BIODIVERSITY ANALYSIS
OF
MARINE DEMERSAL INVERTEBRATE FAUNA
IN
THE PRINCESS ISLANDS REGION

by

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ABSTRACT

A study for the inventory of the diversity of invertebrate species habited in the Princess Islands region, İstanbul was conducted to cover the gap between alike studies conducted all over the top biodiversity centres. The mentioned area is one of the most diverse areas in temperate waters. The biodiversity due to over population has been decreased in the area, and the study was made in comparison with the past study.

Princess Islands region and Bosphorus Strait was studied in detail in 1952 by Muzaffer Demir, which was the starting point for this comperative study in the area after half a century. Between Muzaffer Demir and this study, the only study conducted over invertebrate fauna in the Sea of Marmara was from Bayram Öztürk which is very insufficient.

There are two groups of islands: Habited and inhabited (see Map.3.1 and Map 3.2). The habited islands are 6 km far from the shore and domestic wastes are poured directly to the sea after a initial treatment. The inhabited islands are 12 km far from the shore and comparably have greater biodiversity than the habitat islands coasts which are being polluted both by İstanbul wastes because they are nearer and domestically.

Several dives were done in various sites to observe the species in their habitats. Comparative which-and-where tables of the demersal invertebrate phyla appendix are added with a scale of abundance that will help future studies.

The main concepts as the definitions, value and conservation of biodiversity are also given followed by the key notions of the current trends in conservation biology. Descriptions of the new species and keystone species with their pictures are also added.

KISA ÖZET

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1. INTRODUCTION

1.1 Definition of Biodiversity

Biodiversity refers to "all species of plants, animals, fungi and micro-organisms and the ecological processes or which they are parts" (McNeely *et al.*,1990, p.17). It is also defined as "The variety of organisms considered at all levels, from genetic variants belonging to the same species through arrays of genera, families, and still higher taxonomic levels; including the variety of ecosystems, which comprise both communities of organisms within particular habitats and the physical conditions under which they live" (Wilson, 1992, p. 393).

Accordingly, biodiversity can be analysed on genetic, ecological and species levels. Genetic diversity is the sum of all genetic information included in the genes of organisms. Ecosystem diversity refers to the variety of habitats, relationships among species and foraging. Species diversity is the variety of living organisms on Earth, and the number of species is estimated to be approximately 30 million (Erwin, 1992).

Tropical rain forests are the most biodiverse places in the world. Half of the identified species in the world, are rain forest insects. Temperate climates contain less species but they are found in large populations. Nearly all the animals which are harvested commercially for food, are found in temperate climates.

1.2. The Value of Biodiversity

The values of biological resources can be classified mainly under two groups; direct and indirect values. (McNeely *et al.* 1990)

Direct values are (i) consumptive use values and (ii) productive use values. Indirect values are (iii) non-consumptive use values, (iv) option values and (v) existence values. Consumptive use values are the values that nature's products have, without passing through a market and being consumed directly. Game and various wild animals, plants used by local people, and fire-wood are good example to these kind of products. On the other hand, there are the resources that are considered to be the national income products, such as, animal skins, fur, ivory, honey, fruits, ... etc. Wild genetic resources are used to improve or as new sources of domesticates, wild forage species contribute to livestock and wild species are used as pollinators or pest and rodent control for the crops. As one of the indirect values of natural sources, non-consumptive use values are nature's services rather than the products.

Option values arise from the uncertainty of the future and human being's need for genetic diversity that may be a unique rescue in the future. A medicine may be synthesised some unique plant species. If a gene pool is diminished by the current generation of humans who are maximising their personal benefit, all future generations will suffer (Norton, 1986).

Finally, existence values refer to the fact that all species have the right to exist. The existence of some species, habitats or landscapes must continue for future generations. The last two values are directly related with the values of natural resources. Option values reflect the economic side of biodiversity, while existence values reflect the ethical side. It is hard for an economist to make the cost-benefit analysis of the existence values of biodiversity.

The world is made up of many communities and human being is a part of them. The whole can continue to exist only with the health of its parts. The well-being of one part depends heavily upon the well-being of the other in relation, and if the balance is destroyed, a quick collapse may follow.

1.3. Ecosystems, Populations, Communities: Stability and Equilibrium

Food webs are an important part of ecosystem diversity. In a given ecosystem, all the species are linked to one another by various relationships (Paine, 1966). Species feed on each other and form an equilibrium in the long run.

Ecosystems exist in the state of dynamic equilibrium. When conditions change, it takes some time for the ecosystem to recover or move to another state. Each ecosystem, community or population recovers by its own ways, depending on the surrounding conditions and on its very nature.

There are various types of stabilities. Resilience is the speed with which the system returns to the formal state after the perturbence, while resistance is the power to insist on staying stable despite perturbations. Local stability and global stability are the tendency of the system to return to the original state when subjected to small or large perturbations. Therefore, the stability of the systems depends on the environment in which it exits. This includes the species coexistence, environmental factors, densities of populations and many other factors. If the system is fragile, it cannot withstand changing conditions or habitat alterations, but if it is robust, it is not easily affected by changing conditions (Begon *et al.* 1986).

Ecosystems, populations and communities, have different stability patterns, or in other words, stability varies between different environments. Fragile and complex communities like aquatic ecosystems, are easily hurt by human activities.

1.4. Factors Affecting Biodiversity

Most of the problems of biodiversity decrease, arise from economic reasons and their solutions are again built on economics. Biodiversity is under threat by humans for various reasons. Habitats are fragmented, and some species become extinct because of the enormous increase in human population, and the need for living place and food for the new generations. This increase also is the cause of pollution, habitat destruction, and even climatic changes. Overkill, arising from excessive harvesting and hunting may also cause extinctions when minimum sustainable yield is exceeded. The introduced species caused the extinction of many species in the past.

In the market place, natural resources are not given appropriate prices. Biodiversity turns out to be a public good in the market. Benefits to protect natural habitats are not reflected in the market. Cost-benefit analysis underestimate the net benefits of conservation and overestimate the benefits of exploitation. The exploitator of a natural habitat, never pays its cost, but the cost is shared among the individuals in the society. The current economic planning discount rates tend to encourage the depletion of natural resources. Rather than conserving the rain forest, it is analysed that it will be more beneficial to cut all trees and invest the amount gained by timber.

The natural duration for a species to exist, is estimated as 5 million years for a vertebrate (Raup, 1986). There is a problem when the natural rate of extinction is greater than the actual rate of extinction, and it is generally so, in other words, there ***is*** a problem. The rapid destruction of the top diversity areas in the world leads to the extinction of many species in the last decades.

Countries in the tropics are developing Third World countries, except Australia, and usually their economy depends upon natural sources. So the rapid decrease of biodiversity, which is due to habitat loss, can be explained in terms of economic strategies. Biodiversity turns out to be under threat by governments giving authority to cut the forests, hunt all wild games or fish all the migratory species. If they are not forced by international authorities to preserve, then the case changes.

