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Phytogeographical Distribution and Fruit Diversity of *Lagenaria siceraria* Species in Nigeria

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Abstract

Phytogeographical distribution and fruit diversity of *Lagenaria siceraria* (Mol.) Standl species in Nigeria were accessed. Information on the distribution and fruit diversity was sourced from three herbaria, Forestry Research Institute of Nigeria Herberia, University of Port Harcourt Herberia and the University of Ibadan Herberia. A field survey across fifteen states in Nigeria namely Kaduna, Kano, Plateau, Oyo, Akwa Ibom, Cross River, Taraba, Bayelsa and Enugu, Ebonyi, Ondo, Ogun, Kwara Anambra and Rivers State. A total of twenty-four fruit shapes were accessed. The diversity of fruit shapes across the geographical regions of Nigeria shows that the Guinea savannah has all the twenty-four different landraces represented, while Tropical rain forest has nineteen, Sudan savannah has seventeen and Freshwater swamp and the Saltwater swamp has eleven different fruit shapes respectively. The fruits of *Lagenaria siceraria* (Mol) Standl is considered a topocline since it is not affected only by environmental factors but possess a wide distribution pattern across the geographical regions of Nigeria.

Keywords

Fruit Diversity, *Lagenaria siceraria* (Mol) Standl, Topocline, Ecocline and Phytogeographical Distribution

1. Introduction

Nigeria has a total land mass of 923,768 sqkm [1]. The landraces of *Lagenaria siceraria* (Mol.) Standl. show great diversity [2] [3].

The Species *Lagenaria siceraria* (Mol.) Standl is a member of the family *cucurbitaceae*, it is commonly known as bottle gourd, bird house, trumpet gourd, calabash gourd and white flowered gourd [4] [5] [6].

Archaeological evidence has proved that humans have collected *Lagenaria siceraria* (Mol.) Standl. for about twelve thousand years in both old and new worlds [7] [8]. A history of trans-oceanic drift of bottle gourd has explained its pre-Columbian distribution in tropical America [2]. In the attempt to trace the origin of bottle gourd, it has been suggested that bottle gourd was indigenous to tropical Africa and was dispersed by trans-oceanic drift or human transport to other parts of the world [7].

Lagenaria siceraria (Mol.) Standl. has probably been domesticated independently in Africa, Asia and America and these demonstrations are reflected in the variability of commercial cultivars [7]. However, Decker-Walters D, *et al.* [9] discovered an additional wild indigenous species in Zimbabwe which reinforced the latter hypothesis of Africa as the centre of origin of *Lagenaria siceraria* species.

Varieties of *Lagenaria siceraria* (Mol.) Standl is known throughout West Africa, where it has been grown for containers, but these variants are largely unrecorded in terms of name and characteristics [5]. Brown University [10] has described phytogeography as the study of distribution of species and ecosystems in geographic space, through geological time. Organisms often vary along geographic gradients of latitude, elevation, isolation and habitat area. Modern phytogeography often employs the use of Geographic Information Systems GIS, to understand the factors affecting organism distribution, and to forecast future trends in organism distribution [11]. Several times GIS and mathematical models have been used to solve ecological problems that have a spatial aspect to them [12].

Historical account emphasizes that geographical isolation has been considered a prerequisite for reproductive isolation [8] [13] [14] [15]. Jordan's rule further states that given any species in any region, the nearest related species is not likely to be found in the same region or remote region, but in a neighbouring district separated from the first by a barrier [13] [14] [16]. Recent work has shown that ecological and parapatric speciation is more common than formerly appreciated, and plant species are more sensitive to fine-scale environmental heterogeneity [16] [17] [18] [19]. A report on the closest relatives gives insights into the relative importance of geographical and ecological segregation in speciation. Plants which are characterized as same species are more closely related to each other than to any other species, which can leave a major imprint on the geographical and ecological attributes [20] [21] [22]. The degrees of range overlap and range asymmetry of plant species provide the ability to infer the geographical mode of speciation [16] [23]. Allopatric speciation often times is mistaken for sympatric speciation especially when followed by secondary contact [23] [24] [25] [26]. The greater the reproductive and ecological similarity of plant species to each other than to non-congeners the more recent is the shared ancestry and phylogenetic niche conservatism, as found in a number of plant groups [21] [27] [28]. Nigeria is found in the tropics, where the climate is seasonal and humid. The vegetative zones are controlled by the combined effects of temperature, humidity and the variations that occur in rainfall. This forms a major influence on the

type of indigenous plants that grow successfully in various parts of the country [29].

Nigeria consists of about seven different agro-ecological zones which include salt-water swamp, freshwater swamp, tropical rain forest zone, Guinea Savannah, Sudan Savannah, Sahel Savannahand Montane Vegetation [1]. Phytogeography, therefore, deals with the spatial relationship of plants both in present and past [30], hence *Lagenaria siceraria* with great diversity in fruit shape is part of the vegetative cover of Nigeria. Despite the research on this species the phytogeographical distribution of this species in Nigeria is not available. This research, therefore, tends to bridge the gap in the reporting of phytodistribution and diversity of *Lagenaria siceraria* (Mol.) Standl found in Nigeria.

2. Materials and Methods

2.1. Description of Study Area, Location and Site

Nigeria is a country in West Africa, it has a compact area of 923,768 km^2, and the landmass is bordered by the Chad and Cameroon in the east, the Republic of Benin in the west, the Gulf of Guinea in the south and extends to Niger in the north. Nigeria is situated in the Tropics and is affected by varying climate types from the northern part of Nigeria to the southern part of Nigeria through the middle belt.

Kaduna state is part of the northwest geopolitical zone of Nigeria and occupies a landmass of 46,053 Km^2 (**Figure 1**). The soil is mostly sandy, loamy and clay. The vegetation cover is Sudan Savannah which consists of high plains. The Latitude of Kaduna is 10˚31'35"N and Longitude, 7˚26'9"E. Zaria and Igabi local government areas are part of the local government in Kaduna. Kano state is

