

Drying Technology And Its Effect On The Preservation Of Living Specimens In The Iraq Natural History Museum

Lect. Waad Adnan Mahmood¹, Asst. Lect. Wasan Jalel Ibrahim², Asst. Lect. Walid Khazal Saleh Al-Jabri³

¹Iraq Natural History Museum, University of Baghdad, waadadnan1969@gmail.com

²Iraq Natural History Museum, University of Baghdad, Wasanii335@gmail.com

³Iraq Natural History Museum, University of Baghdad, Walid.k@cois.uobaghdad.edu.iq

Abstract

This study highlights an age-old preservation technique still commonly employed in many science museums: drying. This method is particularly prevalent in natural history museums for conserving biological specimens—ranging from plants and animals to tiny microscopic organisms, regardless of their size. Although drying is effective in maintaining the general structure of specimens, it can sometimes alter their original shape. Drying methods vary: direct drying is used for plant parts and insects, while indirect drying involves preserving body parts such as animal hides, feathers, or fur after mummification.

Different drying approaches include traditional air drying—where specimens are left at room temperature away from sunlight—freeze-drying (lyophilization), and chemical drying. The latter involves the use of chemical substances to remove moisture while maintaining the specimen's form and flexibility, as seen in the plasticization process.

The study's theoretical framework is organized into two main parts: the first explores the use of temperature and humidity sensing technologies for monitoring museum environments, and the second addresses ideal climate conditions within natural history museums. The researcher examined significant previous studies related to temperature regulation and its effects on preserved biological specimens. The third section presents practical case studies from the Iraqi Natural History Museum, analyzing a range of preserved organisms. In the final section, the study offers key findings and recommendations, including suggested temperature and humidity levels and proposals for integrating modern environmental control methods.

Keywords: *Natural History Museum / Preserved Specimens / Drying Storage / Freezing / Dried Plants / Taxidermy*

INTRODUCTION

The preservation of biological specimens through various drying techniques remains one of the most enduring and practical methods employed in natural history museums and scientific collections worldwide. Most of the specimens displayed in museum exhibit halls—such as plants, insects, mammals, and birds—were once living organisms that have been carefully dried and preserved to retain their natural form and educational value (Johnson & Clark, 2019). The degree of drying required for each specimen largely depends on its biological composition and the purpose of its display, whether for aesthetic exhibition or scientific study and research (Ahmed et al., 2021).

Maintaining an optimal balance of temperature and humidity is critical in ensuring the longevity of these specimens. Improper environmental conditions—such as excessive dryness, fluctuating temperatures, or elevated humidity—can cause irreversible damage, including skin cracking, feather deterioration, color fading, and microbial growth (Thomson, 2017; ICOM, 2020). These effects are particularly pronounced in regions with extreme seasonal variations, where shifts in humidity and temperature can accelerate the deterioration process of preserved materials (Brown & Carter, 2018).

Ventilation and building orientation also play significant roles in preserving museum specimens. Exhibit halls that receive direct sunlight during summer months often experience elevated internal temperatures, which not only increase dryness but also promote pest activity, such as mites and rodents, leading to further material losses and structural damage (Pinniger, 2001). Thus, maintaining controlled indoor environments through proper ventilation, shading, and air circulation systems is essential for preventing these risks (Museums Association, 2019).

Drying as a preservation technique varies according to specimen type and intended purpose. Direct drying methods, such as air drying, are commonly used for plant materials and insects, while indirect methods, including mummification and chemical preservation, are employed for animal hides, feathers, or fur (Keller et al., 2022). Freeze-drying (lyophilization) and chemical drying methods—such as the use of desiccants or

plasticization—help maintain the specimen's morphology and flexibility by effectively removing moisture without altering its essential structure (Lee & Park, 2021).

