جامعة عمر المختار
كلية التربية ـ البيضاء
مجلة كلية التربية (مجلة علمية محكمة)
العدد الثالث لعام 2018

DOI: https://doi.org/10.54172/y42v6r45

Use of marine algae (Chaetomorpha sp. and Amphiroaanceps) as biological indicator of heavy metal pollution in in the Coastal of Derna, Libya.

Masoud.M.M.Zatout
Department of Zoology
Faculty of Art and Science
Omar Al-Mokhtar University,Derna, Libya.
Email: marwan2004h@yahoo.co.uk

Salmeen. H.Alhage
Department of Botany
Faculty of Science
Omar Al-Mokhtar University, Al-Bayda, Libya

Abstract

Many organisms serve as indicators of marine pollution, algae have been used extensively to determination of heavy metal pollution in marine environments throughout the world. The coastal areas at grandest risk are in developing countries. preeminence should be given to saving those coastal areas that are still in well condition. Marine pollution in Libya coast, has drawn the attention in the last decades, due to the enormous increment of wastewater discharged into the marine environment. This study aim to investigate the suitability of some algae to act as bio-indicator for heavy metals pollution, which might exist in the coastal marine environment along the Derna beaches. Two algae samples were collected from six different sites in two seasons. The two collected algae were identified as Chaetomorpha sp. (Green algae) and Amphiroaanceps (Red algae). The metals concentrations recorded for the different tissues and sites of the present study confirm the occurrence of significant seasonal variability, with maximum concentrations usually observed in summer. The all of heavy metal show no possibility of very detrimental effects on the domestic aquatic environment of Derna coast.

Keywords—Amphiroaanceps, Chaetomorpha sp., heavy metal, bio-indicators, sewage.

الملخص

العديد من الكائنات الحية يمكن اعتبارها بمثابة مؤشرات للتلوث البحري، وقد استخدمت الطحالب على نطاق واسع لتحديد التلوث بالمعادن الثقيلة في البيئات البحرية في جميع أنحاء العالم. المناطق الساحلية الأكثر عرضة للخطر تقع في البلدان النامية، ينبغي إعطاء الأولوية لإنقاذ تلك المناطق الساحلية التي لا تزال في حالة جيدة. وقد لفت التلوث البحري في الساحل الليبي الانتباه في

.The Author(s). This open access article is distributed under a CC BY-NC 4.0 license ©

جامعة عمر المختار
كلية التربية – البيضاء
مجلة كلية التربية (مجلة علمية محكمة)
العدد الثالث لعام 2018

العقود الأخيرة، بسبب الزيادة الهائلة في مياه الصرف الصحي التي يتم تصريفها في البيئة البحرية. تهدف هذه الدراسة إلى التحقق من ملاءمة بعض الطحالب للعمل كمؤشر حيوي للتلوث بالمعادن الثقيلة، والتي قد توجد في البيئة البحرية الساحلية على طول شواطئ درنة. تم جمع اثنين من الطحالب في ستة مواقع مختلفة خلال موسمين. تم التعرف على الطحالب التي تم جمعها على أنها *Chaetomorpha sp* . (طحالب خضراء) و *Amphiroaanceps* (طحالب حمراء). وتؤكد تركيزات المعادن المسجلة في الأنسجة والمواقع المختلفة للدراسة الحالية حدوث تقلبات موسمية كبيرة، مع ملاحظة الحد الأقصى من التركيزات عادة في الصيف. جميع المعادن الثقيلة لا تظهر أي آثار ضارة للغاية على البيئة المائية المحلية لساحل درنة.

الكلمات المفتاحية: *Amphiroaanceps* ، *Chaetomorpha sp.*، المعادن الثقيلة ، المؤشرات الحيوية، مياه الصرف الصحي.

