Dr. N.W. MOORE

PESTICIDES AND WILDLIFE

COUNCIL OF EUROPE

PESTICIDES AND WILDLIFE

Reduction of pesticide hazards to wildlife

Preliminary assessment of harm to wildlife by different pesticides

by

Dr. N. W. Moore
Head of the toxic chemicals and wildlife division
Nature Conservancy
Monks Wood Experimental Station,
Abbots Ripton,
Huntingdon,
England.

Resolution (70) 24

On regulating the manufacture, marketing and use of pesticides with a view to the protection of the environment.

Council of Europe
67 Strasbourg,
France

1971

Cover: painting of peregrine falcon (Falco peregrinus) with smew (Mergus albellus) at its cliff-side nest, by Bruno Liljefors, 1923. Rijksmuseum Twenthe, Enschede, Netherlands.

This bird is on the decline in many parts of the world due to the ill-effects of pesticides.

CONTENTS

Reduction of pesticide hazards to wildlife: Criteria for the testing, marketing and use of pesticides

Introduction

Pesticides are not specific in their action to pests, therefore there is always a potential hazard to other organisms whenever and wherever they are used. Principal concern is for the human operator and consumer and for domestic animals, but it is generally agreed that hazards to wild organisms should also be reduced as far as possible. Experience in several countries has shown that hazards to wildlife can be greatly reduced if provision is made for wildlife in the testing, marketing and use of pesticides; criteria for these are given in this paper.

Two assumptions are made throughout.

(1) Whereas all harm to individual human beings is unacceptable, some damage to some wild organisms by pesticides is acceptable. As regards wildlife, concern is mainly for the species rather than for the individual.

(2) Each species represents a unique genetic resource and so has value from the scientific point of view. The general public shows, nevertheless, more concern for some species than for others, for example, for vertebrate animals, especially game species, for fish, and for insects of obvious economic importance. Many other less well-known organisms are or may be, however, of special ecological importance, for example in the transference of energy in ecosystems, and so must also be protected from unnecessary harm.

Testing of new chemicals

(a) Need for both laboratory and field trials

Pesticides affect animal populations in two ways. First, by direct toxicological effects, i.e. by causing death or sublethal effects in individuals, and secondly by indirect ecological means, i.e. by affecting food supply, habitat, competitors and predators. The total situation in the field is complex and results from both types of effect acting and interacting simultaneously in the ecosystem.

Laboratory toxicological studies are necessary first steps for making predictions about lethal and sublethal effects, but alone they cannot be used to predict direct and indirect ecological effects. Therefore to assess the wildlife hazards of a new chemical, work has to be done in the field as well as in the laboratory.

(b) Assessing wildlife hazards by using data obtained for medical and veterinary reasons

Many of the data obtained to assess hazards to man and domestic animals are also necessary for assessing hazards to wildlife. For each chemical and its toxic metabolites data on the following are essential for this purpose:

(i) Methods of chemical analysis

(ii) Solubility in water

(iii) Stability in and on soils and crops (residue studies)

(iv) Single dose acute oral toxicity of pesticide on a mammal expressed as the LD50.

(v) Single dose dermal toxicity on a mammal expressed as the LD50.

When the use of a new pesticide may result in chronic effects: the following are necessary also:

(i) Short-term toxicity tests on a mammal to assess the largest fraction of the LD50 which can be tolerated for 1/10th of the life span.

(ii) Long-term toxicity tests to assess the largest fraction of the LD50 which can be tolerated for the total life span of a mammal.

If additional studies on effects on reproduction, neurotoxicity, potentiation, etc., are required for assessing hazards to man and domestic animals, they will usually be required for assessing hazards to wildlife as well.

(c) Additional toxicological data required for wildlife

It is well known that even closely related species may react very differently to the same pesticide, therefore extrapolation from one species to another must always be tentative. However, the greatest differences are those between the main taxonomic groups, therefore animals representing groups other than mammals should be studied as part of normal routine testing. The minimal requirements are as follows:

(i) Single does oral toxicity tests (LD50 or LC_{50}) for

- (a) an avian species, e.g. pigeon, game bird, duck or Bengalese Finch (*Lonchura striata*)
- (b) a fish species, e.g. *Rasbora heteromorpha*
- (c) an insect species, e.g. the honey bee, *Apis mellifera*.

(ii) Contact toxicity LD50 for the honey bee.

(iii) For certain selected pesticides (that may act cumulatively) tests on effects on breeding behaviour, laying, egg hatchability and survival of young in an avian species.

(iv) Levels in an indicator organ (e.g. liver) which are associated with death. They can be got from organs of animals which have died in LD50 tests. This information can be used to interpret incidents in the field where there is a prima facie case for attributing death to the use of the pesticide in question. It is particularly important to obtain this information for the more stable compounds.

(v) Special tests for special circumstances, for example:

(a) feeding trials to determine the effects of dressed cereal seeds on avian species

(b) toxicity data on fish food (Daphnia, etc.) when a chemical is to be used in water.

Standard methods of testing, for example those described by the US Fish and Wildlife Service, 1964, and in Working Document No. 6 of the British Pesticide Safety Precautions Scheme should be used in all cases.

(d) Field trials

When a pesticide could be harmful to birds a field trial should be conducted to determine the effects of the pesticide on populations of wild birds. The essential features of such a trial are as follows:

(i) The treated and untreated control areas should each be at least 4 ha.

(ii) The trial area should be one that is known to contain numerous wild birds. Fields surrounded by hedges or edged by woods are often suitable.

(iii) Assessments of the wild bird population should be made before and at intervals after the pesticide is applied.

(iv) A search for bird (and mammal) bodies should be made in the crop shortly after the application

(v) Chemical analyses should be made to determine whether the pesticide used was the cause of death in those animals which were found dead.

Additional information, for example, on the extent to which birds feed on the treated crop, and on the breeding success in the sprayed area, may also be required.

<u>Surveys during the first years of use of a new chemical</u>

The results of field trials of the type mentioned above are likely to be modified by local conditions, and so are rarely adequate for assessing all unforeseen hazards in the field. These can only be discovered by general surveillance of the pesticide during its first years of use in the field.

Experience has shown that dead wild birds and mammals occurring in fields after the use of pesticides are not often noticed or reported upon to agricultural advisers or to chemical manufacturers; even quite serious incidents involving the death of many animals may not be noticed unless deliberate searches are made. Therefore, even if casualties to birds and mammals are caused, one cannot rely on their being noticed or reported as a matter of course. And so even if casualties to birds and mammals are caused one cannot rely on their being noticed or reported. Therefore when there are reasons for expecting wildlife casualties objective studies should be organised during the first years of use of the new chemical.

(i) A biologist should carry out a specific study into the effects of the chemical on wildlife in the first years of use.

