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Araştırma Makalesi / Research Article

RADYOAKTİF ELEMENTLERİN TAYİNİNDE KULLANILABİLECEK TÜRKİYE DENİZLERİNDEKİ BİYOİNDİKATÖR ORGANİZMALAR

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Özet: *Radyoaktivite konsantrasyonlarının belirlenmesi ve izlenmesinde canlı ve cansız çevre örnekleri önemli yer tutmaktadır. Bu nedenle, doğal ve yapay radyonüklüidler sedimentte yoğun olarak çalışılmaktadır.*
Denizel ekosistemde yaşayan biyoindikatör canlılar; çevre kirliliği, doğal ve yapay radyoaktif elementlerin tayini gibi araştırmalarda değerlendirilmektedir. Türkiye denizleri tür çeşitliliği açısından zengindir. Radyoaktivite konsantrasyonlarının belirlenmesi ve izlenmesinde bazı türlerin yoğun olarak kullanıldığı dikkati çekmekte, buna karşın çoğu türün ise henüz çalışılmadığı görülmektedir.
Bu çalışmada, denizlerde yaşayan ve besin zincirinde önemli rol oynayan biyoindikatör organizmalar hakkında bilgi vermek ve bu tip çalışmalarda kullanılan organizmaların sayısının arttırılması amaçlanmıştır.
Anahtar Kelimeler: *biyoindikatör organizmalar, radyoaktivite, radyoaktif element, Türkiye.*

Bioindicator Organisms Available To Use For Determination Of Radioactive Elements In Turkey's Seas

Abstract: *In determination of radioactive concentration and monitoring alive and lifeless environmental samples possess a significant place. Thus, intense study is carried out related to natural and artificial radionuclider sediment.*
Bioindicator living organisms inhabiting in sea ecosystems; are being evaluated in researches such as determinations of environmental pollution, natural and artificial radioactive elements. Turkey's seas are rich related to diversification of various types. In determining and monitoring radioactivity concentration widespread implementation of some sorts appeal attention and on the other hand inadequate usage of many types is observed.
In the present study, providing information about the bioindicator organisms keep living in seas and plays important role in food supply chain and increasing the numbers of the types of organisms used are aimed.
Keywords: *bioindicator organisms, radioactivity, radioactive element, Turkey.*

Introduction

Environmental pollution is one of the most important problems of modern world. It has been expressed that such pollutants as various metals, radioactive materials, petro-chemical hydrocarbons, pesticides, chlorinated hydrocarbons steadily increase in the environment due to several factors such as increase in population and progressively spreading technology and industry (Ünsal, 1994; Samsunlu and Akça, 1999, Vandermeulen, 1998). As the common and ultimate end point of all pollutants is water, pollutants accumulate in aquatic ecosystems. Thus, most pollution occur in aquatic environment. A number of aquatic species are getting extinct as a result of impairment of natural composition of the water. Organisms in the food chain are losing consecutively due to the increased pollution load during this change. Species which are defined as "bio-indicators" indicate the effects of pollutants and ecological factors in a particular environment by increasing or decreasing in number. Thus, biologically indicator organisms are used as primary indication of the environmental changes. It has been stated that biologically indicator organisms have great importance because they directly indicate the water quality (Jenkins, 1979).

Turkey is surrounded by sea on its three sides and is where species diversity is wide. Its complete database hasn't been made although it has a very long coastal line. Work on this subject is still going on. In the view of available data, it is considered that some of the organisms living in the seas and constituting the aquatic biodiversity may be

