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SIERRA DEL CRISTAL AND ALTURAS DE MOA ITS OPHIOLITIC RAINFORESTS SYNTAXA

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ABSTRACT

In order to know the rainforest characteristics developed over Sierra de Cristal and northeastern part of Moa's highlands the objective was to study these phytocoenosis by using Braun Blanquet method. One alliance and two associations are described for the first time, as soon as physiognomical, ecological and phytosociological characteristics are described which is too important for analyze the latter use of their community property.

Keywords: Rainforests, phytosociology, Sagua-Baracoa.

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SIERRA DEL CRISTAL Y ALTURAS DE MOA, SUS FITOCENOSIS EN LAS PLUVISILVAS SUBMONTANAS SOBRE OFIOLITAS

RESUMEN

Con vistas a conocer las características de las pluvisilvas sobre ofiolitas en la Sierra del Cristal y en la parte noroeste de las Alturas de Moa, el objetivo del trabajo fue estudiar las fitocenosis mediante el método de Braun Blanquet. Se describen por primera vez una alianza y dos asociaciones, así como sus condiciones fisionómicas, ecológicas y fitosociológicas, lo que tiene gran impacto para analizar el posterior uso de sus propiedades comunitarias.

Palabras claves: Pluvisilvas, fitosociología, Sagua-Baracoa.

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1. INTRODUCTION

The rainforest has a wide distribution in tropical belts in planet even in Greater Antilles [4, 5, 6]. In Cuban Archipelago, where over this kind of forest important aspects are also described: protection [7, 8], ecological functioning [9, 10], lichens content [11, 12, 13], ferns and similar plants [14], hepatics and mossy [15, 16], fungus [17] and plants with flowers [18, 19].

Rainforest is fundamentally distributed in Eastern Cuba where the biggest extensions and superior diversity is developed as structural as floristic [20, 21, 22, 23] as phytocenotic [20, 24, 25, 26], in Central Cuba Mountains only existing small pieces of mountain rainforest.

The geographic area [27] where this rainforest developed is one of the more ancient in Cuba, part of which remain emerged continuously since Superior Cretaceous half [28]. Therefore are shelters of the original mountain serpentinitic flora of Cuba [20, 26, 29].

Nevertheless, the low and submontane rainforest on ophiolites (sclerophyll rainforest) restricted in Sagua-Baracoa Subregion [27], were found in areas where the level of rainfalls are the highest in Cuban archipelago [30], it has been less study from the phytocenological point of view [20, 31], and for that the objective was to study these phytocoenoses and its characteristics to be able to know subsequently the propositions for its conservation and sustainable use.

2. MATERIALS AND METHODS

2.1. Characteristics of study area

Low and submontane rainforest on ophiolites have their maximum expression at Sierra del Cristal area and Moa's altitudes. The highest points of these territories are Pico Cristal Peak with 1 231 m asl and El Toldo Peak by 1 175 m asl at Moa's Mountain. Rocks are ophiolites and the developed soils are dark red ferritic.

Air average temperature on highest areas is between 20 to 22°C and in lowest 24 to 26°C, only in El Toldo Peak and Cristal Peak the variability is between 12 to 20°C [32]. Inside territories rain in Cristal Mountain range and Moa's mountain is for about 2 000 mm. Zonally evaporation between Moa's and Cristal Mountains on highest areas is for about 900 mm [33].

2.2. Sampling Methodology

Coordinates were taken in the studied area and a 5 Km radius delimited in which territory inventories were executed with the exposed characteristic.

For studied vegetal formation specific denomination criterion were followed [21, 22]. The vegetation inventories (stands, samples, relevés) were done by using the Braun Blanquet [34] method, following the experience of various authors [26, 31, 35].

These inventories have a minimal area of 625 m² [24] and the abundance-dominance in each species was estimated in each layer and for each species sociability was annotated and separated for a value point in the combined scale of abundance-dominance; the values have their means exposed in Mueller Dombois & Ellenberg [36].

For the vertical structure, the distributions of species in layers were considered by Samek [37]. Considered as sublayers when inside a layer exist a group of elements with good defined altitudes and are different in between. In layer and synusia description the following categories for present species were established in Reyes & Acosta Cantillo [38].



In addition oecotope observations were made in stants and its surrounds; in inventories place inclination of slope, exposition, altitude (masl), general relief and nano and micro relief were measured or estimated.

The ordination of vegetation inventories and separation of syntaxa was carrying out by phytocoenological methods [39, 36]. For the association characteristic combinations the used species are those with degree of presence IV and V [39] and for subassociations the differential combinations. The syntaxa denomination was carrying out according to Internacional Code of Phytosociological Nomenclature [40].

In the character species designation of the alliance recommendations of Braun Blanquet [34] were used as: absolutely restricted (fidel, true), strongly associated and favorably associated.

In the humus layers stratification was measuring (cm), the existence of roots and rootlets were registered and roots mat characteristics [41]. Completed scientific names (genus, species and author) could be observed in Tables and Acevedo-Rodriguez & Strong [42] sometime amended by other authors [43, 44, 45, 46]. Collected plants determinations were made by herbarium comparison of specimen existing in the Centro Oriental de Ecosistemas y Biodiversidad (Herbarium BSC).

Also intrinsic characteristics of communities were studied by using the not parametric indexes Chao2 and Jackknife 1 [47], and so on beta diversity using classic formulations of Jaccard ($c / a+b+c \times 100$) and Sorensen ($2c / A+B \times 100$) founded in Mueller Dombois & ElleMBERG [36].

3. RESULTS

Sintaxonomy

In this work one alliance and two associations were described, developing at the same time the following phytosociological arrangement:

— Class *Tabebuio dubiae* - *Calophylletea utilis* Reyes class. nov. In this contribution.

Holotypus: *Tabebuio dubiae* - *Calophylletalia utilis* ord. nov.

