The bioclimatic characteristics of the sala in the traditional architecture of Tinos and Andros islands

Elias E. Zacharopoulos
School of Architecture, N.T.U.A., Greece
e-mail: zelias@central.ntua.gr

ABSTRACT: Up to the mid-19th century home-based sericulture was widespread in the Aegean islands of Tinos and Andros. Favorable economic conditions lead to the creation of a high volume type of room, called sala, which was intended for silkworm breeding during the springtime and used as a living room the rest of the year. Considering the target for creation of specific tight climatic conditions within this room and the success of the goal, as proven by the results, the sala could be regarded as a clear case of bioclimatic design in the pre-industrial era.

Conference Topic: 8 Traditional solutions in sustainable perspective
Keywords: sericulture, sala, claustra

INTRODUCTION

It is widely accepted that, following slowly evolving guidelines, traditional builders tried to adapt their constructions to the local climate, taking into consideration the building’s use. A particular case demonstrating the ability of traditional architecture to modify the climate and offer specific microclimatic conditions within a building is detected in the islands of Tinos and Andros, where house-based sericulture was practiced for centuries. The reasons justifying the creation of a unique type of room to facilitate sericulture, as well as the tight climatic conditions that had to be achieved indoors will be explained in the following paragraphs.

Sericulture has a long history in Greece, dating back to the Byzantine Era. Two places distinguished for their silk production were the Aegean islands of Tinos and Andros. The French botanist and traveller Joseph Pitton de Tournefort [1], a reliable observer, who visited the archipelago during the years 1770 - 1702 records that Tinos had an annual production of well processed silk weighing approximately 16,000 livres (~6,500 kg) and Andros had a production of silk in excess of 10,000 livres (~4,100 kg). He remarks that silk provided wealth for both islands, exported as thread or knitted in the form of ribbon, socks or gloves.

The economy of the islands those days was agricultural and the house-based sericulture provided the sole revenue for the payment of taxes and import of basic goods. It must be noted that Tinos was then under Venetian rule (until 1715) and Andros was part of the Ottoman Empire (until 1821).

As only indoor space was suitable for silkworm breeding, for a period of approximately six weeks every year, rooms of farmhouses were filled with reed beds on which worms were raised. Doctor M. Zallony [2], stresses the unhealthy consequence of the practice, stating that women of Tinos used their bedrooms for sericulture, fouling the indoor air with the smell of decaying leaves and the often-dead worms.

In times when sericulture was profitable, a large volume type of room was developed in these two islands, suitable for raising worms in springtime and serving as reception or living room for the rest of the year, named sala, from the Italian word. The islanders showed that it was more reasonable to adapt one room of their house for a specific need lasting few weeks a year than to construct a separate enclosure intended exclusively for that cause.

Sericulture came to an abrupt end when disease exterminated in 1860-1862 the tribes of silkworms raised in these islands. Furthermore, the opening of the Suez Canal in 1869 facilitated the import of cheaper silk from Far East [3]. The European silk producers’ response to the challenge was the industrialization of the process, which of course left no ground for the small scale, house-based sericulture.

2. THE SILKWORM

The silkworm Bombyx Mori is a domesticated insect, the cocoon of which is reeled to produce silk thread. Silkworms are totally dependent on human beings for their nourishment and they are fed with mulberry tree leaves, preferably the white variety (morus alba). Therefore, sericulture is closely related to cultivation of mulberry trees.

The life cycle of silkworm goes through four stages commonly known as egg, caterpillar (worm), chrysalis and adult/moth. For silk production only the two first phases are of interest, as the emergence of moth renders the cocoon unsuitable for reeling.

Necessary information for the understanding of the breeding process, described below, were drawn from sericulture guides dating back to the beginning.
of the 20th century [4], as these were considered being closer to the techniques used in the old days.

The life span of the silkworm is dependent on temperature. In a temperature range of 20\(^\circ\)C-25\(^\circ\)C the life of the caterpillar lasts 33 to 38 days, divided in five stages of eating, sleeping and skin shedding, during which it grows from a length of 3mm to a final of 80-90mm. After that, the caterpillar encloses itself in a cocoon, building it with silk filament in three to four days.

Silkworms were reared on beds made of reeds tied together and placed one on top of the other at a distance of 30-40cm for best space utilization. According to old guides, worms emerging from 25gr of eggs (36-40.000 creatures) needed in the final stage 60m\(^2\) of reed beds, approximately 100m\(^3\) of volume and a total of 1000-1200kg mulberry tree leaves.

Popular belief was that silkworms had to be protected from loud or thunderous noises, direct sunrays and droughts. Most important was keeping the life stages of all caterpillars in tune, as out of synchronization worms disturbed breeding and cocoon building.

The climate of Andros (37.5\(^{\circ}\)N, 25.2\(^{\circ}\)E) and Tinos (36.8\(^{\circ}\)N, 24.9\(^{\circ}\)E), the two northernmost islands of the Cyclades group, has been proven favourable for sericulture, as well as for the cultivation of mulberry trees. Andros is larger (445 km\(^2\)), with more water resources, but Tinos (195km\(^2\)) being more populous excelled in silk production.

As already stated, the preferred range of temperature for sericulture was 20\(^\circ\)-25\(^\circ\)C, while the range for relative humidity was 70% to not more than 90%.

Figure 1: Psychrometric chart for springtime in Andros. Comfort range for humans and silkworms is outlined.

