

The Hidden Harmony and Mysterious Connection in the Exploration of the Complex Resemblance Between Diatom Forms and Islamic Ornamentation

الانسجام الخفي والارتباط الغامض في استكشاف التشابه المعقد بين أشكال الدياتومات والزخرفة الإسلامية

L'harmonie subtile et le lien énigmatique dans l'exploration de la complexité des similitudes entre les formes des diatomées et l'ornementation islamique.

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Date of submission: 01 /10 /2024 - Date of acceptance : 19/12/2024 Date of edition : 30/12/2024

ملخص:

أدى التقدم العلمي الذي تحقق في القرن العشرين إلى اختراع العديد من الوسائل والأجهزة على غرار المجهر الرقمي الذي سمح بالكشف عن العديد من الكائنات المجهرية التي تعيش في العالم من حولنا، ومن بين هذه الكائنات تأتي الطحالب المجهرية أو ما يعرف بالدياتومات هذا الأخير الذي قمنا في ورقتنا هذه بمقارنته بالزخارف الإسلامية من حيث الشكل، هذا التشابه الذي سعينا لإثباته انطلاقاً من منظومة خصائص الفن الإسلامي المعروفة كالتركرار والتقابل والتدابر والتشعب وملء الفراغ، من جهة أخرى التشابه أيضاً في العناصر المكونة للزخرفة الإسلامية كالأشكال النباتية والهندسية والرموز وغيرها من أشكال، ما جعلنا نواجه إشكال رئيس أساسه درجة التشابه بينهما وكذا احتمالية كون هذا التشابه إعجاز علمي وإلهام رباني للفنان المسلم دون غيره أو أنه محض مصادفة، وتكمن أهمية مثل هذه الدراسات في ربط الفن بالعلم، وقد اتبعنا المنهج الوصفي التحليل لإجراء هذه المقارنة للوصول إلى نتائج أهمها وجود فعلاً تشابه كبير إن لم نقل تطابق بين أشكال الدياتومات والزخرفة الإسلامية لا يعلم سر ذلك التشابه إلى الله.

الكلمات المفتاحية: الفن الإسلامي؛ الزخرفة الإسلامية؛ الطحالب المجهرية؛ الدياتومات.

Abstract:

The scientific progress made in the 20th century resulted in the invention of the digital microscope, which allowed for the discovery of numerous microscopic organisms living in the world around us. One such organism, the diatom, was compared to Islamic decorative arts in a research study. The similarities in their forms, which were based on repetition, centralization, symmetry, interlacing, branching, and space-filling, prompted researchers to question whether this similarity was a Divine inspiration for the Muslim artist above others scientific miracle, or simply a coincidence. The significance of this study is that it highlights the link between art and science and the potential for connections between seemingly unrelated fields. However, despite the significant resemblance between diatoms and Islamic decorative arts, the reason behind this similarity is still a mystery and may only be known to God.

Keywords : Islamic art; Islamic decoration; microalgae; diatoms.

Résumé :

Les progrès scientifiques du XXe siècle ont abouti à l'invention du microscope électronique, permettant ainsi la découverte d'un grand nombre d'organismes microscopiques peuplant notre monde. Parmi ces organismes, les diatomées ont fait l'objet d'une étude comparative avec les arts

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décoratifs islamiques. Les similitudes de formes, basées sur la répétition, la centralisation, la symétrie, l'entrelacement, la ramification et le remplissage de l'espace, ont amené les chercheurs à s'interroger sur l'origine de cette ressemblance : s'agit-il d'une inspiration divine pour l'artiste musulman, ou simplement d'une coïncidence née d'un miracle scientifique ? L'importance de cette étude réside dans le fait qu'elle souligne le lien entre l'art et la science, ainsi que le potentiel de connexions entre des domaines apparemment sans rapport. Cependant, malgré la similitude frappante entre les diatomées et les arts décoratifs islamiques, la raison de cette ressemblance demeure un mystère, et ne sera peut-être jamais élucidée que par Dieu.

Mots clés : Art islamique; décoration islamique; microalgues, diatomées.

Introduction

Anyone familiar with Islamic ornamentation and its intricacies, if shown an image of diatoms captured with reverse digital polarized light, would analyze and interpret it as Islamic ornamentation, attributed to a specific style among the Islamic artistic designs and patterns left by the Islamic civilization throughout historical ages, from the Umayyad and Abbasid states to the Ottoman Caliphate, passing through different eras. Although the caliphate was vast and differences in decorative styles and patterns among the states existed, they share general features and characteristics that unify Islamic art in terms of centering, repetition, symmetry, proportion, filling of emptiness, shadow, light, intersection, branching, and emanation from a center or point to the circumference of the circle, square, or rectangle. Every Islamic ornamentation, whether geometric, floral or calligraphic, is within a frame bounded by either a circle, square, or rectangle. On the other hand, the intersection of basic shapes produces an infinite number of shapes. Moreover, diatoms' shapes captured with reverse digital polarized light appear at first glance to have some of the aforementioned characteristics to the extent that they resemble decorative patterns. This makes us wonder about the degree of similarity between Islamic ornamentation and diatom shapes. Can this be considered a scientific miracle for the Muslim artist's tendency towards this type of ornamentation, especially if we know that the beginning of the appearance of these ornaments dates back to the Umayyad era, while these diatom shapes were not discovered until the invention of digital and optical microscopes in the twentieth century? This leads us to assume that it is an inspiration from Allah Almighty for the Muslim artist to use botanical and geometric ornamentation, which scholars agree on its permissibility, and to avoid using images of living beings, including humans and animals, which are forbidden to be drawn in many hadiths.

