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THE EARTHWORMS COMMUNITY OF CARIMAGUA (EASTERN PLAINS, COLOMBIA) TAXONOMY AND ECOLOGY OF SPECIES LOOKING FORWARD TO A SUSTAINABLE WAY OF LAND MANAGEMENT ?

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Tropical savannas constitute one of the most predominant ecosystems in South America with an overall extension of almost 250 millions ha The role that these grasslands play over the environment is a key factor to understand its functioning and the response to changes induced by humankind Moreover the great doubt arising from the misunderstanding of ecological processes involved in tropical rain forests and the pressing need to preserve them, not only as stocks for biodiversity but as a main factor in the regulation of global climate makes southamerican savannas to be an important alternative for scientific research and mankind use all under the tendency of a better resource development and its sustainability A good example of this is issue is the recent discovery by CIAT scientists of carbon sequestration in tropical savanna soils with introduced pastures which may suppose one solution to the threat of global warming (Fisher *et al*, 1994)

INTRODUCTION

The European Community through the MACROFAUNA project has been collaborating with CIAT one of the CGIAR (Consultative Group on International Agricultural Research) centers in the world settled in Cali (Colombia) for more than two years, since April 1993 when a french student, Thibaud Decaens, did a first evaluation of the impact of the different land use systems on the whole soil macrofauna communities (defined as those organisms greater than 2 mm) using the methodology recommended in the TSBF handbook of methods, at the Carimagua Research Station on the Eastern Plains of Colombia The results obtained in that previous work were such surprising and promising (Table 1) that in september 1993 began a more detailed study of earthworm communities in contrasting land facets a native savanna and an introduced pasture At this moment, Thibaud has returned to Carimagua to do his PhD thesis about the topic of ecological implications of land use systems following recolonization in disturbed areas

In all this period CIAT particularly the Tropical Lowlands Program has showed a great interest in soil biology studies so that in the near future we will be in the best position to integrate these studies with those related to physical and chemical aspects of savanna soils

Table 1 Total earthworms and macrofaunal biomass in different types of ecosystems at Carimagua (Eastern Plains of Colombia)

ECOSYSTEM	EW BIOMASS	TOTAL BIOM	%EW BIOM
IMPROVED PASTURE	51,09	62 46	82
NATIVE SAVANNA	4 78	15 33	31
GALLERY FOREST	4,72	13,58	35
HIGH-INPUT ANNUAL CROP	2 3	3 23	71

Source T Decaens *et al* 1994

† g fresh weight m^{2}

STUDY AREA

The CIAT-CORPOICA Carimagua Research Station is located on the Eastern Plains of Colombia (Llanos') over flat high plain at 4° 37' N latitude and 71° 19' W longitude and 175 meters altitude (Figure 1) Respective average annual rainfall and temperature is about 2250 mm and 26° C with a dry season from december to march (Figure 2)

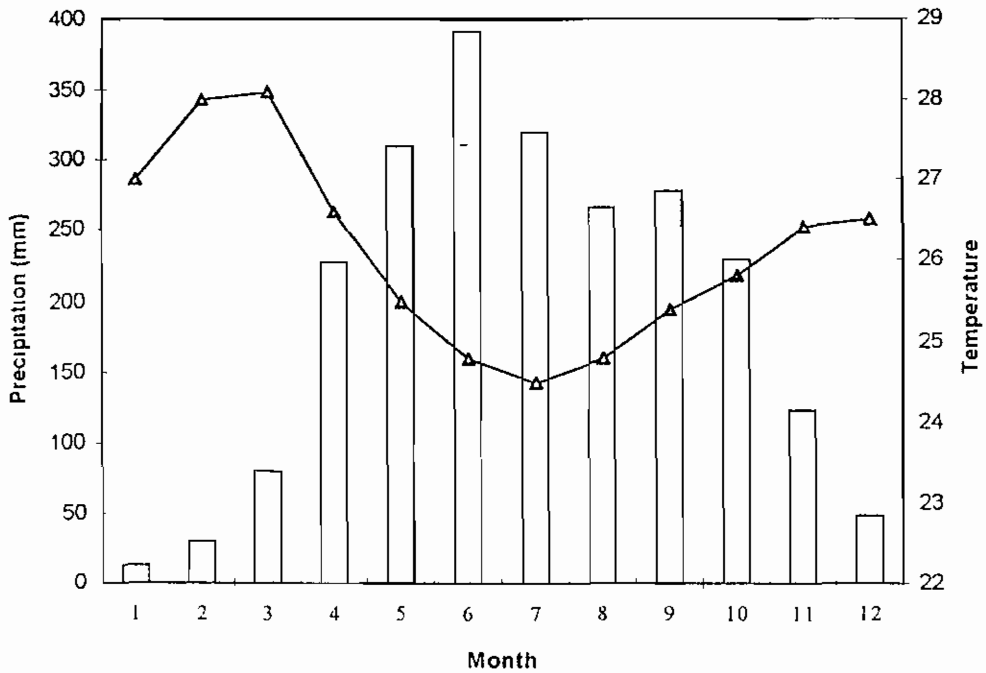


Figure 2 Climate at Carimagua, Eastern Plains (Colombia) Average precipitation and temperature during the last 20 years
Source CIAT data.

Soils of the area are said to be infertiles Oxisols and Ultisols they are acid with low pH (~5) with low Phosphorous (Total P = 1 5 ppm Bray II) and Calcium contents, a high aluminium saturation (80 %) and a low cation exchange capacity (Table 2) The vegetation profile is determined by the different ecosystems that we may find Gallery forest Upland (altos) and Lowlying (bajos) savannas (Figure 3)

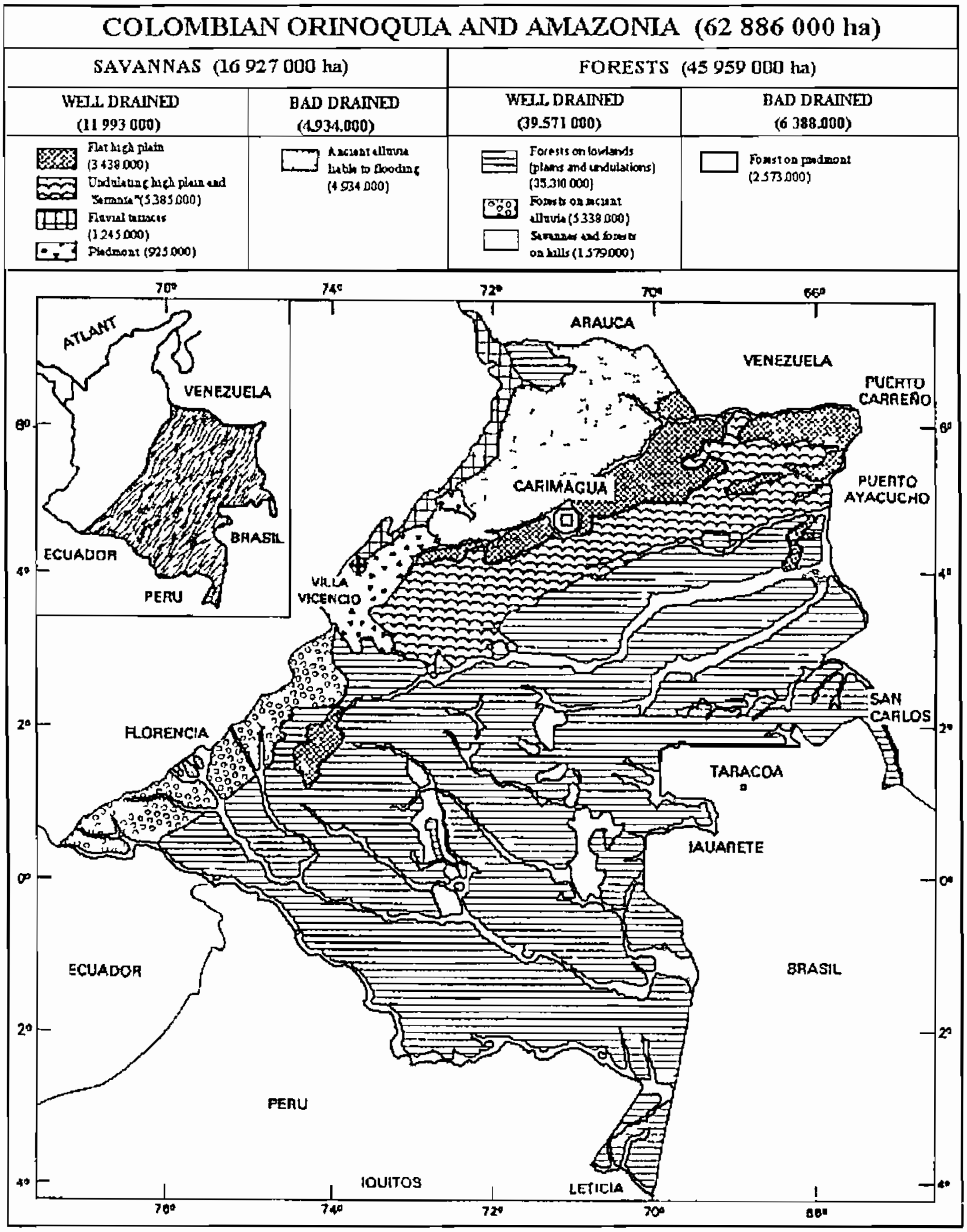


Figure 1 Colombian Orinoquia and Amazonia

(Adapted from Sanchez and Cochrane 1980)

