***Original Research Article***

**Pteridophytes Survey and its Indigenous Uses in Cross River State-Nigeria**

**ABSTRACT**

Pteridophytes (Ferns and fern allies) make up an important component of tropical flora, providing several ecosystem functions, yet it is neglected and understudy compare to the higher plants. The occurrence, distribution and indigenous uses of ferns within the tropical forest of Cross River State were studied with the aim of identifying and documenting the pteridophytic flora in the state. Ten (10 m × 10 m) plots were established for each forest across nine (9) Local Government Areas (LGAs) of Cross River State selected for the study. The study adopted a non-random preferential sampling method where all fern species encountered in each plot were collected, identified, and documented. Collected ferns were identified using taxonomic flora, literatures and experts in the field of Taxonomy, while conservation status of each identified fern species was assessed from recent IUCN 2023 red list website. Voucher specimens were deposited in the Herbarium of University of Cross River State (UNICROSS), Calabar. Structured questionnaire was used to obtained information on the knowledge and uses of identified species. Geographical coordinates of each sampled plot were obtained using a Global Positioning System (GPS) device. Field survey took place across the nine (9) LGAs for a period of six (6) months from July, 2024 to December, 2024. A total of forty five (45) species belonging to twenty three (23) genera and fifteen (15) families were recorded for the study with Erokut in Akamkpa having the highest number of species (41 species), followed by Okwangwo in Boki with thirty-seven (37) species, while Afrike in Bekwara Akpet Central in Biase and Sankwala in Obanliko had the lowest number with fourteen (14) species each. Accordingly, wet season had more species (37 species) than the dry season (29 species). This difference in species richness between wet and dry season was statistically significant at p=0.05. However, *Arthropteris orientalis, Microgramma mauritiana, Nephrolepsis biserrata, Nephrolepsis exaltata, Pityrogramma calomelanos, Platycerium bifurcatum* and *Selaginella versicolor* were the most common species across the various locations, whereas *Adiantum capillus-veneris, A. lunulatum* and *A. vogelii* were only common to Erokut-Akamkpa study location. Overall Shannon diversity index gave a value of 3.62 and evenness value of 0.6407. In general, there were 60% non-epiphytic species, 36% epiphytes while 4% occurred as non-epiphytic and epiphytic species respectively. Conservation status showed that 87% of species were not evaluated while 13% were categorized as least concern. Knowledge on indigenous uses of the species showed only two (2) species (*Diplazium esculentum* and *Platycerium superbum*) of ferns were used by the people with *Diplazium esculentum* frondusedas vegetable while decoction of the leaves of *Platycerium superbum* are used for treating impotency. The study highlighted the rich diversity of ferns and fern allies in Cross River State, with notable variations across locations and seasons, with low level of indigenous utilization suggesting a knowledge gap that needs further ethnobotanical research. Additionally, lack of conservation assessment for most species underscores the need for conservation initiatives to protect these important plant groups.

**Keywords**: Pteridophyte, ferns, indigenous, Survey, Ecosystem

## 1. INTRODUCTION

Pteridophytes (ferns and fern allies) are seedless vascular plants with body structures differentiated into roots, stems, fronds, and pinnae. Their inability to produce flowers, seeds, and fruits (Cryptogamic) makes them different from higher plants (Asikiye et al., 2023; Shoyemi-Obawanle et al., 2022). Some ferns are perennial, annual, terrestrials, aquatics, or epiphytic.  Ferns are among the most prominent and abundant groups of plants that constitute an indispensable part of the natural habitats and flora of tropical forests.  Their diversity, richness, and distribution in tropical parts of the world including Nigeria, are attributed to factors such as seasonality, soil condition, habitat, elevation, rainfall, temperature, and anthropogenic activities (Bandyopadhyay and Dey, 2022). Worldwide, there exist about 11,916 taxa with 337 genera, 51 families, 14 orders, and two classes of ferns, out of which about 2,865 species are epiphytic (PPG-I, 2016). According to Edwin-Wosu et al. (2022) and CBD (2001), there are 165 species of Pteridophytes endemic to Nigeria. Out of the 11,916 species globally recorded (PPGI 2016), roughly a quarter (2,865 species) is epiphytic (Bassey et al. 2024; Haque et al., 2016). The largest genera in the fern group are Asplenium, with 900 species, and Adiantum and Cyathea with 700 species each. Family dominance has been observed for the fern families with Dryopteridaceae (1,100 species) and Thelypteridaceae (950 species) dominating (Azila et al., 2021).

Pteridophytes grow in many different habitats worldwide but are especially abundant in tropical rainforests and subtropical ecosystems, where temperature, light, and humidity are favorable. As a group, ferns thrive best in moist, shady environments, although a few inhabit rock surfaces (Azila et al., 2021). Some hardy species, however, can still occur in drier areas. The greatest diversity of fern species has been found occurring in the tropics where they constitute an average of 7% of all vascular plant species of rainforests with roughly, 70% of ferns found in tropical climates, while the remaining 30% occurring in temperate climates (George, 2020), globally fern diversity declines more strongly towards arid and cold climatic conditions than that of angiosperms. Ferns are usually perennial plants that differ from the more primitive lycophytes in having true leaves (megaphylls), and from the more advanced seed plants (gymnosperms and angiosperms) in lacking seeds. Like all vascular plants, it has a life cycle called alternation of generations, characterized by a diploid sporophytic and a haploid gametophytic phase. Unlike the gymnosperms and angiosperms, ferns' gametophyte is free–living. This group of plants first appeared in the fossil record in the early carboniferous period (Bassey et al., 2023).

