
THE ATTACK OF ANOBIIDS ON BOOKS FROM THE ECCLESIASTIC PATRIMONY

Georgiana Gămălie* and Mariana Mustață

*University "Al. I. Cuza", Faculty of Biology, Department of Zoology and Ecology,
Bd. Carol I nr. 20A, Iași 700505, Romania*

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Abstract

The paper presents several aspects regarding the deterioration caused by several species of *Anobiidae* (Coleoptera) on the rare liturgical books preserved in the Agapia Monastery book reserve (Neamț county) and in the ecclesiastical art housing of the Golia Monastery (Iași county), in the Cetățuia Monastery archive (Iași county), as well as in the book collection of the Saint Nicholas Church Museum of Brașov. We have noticed the attack of 4 species belonging to 4 genera of the *Anobiidae* family.

This paper presents the attack pattern of the species aforementioned, deteriorations, and also recommendations on how to prevent the insect's development on book collections.

Keywords: ecclesiastical patrimony, pests, Anobiidae, conservation

1. Introduction

The ecclesiastical book - be it printed or hand-written by scribes throughout years of prolonged efforts – is first of all a liturgical object, whose main importance lies in what it holds and preaches: the truth of the Gospels and the sacraments of the daily divine service for the faithful. Apart from its liturgical function, the book of prayer is an object of art in itself, if one is to consider the miniatures, the frontispieces, the richly-decorated opening letters it provides, the expensive materials - gold and silver - embellishing it, or the brilliant precious stones decorating it. Carefully preserved nowadays in the archives and museums of the monasteries, the ecclesiastical book remains an important witness of our past, of our Christian faith, of our history. To value, to keep, and to protect such books is to obey the command uttered by our Saviour, that of spreading His learnings to all human beings: "Jesus drew near and said to them: I have been given all authority in heaven and on earth. Go, then to all peoples everywhere and make them my disciples: baptize them in the name of the Father, the Son, and the Holy Spirit, and teach them to obey everything I have commanded you. And I will be with you always, to the end of the age." (Matthew 28.18-20)

* e-mail: geoniamg@yahoo.com

As an object in itself, seen from the perspective of its constituent parts, the book becomes the physico-chemical support of a trophic chain made of numerous species, which attack it in successive waves. First, there are the insects that find in such precious objects both food and shelter. Insects are attracted by the various types of materials out of which the book is made, consuming them in a preferential manner, and thus provoking significant deteriorations, in regards to the aspect and the consequences. The abiotic factors (such as temperature – T, relative humidity – RH) act continuously upon objects, determining subsequent actions of the biotic element. Among the insect pests of books, the coleopterans are the most dangerous ones, their attack being motivated by their food preference. Within this category, the anobiids are the most aggressive ones, as they are the first to attack, opening the way to other coleopterans, such as ptinids and dermestids.

The museum of the Saint Nicholas Church from Șcheii Brașovului, the book deposit of the Agapia Monastery (Neamț county), the archives of the Cetățuia Monastery (at the outskirts of Iași), as well as the storage room for ecclesiastical objects at the Golia Monastery (in the very heart of Iași city) hold valuable old books, which illustrate the history of the printing art in this part of the world and, even more important, give evidence on the history of Romanians, as a Christian people. The amplitude of the insects' attack and, consequently, the deteriorations suffered by the old, valuable books require ample morphological, biological, ecological and etiological investigations of the species involved in such a harmful processes, for an efficient combat of theirs and, equally, for assuring optimum storage conditions by a strict surveillance of the microclimatic parameters.

2. Materials and method

The investigations have been performed on the rare liturgical books preserved in the Saint Nicholas Church Museum (Șcheii Brașovului) and in the museums, storage rooms of books and liturgical objects at the Agapia, Cetățuia and Golia monasteries. Each place presents its own conditions, which favour more or less the development of insect pests on rare books.

First of all, in the Brașov deposit, in a place unheated during cold seasons, which means that the inside temperature decreases considerably, inversely proportional to the values of RH, there are stored over 2,700 volumes, horizontally displayed on metallic shelves, each book being protected by a paper cover. The active presence of the harmful insects is proved, next to the numerous dead larvae and adults, larval exuviae or galleries full of sawdust occurring inside the volumes, by the orifices present on the paper covers. The dead adults found on shelves or on the window frames support this assertion.

