ASPECTS FROM THE ALGOLOGICAL RESEARCH IN ROMANIA

Ioan CĂRĂUŞ
University of Bacău, Romania, RO-610054 Piatra Neamţ,
Dragoş Vodă street, 90; phone 0040233219903;
email carausi@yahoo.com

Abstract. The paper presents some highlights concerning the main topics of algological research in Romania.The studies were begun about 160 years ago. Along this time, the investigations approached different fields of the general knowledge of the algae, as algal flora, physiology, biochemistry, ultrastructure, ecology, laboratory and outdoor culture, use of algae in water bodies management. Last decades, a special attention was paid to the algofloristic investigations, which covered, practically, all the hydrographic basins and, also, the Romanian littoral of the Black Sea.
Keywords: algological research in Romania, historical highlights, algal flora

Introduction

In my opinion, despite its long tradition, the algological research in Romania is far to be well known abroad. This very succinct presentation is an attempt to call general attention to some results of the activity of algologists in past and present.

Results

In Romania, the study of the algae has a relative long history. The first records of algal species in freshwater habitats from Transylvania, the central part of actual territory of Romania, were reported at the middle of XIXth century by F.Schur [17,18]. Later, the investigations on Romanian algal flora developed, that resulting in a gradual and significant increase of the algofloristic knowledge.

Besides these studies, there are to be mentioned other topics approached by Romanian researchers. Even since the beginning of the XXth century a special attention was paid to the algal physiology: Em.Teodorescu studied the influence of different light radiations upon the structure and the morphology of algae. An other botanist – Ioan Grinţescu – defended in Paris, under the guidance of R.Chodat, his PhD thesis entitled "Experimental investigations on the morphology and physiology of *Scenedesmus acutus*". Such studies were continued and developed later. In 1937, the PhD thesis entitled "Contributions to the morphology and physiology of the green alga *Microthamnion kützingianum*" was presented at Cluj University by Ştefan Péterfi. After World War II at the same university there were developed experimental studies concerning the physiology of different species of algae, among them *Botryococcus braunii*, *Spirulina platensis*. Algal physi-

ology was also studied at University of Bucharest, initiated by Professor Nicolae Sălăgeanu and continued by his colleagues/assistants, following the productivity of some algal cultures (*Chlorella vulgaris, Scenedesmus acutiformis*) depending on growth conditions (as temperature, nutrient content) [12], the influence of certain microelements [13], the ultrastructure of *Spirulina* a.o.

At the middle of 70's it was started a national research program, concerning the biochemical and physiological features of *Spirulina platensis*, in order to elaborate optimal methods/devices for large-scale culture, new and suitable growth media; there were also considered the ways of economical use of biomass, as food additive, fodder ingredient (for hens, for fish), as raw material for pharmaceutical industry etc.

Several studies on algal culture were conducted in the Romanian Institute for Marine Research (Constanţa). So, it was investigated the growth characteristics of *Platymonas impellucida* in mono-algal cultures; a special attention was paid to the study of the effects of sublethal cadmium exposure on the metabolism of some marine unicellular algae [9,10,11].

At the beginning of '70s at the Institute of Biological Research Cluj-Napoca it was started the creation of a Culture Collection of Algae; after ten years of efforts, the Culture reached to a number of 600 strains from 260 species of algae. It was – and is – an useful resource of biological material for research purposes and, also, for laboratory activities with students [7].

During the last years there were approached some new, modern, research fields. In this sense there are to be mentioned the thoroughly studies carried on the photosynthesis of algae under laboratory culture conditions. There were studied, for example, effects of microaerobiosis on photosynthesis of different cyanobacteria (*Synechococcus*, *Aphanizomenon elenkinii*), by measuring chlorophyll fluorescence, after their exposure to argon bubbling [8,19], or the effects of anaerobiosis induction on photosystem PS II activity in *Nostoc linckia* and *Cylindrospermum alatosporum* [5].

An other, very interesting field of investigation aims the molecular genetics and taxonomy of algae. From the published results there is to note a paper concerning the genetic variations in *Spirulina* [1]; in an other study [4] deals with the coenobial morphology and molecular taxonomy of different strains of *Desmodesmus communis*.

