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For the definition of an ecological strategy in the protection of agrosystems[1]

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Œuvres de Rabelais: La vie très horrofique du grand Gargantua, tome premier

«Auquel lieu estoit une ample forest, de la longueur de trente & cinq lieues, & de largeur dix & sept, ou environ. Icelle estoit horriblement fertile & copieuse en mousches bovines & freslons; de sorte que c'estoit une vraye briganderie pour les pauvres jumens, asnes & chevaulx. Mais la jument de Gargantua vengea honnestement tous les oultrages en icelle perpetrés sus les bestes de son espece, par un tour duquel ne se doubtoient mie. Car soudain qu'ilz furent entrés en ladicte forest, & que les freslons luy eurent livré l'assault, elle desgaina sa queue, & si bien, s'escarmouchant, les esmoucha, qu'elle en abatit tout le bois; à tord, à travers, de çà, de là, par cy, par là, de long, de large, dessus, dessous, abatoit bois comme un fauscheur faict d'herbes. En sorte que, depuis, n'y eut ne bois ne freslons; mais fut tout le pays reduict en campaigne.»

'There grew near Orleans a large forest about twenty-five leagues long and seventeen leagues wide. There were in it a great number of cattle flies; so that poor horses, donkeys and mares suffered a lot from their attacks. But Gargantua's mare rightly avenged all the outrages committed there on the animals of her species by a trick which the flies could not foresee. For, suddenly, as they had penetrated into that forest, and she was being assaulted by the flies, she unsheathed her tail and flapping herself, scattered them away so hard that she smashed the whole forest; at random, here, there, far and wide, up and down, she felled the trees just as a haymaker mows grass. So that, since then, there have been neither forest nor flies.'

The present situation of the protection of agrosystems offers 2 conflicting aspects.

In particular the use of synthetic insecticides has generally reduced losses and increased yields, but the populations of harmful insects have again, in many cases, reached a dangerous threshold inspite of ever-increasing treatments, which often bring severe alterations in the ecosystems, and cause useful species to disappear and other harmful species to proliferate. Examples of this are provided by the aggravation of the sanitary state of the cacao tree fields in Borneo and of cotton plants in the Canote Valley in Peru after repeated treatments[2]. Besides, the protection of agrosystems often has consequences outside the ecosystems we want to protect[3,4]. Therefore any intervention to ensure protection must be integrated into a system of relationships in which the species to be protected is only one element, even if this one is of paramount importance for man.

In such conditions, it is useless to insist at present upon the need for a so-called integrated control. As any intervention gets integrated by itself, it is obviously a matter of appraising the aspects and the consequences of this integration upon the agrosystem concerned, upon those that will follow it and, as any agrosystem is open, upon the neighbouring ecosystems and the ecosphere itself.

The adoption of an ecological view allows one to devise a programmed integration of human intervention. That is what is expressed by J. de Wilde, who considers the integrated control as 'a stable system of crop protection which, based upon the ecological relations within the crop and the environment, combines several effective pest control methods ...'[5].

Well, in that domain, there is much to be done.

Owing to the sectorialisation of economic aims, and to the technical training they have been subjected to, agronomists are very badly fitted to examine the various aspects of ecological integration. Without going over the whole analysis made by F. E. Egler[6], we must observe with him that 'in their training and in their thinking, they (the agronomists) are strangers in time and space to the complex ecosystem. They want a simplified, if highly unstable environment'. Thus, it is to be assumed that many people among those who discourse nowadays upon the necessity of a so-called integrated control, confess they have completely failed, until now, to study the ecological consequences of their interventions.

Unfortunately, the fundamental principles of ecology are not often taken into account in setting out the principles of integrated control. We do not intend to write a treatise on ecology, or to describe the fundamental characteristics of ecosystems; but it is impossible to define the principles of a strategy of intervention without starting from precise ecological concepts applied to the fundamental aims of agronomy. Even if, as R. Margalef[7] notes, 'ecologists have been reluctant to place their observations and their findings in the frame of a general theory' and have been awkwardly inclined, as G. H. Orians[8] stresses it, to define deliberately productivity of ecosystems considering that the results can be widened and above all that the properties of species can be defined strictly. – The aim of biology applied to agriculture and cattle raising is a double one: it is to get qualitative improvements and an increased quantity of products.