Table 2 Physical and chemical properties of the Oxisols at Carimagua

Depth	Horizon	Clay %	Sand %	Silt %	Texture	pF 2 5 %	pF 4 2 %	C %	pH H_2O 1/1	pH KCl 1N
0 14	Ap	35 9	9 5	54 6	Silt Clay Loamy	31 8	15 4	1 49	4 6	3 7
14 36	AB	36 7	6 9	56 4	Silt Clay Loamy	31 2	12 1	0 71	5 2	4 0
36 80	B01	40 5	7 1	52 4	Silt Clay Loamy	35 6	12 4	1 01	5 3	4 2
80 108	B02	31 3	6 1	62 6	Silt Clay Loamy	35 2	13 9	0 40	5 2	4 3

Depth	Horizon	Ca[1]	Mg	K[1]	Na[1]	Al[1]	P available ppm	Organic matter %	Al saturation %
0 14	Ap	0 16	0 06	0 05	0 20	2 74	2 08	4 36	90
14 36	AB	0 11	0 04	0 03	0 10	2 12	1 11	3 01	92
36-80	B01	0 10	0 03	0 02	0 20	1 05	0 78	1 60	86
80 108	B02	0 10	0 03	0 02	0 10	1 05	0 78	1 60	86

pF 2 5 field capacity

pF 4 2 wilting point

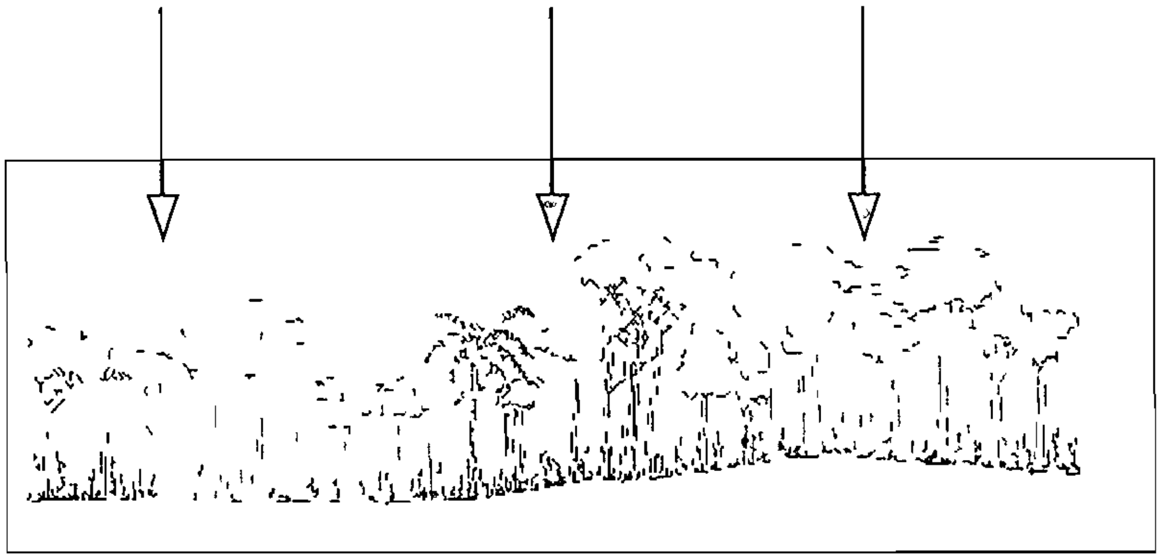
meq/100 g

Soils at the study site have been defined as fine kaolinitic, isohyperthermic typic Haplustox (clay loam soil) Two different systems were evaluated A native savanna (NS) without any kind of management and a 17-yr old grazed pasture that associates an exotic african grass *Brachiaria decumbens*, with an herbaceous legume, *Pueraria phaseoloides* (KUDZU')

GALLERY FOREST

LOWLYING AND MIDDLE SAVANNAS

UPLAND SAVANNAS



Dendropanax arboreus
Xylopia discreta
Trattinickia sp
Enterolobium sp
Jacaranda copaia
Lacistema aggregatum
Bauhinia aromatica
Mauritia minor
Calophyllum sp
Macrolobium sp
Virola sp
Miconia
Tapiria sp
Coccoloba dugandiana

Lycopodium alopecuroides
Blechnum serrolatum
Panicum rugdei
Hyptis conferta
Caraipa llanorum
Bowdicha virgiloides
Vismia sp
Andropogon virgatus
Curatella americana
Bulbostylis paradoxa
Hyptis conferta

Andropogon virgatus
Andropogon bicornis
Axonopus chrysoblepharis
Curatella americana
Hyptis conferta
Bulbostylis paradoxa
Xylopia aromatica
Trachypogon sp

Figure 3 Vegetation profile of different environments at Carimagua

OBJECTIVES

Yet the main objectives and a series of intermediate ones were mentioned in report n° 3 (december 94) of the STD3 project, we present here those aspects that have been succesfully done (despite of some little problems dealing with human relationships at work)

- To evaluate the impact of different types of land use on the density and composition of soil macroinvertebrate communities (Decaens *et al* 1994),
- To describe and quantify the main biological, ecological and demographic parameters of earthworm species and dynamics of their populations in time
- To describe and quantify the effects of earthworms on soil physical and chemical properties selective ingestion of soil organic and mineral fractions, release of available N and P in earthworm casts
- To describe the spatial and temporal distribution of communities and the dynamics of recolonization in the native savanna and in contrasting management systems

METHODS

1 Selection of sampling sites

Two sites were selected according to results obtained in the first part of the study The soil fauna characterization under different land use systems The improved pasture (GLP) takes place in the site called Introducciones II and the NS does in the CULTICORE long-term multiapproach experiment These sites are not very far apart from one to another and present quite contrasting management systems

One plot of 90x90 metres square was identified in each system and divided into small quadrants of 10 by 10 metres square to obtain a total number of 81 sampling quadrants The spatial and temporal dynamics of earhworms were followed in both plots from March 1994 to September 1995

2 Selection of methods

2 1 Field work

To describe the population dynamics of earthworm species two different types of physical methods are combined hand-sorting and washing-sieving of samples

a) Hand Sorting (after Lavelle, 1978) five and monthly quadrats $1m^2$x50 cm depth are randomly taken in both systems The sampling depth varies seasonally to take into account vertical migrations of some species A trench is dug around the quadrat to avoid the possible migration of some individuals out of the block The sample is subdivided into strata 10 cm depth All earthworms in the sampled area are washed first in a tray with water and fixed in 10 % formaldehyde They are later separated in the laboratory into species, adults juveniles and cocoons, counted and weighed

b) Washing and Sieving 10 blocks of 20x20x20 cm are taken in each system by month, carried to the laboratory, washed and passed through sieves of suitable size to ensure the collection of all the earthworms even the smallest ones, and cocoons Combination of these two methods allows us to establish a factor when hand sorting is not accurate enough

c) Surface Cast Deposition Casts deposited over the soil surface are counted in areas of 1 metre square and the number of earthworms estimated This method only works with anecic species which have the ability to form big tower-like casts, easily distinguished from other depositions

d) Spatial A third sampling method is used to assess the horizontal distribution of some species in the plots The experimental design consists in 64 40x40x20 cm samples taken on a regular grid every ten metres (or sometimes 5 depending on the size of the plot) in the nods of a 70x70 m grid The blocks are dug out from the soil and earthworms are counted and differentiated into categories adults, juveniles and cocoons Earthworms are replaced into the dug soil Geostatistical programs are applied (VAR 5 KRIGE GEO-EAS) to look for spatial structure with the purpose to see distribution of earthworms in patches if present

2 2 Laboratory studies

Cultures of the major species have been done under controlled conditions to evaluate their soil ingestion rates and demographic parameters using methodology proposed by Lavelle (1975) We have not succeeded with all species due sometimes to the size of individuals (too small!!!) or to the high mortality of some species under laboratory conditions

Studies on N and P dynamics in earthworm casts across time have been done in collaboration with two colombian students from the National University of Palmira and under the supervision of two principal investigators at CIAT (R J Thomas and D K Friesen) In these studies we have considered two situations laboratory and field conditions (We are expecting to get these data as soon as possible)

2 3 Identification of species

The different species found in the two systems under study were identified as much as possible to make easier their separation at field site even though the identification could not approach the hierarchical level of species All the species were sent to Madrid (Spain) for the ultimate determination by A Moreno, who is the principal determiner of earthworm species

2 4 Moisture samples

Samples were taken in each stratum according to hand sorting method and carried to the laboratory Six subsamples were separated for each stratum weighed (nearly 100 g) and dried in a 60 ° C oven for at least four days to calculate the water content in the soil (expressed as % in dry weight)

RESULTS

1 Taxonomy

About 15 species were found in the area of Carimagua considering all the environments The doubt arises because not all the species update have been fully identified and some of them are new to science