(ii) He should ask farmers specifically to look for wildlife casualties when using the new chemical and to record their observations.

(iii) He should collate the results of his enquiries and check their validity, e.g. by carrying out spot field trials of the type mentioned above.

<u>Marketing</u>

(a) <u>Labelling</u>

Much of the damage done by pesticides is due to misuse. The first requirement to prevent misuse is for each container of pesticides to be labelled accurately and informatively.

To prevent unnecessary hazards to wildlife the following types of information should be clearly shown on the label.

(i) The name of the active ingredient(s) and their concentration(s).

(ii) Statement concerning hazard to game, wild birds, wild mammals, fish and bees.

(iii) Statement about the avoidance of contamination of ponds, waterways, etc.

(iv) Statement about the disposal of rinsings, containers etc.

(v) Statements about specific hazards, e.g. if hazardous to bees - "do not apply at flowering stage".

(vi) Statement about persistence of the chemical.

(b) Restriction of sale of certain pesticides to certain types of user

It is well known that pesticides are often used by people who cannot or do not read labels. This fact must be borne in mind. Pesticides are applied by agricultural contractors, farmers, horticulturalists, foresters and amateur gardeners. Of these groups the first is most likely to carry out the instructions on the label, but particularly among the last group there are many who will not. Therefore the more hazardous pesticides should not be sold to amateur gardeners. Similarly, certain very toxic pesticides should only be applied by specially licensed contractors.

Use

However good the laboratory and field tests, and however good the instructions on the labels, the successful avoidance of hazard depends ultimately on the user. Gross misuse will be deterred by the law but the education of all users of pesticides is an essential requirement in reducing hazard. Manufacturers, salesmen, government agricultural advisers and conservation biologists and members of voluntary organisations all have an obligation to work together in preventing the misuse of pesticides. (See for example the Code of Conduct produced by the Joint ABMAC/Wildlife Education and Communications Committee in the UK.)

Preliminary assessment of harm to wildlife by different pesticides

Authoritative lists of pesticides which are safe, and of pesticides which are dangerous to wildlife, would be valuable to all concerned with preventing unnecessary hazards to wildlife. In the present state of knowledge, it must, however, be stated categorically that it is impossible to produce such lists because so few studies have been made on the complicated effects which result from pesticide use. Even if much more information were available, definitive lists would contain many qualifications and exceptions because the same pesticide may be harmless in one situation and harmful in another. Also, many of the more significant wildlife casualties result from misuse rather than from proper use. It is extremely important, therefore, to take into account the qualifications made below when considering Tables 1 to 3. Under no circumstances should they be considered as lists of "bad" and "good" pesticides. At best they suggest to government agencies, manufacturers, biologists and farmers, possibilities and problems which should be considered when recommending or using certain pesticides.

Introduction

The application of any pesticide will always cause some harm to some wild organisms. The principal aim here is to list those pesticides which are reported to have caused serious casualties to wildlife species which are of special value to man, that is to mammals, birds, fish and bees (Table 1). Experience has shown that dead animals occurring in fields after the use of pesticides are not often noticed or reported on to agricultural advisers or to chemical manufacturers. So, when no wildlife casualites have been reported following the use of a certain pesticide, it cannot be assumed that none has occurred. Therefore a second list of chemicals is given here (Table 2); no reliable reports of wildlife casualties attributable to them are known to the author, but since all of them are "moderately toxic" (acute oral LD50 for the rat is between 50 and 500) or are "highly toxic" (acute oral toxicity for the rat is less than 50), they may on occasion cause mortality to wildlife.

A third list of chemicals is given in Table 3 in order to name those of lower toxicity which have been examined in this study and which have not caused serious hazards to wildlife so far as is known.

It must be emphasised that this is a preliminary study and that many pesticides, especially new ones, are not included in any of the tables.

The nomenclature of pesticides follows that given in the British Standards Recommended Common Names for Pesticides (BS 1831, et seq.). Only the better known synonyms are given.

Pesticides affect different groups differently; it is axiomatic that most insecticides will harm beneficial insects of the same sensitivity to the pesticide as the pest species. The economic significance of this will vary in different instances. In general, fish are more sensitive than land vertebrates; for example, most herbicides do not affect birds and mammals yet some are highly toxic to fish. Aquatic environments are particularly vulnerable to all forms of pollution including pesticides.

The hazard of a particular compound may depend on its formulation: for example, the amines of 2,4-D are more toxic than the esters. A dilute formulation of a very toxic pesticide may do less harm than a more concentrated formulation of a less toxic compound. Methods of application are also important. Some soil sterilants are highly toxic and yet cause no serious effect to birds and mammals; on the other hand, toxic seed dressings can be particularly harmful to wildlife, because the treated seed acts as a poisoned bait if it is left on the surface of the soil.

Many of the reported incidents can be traced to accidents or to the misuse of chemicals, for example spillages into rivers, the application of excessive quantities of pesticides, or their use when flowers are open and attractive to bees.

All pesticides are likely to have indirect ecological effects: if extensive,some of these may be harmful. For example, the introduction of DDT and other insecticides in orchards has caused changes in prey/predator and competitive relationships in insect populations, so that previously rare species have increased and become pests. However, extremely little is known about indirect effects on mammals, birds and fish. Some insecticides potentiate, and some counteract the effects of others - nothing is known about these effects on wildlife.

Evidence that a pesticide has caused harm to wildlife may be circumstantial only. Ideally, dead animals found after the application of a pesticide should be chemically analysed. If they are found to contain residues which are indicative of death, it can be assumed that the pesticide was the cause of death. Until recent years analytical methods had not been as fully developed as they are today and many of the accounts of incidents in earlier years consisted merely of records of dead animals picked up after chemical treatment. Such records mean little if only a few corpses are found, but if many are found it is likely that the chemical treatment did in fact cause the casualties. In this paper only incidents supported by chemical analysis or ones in which there is other strong evidence that the pesticide concerned did cause death are included in Table 1. Even so, absolute certainty cannot be claimed for many cases. In the context of this paper it was considered better to err on the side of caution. This means that some pesticides in Table 1 may be exonerated when more is known about their effects on wildlife. Further, some incidents refer only to misuse. Under no circumstances should Table 1 be used as an authoritative list of pesticides which invariably cause serious hazards to wildlife.

To reduce the size of the bibliography reference is made to key reviews wherever possible. These can be used for obtaining detailed references to the original papers.

This paper is a preliminary one. Most of the records of incidents were obtained in an ad hoc manner and not as the result of special studies. The search of the literature has been extensive but not exhaustive. Further experience of the effects of well-established and new pesticides in the field will make periodical reviews of this paper necessary.