Research Objectives

- Highlighting some aspects of Islamic art, its elements and characteristics that distinguish it from other arts.
- Shedding light on some elements of Islamic ornamentation such as botanical, geometric, and calligraphic shapes.
- Examining the degree of similarity between microscopic algae shapes (diatoms) and Islamic ornamentation by highlighting some features and characteristics of Islamic art and projecting them onto some diatom shapes.

Research Significance

- This type of study embodies the consolidation of the relationship between science and arts to highlight the beauty of the Creator's creativity.
- This type of research leads to deviating somewhat from routine studies of Islamic art and ornamentation, which focus mainly on description and analysis, and creates a new space for archaeological studies that combine art and science.

Research Methodology

This study adopted a descriptive-analytical methodology by collecting information sources, analyzing them, and subjecting them to study. In addition, images were described and analyzed. The comparative methodology was also used by comparing the characteristics and features of Islamic ornamentation with diatom shapes.

1- Islamic Art and its Development

Souad Maher Mohammed explains that Islamic art was built upon the foundations of the arts that were prevalent in the lands conquered by the Arabs, which became part of the Islamic state. These arts include Sasanian, Byzantine, Roman, Indian, Chinese, and Southeast Asian art. While archaeologists have differed in determining the contribution of each of these arts to the development of the new Islamic art, (Maher, 1986, p. 5) what is certain is that Islamic art is characterized by its focus on geometric, botanical, and calligraphic ornamentation, as well as attention to fine details and harmony between colors and shapes. It reflects the values, culture, and religion of Islamic society, Islamic art has undergone significant development throughout different eras, with its styles varying and its artistic manufacturing techniques evolving, (Lintz & al, 2021-2022, pp. 14-17) , Islam emerged from a region on the Arabian Peninsula where the population consisted of two main groups: the settled urban communities, who inhabited the cities in the southern part of the peninsula, such as the ancient states of Ma'in, Saba, and Himyar, and the nomadic Bedouin communities, who lived in tents and roamed the northern regions of the Hejaz, Najd, and Tihama. It is clear that both the settled and nomadic Arabs of that era had artistic sensibilities that influenced the development of Islamic art in some way. These Arabs used tools for their daily life, such as utensils for eating, drinking, and cooking, as well as equipment for weaving fabrics, making clothes, blankets, and carpets, and covering or decorating the floors and walls, (Abderrazek, 2006, pp. 13-14), Therefore, it is unfair to attribute the origins of Islamic art solely to the Sassanians, Byzantines, and others after the Islamic conquests. The history of the Arabian Peninsula indicates that the region was home to several civilizations that witnessed a very high level of development and sophistication, such as the ancient states of Saba, Himyar, and others mentioned in the Quran, as well as the Nabateans, Ghassanids, and the people of Madain Saleh, who carved their homes out of mountains, as mentioned in the Quran. The Arab geographer and archaeologist Abu Muhammad al-Hasan ibn Ahmad ibn Ya'qub al-Hamadani (d. 946 CE) devoted a book to the castles and tombs of the southern Arab lands, which were a symbol of the ancient Arab civilization. The Austrian Orientalist and archaeologist Edward Glaser mentioned that the ancient southern Arab buildings were very advanced, using large marble rocks that were carved in a regular manner, and were held together by lead pegs that connected the stones through holes. The southern Arab was particularly interested in decoration, especially decoration of ceilings, walls, and doors, as well as the use of gold, silver, precious stones, and other materials to adorn them, (Nelson & al,

1958, pp. 150-152) The remains of luxurious buildings such as palaces and castles near Ma'rib, Najran, and the Qarab Najarah support the Arab and European narratives that speak of the greatness and glory that the Arab lands achieved in ancient times, especially in the fields of art and culture (Ibrahim, 1996, p. 27), During the time of Arab Jahiliyyah, many crafts were prevalent among the Arabs, such as carpentry, which was used to transform wood into building materials and decorative items such as boxes that were decorated by painting or carving on their surface. Mining was also a prevalent craft used to create agricultural tools, swords, daggers, armor, knives, polished blades, and engraved blades. Additionally, the craft of metalworking was widespread, including the working of gold, silver, and bronze, where necklaces, bracelets, amulets, anklets, and crowns were created. Tanning was also widespread, as the ancient Arabs turned hides into leather for shoes, belts, and strings for musical instruments, (Ali, 1993, p. 541) Looking back at the Quraysh and the neighboring tribes, we find that the nobility of these tribes looked down on crafts. However, crafts were prevalent in Arab society, where various crafts were designated for slaves and lower classes. Each tribe would boast of its own creations, and poets represented the voice and mirror of the tribe through poetry that documented ancient Arab history and its arts in the Arabic language and Arabic calligraphy. After Islam emerged, artists excelled in using calligraphy for decoration by refining its letters and drawing them in different styles, We cannot forget to mention the market of 'Ukaz, which was a meeting place for traders and tribes during the Hajj season, where various Arab goods and handicrafts made of metal, wood, clay, as well as jewelry, clothing, swords, wooden products, and statues were displayed. Therefore, we can say that Islamic art is ancient and dates back to ancient Arab civilization, which has witnessed development and refinement in some areas but has also experienced stagnation and neglect in other areas. After the emergence of Islam and the spread of this religion in the Arabian Peninsula, its inhabitants abandoned all worldly pleasures and focused on supporting the Prophet Muhammad (peace be upon him) and spreading his message, This continued until many countries were conquered, and the Islamic state strengthened, and stability was achieved in various aspects. When the Arabs conquered Iraq, Iran, the Levant, Egypt, North Africa, and Andalusia, art flourished throughout the empire. It cannot be said that this art was purely Arab, as the Arab share in it was less than that of other Islamic nations. Islamic art in the first three centuries after the Hijra was dominated by the Umayyad style first, then the Abbasid style after the fall of the Umayyads in 750 CE. After the fall of the Abbasids, it included a Moroccan-Spanish style that developed in North Africa and Andalusia, as well as an Egyptian-Syrian style that developed in the Nile Valley and Syria. It also included a Persian style in Iran and an Ottoman style in the Ottoman Empire, (Zaki, 2013, pp. 11-14) Indeed, Islamic arts varied from one caliphate to another in terms of style, pattern, and the use of different types of decorations, including calligraphic, geometric, floral, and even animal, human, and symbolic decorations. Because Islam is the source of inspiration for Muslim artists, they follow what the Prophet (peace be upon him) has brought in terms of taking trees and plants as a pure form away from nature in their various arts. Therefore, they excelled in transforming them, and a special style emerged in Islamic art, which has a great impact and is called "Arabic Riqqa" or "Arabic Tawriq." Additionally, Islamic art is unique in its use of Arabic calligraphy as decoration, which sets it apart from other art forms.