Most of the natural parks are not big enough for sustaining large mammals or birds of pray, because these animals need more area to dwell, feed and reproduce. To protect a big area and not make any use of its natural resources, is very expensive, and generally, Third World countries in the tropics cannot afford this. In addition, national development objectives give insufficient value to living resources. Interest of local people is usually ignored and they are forced to work for industry. The biological resources are exploited for profit rather than being used to satisfy local people's legitimate needs. Also there is still insufficient knowledge about many ecosystems, despite efforts of scientific research. Science is unable to solve today's management problems in sustenance. Conservation activities are very narrowly planned and there are not enough institutions to do their assigned responsibility for conservation.

1.5. Affected Marine Environments

Coasts of most of the big cities (maybe all), are polluted, and therefore coastal ecosystems near the big cities are particular subjects to changes, and all of them have the problem with biodiversity loss. Generally, if the change is rapid, many species become extinct, and few species succeed to exist and increase in number, so they dominate the ecosystem (Ferrington, 1987).

Tropical rain forests are one of the major centres of biodiversity, the megadiversity areas. An equivalent of tropical rain forests, in terms of biodiversity, are deep seas. Deep seas contain a really unknown number of species. In deep sea explorations, nearly all of the species are recorded for the first time. Also, the ecological diversity in the seas is much more complex than in terrestrial life. The relationships between various animals, feeding habitats and body sizes are more diverse in the seas. The largest animal that lived ever from the beginning of life, is the blue whale. It has a feeding habitat that is not present in land, but is very common in sea: Filter feeding, that is filtering a large amount of water and making use of what is available in it.

Since it is easy for a pollutant to travel and disperse in the sea, the coastal ecosystems are affected with marine pollution. The animals take the water in their bodies to extract the dissolved oxygen, so they are subject to the affects of pollution to a greater degree.

1.6. Biodiversity Conservation

Current trends in conservation ecology are mainly centred around two concepts: Small population paradigm and declining population paradigm.

Small population paradigm (SPP), deals with the effect of the smallness of a population on its persistence. SPP is very well served by theory. Although it is not practised so much. Its theoretical background is strong and highly developed. It deals mainly with risk of extinction inherent in low numbers.

"The dynamics of small populations are governed by the specific fortunes of each individual, while the dynamics of large populations are governed by the law of averages" (Caughley, 1994 p.226). Heterozygotic individuals are fitter for survival, and they can withstand changing conditions of catastrophes. As a result of a genetic drift, the number of different alleles at a locus in the population as a whole will have a tendency to decrease if no immigration and mutation take place, with decreasing genetic variations and diversity, heterozygosity and fitness decrease also. Small populations are homozygotic, so they are more fragile.

Declining population paradigm (DPP) deals with the factors responsible for the decline of species. It needs more theory but it serves well in practise.

DPP recognises the evil quartet which is responsible for the extinction of a species. These are (i) overkill, (ii) chains of extinction, (iii) impact of introduced species and (iv) habitat destruction and fragmentation. If the hunting rate is more than the maximum sustained yield for a species, in other words, if a population is overharvested, and it cannot survive sustainably, then it declines. Animals with low intrinsic growth rates like large mammals such as whale, elephant or rhinoceros are under particular threat. They are mainly hunted for economical reasons either for their meat, fat, or some other purposes.

On some cases, the extinction of one species may affect the extinction of the other. An animal may feed exclusively on another and if the later becomes extinct, and if the former can not change its feeding pattern, then it becomes extinct as well. This is called the chain of extinction.

In an ecosystem the balance among the many species is easily broken with the introduction of a new alien species by humans. Alien species introduction is one of the biggest threats. Since AD 1600, out of 30 reptile species, 22 extinctions were because of the introduced species, in the world (Caughley, 1994).

The last one among the evil quartet, which interests us the most, is habitat destruction and/or fragmentation. Habitats may be destructed by fire regime, grazing mammals like sheep, goat; draining of a wetland, cutting down of a patch of forest, and domestic sewage to the sea. These may cause the extinction of many species in that area, even the total extinction of endemic species or variations. More commonly, before destruction, habitats are fragmented and the species existence is also fragmented.

1.7 Biodiversity in Turkey

Turkey is located just between the continents Asia and Europe. It is the route for many migratory birds. Most commonly, the floristic diversity is important. In Turkey there are approximately 9.000 described plant species while in the all Europe there are 12.000. Also, there are approximately 3.000 endemic plant species in Turkey, while in all Europe, there are 2.750 (Ekim *et al.*, 1994). Also, previous studies recorded 73 species of anphibians and 133 species of reptiles living in Turkey. (Demirsoy, 1996a and Demirsoy, 1996b)

Turkey is also important for birds. There are 14 globally threatened species breeding in Turkey. More than 500 species of birds are identified in the 97 "Important Bird Areas" (IBA) in Turkey (Magnin *et al*. 1997).

Turkish coasts are not studied enough, so we can compare the Mediterranean Sea with the world. Among 5000 described species of porifera in the world, 593 species live in the Mediterranean. Among 9500 cnidarians, 420; among 6500 echinoderms, 143 and among 32.000 molluscs, 1376 species live in the Mediterranean (Mojetta, 1996).

1.8 Purpose of This Study

Throughout the world, the centers for biodiversity are continuously explored. In Turkey, however, only a few inventory studies on invertebrate animals, particularly marine invertebrates were conducted. The most recent study was conducted by Muzaffer Demir through 1940's to 1950. This book (Demir, 1952) describes all invertebrate animals, their abundance and habitats in detail.

This study aims to assess a current position of the marine biodiversity in the Princess Islands region. Using Demir's book as a reference, changes that took place over the period of 50 years will be analysed. Besides covering a gap in the literature, it may be a starting point for this type of biodiversity studies.

There is a common belief, supported by literature that "Life below 10 meters of depth is impossible in the Sea of Marmara" (Dz.Hrp.Ak.Denizcilik Gücü Sempozyumu, 1993-1994, p. 17). Our dives, however, proved just the opposite: Life between 0-10 meters is scarce, compared to deeper regions, which accomodate more species. These kind of widespread common belief and non-scientific arguments must be left aside, and conservation issues put on the agenda, at least before everything is lost.

2. MATERIALS and METHODS

2.1 Diving Equipment

During the dives, standard scuba equipment was used. It included 15-18 litres air tank, B.C. (buoyancy compensator), regulator, and dry suit. Regulator was five hosed: Second stage, extra second stage for emergency (octopus), air finimeter, buoyancy compensator inflator hose, and dry suit inflator hose. Secondary equipment included knife, hatchet, underwater torch, gloves, and adjustable fins.

Photographs of the animals were taken in their habitats, using an underwater camera Nikonos V with 35 mm lens, close-up kit, and substrobe flash.

2.2 The Exploration of the Depths and Dive Planning

The study explored coasts of three islands, Yassıada, Sivriada, Kınalıada and Burgazada, in approximately 100 scuba dives. Most of the dives were made solo. Prior to each dive, careful plan was set regarding the dive depth, its duration and purpose. Because of decompression sickness, deeper dives were considerably shorter.

About 60 per cent of the dives were "multi-depth", during which the diver ascended to 42 metres, with the average speed of 25 meters per minute. He stayed in the terminal depth for one minute, then moved to 39, 36, 33 and 30 meters, staying for 1 minute on each level. In the next step, the diver ascended to 27, 24, 21, 18, 15 and 12 meters staying for 2 minutes on each depth. The rest of the air was spent below 9 meters. Duration of the dive was related to the water temperature and lasted up to 60 minutes. The time spent for decompression on various depths during ascending was used for observing the flora and fauna.

