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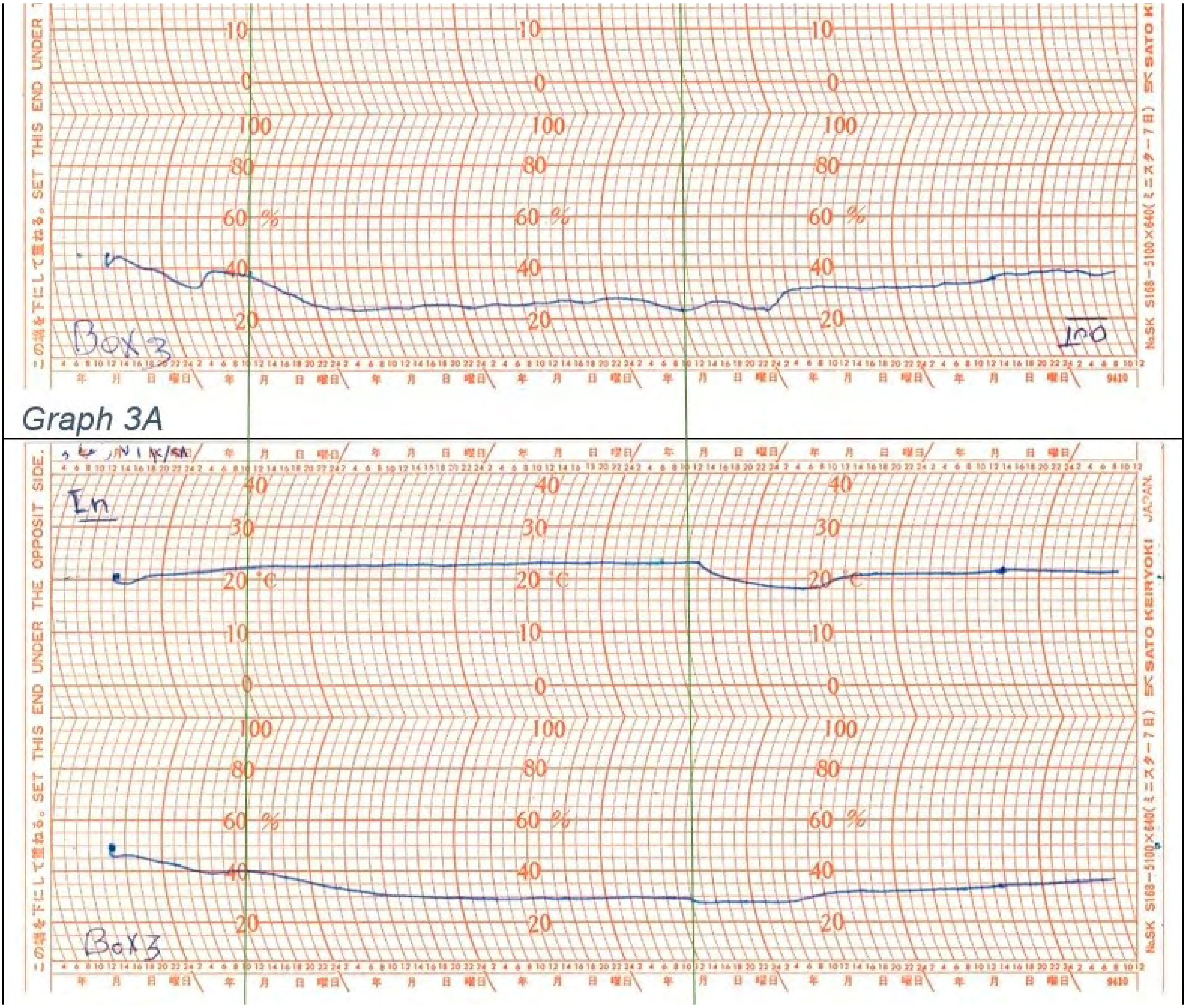

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Content

Foreword

Dear reader,

We have the great pleasure of introducing you to the first issue of 2024, dedicated to **"Collection storage-issues on environmental parameters"**. The scope of the issue is to address storage solutions, housing methodologies, and current practices for books and paper-related materials, which ensure the objective of environmental parameters in a sustainable manner.

Both articles that we received are from conservation practice for collection storage. The first article, by *Sherif Afifi* is entitled **"Evaluating the impacts of environmental fluctuation inside conservation boxes"** and provides a research methodology for the evaluation of commonly used box enclosures, regarding temperature and RH fluctuation as well as sulphur dioxide gas emissions. The second article, by *Manto Sotiropoulou* and *Eleftheria Eleftheraki*, entitled **"Preservation and storage methodology for the "Ergoliptiki" archival collection of architectural and technical documents, drawings and photoreproductions"** discusses a case study of an archival collection with varied materials and the methodology used for the selection and final execution of their storage solutions.

We would like to give special credits to our peer-reviewers who offered their specialized knowledge to maintain the high-quality standards of our publication. Also, to the ERC board and national representatives, along with webmaster Emanuel Wenger and social media administrator Penny Banou for their help in the dissemination of our periodical. As always, many thanks to our wonderful proofreaders Katarina Kelsey, Mathilde Renauld, and Charlotte Wilkinson and for the final layout Anja Props. Finally, to Patricia Engel, for her devotion and guidance to the process of each publication. Our final acknowledgement goes to the readers, as well as all the people who offer their services voluntarily, which form the periodical Conservation Update.

Our next issue will correspond to 2/2024, and will be dedicated to **"Endbands: Structure, decoration, historical aspects, and conservation issues"**. We welcome papers that provide conservation, history, technical issues, and other aspects related to the endbands that are an integral part of the book´s structure.

Submissions must be sent by the deadline of June 20, 2023.

We wish our readers all the best
Marta **Soliva-Sanchez** and Manto **Sotiropoulou**

We would like to share with you some words about how we chose this topic, **"Collection storage-issues on environmental parameters"**:

Collection storage in archival collections and libraries requires a multidisciplinary approach, to balance the objective needs for the permanence of the materials with current sustainability factors. Traditional views and accepted practices may be challenged, which can be addressed with new research for storage materials and monitoring processes.

Manto **Sotiropoulou**

I always find it fascinating how big the storage process can be and how much you can do depending on the collection, material, space, time, and resources available. It is interesting to get to know other ways of looking at this, and to get to know the issues of storing collections.

Marta **Soliva-Sanchez**

Evaluating the environmental fluctuation impacts inside conservation boxes

Sherif Afifi[a]

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DOI: 10.48341/sb35-c772

Keywords:
Preventive conservation
Storage boxes
Archival materials preservation
Storage
Microenvironments

ABSTRACT

Archival materials are often composite objects with intricate chemical and physical structures and present a preservation challenge. Their diverse components react differently to external and internal influences, creating a complex system.

This study investigated the effectiveness of various conservation boxes (Archival Storage Boxes) in mitigating the impact of external environmental changes (temperature and relative humidity) on sensitive materials. Three types of boxes were tested to determine their ability to maintain a stable internal environment when surrounding conditions fluctuated. A hygrothermograph was used to monitor and record these changes. Additionally, the air quality inside the boxes, specifically gas emissions, were measured.

The results confirmed that storing susceptible materials, like photographic materials, inside a sturdy buckram-cloth box significantly delayed the effects of fluctuating relative humidity. The interior environment within the box reached a stable level, largely unaffected by external conditions. Furthermore, the study found that using polyvinyl acetate (PVA) as a box adhesive is detrimental and should be avoided. This finding underscores the importance of selecting appropriate archival-quality adhesives.

1. Introduction

Humidity, temperature, light, and air pollutants all contribute significantly to the deterioration of archival materials. Inappropriate storage environments are a major cause of damage to archives (British Standards, 2012). Fluctuations in relative humidity (RH) can weaken paper-based archival materials, making them more vulnerable to tears, creases, and other forms of mechanical damage (Brimblecombe, 2013). RH fluctuations harm both paper and writing inks, posing a dual threat to the preservation of archival documents (Liu, Fearn, & Strlič, 2022)

While the importance of proper storage for archival materials has long been recognized, recent research has placed greater emphasis on the specific role of storage box materials and construction methods in successful preventative conservation strategies. Several conservators have extensively studied the influence of environmental conditions on manuscripts and rare books, highlighting the critical impact of fluctuating temperature and relative humidity (Feather, 2018).

This study aimed to evaluate the impact of temperature and relative humidity changes on the internal environment of storage boxes. We investigated whether placing a collection item within a box during transport between areas with different environmental conditions offers protection. We also assessed the stability of the internal environment within these boxes when subjected to fluctuating external temperature and RH.

The experiment compared several storage boxes with varying cover materials and adhesives. We sought to demonstrate the differences in temperature and RH fluctuations outside the closed boxes compared to the internal environment, which would ultimately impact the stored objects.

2. Materials and methods

This study used three custom-designed conservation boxes constructed to the following specifications: cubic shape with base dimensions of 15 cm x 15 cm and a height of 20 cm (Figure 1). The boxes were large enough to fully accommodate the hygrometer used for monitoring temperature and relative humidity (RH).

Fig. 1: *Boxes design*

Three preservation boxes were constructed for this study. Box B1 consisted solely of acid-free card. This card was a Rising buffered conservation matting and mounting board, supplied by Gaylord, that is acid-free, lignin-free, and has a pH range of 8.0 to 9.0 with a 3% calcium carbonate buffer. Boxes B2 and B3 utilized the same acid-free carton as B1, but were further covered with buckram cloth. This buckram cloth, a 100% cotton heavyweight starch-filled fabric supplied by Talas, was adhered using different adhesives: PVA (Siag Chemicals) for Box B2 and CMC (Sodium Carboxymethyl Cellulose from Chemajet) for Box B3. A table summarizing the details of the box materials, adhesives and suppliers is presented in Table 1.

Table 1
Boxes materials and adhesives

Box	Adhesive / Supplier	Material / Supplier	Covering Material / Supplier
B1	None	Acid-free carton (1.5 mm) / Gaylord	None
B2	PVA / Siag	Acid-free carton (1.5 mm) / Gaylord	Buckram cloth / Talas
B3	CMC / Chemajet	Acid-free carton (1.5 mm) / Gaylord	Buckram cloth / Talas

Temperature and RH were monitored and measured inside and outside the boxes using two Quartz Oakton Domed Minidrum Hygrothermograph (Model number: 08369-50) with 7-day rotating charts, Temperature Accuracy±3.6°F (±2.0°C) and Humidity Accuracy±5% from 10 to 90%; ±7% from 5 to 9%. Each chart recorded a one-week cycle of temperature and RH data. The hygrothermographs were placed inside and outside the boxes for a period of one week (figure 2).

Fig. 2: *Tow Quartz Domed mini drum hygrothermographs, one inside a Buckram-cloth covered box and another outside.*

The experiment involved moving the boxes between the conservation laboratory and a manuscript reading area. This allowed us to assess the impact of a potentially different environment with varying visitor traffic on the internal conditions of the boxes.

Limitations: Due to the one-week recording capacity of the hygrothermograph charts, each box experiment was conducted for a single week.

Hygrothermograph Calibration: To ensure measurement accuracy, both hygrothermographs were placed together in the conservation laboratory for one day before the experiment began.

Data Collection Procedure:

1. **Day 1:** The hygrothermographs were labeled to identify their positions (inside or outside the box). Due to limitations of having only two devices, each box experiment was conducted separately.
2. **Day 1-2:** One hygrothermograph was placed inside Box B1, and the box was sealed tightly. The box and hygrothermograph remained in the conservation laboratory for one day before being transferred to the manuscript reading area.
3. **Day 2-7:** The box and hygrothermograph remained in the reading area for four days, including a weekend (Friday

and Saturday). This allowed us to observe changes in temperature and RH with varying visitor traffic.

