bazzania roccatii*, *Chiloscyphus muricatus*, *Lepidozia cupressina*, *Radula flaccida*) and *Pilotrichella profusicaulis*, which are dominating the misty upper montane forest (*Podocarpus-Syzygium-Psychotria* community), the ericaceous woodlands and the wet *Podocarpus-Syzygium rowlandii* swamp forest. Nothing is known about the competitive advantage and the potential adaptive value of these asexual diaspores, but the high dominance of these species in the Plagiochilo-Lejeuneetum hepaticolae, the Plagiochilo-Evansiolejeuneetum roccatii and the Pilotrichello-Frullanietum angulatae (Tab. 4, Fig. 5) suppose a high effort of this type in clonal growth and propagation.

Most of the epiphytic species (58 taxa) of the transect belong to the strategy Perennial stayers with moderate or low sexual and asexual reproductive effort (A_p). This strategy is present in all altitudinal zones (Fig. 3), ecological groups (Fig. 4) and communities (Fig. 5), reaching a maximum within the upper tropical lowland zone [Marchesinio-Plagiochiletum salvadoricae prionolejeuneetosum serrulae of the *Julbernardia-Ocotea* transition forest, (Fig. 5)] and the tropical montane zone (Lejeuneo-Plagiochiletum divergentis of the Laurisilvae, Pilotrichello-Frullanietum angulatae of the *Podocarpus-Syzygium rowlandii* swamp forest, Tab. 4, Fig. 5). Beside a long life span, the low reproduction tactic and the small spores, taxa of this strategy are characterized by dioecism (e.g. male and female plants have to be in close proximity for fertilization and sporophyte formation). Most of the Lejeuneaceae (e.g. *Aphanolejeunea exigua*, *Cheilolejeunea pluriplicata*, *Evansiolejeunea roccatii*, *Leucolejeunea xanthocarpa*, *Microlejeunea africana*, *Prionolejeunea serrula*, *Schiffnerolejeunea altimontana*) analyzed, but also *Bazzania decrescens*, *Lepidozia stuhlmannii*, *Metzgeria leptoneura*, *Plagiochila heterostipa*, *Radula holstiana* (liverworts), *Brachythecium vellereum*, *Bryohumbertia flavicoma*, *Leucoloma holstii*, *Leucophanes angustifolium*, *L. molleri*, the *Rhacopilopsis* species and most of the Sematophyllaceae (mosses) belong to this life strategy. Their dominance and high cover value within the epiphytic communities often results on clonal growth. Within the upper tropical lowland zone and the lower tropical montane zone this strategy fits well in the more or less constant environmental conditions, typical of the Perennial stayer strategy. Summarizing the results, and with regard to the life strategy analysis of the BRYOTROP II-transect (Mt. Kinabalu/Borneo, Frey & Kürschner l991b), a frequent change of life strategies within epiphytic bryophytes along altitudinal gradients can be observed, and first tendencies concerning the distribution and evolution of life strategies can be outlined. Despite till yet, no example from the South-American hylaea is analyzed, these tendencies seem to be of a more general validity, typical of tropical and non-tropical epiphytic ecosystems.

Perennial shuttle species (P_p) and Perennial stayers (A_p) with moderately or low sexual and asexual reproductive effort, in both tropical ecosystems are confined mainly to the epiphytic communities of the tropical lowland and the lower tropical montane zone. This strategy is typical of epiphytes, especially liverworts (Lejeuneaceae, Frullaniaceae, Radulaceae with a similar basic architecture) of undisturbed primary rain-forest communities, growing under a well balanced, high temperature and humidity regime.

