ISSN NO: 2771-8840
Date of Publication: 30-09-2022

A Review of Plant Anatomy Tools and Their History

Atheer Hashim Abdulmajeed[1], Hisham majeed shlash[2] , Ashwaq talib hameed[3],
[1] University Of Anbar, College of Agricultural, Iraq. [2] Tikrit University, College of sciences Department of biology, Iraq. [3] University Of Anbar, Education Collage for Women, Iraq.
Corresponding Author's e-mail: ag.atheer.hashim@uoanbar.edu.iq

Abstract: This article tackled a rigorous review of plant anatomy and its history. The anatomy of the plant is significantly essential, and it is grown all over the world. However, most of it is produced in tropical and subtropical countries, and just a few of its species are grown in temperate zones. The anatomical studies are preliminary studies that come before the critical studies of these plants and fulfill the necessary learning for those studies. Although only a small number of plant taxa have really been explored physically up to this point, more species have likely been investigated chemically. This article provides a comprehensive look at the history of plant anatomy tools as well as anatomical investigations that have been conducted on plants

Keywords: Review; Plant anatomy; Biological

1. Introduction

When it comes down to life, our very existence on this planet is contingent upon the existence of green vegetation. Plants are the most fundamental main sources of aquatic food and food companies because of their ability to convert light energy into a form. Trees have all been emitting gas into the air as a "loss" photosynthesis for the past 100 million years, thereby contributing to the formation of an atmosphere that is essential for the survival of aerobic species such as humans and other animals. Not the least important, plants create a sustainable planet for a wide variety of different species. The anatomy of plants, often known as phytology, is the study of the composition and organization of the living organisms known as plants. Plant morphologies, the portrayal of the concrete state, and the outside architecture of plants were initially a part of it. However, since the mid-1900s, plant physiology has been regarded as a separate science that refers only to the internal plant. The study of plant anatomy currently frequently occurs at the cellular level and routinely involves separating tissues and using imaging. Plant anatomy, and much more broadly the research of vegetative organs, has gone thru a turbulent evolution in the 20th century based on newly produced, modern technologies. This is particularly true for the study of plant physiology. It is essential to have a solid understanding of the scientific discipline's history in order to comprehend the most recent advancements in any scientific subject. In chapter 1.1, an overview of the most significant historical events that occurred during the process of developing plant anatomical methodologies is provided. The historical perspective will be maintained throughout the current comment to demonstrate the significant number of innovative approaches to plant anatomical procedures that have mostly emerged over the last half-century. Environmental biology studies plants or their components in the context of their interactions with their "native" or "artificial" environments. There are a variety of applied sciences that include or are predicated on environmental biology. These sciences include agronomy, crop ecology, crop biology, floriculture, biological ecology or development environments, control variable, as well as forest products [1-5]

2. The history of the Plant Anatomy

The development of a necessary magnification tool was important to understanding plant anatomy as it was the only thing that allowed geologists to see beyond the resolving of the naked eye, which is no and over 100 millimeters. Without this tool, plant physiology research would not have been possible. The lens, the fundamental component of magnifying devices, has been around for a very long time; evidence of its origin can be found in archeological digs dating back to the fourth century B.C. Ancient Greece made use of lenses for various purposes, including lighting fires in temples, much like the old Roman Empire did [6].
Theophrastus of Eresus, a Greek theologian from 369 to 262 B.C., is commonly referred to as the "Father of Botanical Science." He presented fundamental ideas in description morphology, focusing on the many kinds of organs and their relationships. He described the gross interior anatomy of the leaves, stems, and roots.

ISSN NO: 2771-8840
Date of Publication: 30-09-2022

Zacharias Janssen, a Dutchman, is credited with building the first stereomicroscope in the year 1590. The invention of fluorescence microscopy and its subsequent usage in scientific research throughout the eighteenth century paved the way for the emergence of new scientific subfields. The study of animals and plant tissues, as well as microbes, was the impetus for the development of cell biology. Robert Hooke first introduced the term "cell" to describe the little compartments that comprise plant material in his work Microsporidia, published in 1667. Hooke's term usage was based on examining the anatomical cork produced by the wine bottle oak [7-9].