4. **Day 7-8:** The box and hygrothermograph were transferred back to the conservation laboratory and remained there for one additional day.

5. **Steps 1-4** were repeated for Boxes B2 and B3 on separate days (* fig. 4). We aimed to conduct the experiments within a short timeframe and under similar environmental conditions. However, the number of visitors in the reading area could not be controlled and may have varied slightly between experiments.

Air Quality Measurement: Gas emissions (sulfur dioxide (SO_2), carbon monoxide (CO), and ozone (O_3)) inside the boxes were measured using an Aeroqual Series 200 gas sensor (fig. 3). Measurements were taken outside the box first, followed by placing the sensor inside the closed box for 15 minutes.

Fig. 3: Measuring air quality (gas emission) inside a Buckram-cloth covered box.

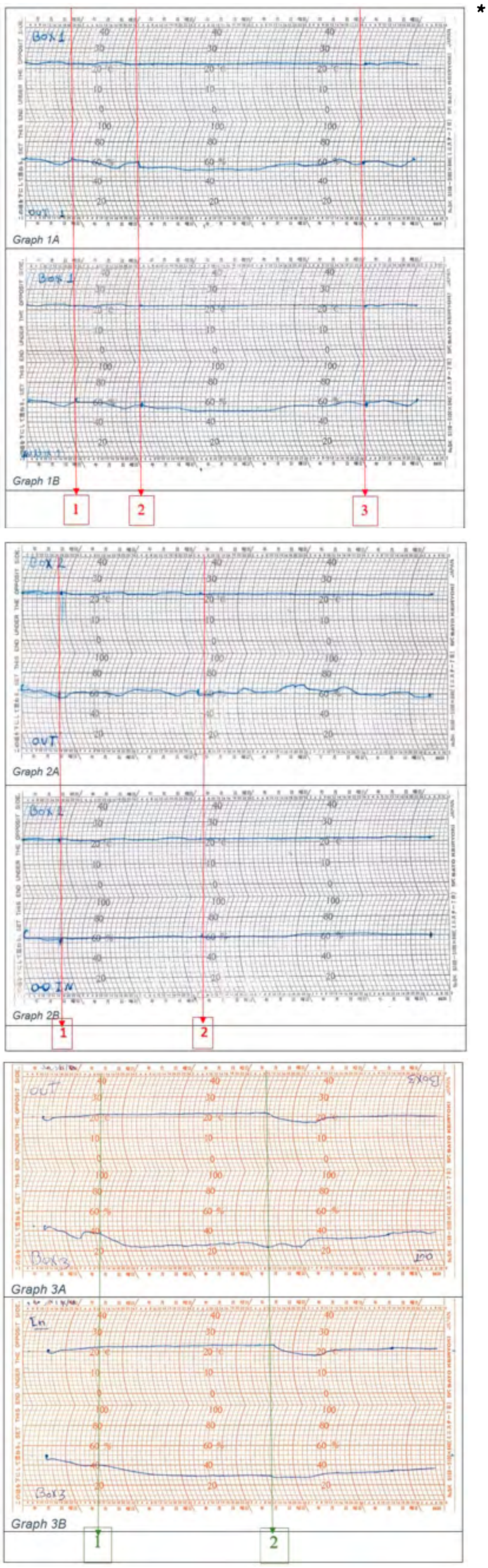

Fig. 4:** Hygrothermograph readings of temperature (T) and relative humidity (RH) inside (Graphs B1, B2, B3) and outside (Graphs A1, A2, A3) of boxes B1, B2, and B3 monitored over a week-long period. Numbers (1, 2, 3) indicate the movement of the boxes between the conservation lab and the reading area.* ****Graphs in full page size are presented on pages 10, 11 and 12.

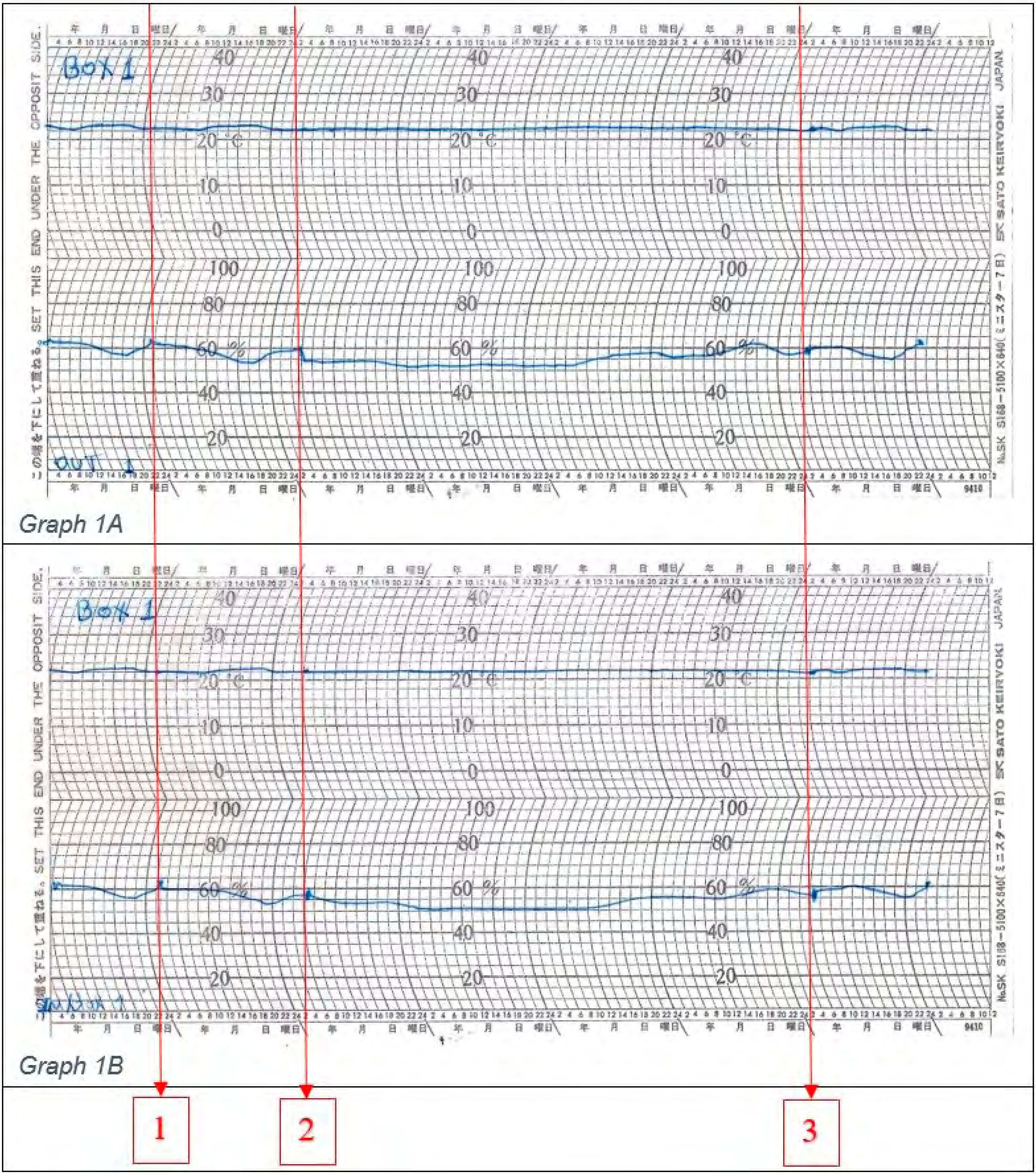

***Fig. 4:** Hygrothermograph readings of temperature (T) and relative humidity (RH) inside (Graphs B1, B2, B3) and outside (Graphs A1, A2, A3) of boxes B1, B2, and B3 monitored over a week-long period. Numbers (1, 2, 3) indicate the movement of the boxes between the conservation lab and the reading area.*

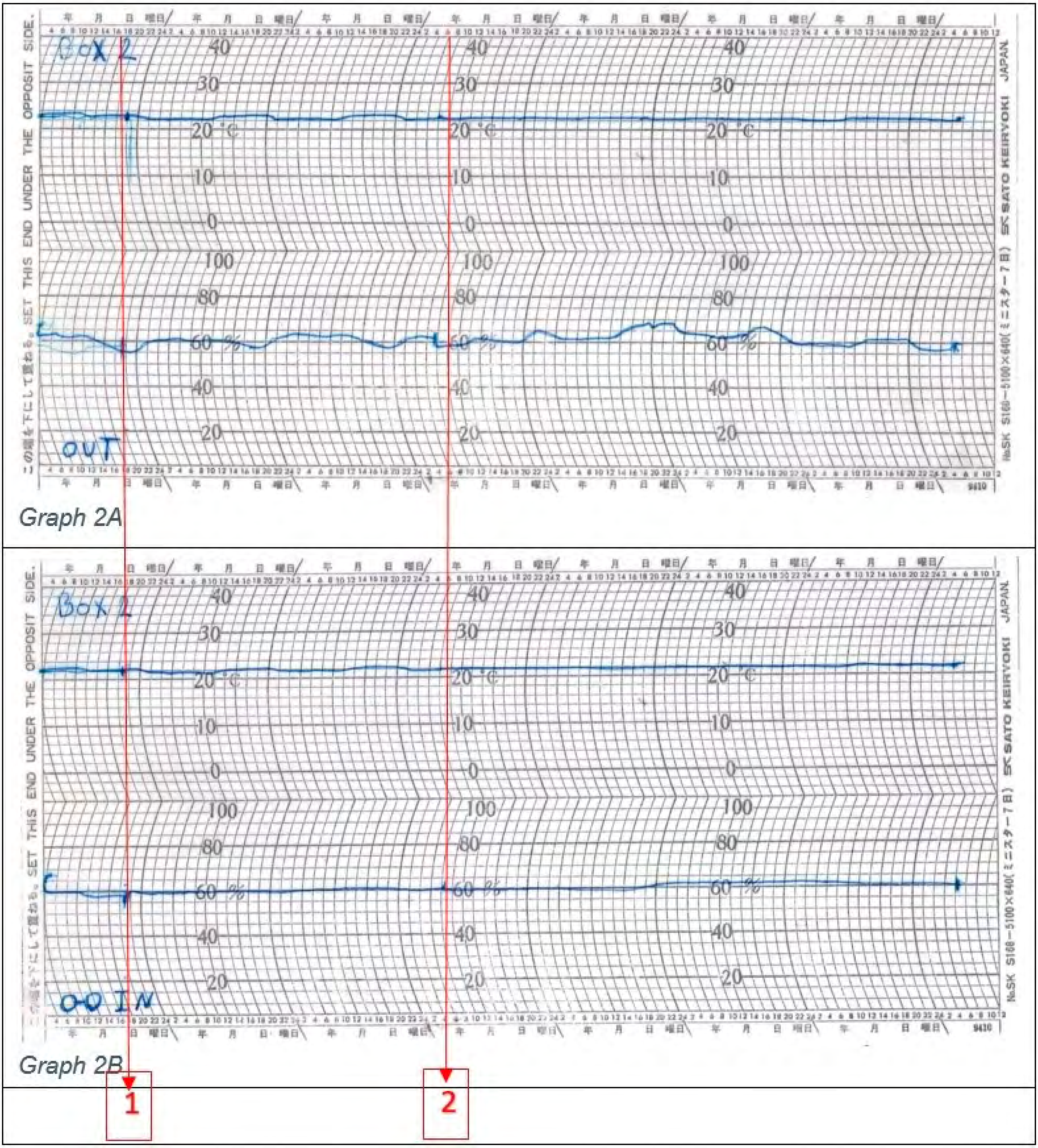

Fig. 4: *Hygrothermograph readings of temperature (T) and relative humidity (RH) inside (Graphs B1, B2, B3) and outside (Graphs A1, A2, A3) of boxes B1, B2, and B3 monitored over a week-long period. Numbers (1, 2, 3) indicate the movement of the boxes between the conservation lab and the reading area.*

