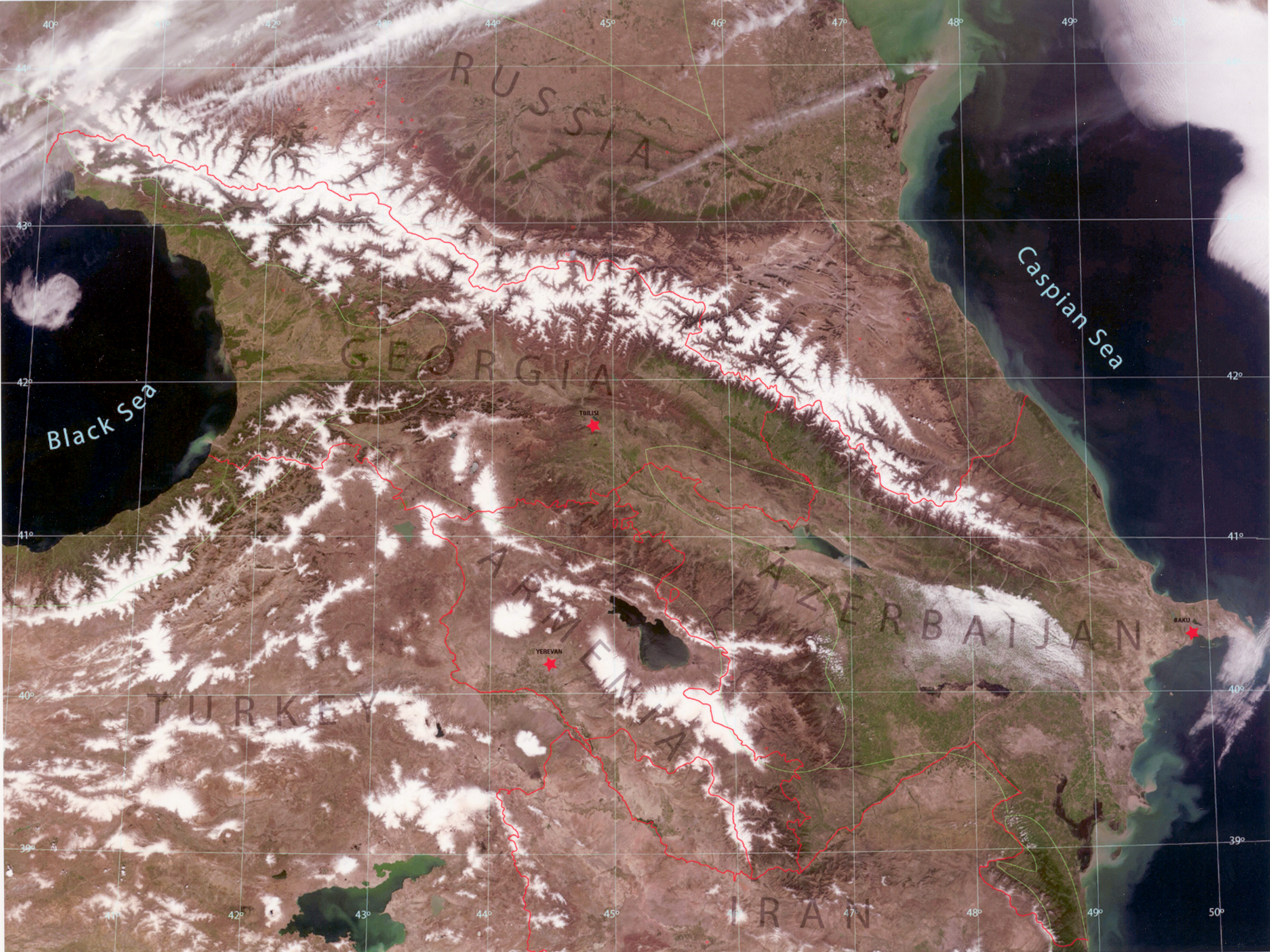
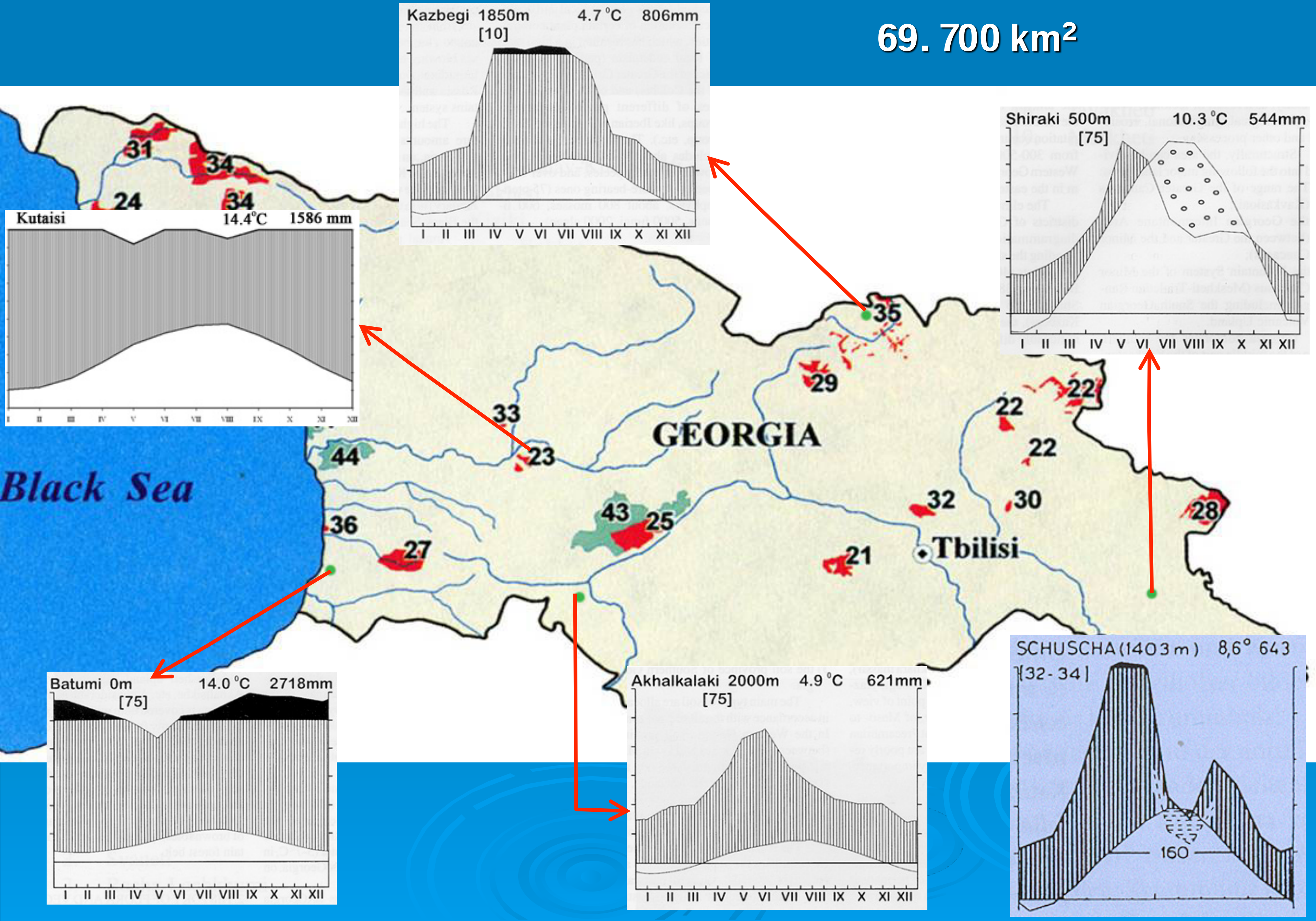
Biotechnological Developments in Georgia

