Boll. Zool. agr. Bachic.
Ser. II, 25 (2), 1993: 173-182

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Outbreaks of *Ips typographus* (L.) (Coleoptera Scolytidae) in spruce stands of Northern Italy (*)

Abstract - Outbreaks of the spruce bark beetle have caused considerable damage to the coniferous woods of the Orobic Prealps in Northern Italy. From 1985 to 1989 more than 40 hectares of forest were destroyed and more than 2000 trees felled. The present paper show the evolution of these outbreaks and the results of these controlling effects with trap trees and pheromone baited traps and also some short critical notes on these methods of control.

Riassunto - *Importanti attacchi di* Ips typographus *(L.) (Coleoptera Scolytidae) in peccete del Nord Italia.*

Nel corso degli anni 1985-89 *Ips typographus* ha causato gravi danni alle peccete delle Prealpi Orobiche nel Nord Italia. Le catture con le trappole a feromoni iniziate nel 1986 e le osservazioni di campo hanno permesso di rilevare le epoche di volo degli adulti, le ovideposizioni e la durata dello sviluppo larvale alle diverse altitudini. Le tecniche di controllo messe in atto evidenziano la necessità di associare al metodo della cattura massiva il taglio fitosanitario al fine di limitare l'espansione dello scolitide.

Key words: *Ips typographus*, outbreaks, pheromone-baited traps, trap trees.

INTRODUCTION

The spruce bark beetle *Ips typographus* (L.) is distributed throughout the Paleartic region. In these last years the beetle has caused great damage to the forests of the Brembana and Seriana Valleys (Orobic Prealps, Northern Italy) which have required controlling action. These attacks usually interested weakened forests even if some cases the forests destroyed were apparently healthy and well looked-after (Schlyter et al., 1984; Grünwald, 1986). Due to

(*) Lavoro effettuato con il contributo M.U.R.S.T. 60% «Ecologia dei fitofagi d'importanza forestale».

the difficulty in controlling the evolution of the infestation with the usual method of grafting, the use of trap trees and pheromone-baited traps were necessary also for the mass-trapping of the pest (Weslien, 1992). Control programmes based on a large mass trapping campaign were carried out in different countries producing positive results in relation to the extention of treated surfaces (Bakke, 1982, 1983; Lindelöw & Weslien, 1986). This paper shows the behavior of these outbreaks and the results of the control using trap trees and pheromone-baited traps. Some short, critical notes on these control methods are also included.

MATERIAL AND METHODS

The observations were carried out from 1986 and 1989 in Gromo, Valgoglio and Piazzatorre, in the district of Bergamo.

The spruce stands of Piazzatorre, in the higher part of the Brembana Valley, is situated on the western side of «Pizzo Badile», covers an area of between 1100 to 1700 meters above sea level. It is a high forest on average of more than 60 years of age, with little renewal. There is superficial soil on calcium substrate of normal consistency and poor fertility. In 1987 after the avalanche in Gremanzo at about 1400 meters of altitude, the non-removal of the felled trees allowed the insects to reproduce abundantly. In the following years the attacks spread out to interest «Il Piazzo» at 1150 meters above sea level and all together 7 hectares were infested in 1989.

The spruce stands of Valgoglio is in the higher part of the Seriana Valley and is located on the southern side of Mount Agnone. The wood extends from S/SW and covers an area of between 1000 and 16000 meters. It is a spruce stands composite by trees of different ages, on superficial soil with metamorphic rock with little fertility. The destroyed area of about 9 hectares is divided into 8 to 9 separate areas of healthy wood between the altitudes of 1100 and 1350 meters. Conditions suitable fot the infestation of the area was caused by a whirlwind. The spruce stands in the area of Gromo, faces N/NE and covers a steep slope of 20°-40° from 700 to 1000 meters. It is a pure population of spruce, all of the same age and mature. The land in general is very steep and superficial, has rocky outcrops and lacks fertility. The damage led to the complete destruction of several hundreds of plants over an area of about 3 hectares. A whirlwind was the cause of the attack in this case too. Further observations were also carried out in the spruce stands of Lenna (area of Santa Trinità) and Clusone (area of San Rocco) situated at low altitude.

Trap trees and pheromone baited traps were placed in areas already infested to keep the pest under control starting from 1986.

