

Assessment of Ficus L. Diversity in Amurum Forest Reserve in Jos, Plateau State, Nigeria

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Abstract: A Study Was Carried Out In Amurum Forest Reserve Of Jos, Nigeria To Measure The Diversity Of Ficus In The Three Habitat Types Of The Reserve. Forty-Nine Plots (25 In The Rocky Outcrop, 8 In The Savanna Scrub And 16 In The Gallery Forest Habitats) Each Measuring 100x100m Were Established After A Pilot Study Was Done To Establish The Positions Where Ficus Occurred In The Reserve. In Each Plot, The Various Ficus Species Encountered Where Identified And Counted. A Total Number Of 720 Individuals Were Sampled Belonging To Twenty-Two (22) Species Of Ficus Were Identified. Mean Ficus Richness And Diversity Was Significantly Different Across The Different Habitats. Mean Richness And Diversity Was Highest In The Rocky Outcrop Habitat, Followed By The Savanna Scrub Habitat And Then, The Gallery Forest Habitat. Non-Metric Multidimensional Scaling (Nmds) Ordination Revealed A Strong Grouping Of Species By Habitat Types. The Results From The Study Revealed That The Genus Ficus Is Widely Distributed In Amurum Forest Reserve And The Rocky Outcrop Habitat Holds Most Of The Species. Ficus Richness And Diversity Being Significantly Higher In The Rocky Outcrop Could Be Because Rocks Are Rich In Minerals And So Provides Them With A Medium For Germination. Ficus Species Also Have The Ability To Withstand Dryness. The Study Confirms That Ficus Are Important Species Of Conservation Value.

I. Introduction

There Is A Rapid Decline Of Variety Of Life On Earth (Possingham And Wilson, 2005). According To Scheffers Et Al., (2012), Human Activities Currently Drive Species To Extinction At 100–1000 Times Their Natural Rate And Therefore The Need To Discover And Describe Species Has Never Been More Urgent. The Establishment Of Protected Areas For In Situ Biodiversity Conservation Is One Of The Management Strategies Adopted To Conserve The World's Remaining Biodiversity (Reyers Et Al., 2000). However, The Effectiveness Of In Situ Conservation Strategies Depends On The Existence Of Adequate Data Bases About The Distribution Of Species And Other Natural Features.

The Ficus L. Commonly Called “Fig” Is An Exceptionally Large Pan-Tropical Genus With Over 700 Species Making Up About Two-Thirds Of The Members Of The Family Moraceae (Berg, 1989, Zerega Et Al. 2004). It Is Recorded To Be The Most Diverse Plant Genera Of The World Occurring As Trees, Shrubs And Epiphytes (Rosted, 2008). Frodin (2004) And (Harrison, 2005), Ranked Ficus To Be The Twenty- First Largest And Diverse Group Of The Seed Plants Which Differ In Growth Habit, Having Both Deciduous And Evergreen Free-Living Trees, Shrubs, Climbers, Stranglers, Rheophytes And Lithophytes And Its Members Play Important Roles In The Communities They Exist. They Play An Important Role In The Terrestrial Ecosystems By Acting As Keystone Species And Thus, The Study Of Ficus Is Important Regarding Existence Of Species, Habitats, Biological Communities And The Interaction Between Species And The Ecosystem (Ian, 1996). The Species Names Of Ficus Are Given Based On Local Geographic Origin, Fruit Shape, Size And Type Of Wasps' Pollinators (Caliskan, Et Al., (2008).

Ficus (Fig) Species Have A Wide Range Of Distribution And Uses. It Is Reported To Be Used Indigenously As Food, Fodder, Fuel Wood, Vegetable, Medicine (Shrestha And Dhillon, 2003). Many Species Are Cultivated For Shade And Ornament In Gardens. Some Species Serve As Good Sources Of Latex/Rubber. The Fig Is A Very Nourishing Food And Is Used As An Industrial Product (Rout And Aparajita, 2009). It Has Been Reported By Shrestha (1999), That Ficus Religiosa (Pipal), F. Bengalensis (Bar), F. Benjamina (Sami), F. Racemosa (Dumri), Especially Have A High Religious Value For Both Hindus And Buddhists And Are Deemed Sacred. The Indigenous Use As Medicine Is Very Important. F. Bengalensis (Bar) Was Found As A Medicinally Important Species, Used To Treat 22 Ailments In Nepal.

