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CENTRIC FORMS IN ARCHITECTURE AND URBAN PLANNING IN ANALOGUES TO PRIMARY BIOLOGICAL STRUCTURES

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Purpose: The article is part of the current issues of human ecology, and particularly the biophilia trend, which focuses on the relationships between humans and nature and their adaptation to the environment, which enables them to survive and function freely in it. The aim of the research is to compare the structures of primary microorganisms from the algae group (diatoms and green algae) and architectural forms produced by humans in terms of the occurrence of radial symmetry as well as centric forms, which humans have used to consciously shape the nearest space since the beginning of their existence.
Design/methodology/approach: The article analyses the spatial structures of algae organisms from the diatom and green algae classes, as well as spatial structures produced by humans in the period from the 2nd millennium BCE to the 19th century CE. The comparison was made by examining individual elements of the composition responsible for harmony, maturity and beauty, which are: compositional axes, rhythms (produced by single and repeatable structural elements) and the central point, which are always derived from the occurrence of radial symmetry in nature.
Findings: The results revealed the occurrence of similar spatial structures in both algae forms and human structures. Basically, two types of forms were distinguished:
Type no. 1: the structure of the organism based on a star-shaped plan; elongated and slender arms with constant proportions are the basic elements of a two-dimensional composition; radial symmetry consists of several axes and does not exceed eight-radius symmetry; the central point at the base of the composition is built on a circular plan and is small in size.
Type no. 2: the structure of the organism based on a circular plan. Algae are characterized by a compact and concentrated form created from many identical cells, which in space constitute elementary particles, permanent modules responsible for the cohesion and balance of the composition; the number of axes of radial symmetry that can be distinguished in individual species is much greater than in representatives of the first type and ranges from a dozen to several dozen axes of symmetry; structures of the system built on the radii of several circles, the central point of which is the center of the composition; individual spatial points spaced at the same distance from each other create a fixed module based on the same proportions, which, processed in fixed rhythms and in various spatial arrangements, creates the structure of the organism.
Research limitations/implications: Only two of the six groups of algae were accepted for the study, which constitute only one of the five kingdoms occurring in nature. It is probable that they represent only a narrow fragment of reality. Considering the fact that the natural world is

based on radial symmetry in many aspects, the study of the structure of individual primary groups of organisms should be extended to other kingdoms and groups.
Social implications: Man subconsciously strives to imitate the structures of nature and create usable forms, among others, based on radial symmetry. The method of shaping space based on the composition of primitive algae presented in the article can be used, among others, in urban planning to create city plans and shape functional and harmonious spaces. Compositions based on star symmetry are always legible, determine spatial dominants and increase the comfort of life of its inhabitants. Radial symmetry can also be helpful in creating contemporary architectural objects, which will be based on repeatable rhythms and a central point, which will allow for a clear and logical layout of space.
Radial symmetry not only organizes space, but also creates a universal pattern that is naturally understandable and comfortable for humans. The repeatability and proportions typical of radial symmetry resemble systems found in nature, which has a positive effect on the psyche of users. All this means that radial symmetry can become a tool for designing universal, repeatable and scalable architectural solutions. It can be used both on a small scale, from detail to large-scale urban layouts.
Originality/value: The article presents an attempt to analyze and systematize the structural features of the original group of organisms with centric forms, such as algae, in terms of compositional features based on radial symmetry and relating these results to spatial structures created by humans. This type of research can influence a better understanding and dissemination of the idea of radial symmetry in design, where we will always find tools responsible for the sense of beauty such as: composition, rhythm and proportions. The article is addressed primarily to architects and planners who are responsible for maintaining spatial order in the urbanized environment, creating a space that is harmonious with nature.
Keywords: radial symmetry, biophilia, organic forms, algae.
Category of the paper: research paper.

1. Introduction

Since the second half of the 20th century, a dominant, geometric and regular arrangement of forming the closest human space has become widespread. Even at the beginning of the 20th century, building elevations were in most cases shaped by architectural details that directly referred to organic shapes and centric forms. This is particularly visible in ornaments, shapes of window and door openings or rosettes always present in sacral architecture. The first settlements and defensive strongholds in which urban life was confined were based on a spherical or elliptical form, which is reflected in nature. In the later period, many planning assumptions were also based on the form of a circle with communication routes spreading out centrally.

Nature has created a uniform code for forming spatial structures, widespread in the world of living organisms, which is based on a rounded line and circular, centric forms and radial symmetry with repeating systems of rhythms and proportions, which are also used by humans. Aristotle believed that beauty is associated with a strict creative pattern encoded in nature - beauty is otherwise known as proportions found in nature. Representatives of many species of

algae, whose structure is based on a centric form, have a very diverse and, at the same time, coherent form, which is often repeated in nature. These are microscopic plant organisms living in water with a size of several to several hundred micrometers. Examining their structure under a microscope, one can see that they consist of uniform, repeatable single cells that arrange themselves into repeatable centric forms. A characteristic feature here is the occurrence of radial symmetry, which generates the formation of constantly repeating rhythmically elements that arrange themselves into a mature composition. Of particular interest in terms of the diversity of forms is the structure of groups of diatoms and green algae, whose natural forms based on systems of rhythms and proportions have often been used for centuries in the urbanization of living space and human art.

This article attempts to answer the question of how repetitive forms based on radial symmetry, found in primitive animals, are reflected in the structures and architectural details created by humans in different eras.

