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DETERMINATION OF DISTRIBUTION OF HARMFUL CLICK BEETLE SPECIES (COLEOPTERA, ELATERIDAE) BY SYNTHETIC SEX PHEROMONES

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Abstract—By means of pheromone traps containing synthetic sex pheromones, areas of the most harmful click beetle species, *Agriotes obscurus*, *A. lineatus*, *A. sputator*, *A. gurgistanus*, *A. ustulatus*, *A. tauricus* Heyd, and *A. lineatus*, occurring in southern regions and differing biologically from the so-called northern species, have been specified and charted in the European and central Siberian areas of the former USSR.

Key Words—Click beetle, *Agriotes gurgistanus*, *A. sputator*, *A. obscurus*, *A. lineatus*, *A. tauricus* Heyd, *A. ustulatus*, Coleoptera, Elateridae, monitoring, sex pheromones, trap.

INTRODUCTION

It is known that harmful click beetle species are distributed according to climatic zones. In the former USSR, *Agriotes gurgistanus* and *A. tauricus* Heyd occur widely in the country's southern regions; *A. sputator*, inhabiting the central and northwestern climatic zones (Dolin, 1964), is also widespread.

The first report of geranyl butanoate as a sex attractant of *A. gurgistanus*

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(Oleshchenko et al., 1980) stimulated us to develop synthetic sex attractant compounds for the widespread click beetle species. On the basis of structure-activity relationships of attractant components established (Siirde et al., 1993) we suggested attractant mixtures for six *Agriotes* species. We also designed a baited pheromone trap, "Estron," for monitoring and trapping them (Oleshchenko et al., 1987). Since click beetle species and their distribution had been earlier determined only by low-efficiency soil sampling, monitoring by means of pheromone traps was of great interest.

METHODS AND MATERIALS

The following synthetic sex attractant compositions and their carriers were used as attractant baits: for *A. obscurus* and *A. lineatus*—a mixture of geranyl hexanoate (4 mg) and geranyl octanoate (1 mg) on a rubber disk (0.5 g) (Oleshchenko, et al., 1986a); for *A. sputator*—a mixture of geranyl (8.5 mg), neryl (0.4 mg), and (*E*)-2,7-dimethyl-2,6-octadienyl (0.8 mg) butanoates on a rubber disk (0.5 g) (Lääts et al., 1990a); for *A. gurgistanus*—geranyl butanoate (5 mg), purity 99%, on a rubber disk (0.5 g) (Oleshchenko et al., 1979a); for *A. tauricus* Heyd—a mixture of geranyl 3-methylbytanoate and (*E*,*E*)-dimethyl-2,6-octadien-1,8-di-(3-methylbutanoate) (4 and 1 mg, respectively) on expanded polyurethane particles (5 × 5 × 10 mm) (Oleshchenko et al., 1979b); for *A. ustulatus*—a mixture of (*E*,*E*)-farnesyl ethanoate with its (*E*,*E*)-6-methyl and (*Z*,*E*)-isomers (85, 11, and 2%, respectively; 10 mg in all) on expanded polyurethane particles (5 × 5 × 10 mm) (Lääts et al., 1990b); and for *A. lineatus* occurring in the western Ukraine—a mixture of (*E*,*E*)-farnesyl ethanoate and neryl 3-methylbutanoate (9.9 and 0.1 mg, respectively) on expanded polyurethane particles (5 × 5 × 10 mm) (Oleshchenko et al., 1979c).

The synthesis of above attractant components is discussed in our preceding papers (Siirde et al., 1991, 1993). The larval density in the soil was assessed by soil samples, consisting of digging control holes 25 × 25 × 30 cm (eight holes per 100 ha), screening the soil, and counting the larvae.

Depending on the click beetle species, the mating flight usually begins in the end of April or early May for *A. sputator* and in early to middle May in the case of *A. obscurus* and *A. lineatus*. For the southern beetle species, *A. gurgistanus*, *A. tauricus* Heyd, and *A. ustulatus*, the mating flight begins in the end of June and early July. The beginning of the mating flight was determined by means of control traps placed in the fields 10–15 days before this period. The Estron pheromone traps (Figure 1) were placed directly on the earth. After the first males had appeared in control traps, a calculated number of traps (one per 10 ha) was distributed uniformly in the fields to be monitored. Trapping was usually carried out for about 35–40 days.

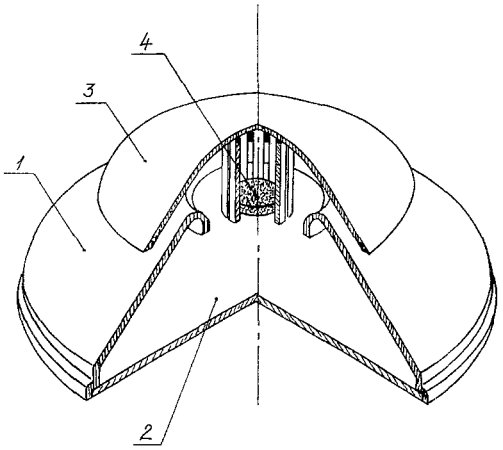

FIG. 1. Estron pheromone trap. 1, body; 2, bottom (160 mm diam.); 3, removable container for attractant bait; 4, attractant bait.