Table 3 List of species found in different ecosystems at Carimagua

Species	Family	Location[†]	Ecological category[‡]	Adult max size[b] mm	g
Andiodrilus voparensis sp nov	Glossosc	NS IP GF	Endogeic	140	2 50
Andiorrhinus ofeliae sp nov	Glossosc	NS, IP	Endo-anecic	200	6
Andiorrhinus sp 2	Glossosc	NS	Endo anecic	#	
Martiodrilus carimaguensis sp nov	Glossosc	NS IP	Anecic	250	25
Martiodrilus sp 2	Glossos	CG	Anecic	#	
Pontoscolex corethrurus	Glossosc	AP	Endogeic	#	
Pontoscolex marcusi ??	Glossosc	AP?	Endogeic		
Glossodrilus sikuani sp nov	Glossosc	NS IP GF	Endogeic	60	0 20
Pheretima sp	Megasc	CL	Epigeic	#	
Dichogaster sp 1	Octoch	NS IP	Epigeic	#	
Ocnerodrilidae 1	Ocnerod	NS IP	Endogeic	25	0 015
Epigeic 1	?	NS IP GF	Epigeic	#	
Epigeic 2	Glossosc ?	CL GF	Epigeic	#	
Epigeic 3	?	GF	Epigeic	#	

NS native savanna IP improved pasture GF gallery forest AP African palm culture CL Carimagua lake CG Caño Gloria near Carimagua

Anecic live in the soil but feed on the soil surface Epigeic live and feed on the soil surface Endogeic live and feed in the soil

[b] Size in milimetres and weight in grames

Not processed

In the two systems studied NS and GLP, there are not great differences in terms of the number of species, 8 in the NS and 7 in the GLP (Table 3) Although the latter is a disturbed area biodiversity has not been affected much that is, the improved pasture (GLP) had the same community composition than the native savanna (NS) except for the species *Andiorrhinus* sp 2 that was found only once in the NS

The situation at Carimagua differs greatly from a high number of tropical american pastures where communities are overdominated by only one exotic species like e g *Pontoscolex corethrurus* in Amazonian pastures at Yurimaguas (Peru, Lavelle and Pashanasi, 1989), Florencia (Colombia, Jimenez, J J , unpublished) Manaus (Brazil) and some pastures from Mexico and Costa Rica But pastures in Carimagua, alone or associated with legumes, contain the native earthworms composition and it is the same situation as in pastures at Lamto (Ivory Coast) in a savanna region

The earthworm community is rather diverse in terms of species size and functional categories Indirect relationships seem to appear among species, i e , in the deeper strata of soil, where SOM is scarce specimens of the family Ocnerodrilidae present an important feature, they live and feed on the rich casts deposited by large individuals of *Martiodrilus carimaguensis* in their vertical burrows

2 Population dynamics

2 1 Density and biomass

During hand sorting method many earthworms of the larger species are cut into pieces and it is difficult to evaluate their individual weight Head portions are counted as individuals to know the density values and relationships have been watched for to relate the maximum diameter of the earthworm in the anterior region to their individual weight Two types of relationships have been found in order to estimate the weight of those cut earthworms a linear one, as in the case of *Glossodrilus sikuani* and an exponential type for *Martiodrilus carimaguensis* (Figures 4 and 5)

Dynamics and life cycles of the earthworm populations are determined by weather conditions the occurence of a four month dry season leads to a high reduction of individuals in terms of density and biomass (Figure 6)

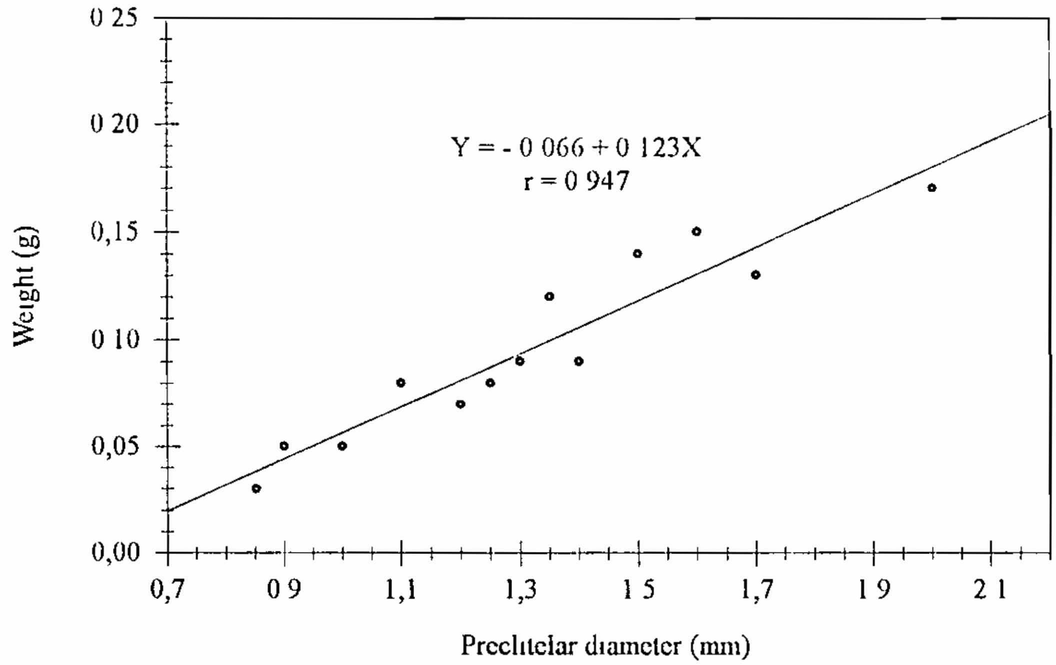


Figure 4 **Estimation of weight for *Glossodrilus sikuani* sp nov**

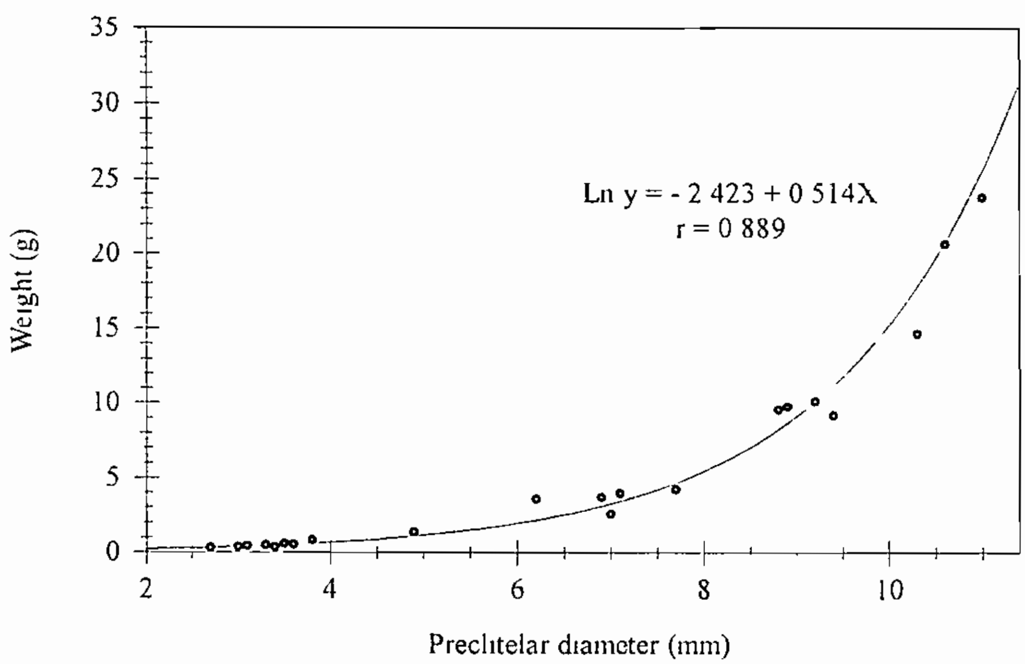
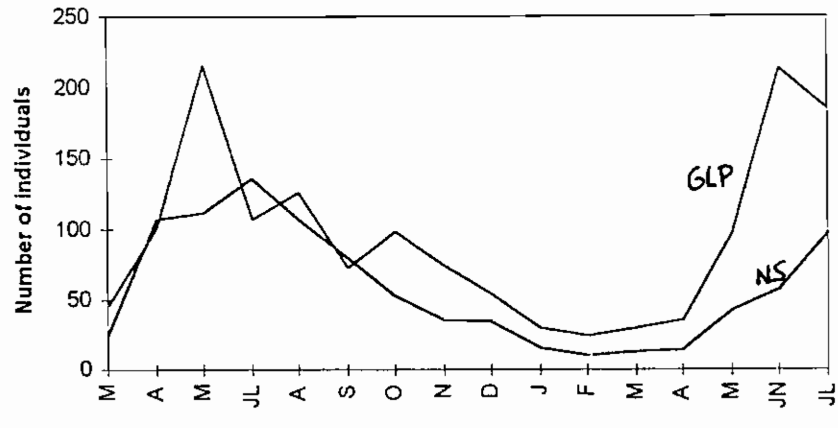
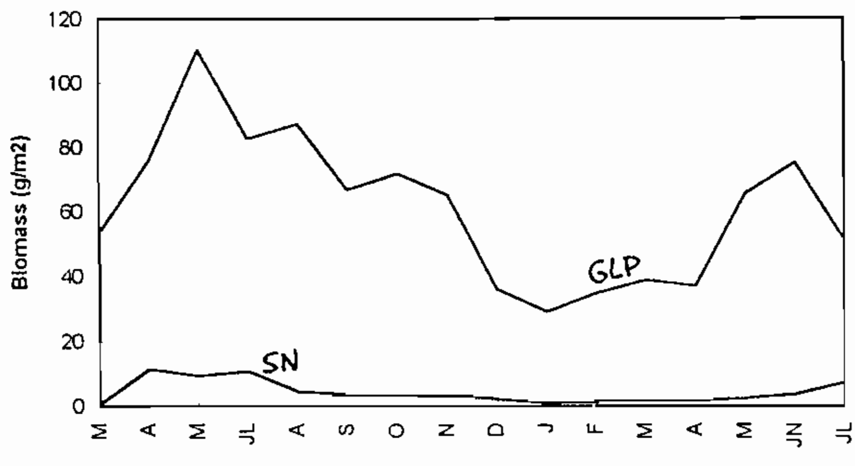