All the traps are the Theyson type (radiator-style), grafted with pheromone 2-methyl-3-buten-2-ol, Ipsdienol(S)-cis-Verbenol (Pheroprax ®). Except for 3 used in 1988. (1 at Piazzatorre and 2 at Valgoglio) and 4 in 1989 (2 at Piazzatorre and 2 at Valgoglio) which were Booregaard type formed by a tube grafted with metilbutenol-cis-Verbenol-Ipsdienol (Ipslure ®) pheromone.

They were always positioned singularly inside the cleaned area following the grafting of plants which were infested by the bark beetle.

A partially shaded area was chosen and a safety distance of about 15 to 20 meters from the healthy plant was respected. The pheromone was positioned a short time before the adult emergence began. It was then replaced twice or three times a season. The duration of the emission of the substance, which was verified using the gradual substitution in contiguous traps and the testing of the capture curves, resulted to be of about 8 to 10 weeks.

Some traps were positioned in direct sunlight instead of in the shade without any noticeably unfavorable effect.

Furthermore, one bait plant (Valgoglio 1988) and 12 baits at ground level were positioned. The bait plant at ground level was prepared as follows; felling of plant (if already felled, separation from the roots), cutting of the top to obtain the length needed, removal of the branches, treatment using insecticide and grafting with pheromone. To be able to count the number of insects killed, very fine netting (the kind used in greenhouse to protect and shade the seedlings), was positioned under the plants, from which the dead insects were regularly removed and counted.

Preference was given to plants already felled but still fresh when choosing the subjects to be used, as done in 1989 when the plants used had already been felled by a late, abundant snowfall at the end of April and weakened, dominated or anyway suffering plants as used in 1988.

The active ingredients used were chosen according to the following necessities: low toxicity, persistence of at least two months, efficacy of action by contact and ingestion and facility of use. The first treatment in 1988 was carried out using a concentrated solution of fenitrothion and fenitrothion + trichlorfon which were effective however, only after 20 days. After this time the bark beetle invaded the bait plant. The treatment was consequently repeated using deltamethryn which gave very good results both in 1988 and 1989. In one case permethryn was used with equally good results.

In 1989 the bait plants were treated with 0.04-0.06 grammes a.i. per linear meter starting from dosages of 4 and 8 cc of product per liter of water using different volumes of solution per unit of surface. The duration of effectiveness in this case was 2 months.

In 1989 the following dosages were used: 4 cc of product per liter on the bait

plant at Valgoglio and 7 cc per liter on those at Piazzatorre and the same quantity of solution was distributed approximately per surface unit.

ECOLOGY AND DEVELOPMENT

Ips typographus is present in the Brembana and Seriana Valleys at altitudes between 600 meters and 1800 and over.

It was considerably difficult to distinguish the first parent generation from the sister generations and the latter from the second generation in consequence of a complex overlapping of the life cycles (Rudinski, 1962; Annila, 1969). The collected data however, enabled us to define the trend of the biological cycle quite precisely over this period of two years.

Above all the adult emergence presented a grading of 20 to 30 days, which is expressed by the trend of the captures and the excavating of the coupling chambers. On average, the period of emergence lasted from the 20 May to the 15th June.

The sister generations were usually observed starting from the end of June to the 15th July, that is 4 to 5 weeks after the first attack of the host.

The complete depositing of the eggs took place in 10 to 15 days, the complete development of the larvae in 30 to 50 days, and the nymphal state lasted about 10 days.

We were able to observe the first adults without pigmentation on about the 25th July, while those with pigmentation could be observed at the beginning of August. In August, especially during the first part of the month, the adults of the first generation reached maturity, while the adults of the sister generation reached maturity in the second part of the month.

Consequently, the complete cycle lasted on average 60 days.

Most of the mature adults prepared for winter, while the remaining adults flew immediately away to start a second generation.

The first depositing of the eggs of the latter took place in the last days of July, as happened at Gromo and Valgoglio in 1988. In this case the first adults started to mature from about the 5th or 10th September, or during August and all the month of September, without however any possibility for the larvae to conclude their cycle.