Introduction

Pollution of heavy metals in aquatic environment is a growing problem worldwide and currently it has reached an alarming rate. The potential ecological effects of rising levels of heavy metals concentrations in the aquatic environment are of great concern caused by their highly bio-accumulative nature and higher toxicity, causing significant and permanent disturbances in the marine ecosystem systems and consequently, environmental and ecological deterioration (Buffle *et al.*, 2009; Akcali and Kucuksezgin, 2011). There are various sources of heavy metals; some originates from anthropogenic activities like draining of sewerage, dumping of Hospital wastes and recreational activities. As heavy metals cannot be degraded, they are continuously being deposited and incorporated in water, thus causing heavy metal pollution in water bodies. Apartfrom destabilizing the ecosystem, the accumulation of these toxic metals in aquatic Food web is a threat to public health and thus their potential long term impact on ecosystem integrity cannot be ignored (Rajendran *et al.*, 1993). Macroalgae have been used extensively to measure heavy metal pollution in freshwater and marine environments throughout the world. They are used as bio indicators because of their distribution, size, longevity, presence at pollution sites, ability to accumulate metals to a satisfactory degree and ease of identification. It is preferred to measure heavy metal levels in bioindicators organisms rather than measuring the concentrations in water and/or sediment samples (Palmer,1980). The coastal areas at grandest risk are in developing countries. They can and should be constrained now and

.The Author(s). This open access article is distributed under a CC BY-NC 4.0 license ©

procedures should be taken to help those countries in safeguarding them. preeminence should be given to saving those coastal areas that are still in well condition. Preventive environmental medicine is a far more effectual and less priced strategy than recovering environmental medicine (Schubel,1994). Marine pollution in Derna coastal, due to the enormous increment of sewage discharged into the aquatic environment, has drawn the attention in the last decades. Derna is one most important town on Libya long stretch of the Mediterranean coast. Little quantitative data are avail-able on the concentration of metals in seaweeds for this area. Little quantitative data are available on the concentration of metals in seaweeds general pollution of this area. This study aim to investigate the suitability of some algae to act as bio-indicator for heavy metals pollution, which might exist in the coastal marine environment along the Derna coast.

Material and Methods

1. Study Area

The study area is located along the Derna coast, the north east part of Libya at latitude 32° North and 22° East. This area included six sites, which are exposed to different degrees of pollution. The location of the six sites is shown and their characteristics are presented in Table 1.

Table 1: The locations of the study sites with latitude and longitude, the nature of substratum and pollution status. The terms 'S1,.... S6 refer to the stations

Site		Latitude	Longitude	the nature of substratum	pollution status
S1	Derna Harbor	32^{0}46'.79	22^{0}39'9.48	rocky	sewer pipes
S2	Shahat company	32^{0}46'18.98	22^{0}38'45.57	rocky	clean sea water
S3	Post station	32^{0}46'28.48	22^{0}38'27..83	rocky	sewer pipes
S4	Republic station	32^{0}46'23.75	22^{0}37'46.25	rocky	sewer pipes
S5	Algarod station	32^{0}46'27.55	22^{0}36'27.55	sandy	clean sea water
S6	Desalination station	32^{0}47'4'.30	22^{0}35'12.02	rocky	fuel and oil

2. Methods

.The Author(s). This open access article is distributed under a CC BY-NC 4.0 license ©

Algal samples were collected in triplicates from two sites along Derna city coast, were cleaned with distilled water and all algal samples were air dried at 90°C (Al-Homaidan*et al.*, 2011), were collected during two seasons, in Spring and Summer, 2016. The two collected algae were identified according to Mattox *et al.*,(1984).as *Chaetomorpha sp.* (Green algae) and *Amphiroaanceps*(Red algae) and then kept to analyze for heavy metals (manganese (Mn), zinc (Zn), cadmium (Cd), and lead (Pb). The concentrations of manganese, zinc, cadmium and lead were determined in the collected algal samples according to previously reported methods (Al-Homaidan*et al.*, 2011). The concentrations of various metals including Mn, Zn, Cd, and Pb were measured in aliquots of algae. All samples were analyzed in triplicates and the concentrations were expressed in µg (metal) per gram dry weight (alga) and the mean values were recorded (Al-Homaidan *et al.*, 2011).

Result and Discussion

The value of algae as bio-indicators has already been recognized in the mid of 19th century (Naicheng, 2014). These algae were chosen to conduct the investigation as bio-indicators for heavy metals pollution of Derna city coastal area at the east of Libya. Due to their they were almost available in all sites during field study. Due to their short life cycle, algae respond quickly to environmental changes and are thus a valuable indicator of water pollution (Domingues, 2007). The concentrations of four heavy metals examined in two algae samples collected from six stations from Derna coast in the year of 2016 are shown in tables 2, 3 and 4 and represented graphically in figures (1) and (2). The concentrations of various toxic heavy metals were determined in all of the collected algal samples, including Pb, Mn, Zn and Cd are important to mention here all sites have different characteristics and peculiarities that are of great importance effect on the levels of heavy metals found in algae, were some of sites contains pollutants such as sewage and waste from local activities, while other sites, were selected free from contaminants.

