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The study of larch bud moth migration in the Engadine Valley by means of a parapheromone[1,2]

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An area of 300 ha of larch forest in Sils and Val Bever (Upper Engadine Valley) was treated in 1978 with 7 to 9 g trans-11-tetradecenyl-acetate per ha formulated as gelatine based microcapsules (60–250 μ ∅). The objective was to inhibit copulation of the autochthonus adults of *Zeiraphera diniana* GUÉNÉE and to measure at the same time the degree of immigration of moths into the treated area. The preliminary results obtained, based on trap catches and on larval census, indicate that immigration exists and can be quantified by the confusion technique. The importance of this immigration, however, will be established later, when treatments have been applied against several consecutive *Zeiraphera* generations.

Trans-11-tetradecenylacetate (*E*11-14Ac) is the sex attractant of the larch bud moth, *Zeiraphera diniana* GUÉNÉE (ROELOFS *et al.*, 1971). The cis isomer of this substance inhibits male attraction (BENZ & VON SALIS, 1973). Since the identification of the sex attractant (parapheromone), several field experiments have been carried out in the Alps, mainly in the Engadine Valley, to collect information on the applicability of the confusion technique in the control of the larch bud moth. The first small plot experiments on the action of the sex attractant and of its cis isomer were conducted in 1975 and 1976. In 1975, *E*11-14Ac and its cis isomer were applied separately by helicopter to 4 larch forest plots of 10 ha each at the rate of 5 g active material/ha. For each substance used, one plot was sprayed over the entire area whereas the other was treated along the perimeter only. In this experiment, only the *E*11-14Ac treatment over the entire area proved to be successful and the catch of males of *Zeiraphera* in traps baited with female moths was reduced by 90%. In 1976 3 experiments were carried out to determine the optimal doses and the most convenient formulation of *E*11-14Ac. The substance was applied at the rate of 5, 20 and 50 g/ha to larch plots of 3 ha each and formulated in three different ways, i.e. as microcapsules (gelatine type capsules as used against the gypsy moth by USDA, slurred in water), as impregnated polyethylene tube dispensers of 12 m length (like those used against *Laspeyresia funebrana* TR.: ARN *et al.*, 1976), and diluted in paraffin oil. Microcapsule and paraffin oil formulations were applied by helicopter whereas the tube dispensers were fixed manually in the crowns and along the trunks of the larch trees. Microcapsules and tube dispensers very strongly or completely inhibited the attraction of males to the traps baited with either living virgin females or sex attractant. During a 55 day period after the application date (30 July) male catch was reduced by 99.3 and 100%, respectively. The paraffin oil treatment did not

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[2]Contribution no. 103 of the Working Group for the study of the population dynamics of the larch bud moth, supported by the Swiss National Science Foundation.

