NICOLAE BUCUR'S CONTRIBUTION TO CREATE AN ORIGINAL SYSTEM OF HALOPHYTES CLASSIFICATION, AN EXAMPLE OF HOLISTIC ECOLOGICAL VISION

CONTRIBUȚIA LUI NICOLAE BUCUR LA REALIZAREA UNUI SISTEM ORIGINAL DE CLASIFICARE A HALOFITELOR, UN EXEMPLU DE VIZIUNE ECOLOGICĂ HOLISTICĂ

GRIGORE M.N.[1]
e-mail: mariusgrigorepsyche@yahoo.com

Abstract. *Halophytes definition and classifications still represent a matter of debate and even a controversial issue. Existing classifications, belonging either to Romanian or foreign researchers are generally based only on subjective or arbitrary criteria. Sometimes, several classifications have been adapted and reformulated starting from previous classifications. Nicolae Bucur' results related to salt-affinity of plants vegetating in salinized meadows led to a new classification of plants, according to their preference for soil salinity. This classification, supported by objective, strictly quantifiable criteria is, as far as we know, the first and perhaps the single existing worldwide. The aim of this paper is to reveal Bucur's significant contribution to halophytes classifications, emphasizing its great potential in the field of international literature referring on halophytes. Moreover, we intend to promote in the scientific media his entire ecological vision about halophytes; unfortunately, we found that, until now, it is almost unknown to the great majority of scientists dealing with halophytes.*
Key words: *halophytes, salinity, ecology*

Rezumat. *Definiția şi clasificarea halofitelor reprezintă un subiect încă intens disputat şi chiar controversat. Majoritatea clasificărilor existente, fie ale autorilor români, fie străini, sunt bazate pe criterii pur subiective sau arbitrare. În alte situații, unele clasificări sunt doar preluări şi adaptări ale unor sisteme deja existente. Rezultatele lui Nicolae Bucur şi colaboratorilor referitoare la halofilia unor plante din pășuni şi fânețe de sărătură au condus la crearea unui nou sistem de clasificare a plantelor în funcție de afinitatea pentru salinitatea solului. Această clasificare, bazată deci pe criterii obiective, strict cuantificabile, este, din ceea ce cunoaştem, printre singurele de acest fel din lume. Scopul acestei lucrări este de a releva importanța contribuției lui Bucur la clasificarea halofitelor, accentuând rolul acesteia în literatura mondială de specialitate. În acest mod, se doreşte promovarea întregii viziuni ecologice despre halofite a lui Nicolae Bucur în comunitatea ştiințifică internațională, câtă vreme aceasta este, din nefericire, practic necunoscută.*
Cuvinte cheie: *halofite, salinitate, ecologie*

[1] "Alexandru Ioan Cuza" University of Iasi, Romania

INTRODUCTION

Halophytes represent a complex and heterogeneous ecological group of plants, including very different species in terms of habitats, taxonomic diversity and adaptive features (Grigore, 2008a, 2008b; 2012; Grigore and Toma, 2010 a, 2010b).

Although they have certainly been recognized since the time of Goethe (ca. 1790, cf. Flowers et al, 1986), halophytes were taken into scientific attention through the promoting papers of Schimper (1903) and especially Warming (1897; 1909); however, even in nowadays there are many controversies regarding halophytes' definition and classifications (Grigore, 2008b; Grigore and Toma, 2010a).

All these issues related to their definitions and classifications, ranging from semantic to physiological level, have been recently reviewed and largely discussed (Grigore, 2012). In this mentioned work, 45 definitions of halophytes are debated, while in others (Grigore, 2008b, Grigore and Toma, 2010a), the existing classifications systems are critically commented.

In the present work, we try to discuss Nicolae Bucur's contribution to create an original classification system of halophytes; in addition, our intention is to find its place among existing classifications – formulated before, and especially after that proposed by Bucur and its colleagues.

It is not our intention to deal with Bucur's biography or with its achievements in the soil science area or academic field. Those interested in could address to other papers (Cotea, 2002). Based on our experience in halophytes area, we try to properly place the results obtained by Bucur in the frame of Romanian botanical literature and, especially in that from abroad, which is often so indifferent to Romanian scientific accomplishments.