In the storage room of old books at the Agapia Monastery, the volumes are deposited on wood shelves wrapped up in cloth, to prevent the accumulation of dust. Unfortunately, the conditions of microclimate (low T and high values of RH) are entirely unsatisfactory, favouring the development of pests. The same

temperature and RH values characterize the archives of the Cetățuia Monastery, where the preservation of books together with icons painted on wood supports and with other objects of cult facilitates the infestation of the volumes by the same insects that attacked the other objects. The deposit of ecclesiastical objects at the Golia Monastery shelters, among others, a most valuable collection of rare books, more precisely 3,400 volumes, most of them dating back to the XIXth century. Throughout the four seasons, the temperature of the storage room is constantly kept around 18°C.

For the present study, the books have been selected according to their age, on one hand, and the origin and area of the deposit in which they are preserved (once known that the microclimatic conditions vary sensibly in one and the same space), on the other. The books have been turned over page-by-page, their covers and bindings being also checked. The biological samples have been collected in glass tubes temporarily labelled with information about their places of provenance (the number under which the book is noted in the catalogue of the collection, and the area within the book in which they had been found, especially the substrate under attack). The thus obtained material has been investigated in the laboratory – i.e., they have been subjected to dissections, preparations in ‘Canada balsam’, scanning electronic Tesla BS 300 and optical microscopic Novex K-Range and binocular magnifying glass Novex AP-8 images, for the determination of the species according to their morphological aspects. In the same time, for the elucidation of certain biological and ecological aspects, rearing insects in the laboratory was necessary.

3. Results and discussion

The investigations performed led to the identification of 4 species, belonging to 4 genera of the *Anobiidae* family (Table 1).

The *Anobiidae* family takes its name from the genus *Anobium* – a Greek word meaning ‘lifeless’ - once known that, when in danger, its representatives mime death. The anobiids are small insects (around 2-9 mm in length) [1], represented by about 1,200 species. Such coleopterans reveal a holometabolic development, along 4 stages: egg, larva, pupa and adult. The adults’ body is cylindrical, the head being partially covered by the pronotum which evidences the sculpture, pubescence or granulation characteristic to the species. The fundamental colour of the body is either brown-reddish or brown-black, with the tegument covered by a fine pubescence. The antennae, made up of 8-11 segments, may be filiform, clavate, serrated or pectinated. The mouth parts are strong, adapted to tearing and chewing. The elytra may evidence longitudinal striations or not, the hind wings are well developed, the adults being capable of flying. The legs are adapted to march, with 5-segmented tarsus [2]. Some of the species evidence sexual dimorphism, most frequently the female being bigger than the male, in other cases the difference occurring at the level of the antenna (*Ptilinus pectinicornis*).

Table 1. Anobiids injurious to books

| Order | Fam. | Genus | Species | Synonymy | Exp. station |
|------------|-----------|------------------|--------------------------------|---|-------------------------------|
| Coleoptera | Anobiidae | <i>Ptilinus</i> | <i>pectinicornis</i> Linné | | Agapia, Braşov |
| | | <i>Stegobium</i> | <i>paniceum</i> Linné | <i>Anobium paniceum</i> L.; <i>Sitodrepa panicea</i> L.; <i>Stegobium paniceus</i> Herbst; <i>Stegobium testaceum</i> Thumb.; <i>Stegobium minutus</i> F.; <i>Stegobium tenuicornis</i> Marsh.. | Cetățuia, Golîa, Braşov |
| | | <i>Anobium</i> | <i>punctatum</i> De Geer | <i>Anobium striatum</i> Oliver; <i>Anobium domesticum</i> Geoffroy; <i>Anobium domesticum</i> Fourcre; <i>Birrhhus domesticus</i> Geoffroy; <i>Ptinus punctatus</i> De Geer. | Braşov |
| | | <i>Xestobium</i> | <i>rufovillosum</i> De Geer | <i>Xestobium tessellatum</i> De Villers; <i>Xestobium tessellatum</i> Herbst; <i>Xestobium pulsator</i> Schall; <i>Xestobium faber</i> Thunberg; <i>Xestobium fatidicum</i> Blumenberg; <i>Xestobium fuscum</i> Linné; <i>Xestobium pertinax</i> Shall; <i>Xestobium pulsatorium</i> Villers ; <i>Xestobium rubiginosum</i> Müller; <i>Xestobium squalidum</i> Lec.. | Cetățuia |

The scarabeiform, white–yellowish larva, covered by fine hairs, has a well-developed thorax and thin legs. The cephalic capsule, brown in colour, is chitinous, while the mouth parts – adapted to tearing and chewing - are provided with very strong mandibles. The pupa – white-yellowish in colour, has well-individualized bodily segments and free appendices. The eggs are of an oval-elongated form, with a characteristic sculpture of the chorion, its colour changing during its embryonic development [3].

