

MONITORING OF *STEGOBIUM PANICEUM* LINNÉ 1758 (COLEOPTERA: ANOBIIDAE) IN BOOK DEPOSITS BY MEANS OF TRAPS

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Abstract. The paper analyzes the results obtained in the monitorization of the *S. paniceum* species in book deposits by means of several type of traps: adhesive yellow boards, pheromonal and kairomonal traps. The investigations have been developed in the year 2006, in three stationary places of Iași, namely: the reading hall of the Romanian Academy Library, a book deposit of the “Mihai Eminescu” Central University Library and the deposit of ecclesial objects of the Golia Monastery. The data resulted from monitorization operations permit signaling out of the attack, controlling of the population level in view of establishing the most suitable treatments, and also of the moment of their maximum efficiency, as well as an approximate localization of the hotbeds. The intense *S. paniceum* attack signaled out in the deposit of the Golia Monastery permitted analyses on the dynamics and sex-ratio of the adults. For the obtainment of an equally accessible and efficient trap, the preference manifested by the *S. paniceum* adults towards the colour and positioning of the adhesive boards on the windows, was followed, the yellow ones, placed on the upper part of the windows, recording the most numerous captures. The combined utilization of such traps reduced the attack, which is therefore an action of direct control.

Keywords: books, *Stegobium paniceum*, monitorization, pheromonal and kairomonal traps, adhesive yellow boards.

Rezumat. Monitorizarea prezenței speciei *Stegobium paniceum* Linné 1758 (Coleoptera: Anobiidae) în depozite de cărți cu ajutorul unor capcane. Lucrarea de față prezintă rezultatele obținute în monitorizarea speciei *S. paniceum* în depozite de cărți cu ajutorul mai multor tipuri de capcane: cartoane galbene adezive, capcane feromonale și kairomonale. Cercetările au fost efectuate în trei staționare din Iași: sala de lectură a Bibliotecii Academiei Române, un depozit al Bibliotecii Centrale Universitare “M. Eminescu” și depozitul de obiecte bisericești al Mănăstirii Golia, în anul 2006. Datele obținute în monitorizare ne permit semnalarea atacului, supravegherea nivelului populației în vederea stabilirii necesității aplicării de tratamente și a momentului de maximă eficiență pentru combatere, precum și o localizare aproximativă a focarelor. Atacul intens de *S. paniceum* semnalat în depozitul Mănăstirii Golia ne-a permis observarea unor aspecte privind dinamica apariției adulților și sex-ratio. În scopul obținerii unei capcane accesibile și eficiente, am testat preferința adulților de *S. paniceum* pentru culoarea și poziționarea cartoanelor adezive pe ferestre, cartoanele galbene amplasate în partea superioară a ferestrelor obținând capturile cele mai mari. Utilizarea combinată a acestor capcane a determinat diminuarea atacului, constituind o acțiune de combatere directă.

Cuvinte cheie: cărți, *Stegobium paniceum*, monitorizare, capcane feromonale și kairomonale, cartoane galbene adezive.

Introduction

A suitable preservation of the patrimonial values assumes their conservation under conditions as close as possible to their initial form, along with their delayed ageing, followed by their natural re-entering, in due time, in the natural circuit of matter. Such objectives require a thorough control of the abiotic factors (temperature, relative humidity, light, atmospheric composition), for assuring an optimum conservation microclimate, specific to each type of material, as well as of the biotic agents. Insects constitute dreaded agents of the patrimonial goods, which become the food and shelter for innumerable echelons of pests. Thus, the Anobiidae cause serious damages to objects made of cellulosic materials, *S. paniceum* – a polyphagous species – being viewed as early as the

beginning of the past century, as one of the most dangerous enemies of books (Houlbert, 1903).

Nowadays, integrated pest management has become part of the conservation actions, quite various methods being applied in combined treatments, for destroying the pest, as well as for minimizing its noxious effects on the humans, environment and objects as such. Special stress is now laid on preventing any possible attack by appropriate cleaning actions and control of the microclimatic parameters, *i.e.* creation of unfavourable conditions for insects' development, on strictly observing the requirements imposed by the conservation norms. For the application of efficient and advantageous conditions of pest control, early tracing of any attack is essential, for impeding its propagation and, hence, for reducing the possible damages. Visual inspections are quite relative, especially in the case of insects living a hidden life, whose larvae and adults are equally photophobic organisms. As the same time, a thorough control of the woody or board covers of the books is hardly possible, the more so that the huge number of books forming libraries and archives require time-consuming control operations.