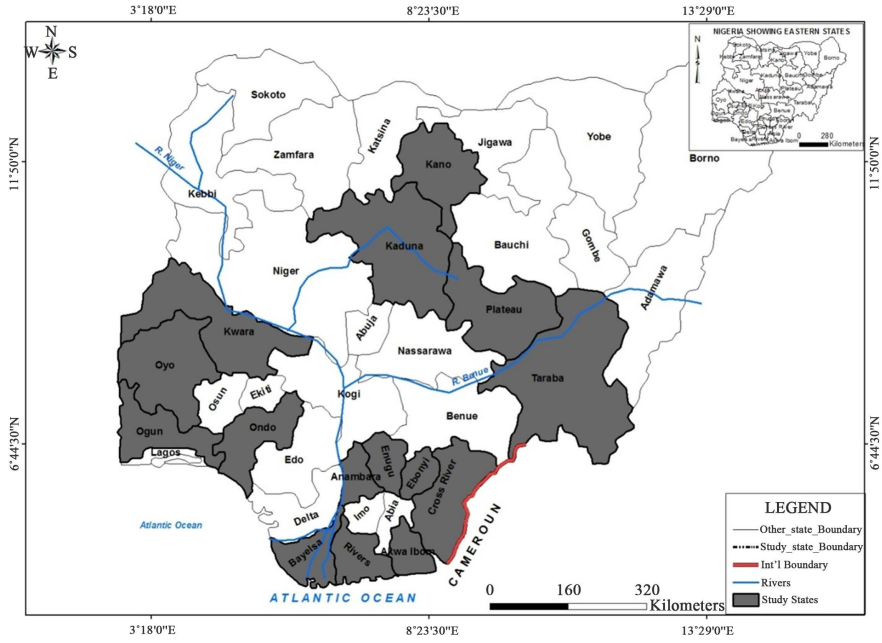

Figure 1. Map of the study area.

located in the northwest of Nigeria and the vegetational belt falls within dry Guinea at the Southern fringe and the Sudan in the larger part of the region [31]. The geographic coordinates of Kano lies at Latitude 11˚46'22.03"N and Longitude 08˚49'21.52"E. Some local government areas includes Taroni, Bebeji, Kudu and Udil. Plateau state is situated in the North Central of Nigeria and occupies 26,899 Km^2. it is located between latitude 10˚06'12.048"N and a longitude of 80˚49'19.507"E. Although it is situated in the tropical Rain forest zone it has a higher altitude and a near temperate climate with average temperature between 13˚C and 22˚C. it consist of many bare rocks which are scattered across the grasslands and is a source of many rivers in Northern Nigeria. Bassa is part of the local government area of Plateau. Taraba state has a landmass of 54,473 Km^2, and situated in the Northeast region, within the middle belt of Nigeria. It consist of undulating landscape with few mountains. The state is located within the Tropical forest zone and has a vegetation of mostly grassland in the northern part and low forest in the southern region. It is found within latitude 07˚13"38.307"N and longitude 05˚01'37.572"E. Gembu local government area is part of the local government area of Taraba state.

Oyo state is located in the Southwest of Nigeria with the capital city as Ibadan and an area cover of 28,454 Km^2. The state is well drained with rivers flowing from the upland in the North-South direction. The vegetation pattern is that of guinea savannah in the north and that of rain forest in the south. Oyo state is situated between latitude 10˚06'12.048"N and longitude 08˚49'19.507"E. Ogun state is situated between latitude 06˚58'10.11"N and longitude 04˚07'22.92"E, the state covers a landmass of 16,409 Km^2 in the Southwest of Nigeria. The northern part of the state is mainly of derived savannah vegetation, the southern part of mangrove swamp and the central part is of the tropical rain forest belt. Ondo state has a landmass of about 14,788.723 Km^2 in the Southwest geopolitical zone of Nigeria. The geographical coordinates of Ondo lies between latitude 07˚18'38.307"N and longitude 05˚01'37.572"E. The vegetational belt lies within the tropical rain forest zone at the south and sub-savannah forest in the northern fringe. Kwara state is located at the West Central region of Nigeria and is situated in the transitional zone within the forest and the guinea savannah regions of Nigeria. The state is situated within 36,825 Km^2 and found within latitude 09˚17'25.52"N and 03˚51'33.94"E of the equator.

Anambra state is situated in the South East geopolitical zone of Nigeria. The state covers an area of 4416 Km^2 and has tropical rain forest vegetation. The state is located at latitude 05˚51'14"N and longitude 06˚51'36"E of the equator. Ihiala is amongst the local government area of Anambra state. Enugu state is found in the Southeastern region of Nigeria. It lies within the foot of an encarpment which is located in the Cross River basin, its vegetational belt cuts across the tropical rain forest zone with a derived savannah. The geographical coordinates is within latitude 06˚26'40.80"N and longitude 07˚33'51.20"E of the equator. Enugu east is part of its local government area. Ebonyi state is situated in the South east geopolitical zone of Nigeria and covers 5935 Km^2. It has large deposit

of salt water and luxuriant vegetation with high rain forest zones in the South and sub-savannah forest in the Northern fringe. The state is found within latitude 06˚14'43.98"N and longitude 08˚10'27.49"E having Afikpo North amongst the Local government area.

Cross Rivers state is a coastal state in the Niger Delta region, it is located in the Southsouth geopolitical zone of Nigeria and occupies 20,156 Km^2 and a geographic coordinates of latitude 06˚36'40.78"N and longitude 08˚47'54.55"E. The vegetation ranges from mangrove swamps through tropical rain forest, to derive savannah, and montane parkland. Ogoja is one of the local government found in Cross River. Akwa Ibom state occupies a total landmass of 8412 Km^2 in the South-south geopolitical zone. It has Tropical rain forest Zone and Fresh water swamp vegetation, it is located within latitude 5˚2'54.89"N and longitude 08˚2'07.27"E. The local government within Akwa Ibom includes amongst others IkotEkpene, MkpatEnin, and Uruan. Bayelsa state in South-south of Nigeria has a landmass of 21,110 Km^2. The vegetational cover is predominantly fresh water swamp, other ecological zones include: Coastal barrier, Island forest and Mangrove forest. It is located within latitude 05˚10'22.67"N and longitude 07˚41'19.80"E, having Ogbia as one of the local government. Rivers state is located in the Niger Delta region, in the South-south geopolitical zone of Nigeria. It consist of a total landmass of 11,077 Km^2 with a geographic coordinates within 04˚43'57.61"N and longitude 07˚14'54.98"E. The local government areas includes: Tai, Eleme, Etcheamogst others. The vegetation cover towards the Inland part consist of tropical rain forest and the coast many mangrove swamps. The topography of the state ranges from flat plains to the network of rivers to tributaries.

2.2. Phytogeographical Field Sampling Design

The spatial distribution of *Lagenaria siceraria* and locations are some of the major aspects analysed. The species were observed and collected from parts of Rivers state, Akwa Ibom, Cross River, Bayelsa, Anambra, Enugu, Ebonyi, Oyo, Ogun, Ondo, Taraba, Kwara, Plateau, Kano and Kaduna states of Nigeria. The area under study were chosen for the reason of accessibility, availability, and prevalence of the species. A systematic ramdom sampling basesd on simple ecological procedure was carried out with various sampling points of different geographical precision coordinates noted in parts of the states under consideration [4].