Improvement of species. The qualitative and quantitative changes are intended to adjust the qualities of products to the economic requirements and tastes of man.

a) The individual performances of cultivated plants and bred cattle can be quantitatively improved; for example, by increasing the number of muscular fibres per kilogram of veal; the content in fat and proteins of milk, in farina and gluten of grain, in juice and sugar of oranges, in oil of sunflower seeds, in proteins of soya sprouts; by increasing the length of cotton fibres. The aim is to increase the biomass of useful products in comparison with the total biomass of the individual. A more traditional aim is to improve assimilaton of the individual by reducing the losses of the elements that are provided for it.

b) The quality of the products can also be improved by modifying the gustative quality and the flavour of fruit, the consistence of the flesh for meat, the aspect of a flower ... A lot of processes are used to attain these 2 objectives (the qualitative and the quantitative one).

Zootechny and agronomic techniques are busy on them. Numerous processes tend to channel the use of energy and metabolites towards the tissues or organs that are consumed or used, for example thanks to the tasseling of corn plants and pruning fruit trees.

Not only is everything done to increase assimilation, but also artificial selection and direct intervention on the genotype tend to create individuals that are sterile biological monsters (seedless fruit), provided with particular hypertrophied organs or tissues. Now all these interventions are not without effect on the sensitiveness of crops and stock farms to enemies. The changes made in the feeding conditions and the alterations of structures result necessarily in a greater fragility and thus a lower resistance to parasites, predators or pathogen germs of cultivated plants or domestic animals. The use of machinery as it is, causes changes in the relations with the enemies which should not be overlooked[9].

For all these reasons, in a general way the changes or selections that are made produce individuals less capable of bearing the stress of natural selection. Moreover, their reduced homeostasis makes them particularly sensitive to the random variations of ecological conditions. We find the most typical example of this in the selection of chickens with reduced feathers. In all cases, they require an increased protection against the variations of ecological conditions in intra- and interspecific competitions, and in front of the attacks of their consumers and decomposers.

Besides, in order to facilitate the operations of farm produce industry, and to reduce losses, all the efforts tend to homogenize the performances and qualities of domestic animals and plants. Now the widespread homogenization of a selected variety is in direct opposition to the whole of natural history. Sex reproduction, which is costly and lavish of gametes and unused individuals, has developed only because it has the enormous advantage of allowing a maximum variability in populations[10]. Every homogenization (every narrowing of a genic pool) constitutes the greatest danger: in 1955, in France, about 30 bovine breeds were raised; at present, 90% of artificial inseminations are made with the sperm of only 5 bull breeds. In particular, homogenization favours the spreading of attacks and epidemics (the example of damage caused by blight to the coffee plant in Brazil is a well-known one).

Thus, when we keep improving the individual qualities, we increase the difficulty of protecting crop fields and stock farms; this constant improvement could not be carried on without danger, ignoring the ecological requirements of concerned populations.

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Extension of the range. Without orienting the intervention towards the modification of individual performances of plants and animals, without even trying to increase productivity, the total production can be increased by extending the farming areas. It must be added that this trend does not compensate for the loss of ploughed lands which has reached over 4 millions acres in France in 16 years, that is 11%; the uncultivated agricultural area representing over 10 millions acres, that is 28% of ploughed lands[11].

3 strategies are used to increase the cultivated acreage: a) the first strategy does not modify the range, but it generalizes the possibilities of development by removing the limiting factors which rendered certain areas unusable. Thus the intervention does not occur on the level of the organism considered, but on the level of the ecosystem. As it operates within the range, it can only have to do with sparing water or mineral substances to favour the settlement of the species. Such an intervention reacts with 2 conflicting aspects on the level of protection against consumers.

On the one hand, the absence of the cultivated species concerned before the area was cultivated did not allow its specific consumers and decomposers to be present. Thus the harmful species will colonize more or less rapidly the new culture, depending on the distance between them and the newly developed area. As far as the other phytophagous and pathogen organisms in neighbouring ecosystems are concerned, the change in ecological conditions may result in disturbances that can hardly be foreseen. Thus, about 1000 species of Arthropods are estimated by R. van den Bosch and V. M. Stern[12] to have settled on lucern, a semiperennial culture, in the central valley of California.

