

DEVELOPMENT OF FUTURE STRATEGIES FOR PEST MANAGEMENT IN EUROPE

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Abstract Global warming together with global trade and tourism gives foreign organisms a lot of opportunities to enter Europe and to find suitable habitats to establish. A number of these species already have a status as pests in their native countries and now start to be of major concern in Europe. A growing rejection of synthetic insecticides by people is observed particularly in industrial countries. The use of these insecticides is restricted e.g. in food production by new national and European directives, and pest management is limited to monitoring and the use of baits in presence of foodstuffs. Consequences for scientific research and for the industry are to invest in insecticides with novel action with special focus to user- and eco-friendly properties. Existing resistance of pests against frequently used insecticides should be overcome by the development of compounds which interfere in the metabolism and nervous system of arthropods in different ways than conventional insecticides. Additionally new monitoring systems are required which will also detect alien species. Completely new control strategies without acute acting insecticides and baits, which can be used without risk of contamination of the environment, should be developed particularly for sensitive areas like food production, pharmacy, hospitals etc. Countries with a vegetation of high diversity (e.g. tropical rainforests) will have a major significance in the research and development of natural compounds for pest control in future.

Key Words Globalization, natural compounds, baits, pheromons, alien species

INTRODUCTION

Pests have lived with man since he started to settle more than 10.000 years ago. A lot of strategies were developed to minimize the economic damage, which was caused by these pests (Levinson and Levinson 1990; Bodenheimer, 1928). With the development of the first synthetic pesticides pest control suddenly started to be feasible without major efforts on the identification and biology of pests. Until 20 years ago, the control of cockroaches and other arthropods relied largely on synthetic insecticide sprays. With the development of baits, which can be selectively applied, where pests like cockroaches, silverfish, ants and flies occur, this situation has changed. With some knowledge on identification and biology of pests these baits could be applied eco-friendly. In the control of cockroach and housefly infestations baits have gained steadily in importance compared with conventional sprays, particularly when used in sensitive areas, e.g. food production, hospitals, kindergartens, etc. Another more user and environmental friendly strategy was the use of larvicides (chitin synthesis inhibitors and juvenile-hormone analogues substances) which were applied as baits or sprays. The development of baits was triggered by the synthesis of new compounds particularly with oral action. Highly sophisticated bait formulations were even more important particularly for control of cockroaches, ants and flies which relied on bait matrices which are highly palatable for special pests. The active ingredient itself started to be of minor importance compared to the older spray formulations. The next important inventions were application devices like the Baitguns. These allow the application of very small amounts of bait at places not accessible for people and pets, but on the trails of the pests (Pospischil et al., 2000).

But nevertheless sprays retained their importance for pest management, and a lot of effort was invested by industry to create more user friendly sprays with less active ingredients but longer residual efficacy and less pollution of the environment. Now with the discussions on the use of synthetic insecticides on one side and the risk of vector borne diseases and economic losses through introduction of many alien pest species on the other side a controversial discussion on the future need of pest control products started.

RESISTANCE

Resistance of invertebrates started to be of major concern already a few years after the first synthetic insecticides reached the market and resistance management strategies exist for a long time. The Insecticide Resistance Action

Committee (IRAC) started 1984 as an inter-company organization to co-ordinate strategies to prevent or delay the development of resistance in arthropods (McCaffery and Nauen, 2006). There is now a great challenge to develop new compounds and synergists to overcome the existing resistances of pests against frequently used insecticides.

CHALLENGE THROUGH INVASION OF NEW PEST SPECIES

Exotic pests have been displaced since hundreds of years by global trade. One example is the introduction of the American cockroach (*Periplaneta americana*) from the tropical Africa to Central America with the slave ships in the 17th century (Bell and Adiyodi, 1982).

The transfer of insects with goods along the Mediterranean coast is known since more than 2000 years (Bodenheimer, 1928; Levinson and Levinson, 1990). During the middle age until modern age pest insects, mainly cockroaches and stored product pests arrived frequently in central European harbours, but if at all they could only survive the summer season in the harbour. Further distribution did not take place. This situation changed in the middle of last century with the strongly increasing urbanization (Robinson, 1996), growing prosperity and progress, modern buildings with central heating and constantly warm climate conditions. The temperature in urban areas is now up to 5° Celsius higher than in rural and natural areas. Large livestock facilities with constantly warm climate and extensive food processing and handling combined with global warming now even provide good conditions for tropical species to establish in temperate regions. The increasing number of buildings with tropical climate conditions in zoological and botanical gardens and later tropical indoor swimming pools also offer excellent conditions for tropical invaders (Holway et al., 2002; Pospischil, 2001, 2004).

Through the increasing trade with aircrafts over long distances between continents even sensitive species like mosquitoes could arrive safely in Central Europe, e.g. *Aedes japonicus* (Switzerland) or *Anopheles* species which cause the so called airport malaria (Anderson et al., 2005). Global warming allows arthropods which already reached South Europe (e.g. *Aedes albopictus*) to enter Central Europe.

But also pests which belong to the native fauna may start to be a challenge. Bed bugs did live together with humans since ~10.000 years, but declined in many countries to unimportance in the mid of the 20th century. The resurgence of bed bugs since the last 15 years has caused immense efforts in research and development of innovative detection and control methods (Boase, 2007). This species was thought to be beaten in the industrial countries since the mid of last century. The strong increase of bed bugs, which is accompanied by the detection of highly resistant populations (Romero et al., 2007) shows the urgent need of new control strategies with good monitoring systems, kits for resistance detection, resistance breaking products and physical control strategies.

