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PESTS ASSOCIATED WITH GREEN BUILDING: AN EMERGING INFESTATION IN ITALY

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Abstract Global warming and the urgent need to preserve our environment have established sustainability as a defining criterion in Western culture for evaluating new business activities. In the context of environmental and economic sciences, sustainability refers to a development model that meets the needs of current generations without compromising the ability of future generations to meet their own needs. Driven by sustainability imperatives, social structures and market demands are pushing companies across all industries to adopt sustainable products and services. Among these sectors, the construction industry, spurred in part by raw material shortages has championed green construction over the past decade.

Key words Gren construction, *Tineola bisselliella*, *Liposcelis bostrychophila*, *Tribolium*, *Lasioderma serricorne*

INTRODUTION

Green construction encompasses methods of designing, constructing, and managing buildings in alignment with environmental sustainability principles, thereby minimizing their ecological footprint. A cornerstone of green building practices is the selection of materials: recognizing that natural resources are finite, green construction prioritizes eco-friendly materials derived from renewable sources. In this context, common insulating materials used in green buildings include: cellulose fibers, Cork, coconut fibers, hemp, linen, cotton, reed, straw, wood fiber insulating panels, mineralized wood, sheep wool. These materials are suitable for both floor and wall insulation (Figure 1, 2, 3, Figure 4).

Figure 1-2-3: Example of straw-insulated in green-building.

Figure 4: Example of a green-construction house built with sheep wool.

Since these insulating materials are of animal or vegetable origin, they can be susceptible to insect infestations if not properly pre-treated and adequately sealed from both the exterior and interior of the building. For example, sheep wool can attract insects such as *Tineola bisselliella* (the common clothes moth), while straw may host pests like *Liposcelis bostrychophila* (booklice), *Tribolium* spp. (flour beetles), and *Lasioderma serricorne* (cigarette beetles).

In addition to these pests, predatory insects and mites such as *Scleroderma domesticus* (a parasitoid wasp), *Pyemotes* spp. (straw itch mites), and *Cephalonomia* spp. (a genus of predatory beetles) have also been identified. Infestations typically occur within the first 6 to 18 months after the house is handed over to the owner, leading to severe **physical issues** (e.g., bites and allergic reactions) and psychological distress (e.g., entomophobia and feelings of alienation due to frustration over purchasing a property that fails to meet expectations). Below are case studies from Italy highlighting these challenges:

FIRST CASE STUDY

Property Type: Green construction house insulated with lime-treated rice husks.
Timeline: Issues reported 10 months after construction completion.
Complaint: The client observed numerous insects and experienced bites covering their body (excluding the face).
Medical Diagnosis: A dermatologist documented "papular lesions arranged in a linear pattern, consistent with exogenous dermatitis."

Figure 5: Bites on the right side.

Figure 6: Bites under the left breast.

Field inspection revealed the presence of the following insects:

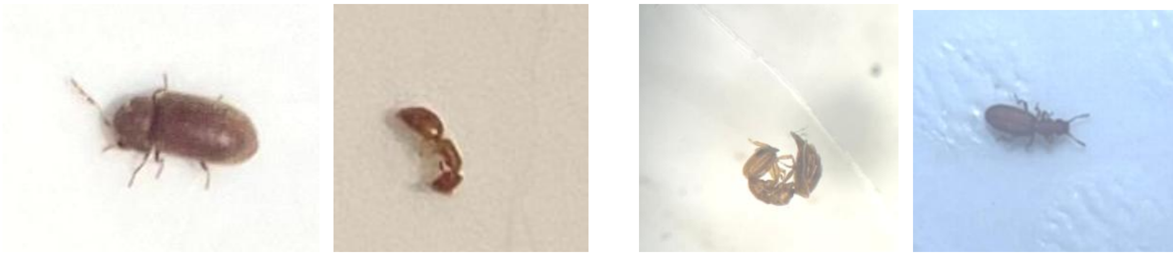

Figure 7-8-9-10 *Stegobium paniceum, Scleroderma domesticus, Cephalonomia gallicola, Tribolium spp.*

In addition to visual inspections, dust samples were collected and analyzed by an accredited external laboratory (EDPA Laboratory). Sampling was conducted in all rooms, revealing not only the aforementioned pests but also specimens and debris of *Entomobrya multifasciata* (a species of springtail). Upon reviewing the construction details, it was noted that the rice husk insulation had been pre-treated with phosphine gas; however, prolonged on-site storage (spanning several months) likely exposed the material to contamination during summer. Identified pest entry points included: gaps along baseboards (wall/floor junctions), electrical outlets, exposed wooden beams (from which pests fell into living spaces). In this case, the client purchasing the green-construction house had been informed of potential pest coexistence and accepted this risk.

Mitigation Measures: Entry points were sealed with insulating plaster. Two targeted pest control treatments were applied to reduce populations. Sealing the wooden roof was deemed impossible due to structural constraints.

Outcome: After 10 months, no new bites were reported, though low-level infestations of *Oryzaephilus* spp. (saw-toothed grain beetles) and *Tribolium* spp. (flour beetles) persisted.

SECOND CASE STUDY

Property Type: Green-construction house insulated with cypermethrin-treated virgin sheep wool (walls and roof).

Timeline: Initial infestations detected 3 months post-delivery, subsiding in winter and peaking during spring/summer.

Complaint: The client reported recurrent swarms of "moths" emerging from electrical outlets and throughout the structure at dusk.

Inspection Findings: All electrical outlets had been temporarily sealed with cellophane and tape by the client. Insulation inspection: sheep wool insulation in all rooms, including the basement garage, showed signs of infestation. External storage area: untreated wool rolls stored outdoors exhibited extensive traces of *Tineola bisselliella* (clothes moth) activity.