On the other hand, in so far as the full spreading of habitats in the range is accompanied by an intervention upon the ecosystem, some detrimental ecological factors may not have completely disappeared. Thus the conditions of development may be partly disturbing, they may weaken the individuals and make them more subject to the attacks of consumers and decomposers either directly or because a too severe intraspecific competition (as, for example, when the density of vegetation does not allow a sufficient water supply) weakens the plants.

b) The second strategy corresponds to the spreading of a species in the whole of its potential range. So far as the ranges of species are determined by the primary periodic factors, the potential range, which is defined by photoperiod, can extend widely beyond the real range at a certain historical time. As all speciations are automatically space phenomena, the emergence area is necessarily ecologically isolated from other ecosystems, whose periodic characteristics are identical, and whose feeding possibilities are of the same kind. Except for species with a high dispersal power, only historical accidents allow a more or less complete colonization of the adequate ecosystems in the potential range[13]. Now, through propagation of his cultivated plants and domestic animals, through the distribution of his goods, man has favoured the movement of a lot of enemies, allowing them to colonize progressively the whole potential range, including its symmetrical fraction on the other hemisphere. A theory of probability dealing with the occurences of exchanges, the damage caused by enemies, the attacks of entomophagous insects would show why there is a more or less important latency period between the arrival of the cultivated plant and that of its main aboriginal enemy, and why the latter seldom arrives with its enemies. Such is the case with Leptinotarsa decimlineata which joined the potato plant only in the 1920's. While it colonizes new ecosystems, the introduced element can 'drag' consumers on to its new habitats. Thus the peach-tree was colonized by Grapholita molesta which, afterwards, attacked progressively that plant in all its original range. This transfer is possible because the characteristics of the colonized host present a sufficient number of common points with the original host(s) of the consumer[14]. Thus, certain individuals exclusively, can utilize the characteristics of the new host and attack it[15].

c) Lastly, in order to ensure a better geographical distribution and to extend the areas used, man introduces species in new ecosystems, where the periodic conditions were incompatible with the evolutionary characteristics of the species concerned. The extension of the range is then related to changes of the evolutionary characteristics of the population, either through selection, or cross-breeds with populations having different adaptative characteristics. The extension, through modification of characteristics of the population generally introduces species in areas where predators and specific pathogen elements are absent, but the selection imposed on the population, to enable it to bear the new periodic conditions, results in changes in its characteristics, which can favour its attack by aboriginal consumers and decomposers. Besides, in these marginal areas, the genic pool of the population introduced is generally more limited, which reduces resistance to attacks. Only a precise observation make it possible to define in each case the new problems set by protection after extending cultures without their evolutionary range.

Alterations of level of the grown or raised population.

A third aim of biology applied to agriculture and cattle raising is to increase ecological productivity by acting upon the dynamics of population, that is increasing the yield per unit of acreage (production) or per unit of time (productivity), or both at the same time.

a) Lengthening of the utilization of space. This productivity can be obtained by reducing the time of occupation of space by each generation. Then production itself remains the same; but as the time necessary to get it is reduced, productivity per unit of acreage is increased by the succession of several productions on the same land. Such a result can be achieved either by using growth hormones or by changing the diets, or by selecting fast-growing varieties (rice and vegetables) which enable to multiply generations, or lastly by using varieties (strawberry plants, fruit trees) or farming methods (hay-making) which lengthen the period of production of useful organs which results in the lengthening of the exploitation period of each generation or of the useful stage of perennial species.

It is also possible to lengthen the time of utilization of the area concerned by shortening the period during which the characteristics of the agrosystems do not allow an agricultural or zoo-technical use. The point is often to free this area from the limits imposed by seasonal fluctuations. This is achieved by irrigation which enables plants to grow in the dry seasons, by using forcing frames or polyethylene tunnels that cause the temperature to rise with a 'hot house effect', or by heating the soil ... Going to the extreme limit, specialized and air-conditioned enclosures can be used: hot houses, poultry and pig factories ...

In the various cases of increased productivity through multiplication of the number of generations, the problems of dynamics of populations have no direct ecological relationship with the factors which determine the level of productions. On the contrary, these cases are attempts to get free from the ecological imperatives which limit, in nature, the usage time of a given area. In such conditions, the various methods in use often put the individuals in conditions of lower physiological resistance and increase their fragility. Thus fast-growing plants often have structures that are less elaborate or have remained immature[16]. In that case protective structures, such as cuticle, ligneous strata, substances reducing digestibility are often more rudimentary, which facilitates the action of enemies. For domestic animals, accelerated growth often goes with actions to limit energy losses related to muscular activity. It results in an increased fragility and a greater sensitiveness to the actions of parasites.

