

**CYTOMORPHOLOGICAL STUDIES ON SOME NIGERIAN
SPECIES OF ACANTHACEAE (*JUSTICIA* SPP)**

BY

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SR/2208/RPR/24/54

UNIVERSITY OF BENIN

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**A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF PLANT
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CERTIFICATION

We certify that **MADUIKE MARVIN CHIEMEKA** of the Department of Plant Biology and Biotechnology, Faculty of Life Science, University of Benin, Benin city, Nigeria, carried out this work.

Signed: -----

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Date

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Date

(Head of Department)

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ABSTRACT

Justicia carnea, also known as the Brazilian Plume Flower, is a tropical shrub from the Acanthaceae family, admired for its striking pinkish-red flowers and lush green foliage. Often grown as an ornamental plant, it attracts pollinators like bees and butterflies while adding vibrant color to gardens. Beyond its beauty, *Justicia carnea* has long been used in traditional medicine for treating anemia, respiratory issues, and inflammation due to its antioxidant and immune-boosting properties. The plant thrives in warm climates with well-drained soil and partial shade, making it a resilient yet eye-catching addition to landscapes. On a cellular level, it exhibits stable meiosis and amphistomatic leaves with diacytic stomata, which help regulate gas exchange and water loss. With its combination of aesthetic appeal, ecological importance, and medicinal value, *Justicia carnea* remains a valuable plant for both gardeners and researchers alike.

CHAPTER ONE

INTRODUCTION

The Acanthaceae family, or Acanthus family, is a diverse group comprising over 250 genera and 4,000 species within the Lamiales order. These plants thrive primarily in tropical and subtropical regions and are noted for their ecological and cultural significance. They exhibit simple, opposite leaves, bilaterally symmetrical flowers, and unique seed dispersal methods, contributing to their adaptability and survival in various environments (Raven *et al.*, 2012).

Acanthaceae plants typically feature simple, unlobed leaves, which vary in shape and size depending on the species and habitat. In tropical areas, the leaves are broad and glossy, suited for retaining moisture, while in arid climates, the leaves are more drought-resistant, enabling water conservation. These plants also lack stipules, further distinguishing them from other families within Lamiales (Judd *et al.*, 2015).

The family's flowers are zygomorphic, meaning they are bilaterally symmetrical. These tubular or funnel-shaped flowers have evolved to attract specific pollinators, such as bees, butterflies, and birds. The unique floral structures create efficient pathways for pollinators to access reproductive organs, fostering intricate relationships between plants and pollinators. Clustered inflorescences enhance visual appeal, increasing the likelihood of successful pollination (Simpson, 2010).

Acanthaceae plants have developed fascinating seed dispersal mechanisms. Many species produce dry capsules that use explosive dehiscence to propel seeds away from the parent plant,

reducing competition for resources. Other species feature seeds with adhesive surfaces or hooks, enabling dispersal via animals, thereby expanding their range (Gleason and Cronquist, 1991).

Ecologically, the Acanthaceae family plays a crucial role in supporting biodiversity. Their nectar and pollen sustain pollinators like bees, butterflies, and hummingbirds, ensuring the health of ecosystems. Their fibrous root systems also stabilize soil, particularly in erosion-prone regions, and enhance soil health across diverse environments (Kearns and Inouye, 1997).

Beyond ecology, Acanthaceae species hold cultural and medicinal value. Traditional medicine systems, such as Ayurveda, utilize plants like *Justicia adhatoda* for treating respiratory and inflammatory conditions. Ornamental species, such as *Aphelandra* and *Fittonia*, are popular in horticulture for their vibrant foliage. As interest in sustainability and herbal medicine grows, the conservation of these species is vital to preserve their ecological, cultural, and medicinal benefits (Mabberley, 2008).

The Acanthaceae family exemplifies diversity and adaptability, making it a cornerstone of tropical and subtropical ecosystems. By conserving these plants, we ensure the continuation of their ecological contributions, honor traditional practices, and support sustainable development for future generations.

1.1 ETHNOBOTANICAL WORKS OF ACANTHACEAE

The Acanthaceae family is widely recognized for its diverse and valuable contributions to traditional medicine across various cultures. This plant family plays a crucial role in systems like Ayurveda, Traditional Chinese Medicine, and African healing practices, where many species are

used for their healing properties. Plants within the Acanthaceae family are often regarded for their potent medicinal effects, making them an essential part of local healthcare in many regions of the world.

One of the standout plants in the Acanthaceae family is *Andrographis paniculata*, commonly known as the "king of bitters." This plant is highly regarded for its powerful anti-inflammatory, antiviral, and antibacterial effects. It has been traditionally used to treat fevers, respiratory infections, and digestive problems, and to enhance immune system function. The leaves of *Andrographis paniculata* are typically prepared as a decoction, which is consumed to help boost immunity and treat illness. Modern research continues to validate these traditional uses, reinforcing the plant's place in contemporary herbal medicine (Kumar *et al.*, 2021; Mishra *et al.*, 2007).

Another key species is *Justicia adhatoda*, also known as the Malabar Nut. This plant has long been a staple in Ayurvedic and Unani medicine due to its active compound, vasicine, which acts as a bronchodilator. It is especially valued for its efficacy in treating respiratory conditions like asthma, bronchitis, and coughs. In many cultures, *Justicia adhatoda* leaves are boiled to create a medicinal tea, or they are ground into a paste for topical application to treat various ailments. This plant's ability to ease breathing and promote respiratory health has made it a go-to remedy in traditional medicine (Arulmozhi *et al.*, 2006; Pandey *et al.*, 2020).

In African traditional medicine, *Justicia flava* (Yellow Justicia) is another important plant within the Acanthaceae family. Its versatility lies in its antibacterial properties, and its leaves are used in teas or infusions to treat a variety of respiratory and digestive disorders. The plant's ability to fight infections makes it an essential resource in local communities. Similarly, *Barleria prionitis*,

known as the Porcupine Flower, is employed in Southern Africa for the relief of rheumatism and joint pain. Its leaves are prepared as a poultice and applied to the affected areas, showcasing the practical application of this family in traditional healing practices (Singh and Singh, 2008; van Wyk *et al.*, 2009).

Beyond their medicinal value, many Acanthaceae species hold cultural and spiritual significance. For example, *Justicia secunda*, commonly referred to as bloodroot, plays an important role in Afro-Caribbean spiritual practices. Its reddish sap is considered symbolic of vitality and life force, and it is often used in rituals focused on protection and energy purification. This deep connection between plants and cultural beliefs illustrates many communities' profound relationship with nature (Moerman, 1998; Lans *et al.*, 2001).

In East Africa, *Thunbergia alata* (Black-eyed Susan) is often used in celebrations and festivals due to its vibrant, cheerful flowers. The plant symbolizes joy and beauty and is commonly used as a decorative plant. This highlights the aesthetic and cultural values associated with Acanthaceae species, which contribute to the community's identity and heritage (Beentje, 1994).