Conclusions

Despite many gaps in our knowledge about the effects of pesticides on wildlife useful conclusions can be based on the data provided in Table 1:

(a) The most hazardous pesticides are those which combine high toxicity and great persistence. These chemicals kill animals both by direct and secondary poisoning. They become widely distributed and can accumulate in both terrestrial and aquatic environments; sometimes animals die or suffer sub-lethal effects as the result of their accumulation in food chains. Aldrin, dieldrin and heptachlor are examples of this group.

(b) Some persistent pesticides are more hazardous than non-persistent pesticides of the same toxicity. For example, DDT is more hazardous than diazinon.

(c) Persistent compounds become so widely dispersed that some are now global environmental contaminants. If their levels in the total environment are high enough they can have effects on a whole species, not just on local populations of it.

(d) Among the non-persistent pesticides hazard depends on toxicity, formulation, use, and methods of application.

(e) Exposed poison baits and seed dressed with pesticides are particularly likely to cause harm to vertebrate wildlife.

These conclusions are well-known to many individuals and organisations. Pesticide hazards to wildlife have been demonstrated in all the inhabited continents. To reduce hazards to man, domestic animals and wildlife, an increasing number of governments discourage the use of the more toxic and the more persistent pesticides and insist on, or encourage the use of less toxic and less persistent substitutes. Nevertheless, there are still many countries with very inadequate arrangements for the control of pesticides: the application of existing knowledge would much improve the situation.

Table 1. PESTICIDES REPORTED TO HAVE CAUSED MORTALITY AMONG WILDLIFE IN THE FIELD

(The table includes a few examples of wildlife casualties due to misuse of pesticides)

Chemical	Acute oral LD50, rat (mg/kg)	Approx. year of introd.	Examples of wildlife incidents: Use	Location	Effects on wildlife	Refs.
**Aldrin oc. I	10-67	1949	Rice seed dressing	Southern States, USA	Widespread heavy mortality of Fulvous Tree Ducks Dendrocygna bicolor; population endangered.	(4)
			Cereal seed dressing	Britain	Several incidents involving mortality of birds	(3)
			Japanese Beetle Popillia japonica control	Illinois, USA	Heavy mortality among game-birds and song birds; also some mammal deaths. Several species of graminivorous birds virtually eliminated in the area.	(2,5)
			Mosquito control	California, USA	Mortality among waterfowl recorded.	(1)
			Grasshopper control	California, USA	Effects on bird populations in the field have been slight but noticeable	(1)
			Industrial accident - lakes contaminated	Colorado, USA	Heavy mortality of ducks and other waterfowl	(6)
**Arsenicals inorganic. I,f.	13-100	1894	Forestry (chemical barking)	California, USA and Germany	Deer (and also other wild and domestic mammals) have died through licking bases of trees treated with sodium arsenite or consuming spillage	(1,7,8)
			Potato haulm	Britain	Several reports of Rabbit Oryctolagus cuniculus killed; following treatment with lead arsenate; a few deaths of small rodents and birds also reported - but most incidents have involved small numbers only.	(9)
BHC (includes Lindane) oc. I	125-600	1945	Cereal seed dressing	Britain	Gamma-BHC said to have been implicated in several cases of deaths among graminivorous birds, but evidence unsatisfactory	(3)
			Cockchafer control	Switzerland	Damage to bees has occurred following treatment of forests.	(10)
			Cockchafer control	Germany	Treatment of forests at 200g/ha resulted in many casualties among adult insectivorous birds and especially their young.	(11)
**Carbaryl (=Sevin) carbamate. I,GR	560	1956	Grasshopper control	Colorado, USA	Bird population declined owing to loss of insect food; however no cases of acute poisoning observed.	(6)
*Chlordane oc. I	335	1950	Grasshopper control	California, USA	Some wildlife loss (deaths of fish and birds) usually results when chemical is used for this purpose.	(1)
Cyanide misc. organic. R		1886	Rabbit control	Britain	Badgers Meles meles and Foxes Vulpes vulpes are sometimes accidentally killed when HCN is used to gas Rabbits Oryctolagus cuniculus.	(12)
2,4-D (includes 2,4,5-T) subst.phenoxy. H	400-666	1942	Scrub clearance	USSR	Several cases of Elk Alces alces and other mammals and birds being killed during aerial applications of 2,4-D and/or 2,4,5-T.	(13)
			Forestry use	Sweden	"Mass deaths" of Great Tits Parus major followed an application of 2,4-D and 2,4,5-T.	(14)
			Field use	Britain Germany, etc.	Deaths of bees have occurred following the spraying of nectar-producing plants when in flower.	(15,16)
**DDT oc. I	113-800	1944			Numerous, mainly minor, incidents involving wildlife deaths associated with the use of DDT have been reported from various parts of the world. DDT (in some cases, together with other organochlorine residues) has caused a reduction in eggshell thickness and in breeding success in several species of birds of prey and fish-feeding birds in Britain and North America since its introduction in the late 1940s. The following examples of wildlife incidents may be cited.	(42,43,44)
			Dutch elm disease control	Maine Michigan New Hampshire Wisconsin USA	High application rates caused heavy mortality of song birds, especially American Robins Turdus migratorius, and included the virtual elimination of local populations. In one incident in Michigan, birds of 94 different species were known or suspected to have died.	(2)
			Rice seed dressing	California, USA	Some deaths of Mallards Anas platyrhynchus Pheasants Phasianus colchicus and other birds.	(2)
			Orchard pests	Southern England	Some deaths of birds, especially Blackbirds Turdus merula, Song Thrushes Turdus ericetorum, also game birds.	(3, 17)
			Pea pests	Britain	Several cases of bird mortality, mostly game birds.	(3)
			(Secondary effects)	New England, USA	Decline and low breeding success of Ospreys Pandion haliaetus attributed to high DDT levels in adult birds and their eggs.	(18,19)
			(Secondary effects)	Michigan, USA	Low hatching success of Herring Gull Larus agentatus eggs associated with high DDT residues.	(20)

Table 1 (cont.)