Figure 5 **Estimation of weight for *Martiodrilus carimaguensis* sp nov**



a)



b)

Figure 6 Changes of average density (a) and biomass (b) of earthworms community from March 94 (n = 3) to July 95 in NS (black line) and GLP (red line) Hand sorting method

Density of individuals, measured as number per meter squared, was not greatly different in both systems but there was a tenfold increase in biomass in the GLP system as compared with the NS, due to the presence of a large population of *Martiodrilus carimaguensis*, which has been favoured by conversion of savanna to pasture Contribution of the different species to the total earthworm biomass in both systems is presented in table 4

Table 4 Mean annual contribution of the species to total biomass

Species	Grass legume pasture	Native savanna
Andiodrilus yoparensis	4 2	24 3
Andiorrhinus ofeliae	3 9	1 9
Epigeic 1	0 5	3 3
Glossodrilus sikuani	5 2	**53 8**
Martiodrilus carimaguensis	**86**	15 1
Ocnerodrilidae	0 5	1 4

The great activity of *M carimaguensis* developed in the GLP system can also be reflected in the number of fresh casts deposited at the soil surface The maximum activity is observed at the beginning of the wet season, in April or May, depending on the duration of the dry period (Figure 7 and Table 5) These values are consistent with the biomass data

Values of density for some species must be corrected using data obtained in the washing-sieving samples This is essentially the case for *Glossodrilus sikuani* since the efficiency of hand sorting for that species varies from 8,6 to 98 2 % with an average value of 57 3 % in the NS (Table 6) This correction system may not apply to the improved pasture since root biomass and soil moisture, that greatly affects hand sorting differ in both systems

Table 6 Number of individuals by metre square in NS obtained with two physical methods and efficiency of hand sorting method related to washing-sieving for *Glossodrilus sikuani* (in percentage)[†]

Month	Hand Sorting	Washing-Sieving	% Efficiency HS/WS
April 94	76 4	90	84 9
May	52	152 5	34 1
July	88 4	90	98 2
August	47 6	72 5	65 6
September	27 2	42 5	64 0
October	17 8	20 0	89 0
November	20 2	27 5	73 4
December	12 8	45 0	28 4
January 95	4 4	17 5	25 1
February	2 8	32 5	8 6
March	4 6	22 5	20 4
April	7 0	45 0	15 5
May	25 2	50 0	50 4
June	33 6	57 5	58 4
July	71 4	92 5	77 2
Average	**32 8**	**57 2**	**57 3**

[†] Cocoons are not included

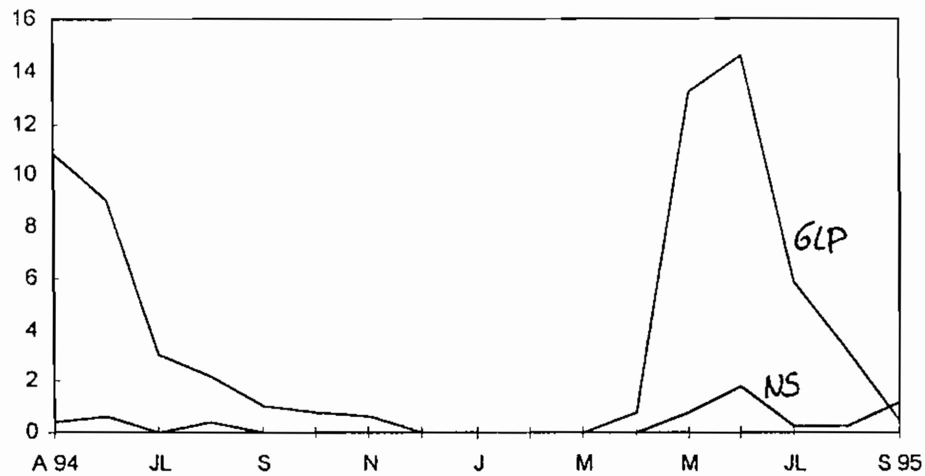


Figure 7 Production of fresh casts of *Martiodrilus carimaguensis* by metre square in NS (black line) and in GLP (red line) since April 94 (Average values from five 1 m^2 samples by month)

Table 5 Monthly average production of casts of *Martiodrilus carimaguensis* by metre square in the two systems during the whole study period

Condition	Native savanna	Improved pasture
Dry casts	31 9 ± 17 0	86 8 ± 44 8
Recent fresh casts	1 18 ± 2 5	12 41 ± 17 9
Non-recent fresh casts	0 47 ± 1 1	6 8 ± 10 0
Total casts	33 6 ± 18 1	106 0 ± 59 7

Fresh casts indicate a real presence of a specimen of *Martiodrilus carimaguensis* and may be considered as an evidence of activity of this species If we count the number of fresh casts (recent and non-recent) in the two systems the improved pasture system presents a production of fresh casts about 10 times greater than the native savanna

2 2 Adaptation to the dry season

Different patterns have been observed regarding the adaptation of populations to the dry season

Some species do not seem to have any specific strategy or resistance form during the summer. This is the case for *Andiodrilus yoparensis* and *Andiorrhinus ofeliae* endogeic species which get deeper into the soil (in the 30-50 cm stratum) and stand still during thedry season. Many earthworms die and survivors reproduce following the onset of the wet season to rapidly increase the population.

Glossodrilus sikuani combines two strategies: quiescence and the production of cocoons at the end of the wet season, in November, which allow them to resist the moisture stress in the soil (that is near pF 4.2).

Martiodrilus carimaguensis is the species that exhibits the most interesting behaviour with a true diapause and found different patterns between adults and juveniles. The latter are only actives during four months, from April to July, while adults remain active until December (8 months). Inactivation occurs after the individuals have gone down at 60-110 cm depth. They form aestivating chambers in which they roll themselves up, after emptying their gut content, and stand until the next season (in laboratory conditions there was no response when putting them into soil with a water content near to pF 2.5).

The specimen usually closes up the end of the gallery with several septa to avoid a loss of tegumental humidity, essential to support a minimal rate of respiration. In august, after juveniles become inactive, the adults start to reproduce and one month later the first cocoons, of an average diameter of 20-25 mm, are deposited at a 30 or 40 cm depth. Two individuals emerge from each cocoon; they rapidly go down and become inactive.

The illustration of this behaviour is given in figures 8 and 9 which show the vertical distribution of the population in the GLP in four different months. In May 1994 all the individuals are concentrated in the first 20 cm and more than 60 % of the whole population were juveniles. At the end of the rainy season the distribution has changed considerably, the most part of the population was between 50 and 70 cm far apart from the topsoil and the cocoons had been deposited in the 30-50 cm interval and all the population below the fourth stratum was inactive.

2.3 Demographic structure

Changes in the demographic structure of the different species have been assesed by looking at monthly weight structures (Figures 10 and 11).

