ISSN 1995-4255, Contemporary Problems of Ecology, 2008, Vol. 1, No. 6, pp. 721–723. © Pleiades Publishing, Ltd., 2008.
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On the Evolutionary Ecological Concept of Plant Protection

N. G. Vlasenko

Siberian Research Institute of Crop Farming and Chemicalization of Agriculture, Siberian Branch of the Russian Academy of Agricultural Sciences, Krasnoobsk, Novosibirsk oblast, 630501 Russia
E-mail: vlas_nata@ngs.ru

DOI: 10.1134/S1995425508060179

The extensive article "The Evolutionary Ecological Concept of Plant Protection" by V. A. Chulkina, E. Yu. Toropova, and G. Ya. Stetsov was published in Sibirskii Ekologicheskii Zhurnal, 2007, No. 3 [1]. Being published in the authoritative scholarly journal, it has aroused perplexity since this concept has come in for a great deal of criticism from leading specialists engaged in the study on plant protection.

The authors of the article claim that the current situation in plant protection practice, when noxious organisms are first allowed to propagate in agroecosystems and then brought under control by being exterminated with pesticides according to the economic injury level, is a consequence of the ignored necessity to develop and apply agrotechnical methods and of the disaggregated approach to the plant protection problem. However, this is not the case. Crop farming in general and plant protection in particular have always used special techniques to control the population of noxious organisms by introducing phytosanitary crop species and clean fallow to crop rotation using fertilizers regulating terms of sowing, standardizing quantity of seeds per hectare, etc. The most promising approach to plant protection is to study the natural self-regulation of hazardous and useful species found in agrocenoses and quantitative assessment of biocenotic process parameters in agrocenosis as affected by different anthropogenic factors. It is obvious today that it is impossible to create a system of plant protection from noxious organisms ignoring the general cultivation process under specific economic and soil-climate conditions. It is found more reasonable to maintain favorable phytosanitary conditions provided, in particular, by plant protection measures, by applying such agrophytosanitary measures as plant protection and conservation in crop farming rather than introduction of independent systems of integrated plant protection. This approach ensures multiple choice of decision-making, variety of options and flexibility of the system in response to a specific situation, local environment and market requirements [2–5]. Current problems of crop protection against plant pests, diseases, and weeds result from poor development of technological procedures, insufficient materials and equipment, and shortage of skilled personnel rather than from the lack of theoretical background.

The authors consider epiphytotiology an ecological science and use it as a methodological base to work out general principles of the integrated plant protection against hazardous organisms. As early as 1994, Gorlenko et al. [6] wrote: "We cannot agree with the author (V. A. Chulkina) that ecologization of plant protection requires the development of epiphytotiology as 'a basis for phytopathology'" (just phytopathology at that time!). Gorlenko and coauthors argue that epiphytotiology as part of phytopathology cannot be "a basis" of the whole of phytopathology. The fundamentals of phytopatholody are several sciences: study of green plants, mycology, bacteriology, phytovirology, phylaxiology, phytophysiopathology, etc. Yet rejecting criticism Chulkina and her coauthors have promoted epiphytotiology as theoretical fundamentals of integrated plant protection [1, 7–9] applying epiphytotiology to all the biocenotic processes in agroecosystems. But they failed to avoid contradictions here again. Their latest article [10] says: "The epiphytotiological process is the concern of epiphytotiology aimed at studying hazardous organisms (plant pathogenic organisms, phytophages, and weeds)." This statement is followed by the definition: "The epiphytotiological process is an objective bioecological phenomenon <u>observed as continuous emergence, course, and fading of diseases (!)</u> in plant populations in time and space."

A. F. Zubkov, a leading specialist of the Institute of Plant Protection (VIZR) has written several articles on this subject. In 2002 Vestnik Zashchity Rastenii (No. 2) published his paper "Can epiphytotiology serve as a theoretical basis for plant protection?" [11]. It contains clear and sound arguments for the failure in finding evidence in favor of the affirmative answer to the question: Can the ideas developed by Chulkina be considered "new phytopathology"? In addition, while examining her model for the epiphytotiological process Zubkov notices that the author's methodological achievement is a shift from the pattern of phytopathological complex like Van der Plank's triangle (1966) to a block-diagram comprising three groups of epiphytotiological process factors – a source of infection, transmitter of infection, and susceptible plant. "This block-diagram is based on the close nature of the epiphytotiological process where the ecosystem is nothing more than an external factor. It can be applied to study the influence exerting by the ecosystem on the epiphytotiological process but it cannot be used to study the ecosystem by means of the epiphytotiological process, as it demonstrates neither epiphytotiological process-natural factor feedback nor impact of the epiphytotiological process on what is called ecosystem." In his another paper [12] Zubkov continues to criticize the position of Chulkina and her coauthors: "There is no reason for considering epiphytotiology a uniting theoretical science as it is not cognitive with regard to phytophages (not to mention zoophages and weeds) and lacks its own methodology and appropriate field research techniques … In principle, an individual science cannot substitute for the methodology of a general science. … For about 70 years, biocenotic processes in agroecosystems have been the concern of agrobiocenology, which has formulated the theory of development of agrobiocenoses and complex self-regulation agrobiocenoses, methodology and field research techniques and ecosystemic aspect of plant protection. Since the 1970s biocenology has been recognized as a base of plant protection (Gilyarov, 1977; 1979). Agrobiocenology is regarded both as an experimental subdivision of biocenology (Tishler, 1971; Gilyarov, 1980) and as a theoretical base of the integrated plant protection (Pavlyushin, 1999)." In 2007 Vestnik Zashchity Rastenii (No. 2) also published the article "The concept of self-regulation in biocenotic processes of agroecosystems", where Zubkov also closely scrutinized phytocenotic, epiphytotiological, epiphytophagic, and entomophagic processes and expressed his opinion about Chulkina's papers on the problems discussed [13].