During 1983–1989, pheromone monitoring was carried out in 420 control stations, using 300,000 traps placed in corn fields over an area of 3 million ha. The results of monitoring are illustrated in Figure 2.

RESULTS AND DISCUSSION

The analysis of results of trapping and soil sampling obtained in different regions and for the different click beetle species with their different population densities showed straight statistical correlations between population density and the number of males trapped. These correlations are presented in the form of nomograms and equations and are recommended for the estimation of pest population densities by number of males caught by Estron traps baited with synthetic attractants (Oleshchenko et al., 1986b).

It should be pointed out that the data published on the distribution of *A. sputator* in northwestern regions of the former USSR (Oleshchenko et al., 1983) are incorrect. The northern border of distribution of this species runs along the parallel Brest–Moscow–Tyumen–Barnaul (Siberia). *A. obscurus* and *A. lineatus* prevail north of this line (see Figure 2).

Based on pheromone monitoring results, it has been established that two different species of *A. lineatus* inhabit the European part of the former USSR: one secreting the sex attractant geranyl octanoate and occurring in the northern region (Borg-Karlson et al., 1988), and the other, whose sex attractant is (*E*,*E*)-

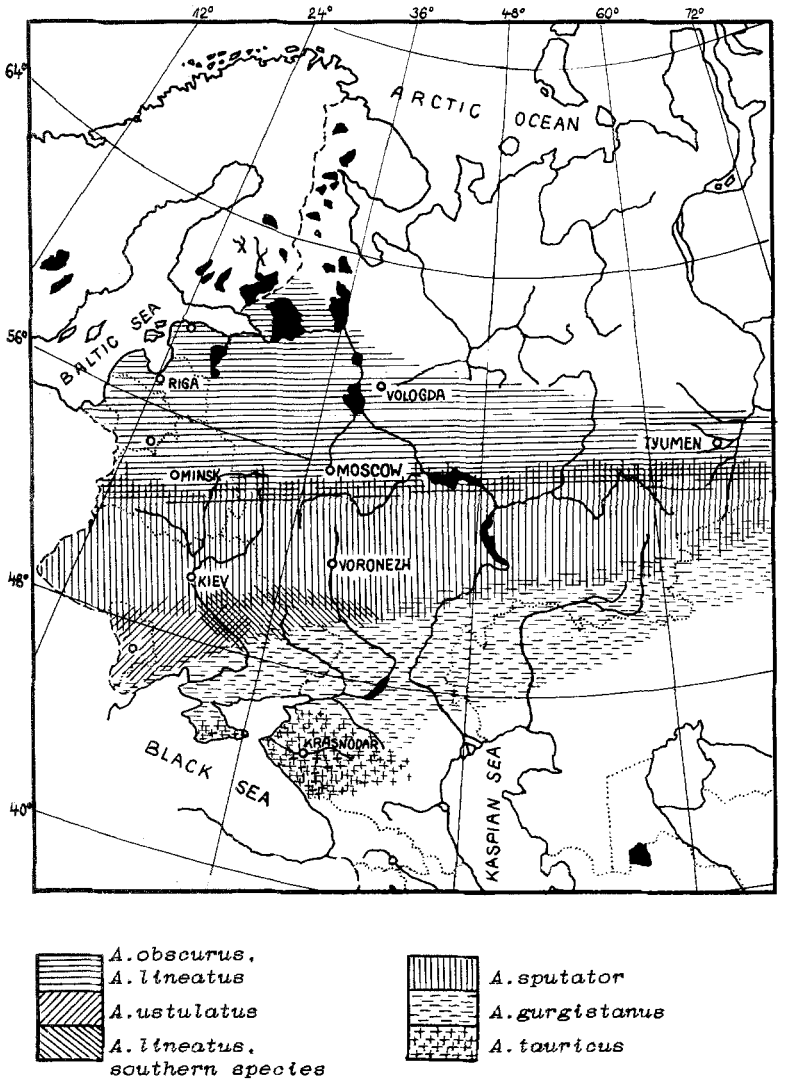

FIG. 2. Occurrence of click beetles *Agriotes* in the European part of the former USSR.

farnesyl ethanoate, occurring in the western Ukraine (Yatsy'nin and Lebedeva, 1984; Lääts, 1982). An extrapolation of the data enables us to predict the distribution of *A. obscurus* and *A. lineatus* in northern Europe, northern Poland, Germany, and France, *A. sputator* in Central Europe; and *A. ustulatus* may prevail in Romania and Bulgaria.

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