In addition to their medicinal and cultural roles, Acanthaceae species also have practical uses in agriculture. Several species contribute to sustainable farming practices. For example, *Justicia flava* is used in some regions to maintain livestock health by preventing respiratory infections. Plants like *Barleria prionitis* are also grown around crops to deter pests, promoting eco-friendly agricultural methods. These plants are part of a natural approach to farming that helps reduce the use of harmful pesticides, contributing to sustainable agricultural practices (Neuwinger, 2000; van Wyk *et al.*, 2009).

Acanthaceae plants are also important in providing food security. In times of drought or food scarcity, certain species can serve as emergency food sources. The tubers of *Ruellia tuberosa*, for example, are edible and can be consumed when other food options are limited. This highlights the role that these plants play in traditional diets and their ability to provide sustenance when food resources are scarce (Ezeabara *et al.*, 2014).

Ecologically, Acanthaceae plants are crucial for maintaining biodiversity and ecosystem health. Many species attract a variety of pollinators, including bees, butterflies, and hummingbirds, which are essential for plant reproduction. These pollinators also help support the reproduction of many other plant species, demonstrating the interconnectedness of Acanthaceae plants with the wider environment. Furthermore, certain species help in soil stabilization and erosion control. Their extensive root systems are particularly useful in areas prone to soil degradation and erosion, common in regions affected by deforestation and land degradation (Kress and Specht, 2005; Pimentel and Kounang, 1998).

Despite these many benefits, Acanthaceae species face significant threats due to overharvesting and habitat loss, particularly as demand for medicinal plants continues to grow. The pressure on these plants has led to unsustainable harvesting practices, threatening their long-term survival. As such, it is essential to prioritize sustainable cultivation and harvesting methods to preserve these valuable resources for future generations (Hamilton, 2004; WHO, 2013).

To address these challenges, community-led initiatives focusing on the sustainable cultivation of Acanthaceae plants have emerged. These initiatives emphasize the importance of traditional knowledge in conservation and promote sustainable practices. By cultivating Acanthaceae species in home gardens and community farms, these efforts reduce pressure on wild populations

while ensuring continued access to these plants for medicinal and cultural purposes (van Wyk et al., 2009; Hamilton, 2004).

In conclusion, the Acanthaceae family holds significant ethnobotanical value across medicinal, cultural, agricultural, and ecological domains. These plants provide remedies for common ailments, hold cultural importance in rituals, support sustainable farming practices, and contribute to maintaining biodiversity. As the demand for medicinal plants rises, sustainable practices must be prioritized to protect these species and their invaluable contributions to human health, culture, and the environment. By integrating traditional knowledge with modern conservation strategies, we can safeguard the future of Acanthaceae plants and the roles they play in society.

1.3 JUSTICIA

Justicia is a large genus in the Acanthaceae family, containing over 600 species mainly found in tropical and subtropical regions. These plants are notable for their colourful, tubular flowers and their extensive medicinal, ecological, and cultural significance, particularly in Africa, Asia, and Latin America.

Key species like *Justicia adhatoda* (Malabar Nut) are widely used in traditional medicine for respiratory issues, thanks to bioactive compounds like vasicine that act as natural bronchodilators. *Justicia flava* (Yellow Justicia) is another significant species in Africa, where it treats respiratory and digestive ailments in humans and livestock. *Justicia secunda* (Bloodroot) is used in the

traditional Caribbean and African practices to support blood health and is valued spiritually for its red sap.

Beyond medicinal uses, *Justicia* plants support pollinators and contribute to biodiversity. Due to high demand in traditional medicine, some *Justicia* species face overharvesting, underscoring the need for sustainable cultivation to preserve these plants for ecological and cultural heritage.

1.4 INDUMENTUM

In *Justicia* species, the indumentum—the surface covering on leaves, stems, and other parts—varies widely and serves crucial functions in adaptation, water conservation, and defense. This layer is primarily made up of simple, unbranched hairs, but specific traits like hair density, length, and structure differ between species, often reflecting their environmental needs and pressures. Some species have glandular trichomes, which are hairs with secretory cells that produce and release chemical compounds. These chemicals can create an unfavorable environment for herbivores by making the plant surface sticky or even toxic, while also acting as a defense against pathogens by limiting fungal and bacterial growth. Non-glandular trichomes, on the other hand, consist of hairs without secretory cells and provide a physical barrier. These non-glandular trichomes give many *Justicia* species a velvety or hairy texture, which serves the dual purpose of protecting against herbivory and reducing water loss. This texture helps create a microenvironment that traps moisture around the plant surface, a vital adaptation in arid or sun-exposed habitats, where moisture retention is critical for survival.

In addition to aiding in water conservation, the presence and type of trichomes can discourage herbivores in multiple ways. Glandular trichomes, by releasing potentially irritating or harmful

chemicals, can repel insects and other herbivores, while non-glandular hairs create a physical deterrent, making it difficult for animals to feed on or move across the plant surface comfortably. Some *Justicia* species also display high-density indumentum on younger leaves and stems, as these parts are more vulnerable to herbivory, showcasing how the plant can adaptively allocate resources for protection. The diversity and complexity of these indumentum traits across *Justicia* species highlight how these plants have evolved to survive under various environmental and ecological pressures. By combining physical and chemical defenses, they enhance their resilience, thriving in habitats from tropical rainforests to arid regions, where moisture conservation and herbivore deterrence are essential.

1.5 WOOD ANATOMY

Justicia species generally exhibit a woody or semi-woody structure, a characteristic that becomes more pronounced in larger species and the older stems of mature plants. This woody framework offers essential support for the plant, especially in environments where they compete for light or endure variable climatic conditions. Structurally, their vascular system includes vessels that are typically arranged either solitarily or in radial multiples, with simple perforation plates that enable efficient and direct water transport through the plant. These simple perforation plates are an adaptive feature for water movement, allowing *Justicia* species to thrive in diverse habitats, from moist tropical forests to drier, open areas.

The wood of *Justicia* species also contains thin-walled fibers, a feature that contributes to a softer wood composition. This softer, more flexible wood is complemented by the presence of axial parenchyma cells, which are longitudinally aligned storage cells that can store nutrients and water, giving the plant some resilience during periods of drought or nutrient scarcity. Thin-

walled fibers and axial parenchyma are typical traits in members of the Acanthaceae family, which tend to exhibit relatively soft wood compared to many other woody plants. This structure allows *Justicia* species to grow flexibly, making them well-suited to adapt to disturbances or pruning, as they can regrow efficiently and transport resources through an intricate yet adaptable vascular system. Overall, the combination of woody and softer anatomical characteristics in *Justicia* supports both stability and flexibility, helping these plants thrive in varied environments and adapt to different ecological pressures.