The Amphiroaantps algae compared with *Chaetomorpha sp.*, showed the lowest concentration of (Pd) 0.754 µg g^{-1} (regardless of location or sampling seasons). According to Sheber and Chatila (1979), metal levels, especially lead, appear to be fairly high, possibly due in part to untreated domestic wastewater,

.The Author(s). This open access article is distributed under a CC BY-NC 4.0 license ©

industrial waste, automobile exhaust, and outdoor incinerators. The results showed that *Chaetomorpha sp.*, recorded the highest concentration of Pb, this result in agreement with (Humaidan, 2011), while the study by (Najjar and Al-Amoudi, 1989), also by (Abear, 2014) in Aljabal akhdar coast, showed lower results than this study where the concentration of Pb (0.684) mg / g. The highest concentration of (Mn) was recorded in the *Chaetomorpha sp.*, compared with *Amphiroaantps* algae (regardless of sampling site or seasons). Chakraborty *et al.*, (2014) reported that the Mn concentration in the algae revealed major spatial differences which might be due to differential background Mn concentrations resulting from selective anthropogenic sources. The average of concentrations in *Chaetomorpha sp.*, 0.747µg g-1 compared with *Amphiroaantps* algae 0.695 µg g^{-1}, which recorded the lowest value of zinc concentration. In general, Cadmium recorded low values irrespective of sites and algal species. This study is consistent with the results by (Abear, 2014) in Aljabal akhdar Libya coast region for Mn, Zn and Cd metals.

Acording to El-Adl *et al.*, (2017) (Cd) was the least accumulated heavy metal along Al-Hanyaa Coastline, Libya. The (Cd) is exceptionally toxic even at very low concentrations which necessitates the study of (Cd) contamination sources as well as its distribution in marine ecosystems. The (Pb), (Mn) and (Zn) concentration is several times higher than the (Cd) concentration, but both elements are present in the macroalgae in concentrations that should not substantially affect the algal life cycle (Strezov and Nonova, 2003). Even when these factors have been minimized in the present study, as all the species were collected under the same conditions, a wide variation in metal content was observed in the different species. The metals concentrations recorded for the different tissues and sites of the present study confirm the occurrence of significant seasonal variability, with maximum concentrations usually observed in summer. Such seasonal variability in metal concentrations have been reported by other authors for Pb and Cu in *Posidonia oceanica* (Malea *et al* ., 1994), for Cd, Cu, Pb and Zn in *Posidonia australis* (Ward, 1987), and for Cd, Cu, Pb and Zn in *Zostera marina L*. (Lyngby and Brix, 1982).The latter authors found that maximum concentrations of heavy metals were recorded when the growth has ceased, and decline of these metals occurred at the beginning of the growth season. Generally, as previously reported by many authors as (Akcali and Kucuksezgin, 2011; Brown *et al*, 1999), there may be a number of reasons for the seasonal differences found,

.The Author(s). This open access article is distributed under a CC BY-NC 4.0 license ©

including: environmental factors, such as variations in metal concentrations in solution, interactions between metals and other elements, salinity, pH etc., metabolic factors, such as dilution of metal contents due to growth; or they may be due to interactions between both kinds of factors, different genetic capacities for metals concentration.

Table 2: Average heavy metals concentrations of Pb, Mn, Zn, and Cd in the selected marine macroalgae collecting during two seasons 2016, along stations of Derna coast.

Algae	Pb	Mn	Zn	Cd
Chaetomorpha sp.	1.104	1.876	0.747	0.01
Amphiroa anceps	0.754	0.709	0.695	0.01

The *Amphiroanceps* algae collected from the S6 at summer recorded the highest concentration of Pb level 1.27±0.3 (µg/g) dry weight) followed by that collected from the both S4 and S5 at the same season (0.92±0.03 (µg/g) dry weight). *Amphirosp* algae, collected from the S6 recorded the highest concentration of Mn (1.18±0.09 and 0.79±0.09 (µg/g) dry weight) in summer and Spring, respectively. On the other hand, the *Amphiro sp.*, recorded the lowest Mn values at the S4 0.32±0.06 (µg/g) in spring (Table 3, fig 1). *Amphirosp* algae recorded a relatively high Zn concentration in summer at the S6 (1.19±0.06 and 0.91±0.01 (µg/g) dry weight) in summer and spring, respectively. While recorded their lowest values in spring at the S4 (0.21±0.01 and S2 0.61±0.04 (µg/g) dry weight) in spring and summer, respectively. In the natural aquatic environment, heavy metals occur at low concentrations (nano gram to micrograms per litre).