The acceleration of turn-over through an increased number of host generations has something in common, in its effects on the population of consumers or microbial organisms, with the renewal of the trophic environment in bacterial cultures. In effect, the rapid succession of host generations at the beginning or in the course of their development (a remarkable phenomenon in market or flower gardening) maintains permanently a favourable trophic environment, generating conditions favourable to rapid multiplication of consumers and pathogen elements. Thus some polyvoltine species are favoured; they become the principal enemies of cultures and stock farms. As a consequence, very serious problems of prevention and protection have to be faced. Breaking the dynamics of harmful populations becomes of prime importance. No absolute eradicating action can be expected with heterogen populations unless the very possibilities of development are removed. That is the reason why the increased utilization of an agricultural area by successive generations of potential hosts must necessarily entail the introduction of breaks in the food base of harmful species. This can be achieved only by crop rotation with plants being introduced that do not belong to the range of potential hosts of harmful species. However, the distribution in space of cultures subjected to rotation must be carried out so that the distance between the species that are likely to be attacked by the same enemies becomes longer than the dispersal power of one generation of harmful species. So Lygus hesperus became the principal enemy of cotton crops in the Central Valley of California, as the complementarity of hosts was increased by the techniques of lucern harvesting[17]. A strategy of rotation, which alone can prevent rapid multiplications of enemies, goes against the specialization of farming aiming at the exclusive production of a given plant; this specialization is made to render farming conditioning and marketing techniques more simple. Crop rotation also implies that the production of neighbouring farms should be coordinated, and not carried out independently.

Thus the shortening of the time necessary to each generation, or the lengthening of the time during which the area can be used, interfers with the methods of protection, and often change radically the nature of the problems to be solved.

b) Increase of the total useful biomass per unit of acreage. An increased productivity is sought mainly by increasing the production of useful biomass per acre.

Certainly the building of special plants, hot houses, rearing factories allows us in theory to increase considerably the biomass per acre; the number of floors only has to be increased.

But this stratification can also be achieved in nature when there is a high incident solar energy. In effect, in forest ecosystems, particularly equatorial and tropical ones, various layers of vegetation allow a high total yield per acre, while weakening for low cultures the impact of ecological factors (for example insolation and evaporation). Likewise, the Italian technique, which is often to be observed near Verona, and which consists in planting on