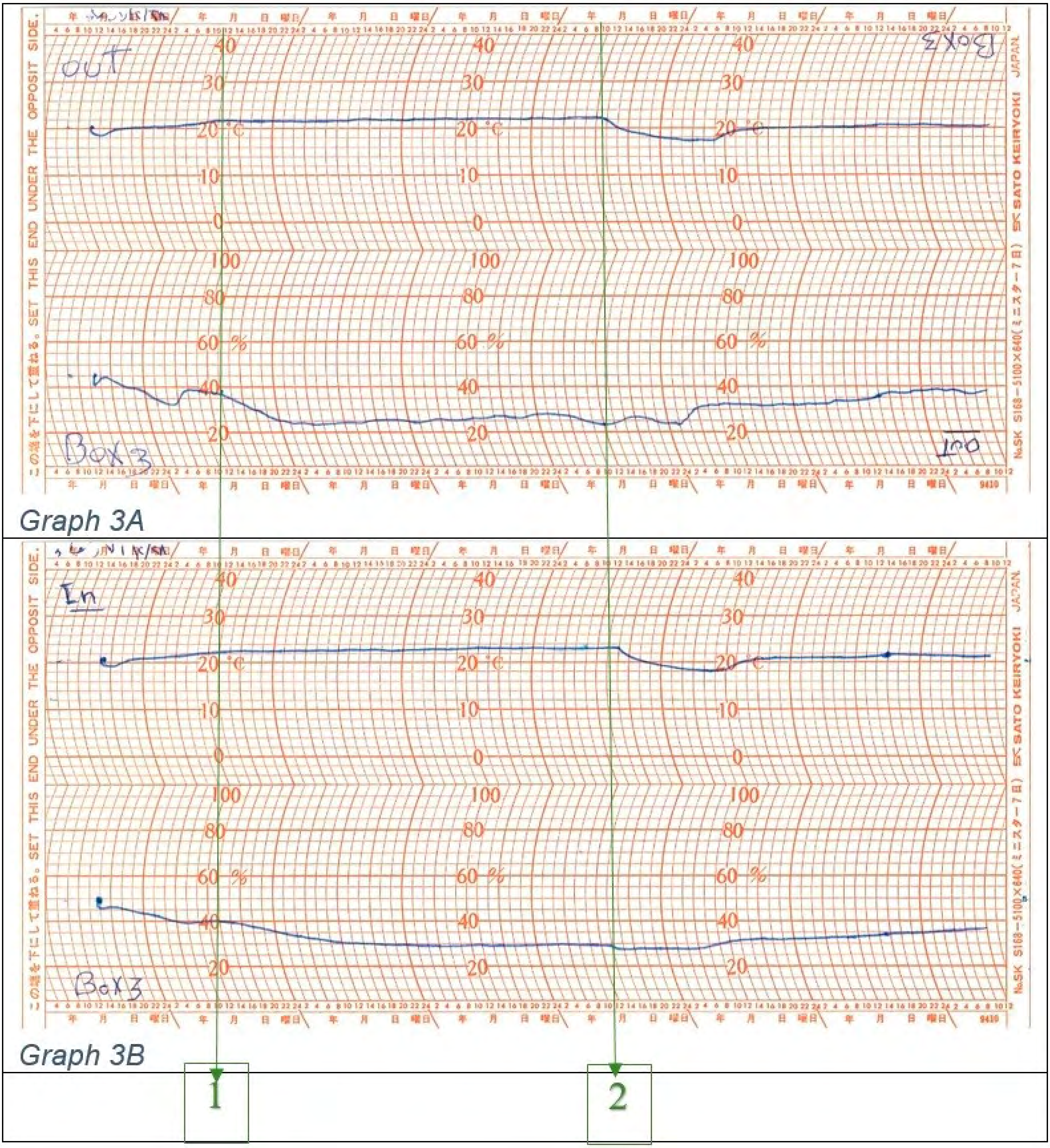

Fig. 4: *Hygrothermograph readings of temperature (T) and relative humidity (RH) inside (Graphs B1, B2, B3) and outside (Graphs A1, A2, A3) of boxes B1, B2, and B3 monitored over a week-long period. Numbers (1, 2, 3) indicate the movement of the boxes between the conservation lab and the reading area.*

3. Results

Temperature and RH were monitored using hygrothermographs placed inside and outside each box. Data was collected for a one-week period for each box. The raw data from the hygrothermographs was used to create line graphs visualizing the recorded temperature and RH values.

For a direct comparison of the temperature and relative humidity (RH) readings of the two hygrothermograph charts (inside and outside the box), the temperature and RH data from the outside readings were traced onto a transparent sheet of Melinex (Fig. 5). While these graphs provide detailed information, a summary table (Table 2) has been created to highlight the key observations for easier reference.

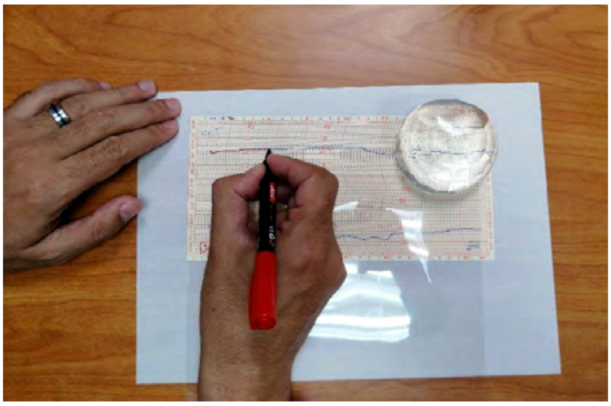

Fig. 5: Tracing of Temperature and Relative Humidity onto a transparent sheet.

3.1 Box B1 (No Adhesive, No Covering)

- Similar temperature ranges were observed inside and outside the box, with slight fluctuations occurring during transfers between the conservation lab and manuscript reading room (Fig. 6). The location changes are indicated on the graph.
- The internal hygrothermograph exhibited a two-hour delay in adjusting to changes in RH compared to the external environment (Fig. 7).

3.2 Box B2 (PVA Adhesive, Buckram-Cloth Cover)

- Temperature changes within the box mirrored those in the surrounding environment, with minimal variation (Fig. 8).
- The internal RH exhibited greater stability compared to the external environment, particularly in the manuscript reading area with higher visitor traffic (Fig. 9).
- Gas emission measurements inside Box B2 detected the presence of sulfur dioxide (SO_2) at a level of 0.16 ppm (Table 2).

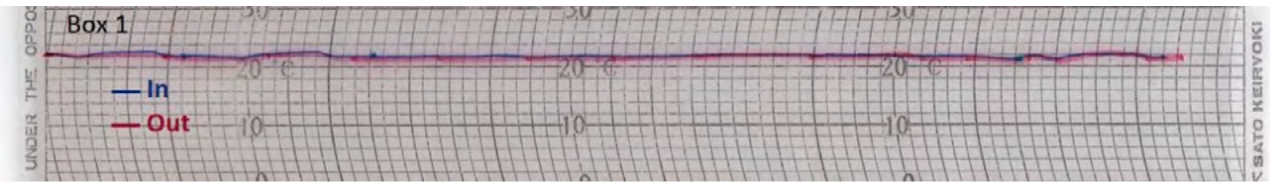

***Fig. 6:** Box (B1) Internal Temperature (Blue) Responds Quickly to External Temperature (Red).*

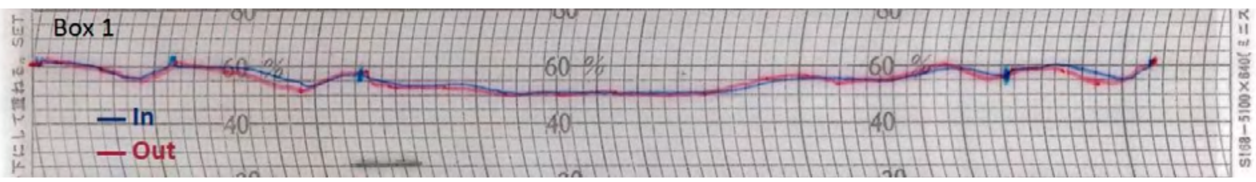

***Fig. 7:** Box B1 Internal RH (Blue) Exhibits a 2-Hour Delay in Response to External RH Changes (Red).*

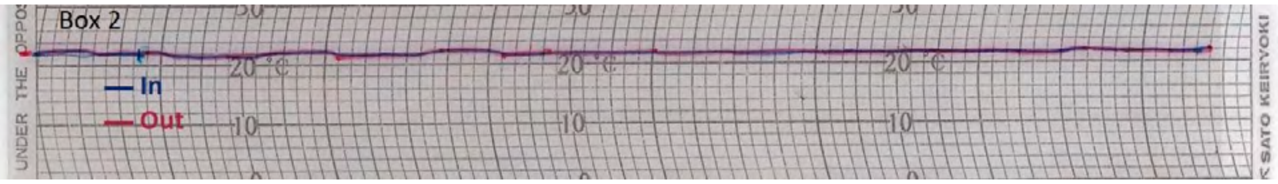

Fig. 8: *Box (B2) Internal Temperature (Blue) Responds Quickly to External Temperature (Red).*

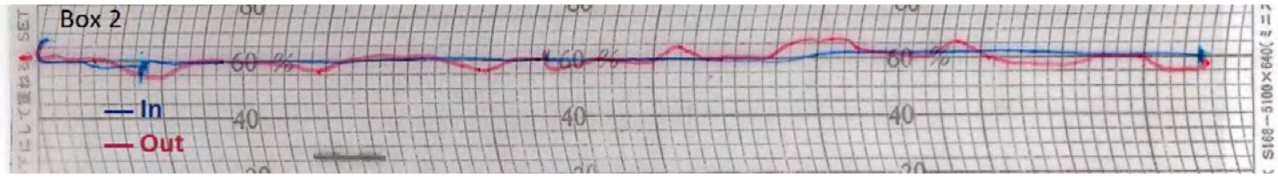

Fig. 9: *Relative humidity (RH) is more stable inside box B2 than outside it.*

3.3 Box B3 (CMC Adhesive, Buckram-Cloth Cover)

- Similar to Box B2, the internal temperature closely followed external changes (Fig. 10).
- The internal RH displayed a pattern of constant change without significant fluctuations, contrasting with the external environment (Fig. 11).
- No gas emissions were detected within Box B3 (Table 2).