Occurrence of heavy metals in excess of the mentioned natural loads indicates the presence of additional external sources (Lobban and Harrisson, 1994).The highest Pb level in *Chaetomorpha sp.*, was recorded in spring for samples collected from S4 1.86±0.2 (µg/g) dry weight) followed by S6 and S5 (1.51±0.4 (µg/g) dry weight) in summer (Table 4, fig 2). The highest Mn level in *Chaetomorpha sp.*, was recorded in summer for samples collected from S1 2.83±0.6 (µg/g), followed by S3 (2.12±0.5 (µg/g) dry weight) in spring. While *Chaetomorpha sp.*, recorded a relatively high Zn concentration in spring at the S2(1.41±0.1 (µg/g) dry weight). while recorded their lowest values in spring and spring at the S3 (0.51±0.1 (µg/g) dry weight). The present data, show the value of average concentration for (Pb), (Mn), (Zn) and (Cd) was in this study, lower than

.The Author(s). This open access article is distributed under a CC BY-NC 4.0 license ©

to those found by Strezov and Nonova (2003) for *Chaetomorpha sp.*, collected in the Tyrrhenian Sea, Atlantic Ocean, and Black Sea.

Table 2: Average concentrations with standard error of metals in *Amphiro sp.*, collecting 2016, along stations of Derna coast.

Stations	Metals							
	Pb		Mn		Zn		Cd	
	Spring	Summer	Spring	Summer	Spring	Summer	Spring	Summer
S1	0.57±0.01	0.85±0.03	0.44±0.02	0.82±0.1	0.54±0.007	0.78±0.008	0.001±0.01	0.003±0.01
S2	0.33±0.02	0.73±0.03	0.60±0.02	0.94±0.02	0.26±0.02	0.61±0.04	0..002±0.06	0.003±0.01
S3	0.71±0.05	0.85±0.02	0.49±0.03	0.74±0.02	0.57±0.06	0.92±0.03	0.002±0.002	0.001±0.00
S4	0.59±0.1	0.92±0.03	0.32±0.06	0.81±0.03	0.21±0.01	0.70±0.03	0.003±0.01	0.005±0.02
S5	0.43±0.08	0.92±0.03	0,59±0.03	0.74±0.03	0..71±0.03	0.90±0.01	0.00±0.0	0.00±0.0
S6	0.85±0.03	1.27±0.3	0.79±0.09	1.18±0.09	0.91±0.01	1.19±0.06	0.00±0.00	0.00±0.0

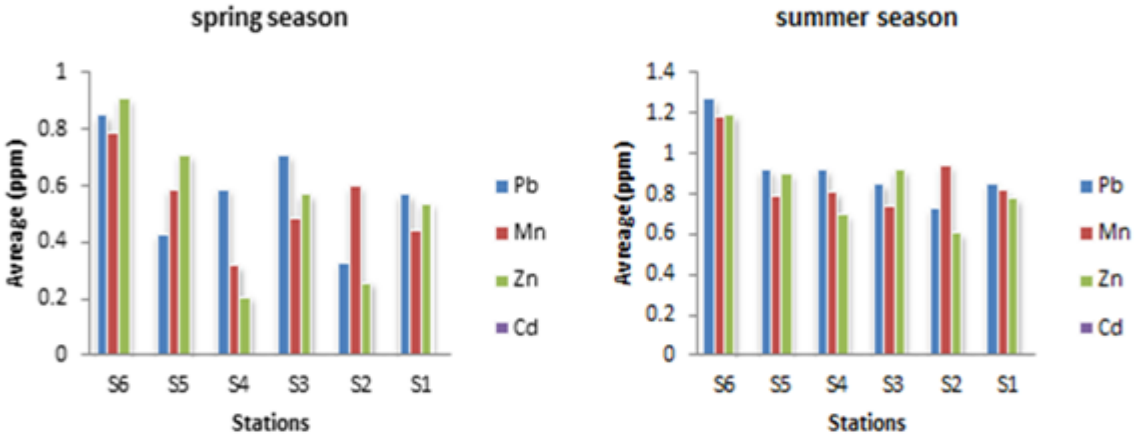

Fig 1:Average concentrations in *Amphiroanceap sp.*, collecting during 2016, in Derna coast.