1.6 CYSTOLITHS

Cystoliths, which are calcium carbonate crystals, are commonly found in *Justicia* species, typically located within specialized cells in the epidermis of their leaves. These cystoliths can vary significantly in shape and size among different species, contributing to the distinctive rough texture of the leaves. This roughness may play a role in deterring herbivores, as the presence of cystoliths can make the plant surface less palatable or more difficult for animals to consume. Additionally, the hard, crystalline structure of cystoliths may physically impede feeding, providing an added layer of defense against herbivory. By incorporating cystoliths into their leaf structure, *Justicia* species enhance their ability to survive in diverse environments, balancing growth and protection effectively. This adaptation not only supports their resilience against potential threats but also highlights the evolutionary strategies employed by these plants to thrive amid varying ecological pressures (Moraes *et al.*, 2018).

1.7 STEM

In *Justicia* species, stems are often quadrangular, especially in younger plants, and as they mature, they tend to become more cylindrical in shape. This morphological transition is a characteristic feature that allows the plants to adapt to their environments as they grow. The stems can be classified as either herbaceous or semi-woody, depending on the specific growth form of the species. This flexibility in stem type contributes to the overall adaptability of *Justicia* plants, enabling them to thrive in diverse ecological conditions. Additionally, the stems often exhibit prominent nodes, which can serve as points for leaf attachment or branching, further enhancing the plant's structural integrity and resilience. The combination of quadrangular to cylindrical stem shapes, along with herbaceous or semi-woody characteristics, illustrates the versatility of *Justicia* species, allowing them to effectively occupy a range of habitats and respond to environmental pressures.

1.8 LEAVES

The leaves of *Justicia* species are typically arranged in an opposite, decussate pattern, meaning they are positioned in pairs across from each other on the stem, alternating in a crosswise manner. Generally simple and entire, these leaves can exhibit a range of shapes, commonly ovate to lanceolate, with smooth or slightly serrated margins. The venation is typically pinnate, with a primary central vein from which smaller veins extend, providing structural support and facilitating efficient nutrient and water transport. Additionally, prominent cystoliths within the leaves contribute to a rough texture on the surface, which may serve multiple functions, including deterring herbivores and enhancing moisture retention. This combination of leaf

characteristics—its arrangement, shape, and texture—highlights the adaptability of *Justicia* species to their environments, supporting both their growth and defense mechanisms.

1.9 INFLORESCENCE

In *Justicia* species, the type of inflorescence varies significantly among species, often appearing as terminal or axillary spikes, racemes, or panicles. This diversity in floral arrangement allows *Justicia* to adapt to different pollination strategies and environmental conditions. Terminal and axillary spikes are particularly common, with flowers densely packed in a linear fashion that enhances their visibility to pollinators. In spike-type inflorescences, flowers are arranged in somewhat dense clusters, creating a visually striking display that can attract a range of pollinators, including bees, butterflies, and hummingbirds. The clustering of flowers enhances their visibility and also facilitates efficient pollination, as many flowers are accessible to pollinators in a compact area.

Racemes and panicles offer additional structural complexity, providing varying degrees of flower density and arrangement. In racemes, flowers are borne on elongated stems, with the oldest flowers at the bottom and new buds developing above, allowing for an extended blooming period. Panicles, which are branched clusters of flowers, can provide even greater diversity in flower arrangement, often leading to a more bushy appearance. This adaptability in inflorescence type enhances the reproductive success of *Justicia* species by optimizing their attraction to pollinators while also promoting cross-pollination, which increases genetic diversity within populations.

Furthermore, the inflorescence structure can vary with environmental conditions, such as light availability and moisture levels. In shaded environments, for instance, *Justicia* species may develop longer, more elongated inflorescences to reach upward for sunlight, whereas in open areas, denser flower clusters may form to attract pollinators effectively. Overall, the variety in inflorescence types among *Justicia* species reflects their ecological versatility, allowing them to thrive in a wide range of habitats while promoting successful reproduction through various pollination mechanisms. This adaptability not only enhances their survival but also contributes to the biodiversity of the ecosystems they inhabit.

1.10 BRACTS AND BRACTLETS

In *Justicia* species, bracts and bractlets are typically present and play an important role in enhancing the visibility of the inflorescence. These structures are often larger or more colorful than the surrounding leaves, contributing to the overall aesthetic appeal of the flowers. The bracts can vary in shape, commonly appearing ovate to lanceolate, and may exhibit vibrant colors or distinctive textures that serve to attract pollinators. This bright coloration and textural variation can make the inflorescence more noticeable against the backdrop of foliage, thereby increasing the likelihood of pollinator visitation.

The presence of conspicuous bracts and bractlets not only enhances the visual display but can also provide additional benefits. They may help protect the developing flowers from environmental stressors and herbivory while simultaneously supporting the reproductive structures during the flowering process. In addition, the attraction of pollinators is crucial for the

reproductive success of *Justicia* species, and the striking features of the bracts and bractlets can significantly influence the behavior of pollinators, encouraging them to visit and promote cross-pollination among flowers.

Overall, the strategic development of bracts and bractlets in *Justicia* serves both functional and ecological purposes, optimizing the plant's reproductive success and ensuring its survival in diverse habitats. Their role in attracting pollinators and enhancing the visual appeal of inflorescences underscores the intricate relationships between plant morphology and pollinator behavior, highlighting the evolutionary adaptations that have occurred in these species over time.

1.11 CALYX

In *Justicia* species, the calyx is typically divided into five lobes, although this number may vary slightly among different species. These calyx lobes are generally narrow and are often equal or nearly equal in size, contributing to a symmetrical appearance that enhances the overall floral structure. The margins of the calyx lobes may feature ciliate edges, which are fringed with fine hairs that can add texture and potentially serve various ecological functions.

The ciliate margins may help protect the developing flower buds from herbivores or environmental stressors, as well as contribute to the flower's attractiveness to pollinators. This intricate design not only provides a visual appeal but also plays a role in the flower's reproductive strategy by facilitating access for pollinators while ensuring that the delicate reproductive organs within the flower are adequately protected. The overall morphology of the

calyx, with its lobes and potential ciliation, reflects the evolutionary adaptations of *Justicia* species to optimize their reproductive success while thriving in diverse habitats.

1.12 COROLLA

In *Justicia* species, the corolla is typically bilabiate (two-lipped) and tubular, an adaptation that enhances pollination by specific insects. This structural configuration facilitates the access of pollinators to the reproductive parts of the flower, ensuring effective transfer of pollen. The upper lip of the corolla is usually smaller, providing a protective cover for the flower's reproductive organs, while the lower lip is more prominent and often three-lobed. This distinctive lower lip serves as a landing platform for pollinators, such as bees and butterflies, allowing them to perch comfortably while accessing the nectar and pollen within the tubular structure.