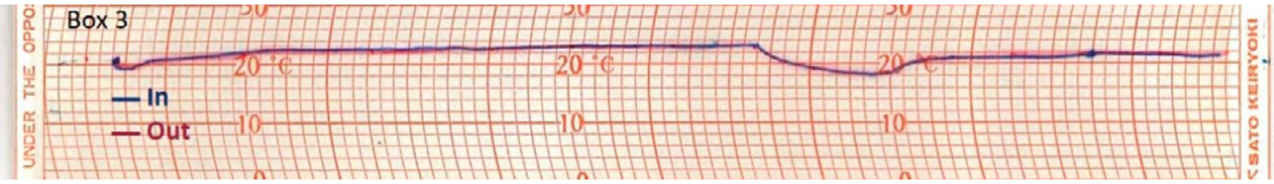

Fig. 10: *Box (B3) Internal Temperature (Blue) Responds Quickly to External Temperature (Red).*

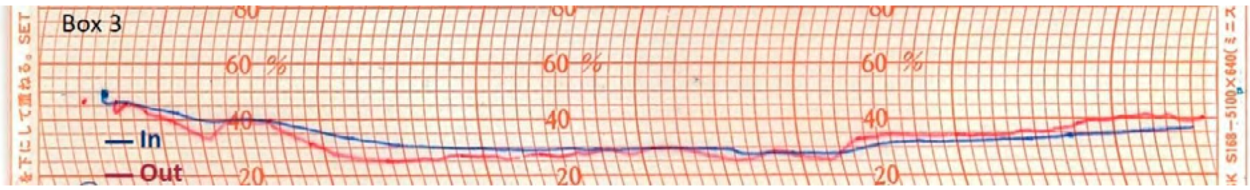

Fig. 11: *Relative humidity (RH) remains more constant inside box B3 compared to the external environment.*

Table 2
Summary of Key Observations from Temperature and RH Data

Box	Internal Temp. Stability	Internal RH Stability	Gas Emissions (SO_2)
B1	Similar to External	Similar to External with Delayed Response (2 hours)	Not Detected
B2	Similar to External	More Stable than External	Detected (0.16 ppm)
B3	Similar to External	Constant Change (no Fluctuations)	Not Detected

4 Discussion and Conclusion

4.1 Temperature:

The experiment demonstrated that the internal temperature of all three boxes adapted swiftly to the surrounding environment, regardless of their construction materials (buckram cloth with adhesive or no covering). In both the conservation lab and manuscript reading room, the temperature ranges inside the boxes were nearly identical to those measured outside the boxes (refer to Figs. 6, 8, and 10). This rapid adaptation to temperature changes suggests minimal influence of the boxes themselves on the internal temperature.

4.2 Relative Humidity:

The impact of the boxes on internal relative humidity (RH) varied depending on the construction materials. Buckram-cloth covered boxes (B2 and B3) exhibited a dampening effect on external RH fluctuations. The hygrothermographs inside these boxes displayed a slower response to RH changes compared to the unboxed environment (Fig. 7 vs. Fig. 9; Fig. 11 vs. external data). This suggests that the buckram cloth covering provided some buffering against rapid RH fluctuations.

In contrast, Box B1 resulted in the internal hygrothermograph mirroring the external RH with a two-hour delay (Fig. 7). This delay could potentially be attributed to the hygrothermograph itself requiring time to equilibrate with the surrounding environment.

4.3 Impact on Archival Materials

The minimal temperature variations observed within the boxes compared to the external environment suggest minimal risk of thermal stress on stored materials. However, the fluctuations in RH, particularly those observed in Box B1 (no adhesive or covering) and the reading room, could potentially impact sensitive archival materials. While the buckram-covered boxes (B2 and B3) offered some mitigation of these fluctuations, further investigation is needed to determine the long-term effects of such variations on different types of archival materials. It's important to consider whether these delayed but smaller fluctuations are preferable to the more immediate, larger fluctuations experienced without enclosures.

4.4 Box Selection and Gas Emissions

The presence of sulfur dioxide (SO_2) emissions detected within Box B2 (PVA adhesive) highlights a potential risk associated with certain adhesives, sulfur dioxide is the main compound responsible for acid deposition (Steemers, et al., 2006). The measured SO_2 level (0.16 ppm) significantly exceeds the recommended limits for archival storage (Canadian Council of Archives, 2003). This finding emphasizes the importance of selecting appropriate archival-quality adhesives for box construction to minimize the risk of off-gassing and potential damage to stored materials.

4.5 Discussion

The observed buffering capacity of buckram-cloth covered boxes aligns with previous research demonstrating the ability of enclosed environments to mitigate rapid external fluctuations (Daniel & Maekawa, 1993). While this buffering effect is beneficial, further investigation is needed to determine the potential risks posed by smaller, delayed fluctuations on various archival materials. Long-term studies examining the deterioration of specific materials (e.g., photographs, paper-based documents) within these buffered environments would provide valuable insight into the ultimate benefits of this storage method.

Research indicates that acid-free archival boxes positively influence the aging process of various paper types (Hanus, Komornikovä, & Minärikovä, 1995). Additionally, storage boxes significantly reduce the uptake of harmful air pollutants by documents stored inside, with the construction of the box often being more important than the specific cardboard material (Judith, Hofenk, Wilma, & Henk, 1996).

The detection of sulfur dioxide emissions from the PVA adhesive in this study raises significant concerns within archival storage. This finding reinforces the conclusions of previous studies highlighting the potential for adhesives to release harmful gasses, potentially damaging stored items (Charles, Guttman, Kenneth, & Jewett, 1993). The paper "Protection of archival materials from pollutants: diffusion of sulfur dioxide through boxboard" specifically examines the movement of sulfur dioxide through common archival storage boxboards, offering valuable insights for the preservation of archival materials.

4.6 Conclusion

This study underlines the potential benefits of using buckram-covered boxes for storing and transporting sensitive archival materials. These boxes offer some buffering capacity against rapid fluctuations in temperature and RH, potentially mitigating stress on stored items. However, the presence of SO_2 emissions from PVA adhesive emphasizes the crucial role of selecting archival-quality materials for box construction. Further research is warranted to determine the long-term effects of even moderately fluctuating RH within enclosures on various archival materials.

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About the author

Sherif Afifi holds the position of Head of Conservation and Restoration at the Library of Alexandria (Bibliotheca Alexandrina) in Egypt, where he has worked since 2006. In 2013, he was selected for voluntary work and training with the British Library Preventative Conservation Team. He has a Master's degree in Photographic and Paper Heritage Conservation from the Department of Chemical Science at the University of Catania, Italy and the Faculty of Applied Arts at Helwan University, Egypt. At present, a Ph.D. candidate. He has been involved in the planning and the application of a number of national and international conservation and restoration projects for the Library of Alexandria and other institutions. He was fundamental in the establishment of the Library of Alexandria's first specialist conservation training center in Egypt and in 2015 he was awarded the ICOM - Egypt certificate in recognition of his efforts in the field of heritage conservation.

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Preservation and storage methodology for the "Ergoliptiki" archival collection of architectural and technical documents, drawings and photoreproductions

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Keywords:
Storage, Archive
Architectural Drawing
Transparent Paper
Photoreproduction
Ledger Book
Loose Documents
20th Century Reprography

ABSTRACT

In 2020-2022, the non-profit organisation MONUMENTA undertook the project "Documentation, conservation and digitisation of Ergoliptiki archive" in collaboration with the National Library of Greece. The project was funded by the Stavros Niarchos Foundation. Ergoliptiki was a construction company that was active during 1915-1940 and was responsible for the construction of many important buildings and public works in Greece. Its archive consists of over 10000 documents, including ledger books, correspondence, photographs, architectural and technical drawings and photoreproductions, that are important documentation of Greece's architectural and technical history. Preventive conservation measures were applied in parallel to cataloguing and documentation processes, leading to a better understanding of the collection's characteristics. Decisions were made to provide effective storage solutions, while maintaining the collection's core values from the material to the digital archive.

1. Introduction

MONUMENTA is a non-profit organisation that undertakes many projects for the protection of the natural and architectural heritage of Greece and Cyprus. These include educational programs and actions to increase awareness for the protection of monuments, with an emphasis on 20th century architecture. They also produce relevant publications, including a book by collector Yannis Lambrou about civil engineer Andreas K. Drakopoulos, who was the technical director of Ergoliptiki company and contributed to the construction of many important buildings in Greece. The archive of Ergoliptiki company, that came to the possession of MONUMENTA by Lambrou, includes the records of the company which was active between 1910s-1940s, and which collaborated with prominent Greek architects and civil engineers and undertook the construction of several important buildings and public works of that era. The study of the archive is important as it includes surviving records of buildings that are now listed as monuments.

In 2020-2022 MONUMENTA received a grant from the Stavros Niarchos Foundation for the project "Documentation, conservation and digitisation of Ergoliptiki archive". Under mutual agreement, after completion of the works the archive would be transferred to the National Library of Greece, which also provided their guidance and expertise. MONUMENTA was able to employ a team of specialised personnel for the needs of the project, within the two years of the project.

The archive included more than 10000 documents in different forms and shapes. Bound volumes included ledger books, letterbooks and binders, while loose documents also include notes, receipts, correspondence, photographs, architectural and technical drawings and plans. Documentation and classification of the archive was executed as part of the project, so conservation works would need to be planned and executed at the same time, with an emphasis to the digitisation needs. There were three teams working in parallel with a central team coordinator: documentation/classification, conservation and digitisation. All people worked in the same space at MONUMENTA, which led to better communication between teams. Because of space limitations, conservation work should be flexible, with prioritisation given on preventive conservation of architectural drawings and plans.[1]

2. Identity of the archive - Classification process and major categories

The archive was received in plastic bags and its initial conservation status was poor (Fig 1, 2). As a result, there was a rough estimate of the archive's true size and contents. The identity of the archive became evident during documentation and classification procedures, executed by personnel with expert knowledge of technical construction procedures (architects, civil engineers and architecture historians), aided by the knowledge gathered about the works of Ergoliptiki company by the previous research of collector Yannis Lambrou. Indications of the company's original archival record keeping were identified inside the bound volumes, that included ledger books and office records. Also, a system of storage of the drawings and photoreproductions was evident by the standard size of the folded doc-

1 Laroque, C., 2003.

uments of approximately 30/21 cm, same as the corresponding written documents. It is not certain if this system of record keeping was applied originally, at a later stage of the company when it was merged with Ergoliptiki A.E. in 1925, or on a later classification when the records were moved to storage. However a list was found, which included the works undertaken by Ergoliptiki, where each work would be a building or individual construction.

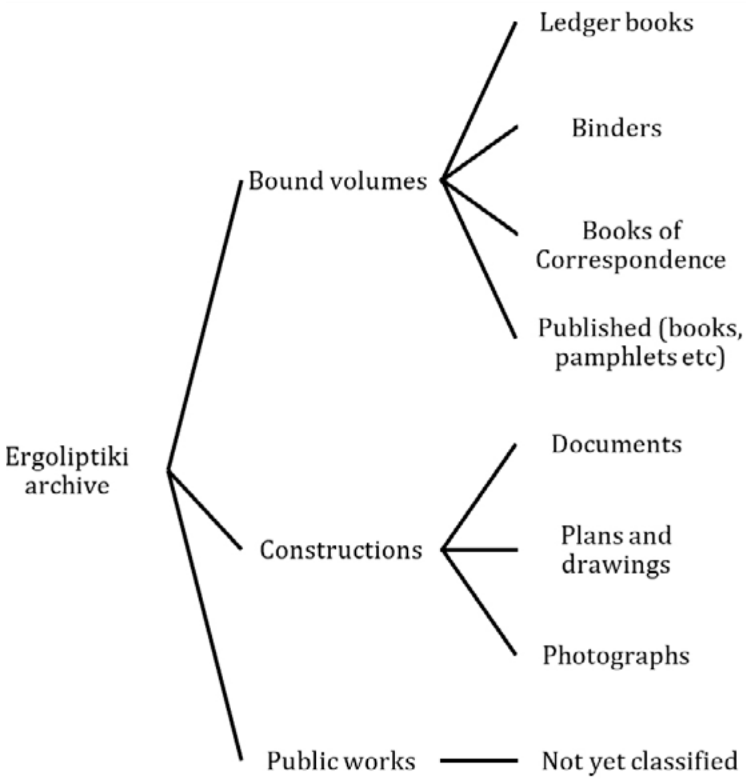
Fig. 1: *The archive was received in plastic bags*

Fig. 2: *Example of a folder containing folded architectural drawings on transparent paper, received in poor condition*

The original record-keeping methodology was applied to the archive's classification, with individual numbering on the documents according to their archival categories. Understanding the classification system was important so that it could also be applied to the storage planning as well as the digital archive. Limitations caused by different formats, sizes or materials were addressed in collaboration between working teams to ensure that the documents would be kept in relation to each other while providing effective storage solutions, according to the materials and their deterioration needs.