MATERIAL AND METHODS

For subsequent discussions regarding the Bucur's contribution for developing a system of halophytes classification, we carefully analyzed its papers (Bucur et al., 1957, 1960, 1961), as well the entire literature existing on our disposal, both from Romania and from abroad (Grigore, 2008a, 2008b; 2012; Grigore and Toma, 2010a, 2010b). The last mentioned has been used as a comparative element and as a general historic and chronologic frame, where the Bucur's results were considered. Attention should be paid that the syntagm "Nicolae Bucur's contribution" is being used for didactic reasons, in order to facilitate the text style. In fact, the papers we are discussing about are the results of a collective work, where also activated other researchers, Bucur's collaborators.

RESULTS AND DISCUSSIONS

Existing halophytes classifications, until that proposed by Bucur (1957) are generally based on arbitrary, subjective criteria (Grigore, 2012); this situation is true for the papers worldwide. Despite that several classification systems may be based on quantifiable, numerical criteria, their ecological value is still a matter of debate. This is because some salinity thresholds proposed for different groups of halophytes are chosen purely on descriptive values, and not on experimental

research. Moreover, it is well known that in nature, ecological factors (soil salinity) are not constant, but they are continuously changing, showing the interrelations established between environmental factors (Grigore and Toma, 2010a). In this category, we can consider several papers (Stocker, 1928; Iversen, 1936; Van Eijk, 1939; Chapman, 1942), which delineate their classifications especially considering the NaCl concentration, as a criterion for various groups of halophytes.

The Romanian classic classifications until that created by Bucur are not based on numerical tolerance thresholds; they are mainly derived from intuition, ecological vision or large professional experience of some botanists. For instance, Guşuleac (1933) provides a halophytes classification depending by „*natural colonization of salinized areas with plants"*; Prodan (1939) classify plants from saline habitats in three categories, taking into account „*the way in which plants support salt"*. Ţopa (1939), in its PhD thesis, chooses as a criterion „*the behavior of plants in relation to salinized environments*". It is very important to underline Ţopa's classification (1939), taken then into attention in 1954; this was considered the most representative and intensely cited classification in Romanian botanical field. We emphasized, several times that all further classifications except for Bucur's, represent, in fact, takes on Ţopa's systems, and sometimes slightly adaptations (Grigore, 2012). Thus, Ţopa (1939), classifies halophytes in: *obligatory, preferential, supporting and accidental*.

Ţopa's classification represents a pivotal point in the entire Romanian botanical literature referring on halophytes; it is, as far as we know, the single paper cited in the works from abroad (Waisel, 1972). However, if comparing with Bucur's classification, a key-explanation must be delineated. In a footnote of its PhD thesis, Ţopa (1939) cited several Romanian and foreign authors, who used in their classifications some terms also found in the Ţopa's classification. Of course, this is not a discussion about origin and originality of its system and associated nomenclature, but it is a very important observation in the entire context when dealing with Bucur's classification.

Bucur's classification (1957) is astonishing, because it is the logic and natural result of scientific activity that is impressive through its vision, conception and harmonious way in which the obtained data are correlated and interpreted. Bucur investigated the salinity thresholds for over 400 species vegetating in salinized meadows and pastures from Jijia-Bahlui depression; in this way, the obtained results, and the derived classification have a high fidelity and consistency. Due to these features, the study conducted by Bucur (1957, 1960, and 1961) is the first of this kind from Romania, and, as far as we know, even the first from worldwide.

For establishing the salt-affinity of species belonging to plant associations with halophytes, the authors used two investigation methods. The first is based on the variation of plant biomass in accordance to salinity changes in the rhizosphere; this method has been used for establishing salinity tolerance for plants cultivated on salinized areas, without irrigation. The second method is

based on the variation of species frequency in the plant communities from salinized meadows.

After applying these methods and obtaining the results (salinity thresholds) for each species, several logic and interesting conclusions have been drawn; these actually offer valuable data about the ecology of species. Thus:

1. In several species, the biomass increases according to the increasing soil salinity in the rhizosphere; here are described two sub-groups.

2. In other species, the biomass decreases according to the increasing soil salinity nearby the roots; two sub-groups are also described.