The adults mate either outside or even inside the nutritive substrate. The eggs are deposited at intervals, either isolated or in groups, in the cracks of the wood or inside the galleries, on covers or on the back of the bindings, where they can be glued with a secretion that gets consolidated when in contact with the air. Sometimes, the females deposit the eggs in the wood in which they were developed, on using their hatching orifices. The female of the *Ptilinus pectinicornis* (Figure 1a) inserts the eggs in the lumen of the xylem vessels, not letting them free in the feeding gallery, thus protecting its progeny by fixing the pronotum at the end of the gallery like a lid [4].

The larva hatches through the side attached to the wood, thus shifting directly to the substrate [2]. The duration of the larval stage varies – as a function of food, T and RH – from a few months to several years, the larva passing through a different number of stages, for examples, 4 in the case of *Lasiorema serricorne*, or between 4 and 6 with *Stegobium paniceum* (Figure

1b). For forming the pupa, the mature larva may build its own cocoon, made of rests of food and silky threads in the galleries of the nutritive substrate – which usually happens with the *Stegobium paniceum* and *Xestobium rufovillosum* (Figure 1d) species, for example. This cocoon is to be found in the vicinity of wood's surface, the adults emerging from the substrate through a flight orifice.

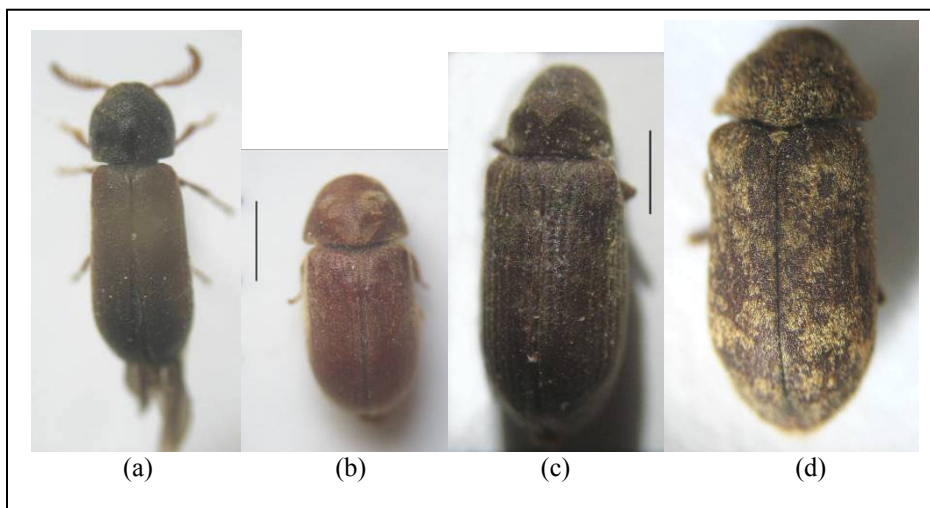


Figure 1. (a) *Ptilinus pectinicornis* ♀, (b) *Stegobium paniceum*, (c) *Anobium punctatum* and (d) *Xestobium rufovillosum* adults (the plotted segments stand for 1 mm)

The flight of the adults begins in the month of May or even earlier, being continued until autumn. In the case of low temperatures, adults enter the diapause for about a few weeks. Some species hibernate in the material they attack in the larval stage, being transformed into pupae in spring and living in the warm season as an imago. The adults of certain species produce a characteristic noise when they knock the wood with their pronotum, which explains the vernacular name that had been given to them - deathwatch beetles. Such sonorous signals, assuring the communication between sexes, are initiated by males, to which the females respond [4, p. 102]. In most of the species, the adults evidence a positive phototropism, so that they may be observed at windows or around sources of artificial light, which is not the case of larvae – known as preferring dark places. This permits the utilization – as both a monitoring and eradication – of UV light traps for catching adult specimens. It is only the females, especially the mated ones that prefer the dark when they have to deposit their eggs.