the same plot of land fruit trees, pergolashaped vines and small plants, increases considerably the yield per acre. Such a stratification, when it is possible owing to ecological conditions, does not automatically complicate defence against primary consumers and decomposers.
In effect, L. Trevor[18] notices that: 'Populations of many pest species of aphids or thrips may be 2–10 times more dense at unsheltered field margins than elsewhere.' The presence of undergrowth and of an important litter can also prevent insects from multiplying. V. O. Lozinskij[19] notes that 'colonies of Cnethocampa processionae and Bombyx neustria appear in areas overgrazed by cattle, an overgrazing which results in the destruction of the undergrowth and herbaceous vegetation, the cracking of soil and the clearing of forest ... At the same time, insectivorous birds and entomophagous insects are destroyed.' N. N. Padij[20] notes effectively that 'the number of predator Calosoma is nearly twice as low in forests without undergrowth. This difference can be accounted for by the absence of litter where Carabids and their larvae can hide. Likewise, the presence of numerous melliferous species among undergrowth shrubs increases the entomophagous action of Tachinidae upon Operophtera brumata caterpillars.' J. Gyorfi[21] considers that half the secondary hosts of the main parasites of Lymantria dispar L. live in the herbaceous layer of woods. He comes to the conclusion that the permanent presence of entomophagous insects is more affected by the heterogeneity of the herbaceous layer than by that of the tree population. But the ecological heterogeneity of population does not correspond to its richness; it is the phenotypic diversity of plants that is the true ecological heterogenity, which operates upon consumer populations[22].
It would be a mistake to infer that, as an increased number of layers of vegetation causes light intensity to decrease, temperature variations to be reduced, it automatically protects cultures. It all depends on the type of habitat in which the enemies have developed. Such densification wich a stratification reduces the attacks of populations coming from open ecosystems, but at the same time, causes populations coming from shady and perennial ecosystems to settle more easily. Thus every densification of the plant population of biocenosis, either in its quantity or in its density, generates new ecological conditions. There we come to a new type of ecosystem, in which the species that have developed in compact plant populations are favoured, and the species coming from open and temporary plant populations are et a disadvantage. So D. C. Lloyd[23] notices that sugar cane plantations, with their shade and the vertical distribution of their vegetation, form stable and compact wholes which can be compared to forest ecosystems, which accounts for the fact that many of their enemies were originated in forests. We could also note in mixed cultures with corn and dwarf beans planted in the same rows, that the attacks of Acanthoscelides obtectus on Phaseolus vulgaris were limited to the periphery of the field. Corn acted as a screen, and when the water content of the soil did not cause etiolation of corn, it prevented females from penetrating under the foliage. The yields per acre of this mixed culture, when the water supplies were sufficient, were higher than the yields of corn or beans grown separately; for the beans alone are then attacked by the insect in the proportion of 85 to 95%[24]. Thus the screen provided by corn crop stops the attacks of the bean weevil.
These modifications in the structure of the ecosystem operate on all the populations, including those of entomophagous insects. Thus the latter coming from open ecosystems have a reduced efficiency in shady ecosystems. For example, Komosko[25] notes that Trichogramma evanescens lays mostly in eggs exposed to the sun.
Moreover, the stratification of crops, by increasing the complexity of ecosystems, creates a sensorial environment in which the maintenance of the links between consumers and their hosts requires a more elaborate discrimination. If the new biocoenosises formed in that way associate plants from different ecosystems, a new chemical environment is formed. Thus the animals have to face new problems of discrimination of signals or locating of hosts. As these problems do not correspond to those they were subjected to in the course of their evolution, certain connections may fail to get established. As a consequence, such composite biocoenosises can have fewer species than might be expected on account of their complexity.
Besides, the establishment of such stratifications implies that the various associated plants can co-exist, or simply live in succession on the same soil. Now the establishment of allelopathic relationships[26] with the appearance of a real territorialism in the intra- and interspecific competition among plants cannot be overlooked. Whenever limiting factors, such as water or mineral salts, prevent the development of a continuous plant cover, allelopathic phenomenons have become particularly important. Thus stratification seems to be more difficult to achieve with species coming from arid or semi-arid areas.
Lastly, stratified crops make the chemical control with polyvalent insecticides more difficult. In effect, these are not easily oriented towards the reduction of the primary consumers of one particular plant population. They affect simultaneously various categories of plants, and thus they can have opposed effects upon the various trophic chains present in the same area. Safety standards for human health may even be transgressed. We had the opportunity to notice that toxic chemicals had been used on trees long enough before fruit-picking for safety regulations to be respected, but under these fruit-trees, there were vegetables to be marketed the day after treatment!
c) Production of optimum density of population. It is possible to obtain an increased biomass per acre by increasing the number of shoots of each plant, either through tilling of graminaceous plants, or with various pruning techniques on fruit trees. The same result is achieved by densifying seed beds and cultures. Feedlots are based on that process, which is related to the supply of artificial food and a reduced activity of domestic animals.
Such interventions generate special conditions for the protection of these cultures and of these feedlots. They interfere with the dynamics of harmful species populations,

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as they favour their increase in number. That is obvious for consumers with a low dispersal power (eggs laid in clusters), or whose cycle is much shorter than their hosts'. Besides, as intraspecific competition of plants is more important, these can become less resistant to attacks. Those facts both help epidemics to propagate extremely rapidly, as can be observed in some feedlots.

In nurseries, where there is always a high density, the importance of damage is increased, as much because juvenile stages are more fragile, as because the same consumer uses many hosts. But conversely increasing the yield by obtaining an optimum density often goes with a reduction of intraspecific or interspecific competitions when the requirements increase with growth.

This reduction of intraspecific competition is obtained by thinning out (beets) or pricking our processes which space out the heads of a lot of crops (rice). Such reduction of intraspecific competition by spacing out can only be operated mechanically. The reduction of plant density, effected in situ, reduces the number of plants that can be used by the primary consumers already living in the agrosystem. They then tend to concentrate their attacks on the remaining plants, which results in increased damage for each plant. The destruction of pulled out excess plants can avoid that concentration only when consumers are hardly mobile. A similar phenomenon has been observed in California with a polyphagous insect, Lygus hisperus, which concentrates on cotton after lucern has been mown[17].

