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Soil Algae of El-Farafra Oasis (The Western Desert, Egypt), and N_2-fixation Efficiency of Five Heterocytous Cyanophytes

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IN TOTAL 47 soil algal morphospecies were cultured and identified from the desert soils of El-Farafra Oasis, The Western Desert (Egypt). The most of them were related to Cyanophyta (34 algal taxa), followed by Chlorophyta and Xanthophyta (5 algal taxa belonging to each). Bacillariophyta represented only by 3 species. Moreover, this work enriched the Egyptian soil algal flora with 5 different algal taxa: *Westiellopsis prolifica* Janet, *Cylindrospermum gregarium* (Zakrz.), *Cylindrospermum. licheniforme* (Bory) Kütz., *Chlorocloster caudatus* Pasch. and *Tetraktis aktinastroides* Pasch. Furthermore, the potentialities of atmospheric N_2-fixation efficiency of *Calothrix elenkinii* Kossinsk., *Nodularia harveyana* f. *sphaerocarpa* (Born. et Flah.) Elenk., *Scytonema ocellatum* Lyngb., *Stratonostoc linckia* (Roth) Elenk. and *Westiellopsis prolifica* Janet were investigated. However, *C. elenkinii, W. prolifica* and *S. ocellatum* exhibited to a large extent the highest fixation rates with mean values of 18.89, 30.52 and 33.01 µmole ml^{-1} h^{-1}, respectively, followed by *S. linckia* (16.71 µmole ml^{-1} h^{-1}) and *Nodularia harveyana* f. sphaerocarpa (12.01 µmole ml^{-1} h^{-1}). In conclusion, *Scytonema ocellatum* and *Westiellopsis prolifica* can used as promising eco-friendly natural bio-fertilizers for the sustainable development in the desert habitats.

Keywords: Soil algal flora, N_2-fixation, Heterocytous cyanobacteria, Desert habitats, Soil amelioration, El-Farafra Oasis, Egypt.

Introduction

Desert and arid lands not only represent biologically important challenging ecosystems that extent over one third of the earth's land surface, but also cryptic algal biodiversity-rich habitats (Bohunická et al., 2015 and Mareš et al., 2015). Edaphic algae are greatly prevalent in soils of all continents in particular, cyanophytes (Řeháková et al., 2007; Zhang et al., 2011 and Venter et al., 2015) followed by eukaryotic algae specifically members of green algae and diatoms (Flechtner et al., 2013 and Fučíková et al. 2014a, b) are the widely-distributed.

Arid and hyper-arid desert habitats are inherently low in nutrients specifically C, N and P (Housman et al., 2006 and Mager & Thomas 2011). To overcome this economically-important problem, numerous studies on Cyanophytes particularly the heterocytous forms (Nostocales), have largely been carried out in order to characterize their highest potentialities on atmospheric N_2-fixtion and to be widely used as natural bio-fertilizers instead of agrochemicals (Osman et al., 2010 and Gheda & Ahmed, 2015). During the last decades, the algal bio-fertilizers technology has been proven to be a highly applicable and a key player instead of inorganic chemical fertilizers (Maqubela et al., 2009). Furthermore, this technique is commonly avoiding soil pollution by adding chemical fertilizers affecting human health (Abdel-Raouf et al., 2012), improves the nutrients-poor soils specifically those important for seedlings germination and crops productivity (Gheda & Ahmed, 2015) and they continuously fix atmospheric nitrogen into the soil even after crop harvest (Sahu et al., 2012).

The main scope of this work is to unearth and identify species composition of soil algal assemblages in El-Farafra Oasis, as well as evaluation of N_2-fixation efficiency of certain isolated heterocytous cyanophytes.

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Materials and Methods

Materials collection

Soil samples were collected through two meteorologically different seasons: summer 2011 and winter 2012. The soil collection was performed according to John (1942). The sub-surface soil layers, normally to a depth of about 17 cm, were removed and freed from gravels and debris and finally had been collected in sterile clean air-tight plastic bags. In general, 30 soil samples were collected in this study. The soil materials were transported to the laboratory for culturing, isolation, identification and finally purification from other microorganisms. To evaluate the N_2-fixation efficiency of axenic mass cultures the most widely-distributed heterocytous blue-green algae were used.