The rest of the dives (40 per cent) were made to examine the abundance of particular species. During these dives, specimens were collected, the underwater habitat observed, and pictures taken.

2.3 Identification of the Species

Prior to the dives, relevant catalogues of the Mediterranean Sea were carefully consulted. After the dives, identification of the animals, which were seen during the dives, was confirmed by examining the literature.

The reference literature consisted of catalogues about Mediterranean and Atlantic area, Europe, and Turkey flora and fauna (Arduino *et al,* 1990, Harris, 1982, Thompson *et al,* 1976, Graham, 1971, Ebreo *et al,* 1992, Mojetta, 1996, Poppe, 1993, Pruvot-Fol, 1954, Sabelli *et al,* 1992, Tenekides, 1981, Vacelet, 1986, Vosmaer, 1933, Schmitt, 1965, Demir, 1952).

Whenever a specimen was identified without doubt, only its abundance was noted, and photograph taken. In case of doubted species, however, a specimen was collected and a careful note about species habitat, abundance, depth of encounter, and behavioural patterns taken. Those notes were used later to make comparative tables. Photographs of all the species taken during the dives, were used later to identify them. After the initial species identification, Mediterranean catalogues were reconsulted and identifications confirmed or altered. The collected species were put in jars with attached notes about their behaviour, habitat and abundance. Specimens were preserved in 10 per cent formeldehyde solution.

Gastropod molluscs were identified by examining the structure of their "radula", the tongue with teeth which is unique in each species. Since there are a lot of studies conducted on mollusca (because of the demand of the shell collectors), their species identification is relatively easy. Also, when a mollusc dies, and if it is a mollusc with a shell (92 per cent have shells), it can still be identified.

Echinoderms were identified by their distinctive body shape, which differs in each species. The Mediterranean echinoderms, sponges and corals, anemones and comb jellies are profoundly listed in the catalogues, because they are important areas of interest among many recreational divers. Some difficulties accompanied the identification of the species which were not calcerous skeletoned or calcerous organnelled species, like some echinodermata, porifera and cnidaria. These species dissolve and burst into pieces after death, handicapping their identification. In some cases, additional dives were required and extra information gathered to ensure the initial identification of species.

2.4 Investigated Habitat

The studied habitat ranged between 0 and 50 meters. The emphasis was on rocky bottoms, where mollusca, cnidaria, porifera and echinodermata species proliferate. Howevere, muddy and sandy bottoms were also observed. Especially, many bivalve molluscs live buried in these kinds of substrata.

2.5 Grouping the Species and Abundance

The species were grouped under five orders according to their abundance:

1. Very very common (VVC): This included the most common species which could be seen everywhere on each dive. These species dominated the islands' marine ecosystem. Only three species could be put in to this category.
2. Very common (VC): The second category included very common species, which could be seen everywhere, but were less abundant than the VCC species.
3. Common (C): Common species category included the species, which could be found commonly in the area, but were not seen on every substratum.
4. Rare (R): Rare category included the species, which could be seen only rarely. Such species were seldom seen more frequently than once in ten dives.
5. Very rare (VR): These species were seen only one, twice or three times during the dives. In some cases, their existence was known from the presence of their shells, skeletons or dead bodies. In other words, the species in this category were represented by up to three specimens.
6. Not recorded (N): This category contains the species which were mentioned by Demir (1952), but which were not encountered during the dives.

2.6 Bases for Estimation of Changes in Marine Biodiversity, That Took Place in the Last 50 Years

Throughout the 1940's to 1950, Muzaffer Demir carried out a study about the marine invertebrate animals in the Bosphorus and the Princess Islands. He picked up bottom material and by comparing with various books and catalogues, he identified the invertebrate species that were found in the area. In his book, the detailed descriptions of the species and their pictures were given. However, especially on mollusca species names, there are synonyms. For this reason, all the catalogues were studied comperably for each species in our study. Widely accepted among marine biology, Bedulli (1987) was used to find out the synonymous names for the species.

In this study, four phyla were selected for both comparing with Demir (1952) and the ease of their observation: Porifera (sponges), Cnidaria (corals, anemones and hydras), Echinodermata (sea stars, sea urchins, brittle stars, crinoids, sea cucumbers), and Mollusca (snails, mussels, clams, oysters, octopi and squids).

3. RESULTS

3.1 The Princess Islands Region

The Princess Islands are located 6 km SSW from the Asian coast of İstanbul. There are 5 inhabited islands, namely, Büyükada, Sedef Adası, Heybeliada, Burgazada and Kınalıada. Just 6 km S from these islands, there are two small islands, Yassıada and Sivriada, which are not inhabited. The coordinates of the islands are between latitudes, $40^0 50'$ E and $40^0 55'$ E, and longitudes, $28^0 55$ N and $29^0 10'$ N.

There are 3 water layers in the coasts of Princess Islands. Their depths seasonally change. These are; (i) 0-20 meters, a polluted layer with particles in suspension, which is subject to external factors like temperature and surface currents resulting from winds of various directions. There is great seasonal temperature change, enormous levels of eutrophication, and the effect of domestic waste water discharges made from point sources; (ii) 20-30 meters, colder (up to 10^0C change), and clearer layer, (iii) 30- meters, a layer consisted of clean Mediterranean water, but nearly totally dark because of the suspended particles in the first layer. The ecosystem in the second and third layers are much more alike with a greater biodiversity than the former.

3.1.1 Inhabited Islands

Büyükada, Heybeliada, Burgazada and Kınalıada have been inhabited since Ottoman times. The population of the islands did not change too much, despite the enormous population growth in İstanbul. (See Tables 3.1 and 3.2 and Map 3.1)

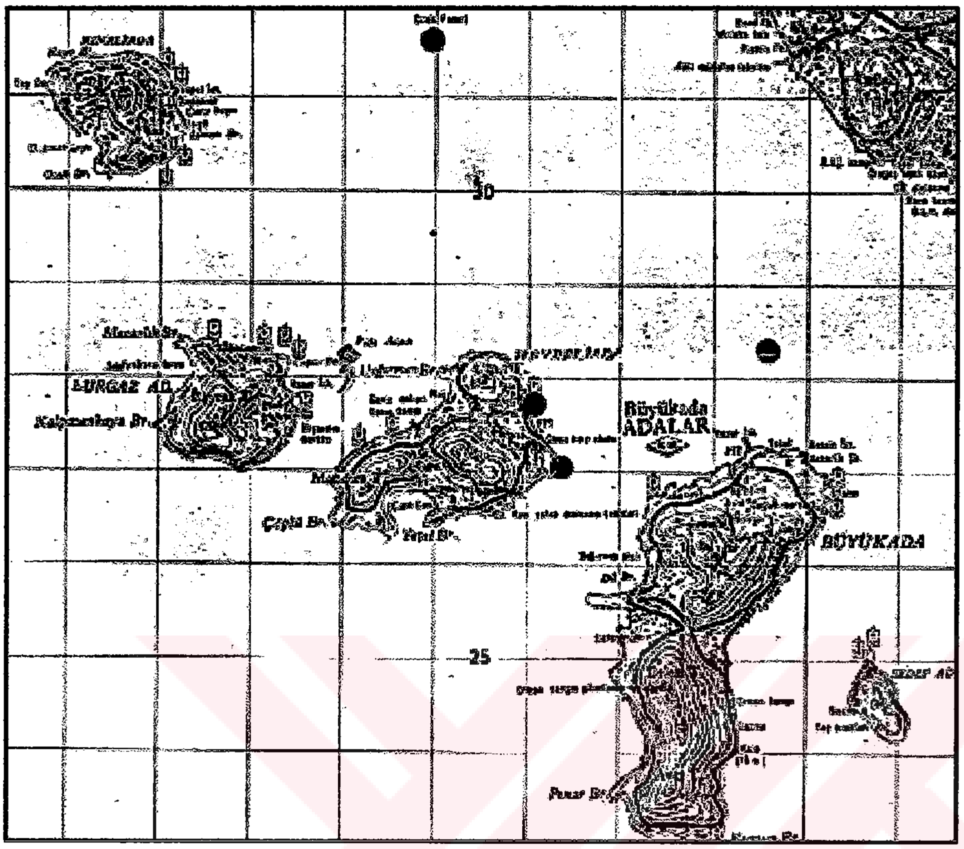
Table 3.1 Population in the Princess Islands
(Source: T. C. Başbakanlık Devlet İstatistik Enstitüsü Başkanlığı)