The 18th and 19th centuries saw significant advancements in optical, which led to the development of numerous lens designs, which allowed for the advancement of scientific practice. The application of advanced spectroscopy technologies, such as an electron, luminescence, and focal plane applied to specific photographers, arithmetical sciences, camcorders, and visual data analysis methods brought about a rebellion in the advancement in the field of plant physiology during the 20th century. This occurred during the time period. The latter half of the 20th century was marked by such dramatic advances in the field of plant physiology that the period can be accurately described [10]

3. Plant Histology Tools

We must design a study approach whenever an issue or query pertaining to an investigation or ecology is posed. In the field of physiological research, where it is helpful to make use of architectural and histology analysis techniques, we are tasked with determining the methods that will be utilized in our investigation. First, we need to settle on a strategy for preparing objects obtained from plant material for inspection in conjunction with a histological approach and a practical kind of micro photography. Then, one of three types of analytic methods—descriptive, quasi, or quantitative—is implemented [11,12]. There are many different approaches one might take in order to get an item ready for microscopic examination. In-plant science, it is widespread for fresh material to be unable to be digested quickly. Many techniques, including fixation, drying, penetration, and anchoring, are utilized when this occurs. A variety of microtomes are utilized throughout the sectioning process. When working with fresh material, one can choose to use either the whole mount techniques, the smear methodologies, or the fresh segment methodologies. When performing histology detection systems, fresh sectioning, which can be done both gratis or with a hand section cut, is often desirable since it avoids artifacts in localization caused by the tissue fixing and/or embedding processes. Combining flow cytometry with fresh sections eliminates the need for pretreatment and is another example of the effective use of fresh segments. When determining the precise location of the enzymes' histology activity, for instance, rapid freezing procedures and cryosectioning are two more methods that can effectively preserve the body state of the examined tissues. Another typical method utilized for the investigation of the plant cuticle is the creation of replicas. To create contrast inside tissues using a variety of dyes, stains, toxic substances, or applicable international histochemistry (or cell biology, formerly also known as microchemical techniques - for example, Johansen 1940) techniques are utilized. These techniques are also known as "microchemical techniques." Although a large number of the earliest applications of staining and colors were in the botany scientists, plant histopathological and cytochemistry, along with the majority of other areas of plant biotechnology, have relied substantially on the processes used in zoology or cancer research. For instance, D.H.F. Link reported the first histopathological staining in 1807, which was about the visualization of alkaloids in plant cells using iron sulfate. The stain was used to highlight the presence of iron sulfate. However, the vast majority of contemporary histological methods were initially created in the field of animal or medical histology, and it is still the case that a lot greater staining procedures have been produced in the field of animal histopathology than in the field of plant histology. In addition, the majority of histochemistry literature concentrates its attention on animal applications. Assessment of histochemical detection may be descriptive or statistical, depending on the circumstances [13,14]

4. Analytical approaches in plant morphology and anatomy

4.1. Analysis with a qualitative focus

Describe Descriptive statistic has been utilized since the ancient Greeks to study plant interior architecture. End of the 19th century: core embryonic and physiological plant morphology principles. He suggested the first physiological categorization of plant tissues depending on their derivation from the apical meristem:

developed dermatogen, problem, Pleroma, and calyptrate. Heinrich Haberlandt's 1884 physiological Pflanzenanatomie divided tissues under functionalities, ignoring visual categorization and groupings. Parametric analysis is important to crop histology courses or atlases. Descriptive statistical informs schematic diagram. Based on the qualitative analysis, we assess if quantitative procedures are useful and which are optimal. Dynamic anatomical research, especially embryonic studies, requires descriptive analysis [15].

For example, embryonic and root differentiating investigations can examine organ maturation and histology. It's sometimes the best technique to capture changes among test variants when investigating ecophysiology or stress physiology. Somatic morphogenesis of Norway spruce altered by varying osmoticum (poly (ethylene glycol) concentration in the growth medium merely shifted the timing of developmental events. Comparison of ploidy gestation demonstrated that a smaller gap between both the early clonal embryo's anatomically and the plantlets stage "limits" the normal flow, which opting month. we intended to achieve in vitro. In some ambient and stress investigations, detailed architectural and histology research focusing on morphological anomalies best reveals a stressor's detrimental impacts. Stress generates apoplastic impediments to water and ion movement, affecting root tissue architecture. Early differentiation of the exodermis in willow seedlings is known to be an efficient barrier limiting passive apoplastic permeation of solutes first from the root system into the root cells, showing that structure in the air circulation variety of shared reed root systems is crucial in preventing water ingress. Most histology studies use descriptive analysis. It can show the presence of a researched molecule in distinct organs during organ growth or stress. Analytical description can reveal a structure's intracellular location [16,17].

4.2. Analyses semi-quantitative

The semi-quantitative technique is performed to evaluate histology stain strength. Usually, a 4-category scale is employed to enable a consistent spectator detection rate. Finer scales are hard to read. 0 = none, 1 = little, 2 = considerable, 3 = a lot. Figure 1 shows four from several mesophyll cells with quasi evaluations of phenolic buildup in the vacuoles. Quasi assessment has been utilized for years, especially for histochemically colored products. In-plant pathology, this scale measured dehydrogenase activity, and starch buildup. Some histologic detection systems, such as salt starch detecting, can provide a spectrum of colors. In this scenario, reproducible evaluation is also desirable because a colored histochemical detection output cannot be thresholded from its backdrop & analysis is used [18].