Monitorization of pests' presence may assure an early detection of the attacks, and provide information on their intensity, thus permitting the identification of the species involved and, consequently, the elaboration of a treatment scheme, according to the existing data on the biology and ecology of the species. In this respect, the traps attracting insects by means of either pheromonal or alimentary baits, or by light and colours, occupy a privileged position. In the control against the pests detected through monitorization, the methods to be applied are selected as depending on the nature of the attacked objects, on the species involved, as well as on their development stage. It is particularly important the knowledge on the sensitivity of each development stage, in part, to a certain treatment, and which is the lethal dose. Hence, on knowing exactly the species involved, on having information on its biology and ecology, as well as on the microclimatic characteristics of the deposit, the moment of maximum sensitivity of the species considered may be quite easily deduced.

Materials and Methods

For the monitorization of the *S. paniceum* presence in book deposits, three types of traps have been utilized, as follows: simple yellow adhesive boards, folding adhesive traps with pheromonal baits and traps with alimentary baits (kairomon), equipped with a reservoir.

The yellow adhesive boards belong to the category of open adhesive traps. Pherocon AM/NB traps, supplied by the Trécé Inc. American Company of Adair, OK, have been employed in the study. The board surface is of 23/14 cm, the glue preserving its properties for several months. The positive phototropism of the *S. paniceum* adults, known as good flyers, explain boards' placement directly on the windows, with their adhesive part inside.

Out of the covered adhesive traps, folding traps made of board – the unfolding and mounting of which create relatively rigid spatial forms with their adhesive surface inside (Ghizdavu, 1983) – have been used. The “S. PANICEUM” traps, offered by the Fuji Flavor Co. Ltd., from Tokyo, Japan, attract the *S. paniceum* males with bait containing the synthetic formula (stegobiene) of the sexual pheromone released by the female. The adhesive surface immobilizes the insects it attracts, provoking soon their death. A trap is active for one month, its spatial arrangement being made according to the indications given by their producer, namely: the distance between the two neighbouring traps ranged between 5 and 10 m, while their positioning avoided the spaces close to the entrance, so that no insects from the other part of the door should be attracted. The traps were situated at a height of 1.5 m, hanging from the shelves.

Besides the adhesive traps, STORGARD Beetle-Traps (DOME™ Design), equipped with a reservoir, supplied by the Trécé Inc. American company, have been utilized. The alimentary attracting agent (kairomone), provoking also insects' suffocation when they enter the reservoir, has been used. The kairomone is a mixture of oils extracted from various plants, put in an inert stabilizing medium. Such traps are efficient in detecting the *S. paniceum* species, as the adults have to feed themselves for attaining sexual maturity, their polyphagy spectrum being extremely large. The traps were put under the book shelves, the kairomone being changed each fortnight. Each week, the traps have been controlled, the captured insects being analyzed in the laboratory. On considering the polyphagy characteristic to this species, a 4th type of trap has been improvised, namely a folding adhesive board with a bait made of granules of fish food (Kronkright, 1991). The trap was put, too, under the book shelves, being tested along 3 months (July 1 – September 30, 2006) at the Golia Monastery of Iași.

Monitorization on the presence of *S. paniceum* species in the three places under study started from different premises. Thus, in the rare book collection of the Golia Monastery, the active presence of this species had been observed as early as an year ago. Occasional measurements of temperature and relative humidity indicate approximately constant values over the whole year, i.e. - 18-20°C and 59-60%, which are nevertheless sensibly varying in the summertime, when the windows get opened. The deposit was monitored between April 1 – September 30, 2006, a period over which all types of traps have been applied, attempts being made at comparing their efficiency and also at a spatial localization of the hotbeds.