2. The concept of beauty

A man shapes their immediate surroundings according to specific canons of beauty, which include: rhythms, proportions and symmetry. The human psyche has the ability to remember perceived spatial arrangements and to isolate individual forms from the environment through simplification and geometrization (Wejhert, 1984). The forms that are best remembered are those that are characterized by balance, symmetry and regularity, and are isolated from a broader context through contrast with the environment (Szymski, Dawidowski, 2006). Forms that are easily noticeable and at the same time beautiful are characterized by order and proportion that the human brain perceives subconsciously. When designing, as the ancient architect Leone Battista Alberti claims, the principle should be applied: "(...) so that one member agrees with the other, creating and consolidating together the glory of the whole work, and this is so that one does not seize all the beauty, leaving the rest ugly (...) and they must be similar to each other in such a ratio that they look rather like an inseparable and completely finished body than separate and scattered members. Then, when giving shape to these members, one must imitate the modesty of nature, because in this as in other things we will praise moderation and condemn excessive passion for building" (Alberti, 1960a, p. 33).

Another ancient architect, Vitruvius, had similar views on beauty and proportions. In his work he wrote: "Proportion is the application of a fixed module in each work of art to both the building's elements and its entirety, from which the law of symmetry results. No building can have a proper layout without symmetry and good proportions, which should be based strictly on the proportions of the body of a well-built human being. […] Similarly,

the elements of temples should have the most appropriate proportions both between their individual parts and in relation to the entire building" (Witruwiusz, 1999, p. 30).

This method of shaping space is constantly present in the world of living nature, which is characterized by logical rhythmicity manifested, among others, by the rhythmicity of the construction of microstructures and symmetry (Satkiewicz-Parczewska, 2001). Man, being a part of nature himself, governed by permanent rules regarding matter and life, is subject to the physical and biological rules governing the universe (Caillois, 1967).

Despite the subconscious tendency to build harmony and beauty, especially since the 20th century, there has been a decline in the quality of standards and a break with tradition, which consisted in ceasing to apply specific canons and orders developed in evolution by artists. Currently, we often deal with chaotic arrangement of space and deliberate or accidental use of disharmony, manifested by the lack of basic elements of beauty: composition, symmetry and harmony in contemporary works of architecture (Maciejko, 2017).

2.1. Symmetry

The basic element of beauty that builds coherence and a sense of beauty is symmetry. As Aristotle said: "What else but a certain kind of uniformity and equally measured intervals? What is the beauty of iambic, trochaic and tribrach... if not that the smaller part of the foot can divide the larger into two equal parts" (Tatarkiewicz, 1962, p. 61).

The idea of symmetry has probably accompanied man since the beginning of his existence: "thanks to which he tried to create order around himself during the process of evolution and later to perceive beauty and perfection" (Weyl, 1997, p. 11).

According to the mathematical definition, symmetry is a system of identical elements, evenly distributed from the axis. Elements located on one side of the axis are a mirror image of those on the other side. Symmetry gives finiteness to a given set of elements and emphasizes static, calm and monumentality (Żórawski, 1973).

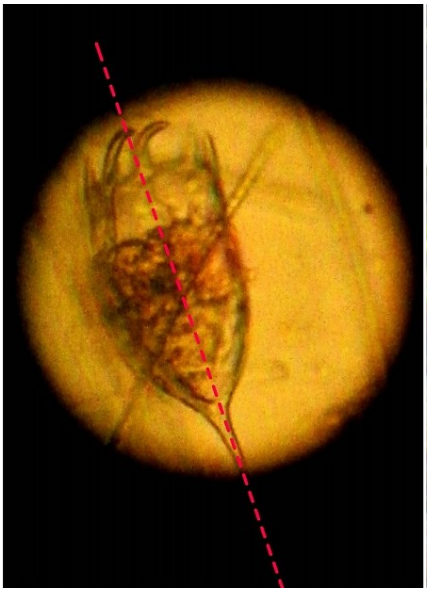
Idea symetrii towarzyszyła człowiekowi prawdopodobnie od początku jego istnienia: „dzięki której starał się podczas procesu ewolucji tworzyć porządek wokół siebie a w późniejszym czasie dostrzec piękno i doskonałość” (Weyl, 1997,p. 11).

2.2. Symmetry in the animal world

In nature, symmetry is present from the very beginning of the life-forming process and is a basic feature of the structure of an organism, which determines the arrangement of its parts in relation to a hypothetical axis. In the world of nature, we distinguish two basic types of symmetry:

Bilateral symmetry. The symmetry of a body made of two similar halves, each of which is a mirror image of the other (figures 1 and 2). It is determined by a plane running along the main axis. Bilateral symmetry occurs in many representatives of almost all groups of plants and

animals. Most animals, including humans, have only one axis of symmetry (Kowalska, 2005) (figures 3 and 4).



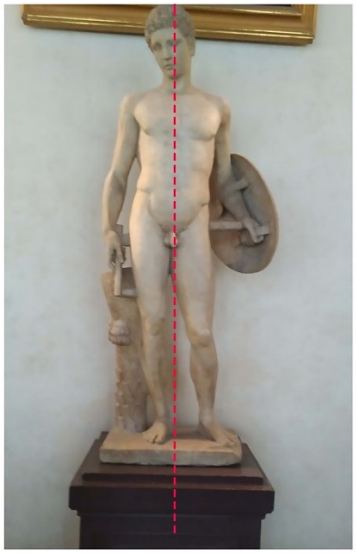
(Figure 1)

(Figure 2)

Figure 1. Bilateral symmetry in a representative of plankton (Rotatoria). Source: own elaboration.

Figure 2. Bilateral symmetry in amphibians (toad). Source: own elaboration.

(Figure 3)



(Figure 4)

Figure 3. Bilateral symmetry of the human face. Source: own elaboration.