used as biologically indicator species. Such organisms have great economical interest as well as possess features that may be used in both determining the pollution and ecotoxicological studies. As all over the world, one can readily see that species belonging to macro-algae and mollusks groups are at the top of the list of the organisms chosen as indicator organism in Turkey (Lyngby and Brix, 1987; Cognetti, 1987). Most studies are on *Mytilus* sp. (Labonne et al. 2002; Uysal, 1978). Several studies were carried out in Turkey such as determining gross natural beta-activity in *Artemis salina* (Uysal 1973), using the microbial proteins used in feeding the larvae of marine organisms (Topçuoglu and Ozyurt, 1982), investigating the indicator properties of *Hermione hystrix* using zinc-65 biokinetics (Ünlü, 1982). Studies carried out with marine organisms have increased recently. Although sediment, green algae, brown algae, red algae, red-calcarius algae, *Zostera* sp. and such macro-organisms as *Posidonia oceanica* (elgrass), starfish, amphipod, brittle star, bivalve, clam, polychaete, crab, octopus, sea urchin, and fish have been used in studies on marine radioactivity, their usage in Turkey has been limited (Fukai and Broquet, 1965). The aim of this study is to contribute to previous studies on determining the pollutants and radioactive metals by allowing other important species to be known in Turkey.

Materials and Methods

Various organisms from algae to macro-organisms of the highest complexity which spreads and distributes in Turkish seas, easily obtained from several depths changing from the coastal line to the deep water, durable, cosmopolite, cheap of economical interest and of which biology is well-known have been chosen as study material.

The species chosen as bio-indicator microorganism may be harvested by hand directly as well as from several depths through diving and fishing equipment easily.

Results

The organisms that were detected as a result of the current study to be able to used as biological indicators of various species ranging from the simplest to the highest complexity have a wide distribution in Turkish's seas. The selected organisms are important ones in that they reflect both pelagic and benthic areas. They include macroalgae, Angiospermophyta, Porifera, Cnidaria, Annelida, Arthropoda, Mollusca, Echinodermata and fish groups.

Organisms selected as bio-indicators in the present study are as follows.

In the context of present study, 15 species of Chlorophyta, 17 species of Phaeophyta and 19 species of Rhodophyta were determined. Most of 6000 to 7000 species of Chlorophyta (green algae) live in fresh water. However, it has been found that almost 15% of these species exist in the seas. Their most important marine species are macroscopic benthic species. They are abundant in coastal waters of the subtropical zones. Green algae are usually indicative of pollution. Phaeophyta (brown algae) constitute the most complex and largest sized species of marine algae. They also contain some species of economical interest. Brown algae are usually indicative of clean areas. Rhodophyta (red algae) are remarkable in that they are sensitive species. List of macroalgal groups is as given Table 1.

REGNUM: PLANTAE

DIVISIO: Angiospermae

Angiospermae is a division containing bloomed plants. This division includes a few species that are able to exist partially or completely in sea-water. Although most of these species exist partially in sea-water, only about 50 species live in sea-water completely. Thus, the fact that marine environment contains very few species of bloomed plants makes the main difference between terrestrial and marine biology.

Table 1: List of macroalgal groups

Divisio	Chlorophyta	Phaeophyta	Rhodophyta
SPECIES	*Bryopsis plumosa*	*Asperococcus bullosus*	*Amphiroa rigida*
	Caulerpa prolifera	*Colpomenia sinuosa*	*Bangia* sp.
	Chaetomorpha capillaris	*Cutleria multifida*	*Callithamnion corymbosum*
	Cladophora pellucida	*Cystoseira barbata*	*Ceramium ciliatum*
	Cladophora prolifera	*Cystoseira corniculata*	*Ceramium rubrum*
	Codium bursa	*Cystoseira crinita*	*Corallina elongata*
	Enteromorpha clathrata	*Dictiyota dichotoma*	*Corallina mediterranea*
	E. compressa	*Dictyopteris polypodiodes*	*Gelidium* sp.
	E. linza	*Ectocarpus confervoides*	*Gigartina acicularis*
	E. ramulosa	*Halopteris filicina*	*Gracilaria confervoides*
	E.intestinalis	*Halopteris scoparia*	*Hypnea musciformis*
	Halimeda tuna	*Padina pavonia*	*Jania rubens*
	Ulva fasciata	*Sargassum hornschucchii*	*Laurencia obtusa*
	Ulva lactuca	*Sargassum vulgare*	*Liagora viscida*
	Ulva rigida	*Scytosiphon lomentaria*	*Lithothamnion* sp.
		Spermatochnus paradoxus	*Nemalion helminthoides*
		Sphacellaria scoparia	*Nitophylum punctatum*
			Polysiphonia elongata
			Porphyra leucosticta

Bloomed-plants of the marine environment are of great importance in the biology of coastal waters although they are represented by a low number of species. They have high biological productivity. Thus, they make the energy source of most marine animals as well as they create an important habitat. Samples of these species are *Posidonia oceanica, Zostera* sp.