But the authors of this study go further with their deductions. Briefly, salt plants are divided in:

a. obligatory halophytes (strictly halophytes, or halophytes); plants that grow only in saline environments: *Salicornia herbacea, Salsola soda, Atriplex hastata, Plantago schwarzenbergiana, Petrosimonia triandra*;

b. facultative halophytes (adaptable halophytes, plants adaptable to salinity); species that develop both in saline habitats and in normal soils. In saline soils, they have a fragile development and can desiccate faster, during dry season or severe droughts: *Lepidium ruderale, Poa bulbosa, Matricaria chamomilla;*

c.halo-phobous: plants whose biomass decreased according to increasing soil salinity.

Using the bio-ecological criterion, plants vegetating on saline soils are divided in:

I. Halophytes (plants vegetating on saline environments).

1) Euhalophytes - halophytes strictly adapted to salinity (strictly *obligate* to salinity) are *exclusively preferential* and grow *only* on salinized environments, with the entire or a part of radicular system, both as seedlings and as mature plants.

2) Neohalophytes - plants able to adapt to salinity; plants to be adapted to halophytic environment; they are *supporting* and *preferential*, living both on non-salinized and salinized media, with the entire or a part of radicular system.

II. Non-halophytes (plants that not grow on saline environments).

They are plants non-adapted to salinized media, non-tolerant to high concentrations of salinity. In relation to concentrations more than 30-40 % milligrams of soluble salts, they could be tolerant and preferential.

The offered explanations are so logical land clearly expressed, that we were able to project an integrated system of equivalency (Grigore, 2008a) between Bucur's system and those proposed by Prodan (1939) and Ţopa (1939).

Bucur's classification is created in an ecological integrative (holistic) context; albeit soil scientist, in his background, Bucur understood that in such classifications the importance of a single environmental factor (soil salinity) must not to be overestimated. Moreover, he emphasized that in nature do not exist "pure" forms of obligatory halophytes or non-halophytes, but there is a continuum of "intermediary" forms, which can vegetate closely related to ecological factors.

A unique and original character of this classification is conferred by the

fact that for plants with different degrees of salt-affinity (euhalophytes, neohalophytes) other ecological factors (apart from soil salinity) are also associated. Thus, the following factors are also considered: the air and soil temperature, light, soil chemical reaction and soil humidity, as secondary factor. In this way, detailed ecological profiles of many species of euhalophytes and neohalophytes are being advanced; therefore, these are described in relation to their preferences for other environmental factors, not only for soil salinity.

As far as we know, in this manner, the most logical and complete system of halophytes classification has been created in the history of Romanian botany. This is as important, as it is derived from the analysis of a very large number of species and their relation with environmental factors.

Actually, the halophytes classification was not the proper goal of study, but rather a natural consequence of obtained results. Unfortunately, this contribution to ecology of halophytes is generally almost completely unknown to scientific literature from abroad. Surprisingly, no other foreign paper consulted by us is as pertinent as these papers really are; actually, we can consider the research conducted by Bucur as a monograph of halophytes ecology. In addition, we can assert that the Bucur's results are less familiar even for the Romanian literature.

The single Romanian classification of halophytes occasionally quoted in abroad literature (Waisel, 1972), is hat of Ţopa (1939); however, as already stated above and in the light of new clarifications, is a matter of debate if this classification is still the most relevant for Romanian botanical literature. Nevertheless, Bucur's work and his classification have to be further promoted and commented in large and diverse scientific fields, since the international scientific community might be receptive and interested in these original contributions (Flowers, personal communication).

CONCLUSIONS

Classification of halophytes, made by Bucur represents for Romanian botany a pivotal moment; this actually opened a new and modern way to deal with an ecological group of plants in an integrative manner. The classification is completely original and, as far as we know, it is among the fewest worldwide. Unfortunately, despite the earlier occurrence of results, the language (Romanian) in which the papers have been written and the limitations of scientific data exchange (imposed by the historical context) had an unexpected, unfavorable effect. This unique monograph about ecology of halophytes remained, in a large extent, undiscovered and un-promoted in international scientific media.

Further comments, underlying the importance of Bucur's results in the international frame of soil science and ecology will strength the prolific value of this Romanian contribution.

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