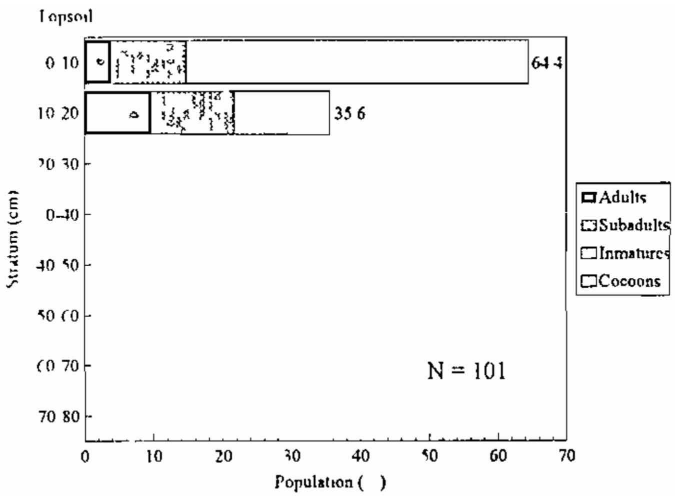


Figure 8 **Vertical distribution of *Martiodrilus* in May 94**

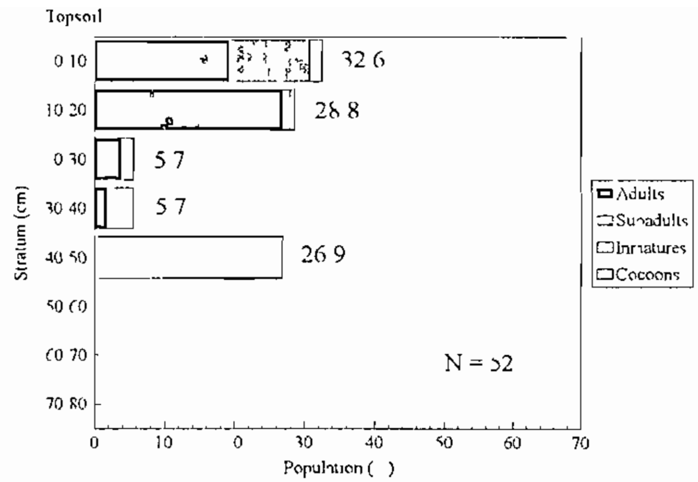


Figure 8a **Vertical distribution of *Martiodrilus* in July 94**

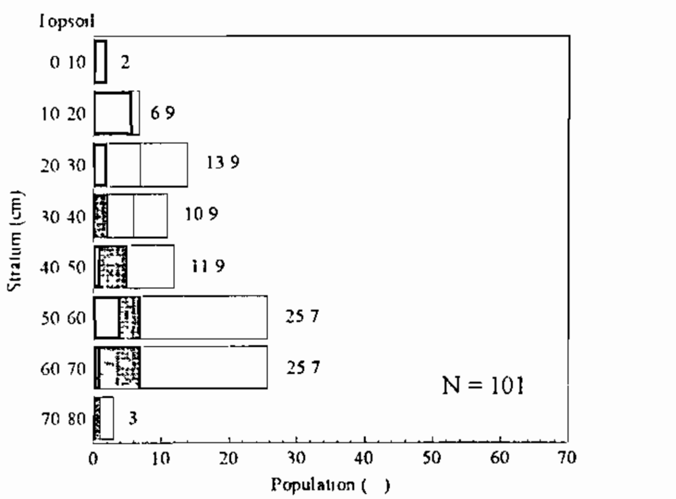


Figure 9 **Vertical distribution of *Martiodrilus* in November 94**

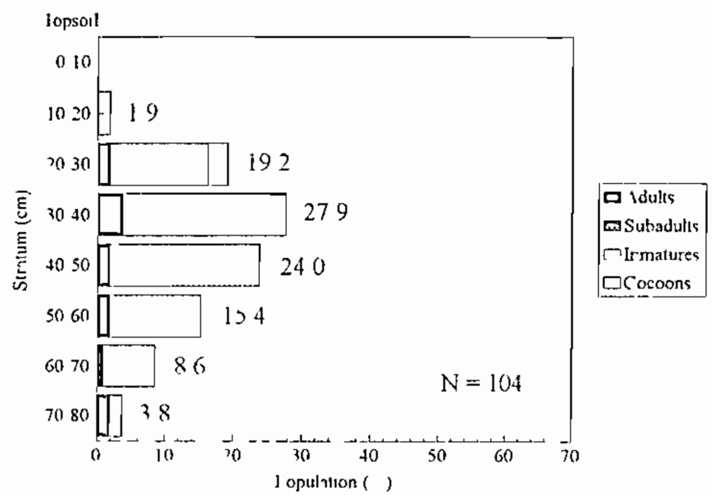
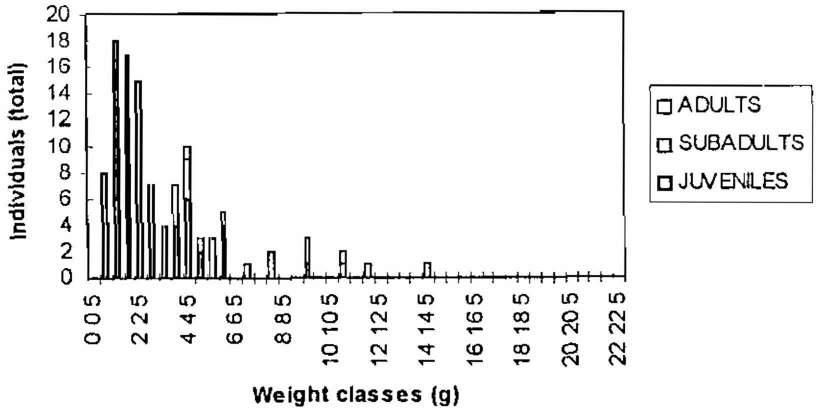
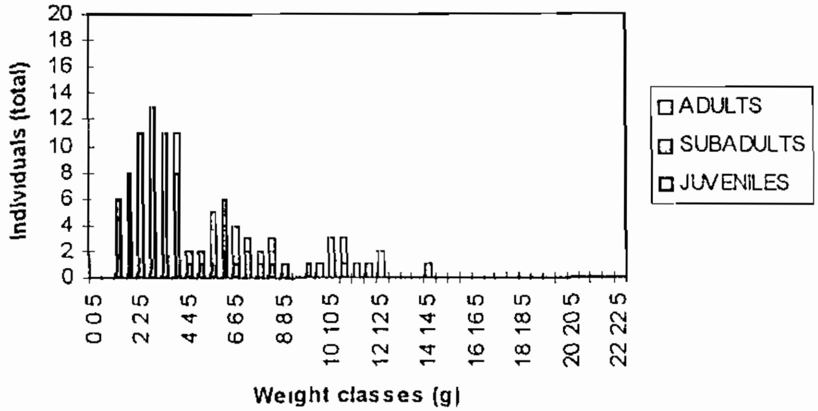


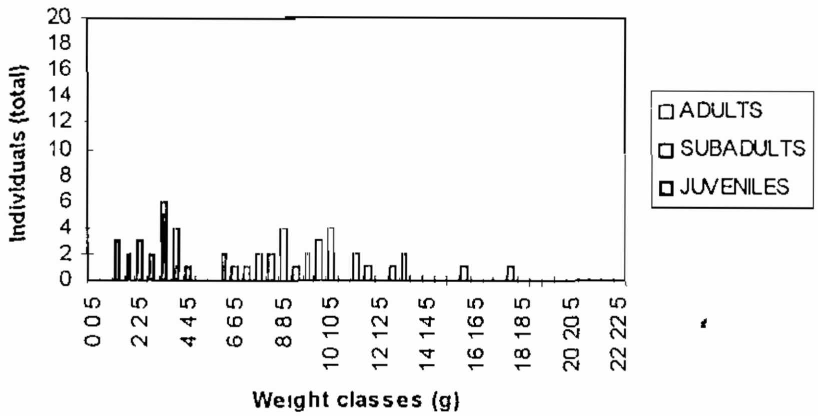
Figure 9a **Vertical distribution of *Martiodrilus* in January 95**



April 94

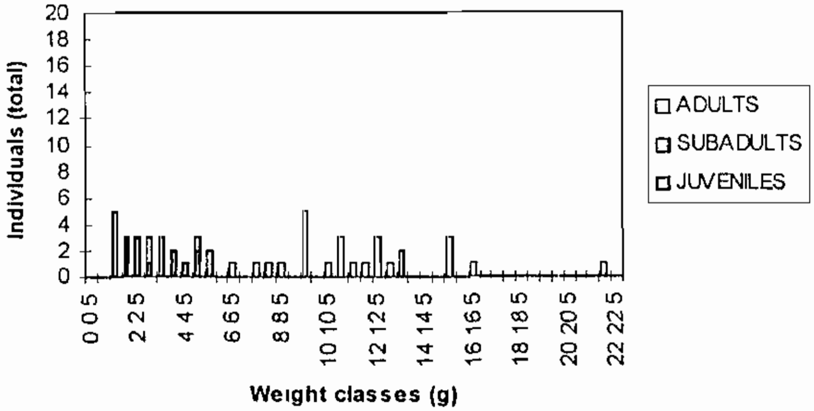


May 94

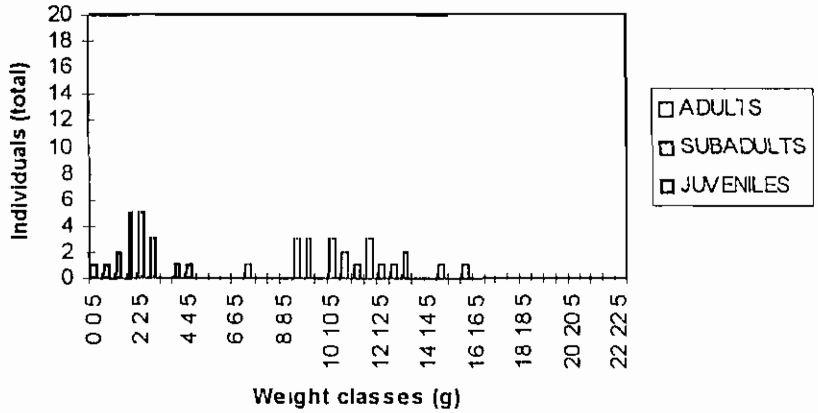


July 94

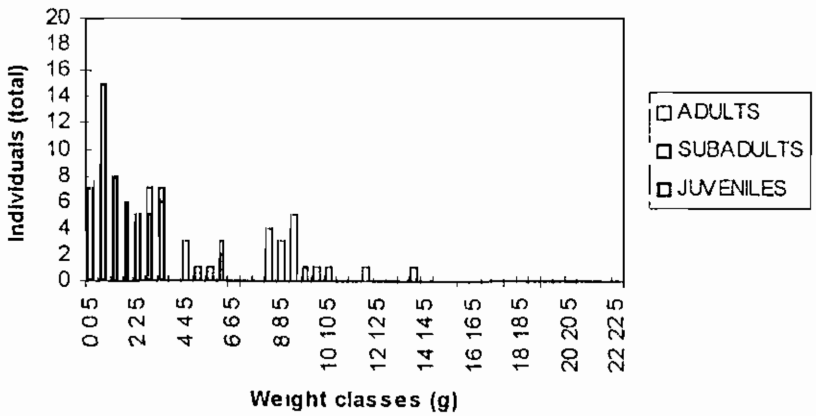
Figure 10a Histograms of weight frecuencies for *Martiodrilus carimaguensis* in the improved pasture