Pteridophytes which make up a substantial component of some tropical and sub-tropical forests of the world play a very beneficial role to mankind, acting as an indicator of forest and environmental disturbances, and have the ability to clean polluted environment through a process called phyto-remediation (Asikiye et al., 2023; Rahmad and Akomolafe, 2018). The ethno-medicinal importance of Pteridophytes is not well known, since it is not easily available like flowering plants.

In Nigeria, ferns and fern allies have an extensive coverage, especially in tropical parts of the country. However, changes in habitat fragmentation, climate change, urbanization, and high levels of poverty with corresponding increases in dependence on forest resources, have threatened the growth, survival, and distribution of fern species (Chioma et al., 2021).  Cross River State which has been adjudged home to one of the 25 Biodiversity Hotspots in the world (Bassey et al., 2024; USAID, 2008), lacks a documented inventory of the fern flora in her forest, which would have served as an indicator for monitoring species loss, level of forest disturbances and general forest productivity. Furthermore, information on their diversity, distribution, and ecology in Cross River State is either lacking or incomplete. However, despite their role in environmental/forest management, and the numerous medicinal and economic uses, this group of plants has been overlooked and underutilized due to their relatively small size compared to higher plants.

**2. MATERIALS AND METHODS**

**2.1 Study area**

The study was carried out in nine (9) out of the eighteen (18) Local Government Areas of Cross River State. Cross River State (CRS) is a coastal state in South-South region of Nigeria, named after the cross river, which passes through the state. Located in the Niger Delta, the state occupies 20,156 square kilometers (Akwaji *et al.,* 2022; Chioma *et al.,* 2021). It shares boundaries with Benue State to the north, Enugu and Abia States to the west, to the east by Cameroon Republic and to the south by Akwa-Ibom and the Atlantic Ocean (CRADP, 1992). The state is situated between Latitude 5o45”N to 5o43”N and Longitude 8o30”E to 8o35”E with an elevation of 140mm to 400mm above sea level.

Cross River State belongs to tropical rainforest belt where rainfall is usually seasonal and at times very heavy. The rainy season in the state starts in April and ends in September, while the dry season commences in October and ends in March. The rainfall pattern is bi-modal with peaks in June and September. The annual rainfall of the area ranges from 2000mm to 2250mm (NIMET, 2023). Relative humidity in the state ranges from 80% to 90% with a humid tropical climate of about 1300 - 3000mm rain fall and 30°C mean annual temperatures prevail over Cross River State, except on the Obudu Plateau, where the climate is subtemperate, with temperatures of 15°C to 23°C (NIMET, 2023). The vegetation ranges from mangrove swamps, through rainforest, to derived savannah, and montane parkland. Just as its rocks are diverse, so also are the mineral resource potentials of Cross River State. Figure 1 present study area.

**2.2 Sampling design and techniques**

Ten (10 m × 10 m) plots separated each by a minimum distance of 50 m were established for each forest across the nine (9) Local Government Areas (LGAs) of Cross River State selected for the study, making a total of 90 plots for the entire study area. For each Local Government Area, one community forest was selected randomly for sampling. The study adopted a non-random preferential sampling method as used by Zakaria and Akomolafe (2019); Akinsoji *et al.* (2016) where all pteridophytes encountered in each plot were collected, identified, and documented where necessary. Pictures of the collected specimens were taken using a hand-held Iphone and android device (Techno and Itel phones) according to the methods of Bassey *et al.* (2024). Collected ferns were identified using taxonomic flora, literatures (Reference Field Guide by Edwin-Wosu, 2019; Introductory Pteridology by Bassey, 2013; Fern and Fern-Allies of West Tropical Africa by Alston, 1959 and POWO, 2023) and experts in the field of Taxonomy, while conservation status of each identified fern species was assessed from recent IUCN 2023 red list website (www.iucnredlist.org). Voucher specimens were deposited in the Herbarium of University of Cross River State (UNICROSS), Calabar.

Structured questionnaire was used to obtain information on the knowledge and uses of the identified fern species, as well as the part (s) of the plant used. Geographical coordinates of each sampled plot were obtained using a Global Positioning System (GPS) device.

**2.3 Data analysis**

The distribution of ferns and its allies per family, genus, species and seasons across the study locations was presented using tables of numbers, percentages and charts. Species diversity was determined using Shannon-Wiener index. t-test was employed to determine differences in species occurrences per seasons. All data were analyzed using Paleontological Statistics (PAST) software.