Giorgi Kvesitadze


RUSSIA
Caspian Sea
Black Sea
GEORGIA
TBILISI
ARMENIA
YEREVAN
AZERBAIJAN
BAKU
TURKEY
IRAN

69. 700 km^2



Kazbegi 1850m 4.7 °C 806mm
[10]
I II III IV V VI VII VIII IX X XI XII
Shiraki 500m 10.3 °C 544mm
[75]
I II III IV V VI VII VIII IX X XI XII
Kutaisi 14.4°C 1586 mm
I II III IV V VI VII VIII IX X XI XII
GEORGIA
Black Sea
Tbilisi
31
34
24
34
35
29
22
22
22
33
23
44
43
25
32
30
28
36
27
21
Batumi 0m 14.0 °C 2718mm
[75]
I II III IV V VI VII VIII IX X XI XII
Akhalkalaki 2000m 4.9 °C 621mm
[75]
I II III IV V VI VII VIII IX X XI XII
SCHUSCHA (1403 m) 8,6° 643
[32-34]
160


Black Sea
თბილისი
1 Mountain meadow soddy, soddy peat and primitive soils
2 Mountain chernozems and soddy mountain meadow soils of Southern foothills
3 Brown soil
4 Forest cinnamonic soils
5 Soddy-calcareous soils
6 Leached and calcareous mountain chernozems
7 Chernozems
8 Grey cinnamonic soil, with natric soil complexes
9 Red and yellow soils
10 Podzolic and grey podzols
11 Raw humus sulphatic, solonet and natric soils
12 Boddy soils
13 Alluvial calcareous and uncalcareous soils
14 Medow calcareous soils of Eastern Georgia
15 Different types of primitive soils

Plants taxonoimic diversity of the Caucasus

Caucasus	6350 species	
	1100 endemics	
Georgia	5100 species	
	1000 endemics	
Alps	4500 species	
	350 endemics	

Above 100 flavonoids of different structure (catechins, proantocyanidines, flavones, flavonols, oxycinnamic acids) have been isolated from the wild and cultural endemic flora of Georgia (*Citrus*, *Rhododendron*, *Vitis*, *Laurocerasus*, *Vaccinium*).

Among tasted plants more than 20 industrially important endemic sources of flavanoids are revealed.

Caucasian plants medicinal preparations

RHODOPESUM
Rhododendron ungernii Trautv.
Flavonoids (catechins, proanthocyanidins).

FATSIFLOGINUM
Fatsia japonica (Thunb.)Decne et panache.
Triterphenyl glucoside.

FLARONIN
Astragalus falcatus Lam.
Flavonoid glucoside, robinin.

TSARUBOL
Paliurus spina-christi Mill.
Neutral lipids, phospholipids, flavonoids, including proantocyanidins.

COLCHICINE
Colchicum speciosum
Colchicin-(S)-N-(5,6,7,9, tetrahydro-1,2,3,10-tetramethoxy-9-oxsobenzo-[ ]-heptalene-7-yl)

Plant Food Colours

From the diverse Caucasus flora the technology of the production of red, yellow and brown colours has been worked out. These colours contain harmless natural pigments and polyphenols similar to green tea, particularly (-) epigallocatechingallate and other biologically active compounds. It has been established that plants polyphenols almost completely abolish the influence of harmful radioactive isotope – Stroncium-90 by absorbing and eliminating it out of the human organism before reaching marrow. These compounds possess antioxidant and antibactericide activities. They block the development of different tumours and cancer diseases, prevent tooth caries, promote digestion, decrease cholesterol level in blood, regulate blood pressure. The use of these colours as products, possessing antiradiation and anticarcinogenic properties is allowed by the Pharmacological Committee of Georgia.

Processing →

Natural colours

Red Yellow Brown

Application →

Food industry (confectionery products, production of meat, ice-cream and other dairy products, both soft and alcoholic drinks),

- pharmaceutical and textile industriers, etc.

Colouring silk, wool, cotton →

Production and use of natural colours derived from plants

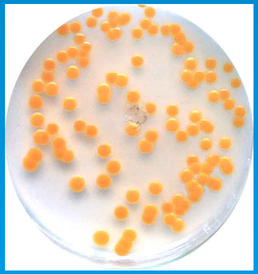
Bacteria

The collections of microorganisms of different taxonomic groups: bacteria, actinomycetes, mycelial fungi and yeasts at Durmishidze Institute of Biochemistry and Biotechnology (DIBB), have been created on the base of strains isolated from different soil climatic zones of Georgia, and account above 5000 strains, including extremophiles. Among the collections have been identified strains active producers of enzymes, secondary metabolites (vitamins, antibiotics, organic acids etc.), medicinal polysacchrides and actively degrading organic contaminants of different structure.