Table 1

Classification of the archive, according to general material type/structure



As it became evident during classification, documents relevant to a specific building or construction could also include plans or drawings. One such example is: Α.ΕΡΓ./ΟΙ./056/2/22, which refers to the category of the Ergoliptiki archive (Α.ΕΡΓ.), of the constructions built by Ergoliptiki (ΟΙ.), with individual number of construction 056 (Diamantopoulos building construction), of the second (2) subfolder (which is the subfolder that includes architectural drawings and plans), page 22 (22nd drawing). This type of classification applies to the digital archive as well as the physical archive, so that researchers that are looking for information for a particular building would have all relevant information in one place.

Table 2

Excerpt from conservation documentation file for documents inside construction of "Diamantopoulos" building (numbered as 056). At the classification stage, plans and drawings were numbered inside the subfolder according to their method of construction. This would facilitate conservation, digitisation and storage procedures.

1	Classification number	Conservation record	Title	Category	Material/ method	Media	Photo
1387	Α.ΕΡΓ.ΟΙ./056/2/14	Α/Σ1366	-	DRAWING/PRINT	transparent/impregnated	ink,red colour	
1388	Α.ΕΡΓ.ΟΙ./056/2/15	Α/Σ1367	"ΟΙΚΟΔΟΜΗ ΚΑΣ Β. ΔΙΑΜΑΝΤΟΠ	DRAWING/PRINT	transparent/impregnated	ink,red colour	
1389	Α.ΕΡΓ.ΟΙ./056/2/16	Α/Σ1368	"ΟΙΚΟΔΟΜΗ ΚΑΣ Β. ΔΙΑΜΑΝΤΟΠ	DRAWING/PRINT	transparent/impregnated	ink,red colour	
1390	Α.ΕΡΓ.ΟΙ./056/2/17	Α/Σ1369	"ΟΙΚΟΔΟΜΗ ΚΑΣ Β. ΔΙΑΜΑΝΤΟΠ	DRAWING/PRINT	transparent/impregnated	ink	
1391	Α.ΕΡΓ.ΟΙ./056/2/18	Α/Σ1370	"ΟΙΚΟΔΟΜΗ ΚΑΣ Β. ΔΙΑΜΑΝΤΟΠ	DRAWING/PRINT	transparent/impregnated	ink	
1392	Α.ΕΡΓ.ΟΙ./056/2/19	Α/Σ1371	"ΟΙΚΟΔΟΜΗ ΚΑΣ Β. ΔΙΑΜΑΝΤΟΠ	DRAWING/PRINT	transparent/impregnated	pencil	
1393	Α.ΕΡΓ.ΟΙ./056/2/20	Α/Σ1372	-	DRAWING/PRINT	transparent/impregnated	pencil	
1394	Α.ΕΡΓ.ΟΙ./056/2/21	Α/Σ1373	"ΚΑΤΟΨΙΣ ΥΠΟΓΕΙΟΥ"	DRAWING/PRINT	transparent/impregnated	pencil	
1395	Α.ΕΡΓ.ΟΙ./056/2/22	Α/Σ1374	-	DRAWING/PRINT	transparent/impregnated	pencil	
1396	Α.ΕΡΓ.ΟΙ./056/2/23	Α/Σ1375	"Διαμαντόπουλος"	DRAWING/PRINT	transparent/impregnated	pencil	
1397	Α.ΕΡΓ.ΟΙ./056/2/24	Α/Σ1376	"ΟΙΚΟΔΟΜΗ ΚΑΣ Β. ΔΙΑΜΑΝΤΟΠ	DRAWING/PRINT	blueprint/cyanotype	negative blue	
1398	Α.ΕΡΓ.ΟΙ./056/2/25	Α/Σ1377	"ΟΙΚΟΔΟΜΗ ΚΑΣ Β. ΔΙΑΜΑΝΤΟΠ	DRAWING/PRINT	blueprint/cyanotype	negative blue	
1399	Α.ΕΡΓ.ΟΙ./056/2/26	Α/Σ1378	"ΕΠΕΚΤΑΣΙΣ ΟΙΚΟΔΟΜΗΣ ΚΑΣ ΚΟ	DRAWING/PRINT	photoreproduction	positive brown	
1400	Α.ΕΡΓ.ΟΙ./056/2/27	Α/Σ1379	"ΕΠΕΚΤΑΣΙΣ ΟΙΚΟΔΟΜΗΣ ΚΑΣ ΚΟ	DRAWING/PRINT	photoreproduction	positive brown	
1401	Α.ΕΡΓ.ΟΙ./056/2/28	Α/Σ1380	"ΕΠΕΚΤΑΣΙΣ ΟΙΚΟΔΟΜΗΣ ΚΑΣ ΚΟ	DRAWING/PRINT	photoreproduction	positive brown	

Conservation needs were taken into consideration at the stage of classification, which is one of the main reasons that architectural drawings and plans were given a separate subfolder category. It was evident from the beginning that they have different conservation needs, due to the diversity of their materials. As individual documents inside the subfolder, they were numbered according to their material or construction. This was mainly for practical reasons, because it would later be easier to separate different materials with different conservation needs and avoid storage of highly oxidised transparent papers together with photoreproductions, without disturbing the archival classification system.

Table 3

Example of classification of the category: construction

Construction Category **Α.ΕΡΓ./ΟΙ./056**	**/01/1-145** (145 pages) *Subfolder containing loose pages*
	/02/1-36 (36 drawings/plans) *Subfolder containing plans and drawings* 1-23: drawings on transparent paper, 24-25:cyanotypes, 26-36 photoreproductions (positive)
	/03/1-3 (3 photographs) *Subfolder containing photographs*

3. Identification and conservation

3.1 Ledger books and bound volumes

Bound volumes were identified as consisting of three major categories: 'ledger books', 'letterbooks' (or 'correspondence books') and 'binders' (containing ledger notes). Other bound volumes are imprinted books, pamphlets etc, classified as general literature, (e.g. books that were used as reference by staff members of Ergoliptiki), as they are not part of the company's creative process.

Ledger books contain financial data, income and outgoings, categorised by year. The information is written on imprinted lists with the logo of the company Ergoliptiki. They may also include track data of buildings and constructions as well as lists of storages, vehicles etc. They are mostly hardbound volumes of significant size, with cloth coverings. Several of these volumes have evidence of being previously archived in folder binders, that were subsequently bound. Folder binders were also found, containing similar lists, both handwritten and copied by transfer copying techniques. The folders are of a standard size green coloured card paper with metal clasps.

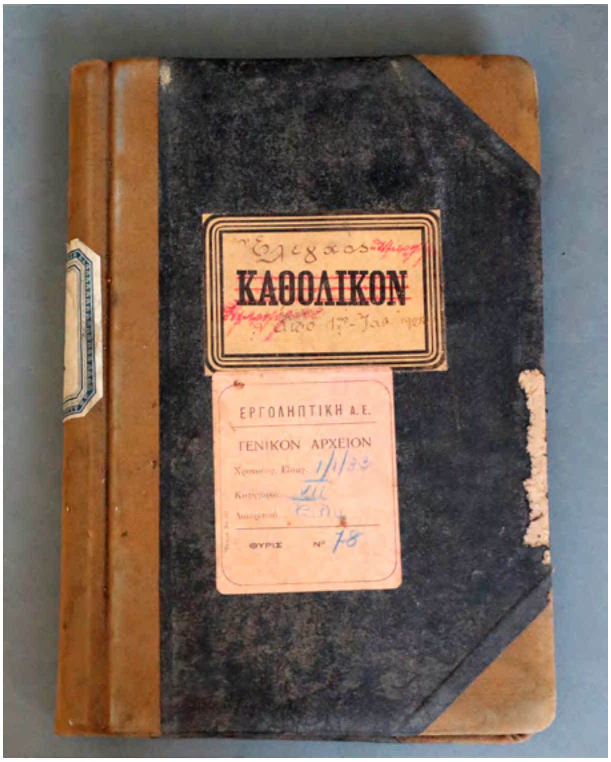


Fig. 3: *Ledger book of 1925, classified in 1933 by Ergoliptiki*

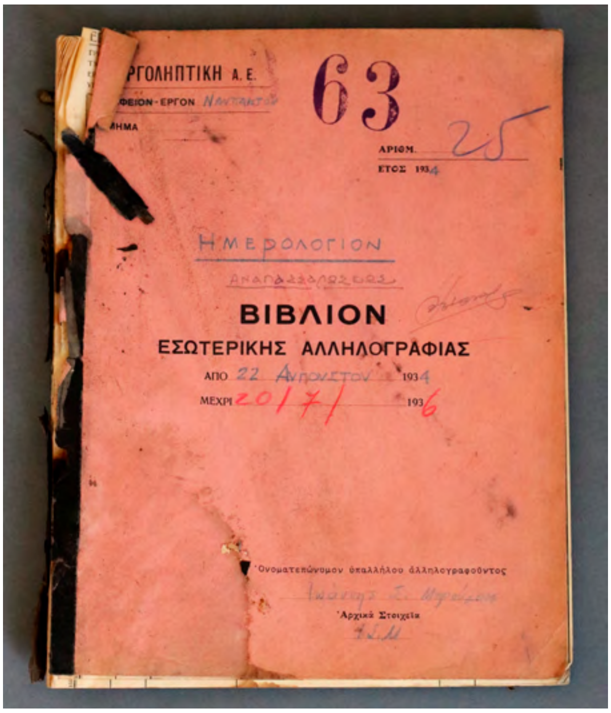


Fig. 4: *Letterbook used for correspondence inside Ergoliptiki company, 1935-1936. This type of volume included copies made with carbon paper.*

Letterbooks or correspondence books are volumes of a standard size with soft covers that contain carbon copies of the letters, so that one copy would remain inside the book, while the original would be sent to the receiver. Carbon copies were used, although there were few transfer copybooks as well - for outbound correspondence, such as offers to clients (fig.5).

Ledger books had major conservation issues, especially on their covers. Bookbinding of these volumes was performed at a later stage and with poor quality materials, susceptible to deterioration. It appears that several of the books contained pages previously archived in binders, that were stapled together before being bound. Overall, even in cases of severe damage to the covers, the written contents of the volumes were protected and kept in fair condition. Conservation treatment consisted of mechanical cleaning and strengthening of the covers, tear mending using suitable adhesives and Japanese tissue paper, removal of old hinges or tapes, spine reinforcement and stitch binding when necessary.

Folder binders were kept, whenever possible and their metal filing mechanism was replaced with similar archival PolyMide™ mechanism. In cases where the covers were missing or severely degraded, they were replaced with archival folders with the same PolyMide™ mechanism (KLUG 2024).