Chemical	Acute oral LD50, rat (mg/kg)	Approx. year of introd.	Examples of wildlife incidents: Use	Location	Effects on wildlife	Refs.
DDT contd.			Gypsy Moth Porthetria dispar and biting flies	New York, USA	Heavy mortality among trout (Salmo) fry.	(2)
			Spruce budworm Choristoneura fumiferana	New Brunswick and British Columbia Canada	Salmon and Trout (Salmo spp.) populations reduced and reproduction curtailed.	(2)
			Mosquito control	Florida, USA New Jersey, USA	Deaths of crabs, fish, frogs, lizards, snakes.	(2)
			Mosquito control	Cyprus	Freshwater fish populations in country "devastated".	(22)
**Dieldrin (HEOD) Oc. I	34-100	1949	Cereal seed dressing	Britain	Many incidents involving large-scale mortality of graminivorous birds, especially Woodpigeons Columba palumbus, game birds, finches, often large numbers - hundreds, even thousands of birds killed; largescale incidents ceased after use of spring-sown wheat was withdrawn in 1962. Secondary poisoning of predatory birds, also Badgers Meles meles and Foxes Vulpes vulpes, frequently recorded. This use of dieldrin has been the cause of an unprecedented and heavy reduction in the populations of several species of birds of prey in Britain. Dieldrin has also been shown to have sublethal effects on predatory birds, notably in reducing the thickness of their eggshells.	(3,17,23, 24)
			Wheat seed dressing	Switzerland	Hundreds of Woodpigeons Columba palumbus killed in one incident	(11)
			Lucerne pests	Hungary	Heavy losses reported among game birds and mammals.	(25)
			Japanese Beetle Popillia japonica etc.	Virginia, USA Illinois, USA	In both cases heavy mortality of Quail Colinus virginianus, song birds, water birds, also Rabbits Sylvalagus sp. and some other mammals	(2)
			Rice pests	California, USA	Emergency, high dose, application killed hundreds of birds (e.g. 400 egrets Casmerodius albus?, 100 Mourning Doves Zenaidura macroura), thousands of fish, etc.	(1)
			Forest pests (especially cockroaches)	Germany	Aerial spraying at 200g/ha resulted in deaths of many insectivorous birds and their broods	(11)
			Imported Fire Ant Solenopsis saevissima	Alabama, USA	Very heavy and widespread mortality of Quail Colinus virginianus and other animals (birds, mammals, fish, amphibia, reptiles).	(26,27)
			Sheep parasites (Secondary effects)	Scotland	Feeding on sheep carrion reduced breeding success in Golden Eagles Aquila chrysaetos.	(28)
			Cole-rape seed pests	Netherlands	Aerial spraying caused deaths of Hares Lepus europaeus.	(29)
			Sandfly larvae	Florida, USA	Heavy mortality of fish recorded	(2)
**Dimethoate op. I,A	245	1961	(Secondary effects)	Britain	One incident of secondary poisoning in Blue Tits Parus caeruleus from eating poisoned honey bees Apis mellifera.	(30)
**DNOC subst.phenols. H,I.	7-40	1892	As herbicide	Europe	Some confirmed incidents (and many unverified reports) of wildlife kills involving either DNOC or "dinitro compounds"; animals affected include game birds, Skylarks, Alauda arvensis, Woodpigeons Columba palumbus, also Rabbits Oryctolagus cuniculus and Hares Lepus europaeus. See also under Sodium Monochloroacetate.	(1)
*Endrin oc. I,A,R	10	1951	Vole/mice control	Germany and Switzerland	Deaths of Hares Lepus europaeus and domestic cats have resulted from the use of the chemicals as a rodenticide.	(10)
			Vole/mice control (30)	Britain	Illegal use as rodenticide is known to have caused mortality of fish when an adjacent waterway became contaminated. The chemical is extremely toxic to fish. It has also been used illegally in Britain to control bird pests, and this has resulted in mortality of protected species.	(3)
			Aphis control, potatoes	California, USA	Use has caused mortality amongst Pheasants Phasianus colchicus.	(31)
			Cutworm control	California, USA	Heavy Rabbit Sylvilagus sp. mortality recorded	(2)
			Aphis control, soft fruit	California, USA	Some mortality of game birds recorded	(31)
			Aphis control, soft fruit	Britain	Three or more minor incidents involving mortality of Rabbits Oryctolagus cuniculus game birds, finches, etc.	(3)

Table 1 (cont.)

Chemical	Acute oral LD50, rat (mg/kg)	Approx. year of introd.	Examples of wildlife incidents: Use	Location	Effects on wildlife	Refs.
Fentin hydroxide misc. organic F	108	1961	Potato haulm	Britain	Mortality of fish in a freshwater reservoir was probably due to accidental contamination following aerial spraying. Residues of the chemical of up to 750 ppm were found in Water Snails.	(30)
**Heptachlor oc. I	60-130	1951	Cereal seed dressing	Britain	Many incidents involving heavy mortality of graminivorous birds, especially Woodpigeons Columba palumbus and game birds; incidents ceased when the chemical was withdrawn from use on spring-sown cereals from 1962 onwards.	(3,17)
			Japanese Beetle Popillia japonica control	Illinois, USA	Applications at 2.2 kg/ha caused the virtual elimination of several species of graminivorous birds.	(2,5)
			Imported Fire Ant Solenopsis saevissima	Alabama, USA	Applications at 2.2 kg/ha produced heavy mortality of birds, mammals, fish, amphibia, etc.; Quail Colinus virginianus populations remained depressed for at least three years.	(2,26,27)
Hexachlorobenzene F	750	1945	Seed dressing	Netherlands	Liver residues of predatory birds found dead ranged from 0.8-431 ppm HCB. Experimental evidence suggests that seed dressed with HCB "may have noxious effects on seed-eating and predatory birds"	(40)
"Kepone" (Chlordecone) oc. I	95-132	1960	Imported Fire Ant Solenopsis saevissima	Alabama, USA	Several dead/dying Quail Colinus virginianus reported in trials of this compound.	(4)
*Mecarbam op. I	31-35	1961	Industrial accident	Britain	Accidental pollution of a river killed virtually all fish for a distance of 15 miles downstream from discharge	(30)
Mecoprop subst.phenoxy.	H 930	1956	Weed control in Barley	Britain	Three pairs of Partridges Perdix perdix (in pens) died after a field 100 m. away was sprayed.	(32)
Metaldehyde aldehyde. M	500-600 (guinea pig)	1940	Slug control	Britain	Several verified reports of domestic animals (dogs, cats, poultry, ducks) dying after eating slug pellets or poisoned slugs. Also some unpublished and mainly unconfirmed reports of wild birds (Woodpigeons Columba palumbus, Pheasants Phasianus colchicus) being killed.	(30)
Organomercury Compounds misc. organic. F	14-210	1914	Cereal seed dressing	Sweden	Many serious incidents involving heavy mortality of seed-eating birds. Secondary poisoning recorded (birds of prey, owls) and low reproductive success of White-Tailed Eagle Haliaetus albicilla, Eagle Owl Bubo bubo, Tawny Owl Strix aluco and Long-eared Owl Asio otus attributed to these compounds. Note that alkyl mercury compounds are more hazardous to wildlife than other organomercury compounds, because they are more slowly eliminated from the animal body.	(14,33)
Paraquat dipyridyl. H	157	1958	Weed control	Britain	There are several reports of deaths of Hares Lepus europaeus, including substantial reduction in local populations, following the use of paraquat on grassland and stubble; also a report of Greenfinches Carduelis chloris which fed on treated weeds immediately after spraying.	(30)
**Parathion (includes Methyl Parathion) op. I,A	2-30	1944	Orchard pests	Washington, USA British Columbia Canada	Field observations in both of these states indicate that slight bird losses normally occur following spraying	(1)
			Orchard pests	Netherlands	Many dead Blackbirds Turdus merula and thrushes Turdus ericetorium found after orchard was sprayed with a 0.06% solution	(11)
			Orchard pests (Citrus fruit)	California, USA	Song birds frequently killed when orchards sprayed, but extent of losses are not known	(1)
			Orchard pests (Citrus fruit)	South Africa	In one incident, 791 birds of various species were found dead immediately after spraying	(11)
			'Misuse'	Netherlands	Large numbers of birds found dead.	(11)
			Not known	Sweden	3,000 Black-headed Gulls Larus ridibundus killed in one incident.	(14)
			Not known	Sweden	5,000-15,000 Starlings Sturnus vulgaris were killed following the use of Parathion and DDT.	(14)
			Various uses	Denmark	18 verified incidents involving the accidental (10) or wilful (8) poisoning of birds of 14 different species reported during 1952-65.	(39)