The subject of one recent Ph.D. thesis [3] referred to the identification of high content of hydrocarbons strains of *Botryococcus braunii* based on morphologic, biochemical and molecular markers.

An other significant achievement of Romanian algologists may be considered the elaboration of a comprehensive "**Treatise of Algology**" in four volumes, totalizing 1700 pages. It was published by Romanian Academy in 1976-1981. 30

authors contributed directly to elaborate the Treatise. The first volume presented the main features concerning the algal morphology, biochemistry, physiology, the multiplication processes, ecology, algal cultivation, economic importance of algae, classification systems and phylogeny. The following volumes were dedicated to main systematic groups of algae: volume II referred to Rhodophyta and Phaeophyta, volume III – to Euglenophyta, Chlorophyta and Xanthophyta and volume IV presented Cyanophyta, Chrysophyta, Cryptophyta, Bacillariophyta and Dinophyta. The general scheme of describing each major group of algae included: Morphology, cell structure, physiology,reproduction, elements of ecology, classification (features of orders, main families and genera). All the volumes are well illustrated, and present a selective literature, for each section.

Finally, I have to mention the studies carried on at the universities in Bucharest and Cluj-Napoca concerning the fossil algae, their presence within different geological deposits.

The studies concerning the **ecology of algae** covered a lot of aspects as the seasonal or multiannual dynamics of algal communities, determined by the changing of environmental conditions or by the impact of human activities, spatial distribution of populations within basins (both on horizontal scale or according to the depth), sedimentation of the phytoplankton in water mass, water-bloom phenomena and their effects upon aquatic ecosystems, contribution of algae to the primary production, ways of algal population of new appeared water bodies, mainly dam reservoirs etc.

There were investigated all types of algal communities – phytoplankton, microphytobenthos, periphyton, even neuston, formations of marine macroalgae, soil algae, etc.

Last, but not least, it must be mentioned the beginning of the use of Diatom Biotic Index in order to evaluate the ecological state of water bodies, a method recommended within European Union.

The most comprehensive and long lasting research efforts aimed to the knowledge of the **algalflora of Romania**, as an important component of the natural capital of this country, and a sensitive feature of global biodiversity, especially in aquatic environments.

This algal flora domain will be presented in some, few, details in this paper.

Among the first larger papers concerning the algal flora of Romania there are the diatomological studies of O.Tömösvary who published in Cluj-Napoca "**Bacillariophyceae in Dacia observatas**" (1879-1880) [24,25], presenting the species identified in a lot of sampling stations in Transylvania. In the same period, Julius Schaarschmidt realized the chapter referring to the Algae, within the synthesis concerning the **Flora of Romania**, edited by A.Kanitz (1879-1881); he listed 270 taxonomic units (species, varieties and forms), identified in locations

from Muntenia, Oltenia and Dobrogea, Danube River and the Black Sea. The same author published three major contributions under the title "**Additamenta ad Algologiam Dacicam**" (1880-1882), presenting the species of algae found by him in Transylvania [14,15,16].

A first comprehensive work on the algal flora of Romania was published in 1907/1908 by Emanoil C. Teodorescu : "**Materiaux pour la flore algologique de la Roumanie**" [23]. The author reported 430 species of algae (except the Diatoms), most of them identified by himself from 54 sampling stations, from various habitats (freshwaters, inland salt waters, marine littoral areas, soils etc.). For the following 50 years, this was the main reference work on the Romanian algae.

In 1956 – 1958, I. Tarnavschi and M. Oltean published a new synthesis on Romanian algal flora: "**Materiale pentru un conspect al algelor din România**" (I-II) [20,21,22]. The authors , based on up-to-date Romanian algological literature (159 sources), listed 1502 species of algae, both freshwater and marine. This work represented for some decades an unique and valuable bibliographical reference, very useful for the developing further algological investigations.

During the last decades of XXth century, the investigations on algal flora of Romania developed significantly. A lot of research projects were carried on by the scientists from Cluj Napoca, dealing especially with algae from mountain areas, rivers, pools, fish ponds, polluted waters, peat bogs, mineral springs, cave walls and other wet habitats, mainly from Transylvania. In Bucharest, a special attention was paid by researchers to the algae flora from Danube, Danube floodplain, Danube Delta, other water bodies, soils and rice fields. Marine algae – both microphytic and large ones – were studied by investigators from research units from Agigea, Mamaia and Constanţa (1). Last, but not least, there are to be mentioned the investigations on algal flora carried out at "Stejarul" (Pângăraţi) Research Station, concerning mainly the man-made lakes.