2.3. Phytogeographical Sampling Procedure

The study involved extensive field trips to different states and herbaria in Nigeria. The geographical and distributional studies of *Lagenaria siceraria* (Mol.) Standl. were carried out using the herbarium specimen from Forestry herbarium Ibadan, University of Port Harcourt herbarium, University of Uyo herbarium and field collections. The locality and coordinates were recorded using the google map. The data were further used to generate a distributional map of the species.

3. Result and Discussion

The result of field collections and herbarium studies are summarized in Table 1, and Figure 2 showing the phytogeographical map of the species across the vegetational belt of Nigeria. The study shows that the species occurs in fifteen states of Nigeria which includes: Kano, Kaduna, Plateau, Oyo, Ondo, Ogun, Ondo, Taraba, Enugu, Ebonyi, Cross River, Akwa Ibom, Bayelsa and Rivers state.

In Nigeria, the species is observed to occur within the Sudan savannah, Guinea savannah, Tropical rain forest, Montane vegetation, Fresh water swamp and Salt water swamp. In kano state the species occurs within two vegetational belt. It is observed to be prevalent in the Sudan savannah and flows to the Guinea savannah towards the western fringe. In kaduna, Plateau, Oyo, Kwara, Enugu, Ebonyi, and Cross River states, the species are widely spread within the Guinea savannah. In Ondo state, *L. siceraria*is found within the boundary within the Guinea savannah gearing towards the Tropical rainforest region, while in Ogun state, the species is prevalent towards the eastern part, within the Tropical rainforest region. The species occurs within the Montane vegetation in Taraba state. The species is observed in Akwa Ibom state to be prevalent in the southern part of the state within the Salt water swamp and towards the northern part of the state within the Tropical rainforest. In Bayelsa, the occurrence of the species were observed only in the Salt water swamp vegetation. In Rivers state, the prevalence of *L. siceraria* is observed at the Tropical rainforest region towards the

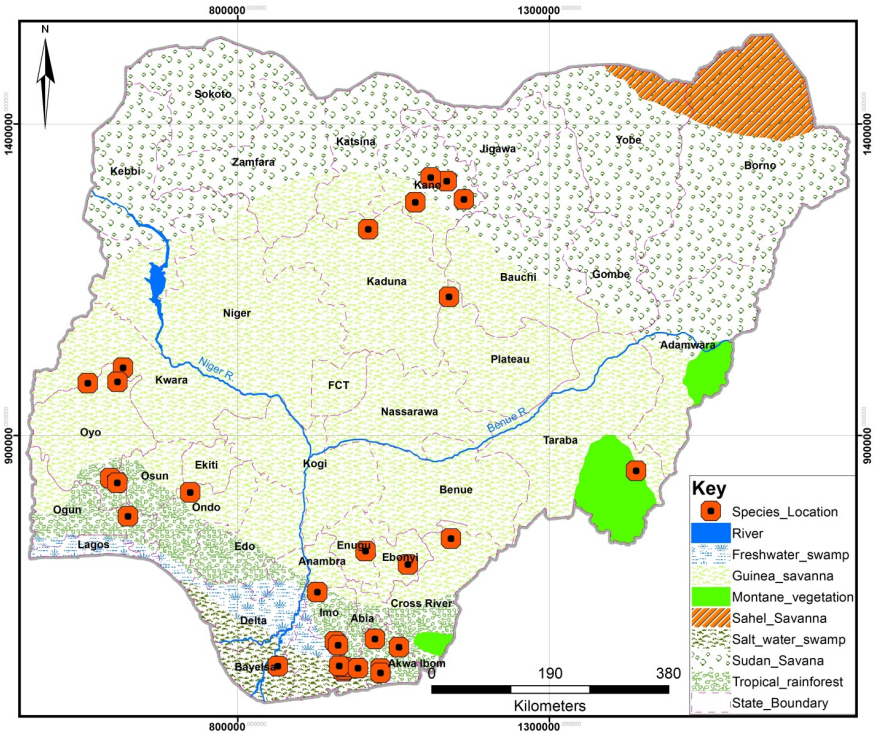

Figure 2. *Lagenaria species* distribution across vegetation belts in Nigeria. Source: Author's fieldwork, (2016).

Table 1. Species coordinates of sampled area.

S/No.	FIELD/HERBARIUM SPECIMEN CODE	COLLECTOR	ALTITUDE	LOCALITY/L.G.A./STATE
1	FHI: 68580	J. A. Enwiogbon	Lat. 05˚51'14"N Long. 06˚51'36"E	Oseakwa village, Ihiala L.G.A., Anambra State
2	FHI: 46398	J. Redhead	Lat. 08˚54'06"N Long. 03˚32'28"E	Alonle Village, Oyo L.G.A., Oyo State
3	FHI: 35830	C. F. A. Onoche	Lat. 06˚26'40.80"N Long. 07˚33'51.20"E	River Ekwulu at Emene, Enugu East L.G.A., Enugu State
4	FHI: 91039	T. K. Odewo	Lat. 07˚13'38.307"N Long. 05˚01'37.572"E	Mabilla Plateau, Gembu L.G.A. Taraba State
5	FHI: 91232 Long	Odewo & Others	Lat. 07˚18'38.307"N Long. 05˚01'37.572"E	Aponwu Forest Research, Akure L.G.A.,Ondo State
6	FHI: 45761	C. Geerling	Lat. 08˚55'08.06"N Long. 03˚58'25.52"E	New Busa to Wava, Ibadan L.G.A, Oyo State
7	FHI: 101826	O. Ohaeri	Lat. 11˚06'00"N Long. 07˚39'38.40"E	Cultural Centre A.B.U. Samara, Zaria L.G.A, Kaduna State
8	FHI: 96171	Odewo & Binuyo	Lat. 09˚17'25.52"N Long. 03˚51'33.94"E	Along New Busa Road, New Busa L.G.A, Kwara State
9	FHI: 82939	Oyayomi & Anyinbisi	Lat. 06˚58'10.11"N Long. 04˚07'22.92"E	Imeko Forest Reserve, ImekoL.G.A.,Ogun State
10	FHI:01B	J. Adesina	Lat. 07˚27'12.47"N Long. 03˚58'06.20"E	FRIN, Ibadan L.G.A, Oyo State
11	FIELD: 001	F. O. Awala	Lat. 07˚30'09.36"N Long. 03˚51'38.43"E	Bude, Ibadan L.G.A., Oyo State
12	UIH: 1418	J. Lowe	Lat. 06˚36'40.78"N Long. 08˚47'54.55"E	Ogoja,Ogoja L.G.A., Cross River State
13	UHI: 1417	J. Lowe	Lat. 06˚14'43.98"N Long. 08˚10'27.49"E	Afikpo, Afikpo North L.G.A., Ebonyi State
14	FIELD: 002	F. O. Awala	Lat. 05˚10'22.67"N Long. 02˚41'19.80"E	IkotEkpene, IkotEkpene L.G.A., Akwa Ibom State
15	FIELD: 003	F. O. Awala	Lat. 04˚44'27.16"N Long. 07˚45'53.53"E	Minya, MkpatEnin L.G.A., AkwaIbom State
16	FIELD: 004	F. O. Awala	Lat. 04˚45'30.69"N Long. 07˚45'24.00"E	MkpatEnin, MkpatEnin L.G.A., AkwaIbom
17	FIELD: 005	F. O. Awala	Lat. 05˚2^{I}54.89^{II}N Long. 08˚2^{I}07.27^{II}E	IduUruan, Uruan L.G.A., AkwaIbom State
18	UPH/C/022	N. L. Edwin-Wosu	Lat. 04˚43^{I}57.61^{II}N Long. 07˚14^{I}54.98^{II}E	Kira, Tai L.G.A., Rivers State
19	UPH/C/037	N. L. Edwin-Wosu	Lat. 04˚42'56.14"N Long. 07˚16'39.16"E	Barayira, Tai L.G.A. Rivers State
20	UPH/C/038	N. L. Edwin-Wosu	Lat. 04˚45'55.03"N Long. 07˚14'50.80"E	Sime, Tai L.G.A., Rivers State
21	FIELD: 006	F. O. Awala	Lat. 10˚06'12.048"N Long. 08˚49'19.507"E	TashanJingir, Basa L.G.A. Plateau State