Bacillus sp. C-7 - active producer of proteolytic enzymes in deep conditions; alkaline protease

Rhodococcus sp. BKM Ac 1170, mutant strain 44 - producers of secondary metabolites: carotinoides, B group vitamins

DIBB collection of bacteria isolated from different soil climatic zones of Georgia, since 1970. Above 3500 strains



Rhodococcus strains degrading naphtalene

Mycobacrerium sp. 235. *Rhodococcus* sp. 227 - degraders of TNT, *Pseudomonas* sp 44, *Rhodococcus* sp. 74, mineral and crude oil.

ACTINOMYCETES

DIBB collection of *Actinomycetes*, including extremophiles, isolated from different soil-climatic zones of Georgia. Since 1965. Above 2000 strains.

Production of enzymes, antibiotics, vitamins, hormones, etc.

Strains active producers of proteolytic enzymes: (*Streptomyces* sp. 28, halophil, *Streptomyces* sp. 154, halophil. Chitinase (*Streptomyces* sp. 101; *Streptomyces* sp. 105).

Degradation of organic contaminants.

Strains degrading oil hydrdrocarbons (open chain and cyclic, including PAH):

Streptomyces sp 138, halophil; *Streptomyces* sp 166, alkaliphil; *Streptomyces* sp.118.

3,4-benzpyrene - *Streptomyces sp.* 51, alkaliphil, *Streptomyces sp.* 69, alkaliphil;

Naphthalene-*Streptomyces sp.* 6, alkaliphil, etc.

MYCELIAL FUNGI

Producers of enzymes *Aspergillus oryzae* 27, *Aspergillus awamori* 11, *Aspergillus niger* 47, *Aspergillus batatae* 21, *Aspergillus usami* 15, (α-amylase, glucoamylase); *Mucor* sp. (acid protease); *Aspergillus tamari* T 53;

Aspergillus wenti 52, *Aspergillus versicolor* 83, *Absidia* sp. K-61, *Chaetomium* sp. S-77, *Pleurotus ostreatus* 88, *Lentinus edodes* 1016, *Pycnoporus coccineus* 310; *Trametes versicolor* 13; *Daedalea quereina* 350; *Phlebia radiata* 312 (cellulases, xylanases); *Pseudotamella gilbosa* 22; *Trametes versicolor* 5; *Pleurotus eringii* 45; *Pleurotus ostreatus* 108, *Cerrena maxima* 681; *Funalia trogii* 146; *Lentinus edodes* 779 (Mn-peroxidase, laccase), etc.

Producers of medicinal polysacharides: *Ganoderma lucidum* 447; *Lentinus edodes* 123, *Pleurotus ostreatus* 24, *Coriolus hirsutus* 68, *Phellinus robustus* 29, etc.

DIBB collection of Mycelial fungi strains (basidial and microscopic), including extremophiles, isolated from different soil-climatic zones of Georgia. Since 1967. Above 4000 strains.

Several dozens of mycelial fungi strains degrading wide spectrum of organic contaminants. *Fusarium* sp. 26; *Mucor* sp. 1; *Trichotecium* sp. 65; *Aspergillus niger* 35; *Penicillium* sp. *51, Trichoderma viride* 9, etc.