It follows that above 800 to 1000 meters, the behavior of *Ips typographus* was as a monovoltine, the possibility of having a complete second generation was limited only to the eggs layed earlier, that is before the 15 to 25th May, with favorable climatic conditions, such as to produce adults before the 20 to the 25th July. Consequently, the late laying of eggs in June or July (from sister

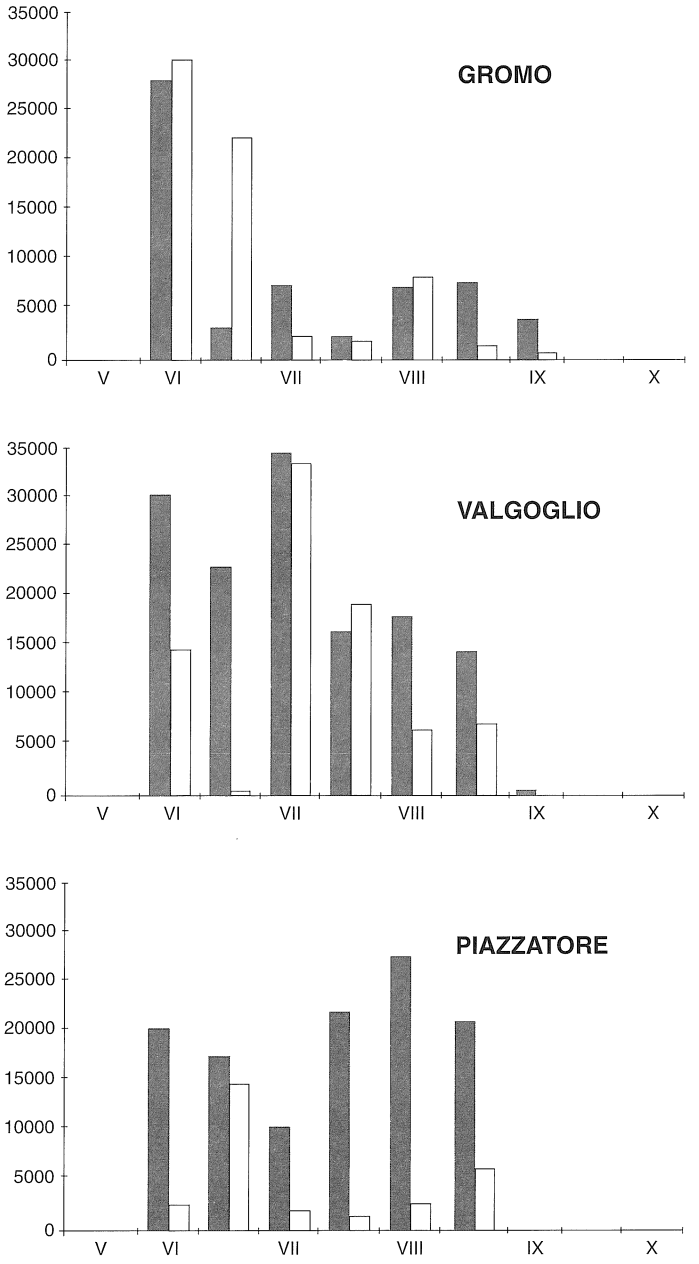


Fig. 1 - Flights of *Ips typographus* (L.) in the years 1988-1989 in Gromo, Valgoglio, Piazzatorre (Orobie Prealps, Northern Italy).

generations) and the complete development of the new adults in August as usual, hindered the possibility of having a second generation.

At an altitude of 600 to 700 meters the presence of a second generation is instead normal, in fact the adult emergence took place from the end of April to the beginning of May and the first generation completed its cycle by the end of July (Bakke et al., 1977).

The difference in altitude between 600 and 1000 to 1400 meters caused on average a difference of 15 to 20 days in the cycle (fig. 1).

Ips typographus feed on suffering plants which were broken or bent by snow or wind, weakened by attacks of parasites or drought or on residual cuts such as branches, summits, trunks and substrates which are easily found in a wood.

The receptivity of a spruce can be evaluated experimentally using parameters of growth and vitality, which however do not permit to distinguish between the plants that will die from those that will survive an attack with complete certainty (Bakke, 1983).

Therefore in theory felling could be started before the attack takes place. In fact these cuts are often made in areas around those that are heavily infested (especially at Piazzatorre) with satisfactory results: unfortunately the insect is also able to colonize plants, which according to these parameters, seem to be in good condition, and therefore the infestation can propagate in an unpredictable way (Nihoul & Nef, 1992).