Continued

22	FIELD: 007	F. O. Awala	Lat. 04˚47'39.92"N Long. 06˚18'52.68"E	Riga Chikun, Igabi L.G. A., Kaduna State
23	FIELD: 008	F. O. Awala	Lat. 11˚30^{I}22.67^{II}N Long. 09˚04^{I}04.99^{II}E	UnguwaUku, Taroni L.G.A., Kano State
24	FIELD: 009	F. O. Awala	Lat. 11˚28'36.31"N Long. 08˚21'17.47"E	Tiga Dam, Bebeji L.G.A., Kano State
25	FIELD: 010	F. O. Awala	Lat. 11˚49'44.35"N Long. 08˚35'14.56"E	SakuwaDawakin, Kudu L.G.A. Kano State
26	FIELD: 011	F. O. Awala	Lat. 11˚46'22.03"N Long. 08˚49'21.52"E	Udidil, Udil L.G.A., Kano State
27	FIELD: 012	F. O. Awala	Lat. 04˚45'04.45"N Long. 07˚26'26.06"E	NonwaUedeme, Tai L.G.A., Rivers State
28	FIELD: 013	F. O. Awala	Lat. 04˚48'07.60"N Long. 07˚09'25.25"E	Nchia, Eleme L.G.A., Rivers State
29	FIELD: 014	F. O. Awala	Lat. 05˚05'07.19"N Long. 07˚09'26.51"E	Ndashi, Etche L.G.A., Rivers State
30	FIELD: 015	F. O. Awala	Lat. 05˚08'18.42"N Long. 07˚06'39.20"E	Oberi, Etche L.G.A., Rivers State
31	FIELD: 016	F. O. Awala	Lat. 04˚47'05.50"N Long. 06˚16'59.72"E	Otuoke, Ogbia L.G.A. Bayelsa State.

northern part of the state and at the western part the species are observed at the Fresh water swamp while towards the southern pole the species occurs at the Salt water swampvegetational belt.

Phytodistrbution of *Lagenaria siceraria* (Mol.) Standl. Across Agro-Ecological Zones of Nigeria.

The diversity of fruit shapes in the landraces of *L. siceraria* across vegetational belt of Nigeria were taken into consideration. In **Figure 3** twenty-four fruit shapes is observed in the Northern and Southern Guinea Savanna which includes: Snake Gourd, Pot Gourd, Bushel Gourd, African Bottle Gourd, Indian Gourd, Caveman Club Gourd, Long Handle Dipper Gourd, Extra Large Pawpaw Gourd, Cup Gourd Kettle Gourd, Warted Bushel Gourd, Pennis Shield Gourd, Palm Wine Gourd, Swan Gourd, Water Jug Gourd, Mini Dipper Gourd, Chinese Bottle Gourd, Long Siphon Gourd, Powder Horn Gourd, Goose Neck Gourd, Base Ball Gourd, Bird House Gourd, Nigeria Rattle Gourd and Microphone Gourd.

In Dry and Wet Lowland Rainforest nineteen landraces is identified (**Figure 4**) by its fruit diversity which includes: African Bottle Gourd, Snake Gourd, Pot Gourd, Bushel Gourd, Caveman Club Gourd, Long Handle Dipper Gourd, Cup Gourd, Kettle Gourd, Warted Bushel Gourd, Indian Gourd, Pennis Shield Gourd, Palm Wine Gourd, Swan Gourd, Water Jug Gourd, Mini Dipper Gourd, Chinese Bottle Gourd, Long Siphon Gourd, Powder Horn Gourd and Nigeria Rattle Gourd.

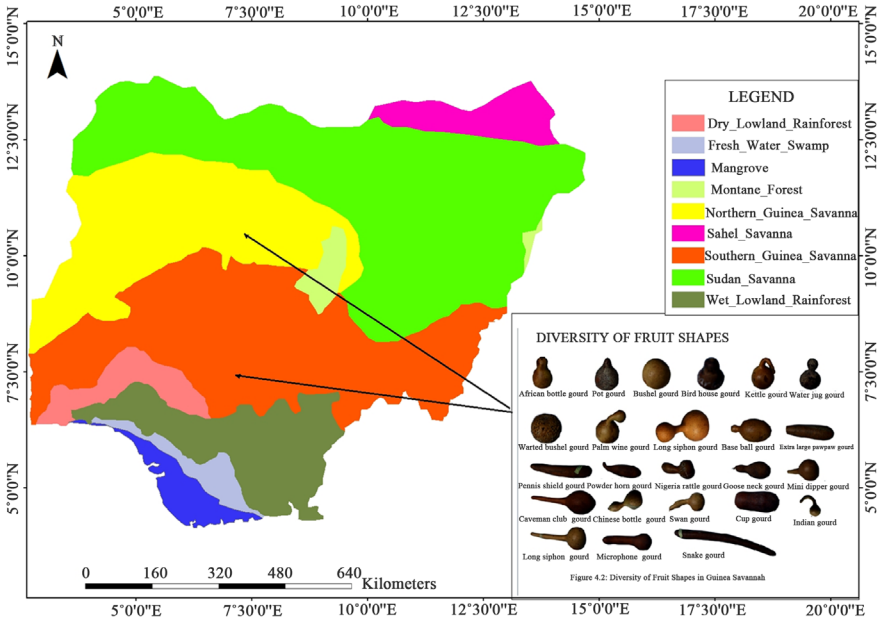

Figure 3. *Lagenaria species* distribution across Guinea savannah.

