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STUDY ON THE EFFECT OF PHEROMONES ON THE BARK BEETLES OF THE SCOTS PINE

G. ISAIA[1] A. MANEA[1] M. PARASCHIV[2]

Abstract: *In this paper we study one of the most important bark beetles of Scots pine from economic point of view - Ips sexdentatus Boern. and Ips acuminatus Gyll. For these species of Scolytinae we tried to achieve two main objectives: testing the efficiency of different types of experimental pheromones in order to improve the composition and developing the knowledge and clearing up some ambiguous aspects concerning the flight dynamics of the insects. Therefore, it is necessary to know the local characteristics of the flight of bark beetles in order to be able to intervene at the moment when the population begins its outbreak.*

Key words: *pine bark beetles, aggregation pheromones, efficiency of pheromones, dynamics of the flight, stock way of pheromones.*

1. Introduction

Since 1990 more and more standing dead Scots pines trees have been noticed in Maramureş, Suceava and Transylvanian Plateau. All these were observed in the context of climatic excess and alternance that influenced the phytosanitary state of the forest.

The dynamics of the Scots pine drying were certainly influenced by the intensity of biotic factors as fungi and insects. Thus, due to drought periods, a significant infestation with bark beetles appeared in Scots pine stands situated in areas with degraded ground and superficial soil [2], [4].

The control measures against outbreaks mainly consist of evacuating infested trees from the forest before the new generation of adult beetles emerge and installing trap trees in those areas [6]. In this context the use of modern control methods appears as a necessity.

2. Objectives

As a consequence we have thought to study the most important bark beetles of Scots pine from economic point of view: *Ips sexdentatus* Boern. and *Ips acuminatus* Gyll. For these species of *Scolytinae* we tried to achieve two main objectives: *i*) Testing the efficiency of different types of experimental pheromones in order to improve the composition; *ii*) Developing the knowledge and clearing up some ambiguous aspects concerning the flight dynamics of the insects.

[1] Dept. of Silviculture, *Transilvania* University of Braşov.
[2] Forest Research and Management Institute Braşov.

Fig. 1. *Experimental plots: Nehoiu Forest District* (*left*) *and Dumitreşti Forest District* (*right*)

3. Research Areas, Materials and Methods

The experimental plots were placed in Scots pine stands with infested standing trees, as follows: subcompartment 89, V Cernatu-Viforîta Management Unit, Nehoiu Forest District and subcompartment 76J, II Vintileasca Management Unit, Dumitreşti Forest District (Figure 1).

In each plot we installed 8 winged funnel traps loaded with different types of lures. The traps were placed at a minimum distance of 30 m between them.

There were tested aggregation pheromones of *Ips sexdentatus* and *Ips acuminatus* using different combinations of components: ipsdienol, cis-verbenol, ipsenol, metilbutenol, α-pinene and, for blend stability, polietilenglicol (PEG).

The following variants of aggregation pheromones were tested:

V1 = ipsdienol + α-pinene,
V2 = ipsdienol + PEG,
V3 = ipsdienol + metilbutenol and
V4 = ipsenol + cis-verbenol + ipsdienol + PEG.

Each pheromone type was provided both as a dispenser (=Vpl) and as a little bottle (=Vst) in order to test the efficiency of each stock way of the pheromone (Figure 2).

The captured biological material was collected one time per week between June 1st and July 22nd 2006.

The replicates were assured by rotating the lures from one trap to another during the entire experiment. In this way, the possible influence of catches by the field conditions was avoided.

The results were compared by using the index **Ia** = intensity of attraction, representing the number of captured insects per day and trap.

Fig. 2. *Stock way of pheromones: as a dispenser* (*left*) *and as a little bottle* (*right*)

4. Results and Discussions

4.1. Results Regarding the Capture Dynamics

Our speciality literature says that the spring flight of *Ips sexdentatus* takes place in April-May [5]. Simionescu [8] shows that the spring flight starts in May and lasts

two months, but if the weather is cold it may be late one month. The second flight takes place in July-August [5] and it may represent 25% from the total [8]. Mihalciuc et al. [7] tested experimental and commercial pheromones for *Ips sexdentatus* and reported that the wintering adults fly in May and the catch in June is due to the flight of beetles which will give rise to the sister generation.

So, there are few data concerning the flight dynamics of *Ips sexdentatus* in Romania. The same situation can also be noticed for *Ips acuminatus.*

By analyzing Figure 3 one can observe that the maximum of the first flight is reached between May 26th and June 2nd. The fact that after this week the captures decrease shows that the first flight of *Ips sexdentatus* had already started.