The bilabiate design is particularly effective in attracting specific pollinators that are adapted to navigating such flower shapes. By providing a stable landing area and directing pollinators toward the flower's center, this morphology increases the likelihood of successful pollination, which is essential for the reproductive success of *Justicia* species. Additionally, the color and patterning of the corolla may further attract pollinators, creating a visual signal that guides them to the flower. Overall, the tubular and bilabiate characteristics of the corolla reflect the evolutionary adaptations of *Justicia* to optimize interactions with their pollinators, enhancing their reproductive efficiency while thriving in diverse ecological niches.

1.13 ANDROECIUM (STAMENS)

In *Justicia* species, the androecium typically consists of two stamens, although some species may exhibit four stamens, reflecting the diversity within the genus. These stamens are attached to the corolla tube, playing a crucial role in the reproductive process. Depending on the species, the anthers can be either monothealous (one-lobed) or dithealous (two-lobed), showcasing further variation in flower structure.

The configuration of the stamens is significant for pollination, as it affects how pollen is released and how easily pollinators can access it. Monothealous anthers, being simpler in structure, may facilitate easier pollen dispersal, while dithealous anthers can produce a greater quantity of pollen due to their dual-lobed design. This adaptability in stamen morphology ensures that *Justicia* species can optimize their reproductive success across various environmental conditions and among different pollinator communities. Overall, the structure and arrangement of the androecium in *Justicia* reflect its evolutionary adaptations, enhancing both pollination efficiency and reproductive outcomes within diverse habitats.

1.14 POLLEN

In *Justicia* species, pollen grains are typically tricolpate, featuring three grooves, or tri- to tetracolpate, which means they have three to four furrows with pores. This structure is significant as it influences the pollen's dispersal and adherence mechanisms during pollination. The grooves and pores enhance the surface area of the pollen grains, facilitating their attachment to pollinators as they visit the flowers.

Additionally, the surface of the pollen grains is often echinate, meaning it has spiny projections, or reticulate, displaying a network-like pattern. These features further aid in adhesion to pollinators, increasing the likelihood that pollen will transfer from one flower to another, thus promoting effective cross-pollination. This adaptation is crucial for the reproductive success of *Justicia* species, as it enhances their ability to interact with a variety of pollinators, ensuring the transfer of genetic material across populations. The unique characteristics of *Justicia* pollen grains illustrate these plants' evolutionary strategies to maximize reproductive efficiency and adaptability in diverse ecological contexts.

1.15 GYNOECIUM (PISTIL)

In *Justicia* species, the gynoecium is characterized by a bicarpellate ovary, which contains two ovules per locule. This structure is essential for the development of seeds following fertilization, and the arrangement of ovules supports efficient reproduction. The ovary's design reflects evolutionary adaptations to maximize the chances of successful fertilization in diverse environments.

The style of the *Justicia* flower is typically simple and elongated, culminating in a stigma that may be bifid (split into two parts) or entire (undivided). This variation in stigma morphology is crucial, as it allows for adaptations to different pollination mechanisms. A bifid stigma may provide a broader surface area for pollen capture, enhancing the likelihood of successful pollination, particularly in flowers that attract specific pollinators. Conversely, an entire stigma

may be more effective in other contexts, depending on the flower's overall structure and the behavior of visiting pollinators.

Overall, the design of the gynoecium in *Justicia* species—featuring a bicarpellate ovary, multiple ovules, and a versatile style with a bifid or entire stigma—highlights the intricate adaptations these plants have evolved to optimize reproductive success. These features facilitate interactions with a variety of pollinators, ensuring efficient pollen transfer and seed development across the diverse habitats in which *Justicia* thrives.

1.16 FRUIT

Justicia species, the fruits are typically classified as capsules, specifically schizocarpic capsules, which are known for their explosive dehiscence that facilitates seed dispersal. This mechanism allows the capsules to split open suddenly, releasing seeds over a wide area, thereby increasing the chances of germination and establishment in suitable habitats.

The capsules are often two-valved, meaning they consist of two halves that open to release the seeds. Within these capsules, a hardened, seed-bearing section usually provides structural support and aids in effective dispersal. This hardened portion not only protects the seeds during development but also plays a crucial role in ensuring that seeds are ejected forcefully and at a distance, maximizing their potential to reach new growing locations.

The explosive nature of the dehiscence is an evolutionary adaptation that enhances the reproductive success of *Justicia* species by enabling rapid and effective seed dispersal. This

strategy helps the plants colonize new areas and take advantage of varying environmental conditions, contributing to their resilience and adaptability across different ecosystems. Overall, the fruit structure of *Justicia* species exemplifies their specialized mechanisms for reproduction and survival in diverse habitats.

1.17 SEEDS

In *Justicia* species, the seeds are generally flattened and may possess a sticky coating that enables them to adhere to animals, facilitating their dispersal. This sticky texture enhances the seeds' chances of being transported away from the parent plant, which can help reduce competition for resources and increase the likelihood of establishing new populations in suitable habitats.

Additionally, some species feature seeds with hygroscopic mechanisms that allow them to absorb moisture from the environment. This ability to take up water is crucial for germination, as it enables the seeds to swell and initiate the growth process under optimal conditions. By effectively utilizing ambient moisture, these seeds can time their germination to coincide with favorable environmental conditions, increasing the chances of successful establishment and survival.

Together, these adaptations in seed morphology and function illustrate the evolutionary strategies of *Justicia* species for maximizing reproductive success. The flattened, sticky seeds promote effective dispersal, while hygroscopic properties enhance germination potential, allowing these plants to thrive across a variety of ecological niches. These mechanisms reflect a complex

interplay between plant morphology and environmental interactions, underscoring the resilience and adaptability of *Justicia* species in diverse habitats.

1.18 OBJECTIVE

The research on *Justicia* species focuses on several key areas to deepen our understanding of this diverse genus. One major objective is systematic classification and identification, aiming to differentiate *Justicia* species based on their unique morphological, anatomical, and reproductive traits. This effort also seeks to clarify taxonomic relationships within the Acanthaceae family, which is crucial for accurate identification and conservation.

Another significant focus is on the evolutionary and phylogenetic aspects of *Justicia*. Researchers aim to investigate the evolutionary history of the genus, its genetic relationships with related genera, and its adaptations to various ecological niches. These studies contribute to a broader understanding of evolutionary biology and how these plants have adapted over time.

Ecological and environmental adaptations are also key areas of research. By examining specific morphological features and anatomical structures, scientists seek to understand how *Justicia* species thrive in different environments and defend against herbivory. This knowledge is vital for understanding their survival strategies in diverse habitats.

Additionally, the medicinal and economic potential of *Justicia* species is being explored. Researchers are analyzing their phytochemical composition to identify bioactive compounds

with potential applications in pharmaceuticals and agriculture, highlighting their economic significance.

Pollination and seed dispersal mechanisms of *Justicia* are another crucial research focus. Scientists are studying the specialized floral structures that facilitate interactions with specific pollinators, as well as seed dispersal strategies that enhance reproductive success. Understanding these mechanisms can improve knowledge of plant reproduction and adaptability.