In the Brembana and Seriana Valleys the principle cause of the more serious attacks can said to be weather damage caused to groups of trees of varying numbers, because the damaged wood was not removed in time.

Another decisive factor was the climatic course, which in recent years alternated exceptionally mild winters and cold, dry winters. In particular, the spring drought in coincidence with germination surely weakened the woods, especially those situated on superficial soil and porous subsoil, influencing as did the hot dry summers.

Other factors such as weakness inherent to the absence of other plants and the growth at an altitude too low with respect to the optimal position, often caused by a mistaken artificial planting and secular anthropic selection which favored considerably *Picea. excelsa*, considered to be a rare and precious species.

The infestation spread out like on «oil slick» covering homogeneous areas with pedological characteristics and vegetation, often moving up (Gromo) or down (Piazzatorre) valleys or whole slopes. In some cases the infestation seemed to extend until the complete destruction of the wood took place, as in the case of Gromo, but usually the gradual lessening of the predisposing factor limited the damage to a few hectares, on the condition that the controlling techniques were carried out appropriately.

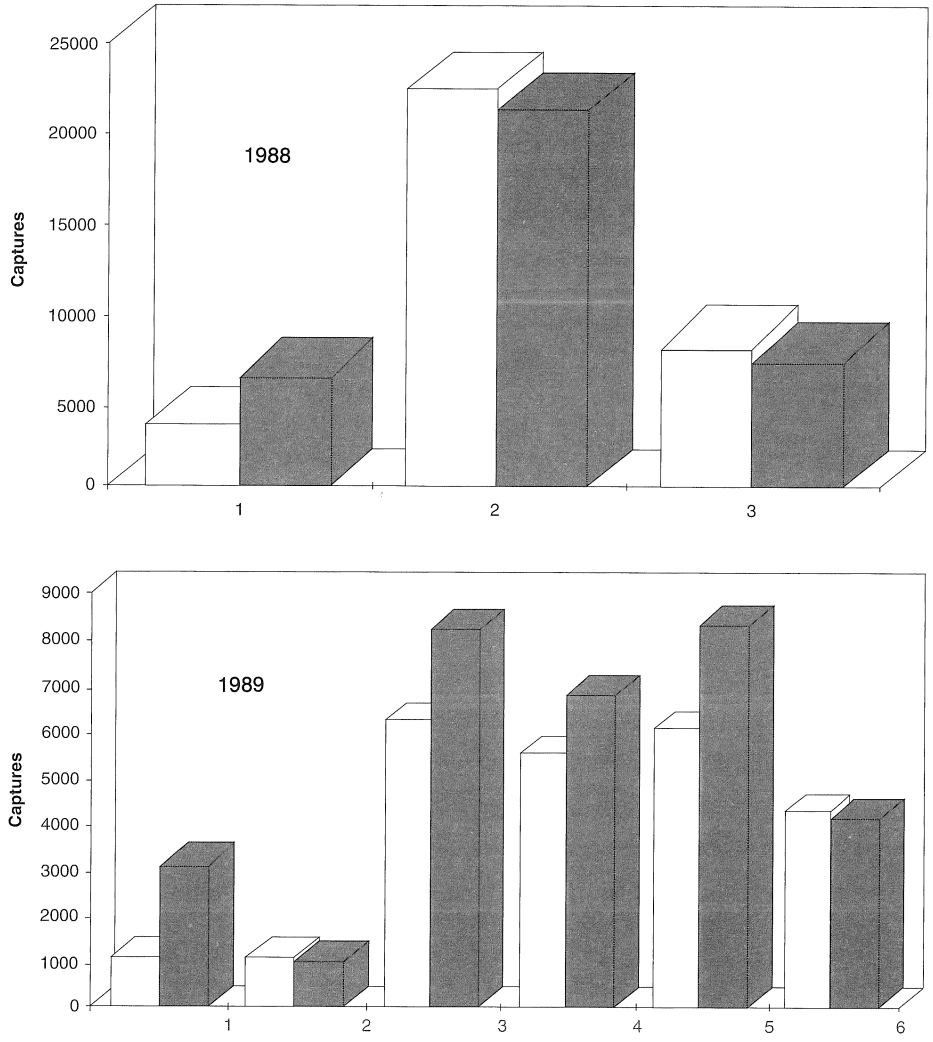
RESULTS AND DISCUSSION

Trap trees and pheromone baited traps utilized in the mass trapping, proved their efficacy in containing the outbreaks of *Ips typographus*, contributing to the progressive numeric reduction of the population of the pest (tab.1). The number of the specimens captured with traps positioned a few meters apart in equivalent positions do not show any significant difference between these two

Tab. 1 - Total of captures and infestated trees in the experimental areas.