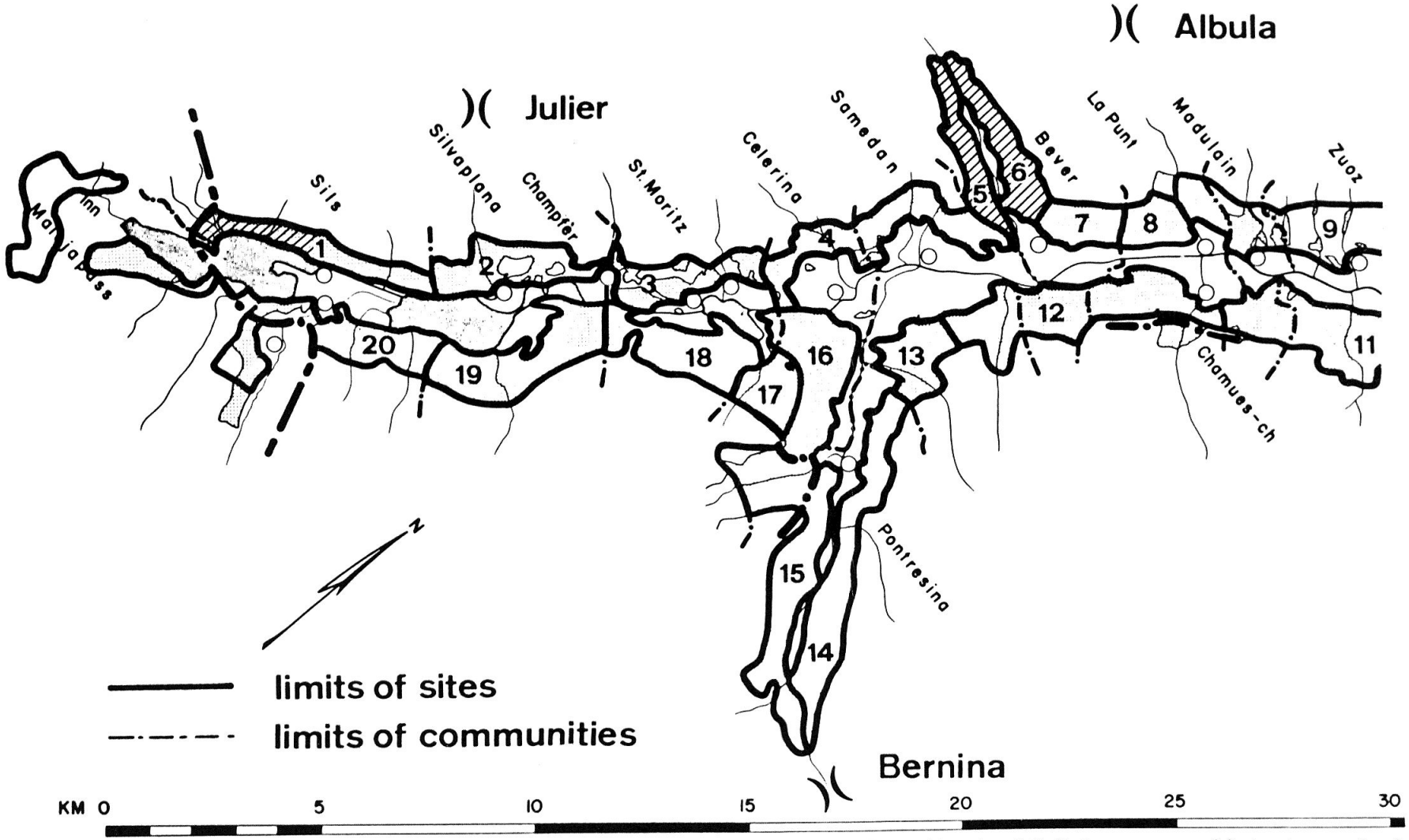

Fig. 1: Experimental sites in the Upper Engadine Valley: Sils area (western half of site 1) and Val Bever (sites 5 and 6). Reference areas of first order are sites 1 (eastern half), 4 and 7 (adapted from BALTENSWEILER & FISCHLIN, 1979).

hinder male attraction enough, and reduction of male catches did not exceed 88.4%. The effect of environmental conditions on the emission rate of the tube dispensers and of the microcapsules was measured periodically. Depending on the exposure the lure content of the formulations was reduced to 30% during the experiment with the tube dispensers and to 7% with the microcapsules.

The results obtained in these preliminary experiments justified planning the application of the confusion technique over the entire valley of the Upper Engadine in 1977, which means at the beginning of a new larch bud moth cycle (AUER, 1978). In 1976, however, males of the larch bud moth were caught in the experimental plots about 2 weeks before the emergence of the autochthonous population. This confirmed previous observations that continuous immigration of *Zeiraphera* adults might occur into the upper regions of subalpine mountain valleys (BALTENSWEILER & FISCHLIN, 1979). It was also clear that this immigration must contribute significantly to the regular cyclic change of population densities of the insect in the Alps. It was therefore decided to quantify the immigration of larch bud moth adults before investing further funds in a technique which might be inefficient.