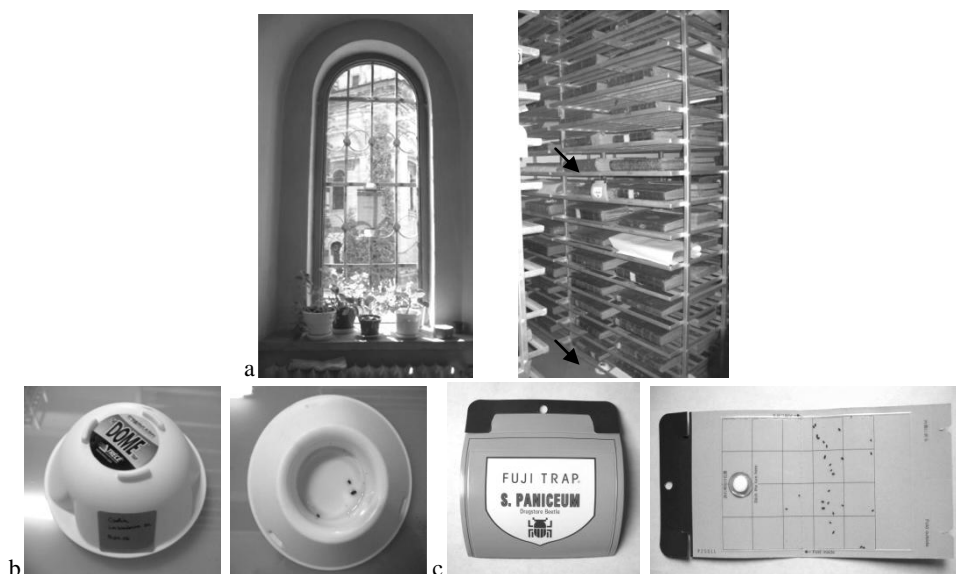


Figure 1. Traps' arrangement in the deposit of the Golia Monastery: yellow adhesive board on the window and pheromonal and kairomonal traps on/under the bookshelves (a); kairomonal (b) and pheromonal trap (c).

In the reading room of the Library of the Romanian Academy (the Iași Branch), yellow adhesive boards were placed on 2 windows, between April 12 - September 30, 2006. In this space, special attention has been given to dermestids – observed here an year ago-, the traps having pheromonal baits for the *Anthrenus verbasci* species (Dermestidae). Capturing of the *S. paniceum* adults was quite a surprise, as no sign of a possible attack

from the part of this species had been observed during previous visual inspections. The large surface of the reading room, along with the huge number of volumes here preserved hinder a timely tracing of the pests, which leave the volumes they had attacked only in their adult stages.

The book deposit from the dome of the “Mihai Eminescu” Central University Library of Iași was monitorized between April 13 - June 9, 2006 (when the space had been subjected to consolidation operations), by means of the same yellow adhesive boards, placed on the windows, and by “S. PANICEUM” pheromonal traps. A year ago, traces of this species’ attack on the board covers of some volumes had been observed, numerous dead adults, but not single living organisms, having been traced. The traps were mounted for finding out if these were signs of an old, stopped attack, or of an active one.

The number of traps within each monitorized space was established as a function of its surface, their positioning being indicated on a scheme of the room under consideration. The traps were controlled each week, their position being changed if no captures had been produced in their initial place. Each control involved recording of the number of captured insects, the species and stage in which they occurred, along with information on the modification of a trap’s position or on the tracing of either living or dead insects in the deposit, on objects or on the walls.

Results and Discussion

In the reading room of the Library of the Romanian Academy (the Iași Branch), the first *S. paniceum* adults were caught in the end of May, the total number of individuals captured over almost 6 months on the boards (29), indicating a weak, hardly intense attack.

In the deposit of the “Mihai Eminescu” Central University Library only one *S. paniceum* adult was captured on the yellow board placed in the first-floor store of the dome, on June 9, 2006, *i.e.*, in the last week of monitorization. Also, on the window frame on the second floor of the dome, a living adult of *S. paniceum* was discovered in the same day. The two living adults indicate an active attack of this species, yet the short monitorization period did not permit a correct evaluation of the attack’s intensity or its localization.

At the Golia Monastery, a much more intense attack could be observed, so that the data here collected permit a more detailed analysis. The total number of *S. paniceum* adults captured was around 1600, of which 1173 adults on the yellow boards, 173 on the colored ones, 115 in the kairomonal traps, 108 in the pheromonal ones, and only 25 in the trap containing fish food. Mention should be made of the fact that, in all traps, *S. paniceum* adults had been caught, the traps containing alimentary attractants, *i.e.*, fish food or kairomone, being the only ones in which larvae, in different development stages, had been also found. In all types of traps, a hymenopteran parasitizing the *S. paniceum* larvae was also captured. The relation between *Lariophagus distinguendus* Förster (Hymenoptera: Chalcidoidea, Pteromalidae) and *S. paniceum* host is mentioned for the first time in Romania.

