Soils and Vegetation of Tropical Heath Forests and Bogs
- Hill Forest Area of the Rio Avisado, Peru -

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Tropical Heath Forests

Heath forests occur as locally well defined vegetation formations throughout the humid tropical lowlands although local names and scientific nomenclature vary. Other reported sites of heath forests closest to the study region are located in the lowlands of eastern Peru [7] [9].

This formation is commonly characterized as a xeromorphic or sclerophyllous scrub community [3] [8] [12] of perhumid tropical lowlands[15]. According to Specht & Wormersley [12] the occurrence of tropical heath forests has a distinct gap between lowlands and subalpine regions; only in Borneo they can also be found at elevations between 1 000 - 2 000 m a.s.l. [8]. All heath forest types are exclusively found on slightly elevated sites featuring extremely nutrient poor, leached, white sandy soils which are drained by black water rivers [2] [3] [7] [12] [15]. Those soils form either on mostly Pliocene / Pleistocene alluvial or litoral sand deposits or are bleached *in situ* as ground water podzols resulting in substrates of almost pure quartzitic sand [2] [10] [12]. Heath forests developing in seasonal savannas or peat swamps on mesa-like outcrops of sandstone, where a hardpan at the place of an ancient water table impedes drainage, are well described for South America by Sarmiento & Monasterio [10] and for Asia by Brünig [2]. According to Brünig [2], water stress under either poor or excessive drainage is the key factor for the development of heath forest vegetation. Both situations are found on the white sand plateaus in the Rio Avisado area. Waterlogged conditions are found in the center whereas soils toward the rim of the plateaus drain deeply.

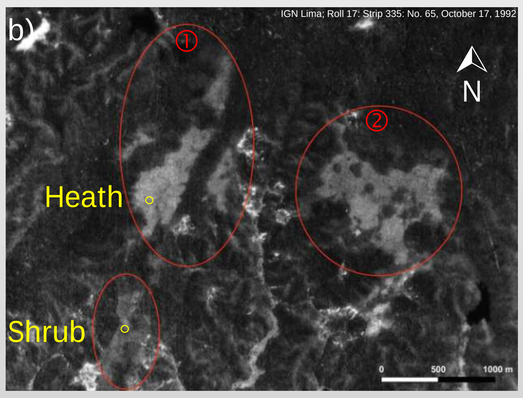
Most authors consider heath forests as pedobiomes or rather peinobiomes in the sense of Walter & Breckle [14], since extremely adverse edaphic conditions are held responsible for the reduced plant growth [1] [6] [7]. Soils are described to be either of coarse texture with a low water retention capacity or mostly waterlogged due to a shallow duripan [2] [6] [8] [10]. Macronutrients such as N and P are low in all white sand soils [4] [5] [12] [13].

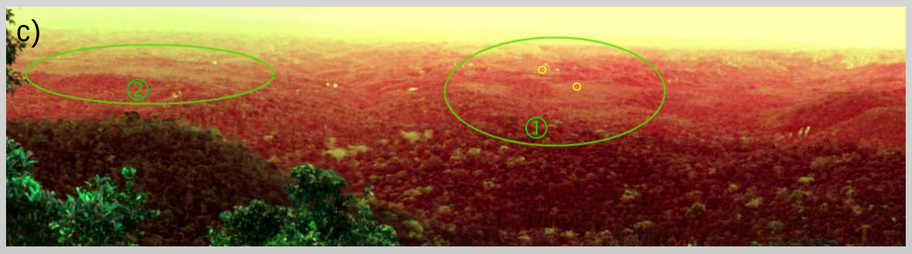
Location

The Rio Avisado watershed is situated in the Alto Mayo Valley of Northern Peru approx. 40 km north of Moyobamba at elevations around 950 m a.s.l. which is at the brink between tropical lowland and (sub)montane vegetation zones (light and dark green in edited NOAA-AVHRR image in Fig. a).

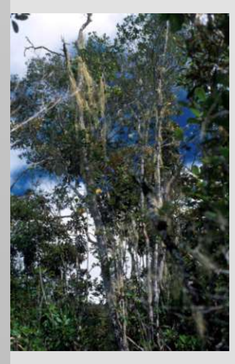
The insular vegetation types herein classified as heath forests and shrublands are found between semi-deciduous rainforest on small mesetas of less than one km² each within the otherwise deeply dissected peneplain on the foot of the Cordillera Cahuapanas. They are easily distinguished in aerial photography (Fig. b) by their bright and smooth texture. Figure c) is a false color panoramic view from the Cordillera. Corresponding sites between b) and c) are numbered, yellow circles indicate the locations of the transects below.