This study aims to explore the relationship between temperature, humidity, and the preservation quality of dried biological specimens in museum environments. It focuses on two main aspects: first, the application of modern sensing technologies for environmental monitoring; and second, the identification of ideal climate parameters suitable for natural history museums. The study also includes case studies from the Iraqi Natural History Museum, analyzing the preservation of various specimens and assessing the effects of environmental fluctuations. The findings contribute to improving preservation standards by recommending optimal temperature and humidity ranges and proposing the integration of modern environmental control systems to enhance long-term conservation.

Research Problem:

The research problem lies in the impact of high temperatures in the exhibit hall of the Natural History Museum and the most important methods that can be achieved to maintain stable temperatures in the hall, as well as the relationship between temperature and relative humidity and the impact of these two environmental factors on preserved living specimens. Drying in the museum, and providing the necessary solutions and proposals to solve this problem, which is a major cause of the deterioration and damage of many preserved living specimens and models, whether large or small, of plants or animals. Therefore, the research problem can be summarized by posing the following questions:

- 1 -What are the optimal temperatures in the exhibit hall of the Iraqi Natural History Museum, and what are the means to ensure constant temperature in this hall?
- 2 -The effect of temperature variations on living museum specimens, whether plant or animal, using the various drying methods used in the museum's exhibit hall.
- 3 -What are the mechanisms and methods that can be applied to specimens preserved by drying after they are displayed in the hall, and what are the methods used to avoid damage to dried plant and animal specimens and models?

Importance of the Research:

The research presents the most important methods that can be used to improve the appearance of preserved living specimens in the hall of the Iraqi Natural History Museum by controlling the temperature and humidity in the hall, and clarifying the resulting damage that can be caused to preserved specimens when temperatures fluctuate. Its rise or fall depending on the season, in addition to the possibility of modifying some procedures on the specimens and compensating for damaged ones by employing other drying methods that are less affected by the variations in temperature in the exhibition hall.

Research objective: Controlling temperature regulation in the exhibition hall in order to properly preserve dried plant and animal specimens and ensure they are free from the effects of excessive dehydration caused by high or low temperatures.

Research boundaries:

Time boundary: 2025

Spatial boundary: Natural History Museum

Definition of terms:

Technology Language:

Technology: (noun) An industrial noun from the word "tiqn": a method or art in carrying out a scientific work or research, etc., or a set of means, methods, and approaches specific to a profession or art, as stated in (The Comprehensive Dictionary of Meanings, 2025). Technology is also used (Munir al-Baalbaki, 2008; Shapsigh et al., 2016) or technology (Munir al-Baalbaki, 2008). The latter is a foreign word of Greek origin. It consists of two parts: the word "techno," meaning craft, skill, or art, and the word "logi," meaning science or study. The word technology, therefore, means applied science. Many scholars have provided numerous other definitions of the word. Technology in practice:

Technology is defined as the sum of techniques, skills, technical methods, and processes used in the production of goods or services or in achieving objectives, such as scientific research. Technology can be the knowledge of techniques, processes, and the like, or it can be embedded in machines to allow operation

without detailed knowledge of their workings. Systems (such as machines) that apply technology by taking inputs, changing them according to the system's use, and then producing an outcome are referred to as technical systems or technological systems (Munir Al-Baalbaki 2008).

Drying Language:

(Noun) The root of the verb "jafa" (to dry): heating something to remove moisture from it, either naturally in the sun or artificially with heat machines, drying by fire. Jajafa: (verb), jajafa (to dry), jajafa (to dry), jajafa (to dry), huwa mujaffin (he is a dryer), and the passive participle is mujaffaf (dried). Jajafa (to dry) clothes: remove moisture from them, dry them, jajafa (to dry) meat/fruit: preserve them, drying [jiff]. (Source: jajafa):- I hastened to dry the hall of the house: - : dry it, remove water from the floor. (Al-Ma'jam Al-Ma'ani Al-Jami' 2025). Drying Procedurally:

The removal of water or other solvents by evaporation from solids, semi-solids, and liquids. This process is often used as the final step before sale or packaging. To be considered dried, the final product must be in a solid state, and a heat source and a substance are required to remove the vapors produced by the drying process. In biological products, such as food, grains, and pharmaceuticals such as vaccines, water is often the solvent (Al-Shihabi, 2003).