Figure 4. Symmetry of the human body. Source: own elaboration.

Radial symmetry. The symmetry of a body whose appearance does not change after rotation around the axis by a part of the rotation determined by the type of symmetry. A characteristic feature is a large number of planes of symmetry running through the body of the organism along the main axis. The nomenclature is based on the number of rays that can be determined in a given case, e.g.: biradiate symmetry (two rays, two planes of symmetry), triradiate symmetry (three rays, three planes of symmetry) (Larousse, 1990). Bilateral symmetry is characteristic of

most animals and higher organisms and has developed in connection with active movement. Radial symmetry is most common in primitive animals and is most widespread in forms of algae representatives - microscopic organisms inhabiting the sea.

3. Algae. General characteristics

Algae are plant and animal organisms with small body sizes that float freely in water (5 um to 10 mm in diameter). They do not have the ability to move and their specific gravity is as close as possible to the weight of water. In many species of algae, the process of settling is significantly delayed by their microscopic size and the presence of various outgrowths that significantly increase the surface area. They are the primary producers of organic matter and oxygen produced in the process of photosynthesis (Pliński, 1992).

The most complex and representative shapes are those of algae from the diatom and green algae classes. Their form is spherical in many cases. Studies have shown that the richness of species decreases exponentially with the elongation of cells and the departure from the circular form (Stanca et al., 2013).

Chlorophyta are a group of algae most closely related to terrestrial organisms, which in evolution constitute one of the three developmental lines of plants. These are unicellular and multicellular organisms that have the ability to form extensive colonies. To date, 9000 species have been identified (Radziejewska et al., 2002).

In turn, diatoms (Bacillariophyceae) are unicellular algae that occur singly or can form colonies of various forms. The shape of the cell variety in individual species is a variety of one of two basic types: centric (round) in diatoms from the centrales group or elongated in the pennales group. The actual diatom cell is enclosed in a two-part, box-like (with a "lid" and a "bottom") siliceous shell saturated with pectin (Żmudziński, 1997).

3.1. Coenobium

Algae, as one of the few groups of phytoplankton, have the ability to create complex colonies from individual cells (Campbell, 2018) into extensive structures - coenobium. Coenobium is a common unit that brings together from several to several hundred individual algal cells using a common gelatinous shell that is a binder of the entire structure (Strasburger, 1967). The name coenobium itself derives its origin from one of the forms of monastic life in the monastic community - coenobitism. Coenobium in different species of algae are arranged in various shapes, but we can observe a certain property that many coenobium take on a centric form in the form of star symmetry based on a circle. The construction of the central system begins with fragmentation and the construction of the system from one repeating element (cell). A given element in the form of repeating rhythms spreads from the central point and arranges

itself into a centric structure based on star symmetry. Each individual cell can give rise to a new coenobium.

4. Methodology

In terms of research, the focus was on a detailed analysis of the centric forms of selected representatives of algae species from the diatom and chlorophyta, which were compared with centric forms produced by humans. The detailed analysis primarily concerns the following elements responsible for the construction of the studied structures: radial symmetry, central point and repeatable modules appropriately arranged in relation to the composition axis. Two types of centric systems were distinguished, based on a star-shaped plan and a circular form.

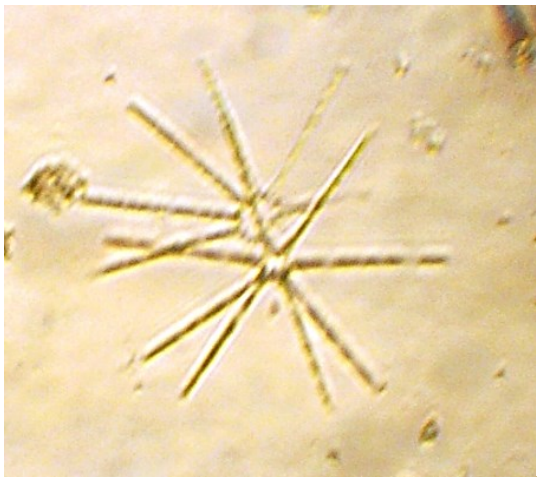
Representatives of some of the oldest and most primitive organisms on Earth, which appeared around 700-750 million years ago, were selected for analysis. These organisms are unicellular and have the ability to form colonies that form centric forms and in their assumptions refer to the canons of beauty.

In the case of buildings and architectural assumptions, those examples (from different eras and on different scales) were selected for analysis that show the characteristic way of shaping compositional systems that is present in primitive algae.

4.1. Type No. 1. Star symmetry

4.1.1. Centric structures of algae based on star symmetry

The structure of the species Asterionella sp. (figures 5 and 6), a freshwater representative of the diatom class of algae, is based on star symmetry. In this case, the coenobium most often occurs in the form of six individual cells that create a star structure. The coenobium of Asterionella sp. may fall apart or change the number of modules under the influence of environmental changes, but in its essence it will always strive to create six-axis symmetry. Similar features are presented by another species of diatoms - Staurastrum gracile, in which we can distinguish a constant three-axis symmetry (figure 7).