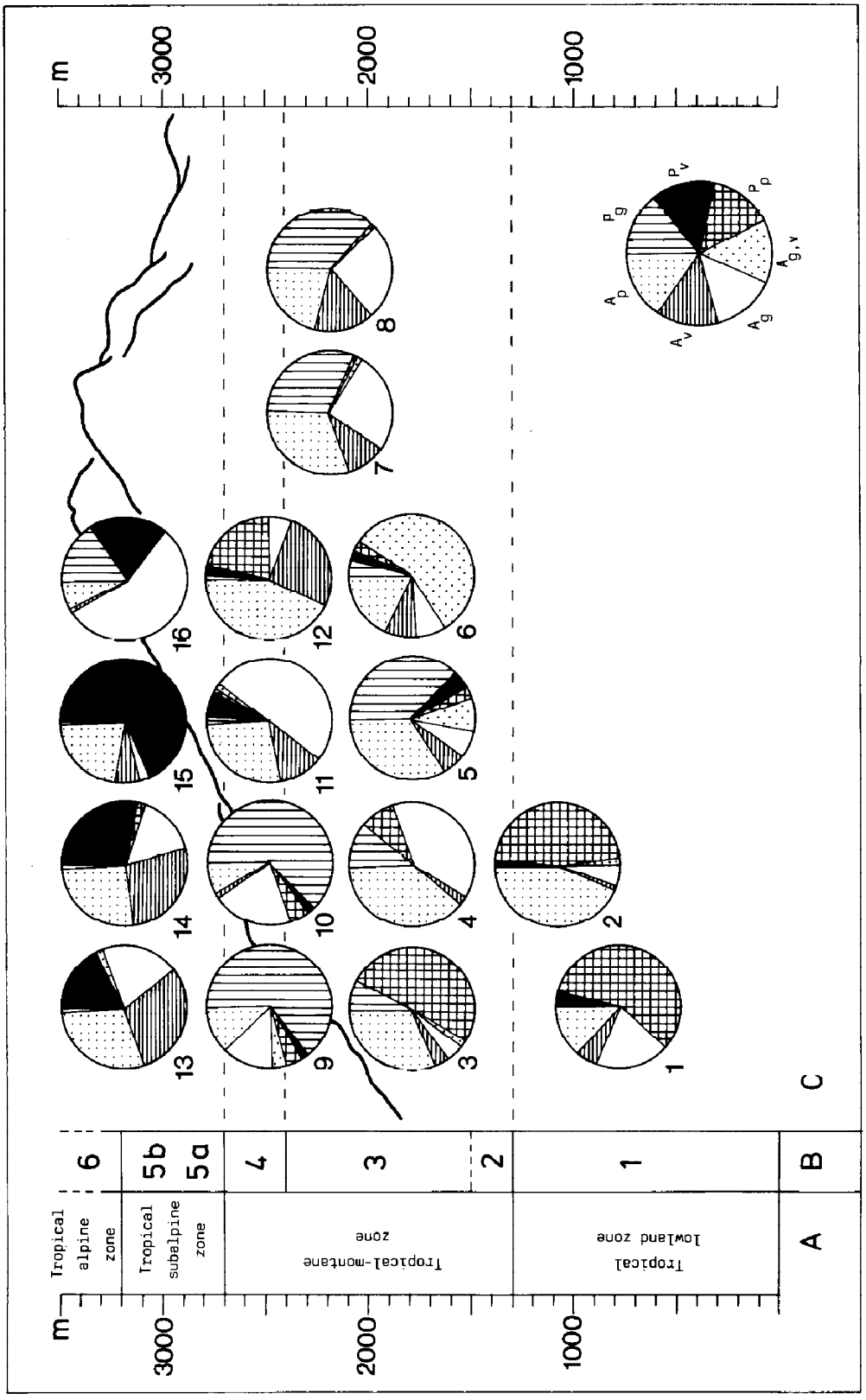
Within the montane rain-forests and the cloudy moss forests of the upper tropical montane zone, the life strategy changes. As in the Mt. Kinabalu transect, in the eastern Congo basin and the adjacent mountains, Perennial shuttle species with high asexual reproductive effort (P_v), e.g. an increased reliance on asexual propagules and clonal growth for population maintenance dominate, and the sporophyte production is much reduced. The characters, typical of this strategy (Tab. 1) must be seen as a set of co-evolved adaptations to the perhumid, cloudy and misty and cooler climate of this distinct altitudinal zone, favouring an asexual reproduction and the growth of epiphytes.

This life strategy is replaced in the secondary woodlands and the unique ericaceous woodlands and the *Dendrosenecio* subpáramo (upper tropical montane and tropical subalpine/alpine zone) of