Applied media, culture conditions, isolation and purification of algal taxa

Three different algal growth media: Chu #10 (Chu, 1942), BBM (Bold, 1949 and Bischoff & Bold, 1963) and COMBO medium (Kilham et al., 1998) were virtually used for cultivation of the soil algae based on their nutrients divergences and their highly applicable ranges for flourishing a wide variety of different algal divisions. Traditional technique for culturing and isolation of soil algae were recommended by Andersen & Kawachi (2005). The classification systems of Gollerbach et al. (1953), Desikachary (1959), De Desenko-Schegolova et al. (1959), De Desenko-Schegolova & Gollerbach (1962) and Philipose (1967) had been used for algal identification.

Evaluation of atmospheric N_2-fixation capacity

Five heterocytous cyanophytes that easily give axenic and highest growth masses were recommended for the evaluation of atmospheric N_2-fixation capacity using N-free Allen's medium (Allen, 1968). Then 1-ml of each cultured strain had been used as a standard inoculum to estimate the total number of individuals using Sedgewick Rafter Counting Cell Slide. Moreover, Acetylene Reduction Assay "ARA" of Hardy et al. (1973) [using digital gas chromatography DANI GC1000] was followed for determining N_2 fixation.

Where ARA (µmole C_2H_4 /ml/h) =

$$\frac{\text{Reading (R) x air space in the vial (ml) x 1000}}{\text{culture volume (ml) x gas voulume injected for ethylene measurement (ml) x incubation time (h)}}$$

i.e., R is the amount of ethylene gas formed, air space of vial was 400 ml, algal culture volume was 100 ml, gas mixture injected into the column was 1 ml, incubation time was 24 h and 1000 = to convert ethylene concentration from nmole into µmole.

Statistical analysis

Data for the N_2-fixation evaluation were expressed as mean of three replicates ± SD using the T test.

Results and Discussion

In total 47 soils algal morpho-species had been identified. These belonging to four algal divisions: Cyanophyta contributed the dominant division with 33 different species belonging to 18 genera, followed by 5 taxa belonging to each of Chlorophyta and Xanthophyta. Diatoms represented only by 3 species. Most of the identified Cyanophytes were related to order Nostocales and order Oscillatoriales. In agreement with these results, contributions of Flechtner et al. (1998), Johansen et al. (2001) and Alwathnani & Johansen (2011) on the hottest and driest Deserts of California, and Patzelt et al. (2014) on the hyper-arid Atacama Desert in Chile pointed out that the filamentous and heterocystous blue-green algae like *Schizothrix*, *Nostoc*, *Scytonema* and *Calothrix* compose the main soil algal taxa. *Westiellopsis prolifica* is also considered as one of the main subtropical arid soil habitats (Tiwari et al., 2005). Concerning green algae, there are some recent studies pointed out their remarkable distribution in dry desert habitats (Cardon et al., 2008; Flechtner et al., 2013 and Fučíková et al. 2014a, b). Scarcity of diatoms and xanthophytes in soil algae was also confirmed by contributions of Zancan et al. (2006).

The most frequent taxa on all applied growth *media were represented by: Anabaena variabilis* Kütz., *Lyngbya limnetica* Lemm., *Stratonostoc. linckia* f. *calcicola* (Bréb.) Elenk., *Westiellopsis prolifica* Janet, *Chloridella simplex* Pasch, *Pleurochloris pyrenoidosa* Pasch, *Chlamydomonas dactylococcoides* Scherff. et Pasch and *Chlamydomonas globosa* Snow.

Based on available literature (El-Gamal, 1990; Shaaban, 1994; Mansour, 2004; Hamed, 2008 and Mansour & Shaaban, 2010), this work enriched for the first time the Egyptian soil algal flora with 5 different algal taxa: *Cylindrospermum gregarium, C. licheniforme, Chlorocloster caudatus* and *Tetraktis aktinastroides* (Fig. 1; A-D), in addition *to Westiellopsis prolifica (*Fig. 2; E1-E2).