Two rainforests types were found, the low and submontane rainforests on ophiolites (sclerophyll rainforest) and submontane rainforest on bad drainage soils. Canopy layer have about 20 to 25 m tall and 80 to 100 % cover. Rainfall is between 1 500 to 3 500 mm, with a regular distribution. Rocks are ophiolites and soils are ferritic dark red and ferritic yellowish leach. They are present since Nipe's plateau (20°33'North, 75°47'West – west locality) until Miel's river basin (20°13'North, 74°31'West – east locality).

Composition & character species. Strongly associated: *Calophyllum utile*, *Tabebuia dubia*, *Sloanea curatellifolia*, *Alsophylla minor*, *Terminalia aroidoi* (T. nipensis), *Coccoloba wrightii*, *Cyrilla coriacea*, *Buxus rotundifolia*, *Pimenta odolens*, *Podocarpus ekmanii*, *Bonnetia cubensis*, *Ravenia ekmanii*, *Protium fragans*, *Byrsonima biflora* (B. cuneata), *Antirhea shaferi*, *Laplacea moensis*, *Lyonia lippoldii*, *Calycogonium grisebachii*, *Euphorbia munizii*, *Votomita monantha*, *Spathelia wrightii*, *Miconia jashaferi*, *Miconia moensis*, favorably associated: *Byrsonima spicata*, *Hieronima nipensis*, *Magnolia cubensis* ssp. *cubensis*, *Guapira rufescens*, *Guatteria blainii*, *Sideroxylon jubilla*, *Matayba domingensis*, *Coccoloba shaferi*, *Guettarda valenzuelana*.

— Order *Tabebuio dubiae*-*Calophylletalia utilis* Reyes ord. nov.

Holotypus: *Pimento odolentis*-*Calophyllion utilis* Reyes 2017.

With the characteristics of the class.

Sintaxonomy. When *Tabebuio dubiae* - *Calophylletea utilis* class nova is compared with *Ocoteo* - *Cyrilletea racemiflorae* Borhidi 1996 it has a 90,7 and 88,5 % respectively of difference between their characteristics combination's species. At the same time when confront the new order *Tabebuio dubiae* - *Calophylletalia utilis* with *Podocarpus ekmanii* - *Sloanetalia curatellifoliae* Borhidi and Muñiz 1996 they had a 75 and 67 %



respectively of dissimilarity. I transfer in this paper *Pimento odiolentis*-*Calophyllion utilis* Reyes 2017 from Borhidi's class and order to *Tabebuio dubiae* - *Calophylletea utilis* Reyes.

Studied alliance: *Terminalio aroidoi* - *Tabebuio dubiae* Reyes.

— Alliance *Terminalio aroidoi* - *Tabebuio dubiae* Reyes all. nov. In this contribution.

Holotypus: *Terminalio aroidoi*-*Tabebuio dubiae* Reyes & Acosta ass. nov.

Composition & character species. Strongly associated: *Terminalia aroidoi* (*Terminalia orientensis*), *Chaetocarpus globosus* subsp. *oblongatus*, *Coccoloba wrightii*, *C. diversifolia*, *Calycogonium grisebachii*, *Callicarpa oblanceolata*; favorably associated: *Tabebuia dubia*, *Macrocarpae pinetorum*, *Mazaea shaferi*, *Varronia nipensis* and *Cyrilla coriacea*.

Vegetal formation is submountain rainforest on ophiolites. The canopy layer has about 20 m high with 80 to 90 % cover. Rocks are ultramafics and soils are ferritic dark red, from shallow to moderately deep, good drainage and fresh. In the general sense the edafotopo is poor and acidic. Rainfalls vary in about 2 000 mm and temperature average is 21°C. This alliance is limited to Sierra del Cristal, it was study between 680 and 840 m above sea level.

When *Terminalio aroidoi* - *Tabebuio dubiae* is compared with *Pimento odiolentis* - *Calophyllion utilis* Reyes 2017 it has a 80 and 90 % of difference between their species, and with *Podocarpus ekmanii*-*Byrsonimion orientensis* Borhidi & Muñiz 1996 of 94 to 80 % of dissimilarity.

Found association: *Terminalio aroidoi* - *Tabebuio dubiae* Reyes & Acosta.

— *Terminalio aroidoi* - *Tabebuio dubiae* Reyes & Acosta ass. nov. In this contribution.

Holotypus: Table 1, rel. 8.

Vegetal formation is submountain rainforest on ophiolites. The canopy layer shows a discontinuity (continental), with trees height between seven and 20 m and a cover of 80 to 90 %. The constant and abundant species are *Tabebuia dubia* (Wr. ex Sauv.) Britt. ex Seibert., *Calophyllum utile* Bisse, *Cyrilla coriacea* Berazaín and *Podocarpus ekmanii* Urb.; also constant are *Sideroxylon jubilla* (Ekm. ex Urb.) Gaertn. and *Hieronyma nipensis* Urb. and as frequent *Pera* sp. (abundant sometimes), the rest of species are found in Table 1.

Shrub layer is relatively dense, with a variable cover between 50 and 90 %, constant and abundant species are *Miconia baracoensis* Urb. and *Cyathea parvula* (Jenm.) Domin; while *Coccoloba wrightii* Lindau is constant.

Herbaceous layer cover is between 40 and 95 %, but frequently between 50 and 90 %. Constant species are *Tabernaemontana amblyocarpa* Urb., *Callicarpa oblanceolata* Urb., *Cyathea parvula* (abundant), *Piper* sp., *Bactris cubensis* Burret and *Antirhea shaferi* Urb., etc (Table 1).

Between lianas constant are *Platygyne hexandra* (Jacq.) Muell. Arg. and *Mikania hioramii* Britton & B. L. Rob. and as frequent *Smilax havanensis* Jacq. and *Vanilla bicolor* Lindl.

As epiphytal synucia *Guzmania monostachia* (L.) Rusby ex Mez (abundant) and *Elaphoglossum chartaceum* (Bak. ex Jenm.) C. Christ. are constants *Marcgravia evenia* Krug & Urb. subsp. and *evenia* as frequent.