2- Islamic decoration

The decorative arts are a distinct form of art that is linked to drawing and painting. They showcase harmonious engravings. (Al-Juday & Otterbeck, 2017, p. 77) And Islamic decoration

refers to the ornamental designs that are used to adorn buildings, whether they are made of plaster, stone, wood, marble, or other materials. Islamic architecture and art have given special and continuous attention to these decorations, reaching a great level of quality, skill, and diversity as a result of the continuous efforts of Muslim artists in this field. They carved wood, crafted doors, wrought metals, carved stones, engraved gypsum, colored ceramics, lowered marble, and other various types of decorative work with their hands.(Assim, 2000, p. 131).

2-1. The evolution of Islamic decoration

Decoration is one of the Islamic arts that flourished during the Islamic era, and it included many artistic spaces on many internal and external architectural facades using different materials such as plaster, marble, mosaic, and other materials, (Al-Hajan & others, 2013, p. 583) The Islamic art of decoration reflects the mixture of different civilizations and various artistic styles that were presented to the artist in the vast Islamic world at that time. We see the lotus flower inspired by Chinese and ancient Egyptian heritage, and we see the influence of the artistic heritage of the Levant in those braided and undulating strips of palm fronds and their halves and roses. The influence of the Sasanian civilization that grew in Central Asia and Iran is still evident in the winged and feathered decorative shapes. These decorations have grown, evolved, and shone, occupying entire pages alongside geometric shapes. The spaces were filled with strips of leaves and the margins were encircled with golden braided lines in blue and red colors. (Wilson, 2011, p. 8).

2-2. Islamic decoration elements

2-2-1. Plant-based Decoration

Plant-based Decoration refers to any ornament or decorative element that is based on plant elements such as stems, leaves, flowers, and fruits. These decorations can take on various shapes and forms, whether they are natural or stylized to a degree that is far removed from their original appearance, (Mohamed Adly, 2011, p. 135) Plant-based Decoration is one of the most prominent aspects of Islamic art that demonstrates the Muslim artist's departure from representing and imitating nature, in response to the religious doctrine and its directives. The Muslim artist reached a level of creativity that no artist before him had ever achieved, to the extent that this type of Islamic decoration was called Arabesque or Arabic Riqqash or Arabic Tawriq.(Rezki, 2015, p. 84).

2-2-2. geometric decoration

In geometric decoration, the Muslim artist breathed new life into it and it appeared in a new form of artistic beauty that had not existed before. The artist did not invent geometric shapes, but he excelled in dividing these known shapes, resulting in various decorations that indicate his mastery of the science of geometry, (Marzouq Abdel Aziz, 1965, p. 185) Geometric patterns have become an essential element of decoration in Islamic art, where the focus was not only on simple geometric shapes such as triangles, squares, rhombuses, pentagons, and hexagons, but also on complex geometric compositions with multi-sided star shapes. (Rabah, 2004, p. 8) Muslims excelled in this type of decoration and were innovative and complex in their designs(Zaki, in Islamic arts, 1938, pp. 19-32).

2-2-3. Human and animal decorations

Human and animal decorations were prohibited in the early Islamic period out of fear of returning to idol worship. However, they were frequently depicted in Persia and India, and then in Egypt and Syria during the Fatimid and Ayyubid periods, and later in Al-Andalus, although to a lesser extent (Inayat, 1993, pp. 25-26). However, this type of decoration cannot be attributed to Islam since there are many authentic hadiths that prohibit pictorial representation, and warn of the punishment that awaits the creator of such images. Therefore, Muslim artists refrained from using human and animal decorations in their artwork, obeying the Prophet's prohibition, except for a few rare cases. Consequently, this type of decoration did not reach the same level of prominence as other types of Islamic decoration in the Islamic world.

2-2-4. calligraphic decorations

Islamic civilization was distinguished from other civilizations by many features, including the unique decorative element of Arabic calligraphy. It represents a complete work of art with various styles and forms, and numerous examples can be seen in entrances, domes, minarets, and other architectural elements. Arabic calligraphy includes over a hundred different types of scripts, with the most commonly used being Kufic, Thuluth, Naskh, Ijazah, Tawqi', and Persian scripts. Muslim artists developed this decorative element and transformed it into various artistic forms, using it in Islamic decorations in a beautiful and artistic way (Waziri, 2000, p. 97).