Several Studies Have Revealed That Ficus Contribute Greatly In The Study Of The Interaction Of Other Flora And Fauna Species In An Ecosystem But Sometimes Identifying And Differentiating Ficus Species Is Challenging Because Of Their Morphological Similarities. Although The Asian Species Of Ficus Have Been Worked Out By Corner (1965), However There Is No Separate Account Of Species Found In Nigeria Except For Comparative And Diversity Studies Of Fig-Wasps And Pharmacognosistic Studies Of Some Species. Similarly, Previous Studies Carried Out In Amurum Forest Reserve By Daru, (2007); Yadok, Et Al., (2009) And Yessoufou Et Al., (2012); Focused On The Diversity Of Fig Wasps In Some Ficus Species And The Interaction

Of Figs And Frugivores Respectively. To The Best Of My Knowledge, There Is No Adequate Information On Ficus Species Diversity In Nigeria. Thus The Aim Of This Study Was To Analyse Ficus Plant Community Composition And Diversity In Amurum Forest Reserve Of Jos, Nigeria. The Objectives Of The Study Included- 1. To Assess Ficus Species Composition In Amurum Forest Reserve And 2. To Measure Ficus Diversity In Relation To The Habitat Types Of Amurum Forest Reserve

II. Materials And Methods

Study Site

The Study Was Carried Out In The Amurum Forest Reserve, A 300ha Forest Fragment Located 15 Km Northeast Of Jos In North -Central Nigeria, At Latitude 09°53' N, Longitude 08°59' E, And At 1280m Above Sea Level (Vickery And Jones, 2003). Amurum Forest Is One Of The Important Bird Areas (Iba) In Nigeria With At Least 278 Bird Species. The Reserve Houses Some Endemic Bird Species-Lagonosticta Sanguinodorsalis Payne (Rock Firefinch) And Vidua Maryae Payne (Jos Plateau Indigo Bird) (Ezealor, 2001). Other Faunal Species Include Rock Hyraxes, Bat, Rabbits And Several Species Of Reptiles (Ibrahim 2002)

It Comprises Of Three Major Habitats-The Gallery Forest, Savanna Woodlands, And Rocky Outcrops, All Of Which Differ Remarkably In Floristic Composition (Yessoufou, Et Al., 2012). The Soil Is, For The Most Part Brick Red Laterite Around Gullies And A Mixture Of Sand And Clay In The Savanna. Temperature Ranges From 8° To 38° C, And Mean Annual Rainfall Is 1411mm (Payen, 1998).The Common Tree Species Include Khaya Senegalensis, Daniella Oliveri, Parkia Biglobosa, Lophira Lanceolata, Ficus Spp (Ezealor, 2002).

Amurum Forest Reserve Is A Vulnerable Site Of Conservation Concern Because Of Its Small Size And Proximity To The Urban Community Of Jos. Though The Reserve Is A Protected Area, There Are Still A Few Sporadic Cases Of Wood Cutting And, Grazing And Setting Of Fire (Abiem, 2013; (Agaldo, 2010).

