

## Do we need plants to survive? Triggering interest in Plant Science

Precisamos de plantas para sobreviver? Despertando o interesse pela Ciência das Plantas

¿Necesitamos las plantas para sobrevivir? Despertar el interés por las Ciencias de las Plantas

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### **Abstract**

The concept of plant blindness deals with the human inability to perceive the plants around, although they are essential for the basis of life on Earth. Furthermore, the daily human coexistence with plants or with products derived from plants is indisputable. We look for strategies to reverse the perceptive capacity of plants in our daily lives, bringing the *Scientia amabilis*; to the foreground, focusing on Botany as a fundamental area of Biological Sciences. We proposed to undergraduate students of Biological Science the production of a botany notebook in which they record their daily experiences with plants and plant-derived products. The activity was carried out in four steps: (1) production of the text; (2) a conversation circle; (3) insertion of scientific botanical data in the notebooks; and (4) analysis of the notebook text contents. The relationships established by the students focused on the utilitarian perception. The scientific approaches followed mostly the logic of the textbooks, with emphasis on plant structures, followed by plant systematics and physiology. The analysis of the texts and the narrative of the students allows us to conclude that the production of the Botany Notebooks improved the students' perception the importance of plants for human survival and served as a trigger for interest in discussions of botanical the environmental balance and the maintenance of all levels of life on Earth.

**Keywords:** Active methodologies; Botanical knowledge; Plant blindness; Teaching botany.

### **Resumo**

O conceito de invisibilidade botânica aborda a incapacidade humana de perceber as plantas ao redor, embora sejam estas essenciais para a base da vida na Terra. Ademais, a convivência humana diária com plantas ou com produtos derivados de plantas é indiscutível. Desta forma, buscamos estratégias que revertam a capacidade perceptiva das plantas no nosso cotidiano, trazendo a "*Scientia amabilis*" para o primeiro plano e focando na Botânica como uma área fundamental das Ciências Biológicas. Propusemos aos alunos de graduação em Ciências Biológicas, a produção de um caderno botânico, no qual eles fizessem o registro de experiências cotidianas com plantas. A atividade foi realizada em quatro etapas: (1) a produção do texto; (2) roda de conversa; (3) inserção de dados botânicos científicos e (4) análise do conteúdo dos Cadernos. As relações estabelecidas pelos estudantes com as plantas permitiram avaliar a percepção

utilitarista. As abordagens científicas seguiram a lógica dos livros didáticos com ênfase na abordagem das estruturas das plantas, seguida pela sistemática e fisiologia vegetal. A análise dos textos e da narrativa dos estudantes permitiu concluir que a produção dos Cadernos Botânicos aprimorou a percepção da importância das plantas para a sobrevivência humana e serviu como disparador de interesse para discussões de temáticas botânicas relativas ao equilíbrio ambiental e a manutenção de todos os níveis de vida na Terra.

**Palavras-chave:** Metodologias ativas; Conhecimento botânico; Cegueira botânica; Ensino de botânica.

### Resumen

La invisibilidad botánica se refiere a la incapacidad humana para percibir las plantas que nos rodean, aunque sean esenciales para la base de la vida en la Tierra. Además, la coexistencia diaria del ser humano con las plantas o con productos derivados de ellas es indiscutible. Por ello, es necesario buscar estrategias que reviertan la capacidad perceptiva de las plantas en nuestra vida cotidiana, trayendo la "*Scientia amabilis*" al primer plano y centrándose en la Botánica como área fundamental de las Ciencias Biológicas. En ese sentido se propuso a los estudiantes universitarios de Ciencias Biológicas la elaboración de un cuaderno botánico en el que registraron sus experiencias cotidianas con las plantas. La actividad se desarrolló en cuatro etapas: (1) elaboración de los cuadernos; (2) círculo de conversación; (3) inserción de datos botánicos científicos; y (4) análisis del contenido de los cuadernos. Las relaciones establecidas por los alumnos con las plantas. Los enfoques científicos siguieron la lógica de los libros de texto, haciendo hincapié en el enfoque de las estructuras vegetales, seguido de la sistemática y la fisiología de las plantas. El análisis de los textos y de la narrativa de los alumnos permitió concluir que la producción de los Cuadernos de Botánica mejoró la percepción de la importancia de las plantas para la supervivencia humana y sirvió como disparador del interés por la discusión de temas botánicos relacionados con el equilibrio ambiental y el mantenimiento de todos los niveles de vida en la Tierra.