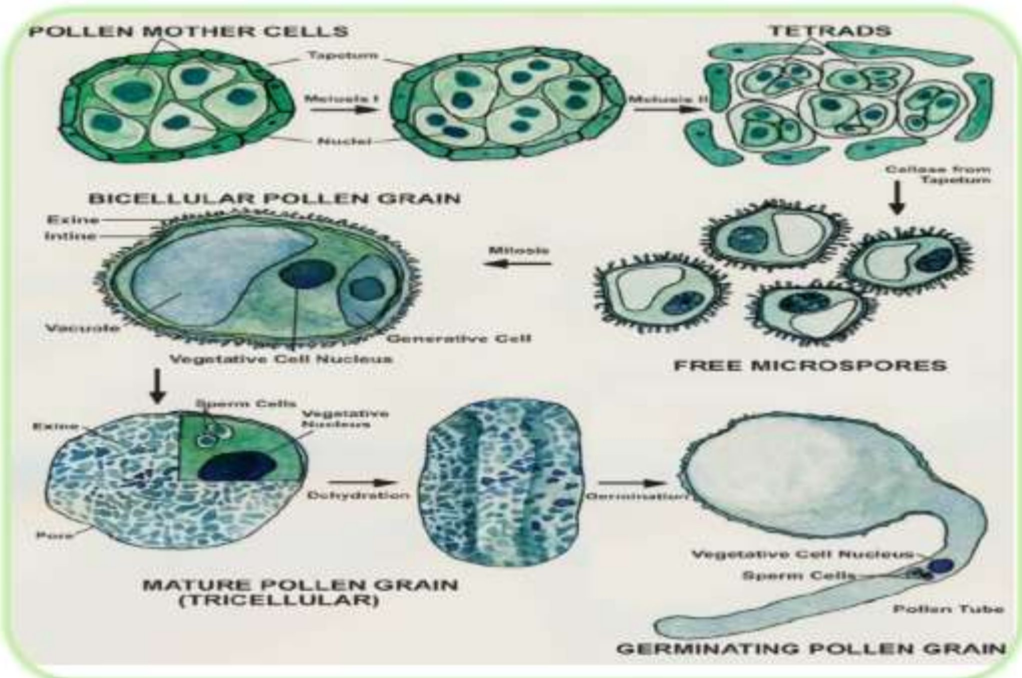

Figure 1. Model illustrating the Process of Microsporogenesis

ISSN NO: 2771-8840
Date of Publication: 30-09-2022

4.3. Quantitative analysis

The paper written by Professor Pazourek of Carl School in Prague (1988), who was one of the first plant scientists to use morphological techniques, defines the concept of a research community of quantifiable physiology: "quantifiable plant anatomy is a branch of science concentrating on the research of linear association of structural features, kleenex, as well as tissue clusters in plant organs." In other words, quantifiable tree anatomy of the linear association between structures, kleenex, and skin clusters in plant organs.