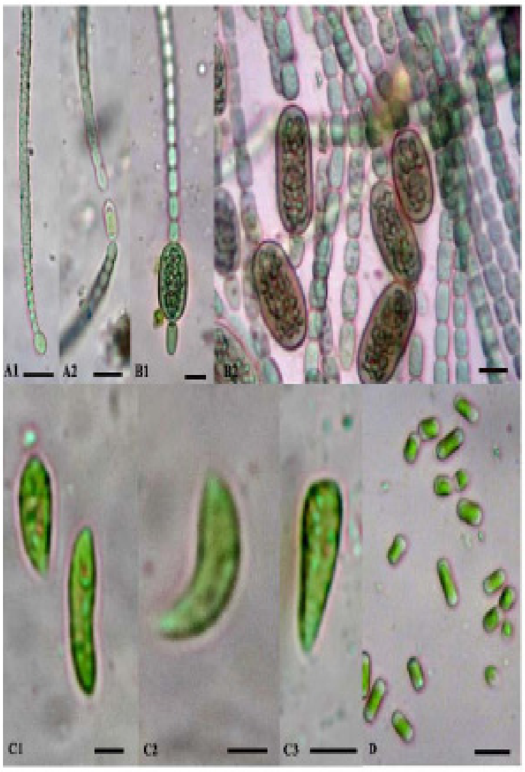

Fig. 1 (A–D): A1-2, *Cylindrospermum gregarium* (Zakrz.) Elenk; B1-2,*Cylindrospermum licheniforme* (Bory) Kütz.; C 1-3, *Chlorocloster caudatus* Pasch. and D, *Tetraktis aktinastroides* Pasch. Scale bar = 10 µm.

In the late exponential phase, *Calothrix elenkinii* Kossinsk, *Nodularia harveyana* f. *sphaerocarpa* (Born. et Flah.) Elenk, *Scytonema ocellatum* Lyngb, *Stratonostoc linckia* (Roth) Elenk. and *Westiellopsis prolifica* Janet (Fig. 2. A-E2) were easily give mass growth and axenic cultures. So, these five heterocystous cyanophytes were selected and recommended for the evaluation of atmospheric N_2-fixation efficiency.

N_2 fixation rates presented in Table 1 and Fig. 3 showed that, there are remarkable differences among the studied heterocytous cyanophytes. In particular, *Calothrix elenkinii, Westiellopsis prolifica* and *Scytonema ocellatum* exhibited to a large extent the highest fixation rates with mean values of 18.89, 30.52 and 33.01 µmole ml^{-1} h^{-1}, respectively. *Stratonostoc linckia* and *Nodularia harveyana* f. *sphaerocarpa* had the 4^{th} and 5^{th} ranks with mean values of 16.71 and 12.01 µmole ml^{-1} h^{-1}, respectively.