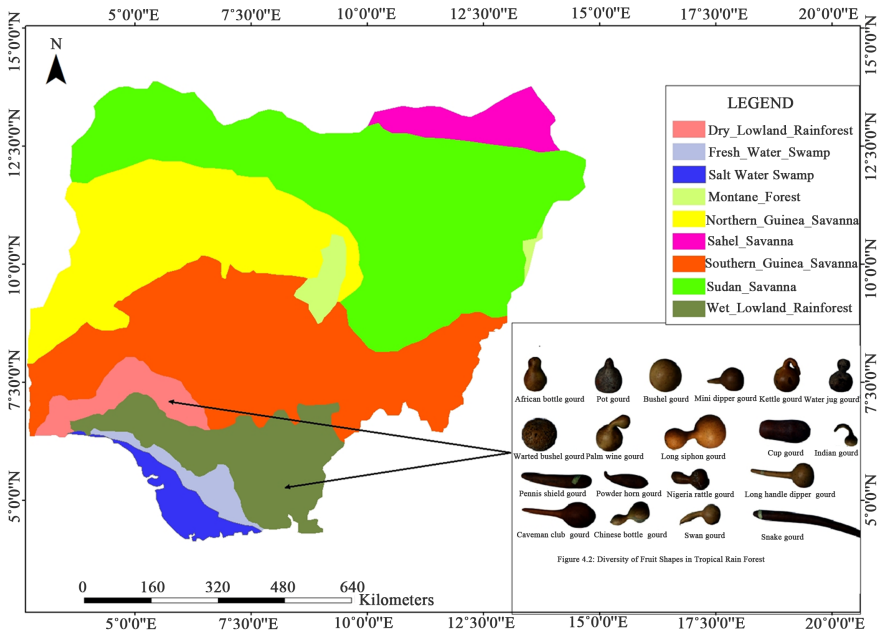

Figure 4. *Lagenaria species* distribution across Tropical rainforest.

The diversity of fruit shapes observed in *L. siceraria* landraces found in Nigeria is about seventeen within the sudan savanna (Figure 5) this includes: Snake Gourd, Pot Gourd, Bushel Gourd, African Bottle Gourd, Indian Gourd, Caveman Club Gourd, Long Handle Dipper Gourd, Cup Gourd, Kettle Gourd, Warted Bushel Gourd, Pennis Shield Gourd, Palm Wine Gourd, Mini Dipper Gourd, Long Siphon Gourd, Powder Horn Gourd, Goose Neck Gourd and Nigeria Rattle Gourd.

The diversity of fruit shapes observed in Figure 6 within the Fresh water

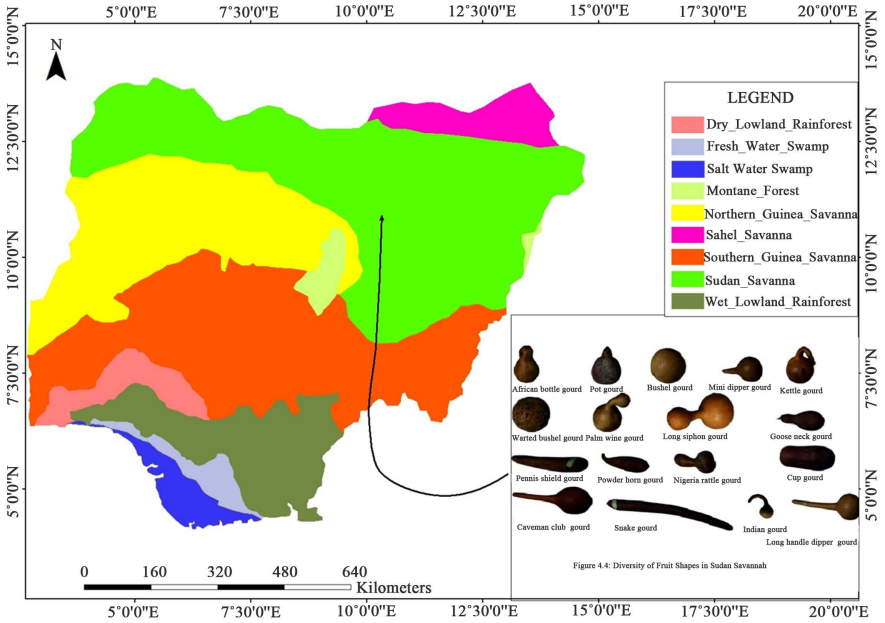

Figure 5. *Lagenaria species* distribution across Sudan savannah.

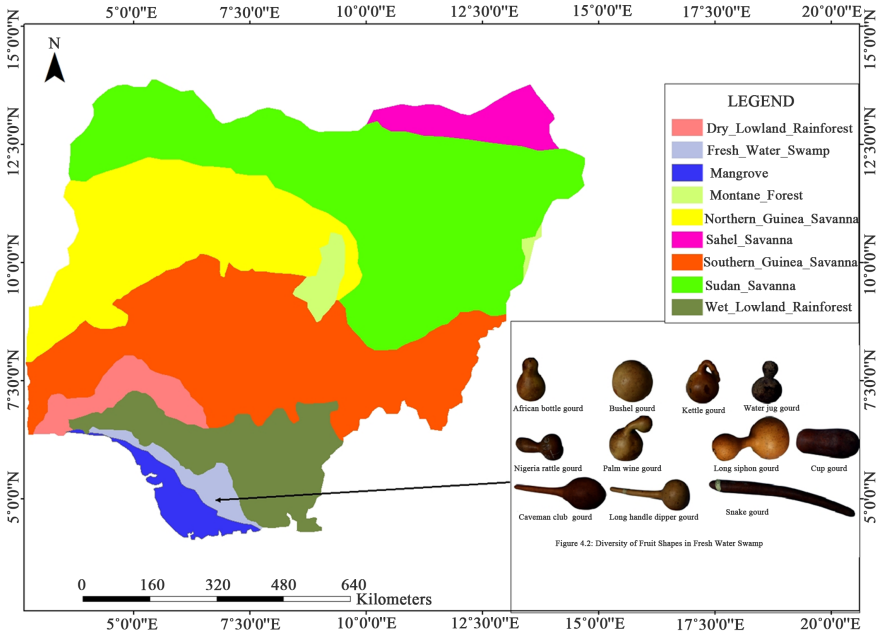

Figure 6. *Lagenaria species* distribution across Fresh Water Swamp.

Swamp vegetation are eleven which includes: Snake Gourd, Bushel Gourd, African Bottle Gourd, Caveman Club Gourd, Long Handle Dipper Gourd, Cup Gourd, Kettle Gourd, Palm Wine Gourd, Long Siphon Gourd, Water Jug Gourd and Nigeria Rattle Gourd.