August 94

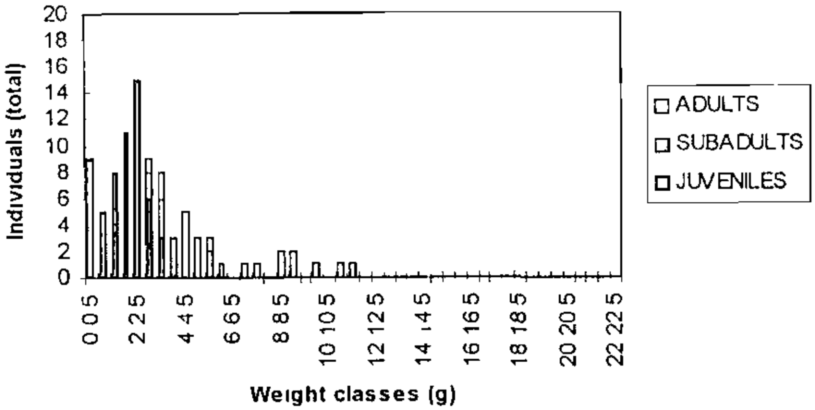


September 94

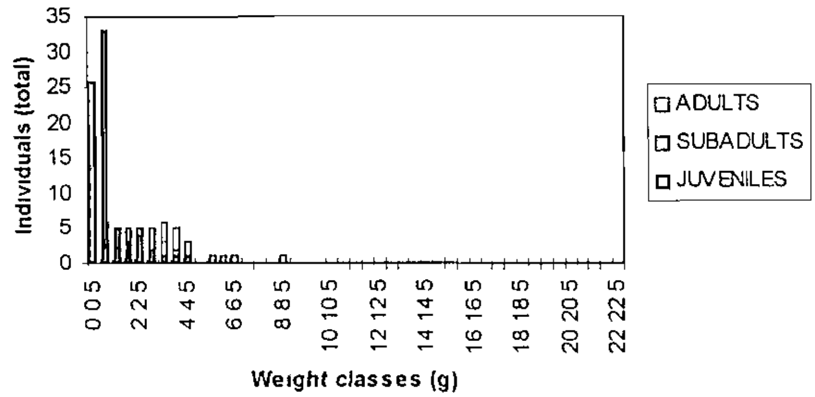


October 94

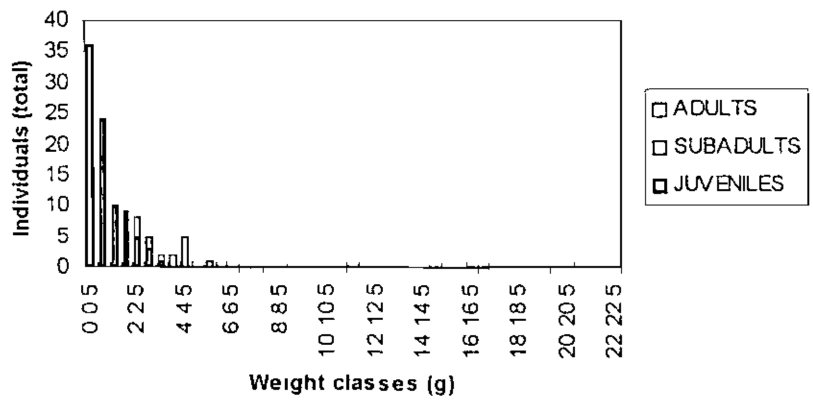
Figure 10b **Histograms of weight frecuencies for *Martiodrilus carimaguensis* in the improved pasture**



November 94

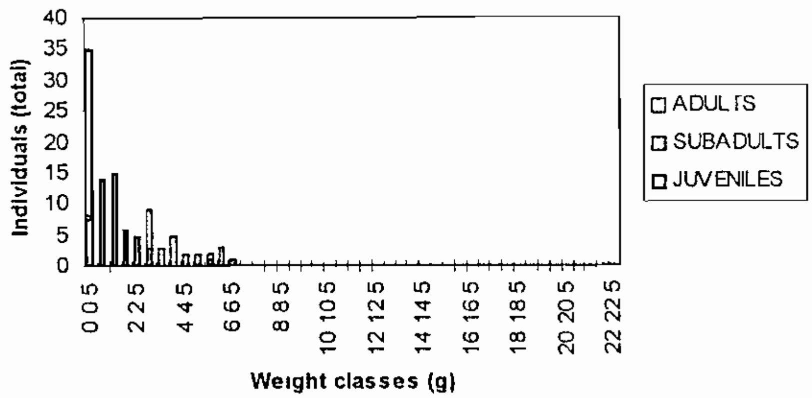


December 94

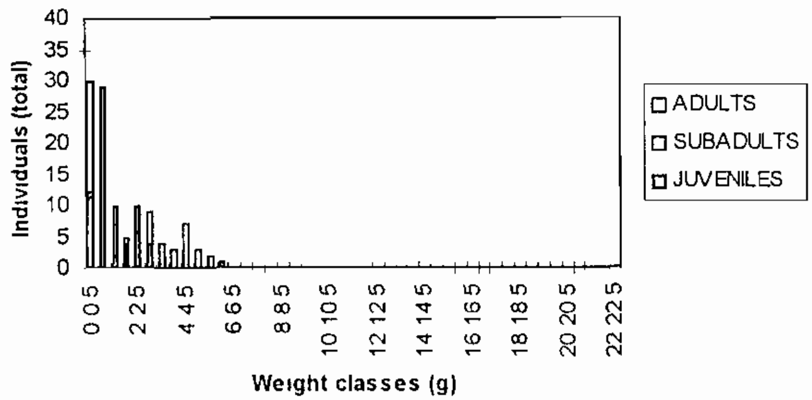


January 95

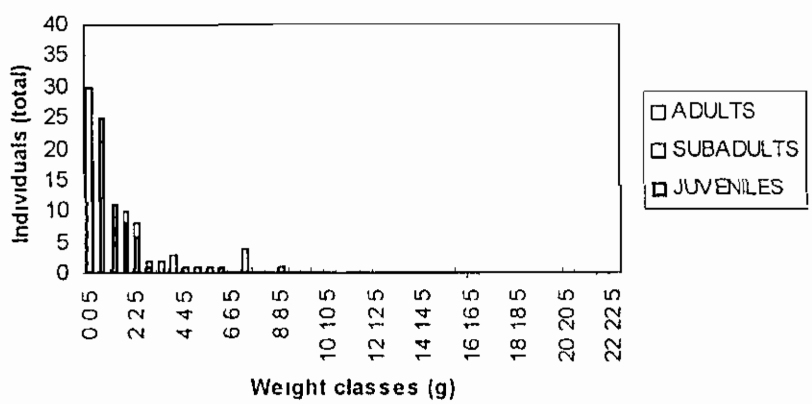
Figure 10c Histograms of weight frecuencies for *Martiodrilus carimaguensis* in the improved pasture



February 95

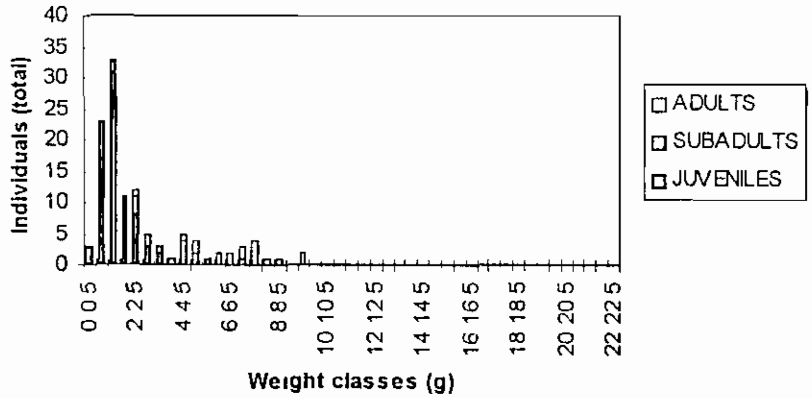


March 95

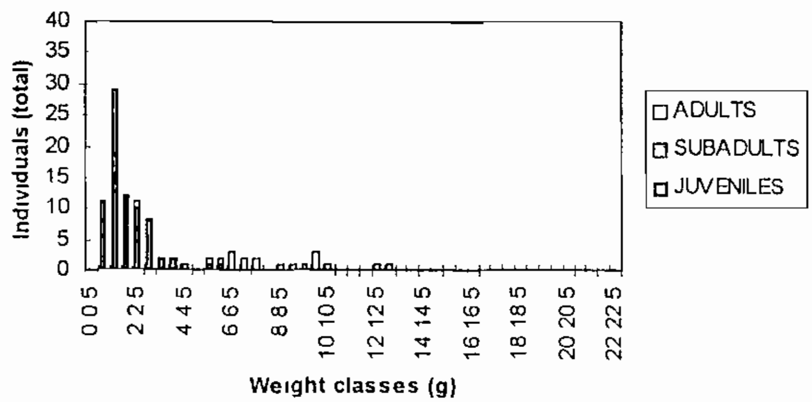


April 95

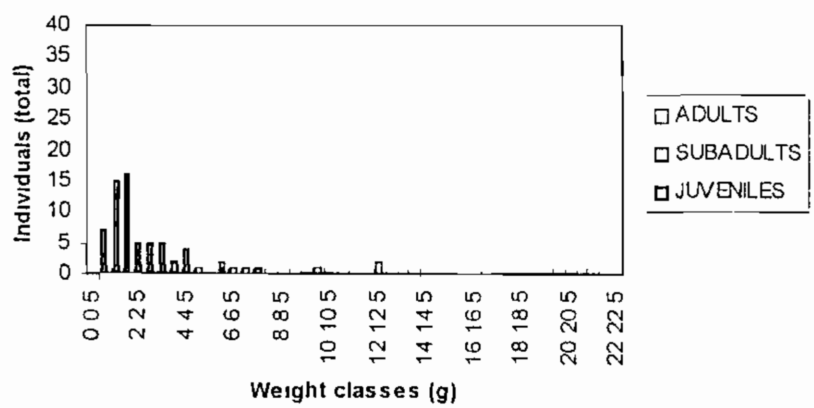
Figure 10d Histograms of weight frecuencies for *Martiodrilus carimaguensis* in the improved pasture