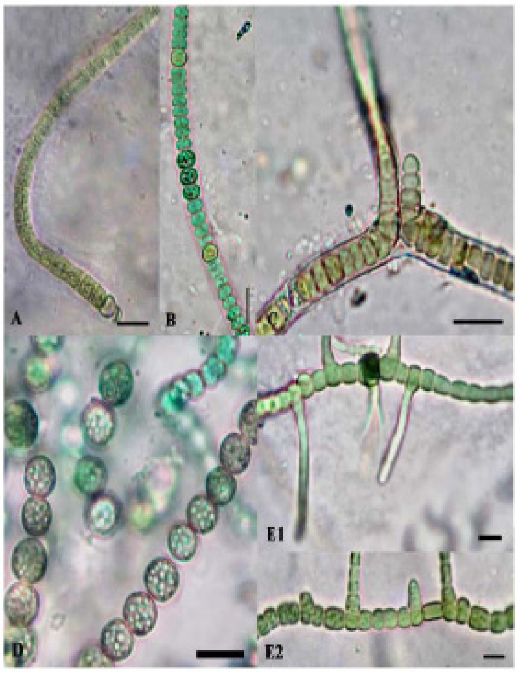

Fig.2 (A-E2). The late exponential growth phase of: A, *Calothrix elenkinii* Kossinsk; B, *Nodularia harveyana* f. sphaerocarpa (Born. et Flah.) Elenk; C, *Scytonema ocellatum* Lyngb; D, *Stratonostoc linckia* (Roth) Elenk and E1 & E2, *Westiellopsis prolifica* Janet. Scale bar = 10 µm.

Variations in amounts of N_2 fixation rates in different blue-green algae taxa were discussed in some previous studies (Moisander et al., 1996; Osman et al., 2010; Gheda & Ahmed, 2015 and Khanna et al., 2016). This study pointed out that *Calothrix elenkinii*, *Scytonema ocellatum* and *Westiellopsis prolifica* have the highest potentials of N_2 fixation on the basis of individual unit. Therefore, they could be widely-used as excellent natural bio-fertilizers and in reclamation of the nutrients-poor desert soils of El-Farafra Oasis. In agreement with these results, recent contribution of Priya et al. (2015) showed that there is a significant increase in rice plant growth inoculated with *Calothrix elenkinii*. Goyal (1993) confirmed that *Scytonema* grows well on the soil surface and fixes more nitrogen than the most widely-distributed genera such as *Nostoc* and *Anabaena*. In addition, González (2003) stated that, *Scytonema. ocellatum* isolated from the tropical soil in Mexico not only could be used as an excellent soil bio-fertilizer but it also improves the soil water-holding capacity. As regard to *Westiellopsis prolifica*, there are some studies supported well its utilization as soil bio-fertilizers (Jha et al., 1987; Jha & Kaushik, 1988; Prabu & Udayasoorian, 2007; Singh & Dhar, 2010 and Paudel et al., 2012).

TABLE 1. Mean values (mean ± SD) of the produced C_2H_4 and the fixed atmospheric N_2 by the heterocytous cyanophytes.

Algal taxa	C_2H_4 concentrations (nmole ml^{-1} h^{-1})	Nitrogen fixation rate (µmole ml^{-1} h^{-1})
Calothrix elenkinii (45 x 10^3 individuals/ml)	4721.89 ± 557.67	18.89 ± 2.23
Nodularia harveyana f. *sphaerocarpa* (91 x 10^3 individuals/ml)	3003.67 ±1541.70	12.01 ± 6.17
Scytonema ocellatum (198 x 10^3 individuals/ml)	8252.20 ±5870.01	33.01 ± 23.48
Stratonostoc linckia (485 x 10^3 individuals/ml)	4177.89 ±3462.10	16.71 ± 13.85
Westiellopsis prolifica (223 x 10^3 individuals/ml)	7630.50 ±1775.20	30.52 ± 7.10

Values are expressed as mean ± SD, n=3.