Effect Linguistically:

Effect: (terms) from trace, leaving a mark on something. Effect: (noun) the source of influence on/affected/affected, or side effect: a negative effect of a drug, etc., and also comes from influence and the ability to produce a strong effect (Al-Ma'jam Al-Ma'ani Al-Jami' 2025).

Effect Procedurally:

In scientific terms, "effect" means the ability to produce a change or result. It is the action or process that causes something else to have an effect. This influence can be physical, chemical, biological, or even social or psychological. Simply put, influence is the force that leads to a change. For example, in physics, the effect of a force on an object could be to change its speed or direction of motion. In chemistry, the effect of a chemical reaction could be the formation of a new substance. In the social sciences, the effect of an advertising campaign could be to change consumer behavior (Wayback Machine 2016, 2017).

Preservation in language: to prevent damage, loss, or contamination, such as "to preserve food." The word "preservation" also denotes the preservation of something. It is said: "to preserve something" (*ḥifẓā*) - with a kasra - meaning to guard it. Preservation also means: to preserve it. Similarly, preserving food and other things: to protect them from spoilage or contamination. Various methods are taken into account for preserving food and other materials (Ahmed, 2020).

Procedural preservation:

It is the preservation of something, whether living or non-living, in its intact, complete form without spoilage, whether the preserved thing is of plant or animal origin, especially in natural history museums, which are concerned with preserving many different scientific models of different origins, including plant and animal, using various traditional and modern preservation methods, with the aim of presenting these models in the best possible way that the audience (viewer, follower, or visitor) can accept, without altering their texture, consistency, or specific shape.

Language model: [Singular]: plural: models and models: someone or something taken as an example to be emulated (see: n m w dh j - model). A model, an example to be emulated, or an example to be worked on. "Industrial model/ Miniature/Dress - A Model of Agricultural Production.

Procedural Model:

A model organism is a non-human species studied in detail to understand specific biological phenomena, with the expectation that new discoveries from the model organism will provide insight into processes in other organisms. Model organisms are widely used to discover the causes and potential treatments for human diseases, especially when such experiments in humans are considered inappropriate or unethical. This method is possible due to the common ancestry of all living organisms and the conservation of metabolic and developmental pathways, as well as genetic material, during evolution. Although studying model organisms can be useful and beneficial, caution must be exercised when generalizing from one organism to another (Fox, 1986; Stanley and Johnston, 2005).

Section One: Preserving Plant Specimens by Drying

Many living specimens of various plant and animal species are preserved after being completely dried and free of moisture. For example, plants are preserved after being pressed and dried so that they are suitable for display in the exhibition hall or for storing replicas as scientific storage that can be referred to when necessary to study a specific type of local plant. These plants are subjected to traditional drying, where they are pressed between special absorbent paper, thus allowing them to dry to their ideal shape. Plants, especially flowers, can be dried using freezing or cold air cooling techniques, with the possibility of recoloring them according to the species, as explained by (Senjam, 2025). Plants can also be preserved by spraying. (Díaz-Montes, 2025) explains the possibility of preserving plants, including flowers, dry, retaining their shape and luster after spraying with various solutions. Spray drying has emerged as an effective and low-cost packaging technique, offering important advantages such as enhanced stability, improved processing properties, and protection against deterioration. Collecting and preserving plants in their dry form extends beyond preserving them as a preserved model for viewing or study, but rather for the identification of these wild plants in particular, which are spread in different countries and regions of the world.