Table 3: Average concentrations with standard error of metals in *Chaetomorpha sp.*, collecting 2016, along stations of Derna coast

Stations	Metals							
	Pb		Mn		Zn		Cd	
	Spring	Summer	Spring	Summer	Spring	Summer	Spring	Summer
S1	0.71±0.08	0.95±0.2	1.94±0.4	2.83±0.6	0.82±0.1	1.03±0.3	0.02±0.05	ND
S2	0.93±0.1	1.19±0.3	1.43±0.2	1.88±0.6	1.41±0.1	0.73±0.8	0.03±0.1	0.03±0.02
S3	0.70±0.08	1.24±0.2	2.12±0.5	2.67±0.3	0.51±0.1	0.75±0.8	ND	ND

.The Author(s). This open access article is distributed under a CC BY-NC 4.0 license ©

S4	1.86±0.2	1.24±0.2	1.85±0.3	1.91±0.2	0.64±0.2	0.84±0.9	ND	ND
S5	1.13±0.3	1.51±0.4	1.04±0.1	1.41±0.6	0.68±0.4	0.92±0.3	ND	ND
S6	1.25±0.4	1.51±0.4	1.97±0.1	1.41±0.6	0.75±0.8	0.86±0.2	ND	ND

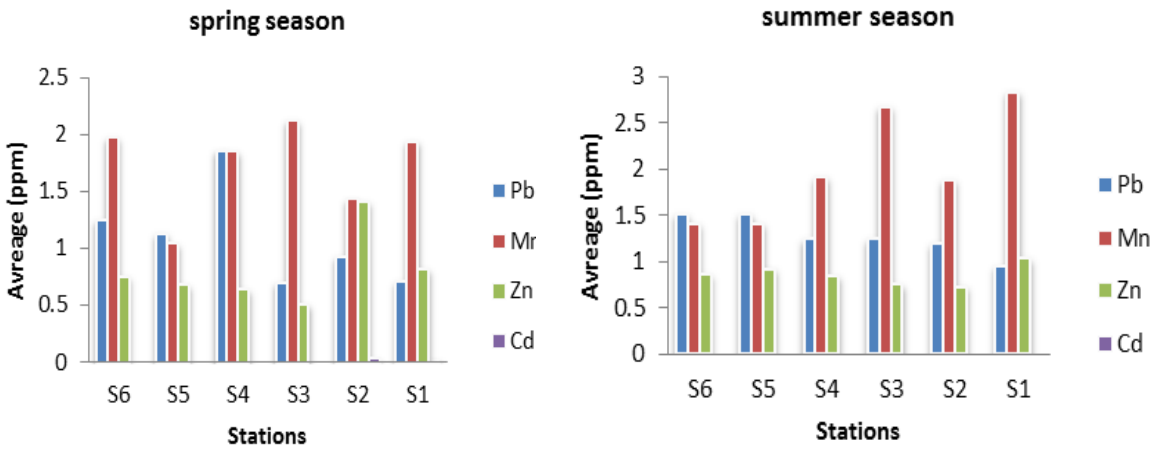

Fig2: Average concentrations in *Chaetomorpha sp.*,collecting 2016, inDerna coast.

Conclusions

The obtained heavy metal contents indicated that *Amphiroanceap sp.*, demonstrated various degrees of metal concentration. while high levels of (Mn) were detected in *Chaetomorpha sp.*, algae. Drainage of waste into the coast of city are probably the main cause of this problem. The information compiled from the above recommendations can then direct strategies for initial environmental surveys to investigate contamination of heavy metals in Derna coast.