**Palabras clave:** Metodologías activas; Conocimiento botánico; Ceguera de las plantas; Enseñanza de la botánica.

## 1. Introduction

### The Botany Notebook as a tool to face the plant awareness disparity

Since ancient times, plants have been expressive parts of human life, as part of the natural and domestic environments, due to processes of domestication for food, medicine production, furniture, housing construction, and energy sources (Faria, 2012; Beerling, 2017). Therefore, the interdependence of plants and most of all the other life forms urges us to understand that the successful existence of *Homo sapiens* and hundreds of other species is directly related to the integrity of the plant kingdom (Faria, 2012).

The explosion of photosynthetic beings in the occupation of the planet, about ...Mi years ago, was responsible for the explosion of other heterotrophic life forms. Photosynthesis caused major changes in the terrestrial atmosphere over geological time, leading to changes on Earth surface and taking part in the regulation of the climate in the soil-plant-atmosphere *continuum* (Viessman *et al.* 1972; Brady 2013; Beerling 2017). The plants participate in the emission of volatile organic compounds (Spinelli *et al.*, 2011), in the maintenance and conservation of water bodies, and in a multitude of other ecosystem services, which have been revealed by the improvement of the botanical knowledge (Stevenson, 1994; Tivet *et al.*, 2013; Gupta & Germida, 2015). Therefore, to trigger the interest of the students toward botanical themes is fundamental in the formation of conscientious citizens for decision-making in plant conservation.

However, despite the social, cultural, ecological, and academic relevance, there is a lack of interest and lots of misinformation about plants among the ordinary people and even among students from elementary to undergraduate education (Melo *et al.*, 2012; Arrais *et al.*, 2014). The teaching and learning of botany rely on the idea that the concepts are arid, boring, and out of the modern context (Salatino & Buckeridge, 2016). Paradoxical as it may seem, it is common for human beings to ignore the presence of plants in their daily routine, which has been named as the "plant blindness" or the "Plant Awareness Disparity" (PAD) for the modern society is disconnected from the plant kingdom (Wandersee & Schussler, 1999, 2002; Parsley, 2020).

Learning is the result of the interaction between mental structures and our surrounding environment, as people learn in many places and contexts throughout their lives (Falk 2005). If learning is driven primarily by each student's unique intrinsic

needs and interests, it is natural that the teachers use everyday situations in class and develop activities that favor the interest and free choice of the students. Therefore, the daily routine can be used to trigger the students' interest in the construction of more sophisticated concepts about the role of plants in human life and in the life of all other life forms. Currently, the production of Botany notebooks – an activity aiming to register the presence of plants or plant-derived products in the students' daily routine allowed them to examine their ideas about the role of plants in our daily lives and in the life of the planet through.

Taking for granted that plants are an integral part of human routine, the use of investigative activities, especially in teaching botany may approximate the academic community from the plant kingdom, reduce plant awareness disparity, and make the science of plants meaningful in its relation to the student's daily life (Pereira *et al.*, 2009). Learning requires a plethora of resources, working synergistically to trigger the interest and engagement of the students in what they do and don't know about the world in which they live (da Silva *et al.*, 2021). Accordingly, we assume that the academic environment is appropriate to discussing the botanical concepts and experiencing active methodologies, such as the production of the Botany Notebooks toward improving the teaching practice. Active methodologies focus on changing the learning paradigm and the relationship between students and teachers, with the aim of allocating the students as protagonists of the education process, while the educators mentor the process (Mamede, 2015). In such a perspective, the students may develop security, and be confident to face complex situations, to expose their opinions, to respect different thoughts (Berbel, 2021), and improve their interest in learning about the botanical species that are directly linked to their daily activities, as well as about environmental issues (Corrêa *et al.*, 2020).

The production of Botany Notebooks as an educational active methodology aims to (1) stimulate the student perception on the presence of plants in the surrounding environment; (2) evoke his/her autonomy to knowledge construction on Botany; and (3) set a favorable mood for exploring plant biology concepts.