Table 1 (cont.)

Chemical	Acute oral LD50, rat (mg/kg)	Approx. year of introd.	Examples of wildlife incidents: Use	Location	Effects on wildlife	Refs.
**Phosphamidon op. I,A	17-18	1957	Spruce budworm Choristoneura fumiferana	New Brunswick Canada	Serious bird losses followed heavy aerial application.	(34,35)
			Larch bud moth Eucosma griseana	Switzerland	Aerial spraying caused loss of 60-80% of original bird population; 76 dead adult insectivorous birds collected in 20 ha. Population normal the next year.	(10)
**Schradan op. I,A	10	1945	Aphis control Brassicas	Britain	Several incidents concerning the deaths of birds and Rabbits Oryctolagus cuniculus and other mammals, especially in 1952 when the chemical was applied more extensively than usual to deal with a heavy aphis infestation	(1,9,21)
Sodium fluoroacetate (Compound 1080) misc. organic R	3	1946	Squirrel control	California, USA	Several incidents involving the loss of game birds and, especially, domestic animals (notably dogs which ate poisoned squirrels).	(1)
*Sodium monochloroacetate subst.aliphatic	300-400	1951	Weed control in White Clover	Denmark	170 Grey Lag Geese Anser anser found dead after field was treated with 'monochloroacetate'.	(11,39)
			Potato haulm	Sweden	"Thousands" of Chaffinches Fringilla coeleba died in one locality after treatment of potato haulm with 'monochloroacetate' and dinitro compounds.	(14)
Strychnine plant derived. R	16	1820	Vertebrate pests (squirrels, Red-winged Blackbirds Ageliaus phoeniceus, etc.)	California, USA	Several incidents reported involving the loss of game birds, pigeons, etc. Wildlife losses following the use of strychnine for the control of mammal pests have occurred in various other parts of the world.	(1)
* TDE (=DDD) oc. I	2500	1944	Gnat control	California, USA (Clear Lake)	Heavy mortality of Western Grebes Aechmophorus occidentalis and reduction of breeding population as a result of accumulation of the chemical in fish, following its application to lake waters in several successive years.	(1,36)
			Tipulid fly control	California, USA	Mortality of birds and Kangaroo Rats Dipodomys sp.	(31)
Telodrin	5-10	1951	Industrial accident river and shallow seas contaminated	Netherlands	Mortality of Sandwich Terns Sterna sandvicensis at a coastal breeding colony in 1964 and 1965 caused by combined action of "telodrin" dieldrin and endrin. A very marked decline in Netherlands' population of this species is believed to have been due to poisoning by these insecticides	(41)
**TEPP op. I	1-2	1939	Ash tree pests	California, USA	Large numbers of Cedar Waxwings Bombycilla cedrorum killed.	(1)
			Orchard pests	Washington, USA	Several hundred dead or sick Pheasants Phasianus colchicus found in one year (1947); up to 60 Pheasants found in a single orchard. (Now no longer in wide-scale use).	(1)
Thallium misc.inorganic R.	15-25	1920	Squirrel control	USA	Many examples of mortality among graminivorous birds and mammals. Secondary poisoning (of owls, birds of prey, etc.) also recorded.	(1)
			Rodent control	Denmark	Three verified incidents involving mortality of Pheasants Phasianus colchicus and Partridges Perdix perdix in period 1952-65; also a suspected case of poisoning of a Buzzard Buteo buteo through the ingestion of rodents poisoned with the chemical.	(39)
*Toxaphene oc. I	69	1949	Mosquito control	USA	Several incidents recorded involving the poisoning of large numbers of fish.	(1)
			Rough fish control	California, USA	Use at low-levels caused substantial mortality among Pelicans Pelecanus sp.	(31)
			Forest pests	California, USA	Deaths of 40-50 Jays Aphelocoma sp. and 'some' Wood-peckers followed spraying in one incident.	(1)
			Mosquito control	N. Dakota, USA	Experimental application (at 1.7 kg/ha) to lake surface killed 8% of bird population (mainly Coots Fulica americana, young ducks)	(1)

Table 1 (cont.)

Chemical	Acute oral LD50, rat (mg/kg)	Approx. year of introd.	Examples of wildlife incidents: Use	Location	Effects on wildlife	Refs.
Toxaphene cont.			Mosquito control	N. Dakota, USA	Experimental application (oil formulation, at 2.2 kg/ha) to lake caused heavy mortality of birds. All birds that entered water died; others in dense marginal vegetation were killed. No young birds observed for five weeks after spraying	(1)
			Crop pests	USA	Several incidents reported involving the loss of game birds, geese, etc. However, field applications at normal crop insect levels do not usually cause serious wildlife losses.	(1)
			Rodent control	USA	Experimental use at high rates of application caused death of game birds, Rabbits Sylvilagus sp., etc., and led to secondary poisoning of dogs.	(1)
			Grasshopper control	Colorado, USA	Aerial application (at 2.2 kg/ha) contaminated pond and caused deaths of many equatic animals, also reptiles and 20 birds.	(6, 38)
			Crop pests	California, USA	Heavy mortality of fish-eating birds recorded at one lake in each year, 1960-63; a total of more than 1,100 birds were killed.	(31)
Zinc phosphide misc. inorganic R	40	19th century	Control of vertebrate pests	Netherlands	Broadcast poisoned wheat killed 500-1,000 of a flock of 7,000 wild grey geese. (Elsewhere secondary poisoning has affected domestic animals, but not wild ones so far as is known).	(1)

NOTES TO TABLE 1

*Pesticides thus marked are moderately toxic to bees (LD50 2.0-10 ug/bee)
** " " " " highly " " " (LD50 0.001-1.99 ug/bee)

The information given beneath the common name of each pesticide refers to (a) the chemical grouping to which it belongs; and (b) the normal use to which it is put. In general, the classification of the British Agricultural Chemicals Approval Scheme has been followed.