Locality	Year	Gen. hiber.	First gen.	Total	n° trees
Gromo	1987	288900	47250	336150	800
	1988	83100	26000	109100	40
	1989	60500	10000	70500	20
Piazzatorre	1986	80000	25600	105600	900
	1987	16000	600	16600	200
	1988	83100	26000	109100	50
	1989	31100	7150	38250	0
Valgoglio	1987	350300	47250	397550	100
	1988	122200	17450	139650	20
	1989	74500	17800	92300	2

methods of capture (figs. 2, 3). The trap trees however permitted the capture without conditioning an attack of the healthy trees nearby, in fact 6 out of 12 trap trees were situated a few meters from healthy plants in a wood without causing the colonization; in two cases the trap trees were even leant against a healthy fir tree (stopping the plant from rolling down into the valley). (6200 and 4000 specimens were captured in these two cases). The two trap trees at Piazzatorre in 1988 were positioned in the central part of the wood at 20 to 30 meters from a cleaned area because of the investigation already in act, and in a radius of 50 meters there were 50 trees. Even if 21,200 specimens were attracted and captured no one of the healthy plants were attacked. The capacity of the trap trees taken from the same tree and graffed with only 1 central capsule of pheromone and 2 capsules hallway alone the 3 external parts was also verified. The number of insects captured in this 2nd case demonstrated an evidently larger attractiveness with respect to those with a single central capsule (fig.4).



Figg. 2-3 - Captures with trap trees and pheromone traps in 1988 and 1989.

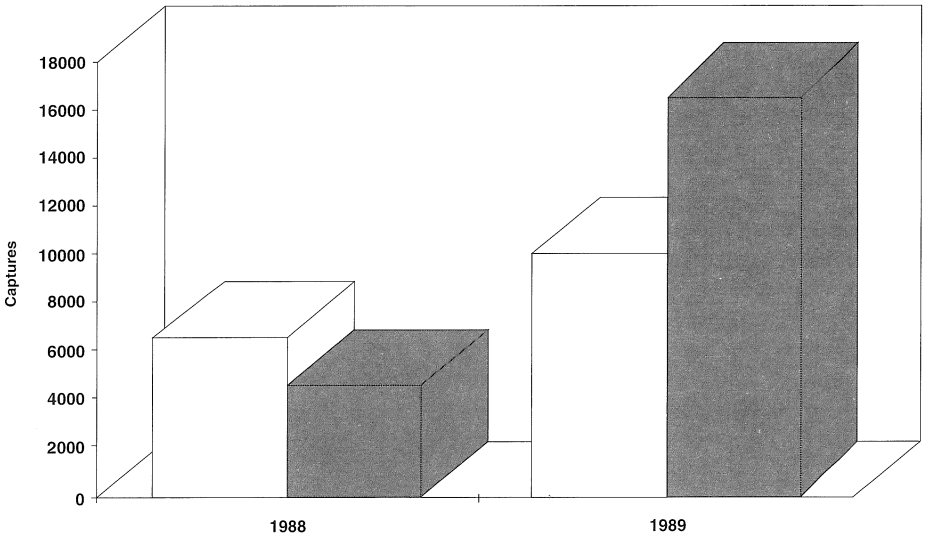


Fig. 4 - Captures with trap trees grafted with one or two doses of pheromone.

CONCLUSIONS

The use of trap trees and pheromone baited traps can be considered complementary. The preparation of the trap trees is definitely more impegnative than pheromone traps. The latters need regular controlling every 7-10 days while the former differ as the don't need any periodic controls except for the replacement of the pheromone and the repeated treatment with the insecticide.

The grafting and the removal of infested material proved to be very effective.

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Ricevuto il 25 ottobre 1993; pubblicato il 20 dicembre 1993.