3- The Elements of Decorative Composition

4-1. The Point

The point is considered one of the smallest and most precise internal elements in any artistic or decorative composition. It may stimulate a feeling of movement in the receiver because it is not just a spatial marker. It does not only evoke a kinetic activity that is confined to the space it occupies, but it extends to the surrounding space as well (Al-Husseini, 2016, p. 112).

4-2. The Line

The line is the continuation of adjacent points in different directions, whether this continuity produces straight, curved, wavy, or broken lines, whether they are harmonious, conflicting, balanced, intersecting, or spiral lines. The line determines the nature of the image. The line is associated with movement, which represents continuity. Thus, Muslim artists used lines and their different types in decorating their artworks to unify the elements of decorative units forming the scene.(Al-Musawi, 2011, pp. 143-145).

3-3. The Form

The form is created when lines move and intersect to enclose different surfaces, either on the same level known as spaces or planes, or when some surfaces are highlighted to contrast with the background. The form is achieved through the convergence of the pattern that is created by the decorative elements with the physical surface on which the decorative subject is executed. (Al-Husseini, 2016, p. 114).

3-4. The Color

The elements of artistic composition contribute to creating a cohesive and effective visual structure in Islamic art, due to the enormous expressive and aesthetic potentials of color. In Islamic art, color is considered the distinctive and manifested characteristic of the image structure, encompassing aesthetic qualities that occupy spaces within the Islamic image scene. Especially the colors mentioned in the Holy Quran, which are the light green color of sandalwood, the blue color of turquoise, the dark red color of coral, the white color of pearls, and the crimson color of rubies, in addition to the golden color, which was considered a celestial color by Muslim artists. Color possessed a tremendous spiritual energy for Muslim artists (Al-Musawi, 2011, pp. 150-152).

3-5. Texture

The importance of this element lies in its use to distinguish between the parts of the composition, giving each part its unique nature. For example, roughness for a rough surface, and smoothness for a smooth surface. The variety in textures between the parts of the composition works to give it vitality and prevents it from becoming monotonous and boring (Al-Husseini, 2016, p. 118), Muslim artists benefited from every material, every decoration, and every color in enriching the surface, utilizing the tactile values of natural materials' surfaces and diversifying the decorative element's scope (Al-Alfi, 1998, p. 107).

3-6. Space

The frame of the image works to highlight the space, whether it is in the foreground, background, or above, for the subject included in the image. One of the major mistakes that an artist can make is to misuse the spaces, leaving a large void that does not express any meaning, or not leaving a space that should exist. The void, whether for the main subject or the surrounding elements, can strengthen the sense of movement and its direction (Riyad, 1974, p. 158).

3-7. Light and Shadow

Light and shadow are essential elements in Islamic art, and colors often play this role. Muslim artists used them to add an artistic and aesthetic element to their compositions (Abdullah , 2016, p. 30).

3-8. The Rhythm

It is the alternation and the rule on which Islamic art is based, through repetition, symmetry, sequence, and coherence. Each of these elements affects the other so that nothing is lost in beauty (Abdullah , 2016, p. 30).

4- The rules and decorative systems in Islamic decorative design

4-1. Balance

Balance is the fundamental rule that must be present in every decorative design and in every sound artwork. The comprehensive meaning of balance expresses the integrated artistic composition through the distribution of elements, units, colors, and the coherence of their relationships with each other and the surrounding spaces. Balance is used in Islamic decoration, from borders, frames, fillings, and enjoyable surfaces. The most beautiful rhythms of balance can be prepared in harmony, and no distribution can be restricted by specific constraints. What must be considered when

designing any design is the general principles that ensure the design's compositional integrity (Mohamed Youssef & Hamouda Al-Qadi, 1992, p. 155).

4-2. Repetition

Repetition is one of the most important rules of Islamic ornamentation and is frequently found in nature. For example, the leaves of a tree branch are arranged on both sides in a beautiful pattern, sometimes alternating and sometimes in reverse. The pattern becomes more intricate as it approaches the end. Repetition is one of the simplest rules of Islamic decorative composition, where by repeating any element or decorative unit, whether natural or artificial, a beautiful decorative composition can be created, even if the element itself is not inherently beautiful. There are various methods of decorative repetition depending on the formation of the decorative units. One of the most prominent methods adopted by Muslim artists is regular repetition, where decorative units are arranged in a fixed and alternating position. Another method is reverse repetition, where decorative units are arranged in opposite positions, sometimes upwards and sometimes downwards. In addition, there is alternating repetition, where two different decorative units are used in a sequence (Talu, 1986, p. 17).

4-3. Symmetry

Symmetry refers to a situation where one half of a shape is identical to the other half, whether it is the upper half, lower half, or the two sides, right or left. It can also refer to a work of art composed of repeated and similar units. Symmetry is an inherent state that can be easily identified, as in the human face or body, plant leaves, butterflies, and other natural shapes. Symmetry is considered one of the most important rules in Islamic ornamentation design, as it adds a sense of balance and unity, especially when accompanied by diversity. Symmetry can be either half, where decorative designs complete the other half in a symmetrical direction, or complete symmetry, where the decorative design consists of two completely similar formations in opposite directions (Chechter , 2008, pp. 61-62).