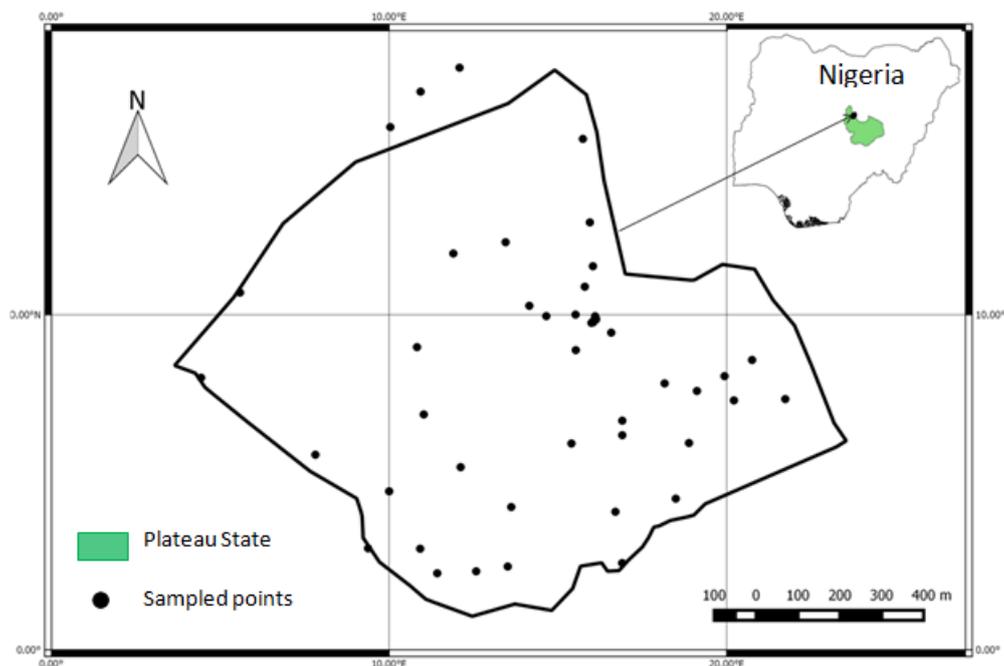


Figure 1: Map Of Study Area Showing Points Where Plots Were Made In Amurum Forest Reserve

Data Collection

A Two Weeks Pilot Survey And Thorough Focal Scanning Of Ficus Species Was Conducted In The Three Habitat Types Of The Reserve And Where Ficus Species Are Encountered, Red Ribbons Was Used As Tags For Easy Future Sighting. This Was Done To Enable Opportunistic Data Collection. Identification Of Ficus In The Field Was Done Using Arbonnier (2004).

The Study Was Conducted Between The Month Of August And September 2014. Preferential Sampling Technique Was Used With Respect To The Occurrence Of Ficus Species As Tagged During The Pilot Study, Merckx Et Al, (2011). Forty-Nine (49) 100 X 100m Plots Were Established Using A Measuring Tape. The Coordinates For Points Where Plots Were Established Were Recorded Using Garmin Etrex® Global Positioning System (Gps) (Fig 1). Of The Total Plots Sampled, 25 Were In The Rocky Outcrops, 8 In The Savanna Woodland And 16 In The Gallery Forests. In Each Plot, The Various Ficus Species Encountered Where Identified And Counted. Voucher Specimens Were Collected And Deposited At The Herbarium Of The University Of Jos.

Data Analysis

Data Was Analyzed Using R Statistical Software Version 3.0.2 .

- Plant Species Diversity Was Calculated Using Shannon - Weiner Diversity Index (Clarke And Warwick, 2001).
- One-Way-Anova Was Used To Compare The Abundance, Species Richness And Diversity Of *Ficus* Among The Habitat Types In The Reserve. Multiple Comparisons Were Carried Out Using Tukey’s Hsd (Honest Significant Difference) Test To Compare The Significant Difference *Ficus* Species Between The Habitats.
- Non-Metric Multidimensional Scaling (NmDS) Ordination Method Was Used To Characterize The *Ficus* Community Structure Of The Reserve. NmDS Is An Ordination Technique, Which Functions In An Iterative Manner By Minimizing Stress Between Distance In The Original Matrix And Distance In An Ordination Space (McCune And Grace, 2002). It Was Used To Describe The Pattern Of Plant Species Distribution. Only Plots Having A Total Number Of 5 Individual Plants And Above Were Used In The Analysis.

