

# PHYTOGEOGRAPHY AND BIODYNAMIC ASSESSEMENT OF SPECIES OF CUCURBITS IN THE NIGER DELTA AREA OF NIGERIA

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## ABSTRACT

A systematic study involving inventorization and phytogeographical biodynamic study was carried out on the species of cucurbits (*Cucurbitaceae*) found in the Niger Delta Area of Nigeria. This research was aimed at carrying out a survey toward: establishing the phytogeographical distribution and biodynamic of these species in the Niger Delta areas; assess their diversity (i.e. varieties, cultivars) within the species occurring in the area and establish the wild and cultivated species in the area. The study recorded fifteen species of cucurbits belonging to eleven genera, with five genera occurring only in the wild. A number of the species were found to have established cultivars. *Lagenaria siceraria* for instance has four different cultivars. Virtually field observation has shown that every farming family (e.g. in Rivers State) has at least one Cucurbit species in its garden. Observation on cultivars in many gardens shows that they are susceptible to infection but tolerant to drought and water logging. The species enumerated were found to display restricted occurrence in certain ecological habitats or zones but were all found to be mesophytes that have successfully adapted to the area with marked preference for tropical climates. Report from the field study has also shown that Bayelsa State is devoid of many species particularly those in cultivation.

**KEY WORDS:** Phytogeography, Niger Delta, Cucurbitaceae agroecological zones, mesophytes.

## INTRODUCTION

Phytogeography entails the biodynamic distribution of plant species over the earth surface with reverence to agro-climatic and environmental cues that govern such macrophytic distribution. Phytogeographical line of evidence in taxonomy tends to reflect dynamic trend of variation in species richness. Such trend of distribution do imply biological barrier that create biotic difference on the natural biota, with variation in the morpho-anatomical structures. Variation in species richness with elevation has been known for over a century (Pianka, 1966; Lomolino, 2001). Report from world exploration in the 18<sup>th</sup> and 19<sup>th</sup> centuries have shown slight differences in some species within a genus in their habitat, from region to region. One species might be in mountains, one in low land, others along the coast, thus were considered as variant of single species due to geographical distribution (Elliot-Weiser *et al.*, 1974). Several studies have found a decreasing trend in species richness with increasing elevation (Hamilton, 1975; Gentry, 1988; Stevens 1992), where as others found a hump shaped relationship between species richness and elevation (Rahbek 1995; Lieberman *et al.*, 1996; Odland and Birks, 1999; Grytness and Vetaas, 2002).

The concept of phytogeography (among other systematic lines of evidence) in taxonomy could be utilized in unveiling species frequency distribution among other plant species in Nigeria, the biodynamic trend in terms of distribution and habitation of some species of cucurbit within the Niger Delta region of Nigeria. The cucurbits belong to a moderately large family of about 100 to 130 genera and over 750 to 900 species worldwide (Jeffrey 1964, 1980 and Yamaguchi, 1983). The family is represented in Nigeria by 21 genera and 41 species (Hutchinson and Daiziel 1954; Okoli, 1984; Ibiok, *et al.*, Ndukwu 2000). These include cultivated and wild species. Among the cultivated genera in the Niger Delta are *Citrullus*, *Telfaira*, *Cucurbita*, *Cucumeropsis*, *Lagenaria*, *Cucumis* and *Trichosanthes*. While *Telfaira occidentalis* is cultivated for its leaves and seeds, *Cucurbita moschata*, and *Cucurbita maxima* for their leaves and fruits, others are cultivated for their fruits and/or seeds. Among the wild genera in the area are *Luffa*, *Lagenaria*, *Coccinia*, *Momordica* and *Zehneria*. Cucurbitaceae is an interesting and in some ways unusual family distributed all over the warm parts of the world (Cobley and Steele, 1976). Most species of cucurbits are vines, prostrate annual or occasional perennial, rapid growing hers. Flowers vary from