Figure 11: *Tineola b.* inside a sealed electrical outlet. **Figure 12:** Specimens found on ground.

Figure 13: Tinea bisselliella trapped in the water conduits.

Figure 14-15: Rolls of wool pre-treated showing clear traces of *Tineola bisselliella*.

To control the infestation and avoid removing the insulation, a heat-treatment strategy was implemented. This involved deploying electric convector heaters in sufficient quantities to raise the ambient temperature to 53°C, targeting all life stages of Tineola bisselliella (eggs, larvae, and adults). To evaluate heat distribution within the insulation's outermost layers, temperature probes were installed after drilling access points into the wall.

Figure 11: Example of heat machine used. **Figure 12**: Temperature probe sensor

Based on the building's dimensions, 18 heating units were strategically deployed. The treatment's efficacy was significantly impacted by external climatic conditions, particularly unseasonably high temperatures. For instance, cross-referenced data from August 29, 2017, revealed a sharp drop in external temperatures due to a precipitation event (see graph below). To mitigate heat loss and maintain treatment effectiveness, internal temperatures were elevated to 55°C during this period.

Giorno	T Media	T min	T max	Precip.	Umidità	Vento Max	Raffica	Fenomeni	Info
19	28 °C	21 °C	34 °C	n/d	43 %	18 km/h	-		
20	24 °C	20 °C	28 °C	-	51 %	17 km/h	-	Nessuno	
21	22 °C	16 °C	28 °C	-	47 %	18 km/h	-	Nessuno	
22	23 °C	16 °C	28 °C	-	39 %	21 km/h	-	Nessuno	
23	25 °C	18 °C	31 °C	-	44 %	22 km/h	-	Nessuno	
24	25 °C	18 °C	34 °C	-	51 %	26 km/h	-	Nessuno	
25	27 °C	20 °C	34 °C	-	58 %	21 km/h	-	Nessuno	
26	28 °C	21 °C	34 °C	-	52 %	21 km/h	-	Nessuno	
27	29 °C	22 °C	37 °C	-	45 %	17 km/h	-	Nessuno	
28	28 °C	23 °C	34 °C	n/d	47 %	31 km/h	-		
29	25 °C	18 °C	31 °C	-	57 %	22 km/h	-	Nessuno	

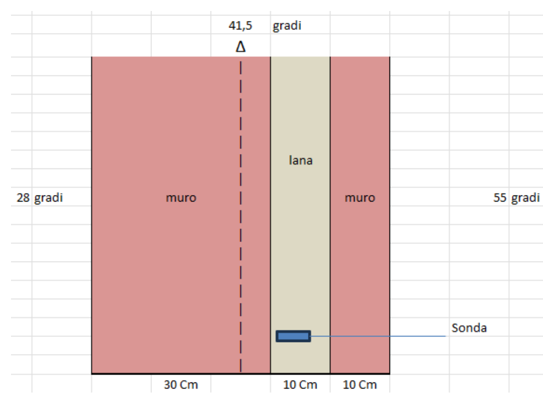

Figure 13: Seasonal temperatures. **Figure 14**: Temperature calculation.

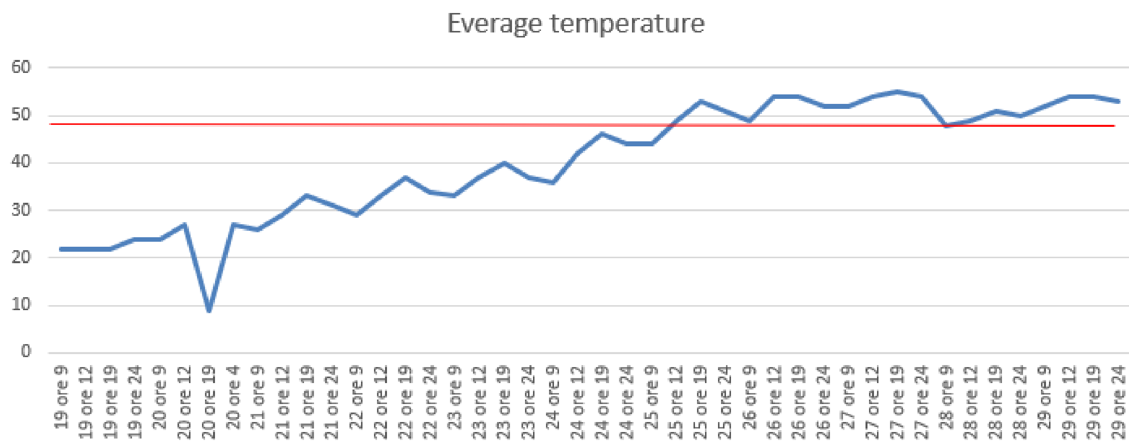

Figure 15: Average temperatures.

End of Treatment

At the end of the treatment, monitoring traps for *Tineola bisselliella* (clothes moths) were set, but no new captures were detected. Seven years after the treatment, the client has not reported any new infestations or sightings of *Tineola bisselliella.*

Figure 16*:* *Tineola bisselliella* body dead detected post-treatments.

CONCLUSIONS

Human responses to sustainable needs for addressing the environmental emergency will inevitably lead to an adaptation of pests, particularly in the case of increased mite infestations such as *Dermatophagoides pteronyssinus* or *D. farinae* (mites related to household dust). These mites, which were previously more evident during the May-June period, are now active until the end of September

The great challenge will be collaboration between architects and Pest control experts, who through effective collaboration can evaluate all architectural and sustainable solutions with the possible consequences on pests.