The following abbreviations are used:-

oc	organochlorine	A	Acaricide
op	organophosphorus	H	Herbicide
misc.	miscellaneous	F	Fungicide
subst.	substituted	GR	Growth regulator
		M	Molluscicide
		I	Insecticide
		R	Rodenticide

Table 2

A LIST OF MODERATELY AND HIGHLY TOXIC CHEMICALS WHICH ARE NOT KNOWN TO HAVE CAUSED SERIOUS HARM TO WILDLIFE

Note that most of the chemicals listed are moderately or highly toxic to bees and some have caused casualties to them in the field

(a) Highly toxic chemicals (acute oral LD50 for rat: 1-50 mg/kg)

Azinphos-ethyl	(1953)	Fentin acetate	(1958)
Azinphos-methyl	(1953)	Isodrin	(1951)
Carbophenothion	(1955)	Medinoterb acetate	(1967)
Chlorfenvinphos	(1964)	Mercuric chloride	(1892)
Demeton	(1951)	Mevinphos	(1955)
Demeton-S-methyl	(1951)	Nicotine	(1746)
Dimefox	(1949)	Pentachloraphenol	(1940)
Dinoseb	(1945)	Phorate	(1955)
Disulfoton	(1957)	Sodium fluoride	(19th century)
Endosulfan	(1956)	Sulfotep	(1945)
Endothal	(1956)	Thionazin	(1962)

(b) Moderately toxic chemicals (acute oral LD50 for rat: 50-500 mg/kg)

Arprocarb	(1963)	Dimexan	(1960)
Azobenzene	(1936)	Dinoseb acetate	(c.1960)
Binapacryl	(1960)	Diquat	(1959)
Bromoxynil	(1963)	Dithianon	(1960)
Copper salts	(1885)	Ethion	(1955)
D-D mixture	(1943)	Ethoate methyl	(1963)
Di-allate	(1961)	Fenchlorphos	(1954)
Diazinon	(1955)	Phenkapton	(1957)
Dichlorvos	(1957)	Phosalone	(1964)
Formothion	(1962)	*Rotenone	(1870)
Ioxynil	(1964)	Trichlorphon	(1952)
Mercurous chloride	(1929)	Trifluralin	(1965)
Morphothion	(1957)	Vamixothion	(1962)
Oxydemeton-methyl	(1962)	**Warfarin	(1944)

The date given in brackets refers to the year in which the pesticide was introduced. In many cases these dates are very approximate.

*Rotenone (Derris) is highly toxic to fish, and is used in control of coarse fish in some countries. This use inevitably causes mortality among non-pest species.

**Warfarin is used in rat control and a few cases are known of secondary poisoning of domestic animals. But wildlife has apparently not been affected. Normal use in buildings presents negligible hazard to wildlife.

Table 3

SOME PESTICIDES OF LOW TOXICITY
NOT KNOWN TO HAVE HARMED WILDLIFE

Ametryne	Malathion
Aminotriazole	Mancozeb
Ammonium sulphamate	Maneb
Atrazine	Manganese
Barban	MCPA
Benazolin	MCPB
Bromacil	Menazon
Captan	Metham Sodium
Chlorbenside	Methoxychlor
Chlorbenzilate	Metiram
Chlorbufam	Metobromuron
Chloroxuron	Monolinuron
"Chlorthion"	Monuron
Cresylic acid	Nabam
Cycluron	Petroleum oils
Dalapon	Picloram
Dazomet	Prometryne
2,4,D-B	Propachlor
Desmetryne	Pyrazon
Dicamba	Pyrethrum
Dichlofluanid	Quinomethoate
Dichlorprop	Quintozene
Dicloran	Simazine
Dicofol	Sodium chlorate
Dinocap	Sodium trichloroacetate
Dithiocarbamates	Sulphur
Diuron	Tar oil
Fenoprop	TBA
Fenuron	Tecnazene
Formaldehyde	*Thiram
Lenacil	Tri-allate
Lime sulphur	Ureas
Linuron	Zineb
Maleic hydrazide	Ziram

* Laboratory experiments show that levels of Thiram likely to be encountered in the field (seed-dressing use) can affect reproduction of Red-legged Partridges *Alectoris rufa*.

Acknowledgement

It is a pleasure to acknowledge the invaluable help of my colleague, Mr. J. L. F. Parslow, in preparing this report.

References

1. RUDD, R.L. and GENELLY, R.E. 1956. Pesticides: their use and toxicity in relation to wildlife. State of California, Dept. Fish and Game Bull. No. 7

2. DUSTMAN, E.H. and STICKEL, L.F. 1966. Pesticide residues in the ecosystem. Pesticides and their effects on soils and water. American Soc. of Agronomy, Special Publication No. 8.

3. JOINT COMMITTEE OF THE BRITISH TRUST FOR ORNITHOLOGY and the ROYAL SOCIETY FOR THE PROTECTION OF BIRDS ON TOXIC CHEMICALS. Reports, Nos. 1-6, 1961-67.

4. UNITED STATES DEPT. OF THE INTERIOR. 1962. Effects of pesticides on fish and wildlife: a review of investigations during 1960. Fish and wildlife circular, No. 143.

5. SCOTT, T.G., WILLIS, Y.L. and ELLIS, J.A. 1959. Some effects of a field application of dieldrin on wildlife. J. Wildl. Mgmt., 23: 409-427.

6. FINLEY, R.B. 1961. Direct and indirect effects of some insecticides on western wildlife. 40th annual conference. W. Assn. Game and Fish Comms. 1960, 121-129

7. BLOSSFELD, O. 1962. Erwünschte und unerwünschte Nebenwirkungen der chemischen Entrindung. Deutsch. Akad. der Landwirtschafts-wissenschaften. Tagungsberichte, No. 54, 103-107.

8. RUMMLER, H. J. 1962. Zur Frage der Gefährdung wildlebender Tierarten durch die Anwendung kambizider Mittel. Deutsch. Akad. der Landwirtschaftswissenschaften. Tagungsberichte, No. 54, 109-112.

9. EDSON, E. F. 1954. The hazards of pesticides to wildlife. Medical laboratories, Pest Control Limited, Cambridge, 31 pp.

10. SCHNEIDER, F. 1966. Some pesticide-wildlife problems in Switzerland. Pesticides in the environment and their effects on wildlife. J. appl. ecol. 3 (Suppl.) 15-20.