The level of captures increases in the second half of June and this means the beginning of the flight of the beetles that will give rise to the sister generation. The drastic reduction of captures during the period June 9th - June 16th is due to the heavy rainfall that took place every day and thus the mean temperatures decreased under 16.5 ºC, the threshold that release the flight of bark beetles [3].

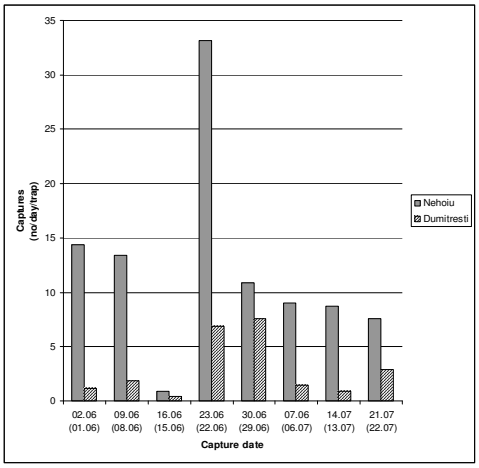

Fig. 3. *Capture dynamics of Ips sexdentatus*

The second flight of *Ips sexdentatus* begins on July 7th at Nehoiu and on July 13th at Dumitreşti. Because we stopped the experiments after eight weeks, we could not observe the entire period of the second flight.

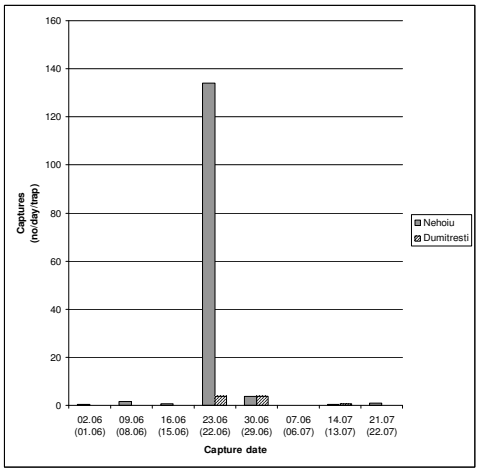

Fig. 4. *Capture dynamics of Ips acuminatus*

In Nehoiu Forest District the captures were maximal for both studied species during the week June 15th - June 22nd. Thus, **Ia** was of 33.14 insects/day/trap for *Ips sexdentatus* and of 134 insects/day/trap for *Ips acuminatus.* In Dumitreşti Forest District the maximum flight occurred for two weeks, June 15th - June 29th, but the captures were obviously less numerous than those in Nehoiu Forest District, with **Ia** of 7.57 insects/day/trap for *Ips sexdentatus* and of 3.86 insects/day/trap for *Ips acuminatus.*

4.2. Results Regarding the Capture Distribution on Pheromone Variants

4.2.1. Capture distributions of *Ips sexdentatus* on pheromone variants

Vite et al. [9] mentioned that the male beetle of *Ips sexdentatus* initiates the boring

Table 1

Distribution of Ips sexdentatus captures considering the experimental variants at Nehoiu between 25.06-09.06

Captures (mean ± standard deviation)							
V1pl	V1st	V2pl	V2st	V3pl	V3st	V4pl	V4st
11.5 ± 13.4[b]	65.0 ± 14.1[a]	16.0 ± 7.1[b]	0.5 ± 0.7[b]	0.5 ± 0.7[b]	1.5 ± 2.1[b]	2.5 ± 0.7[b]	0

Note: Means with the same letter are not significantly different ($P = 0.05$)

and releases an aggregation pheromone consisting mainly of ipsdienol. Our results also show that the presence of ipsdienol assures, in both experimental plots, a very efficient attraction. The results of experiments with aggregation pheromones performed between 2000 and 2005 and reported by Mihalciuc et al. [7] also showed that higher captures of *Ips sexdentatus* were recorded when ipsdienol was included in the lures. But the results obtained in 2006 showed that the adding of ipsenol and cis-verbenol to ipsdienol determinates a significant increasing of the attraction: 2.41 in comparison with 0.62 captures/day/trap [6].

In the experiment made at Nehoiu it followed that the response of the bark beetles to various experimental variants of pheromones was not the same along the tested period. As a consequence, we analyzed the response of *Ips sexdentatus* to different experimental pheromones by grouping data in two periods: May 26th - June 9th and June 16th - July 21st.

For the first interval we used T-Test in order to show that the variant V2st (α - pinene + ipsdienol) proved to be the most efficient (Table 1). At the moment when the first flight is finished the addition of α - pinene does not increase the attraction (Figure 5).

The variant analysis of captures (Table 2) shows that date and variants had a significant effect on the catch of *Ips sexdentatus*.