Further on, the accumulation of more and more scientific information, and the diversity of professional journals including algological contributions generated certain difficulties in establishing which of the identified species of algae represent new additions for the algal flora of Romania. There were some cases when different authors reported, separately and not simultaneously, the same species as a new floristic record. The huge amount of published information on algal records in Romania during the last four decades of the 20th century made possibly – and necessary – a new listing of the species of algae found on the territory of Romania.

After analyzing 1388 publications, which referred to about 2000 sampling locations, it was compiled a comprehensive list of the algae identified up to now in Romania [6]. On this base, a synthesis concerning the number of genera, species and infraspecific taxons is presented below.

Group of Algae	Genera	Species	Infraspecific taxons
Cyanophyta – Cyanobacteria	126	653	123
Rhodophyta	43	93	21
Chrysophyta	78	250	34
Prymnesiophyta	1	1	0
Xanthophyta	65	229	24
Bacillariophyta	172	1409	453
Dinophyta	46	166	19
Phaeophyta	25	34	5
Raphidophyceae	1	1	0
Cryptophyta	9	29	0
Euglenophyta	30	296	124
Chlorophyta	324	1648	567
Charophyta	6	37	38
Glaucophyta	1	1	1
TOTAL	**927**	**4847**	**1419**

It may be supposed that the huge information on the list of algae identified in Romania will be useful to the specialists interested to know the geographical distribution of different species.

Conclusions

In principle, the algological investigation has a solid tradition in Romania and it may be developed in future, especially by students, doctoral students, using modern facilities offered by new technologies, by new progresses in algal taxonomy, by access to internet information sources.

References

1. Aldea R., A.Creţu, A,Nicoară, N.Dragoş – Genetic variation of *Arthrospira* (*Spirulina*) strains assessed by PCR technique based on genome repetitive sequences. *Contrib.Botan*., 2002-XXXVII : 126-136
2. Bavaru A., A.S.Bologa, H.V.Skolka – A checklist of the benthic marine algae (except the diatoms) along the Romanian shore of the Black Sea. *Rev.Roum. Biol., Biol.Véget*., 1991, 36, 1-2: 7-22
3. Bica A. – Markeri morfologici, biochimici şi molecular pentru identificarea tulpinilor de *Botryococcus braunii* înalt producătoare de hidrocarburi. Rezuma-