EXPERIMENTAL DESIGN

Experimental areas

The Upper Engadine, situated in the central part of the Alps, runs in a SW-NE direction. On both sides mountain barriers rise to 3000–3800 m and isolate the valley except for two passes in the northwest (Julier and Albula) and one from the southeast (Bernina). Due to a unique geomorphological feature, the Upper Engadine is wide open at its head toward the deeply entrenched Val Bregaglia; however, there are no extensive larch stands in this latter valley. Towards the northeast the Upper Engadine descends into the Lower Engadine with vast tracts of larch forests. The Upper Engadine contains 6000 ha of forests; in southeast exposure there are predominantly pure larch stands whereas on slopes exposed to the northwest the mixed larch-cembran pine forest predominates. The experimental area to be chosen had to conform to the immigration hypothesis and should also belong to the sites with fastest population growth. Historical records have revealed that the first signs of defoliation generally appear in pure larch stands on slopes with south or southeast exposure. The Sils area (site 1 along the lake, 70 ha, fig. 1) was therefore selected for treatment with sex attractant because it is considered to be a typical area for moth convergence (BALTENSWEILER & FISCHLIN, 1979). In addition, Val Bever (sites 5 and 6, 230 ha) was selected for its topographical isolation (fig. 1). Sites 1 (portion between the lakes), 4 and 7 with similar ecological features, were considered as reference areas of the first order, whereas the entire Upper Engadine served as a reference area of the second order.

The application of parapheromone

The 2 areas of Sils and Val Bever were treated by helicopter immediately after the first male moths were caught on parapheromone-baited sticky traps.