REGNUM: ANIMALE
PHYLUM: PORIFERA
They are of economical interest despite being a primitive group. Species that may be used as ornaments or bath-sponge may be obtained readily from every depth. Samples of these species are as follows: *Tethya aurantium, Geodias gigas, Suberites domuncula, Axinella verrucosa, Axinella damicornis, Halichondria panicea, Euspongia officinalis.*

PHYLUM: CNIDARIA
They are metazoans with simple radial symmetry which are living free or sessile. For example: *Aurelia aurata*, *Actinia equina.*

PHYLUM: ANNELIDA
CLASSIS: POLYCHAETA
Most of them are long- or round-bodied annelids. Although they are found in almost each depth of all seas, they make the characteristic forms of the littoral zone. For example: *Nereis diversicolor*

PHYLUM: ARTHROPODA
Arthropods which make the richest group of animals are animals with bilateral symetry. Their most characteristic feature is having joints that gives the name of their phylum. They are species of great importance in fishing and raising aquatic products. It is a group of great economical interest. Species belonging to Arthropoda are given in Table 2.

PHYLUM: MOLLUSCA
They make the second richest group of animals. Gastropods are the group of mollusks which is richest in number of species. Bivalves are most frequently used species in determining pollution and radioactive material. Cephalopods constitute the commercial group of mollusks that is of economical importance. Species belonging to Mollusca are given in Table 2.

PHYLUM: ECHINODERMATA
Echinodermata are the species that are most frequently used in toxicological studies. Species in this group are very important in that they are indicative of environmental cleanness and in terms of environment. They may be found in various depths. They are found in all Turkish' seas except for Black Sea including Aegean, Marmara and Mediterranean Seas. Species belonging to Echinodermata are given in Table 2.

SUBPHYLUM: VERTEBRATA
SUPERCLASSIS: PISCES
CLASSIS: CHONDRICHTHYES and OSTEICHTHYES
Taxonomical studies carried out in Black Sea and Marmara Sea indicates that these seas contain a fixed ichtiofaunal structure but this is not true for Aegean and Mediterranean Seas. All coasts on Eastern-Mediterranean and Southern Aegean areas particularly Eastern-Mediterranean coasts (especially the sublittoral zone) have gained a tropical character with invasion of Lesseptian migratory fish species.
It has been found that Turkish fish fauna includes about 500 fish species. It has also been found that 61% of these species is of Atlanto-Mediterranean origin, 18% Mediterranean endemic, 14% cosmopolite and 7% is of Red-Sea origin (Kence et al, 1990). Additionally, the fish species of economical interest which exist in clean and polluted areas and that may be used in studies on determining radioactive elements as well as in other studies were given briefly below (Table 3).