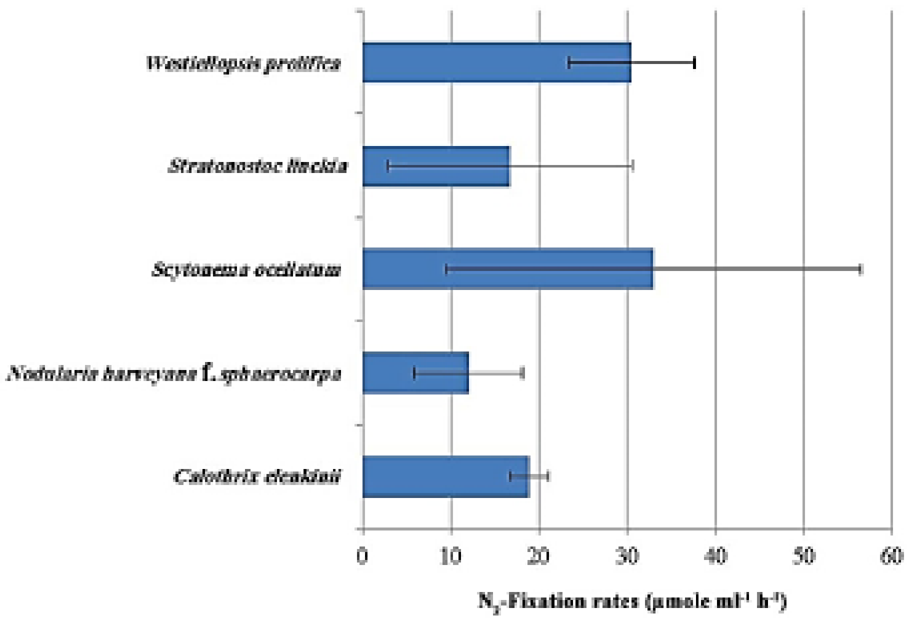

Fig.3. Atmospheric N_2-Fixation rates (mean ± SD) in the selected five axenic heterocystous cyanophytes.

Conclusion

In conclusion, the isolated blue-green algal taxa of El-Farafra Oasis, specifically *Scytonema ocellatum* and *Westiellopsis prolifica* can be considered as promising eco-friendly natural bio-fertilizers for the sustainable development in the desert habitats.

References

Abdel-Raouf, N., Al-Homaidan, A.A. and Ibraheem, I.B.M. (2012) Agricultural importance of algae. *African Journal of Biotechnology*, **11**(54),11648–11658.

Allen, M.M. (1968) Simple conditions for growth of unicellular blue-green algae on plates. *Journal of Phycology,* **4,** 1–4.

Alwathnani, H. and Johansen, J.R. (2011)Cyanobacteria in soils from a Mojave Desert ecosystem. *Monographs of the Western North American Naturalist,* **5,**71–89 pp.

Andersen, R.A. and Kawachi, M. (2005) Traditional microalgae isolation techniques. In: "*Algal Culturing Techniques*". Andersen, R.A. (Ed.), pp. 83–100, Elsevier Academic Press, Inc.

Bischoff, H.W. and Bold, H.C. (1963) Phycological studies IV. Some soil algae from enchanted rock and related algal species. *University of Texas, Austin,* **6318,** 1–95.

Bohunická, M., Pietrasiak N., Johansen, J.R., Gómez, E.B., Hauer, T., Gaysina, L.A. and Lukešová, A. (2015) *Roholtiella*, gen. nov. (Nostocales, Cyanobacteria)-a tapering and branching cyanobacteria of the family Nostocaceae. *Phytotaxa,* **197** (2), 84–103.

Bold, H.C. (1949) The morphology of *Chlamydomonas chlamydogama* sp. nov. *Bulletin of Torrey Botanical Club,* **76,**101–108.

Cardon, Z.G., Gray, D.W. and Lewis, L.A. (2008) The green algal underground: Evolutionary secrets of desert cells. *Bioscience,* **58(**2), 114–122.

Chu, S.P. (1942) The influence of the mineral composition of the medium on the growth of planktonic algae. Part I. Methods and culture media. *Journal of Ecology,* **30,** 284–325.

Desikachary, T.V. (1959) "*Cyanophyta*". Indian Council of Agricultural Research, New Delhi, 686 pp.

De Desenko-Schegolova, N. T. and Gollerbach, M. M. (1962) "*Freshwater Algae of USSR*". Vol. 5. Xanthophyta. Pub. Acad.” Sov. Nauke” USSR, Moscow, Leningrad. 272 pp.

De Desenko-Schegolova, N.T., Matvianko, A.M. and Shkorbatov, D.A. (1959) "*Freshwater Algae of USSR*", Vol. 8. Chlorophyta: Volvocineae. Pub. Acad. “Sov. Nauke” USSR, Moscow, Leningrad, 230 pp.

El-Gamal, A.D. (1990) Studies on the algal flora of a cultivated land (El-Khanka district) according to cultivation succession. *M.Sc. Thesis.* Fac. Sci., Al-Azhar Uni., Egypt, 169 pp.