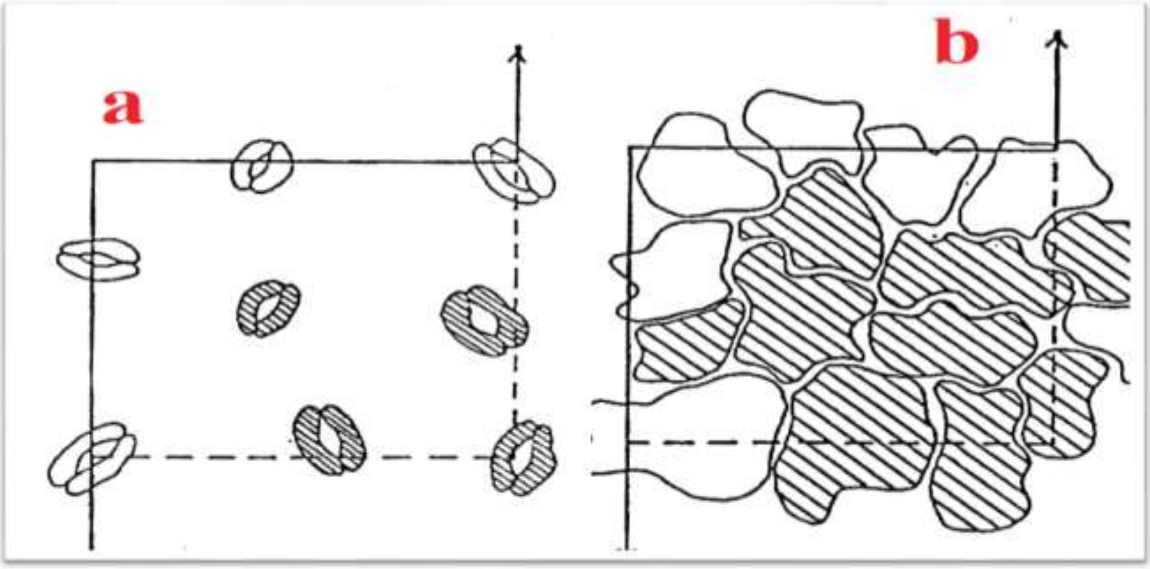

Figure 2. a sampling framework free of bias. (From Kubinova and Albrecht Oval 1999)

As a result of the progress made in mathematical studies and computer technology during the 20th century, this industry now uses a wide variety of approaches and instruments. This section will discuss the historical landmarks that were influential in image analysis and stereology. Provides an introduction to the fundamental idea underlying stereological approaches as well as picture analysis. Instances of systematic procedures that provide distinct quantitative plant factors, planar and spatial factors, are treated in a different fashion. It should become clear that many methodological methods can be integrated effectively during quantification, as shown in figure 2. This is going to be covered in more detail later. The many approaches to determining the quantitative significance of colored histochemical reactions are reviewed. The section on Experimental Design goes over some crucial components of incorporating quantitative analysis into a research project [19,20]

5. The scaling concept as it relates to plant anatomy

There is no question that the scale is without question among the essential components of any investigation. Through the work that has been accomplished as a result of the confluence of ideas largely generated in finance, ecology, and applied mathematics over the past forty years, the basic function that scale plays has become clearer. No one explanation of scale applies to all situations; nevertheless, philosophically, the scale can be thought of as the windows of sight, the gauging tool, or the filters by which an item can be observed or perceived at various echelons. The process of scaling involves moving data or information from one level of measurement to another. In practice, scaling can be accomplished by either a bottom-up or a top-down methodology. The process of taking information at lower scales to infer processes at higher stages is called upscaling. A large number of features operating in a non-linear manner and possessing adaptive features over time are the defining characteristics of dynamic structures. Complex systems often take the shape of hierarchies, which means that they are made up of interconnected subsystems. These subsystems, in turn, are made up of even more granular subsystems, and this process continues until the most fundamental level is reached. Interactions can occur at varying orders of magnitude between and within the subsystems that make

ISSN NO: 2771-8840
Date of Publication: 30-09-2022

up a hierarchical system. In general, interactions between members of the same management stage are greater and more regular than contacts between levels [21-23].

Plants can be thought of as multi-tiered or hierarchically organized and complicated. As we move thru the layers, we may find ourselves with the following progression: planet > environment > environment > society > plant > organs > tissues> cellular > chloroplasts > barrier > atom > semi level. What occurs at one layer is understood according to what occurs at the level beneath, as well as what occurs just at a level above is what gives what happens at the lower level its importance (or meaning). The intricate whole represents something that is not present in the individual components. Units are connected to one another through a hierarchy in ways they could not do independently. An "emerging property" is a novel and, in some ways, unanticipated element of the entire structure that develops due to the combination of units from one scale to construct the next scale. The principle that all lesser scales are required to operate higher scales is one of the basic foundations that regulates all complicated shapes, including both organic and mechanical ones. For instance, this explains the action of a herbicide, which occurs when a chemical disrupts the functioning of a lower scale. This alone is enough to undermine (and ultimately kill) the organism. The processes accompanying plant life, advancement, and physiological effects are governed by a set of internal factors and thus are ruled by a propensity to obtain greater levels of complexity. This propensity is governed by the fact that plants have a tendency to obtain greater layers of difficulty. For instance, seed germination is the result of a spike in the volume and size of cells, market segmentation is the process by which pluripotent cells become specialized, and growth is the process of genetically coded distinction, in which exact genetic organisms take on various forms. Many times, the operations of dynamic structures take place on many scales. For instance, the expression of a plant's stress response often begins at the metabolic level, then moves to the structural level, and macroscopic alterations are visible (Fig. 3). Scaling is an essential concept in the field of environmental justice biology. It prioritizes complex research due to the complexity of multi-disciplinary approaches, and as a result, it can lead to the identification of global challenges such as pollution issues or global nutrient availability, as well as climate change.