Species which contribute 75 % or more of fallen leaves are *Calophyllum utile*, *Tabebuia dubia*, *Matayba oppositifolia* (A. Rich.) Britton, *Cyrilla coriacea*, *Clusia tetragyna* Vesque and locally *Sideroxylon jubilla*, *Hieronyma nipensis*, *Guettarda monocarpa* Urb. and *Miconia baracoensis*. Commonly in this phytocoenosis is found a big quantity of fallen and rotten trees which generally are covered by lichens and moss.

It developed in Sierra del Cristal and was studied between June 18 to 23 2000 (20°32'North, 75°42'West and 20°32'North, 75°28'West), mainly in the south slope, between 680 and 840 m above sea level, the conservation is good. Rainfall level is about 2 000 mm and average of temperature is nearly 20°C. The



presence of fog and low cloud in this area is important for the preponderant economy of water in this ecosystem. Soils are red ferritic poor and acidic over ophiolite complex rocks, sometimes rocky outcrops are found in surface. The humus layers are well developed; L layer is uniform distributed in surface with a 5 to 10 cm variation. Layers F and H generally are mixed and constituted a root mat between 8 and 15 cm, more frequently between 10 and 15 cm.

Characteristic combination reach 36 species (see Table 1). Two subassociations are present:

- *Terminalio aroidoi* - *Tabebuietum dubiae tabernaemontanetosum ambliocarphae* Reyes subass. nov.
- *Terminalio aroidoi* - *Tabebuietum dubiae typicum* Reyes subass. nov.

Differences in between depend of soil deep.

The subassociation *tabernaemontanetosum ambliocarphae* (Typus: Table 1, rel. 4) developed over shallow soils and generally with rocky outcrops in surface (differential combination can be observed in Table 1).

While *typicum* subassociation (Typus: Table 1, rel. 8) present in moderately deep soils with no surface rocky outcrops, and is characterized mainly for absence of species that compound differential combination of the other subassociation, the only positive difference is *Magnolia* sp. and other species that conform differential combinations of the variants (Table 1).

Two variants are found *Eugenia floribunda* and *Dicranopteris flexuosa*. The first is observed in places where environmental moisture is big with a differential combination compound by *Eugenia floribunda* (Willd.) O. Berg, *Homolepis glutinosa* (Sw.) Zuloaga & Soderstr. and *Tolumnia* sp. Second is present in the greater height of the association and is defined by *Machaerina filifolia* Griseb., *Dicranopteris flexuosa* (Schrad.) Underw. and *Byrsonima* sp. and are absent *Jacaranda arborea* Urb., *Platygyne hexandra* e *Ilex nitida* (Vahl) Maxim. that are part of characteristic combination.

Table 1. *Terminalio aroidoi* - *Tabebuietum dubiae* in the ophiolitic rainforests of Sierra del Cristal. Pp- shallow, Mp- moderate deep, SW – southwest, NE – northeast, SE – southeast, S – south.

SUBASSOCIATIONS	TABERNAEMONTANETOSUM AMBLIOCARPAE					TYPICUM				PRESEN
VARIANTS						EUGENIA FLORIBUNDA				DICRANOPTERIS FLEXUOSA
N. ORDER.	1	2	3	4	5	6	7	8	9	10
ALTITUDE (MASL)	755	680	780	760	770	770	780	780	840	830
INCLINATION (DEGREES)	20	35	10	10	10	12	15	10	15	10
EXPOSITION	SW	NE	SE	SW	SE	NE	SE	SE	S	SE
SOILS	Pp	Pp	Pp	Pp	Pp	Mp	Mp	Mp	Mp	Mp
E ₃ - CANOPY LAYER (COVERS %)	80	80	80	80	90	90	80	80	80	80
E ₂ - SHRUB LAYER (%)	50	90	90	70	60	80	80	70	50	60
E ₁ - HERBACEOUS LAYER (%)	95	90	50	50	40	50	40	70	90	50
N. SPECIES	51	57	47	52	50	50	43	54	53	44
50.1										
CHARACTERISTICS										
E _{3,1} - <i>TABEBUIA DUBIA</i> (WR. EX SAUV.) BRITT. EX SEIBERT.	4.2	4.2	4.1	4.2	4.1	4.2	4.2	2.1	4.1	3.1
<i>CALOPHYLLUM UTILE</i> BISSE	2.1	2.1	4.2	3.1	4.1	4.2	3.1	4.2	1.1	2.1
<i>PODOCARPUS EKMANII</i> URB.	3.1	3.1	2.1	3.1	3.1	1.1	.	2.1	+1	2.1
<i>CYRILLA CORIACEA</i> BERAZAÍN	1.1	1.1	1.1	2.2	2.2	3.2	1.1	1.1	2.1	2.1
<i>MATAYBA OPPOSITIFOLIA</i> (A. RICH.) BRITT.	1.1	1.1	R.1	3.1	1.1	R.1	2.1	3.1	R.1	1.1
<i>HIERONYMA NIPENSIS</i> URB.	R.1	R.1	R.1	3.1	1.1	1.1	R.1	1.1	1.1	R.1
<i>SIDEROXYLON JUBILLA</i> (EKM. EX URB.) GAERTN.	2.1	.	R.1	1.1	1.1	1.1	R.1	1.1	1.1	1.1