It is very different in obtaining an optimum density by reducing interspecific competition with chemical devices. The use of weed-killers can deeply disturb the ecosystem by affecting bacterial flora[27], as well as often showing a high toxicity for vertebrates, including man. The accidents caused by dioxine, associated to 2, 4, 5 D used by the American Army in Viet-Nam provide an example of it[28]. In these conditions, it is hard to admit that the intervention with chemical substances affecting plant physiology has no direct effect on insect populations and soil bacterial flora. Moreover, any alteration of the composition of plant secondary substances can have an effect upon the synthesis of secondary substances involved in the chemical communication of insects[29].

The reduction of interspecific competition between plants causes an homogenization of agrosystem which affects the development of primary consumer populations and the activity of polyphagous entomophagous insects. Besides, the alteration of plant cover has complex effects upon the development of hypogeal instars of insects[18] which require, in each case and for each situation, precise analysis. Thus it is impossible to appreciate in general the type of alteration of insect population dynamics after the type of intervention.

The protection of pastures against insects is an application of the struggle against interspecific competition aiming at favouring consumption by cattle. But in that case also, the use of chemicals with a low specificity can be harmful for cattle, and, via the latter, for man. The well-known example of D. D. T. absorbed by cows and concentrated in milk shows how dangerous such methods are.

Thus the elimination or reduction of interspecific competition requires a careful study of the effects upon all the elements of the agrosystem and on the downward links in the food chains.

Action against destructors of populations under exploitation.

The tithe paid by man to the enemies of crops and stock farming has often been underlined. There still exist a lot of regions where man only harvests what is left by his enemies. The increase in agricultural yields, plant and animal ones, in the past decades, is to a great extent related to the improvement of protection methods.

The strategy which seems to be most close at hand is the one that consists of attacking directly harmful populations by causing their mortality. Such is the origin and basis of phytopharmacology and many patent veterinary medicines. In doing so, we try to break deliberately the natural trophic chain by preventing these plants and animals from being consumed or decomposed by various organisms before we can use them for our profit.

That means once we have used the interesting fraction of the biomass of animal plants and animals, we are no longer opposed to the destruction and decomposers. On the contrary, their action contributes to the recycling of mineral matters. It is the same with stumps and animal excrements and wastes. Furthermore any shipping off of these plant wastes results in a rapid impoverishment of ecosystems[11]. Even burning them limits their ecological utilization by depriving soil microorganisms of the energy necessary to their activities, which thus reduces the cation and organic nitrogen content of the soil[11].

The importance of consumption or decomposition, in the regression of the biomass that can be used by man, depends on morphology and the ontogenic stage attacked. Thus consumption by Noctuids or Rodents of the hypocotyled axis of a tree causes elimination of the plant; on the other hand, the consumption of far larger quantities of leaves will have no notable effect, the development of substitute buds will even often allow a restoration of foliar surface[30]. F. E. Eckardt[31] even considers that meadow plants have developed towards a strategy which increases the green biomass produced when they are grazed to allow the maintenance of a sufficient photosynthesis.

Therefore our intervention is never systematic, but it depends on the stages attacked or to be protected. As the number of harmful species to be destroyed is very high, research has been turned towards the production of chemicals as polyvalent as possible. Moreover, as the niches of enemies are variable and all the stages of development up to harvesting or slaughtering are liable to be attacked, research aiming at obtaining a persistent effect has been associated with that of polyvalence. Such aims have been encouraged and taken up by large firms manufacturing phytopharmacological products, which could thus get markets corresponding to their ambitions[32]. But such orientations are in absolute opposition with ecological imperatives. Moreover, side effects of blind treatments have been stressed for a long time. Public opinion was warned by R. Carson[33]. The importance of the market represented by polyvalent chemicals has given rise to a bitter reaction from the producing firms. B. Commoner[34] gave a very accurate analysis of the foundations of this selfish argumentation which, unfortunately, has sometimes been taken up by biologists. The profits at stake were so important that the people insisting upon the negative effects of those chemicals have been grossly abused[36].

Whereas everything must be attempted, on the contrary, to adjust the intervention to the target to be reached in order to limit as much as possible the uncontrolled and side effects of interventions, J. D. Djerassi and his associates[32] show that the research of specific products goes against the interests of manufacturers who try to restrain as much as they can such research that would result in a fragmentation of market.

The fight upon the orientation of research is illuminating as to how a lot of considerations far from strictly agronomic and ecological aspects interfere in the definition of strategy. In all the papers dealing with the protection of ecosystems, it is traditional to distinguish the methods according to the techniques in use. Thus the paper or the lecture is about mechanical, or clinical, genetic, biological control, or control based on farming methods.