Table 2: List of species of Arthropoda, Mollusca and Echinodermata

PHYLUM	ARTHROPODA	MOLLUSCA	ECHINODERMATA
	Balanus perforatus	*Arca noea*	*Amphiura chijaei*
	Balanus improvisus	*Cardium edule*	*Arbacia lixula*
	Idotea balthica	*Cassidaria echinophora*	*Astropecten aranciacust*
	Idotea metallica	*Cerithium vulgatum*	*Ceramaster placenta*
	Gammarus locusta	*Chiton olivaceus*	*Echinocardium cordatum*
	Panaeus kerathurus	*Chlamys varia*	*Echinus acutus*
	Panaeus japonicus	*Conus mediterraneus*	*Holothuria tubulosa*
	Parapenaeus longirostris	*Donax trunculus*	*Masthasterias glacialis*
	Palaemon serratus	*Ensis ensis*	*Ophioderma longicaudum*
	Palaemon elegans	*Haliotis tuberculata*	*Ophiura texturata*
S	*Crangon crangon*	*Loligo vulgaris*	*Paracentratus lividus*
P	*Palinurus vulgaris*	*Mactra corallina*	*Spatongus purpureus*
E	*Homarus gammarus*	*Modiolus barbata*	*Sphaerechinus granularis*
C	*Pagurus cuanensis*	*Monodonta turbinata*	
I	*Pachygrapsus marmoratus*	*Mytilus galloprovincialis*	
E	*Carcinus mediterraneus*	*Octopus vulgaris*	
S	*Eriphia verrucosa*	*Ostrea edulis*	
	Maia squinado	*Patella coerulae*	
	Squilla mantis	*Pecten jacobaeus*	
	Squilla desmaresti	*Pinna nobilis*	
		Rapana venosa	
		Sepia officinalis	
		Solen marginatus	
		Tapes decussatus	
		Turitella communis	
		Venus verrucosa	

Table 3: List of fish species

	PISCES	
S P E C I E S	*Alosa caspia bulgarica*	*Mullus barbatus*
	Alosa fallax nilotica	*Mustellus mustellus*
	Anguilla anguilla	*Pomatamus salsator*
	Belone belone	*Raja clavata*
	Boops boops	*Raja radula*
	Bothus podas podas	*Salmo trutta labrax*
	Conger conger	*Sarda sarda*
	Dasyatis pastinaca	*Sardina pilchardus*
	Dasyatis violacea	*Scomber japonicus*
	Dicentrarchus labrax	*Scomber scombrus*
	Diplodus annularis	*Scophthalmus rhombus*
	Diplodus vulgaris	*Solea vulgaris vulgaris*
	Engraulis encrasicolus	*Sparus aurata*
	Gobius cobitis	*Squalus acanthias*
	Gobius niger	*Squatina squatina*
	Gobius paganellus	*Thunnus alalunga*
	Hippocampus hippocampus	*Torpedo torpedo*
	Liza ramada	*Trachurus trachurus*
	Lophius piscatorius	*Trigla lucerna*
	Merlangius merlangus	*Trisopterus minutus*
	Mugil cephalus	*Zeus faber*

Conclusion

Currently the bioindicator organisms are used widely. They are very important because they serve as an early-warning system for the pollution. Turkey is rich in indicator macroorganisms. It is important not only for its own region but also the entire world with different marine characterization and organism diversity living in its environments. As a consequence of preliminary study we carried out 15 species of green algae, 17 species of brown algae, 19 species of red algae, 2 species of Angiospermae, 7 species of Porifera, 2 species of Cnidaria, 1 species of Annelida, 20 species of Arthropoda, 26species of Mollusca, 13 species of Echinodermata and 42 species of fish were found in determining radioactive elements (Fig. I). New species will go on to be included in this list as database of Turkey grows.

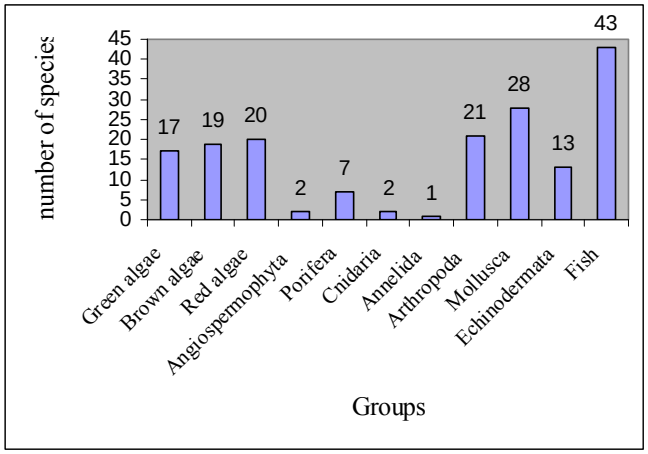

Figure I: Species to use for determination of radyoactive elements.

We consider that our country has very high number of indicator organisms in studying pollution and radioactive metals and that various macroorganisms will be used more frequently in the future studies.

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