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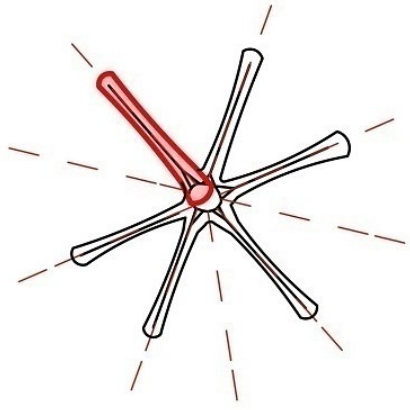
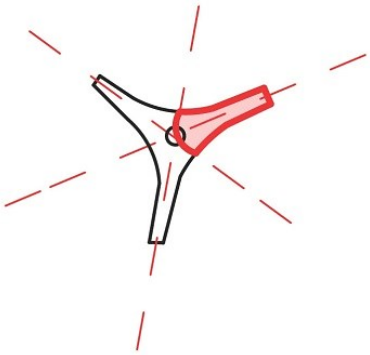


(Figure 6)

Figure 5. Asterionella sp. Enlarged photo. Source: own elaboration.

Figure 6. Asterionella sp. The cell forming the cenobium structure is marked in red. Source: own elaboration.



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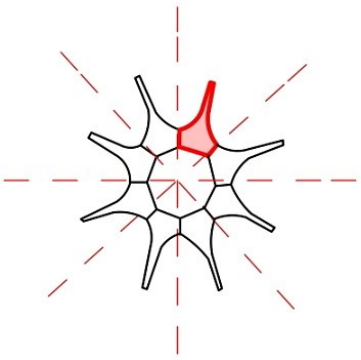


(Figure 8)

Figure 7. Scheme of Asterionella sp. Source: own elaboration.

Figure 8. Scheme of Pediastrum simplex. Source: own elaboration.

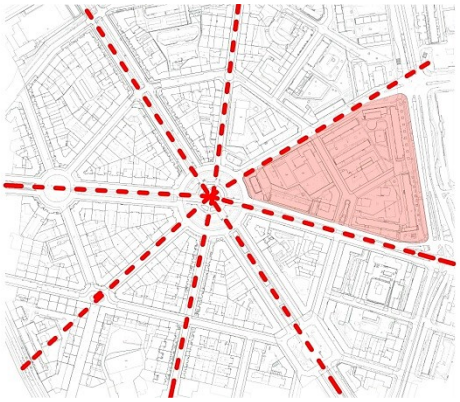
Following the further developmental evolution of subsequent representatives of diatoms, we can state that the radial ends of the arms begin to change their proportions and the central point of negligible size grows. These features are present in another representative of diatoms - Pediastrum Simplex, where we can observe the process of slowly approaching a circle (figure 8). The central part of the system begins to grow significantly and the arms slowly disappear. The simplex pedastrium heralds the beginning of the transition to the next form, the system of which is based on a circle.

As shown in figures no. 5-8, individual cells (marked in red) in the form of elongated rays connected in cenobia create a star-shaped structure.

4.1.2. Architectural structures based on star symmetry

In human architecture, star-shaped forms are characteristic of the spatial arrangements of larger urban agglomerations, an example of which is Grunwaldzki Square in Szczecin. The square was modelled on the concepts of Georges Haussmann, responsible for the

reconstruction of 19th-century Paris. The focal point of the composition is a square in the shape of a circle from which a network of eight communication routes underpinned by greenery radiates (figure 9 and 10). Between the streets, tenement houses were built, similar in shape to an equilateral triangle, which, repeated in different arrangements, constitute the basic module of the square's composition (Kozińska, 2015).



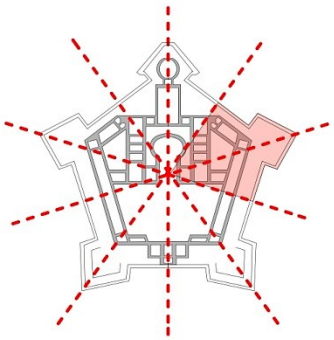
(Figure 9)

(Figure 10)

Figure 9. Scheme of Grunwald Square in Szczecin. Source: own elaboration.

Figure 10. A bird's eye view of Grunwald Square. Source: own elaboration.

However, it should be remembered that the very idea of star symmetry and ideal proportions existed already in the antiquity. The first plan of an ideal city was presented by the architect Vitruvius. According to his concept, the ideal city is to be planned on the plan of a regular polygon, the corners of which can be connected by a circle. All sides of such a figure should have the same length and the angles should have the same inclination. The plan of the ideal city was based on the symmetry of streets and shapes as well as the appropriate proportions of individual elements such as: the proportions of internal squares in relation to the width of communication frontages and the height of tenement houses (Szpakowska, 2012).



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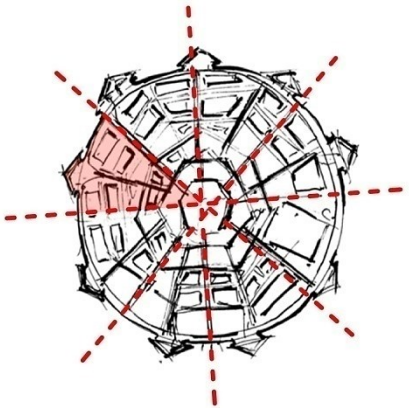


(Figure 12)

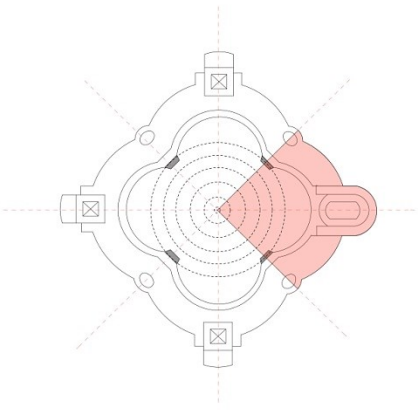
Figure 11. Scheme of the castle in Krzyżtopór. Source: own elaboration.

Figure 12. Plan of the ideal city – Palma Nuova. Source: own elaboration.