barely noticeable into large and conspicuous as in *Lagenaria guineensis*, and *Luffa aegyptiaca*. Fruit range from small and dry to large and tasty. However all the cucurbits species share certain common characteristics and are generally easily recognized by observing several conspicuous features among which are: annual vines, with leave usually five lobed and palmately veined, divided leaves having long petioles and leaves alternatively arrange on the stem. Stem tendrils spring-like in structure are common. Male (Staminate) and female (Pistillate) flowers (unisexual flowers) are separate on the same or different plant (monocious). Flowers possess five sepals, five fused whitish or yellow petals and five stamens (male) variously joined together and an inferior ovary, usually of fused carpels. Fruits large and fleshy, usually with a hard outer covering (a special type of leathering termed a pepo). Seeds are attached to the ovary wall (parietal placentation) and not to the center. Many large, fairly flat seeds in which the embryo has two very large cotyledons are found. Archaeological evidence has indicated that Cucurbits were present in ancient and prehistoric cultures. While *Lagenaria* was associated with man as early as 1200 BC in Peru, similar archaeological expedition in the Oaxaca region of Mexico have reported *Cucurbita pepo* to be associated with man as early as 8500 BC and cultivated by 4050 BC (Esquinas-Alcazar and Gulick 1983). Although most cucurbits are known for their old world origins (Whitaker and Davis, 1962), many species of this family originated in the new world and at least seven genera have origins on both hemispheres (Esquinas-Alcazar and Gulick, 1983).

It has been envisioned that elevation gradient can contribute important insights into developing a general theory of species diversity (Korner, 1999). There is tremendous genetic diversity within the cucurbitaceae family with its adaptation ranging from tropical and subtropical regions, deserts and temperate location to few species adaptable to production at elevation as high as 200m (Timothy, 1993). The elevation gradient through species richness is intricately related to species-latitude and species area relationships (Lomolino, 2001). The elevation gradient in the species richness pattern is commonly explained by similar factors (i.e. climatic factor, productivity and other energy-related factors) to the latitudinal gradient (Richardson and Lum, 1960; Currie, 1991; Rohde, 1992; Wright *et al.*, 1993; Grytness *et al.*, 1999).

Taxonomic studies including aspect of morphological, anatomical and cytological features of some species of cucurbits have earlier been reported (Dalziel, 1973; Jeffrey, 1964; Hutchinson and Dalziel 1958; Pursglove, 1968; Okoli, 1984; Burkill 1985; Ibiok *et al* 1991; Agbagwa, 1997; Ndukwu 1998; 2000). In spite of the sizeable volume of information on the cucurbitaceae, data on phytogeographical distribution especially in the Niger Delta area are either not available or scanty. In the light of this inadequacy, this research is aimed at carrying out a survey toward: establishing the phytogeographical distribution and biodynamics of this species in the Niger Delta area; assess their diversity (i.e. varieties, cultivars) within the species occurring in the area and establish the wild and cultivated species in the area.

## MATERIALS AND METHODS

### Location of the Study Area:

Geographically the Niger Delta is the Southern segment of Nigeria, created by myriads of islands segmented by lagoons and channels which empty into the Bight of Benin in the East Atlantic Ocean. The delta is supplied with water by the Rivers Niger and Benue. These Rivers (now joined) break up at Abor into the Rivers Nun and Forcados (including their tributaries). The Niger Delta proper is thus that portion of the land mass (including water) traversed by the Rivers Nun and Forcados (including their tributaries). The portion of the Niger Delta traversed by the River Nun is the present Bayelsa State, while the present Delta State is traversed by the River Forcados. The Nun River breaks out into many channels and creeks such as *Santa Barbara St. Nicholas, Brass, Nun Sangana, Fishtown, Koluama, Middleton, Digatoru, Pennington, Dodo and Ramos Rivers*, which empty into the Atlantic Ocean, (Alagoa, 1999).

The Niger Delta has also been seen from the ecological perspective as that portion of the southern Nigeria stemming from a northern apex situated at Aboh, bounded in

the east and west by the Imo river and by the Benin river respectively and on the south by Atlantic Ocean (Fubara *et al*, 1988). It is the Africa's largest Delta covering some 70,000 square kilometers (km<sup>2</sup>), of which one third of the area is made up of wetland (Afolabi, 1998). The Niger Delta area covered in this study includes parts of Rivers, Delta, Bayelsa, Edo, Akwa-Ibom and Cross River States. Others are parts of Abia, Imo and Ondo States. The area extends from latitude 4° 30' N and 8° N and longitude 4° E and 8° 45' E

The area is generally tropical, thus its climatic regimes exhibit maximum temperature. Seasonal and latitudinal variations do affect the maximum temperature, diurnal and seasonal ranges, relative humidity, high rainfall pattern which is comparatively uniform due to the proximity of the region to the Atlantic Ocean. (Alagoa, 1999). The vegetation is characterized by coastal ridge barriers, mangroves, fresh water swamp and lowland rainforest, which are attributes of a large river delta in the tropical region (Teme, 2001) (see study map).