General Results

A Total Of 720 Individual Plants Belonging To Twenty-Two Species Of *Ficus* Were Recorded And Nineteen Species Identified During The Survey. Overall *Ficus* Species Richness And Abundance Was Highest In The Rocky Outcrop 20 Species, 605 Individual As Compared To The Other Habitat Types. The Gallery Forest Had 5 *Ficus* Species And 78 Individuals While The Savanna Scrub Habitat Had 9 Species And 37 Individual Plants (Table 1)

The Mean Number Of *Ficus* Species Recorded Per Habitat Was Higher In The Rocky Outcrop (27.50±42.62, N=20) Than In The Gallery Forest (3.54±9.57, N=9) And In The Savanna Scrub (1.68±2.40, N=5).

Table 1: List Of *Ficus* Species Present In The Habitat Types

S/N	Species Code	Species	Gallery Forest	Rocky Outcrop	Savanna Scrub
1	Fiabut	<i>Ficus Abutilifolia</i> (Miq.) Miq.	0	176	0
2	Fiaspe	<i>Ficus Asperifolia</i> Miq.	0	0	3
3	Fibenj	<i>Ficus. Benjamina</i> L.	0	0	5
4	Ficord	<i>Ficus Cordata</i> Warb	0	112	0
5	Ficoro	<i>Ficus Coronate</i> Spin	4	10	2
6	Fiexas	<i>Ficus Exasperate</i> Vahl	0	1	3
7	Figlum	<i>Ficus Glumosa</i> Del.	0	63	0
8	Fiinge	<i>Ficus Ingens</i> (Miq.) Miq.	0	18	0
9	Fileca	<i>Ficus Lecardii</i> (Wab) Cc Berg	0	60	0
10	Filute	<i>Ficus Lutea</i> (Miq/Miq.)	25	47	0
11	Fimamo	<i>Ficus Mamornata</i> Baker	0	1	0
12	Fiovat	<i>Ficus Ovate</i> Vahl	40	16	8
13	Fipeti	<i>Ficus Petiolaris</i> L.	0	1	0
14	Fireli	<i>Ficus Religiosa</i> L.	0	9	0
15	Fisp1	<i>Ficus Sp 1</i> (Not Identified)	0	1	0
16	Fisp2	<i>Ficus Sp 2</i> (Not Identified)	0	1	0
17	Fisp3	<i>Ficus Sp3</i> (Not Identified)	0	1	0
18	Fisur	<i>Ficus Sur</i> Forssk	2	12	4
19	Fisyco	<i>Ficus Sycomorus</i> (Wab) Cc Berg)	0	6	5
20	Fithon	<i>Ficus Thonningii</i> Vahl	0	22	6
21	Fiumbe	<i>Ficus Umbellate</i> Vahl	0	43	0
22	Fivoge	<i>Ficus Vogelii</i> Vahl	7	5	1
			78	605	37

Key: 0 =absent

Mean *Ficus* Richness And Diversity In Amurum Forest Reserve

The Mean *Ficus* Richness Was Significantly Different (F=30.57; Df=2; P<0.001) Across The Three Habitat Types (Figure 2). The Rocky Outcrop Habitat Had The Highest Mean *Ficus* Species Richness Which Was Followed By The Savanna Scrub Habitat. The Gallery Forest Habitat Had The Least Mean *Ficus* Species Richness.

Mean Diversity Of *Ficus* Also Differed Significantly (F=22.87; Df=2; P<0.001) Across The Three Habitat Types With The Rocky Outcrop Having The Highest Mean *Ficus* Diversity, Followed The Savanna Scrub Habitat And Then The Gallery Forest Habitat (Figure 3).

Multiple Comparisons Between The Habitats Using Tukey’s Post-Hoc Test Showed A Significant Difference In *Ficus* Species Richness And *Ficus* Diversity Between The Rocky Outcrop And The Gallery Forest, Between The Rocky Outcrop And The Savanna Scrub And A Non Significant Difference Between The Gallery Forest And The Savanna Scrub As Shown In Tables 2 And 3 Respectively.