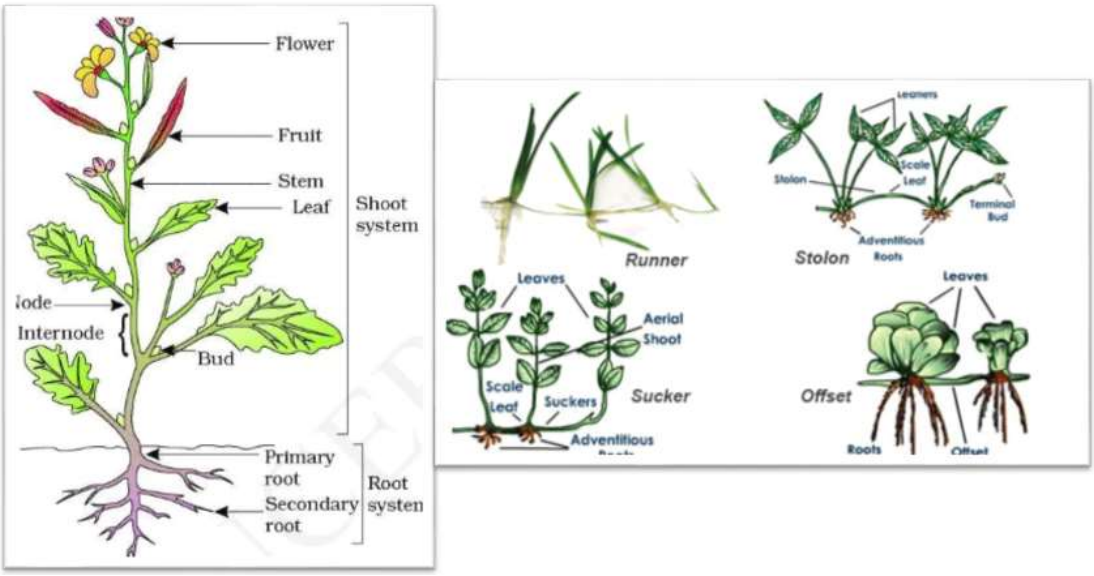

Figure 3. The Structure of Plants and How Their Components Contribute to Their Overall Function

The use of remote sensing opens up a lot of opportunities for scaling. It is a fantastic example of the many different levels of scientific methodologies that may be applied, as well as how the growth of technologies impacts the progress of a discipline that has only been around for a few decades [24].

5.1. The use of remote sensing in the study of the morphology and anatomy of plants

The use of satellite data in the study of the morphological features of plants "Remotely sensed" is defined as "the science and art of collecting data, area, or event by the interpretation of collected data that is not in touch

ISSN NO: 2771-8840
Date of Publication: 30-09-2022

with the object, area, or phenomenon under examination," as stated in the US Army Handbook of Satellite Data. The use of remote sensor devices can be carried out on the surface, in the air, or even in space. Photographic cameras recorded information in the visible spectrum and were among the earliest devices to be utilized. They are still useful, but the most powerful devices for remote sensing are distinct sensors known as spectroradiometers. These instruments can acquire information from many kinds of radiation, such as the ultraviolet (UV), visible (viewable), and indigo (IR) regions. The visible and infrared parts of the spectrum are the most helpful ones to use while carrying out diagnostic procedures on vegetation. The general shape of radiance curves is the same for all vegetation; however, the absolute values, local minima and amplitudes, spectral position of turning points, and other characteristics vary, and these characteristics are useful for diagnosis of the organism type, foliar age category, and harm class. Certain leaf structural or physiological elements predominately affect the path a spectral curve takes through various regions. This is the case regardless of which area the curve is being examined. The presence of a variety of chemical compounds in plant material is reflected in the presence of distinct reflection peaks and absorption characteristics. In addition, the spectral data are utilized for the development of spectral indices, which correlate with a variety of physiological or structural factors as well as states of plant physiology. The spectral reflectance of the plant can be used to evaluate the damage to the foliage. A large number of different variables influence reflectance in the near-infrared spectral band. Generally, the reflectance range between 800 and 900 nanometers generally represents the structural (cellular) reflectance wavelength. The idea of scaling up places a significant emphasis on remote sensing that is gathered through the use of satellites. Landsat, which was released in 1972, was the first orbital spectrum sensor. It carried only multiple scanners, which was referred to as the Multispectral Scanner (MSS). The MSS was able to acquire reflect solar radiation in four visible bands (a green band, a reed quintet, & three near-infrared bands) and two near-infrared bands. However, this detector had many drawbacks, one of which was that it recorded reflectance data in large (50-100 nm wide). These discontinuous bands cannot detect the specific spectral features required to evaluate a tree's healthiness on the floor level [25-27].