An excellent example of an ideal city is "Palma Nova", which was designed in the 16th century by the Venetians. In the city center there is a hexagonal regular public square in the shape of a regular polygon, the extreme points of which are inscribed in the line of a circle (figure 12). From the central point of the square, six streets radiate in a star shape with the same dimensions: width and length, which lead to the entrance gates.

In later times, up to the 20th century, defensive fortresses were built on star symmetry and the principles of the ideal city, an example of which is the Krzywotopór castle in Ujazdów (figure 11) from the 17th century. Krzyżtopór was built on a pentagonal plan with bastions in the shape of rhombs on the edges of the figure. The axial symmetry and geometricization of the palace were determined by the towers of the palace and gates growing from the corners of the figure. The city was surrounded by walls that in their form constitute a polygonal star, with its shape referring to the petals of the stitch.

The composition of the People's Hall in Wrocław, which was built at the beginning of the 20th century, also refers to the principles of the ideal city and radial symmetry.



(Figure 13)

(Figure 14)

Figure 13. Scheme of Centennial Hall in Wrocław. Source: own elaboration.

Figure 14. Contemporary Concept of land development of the Area Around the Coal Tower in Szczecin based on Star Symmetry. Source: own elaboration.

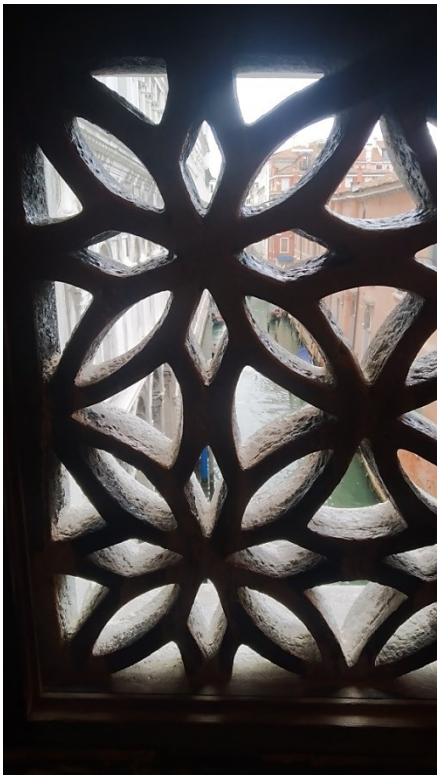
The object based on three-axis symmetry is topped with four protruding arms (figure 13). The central point in the form of a stage based on a circle is covered by a reinforced concrete dome consisting of 32 ribs ending with a central ring. The people's hall is a transitional form, which is already tending to close the plan of the body in a circle. The central part of the layout begins to grow significantly and the process of slow disappearance of the arms begins.

(Figure 15)

(Figure 16)

Figure 15. Floor of the church in Ravenna. Source: own elaboration.

Figure 16. The rose window of the Gothic church in Valencia. Source: own elaboration.



(Figure 17)

(Figure 18)

Figure 17. Detail of a window from the Italian Renaissance. Source: own elaboration.

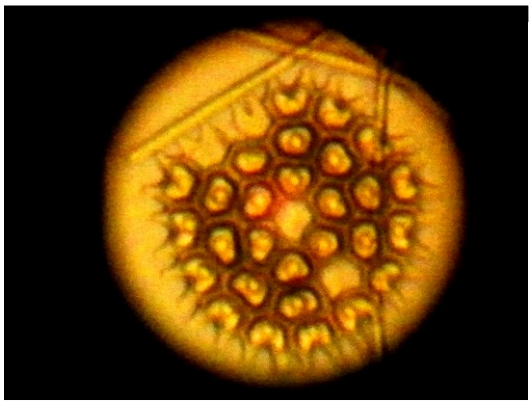
Figure 18. The star vault of the Prague church of a window. Source: own elaboration.

The star shape is a common motif that is repeated in small architecture or details in the form of elements illuminating objects, vaults or floor patterns (figures 15-18).

4.2. Type No. 2. Centric structures based on a circle

4.2.1. Centric structures of algae based on a circle

In the process of evolution, due to the growth of the central point and the disappearance of radial arms, coenobium in subsequent representatives of phytoplankton approached the ideal form – a circle. Characteristic of organisms representing type 2 is that from the central point radiate several circles that at regular intervals connect the entire composition. Individual cells arrange themselves in a circle around the central point, simultaneously creating a repeating module identical for the entire composition.



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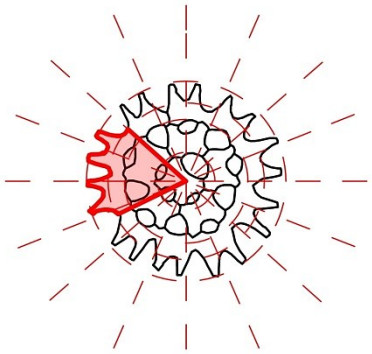
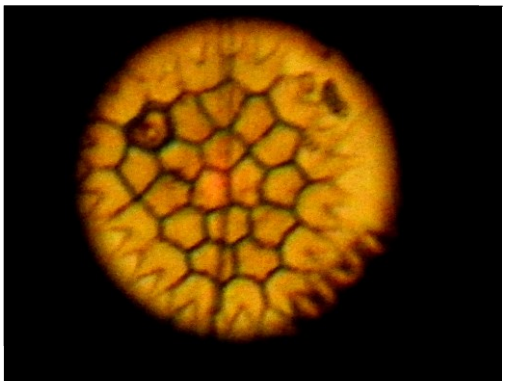


(Figure 20)

Figure 19. Pediastrum duplex. Enlarged photo. Source: own elaboration.