Conservation and biodiversity preservation play an essential role in this research. The documentation and protection of rare, endemic, or threatened *Justicia* species are vital for maintaining biodiversity and understanding their ecological roles in natural habitats. This knowledge contributes to effective conservation strategies.

Finally, the agricultural and horticultural potential of *Justicia* species is being assessed. Given their diverse flower forms and adaptability, researchers are exploring their viability for ornamental use and their role in promoting pollinator-friendly landscapes and sustainable agricultural practices. Collectively, these research objectives aim to enhance our understanding of *Justicia*, contributing to conservation, ecological insights, and various practical applications.

CHAPTER TWO

MATERIALS AND METHODS

2.1 SOURCE OF PLANT MATERIALS

The matured plants were identified at the herbarium of the Department of Plant Biology and Biotechnology, University of Benin, by Professor Akinnibosun Henry Adewale (FLS, MRSB; London, LMBOSON, MECOSON, MAEIAN; Nigeria). The voucher specimens were deposited in the University of Benin Herbarium with voucher numbers UBH-J386 for *Justicia carnea* and UBH-J680 for *Justicia adhatoda*.

2.2 MORPHOLOGICAL CHARACTERISTICS

Morphological characteristics studied includes the leaves, its length and width with the length of its petiole and the height of each species.

2.3 MEASUREMENT OF THE LENGTH AND WIDTH OF THE LEAVES

AND PETIOLE

The length and width of twenty leaves each of the plant species were measured using metre rule and recorded and the mean calculated.

2.4 HEIGHT OF PLANT SPECIES

The height of the different species were measured using measuring tape and recorded.

2.5 TECHNIQUE FOR OBTAINING EPIDERMAL PEELS

Epidermal studies were carried out on fresh material. Samples of fresh material were taken from similar regions of the abaxial and adaxial surface of each leaf species, Usually at the middle area of the leaves. Epidermal peels were obtained following the method of Gill and Nyawuame (1990).

2.6 SCHEDULE FOR FOLIATE SPECIMEN

Epidermal peel was obtained by peeling off using a pair of forceps, later it was bleached and washed up with tap water. The bleached material was mounted on the slide after washing up with distilled water. A Carmel hairbrush was used to clean the bleached materials until the stomata were visible. Clear epidermal structure was then seen under the microscope using magnification $\times 400$.

2.7 PHYTO-DERMOLOGICAL STUDIES

Stomata distribution, epidermal cells, nature of stomata abnormalities and general morphology of the mature stomata were observed. The terminologies of matured stomata used are those of Rasmussen (1981) and (1970).

2.8 STOMATA TERMINOLOGY

Type A:

Ranunculaceous (Anomocytic) type: Stomata surrounded by a few numbers of cells that are identical in form and size from the rest epidermal cells.

Type B:

Anisocytic (unequalled, Cruciferous) type: Stomata surrounded by three unequalled subsidiary cells of which one is distinctly smaller than the other one.

Type C:

Dictytic - Paracytic (Parallel cells, Rubaceous) type: Stomata surrounded on either side by one or more subsidiary cells parallel to the long axis of the pore and guard cells.

Type D:

Actinocytic (pericytic) type: Stomata surrounded by a cuticle of radiating subsidiary cells.

Type E:

Bicytic - Diacytic (Cross Celled, Liabiatous - Caryophyllaceous) type: The stomata are surrounded by a pair of subsidiary cell whose common wall is at right angles to the guard cells.

Type F:

Tetracytic (Monocotyledons) type: Here, stomata are surrounded by four subsidiary cells (2 lateral and polar). It is commonly found among monocotyledon.

Type G:

Hexacytic (Monocotyledons) type: Here, stomata are surrounded by six subsidiary cells (four laterals and two polar).

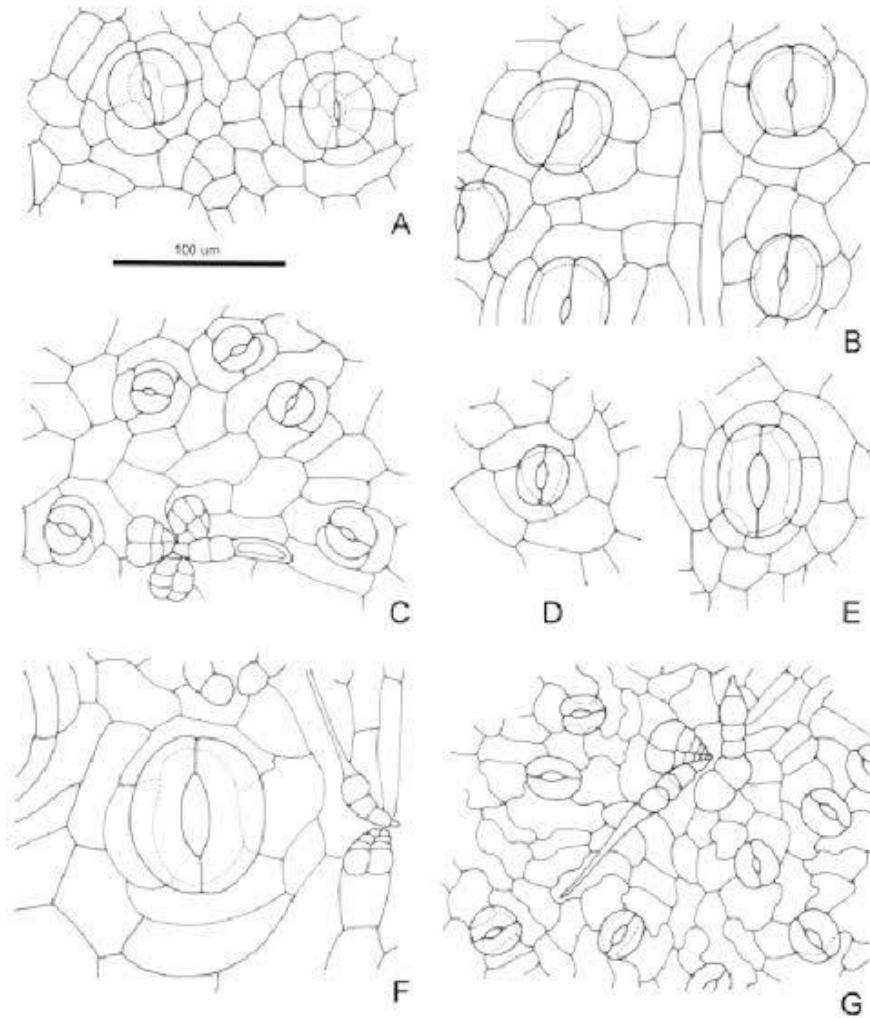


Figure 1 : Stomata terminology (researchgate.net)