The hyperspectral device, which NASA created, is a novel remote sensor system containing specific groups and less than 10 nanometers broad, providing continuous coverage of particular spectral regions. One of the benefits of using spectral data is that it enables the detection of small changes in breast form as well as fine characteristics. These variances are manifestations of metabolism and cell changes that have occurred at the needle and anomy levels due to damage (Fig. 4). The structure and position of fine features in hyperspectral data taken from aircraft are frequently extremely comparable to those produced from laboratory spectrometers. The use of remote sensing in conjunction with ecological physiological visualizer scaling up, for example, from individual leaves to entire stands. Many of the initial efforts to "scale up" physiological data, such as transpiration or sunlight, to an entire forest stand were defined on the basis taken at the level of individual leaves and then projected to the level of a whole canopy. This method is plagued by sampling and projection errors because the system characterized by photosynthesis across the tree crown can create a great deal of variation in the photosynthetic parameters being measured.

Another issue that has arisen as a result of this scaling-up process is the fact that some sure-to-refer circumstances, which are essential to the physiology of the leaf, are insignificant at the canopy level. Eddy covariance is a method that allows for the measurement of the net ecosystem flux of carbon from the forest canopy in a way that is non-intrusive and over extended periods. Advances in both apparatus and theory achieved this technique. The remotely sensed technology can provide a chance to thwart the scalability problems noted by yielding hand calculations of canopy-level respiration, as well as yield metrics of foliar efficiency and stand configuration. This would be possible because remote sensing included a chance to sidestep scaling troubles. The use of remote sensing techniques has the ability that provides surveillance that is large-scale, long-term, and cost-effective.

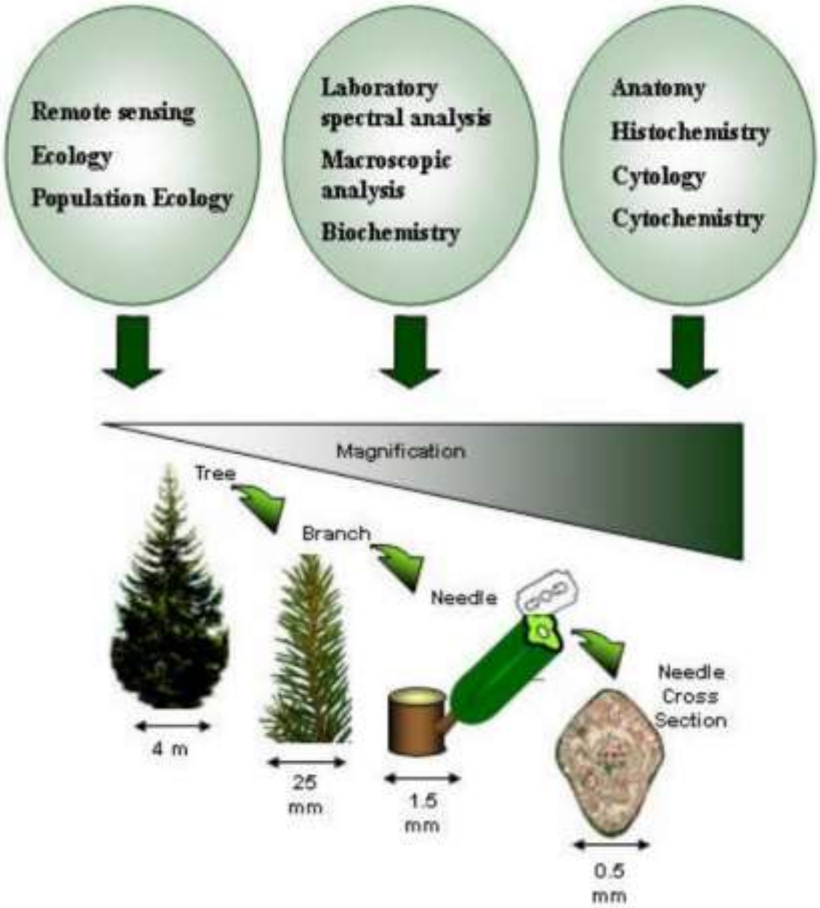

Figure 4. Scaling in the study of forest ecosystem using a multidisciplinary approach.

Therefore, data obtained through satellite imaging have begun to have a wide utility in many practical domains of plant science, such as agriculture, gardening, and forestry, all of which are places where maintaining a soil's physiologic health is of significant relevance. Biochemical and macroscopic markers are essential components in the process of determining the physiological status of plants or their overall state of health. They contribute to the process of detecting damage on a hierarchical level that is lower than the macroscopic level. These early damage markers allow for "early" recognition of the beginning stages of plant damage/recovery, characterized by latent, irreversible, and not yet visible changes. In order for scientists to calibrate and confirm satellite images, they utilize a variety of ground-based approaches to defining ground conditions. These methods are frequently referred to as "ground truth." Laboratory pharmacological, histochemical, and architectural analyses are carried out so that researchers can obtain data that is representative of reality at the physiological and macro levels. In addition, scientific spectroradiometers are utilized in the process of measuring spectrum reflectance. The width of the spectral bands produced by these devices is only 1.5 nanometers, resulting in a continuous reflectance curve. In this method, the search for the fundamental truth starts at the microscale with the examination of needle-thin slices to ascertain the level of cell injury or health, and it continues all the way up to the macroscale with the examination of a canopy (Fig. 4) [28,29].