***Fig. 5:** Example of a copybook used for outbound correspondence of 1925.*

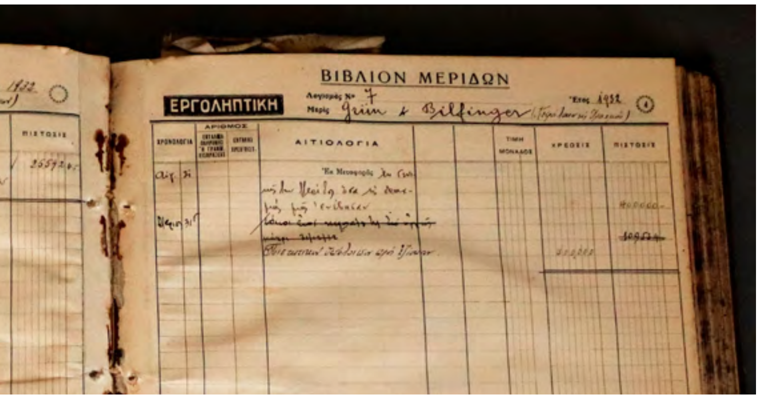


***Fig. 6:** Detail of a ledger book of 1932 containing pages previously stored on a binder.*

3.2 Loose documents and photographs

Loose documents that were classified in construction categories include contracts, invoices, payroll, estimate reports, assignment records, service offers, projects studies, structural static calculations, measurements, terms of reference regarding the construction sites, extrajudicial documents, drafts and sketches of the buildings. Correspondence letters and telegrams, and their copies on transparent paper are also included. The type of paper is varied, with inexpensive scraps of paper being used on several occasions, for taking notes. A paper envelope of different colour would be used as an enclosure to store certain buildings or public works, although most of such enclosures are missing.

Overall condition of the documents was varied, depending on their materials. Documents made of transparent paper were the most fragile, especially on the edges and the areas they were folded. Most of the documents had a metal pin on, to clasp together two or more referential documents. The metal

***Fig. 7:** Original enclosure containing loose documents.*

pins were oxidised and as a result, most of the documents had punctures on the upper left side of the paper, where the pin was usually put, and stains caused by the oxidised metal. The documents gradually became weaker and more friable, particularly on the areas where the metal pins were in direct contact with the paper.

During conservation treatment, metal pins were carefully removed and, where necessary, replaced by plastic, rustproof clips. Treatment included tear mending, lining and infilling necessary for structural reinforcement of the paper, for the next step of digitisation.

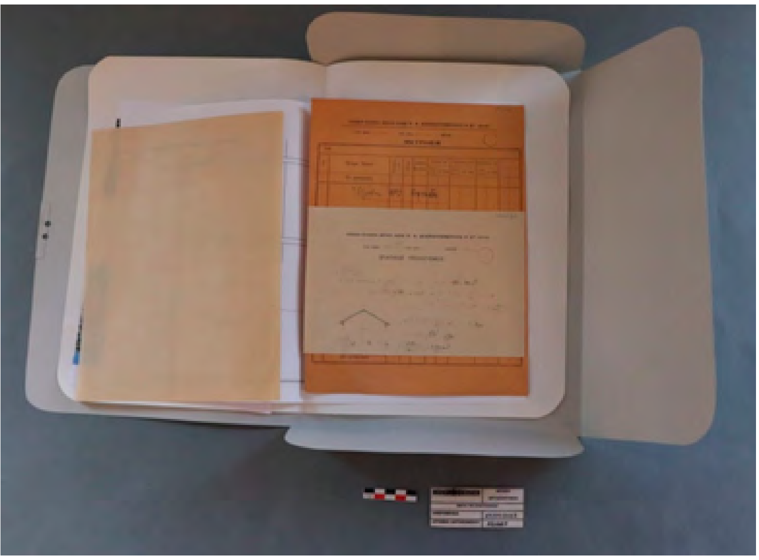


Fig. 8: *Documents made of transparent and coloured paper, after treatment.*

Photographs are also included in construction folders. They were taken by Ergoliptiki during the construction process as a form of documentation of the agreed terms of reference. Some photographs were later attached on a cardboard frame, labeled and classified. On occasion, a metal hinge was attached on the back of the cardboard frame for mounting purposes.

Overall, the photographs were in moderate conservation status, with silver mirroring being a common surface attrition. Poor quality cardboard frames contributed to degradation as well as the collection of dust, spots of unknown adhesive substance and tears around the edges of the cardboard. Conservation treatment to photographic material was limited to the necessary steps prior to digitisation and storage. Surface cleaning was necessary for all items, while flattening, tear mending or infilling were applied on occasion. A survey of the techniques used for photographic material was not possible at this stage.

3.3 Architectural and technical drawings and prints

Architectural and technical drawings and prints were all initially folded to the same size of corresponding loose documents. When received, they were not opening properly, as they deteriorated while in storage, especially drawings on transparent paper. Classification took place before opening, to three major categories, handwritten on paper, handwritten on transparent paper and photoreproductions. Photoreproductions would also be divided to blueprints (negative photoreproductions) and whiteprints (positive photoreproductions).

Fig. 9: *A typical example of the subfolder containing drawings and prints*

Humidification in a sympatex™-wet blotter sandwich was used, to avoid further damage while opening. It was important that the drawings would open and stay flat, so that they could later be digitised safely. Conservation of the drawings focused on reinforcement of the tears and creases, which was especially challenging for drawings on transparent paper. One additional difficulty was the variation in sizes, as approximately 10% of treated drawings would not fit to an A0 storage cabinet after opening.

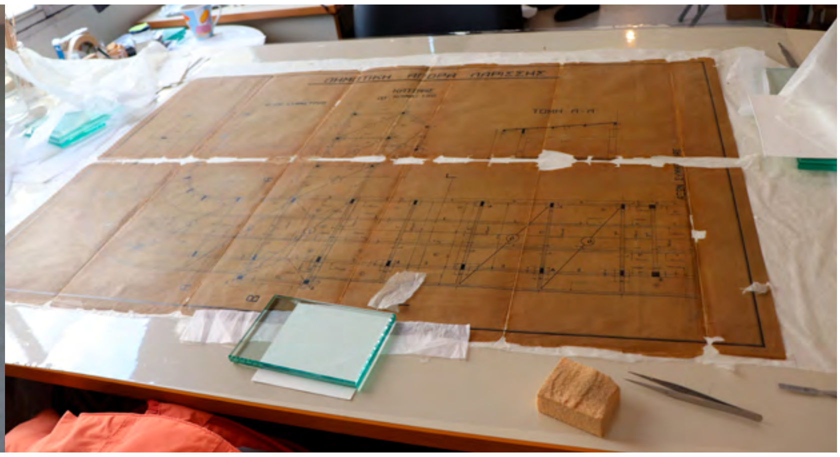


Fig. 10: *Drawings on transparent paper (a) before opening (b) during conservation treatment*

A survey of the collection was necessary to determine the necessary conservation procedures and final decision for their storage solutions. Although a first classification was made upon arrival, all drawings and plans were re-examined after their opening. The conservation team identified the substrate and media and documented their finds, according to their visual and deterioration characteristics, using literature guidelines (Kissel and Vigneau 1999, Glück et al. 2012, Price 2010) and specialised training[1]. Simple and inexpensive techniques were used, such as magnification tools, the use of a digital microscope and the use of raking and transmitted light. Special markings such as stamps and watermarks were also examined.

Macroscopic examination showed that drawings on transparent paper were mostly executed with black ink, on scale, while some of them also had red colour on the verso. Some had corrections or additions with pencil and coloured pencils, and they also had the stamp of Ergoliptiki company, signed with the number and date of the drawing. On several occasions, translucent paper was also used for drawing technical charts of measurements, by civil engineers. A very dark, rigid and fragile paper was used as substrate for most of these drawings. This type of damage is typical of an impregnated paper that was used as a prototype to produce copies with photoreproductive processes.

Photoreproductions of this era could be made with a variety of photochemical or photomechanical techniques, as shown at the table 4.

For identification purposes, watermarks were considered a clear indication of the used printing technique. The distinctive "Ozalid" and round watermarks were found on several whiteprints, identified as diazotypes (Kissel and Vigneau 2009:pp37.43). The 'Dorel' process was also identified through character-

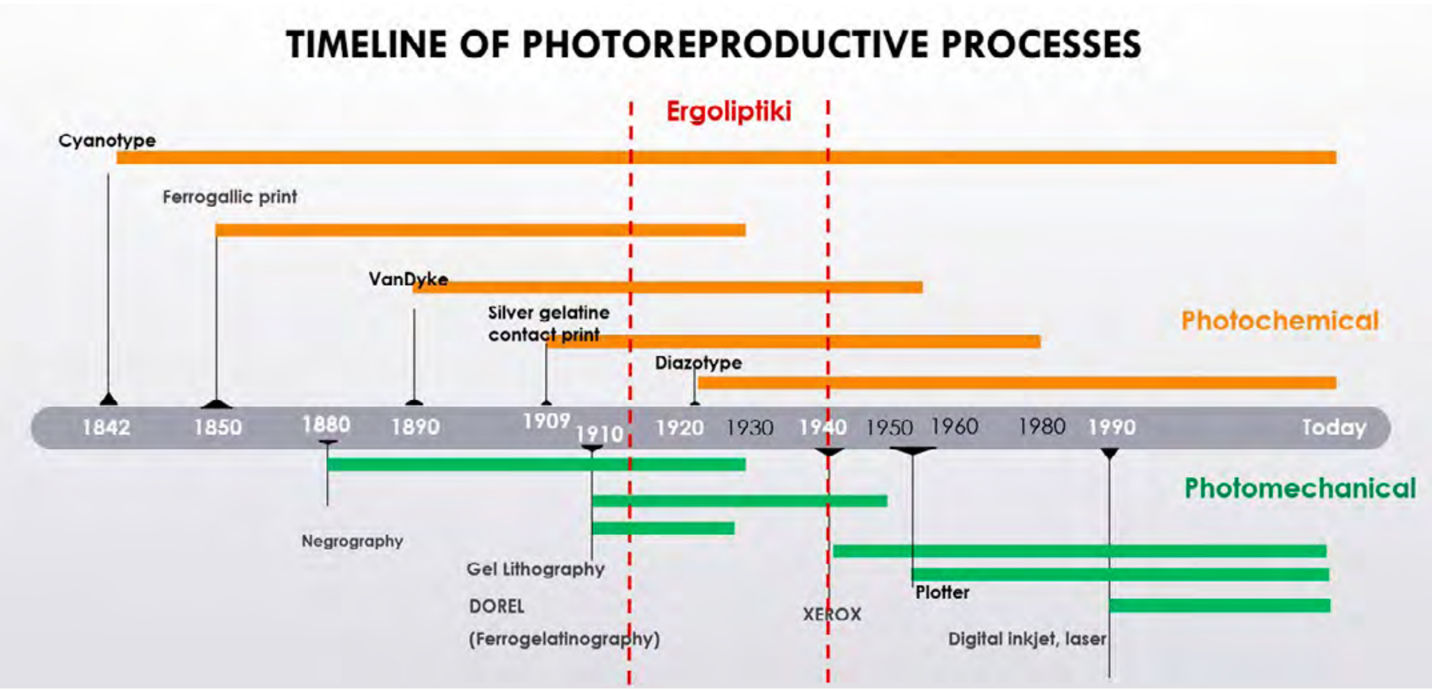
1 The author attended IADA (2020) seminar

istic watermarks on paper with the inscription 'PROCEDES DOREL PARIS'. Three more identification marks on 'Dorel' were found, made by a Greek printing company, that seems to have been active at that time. It was imprinted as 'N.K. ΛΕΒΙΔΗΣ κ ΣΙΑ ΖΕΛΑΤΙΝΟΤΥΠΙΑ "ΝΤΟΡΕΛ" ΑΘΗΝΑΙ ΡΟΜΒΗΣ 20', translated as 'N.K. Levidis & Co [Gelatinotype] 'DOREL' Athens, Romvis 20'. 'ΖΕΛΑΤΙΝΟΤΥΠΙΑ' could therefore be the Greek translation of the time for the process that was invented in 1900 by the French brothers Dorel, also described as Gel-lithograph (Kissel and Vigneau 2009, p.91). On another stamp by Levidis company, the description is 'ΣΙΔΗΡΟΖΕΛΑΤΙΝΟΓΡΑΦΙΑ Συστήματος Ντορέλ' translated as 'ferrogelatinography of system Dorel' (trnsl). The process 'Ferrogelatinography', described by Glaphkides[2] (1960, p.680), was a variation of the collotype process.