Year	Population	Male	Female
1950	15.405		
1955	16.564	9.517	7.047
1960	19.834	12.109	7.725
1965	15.219	9.084	6.135
1970	17.600	10.841	6.795
1975	13.171	7.213	5.968
1980	18.232		
1985	14.785		
1990	19.413	10.740	8.673

Table 3.2 Population in İstanbul
(Source: T. C. Başbakanlık Devlet İstatistik Enstitüsü Başkanlığı)

Year	Population
1927	806.863
1935	883.599
1940	991.237
1945	1.078.399
1950	1.166.477
1955	1.533.822
1960	1.882.092
1965	2.293.823
1970	3.019.032
1975	3.904.588
1980	4.741.890
1985	5.842.985
1990	7.309.190
1997	9.198.809

The domestic sewage of these islands is discharged directly to the sea after primary treatment. This group of islands are located parallel to the Asian coast of İstanbul with a distance of 6 kilometres, so they are affected from the domestic and industrial waste water discharges from the main land.

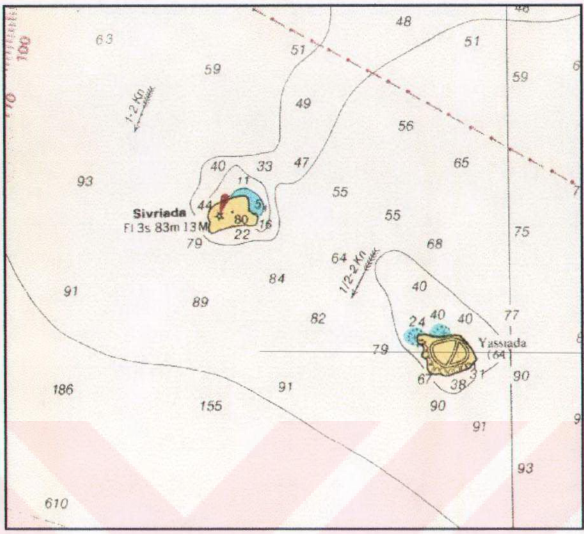


Map 3.1 The Princess Islands region (Source: Kandilli Observatory)

3.1.2 The Desolate Islands

Yassıada which was once used as a penal settlement for political prisoners, then as a campus for İstanbul Üniversitesi Su Ürünleri Fakültesi, is now abondoned for the last 5 years. Sivriada is completely desolate except for a little dock with a small number of boats (See Map 3.2). The islands are 12 km from the main land and 6 km from the inhabited islands.

The inhabited islands and the desolate islands were different in their underwater physical appearances. The inhibited islands were sandy and muddy because of the lack of flora. The soil was swept to the sea, producing a muddy habitat, which covered the rocky substratum and which prevented the demersal fauna to establish itself.



Map 3.2 Sivriada and Yassıada, scale, 1:40.000 (Source: Türkiye, Seyir, Hidrografi ve Oşinografi Başkanlığı)

3.2 The Princess Islands Demersal Invertebrate Fauna

In the first 20 metres, the most common marine organisms are sea stars, *Martasterias glacilis* and *Asterias rubens,* and mussel, *Mythilus edulis.* Other than these 3 invertebrates, *Lima hians*, filter feeder bivalve; *Balanus crenatus*, filter feeder barnacle; *Gibbula adansoni*, *Rissoa parva, Bittium reticulatum*, small (6mm.) gastropods; *Cerithium vulgatum*, *Nassarius reticulata*, hard shelled omnivore gastropods; *Caryophyllia smitthii*, calcareous skeletoned solitary coral; *Actinia equina*, non-skeletoned big (50mm. in diameter), solitary coral in the supralittoral to 3m. are the most common demersal invertebrate animals.

As it is stated before, the two layers are totally different in both biodiversity, and physical conditions. The surface layer, which is down to 15-20 meters (seasonally changing), is poor in biodiversity and the dominating species shall be described here:

3.2.1 Species Dominating the Marine Ecosystem (VVC Species)

As described before, the surface layer is more open to outside alterations like pollution, or physical changes. We can see three species dominating the ecosystem.

3.2.1.1 *Mythilus edulis*

Description: This mollusc is from the bivalves class; it lives between two calcium carbonate shells which is secreted by the mantle of the animal. The shells are brown to black in juveniles and blue-black in adults with many vermetus species, barnacles and algae, attached. The animal's flesh is coloured from light yellow to orange.

Dimension: The animal is a veliger (free-swimming pelagic larvae) in its first months of life and not more than 1 mm in size. The adult animal can grow up to 100-120 mm and after reaching a certain length, it grows through increased width.

Figure 3.1 ***Mythilus edulis*** **together with** ***Asterias rubens,*** **Sivriada, 9 meters.**

Habitat: *M. edulis* live attached to rocks or strong plants by means of bysus, which is the moustache like organnel which helps the animal to stabilise itself and live with clusters of the same species together for its whole life. The animal feeds by filter feeding, so it generally lives where there is current, so that lots of nutrients can pass through it. It can withstand severely polluted areas. (Ferrington, 1987)

Distribution: *M. edulis* is the most common marine organism of the temperate waters, covering all the rocks with billions of individuals. Its habitat ranges from the surface up to 20-30 meters. It can withstand supralittoral conditions when there is low tide, by storing water and enclosing it by means of the addictor mussel which is used to close the valves. It has many variations within the same species.

3.2.1.2 *Marthasterias glacilis*

Description: *M. glacilis* can differ in colour, from grey, through green to yellow, red or the most common, dark brown. It feeds on other sea stars, crustaceans and molluscs, mainly *Mythilus edulis*. It has strong spines and they are placed zigzag on the dorsal. Supramarginal spines can be bigger than the carinal ones.

Dimension: *M. glacilis* is one of the biggest sea stars of Mediterranean and The Sea of Marmara. It can grow up to 500 mm. in diameter and width of an arm can be 20 mm.