Therefore, preservation is from an awareness and educational aspect for society, those interested and students, in addition to methods of drying different types of medicinal plants of economic importance according to the region and country, in addition to the community's knowledge of these plants, which are usually inherited through generations, as stated by (Jovanovic et al. 2024). The preservation of plants after drying them using various drying or non-dried preservation methods is not limited to displaying them in the halls designated for the plant sections in natural history museums, but rather extends to preserving plants in specialized herbariums in these museums to preserve local and endemic plants, as well as invasive and imported plants. These procedures in the plant herbarium are very important for researchers and students specialized in botany and the diversity of plant cover, knowing that the plant herbarium provides a rich and clear scientific idea about the study of botany in all its aspects, including anatomy, diagnosis and classification in various scientific studies, as happened in Poland, which prepared plant herbariums in natural history museums as a source of data in research on plant classification and geographical sciences, as explained by (Rosta ´nski et al. 2024; Nasution, 2024), as shown in Figure (1) a b c d.





Figure (1) shows the preservation of dried plants for the purpose of study in the herbarium and writing the complete taxonomic information about each species (Rosta'nski et al., 2024).

Recent studies of plant preservation in museums after drying and displaying them show that despite their dryness, these plants continue to absorb some impurities, metals, and other substances through the air. These substances become trapped in the leaves of dry plants, especially in crowded cities. Grifoni et al. (2025) observed the presence of metal particles and residues from the corrosion of car brake metals in the crowded streets near a museum in Argentina. These particles did not accumulate in the museum halls, demonstrating that lichens are reliable biological monitors of airborne particles.

Section Two: Preserving Animal Specimens by Drying

Preserving various species of animals is an important requirement in the halls of natural history museums worldwide. Preservation methods vary depending on their species, size, and the part of the animal being preserved. Taxidermy and insect preservation, as explained by Ghaleb (1988; Baalbaki, 2013), involves preserving an animal's body by stuffing or supporting it for display or study. Animals are often preserved in a lifelike state. Taxidermy is primarily performed on vertebrates (mammals, birds, fish, reptiles, and, less commonly, amphibians), but it can also be performed on larger insects and spiders in some cases. Taxidermy is performed for a number of purposes, including display in a natural history museum, hunting trophies, and the study of hides. Taxidermy also aids in anatomy, sculpture, painting, and tanning. Failure to maintain appropriate temperatures in the exhibit hall causes the damage of many animals of various species due to excessive dehydration, cracking, and damage to their skins, in addition to the breakage of many dried and preserved insect fragments in the hall. This damage is caused by temperatures exceeding the required level for preserving these objects in the summer and exposure to cold weather in the winter, which damages the preserved animal pieces.

Therefore, it is necessary to provide a proper climate for the hall, as well as for storage areas containing many stuffed animal models preserved for study (Brimblecombe et al. 2025). Controlling internal climate conditions has been considered the optimal approach to mitigating the risks posed by climate change. However, heating and air conditioning systems, although inefficient, are now insufficient to meet the sustainable energy demand in these spaces, taking into account the temperature thresholds proposed by the standards for reducing thermal degradation. Although thermal insulation of the building envelope can reduce energy demand due to reduced heat transfer by conduction, this solution may be responsible for overheating problems, especially in the summer due to increased exposure to strong sunlight (Frasca et al. 2024). Many stuffed animals have been damaged and cracked due to the extreme high temperatures in the summer and low temperatures in the winter in the exhibition hall of the Iraqi Natural History Museum. This poses a major problem for the preservation of models, whether they are stuffed animals, preserved insects, or even other models preserved using plaster models or preserved in various types of preservative solutions, as we can see from Figure (2) (a b c d).



Figure (2) illustrates the damage caused to some taxidermied objects by temperature variations within the exhibit hall

Drying Live Models for Museum Display and the Effect of Temperature on Exhibits

The purpose of drying specimens, whether plant or animal specimens of various types, is to rid these objects, skins, or even tissues of moisture, preserving their fixed shape and attractive, eye-catching appearance, while preserving the various parts of these objects intact and undamaged. Hence, the importance of maintaining constant temperatures in the display after drying of various types, including pressure drying, as with plants, or air drying, as with some animal and insect species. This requires the introduction of modern mechanisms and technologies to ensure the preservation of these tissues and skins, such as the technology of exposing skins to various types of radiation at specific levels to reduce the damage resulting from excessive dryness due to temperature variations in the exhibit halls, as explained by (Lupo et al. 2025). Castelain (2024) explains that exposure to excessive heat may expose stuffed specimens, especially those with feathers and hair from various animals, to attacks by insect pests that become active when temperatures rise and there is a lack of disinfection, dusting, and sterilization processes, in addition to damage caused by rodents.

