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RECENT ENVIRONMENTAL ENZYMOLOGICAL INVESTIGATIONS

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Abstract: This article is a brief review of the environmental enzymological investigations, conducted by specialists from institutions in Cluj ("Babeş-Bolyai" University, Biological Research Institute, University of Agricultural Sciences and Veterinary Medicine, and Environmental Protection Inspectorat), and published *in extenso* in the period of January 1997-March 2002.

The papers are structured into the following chapters: Soil enzymology; Peat enzymology; Enzymology of natural waters and bottom sediments, including therapeutic muds; Enzymology of waste waters and activated sludges, and Enzymology of cave deposits.

Through these papers published in the last 5 years as through those published before, the environmental enzymologists of Cluj have represented honourably their institutions, and have contributed, modestly but favourably, to the image of our country in the world.

Environmental enzymology was defined by us in 1986 (Stud. Univ. Babeş-Bolyai, Biol., **31** (1), 3-13) as a synthetic scientific discipline comprising 8 domaines. In other words, the environmental enzymological papers can be structured into 8 chapters: I. Soil enzymology; II. Peat enzymology; III. Enzymology of natural waters and bottom sediments, including therapeutic muds; IV. Enzymology of waste waters and activated sludges ; V. Compost and farmyard-manure enzymology; VI. Humus enzymology; VII. Clay enzymology, and VIII. Miscellanea.

This article is a brief review of the environmental enzymological investigations, conducted by specialists from institutions in Cluj ("Babeş-Bolyai" University, Biological Research Institute, University of Agricultural Sciences and Veterinary Medicine, and Environmental Protection Inspectorat), results of these investigations having been published *in extenso* in the period of January 1997-March 2002 in 32 papers, which belong to Chapters I (21 papers), II (4 papers), III (5 papers), IV (1 paper), and VIII (1 paper).

Majority of the papers (18 out of 32) and all review papers were published in English.

Chapter I. SOIL ENZYMOLOGY

The soil enzymological investigations may be characterised by a richness of topics.

Research methods. Popa *et al.* [29,30] applied the resazurin reduction method for determination of soil dehydrogenase activity. One of the sections of the book published by Drăgan-Bularda [6] contains the description of methods for determination of some soil enzyme activities.

Enzyme kinetics. Simihăian [31] and Simihăian and Silberg [32] studied the kinetic properties of soil urease and the effect of temperature and pH on these properties.

Polysaccharidases. Drăgan-Bularda and Paşcu [7] carried out fundamental studies on the complex of soil polysaccharidases.

Accumulation of enzymes in soil. Chistol *et al.* [3] found that chloroform fumigation of soil, which leads to death and lysis of soil microorganisms and to release of endoenzymes from the lysed microbial cells, did not cause any significant changes in the soil catalase, invertase and phosphatase activities. This finding proves that the activity of accumulated soil enzymes is much higher than that of the enzymes present in the momentarily proliferating soil microorganisms.

Technogenic soils. Blaga *et al.* [1] determined catalase, dehydrogenase and invertase activities in degraded soils and levelled mine spoils (anthropic protosols) at several strip mining enterprises in Transylvania (Şuncuiuş, Aghireş, Mihăieşti, Hida and Ip). The results showed that each enzyme activity was much lower in the protosols than in the degraded soils at each mining enterprise.

Paşca *et al.* [21,22] continued the enzymological study on the evolution of a technogenic soil at the lead and zinc mine in Rodna. Some of the results obtained were also presented by Paşca in the 16th World Congress of Soil Science (Montpellier, 1998) and published in the journal Soil & Tillage Research [23] as well as in the First International Conference on Soils of Urban, Industrial, Traffic and Mining Areas (Essen, 2000) and published in the Proceedings of the Conference [26]. The enzymatic activities were found to be sensitive indicators of the recultivation efficiency.

Ecotoxicological tests. Popa [27,28] proved that dehydrogenase activity and enzyme induction in soil may serve as ecotoxicological tests for inorganic pollutants (heavy metals) and organic ones (phenol, 2,4-dichlorophenoxy acid, detergents, fuel oil).

Review papers. Five review articles [9-13] and two books [14,15] were published.

Finally, we also mention a paper, which does not refer to investigations by soil enzymologists in Cluj, but to the 100th anniversary of the appearance of the first paper on soil enzymes. This paper was elaborated by the American plant scientist A. F. Woods and published in English in the German journal Centralblatt für Bakteriologie. Abteilung II, in 1899 (S. Kiss, 1999, *Centenary of soil enzymology*, Stud. Univ. Babeş-Bolyai, Biol., **44**, (1-2), 213).