As you can see in the next diagram (Figure 5), most beetles of *Ips sexdentatus* were captured for variant V4st (ipsdienol + PEG). For *Ips sexdentatus* the presence of metilbutenol in combination with ipsdienol had an inhibitory effect (0.44 insects/ day/trap for V3pl and 1.14 for V3st). The same situation was reported by Mihalciuc et al. [6].

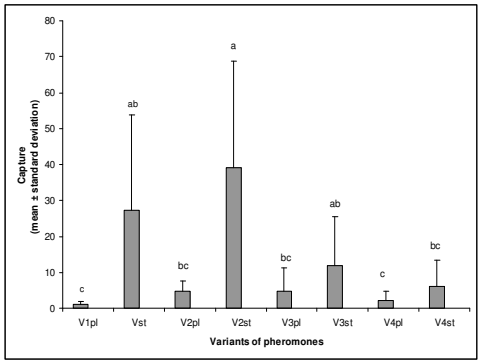

Fig. 5. *Distribution of Ips sexdentatus captures per variants of pheromones at Nehoiu between 16.06 and 21.07* (*Columns with the same letter show that the means are not significantly different from each other for P = 0.05*)

Concerning the efficiency of the stock way of the pheromone, better results for *Ips sexdentatus* were obtained when we used the little bottle because the flight of this bark beetle is spread in time and the pheromone was uniformly diffused during a long time. The fact that the flight of *Ips acuminatus* is very concentrated in time (one or two weeks) explains why the use of the dispenser was more convenient in this

case. Further tests are necessary to confirm the efficiency of one or the other of stock ways.

Table 2

Effect of the date and the pheromone variants on the Ips sexdentatus captures at Nehoiu between 16.06-21.07

Factor	DOF*	F**	P***
Date	4	2.916	0.039
Pheromone variant	7	6.462	< 0.001

* DOF - degrees of freedom;
** F - Fisher coefficient;
*** P - calculate probability.

The small number of captured beetles and the alternation of periods with and without catches lead to uncertain results in the case of the experiment performed at Dumitreşti (Table 3).

Table 3

Attraction of the experimental variants at Dumitreşti in 2006

Pheromone variants	**Mean ± standard deviation**	**Percent from total capture [%]**
V1pl	5.88 ± 13.05[a]	28.3
V2pl	3.50 ± 4.60[a]	16.9
V2st	4.75 ± 7.52[a]	22.9
V3pl	2.88 ± 2.75[a]	13.9
V3st	0.88 ± 1.36[a]	4.2
V4pl	0.50 ± 0.53[a]	2.4
V4st	2.38 ± 4.78[a]	11.4

4.2.2. Capture distributions of *Ips acuminatus* on pheromone variants

Bakke [1] presented ipsenol, ipsdienol and cis-verbenol as components of the aggregation pheromone for *Ips acuminatus*. Mihalciuc et al. [6] reported that for *Ips acuminatus*, in 2006, the combination ipsdienol, ipsenol, cis-verbenol and polietilenglicol was the most efficacious.

In 2007, the index of efficiency established for the same combination registered a value of 1.08 captures/day and trap, comparable with the value of 1.54 captures/day/trap established for Acuwit [6].

In our tests from Nehoiu Forest District, the combination ipsenol + cis-verbenol + ipsdienol + PEG was very efficient. The capture at V4pl was of 13.25 insects/ day/trap and at V4st was of 3.84 insects/ day/trap, much higher than the known data from the literature [6], [7].

5. Conclusions

By these researches we found some new data for our country referring to: the dynamics of the flight in the case of bark beetles *Ips sexdentatus* and *Ips acuminatus*, the preference of this bark beetle of pines for an appropriate pheromonal composition, the efficiency of the stock way of the pheromone.

The studied species of *Scolytinae* presented different flight diagrams in each experiment. Therefore, it is necessary to know the local characteristics of the flight of bark beetles in order to be able to intervene at the moment when the population begins its outbreak.

For *Ips sexdentatus*, our results obtained in 2006 show that the presence of ipsdienol assures, in both experimental plots, a very efficient attraction and the presence of metilbutenol in combination with ipsdienol has an inhibitory effect. In our tests from Nehoiu Forest District, the combination ipsenol + cis-verbenol + ipsdienol + PEG was very efficient for *Ips acuminatus* and the capture was of 13.25 insects/day/trap, much higher than the known data from the literature.

Through the research presented in this paper we achieved important theoretical and practical results concerning the knowledge of the pest insects involved in the drying phenomenon of pines in Romania. Our conclusions will be validated or not by future researches.

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