This requires a great deal of effort to restore and restore damaged animal models using various methods, including reattaching feathers and hair, and the possibility of using environmentally friendly materials to restore these models. Hengko (2022) explained in an article it published the importance of temperature and humidity in museums. It is essential to pay attention to the temperature and humidity associated with them, particularly in the exhibition halls of natural history museums. To understand this matter, it is necessary to identify the halls and museums in general where temperature considerations are required, such as natural history museums, which display many organisms that have been dried or mummified. These objects are preserved in a way that prevents them from constantly drying out after their initial drying when they are prepared for display in the museum. The appearance of these models and specimens changes over time due to the variations and changes in temperature and humidity throughout the seasons, as well as the effects of lighting, dust, and other unstable environmental factors in the exhibition hall due to this temperature variation.

Natural history museums play a vital role in biodiversity, evolution, genetics, and the environmental impacts of climate change. Additionally, they play another essential role in protecting the species preserved in natural history museums, laboratories, and elsewhere. They are also very useful in education, research, demonstrations, and many other educational activities. Natural history museums also house insects, which are very useful for various purposes, such as research and micro-level study. Therefore, these insect species must be documented, as preserved specimens can serve as evidence informing people about these species and their environmental status, especially after proper drying and display. Given the importance of these specimens, they must be preserved under the correct environmental conditions, particularly temperatures, to be of benefit. The term conservation can be defined as techniques for halting deterioration and stabilizing a material by creating the appropriate conditions inside and around the object to maintain its stability. Conservation is done in two ways: wet conservation and dry conservation, and there are different techniques for this. Dry conservation involves various steps, such as collection, killing, restoration, fixation, labeling, storage, and disinfection. After the conservation process is completed, specimens must be displayed in models or stored. Therefore, they can be utilized, as these preserved insect specimens have a great impact in various disciplines, such as education, exhibition research, recording purposes, microscopic studies, etc. (Thompson, 1992; Deegan, 2006; Raza, 2023).

RESULTS AND CONCLUSIONS

1. Most of the living specimens preserved using various drying methods in the exhibit hall are originally living organisms, either plants or animals, such as insects, mammals, and birds
2. Each living organism has an appropriate drying degree depending on the species on display and the purpose of the display, whether for aesthetic purposes or for study purposes after storage and ensuring the dryness of the living specimens.
3. Each dried organism has an optimal temperature and humidity that can be standardized within the hall to preserve these specimens, especially live plants and animals.
4. Many living scientific specimens, whether preserved for display in the hall or stored as study specimens, are susceptible to damage and excessive drying due to high or low temperatures, accompanied by changes in humidity during the seasons.
5. Ventilation is an important factor in controlling temperatures within the exhibit hall, as well as the building's aspects that are directly and strongly exposed to the sun during the summer.
6. Drying preserves the bodies of various living organisms when proper preservation conditions are adhered to within the exhibit hall. It also allows for the possibility of restoring, coloring, and re-creating the model from time to time.
7. Increased dryness due to high temperatures causes significant problems and damage to the skins of stuffed animals and the feathers of birds, blurring the features of the preserved animal and altering its appearance when first preserved. This is directly related to the high temperatures. Indirectly, high temperatures may contribute to the activity of many insect pests, such as mites, as well as the activity of rodents, which cause losses and damage to models and specimens.