May 95



June 95



July 95

Figure 10e **Histograms of weight frecuencies for *Martiodrilus carimaguensis* in the improved pasture**

2 4 Pı oductıon of cocoons

At field sıte dıfferences not only ın the number of cocoons deposıted each month by *Andıodrılus yoparensıs* and *Glossodrılus sıkuanı* but the duratıon of the cocoon deposıtion penod have been found ın both systems (Fıgures 12 and 13)

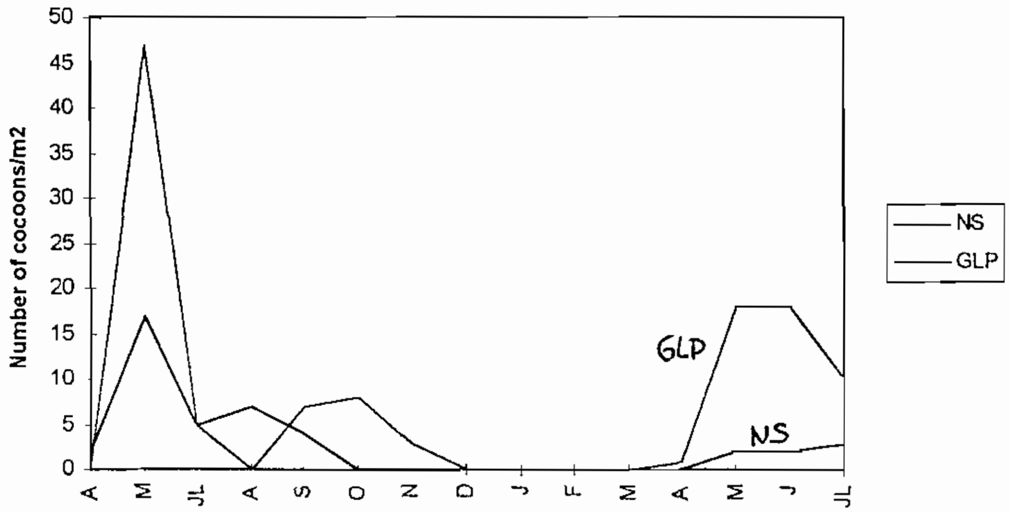


Fıgure 12 Number of cocoons monthly deposıted by *Andıodrılus yoparensıs* (hand sortıng method)

(Total number referred to 5 samples by month)

For *A yoparensıs* ın GLP system, thıs penod goes untıl November, whereas ın NS September ıs the last month ın whıch cocoons were deposıted Thıs dynamıcs shows the dıfferences ın soıl envıronmental factors such as mıcroclımatıc condıtıons root densıty and bıomass etc further studıes must take ınto account these factors (Thıbaud s PhD thesıs)

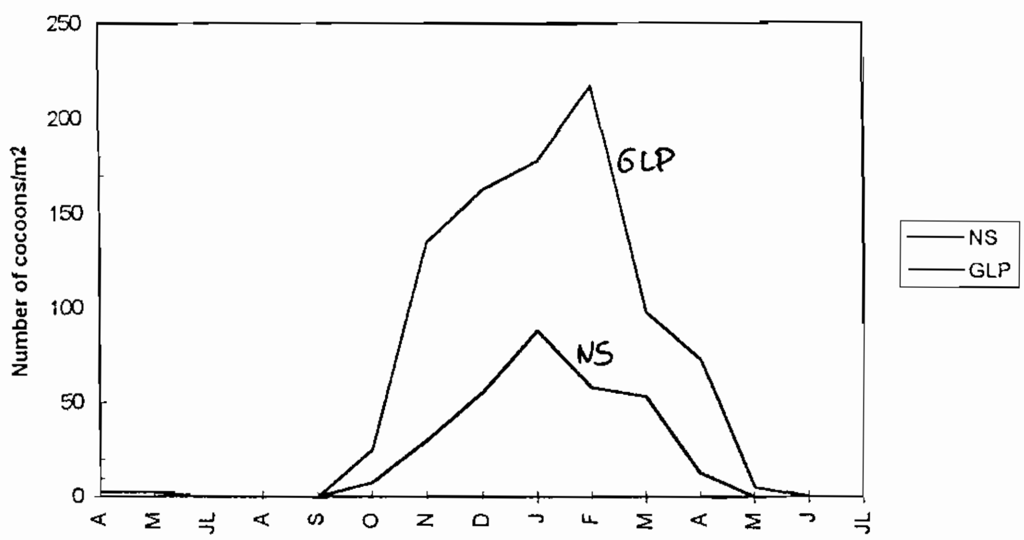


Figure 13 Seasonal changes in the abundance of cocoons produced by *Glossodrilus sikuani* (washing-sieving)

Cocoons observed in January February and March were not deposited in that period since all the individuals were inactive

3 Laboratory studies

Cultures of the major species have been done in order to assess demographic parameters (production of cocoons and growth rate) and feeding rates of mineral and organical soil particles

Andiodrilus yoparensis was the best adapted species to laboratory conditions Cultures of other species have been largely unsuccessfull and a high mortality of specimens have ocurred, even though with the method of blocks

In figure 14 we may observe the growth period of individuals in one culture of *Andiodrilus yoparensis* Six pots with five juveniles emerged from cocoons deposited in the field and hatched in the laboratory, and other six pots with two adults have shown distinct values for ingestion rate between juveniles and adults

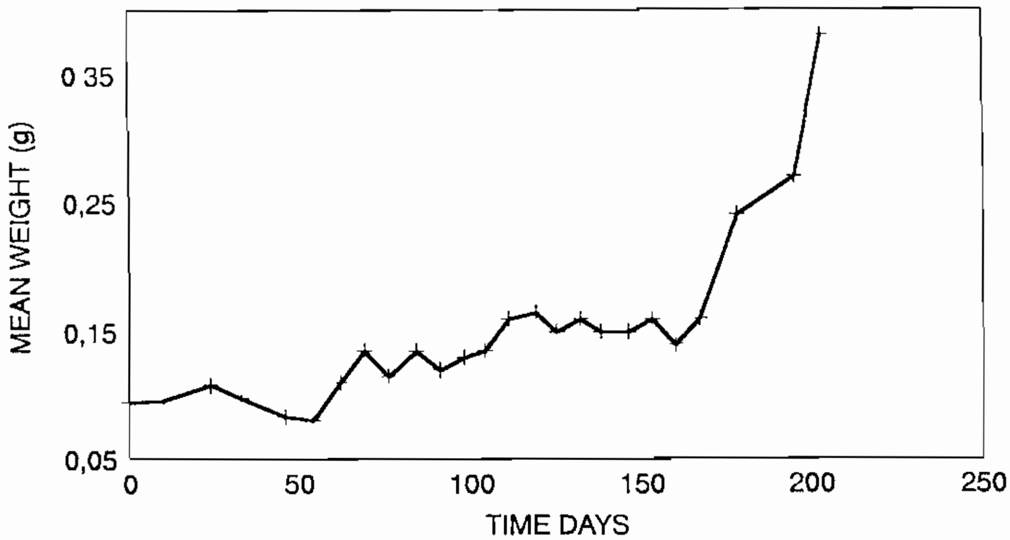


Figure 14 Growth of juveniles of *Andiodrilus yoparensis* during 200 day period in laboratory conditions

Studies on N and P dynamics in different ageing casts were done with *Martiodrilus carimaguensis* Lab and field conditions were evaluated Data are not yet available but initial results have put in evidence the role that this species may have in the dynamics of these two elements in the soil

4 Spatial distribution of populations

The spatial distribution of some species has been assessed using GEOSTATISTIC treatments in order to visualize and follow the horizontal movements of their populations over seasons

We sampled NS and GLP systems at three different times September/October 93 October/November 94 and May/June 95 Of the major species only populations of *Glossodrilus sikuani* had a spatial structure Distribution in patches, with high density, a few tens of meters in diameter with distinct patterns for adults and juveniles found From October 93 to November 94 substantial differences had been observed in the spatial structure (Figures 15 and 16)