E _{2,1} - <i>CYATHEA PARVULA</i> (JENM.) DOMIN	2.1	1.1	3.2	3.2	3.2	2.1	R.1	2.1	3.2	1.1	V(R-3)
<i>MICONIA BARACOENSIS</i> URB.	+1	R.1	1.1	2.1	1.1	2.1	2.1	2.1	1.1	1.1	V(R-2)
<i>CHAETOCARPUS GLOBOSUS</i> SUBSP. <i>OBLONGATUS</i> (ALAIN) BORHIDI	R.1	3.1	R.1	1.1	2.1	1.1	1.1	1.1	.	1.1	V(R-3)
<i>BACTRIS CUBENSIS</i> BURRET	+1	+1	1.2	R.1	1.2	R.1	+1	1.2	.	R.1	V(R-1)
E ₂ - <i>DITTA MYRICOIDES</i> GRISEB.	2.1	R.1	R.1	R.1	R.1	R.1	R.1	+1	R.1	1.1	V(R-2)
<i>CLUSIA TETRASTIGMA</i> VESQUE	1.1	1.1	1.1	1.1	.	1.1	2.2	R.1	2.1	3.2	V(R-3)
<i>COCCOLOBA WRIGHTII</i> LINDAU	R.1	.	R.1	1.1	R.1	1.1	1.1	1.1	R.1	R.1	V(R-1)
<i>GUAPIRA OBTUSATA</i> (JACQ.) BRITT.	R.1	1.1	R.1	R.1	1.1	1.1	.	1.1	1.1	1.1	V(R-1)
E ₁ - <i>CALLICARPA OBLANCEOLATA</i> URB. <i>PIPER</i> SP.	R.1	R.1	R.1	R.1	R.1	.	R.1	R.1	R.1	R.1	V(R)
EP- <i>GUZMANIA MONOSTACHIA</i> (L.) RUSBY EX MEZ	R.1	R.1	R.1	R.1	.	R.1	R.1	R.1	R.1	R.1	V(R)
E _{3,2} - <i>PERA</i> SP.	1.1	1.1	1.1	2.2	2.2	2.2	2.2	2.1	1.1	2.2	V(1-2)
E _{3,1} - <i>ZANTHOXYLUM CUBENSE</i> P. WILS.	.	.	R.1	1.1	1.1	1.1	1.1	2.1	2.1	2.1	IV(R-2)
<i>TERMINALIA AROLDI</i> BISSE (<i>TERMINALIA ORIENTENSIS</i> MONACH.)	1.1	.	1.1	1.1	.	R.1	R.1	R.1	R.1	1.1	IV(R-1)
<i>CHIONANTHUS DOMINGENSIS</i> LAM.	R.1	2.1	.	R.1	1.1	.	1.1	1.1	R.1	R.1	IV(R-2)
<i>JACARANDA ARBOREA</i> URB.	.	2.1	+1	R.1	1.1	.	R.1	1.1	1.1	1.1	IV(R-2)
<i>GUATTERIA BLAINII</i> (GRISEB.) URB.	1.1	.	R.1	1.1	+1	R.1	R.1	R.1	.	.	IV(R-1)
E _{2,1} - <i>MAZAEA SHAFERI</i> (STANDL.) DELPRETE	1.1	R.1	1.1	1.1	.	1.1	.	1.1	R.1	.	IV(R-1)
<i>CALYCOGONIUM GRISEBACHII</i> TRIANA	1.1	.	1.1	1.1	1.1	2.1	1.1	2.1	.	1.1	IV(1-2)
<i>GUETTARDA MONOCARPA</i> GRISEB.	R.1	.	.	R.1	R.1	R.1	1.1	1.1	1.1	2.1	IV(R-2)
<i>LAPLACEA</i> SP.	2.1	R.1	1.1	1.1	R.1	.	2.1	.	.	1.1	IV(R-2)
<i>ILEX NITIDA</i> (VAHL) MAXIM.	R.1	.	R.1	R.1	R.1	R.1	.	1.1	.	1.1	IV(R-1)
<i>COCCOLOBA DIVERSIFOLIA</i> JACQ.	R.1	1.1	R.1	R.1	1.1	.	1.1	R.1	.	.	IV(R-1)
E ₁ - <i>ANTHIREA SHAFERI</i> URB. <i>ILEX</i> SP.	.	R.1	R.1	.	+1	R.1	.	R.1	1.1	1.1	IV(R-1)
L- <i>MARCGRAVIA EVENIA</i> KRUG & URB. SUBSP. <i>EVENIA</i>	R.1	.	R.1	.	1.1	1.1	+1	2.1	+1	2.1	IV(R-2)
<i>SMILAX HAVANENSIS</i> JACQ.	R.1	.	.	1.1	1.1	.	R.1	R.1	R.1	R.1	IV(R-1)
<i>VANILLA BICOLOR</i> LINDL.	+1	+1	.	R.1	.	+1	+1	R.1	R.1	.	IV(R+)
<i>PLATYGYNIA HEXANDRA</i> (JACQ.) MUELL. ARG.	R.1	+1	R.1	R.1	R.1	R.1	R.1	R.1	.	.	IV(R+)
EP- <i>ELAPHOGLOSSUM CHARTACEUM</i> (BAK. EX JENM.) C. CHRIST.	.	.	R.1	R.2	R.1	R.2	R.2	1.2	R.1	1.2	IV(R-1)
<hr/>											
DIFFERENTIALS	TABERNAEMONTANETOSUM					TYPICUM					
<hr/>											
AMBLOICARPAE											
<hr/>											
E ₂ - <i>TABERNAEMONTANA AMBLOICARPA</i> URB.	1.1	R.1	R.1	R.1	R.1	.	.	.	.	.	III(R-1)
E ₁ - <i>NEOBRAZEA VALENZUELANA</i> (A. RICH.) URB.	1.1	.	1.1	R.1	1.1	R.1	.	.	.	.	III(R-1)
<i>ARTHROSTYLIDIUM</i> SP.	4.3	4.3	2.2	1.2	+2	.	.	.	.	.	III(+4)
<i>COCCOCYPSELUM HERBACEUM</i> AUBL.	R.1	R.1	+1	R.1	R.1	.	.	.	.	.	III(R+)
E ₃ - <i>MAGNOLIA</i> SP.	.	.	.	.	.	1.1	1.1	R.1	R.1	R.1	III(R-1)
E _{2,1} - <i>EUGENIA FLORIBUNDA</i> WEST.	.	.	.	.	.	2.1	R.1	R.1	.	.	II(R-2)
E ₁ - <i>HOMOLEPIS GLUTINOSA</i> (SW.) ZULOAGA & SODERSTR.	.	.	.	.	.	R.2	R.2	R.2	.	.	II(R)
<i>TOLUMNIA</i> SP.	.	.	.	.	+1	+1	R.1	R.1	.	.	II(R+)
E ₂ - <i>BYRSONIMA CRASSIFOLIA</i> (L.) KUNTH	.	R.1	.	.	.	.	.	.	R.1	1.1	II(R-1)
E ₁ - <i>MACHAERINA FILIFOLIA</i> GRISEB.	.	.	.	.	1.2	.	.	.	2.2	2.2	II(1-2)
<i>DICRANOPTERIS FLEXUOSA</i> (SHROD.)	.	.	.	.	.	.	.	.	R.2	R.2	I(R)