The anobiids are xylophagous and, equally, polyphagous insects, developing endosymbiotic relations with several species of yeasts, bacteria, protozoa and microscopic fungi, by means of which they succeed in digesting the lignin and the cellulose from wood [1, p. 22]. These microorganisms are transmitted from one generation to another, at the same time with eggs'

deposition and larvae's hatching. Their preference for the nutritive substrate differs from one species to another; thus, *Ptilinus pectinicornis* attacks the furniture made of wood, preferring the hardwoods (beech, oak, walnut), the damages provoked to softwoods being only rarely noticed. On the contrary, *Anobium punctatum* (Figure 1c) prefers the softwood species [2]; more than that, when they are permitted to, females choose the best substrate for their progeny, when they deposit the eggs. They prefer certain woods (softwoods, oak, willow, poplar, beech, lime tree, sycamore maple, walnut), older and rugged, with several cracks and galleries. Also, they seek for the wood with higher humidity, which is – to them – even more important than the wood species itself [3]. As a polyphagous species, *Stegobium paniceum* consumes products rich in starch, such as bread, flour pastes, biscuits, flour, as well as medicinal herbs, vegetables and dehydrated fruits, tea, coffee, spices of various kinds, herbariums, wood, insect collections, mummies, even plastics. In the case of *Xestobium rufovillosum*, the nutritive spectrum is quite large, the larvae consuming hardwoods (oak, walnut, beech), paper, leather and the tissues (silk, velvet) from the bindings of the books.

The duration of the development cycle varies – as a function of the environmental conditions – from several months to several years. For example, in non-heated spaces, *Stegobium paniceum* has 1-2 generations per year while, in heated rooms, 3-4 generations can emerge. The optimum values of T and RH differ from one species to another. Thus, for *Stegobium paniceum*, the optimum values are of 30°C and 80-95% RH, respectively – when the biological cycle is completed within about 40 days while, for *Anobium punctatum*, the optimum T is of 20°C [5]. Knowledge of the influence of such parameters – *i.e.*, T and RH – on the development cycle of such pests, and of their biological area, as well, are of special importance for their combat by means of temperatures either extremely low or exceeding the maximum threshold.

The duration of the development cycle is influenced, too, by the quality of the nutritive substrate. Thus, in old, depreciated wood, *Xestobium rufovillosum* is developing within a much shorter period (*i.e.*, between 10-17 months), comparatively with the up to 55 months it needs in healthy wood. The attack of the *Xestobium rufovillosum* species is associated with the depreciation induced in wood by *Coniophora cerebella* and *Merulius lacrymans* [4, p. 102]. For the deposition of their eggs, the females prefer the wood attacked by fungi, either destroyed or not by *Xestobium rufovillosum*. When they have only one woody species at their disposal, they may refuse to deposit their eggs [6]. The attack is firstly extended as a function of the nature of the wood species, the old, fungi-attacked oak wood being the first in their preferences. Adults' longevity varies, too, as a function of hereditary inheritance, food, environmental factors; usually, the duration of their life is of one month, males living less than females [3].

The attack of anobiids – as both larvae and adults - is mainly occurring in the books' covers, although their galleries may penetrate the whole body of the book, the leather, the wood, the board and the paper. The larvae enter the book by 'digging' a circular gallery behind the bindings or on the lateral sides, the diameter of which increases as the larva grows. Its whole development cycle occurs inside the book, the adult leaving it through a flight orifice. Signs of their presence are the excrements of both larvae and adults, as well as the fine sawdust powder resulted from their feeding processes. Circular in cross-section, the galleries evidence a sinuous trajectory, extended from the edges towards the centre of the pages. The diameter of the flight orifices may provide important clues on the type of species involved in the attack. Thus, in the case of *Anobium punctatum*, such holes are of 1-2 mm in diameter, of only 1 mm in *Stegobium paniceum* and of 3 mm, respectively, in the case of *Xestobium rufovillosum*.

All these species have a large areal in which they may be found, some of them being even cosmopolitan - a situation favoured by the trade made with infested woody materials.