Chapter II. PEAT ENZYMOLOGY

A paper on enzymological properties of a eutrophic peatland under agricultural use and a paper on enzymatic potential of some interglacial peats utilisable in balneotherapy were presented by Paşca in the International Symposium on Natural and Agricultural Ecosystems in Peatlands and Their Management (Saint-Malo, France, 1997) and in the International Symposium on

Peat Therapy on Its Way into the Next Millennium (Bad Kissingen, Germany, 1999), respectively, and published in the journal of the French Ecological Society [24] and in the Proceedings of the Peat Therapy Symposium [25], respectively.

Crişan *et al.* [4,5] performed studies on enzymatic activity of peat under different plant associations in the moor Căpăţâna and of the therapeutic peat from Băile Someşeni-Cluj.

Chapter III. ENZYMOLOGY OF NATURAL WATERS AND BOTTOM SEDIMENTS, INCLUDING THERAPEUTIC MUDS

Carrying out a fundamental study, Muntean *et al.* [17] have proved that the microbial synthesis of phosphomonoesterases in salt lake sediment is enhanced by lack of assimilable mineral *o*-phosphate and is induced by enzyme substrate, whereas the excess of mineral *o*-phosphate as final reaction product exerts a repressive effect on the biosynthesis and activity of these enzymes.

The enzymological researches on sediments from the Ursu and Negru salt lakes (Sovata) were continued by Muntean *et al.* [19]. Enzymological researches were also carried out on muds from the salt lakes in Bazna and Blaj (Drăgan-Bularda *et al.* [8]) and on the mud from the salt swamp Alunei-Târnăveni (Muntean *et al.* [20]).

For bioremediation of a used therapeutic mud, Muntean *et al.* [18] applied enzymological techniques.

Chapter IV. ENZYMOLOGY OF WASTE WATERS AND ACTIVATED SLUDGES

The fermented and dried sludge (from the Someşeni waste water treatment plant of the city of Cluj-Napoca) exhibited enzyme activities and was used by Blaga *et al.* [2] for fertilisation of levelled mine spoils (anthropic protosols) at the iron strip mine in Căpuş. The sludge was administered on experimental plots at rates of 20-140 t/ha. Unfertilised and minerally fertilised ($N_{150}P_{80}K_{40}$) plots were the controls. All plots were cultivated with maize for 3 years. The soil was analysed for determination of catalase, dehydrogenase and invertase activities. The results showed that in the plots fertilised with sludge, in comparison with the control plots, the enzyme activities increased. The increase in catalase and dehydrogenase activities correlated, whereas that in invertase activity did not correlate with the rate of sludge administration. We also emphasise the results of chemical analyses which indicated no evident signs of soil pollution even when the sludge was administered at its higher rates.

Chapter VIII. MISCELLANEA

For the period of 1997-2002, this chapter may receive the title ENZYMOLOGY OF CAVE DEPOSITS.

The paper presented by Manolache in the 12th International Congress of Speleology (La Chaux-de-Fonds, Switzerland, 1997) and published in the

Proceedings of the Congress [16] may be considered the most comprehensive study on enzyme activities in cave deposits. Activities of two redoxases (dehydrogenase and catalase), four disaccharidases (invertase, maltase, cellobiase and lactase) and three polysaccharidases (amylase, inulinase and dextranase) were examined in deposits of several caves. The results have proved that the cave deposits are enzymatically active. This finding suggests that the cave deposits make possible the process of enzyme accumulation.

We think that the conclusion may be drawn that, in the last 5 years as before, the environmental enzymologists of Cluj have honourably represented their institutions everywhere, and have contributed, modestly but favourably, to the image of our country in the world.

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CERCETĂRI RECENTE DE ENZIMOLOGIE A MEDIULUI ÎNCONJURĂTOR

(Rezumat)

Acest articol este o scurtă trecere în revistă a cercetărilor de enzimologie a mediului înconjurător, conduse de specialişti de la instituţii clujene (Universitatea "Babeş- Bolyai", Institutul de Cercetări Biologice, Universitatea de Ştiinţe Agricole şi Medicină Veterinară, şi Inspectoratul de Protecţie a Mediului) şi publicate *in extenso* în perioada ianuarie 1997 - martie 2002. Lucrările sunt structurate în următoarele capitole: Enzimologia solului; Enzimologia turbei; Enzimologia apelor naturale şi a sedimentelor acvatice, inclusiv nămolurile terapeutice; Enzimologia apelor reziduale şi a nămolurilor activate, şi Enzimologia depunerilor din peşteri.

Prin aceste lucrări publicate în ultimii 5 ani, ca şi prin cele publicate mai înainte, specialiştii clujeni în enzimologia mediului înconjurător au reprezentat cu cinste instituţiile lor şi au adus o contribuţie modestă, dar favorabilă, la imaginea ţării noastre în lume.