### Species Assessment

The study involving extensive field trips in parts of the Niger Delta started in December 2004. During the field trips collections were made of life specimens either in cultivation or in the wild using the simple random sampling method based on standard procedure for ecological assessment for each location. Specimens, which could not be readily collected, were purchased from local markets within the study area where they were displayed for sale. (E.g. the fruit garden market by Kaduna street in Port Harcourt and a sandfill during market in yeneagoa Bayelsa State. Attempts were made to identify the specimens to species level in the field. Those that could not be readily identified were later identified in the herbarium with the aid of reference books and Floras such as *Flora of West Tropical Africa* (Hutchinson and Dalziel, 1954), and *Useful Plant of West Tropical Africa* (Burkill, 1985).

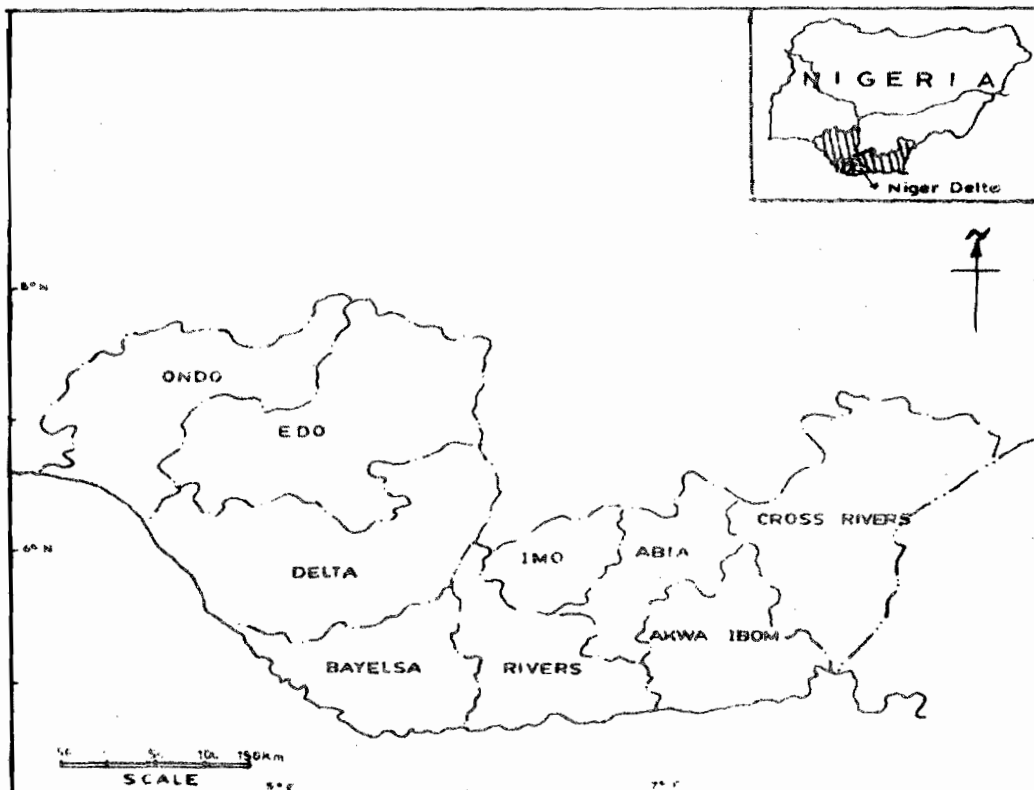


Fig.1 Map of the Niger Delta States Showing Sample Area

## RESULTS

## Distribution

The assessment of the distribution of the various species including, *Lagenaria guineensis*, *Citrullus lanatus*, *Cucumis sativus*, *cuucurbita moschata*, *Lagenara siceraria*, *Luffa aegyptiaca*, *Telfairea occidentalis*, *Trichosanthes cucumerina*, *Cucumeropsis manni*, *Cucurbita maxima*, *Coccinia barteri*, *Momordica charantia*, *Zehneria capillacea* and *Zehneria beuraria* show that they are all mesophytic in environmental and habitat adaptation and thus occurs in some parts of the tropical rainforest zones of the Niger Delta. Among other species, *Lagenaria siceraria* is known to have established cultivars or variety such as the cupshaped gourd, bottle gourd, snake gourd and the basin shaped variety. Virtually, observation has shown that every farming family (particularly in Rivers State) has at least one cucurbit species in its garden especially during the cultivation period between the month of March and April in the farming season. Beside the range of species already in cultivation many more species are known to occur in the wild (at least six of such species) as can be observed (Table 1). Observations on cultivars in many gardens show that they are susceptible to infection but fairly tolerant to drought and water logging and generally mesophytic in environmental adaptation. Further observations on vegetative and floral features and information from the geographical distribution (Fig. 1) of the cucurbits investigated have also indicated that all the species, no matter their mesophytic inclination, are perennial or annual herbaceous climbers or occasionally prostrate runners with marked preference for tropical climates.