4-4. Branching

This sentence appears to be a duplicate of the previous sentence, which discusses the use of contrasts in decorative formations and gives examples of natural units that originate from a single point, such as cacti, palm tree heads, and flowers, as well as single lines such as tree branches and plant leaves (Mohamed Youssef & Hamouda Al-Qadi, 1992, p. 206), The branching effect is frequently seen in Islamic ornamentation, especially in the decoration of calligraphic bands, fillings, and surfaces. The branching can originate from a point where energy is usually dormant or semi-dormant until it moves in paths and directions. In this process, parts of the unit emerge from a single point in a symmetrical position. The branching can also occur from a line where parts of the unit are connected to a line that branches off (Al-Draisa &Adly , 2014, pp. 55-56).

4-5. Interconnection and Intersection

Interconnection is based on linking two decorative elements, where each one belongs to the other and they are connected in a way that each one derives its existence from the other. Intersection is a formal representation of a specific pattern of organized or unorganized shapes that move towards another opposite direction or the intersection of two shapes with contrasting colors (Al-Husseini, 2016, p. 136).

4-6. Filling the Space

Muslim artists work on covering spaces and surfaces and avoid leaving them without decoration or ornamentation. They do not believe in making the decoration brief or seeking to show it by creating gaps. The dislike of empty space among Muslim artists has led them to embrace repetition, which some Westerners describe as infinite repetition. They interpret this as reflecting the spirit of Islamic religion or the nature of the desert in which the Arabs originated. However, this interpretation is not a solution, and the reason for Islamic art's excessive focus on this field is its decorative nature and the aversion of Muslim artists to empty spaces without decoration (Zaki, Arts of Islam, 1948, p. 677).

5- Diatoms

Diatoms are single-celled microalgae, and regardless of their cell shape or size, they are composed of the same basic parts, which include the nucleus, cytoplasm, cell membrane, and cell wall (McLaughlin, 2012, p. 01), Diatoms reproduce vegetatively by binary fission (Tomas, 1996, p. 07), The name "diatom" is derived from two Greek words, "dia" which means "through" and "temnein" which means "to cut," because their cells are divided into two halves or parts that resemble a box. They are one of the most common types of plant plankton. They can be found in both marine and freshwater environments, at high and low temperatures, and in highly saline and low-salinity waters. Diatoms play an important role in the oceans, where they significantly sequester amounts of carbon dioxide and synthesize carbohydrates that serve as a primary food source for zooplankton in the marine food chain. There are over 1250 genera of diatoms in the class Bacillariophyceae. Fossil evidence indicates that diatoms originated during or before the early Jurassic period. Diatoms are often visible to the naked eye as a golden coating growing on vessels, glass, or rocks in fish tanks, and they usually form brownish membranes. When viewed under the highest magnification of the scanning electron microscope, their cells appear extremely attractive and display beautiful designs and patterns (Seckbach & Kociolek, 2011, p. xi).

5-1. Classification of diatoms

Due to the huge number of species, the classification problem is very challenging. but the use of artificial intelligence in microscopy has deeply marked the field of biological samples investigation, paving the way to remarkable advances in imaging and automatic classification. (Memmolò & others, 2020) diatoms are generally divided into the centric that is circular with radial symmetry and the pennate that is elongated with primarily bilateral symmetry. The latter group is further divided into the raphid and araphid diatoms, depending on the presence and absence of raphe. While other features such as chloroplast and auxospore behavior were used to define diatom taxa, the most significant classification in the late 20th century was proposed with three classes of diatoms: the centric (Coscinodiscophyceae), pennate without raphe (Fragilariophyceae), and pennate with a raphe (Bacillariophyceae) (Fu & others, 2022).

6- Similarities Between Diatoms and Islamic Ornamentation

The Muslim artist's inclination towards botanical and geometric ornamentation indicates divine inspiration to use nature, including trees, plants, flowers, and leaves, on one hand, and geometric shapes derived from the sun, moon, stars, and planets, on the other. In the twentieth century, scientific discoveries and cognitive advancements led to the emergence of many inventions that changed the human perspective on various things, especially invisible creatures and beings that humans did not know existed. The veil was lifted from them with the emergence of advanced microscopes that allowed humans to see their physiological structures and formations. These structures and formations have been found to correspond with what is mentioned in the Qur'an and the Prophet's Sunnah, which has led many Western scientists to embrace Islam, such as embryologists who were delighted to discover the stages of fetal development, only to be shocked that what they discovered had been mentioned in the Qur'an over fourteen centuries ago. The Prophet (peace be upon him) ordered that vessels that had been licked by dogs be washed seven times, the first time with soil. Recent studies have proven the danger of bacteria carried in a dog's saliva and the role of soil as a disinfectant, on the one hand, and its crucial role in absorbing dog germs, on the other, and so on in various fields. Among these discoveries are microscopic algae of various types, such as the single-celled diatom algae. These algae can be imaged using inverted polarized light microscopy to reveal their stunning shapes, which closely resemble various Islamic ornamentation patterns. This proves that despite the Muslim artist's dependence on visual elements from nature to create different ornamentations and designs, their creativity led them to form a decorative system that seems to have been inspired by micrographic images of diatoms. This makes us wonder if this is a coincidence or a scientific miracle, especially since their similarity was with Islamic ornamentation, not with other ornamentation patterns, whether in terms of their constituent elements or their principles and characteristics.