Figure 3.2 Clusters of *Marthasterias glacilis* in Sivriada, 7 metres

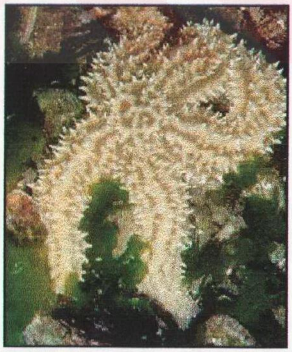


Figure 3.3 *Marthasterias glacilis*, feeding on mussels, Kınalıada, 9 metres

Habitat: Although generally, it is seen on rock bottoms, it can also be found on mud, sand or coarse bottoms. It is the top predator of the ecosystem in the Princess Islands region.

Distribution: *M. glacilis* is common on all Turkish coasts. Its habitat ranges from surface to 200 metres depth.

3.2.1.3 *Asterias rubens*

Description: *A. rubens* is coloured from dirty white to pale pink, sometimes with pale blue spots. Its spines are soft and up to 2 mm. in length.

Dimension: It can grow up to 200 mm. and the arms can be up to 25 mm. in width.

Habitat: *A. rubens* occurs on every kind of substratum from mud to rock or sand. It lives in habitats of temperature up to 20^0C. It feeds on molluscs, mainly on *Mythilus edulis* like *Martasterias glacilis.*

Distribution: It is the "common sea star" of British and North Atlantic coasts. It lives from surface to 30 meters. This species was not recorded previously in the region by Demir (1952).

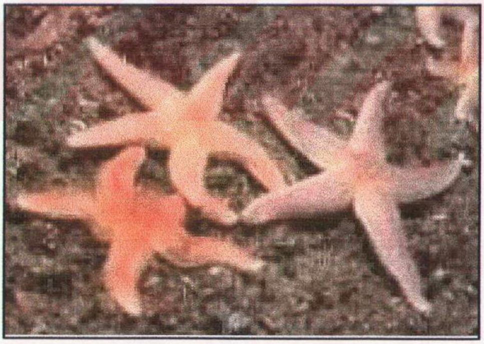


Figure 3.4 Three specimens of *Asterias rubens* on a rocky substratum in Yassıada, 5 metres depth

3.2.2 Very Common Species (VC)

Some species were very commonly encountered during the dives. Among 23 cnidarians, 3 of them were common. In the phylum echinodermata, 6 were very common among 27. Mollusca have 14 very common species among 118 and there were no very common poriferan species (See Table 3.3).

3.2.3 Common Species (C)

Common cnidarian species were 7 among 23. Echinodermata pyhlum had 12 among 27. There were 13 common species among 118 molluscs, and no common poriferans were noted (See Table 3.3).

3.2.4 Rare Species (R)

In the Rare (R) category, 4 cnidarians were present. 8 echinoderms, 18 molluscs and 3 poriferans were rarely noted (See Table3.3).

3.2.5 Very Rare Species (VR)

This category, in which extremely rare species, which were represented by up to 3 specimens, included 3 cnidarians and 3 molluscs. No very rare echinoderm or porifeans could be found (See Table 3.3).

Table 3.3 Number of VC, C, R and VR species in the 4 phyla

Abundance	Phyla Cnidaria	Echinodermata	Mollusca	Porifera
VC	3/23	6/27	14/118	0/12
C	7/23	12/27	13/118	0/12
R	14/23	8/27	18/118	3/12
VR	3/23	0/27	3/118	0/12

3.2.6 New Recorded Species (N)

These are some newly recorded species which were not reported in Muzaffer Demir's book. They may be not reported due to their low abundance or non existence in those days, or they could not be picked up by their materials and methods. The paranthesis near the names of the species indicates the abundance of the animals now.

3.2.6.1 *Asterias rubens* (VVC)

This species was formerly described. It was not recorded before, and now it is extremely common around Princess Islands.

Figure 3.5 *Asterias rubens*, Yassıada, 5 metres

3.2.6.2 *Paramuricea clavata* (C below 20 m)

Description: This cnidarian is a gorgonian which varies from dark red to purple in colour. It has huge fans made up of dense, irregular ramifications, often merged into each other. The branches are thin and flexible. The presence of defensive spincules give them their rough surface.

Dimension: The colony can grow to 1000 mm in diameter. However, it is generally 400 to 800 mm in diameter.

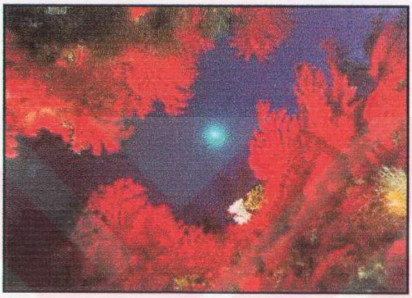


Figure 3.6 *Paramuricea clavata* is the only Mediterranea species which can rival the tropical species in size

Habitat: *P. clavata* grows on rocky bottoms, attached to rocks.

Distribution: It lives below depths of 25 metres. It is widely spread in the Mediterranean.

Figure 3.7 *Paramuricea clavata* together with a sea urchin, Yassıada, 25 metres

3.2.6.3 *Parazoanthus axinellae* (R below 20m)

Description: This is a colonial cnidarian, consisting of elongated, brilliantly yellow coloured polyps. Polyps are 24-36 tentacled in two cycles. They start from a common encrusting base on rock. Colonies can cover broad surfaces.

Dimension: The colony can grow to variable sizes in height and width. Polyps can reach to 20 mm.

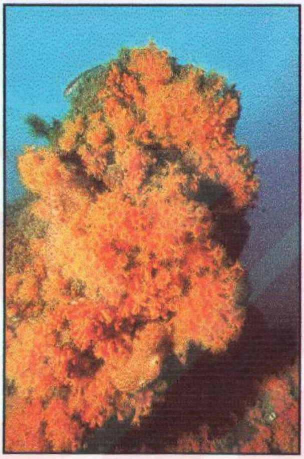


Figure 3.8 Encrusting on the rocks, sometimes *Parazoanthus axinellae* can cover broad surfaces

Figure 3.9 *P. axinellae*, Sivriada, 28 metres

Habitat: *P. axinellae* can be found on every kind of substrata, but the colony encrusts itself on rocks, sea squirts, sponges, shell substrata and frequently on the skeleton of large sea fans.

Distribution: It lives in the shallow supralittoral and offshore up to 100 meters of depth. It is found in the coastal regions of South West Britain extending to Spain and commonly in the Mediterranean.

3.2.6.4 *Cereus pedunculatus* (C in 0-20m, R below 20m)

Description: It is a tall and trumpet shaped solitary cnidarian, with a broad and patterned oral disc, with 500 - 1000 short, brightly patterned tentacles. The column has cinclides at the top. It has numerous pale suckers, often with adhering debris. It is commonly called "daisy anemone".

Dimension: It can grow up to 120 mm in the diameter of the oral disc and the column can reach to 250 mm in height.