In the Salt water Swamp vegetational belt **Figure 7**, Snake Gourd, Pot Gourd, Bushel Gourd, Indian Gourd, Caveman Club Gourd, Long Handle Dipper Gourd, Cup Gourd, Palm Wine Gourd, Chinese Bottle Gourd and Nigeria Rattle Gourd are observed to be widely distributed.

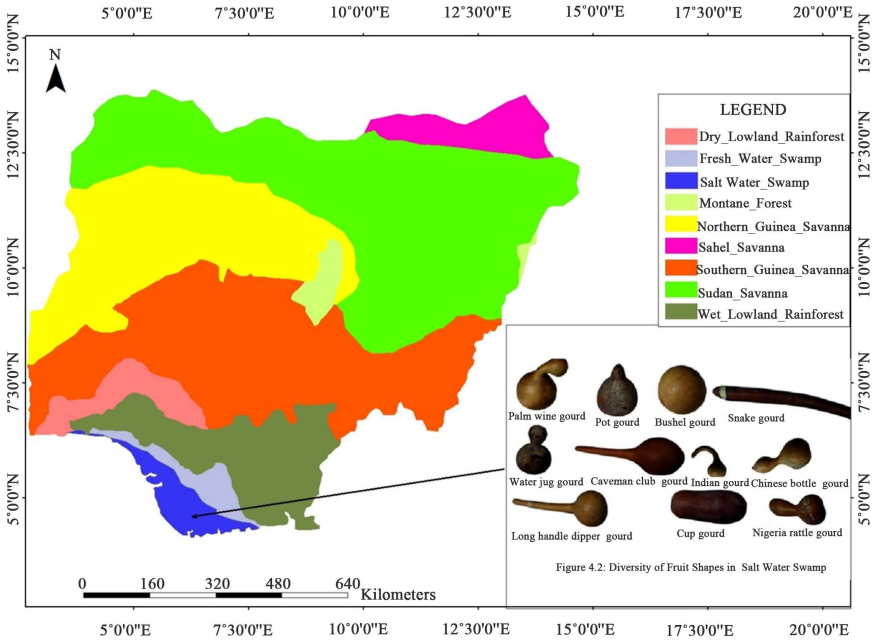

Figure 7. *Lagenaria species* distribution across Salt Water Swamp.

Geographical distribution of *Lagenaria siceraria* (Mol.) Standl. within fifteen states in Nigeriawas taken into account and formed the basis of the morphological-geographical approach introduced. The principle of discontinuity in natural variation was employed, and the species were delimited by the lines of zones of discontinuity found in nature, in congruence with the work of [32]. Thus the species is observed to occur within six geopolitical zones in the North East the species is located in Taraba state, in the North West it is found in Kaduna and Kano state, within the North Central *L. siceraria* occurs within kwara and Plateau state. In the South West geopolitical zone the species is observed in Ogun, Ondo and Oyo state. The occurrence of the species within the South East states includes Anambra, Ebonyi and Enugu. Finally, in the South South geopolitical zone the species is widely spread within Akwa Ibom, Cross River, Bayelsa and Rivers state.

The discontinuity in variation that exists within a single species has been of great concern to taxonomist in the definition of speciation [33] [34] [35]. This discontinuity exists as a result of isolation in nature which aids in establishing and widening the gap between species thereby allowing evolution. According to [33], environmental factors had been of consequential effect in shaping the appearance of a plant, hence the various landraces of *Lagenaria siceraria* (Mol.) Standl.

The spatial relationship of the species both in present and past (Wickens, 2008) were observed using Geographic Information System (GIS) as represented in **Table 1**. *Lagenaria siceraria*as part of the vegetative cover of Nigeria shows great diversity in fruit shape across the agro-ecological region of Nigeria (**Figure 2**). From the foregoing, it is observed that the diversity of fruit shapewithin the

Southern and Northern Guinea Savannah demonstrates that the Guinea Savannah is the primary centre of fruit diversity having all the twenty-four different fruit shapes represented in Nigeria (**Figure 3**) these includes: Snake Gourd, Pot Gourd, Bushel Gourd, African Bottle Gourd, Indian Gourd, Caveman Club Gourd, Long Handle Dipper Gourd, Extra Large Pawpaw Gourd, Cup Gourd Kettle Gourd, Warted Bushel Gourd, Pennis Shield Gourd, Palm Wine Gourd, Swan Gourd, Water Jug Gourd, Mini Dipper Gourd, Chinese Bottle Gourd, Long Siphon Gourd, Powder Horn Gourd, Goose Neck Gourd, Base Ball Gourd, Bird House Gourd, Nigeria Rattle Gourd and Microphone Gourd.

The research further buttressed that the centre of diversity were also the centres of origin of the species since it holds the relics of the ancestral genetic material of the species. The tropical rain forest has about nineteen (**Figure 4**) diversity of fruit shapes which includes: Snake Gourd, Pot Gourd, Bushel Gourd, African Bottle Gourd, Indian Gourd, Caveman Club Gourd, Long Handle Dipper Gourd, Cup Gourd, Kettle Gourd, Warted Bushel Gourd, Pennis Shield Gourd, Palm Wine Gourd, Mini Dipper Gourd, Long Siphon Gourd, Powder Horn Gourd, Goose Neck Gourd and Nigeria Rattle Gourd in both the Dry and Wet Lowland Tropical Rainforest vegetational belt of Nigeria. *Lagenaria siceraria* (Mol) Standl distribution at the Salt water swamp (**Figure 5**) includes the following Snake Gourd, Pot Gourd, Bushel Gourd, Indian Gourd, Caveman Club Gourd, Long Handle Dipper Gourd, Cup Gourd, Palm Wine Gourd, Chinese Bottle Gourd and Nigeria Rattle Gourd while the Freshwater swamp (**Figure 6**) also have eleven different fruit shapes within the zone these includes Snake Gourd, Bushel Gourd, African Bottle Gourd, Caveman Club Gourd, Long Handle Dipper Gourd, Cup Gourd, Kettle Gourd, Palm Wine Gourd, Long Siphon Gourd, Water Jug Gourd and Nigeria Rattle Gourd. The distribution of the fruit diversity towards the Sudan Savannah shows about seventeen different fruit shapes such as Snake Gourd, Pot Gourd, Bushel Gourd, African Bottle Gourd, Indian Gourd, Caveman Club Gourd, Long Handle Dipper Gourd, Cup Gourd, Kettle Gourd, Warted Bushel Gourd, Pennis Shield Gourd, Palm Wine Gourd, Mini Dipper Gourd, Long Siphon Gourd, Powder Horn Gourd, Goose Neck Gourd and Nigeria Rattle Gourd (**Figures 7-13**). Although most landraces are found fairly continuously throughout the area of distribution, some have distribution patterns which are interrupted by some areas from which the species is absent and this pattern is seen as disjunct distribution [34] [35]. The disjunction might have arisen from the long-range dispersal of the landraces from one area to another.