Flechtner, V.R., Johansen, J.R. and Clark, W.H. (1998) Algal composition of microbiotic crusts from the central desert of Baja California, Mexico. *Great Basin Naturalist,* **58,** 295–311.

Flechtner, V.R., Pietrasiak, N. and Lewis, L.A. (2013) Newly revealed diversity of green microalgae from wilderness areas of Joshua Tree National Park (JTNP). *Monographs of the Western North American Naturalist,* **6,** 43–63.

Fučíková, K., Lewis, P.O. and Lewis, L.A. (2014a) Putting incertae sedis taxa in their place: a proposal for new families and three new genera in Sphaeropleales (Chlorophyceae, Chlorophyta). *Journal of Phycology,* **50,** 14–25.

Fučíková, K., Lewis, P.O. and Lewis, L.A. (2014b) Widespread desert affiliation of trebouxiophycean algae (Trebouxiophyceae, Chlorophyta) including discovery of three new desert genera. *Phycological Research,* **62,** 294–305.

Gheda, S.F. and Ahmed, D.A. (2015) Improved soil characteristics and wheat germination as influenced by inoculation of *Nostoc kihlmani* and *Anabaena cylindrical*. Rend. Fis. Acc. Lincei, **26,** 21–131.

Gollerbach, M.M., Kosinckaja, E.K. and Polanskii, V.I. (1953) "*Freshwater Algae of USSR*", Vol. 2. Cyanophyta. Pub. *“Sov. Nauke” Moscow,* **652** pp.

González, A.Á. (2003) Optimización de la cianobacteria *Scytonema ocellatum* cepa SLC 1097-22, evaluación de su capacidad como biofertilizante y su contribución en la retención de humedad en el suelo. *M.Sc. Thesis.* Centro de Investigaciones Biológicas del Noroeste, S.C., Mexico, 149 pp.

Goyal, S.K. (1993) Algal biofertilizer for vital soil and free nitrogen. *Proceedings of the Indian National Science Academy,* **B59** (3&4), 295–302.

Hamed, A.F. (2008) Biodiversity and distribution of blue-green algae/cyanobacteria and diatoms in some of the Egyptian water habitats in relation to conductivity. *Australian Journal of Basic and Applied Sciences,* **2**(1), 1–21.

Hardy, R.W.F., Burns, R.C. and Holsten, R.D. (1973) Applications of the acetylene-ethylene assay for measurement of nitrogen fixation. *Soil Biology and Biochemistry,* **5,** 47–81.

Housman, D.C., Powers, H.H., Collins, A.D. and Belnap, J. (2006) Carbon and nitrogen fixation differ between successional stages of biological soil crusts in the Colorado Plateau and Chihuahuan Desert. *Journal of Arid Environments,* **66,** 620–634.

Jha, M.N. and Kaushik, B.D. (1988) Response of *Westiellopsis prolifica* and *Anabaena* sp. to salt stress II. Uptake of Na^+ in the presence of K^+ as chloride, nitrate and phosphate. *Current Science,* **57,** 667–668.

Jha, M.N., Venkataraman, G.S. and Kaushik, B.D. (1987) Response of *Westiellopsis prolifica* and *Anabaena* sp. to salt stress. *Mircen Journal,* **3,** 99–103.

John, R.P. (1942) An ecological and taxonomic study of the algae of the British soils. I. The distribution of the surface growing algae. *Annals of Botany,* **6,** 323–349.

Johansen, J.R., Britton, C., Rosati, T.C., Xuesong, L., St. Clair, L.L.,Webb, B.L., Kennedy, A.J. and Yanko, K.S. (2001) Microbiotic crusts of the Mojave Desert: factors influencing distribution and abundance. *Nova Hedwigia Beiheft,* **123,** 339–369.

Khanna, N., Raleiras, P. and Lindblad, P. (2016) Fundamentals and recent advances in hydrogen production and nitrogen fixation in cyanobacteria. In: "*The Physiology of Microalgae, Developments in Applied Phycology*" **6**, M.A. Borowitzka et al. (Ed.), pp. 101–127. Springer, Switzerland.