Morphological observation has further shown that members of the cucurbit family studied share common characteristics and several conspicuous features among which are: annual or perennial vines with leaves usually five lobed and palmately veined, divided leaves having long petioles, and alternatively arranged on the stem. Tendril springlike in structure are common. Male (staminate) and female (pistillate) flowers are separate on the same or on different plants. Flowers ranging from barely noticeable to large and conspicuous, with five sepals, five fused whitish or yellow petals and five stamens (male) variously joined together and an inferior ovary (female), usually of fused carpels. The fruits range from small and dry to large, tasty, and fleshy, usually with a hard outer covering (a special type of leathery berry termed a pepo). The fleshy fruits are termed "squash" and the hard-shelled squash are the "gourds". Seeds are attached to the ovary wall (parietal placentation) and not to the center.

Many large, fairly flat seeds in which the embryo has two very large cotyledons. In spite of these common features, there are variations among the species as can be observed (Table 2)

They sometimes display very restricted occurrence in certain ecological habitats or zones as can be observed (Table 1). It has been observed that in some of the areas under investigation, all the species in question were found to occur both in the wild and in cultivation. Rivers State (Ikwerre LGA-North & South; Obio /Akpok LGA; Emohua LGA; Port Harcourt- North & South LGA; Tai, Ahoada West & East. and Abua Odua LGAs) and Cross River State (Odukpani, Akampa, Akpabuyo, Calabar municipality and Calabar North and Obubra) have been noted to have occurrence of similar species. Virtually all the species under investigation are found in the two States, though with variation in distribution in certain areas like Akampa Oban forest where *Telfairea occidentalis* grows wild within the State. In Rivers State some Local Government Areas and their communities were observed to be associated with different species of cucurbits for their life and cultural purposes. The Ikwerre people comprising areas such as Ikwerre LGA (Elele, Igwuruta, Omerelu, Aluu, Ubima and Ipo) are known for the cultivation of cucurbits. Others include Obio/Akpok LGA (Rumuekini, Choba, Ogbogoro, Rumuosi, and Rumualogu); Emohua LGA (Rumuodogo, Rumuji, Ibaa, Ogbakiri and Emohua); Port Harcourt LGA (fruit market) Tai (Kira, Sime and Barayira), Ahoada West and East and Abua Odua Local Government Areas.

In Cross River State, various areas were observed and noted for various cucurbit species (Table 1), and these include local council areas such as Odukpani, Akampa, Akpabuyo, Obubra Calabar municipality and Calabar North. Bayelsa State is devoid of species such as *Trichosanthes cucumerina*, *Cucumis sativus*, *Lagenaria siceraria*, *Citrullus lanatus*, *Cucurbita moschata*, *Cucumeropsis manni*, *Cucurbita maxima*, *Zehneria capillacea* and *Zehneria beuraria* except those occurring in the wild.

Another area known to be associated with wide occurrence of cucurbit cultivation is Akwa Ibom State. Other areas of known interest, though with little restriction either by culture or environment influenced are Delta State (Bomadi and Ughelli Local Government areas), Edo State (Ovia and Owan West Local Government Areas), Abia (Ukwa-West Local Council comprising Uzuaku-Asa and Obehie-Asa) Imo State and Ondo State (Ono Local Government Area, Ondo municipality and Ore Local Government Area) were also observed and noted for various cucurbits occurrence.