11. PRZYGODDA, W. 1966. Methods of studying the effects of pesticides on birds for workers who have no facilities for chemical analysis and biological tests. Pesticides in the environment and their effects on wildlife. J. appl. ecol. 3 (Suppl.) 173-179.

12. MELLANBY, K. 1967. Pesticides and pollution. Collins, London, 221 pp.

13. ROTHMAN, H. 1968. Pesticide-wildlife problems in the Soviet Union. Dept. of Liberal Studies in Science, Internal Research Rep. No. 10, 5 pp.

14. OTTERLIND, G. and LENNERSTADT, I. 1964. Den Svenska fågelfauna och biocidskadorna. Var. Fågelvärld, 23, 363-415.

15. WAY, J. M. 1969. Toxicity and hazards to man, domestic animals and wildlife from some commonly-used auxin herbicides. Residue reviews 26 37-62.

16. DALLMANN, H. 1962. Untersuchungen zur Toxizitat von Wuchsstoff-Herbiziden auf die Honigbiene. Deutsch. Akad. der Landwirtschafts-wissenschaften, Tagungsberichte, No. 54, 23-27.

17. MINISTRY OF AGRICULTURE, FISHERIES AND FOOD. 1965. Infestation control. London, 100 pp.

18. AMES, P. L. and MERSEREAU, G. S. 1964. Some factors in the decline of the osprey in Connecticut. Auk, 81. 173-185.

19. AMES, P. L. 1966. DDT residues in the eggs of the osprey in the north-eastern United States and their relation to nesting success. Pesticides in the environment and their effects on wildlife. J. appl. ecol. 3 (Suppl.) 87-97.

20. KEITH, J. A. 1966. Reproduction in a population of herring gulls (Larus argentatus) contaminated by DDT. Pesticides in the environment and their effects on wildlife. J. appl. ecol. 3 (Suppl.) 57-70.

21. MIDDLETON, A.D. 1954. The effects of certain insecticides and herbicides on game birds and other wildlife in farm crops. Int. Un. Prot. Nat., 4, Copenhagen, 161-163.

22. STEINITZ, H. 1952. Notes on fishes from Cyprus. Bull. Inst. Oceanogr. (Monaco), 1004, 1-12.

23. BLACKMORE, D. K. 1963. The toxicity of some chlorinated hydrocarbon insecticides to British wild foxes (Vulpes vulpes). J. comp. path. ther., 73, 391-409.

24. JEFFERIES, D. J. 1969. Causes of badger mortality in eastern counties of England. J. Zool, London, 157.

25. BENCZE, L. 1962. Durch Anwendung von Pflanzenschutzmitteln entstandene Schaden im Wildbestand. Deutsch. Akad. der Landwirtschaftswissenschaften, Tagungsberichte, No. 54, 85-89.

26. BAKER, M.F. 1958. Observations of effects of an application of heptachlor and dieldrin on wildlife. Proc. 12th ann. conf. Southeast Assn. of Game and Fish Comms., 244-247.

27. CLAWSON, S. G. and BAKER, M. F. 1959. Immediate effects of dieldrin and heptachlor on bobwhite. J. Wildl. Mgmt., 23, 215-219.

28. LOCKIE, J. D. and RATCLIFFE, D. A. 1964. Insecticides and Scottish Golden Eagles. Br. Birds, 57, 89-102.

29. Van KLINGEREN, B., KOEMAN, J. H. and Van HAAFTEN, J. L. 1966. A study on the hare (Lepus europeus) in relation to the use of pesticides in a polder in the Netherlands. Pesticides in the environment and their effects on wildlife. J. appl. ecol. 3 (Suppl.), 125-131.

30. NATURE CONSERVANCY. Unpublished material in files of the Toxic Chemicals and Wildlife Division, Monks Wood Experimental Station, England.

31. HUNT, E. G. and KEITH, J. O. 1963. Pesticide-wildlife investigations in California - 1962. Univ. of California, Davis, Calif. 29 pp.

32. ASH, J. S. 1963. Mortality to game and other wildlife caused by agricultural chemicals in 1962. Ann. Rep. Game Res. Assn., 2, 12-22.

33. BORG, K.,WANNTORP, H., ERNE, K. and HANKO, E. 1966. Mercury poisoning in Swedish wildlife (summary). Pesticides in the environment and their effects on wildlife. J. appl. ecol. 3 (Suppl.), 171-172.

34. FOWLE, C. D. 1965. A preliminary report on the effects of phosphamidon on bird populations in Central New Brunswick. Canadian Wildlife Service Occasional Papers No. 7.

35. FOWLE, C. D. 1966. The effects of phosphamidon on birds in New Brunswick forests (abstract). Pesticides in the environment and their effects on wildlife. J. appl. ecol. 3 (Suppl.), 169-170.

36. HUNT, E. G. and BISCHOFF, A. I. 1960. Inimical effects on wildlife of periodic DDD applications to Clear Lake. Calif. Fish and Game, 46, 91-106.

37. GROLLEAU, G. and BIADDI, F. 1966. Note on the effects of thiram on the laying and rearing of the red-legged partridge (Alectoris rufa). Pesticides in the environment and their effects on wildlife. J. appl. ecol. 3 (Suppl.), 249-251.

38. KEITH, J. O. 1966. Insecticide contaminations in wetland habitats and their effects on fish-eating birds. Pesticides in the environment and their effects on wildlife. J. appl. ecol. 3 (Suppl.), 71-85.

39. MULLER, J. 1966. Pesticiderns betydning for fuglevildlet: Denmark. Meddr. St. vet. Serumlab 433, 1-9.

40. VOS, J.G., BREEMAN, H.A. & BENSCHOP, H. (? in press). The occurrence of the fungicide hexachlorobenzene in wild birds and its toxicological importance. A preliminary communication.

41. KOEMAN, J.H., OSKAMP, A.A.G., VEEN, J., BROWER, E., ROOTH, J., ZWART, P., v.d. BROEK, E. and van GENDEREN, H. 1967. Insecticides as a factor in the mortality of the Sandwich Tern (Sterna sandvicensis). A preliminary contribution. Mededelingen Rijksfaculteit Landbouw-wetenschappen Gent, 32, 841-854.

42. RATCLIFFE, D.A. 1967. Decrease in eggshell weight in certain birds of prey. Nature, 215, 208-210.

43. HICKEY, J.J. and ANDERSON, D.W. 1968. Chlorinated hydrocarbons and eggshell changes in raptorial and fish-eating birds. Science, 162, 271-273.