## 2. Methodological Procedures

Academic students (n = 52) of the Teaching degree in Biological Sciences of the *Universidade do Estado de Minas Gerais/campus Ibirité* (UEMG/Ibirité) were invited to register a one-week experience on the participation of plants and plant-derived products in their daily routine in a Botany Notebook. The process of producing the notebooks and their analysis were carried out in four steps (Figure 1):

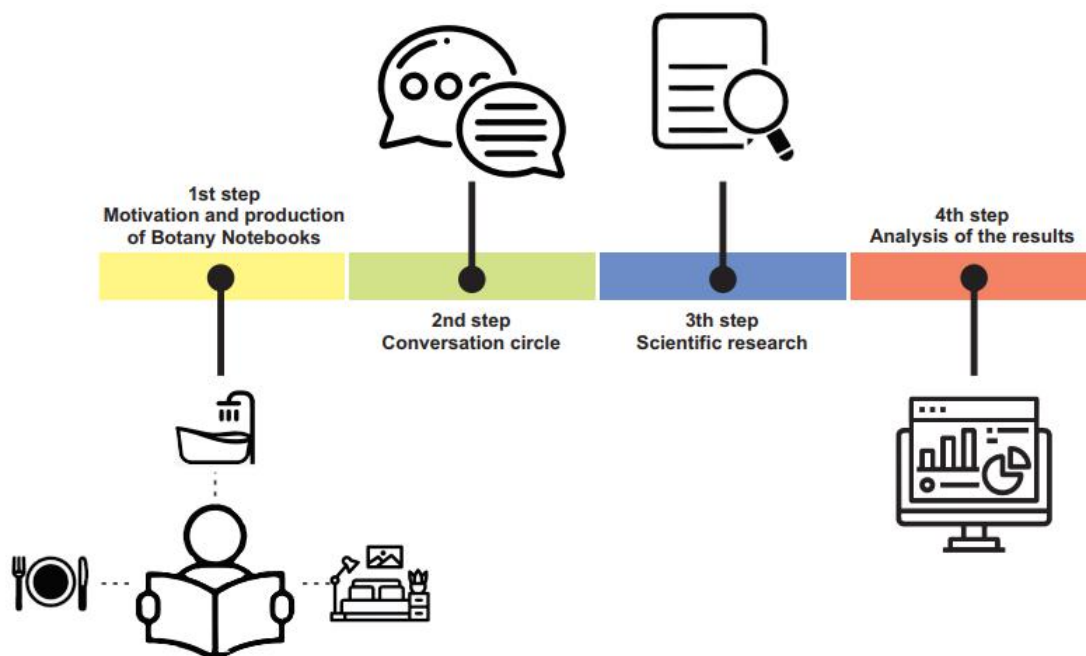
Step one – Personal writing of the Botany Notebooks along a one-week routine.

Step two – Sharing of the personal experiences in a conversation circle, when each student had 3-5 minutes to report his/her impressions, feelings, and changes in perceptions that emerged during the week of producing their botany notebooks.

Step three – Based on the discoveries and surprises reported in the conversation circle, the students were encouraged to insert a free choice topic of a scientific botanical research in their notebooks.

Step four - The texts of the Botany Notebooks were analyzed, and the words (nouns) and expressions were annotated and classified into five categories: (1) food, (2) plant-derived products (waxes, oils, medicines, furniture, clothing, among others), (3) environmental comfort, (4) places, and (5) fuel. The absolute and relative frequencies of the words and expressions were analyzed with the Excel™, and Wordclouds™ softwares. The topics on scientific research inserted in the Botany Notebooks were classified into three classical botany areas: (1) plant structure (reference to plant organs and tissues), (2) plant systematics (citation of scientific names), and (3) plant physiology (insertion of metabolic processes).

**Figure 1** – Timeline of the four steps used for producing and analyzing the Botany Notebooks.



Source: Authors (2022).

### 3. Results and Discussion

#### The Botany Notebooks and the conversation circle

The Botany Notebooks (Figure 2) were written in Portuguese, the students' native language, and in various formats - only texts, texts with drawings, photographs, and labels of plant-derived products, references to movies, books, and poetry, among others.