 **Figure 1**: Map of study area

 **Source**: Cross River Geographic Information System (CRS-GIS)

**3. RESULTS AND DISCUSSION**

**3.1 Results**

Results of the study as shown in Table 1 and Appendix 1 recorded a total of forty five (45) species belonging to twenty three (23) genera and fifteen (15) families. The most abundant family was Pteridaceae with four (4) genera and ten (10) species, followed by Dryopteridaceae with three (3) genera and six (6) species as well as Polypodiaceae with three (3) genera and five (5) species (Table 1). In terms of species richness, Erokut in Akamkpa Local Government (LGA) recorded the highest number of species (41 species), followed by Okwangwo in Boki LGA with thirty-seven (37) species, while Afrike in Bekwara LGA, Akpet Central in Biase LGA and Sankwala in Obanliko LGA had the lowest species richness with fourteen (14) species each (Figure 2 and Appendix 2). Accordingly, wet season had more species (37 species) compared to the dry season with twenty nine (29) species (Figure 3 and Appendix 2). This difference in species richness between wet and dry season was statistically significant at p=0.05. Diversity indices showed an overall Shannon value of 3.362 and evenness value of 0.6407. However, diversity index values across study locations revealed Erokut in Akamkpa Local Government Area (LGA) had the highest index value, followed by Okwangwo in Boki LGA, Afrike in Bwkera and Sankwala in Obanliko LGA respectively (Table 2).

According to the distribution pattern, *Arthropteris orientalis, Microgramma mauritiana, Nephrolepsis biserrata, Nephrolepsis exaltata, Pityrogramma calomelanos, Platycerium bifurcatum* and *Selaginella versicolor* were the most common species across the locations, while *Adiantum capillus-veneris, A. lunulatum* and *A. vogelii* were only recorded in Erokut-Akamkpa (Appendix 1). The result also showed that *Diplazium esculentum*, *Nephrolepsis biserrata*, *Nephrolepsis exaltata*, *Microgramma mauritiana*, *Asplenium africanum*, *Arthropteris orientalis*, *Coniogramme africana*, *Pityrogramma calomelanos* and *Selaginella versicolor* were the most abundant species while *Bolbitis salicina*, *Pteris tremula*, *Pteris burtonii* and *Dryopteris-filix-mas* were the least abundant species in the study area (Table 3).

Also**,** all species recorded were terrestrial in habitat (Appendix 1). In terms of plant growth for, majority (60%) of the species were non-epiphytes followed by 36% that were epiphytes while 4% exhibited both non-epiphytic and epiphytic characteristics (Figure 4). It was also shown that 87% of the identified species were not evaluated, while 13% have been assessed and categorized as least concern (Figure 5). On the indigenous uses of the identified species only two (2) species (*Diplazium esculentum* and *Platycerium superbum*) were knowledgeable to the people accounting for 6.7% of the total species recorded for the study (Table 4). *Diplazium esculentum* for instance,is usedas vegetables for soup making by the people of Ekori in Yakurr Local Government Area (LGA) and Akpet Central in Biase LGA, while *Platycerium superbum* is used for treating impotency in Ukorshie in Obudu LGA.

 **Table 1**: Number of families, genera and species of ferns and fern allies in the study area

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Family**  | **Number of genus** | **Number of species** |
| 1 | Aspleniaceae | 1 | 4 |
| 2 | Athyriaceae | 1 | 1 |
| 3 | Coniogrammaceae | 1 | 1 |
| 4 | Cyatheaceae | 1 | 1 |
| 5 | Dennstaedtiaceae | 1 | 1 |
| 6 | Dryopteridaceae | 3 | 6 |
| 7 | Logodiaceae | 1 | 1 |
| 8 | Lomariopsidaceae | 1 | 1 |
| 9 | Nephrolepdiaceae | 1 | 3 |
| 10 | Oleandraceae | 1 | 1 |
| 11 | Polypodiaceae | 3 | 5 |
| 12 | Pteridaceae | 4 | 10 |
| 13 | Selaginellaceae | 1 | 5 |
| 14 | Tectariaceae | 1 | 2 |
| 15 | Thelypteridaceae | 2 | 3 |
| **Total** | **23** | **45** |

 **Source**: Researcher’s field survey (2024)



 **Figure 2:** Species distribution across locations **Figure 3**: Species distribution per seasons

 **NOTE**: **A-E**= Akamkpa-Erokut; **B-A**= Bekwera-Afrike; **B-AC**= Biase-Akpet Central;

 **B-O**= Boki-Okwangwo; **CM-A**= Calabar Municipal-Adiabo; **O-S**= Obanliku-Sankwala;

 **O-I**= Obubra-Iyamayong; **O-U**= Obudu-Ukorshie; **Y-E**= Yakurr-Ekori

 **Source**: Student’s field survey (2024)

**Table 2**: **Diversity indices**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variable**  | **A-E** | **B-A** | **B-AC** | **B-O** | **CM-A** | **O-I** | **O-S** | **O-U** | **Y-E** |
| Taxa | 41 | 14 | 14 | 31 | 17 | 15 | 19 | 17 | 16 |
| Shannon | 3.46 | 2.524 | 2.294 | 3.26 | 2.528 | 2.454 | 2.739 | 2.54 | 2.365 |
| Evenness  | 0.7758 | 0.89917 | 0.7083 | 0.8399 | 0.7367 | 0.7755 | 0.8144 | 0.7461 | 0.6652 |