TABLE 1: SUMMARY OF CUCURBIT OCCURRENCE IN NIGER DELTA AREAS OF NIGERIA

S/N	SPECIES	CUCURBITIS								NIGER DELTA STATES				
		CUTURAL STATUS	RIVERS	BAYELSA	DELTA	AKWA IBOM	CROSS RIVER	EDO	IMO	ABIA	ONDO			
1	<i>Trichosanthes Cucurmeria</i>	C	+	-	-	-	-	-	-	-	-	-	-	-
2	<i>Lagenaria guineensis</i>	W	+	+	+	+	+	+	+	+	+	+	+	+
3	<i>Momordica charantia</i>	W	+	+	+	+	+	+	+	+	+	+	+	+
4	<i>Citrullus vulgaris</i>	C	+	-	+	+	+	+	+	+	+	+	+	+
5	<i>Luffa aegyptiaca</i>	W	+	+	+	+	+	+	+	+	+	+	+	+
6	<i>Cucumis sativus</i>	C	+	-	-	-	-	-	-	-	-	-	-	-
7	<i>Lagenaria siceraria</i>	C	+	-	+	+	+	+	+	+	+	+	+	+
8	<i>Telfairia occidentalis</i>	C	+	+	+	+	+	+	+	+	+	+	+	+
9	<i>Cucurbita moschata</i>	C	+	-	-	-	-	-	-	-	-	-	-	-
10	<i>Cucurbita maxima</i>	C	+	-	-	-	-	-	-	-	-	-	-	-
11	<i>Cucumeropsis mannii</i>	C	+	-	-	-	-	-	-	-	-	-	-	-
12	<i>Coccinia barten</i>	W	+	+	+	+	+	+	+	+	+	+	+	+
13	<i>Citrullus lanatus</i>	C	+	-	-	-	-	-	-	-	-	-	-	-
14	<i>Zehneria capillacea</i>	W	+	-	-	-	-	-	-	-	-	-	-	-
15	<i>Zehneria baunorara</i>	W	+	-	-	-	-	-	-	-	-	-	-	-

NOTE:  
 C-Cultivated  
 W-Wild  
 +-Presence  
 - Absence

TABLE 2: MORPHOLOGICAL FEATURES AND VARIATION IN A SUMMARY

SPECIES	DURATION & HABITAT.	STEM	TENDRIL	LEAVES	INFLORESCENCE	FLOWER	STAMENS	PISTILS	FRUIT	SEED	OTHER REMARKABLE FEATURES
<i>Trichosanthes cucurmeria</i> Linn	Annual herb	5-angled slightly furrowed and hairy	trifid	Simple, deeply 3-7 lobed with prominent mid rib, ovate	Monocloious -raceme -soltary	White, gamo-petalous lobed.	3-7 whitish and anthers	tricapillary	Long, slender tapering green	Thick dark	This pieces is rarely wild
<i>Lagenaria guineensis</i> (G. Don) C. Jeffrey	Perennial Herb	Roundish with slightly deeps 5 groves, Glatrous, sinuate hairs roots at nodes	bifid	Glabrous rough surface to touch simple, 3-5 lobed, 2 pointed glands at the lamina base.	Dioecioious -raceme -soltary	White, woolly, polypetalous,	3, yellowish green,	3 carpels 3 stigma	Dark-green, with cream or greenish white blotches.	Oval, dull or cream white	Long tubular calyx, flowers opens at sunrise 6:30 to 7:00 am and closes at sun set 12.00 to 4.00pm. occurs in wild
<i>Momordica charantia</i> Linn.	Annual herb	Scalrid and pubescent, rounded or slightly 5 angled.	Simple	Simple, palmately 5 to 7 deeply lobed	Monocloious -raceme -soltary	Yellow polypetalous	5, yellowish	5 stigmas	Green when unripe and orange-red when ripe but with rough surface	Flat, red and oblong	The fruit wall has blotches that gives an irregular surface, occurs in wild.
<i>Citrullus vulgaris</i> (Linn.) Schrad.	Annual herb	Scabrid and pubescent, rounded or 5- angled	bifid	Palmately lobed 3-5 ovate	Monocloious -raceme -soltary	Polypetalous pale yellow flower.	3 yellow	3 carpels 3 stigmas	Large, roundish, whitish green.	Flat, cream white	Really occur in wild.