Structure





		Heath Forest	Shrubland	
Max. Height		**7.7**	**4.2**	m
Mean Height		**4.4**	**2.4**	m
Mean Diameter*		**6.6**	**3.6**	cm
Basal Area		**9.2**	**6.4**	$m^2\ ha^{-1}$
Stem Density**	Total	**8966**	**17805**	$\#\ ha^{-1}$
	> 3 cm	**2262**	**1284**	$\#\ ha^{-1}$
Biomass		**25.1**	**13.9**	$t\ ha^{-1}$

* = taken at breast height from all individuals
** = threshold corresponds to 10 cm girth at breast height

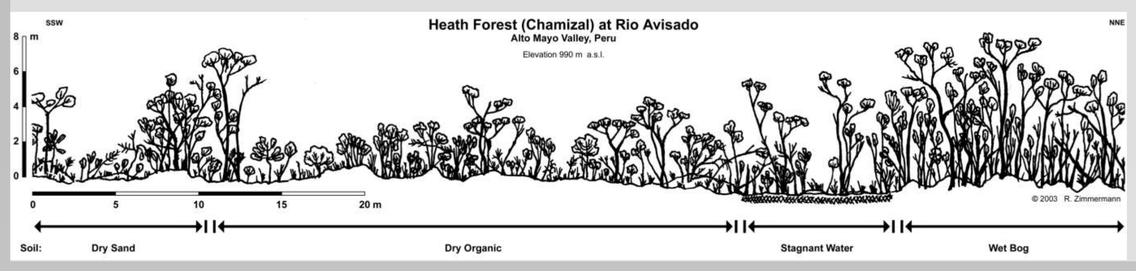
Heath forests, locally termed "Chamizales", are open and low statured forests with gnarled trees up to 8 m height that bear almost exclusively sclerophyllous, microphyllic leaves. They occur under well drained conditions. The ground is often covered by *Cladonia* sp. (left).

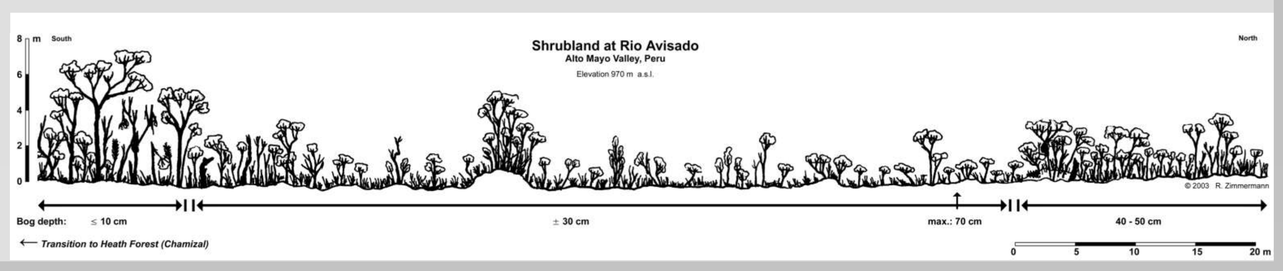
Shrublands are confined to mostly waterlogged sites with *Sphagnum* sp. bog of variable depth. Leaves resemble those in heath forests while shrubs shorter than 4 m with numerous thin stems dominate (right).

The physiognomy suggests nutrient scarcity (see soil analysis below) and general water stress.