 **Overall Shannon Diversity**=3.362; Evenness=0.6407

 **NOTE**: **A-E**= Akamkpa-Erokut; **B-A**= Bekwera-Afrike; **B-AC**= Biase-Akpet Central; **B-O**= Boki-Okwangwo;

 **CM-A**= Calabar Municipal-Adiabo; **O-S**= Obanliku-Sankwala; **O-I**= Obubra-Iyamayong;

 **O-U**= Obudu-Ukorshie; **Y-E**= Yakurr-Ekori

 **Source**: Researcher’s field survey (2024)

 **Table 3: Species abundance in the study area**

|  |  |  |  |
| --- | --- | --- | --- |
| **Most abundant species** | **Number of individuals**  | **Least abundant species** | **Number of individuals** |
| *Diplazium esculentum*  | 117 | *Bolbitis salicina* | 3 |
| *Nephrolepsis biserrata* | 88 | *Pteris tremula*  | 3 |
| *Nephrolepsis exaltata*  | 59 | *Pteris burtonii*  | 2 |
| *Microgramma mauritiana* | 49 | *Dryopteris-filix-mas*  | 2 |
| *Asplenium africanum* | 37 |  |  |
| *Arthropteris orientalis* | 35 |  |  |
| *Coniogramme africana*  | 34 |  |  |
| *Pityrogramma calomelanos*  | 34 |  |  |
| *Selaginella versicolor*  | 31 |  |  |

 **Source**: Student’s field survey (2024)

 **Figure 4**: Species habit/life form **Figure 5**: Species conservation status

 **Source**: Researcher’s field survey (2024)

**Table 4: Indigenous uses of identified species**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Scientific name** | **Local name**  | **Uses** |
| 1 | *Adiantum capillus-veneris* L. | Not Available | No knowledge  |
| 2 | *Adiantum lunulatum* Burm.f. | Not Available | No knowledge  |
| 3 | *Adiantum vogelii* Klotzsch. | Not Available | No knowledge  |
| 4 | *Alsophila camerooniana* (Baker) R.M. Tryon | Not Available | No knowledge  |
| 5 | *Arthropteris monocarpa* (L.) J.Sm. | Not Available | No knowledge  |
| 6 | *Arthropteris orientalis* (L.) J.Sm. | Not Available | No knowledge  |
| 7 | *Asplenium africanum* (Willd.) Hook. | Not Available | No knowledge  |
| 8 | *Asplenium cuneatum* (L.) Sw. | Not Available | No knowledge  |
| 9 | *Asplenium macrophlebium* (Blume) Baker. | Not Available | No knowledge  |
| 10 | *Asplenium nidus* L. | Not Available | No knowledge  |
| 11 | *Bolbitis acrostichoides* (Afzel.) Ching | Not Available | No knowledge  |
| 12 | *Bolbitis auriculata* (Lam.) Alston | Not Available | No knowledge  |
| 13 | *Bolbitis salicina* (Hook.) Ching. | Not Available | No knowledge  |
| 14 | *Coniogramme africana* Hieron. | Not Available | No knowledge  |
| 15 | *Diplazium esculentum (*Retz.*)* Sw. | Ekwa in Biase LGA and Ikpaladidi in Yakurr LGA | Young fronds are use as vegetable for making of soup |
| 16 | *Dryopteris kirkii* (Hook) Alston | Not Available | No knowledge  |
| 17 | *Dryopteris-filix-mas* (L.) Schott. | Not Available | No knowledge  |
| 18 | *Lomariopsis guineensis* (Underw.) Alston  | Not Available | No knowledge  |
| 19 | *Lygodium smithianum C.*Presl exkuhn | Not Available | No knowledge  |
| 20 | *Microgramma mauritiana* (L.) Underw. | Not Available | No knowledge  |
| 21 | *Microlepia speluncae* (L.) C.Chr. | Not Available | No knowledge  |
| 22 | *Nephrolepsis biserrata* (Sw.) Schott. | Not Available | No knowledge  |
| 23 | *Nephrolepsis exaltata* (L.) Schott. | Not Available | No knowledge  |
| 24 | *Nephrolepsis* *undulata* (Afzel.ex.Sw.) J. Sm. | Not Available | No knowledge  |
| 25 | *Oleandra distenta* (L.) C.Presl. | Not Available | No knowledge  |
| 26 | *Phymatosorus scolopendria* (L.) Bostock & Child. | Not Available | No knowledge  |
| 27 | *Pityrogramma calomelanos* (L.) Link. | Not Available | No knowledge  |
| 28 | *Platycerium bifurcatum* (Cav.) C.Chr. | Not Available | No knowledge  |
| 29 | *Platycerium elephantotis* (Hook.) Desv. | Not Available | No knowledge  |
| 30 | *Platycerium superbum* (Soland.) Dev. | Benyiewho | Decoction of the leaves are use for treating impotency |
| 31 | *Polystichum munitum* (Kaulf.) Presl. | Not Available | No knowledge  |
| 32 | *Pteridium aquilinum* (L.) Kuhn. | Not Available | No knowledge  |
| 33 | *Pteris burtonii* (Hook.) A.R.Sm. | Not Available | No knowledge  |
| 34 | *Pteris linearis* (Sw.) A.R.Sm. | Not Available | No knowledge  |
| 35 | *Pteris tremula* (L.) Kuntze | Not Available | No knowledge  |
| 36 | *Pteris tripartita var. tripartite* (L.) J.Sm | Not Available | No knowledge  |
| 37 | *Pteris vittata* L. | Not Available | No knowledge  |
| 38 | *Selaginella cathedrifolia* Spring | Not Available | No knowledge  |
| 39 | *Selaginella versicolor* Spring | Not Available | No knowledge  |
| 40 | *Selaginella vogelii* Spring | Not Available | No knowledge  |
| 41 | *Selaginella kraussiana* (Kunze) A. Br. | Not Available | No knowledge  |
| 42 | *Selaginella uncinata* | Not Available | No knowledge  |
| 43 | *Thelypteris dentata* (Forssk.) C.V.Morton. | Not Available | No knowledge  |
| 44 | *Triplophyllum funestrum* (Desv.) C. Chr. | Not Available | No knowledge  |
| 45 | *Triplophyllum* *securidiforme* (Baker) C. Chr.  | Not Available | No knowledge  |