EDIBLE MUSHROOMS

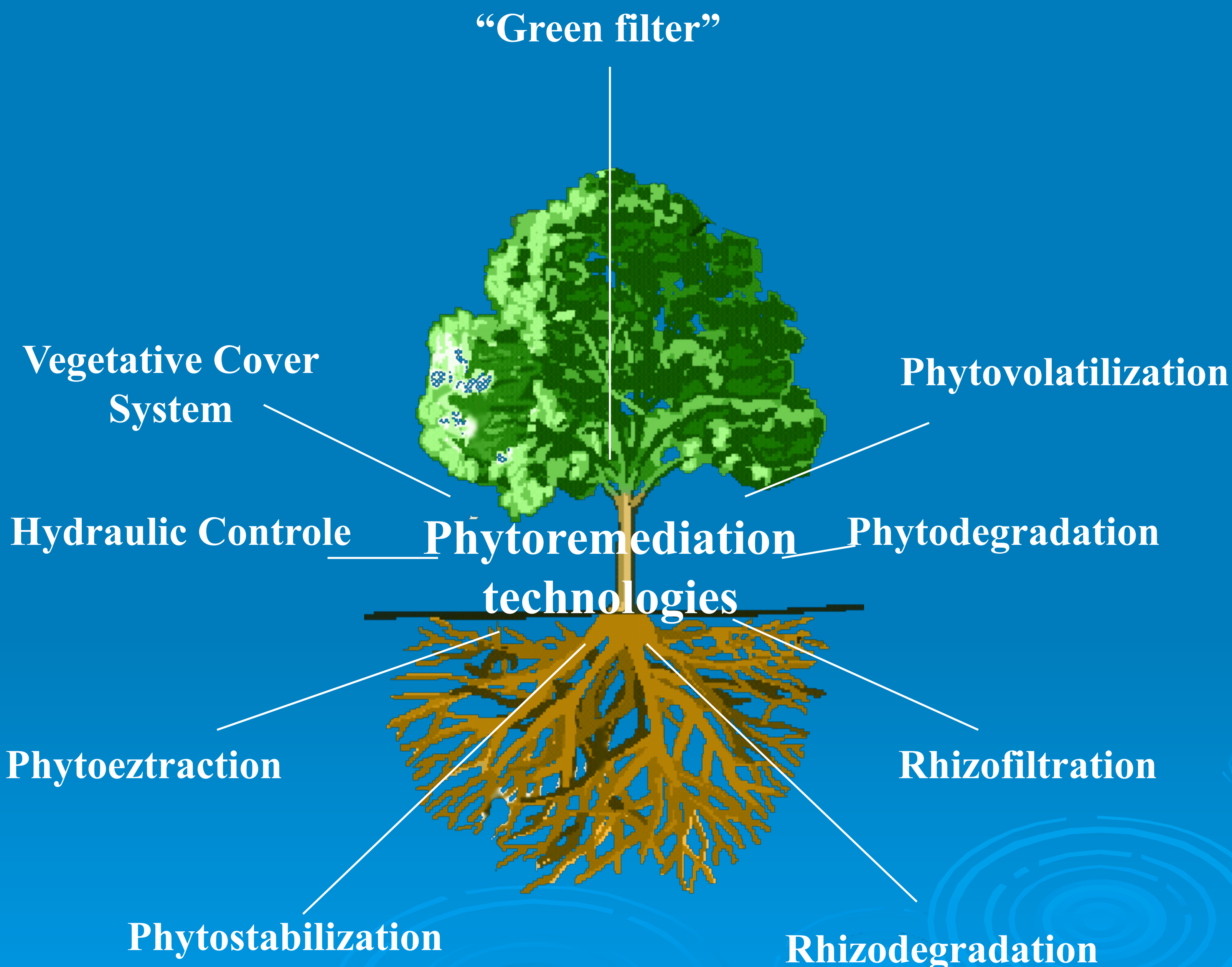
More than 7000 species of basidiomycetous fungi are widespread in various ecosystems of Georgia: semi-desert and forests, alpine and subtropics, mountains and steppes. Besides the local species there are strangers from Mediterranean areas, the European Plane, the Iranian Highland and Central Asia. 570 species, 62 varieties and forms of *Agaricales* basidiomycetes are described (*1*). The most species-rich genera are *Russula*, *Lactarius*, *Mycena*, *Inocybe*, *Clitocybe*, *Coprinus*, *Marasmius*, *Collybia*, *Pholiota*, *Agaricus*, *Pluteus*, *Polyporus*, *Hygrophorus*, *Lepiota*, *Oudemansiella*, *Calocybe*, *Omphalina, Panaeolus, Pleurotus, Agrocybe, Stropharia*. In addition to these fungi, 258 species of *Aphyllophorales* basidiomycetes have been described (2). Analysis showed several ecological groups including mycorrhizal (182 species), xylotrophs (128), litter saprotrophs (132), humus saprotrophs (91), coprotrophs (13), herbotrophs (7), bryotrophs (5), sphagnotrophs (4), carbotrophs (4) and mycotrophs (4).

Especially widespread and widely used in Western Georgia is *Amanita caesarea*.