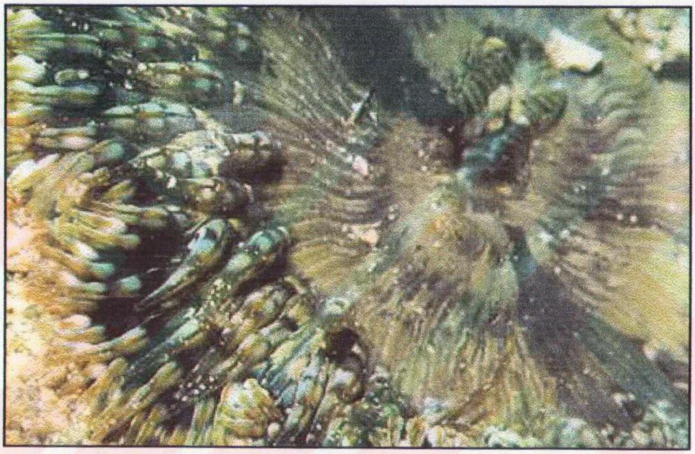


Figure 3.10 Closer view to the oral disc, mouth and short polyps of *Cereus pedunculatus*

Habitat: *C. pedunculatus* is usually encrusted deep with crevices in pools, also on sandy coasts, attached to a stone deeply buried with disc expanded at the surface of the sand.

Distribution: It is found from the middle shore to shallow supralittoral on rocky coasts. It lives in the South and West coasts of Britain and Ireland and it is present in the Mediterranean.

3.2.6.5 Cnidarian species (VR)

Description: This is a colony forming cnidarian that is found on dead parts of corals. It has 24-36 polyps and has no skeleton. It is transparent. The polyps are tied to each other in the colony. Its parasyticism is suspectable.

Dimension: The polyps can grow to 20 mm in height.

Figure 3.11 Cnidarian species, Yassıada, 31 metres

Habitat: The only specimen was found in 31 metres.

Distribution: Since this species could not be exactly identified, its distribution is not clearly known. The only specimen was found in Yassıada.

3.2.6.6 Cnidarian species (VR)

Description: This is another colony forming cnidarian that is found on dead cnidarian skeletons. 24-36 polyps in two rows situated on the outermost circle of the oral disc, and shorter polyps extended to mouth. It lacks a skeleton. It is transparent. The polyps are tied to each other in the colony.

Dimension: The polyps of the only found species were 15 mm in height.

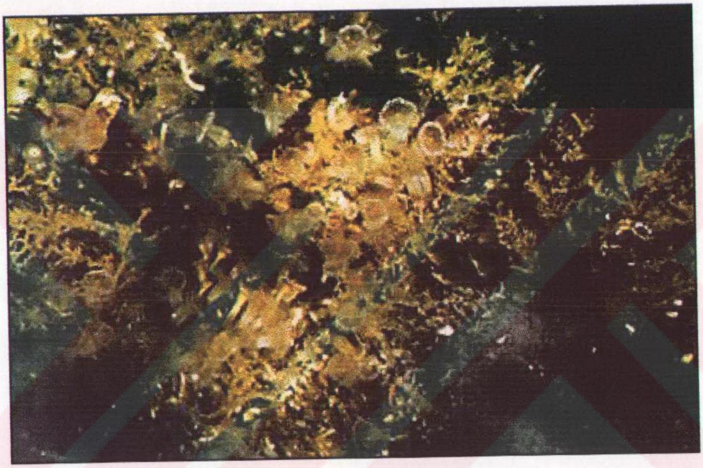


Figure 3.12 Cnidarian species, Sivriada, 29 metres

Habitat: The only specimen was found in 29 metres.

Distribution: The only specimen was found in Yassıada.

3.2.6.7 *Stichopus regalis* (C)

Description: This is a distinctive sea cucumber, slightly flattened, with obvious dorsal and ventral surfaces. The dorsal surface is covered with rows of large papillae, and long pointed papillae from a frilly skirt around the edges of the animal. The ventrally situated mouth is encircled by a rosette of small papillae. The deposits (tables), are flat. It has perforated discs each with a central spiny pillar.

Dimension: It may reach to 300 mm in length.

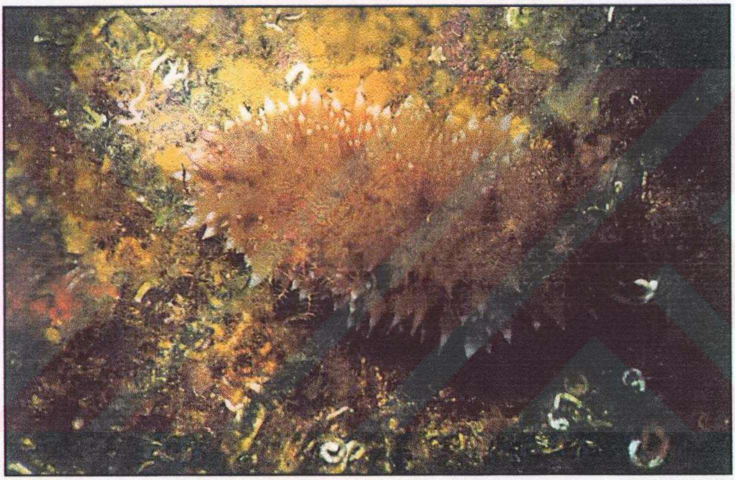


Figure 3.13 *Stichopus regalis*, Yassıada, 13 metres

Habitat: It lives on sandy or muddy bottom, feeding on every kind of organic matter.

Distribution: *S. regalis* is found in the Mediterranean, Biscay and Canary Isles, from shallow sublittoral to 30 metres.

3.2.6.8 Sea cucumber species (R)

Description: This sea cucumber resembles the common Mediterranean species *Holothuria tubulasa,* but the papillae are shorter. It is dark brown with yellow spots.

Dimension: It can grow to 250-300 mm in length.

Figure 3.14 Sea cucumber species, Sivriada, 28 metres

Habitat: It is found on rocky bottoms or on mussel covered substratum, in depths of 20-30 metres.

Distribution: It is found rarely in Yassıada and Sivriada.

3.2.6.9 *Atrina fragilis* (R)

Description: This large bivalve mollusc is light coloured. It is smooth on its shells, but generally it has 5 to 10 delicate ribs. Sometimes it is covered with a sculpture of small scales. It is the smallest of the European fan mussels.

Dimension: *A. fragilis* can grow to 120 to 250 mm but the width varies. Exceptional specimens can be up to 400 mm.

Figure 3.15 Two *Atrina fragilis* specimens with notable variety in width

Habitat: It lives on mixed muddy bottoms, where it can stabilise itself half buried.

Distribution: *A. fragilis* lives from the Northern Coast of British Isles to Spain into Mediterranean. It lives from 25 m to 600 m depth.

Figure 3.16 *Atrina fragilis,* Yassıada, 32 metres

3.2.7 The four phyla and comparative abundance

Four phyla were selected to estimate changes in biodiversity that took place in the last 50 years. The selection based on the easiness of observation, availability of catalogues, and the animals' existence in the divable areas. It has to be noted that all the keystone species and families are included in these phyla so this study could reflect the demersal biological diversity.

Comparison tables were prepared separately for various taxonomic levels. The first column includes the name of the species, the second refers to the abundance estimated by Demir (1952), the third shows the abundance of species observed during the dives between 0 to 20 metres of depth and the fourth shows the abundance between 20 and 40 metres. Because names of many animals have been changed through the 50 years, whenever possible, the names used by Demir (1952) are consequently employed.