**Source**: Researcher’s field survey (2024)

**3.2 Discussion**

The present study recorded a total of forty-five (45) species across the study locations and seasons with Pteridaceae dominating the list of species identified.  This number of species is high compared to those reported for other ecosystems in previous related studies within the study area and outside Cross River. These results align with recent studies emphasizing the high diversity of ferns in tropical rainforest ecosystems. For instance, while Bassey (2013) reported 39 species in Akwa Ibom State, Akinsoji et al. (2016) reported 16 species in parts of Lagos and Osun States, Adonipekun et al. (2019) reported 11 species in Lagos, Asikiye et al. (2023) and Azila et al. (2021) both reported 10 species in Rivers State University, Rivers State and in Shere Hills of Jos North L.G.A Plateau State respectively, Akomolafe and Sulaimon (2018) reported 7 species both in Lafia and Doma Metropolis of Nasarawa State, and Nwaka et al. (2022) who identified 6 epiphytic ferns in Cross River National Park. On the other hand, the number of species in the present study is low compared to 49 species reported in the Osomba range by Bassey et al. (2023) and 50 species reported Bassey et al. (2024) in Osomba hills both in the Cross River National Park respectively. Although, Erokut in Akamkpa LGA had the highest species richness (41 species), followed by Okwangwo in Boki LGA (37 species) while the lowest richness (14 species) was recorded in Afrike (Bekwara LGA), Akpet Central (Biase LGA), and Sankwala (Obanliko LGA). These patterns according to Gómez et al., (2022) are likely influenced by habitat variability, microclimatic conditions, and human disturbances, which have been reported as key factors in fern distribution. According to Bassey et al. (2023) and Jeyalatchagan et al. (2020) areas with elevated gradients have more species than regions with low elevation. This could explain the high number of species recorded in Erokut and Okwangwo areas of the study. Seasonal variations were also observed, with the wet season recording more species (37 species) compared to the dry season (29 species). The statistical significance of this difference (p<0.05) suggests a slight but notable impact of seasonal changes on species diversity. Previous research (Bhowmik and Singh, 2022; Akomolafe et al., 2021) has shown that ferns thrive in humid conditions, which may explain the seasonal trend observed in the present study.

The findings further showed that all the identified species were found across the various locations except for Adiantum capillus-veneris, A. lunulatum, and A. vogelii which were found only in Erokut location of the study area. This occurrence, according to Akinsoji et al. (2016) is possible as some species are said to have high plasticity occupy nearly all habitats available, and occur in various life forms. More so, the presence of Adiantum capillus-veneris, A. lunulatum, and A. vogelii being recorded only in Erokut is evidence of the fact that Erokut being a section of the Cross River National in Oban, Akamkpa Local Government Area, is very rich with diverse species of plants some of which are endemic to the area. Bassey et al. (2024) had earlier reported the species Adiantum capillus-veneris in Osomba Hills of the Oban axis. This means that Adiantum capillus-veneris, A. lunulatum, and A. vogelii are endemic to the Oban division of the Cross River National Park. In another related report, Bassey et al. (2023) and Akinsoji et al. (2016) opined that the occurrence of ferns in different sites is a good indicator of ecological condition in tropical vegetation which points to the fact that several species of ferns were recorded in all the locations. Similarly, and according to the assertion of Bassey et al. (2024)and Nwaka et al. (2022), the relatively high number of ferns found in the study for instance,  Erokut (41 species), Okwangwo (31 species) and Iyamayong (20 species) could probably be due to a combination of suitable microclimatic conditions favorable to the species there. This high number of species in Erokut, Okwangwo, and Iyamayong was expected as these locations are protected areas, and as such should have more species compared to other locations that are unprotected areas. Accordingly, Bassey et al. (2024) and Jeyalatchagan et al. (2020) have reported that high species composition in areas with high moisture, humidity, and shaded microhabitats suggests that such species may have adapted to such an environment.  On the other hand, the relatively low number of species recorded in other locations could be attributed to human activities such as deforestation, urbanization, and industrialization leading to the loss of more biodiversity.