A: Anomocytic

B: Actinocytic

C: Anisocytic

D: Bicytic - paracytic

E: Bicytic - paracytic

F: Tetracytic

G: Hexacytic

2.9 CYTOLOGICAL TECHNIQUES:

a. Schedule of meiosis

Young flower buds were fixed in 1:6 acetic acid - alcohol: Chloroform for 12 hours and then transferred to 70% alcohol. Staining of the chromosomes was improved by saturating the acetic acid in the fixative with ferric acetate. The anthers were subsequently squashed in 2% aceto - carmine and finally chromosomes number was confirmed by examining at least 10 - 20 well spread cells. The slide were made permanent by passing through acetic acid/absolute alcohol series and mounted in "euparal" (McClintock's method in Johansen, 1940)

b. Schedule for mitosis:

Young root - tips were prefixed in saturated aqueous solution of para-dichlorobenzene for 2 hours at 16°C, then they were washed in distilled water and fixed in 1:3 acetic alcohol for 12 hours. The root tips were then hydrolyzed in 1:9 concentrated hydrochloric acid in water for 10 minutes at 60°C. Root tips were then washed with distilled water and dipped in aceto - carmine solution with 1 - 2 drops of ferric chloride in it. The root tips were again washed and squashed in 2% acetocarmine. The chromosomes number was confirmed by examining at least 20 well - spread cells.

CHAPTER THREE

RESULTS

3.1 Morphological results

Twelve plant taxa belonging to two (2) different species were collected and identified as *Justicia carnea*, *Justicia adhatoda*

***Justicia carnea* (Brazilian Plume Flower)**

- ❖ Growth Habit: Shrubby, evergreen perennial
- ❖ Height: 1–2 meters (3–6.5 feet) tall
- ❖ Leaf Size: 15–20 cm (6–8 inches) long and 5–8 cm (2–3 inches) wide
- ❖ Leaf Color: Dark green, sometimes with a slightly glossy surface
- ❖ Leaf Texture: Leathery and slightly rough with a somewhat thick feel.
- ❖ Leaf Upper Surface: Glossy or slightly shiny.
- ❖ Leaf Lower Surface: Matte, sometimes slightly hairy.
- ❖ Venation : Pinnate venation
- ❖ It has a simple Leaf
- ❖ Leaf Shape: Oval to lanceolate (elliptical shape) with a pointed tip.
- ❖ Leaf Margin: Entire (smooth edges), without serrations or lobes.



Plate 1 : *Justicia carnea*.



Plate 2: The leaves of *Justicia carnea*. (a) Upper surface and (b) Lower Surface



Plate 3: Photograph of the Upper Epidermal Layer of *Justicia carnea*.

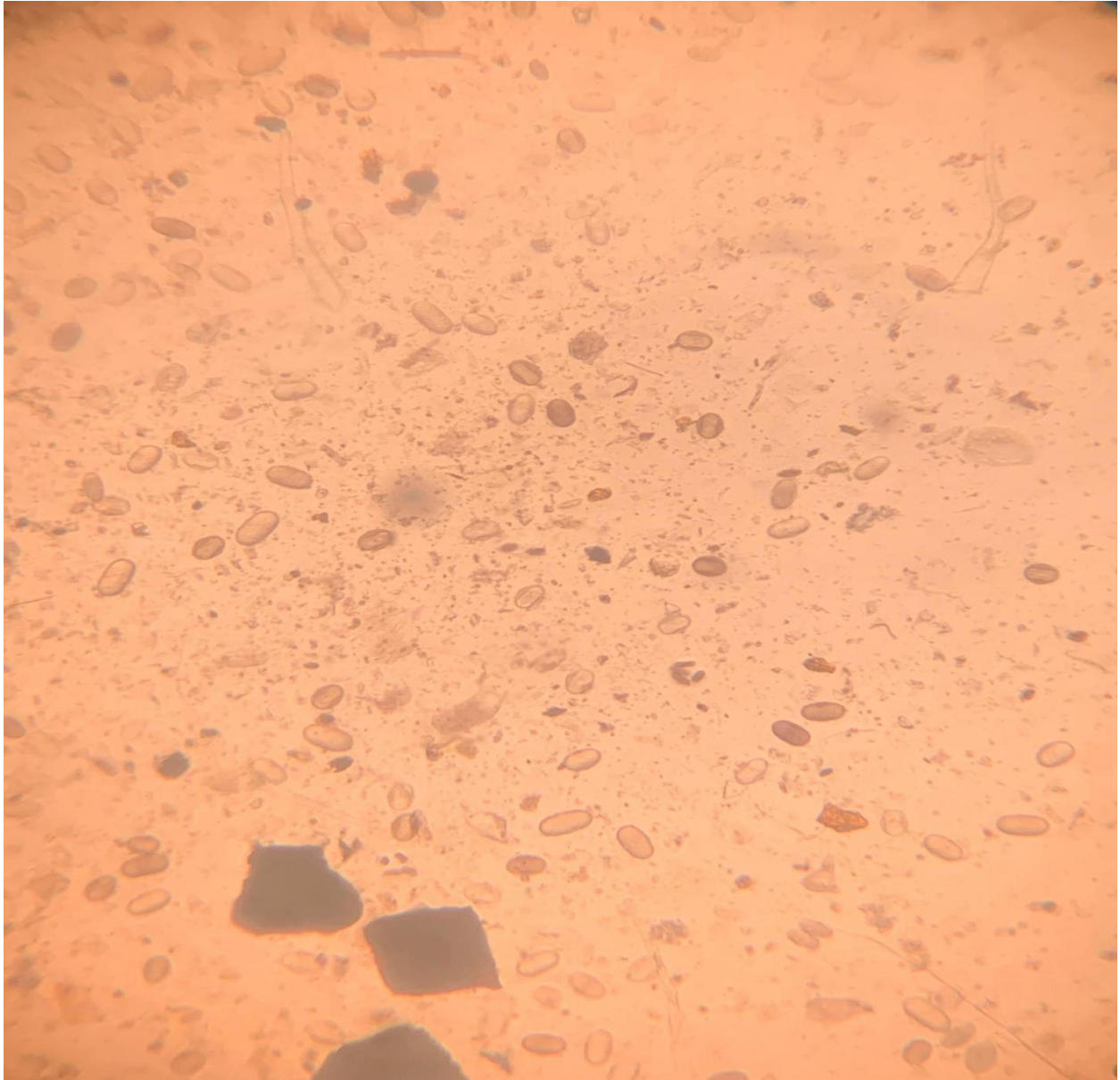


Plate 4: Photograph of the pollen image of *Justicia carnea*.