6. Conclusions

There is no doubt that we are in the midst of a golden age for applying anatomic tools in the field of plant science. It's become a highly essential tool in physiology and scores better examination of plant species on various hierarchies, and it can take on several distinct forms. This commentary provides a concise overview of some of the more important plant anatomical research methodologies that are now accessible. Methods of investigation in plant anatomy were highlighted, with a particular focus on quantitative analyses conducted through the use of stereological concepts and image analysis. I have high hopes that the application of

ISSN NO: 2771-8840
Date of Publication: 30-09-2022

historical perspective throughout the entire work will justify the assertion that the latter half of the 20th century witnessed a period that may be referred to as the "Revolution in Plant Anatomy." In environment physiologists and other branches of plant biology, the morphological and histology alterations that are disclosed by data statistics relatively frequently are those of a financial method. Quantification techniques are particularly helpful in the study of plant anatomy because they allow for a more accurate analysis of the results acquired on other hierarchy levels. A wide variety of quantitative approaches available for computer vision and morphological procedures can be used to conduct quantitative analyses of anatomical structures. Estimates of system parameters can be obtained through the use of morphological principles. The most effective strategy is frequently one that utilizes a mix of quantitative and systematic approaches. This study focused on a comprehensive examination of plant anatomy and its history. The structure of the plant is critically important, and it is cultivated in many different countries throughout the world. On the other hand, the vast majority of it is produced in tropical or subtropical countries, and only a few of its species