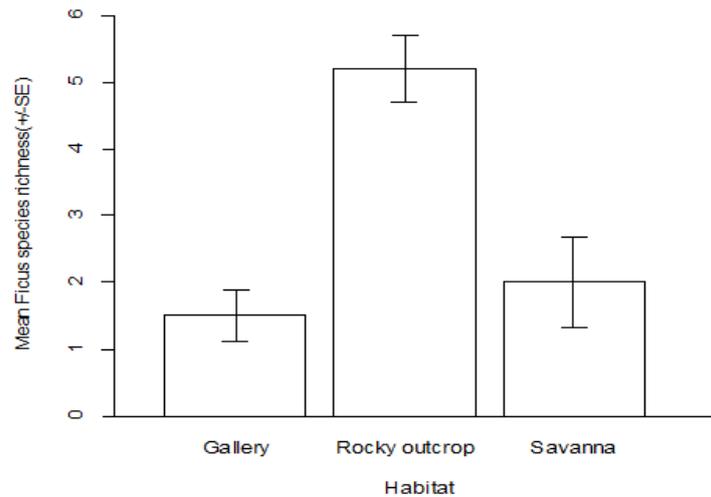


Figure 3: Mean Plant Species Richness Across Habitats In Amurum Forest Reserve.

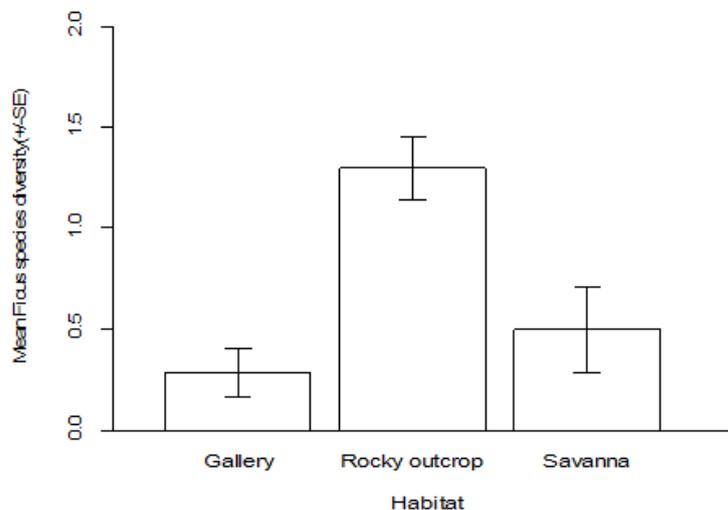


Figure 4: Mean Diversity Of *Ficus* In The Three Habitats Of Amurum Forest Reserve

Table 2: Tukey’s Hsd Test For Multiple Comparison Of *Ficus* Richness Between The Three Habitat Types

Habitat	Habitat	Difference In Means	Standard Error	P-Value
Savanna Scrub	Gallery Forest	0.50	3.20	0.74
Rocky Outcrop	Gallery Forest	3.72	2.53	0.00
Rocky Outcrop	Savanna Scrub	3.21	3.12	0.00

P Value In **Bold** Indicates Significant Variation.

Table 3: Tukey’s Hsd Test For Multiple Comparison Of *Ficus* Diversity Between The Three Habitat Types.

Habitat	Habitat	Difference In Means	Standard Error	P-Value
Savanna Scrub	Gallery Forest	0.21	1.02	0.58
Rocky Outcrop	Gallery Forest	1.01	0.74	0.00
Rocky Outcrop	Savanna Scrub	0.79	0.92	0.00

P Value In **Bold** Indicates Significant Variation

Ficus Species Community Structure

Non-Metric Multidimensional Scaling (NmDs) Ordination Resulted In A 2-Axis Optimal Solution. Final Stress Was 12.5, Within The 10-20 Range Typically Found In Ecological Community Data Sets (McCune And Grace, 2002 As Reported By Naidoo, 2004). Stress Is A Statistic Of Goodness Of Fit And It Is A Function Of Observed Dissimilarities And Ordination Distances.