The motivation built by the conversation circle was important for the construction of knowledge and for changing concepts and started with a simple motivation question: "What were your general feelings when you were writing your Botany Notebooks?". Most of the students expressed the importance of plants as components of their daily routine and the surprise with the human life dependence on plants. We noticed, through their testimonies, that experimentation and life stories should be intertwined toward improving the pleasure of achieving the botanical knowledge. The importance on plants and of the related academic knowledge were pointed out as essential for human life in the texts, which reinforced that learning is a behavioral change phenomenon achieved through experiences constructed by emotional, relational, and environmental factors. The construction of more sophisticated concepts about plant occurs through the active involvement of the student (Driver 1989) and the simple look around us (Dewey, 1915). Such perception is evidenced in the texts produced by the students:

*"... I thought it would be difficult to find plant components in my daily life, but I got surprised just on the first day, when I noticed that almost everything in my own room was made of plants."*

*"... It was amazing to realize how Botany is present in my life."*

*"... Wow! It is scary how much we depend on plants. "*

*“...Besides learning about the total relationship of life and routine, I was able to go a little deeper into the castor bean (which is abundant in green open areas). I went back to my childhood days, when I played with my brother and cousins by throwing castor beans on each other. Thanks for the opportunity!”*

**Figure 2** - Botany Notebooks produced by the undergraduate students of the Teaching degree of the Biological Sciences course – Universidade do Estado de Minas Gerais/Campus Ibirité.



Source: Authors (2022).

The Botany Notebook proved to be a powerful tool to trigger the interest and influence the students' meaningful learning. It also reiterates that students' daily routine can become fundamental triggers in the construction of academic concepts besides emphasizing the importance of observing, taking notes, and reflecting on the surrounding environment. The activity may go forward to other areas of academic education as it may be used to encourage eye-to-eye conversation and even favor the rescue of childhood memories.

### **Diversity of words in the Botany Notebook**

The analysis of the Botany Notebooks resulted in the identification of plants as an integral part of the student's daily routine. Four hundred and twenty (420) distinct words and expressions, whose color and sizes express the categories and the importance of plants in the student's texts, compose an illustrative word cloud (Figure 3). The chosen format for the word cloud - a house - refers to the place the students most explored in their routines. In addition, most of the words cited in the Botany Notebooks relate to the home environment.

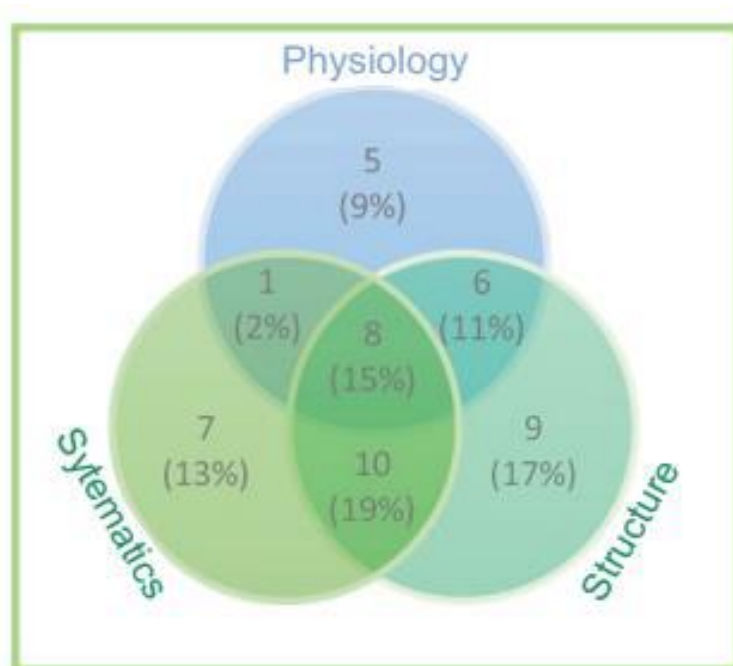


Knapp, 2019). The utilitarian view highlighted in the notebooks exposes the emerging demand for teacher education to focus on the importance of plants to the planet's survivorship. It is also imperative to promote visibility and the importance of the plant kingdom in undergraduate classes. The future teachers may connect botanical concepts inserted in the Botany Notebooks to the conservation of terrestrial and aquatic life, regulation of the climate, and many other ecosystem services. The construction of an interdependent look at plants and the importance of the relationships they establish with other life forms are also important topics. The lowest frequency of words cited in the notebooks related to plants as energy sources for they are raw material for ethanol and charcoal. Moreover, the scientific items inserted on free choice in the notebooks brought up plant species used to produce biofuels, clean and renewable energy, a category also related to the utilitarianism of plants to mankind.