UNDERW.											
ACCOMPANERS											
E ₁ - <i>PALICOUREA ALPINA</i> (SW.) DC.	.	.	.	R.1	2.1	2.1	2.1	3.2	.	3.2	III(R-3)
<i>VARRONIA NIPENSIS</i> (URB.) BORH.	R.1	.	.	R.1	.	.	R.1	R.1	R.1	.	III(R)
<i>MIKANIA HIORAMII</i> BRITTON & B. L.	R.1	R.1	.	.	.	R.1	R.1	R.1	R.1	.	III(R)
ROB.											
<i>HEDYOSMUM NUTANS</i> SW.	.	R.1	+1	.	.	2.2	R.1	1.1	3.2	.	III(R-3)
<i>SCLERIA SECANS</i> (L.) URB.	.	.	+2	+2	+2	.	.	+2	R.2	.	III(R-+)
EP- <i>EPIDENDRUM NOCTURNUM</i> JACQ.	R.1	.	R.1	R.1	.	.	.	.	R.1	R.1	III(R)
E ₃ - <i>PINUS CUBENSIS</i> GRISEB.	.	R.1	.	R.1	R.1	.	.	R.1	.	.	II(R)
<i>LYONIA</i> SP.	.	R.1	.	.	.	.	R.1	.	R.1	R.1	II(R)
E _{2,1} - <i>MYRSINE CORIACEA</i> (SW.) R. BR.	R.1	+1	.	.	.	.	.	.	R.1	R.1	II(R-+)
EX ROEM											
<i>ERITHALIS</i> SP.	R.1	R.1	.	.	.	.	.	.	R.1	R.1	II(R)
E ₁ - <i>MICONIA DODECANDRA</i> (DESV.)	.	.	R.1	2.1	.	R.1	.	R.1	.	.	II(R-2)
COGN.											
<i>ILEX MACFADYENII</i> (WALP.) REHDER	.	+1	1.1	.	.	.	.	R.1	R.1	.	II(R-1)
SUBSP. <i>MACFADYENII</i>											
<i>CASEARIA CRASSINERVIS</i> URB.	.	.	+1	R.1	.	.	.	R.1	1.1	.	II(R-1)
L- <i>LYGODIUM VOLUBILE</i> SW.	.	R.1	.	.	.	.	R.1	R.1	R.1	.	II(R)
EP- <i>DILOMILIS OLIGOPHYLLA</i> (SCHLTR.)	R.1	.	R.1	R.1	.	.	.	R.1	.	.	II(R)
SUMMERHAYES											
<i>DICHAEA HYSTRICINA</i> RCHB. F.	R.1	.	.	.	.	R.1	.	.	R.1	R.1	II(R)
E ₁ - <i>ICHNANTHUS MAYARENSIS</i> (WR.)	.	.	+2	+2	+2	.	.	.	.	.	II(+)
HITCHC.											
<i>LEPIDAPLOA WRIGHTII</i> (SCH. BIP.) H.	.	.	.	.	+1	.	.	R.1	R.1	.	II(R-+)
ROB.											
<i>MACROCARPAE PINETORUM</i> ALAIN	.	R.1	R.1	.	.	.	.	+1	.	.	II(R-+)
<i>SCLERIA</i> SP.	.	.	.	.	+2	R.2	.	+2	.	.	II(R-+)
L- <i>CHIOCOCCA ALBA</i> (L.) HITCHC.	R.1	R.1	.	.	R.1	.	.	.	.	.	II(R)
<i>IPOMOEA CAROLINA</i> L.	.	R.1	R.1	.	R.1	.	.	.	.	.	II(R)
E _{3,2} - <i>CLUSIA ROSEA</i> JACQ.	R.1	.	.	.	.	R.1	.	.	.	.	I(R)
E _{3,1} - <i>SLOANEA CURATELLIFOLIA</i>	.	R.1	.	.	R.1	.	.	.	.	.	I(R)
GRISEB.											
<i>SCHEFFLERA MOROTOTONI</i> (AUBL.)	.	R.1	.	.	.	R.1	.	.	.	.	I(R)
MAGUIRE											
E _{2,1} - <i>COCCOLOBA NIPENSIS</i> URB.	.	.	.	.	R.1	.	.	.	.	R.1	I(R)
E ₁ - <i>CUPANIA AMERICANA</i> L.	.	.	R.1	.	.	R.1	.	.	.	.	I(R)
<i>PIMENTA ODIOLENS</i> (URB.) BURRET	.	.	.	.	R.1	.	.	.	R.1	.	I(R)
<i>KOANOPHYLLON RHExIOIDES</i> (B.L.	.	.	.	R.1	.	.	.	R.1	.	.	I(R)
ROBINS.) KING & ROBINS.											
<i>CLERODENDRUM</i> SP.	.	.	.	.	R.1	.	.	.	.	R.1	I(R)
L- <i>PASSIFLORA SEXFLORA</i> A. JUSS.	.	R.1	.	R.1	.	.	.	.	.	.	I(R)
EP- <i>TRICHOMANES SCANDENS</i> L.	.	.	.	.	R.2	R.2	.	.	.	.	I(R)
<i>JACQUINIOLA GLOBOSA</i> (JACQ.)	.	.	.	.	.	R.1	.	.	R.1	.	I(R)
SCHLTR.											