Figure 20. Pediastrum duplex. The cell forming the cenobium structure is marked in red. Source: own elaboration.

In Pediastrum duplex, a representative of the green algae group, the cells are gathered in flat colonies differentiated by edges and internally elongated processes (figures 19 and 20). Cenobia usually consist of 4-64 cells, although they can reach up to 128. The cells in the colony can be tightly adjacent to each other or touch each other at the ends, leaving free spaces. In the structure itself, we can clearly distinguish several circles around which the entire colony is built. Similar properties can be observed in Pedastrium tetras (figures 21 and 22).



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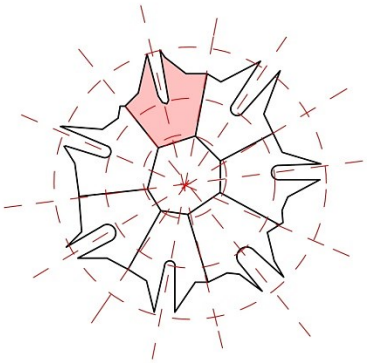
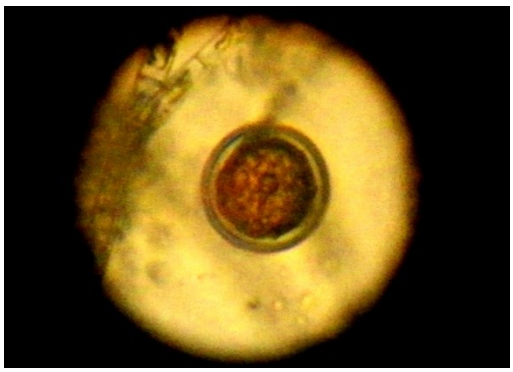


(Figure 22)

Figure 21. Pedastrium tetras. Enlarged photo. Source: own elaboration.

Figure 22. Pedastrium tetras. The cell forming the cenobium structure is marked in red. Source: own elaboration.

Another almost ideal form, similar to a circle, is a cyst (endospore). This is a resting form that allows organisms to survive unfavorable conditions (low temperature, drought) and produces spores stored inside the cell. A cyst is characterized by a significant degree of dehydration of the cytoplasm as well as thick and multi-layered covers.



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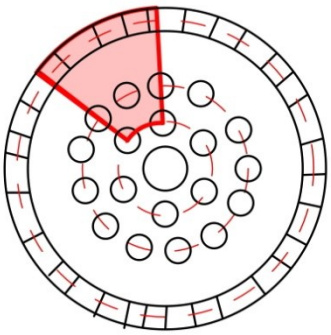


(Figure 24)

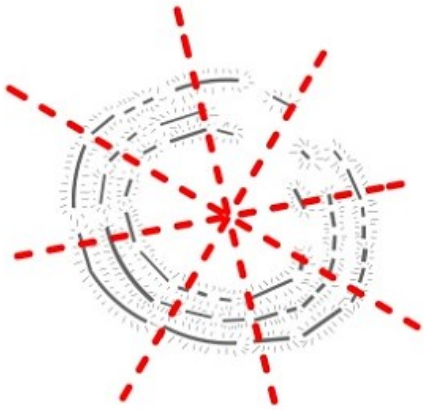
Figure 23. Cyst. Enlarged photo. Source: own elaboration.

Figure 24. Cyst. The cell forming the cenobium structure is marked in red. Source: own elaboration.

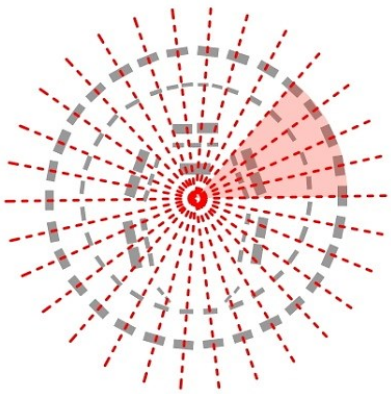
The protective layers of the endospore, similarly to the previously mentioned species of green algae, are arranged in central circles radiating from the central point of the composition (figures 23 and 24).

4.2.2. Centric structures based on the form of a circle produced by human

The first structures shaped by man were based on a circular form, also characterized by a radial structure. The original stronghold structure shown in figure no. 25 has a form close to a circle and is characterized by a four-radius symmetry. Individual defensive ramparts were shaped on three circles with the central point of the entire composition. It is also worth paying attention to the repeating rhythms. The entire composition consists of two types of earth mounds, a longer one and a shorter one, which is often built on a 1:2 ratio (especially within the first rampart).



(Figure 25)



(Figure 26)

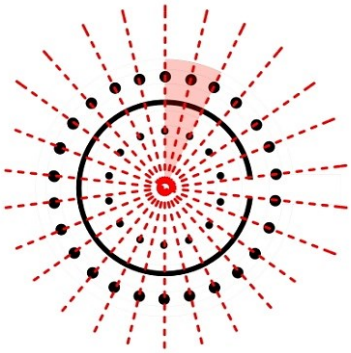
Figure 25. The original stronghold from the turn of the 6th and 7th centuries BC in Opole Lubelskie. Source: own elaboration.

Figure 26. Stonehenge. 2095-1600 BC. Source: own elaboration.