The study showed overall high diversity indices which could mean the study area has a more complex, stable, and productive ecosystem, thus it is a suitable ecosystem for living things since ferns are important ecological indicators and are sensitive to environmental conditions. Similarly, the high diversity indices recorded in Erokut and Okwangwo indicated a more diverse and richer species compared to other locations. However, other locations with relatively high diversity indices mean that the pteridophyte communities in those locations were similar. These values according to Bassey et al. (2024) and Zhou et al. (2023) further confirm that the study area supports a highly diverse fern community, comparable to findings in similar tropical environments. According to Festus et al. (2024); and Joevi and Cristy-ann (2023) Fern richness is greatest in areas of high topographic relief and complexity, high evapotranspiration, and high humidity. These features are thus typical of most locations in the study area.

                All species were terrestrial, with 60% being non-epiphytes, 36% epiphytes, and 4% exhibiting both habits. This finding conforms to the study of Akinsoji (2016) who reported 46% terrestrial species, 32% lithophytes, and 22% epiphytes in the study. This aligns with the report of Mehltreter et al. (2021) who posited that most tropical ferns prefer terrestrial habitats, though significant proportions are epiphytic. The dominant nature of the terrestrial ferns could also be an indicator of the lesser degree of disturbance of the forests in the study area when considered on a larger scale. Thus researchers (Gbenga et al., 2022) have confirmed the dominant nature of terrestrial ferns in less-disturbed areas.

Based on conservation status, a significant 87% of the recorded species had not been evaluated, while 13% were classified as Least Concern (LC). This conservation status could be attributed to their abundance in the field according to Jeffry et al. (2022). Although, PPG I (2022) and Brummitt et al. (2016) reported that 16% of pteridophyte and lycophyte species are globally threatened with extinction and that 22% are of elevated conservation concern being threatened or near threatened, the lack of conservation assessment for the majority of the identified species highlights the urgent need for further research and conservation efforts, as many tropical ferns face threats from habitat destruction and climate change.

Despite the high diversity of species recorded in the study, only two species (Diplazium esculentum and Platycerium superbum) had documented indigenous uses in the study area. Diplazium esculentum is used as a vegetable in Ekori-Yakurr and Akpet Central-Biase, while Platycerium superbum is used in Ukorshie-Obudu for treating impotence. Reports of Irfana et al. (2024) and Akomolafe and Sulaimon (2018) documented similar use of Diplazium esculentum as seen in the findings of this study. However, the limited number of utilized species contrasts with studies in Nigeria and other tropical regions (Akomolafe and Sulaimon (2018); Suresh et al., 2021) where ferns have multiple ethnobotanical applications.

**4.0 CONCLUSION**

The study provided details on the distribution, diversity, and indigenous uses of ferns and their allies in Cross River State. With noticeable variances between sites and seasons, it brought to light Cross River State's vast diversity of ferns and fern allies. However, the limited knowledge of indigenous utilization, points to a knowledge gap that needs more ethnobotanical investigation. Furthermore, the majority of species identified lack conservation assessments, which emphasizes the necessity of conservation efforts to safeguard these significant plant groups. Lastly, it is important to remember that conserving these varied living forms involves more than just preserving species and their environments. It involves preserving nature's ability to provide commodities and services for a range of human consumptions, as its loss carries a significant cost.

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 **Appendix 1: Species distribution across study locations**

|  |  |  |
| --- | --- | --- |
| **S/N** | **Scientific name** | **Study location** |
| **A-E** | **B-A** | **B-AC** | **B-O** | **CM-A** | **O-I** | **O-S** | **O-U** | **Y-E** |
| 1 | *Adiantum capillus-veneris* L. | + | - | - | - | - | - | - | - | - |
| 2 | *Adiantum lunulatum* Burm.f. | + | - | - | - | - | - | - | - | - |
| 3 | *Adiantum vogelii* Klotzsch. | + | - | - | - | - | - | - | - | - |
| 4 | *Alsophila camerooniana* (Baker) R.M. Tryon | + | - | - | + | + | - | + | + | - |
| 5 | *Arthropteris monocarpa* (L.) J.Sm. | + | - | - | + | + | - | - | - | - |
| 6 | *Arthropteris orientalis* (L.) J.Sm. | + | + | + | + | + | + | + | + | + |
| 7 | *Asplenium africanum* (Willd.) Hook. | + | + | + | + | + | + | + | - | + |
| 8 | *Asplenium cuneatum* (L.) Sw. | - | - | - | + | - | - | + | - | - |
| 9 | *Asplenium macrophlebium* (Blume) Baker. | + | - | - | - | - | - | - | - | - |
| 10 | *Asplenium nidus* L. | + | + | - | + | + | + | + | + | + |
| 11 | *Bolbitis acrostichoides* (Afzel.) Ching | + | - | - | + | - | - | - | - | - |
| 12 | *Bolbitis auriculata* (Lam.) Alston | + | - | - | + | - | - | - | - | - |
| 13 | *Bolbitis salicina* (Hook.) Ching. | + | - | - | - | - | - | - | - | - |
| 14 | *Coniogramme africana* Hieron. | + | - | + | + | + | + | + | + | + |