44. ANDERSON, D.W., HICKEY, J.J., RISEBROUGH, R.W., HUGHES, D.F., and CHRISTENSEN, R.E. 1969. Significance of chlorinated hydrocarbon residues to breeding pelicans and cormorants. Canadian Field Nat., 83, 91-112

45. HICKEY, J.J. (Ed.) 1969. Peregrine Falcon Populations: their biology and decline. Madison, Milwaukee and London.

COUNCIL OF EUROPE

COMMITTEE OF MINISTERS

RESOLUTION (70) 24

(Adopted by the Ministers' Deputies on 2 July 1970)

ON REGULATING THE MANUFACTURE, MARKETING AND USE OF PESTICIDES WITH A VIEW TO THE PROTECTION OF THE ENVIRONMENT

Considering that at present the use of pesticides is indispensable, in particular against the carriers of diseases, for agriculture and for the protection of foodstuffs;

Considering also that their widespread and occasionally ill-considered use and sometimes their accumulation constitute a danger not only to man, and domestic animals, but also to wildlife, and that some pesticides may have effects other than those for which they were applied;

Considering that it is urgent to avert that danger by concerted action, at the European level among others, and that in order to do so it is necessary to harmonise measures in the member states of the Council of Europe governing the manufacture, marketing, transport and use of pesticides;

Considering that - although considerable protection of the environment can be, and actually has been, obtained in some European countries through intelligent co-operation between all interested parties within the existing legal framework protecting the health of man and domestic animals - the legislation of a certain number of Council of Europe member states does not appear to take sufficient account of the harmful secondary effects of pesticides on the environment, and that the relevant regulations should therefore where necessary be amplified accordingly;

Considering that the use of pesticides is not the only means of protecting plants and that progress in biology and ecology has revealed other methods of plant protection less dangerous to public health and the environment such as selecting resistant strains or biological control that can in some particular cases successfully replace the use of chemicals;

Recalling that the Committee of Ministers had drawn the attention of the governments, among other things, to the need to accelerate studies on the contamination of the environment by pesticides and their residues, and especially on their possible harmful effects on wildlife, as well as to promote the spread of information with the aim of extending scientific research and warning against ill-considered use of these substances;

Having consulted the European Committee for the Conservation of Nature and Natural Resources on the hazards to the environment and wildlife arising from the use of poisonous substances;

The Committee of Ministers

1. Draws the attention of the governments of member states to the need for a complementary legislative control such as will ensure that the manufacture and marketing and use of pesticides comply with the requirements for protecting both the environment and public health;

2. Recommends the governments of member states, insofar as they have not already done so, to take into account the principles set out in the Appendix to the present resolution when preparing or revising legislation on the manufacture, marketing or use of pesticides;

3. Recommends the governments of member states to support action taken to standardise control methods taking particular account of the requirements which pesticide manufacturers must meet regarding the nature and presentation of the toxicity of their products and which are set forth in the second edition of the publication Agricultural pesticides of the Partial Agreement in the social and public health fields, it being understood that such controls should also cover harmful effects on wild fauna and flora, bearing in mind the factors of concentration within the food chain;

4. Recommends to the governments of member states that where possible the body responsible for the authorisation of the use of pesticides should contain a biologist who may advise on environmental problems;

5. Reiterates the recommendation made to the governments of member states in 1966 with a view to accelerating research programmes on contamination of the environment by pesticides and their residues and on safety measures to be observed during their transportation or use;

6. Requests the governments of member states to keep the Secretary General of the Council of Europe informed, every three years, of the action they have taken on the present resolution.

APPENDIX

PRINCIPLES RELATING TO THE MANUFACTURE, MARKETING AND USE OF PESTICIDES

I. General principles

(i) Any regulation applicable to the manufacture, marketing and use of pesticides should consider both public health and the environment.

(ii) The content of such regulation should not be overlooked in the framing of new legislation on the protection of crops and of domestic animals. Its principal aims should be :

- to protect plants and stocks of foodstuffs against harmful organisms or diseases;

- to prevent undue hazards to animals, plants and micro-organisms useful in pest control or of which the conservation is desired;

- to avoid hazards to public health as well as damage to the living environment - water, soil, flora and wildlife - which might be brought about by the use of pesticides.

II. Control of the manufacture and marketing of pesticides

(i) Any regulations concerning pesticides should stipulate that their marketing be authorised only provided the manufacturer or importer has submitted to the competent authorities for assessment the results of chemical, physical, toxological and biological studies.

(ii) Physical, chemical and biological studies of each pesticide should also aim at a reasonable assessment of its effects on :

(a) the ecological balance of the environment;

(b) the physical, chemical and biological properties of soil and water.

(iii) The analyses and tests referred to in paragraph (ii) should also endeavour to cover any cumulative effects which might follow the repeated application of a single pesticide and, if possible, any combined effects of applications of pesticides having different chemical compositions.

(iv) Applications for authorisations in accordance with paragraph (i) should be accompanied by data enabling the authorities to assess the effects of the use of the product on the environment.

(v) If the data presented indicate unduly harmful effects on the natural environment it should be possible to refuse authorisation in accordance with paragraph (i).

(vi) It should be possible to withdraw the authorisation to use a pesticide if the regular application of the product has shown unduly harmful effects on the natural environment.

(vii) The packaging and labelling of pesticides marketed for sale should bear exact instructions concerning :

- the active ingredients of the product;

- the method of using and transporting it and any safety measures to be taken in this connection;

- the hazards which it might present to the environment, especially for fauna and flora (for example, game, fish, pollinating insects etc.), in particular by its excessive use or prolonged effects ;

- the disposal of waste material and emptied containers and the cleaning equipment used during application of pesticides.

(viii) The sale, handling and use of highly toxic pesticides should be subject to effective control.

III. Measures for protecting the environment during the application of pesticides

(i) Provision should be made in legislation or by other arrangements for the protection of the environment, including :

(a) precise demarcation of the area to be treated with pesticides, and the conditions of use, e.g. by qualified persons and under favourable weather conditions, particularly when applied from the air, with a view to preventing contamination of :

- water, including rivers, lakes, pools, springs, wells and all sources serving for human consumption, industrial production and agricultural irrigation;
- breeding places for game and protected hunting reserves;
- nature reserves ;

(b) the regulation of treatment during flowering periods when plants are visited by pollinating insects, particularly bees ;

(c) the precautions to be taken to protect soil against repeated applications of persistent pesticides ;

(d) the discharge of rinsing water and the dumping of containers in the countryside after use.

(ii) Provisions should be enacted to the effect that dangerous pesticides should be used under the responsibility of professionally qualified persons. The qualifications in question should be supplemented by accurate knowledge of the toxic effects of pesticides, not only on man but also on the natural environment.

Specialised courses should therefore be organised by the competent authorities for those persons who will be called upon to use pesticides.

IV. Penalties

Any measure laid down by a law or a regulation based on the above-mentioned principles should be accompanied by penalties for its infringement.