Kilham, S.S., Kreeger, D.A., Lynn, S.G., Goulden, C.E. and Herrera, L. (1998) COMBO: A defined freshwater culture medium for algae and zooplankton. *Hydrobiologia,* **377,** 147–159.

Mager, D.M. and Thomas, A.D. (2011) Extracellular polysaccharides from cyanobacterial soil crusts: a review of their role in dryland soil processes. *Journal of Arid Environments,* **75,** 91–97.

Mansour, H.A. (2004) Soil algae of North Sinai and the possibility to utilize some of them. *Ph.D. Thesis.* Fac. of Sci., Ain Shams Uni., Egypt, 185 pp.

Mansour, H.A. and Shaaban, A.S. (2010) Algae of soil surface layer of Wadi Al-Hitan Protective Area (World Heritage Site), El-Fayum Depression. *Journal of American Science,* **6**(8), 243–255.

Maqubela, M.P., Mnkeni, P.N.S., Issa, O.M., Pardo, M.T. and D'Acqui, L.P. (2009) *Nostoc* cyanobacterial inoculation in South African agricultural soils enhances soil structure, fertility and maize growth. *Plant Soil,* **315,**79–92.

Mareš, J., Lara, Y., Dadáková, I., Hauer, T., Uher, B., Wilmotte, A. and Kaštovský, J. (2015) Phylogenetic analysis of cultivation-resistant terrestrial cyanobacteria with massive sheaths (*Stigonema* spp. and *Petalonema alatum*, Nostocales, Cyanobacteria) using single-cell and filament sequencing of environmental samples. *Journal of Phycology,* **51**(2), 288–297.

Moisander, P., Lehtimaki, J., Sivonen, K. and Kononen, K. (1996) Comparison of $^{15}N_2$ and acetylene reduction methods for the measurement of nitrogen fixation by Baltic Sea cyanobacteria. *Phycologia,* **35** (6),140–146.

Osman, M.E.H., El-Sheekh, M.M., El-Naggar, A.H. and Gheda, S.F. (2010) Effect of two species of cyanobacteria as biofertilizers on some metabolic activities, growth, and yield of pea plant. *Biology and Fertility of Soils,* **46,** 861–875.

Patzelt, D.J., Hodač, L., Friedl, T., Pietrasiak, N. and Johansen, J.R. (2014) Biodiversity of soil cyanobacteria in the hyper-arid Atacama Desert, Chile. *Journal of Phycology,* **50**(4), 698–710.

Paudel, Y.P., Pradhan, S., Pant, B. and Prasad, B.N. (2012) Role of blue green algae in rice productivity. *Agriculture and Biology Journal of North America,* **3**(8), 332–335.

Philipose, M. T. (1967) Chlorococcales. Indian Council of Agricultural Research, New Delhi, 363 pp.

Prabu, P.C. and Udayasoorian, C. (2007) Native cyanobacteria *Westiellopsis* (TL-2) sp. for reclaiming paper mill effluent polluted saline sodic soil habitat of India. *Electronic Journal of Environmental, Agricultural and Food Chemistry,* **6**(2),1775–1786.

Priya, H., Prasanna, R., Ramakrishnan, B., Bidyarani, N., Babu, S., Thapa, S. and Renuka, N. (2015) Influence of cyanobacterial inoculation on the culturable microbiome and growth of rice. *Microbiol. Res.* **171,**78–89.

Řeháková, K., Johansen, J.R., Casamatta, D.A., Xuesong, L. and Vincent, J. (2007) Morphological and molecular characterization of selected desert soil cyanobacteria: three species new to science including *Mojavia pulchra* gen. et sp. nov. *Phycologia,* **46**(5), 481–502.

Sahu, D., Priyadarshani, I. and Rath, B. (2012) Cyanobacteria-as potential biofertilizer. CIBTech *Journal of Microbiology,* **1**(2-3), 20–26.