 **NOTE**: **A-E**= Akamkpa-Erokut; **B-A**= Bekwera-Afrike; **B-AC**= Biase-Akpet Central; **B-O**= Boki-Okwangwo; **CM-A**= Calabar Municipal-Adiabo;

 **O-S**= Obanliku-Sankwala; **O-I**= Obubra-Iyamayong; **O-U**= Obudu-Ukorshie; **Y-E**= Yakurr- Ekori; **Positive (+) =**Present**, Negative (**-) =Absent

 **Appendix 1 Contd.: Species distribution across study locations**

|  |  |  |
| --- | --- | --- |
| **S/N** | **Scientific name** | **Study location** |
| **A-E** | **B-A** | **B-AC** | **B-O** | **CM-A** | **O-I** | **O-S** | **O-U** | **Y-E** |
| 15 | *Diplazium esculentum (*Retz.*)* Sw. | + | - | + | + | + | + | + | + | + |
| 16 | *Dryopteris kirkii* (Hook) Alston | + | - | - | - | - | - | - | - | - |
| 17 | *Dryopteris-filix-mas* (L.) Schott. | + | - | - | - | - | - | - | - | - |
| 18 | *Lomariopsis guineensis* (Underw.) Alston  | + | - | - | - | - | - | + | + | - |
| 19 | *Lygodium smithianum C.*Presl exkuhn | + | - | - | + | - | - | - | - | - |
| 20 | *Microgramma mauritiana* (L.) Underw. | + | + | + | + | + | + | + | + | + |
| 21 | *Microlepia speluncae* (L.) C.Chr. | + | - | - | - | - | - | - | - | - |
| 22 | *Nephrolepsis biserrata* (Sw.) Schott. | + | + | + | + | + | + | + | + | + |
| 23 | *Nephrolepsis exaltata* (L.) Schott. | + | + | + | + | + | + | + | + | + |
| 24 | *Nephrolepsis* *undulata* (Afzel.ex.Sw.) J. Sm. | - | + | - | - | + | + | - | - | + |
| 25 | *Oleandra distenta* (L.) C.Presl. | + | - | - | + | - | - | + | + | - |
| 26 | *Phymatosorus scolopendria* (L.) Bostock & Child. | + | - | - | + | - | - | + | + | - |
| 27 | *Pityrogramma calomelanos* (L.) Link. | + | + | + | + | + | + | + | + | + |
| 28 | *Platycerium bifurcatum* (Cav.) C.Chr. | + | + | + | + | + | + | - | + | + |
| 29 | *Platycerium elephantotis* (Hook.) Desv. | - | + | - | + | + | + | + | - | - |
| 30 | *Platycerium superbum* (Soland.) Dev. | - | + | + | - | - | - | + | - | + |

 **NOTE**: **A-E**= Akamkpa-Erokut; **B-A**= Bekwera-Afrike; **B-AC**= Biase-Akpet Central; **B-O**= Boki-Okwangwo; **CM-A**= Calabar Municipal-Adiabo;

 **O-S**= Obanliku-Sankwala; **O-I**= Obubra-Iyamayong; **O-U**= Obudu-Ukorshie; **Y-E**= Yakurr- Ekori; **Positive (+) =**Present**, Negative (**-) =Absent

 **Appendix 1 Contd.: Species distribution across study locations**

|  |  |  |
| --- | --- | --- |
| **S/N** | **Scientific name** | **Study location** |
| **A-E** | **B-A** | **B-AC** | **B-O** | **CM-A** | **O-I** | **O-S** | **O-U** | **Y-E** |
| 31 | *Polystichum munitum* (Kaulf.) Presl. | + | - | - | - | - | - | - | - | - |
| 32 | *Pteridium aquilinum* (L.) Kuhn. | + | - | - | + | - | - | + | + | - |
| 33 | *Pteris burtonii* (Hook.) A.R.Sm. | + | - | - | - | - | - | - | - | - |
| 34 | *Pteris linearis* (Sw.) A.R.Sm. | + | - | - | + | - | - | - | - | - |
| 35 | *Pteris tremula* (L.) Kuntze | + | - | - | - | - | - | - | - | - |
| 36 | *Pteris tripartita var. tripartite* (L.) J.Sm | + | - | - | + | - | - | - | - | - |
| 37 | *Pteris vittata* L. | + | - | + | + | - | - | - | - | + |
| 38 | *Selaginella cathedrifolia* Spring | + | + | - | + | + | + | - | + | + |
| 39 | *Selaginella versicolor* Spring | + | + | + | + | + | + | + | + | + |
| 40 | *Selaginella vogelii* Spring | + | - | + | + | - | - | - | - | - |
| 41 | *Selaginella kraussiana* (Kunze) A. Br. | + | + | + | + | + | + | + | + | - |
| 42 | *Selaginella uncinata* | + | - | - | + | - | - | - | - | + |
| 43 | *Thelypteris dentate* (Forssk.) C.V.Morton. | + | - | - | + | - | - | - | - | - |
| 44 | *Triplophyllum funestrum* (Desv.) C. Chr. | + | - | - | + | - | - | - | - | - |
| 45 | *Triplophyllum* *securidiforme* (Baker) C. Chr.  | + | - | - | + | - | - | - | - | - |