tul Tezei de Doctorat. Univ."Babeş-Bolyai", Facult.Biol.-Geol.,Cluj-Napoca, 2010, 33 p.
4. Bica A., L.Barbu-Tudoran, B.Drugă, C.Coman, A.Nicoară, T.Szöke-Nagy, N.Dragoş – *Desmodesmus communis* (Chlorophyta) from Romanian freshwaters: coenobial morphology and molecular taxonomy based on the ITS2 new isolates. *Annals of RSCB*, 2012, XVII, 1 : 16-28
5. Bercea V., A.Bica, B.Drugă, C.Sicora, N.Dragoş – The effect of argon-induced anaerobiosis on the activity of photosystem PS II in some Nostocales species. *Studia Univ. Babeş-Bolyai, Biologia*, 2011, nr.2
6. Cărăuş I. – Algae of Romania. A distributional checklist of actual algae. *Studii şi Cercetări, Biologie*, Univ.Bacău, 2002, 7; Third revision, 2012, 809 p.
7. Dragoş N., L.St.Péterfi, L.Momeu, C.Popescu – An introduction to the Algae and the Culture Collection of Algae at the Institute of Biological Research Cluj-Napoca. *Cluj University Press*, 1997, 268 p.
8. Hegedüs A., V.Bercea, C.Sicora – The study of Photosystem II (PS II) activity based on chlorophyll fluorescence in *Aphanizomenon elenkinii* AICB 709, under light stress conditions. *Studia Univ.Babeş-Bolyai, Biologia*, 2012, no.2
9. Mihnea P.E. – Notes on *Platymonas impellucida* (McLachlan &Parke) species in mono-algal cultures. *Cercet.Marine IRCM* (Constanţa), 1971, 1 : 83-94
10. Mihnea Pia Elena, Gh.Munteanu, Elena Ghiţescu – Chronic toxicity of sublethal cadmium exposure in marine biota from brackish environments. *Cercet. Marine IRCM* (Constanţa), 1990, 23: 91-105
11. Mihnea Pia Elena, Gh.Munteanu, I.Pecheanu – Effect of Cd^{2+} on the metabolism of the marine unicellular algae *Cercet.Marine IRCM* (Constanţa), 1980, 13: 199-211
12. Sălăgeanu N. L.Ionăşescu – Unele procese fiziologice la algele *Chlorella vulgaris* şi *Scenedesmus acutiformis* cultivate în laborator pe diferite medii nutritive. *An.Univ.Bucureşti, Biol.veget*., 1970, XIX, 117-126
13. Sălăgeanu V. – Influence of NO3 on the synthesis of free aminoacids in *Spirulina platensis* (Gom.) Geitler in the presence and absence of Mo. *Rev.Roum. Biol., Biol.Véget*., 1976, 21, 2, 107-110
14. Schaarschmidt J., A.Támas – Additamenta ad algologiam Dacicam. I. Enumeratio algarum nonnularum in comitatibus Kolos, Torda-Aranyos, Udvarhely et Hunyad lectarum. *Magyar Növenytani Lapok* (Cluj), 1880, IV, 43,44
15. Schaarschmidt J. – Additamenta ad algologiam Dacicam. II. Enumeratio algarum nonnularum in comitatibus Naszod-Beszterce, Doboka, Kolos, Torda-Aranyos, Also-Fehér, Udvarhely, Fogaras, Szeben et Hunyad lectarum. *Magyar Növenytani Lapok* (Cluj), 1880, 46, 4 : 129-137
16. Schaarschmidt J. – Additamenta ad algologiam Dacicam. III. Enumeratio algarum nonnularum in comitatibus Bihar, Kolos, Maros-Torda, Also-Fehér, Hunyad, Háromszék Udvarhely lectarum *Magyar Növenytani Lapok* (Cluj), 1882, VI : 37-47
17. Schur F. – Beitrage zur Kenntniss der Flora von Siebenburgen. *Verh. Mitteil.d.siebenburg.Vereins f.Naturwiss.zu Hermannstadt,* 1852, III, 16 : 84-93
18. Schur F. – Sertum Florae Transsilvaniae. Enumeratio systematica omnium plantarum, quae in Transsilvania spontae crescent et in usum homnium copio-

sius coluntur. *Verh.Mitteil.d.siebenburg.Vereins f.Naturwiss.zu Hermannstadt,* 1853, 4, 12 : 101-108
19. Szekeres E., V.Bercea, N.Dragoş, B.Drugă – Effects of microaerobiosis on photosynthesis in the cyanobecterium *Synechococcus* sp. PCC 7002. *Studia Univ. Babeş-Bolyai, Biologia*, 2014, no.1 : 21-40
20. Tarnavschi I., M.Oltean – Materiale pentru un conspect al algelor din R.P.R. I. *An.Univ.Bucureşti, Ser.Şt.Natur.,* 1956, 12 : 97-149
21. Tarnavschi I., M.Oltean – Materiale pentru un conspect al algelor din R.P.R. II. *Stud.Cercet.Biol., Biol.Veget.*, 1958, X, 3 : 269-290
22. Tarnavschi I., M.Oltean – Materiale pentru un conspect al algelor din R.P.R. II (continuare). *Stud.Cercet.Biol., Biol.Veget.*, 1958, X, 4 : 317-344
23. Teodorescu Em.C. – Matériaux pur la flore algologique de la Roumanie. *Beihefte Botan.Centralblatt*, 1908, XXI, II, 2 : 103-219
24. Tömösvary O. – Bacillariaceas in Dacia observatas. I. *Magyar Növenytani Lapok* (Cluj), 1879, 3, 34 : 145-152
25. Tömösvary O. – Bacillariaceas in Dacia observatas. II. *Magyar Növenytani Lapok* (Cluj), 1880, 4, 38 : 17-20