The introduction of diseases by infested people or animals must not be underestimated. In case of the blue tongue virus, which was introduced to Central Europe 2006 via infested animals, native biting midges of the genus *Culicoides* started to transmit the virus instead of the original vector *Culicoides imicola*, which does not occur in Central Europe. The outbreak of the blue tongue disease in several Central European countries caused high economic loss in livestock, but strategies to overcome this disease were not available and had to be developed first (Mehlhorn et al., 2009).

The number of alien species, which arrive and establish in Europe as well as in other continents worldwide, grows steadily. Efforts have to be undertaken to overcome hazards caused by these invaders to people and animals (livestock and pets) and adverse effects to nature (Holway et al., 2002).

PEST MANAGEMENT AS A GLOBAL TASK

Global warming allows aliens from tropical areas to establish even in temperate zones of the northern or southern hemisphere where the low temperatures did not allow survival for these species outdoors thirty to twenty years ago. Examples are mosquitoes like the tiger mosquito *Aedes albopictus* or the Asian mosquito *Aedes japonicus*.

Global trade and tourism allow pest organisms to travel undetected between continents within a few days. In the past most goods arrived with ships at the harbours and were checked during unloading. Nowadays many goods like fruits, vegetables and other foodstuffs arrive by airfreight directly at their destination in the interior, or they arrive as container freight and are put on a truck directly after unloading in the harbour. Infestation of goods is often first recognized at the final destination and the local PMP has to identify the pest and decide what measures to take. The pest control business has to consider these changing conditions and establish a training of the pest management professionals to provide them with the right answers to the new situation in pest control (Pospischil, 2001).

CONSEQUENCES FOR INDUSTRY

The development of new and innovative technologies including formulations and innovative concepts for the near future is a challenge for the pest control industry, but also for federal institutes and universities. The pest management needs new innovative strategies to overcome the described hazards which are caused by the elimination of older insecticides, increasing resistance and new introduced pest species but also by the present standards in urban and rural habitats.

Research and Development of New Compounds

New compound groups with novel mode of action are urgently needed to overcome resistance problems. Other important requirements of these new pesticides are user- and eco-friendly characteristics. Innovative formulation- and application techniques are required to apply the product directly on the surfaces to be treated without contamination of room air or environment (e.g. against flies in livestock). Substances with potency as synergists should be identified with regard to mechanisms which inhibit metabolic enzymes like the cytochrom P 450 complex. Test systems for the screening of new compounds should also include recently introduced pest species.

Plants developed a lot of strategies and toxic substances during their evolution to defend themselves against predators. Natural products will be one of the important components in pest management in the future. Countries with a vegetation of high diversity (e.g. tropical rainforests) are wellcome resources of natural active ingredients. The global cooperation in the research and development of these natural compounds and their use in pest control will be an important objective for the pest control industry in the future.

In the past toxicological effects against humans and companion animals or eco-systems have shown to have a stronger impact on the decision for development of a new active ingredient than its action against arthropod pests. However, it is also a fact that an excellent formulation may overcome weak efficacy of the active ingredient itself. High sophisticated formulations will be therefore more important in future for the development of pest control products than the active ingredient itself. Synergists are already important factors in insect control. Their significance will increase strongly. Bait techniques open a lot of possibilities for innovative and targeted pest control for the future, not only for common pests but also for exotic invaders.

Detection kits for frequently used insecticides to recognize starting resistance and avoid unsuccessful treatments, particularly in stored product protection, but also in fly- and cockroach control need to be developed.

Monitoring and Preventive Measures in Pest Management

In the future more attention should be given to monitoring systems which are equipped with attractive lures, pheromones etc. against annoying pests like cockroaches, ectoparasites like mosquitoes, bed bugs, fleas etc., and stored product pests.

Future pest management should start with the construction of a new building. A pest management professional should be in the planning team from the start on to take care of a pest proof construction, such as windows, extension and ventilation joints, which do not give access to pest species, sealed cable ducts, rounded corners, to avoid accumulation of dirt and equipment which does not give shelter for pests. Another important task for pest control industry is to develop insect-proof products for the construction and equipment of new buildings.

The nanotechnology may help to create vertical surfaces which are smooth and prevent pests to climb up. Insect proof air ventilation systems may be used to avoid penetration of arthropods into buildings to hibernate.

CONCLUSION

The pest control business is triggered by the fast global trade, changing living conditions in urban areas large modern livestock facilities and environmental factors like global warming. A large number of exotic arthropods were established far away from their origin in the last decades in Europe. Due to these facts continuous changes in pest management are subjected, to which industry, public health authorities, food processing industry, pest management professionals, physicians and veterinarians must adjust themselves (Pospischil, 2001).

Most alien arthropods have a different way of life than native species and require special control strategies. Detailed descriptions of economically important species are often found in their countries of origin or in the American and Australian literature. Modern pest management requires therefore global knowledge of pest control strategies and the study of global pest control literature. Some control advice may also be found in the global net, when the respective alien species has been identified.

Industry should realize changes in pest control even earlier than the pest control companies to develop innovative products and strategies before they are really needed and provide the pest management professionals

with these tools at an early stage. Eco-friendly strategies like natural compounds, impregnated tissues, innovative baits, physical control methods and effective monitoring devices are required additionally to the already existing product types.

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