Such a typically mechanistic approach does not allow one to define an efficient strategy, for it conceals the nature of problems. It is in accordance with the nature of the problem, that is fundamentally according to the type of agrosystem and its relationships with the neighbouring ecosystems, that the strategy must be considered and devised. *Any definition of control methods starting from the intervention tool tends to conceal the specific nature of every problem to be faced.* It shows that the specialists in charge of the protection of agrosystems find it hard, as R. Margalef[7] underlines it, to set their concerns in a global ecological approach.

Every intervention consists of altering biocoenotic relationships in a particular ecosystem, marked in space, and having its own links with its environment. Therefore, *it is impossible to define a priori an efficient technique; it is impossible to recommend in the abstract a control method effective in all situations to eradicate a given enemy of cultures.* It is surprising that M. E. Solomon[37] regrets we are unable to work out the plans of protection of any crop. In this respect, we may wonder about the value of books on culture protections and of their instructions. Basically the problem is to identifying properly the enemy, having a book recent enough, and using the good recipe outside time and space. What a pity it is not so! Everything would be so simple!

Being satisfied with general precepts would be acting as if, in the field of human health, we could accept that medicine should be reduced to general treatises at the people's disposal, and these would look after themselves from the latest brochures issued by pharmaceutical firms: What scholastic fixism! An unchanging recipe for unchanging beings in an unalterable environment! On the contrary, it is by integrating compulsorily each problem of protection into the web of ecological necessities peculiar to each type of crop and rearing, and at the same time by giving these necessities their proper place in the whole of local and general ecological conditions, that we can expect an effective intervention. That necessarily implies the training of interveners with a good fundamental ecological knowledge, capable of analyzing a particular situation, and, therefrom, of proposing specific steps. Though it is out of the question for us to re-examine the whole of ecological fundamentals that must necessarily determine the methods of intervention, it is necessary to insist on a few fundamental aspects the disregard of which produces many strategic mistakes.

The ecosphere is by nature a periodic open system, in which the incoming energy flow is characteristic of each area. Life has organized itself at the interface of the atmosphere and of the other zones in accordance with these basic daily and seasonal periodicities. A factor need not be constant to determine selection. K. E. F. Watt[38] has rightly stressed that any factor repeated with a definite periodicity allows a determined selection. Thus repetitiveness of phenomenons has determined the evolution of species according to local periodic characteristics[39], imparting a seasonal cycle and a circadian rhythm according to latitude[40]. Producers have cycles of development which adjust their rhythms of photosynthesis to the periodic characteristics of the ecosystem. Therefore every biological cycle corresponds to an adjustment of the activities of the plant to the periodic conditions of its place of evolution.

The plant cycle generates a periodic constraint for consumers whose life is thus related to the periodic characteristics of their hosts and of the other ecological factors. No study can claim to analyze the biology of a population when putting it in an unchanging system, or a system with periodic characteristics not belonging to its original range. It is impossible to separate the various periodicities and to give more importance to certain ones. *The local periodic conditions make a whole, and selection was determined by this whole.* It is as a whole that periodicities have exerted their selecting influences. The separate study of the effects of light and temperature is as little instructive as the independent study of each vowel. Afterwards we have no more knowledge of ecological problems than we have of a language!

With agriculture man has introduced further periodicities. All farming methods are submitted to a time table. The very methods of protection are repetitive in their nature as well as in the time of interventions. Thus by his action man determines selection, not only of cultivated plants, and domestic species, but of all the organisms related to the agrosystem. He creates the conditions that cause a new type of biocoenosis to appear, showing a flexibility and a cyclic stability that can be compared to those of natural ecosystems. Such a system can get a great maturity, in the meaning given by R. Margalef[41].

Any population, after becoming a permanent element in an agrosystem is automatically adapted to this agrosystem; it means that its evolution has been determined by the characteristics, the periodic ones in particular, of the agrosystem. Therefore, *resistance to interventions for the protection of crops is not related to the nature of the intervention, but to the repetitiveness of the phenomenon.* The more regular the latter's periodicity is, the easier resistance is made.