<i>Luffa aegyptiaca</i> . Miller.	Annual herb	Scabrid, 5- angled, root at nodes	tetra to penta fid	Simple: deeply 6-7 lobed, broadly ovate, glabrous, scabrous to touch	Monococious -solitary	yellow polypetalous, 5 petals, deeply lobed	5- yellow anthers	3- carpels with thick bilobed stigma nonadephus	Cylindrical with light furrows, operculum present, brown	Black flat woody test	Yields the bath loofah species
<i>Cucumis sativus</i> Linn.	Annual herb	5-angled scabrid and pubescent	Simple	Simple, slightly deep, 5-lobed, broadly ovate, pubescent to hirsute scabrous, acute apex, cordate base.	Monococious -raceme -solitary	Polypetalous yellow flower	5- yellow anthers	5 carpels	Cylindrical with gland like structure on the surface at the tender stage.	White and flat	Mature fruit takes a smooth surface though with some scars.
<i>Legenaria siceraria</i> (Molina) Standley	Annual herb	5-angled longitudinally and deeply furrowed, pubescent	bifid	Widely ovate dentate, simple with 2-glands at lamina base cordate base	Monococious -raceme -solitary	White wooly, polypetalous	3, whitish	3-thick stigmas, 3-carpels.	Variable with very hard rind, brownish.	Compress sed, tan or white sculpture	Calabash or bottle gourd, flute guard,
<i>Telfairia occidentalis</i> , Hooker, fil	Perennial herb. Moderately strong when old	5-angled when young and hairy	bifid	Compound, 3-5 foliolate	Dioecious -raceme -solitary	White with purple centres polypetalous, or nearly gamopetalous	3 purple colour	3- carpels trilocular 10 ridged spindle-shaped	Large, 10 ridge, whitish with wax covering 90cm long	Layer, fat (broad), purple with large oily cotyledons	The 1 -ridged, layer pumpkin, rarely wild.
<i>Cucurbita moschata</i> (Duch. ex Lam ) Duch ex prolect	Annual herb moderately strong	Rounded or smoothly 5- angled, furrowed, pilose at ribs only	tri to tetra fid	Reniform cordate, shallowly 5-7 lobed with deep sinus	Monococious -raceme -solitary	Yellow gamopetalous and very tubular	3, stamens yellow anthers	3- carpels unilocular with forked stigma	Large, roundish green often with white blotches hard stalk in sunkun attachment slightly deep whitish furrows		
<i>Cucurbit maxima</i> Duch ex. Lam.	Annual herb	Soft and rounded with grooves and pubescen.	tri to penta fid	Slightly 5-7 lobed, reniform base, cordate shape	Monococious -raceme -solitary	Massive bright yellow gamopetalous intricate and valvate	3- stamens yellow, massive, variously folded anthers			Fat, dull milky- white or tan	Profuse annual with large cordate leaf and covered with pilose hairs. Rarely occurs in wild
<i>Cucumeropsis mannii</i> Naud.	Annual herb.	Roundish, pubescent.	Simple	Simple: palmately lobed reniform cordate	Monococious -raceme -solitary	Creamy- yellow, valvate polypetalous	3- cream yellow.	6- carpels, ovary cylindrical	Variable: oval; faded green.	Smooth whitish green	Cultivated in Nigeria
<i>Coccoloba barkeri</i> (Hooker) Keay	Perennial herb: moderately hard	Roundish glabrous, roots at nodes	Simple	Simple: deeply 2-3 lobed cordate	Dioecious both land an racemose	Yellow, gamopetalous	3- yellow anthers	3- carpels with single thick stigma	Triangular spherical, green with vertical small white blotches.	Small dull white tan winged.	Profuse, coriaceous leaves

## DISCUSSION

The distribution of plants over the earth's surface also known as phytogeography has found application in taxonomy. Besides, information from such distribution studies provides clues to agro-climatic and environmental factors necessary for crop development. In Nigeria, the Niger Delta is recognized with three major agro ecological zones. The mangrove salt water forest, the freshwater swamp forest and the tropical rainforest zones. The biodynamic assessment of the species shows that they are all mesophytic in environmental and habitat adaptation and thus occurs in some parts of the tropical rainforest and fresh water swamp forest ecological zones (subzones) of the region. Stace (1980) pointed out that each taxon exhibits a certain pattern of distribution and that the coincidence of areas occupied by related taxa has a bearing on the classification of the group, especially when its evolution is taken into consideration.