### Scientific biases on the Botany Notebooks

The most frequent botanical scientific areas cited in the Botany Notebooks were plant structure (62%), followed by plant systematics (49%), and plant physiology (38%). Nine notebooks (17%) brought up data only on plant structure, seven notebooks (13%) had only data on plant systematics, and five notebooks (9%) assigned only to data on plant physiology. Ten notebooks (19%) inserted both plant structure and systematics items; six notebooks (11%) had plant systematics and physiology items; eight notebooks (15%) referred to the three botany areas, and seven notebooks (13%) had no reference to any botanical areas (Figure 4).

**Figure 4** - Percentages of the data inserted in the notebooks grouped by the botanical areas.



Source: Authors (2022).

Most notebooks focused only on one botanical area, and the most frequent was plant structure followed by plant systematics, which may reflect that the descriptive approach of plants in basic education still prevails in Higher Education Institutions responsible for training Biological Sciences teachers (Camelo Júnior et al., 2022). The memorization of plant names, forms, and types, many times evaluated as tedious and boring (Salatino & Buckeridge, 2016) is one of the symptoms that may

distance the students from the science of plants. The challenge of turning plants into good models of realistic, philosophical, and integrative teaching (Jose *et al.*, 2019), as well as connecting the conceptual network to daily lives must be faced.

The low percentage of notebooks with data on plant physiology (9%) brings another important topic, the need to insert experimental activities in teaching botany (Camelo Júnior *et al.*, 2022). Learning is not restricted to what happens in the classroom for the experimental activities in academic laboratories and the everyday life experiences may be helpful in constructing a favorable scenario inside and outside the school (Wandersee, 1986). The achievement to such a scenario toward the science of plants requires the development of educational activities that promote good sensations regarding the botanical concepts (Huang, 2019). The reports of the integrative experience stimulated by the production of the Botany Notebooks indicated an increase in the interest about plants and the meaningful botanical learning.

*“I consider that teaching Botany may involve the interface with other areas of knowledge, including Environmental Education. I realize the importance of developing pedagogical practices that articulate what is learned in the disciplines with what we experience with plants in the environment, whether in research or in teaching”.*

### **The perception of a new Botanical approach**

Plant blindness affects many academic and non-academic people, but it can be reduced and even extinguished if strategies such as the production of the Botany Notebooks are adequately used. This activity encourages the perception of plants in the surrounding environments and may highlight the importance of plants to the Earth's ecological dynamics. So, we propose the insertion of an investigative approach on scientific books or databases articulated with the daily experiences toward connecting the importance of the knowledge on Botany concepts with biodiversity conservation. Some fragments of the personal conclusions of the Botany Notebooks revealed the student's awareness on the participation and importance of plants in their lives:

*“This botany notebook makes us put an end to plant blindness. During the process I realized ... a lot more about botanical things and many others I did not write in the notebook”.*

*“Besides the need to maintain life, clean air, nature, and the environment, plants are present in some way in essences, dyes, spices, aesthetics, fabrics, paintings, in several branches of industry”.*

The Botany Notebook effectively worked out as an active methodology for the students assumed the protagonism of their learning processes. The activity stimulated their own view on plant observations, scientific writing, and social interactions, and increased their enthusiasm for plants. The production of the notebooks opened their eyes to the importance of the botanical concepts to the understanding of the biodiversity that inhabits our planet.

*“I loved producing this notebook, I found it very didactic and encourages all of us to observe nature in all of its aspects.”*

Brazil is the home to the greatest biological diversity on the planet and providing future teachers of basic education with a broad view of our nature may be a way to engage the whole society in understanding the opportunities to conserve biodiversity (Andrade *et al.*, 2012). The knowledge on the risks that the loss and the degradation of ecosystems impose (Constanza, 2000) may promote the society's demand on the integration of ecosystem services in public policies (Slootweg *et al.*, 2008). So, we expect that the production of Botany Notebooks, as an active methodology, will make students aware of the presence of plant



kingdom in their daily lives, and also of the importance of plants to sustain life. The production of the Botany Notebooks allows students to appreciate the important roles that plants have played, are playing, and will continue to play in the future. The future biologists and biology teachers will be able to contribute more effectively to the teaching botany, as asserted in this testimonial:

