Pheromonal communication in European pest click beetles (Coleoptera: Elateridae): overview of research of the past decade

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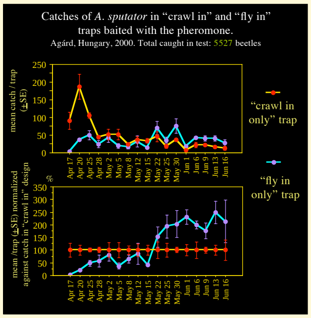
The implementation of IPM strategies against wireworms has been very difficult because of the shortage of reliable information on the key aspects of the species until few years ago. One of these key aspects is represented by the species distribution over the different European regions. Knowing the species present allows to establish promptly oriented monitoring programs saving time and materials and a general prediction of damage risk for the sensitive crops based on the knowledge of biology and behaviour of the different *Agriotes* species. When we started our studies in the early nineties, information on pheromone components from some species had already been published mainly by scientists from the Soviet Union (see for example Borg-Karlson et al., 1988, Kudryavtsev et al., 1993, Siirde et al., 1993, Yatsynin et al., 1996). By the end of the millenium, the composition of the female-produced sex pheromones for virtually all important European pest click beetles became known, including *Agriotes brevis, A. lineatus, A. litigiosus, A. obscurus, A. proximus, A. rufipalpis, A. sordidus, A. sputator* and *A. ustulatus* (Coleoptera: Elateridae) (Tóth et al., 2002a,b 2003, Tóth and Furlan, 2005).

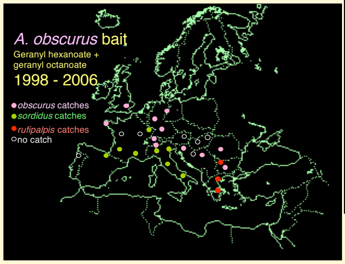
Optimal trap design

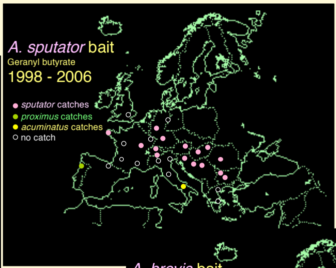


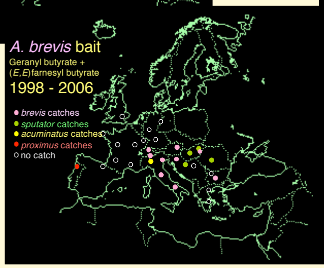
Conventional pheromone trap designs used with other insects were not performing satisfactorily with click beetles. Several species move preferably crawling on the soil surface in early spring, while later, when temperatures go up, they fly actively. "Crawl in only" trap designs (into which beetles could get into by crawling) were catching large numbers very early in the spring, but "fly in only" designs caught better later in the season (but were not good in early spring).

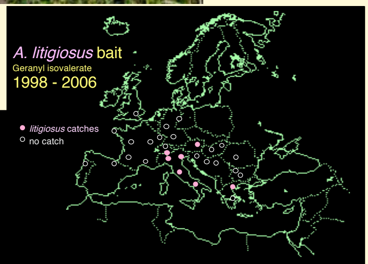
Based on these experiences a special trap design, the YF click beetle trap has been developed, into which beetles could get in both crawling and flying (Furlan et al., 2004).

The YF click beetle trap, which, baited with pheromone, has been optimized for capturing *Agriotes* spp.



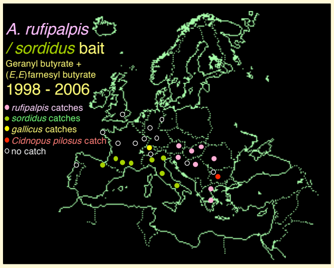






"Twin" species

In some cases "twin" species were found with respect of pheromone composition. For example both *A. sordidus* and *A. rufipalpis* appeared to use geranyl hexanoate in their pheromone. However, so far we were unable to register specimens of both species in one trap at any site, which suggests that the two species are geographically well separated.



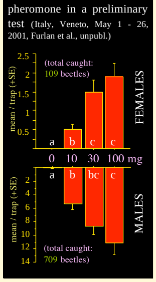
A similar case was found recently in *A. lineatus* / *A. proximus*, both responding to the blend of geranyl octanoate and geranyl butanoate. Also, antennae of both species reponded with similar intensity to these two compounds in electroantennogram studies (EAG). The only difference between the two species was that while *A. proximus* showed some response in the field to geranyl butanoate on its own, the same was true for *A. lineatus* and geranyl octanoate (Tóth et al, unpublished).

The two species are taxonomically separated due to mainly one constant morphological difference but there is no study demonstrating biological separation. Genetic or classical biological studies would be needed to clear up this issue.