Further observation on vegetative, floral features and information from the geographical distribution of the species investigated have also indicated that all the species (however their mesophytic inclination) are marked with preference for tropical climates, hence the area of study is geographically located in the rainforest axis of the country. They sometimes display very restricted occurrence in certain ecological habitats or zones. Species richness studies from temperature zones stress the importance of energy as a limiting factor (Currie 1991); where as tropical studies emphasize the importance of moisture and related factors (Gentry, 1982, Brown 1988). Lomolino (2001) pointed out that many components of climate and local environment (e.g. temperature, precipitation, seasonality and disturbance regime) vary along the elevation gradient and ultimately create the variation in species richness such as in *Cucurbita maxima*, *Lagenaria siceraria*, and *Telfairea occidentale*.

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## REFERENCES

- Afolabi, D., 1998. The Nigerian Mangrove ecosystem. Third Regional workshop of the Gulf Guinea Large Marine Ecosystem (GOGLME), Lagos Nigeria.
- Agbagwa, I.O., 1997. Morphological and anatomical studies on Nigeria species of *Cucurbita* L. (cucurbitaceae). M.Sc. Thesis. University of Port Harcourt unpublished.
- Alagoa, E.J., 1999. The land and people of Rivers State, Central Niger Delta. Onyema Research Publications, Port Harcourt, Rivers State Nigeria.
- Arevalo, J.R. Delgado, J.D Otto, R., Naranjo, A, Salas, M. and Fernandez-Palacios, J.M., 2005. Distribution of alien Vs. native plant species in roadside communities along an altitudinal gradient in Tenerife and Gran Canaria (Canary Island). *Perspect Plant Ecol. Evol. Syst.* 7(3): 185-202.
- Becker, T., Dietz, H., Billefer, R, Buschmann, H., and Edwards, P.J., 2005. Altitudinal distribution of alien plant species in the Swiss Alps. *Perspect Plant Ecol. Evol. Syst.* 7(3): 173-183.
- Brown, J.H., 1988. Species diversity, Analytical biogeography (eds. A.A. Myers and P.S. Giller). Chapman and Hall, London.
- Burkill, H.M., 1985. Useful Plant of West Tropical Africa. Ed. 11 vol. 1 Cambridge Univ. Press, Cambridge.
- Cobley, L.S. and Steele, W.M., 1976. An Introduction to the Botany of Tropical Crops. Longman, London.
- Curie, D.T., 1991. Energy and large-scale patterns of animal and plant-species richness. *American naturalist* 137, 27-49.
- Dalziel, J. M., 1937. The Useful Plants of West Tropical Africa. Appendix to the Flora of West Tropical Africa, Crown Agents, London vol. part 1.
- Elliot-Weiser, T. Ralph, S., and Micheal, G.B., 1974. Botany, An Introduction to Plant Biology 5<sup>th</sup> edition John Wiley and Sons, New York.
- Esquinas-Alcazar, J.T. and Gulick, P.J., 1983. Genetic Resources of Cucurbitaceae Int. Board for Plant Genet. Resources Rome.
- Fubara, D. M.J., Teme, S.C., Mgbekwe, T., Gobo, A.E. T. and Abam, T.K.S., 1988. Master plan design of flood and erosion control measures in the Niger Delta IFERT Technical Report No 1
- Gentry, A. H., 1988. Changes in Plant Community diversity and floristic Composition of climate and geographical gardens. *Annals of the mission Botanical gardens* 19:489-503.
- Grytnes, J. A., Birks, H. J. B. and Peglar S.M., 1999. Plant species richness in fennoscandia, evaluating relative importance of climate and history. *Nordic Journal Botany* 19: 489-503.
- Grytnes, J.A. and Vetaas, O. R. 2002. Species richness and altitude, a comparison between simulation models and interpolated plant species richness along the Himalayan altitudinal gradient Nepal *American Naturalist* 159:294-304.
- Hamilton, A. C., 1975. A quantitative analysis of altitudinal zonation in Uganda forests. *Vegetation* 30: 99-106.
- Hutchinson, J. and Dalziel, J. M., 1954. Flora of West Tropical Africa. Crown Agent London vol. 1 part 1
- Hutchinson, J. and Dalziel, J. M., 1958. Flora of West Tropical Africa. Crown Agent London vol. 1 part 1
- Ibiok, M. N. Ndukwu, B. C. and Umoh, N., 1991. Varieties of gourds (*Lagenaria siceraria*) in Akwa Ibom State. *The Nigeria field* 56: 115-119
- Jeffrey, C., 1964. Key to the Cucurbitaceae of West Tropical Africa with a guide to localities and little known species. *J. W. African Sci. Assoc* 9:79-97
- Jeffrey, C., 1980. A Review of the Cucurbitaceae. *Bot. J. Linn Soc.* 81:233-247
- Korner, C., 1999. Alpine Plant life. Springer Verlag, Berlin
- Lieberman, D., Lieberman, M. Peralta, R. and Hartshorn G.S., 1996. Tropical forest structure and composition on a large-scale altitudinal gradient in Costa Rica. *Journal of Ecology* 84: 137-152.