ISSN NO: 2771-8840
Date of Publication: 30-09-2022

References

1. Albrechtová, J. (1994). Quantitative analysis of leaves of sun and shade ecotypes of Solanum dulcamara L. Acta Stereologica.
2. Pang, Y., Li, L., & Bian, F. (2020). Photosynthetic and ultrastructural adaptability of Anemone shikokiana leaves to heterogeneous habitats. *Brazilian Journal of Botany*, *43*(4), 979-988.
3. Yu, L., Fujiwara, K., & Matsuda, R. (2022). Recent levels of daily photosynthetic photon flux density have a larger influence on the light acclimation responses of cucumber leaves than earlier. *Horticulture, Environment, and Biotechnology*, *63*(1), 55-63.
4. Baker, C. R., Stewart, J. J., Amstutz, C. L., Ching, L. G., Johnson, J. D., Niyogi, K. K., ... & Demmig-Adams, B. (2022). Genotype-dependent contribution of CBF transcription factors to long-term acclimation to high light and cool temperature. *Plant, Cell & Environment*, *45*(2), 392-411.
5. Yu, L., Fujiwara, K., & Matsuda, R. (2021). Estimating Light Acclimation Parameters of Cucumber Leaves Using Time-Weighted Averages of Daily Photosynthetic Photon Flux Density. *Frontiers in plant science*, *12*, 809046-809046.
6. ALBRECHTOVA, J., & KUBlNOVA, L. U. C. I. E. (1991). Quantitative analysis of the structure of etiolated barley leaf using stereological methods. *Journal of experimental botany*, *42*(10), 1311-1314.
7. Hunt, L., Fuksa, M., Klem, K., Lhotáková, Z., Oravec, M., Urban, O., & Albrechtová, J. (2021). Barley Genotypes Vary in Stomatal Responsiveness to Light and CO2 Conditions. *Plants*, *10*(11), 2533.
8. Kubínová, Z. (2019). Study of quantitative parameters of Norway spruce needle structure under the effect of elevated CO_2 concentration and different irradiance.
9. Böszörményi, A., Dobi, A., Skribanek, A., Pávai, M., & Solymosi, K. (2020). The effect of light on plastid differentiation, chlorophyll biosynthesis, and essential oil composition in rosemary (Rosmarinus officinalis) leaves and cotyledons. *Frontiers in plant science*, *11*, 196.
10. Sathasivam, M., Hosamani, R., & Swamy, B. K. (2021). Plant responses to real and simulated microgravity. *Life Sciences in Space Research*, *28*, 74-86.
11. Ali, A., & Arif, W. P. (2019). Developing of guidance for laboratory practice of islamic science-integrated plant anatomy-physiology. *Biosfer: Jurnal Pendidikan Biologi*, *12*(1), 70-82.
12. Legland, D., Devaux, M. F., & Guillon, F. (2018). Quantitative imaging of plants: multi-scale data for better plant anatomy. *Journal of Experimental Botany*, *69*(3), 343-347.
13. Daniel, A. D. I., & Tawakaltu, I. N. (2019, October). Effects of Pseudocedrela kotschyi stem bark on blood chemistry and histology of some organs in rats. In *Science Forum (Journal of Pure and Applied Sciences)* (Vol. 16, No. 1, pp. 1-1). Faculty of Science, Abubakar Tafawa Balewa University Bauchi.
14. Pappas, M. L., Baptista, P., Broufas, G. D., Dalakouras, A., Djobbi, W., Flors, V., ... & Papadopoulou, K. (2020). Biological and molecular control tools in plant defense. In *Plant defence: biological control* (pp. 3-43). Springer, Cham.
15. Poorter, H., Niinemets, Ü., Ntagkas, N., Siebenkäs, A., Mäenpää, M., Matsubara, S., & Pons, T. (2019). A meta-analysis of plant responses to light intensity for 70 traits ranging from molecules to whole plant performance. *New Phytologist*, *223*(3), 1073-1105.
16. Doležal, J., Dvorský, M., Börner, A., Wild, J., & Schweingruber, F. H. (2018). *Anatomy, age and ecology of high mountain plants in Ladakh, the Western Himalaya*. Springer.
17. Steven, B., Huntley, R. B., & Zeng, Q. (2018). The influence of flower anatomy and apple cultivar on the apple flower phytobiome. *Phytobiomes*, *2*(3), 171-179.
18. Song, Q., Jiang, P., Zheng, S., Kong, Y., Zhao, Y., & Shen, G. (2019). Dynamic Semi-Quantitative Risk Research in Chemical Plants. *Processes*, *7*(11), 849.
19. He, T., Marco, J., Soares, R., Yin, Y., & Wiedenhoeft, A. C. (2019). Machine learning models with quantitative wood anatomy data can discriminate between Swietenia macrophylla and Swietenia mahagoni. *Forests*, *11*(1), 36.
20. Xie, F., Shi, Z., Zhang, G., Zhang, C., Sun, X., Yan, Y., ... & Chen, Y. (2020). Quantitative leaf anatomy and photophysiology systems of C3 and C4 turfgrasses in response to shading. *Scientia Horticulturae*, *274*, 109674.
21. Chen, G., Weng, Q., Hay, G. J., & He, Y. (2018). Geographic object-based image analysis (GEOBIA): Emerging trends and future opportunities. *GIScience & Remote Sensing*, *55*(2), 159-182.

ISSN NO: 2771-8840
Date of Publication: 30-09-2022

22. Wang, M., Peng, J., Du, Y., Qiu, S., & Zhao, M. (2021). Scale consistency for investigating urbanization level, vegetation coverage, and their correlation. *Urban Forestry & Urban Greening*, *59*, 126998.
23. Marceau, J. F. (2010). The Fourth Amendment at a Three-Way Stop. *Ala. L. Rev.*, *62*, 687.
24. Ogbaga, C. C., Amir, M., Bano, H., Chater, C. C., & Jellason, N. P. (2020). Clarity on frequently asked questions about drought measurements in plant physiology. *Scientific African*, *8*, e00405.
25. Damm, A., Paul-Limoges, E., Haghighi, E., Simmer, C., Morsdorf, F., Schneider, F. D., ... & Rascher, U. (2018). Remote sensing of plant-water relations: An overview and future perspectives. *Journal of plant physiology*, *227*, 3-19.
26. Konings, A. G., Rao, K., & Steele-Dunne, S. C. (2019). Macro to micro: microwave remote sensing of plant water content for physiology and ecology. *New Phytologist*, *223*(3), 1166-1172.
27. Huang, C. Y., Anderegg, W. R., & Asner, G. P. (2019). Remote sensing of forest die-off in the Anthropocene: From plant ecophysiology to canopy structure. *Remote Sensing of Environment*, *231*, 111233.
28. Storch, I., Penner, J., Asbeck, T., Basile, M., Bauhus, J., Braunisch, V., ... & Yousefpour, R. (2020). Evaluating the effectiveness of retention forestry to enhance biodiversity in production forests of Central Europe using an interdisciplinary, multi-scale approach. *Ecology and evolution*, *10*(3), 1489-1509.
29. Lutz, J. A., Larson, A. J., & Swanson, M. E. (2018). Advancing fire science with large forest plots and a long-term multidisciplinary approach. *Fire*, *1*(1), 5.