3.2.7.1 Cnidaria

This is the phylum of corals, anemones, gorgons and hydra colonies. They have a gastrovascular cavity in which digestion and circulation occurs. Anus and mouth are the same openings. They have radial symmetry. They are formed of one gelatine substance between two layers of epiderms. They reproduce both sexually and asexually. Nearly all have poisonous cells named as knidosites. They are excusively aquatic and most of them are marine. About 9.000 species were described all over the world. 41 species were described by Demir (1952). Only 23 bigger bodied species were compared in this study, because of the difficulty in observing the others which are too small (See Table 3.4).

Table 3.4 Species abundance in comparison, anemons, corals, phylum Cnidaria

Species	1950's	0-20m	20-40m
Lucernaria campanulata	VR	N	N
Aurelia aurita	VC	VC	N
Clavularia crassa	VC	N	N
Alcyonium palmatum	VC	N	C
Muricea placomus	VC	N	C
Muricea macrospina	VR	N	N
Gorgonia verrucosa	VR	N	C
Rhipidigorgonia flabellum	VR	N	N
Pennatula phosphorea	VC	N	N
Pteroides griseum	VR	N	N
Veretillium cynomorium	VC	N	VR
Cophobelemnon leuckartii	VC	N	N
Cerianthus solitarius	C	R	R
Sagartia ?	VC	N	N
Actinia equina	VC	VC	N
Anthea cereus	VC	VC	N
Caryophylia clavus	VC	C	C
Paracyathus pulchellus	C	R	C
Paramuricea clavata	N	N	C
Cnidarian species	N	N	VR
Cnidarian species	N	N	VR
Parazoanthus axinellae	N	N	R
Cereus pedunculatus	N	C	R

3.2.7.2 Echinodermata

Echinodermata is a large phylum with 6.000 described species all over the world. Since they dominated the seas in the past, over 20.000 fossil records are present. They have tube feet, which helps them to hold any kind of substrata and the prey. The phylum is exclusively marine. It consists of sea stars, brittle stars, crinoids, sea urchins, heart urchins and sea cucumbers. They have radial symmetry. Their body is formed of 5 identical parts. But this is a little bit expended to one side in sea cucumbers and heart urchins. 27 species of echinoderms were recorded by Muzaffer Demir in 1952 (See Table 3.5).

Table 3.5 Species abundance in comparison, phylum Echinodermata

Species	1950's	0-20m	20-40m
Antedon rosacea	VC	R	VC
Hacellia attenuata	R	N	N
Pentagonaster placenta	VR	N	N
Astropecten spinulosus	R	C	R
Astropeceten bispinulosus	R	C	R
Astropecten squamatus	R	C	R
Luidia ciliaris	VR	N	N
Asterina gibbosa	VC	VC	C
Echinaster sepositus	C	N	N
Marthasterias glacylis	VC	VVC	VC
Ophiomyxa pentagona	C	N	R
Ophiura lacertosa	VC	N	N
Ophiura albida	C	N	N
Amphiura squamata	VC	N	N
Ophiothriz fragilis	VC	VC	C
Stylocidaris affinis	VR	N	N
Centrosephamus longispinus	VR	N	N
Echinus acutus	VC	N	N
Echinus melo	C	C	R
Sphaerechinus granularis	VC	N	N
Strongylocentrotus lividus	VC	C	C
Echinocyamus pusillus	VR	R	R
Schizaster canaliferus	C	C	C
Brissopsis lyrifera	R	C	C
Cucumaria planica	R	N	VC
Holothuria tubulosa	VC	VC	C
Leptosynapta inhaerens	VR	N	N
Asterias rubens	N	VVC	C
Sea cucumber species	N	R	R
Stiphogus regalis	N	C	C

3.2.7.3 Mollusca

This is one of the largest phyla in number of species. All over the world, it has 50.000 described species, and with the fossil records it extends to 100.000. They are generally aquatic and the ones which are terrestrial live by means of capturing water inside their shells. Muzaffer Demir recorded 118 species. (See Tables 3.6, 3.7, 3.8, 3.9 and 3.10)

Table 3.6 Species abundance in comparison, order Archeogastropoda, phylum Mollusca

Species	1950's	0-20m	20-40m
Acanthochiton discrepans	C	N	N
Acanthochiton fascicularis	C	N	N
Chiton olivaceaus	R	C	C
Chiton marginatus	C	N	N
Fissurella mediterranea	VR	N	N
Fissurella graeca	VR	N	N
Fissurella gibberula	VC	R	N
Emarginula conica	R	N	N
Emarginula cancellata	R	N	N
Calypteraea chinensis	VC	VC	VC
Crepidula unguiformis	C	C	C
Capulus hungaricus	C	N	N
Acmeaea unicolor	R	N	N
Patella caerula	VC	R	N
Vermetus triqueter	VC	N	N
Monodonta turbinata	VC	VC	N
Gibbula maga	C	N	N
Gibbula divaricata	VC	C	N
Calliostoma granulatus	C	N	N
Astralium rugosum	VC	N	N
Phasianella speciosa	VC	N	N
Truncatella truncatula	VC	N	N
Turritella communis	R	N	N
Litorina neritoides	C	VC	N

Table 3.9 Species abundance in comparison, classis Bivalvia, phylum Mollusca

Species	1950's	0-20m	20-40m
Teredo navalis	VC	N	N
Pholas dactylus	VC	N	N
Gastrochaena dubia	C	N	N
Pinna nobilis	C	N	R
Atrina fragilis	N	R	R
Solen ensis	VC	N	N
Solen vagina	C	C	N
Saxicava rugosa	C	N	N
Saxicava arctica	C	N	N
Corbula gibba	VC	N	C
Mactra subtruncata	C	N	N
Ostrea edulis	VC	VC	R
Anomia ephippium	VC	N	N
Pecten jacobeus	VR	N	R
Pecten glober	VC	N	N
Pecten varius	VC	R	R
Lima squamosa	R	R	R
Lima hians	VC	VC	R
Avicula hirundo	VC	N	N
Modiolaria marmorata	VC	N	N
Mythilus edulis	VC	VVC	VC
Lithodomus lithophagus	C	N	N
Chama gryphoides	VC	N	N
Arca lactea	VC	N	N
Arca diluvii	VC	N	N
Arca noe	R	N	N
Pectunculus glycymeris	VC	R	N
Leda fragilis	C	N	N
Leda pella	VC	N	N
Nucula nitida	C	N	N
Nucula sulcata	C	N	N
Nucula nucleus	C	N	N
Cardium edule	VC	R	N
Cardium mucranatum	C	N	N
Cardium paucicostatum	C	N	N
Lucina reticulata	R	N	N
Lucina spinifera	VC	N	N
Lucina leucoma	VC	N	N
Isocardia cor	R	N	N
Venerupio irus	VC	N	N
Gouldia minima	C	N	N
Cytherea rudis	C	N	N
Dosinia lupinus	C	C	R
Dosinia exoleta	C	C	R

Table 3.9 (continued) Species abundance in comparison, classis Bivalvia, phylum Mollusca