- Limolino, M. V., 2001. Elevation gradients of species richness, historical and Prospective view. *Global ecology and Biogeography* 10: 3-13.
- Ndukwu, B. C., 1988. Morphological, Anatomical and cytological studied on some lesser known Nigerian cucurbits M.Sc. Thesis, University of Port Harcourt, Unpublished.
- Ndukwu, B. C., 2000. Conservation of *Trichosanthes* Linn. (Snake gourds) Genetic Resources in Nigeria. *Nigeria Society for Biological Conservation* 7:9-13.
- Odland, A. and Birks, H. J. B., 1999. The altitudinal gradient of vascular plant species richness in Aurland, Western Norway. *Ecography*, 22:548-566.
- Okoli, B. E., 1984. Wild and cultivated cucurbits in Nigeria. *Econ. Bot.* 38 (3): 350-357.
- Pianka, E. R., 1966. Latitudinal gradient in species diversity, a review of concept. *American naturalist* 100:33-36.
- Purseglove, J. W., 1968. *Tropical Crops Dicotyledono*. Vol. 1 Longman, London.
- Rahbek C., 1995. The elevational gradient of species richness, a uniform pattern *Ecography* 1:20-205.
- Richardson, P. J. and Lum, K., 1980. Pattern of plant species diversity in California: relation to weather and topography. *American Naturalist* 116:504-536.
- Rohde, K., 1992. Latitudinal gradient in diversity, the search for the primary cause, *Oikos* 65:514-527.
- Stace, C. A., 1980. *Plant Taxonomy and Biosystematics*, Contemporary Biology Edward Arnold, London.
- Steven, G. C., 1992. The elevation gradient in attitudinal range, an extension of Rapport's Latitudinal rule to altitude. *American Naturalist*, 140:893-911.
- Teme, S. C., 2001. Environmental Peculiarities of the Niger Delta in Petroleum Exploration Operations. In: *The National Conference of Pipeline Vandalisation and Degradation of the Niger Delta Environmental*. Rivers State Ministry of Environment and Natural Resources in collaboration with Green House Foundation and B. Jean Communication Limited Port Harcourt Rivers State 27<sup>th</sup>-29<sup>th</sup> Nov. 2001.
- Timothy, J. Ng., 1993. New Opportunities in the *Cucurbitaceae*. P. 538-546 In: Janick, J. and Simon, J.E. (eds.) *New Crops* Wiley, New York.
- Whitaker, T.W. and Davis, G.N., 1962. *Cucurbits*. Inter-science Publishers, Inc. New York.
- Wright, D. H. Currie, D. J. and Maurer, B. A., 1993. Energy supply and patterns of species richness on local and regional scales. Species diversity in ecological communities, historical and geographical perspectives (eds. R.E. and D. Schluter) Pp. 66:74 University of Chicago Press, Chicago.
- Yamaguchi, M., 1983. *World Vegetable AVI*. West Port.