New research directions

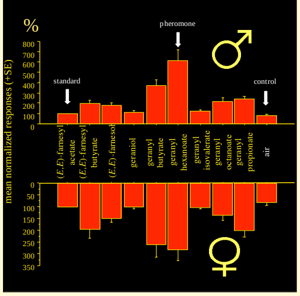
Future research efforts are directed towards: (1) establishment of correlations between trap catch and population density and/or damage levels in several representative crops; (2) study of the interactions of the respective pheromone compositions with the objective of combining pheromone baits in the same trap for catching several click beeetle species with a single trap; (3) development of attractants for female beetles.

Catches of male and female *A. sordidus* in traps baited with different doses of the pheromone in a preliminary test (Italy, Veneto, May 1 - 26, 2001, Furlan et al., unpubl.)

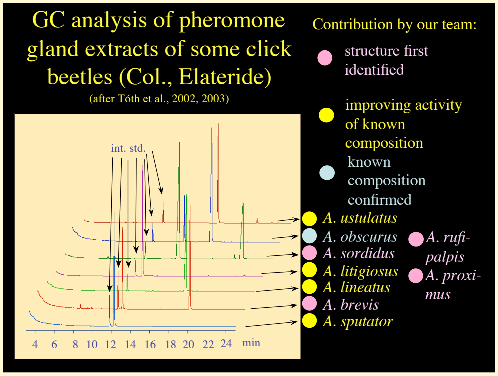


Originally it was thought that the pheromone of *Agriotes* click beetles falls into the "classical" sex pheromone category (is produced by females, attracts males). From unpublished experiments we obtained increasing evidence that in several *Agriotes* species the synthetic pheromone attracts also females, so perhaps this categorization should be revisited and it is possible that the click beetle pheromones show some "aggregation" traits also. In EAG studies both females and males show similar response intensities to a series of pheromone structures, responding best to the respective pheromone components of the species, suggesting that female beetles are also capable to perceive and differentiate between pheromone signals.

EAG responses of *Agriotes sordidus* to click beetle pheromone components (means of 10 antennae)



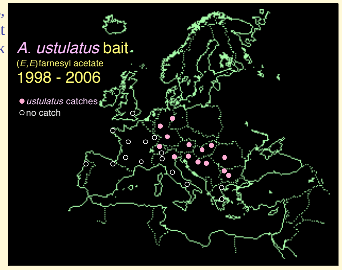
Structure elucidation of pheromone components

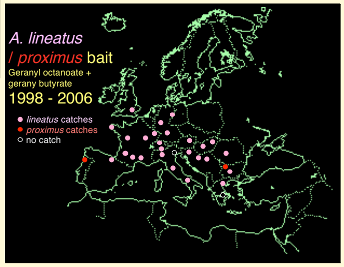


Europe-wide distribution

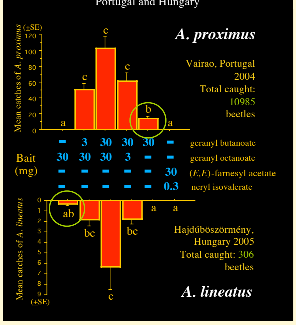
The YF trap baited with the respective pheromone bait, proved to be effective to detect the presence of species also at very low population levels. Having conducted a survey at many European countries, distribution maps of the species could be established (Furlan et al., 2007).

Some of the pheromone baits proved to be highly specific, while others, due to the presence of common components, occasionally caught also non-target click beetles.





Catches of *A. proximus*and *A. lineatus* in field tests in Portugal and Hungary



There are also indications suggesting the possibility of geographically different pheromone compositions in *A. proximus*.

A. proximus we caught with a blend of geranyl butanoate and geranyl octanoate in Portugal and Bulgaria, while in the literature two completely different compounds, (*E,E*)-farnesyl acetate and neryl isovalerate had been described as pheromone components for a Russian population of *A. proximus* (Yatsynin et al., 1996).

No *A. proximus* was caught with this blend at any of our test sites in Europe. It is interesting to note that a similar discrepancy was reported in the case of *A. lineatus* also. While geranyl octanoate was the main pheromone component in populations in Eastern Europe (Russia), again the mixture of (*E,E*)-farnesyl acetate and neryl isovalerate was reported to attract *A. lineatus* populations in Western Ukraine (Kudryavtsev et al., 1993, Siirde et al., 1993). In contrast to this, in our studies populations of *A. lineatus* responded uniformly to baits with geranyl octanoate plus geranyl butanoate all over Western, Central and Southern Europe, even in areas neighbouring Western Ukraine (Hungary, Romania, Bulgaria). Even *A. lineatus* populations in Canada (introduced from Europe in the past) responded to the geranyl octanoate / butanoate blend (Vernon & Tóth, 2007).

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