The space within which the rare book fund is preserved is of about 89m² (16.5 x 5.4m). In the attempt of localizing the hotbed of the attack by means of traps, the space had been represented as a system of xOy axes, in which position 0 is represented by the south-west corner of the room (Nansen, 2004). Here, two pheromonal (F₁(8,2) and F₂(13,4)) and three kairomonal (K₁(9,2), K₂(11,2) and K₃(13,2)) traps were installed (Fig. 2). Initially, traps K₂ had been put in the north-western part of the deposit. The first *S. paniceum* adults (2) were caught in K₃ in the first week of May, another one being captured, a week later, in K₁. The absence of any capture in the north-west trap for two months after its installation justifies its re-positioning between the other two.

The captures obtained in identical traps, over the same period of time (*i.e.*, May 31 – September 30, 2006) have been then compared. Thus, 18 adults had been caught in trap K₁, 21 adults in K₂ and 66 *S. paniceum* adults in K₃, respectively, a hotbed being identified in the south-east part of the deposit (Fig. 2b). Trap F₁, showing the highest number of adults (55), *versus* F₂ (only 25), is indicative of a second hotbed in the center of the deposit (Fig. 2b). Instead, K₁ indicates a weak attack in the central space of the deposit, which somehow contradicts the data provided by F₁- placed in its close vicinity. Such a situation may be nevertheless explained by the different positioning – as to their height- of the two types of traps, and also by their different attraction degree, in both traps most of the captured adults being males. Consequently, the hotbed is localized on the upper shelves, in the vicinity of the pheromonal trap, at a longer distance from the kairomonal one, situated on the floor. Along the whole monitorization period, the presence of insects in the volumes arranged on the shelves containing the traps had been also checked, the active attack in the areas of the F₁, F₂ and K₃ traps being thus confirmed. However, the exact intensity of the attack in each point could not be evaluated.

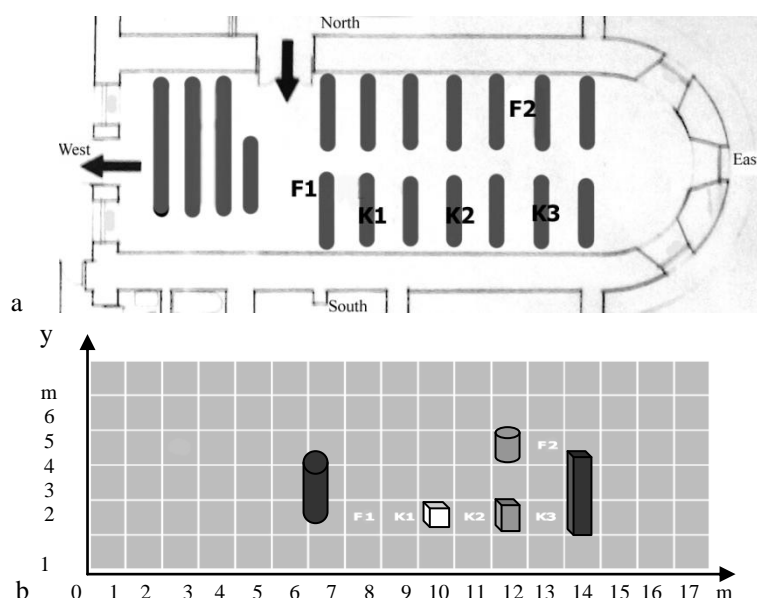


Figure 2. Traps' installation (a) and spatial localization of the hotbeds of the *S. paniceum* species attack in the collection of rare book of the Golia Monastery (b).

Adhesive yellow boards had been placed on four of the deposit's five windows, corresponding to its four corners. The unequal degree of windows' lighting, induced by an uneven exposure to the sun, or by some obstacles – such as the monastery's wall and the west-oriented hall, influences the number of captures, making such data useless in the spatial localization of the attack, the more so that the adults are photophilic organisms, and also good flyers, while the surface of the deposit is quite reduced (89 m²).

A comparison between the weak captures made with the same trap put into evidence their variation in time. To check whether thus phenomenon reflects the dynamics of the *S. paniceum* population, the data provided by the three types of traps have been compared, on illustrating this with two traps, each of the same type (Fig. 3). Differences might be thus recorded between the variations indicated by identical traps, yet installed in various parts of the deposit, which might be explained by the different conditions of the

space under monitorization (temperature, relative humidity and lighting degree, closely correlated with the meteorological conditions).