***Justicia adhatoda* (Malabar Nut) Plant**

- ❖ Growth Habit: Shrubby, evergreen perennial
- ❖ It has a dense, bushy appearance with multiple branches.
- ❖ Height: 2–4 meters (6.5–13 feet) tall
- ❖ Leaf Size: 10–15 cm (4–6 inches) long and about 4 cm (1.5 inches) wide.
- ❖ Leaf Color: Dark green on the upper surface, lighter green underneath.
- ❖ Leaf Texture: Smooth and leathery.
- ❖ Leaf Upper Surface: Glossy or slightly shiny.
- ❖ Leaf Lower Surface: Dull, slightly hairy, with visible venation.
- ❖ Venation : Pinnate venation
- ❖ It has a simple Leaf
- ❖ Leaf Shape: Lanceolate (lance-shaped) with a pointed tip.
- ❖ Leaf Margin: Entire (smooth edges), without serrations or lobes.



Plate 5: *Justicia adhatoda*.

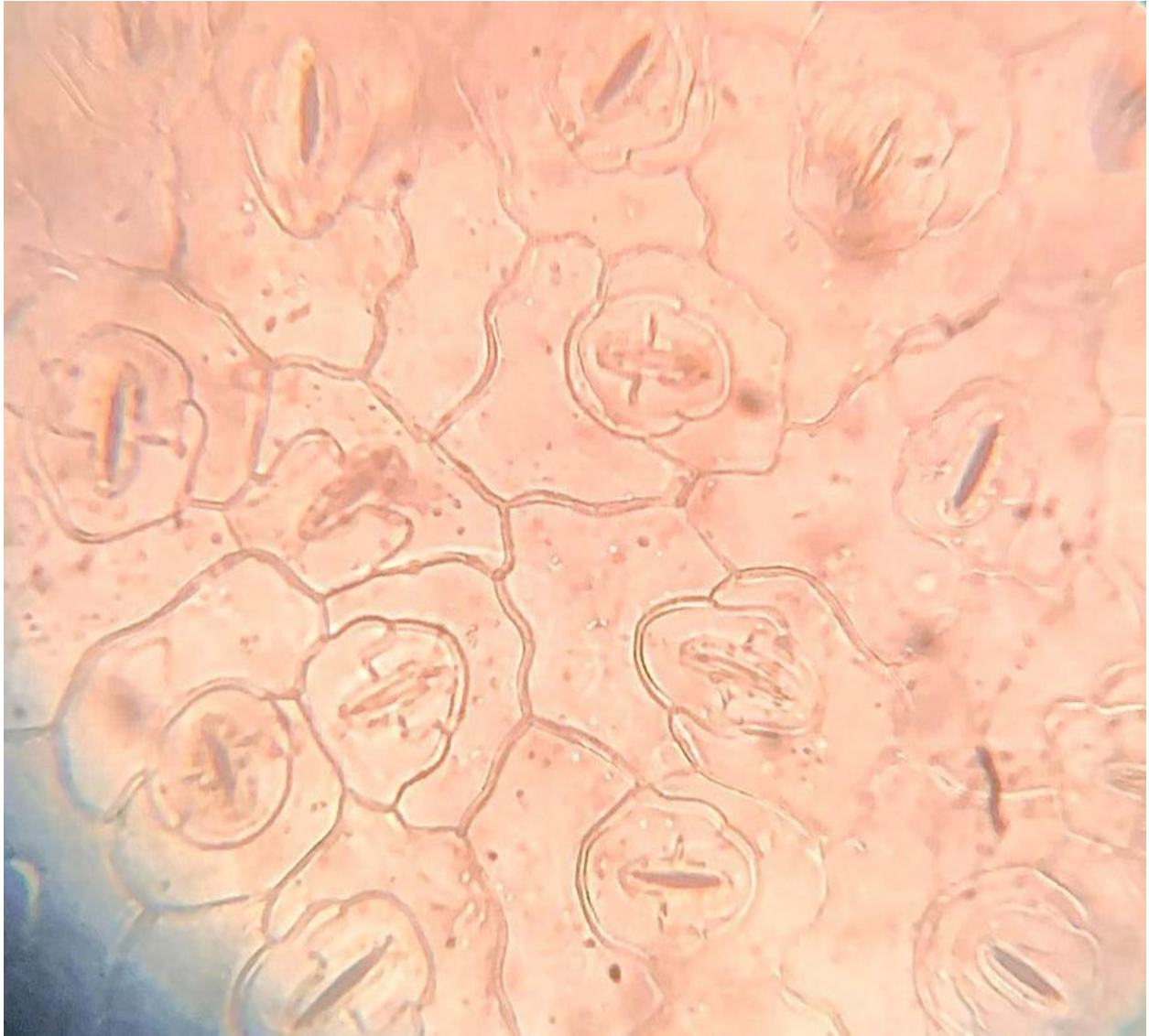


Plate 6: Photograph of the Upper Epidermal Layer of *Justicia adhatoda*.



Plate 7: Leaf of *Justicia adhatoda*.