In addition. Inv. 1. *Tabebuia* sp. r.1, *Pteridium caudatum* (L.) Maxon r.2, *Tillandsia* sp. +1, *T. bulbosa* Hook. r.1, *Erythroxylon* sp. r.1; Inv. 2. *Ocotea leucoxydon* (Sw.) Mez r.1, *Ficus membranacea* C. Wr. r.1, *Pimenta racemosa* (Mill.) J.W. Moore r.1, *Buchenavia tetraphylla* (Aubl.) R.A. Howard 1.1, *Gesneria* sp. r.1, *Phaius tankervilleae* (Banks) Blume r.1, *Spathelia* sp. r.1, *Blechnum occidentale* L. +2, *Passiflora penduliflora* Bert. r.1, *Echites umbellata* Jacq. r.1, *Peperomia maculosa* (L.) Hook. +1, *Philodendron lacerum* (Jacq.) Schott r.1, *Nephrolepis rivularis* (Vahl) Mett. ex Krub +2; Inv. 3. *Tillandsia fasciculata* Sw. r.1; Inv. 4. *Coccothrinax*



orientalis (León) O. Muñiz & Borhidi r.1, *Vernonia* sp. r.1, *Oeceoclades maculata* (Ldl.) Ldl. r.2, *Tillandsia pruinosa* Sw. r.1; Inv. 6. *Casearia sylvestris* Sw. var. *syvestris* r.1, *Elaphoglossum herminieri* (Bory & Fee) T. Moore r.2, *Hymenophyllum polyanthos* (Sw.) Sw. r.2, Inv. 7. *Lyonia macrophylla* (Britt.) Ekm. ex Urb. r.1; Inv. 9. *Smilax lanceolata* L. r.1, *Koanophyllon polystictum* (Urb.) King & Robins. r.1, *Macrocarpae pinetorum* Alain r.1, *Sticherus remotus* (Kaulf.) Spreng. 2.2, *Galactia* sp. r.1; Inv. 10. *Erythroxylum* sp. r.1, *Adiantopsis pauperula* (Kuntze) Fée r.2.

— Pimento odiolentis - *Calophyllum utilis* Reyes 2017

Found association: *Buxo rotundifoliae-Calophylletum utilis* ass. nov.

— *Buxo rotundifoliae-Calophylletum utilis* Reyes & Acosta ass. nov. In this contribution.

Holotypus: Table 2, rel. 2.

This submountain rainforest on ophiolites was intensely exploted, although it's locally structure and floristic composition is conserved, choosing for the relevés the more conserved areas. The arboreal layer is between 10 and 20 m high, occasionally are observed predominants even 25 m and cover between 70 and 90 %. In this layer constant and abundant species are *Calophyllum utile*, *Jacaranda arborea*, *Bactris cubensis*, *Tabebuia dubia*, *Hieronyma nipensis* and *Antirhea shaferi*, abundant in occasions *Sideroxylon jubilla* and *Matayba oppositifolia* (Table 2).

Shrub layer is relatively dense with a cover between 40 and 80 %. Abundant species are *Cyathea parvula*, *Spathelia vernicosa* Planch., *Palicourea crocea* (Sw.) Roem. & Schult., *Buxus rotundifolia* (Britton) Mathou and *Antirhea shaferi*.

Herbaceous layer is generally very dense, with a cover of 80 to 90 %. The abundant species are *Cyathea parvula*, *Buxus rotundifolia*, *Arthrostylidium urbanii* Pilg. and *Miconia moensis* (Britton) Alain. Frequently a moss layer is observed with *Leucobrium giganteum* Mull. reaching occasionally a high cover.

In liana synucia more abundant is *Platygyyna hexandra*, that make difficult the field work in this formation, also are frequent although diffuse *Vanilla bicolor*, *Dioscorea nipensis* R.A. Howard, *Mikania hioramii* and *Smilax havanensis* Jacq. The epiphytic synucia found diffuse and in small quantity, more observed is *Guzmania monostachia*.

Two variants are found *Byrsonima biflora* and *Gesneria nipensis*. Both present a clear differential combination observed in Table 2.

In a great part of the area slope is moderate, between five and ten degrees and predominant exposition is north. Soil is ferritic dark red, generally deep. A root mat is observed between 4 and 12.5 cm. It was studied March 15 to 20 2010 in the basin of Revuelta de los Chinos creek (20°36'North, 74°56'West), south of Moa city and north-northwest of El Toldo, the highest point of Moa's altitudes.

Table 2. *Buxo rotundifoliae - Calophylletum utilis* in the ophiolitic rainforests of Alturas de Moa. N – north, E – east.

VARIANTS	BYRSONIMA BIFLORA		GESNERIA NIPENSIS	PRESEN
N. ORDER	1	2	3	4
ALTITUDE (MASL)	420	350	340	342
INCLINATION (DEGREES)	15	5	10	10
EXPOSITION	NNW	NW	N	E
E ₃ - CANOPY LAYER (COVERS %)	70	90	70	70
E ₂ - SHRUB LAYER (%)	80	50	40	50
E ₁ - HERBACEOUS LAYER (%)	90	80	80	90
N. SPECIES	64	55	51	53
CHARACTERISTICS				
55.7				