4. Case studies

4.1. The New Testament, Bălgrad 1648 - Collection of rare books of Saint Nicholas Church from Șcheii Brașovului

The New Testament, which – as known - is a part of the Holy Scriptures, is structured into 27 books, describing the life and teachings of our Saviour – Jesus Christ – the new promise of man to God. Transmitted by Jesus orally, it has been written down by His disciples and Apostles. Thus, the New Testament has been issued as early as the first century of the Christian era, the Books of the Apostles having a historical, a didactic and – equally - a prophetic character. The value of the Holy Scriptures has been exquisitely synthesized by Saint Apostle Paul, as follows: "All Scripture is inspired by God and is useful for teaching the truth, rebuking error, correcting faults, and giving instruction for right living, so that the person who serves God may be fully qualified and equipped to do every kind of good deed." (2 Timothy 3.16-17)

The liturgical value of the Holy Scriptures, the need for a better and thorough knowledge of their concepts explains the translations made into Romanian, beginning with the New Testament in 1648, at Alba-Iulia, by Simion Ștefan, the Metropolitan of Transylvania, the complete translation of the holy text – *i.e.*, the whole Bible – following quite soon, in 1688, at Bucharest. A copy of the New Testament of Belgrad (Alba-Iulia) is preserved in the library of the Saint Nicholas Church, where it had been brought, in 1978, from the Church of Viștea de Sus. The volume is made of manual paper; the wood covers are wrapped in leather (the metallic clasps that kept the covers together being lost). The conservation condition of the volume is precarious, the binding being destroyed on the whole; also, considerable material losses may be noticed (Figure 2).



Figure 2. Deteriorations provoked by *Anobiidae* to the leather wrappings of the covers.

In the case now under study, the combined attack of two anobiids species – *i.e.*, *Anobium punctatum* and *Ptilinus pectinicornis* – has been signalled on both the woody cover and leather, and on all through the body of the book, in which dead adults and larval exuviae have been found (Figure 3). In time, the compounding elements have been dispersed, so that the leather and the woody covers appeared completely separated from the body of the book, the main cause having been firstly the attack of the insects which – through their galleries and hatching orifices – had loosened the structure, resulting in gradual losses of the materials forming it: leather, wood, paper. Equally, storage in an atmosphere favouring the development of moulds and unsuitable handling added to the deterioration process.

The wood covers show galleries and hatching orifices, which are much more numerous on the cover initially wrapped in leather. Dead adults may be noticed – under the leather wrapping or under the flyleaf - in the exit end of the galleries, in orifices and partial galleries (Figure 4). In the body of the book, the attack of anobiids is less intense, being concentrated towards the bindings and in the vicinity of the upper and lower edges.



Figure 3. Deteriorations caused by *Anobium punctatum* and *Ptilinus pectinicornis* to the first wood cover – assembly inside the book, with a flyleaf fragment (a), and (b) outside the book – (c) profile detail.

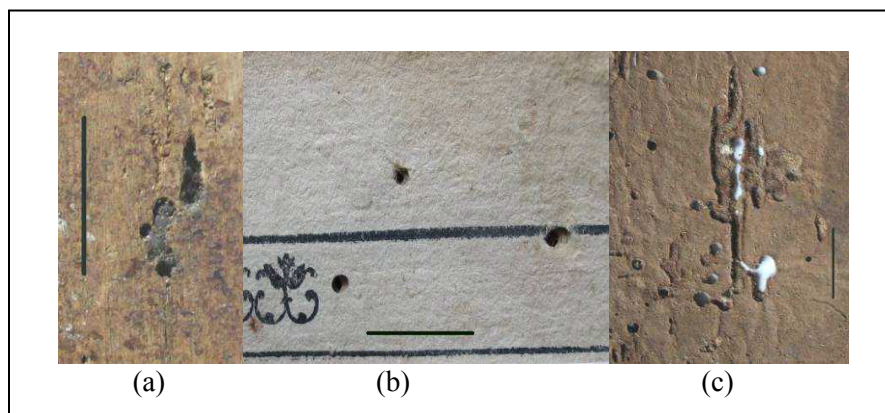


Figure 4. Details of the attack of anobiids upon the first woody cover (a), as well as upon the paper (b) and leather (c). The plotted segments represent 1 mm.

4.2. Collection of Sermons, Buda 1811 - Collection of rare books of Saint Nicholas Church from Șcheii Brașovului

In the Christian cult, the sermon represents the most direct manner of transmitting the teachings of the Gospel and thus, of granting a minimum religious training to the believers. It has been practiced by the Saviour along the three years of His work on earth, and carried on by the Apostles afterwards, as a means of preaching the Evangel [7].

‘Sermons or teachings for all Sundays and holydays of the year’ has been issued in Buda, in three volumes, between 1810-1811, under the direct supervision of Petru Maior, who acted as a licenser of press in the Printing House. The volume, brought in the deposit of Braşov from the Şercaia (Făgăraş) parish, in 1980, has wood covers wrapped in leather decorated with geometrical motifs, the covers still having – although partially destroyed – metallic clasps.