Shaaban, A.S. (1994) Freshwater algae of Egypt. In: *UN Environmental Programme,* National Biodiversity Unit, Biological Diversity of Egypt. GF/6105-92-02-2205, 150 pp.

Singh, N.K. and Dhar, D.W. (2010) Cyanobacterial reclamation of salt-affected soil. In: "*Genetic Engineering, Biofertilisation, Soil Quality and Organic Farming. Sustainable Agriculture Reviews*" 4. Lichtfouse, E. (Ed.), Springer Science + Business Media B.V., Dordrecht, 243–275 pp.

Tiwari, O.N., Singh, B.V., Mishra, U., Singh, A.K., Dhar, D.W. and Singh, P.K. (2005) Distribution and physiological characterization of cyanobacteria isolated from arid zones of Rajasthan. *Tropical Ecology,* **46**(2),165–171.

Venter, A., Levanets, A., Siebert, S. and Rajakaruna, N. (2015) A preliminary survey of the diversity of soil algae and cyanoprokaryotes on mafic and ultramafic substrates in South Africa. *Australian Journal of Botany,* **63**(4), 341–352.

Zancan, S., Trevisan, R. and Paoletti, M.G. (2006) Soil algae composition under different agro-ecosystems in North-Eastern Italy. *Agriculture, Ecosystems and Environment,* **112,** 1.

Zhang, B., Zhang, Y., Downing, A. and Niu, Y. (2011) Distribution and Composition of Cyanobacteria and Microalgae Associated with Biological Soil Crusts in the Gurbantunggut Desert, China. *Arid Land Research and Management,* **25**(3),275–293.

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طحالب تربة واحة الفرافرة (الصحراء الغربية، مصر) و كفاءة تثبيت النيتروجين الجوى لخمسة من الطحالب الخضراء المزرقة ذات الحويصلات المغايرة

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تم زراعة و تعريف 47 نوع مختلف من طحالب تربة واحة الفرافرة (الصحراء الغربية، مصر). أغلب الأنواع التى تم تسجيلها تتبع الطحالب الخضراء المزرقة (34 نوع)، متبوعة بـ 5 أنواع لكل من الطحالب الخضراء و الخضراء المصفرة. و تم أيضا تمثيل الدياتومات من خلال 3 أنواع فقط. هذا وقد أضافت هذه الدراسة 5 أنواع طحلبية جديدة على ما تم تعريفه من طحالب التربة المصرية، وهى:

Westiellopsis prolifica Janet, *Cylindrospermum gregarium* (Zakrz.), *Cylindrospermum. licheniforme* (Bory) Kütz., *Chlorocloster caudatus* Pasch. and *Tetraktis aktinastroides* Pasch.

علاوة على ذلك، تم تقدير كفاءة تثبيت النيتروجين الجوى لخمسة من الطحالب الخضراء المزرقة ذات الحويصلات المغايرة مثل:

Calothrix elenkinii Kossinsk., *Nodularia harveyana* f. *sphaerocarpa* (Born. et Flah.) Elenk., *Scytonema ocellatum* Lyngb., *Stratonostoc linckia* (Roth) Elenk. and *W. prolifica* Janet.

ولقد أسفرت النتائج أن كل من *C. elenkinii. S. ocellatum, W. prolifica* لديهم القدرة الأعلى على تثبيت النيتروجين الجوى بمتوسط قيم 33.01 30.52 , 18.89 $\mu mole\ ml^{-1}\ h^{-1}$ بالتتابع، و يليهم فى ذلك كل من الطحالب:

S. linckia (16.71 µmole ml-1 h-1) ثم *N. harveyana* f. sphaerocarpa (12.01 $\mu mole\ ml^{-1}\ h^{-1}$)

و نستنتج من هذه الدراسة على إمكانية إستخدام الخمس طحالب سالفة الذكر خاصا (*Scytonema ocellatum* , *Westiellopsis prolifica*) كمخصبات بيولوجية, واعدة وصديقة للبيئة للتنمية المستدامة فى البيئات الصحراوية.