E _{3,2,1} - <i>CALOPHYLLUM UTILE</i> BISSE	2.1	2.1	3.1	3.1	4 (2-3)
<i>ANTIRHEA SHAFERI</i> URB.	1.1	1.1	1.1	2.1	4 (1-2)
<i>ZANTHOXYLUM CUBENSE</i> P. WILS.	R.1	1.1	R.1	R.1	4 (R-1)
<i>CLUSIA TETRASTIGMA</i> VESQUE	R.1	1.1	R.1	R.1	4 (R-1)
<i>MATAYBA OPPOSITIFOLIA</i> (A. RICH.) BRITT.	+1	R.1	3.1	2.1	4 (R-3)
<i>BACTRIS CUBENSIS</i> BURRET	+1	1.1	2.1	1.1	4 (+-2)
<i>CYATHEA PARVULA</i> (JENM.) DOMIN	3.2	3.1	4.3	3.2	4 (3-4)
E _{3,2} - <i>SIDEROXYLON JUBILLA</i> (EKM. EX URB.) GAERTN.	+1	2.1	+1	2.1	4 (+-2)
E _{3,1} - <i>JACARANDA ARBOREA</i> URB.	2.1	3.2	1.1	2.1	4 (1-3)
<i>DITTA MYRICOIDES</i> GRISEB.	1.1	+1	+1	1.1	4 (+-1)
E _{2,1} - <i>BUXUS ROTUNDIFOLIA</i> (BRITT.) MATHOU	2.1	2.1	1.1	3.2	4 (1-3)
<i>SPATHLIA PINETORUM</i> M. VICT.	1.1	1.1	2.1	1.1	4 (1-2)
<i>MICONIA MOENSIS</i> (BRITT.) ALAIN	2.1	1.1	R.1	R.1	4 (R-2)
<i>MYRSINE CORIACEA</i> (SW.) R. BR. EX ROEM	+1	R.1	R.1	+1	4 (R-+)
<i>PALICOUREA CROCEA</i> (SW.) ROEM. & SCHULT.	3.1	2.1	3.2	1.1	4 (1-3)
E ₁ - <i>PIPER ARBOREUM</i> AUBL.	R.1	1.1	+1	R.1	4 (R-1)
<i>CLIDEMIA UMBELLATA</i> (MILL.) L.O. WILLIAMS	R.1	+1	R.1	+1	4 (R-+)
E ₀ - <i>LEUCOBRIUM GIGANTEUM</i> MULL. HAL.	3.2	+2	+2	1.2	4 (+-3)
L- <i>MARCGRAVIA EVENIA</i> KRUG. & URB. SUBSP. <i>EVENIA</i>	R.1	+1	+1	1.1	4 (R-1)
<i>ARTHROSTYLIDIUM URBANII</i> PILG.	3.3	3.3	2.2	3.3	4 (2-3)
<i>PLATYGYNIA HEXANDRA</i> JACQ.	2.1	2.1	1.1	1.1	4 (1-2)
E _{3,2,1} - <i>TABEBUIA DUBIA</i> (WR. EX SAUV.) BRITT. EX SEIBERT.	1.1	3.2	1.1	.	3 (1-3)
<i>HIERONYMA NIPENSIS</i> URB.	1.1	.	1.1	1.1	3 (1)
<i>ILEX REPANDA</i> LOES	1.1	+1	.	+1	3 (+-1)
E ₃ - <i>GUAPIRA OBTUSATA</i> (JACQ.) BRITT.	+1	.	2.1	+1	3 (+-2)
<i>BYRSONIMA MOENSIS</i> ACUÑA & ROIG	.	R.1	1.1	+1	3 (R-1)
<i>PLUMERIA OBTUSA</i> L. SUBSP. <i>OBTUSA</i> .	+1	R.1	.	R.1	3 (R-+)
E _{3,2} - <i>OURATEA STRIATA</i> (V. TIEGH) URB.	1.1	+1	.	R.1	3 (R-1)
E _{3,1} - <i>PODOCARPUS EKMANII</i> URB.	1.1	+1	1.1	.	3 (+-1)
E _{2,1} - <i>SCOLOSANTHUS LUCIDUS</i> .BRITT.	+1	1.1	.	R.1	3 (R-1)
<i>TAPURA CUBENSIS</i> (POEPP. & ENDL.) GRISEB.	+1	+1	R.1	.	3 (R-+)
<i>CHIONANTHUS DOMINGENSIS</i> LAM.	R.1	R.1	+1	.	3 (R-+)
<i>CORDIA</i> SP.	R.1	R.1	R.1	.	3 (R)
L- <i>VANILLA WRIGHTII</i> RCHB.	R.1	+1	R.1	.	3 (R-+)
<i>DIOSCOREA GRISEBACHII</i> PLANCH.	R.1	+1	.	+1	3 (R-+)
<i>MIKANIA HIORAMII</i> BRITTON & B. L. ROB.	R.1	+1	+1	.	3 (R-+)
<i>SMILAX HAVANENSIS</i> JACQ.	R.1	+1	R.1	.	3 (R-+)
EP- <i>GUZMANIA MONOSTACHIA</i> (L.) RUSBY EX MEZ	R.1	+1	.	R.1	3 (R-+)
DIFFERENTIALS	BYRSONIMA BIFLORA		GESNERIA NIPENSIS		
E _{3,1} - <i>BYRSONIMA BIFLORA</i> GRISEB. (<i>BYRSONIMA CUNEATA</i> (TURCZ.) P.	2.1	1.1	.	.	2 (1-2)

WILSON)					
E ₃ - GUATTERIA CUBENSIS BISSE	+1	1.1	.	.	2 (+-1)
CYRILLA CORIAEA BERAZAÍN	+1	(R.1)	.	.	2 (R-+)
E _{2,1} - COCCOLOBA SHAFERI BRITT.	R.1	R.1	.	.	2 (R)
CHAETOCARPUS ACUTIFOLIUS (BRITTON & P. WILSON) BORHIDI	R.1	R.1	.	.	2 (R)
E ₁ - VERNONANTHURA HIERACIOIDES (GRISEB.) H. ROB.	R.1	R.1	.	.	2 (R)
ILEX MACFADYENII (WALP.) REHDER SUBSP. MACFADYENII	R.1	R.1	.	.	2 (R)
OVIDEA CUBENSIS SCHAUER) I.E. MENDEZ (CLERODENDRON LINDENIANUM A. RICH.)	R.1	+1	.	.	2 (R-+)
E _{3,2,1} - GESNERIA NIPENSIS BRITT. & P. WILS.	.	.	2.1	R.1	2 (R-2)
E _{3,1} - SLOANEA CURATELLIFOLIA GRISEB.	.	.	1.1	1.1	2 (1)
SCHEFFLERA MOROTOTONI (AUBL.) MAGUIRE	.	.	+1	R.1	2 (R-+)
OCOTEA LEUCOXYLON (SW.) MEZ	.	.	R.1	1.1	2 (R-1)
GUATTERIA BLAINII (GRISEB.) URB.	.	.	1.1	R.1	2 (R-1)
E _{2,1} - CASEARIA SYLVESTRIS SW.	.	.	1.1	R.1	2 (R-1)
HYPERBAENA CUBENSIS URB.	.	.	R.1	R.1	2(R)
L- SCHRADERA CEPHALOPHORA GRISEB.	.	.	+1	+1	2 (+)
ACCOMPANIER					
E _{3,2,1} - GUAPIRA RUFESCENS (GRISEB.) LUND.	.	3.1	.	1.1	2 (1-3)
NEOBRACEA VALENZUELANA (A. RICH.) URB.	.	+1	.	R.1	2 (R-+)
E _{3,1} - CLUSIA ROSEA JACQ.	.	R.1	1.1	.	2 (R-1)
TABERNAEMONTANA AMBLIOCARPA URB.	R.1	.	.	+1	2 (R-+)
E _{2,1} - ERYTHROXYLON LONGIPES O.E. SCHULZ.	2.1	.	.	R.1	2 (R-2)
E ₁ - SOLANUM GUNDLACHII URB.	+1	.	.	R.1	2 (R-+)
PURDIAEA VELUTINA BRITT. & WILS.	R.1	.	1.1	.	2 (R-1)
ALVARADOA ARBORESCENS GRISEB.	.	R.1	R.1	.	2 (R)
COCCOCYPSELUM HERBACEUM AUBL.	.	R.1	R.1	.	2 (R)
MECRANIUM AMYGDALINUM (DESR.) C. WRIGHT	.	+1	R.1	.	2 (R-+)
L- CISSUS GRISEBACHII PLANCH.	R.1	.	.	R.1	2 (R)