6-1. Plant-based Decorative Forms

The Muslim artist resorted to using various plants and flowers as a source of inspiration in creating their ornamentation. They excelled in drawing them, whether in their original form or stylized form. Islamic art became famous for this style, which is now known as Arabic calligraphy. Nature was a vast field from which the Muslim artist drew various botanical shapes, and each region was characterized by specific botanical ornamentation that imitated those found in its environment. Some plants and flowers held a special place for Muslims, such as the date palm fronds, which represent the desert environment, and the pine cones and carnations, the latter being one of the herbs that have been used since ancient times to treat various illnesses. The Prophet (peace be upon him) encouraged the use of perfumes and said, "The things that are dearest to me in this world are women and perfume, and the coolness of my eyes is in prayer" (Narrated by An-Nasa'i). Cloves are one of the ingredients used in perfumes, and the angels love pleasant scents, while the devils love foul smells. The clove plant held a special place among Muslims as well. In addition to its use in perfumery and medicine, Muslim artists used the clove flower as a decorative element to adorn many materials, especially the Ottomans, who used it extensively in its original and stylized form in the decoration of their buildings, pottery, and even gypsum and metal items. To the extent that many archaeologists now associate Turkish art with the clove, the lily, and the like. In the following figure, we can see a great similarity between the filamentous diatoms and the clove flower, especially in its stylized form after artistic decoration.

Figure 01: A model of filamentous diatoms (bidulphia)



Source: <https://www.sciencephoto.com/media/918738/view/licmophora-diatoms-light-micrograph>.

Figure 02: Botanical ornamentation represented by the clove flower

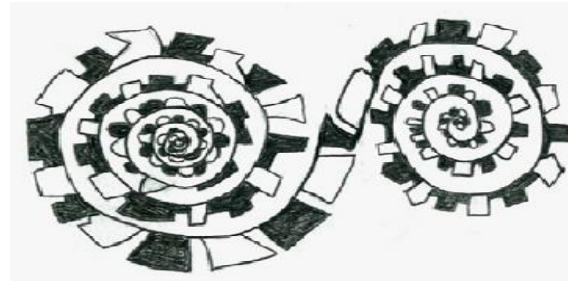


Source: (by the researcher).

6-2. Spiral lines

This style of ornamentation was widely used in Islamic countries, especially since it achieves the principle of filling the void. It consists of ornamentations that extend in a twisted or circular shape, with circular geometric intersections and spirals in an abstract style. By comparing some models of Islamic ornamentation with spiral style to some diatom shapes, we found a great similarity if not an exact match. These ornamentations start from a point in a spiral direction, then bend again. Muslim artists were inspired by this characteristic from mollusks, especially snails, as well as some marine animals and plants that take on a spiral shape, such as climbing plants that take on a matrix system of twists, as drawn by their leaves. This style was widely used in various regions of the Ottoman Empire, especially in decorating various buildings, especially religious ones such as mosques. Every part of their walls, windows, and pulpits were decorated with various forms of spiral ornamentation. It was also used in ribbons and borders, where Muslim artists excelled in using Arabic calligraphy as a decorative style in a twisted form branching from plant branches in a geometric frame. This resulted in the integration of calligraphic, plant, and geometric ornamentations on one surface. The execution of these spiral ornamentations was not limited to one material, but was embodied in various materials such as gypsum, marble, wood, and ceramic tiles, even in traditional handicrafts. By referring to diatoms, we find that the spiral style in some of its types remarkably imitates these Islamic ornamentations, whether in the way they twist or in the way they start from a central point towards an infinite space, and sometimes end at another central point. This similarity suggests a spiritual connection between Muslims and all creatures created by Allah. It even led many foreign scholars to embrace Islam when they discovered the manifestations of the Creator's power. Muslim artists found other sources of creativity in deviating from portraying human and animal figures.

Figure 03: *Fossilized diatoms*



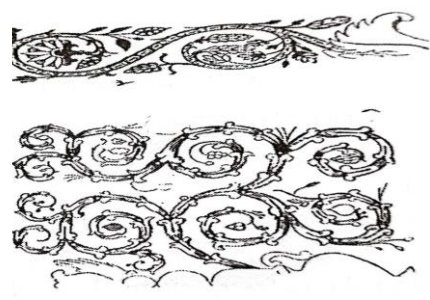
Source: (Najm & al, 2013, p. 321)

Figure 04: *Examples of some twisted (spiral) ornamentations from the Sidi El Kettani Mosque in Constantine*



Source: (by the researcher)

Figure 05: *Examples of some twisted (spiral) ornamentations*



Source: (Al-Alusi, 2017, p. 87).