However, forms based on a circle were characteristic primarily of public and sacred. The oldest ideal forms derive from the tholos – a building of a temple character, consisting of a naos (rotunda) surrounded by a colonnade (figure 28). figures no. 26 and 27 show two representative forms of the tholos located in Epidaurus (4th century BC) and the oldest of them presenting a sacred object in Stonchage (2nd millennium BC). By comparing these forms, one can find clear similarities. Both temple complexes exhibit features of radial symmetry and are based on three circles that define rhythmically repeating colonnades. Individual columns (or stone blocks) occur in relation to each other in constant rhythms and proportions, which is why they constitute the basic module for the entire composition.

The features of the tholos are also exhibited by the form of the Greek theater (figures 29 and 30). The focal point here is the stage. The composition of the system consists of several circles that spread out from the central point.

In turn, in the Pantheon, a rotunda with a diameter of 43.6 m, the central Roman temple dedicated to planetary deities, the lines of symmetry are determined by niches (figures 31 and 32). In this case, we are dealing with eight-radius symmetry. The central part of the composition, based on a circular plan, has been significantly expanded and is separated by rhythmically repeating columns that support the dome.

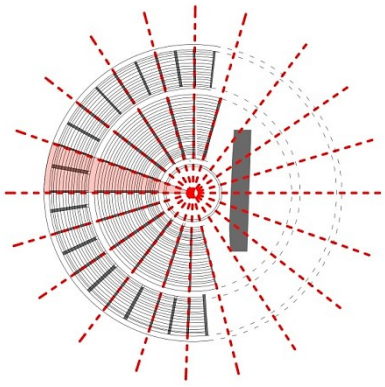


(Figure 27)

(Figure 28)

Figure 27. Scheme of the tholos at Epidaurus. 370 BC. Source: own elaboration.

Figure 28. Decorative form of a tholos from the 19th century. Source: own elaboration.

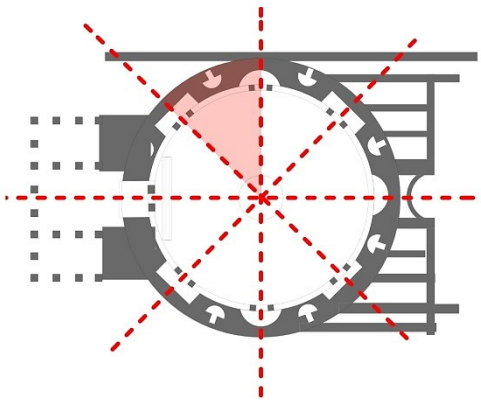


(Figure 29)

(Figure 30)

Figure 29. Scheme of the amphitheater, Epidaurus. 330 BC. Source: own elaboration.

Figure 30. Odeon of Herodotus in Athens. 161 CE. Source: own elaboration.



(Figure 31)

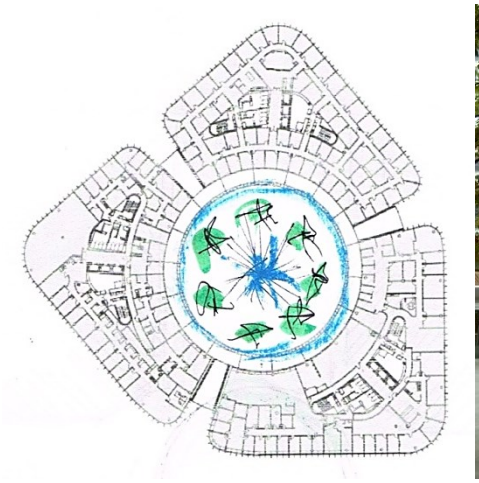
(Figure 32)

Figure 31. Scheme of the Pantheon. Rome, 125 AD. Source: own elaboration.

Figure 32. The colonnade in the Pantheon supporting the dome. Source: own elaboration.

Nowadays, public spaces are also designed based on a centric plan, an example of which is the inner courtyard of the Metropolitan building in Warsaw designed by Norman Foster (figures 33 and 34). Greenery in the form of dwarf ornamental trees was used as compositional elements here, which, like colonnades in ancient temples, situated on a circle at equal intervals,

emphasize the cohesion of the composition (figures 35 and 36). A characteristic element of the layout is also a fountain that marks the boundaries of the internal water reservoir, which is the central point of the composition.



(Figure 33)

(Figure 34)

Figure 33. Scheme of the inner square of the Metropolitan. Warsaw. Source: own elaboration.

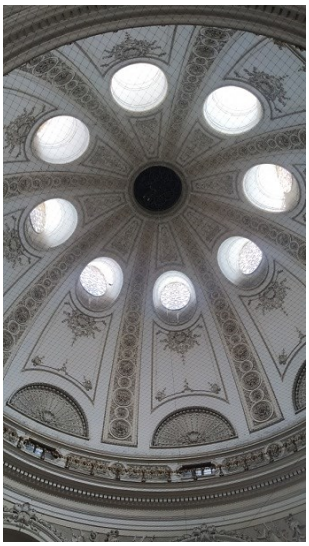
Figure 33. View of the square. Source: own elaboration.

(Figure 35)

(Figure 36)

Figure 35, 36. Natural elements in the form of trees and water constituting elements of the composition.

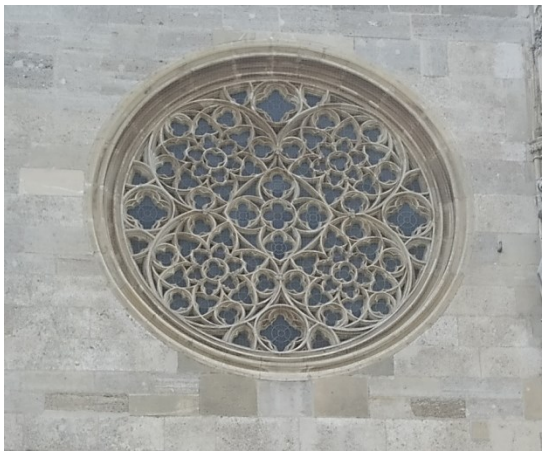
The procedure associated with the use of a dome became particularly popular in the Baroque era.