 **NOTE**: **A-E**= Akamkpa-Erokut; **B-A**= Bekwera-Afrike; **B-AC**= Biase-Akpet Central; **B-O**= Boki-Okwangwo;

 **CM-A**= Calabar Municipal-Adiabo; **O-S**= Obanliku-Sankwala; **O-I**= Obubra-Iyamayong; **O-U**= Obudu-Ukorshie;

 **Y-E**= Yakurr- Ekori; **Positive (+) =**Present**, Negative (**-) =Absent

 **Appendix 2: Species distribution per season**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Species**  | **Wet season**  | **Dry season**  |
| 1 | *Adiantum capillus-veneris* L. | ***√*** | ***√*** |
| 2 | *Adiantum lunulatum* Burm.f. | ***√*** | ***√*** |
| 3 | *Adiantum vogelii* Klotzsch. | ***√*** | *X* |
| 4 | *Alsophila camerooniana* (Baker) R.M. Tryon | ***√*** | ***√*** |
| 5 | *Arthropteris monocarpa* (L.) J.Sm. | ***√*** | *X* |
| 6 | *Arthropteris orientalis* (L.) J.Sm. | ***√*** | *X* |
| 7 | *Asplenium africanum* (Willd.) Hook. | ***√*** | ***√*** |
| 8 | *Asplenium cuneatum* (L.) Sw. | ***√*** | ***√*** |
| 9 | *Asplenium macrophlebium* (Blume) Baker. | ***√*** | ***√*** |
| 10 | *Asplenium nidus* L. | ***√*** | ***√*** |
| 11 | *Bolbitis acrostichoides* (Afzel.) Ching | ***√*** | ***√*** |
| 12 | *Bolbitis auriculata* (Lam.) Alston | *X* | ***√*** |
| 13 | *Bolbitis salicina* (Hook.) Ching. | *X* | ***√*** |
| 14 | *Coniogramme africana* Hieron. | ***√*** | *X* |
| 15 | *Diplazium esculentum (*Retz.*)* Sw. | ***√*** | ***√*** |
| 16 | *Dryopteris kirkii* (Hook) Alston | ***√*** | *X* |
| 17 | *Dryopteris-filix-mas* (L.) Schott. | ***√*** | *X* |
| 18 | *Lomariopsis guineensis* (Underw.) Alston  | ***√*** | ***√*** |
| 19 | *Lygodium smithianum C.*Presl exkuhn | ***√*** | ***√*** |
| 20 | *Microgramma mauritiana* (L.) Underw. | ***√*** | *X* |
| 21 | *Microlepia speluncae* (L.) C.Chr. | ***√*** | ***√*** |
| 22 | *Nephrolepsis biserrata* (Sw.) Schott. | ***√*** | ***√*** |
| 23 | *Nephrolepsis exaltata* (L.) Schott. | ***√*** | ***√*** |
| 24 | *Nephrolepsis* *undulata* (Afzel.ex.Sw.) J. Sm. | ***√*** | ***√*** |
| 25 | *Oleandra distenta* (L.) C.Presl. | ***√*** | *X* |
| 26 | *Phymatosorus scolopendria* (L.) Bostock & Child. | ***√*** | *X* |
| 27 | *Pityrogramma calomelanos* (L.) Link. | ***√*** | *X* |
| 28 | *Platycerium bifurcatum* (Cav.) C.Chr. | ***√*** | *X* |
| 29 | *Platycerium elephantotis* (Hook.) Desv. | ***√*** | *X* |
| 30 | *Platycerium superbum* (Soland.) Dev. | ***√*** | ***√*** |
| 31 | *Polystichum munitum* (Kaulf.) Presl. | *X* | ***√*** |
| 32 | *Pteridium aquilinum* (L.) Kuhn. | ***√*** | ***√*** |
| 33 | *Pteris burtonii* (Hook.) A.R.Sm. | *X* | ***√*** |
| 34 | *Pteris linearis* (Sw.) A.R.Sm. | ***√*** | *X* |
| 35 | *Pteris tremula* (L.) Kuntze | ***√*** | *X* |
| 36 | *Pteris tripartita var. tripartite* (L.) J.Sm | ***√*** | ***√*** |
| 37 | *Pteris vittata* L. | ***√*** | ***√*** |
| 38 | *Selaginella cathedrifolia* Spring | ***√*** | *X* |
| 39 | *Selaginella versicolor* Spring | ***√*** | *X* |
| 40 | *Selaginella vogelii* Spring | ***√*** | ***√*** |
| 41 | *Selaginella kraussiana* (Kunze) A. Br. | ***√*** | ***√*** |
| 42 | *Selaginella uncinata* | ***√*** | ***√*** |
| 43 | *Thelypteris dentata* (Forssk.) C.V.Morton. | *X* | ***√*** |
| 44 | *Triplophyllum funestrum* (Desv.) C. Chr. | *X* | ***√*** |
| 45 | *Triplophyllum* *securidiforme* (Baker) C. Chr.  | *x* | ***√*** |