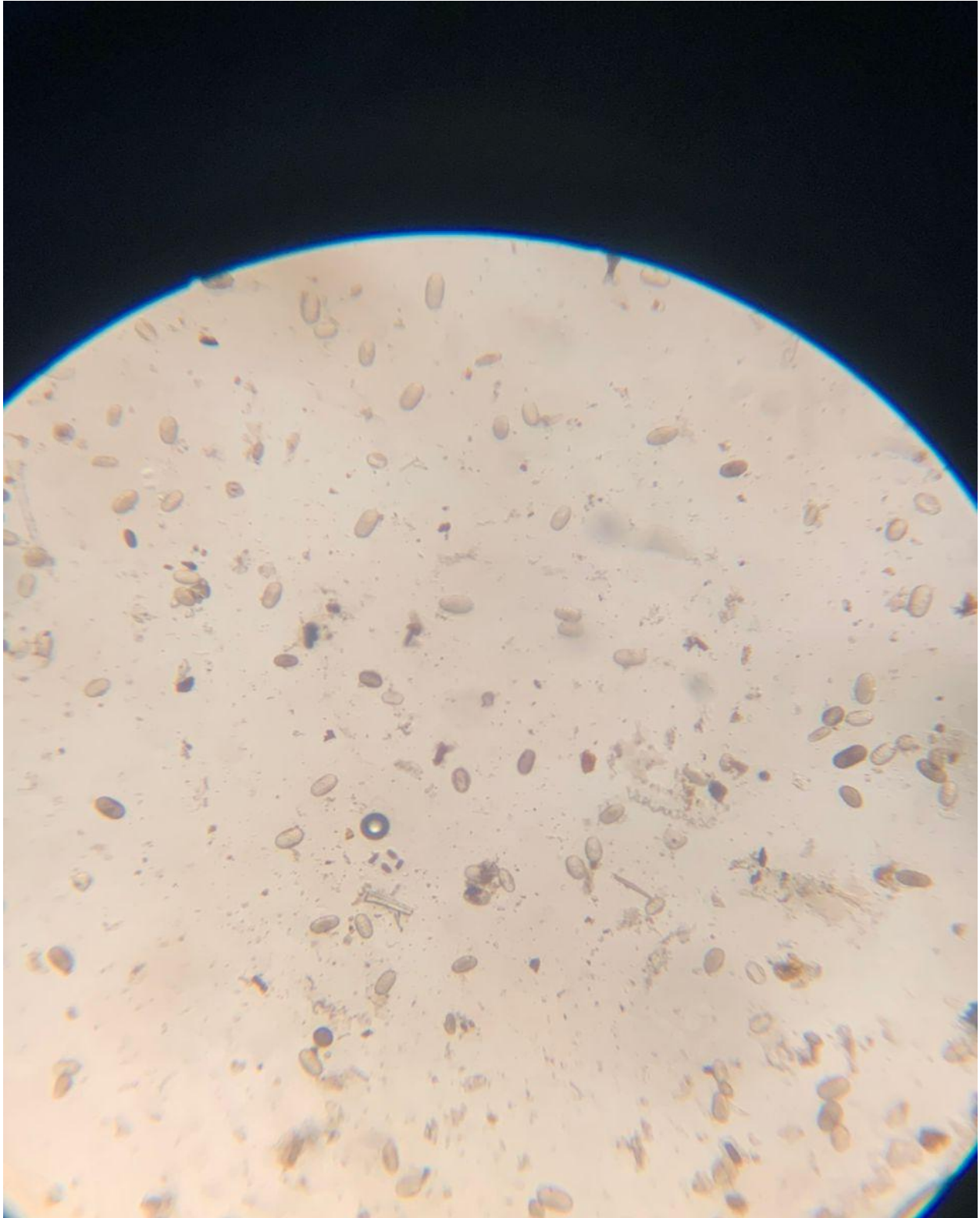


Plate 8: Photograph of the pollen image of *Justicia adhatoda*.

3.2 CYTOLOGICAL RESULT

Chromosome number

After a repeated strenuous effort I could not determine the chromosome number of any of the species.

From both mitotic and meiotic studies, the chromosome number of both varieties proved very difficult with no flowering or pollen in plant.

Cytology of this species is reported for the first time. Chromosome report so far available indicate that all known species have their chromosome numbers in multiples of 8 and all of them are polyploids.

3.3 PHYTODERMOLOGICAL STUDIES

Most species have broadly ovate leaves with winged petioles and are amphistomatic. Leaf epidermis and waxy cuticles of varying thickness are vital in regulating water loss and protecting tissues from excessive sunlight.

CHAPTER 4

4.1 DISCUSSION

Morphological features constitute the orthodox tool of the taxonomist because of their diagnostic value in taxonomic evaluation. The morphological features of an organism are not by accident but as a result of long evolution of successive adaptation of living things to their environment while some others are a result of mutation.

4.2 CHROMOSOME NUMBER

Chromosome numbers has been widely used in systematic investigation in the plant kingdom. The information on chromosome number when used in conjunction with other taxonomic data needs to provide a better understanding of the tribal and generic relationship between plant kingdoms. The Chromosome number of the species could not be confirmed because of the low production of pollen grains from their bud. Cytological information on the family is too scanty and scattered.

4.3 EPIDERMAL MORPHOLOGY

The cuticle of the dicot leaf is an easily studied character and therefore very important in the intra-generic systematic and phylogeny. Various authors have stressed the taxonomic importance of morphological types of stomata and their ontogeny. At present our knowledge of stomatogenesis is highly uneven in different groups of plant. Existing stomatal theories observed

that stomatal density has correlation with guard cell lengths when the stomata are present on both leaf sides of herbaceous plants (Wilmer, 1993).

4.4 POLLEN GRAIN SIZE

The use of pollen characters as a reliable indicator of ploidy level in plant species has been stressed by many workers. The result from this research was inconclusive.

4.5 STOMATA SIZE

The variation in stomata size were ascertained as a taxonomic parameter. *Hypoestes Forskaolii* possesses anomocytic stomata, *Acanthus mollis* possesses bicytic stomata and *Mussaenda Elegans* Anomocytic stomata

REFERENCES

- Arulmozhi, S., Kumar, K., and Pandey, A. (2006). *Justicia adhatoda*: A review of its medicinal properties. *International Journal of Ayurvedic Medicine*.
- Beentje, H. J. (1994). *Thunbergia alata* in East Africa. *East African Plants Journal*.
- Ezeabara, C. A., Ojo, O. A., and Adedayo, A. I. (2014). Edible tubers of *Ruellia tuberosa* in times of drought. *African Journal of Food Security*.
- Gleason, H. A., and Cronquist, A. (1991). *Manual of Vascular Plants of Northeastern United States and Adjacent Canada* (2nd ed.). The New York Botanical Garden Press.
- Hamilton, A. (2004). Sustainable cultivation of medicinal plants: A community-driven approach. *Journal of Ethnobotany*.
- Judd, W. S., Campbell, C. S., Kellogg, E. A., and Stevens, P. F. (2015). *Plant Systematics: A Phylogenetic Approach* (4th ed.). Sinauer Associates.
- Kearns, C. A., and Inouye, D. W. (1997). *Pollinators and Plant Reproductive Success*. Springer-Verlag.
- Kress, W. J., and Specht, C. D. (2005). Pollination ecology of the Acanthaceae. *Ecological Review Journal*

Kumar, P., Sharma, R., and Chaudhary, H. (2021). The medicinal uses and bioactive compounds of *Andrographis paniculata*. *Phytotherapy Research Journal*.

Lans, C., Turner, N. J., and Khare, C. P. (2001). The spiritual and medicinal significance of *Justicia secunda*. *Journal of Afro-Caribbean Studies*.

Mishra, S. H., and Tiwari, A. K. (2007). A review on the medicinal properties of *Andrographis paniculata*. *Pharmacognosy Review*.

Moerman, D. E. (1998). *Justicia secunda* in Afro-Caribbean spiritual rituals. *Ethnobotany Journal*.

Mabberley, D. J. (2008). *The Plant Book: A Portable Dictionary of the Vascular Plants* (3rd ed.). Cambridge University Press.

Neuwinger, H. D. (2000). *Medicinal plants in African traditional medicine*. World Health Organization Report on Traditional Medicine.

Pandey, A. K., and Srivastava, S. (2020). The pharmacological efficacy of *Justicia adhatoda* in treating respiratory diseases. *International Journal of Pharmacology*.

Pimentel, D., and Kounang, N. (1998). Soil erosion and its ecological impacts. *Environmental Science and Technology Journal*.

Raven, P. H., Evert, R. F., and Eichhorn, S. E. (2012). *Biology of Plants* (8th ed.). W.H. Freeman and Company.

Simpson, M. G. (2010). *Plant Systematics*. Elsevier Academic Press.

Singh, V., and Singh, D. (2008). The medicinal use of *Barleria prionitis* in Southern Africa. *Journal of Traditional African Medicine*.

van Wyk, B. E., and Wink, M. (2009). *Barleria prionitis*: Uses and benefits in African medicine. *Ethnopharmacology Review*.

WHO (2013). *Traditional Medicine Strategy 2014–2023*. World Health Organization.