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PRESENT TENDENCIES TO CONTROL VECTORS OF PARASITES

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During the last few decades synthetic insecticides have been extensively used in the world, generally with great benefit, for the control of important pests or vectors of diseases.

The discovery of DDT opened a new era in pest control. Being extremely effective at low rates, this insecticide provided a prolonged effect maintaining its lethal properties for months after application. DDT was followed by various other organochlorines, then by organophosphorous compounds, carbamates and synthetic pyrethroids. /

The success of these chemical insecticides was gradually eroded by two unexpected and undesirable consequences: the emergence of resistant strains in most of the vectors and the toxic effect for the non-target animals leading to contamination of the environment.

Resistant strains of pests were very rare before the Second World War. They increased in number with the introduction of synthetic insecticides. Gradually resistance extended to more and more pests and at present about 400 species of arthropods are become resistant to synthetic insecticides. Among these about one third are of Public Health importance. Resistance involves all arthropod genera of medical importance except tsetse flies and sandflies.

So far, it has not been possible to restore susceptibility to an insect population which has become resistant. The only way to prevent this trouble is to avoid excessive use of insecticides and to try to detect emergence of resistant strains as early as possible. As soon as resistance appears an alternative insecticide or another method of control should be used. Very often resistance in insects of Public Health importance is a consequence of extensive uses of insecticides in agriculture and it might be difficult for medical officers to prevent this pollution.

Current vector control is still based largely on chemical compounds but there is a tendency to limit and supervise more carefully their application, thus preventing as far as possible emergence of resistance and pollution of environment.

The following insecticides are at present commonly used in vector control: DDT has been restricted for Public Health use by numerous national governments in the world, however in many tropical countries it is still widely employed, especially to control tse-tse flies and sandflies and occasionally against anophelines, lice, fleas, bed bugs etc...., at least in the areas not yet affected by resistance.

Another widely used organochlorine is Gamma HCH (Lindane), it is active against lice, fleas, chiggers, *Sarcoptes scabiei,* Triatominae, ticks, etc. Dieldrine, another compound of this group is effective against a wide range of arthropods, but it is toxic for vertebrates.

Among the organophosphorous compounds, Malathion is probably the most widely used. It has a low toxicity for mammals and can be used in domiciliary applications to control domestic vectors or parasites (mosquitoes, lice, fleas, etc...).

Fenitrothion resembles Malathion by its low toxicity and it can replace the latter for imagocide applications in antimalaria campaigns. Dichlorvos (Vapona) has a fumigant action and its vapor kills domiciliar mosquitoes. Temephos (Abate) is a very useful insecticide. It is not toxic for mammals and is widely used against larvae of Diptera, mainly mosquitoes and black flies, however recently resistance has been observed in some strains of *Simulium damnosum.* Diazinon and Trichlorfon are used to control flies and cattle ticks.

Two carbamate compounds are commonly used: Propoxur in domiciliar applications against anophelines and Triatominae and Carbaryl against ticks and fleas.

Sinthetic pyrethroids were available since 1949 but it is only after 1965 that compounds with activity highel than natural pyrethrins, such as Permethrin and Decamethrin, were produced. Decamethrin is particularly interesting because it has a very high insecticidal activity and a prolonged residual action. It has been used with success in field tests agains Triatominae, tse-tse flies, ticks, etc...

During these last years many researches have been performed in order to find efficient biological agents that could destroy the vectors without killing their natural ennemies.

Among the new tools which are available at present, probably the most promising are the insecticides produced by some bacteria, especially *Bacillus thuringiensis* var. *israelensis* serotype 14 (BTI). This strain produces a substance highly toxic for mosquito and *Simulium* larvae and harmless for non-target organisms. The toxic agent is a crystal of protein elaborated in the spore of the bacterium. BTI is active at very small doses. It acts primarly as a stomach poison destroying the cells of the midgut. It has no contact effect. The production of this bacterium is fairly easy. The formulation of the sporulated culture is still in the experimental stage but one may expect that these biological insecticides will gradually replace the synthetic insecticides for the control of mosquitoes and black flies.

Another bacterium with insecticide activity is *Bacillus sphaericus* particularly the strain 1593 isolated in Indonesia. It produces a larvicide factor which is very potent against larvae of mosquitoes, especially *Culex quinquefasciatus*.

Several fungi *(Coelomomyces, Culicinomyces, Metarhizium)*, Microsporidia *(Nosema, Thelohania, Vavraia)* and viruses cause fatal diseases in mosquito larvae or adults and have already been used in the field with variable success.

Nematodes have also been used as biological agents to control mosquitoes. The most promising species is *Romanomermis culicivorax* (Mermithidae). It kills mosquito larvae and is safe to mammals and other non-target organisms.

Predators may play a part in the control of vectors. Larvivorous fish has been used in the past to control larvae of mosquitoes. With the emergence of resistance against chemical insecticides a renewed interest has been given to this biological mode of control. The most interesting species is *Gambusia affinis*. It is a small species which adapts to a wide range of environments. It feeds on aquatic insects and insect larvae and it is an efficient predator of mosquito larvae. Since 1966 it has been extensively used in Iran in the antimalaria campaign with good results.

For mosquitoes breeding in highly polluted waters, such as *Culex quinquefasciatus* another fish *Poecilia reticulata,* also called "guppy" can succeed where *Gambusia* has failed.

Larvivorous fishes can provide a good help in the control of mosquito larvae, however they are inefficient against some important vectors such as *Aedes aegypti* and *Anopheles gambiae* which breed in very small ponds inaccessible to the fish.

The mite *Macrocheles muscadomesticae* prey on eggs of the house-fly and it could have a place in an integrated fly control programme.

Genetic control is potentially a very efficient tool for the control of arthropod vectors of diseases. It is a highly selective method that causes elimination of a target species without affecting other organisms living in the same area. The main procedures used for obtaining reproductive failure are the release of sterilized males and the release of insects carrying harmful genes. In the U.S.A. the screwworm *Cochliomyia hominivorax* has at one time been eradicated by the release of sterilized males but reinfestations occured in the Southern regions.

Arthropods secrete several substances which can be used for their control. One of these is the sexual pheromone produced by the female and which acts as an odour attractant for the males.

Insects produce a complex of hormones which regulate the growth, the metamorphosis and the reproduction. Chemical compounds that mimic these hormones have now been obtained naturally or synthetically and may be used for the control of vectors. The most efficient are the Juvenile hormone mimics which block the metamorphosis causing stagnation of the insect in its immature stages.

Owing to toxicity of chemical insecticides and their failure to eradicate the vectors of diseases it is become necessary to give increasing consideration to alternative techniques, especially those based on biological and genetic control.

Only integrate control utilizing a combination of physical, biological and chemical measures will achieve a satisfactory control of pests and vectors of diseases.