The Ordination Plot Revealed A Grouping Of Sampling Stations By Habitat Types (Figure 5). Rocky Outcrop And Gallery Forest Habitats Clustered Separately. The Three Sampling Stations Of The Savanna Scrub Habitat Were The Most Dissimilar As They Did Not Cluster Together But Appeared In Different Sections Of The Ordination Plot.

An Ordination Plot Of The Species Scores Revealed That Ficus Species Clustered According To Habitat Type (Figure 6).

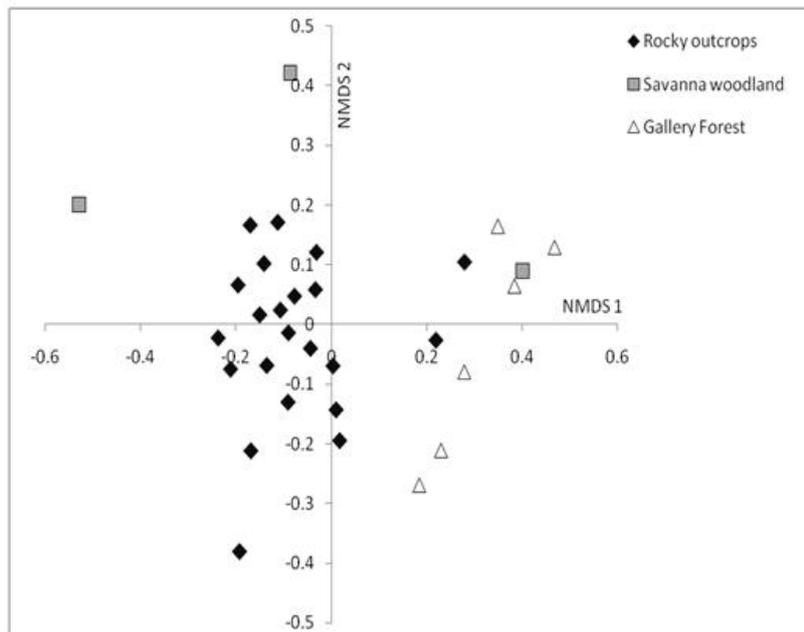


Figure 5: Ordination Plot Of Sampling Points Along Non-Metric Multi Dimensional Scaling (NmDs) Axes 1 (X-Axis) And 2 (Y-Axis). (Sampling Points More Close Together Are More Similar In Their Ficus Species composition).

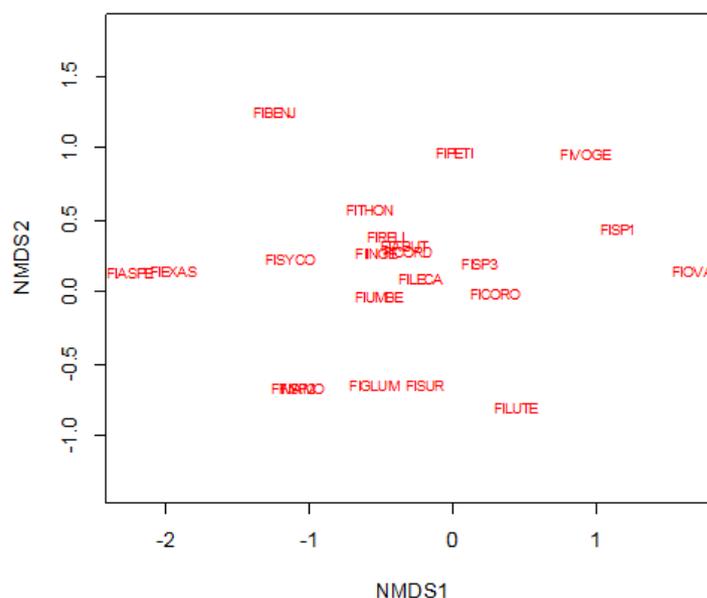


Figure 6: Ordination Plot Of Ficus Species Along Non-Metric Multidimensional Scaling (NmDs) Axes 1 (X-Axis) And 2 (Y-Axis). (See Table 2 For Species Abbreviations).