This survey of the conditions that determine the evolution of species shows that *there could not be, and there is not, any perfect method of protection. It is not the method of protection which causes resistant populations to appear; it is the repetitive use of the method.*

Since the condition allowing the orientation of selection, that is the development of resistant populations, is the repetitiveness of a given type of intervention, the only possible strategy of protection is the breaking of the repetitive process.

The set of available protection methods (crop rotation, choosing of varieties, mechanical, chemical and biological interventions) allows to the use of the methods alternately without any definite frequency. Thus each one of the

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methods in use, as it exerts a selection pressure in a different direction, operates on different types of individuals. As each intervention has no repetitive aspect, it becomes a new selective factor, with a catastrophic aspect for a population which has not been prepared by previous selections to bear it. Now Watt[38] considers that the more the ecosystem where a population lives, corresponds to a predictable environment, the more that population has acquired a genetic rigidity, and the more subject it can be to extermination by a catastrophic factors. It is in this way that climatic events can have a decisive effect on populations, provided that they have no repetitive aspect. That shows the scholastic aspect of the dispute on the relative importance of biotic or abiotic factors[42].

The catastrophic effects of interventions of various kinds can thus eradicate progressively a whole population. Thus we can expect total eradication of a harmful population, but such a result could not be permanent. In effect, every agrosystem, often far more than many ecosystems, is an open system. It can always be recolonized. Keeping empty niches in it requires permanent action. But the price paid for any success is a consequent carelessness. As an ecosystem with unoccupied niches is permanently unbalanced, only permanent action prevents attacks for the occupation of available niches.

Therefore, *there exists neither permanent solution, nor hierarchy in the value of strategies, nor ideal recipe, nor all-purpose produce*. All discussions on the research for an ideal technique look very much like the discovery of the philosopher's stone.

The fact that some people may have such aims a century after Darwin and Haeckel shows that mechanism and fixism have still left deep impressions.

42 V. Labeyrie, in: Statistical ecology, vol. 2. Ed. G. P. Patil. Pennsylvania State University Press 1971.

CONGRESSUS

Switzerland

International symposium on gut hormones

Lausanne, 18–19 June 1977

To mark the 75th anniversary of the discovery of the first 'hormone' by Bayliss and Starling, an international symposium sponsored by the Widmar foundation will review the whole field of gastrointestinal hormones.

Each hormone will be covered in depth and the wider clinical and scientific implications discussed in eight intensive sessions. *Topics:* Chemistry, Evolution (developmental), Techniques, Secretin, Motilin, CCK, Pancreatic Polypeptide, GIP, Gastrin, Glucagon, Paracrine–Neurotransmitter system, VIP, Somatostatin, Neurotensin–Bombesin–Sub P–Endorphins, Duodenal Ulcer, Endocrine Tumours.

Organizing Committee: S. R. Bloom, P. Magnenat, J. M. Polak and J.-P. Felber.

Further information by Dr S. R. Bloom, Department of Medicine, Hammersmith Hospital, Du cane Road, London W12 OHS, England.

Italy

EUCHEM Conference on Structure, Synthesis and Biosynthesis of Mono- and Sesquiterpenoids

in Varenna (Lake Como), 25–31 August 1977

About 12 plenary lectures will be given by invited speakers and a limited number of short communications will be accepted from the participants. Further information by: Conference on Mono- and Sesquiterpenoids, Laboratorio di Chimica Organica dell'Università, via C. Saldini 50, I–20133 Milano, Italia.

France

17th International Congress of Physiological Sciences

in Paris, 18–23 July 1977

The first two days will be devoted to general lectures and during the last four days specialized meetings will take place. Further information can be obtained from the National Physiological Society of each country or by writing to the Congress Secretary: Prof. J. Scheerer, Secrétariat du 17. Congrès Int. des Sciences Physiologiques, U. E. R. Pitié-Salpêtrière, Cedex 1300, F–75300 Paris-Brune, France.

The Netherlands

The 7th European Food Symposium on product and process selection in the food industry

at Eindhoven, 21–23 September 1977

The symposium will be organized by the Food Working Party of the European Federation of Chemical Engineering in cooperation with the Dutch Society of Nutrition Science and Food Technology and IUFoST. Topics: 1. Food industry and society; 2. Product and process selection: procedures and techniques; 3. Examples of product selection based on economic considerations; 4. Examples of process selection based on economic considerations. Further informations by the Food Working Party, c/o Gesellschaft Deutscher Chemiker, P.O. Box 90 04 40, D–6000 Frankfurt 90, Federal Republic of Germany.