Silkworm breeding started with artificial hatching of eggs near the end of March, when mulberry trees began to bud. A psychrometric chart corresponding to springtime for the island of Andros is presented in fig. 1. On top of the comfort range for humans, the “comfort” range for silkworms is outlined between 20\(^\circ\)-25\(^\circ\)C and 70-90% RH. The ambient temperature is favourable, but the higher level of humidity needed was indeed provided by the water content of mulberry leaves. In fact, the challenge was to lower the humidity level indoors, especially in the last stages of breeding, when in a volume of 100m\(^3\) up to 800kg of mulberry leaves containing 65% water were brought in. Controlled ventilation proved to be the only practical way to achieve the necessary microclimatic conditions, a thing that strongly influenced the design of the sala.

3. THE SALA

It is no easy task to track the origins and the development of the sala in the course of time. Extended on site research for this cause has not been conducted yet: A certain level of difficulty arises from the fact that since the downfall of sericulture alterations and additions have transformed the sala appearance.

In any case, basic aim of the present study was the effort to create a model of a typical sala, based on recent research [5,6] and data collected on site.

The construction of a sala followed the traditional method of stone load-bearing walls and earth-covered flat roof, which dictated the overall dimensions. The length of the room could be in the range of 6.00 to 7.00 meters. Considering the lack of long wooden beams, especially in the island of Tinos, a stone arch was built lengthwise, halving the span to be bridged. Thus, the depth of the room measured around 6.00 meters (fig. 2).

Figure 2: Axonometric of a house with a sala in the island of Tinos [7]

As already mentioned, reed beds on which silkworms were reared were placed one on top of the other, hung from ropes tied to the ceiling beams. In an effort to increase the number of reed beds per room, the height of the sala was elevated up to 4.50 meters.
Very significant for the climatic control in the sala were the openings. In all known cases the façade of the room had three openings, one central door and two windows, symmetrically placed. The back wall had no openings, except in cases where a door leading to a room behind was needed. Sidewalls had a maximum of two windows each, placed on either side of the longitudinal arch. Probably in new constructions the sala was freestanding, a fact that has to be examined case by case, considering that after the termination of sericulture rooms were often added to the sides of the sala.

Openings were closed with solid wooden shutters only, as glass panes were not available. But the element that most of all signals the existence of the sala is the slab covering the arch over doors and windows, pierced with hole(s), to form a type of claustra. Its original form was a simple stone slab with a round hole in the middle. In the course of time, marble was used instead and the area of the hole was distributed into a number of smaller openings, integrated in the design of the carvings that decorated the face of the claustra. Decorated claustra became the emblem of the sala and in general the local architecture of Tinos (fig. 3).

**Figure 3:** Decorated marble claustra from Tinos, dated 1807

In a preliminary examination of 18th century typical marble claustra belonging to the Byzantine Museum of Athens, I was astonished to find that irrespective of the design the total area of holes in a claustra was about 0.075m², which corresponds to a single hole with diameter of approximately 0.30 meters. The smaller openings preferred had the benefit of reduced glare and hindered the entrance of birds that could prey on the worms.

Based on all the above, regarding room size and openings, a model of a typical sala was created, as seen in fig. 4.

Correct orientation was fundamental for a sala. Andros and Tinos are well known for the strong northerly winds that sweep the countryside. Villages were built facing south and where possible protected by mountainside on the north. Existing studies show that in most cases the sala façade was oriented to the south. So, it was no surprise that the ECOTECT program used to check optimum orientation for the sala model predicted 185° for Andros and 187.5° for Tinos.

**Figure 4:** Model of a typical sala

The sala was built with minimum 60cm thick slate stonewalls, plastered with clay on the internal face only. Regarding the flat roof, this was a typical construction of reeds or slate on top of the beams, topped with well-compacted clay soil, giving a total thickness close to 40cm. As for the floor, it was usually covered with slate slabs on top of the soil, or over the stone vaults of the basement.

The combination of high mass shell construction, with large openings (in the range of 0.90X1.40m for the windows and 1.00X2.30 for the doors), enclosing a high volume room, resulted in an internal temperature fluctuation following the external with small time-lag, but reduced amplitude (fig.5).

**Figure 5:** Temperature and Relative Humidity measurements for a sala in Andros (26-29 June)

For the period of sericulture, in springtime, this type of thermal behaviour must have been perfectly suitable. Probably the sala thermal environment was unpleasant only during wintertime. It is a fact that after sericulture came to an end, the islanders closed some of the non-south facing windows, built walls behind claustra or sealed their openings.
Windowpanes and better sealing joints in casements were also introduced. Control of humidity levels must have been the biggest challenge in the sala. Source of humidity, as already explained, were the mulberry leaves, shredded in fine pieces for feeding silkworms. The obvious means to reduce internal humidity levels and disperse the bad odour linked with sericulture was to ventilate the room.

Ventilation in sericulture time had strict limitations: The air current should not disturb the silkworms, mix the mulberry leaves or oscillate the reed beds hung from the ceiling. Draughts were totally undesirable. Direct sunrays should not enter the room, as they could heat silkworms near the window and accelerate their life cycle.

For the control of ventilation window shutters must have been frequently operated - after all, sericulture was a labour intensive activity. Fig. 6 presents the case of a window with four shutters, which no doubt was created for better ventilation control. Unfortunately, such original windows shutters are very rare today, reducing our chance to study their typology.

**CONCLUSION**

The case of the sala in Tinos and Andros islands is unique because it proves that people using simple techniques managed to create indoors the precise climatic conditions required for successful sericulture. In addition, the form of the sala and its components, especially the claustra, is a lesson of architecture itself and provides food for thought for our generation.

**ACKNOWLEDGEMENT**

I would like to thank Ms Flora Bougiatioti for her assistance in computer programming.

**REFERENCES**

[1] M. Pitton de Tournefort, Relation d’un Voyage du Levant, Amsterdam, 1717
[6] K. Papaioannou, The Traditional Greek House, Athens 2003 (in Greek, with summary in English)