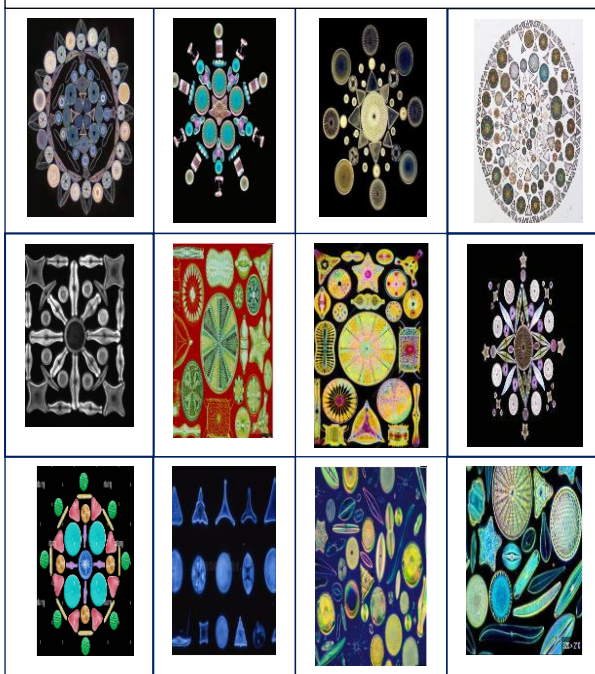
6-3. Geometric shapes and symbols

The Muslim artist used geometric shapes to create decorative elements, including stars of various shapes such as pentagons, hexagons, and octagons, as well as lines, dots, semi-curved shapes, and connected and intersecting circles and semi-circles. The artist used hooks and flat forms to create beautiful decorative ribbons, and used squares, rectangles, and triangles in three-dimensional or flat forms to create friezes or decorative ribbons. Curved shapes with prominent or indented decorative fillings were also used. Muslim artists commonly used these geometric shapes to create a unified system and framework of decorations, where they filled in the desired spaces in parallel with Islam's rejection of emptiness in many aspects, such as filling spiritual emptiness with remembrance of Allah, lining up in prayer, and not leaving space for Satan. Muslim artists borrowed geometric shapes and incorporated them into a decorative system, whether calligraphic or vegetal, to create a unified form as if it were one piece. This endless creativity of the Muslim artist made these decorations merge with each other in a beautiful decorative pattern. The artist showed light and shadow in coloring the decorations and demonstrated the third dimension of the geometric shapes, making the drawings look realistic, clear, beautiful, and creative. By comparing these geometric decorations with microscopic diatom shapes, especially those that live and grow in clean or mineral water, we find a richness of different geometric shapes such as polygons, circles, triangles, stars, and other formations with their various types and shapes. This similarity is perhaps the most consistent with the geometric decorations employed in Islamic art. Muslim artists went

The Hidden Harmony and Mysterious Connection in the Exploration of the Complex Resemblance Between Diatom Forms and Islamic Ornamentation

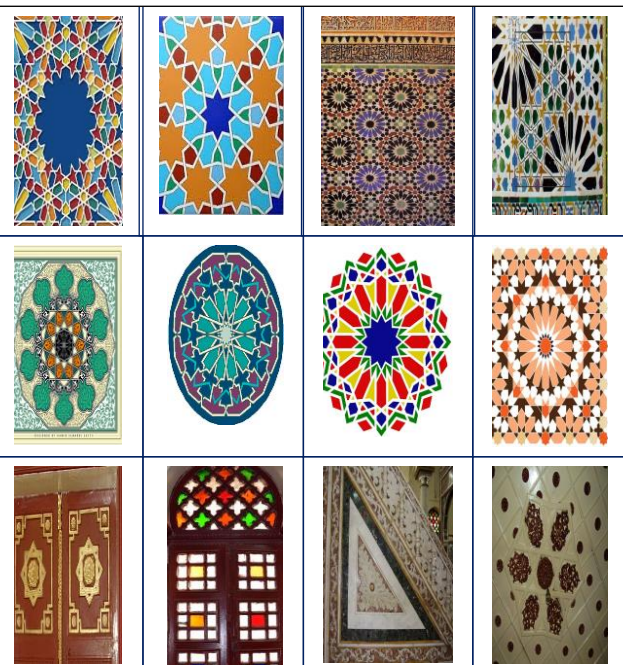
through several stages before arriving at this form of art, after the stability of the Islamic Caliphate and the growth and flourishing of its sciences, as well as the development of various arts, such as decorative and architectural arts, crafts, and industries. We tried to clarify this similarity by presenting some images of geometric decorations executed on wood, marble, doors, pulpits, ceilings, ceramic tiles, metal, wooden artifacts, and some jewelry. On the other hand, we included some images of diatoms captured with digitally inverted polarized light, which contained many strange geometric shapes and symbols. In addition to containing plant decorations that included a wide variety of geometric and symbolic shapes, the question that arises every time is whether this similarity is a coincidence or another scientific miracle where the microscopic geometric shapes produced by digital light reflection coincided with the geometric shapes invented by the Muslim artist.

Figure 06: Some images of diatoms with geometric shapes



Source : National Geographic
<https://www.youtube.com/watch?v=qxkbSk--EUY>.

Figure 07: Examples of Islamic geometric decorations on various materials



Source: some taken by the researcher and
<https://www.pinterest.com/pin/733875701799144172/>

6-4. Other diverse decorations

There are other types of diatoms with beautiful shapes that resemble, to some extent, other types of Islamic decorations. The similarities are found in terms of elements, characteristics, and features of Islamic art that distinguish it from other arts mentioned at the beginning of our research, such as symmetry, reflection, tessellation, texture, rhythm, diversity, shadow and light, color, unity, and imagination. Islamic art also avoids depicting living creatures out of respect for God's creation, and its designs are centered around a rotational axis. There are many elements and features that distinguish Islamic art from others, which is a testament to the vastness and richness of Islamic art.

We have tried to collect as many pictures as possible of diatoms and Islamic decorations that share these characteristics. Muslim artists focused on the center of the Earth to create their art and

placed their attention on the Kaaba, the direction of prayer for Muslims, which they circumambulate in harmony and great coordination. They turn their faces towards it during prayer. If the Earth were level, every Muslim would prostrate towards the Kaaba, bowing their faces to the one God, and they would share the same characteristics and features, united in their rows like a well-constructed building that supports each other, filling in the gaps, and leaving no openings for Satan. In this way, they support each other in their lives, united by Islam, one direction of prayer, and one Lord.