In all the three types of traps, the first captures were made in the first week of May. Most of the adults were caught in the pheromonal and kairomonal traps in the third week of June, while captures on the yellow adhesive boards were recorded later, in the beginning of July. A possible explanation of this phenomenon might be that, in the pheromonal and kairomonal traps, most of the captured adults are males, unlike the case of the yellow adhesive boards, where females are prevailing, the males appearing before the females, which they expect in view of mating. Over most of the monitorization period, the captures made on the yellow adhesive traps are more numerous than in the other two types of traps, with the only exception recorded in the month of May, when more adults had been caught by means of pheromones.

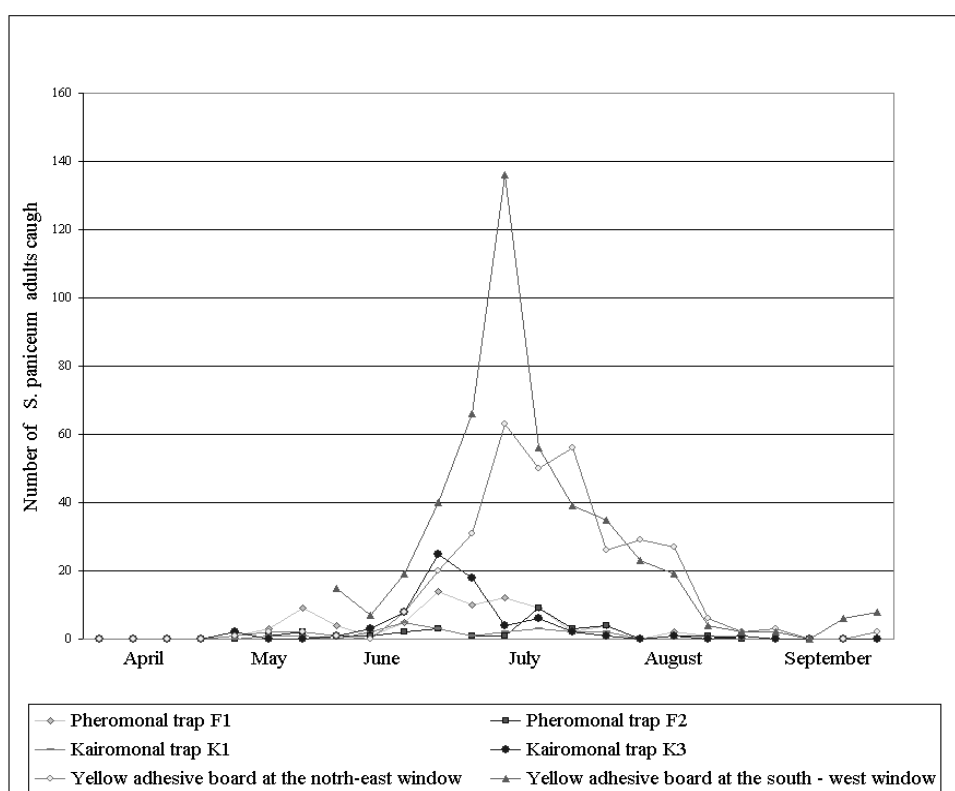


Figure 3. Variation of the captures obtained with different traps in the deposit of ecclesial goods of the Golia Monastery (Iași) between April 1 and September 30, 2006.

Mention may be possibly made of a superposition of generations, caused by a successive deposition of the eggs over a period of 6-25 days or even more, by the different duration of development for the larvae belonging to the same pontia on various nutritive substrate and by the equally important adults' longevity, seen as varying – as a function of the food they find, of temperature and relative humidity – between 22 and 35 days (Mustață, 1994).

For each type of trap, the sex ratio was analyzed, which involved processing of the data collected over the same time period (May 20-July 3, 2006). On the yellow adhesive board placed on the south-west window, 283 *S. paniceum* adults – of which

85.1% are females and only 14.8% males – were captured. In the K_3 kairomonal trap, out of the 59 adults here present 25.4% are females, the males being of majority: 74.5%. Most of the females captured with this trap had eggs, being in course of ponta deposition. In the two pheromonal traps, 43 adults were caught – most, as actually expected – males (88.3%) along with a few females (11.6%). Possibly, the females were to be found here only by accident, the traps being installed near the books.