It is doubtful that the ecological classification of organism species (*K*- and *r*-strategies) can be applied in plant protection practices. The types of strategies are quite uncommon — transitions from one to another type of strategy are found more frequently in nature. The type of species strategy is not actually stable and each species can change it when it appears in different parts of the habitat, various cenoses and environment [14]. As populations are characterized by a flexible type of strategies it seems unreasonable to consider this feature to be principal in the formation of plant protection systems. Yet, according to Chulkina's classifications, hazardous organisms (pests) are to be monitored, their development is to be forecasted and protective measures are to be worked out.

Chulkina et al. have formally divided hazardous organisms (pests) into four groups and ten subgroups according to their transmission patterns and ecological niches (Table 3, page 341) [9]. It is not clear, for example, why perennial weeds fall into the soil-ground subgroup and groups of soil or root-tuberous organisms whereas annual or biennial weeds fall into the ground-soil subgroup, groups of ground-air or stem-leaf organisms. Provided that such a division is made only according to way of reproduction (the first group — vegetative reproduction, and the second group — seedage), it should be noted that perennial plants can reproduce themselves by seeds too. The modern classification of weeds is based on biological characteristics of plants and takes into account a much wider range of features which facilitate the development of pest control. For example, Devil's grass (*Agropyron repens*) (subgroup of perennial rootstock weeds) and sheepbine (*Convolvulus arvensis*) (subgroup of offset weeds) belong to the group of perennial weeds. According to the classification suggested by Chulkina and coauthors these weeds must be in one and the same subgroup – the subgroup of ground-soil organisms, and, therefore, pest control must be based on the similar principles. But if we proceed from the biological features of the above-mentioned weeds the first control system should be based on the "suppression" method, that is breaking rhizomes which takes buds out of the dormant stage and then putting some root sections and Devil's grass shoots deep into ground. This agrotechnical technique is also applied against sedge grass (*Equisetum arvense*), which also falls into the subgroup of perennial rootstock weeds. The second control system is based on the "depletion" method, that is keeping underground seedlings of offset weeds down not to grow into sprouts during the summer time [15]. Chulkina and coauthors place snapping beetles (Elateridae) into the same subgroup. In fact, the life cycle of hazardous species of snapping beetles depends intimately on the soil [16]. The complexity of pest control against wireworms is explained by the specific biology of the pest: the development cycle of a snapping beetle generation ranges from 3 to 5 years depending on weather conditions, i.e., larvae turn into mature beetles in 3–4 years (it is mature beetles who damage crops). One of the most important wireworm control activities extermination of Devil's grass and other crop weeds (larvae prefer to feed on sprouted crop seeds and Devil's grass roots). Another method is baiting wireworms at potato or beet. Oat, barley, and maize bands are also used as baits to get rid of pests.Thus, the authors' claim that their ecological classification of noxious organisms would permit a system approach to the creation of unfavorable conditions for the life cycle of pests contradicts the state-of-the-art plant protection. What is the sense in this classification if there exist classifications of pests, diseases, and weeds and the developed methods, including agrotechnical ones, allow the numbers and harm of agriculturally hazardous objects to be minimized? Strictly speaking, even the measures proposed by the authors as strategical and tactical have long been known and used in the practice of plant protection. Moreover, Chulkina et al. do not rule out the use of pesticides either, though, for an unknown reason, they call these mesures safe. However, at present, there are no ecologically safe fungicides, insecticides, and weedicides. These substances are all of chemical nature and, to a certain degree, affect the nontarget objects of agrocenosis thus diminishing its biodiversity [17].

I believe that the paper contributes no novelty to the theory and practice of plant protection while contain unproved statements, scholastic classifications, and arbitrary substitutions of universally accepted terms. For example, the authors have no clear idea of what is ecological niche. It is not a habitat as they believe but the sum of all factors of the environment (community or ecosystem) within which a given species can exist in nature and act to form its own environment (formally, it is part of a multidimensional space whose changes correspond to the factors necessary for the normal life of the species) [18]. Therefore, the following phrase is rather perplexing: "agricultural seeds form a unique ecological niche whose peculiarity has a considerable effect on the life cycle of pests" (!). What to do then with Gause's principle (prohibited co-occurrence of closely related organisms)? Then, the term "ecological equivalents" mean organisms that occupy the same ecological niche in different geographical regions [19]. Thus, there cannot be seed, soil, ground-air, and transmission equivalents. The term "ecological strategy" means ways of survival and maintenance of population stability in communities and ecosystems [20]. How can this understanding of strategy be applied to a life cycle, which is defined as the various stages through which an organism passes, from fertilized ovum to the fertilized ovum of the next generation?

Yet, the first consideration is that the authors providing "theoretical support" to the existing techniques and methods of plant protection do not advance the scientific frontiers; moreover, they disorient researchers and take them away from solving actually important problems.

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