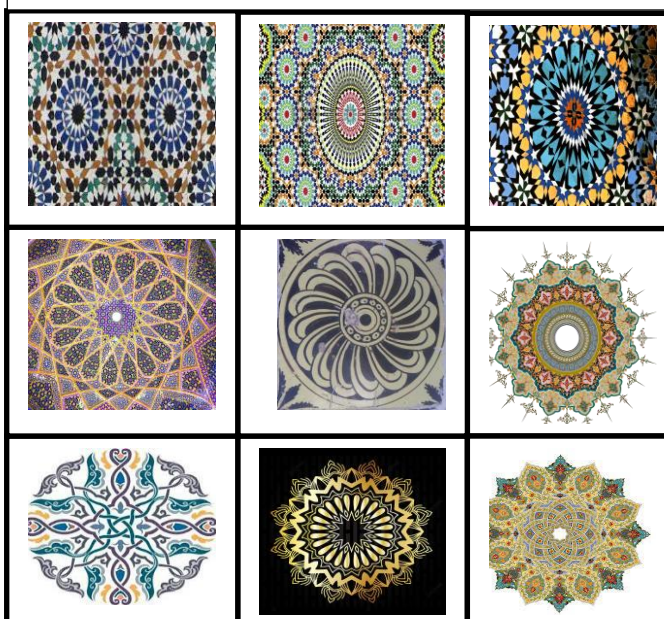
The decorations start from a point or center that represents the starting point for organizing the decorative rows in a rotational plane, regardless of the models or shapes, whether in diatoms or other Islamic decorations. It is the same principle that unites them.

Figure 08: Some examples of diatom images that resemble Islamic decorations



Source : National Geographic:
<https://www.youtube.com/watch?v=qxkbSk-EUY>).

Figure 09: Some examples of Islamic decorations



Source
: <https://www.pinterest.com/pin/733875701799144172/>).

Conclusion

In our paper we tried to shed light on the connection between science and art, focusing on the similarities between Islamic ornamentation and images of diatoms captured using electron microscopy with digital polarizing light. Although our study was theoretical and involved projecting characteristics of Islamic art onto images of diatoms, we were surprised to find a strong connection between these elements and the features of symmetry, texture, contrast, shadow, light, color, unity, and others. However, this raises the question of whether this similarity is mere coincidence or a scientific miracle and divine inspiration for Muslim artists.

One issue we faced during this fascinating research was the prohibition of ornamentation in Islam and its classification as a worldly matter that distracts people from the hereafter and death. Specifically, there is a dislike of ornamentation in mosques because it distracts worshippers from prayer. The Prophet (peace be upon him) said, "The Hour will not be established until people

compete with one another in constructing tall buildings. (Al-Daraqutni, 2004, p. 381). In another hadith, it is mentioned that the Prophet (peace be upon him) slept on a mat and refused an offer of a cushion, saying, "What do I have to do with worldly things? My connection with the world is like that of a traveler who takes shade under a tree and then moves on. (Al-Tirmidhi, 2000, pp. 541-542).

There are many narrations that show the Prophet's (peace be upon him) detachment from worldly possessions. He lived a simple life in terms of shelter, clothing, and food. He died without having his fill of barley bread, and he did not desire the adornments of this world or its pleasures. He urged his companions and all Muslims to distance themselves from the world and its adornments, and he lived as a guest who would soon depart. In a hadith Qudsi, the Prophet said, "Live as you wish, for you will die; love whoever you wish, for you will part with him; and do whatever you wish, for you will be recompensed accordingly. O Muhammad! The believer's honor is in his night prayer, and his dignity is in his self-sufficiency from people" . (Al-Tabarani, 1995, p. 306)

Despite being the best to have lived as a king, a prophet, or a messenger, he chose to be a servant of Allah, poor, and not inclined towards extravagance in anything, no matter how great. He feared that his nation would incline towards this world and its pleasures and distance themselves from seeking the Hereafter, and he cautioned them to perform what was obligatory upon them and guided Muslims towards what would benefit them and win them Paradise and save them from the Hellfire. He said to his companions and all Muslims, "Hold on steadfastly until you meet me at the Pond" (Bukhari). Our great Prophet (peace be upon him) told us, through many narrations, about the punishment of Allah and His warning, and about the desires of Satan and his schemes. He warned us against following our desires and the adornments of this world, which leads to forgetting the Hereafter and inclining towards this world and its construction.

His home, peace be upon him, was made of mud, and the roof was made of palm trunks, and his bed was made of palm fronds and some wool or leather. There were no decorations or fancy utensils in his house, and even what he gained from the spoils of war, he distributed among the Muslims, leaving nothing for himself. He died without leaving behind any inheritance or anything except for the simple homes of the Mothers of the Believers, where he resided until they passed away. These homes were included in the Prophet's Mosque when it was expanded.

We follow the Book of Allah and the Sunnah of His Prophet (peace be upon him), for it is a revelation from Allah. Our Prophet (peace be upon him) informed us that the previous nations perished because of their competition for this world, building palaces, seeking sovereignty, and adorning this world with its pleasures. It is also narrated that when Omar ibn al-Khattab ordered the renovation of the Prophet's Mosque, he told the builders, "Be moderate in decorating the place. Do not use too much red or yellow." That is, do not decorate or color too much.

This topic is exhausting for us as we know that the Prophet (peace be upon him) did not like decorations and colors. However, the mosques today and in previous eras are characterized by extravagant and excessive decorations that fill mosques, homes, and palaces. Do we contradict what our noble Prophet (peace be upon him) came with? On the other hand, the significant similarity, if not identical, between the forms of diatoms and Islamic decorations makes us wonder if it is a mere coincidence or a scientific miracle. We do not want to write a research paper that we will be held

accountable for before our Creator, proving what is false or contradicting what our Prophet (peace be upon him) came with. However, we know with certainty that Allah Almighty created everything, and He is the knower of the secrets and the manifest. Nothing moves on earth and in the heavens except by His will. And at the end, all we can say is that the result of this study can lead to other questions that can be the starting point for further research and studies.

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