*“Plants are present in all our daily lives, whether in the routine of study, work or leisure. Practically everything involves plants, either directly or indirectly. If plants are so important for life, why is there a high level of deforestation? Why is there no sustainable consumption? These are some questions that unfortunately can only impact industry and commerce when trees are in near shortage and the planet is in crisis. As was said at the beginning of this assignment, plants are extremely important in maintaining life. Without them, for example, strictly herbivores would die first, then consumers of these animals would run out of food and end up dying, too. These and other factors related to the disappearance of plants would cause a chain of events that will result in the end of life on Earth. Finally, it is worth mentioning that plants have a high diversity, and because of this, they can be useful in many applications. The Botany Notebook made me realize the importance of plants and how we explore their resources every day. Many times, we do not even notice that most of the things we have contact with are composed of or at least, related to plants’.*

#### 4. Conclusion

The Botany Notebook effectively worked out as an active methodology for the students assumed the protagonism of their learning processes. The activity stimulated their own view on plant observations, scientific writing, and social interactions, and increased their enthusiasm for plants. The production of the notebooks opened their eyes to the importance of the botanical concepts to the understanding of the biodiversity that inhabits our planet.

#### 5. To go beyond

The production of the Botany Notebooks has revealed as an efficient strategy to minimize plant blindness and motivate the students to the importance of Botany knowledge. We propose that the production of the notebooks may be followed by didactic sequences constructed under the different contexts, school levels, and teacher creativity. It can also help facing teaching challenges especially in exceptional situations, such as the one of COVID-19 pandemic. Such situation has reinforced the need to break the paradigms of descriptive teaching and promote the autonomy of the students toward self-strategies of constructing knowledge.

We propose two didactic sequences to be used after the production and discussion of the Botany Notebooks, and aim to make the students change their attitudes toward nature conservation and be motivated to learn Botanical concepts.

**Table 2** – Didactic sequences suggested for inserting the Botany Notebooks in classroom routine.

<b>Didactic Sequence 1: dealing with adaptations to environmental conditions</b>	
"It is not the strongest that survives, nor the most intelligent, but the one that best adapts to changes" (Darwin, 1859)	
Motivating question:	What environmental conditions are the plants in your surroundings exposed to?
Development:	Look around your home for sites with different environmental conditions (sun/shade, dry/humidity) and the characteristics of plants in such sites.
Activity 1:	Produce cards from the topics listed below with the characteristics of the plants you observed. <ul style="list-style-type: none"> <li>a) Cards to identify monocots and eudicots;</li> <li>b) Cards with the types of stems, root, leaf or flower;</li> <li>c) Cards with various environmental characteristics.</li> </ul>

Activity 2:	Choose one plant from those you observed and: <ol style="list-style-type: none"> <li>Produce an exsiccate with the chosen plant;</li> <li>Go through an interactive taxonomic identification key;</li> <li>Identify your plant with its scientific name;</li> <li>Look for popular names of the chosen plant.</li> </ol>
Activity 3:	<ol style="list-style-type: none"> <li>Now that you have the identity of the plant, research plant functions related to development - rate of photosynthesis, water transport, rate of transpiration, etc.</li> <li>Make a report of the functions your plant may perform to face the environmental conditions and relate them to the plant characteristics you illustrated in activity 1.</li> </ol>
Toward the conclusion:	The teacher makes a compilation of the results presented by the students, organizing the knowledge, and establishing the connections with the contributions of scientists who have previously studied the theme addressed.

<b>Didactic Sequence 2:</b> the perspective of ecosystem services	
"Nature everywhere speaks to man in a voice [...] familiar to his soul" (HUMBOLDT, 1769-1859)	
Motivating question:	Can you find non-derived plant products or plant-independent services in your daily routine?
Development:	Ask the students to list where the non-derived plant products come from and/or how they are obtained. From this list, the students will produce the script for a movie 'Life without plants'. The script should include: <ul style="list-style-type: none"> <li>Consistent characters of the story</li> <li>Development of the story</li> <li>Description of the moral of the story</li> </ul>
Toward the conclusion:	The teacher may conclude the activity by summarizing the main processes in which plants participate (photosynthesis, transpiration, soil nutrition, water cycle, etc.), relating them to the different life forms and to the environmental conditions of our planet. The end may be the improbable life without plants.

Source: Authors (2022).

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