The attack of the *Anobium punctatum* species has been evidenced both on the cover’s wood and on the paper, the adults’ hatching orifices crossing the leather, as well. The wood covers show an intense attack, evidenced by the galleries full of sawdust and excrements, and by the hatching orifices made by adults, all such traces having induced lowering of the mechanical strength and thus its scission. The species involved in the present deterioration have been identified by the dead adults found at the end of the galleries made in wood and paper, as well as by the dead larvae and larval exuviae.



Figure 5. Deteriorations provoked by *Anobium punctatum* on leather, wood and paper.

The body of the book is deteriorated in the vicinity of its edges, as well as in its binding (Figure 5). The size of the galleries varies as a function of larvae's development stage. The galleries are irregularly shaped, the ones occurring parallel to the leaves' plane extending over 7-10 leaves, and even more. Sometimes, the galleries cross the whole body of the book, perpendicular to the leaves' plane.

4.3. The Lives of Saints on the Month of December, 1882 - Archives of the Cetățuia Monastery

The manuscript, written on manual paper, has leather-wrapped board covers. The attack of the *Stegobium paniceum* species has been indicated by dead adults and larval exuviae, as well as by the characteristic lodges for the pupal development occurring in the board (Figure 6). The cover also contained numerous larval exuviae of *Attagenus piceus* and *Attagenus pellio*, along with exuviae of *Anthrenus museorum* (Coleoptera: Dermestidae).



Figure 6. Attack of the *Stegobium paniceum* (Anobiidae), *Attagenus piceus*, *Attagenus pellio* and *Anthrenus museorum* (Dermestidae) upon a board cover.

The considerable intensity of the attack made the board and the leather prone to break, causing the loss of certain fragments, too. The galleries enter the body of the book only in the first 12-15 pages, at its outset and its end, the middle pages being attacked only in the area of the upper margin of the folio.

4.4. Teachings of the Holy Scriptures - Archives of the Cetățuia Monastery

It is a Greek manuscript with leather-wrapped hardwood covers, with only partially preserved clasps. In this case, the attack of two anobiids species - *i.e.*, *Xestobium rufovillosum* and *Stegobium paniceum* - has been evidenced on the wood, leather and paper, as well (Figure 7).

The signs of the presence of such pests are the dead adults, the larval exuviae, as well as the characteristic aspect of the deteriorated areas, mainly the large diameter of the galleries produced by the larvae of the *Xestobium rufovillosum* species, seen as full of sawdust – in the case of wood – or of excrements and of a fine felt - when they penetrate the paper. The galleries dug in paper across several pages, causing their fragmentation. In such galleries, in the cover, dead adults of *Stegobium paniceum* have also been found.



Figure 7. Deteriorations caused by *Xestobium rufovillosum* on the covers wrapped in leather, on the wood and paper of the book (the plotted segment stands for 10 mm).

5. Conclusions

The investigations undertaken on the old books fund at the Museum of the Saint Nicholas Church (Șcheii Brașovului), in the book deposit of the Agapia Monastery, in the collection of ecclesiastical objects of the Golia Monastery and, finally, in the archives of the Cetățuia Monastery, signalised the attack of 4 *Coleoptera* species, belonging to 4 genera of the *Anobiidae* family. The various stages of the deteriorations induced by insects have been followed by a minute analysis of four case studies, as follows: The New Testament, Collection of Sermons, The Lives of Saints on the Month of December and Teachings of the Holy Scriptures. As evidenced in the figures, the deteriorations caused by the insects' successive attack are considerable. Anobiids are the first to enter the book, where they 'dig' galleries in the covers' wood or in the paper, thus opening the way to other insects, such as the *Ptinidae* and the *Dermestidae*.

Severe preventive and curative measures are to be therefore taken for limiting the activity of such pests. A first step will consist of surface cleaning in order to remove surface dirt and dust of each piece and removing mending tapes and adhesive residues, while the mechanical elimination of the insects is to be done as a second step. For the volumes showing an ongoing attack mainly upon the wood covers, the application of insecticide (chemical or physical) treatments is recommended. Also, for an appropriate surveillance of the presence of living pests, either pheromonal [8] or light (UV) traps should be used, whereas major interventions are indicated only in the case of a widespread attack of insects. At the same time, the preserving environment for rare books is to be improved, mainly by providing the optimum preservation conditions, as well as by avoiding values of the microclimatic parameters that favour pests' development.

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