Fig. 11: *One of the marks by the Levidis company for Dorel process (b) stamp by the same company with inscription 'ferrogelatinography of system Dorel'*

Table 4

Timeline of photoreproductive processes used for architectural drawings (M. Sotiropoulou)



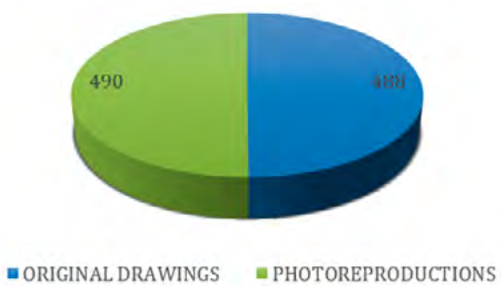
2 (1) 'A thick gelatin layer containing ferrous sulphate, a hygroscopic compound (glycerin) and a wetting agent (sodium taurocholate or ox-gall), pressed onto an exposed ferro prussiate image which is unwashed. The excess ferricyanide forms a ferrous ferricyanide which tans the gelatin locally, enabling it to accept greasy ink, as in collotype.'

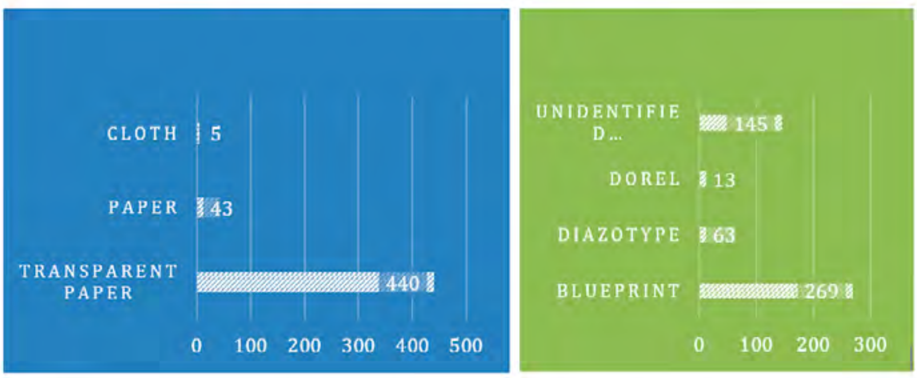
The terminology used for the description of photographic processes used for the reproduction of architectural prints vary, according to different chemicals, use of papers, slight variations etc. There are also several misunderstandings of the processes, which are sometimes described as 'photocopies' (Sumanov 2020). Archival classification is also confusing because it divides drawings and prints to 'original' and 'copies'. Drawings on transparent paper could also be copies of drafts made on paper. Also, photoreproductions inside the Ergoliptiki archive on most occasions have handwritten notes and corrections.

Inside the archive, there was written a list of material supplies which included 'paper for heliotype (ηλιοτυπία)' and 'ammonia for heliotype'(trnsl). This adopted term might mean any of the photoreproductive processes that use light to produce copies, as described by Brown (1900) who uses the term 'heliographic processes'. The term 'Heliotype' has been used to describe different processes, one of which is a variation of collotype by Ernest Edwards in the United States (Mustalish 1997, Melby 2023). The Greek term 'ηλιοτυπία' is described by Pavlopoulos (Παυλόπουλος 2021: p.142) as a variation of photogravure, who also suggested the term's use for blueprints and diazotypes as incorrect. The safest assumption for Ergoliptiki company is that the term's use refers directly to the diazotype process, because of the mentioning of ammonia for development (Price 2020: pp198-202). The supplies of photosensitive papers and developers to produce photoreproductions inside the company would be the adopted method to produce inexpensive and fast copies of the drawings, for distribution to the people involved in the building process. This is also evident because of the many corrections on top of the drawings, blueprints or diazotypes. Overall, Dorel prints were fewer, and possibly executed only for final prints, as it was a more expensive and permanent technique, produced on a good quality of paper.

Table 5

Ratio of treated original drawings/photoreproductions in the Ergoliptiki archive





a) Types of treated handwritten drawings according to their substrate material
b) Types of photoreproductions according to the used printing techniques

While negative cyanotypes were easily identified, whiteprints were more challenging. Upon magnification, several photoreproductions had brown lines to white substrate, with printing embedded to the paper fibers. These could be identified either as diazotypes, sepia or ferrogallic prints. Dorel prints, on the other hand, showed a different texture, which is distinctive and indicative of photomechanical processes. All examined features were documented, but the printing technique was only established through definite indications, such as watermarks.

Identification of the materials is important for conservation purposes and even more for storage. Several deterioration issues of prints and drawings overlapping each other due to the previously adopted storage system were evident. (fig.12). Whiteprints made of photosensitive papers, especially Ozalids, faded significantly, so that in some cases they were illegible. Blueprints also showed varied colour intensity, that may be due to different chemical mixture used for printing, insufficient washing or deterioration (Price 2002:pp233,269).

4. Collection storage

There are several approaches for storage of architectural collections, according to intellectual value, size, material etc (Laroque 2023). Available storage facilities are also a factor, because of the large size of architectural prints and drawings. Storage facilities of the National Library of Greece provided limited flat storage drawers of a size A0 and larger, which was taken into consideration. The unity of the collection, as described, would suggest that all prints and drawings should be stored to their corresponding subfolder, classified by construction number. The same applies to loose documents, as well as photographs.

According to size, the archive can be divided in two major categories: items that can be stored in cabinet storage with shelf units, and items that require flat storage drawers.

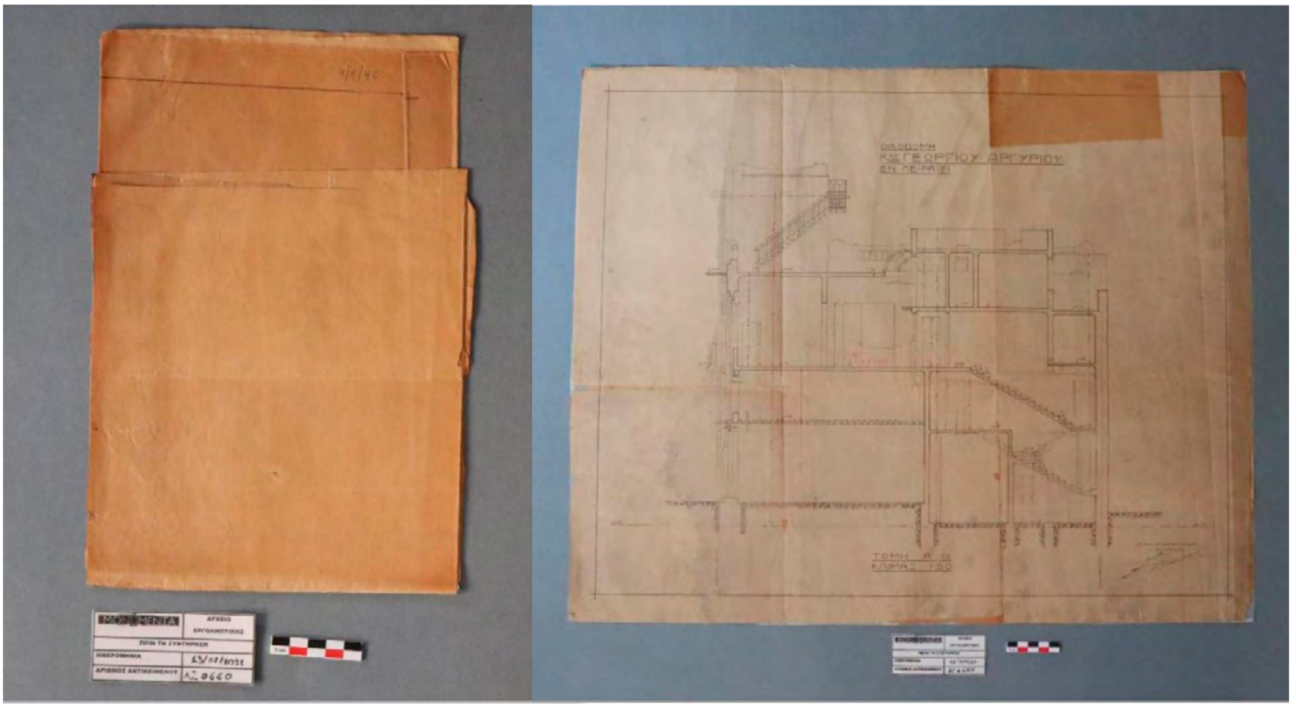


Fig. 12: *After opening, the print showed local deterioration, only on the side that was in contact with an oxidised drawing on transparent paper.*

Table 6
Storage of archival categories inside cabinet and flat storage

Cabinet storage	**Archival category A.ΕΡΓ./K** Boxes containing ledger books and bound material Clamshell boxes of custom size	Each volume separated inside acid free tissue	
	Archival category A.ΕΡΓ.OI./ Boxes containing loose documents and photographs Clamshell boxes of custom size	Each archival category inside four flap folder (archival board)	Each subcategory inside two-fold enclosure (archival paper) Photographs inside individual enclosures (separate subcategory)
	Not yet classified or partially classified, digitized or examined by the conservators	Clamshell boxes containing loose documents inside two fold enclosures (initial classification)	
Flat storage	**Archival category A.ΕΡΓ.OI./…/** Four flap folders (archival board, corrugated board) Stored inside drawers A0 or larger	Each individual drawing or print inside two-fold enclosure Separated inside the secondary enclosure according to type/material	

Ledger books and bound volumes were individually wrapped in acid free tissue paper and stored in clamshell archival boxes. The title of the book/volume was written on the upper right corner of the wrapped object, accompanied by its identification code. The content of each box was written in labels that were placed on the visible sides of the boxes.

Fig. 13: *Labeled archival clamshell boxes containing books and bound volumes.*

After necessary treatment, loose documents were placed in bi-fold enclosures, made of acid free archival paper (120gsm), according to subfolder category. Different types of materials that may produce offsetting (such as coloured/ transparent paper) were individually wrapped in acid free, translucent tissue paper. The bi-fold enclosures were then placed into secondary four-flap enclosures made of light grey archival board (240 gsm) according to archival folder category (construction). Four-flap enclosures of the same size were then put in custom-made archival clamshell boxes of the same size and carefully stored on shelving units.

Photographs were stored individually inside glassine paper enclosures and as subcategories in separate subfolders inside the construction categories. As there was not an option for individual storage of photographic material, they were stored according to their classification. Separate folders properly labeled and documented provide flexibility for future separation of photographic material, if necessary.

Fig. 14: *A photograph is placed in a protective sleeve made of silver safe archival paper inside a four-flap enclosure.*

The decision for architectural and technical drawings and prints was that after conservation they would remain flat and stored separately between unbuffered archival tissue (18gsm), in the form of a bi-fold enclosure that would be semitransparent and lightweight. The storage solution was according to the classification of the archive. Each subfolder of drawings from a specific construction would then be stored in one or more secondary archival four flap folders made of cardboard, according to their type or size. The folders were constructed with archival board of 330 gsm, reinforced on the back, when necessary, with corrugated archival board (thickness 1.8 mm, 730 gsm) in accordance with the EN ISO 9706 standard. The 629 architectural drawings and plans transferred to the National Library of Greece were inside 52 four-flap folders, 10 of which exceeded the A0 size. The four-flap folders were created so that each folder should contain the designs according to their material/technique, by separating drawings on transparent paper from photoreproductions. On several occasions it was not feasible to create numerous folders from cardboard, so different materials/techniques would be separated inside the same folder using unbuffered archival paper (120gsm).