		Associations (Kürschner 1995a)	Life strategy								
			$B_{v,g}$	B_g	B_v	P_g	P_v	P_p	$A_{g,v}$	A_g	A_v	A_p
Lejeuneo flavae Plagiochilion salvadoricae	1	Marchesinio-Plagiochiletum salvadoricae plagiochiletosum praemorsae	0.1		-	-	3.4	58.3	-	19.9	5.4	12.9
	2	Marchesinio-Plagiochiletum salvadoricae prionolejeuneetosum serrulae	-	-	-	-	1.1	46.9	1.7	5.7	0.1	44.5
Plagiochilion divergentis	3	Lejeuneo-Plagiochiletum divergentis plagiochiletosum fusiferae	-	-	0.2	7.6	-	50.9	1.7	4.8	3.9	30.8
	4	Lejeuneo-Plagiochiletum divergentis plagiochiletosum heterostipae	-	0.7	-	10.5	-	8.2	-	39.5	2.2	38.8
	5	Lejeuneo-Plagiochiletum divergentis typicum	-	-	-	38.1	4.6	2.8	7.4	7.0	5.9	34.2
	6	Plagiochiletum terebrantis	-	-	-	3.9	2.4	2.4	57.8	7.9	8.2	17.4
	7	Drepanolejeuneo-Microlejeuneetum africanae plagiochiletosum divergentis	-	-	-	31.5	-	0.6	1.1	25.8	9.9	31.1
Plagiochilion squamulosae	8	Drepanolejeuneo-Microlejeuneetum africanae plagiochiletosum squamulosae	-	-	-	36.8	-	0.1	-	26.6	15.4	21.1
	9	Plagiochiletum squamulosae	-	-	-	65.3	1.6	4.6	3.6	12.8	-	12.1
	10	Frullanio-Hylocomiopsietum cylindricarpae	-	-	-	62.3	1.8	5.1	-	21.2	1.0	8.6
	11	Orthodontio-Campylopetum hildebrandtii	-	-	-	1.7	6.1	0.3	0.3	52.2	11.6	27.3
	12	Pilotrichello-Frullanietum angulatae	-	-	-	0.7	2.8	21.3	-	5.7	26.5	43.0
Plagiochilion colorantis	13	Plagiochilo-Lejeuneetum hepaticolae	-	-	-	0.9	17.3	-	1.9	19.9	30.1	29.9
	14	Plagiochilo-Evansiolejeuneetum roccatii campylopetosum hildebrandtii	-	-	-	0.5	28.2	1.7	-	15.6	27.6	26.4
	15	Plagiochilo-Evansiolejeuneetum roccatii herbertetosum doggeltiani	-	-	-	0.5	69.2	-	-	2.7	6.1	21.5
	16	Sematophyllo-Campylopetum nivalis	-	-	-	15.9	19.9	-	-	57.0	0.2	7.0

Tab. 4. Life strategies and mean percentage cover values (%) in the epiphytic bryophyte communities of eastern Zaire (Mt. Biega, Mt. Kahuzi) and Rwanda (Forêt de Nyungwe) (for abbreviations see Tab. 1).

Fig. 5. (p. 147) Life strategies (mean percentage cover values in %) within the bryophyte communities of the Lejeuneo flavae-Plagiochilion salvadoricae (1,2), the Plagiochilion divergentis (3-7), the Plagiochilion squamulosae (8-12) and the Plagiochilion colorantis (13-16) in eastern Zaire (Mt. Biega, Mt. Kahuzi) and Rwanda (Forêt de Nyungwe) (C). (For the syntaxonomic nomenclature (1-16) and values below 1 % see Tab. 4; for A, B see Fig. 1).


m
3000
2000
1000
Tropical alpine zone
Tropical subalpine zone
Tropical-montane zone
Tropical lowland zone
6
5b
5a
4
3
2
1
A
B
C
A_p
P_g
P_v
P_p
$A_{g,v}$
A_g
A_v
1
2
3
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16

the African volcanos by Perennial shuttle species (P_g) and Perennial stayers (A_g) with high sexual reproductive effort. Under the already xeric conditions, the strong diurnal climatic variations and the heavy winds of the subalpine/alpine zone, numerous mosses typical of the epiphytic communities, are building regularly sporophytes. Their small spores, produced in large numbers, can reach the distant phorophytes, establishing new populations. Taxa with high asexual reproductive effort (e.g. Herbertaceae) in this zone are confined to sites, strongly influenced by the daily mists, rising up from the upper montane zone. Within the woodlands of the upper tropical montane zone, the epiphytes mainly show a shuttle strategy, characterized by relatively large spores. They have a lower dispersal capacity, but probably better chances of successful establishing in the diaspore bank of these woodlands. This indicates, that with increasing aridity, the asexual reproductive effort of tropical, as well as non-tropical epiphytic bryophytes (Frey & Kürschner l995a) declines.

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