In addition. Inv. 1. *Jacaranda coerulea* Griseb. +1, *Lyonia* sp. +1, *Illicium cubense* A.C. Smith +1, *Magnolia* sp. r.1, *Pera bumeliifolia* Griseb. 1.1, *Chaetocarpus globosus* subsp. *oblongatus* (Alain) Borhidi r.1, *Rubiaceae* +1, *Ossaia* sp. 1.1, *Eugenia* sp. r.1, *Vernonia* sp. +1, *Casearia* sp. r.1, *Hedyosmum nutans* Sw. +1, *Tillandsia fasciculata* Sw. r.1, *Aechmea nudicaulis* (L.) Griseb. r.1; Inv. 2. *Guettarda monocarpa* Urb. r.1, *Laplacea* sp. +1, *Maytenus* sp. r.1, *Galactia* sp. r.1, *Phylodendron lacerum* (Jacq.) Schott r.1; Inv. 3. *Calyptronoma occidentalis* (Sw.) H.E. Moore +1, *Miconia dodecandra* (Desv.) Cogn. 1.1, *Micropolis polita* Pierre subsp. *polita* r.1, *Linodendron aroniifolium* Griseb. +1, *Guettarda valenzuelana* A. Rich. r.1, *Oplismenus* sp. r.1; Inv. 4. *Ocotea cuneata* (Griseb.) Urb. 1.1, *Coccoloba* sp. r.1, *Psychotria* sp. r.1, *Miconia jashaferi* Majure & Judd +1, *Meriania albiflora* Carmenate & Michelangeli r.1, *Ocotea spathulata* Mez r.1,



Philodendron consanguineum Schott r.1, *Triopteris jamaicensis* L. var. *ovata* r.1, *Lygodium cubensis* Humb., Bonb. & Kanth +.1.

Beta diversity (β)

In the floristic comparison between *Terminalio aroidoi* - *Tabebuietum dubiae* (Sierra del Cristal) and *Buxo rotundifoliae*-*Calophylletum utilis* (Moa's altitude); values contrast (0.44 dissimilarity), at the same time both reach a high common species porcentaje (c) (Table 3).

When exposed community are studied, in the non parametric indexes Chao2 and Jackknife 1 small differences are observed, in Sierra del Cristal, with 96 species, found values are 122 and 118.5 and in north of Moa's altitude, with 70, 78.2 and 85.7 respectively.

Table 3. Comparison of Beta diversity (β) between syntaxa of Sierra del Cristal and north part of Moa's altitude.

COMPARATION	A	B	C	CIN%	SORENSEN INDEX	JACCARD INDEX	DISSIMILARITY	NR. SP.
SIERRA DEL CRISTAL MOA'S ALTITUDE	47	58	38	26.6	0.72	0.56	0.44	143

4. DISCUSSION

Low and submontane rainforest on ophiolites have their maximum expression at Sierra de Cristal area and Moa's altitudes. This forest have some characteristics about conservation and nutrients recycling [10] and some kind are similar to amazonic vegetation [1, 3] although they are floral different.

When compare the average number of species between the two studied associations in this paper and *Pimento odiolentis*-*Calophylletum utilis* [31], is observed that *Terminalio aroidoi* - *Tabebuietum dubiae* of Sierra del Cristal has the less average number of species with 50,1, while the biggest is present in the before mentioned [31] with 68,0, showing that in this kind of rainforest in Alturas de Moa and Cuchillas del Toa are floral more rich than Sierra del Cristal. Likewise behavior species number of the characteristic combination and the number of wooded species.

Borhidi [20] had recognized the phytogeographic flora of Sierras de Moa and Toa district (Moaense) as one of the ancient of Cuban archipelago. At the same time López *et al.* [48] confirmed that in this territory the major number of endemic taxa has been originated. Equally Reyes & Acosta [26]) confirm that Nipe's and Moa-Baracoa-Asunción-Sierra del Purial remain to biodiversity disposition at least since half of Superior Cretaceous period and that Sierra del Cristal had occupy its actual position Maastrichtian or in the early Paleocene, which could have influences about the floral poverty of their phytocoenoses.

Borhidi [49] explains that due of the toxic elements of serpentinites its flora is very specific and for that is considered that these rainforest are very ancient and keep remain cenologically separated of other kind of surrounded vegetation.

The great floral similarity and comparts percentage of species between Sierra del Cristal and the north Moa's (Table 3) indicate that they have a superior diáspora interchange; this is facilitated because of vegetation in intermediate zone between both areas is of broadleaf, closer to the rainforest.



5. CONCLUSION

An alliance and two associations are exposed in a new and not studied areas since the phytocenotic point of view this description, with the structural and ecological conditions exposed can be used in the typology and sustainable use of this vegetal formation.

The strongest relationships between both areas suggest conditions that made easy species dispersion although with enough differences even at alliances levels.

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