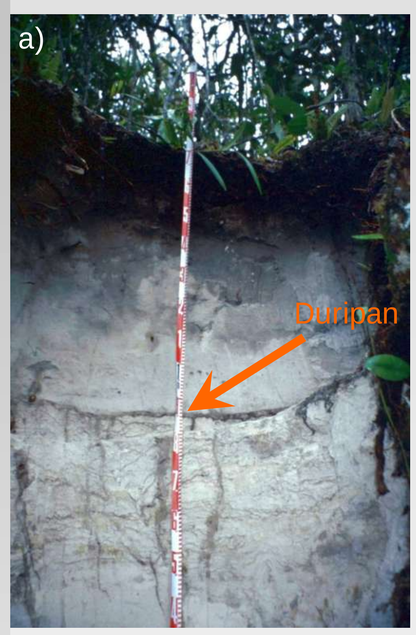








Soils



	Heath Forest		Shrubland		
	topsoil	subsoil	topsoil	subsoil	
pH_{H2O}	**3.3**	**4.1**	**2.7**	**3.3**	-
CN Ratio	**28.4**	**19.3**	**30.1**	**39.5**	-
C	**2.9**	**0.3**	**5.0**	**1.0**	%
CEC_{eff}*	**22.1**	**4.6**	**44.4**	**13.7**	$cmol_c\ kg^{-1}$
Base Satur.	**1.1**	**0.0**	**0.6**	**0.9**	%
K^+	**0.11**	**0.00**	**0.10**	**0.07**	$cmol_c\ kg^{-1}$
Al^{3+}	**0.31**	**0.00**	**1.50**	**0.18**	$cmol_c\ kg^{-1}$
P**	**1.0**	**-**	**0.0**	**-**	ppm
Thickness Topsoil***	**11.8**		**18.8**		cm
Sand	**84.6**		**59.0**		%
Silt	**10.6**		**30.2**		%
Clay	**4.8**		**10.8**		%

* = NH_4NO_3-Extraction; ** = $NaHCO_3$- Extraction; *** = uppermost mineral horizon

Soils of both vegetation types have developed on slightly concave mesetas of holocenic white sandy deposits with a duripan at different depths. They are extremely poor in plant available nutrients, especially phosphorus. *Chamizales* are found towards the edges of these mesetas where the soil (a) is coarser textured, better drained and the duripan is found lower than in shrubland soils (b) that are almost permanently waterlogged (sampling there was restricted to few drier locations).

Soil types may be classified as Arenosols or Podzols but available data did not allow a specific classification.

Differences in texture and within the already low base saturation may be explained by more intense leaching under *chamizales*. The high CEC_{eff} is an effect of the acidity included. Lower pH values in the topsoil indicate organic acids to be involved, also Al^{3+} is expected to be chelated by organic complexes under such acidic conditions.



Vegetation


Sobralia cf *virginalis*


Schefflera sp


Cavendishia aff *bracteata*

Family	Species
APOCYNACEAE	*Mandevilla* sp
AQUIFOLIACEAE	*Ilex* cf *andarensis*
ARALIACEAE	*Schefflera* sp
AREACEAE	*Mauritella aculeata*
BOMBACACEAE	*Pachira* sp
CLUSIACEAE	*Caraipa* sp *Clusia* cf *haughtii*
CUNNONIACEAE	*Weinmannia* sp
ERICACEAE	*Bejaria* cf *infundibula* *Cavendishia* aff *bracteata* *Psamisia* cf *guianenesis*
ERYTHROXYLACEAE	*Erythroxylum* sp
FLACOURTIACEAE	*Abatia* sp
HUMIRIACEAE	*Humiria balsamifera*
LAURACEAE	*Nectandra* sp
MELASTOMATACEAE	*Miconia* spp *Tibouchina* cf *aspera*
MYRSINACEAE	*Myrsine* cf *jelskii*
ORCHIDACEAE	*Maxilaria* cf *gigantea* *Stellis* sp *Epidendrum secundum* *Epistephium* sp *Sobralia* cf *virginalis*
POACEAE	*Olyra* sp
PTERIDOPHYTA	*Trichomanes* spp *Schizaea* sp *Actinostachis* sp *Selaginella* sp
ROSACEAE	*Prunus* sp
RUBIACEAE	*Hemidioidia* sp *Stachyarrhena* sp *Psychotria* sp

Strong floristic similarities exist with other Amazonian heath forests as reflected in literature.

A preliminary floristic inventory yielded 20 woody species from 15 families, whereas adjacent rainforests harbored 284 woody species from 54 families. Although collection took place mostly in vegetative stages, it emphasized the low floristic diversity probably owing to enhanced adaptation.

Humiria trees dominate the higher heath forest, while *Schefflera* is mainly found in transition to shrub which is dominated by *Tibouchina*.

Family	Genus	Species	Heath Forest Location	Reference
Evergreen sclerophyllous			all tropics	[6] [8] [12]
Arecaceae	*Mauritiella*	sp	Chamizal, Peruvian Amazon	[9]
Clusiaceae			Varillal, Peruvian Amazon	[9]
Clusiaceae	*Clusia*	ssp	Campina / Bana, Rio Negro; Muri, Guyana	[7] [8] [12]
Cunnoniaceae	*Weinmannia*	sp	Padang, Borneo	[1]
Ericaceae			all tropics	[7]
Humiriaceae	*Humiria*	*balsamifera*	South America	[7] [8]
Melastomataceae	*Miconia*	ssp	Campina, Brazil	[6]
Orchidaceae			Campina, Brazil ; Padang, Borneo	[7] [12]
Sphagnaceae	*Sphagnum*		all tropics	[6]
	Cladonia		Bana, Venezuela	[7]


Epidendrum secundum


Mandevilla sp


Tibouchina cf *aspera*


Bejaria cf *infundibula*

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