With a view to increase the efficiency of the adhesive boards, adults' preference for their color, as well as for their positioning on windows, was tested. Consequently, on two yellow adhesive boards of identical size (23/14 cm), placed on the same window, one in its upper part, the other on the inferior part, at a distance of 60 cm one from another, 201 adults – of which 130 on the upper board and only 71 on the bottom one – have been captured between July 3 – September 30, 06. Adults' chromatic preference was tested by mounting of equally-sized (10/10 cm) boards, impregnated with the same type of adhesive, yet differing in color, on the same window, at a distance of 10 cm among them. 12 boards have been used, two for each of the following colors: red, yellow, blue, green, brown and white. Each two boards of the same color have been arranged so that not to occur on the same row. Between July 10 – September 25, a total number of 173 *S. paniceum* adults have been captured, the highest yield being recorded on the yellow boards (49 individuals), followed by the brown ones (39), the red ones occupying only the third position (29). In 5 of the six colors, adults' preference for the upper board is evident, with the exception of the green one which, nevertheless, attracted the most reduced number of insects (6 on the upper and 7 on the lower one). Also, on the yellow boards, the adults are concentrated on the upper part (Fig. 4b). All these observations assert the importance of both color of the adhesive boards and of their positioning on the window, the most efficient ones being the yellow boards arranged on the upper part.

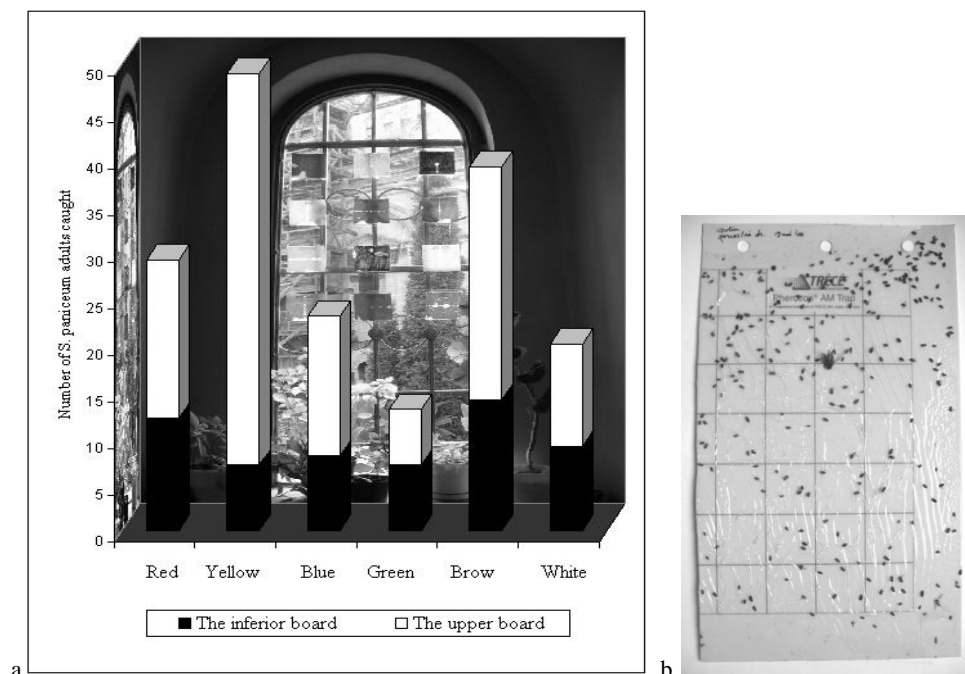


Figure 4. Chromatic preference of the *S. paniceum* adults captured by means of coloured adhesive boards (a) and the adults captured on the yellow board mounted on the window (b).

Conclusions

Monitorization of the active presence of the *S. paniceum* species in libraries, archives and book deposits by means of yellow adhesive boards mounted on the upper half of non-blind windows represents a reliable and accessible method. Although the pheromonal and kairomonal traps record a reduced number of captures, a combined utilization of the three types of traps is nevertheless recommended, for lowering the intensity of the attack by removal of the individuals of both sexes, as well as of their larvae.

Out of the three places subjected to monitorization, the most intense attack of *S. paniceum* was recorded in the collection of rare book of the Golia Monastery. The variation, in time, of the captures made with the three types of traps reflects quite well the dynamics of the pest population, along with a superposition of its generations. A timely tracing of the attack was possible, to the same extent, with all three types of traps. The sex ratio was analyzed *versus* the type of trap; thus, in the pheromonal and kairomonal traps, more males (88.3% and, respectively, 74.5%) were caught, unlike the case of the yellow adhesive boards, on which the ratio is reversed (of 14.8 males to 85.1 females of a total of 100 adults). Spatial localization of the hotbeds by means of pheromonal, kairomonal or yellow adhesive board traps is quite relative, while the reduced surface of the deposit of the Golia Monastery requires application of treatments to the whole collection.

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