Recommendations and Suggestions:

The researcher recommends the following:

1. Regulate ventilation in the exhibit hall, especially during the summer, to eliminate hot convection currents.
2. Develop dry air-cooling systems that are appropriate for the size of the hall, the number of preserved specimens, and the type of specimens.
3. Reduce the use of heat-absorbing materials, such as wood and cellulose, and replace them with heat-insulating materials, such as foam and cork.
4. Connecting cooling, air conditioning, and ventilation systems to an electronic system equipped with automatic sensors to ensure temperature and humidity control in the exhibition hall.
5. Replacing traditional stereo lighting, which generates temperatures inside display cases, with economical, dynamic lighting with an acceptable beam and intensity for the eye and viewer, while ensuring that live

specimens are not overly dried when this lighting is applied, mimicking the nature of the organism on display in the exhibition hall.

6. Proper drying procedures are in place from the first step of preserving specimens, whether plant or animal, according to the skills and experience of those responsible for this work, each according to their specialization.

REFERENCES

- Ahmed Mukhtar Omar (2020). The official website of the Comprehensive Library. <https://ontology.birzeit.edu/lexicalconcept/303011560>
- Ahmed, S., Noor, R., & Malik, K. (2021). Methods of biological specimen preservation in natural history museums: A comparative analysis. *Journal of Museum Studies*, 15(2), 44-58.
- Brown, T., & Carter, H. (2018). Climate control in museums: A study of environmental parameters and preservation outcomes. *Conservation Science Quarterly*, 7(3), 201-215.
- Castelain, L. (2024). Conservation of extensively falling out hairs and feathers in a Rowland Ward's 19th century diorama. *Journal of Natural Science Collections*. 12. pp. 126-135.
- De, L., & Senjam, B. (2025). Flower Drying Techniques for Orchids. *Geography, Earth Science and Environment: Research Highlights Vol. 6*, 177-199. <https://doi.org/10.9734/bpi/geserh/v6/4548>
- Deegan, M. (2006). *Digital Preservation*, Facet Publishing, 7 Ridgmount street, London, WC1E 7AE.
- Díaz-Montes, E. (2025). Advances in the Preservation of Plant-Based Pigments via Spray Drying—A Systematic Review. *Processes*, 13(3), 663. <https://doi.org/10.3390/pr13030663>
- Dictionary of Tourism Terms (in Arabic and English). Reviewed by: Ruhi Al-Baalbaki (2nd ed.). Riyadh: Saudi Ministry of Tourism. 2013. p. 151.
- Edward Ghaleb (1988). *The Encyclopedia of Natural Sciences: Researching Agriculture, Botany, Animals, and Geology* (in Arabic, Latin, German, French, and English) (2nd ed.). Beirut: Dar Al-Mashreq. Vol. 1, p. 282.
- Fox Michael Allen (1986). *The Case for Animal Experimentation: An Evolutionary and Ethical Perspective*. Berkeley and Los Angeles, California: University of California Press. ISBN:0-520-05501-2.
- Frasca F., Siani A. M., Bertolin C.(2024). Energy demand for indoor climate control in museums: challenges and perspectives in time of a changing climate, *Procedia Structural Integrity*,55:32-38 <https://doi.org/10.1016/j.prostr.2024.02.005>.
- Grifoni L., Winkler A., Marcos A.E., Antonello C.L., Lella Di, Marte F., Sgamellotti A., Spagnuolo L., Tascon M. , Posada D.B., Marié D.C., Scoccimarro M. , Loppi S. (2025). Magnetic and chemical biomonitoring with lichens and vascular plants for the preservation of cultural heritage: A case study at two museums in a megacity (Buenos Aires, Argentina), *Science of The Total Environment*,988: 179836 <https://doi.org/10.1016/j.scitotenv.2025.179836>.
- Hengko (2022). What Is Museum Temperature And Humidity Standards ?, Hengko Technology Co., Ltd, <https://www.hengko.com/news/what-is-museum-temperature-and-humidity-standards/>