1. Nakhutsrishvili V., (1975). Agarics mushrooms of Georgia, Tbilisi, 209 pages
2. Flora of Cryptogrammic Plants and Fungi of Georgia., (1996). Tbilisi, 885 pages

Bacteriophage application in the Infection Pathology

- **Intesti** Bacteriophage-in intestinal infections: *Shigella* (*Flexner, Zonne, Newcastle*), *Salmonella* (*Paratyphus A, Paratyphus B, Typhimurium, Enteritidis, Choleraesuis, Oranienburg*), enteropathogenic serotypes of *E.coli* (10 types), *Proteus, Enterococcus, Staphylococcus, Pseudomonas*.
- **Pyobacteriophage**-against suppurative infections (*Staphylococcus, Streptococcus, E.coli, Pseudomonas, Proteus*).



"Green filter"
Vegetative Cover System
Phytovolatilization
Hydraulic Controle
Phytoremediation technologies
Phytodegradation
Phytoeztraction
Rhizofiltration
Phytostabilization
Rhizodegradation

At Durmishidze Institute of Biochemistry and Biotechnology, since 1960 the investigations to characterize higher plants potential to absorb and metabolize xenobiotics have been carried. The evaluation of over 100 plants potential to degrade above 150 contaminants of different structure: alkanes, alkenes, aromatic including polycyclic hydrocarbons, phenols, aldehydes, etc. has been established. As a result of over 20 years investigation the concept of “Green filter” has been elaborated, envisaging the purposeful planting of selected plants around or along the sources of contamination (highways, chemical and metallurgical factories, gas and oil pipelines, etc).

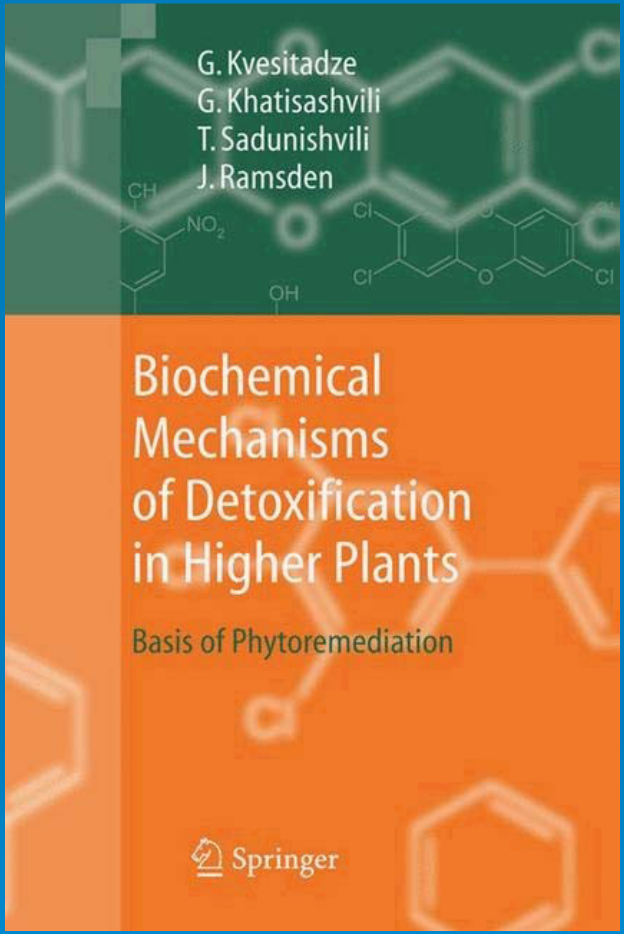
Green Filter Technology

Plants can very effectively hinder the emission of environmental contaminants. Good examples are exhaust gases of motorcars: carbon monoxide, nitrogen and sulfur oxides, aromatic hydrocarbons, etc.

A “Green filter” 30m wide of five layers (four lines of shrubs, mulberry and fustic, 70 cm high, and a fifth line of maple, birch, and elm 6-8 m high, plant age 10-20 years) planted along a highway reduces carbon monoxide concentrations in the air by 60-70%.