Furthermore, the disjunction might be as a result of depopulation of the area and the antique found in the salt and fresh water swamp represent the former wide, continuous distribution pattern. The landraces may not be seen as having originated independently in the various ecological zones, because the different fruit shapes observed in the Guinea savannah can be seen in the other ecological zones, hence are thought to have a common ancestor. The spread of the

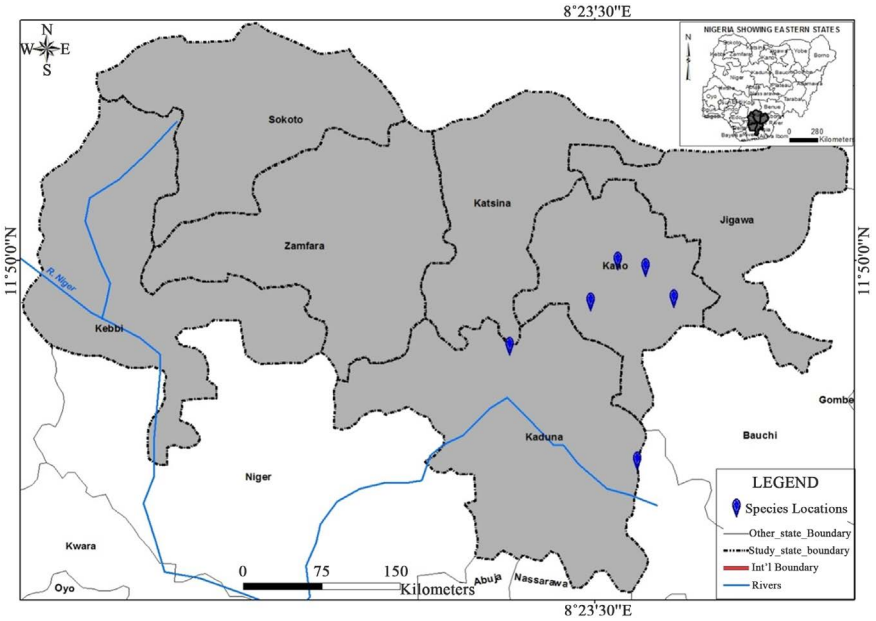

Figure 8. North west geopolitical zone.

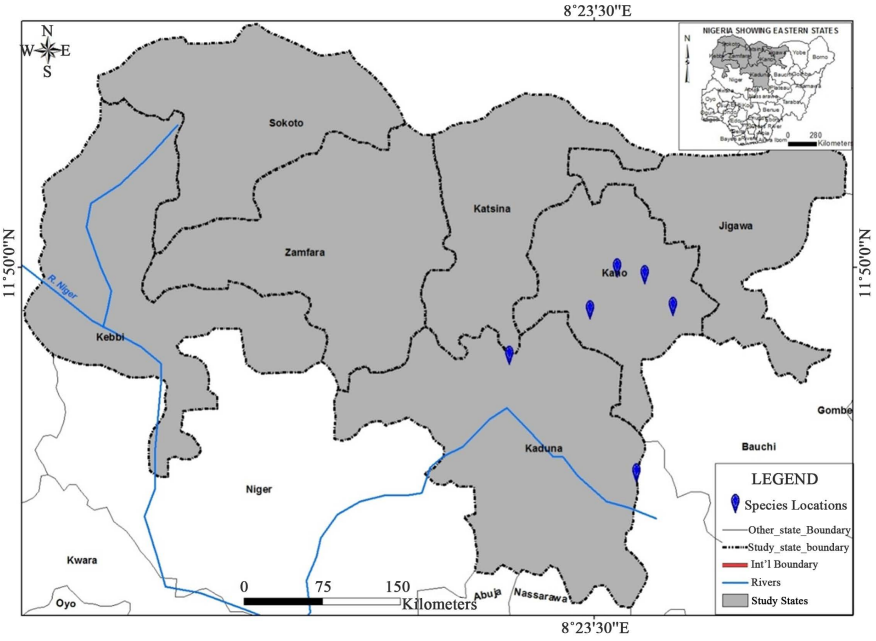

Figure 9. North east geopolitical zone.

landraces across the various ecological zones points to the fact that they are vicariance a term introduced [35]. The vicariants may have arisen from migration across the ecological zones and evolving through divergent evolution. Singh G [33] states that geographical separation of lineages leads to lineage independence and ensuing speciation. The separation of the landraces of *L. siceraria* across the ecological zones of Nigeria over time resulted to the development and maintenance of gene combinations which controls the morphological, physiological and anatomical characters of the species as seen in the diversity of fruit, seed, and

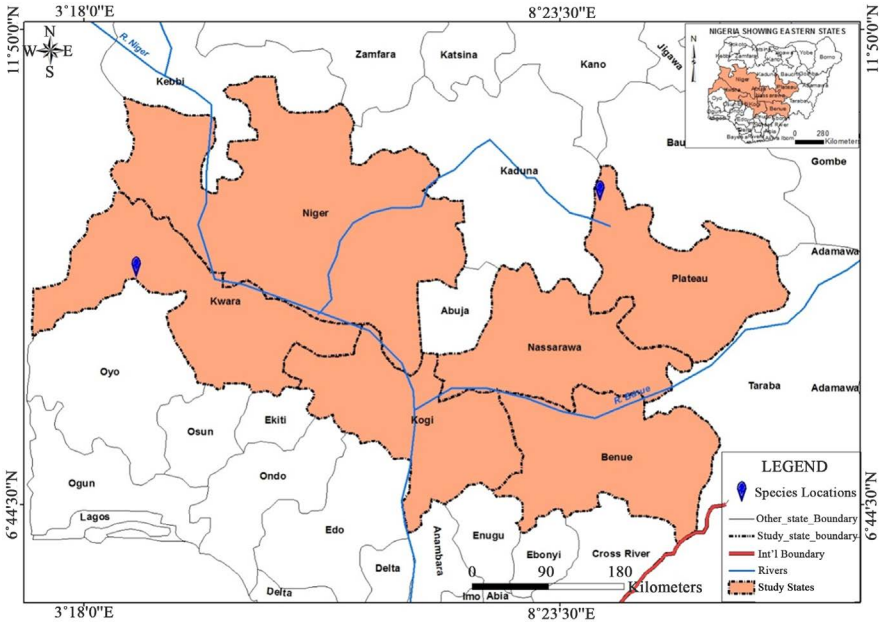

Figure 10. North central geopolitical zone.