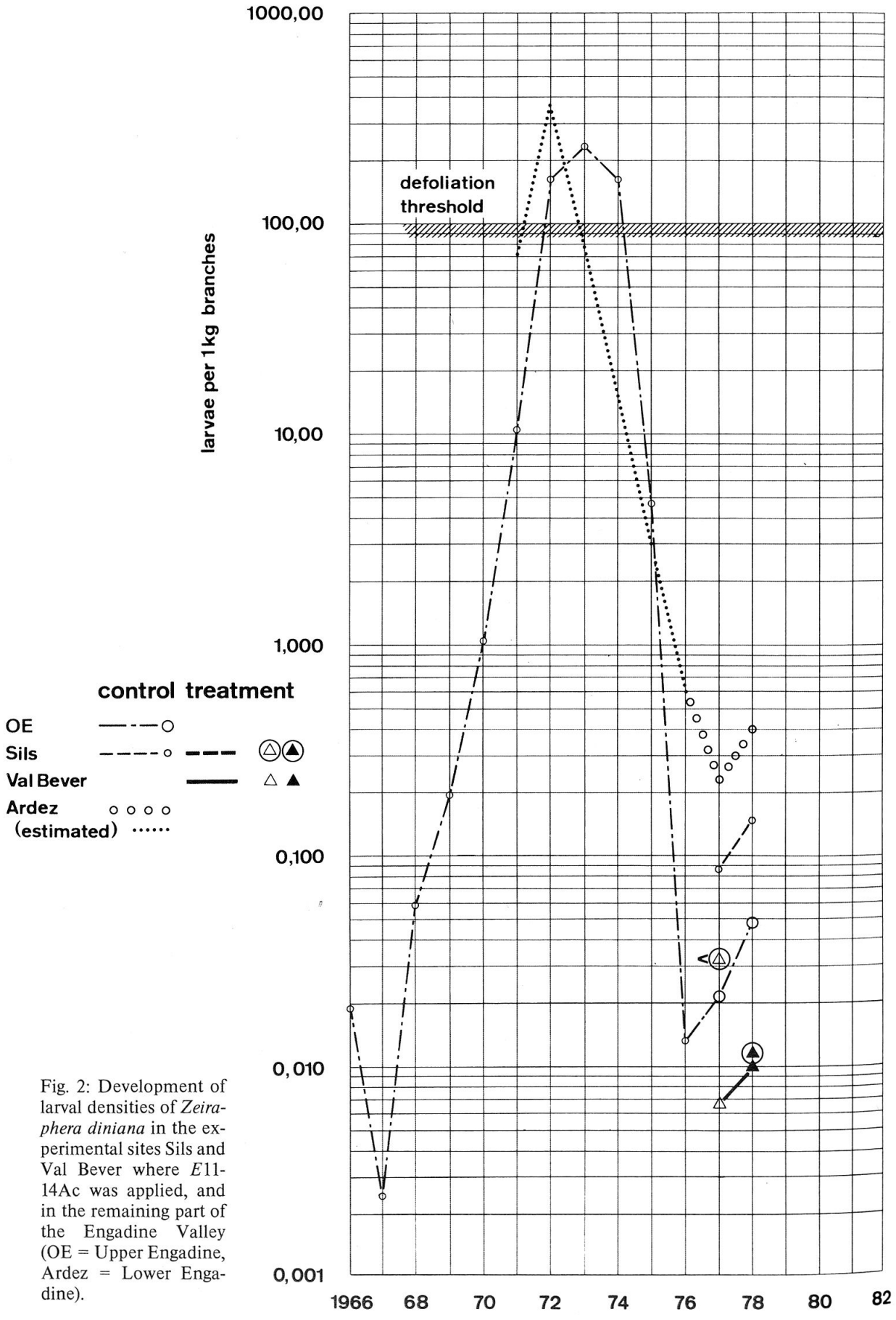

Fig. 2: Development of larval densities of *Zeiraphera diniana* in the experimental sites Sils and Val Bever where *E*11-14Ac was applied, and in the remaining part of the Engadine Valley (OE = Upper Engadine, Ardez = Lower Engadine).

Seven to 9 g of *E*11-14Ac/ha formulated in gelatine based microcapsules (60–250 μ ∅), were applied. The distribution of the capsules was evaluated on colored glossy paper exposed within or below the crowns of the larch trees. The emission rate was monitored by analysing the sex attractant content of the slurry exposed in petri dishes placed vertically and orientated towards the north and the south. These petri dishes were located on an observation tower 24 m in height, or just above the top of the larch crowns near the experimental area of Val Bever. After 60 days exposure the microcapsules still contained 13.3% (southern exposure) and 41.5% (northern exposure) of the initial amount of sex attractant.

Evaluation of the confusion effect

The degree of disruption of chemical communication between sexes achieved by the application of *E*11-14Ac was measured in 2 ways: (1) percentage of suppression of moth catch on traps baited with virgin females or with *E*11-14Ac as compared with the reference areas; (2) analysis of the larval density in the following generation.

The traps used consisted of galvanized metal plates (500x500x2 mm), covered with tanglefoot, and with a central hole (∅ 100 mm) into which either a cage with 2 virgin females was fitted or a rubber stopper containing the sex attractant was fixed. Each rubber stopper was treated with 1 μl paraffin oil containing 1% *E*11-14Ac.

In 1977 and 1978 20 traps baited with *E*11-14Ac, 6 traps baited with females and 4 dummy traps in six groups were distributed throughout the Val Bever area; 13 *E*11-14Ac and 2 dummy traps were mounted in the crown canopy of the Sils area. For the check 63 *E*11-14Ac traps, 8 female traps and 1 dummy trap were exposed in 9 groups at various locations throughout the Engadine Valley.

The larval density was estimated by analysing 423 kg branches from 164 trees in the experimental area and from 705 kg of 479 trees in the reference area.

RESULTS

The results are preliminary since only two of the planned treatments have been performed and the result of only one population census are available for interpretation.

The suppression of moth catch achieved is considered to be satisfactory: in 1977 it amounted to 92.2%, in 1978 it rose to 99.45% in Val Bever (♀ traps) and 99.7% in Sils (*E*11-14Ac traps only). In Val Bever 1 male was caught during 1224 trap nights, whereas in Sils 3 males were found in the course of 710 trap nights. Suppression of moth catch does not conclusively prove that resident females remain unfertilized. However, population densities are at such low levels that it is not feasible either to attempt to catch females by light trapping in order to verify the rate of copulation.

Population density in the larval stage is the more reliable parameter for the evaluation of the efficiency of the confusion technique. Fig. 2 depicts the larval densities during a full cycle for the Engadine area and for the experimental sites in 1977 and 1978. The densities of the experimental areas in 1978 were considerably lower than either of the controls. Unfortunately the census results are conform

with a negative binomial distribution; therefore, ordinary statistical procedures to test differences between means are not possible. Although the Val Bever population increased from 1977 to 1978 at approximately the same rate as the two reference areas, the low densities of the experimental sites in 1978 provide the necessary stimulus to proceed with the experiment.

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