III. Discussion

A Total Number Of 22 Ficus Species Were Recorded From The Study. This Is More Species When Compared To Previous Studies Done In Amurum Forest Reserve By Abalaka (2009) As She Recorded Twelve Species. This Difference May Be Due To The Sampling Technique And Plot Size Which Gave An Opportunity For More Species To Be Sampled. From The Results Of This Study, The Rocky Outcrop Holds A Large Number Of Ficus Species Compared To The Other Habitats (Savanna And Gallery Forest).

Ficus Richness And Diversity Was Significantly Higher In The Rocky Outcrop. This Could Be Accredited To Soil Factor (Such As Soil Mineral And Soil Type), Ability To Withstand Dryness Provides Them With A Medium For Germination And Dispersal Activities Takes Place More On Rocks Outcrop By Fauna Species Especially The Bat. (Burrows And Burrows 2003; Jansen, 2005; And Burring 2006). Jansen, (2005) And Orwa Et Al., (2009) Reported That Ficus Species Are Commonly Found In Rocky Outcrops And Rocky Hills.

From The Ordination Plot (Fig 6), The Species Showed A Similarity In The Habitat Which They Occurred. Species Such As *F. Abutilifolia*, *F. Codata*, *F. Glumosa*, *F. Ingens*, *F. Religiosa*, *F. Lecardii*, *F. Marmorata*, *F. Lutea*, *F. Vogelii* Where Identified To Occur In The Same Habitat Type Which Is The Rocky Habitat. This Study Agrees With The Study Of Burrows And Burrows (2003) And Burrow (2006) In Which They Suggested Rocky Figs To Be Of The Same Ancestral Origin In Terms Of Habitat While Some Have Developed An Adaptation To Thrive In Other Habitat Types As Observed In Amurum Forest Reserve. The Most Abundant In The Gallery Forest Includes: *F. Vogelii* And *F. Lutea* Were Found More In Gallery Forest. Meanwhile, *F. Sur* And *F. Sycomorus*, *F. Exasperate*, *F. Asperifolia*, Were Found To Be Restricted To The Savanna Only. But *F. Coronate*, *F. Lutea*, *F. Vogelii* Was Found In Rocky Outcrop, Savanna Scrub And Gallery Forest.

It Was Observed In Different Plots And Among Same Species Exhibiting Different Leaf Age And Fruiting Season. At Different Period During The Study, Same Species Of *F. Glumosa*, *F. Abutilifolia*, *F. Umbellata*, *F. Cordata*, *F. Lutea* And *F. Ovate* Were Found Fruiting And Leafing At Different Period. It Is Assumed That Environmental Factors Such As Soil Type, Amount Of Water And Mineral Composition Are Assumed To Be The Factors Responsible For The Leafing And Fruiting Variation In The Same Period Found At Different Location Among Same Species There By Given The Species Morphological Difference.

IV. Conclusion

There Was A Significant Difference Of Ficus Richness And Diversity In The Three Habitat Types Of Amurum Forest Reserve. Therefore, This Suggests That Habitat Plays A Functional Role In The Distribution Of Ficus Species. From Observation, There Was An Interaction Between Ficus Species And Fauna Species. These Suggest That In The Wild, Ficus Species Provide Shelter, Food For Frugivor And A Breeding Ground For Wasps, Aves And Mammalian Species As Earlier Suggested By Melvin (2007), Daru (2007), Yadok And Mwansat (2009) And Yessoufou, Et Al., (2012). This Study Agrees With The Study Of Frank Et Al., (1991), Where He Suggested That Ficus Are Key Stone Species. Amurum Forest Reserve Being An Important Bird Area These Plant Species If Properly Conserve Can Fully Be Utilized By Bird Species. It Was Also Observed That Ficus Species Also Interact With Their Close Neighbors, Other Woody Plant Species As Some Ficus Species Used Them As Support During Growth Until Maturity.

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