References

.The Author(s). This open access article is distributed under a CC BY-NC 4.0 license ©

1. Al-Homaidan AA, Al-Ghanayem AA, Alkhalifa AH (2011) Green algae as bioindicators of heavy metal pollution in WadiHanifah stream, Riyadh, Saudi Arabia. International Journal of Water Resources and Arid Environments 1(1): 10–15.
2. Abear,M.M. (2014). Assessment of heavy metals and hydrocarbons in some types of algae as an indicators of contamination at some aljabal alakater Libya coast regions.
3. Akcali , I. and Kucuksezgin, F. (2011). A bio monitoring study Heavy metals in macro algae from eastern Aegean coastal areas. Mar. Pollut. Bull. 62:637-645.
4. Buffle J, Wilkinson KJ, Van Leeuwen HP (2009). Chemodynamics and bioavailability in natural waters. Environ. Sci. Technol. 43:7170-7174.
5. Chakraborty, S.T.; Bhattacharya, G.; Singh, J.P. and Maity. (2014). Benthic macro algae as biological indicators of heavy metal pollution in the marine environments. A bio monitoring approach for pollution assessment. Eco toxicology environmental safety, 100: 61-68.
6. Capiomont, A., Piazzi, L. and Pergent, G. (2000) Seasonal variations of total mercury in foliar tissues of Posidoniaoceanica. Journal of the Marine Biological Association, 80, 1119-1123. doi:10.1017/S0025315400003192
7. Domingues , R.and Galvão ,H. (2007). Phytoplankton and environmental variability in a dam regulated temperate estuary. Hydrobiologia. 586: 117-134.
8. El-Adl, Magda Faiz ; El-Katony, Taha Mohamed, and Bream, Ahmed Saber. (2017). Effect of sewage pollution on macroalgal diversity and heavy metal accumulation along Al-Hanyaa coastline, Libya. Advances in Environmental Biology. Feb.2017, Vol. 11 Issue 2, p52, 8 p.
9. El-Naggar MEE, Al-Amoudi OA (1989) Heavy metal levels in several species of marine algaefrom the Red Sea of Saudi Arabia. JKAU Sci 1:5–13
10. Lyngby, J. E. and Brix, H. (1982) Seasonal and environmental variation of cadmium, copper, lead and zinc concentration in eelgrass (Zoatera marina L.) in the LimIord, Denmark. Aquatic Botany 14, 5-74.
11. Lobban, C.S. and Harrison, P.J. (1994). Seaweed Ecology and Physiology, 1st ed. Cambridge University Press, 366 pp.
12. Malea, P.; Haritonidis, S. and Kevrekidis, T. (1994). Seasonal and local variations of metal concentrations in the seagrass Posidonia oceanica (L.) Delile in the Antikyra Gulf, Greece. The Science of the Total Environment 153, 225-235.
13. Mattox, K. R. and stewart. K. D. (1984). Classification of the green algae : a Merz, Sinclair Knight. (2013). Characterizing the relationship between water quality and water quantity, *St Leonards Nsw 2065*, Australia.
14. Naicheng ,W.u.; Britta; Schmalz; Nicola and Fohrer. (2014). Study progress in river in phytoplankton and its use as bio-indicator – a review. Austin Journal of Hydrology ,1(1): 9 p.

.The Author(s). This open access article is distributed under a CC BY-NC 4.0 license ©

15. Palmer, C. M. (1980). Algae and water pollution: the identification, significance, and control of algae in water supplies and in polluted water. Algae and water pollution: the identification, significance, and control of algae in water supplies and in polluted water. Castle House Publications.

16. Rajendran K. Sampathkumar P. Govindasamy C. Ganesan M. Kannan R and Kannan L. Level of Trace metals (Mn, Fe, Cu and Zn) in Some Indian Seaweed. Marine Pollution Bulletin 5:1993: 283-285.

17. Schubel, Jerry R. (1994). "Coastal Pollution and Waste Management", Commission on Geosciences, Environment, and Resources National Reearch Council, Environmental Science in the Coastal Zone: Issues for Further Research, (Prooceedings of a Retreat Held at the J. Erik Jonsson Woods Hole Center, Massachusetts, June .,25-26, (1992), (Washington, D.C: National Academy Press) S.124-148.

18. Shiber, J. G. and Shatila, T. (1979). Certain metals in three coastal algae from Ras Beirut waters. Hydrobiologia. 63: 105-112.

19. Strezov, A . and Nonova , T.(2003). Monitoring of Fe, Mn, Cu, Pb and Cd levels in two brown macro algae from the Bulgarian Black Sea coast Intern. J. Environ. Anal. Chem., 83, 1045-1054.

20. Ward, T. J. (1987). Temporal variation of metals in the seagrass Posidonia australis and its potential as a sentinel accumulator near a lead smelter. Marine Biology 95, 315-332.

.The Author(s). This open access article is distributed under a CC BY-NC 4.0 license ©