Plants according to their ability to assimilate benzene and toluene from air

Group of plants	Amount of absorbed aromatic hydrocarbon by 1 kg of fresh leaves, for 24 hours, mg	Plants	
Strong absorbers	1.0 – 10.0	Maple (*Acer campestre*) Oleaster (*Elaeagnus angustifolia*) Locust (*Robina pseudoacacia*) Wild pear (*Pyrus caucasica*) Walnut (*Juglans regia*) Almond-tree (*Amigdalus communis*) Cherry-tree (*Cerasus avium*) Amorpha (*Amorpha fructicosa*) Cherry-tree (*Cerasus vulgaris*) Chestnut (*Castanea sativa*)	Apple-tree (*Malus domestica*) Zelkova (*Zelcova caprinifolia*) Poplar (*Populus canadensis*) Ryegrass (*Lolium perene*) Lilac (*Siringa vulgaris*) Weeping willow (*Salix*) Catalpa (*Catalpa bignonioides*) Platan-tree (*Platanus orientalis*) Sophora (*Sophora japonica*)
Average absorbers	0.1 – 1.0	Alder (*Alnus barbata*) Asp (*Populus tremula*) Elm (*Ulmus filiacea*) Ash (*Fraximus excelsior*) Tea (*Camellia sinensis L.*) Persimmon (*Diospyros lotus*) Bay laurel (*Laurus nobilis*)	Gleditdchia (*Gleditschia triacanthos*) Kidney (*Phaseolus vulgaris*) Pine (*Pinus*) Pine (*Pinus eldarica*) Thuja (*Tuja*) Apricot (*Prunus armenicana*) Vine (*Vitis vinifera*)
Weak absorbers	0.001 – 0.1	Fir (*Picea abies*) Mulberry (*Morus alba*) Lime-tree (*Tilia cauxasica*) Reed (*Phragmites communis*) Maize (*Zea mays*) Wild plum (*Prunus divaricata*) Kiwi (*Apteryx australis*) Aloe (*Aloe*) Medlar (*Mespilus germanica*) Rose (*Rosa*) Platan-tree (*Platanus*)	Cypress (*Cupressus sempervirens var. Pyramidalis*) Geranium (*Pelargonium roseum*) Privet (*Ligustrum vulgare*) Fig (*Ficus carica*) Pomegranate (*Punica granatum*) Rhododendron (*Rhododendron ponticum*) Peach-tree (*Persica vulgaris*) Potato (*Solanum tuberosum*) Tomato (*Lycoperssicum esculentum*) Pussy-willow (*Salix alba*) Cherry-plum (*Prunus vachuschtii*)



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Biochemical Mechanisms of Detoxification in Higher Plants

Basis of Phytoremediation

Plants play a key role in purifying the biosphere of the toxic effects of industrial activity. This book shows how systematic application of the results of investigations into the metabolism of xenobiotics (foreign, often toxic substances) in plants could make a vastly increased contribution to planetary well-being. Deep physiological knowledge gained from an accumulation of experimental data enables the great differences between the detoxifying abilities of different plants for compounds of different chemical nature to be optimally exploited. Hence planting could be far more systematically adapted to actual environmental needs than is actually the case at present. The book could form the basis of specialist courses in universities and polytechnics devoted to environmental management, and advanced courses in plant physiology and biochemistry, for botany and integrative biology students. Fundamental plant physiology and biochemistry from the molecular level to whole plants and ecosystems are interwoven in a powerful and natural way, making this a unique contribution to the field.

Contents: Plant and environment.- The fate of pollutants in plant cell.- Ecotechnologies based on phytoremediation

Biotechnologies developed at Durmishidze Institute of Biochemistry and Biotechnology

- Production of 20 different oxidative and hydrolytic enzymes isolated from microorganisms and plants (amylases, cellulases, proteases, xylanases, Mn-peroxidase, laccase, etc)
- Pectin (from 10 varieties of endemic plants)
- Carotenoides (from bacteria)
- Bacteriophages, the biological effective means against plant pathogenic bacteria
- Edible and medicinal mashrooms;
- Medicinal polysaccharides

Organizations involved in biotechnology developments:

Durmishidze Institute of Biochemistry and Biotechnology;
Georgian Technical University;
Institute of Molecular Biology;
Eliava Institute of Bacteriophage, Microbiology and Virology;
Institute of Botany;
Institute of Zoology;
Institute of Subtropical Cultures;
Georgian Agrarian University.
Tbilisi State University

Above 25 average and small companies participate in Georgia in production and distribution of biotechnological products.

Central Caucasus

KAZBEGI

Svaneti. Ushguli.

Shatili

Tusheti