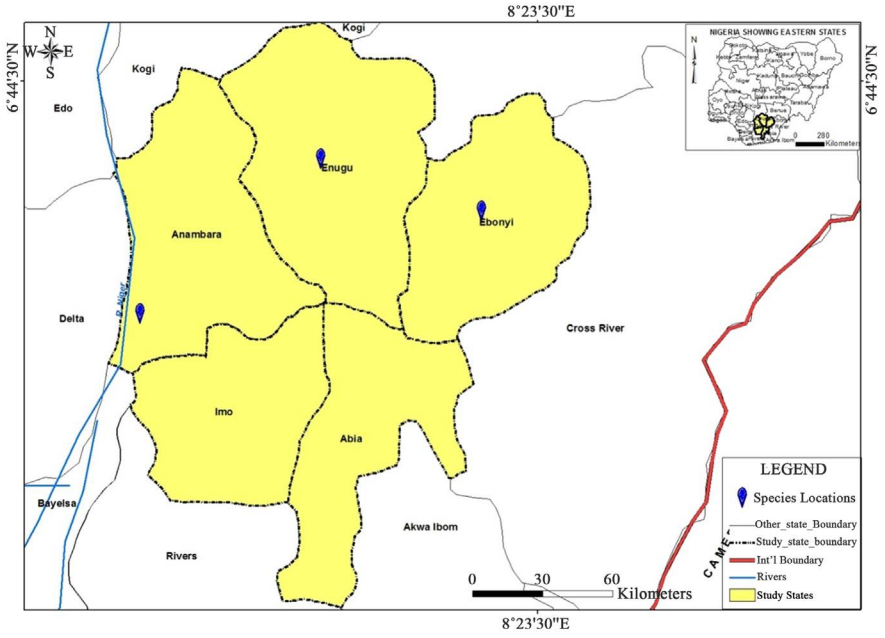

Figure 11. South east geopolitical zone.

gene. Another major observation is in the development of reproductive isolation when the twenty-four different fruit shapes randomly selected across the agro-ecological zones were potted in the ecological centre of the University of Port Harcourt, they were subjected to the same environmental condition such as temperature of 26˚C, rainfall, soil texture, they all germinated and grew together under the same condition thereby eliminating environmental plasticity but maintained their specific fruit shapes hence, are not an ecocline but a topocline, since it is found growing across the geographical regions of Nigeria.

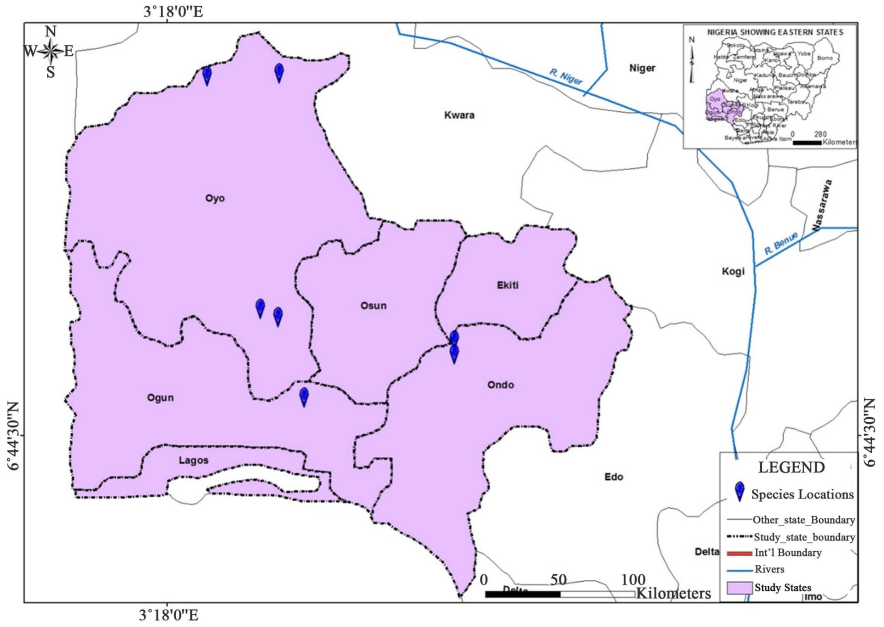

Figure 12. South west geopolitical zone.

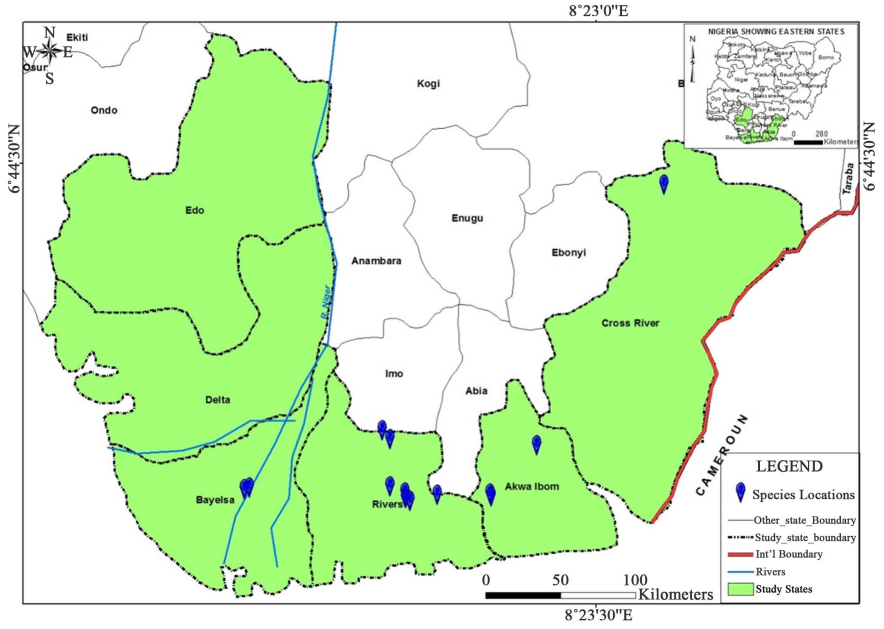

Figure 13. South south geopolitical zone.

4. Conclusion

The phytodistributional studies of *L. siceraria* have shown that the landraces have a wide distribution and variation which spreads across the agro-ecological zones ranging from Guinea savannah as the centre of origin having a total of twenty-four different fruit shapes to Tropical rain forest, across the Sudan savannah through the Fresh and Saltwater swamp hence proven to be a topocline since they are not limited only by environmental factors. The separation of the landraces over time across the zones has resulted in allopatric speciation of the

species hence the morphological diversity of the fruits. The present study has provided some vital information on the phytodistribution of the species across the ecological zones of Nigeria.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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