Architectural photoreproductions have similar features as photographic material and therefore their enclosures should not have an alkaline buffer (Lavédrine 2003:43-47). However, they are affected by oxidation and a balance should be kept so that they would not suffer from highly acidic material in contact, or by the acidity of their paper itself. A neutral pH enclosure is therefore the safest choice. Blueprints also do not benefit from polyester encapsulation, as they can change colour with the absence of oxygen. (Ware 2012). As for whiteprints, although many were not identified to the extent of the exact printing technique, they all received the same storage methodology reserved for diazotypes, with the use of archival unbuffered enclosures.

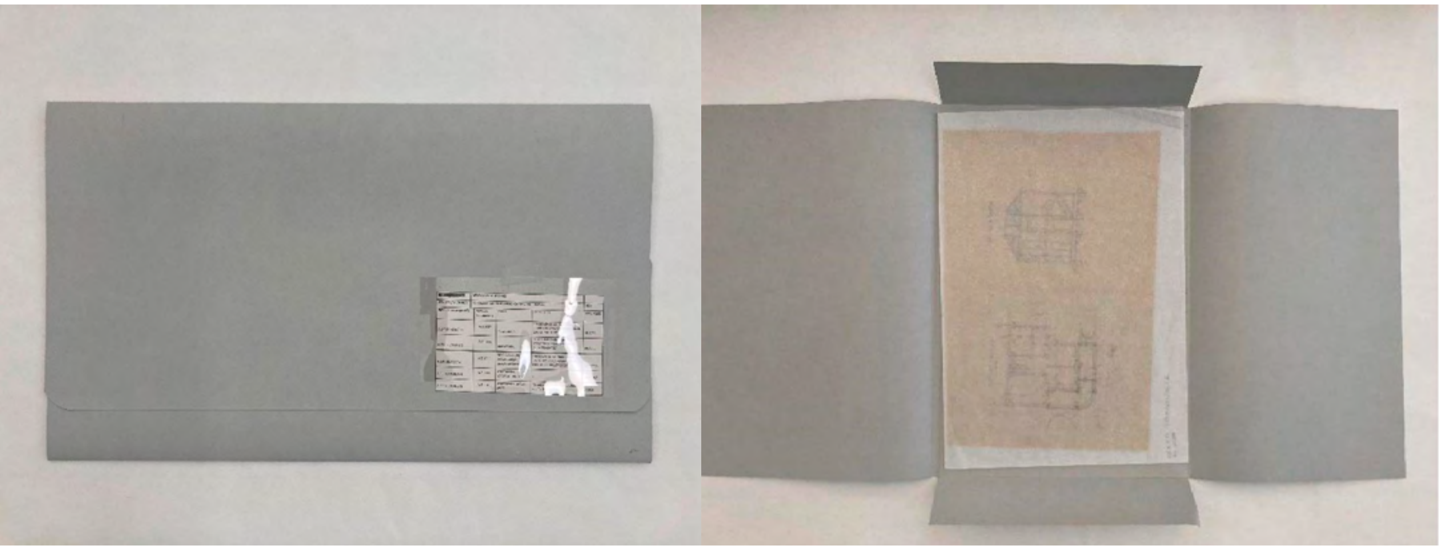


Fig. 15: *Example of a four-flap enclosure for storage of architectural drawings (C.Tsaroucha, National Library of Greece)*

Drawings on transparent paper are the most damaged documents and it was necessary that they received treatment prior to digitisation. Classification of the rest of the archive showed that there are almost 2000 drawings from the category 'Constructions' (Α.ΕΡΓ.ΟΙ./) not yet treated. Untreated drawings were stored in cabinet storage, in separate enclosures according to their subfolders of documents.

6. Untreated documents

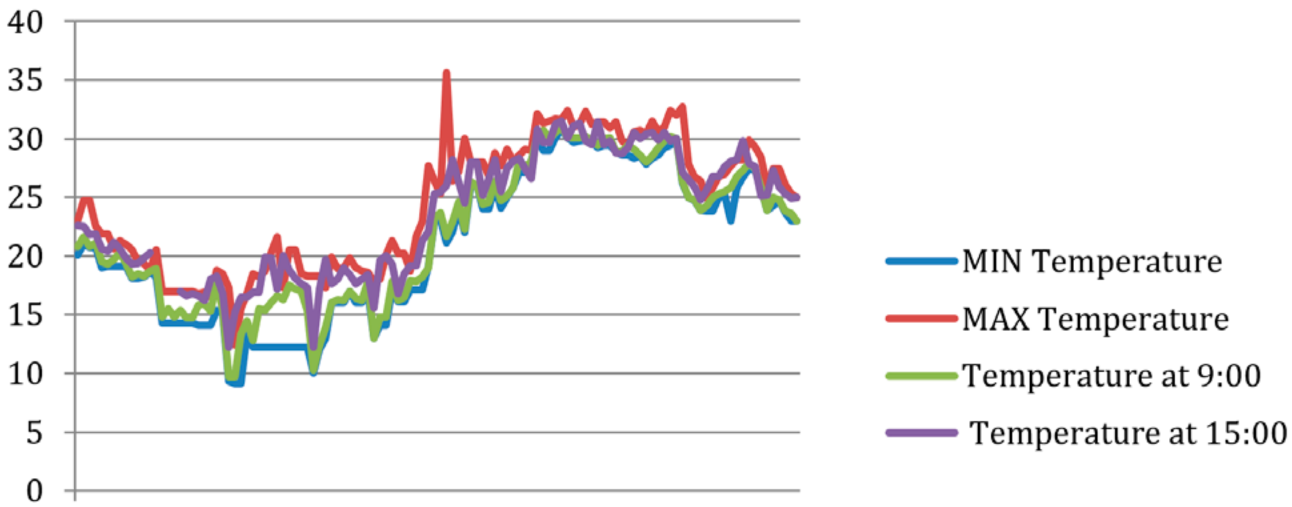
Not all documents were classified during the two-year project, and even fewer were treated and digitised. It was important however that the main classification should be finished, so that a significant part of the archive, in specific construction categories, would be complete, before being transferred to the National Library of Greece. At the end of the two-year period, conservation treatments were complete for 31,085 archives. These included 992 drawings and prints, 226 bound volumes (24,007 pages), 124 folders of documents (6,038 pages) and 48 photographs. The overall number of Ergoliptiki constructions found in the archive are 400, as well as several documents on the category of public works that are not yet classified. These documents remained in storage in MONUMENTA facilities, as they prepare for future funding.

7. Environmental parameter monitoring inside MONUMENTA facilities

Treated documents were transferred to the facilities of the National Library of Greece, which has a controlled storage environment. To monitor the environmental parameters inside the MONUMENTA facilities during the two-year project, the use of a digital thermo-hygrometer was a simple and inexpensive solution. Every day the temperature and relative humidity was recorded at 9:00 am and 3:00 pm., as well as the maximum and minimum temperature and humidity rates. A diagram, using every data record from October 2020 to October 2021, shows the fluctuation of the temperature and relative humidity range within a year.

As seen on the graph below, the daily temperature fluctuation is around 2-5°C, which is a safe range to prevent deterioration and further damage to the archive. During the summer, especially in July and August, when the temperature ranges are notably higher, the use of an air conditioning system was required to establish the ambient conditions.

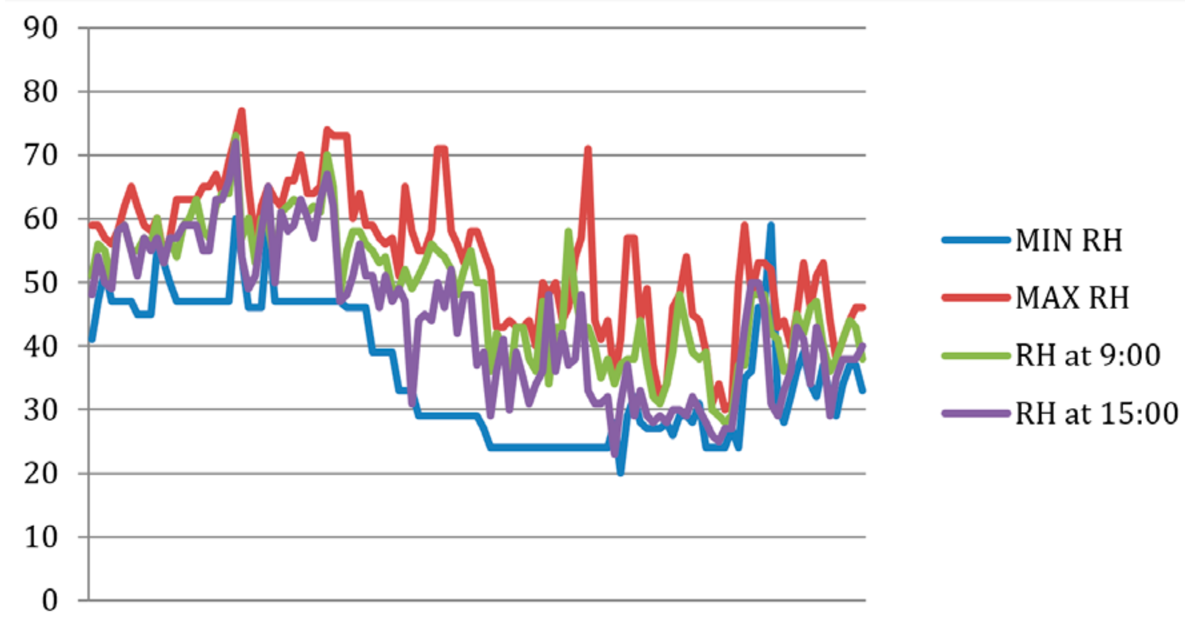
Diagram 1
Daily fluctuations of temperature are approximately 2-5°C



Regarding the relative humidity ranges, it is worth mentioning that the average relative humidity percentage was generally high during the winter of 2020-2021, due to specific weather conditions at the time, with an average of 50% RH. However, the fluctuation of the relative humidity percentage throughout the day was around 10-15%. The use of a dehumidifier could be used as a secondary measure, to keep the humidity level constant.

A future survey will be beneficial for the archive that remains in storage inside MONUMENTA facilities.

Diagram 2
Daily fluctuations of relative humidity are approximately 10-15%



8. Conclusions

The two-year project resulted in the classification, conservation, digitisation and storage of a significant part of the archive of Ergoliptiki company, consisting of varied materials with special preservation needs. The study and conservation procedures of the archive highlighted the creative methodology within the company, which extended from their every-day use of documenting the process, drafting, drawing, and reproducing their records to final building construction. Surveying the collection was not possible prior to the project, so decisions about the storage were made according to day-to-day finds. A flexible approach was established in addition to standard procedures for such collections.

Archives containing architectural drawings and prints, such as Ergoliptiki company archive need to be understood and appreciated according to their intellectual value as well as material structure without compromise of one against the other. Material and processes of the 20th century are especially challenging because they are often disregarded as of low value, because of their fragile material. It is important that curators, archivists, conservators as well as professionals with specialised knowledge- such as architects and engineers-work together at all stages to provide effective solutions for their future preservation. Documentation of the finds and the final digitised content will lead to a better appreciation of 20th century architectural and technical history of Greece.

Acknowledgements

We would like to thank all the staff that worked on the two-year project for the beautiful collaboration and Stavros Niarchos Foundation for the funding of the project. Special thanks to the director of MONUMENTA Irene Gratsia, and to the head conservator of National Library of Greece Christina Tsaroucha for their guidance. This is dedicated to the late Yannis Lambrou, who collected and rescued the Ergoliptiki archive.

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