(Figure 37) (Figure 38)

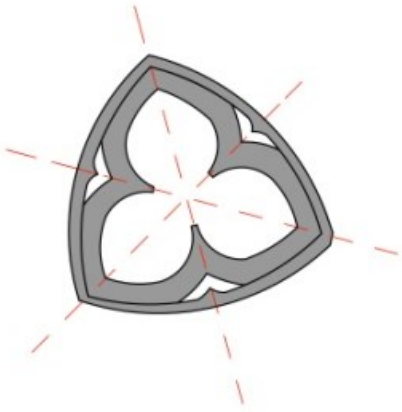
Figure 37, 38. Examples of domes enriched with illusion painting or architectural elements. Source: own elaboration.

Domes were enriched with additional elements in the form of illusory paintings (figure 37) or openings illuminating the object (figure 38), which always emphasized the symmetry of the composition.

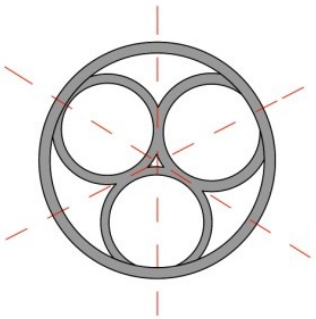


(Figure 39) (Figure 40)

Figure 39, 40. Examples of wall rosettes of gothic. Source: own elaboration.



(Figure 41)



(Figure 42)

Figure 41, 42. Frequent organic motifs found in window openings in the Gothic period. Source: own elaboration.

In detail, circular forms were represented by, among others, church rosettes, which were characterized by ideal proportions (figures 39-42).

5. Findings

The analysis carried out showed that the centric forms of larger spatial layouts designed by humans are based on two types of structures that occur in primitive organisms and their basic feature is the occurrence of radial symmetry.

Representatives of the first type of algae species (based on star symmetry) are less complex and have the following features:

- the structure of the organism is based on a star plan,
- elongated and slender arms with constant proportions are the basic elements of a two-dimensional composition,
- radial symmetry consists of several axes and does not exceed eight-radius symmetry,
- the centric point at the base of the composition is built on a circular plan and is small in size.

Type no. 1 is characteristic of larger urban layouts and is particularly characteristic of the plans of 19th and 20th century city centers (e.g. Paris, Szczecin), defensive fortresses and cities based on the idea of the "ideal city" (created during the Renaissance and the idea of which dates back to antiquity). Radial symmetry is characterized by a central point in the form of a public, open square from which axes of symmetry radiate out, defining harmonious rhythms and proportions for the entire layout. The above features can also be found in larger cubature objects that imitate the structure of the ideal city.

The structure of type no. 2 is much more developed and the following features can be distinguished in it:

- they are characterized by a compact and concentrated form created from many identical cells that in space constitute elementary particles - permanent modules responsible for the cohesion and balance of the composition,
- the number of radial symmetry axes that can be distinguished is much greater than in type no. 1 and ranges from a dozen to several dozen axes of symmetry,
- the structures of the system are built on the radii of several circles whose central point is the center of the composition,
- Individual spatial points spaced at the same distance from each other create a permanent module based on the same proportions, which, processed in constant rhythms and in various spatial arrangements, creates the structure of the organism.

Spatial structures of type no. 2 are characteristic primarily of larger public buildings and temples that originate from the original form of the tholos, where its mature form appeared in ancient Greece. The center of gravity of the repeatable modules of the composition is based on several circles radiating from the central point of the composition. Basic spatial units are built from single points, e.g. in the form of columns, which occur in fixed distances and proportions to each other, and thanks to radial symmetry and its arrangement, they create constantly repeating rhythms.

The examples presented are limited to the European cultural sphere. However, it should be remembered that space was shaped differently outside Europe. Research on architectural assumptions from other cultural circles in relation to centric forms requires deeper and further research.

6. Discussion

For centuries, attempts have been made to find uniform principles in nature that shape beauty. Many different theories have been created on this subject, based on, among others: the golden ratio, Fibonacci sequences or fractal structures. According to them, every day we encounter geometric objects that are self-similar and can be infinitely complex, by which we mean that their smallest particles resemble the entirety of the created structure. This property is often found in nature, e.g. in trees that resemble a structural whole (Bociek, Wytrki, 2021). At the end of the 20th century, the biophilia hypothesis gained popularity, which examines the relationships of highly developed species with nature and their adaptation to the environment enabling them to survive. In addition to the natural environmental conditions in which we live every day (chemical and physical conditions such as light, wind, temperature), humans also create feedback with the spatial order of nature, manifested through appropriately occurring rhythms, divisions and systems of proportions that, when perceived by humans, affect their way of thinking and aesthetics and, as a result, determine the canons of beauty (Celadyn, 2023).

The research presented in this article is consistent with this hypothesis. Humans subconsciously use radial symmetry and a system of spatial structures to shape their immediate surroundings, which have been present in nature since the beginning of life and whose traces can be found in some of the most primitive organisms - algae (from the diatom and green algae classes), the first fossils of which appeared about 750 million years ago. Since, as it was shown in the article, man subconsciously strives for a sense of order, stability and beauty, a thorough examination of the structures of primitive organisms, especially in the aspect of radial symmetry, will help us better understand the needs and way of thinking and spatial orientation in the field of the species Homo sapiens.

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