- International Council of Museums (ICOM). (2020). *Guidelines for museum climate management*. ICOM Publications.
- Johnson, M., & Clark, D. (2019). Preserving life: Techniques and ethics in biological specimen conservation. *Natural History Conservation Review*, 12(1), 33-49.
- Jovanovic, D., Koturevic, B., Ljustina, A. et al. How familiar is the population of Southeast Serbia with the biosafety procedures for collecting, preparing and preserving wild plants from their surroundings. *Eur. Phys. J. Plus* 139, 699 (2024). <https://doi.org/10.1140/epjp/s13360-024-05500-9>
- Keller, L., Schmidt, A., & Torres, P. (2022). Advances in drying and preservation technologies for museum specimens. *Journal of Applied Conservation*, 28(1), 55-72.
- Lee, H., & Park, J. (2021). Freeze-drying applications in biological specimen preservation. *Museum Technology and Conservation*, 19(2), 88-102.
- Lupo C., Oliveira M.J. A, Araujo M.S., Otubo L., Mello-Castanho S.R., Vasques, A.S.P.(2025) Application of ionizing radiation in the preservation and conservation of taxidermied animal skins in natural history museums. *Brazilian Journal of Radiation Sciences*, 12(4A (Suppl.)), e2666. <https://doi.org/10.15392/2319-0612.2024.2666>
- Munir AL-Baalbaki; Ramzi AL-Baalbaki (2008). *Al-Mawrid AL-Hadith: An English-Arabic Dictionary* (in Arabic and English) (1st ed.). Beirut: Dar Al-Ilm Lil-Malayin. p. 1208.
- Museums Association. (2019). *Environmental standards for museum collections*. Museums Association Press.
- Mustafa AL-Shihabi (2003). Ahmad Shafiq AL-Khatib (editor). *AL-Shihabi Dictionary of Agricultural Sciences Terms* (in Arabic and English). and Latin) (5th ed.). Beirut: Maktabat Lubnan Publishers. p. 647.
- Nasution N.H. & Nasution I.W. (2024). Making Dry Herbarium Preservation To Support Biodiversity Lessons In Schools. *International Journal of Community Service Implementation*, 2(1). <https://doi.org/10.55227/ijcsi.v1i5.214>
- Omar Shabsigh; Omaira Al-Dakak; Nawar Al-Awa; Hashem Warquzq (2016). *Dictionary of Electrical, Electronic, and Communications Engineering Terms* (in Arabic and English). Damascus: Academy of the Arabic Language in Damascus, p. 197.
- Personality Psychology... Dr. Asaad Al-Amara (Arab Academy in Denmark). Archived copy dated August 19, 2016, on the Wayback Machine.
- Pinniger, D. B. (2001). *Pest management in museums, archives and historic houses*. Archetype Publications.
- Raza M.T. & Jahangeer (2023). Dry Preservation Technique of Natural History Specimens (With Special reference of Insects), *Thoughts of Scientific Research: International Book of Multidisciplinary Studies* (2): 3-13.
- Rosta ́nski, A.; GeroldSmieta ́nska, I.; Tokarska-Guzik, B. ́ Historical and Contemporary Herbaria as a Source of Data in Plant Taxonomy and Phytogeography Research: An Example from Poland. *Diversity* 2024, 16, 434. <https://doi.org/10.3390/d16080434>

29. Stanley Fields, Mark Johnston, Whither Model Organism Research? *Science* 307,1885-1886(2005). DOI: 10.1126/science.1108872.
30. The Comprehensive Dictionary of Meanings (2025). <https://www.almaany.com>
31. The Meaning of "Animal" in "Al-Jami'" (The Mosque), "Al-Mughni" (The Singer), and "Al-Wasit" (The Mediator). Archived 2 October 2017 on the Wayback Machine.
32. The Meaning of the Proverb: "Man is naturally civilized." (Center for Studies, Research, and Heritage Revival). Archived 19 September 2017 on the Wayback Machine.
33. The Meaning of the Proverb: "Man is naturally civilized." (Center for Studies, Research, and Heritage Revival). Archived 19 September 2017 on the Wayback Machine.
34. Thompson, J.M. A (1992). *Manual of Curatorship*. 2nd Edition. Oxford: Butterworth
35. Thomson, G. (2017). *The museum environment* (3rd ed.). Routledge.