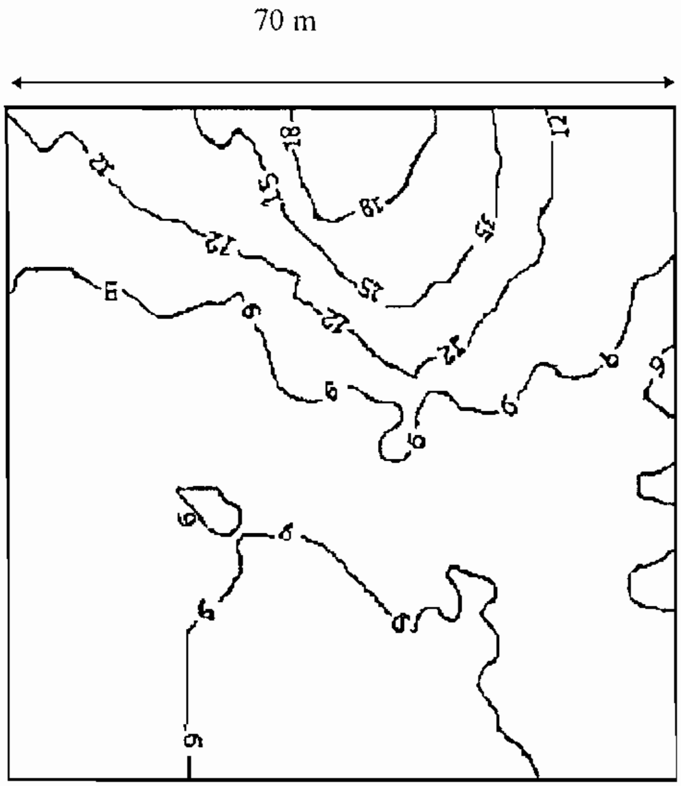


Figure 15 Spatial distribution of juveniles of *Glossodrilus sikuani* in GLP system in September 93

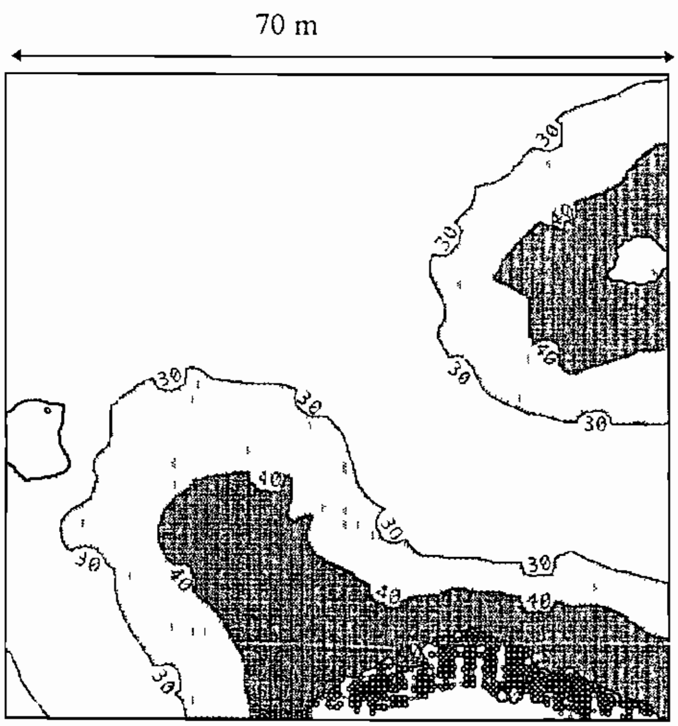


Figure 16 Spatial distribution of juveniles of *Glossodrilus sikuani* in GLP system in November 94 (Numbers are density by metre square)

The next step is to seek relationships between the patchiness and soil environmental factors and/or weather Rossi in a study with populations of *Polypheretima elongata* in Martinique (French West Indies) has found that demographic factors seem to regulate this spatial distribution

Geostatistics have also been applied to distribution of fresh surface casts, deposited by *Martiodrilus carimaguensis* as an indirect assessment of populations, since regular samples of 40x40x20cm did not allow to observe any spatial distribution due to the large size of this species These data confirm the patchy distribution of this species (Figure 17)

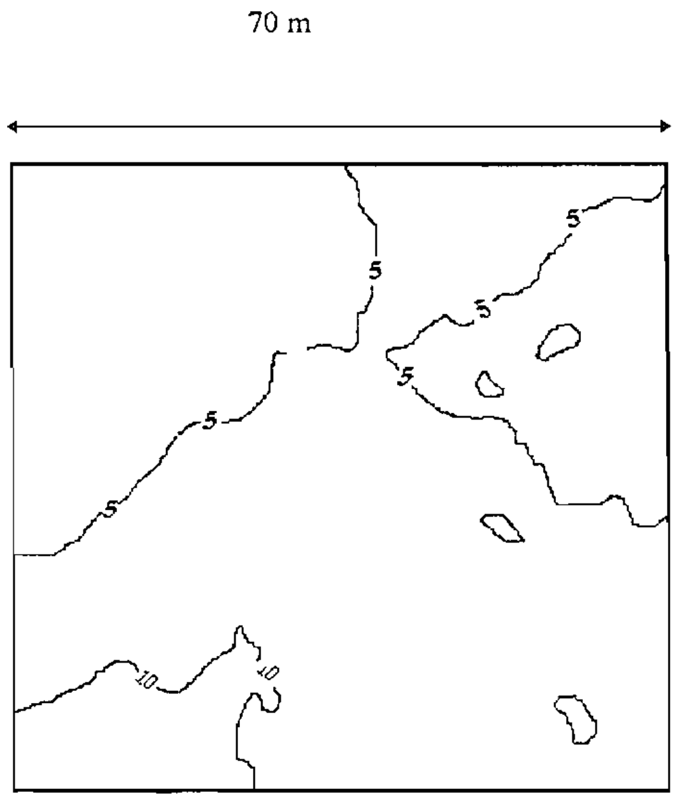


Figure 17 Distribution of fresh casts in the improved pasture at the end of the rainy season (November 94)

In spite of the fact that we did the samples at the end of the wet season, when the activity of this species is highly reduced, a patchy distribution was observed

So far there is a lack of data processing although observations at field site have shown differences in the movement of these spatial spots

4 "CULTICORE" Experiment

A long-term and multiapproach experiment was established by CIAT in 1993 to evaluate and understand processes in Sustainable crop rotation and ley-farming systems for the acid-soils savannas (title of the project) with international collaboration of several institutions IFDC (USA) CORPOICA (Colombia), CIRAD and ORSTOM (France) and UCM (Spain)

One of the main objectives of this project is to contrast soil biophysical measures of sustainability in potentially degrading and non-degrading production systems and based on these measures, develop predictors of system performance

Collaboration of ORSTOM and UCM has been asked to evaluate the effects of land use practices under test in the soil faunal activities and spatial distribution of the populations in this experiment, a split-plot design in four randomized blocks

Three contrasted treatments have been evaluated

- Treatment # 1 A rice monoculture (*Oryzica sativa* var Savanna 6) one crop per year in the first semester
- Treatment # 5 A rice-pasture rotation Rotation of rice with pastures planted to *Brachiaria humidicola* + *Centrosema acutifolium* + *Stylosanthes capitata* + *Arachis pintoi* Rice is planted at the same time as pasture grasses After harvesting rice the pasture is maintained and grazed for 4-5 years before another cycle is started
- Treatment # 10 A maize (*Zea mays* var Sikuani)-pasture rotation The same as number 5 but *with Panicum maximum* + *Glycine wightii* + *Arachis pintoi* pasture sown with rice in the second year

Since June 94 a regionalized sampling was undertaken to assess distribution of earthworm populations and follow the dynamics of recolonization in disturbed areas

Preliminary observations have shown a huge reduction of earthworm density and no spatial structure has been observed, following the destruction of the native savanna, ploughing and cropping to rice In treatment number 5 however, the density of the same populations for some species is increasing and spatial structures are expected to appear

We had to leave treatment # 10 due to several problems of pasture establishment and only one series of samples was done in this system

CONCLUSIONS

1 Earthworms (Oligochaeta) are the main component of soil macrofauna communities in different land use systems at Carimagua

2 Of the earthworm species separated in Carimagua there are some new to science and indigenous names have been assigned to them (*Andiodrilus yoparensis* *Andiorrhinus ofeliae* *Glossodrilus sikuani* and *Martiodrilus carimaguensis*) and others are waiting for an ultimate determination and their possible new specific name

3 Pastures alone or associated with legumes, constitute the systems with the highest values of earthworm biomass due to the presence of a large population of *Martiodrilus* sp

4 Biodiversity of earthworms is not affected by this practice However, the community composition of different species is rather distinct

5 High input annual cultures have a negative impact on soil macrofauna communities application of chemical compounds (herbicides and pesticides) into the soil, such as tillage and low organic inputs incorporated are the principal factors that contribute to decrease earthworm abundance

6 Monthlv five 1 m^2 and ten 20x20x20 cm samples taken in each system have been the appropiate number to obtain demographic changes and describe dynamics of populations of different species

In the improved pasture system the fast incorporation of organic matter into the soil by Scarabeinae (Coleoptera) and a specific strategy to resist the dry period allows *Martiodrilus* to maintain a high density of individuals across the year

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