Species	1950's	0-20m	20-40m
Venus fasciata	C	C	N
Venus gallina	VC	VC	N
Venus ovata	C	N	N
Venus verrucosa	C	VC	VR
Tapes decussatus	VC	VC	VR
Tapes aureus	VC	N	N
Petricola lithopaga	C	N	N
Donax trunculus	VC	VC	C
Psammobia ferroensis	VC	R	N
Tellina exigus	VC	N	N
Tellinus donacina	VC	R	N
Capsa fragilis	C	C	N
Neaera cuspidata	R	N	N
Syndesmya alba	VC	N	N

Table 3.10 Species abundance in comparison, classis Cephalopoda, phylum Mollusca

Species	1950's	0-20m	20-40m
Elodone moschata	VC	N	N
Octopus vulgaris	C	N	N
Sephia officinalis	C	N	N
Sephiola Rondalettii	R	N	N
Loligo vulgaris	C	N	N
Ommatostarephes seittataus	VR	N	N

3.2.7.4 Porifera

Porifera is the most simple animal in the kingdom, animalia. They can be considered as unicellular organisms living together by sharing a body and making a division of labour. They have pores through which water flows (by the help of ciliated cells) bringing oxygen and food. There are 5.000 described species all over the world, and Demir (1952) described 12 species (See Table 3.11).

Table 3.11 Species abundance in comparison, phylum Porifera

Species	1950's	0-20m	20-40m
Leucosolenia variabilis	C	N	N
Sycandra raphanus	VC	N	N
Tethya lyncurium	C	R	N
Gellinus ?	VC	N	N
Prusuberites epiphytum	C	N	N
Suberites domuncula	R	R	N
Suberites carnosus	C	R	N
Haliochondria panicea	VC	N	N
Haliclona limbata	VC	N	N
Haliclona montagui	C	N	N
Geodia barreti	VR	N	N
Stellata ?	VR	N	N

4. DISCUSSION

4.1 Differences in Materials and Methods in This Study

Demir's book was written in 1952 when diving was serving military purposes and was not common. Muzaffer Demir used different materials and methods to collect samples. Although he explored mainly the sand and mud bottom areas, because he used trawls and could only pick up specimens from the rock by means of buttlocks, it can be stated that his book reflects the demersal biodiversity of the region. They could collect substrata randomly, and were unsuccessful to pick up the species living among rocks, cavities and the species which grow inside rocks or living strongly tied to the bottom. But on the dives of this study, everywhere could be looked at, especially among rocks or stone bottoms. Sand and mud dwelling species could be explored up to 5 centimetres of depth in mud and sand.

4.2 Comparison Between Inhibited Islands and Desolate Islands

There was a great difference in biodiversity between the islands. The inhabited islands were rich in bivalve molluscs and some mud dwelling organisms, while the islands which are not inhabited, namely, Yassıada and Sivriada were rich in all taxa.

4.2.1 Bottom Structure

The bottom structures of the two groups of islands are directly affected by the physical appearances of the islands. The inhabited islands are rich in number of trees as compared to the whole of İstanbul, but there is human residence. Because of the existence of houses, the original floral structure is destroyed by human impact. On the other hand, Sivriada is totally rocky, almost made up of rocks, and now, there is a big stone quarry. Throughout years, even the shape of the island has been changed, because large amounts of rocks were removed from the island for building purposes in İstanbul. Yassıada is very rich in flora. Some parts are even impenetrable because of plants. There are many trees as well as Mediterranean maquis, scrub, bushes and small plants.

We can expect soil erosion near the inhabited islands, which might have destroyed the underwater habitat, especially rocky bottoms. Yassıada remains its original bottom and Sivriada is unaffected from land erosion.

As expected, this was the situation that was observed during the dives. The inhabited islands have a muddy bottom structure which restricts the growth of demersal invertebrate organisms, like corals, feather stars, some sea stars and many gastropods. Thus, soil erosion near the inhabited islands may be one of the parameters which is responsible for local extinctions.

4.2.2 Human Impact

Human impact on the inhabited islands was another cause of the difference in biodiversity. During the dives, visionary pollution was observed on the coasts of inhabited islands. There were enormous amounts of plastic bags, other packaging materials, cigarette packages and butts. Also, the domestic wastewaters of these islands were being directly discharged into the sea.

Kınalıada has one of the biggest main domestic sewage pipes in İstanbul. The biodiversity near the exhaust was destroyed by proliferating mussels (*Mythilus edulis*) and the predator sea stars feeding on them (*Marthasterias glacilis* and *Asterias rubens*). The pipe discharges nutrient rich water, and the mussels filter feeding on these waters, grow very quickly in number. Every year, the mouth of the discharge is cleaned by commercial divers, because mussels make it plugged.

4.3 Demersal Invertebrate Fauna

In the last 50 years, conditions changed in the region. Because of the pollution resulting from human population, the amount of nutrient rich domestic sewage increased. This affected the ecosystem starting from the overgrowth of the filter feeder *M. edulis* population. *M. Glacylis*, which used to feed mainly on *A. rubens* changed its diet together with *A. rubens* to *M. edulis* and grew in number and dominated the ecosystem as the top predators. The other bivalves, which are said to be very common in Muzaffer Demir's book in 1952, went extinct affected by pollution, destruction of most of the feeding habitats and increasing number of predators. The changing conditions forced the animals either to become extinct or to increase in number but both had the same result: Biodiversity decrease. Bigger-bodied animals like *Astrea rugosa*, went extinct (at least, has not been seen during at least 100 dives, but normally seen on rocks (same habitat with the top predators). It was categorised as very common in Demir, 1952. Same sort of animals with the body size-shell defence ratio, but having different habitats like mud or sand, continued to live like *Cerithium vulgatum* and *Nassarius reticulata*. They are still very common as reported before (Demir, 1952).

Tiny animals like *Ophiura ophiura*, a brittle sea star; *Croneplex rhomboides*, a tiny crab; *Callianassa tyrrhera*, the burrowing prawn, could have somehow survived against (i) changing water qualities, and (ii) predators, by their easily-escaping capabilities using speed, or different patterns of defence mechanisms such as burrowing, back-jet-swimming and acquiring tasteless or poisonous flesh.

4.3.1 Ecosystem Domination and Very Very Common Species

Throughout the world, *Mythilus* species dominate the severely polluted areas near the big cities (Ferrington, 1987). These species have a strong tendency to adapt to different conditions. In these areas, the predator(s) feeding upon mussels increase. For example, in the Bosphorus and the Black Sea, mussel (*Mythilus edulis*) is the most common animal. *Rapana thomasiana* which is also very common now, is a large (shell diameter up to 150 mm) gastropod mollusc of Japanese origin. It is assumed that this animal might have been carried in ballast waters of commercial ships cruising between Japan and the Black Sea. Another possibility is that these animals have strong foot muscles, by means of which they can stabilise themselves on hard surfaces like underwater parts of ships. Additionally, the eggs of this animal which stabilise themselves strongly by means of adhesive glands, might have been carried on the hulls of ships. This was first recorded in Novorossisk Bay in 1946 (Drapkin, 1953). In 1970's it penetrated to the Sea Of Marmara (Zaitsev, 1997). Now, it is found everywhere in the Black Sea and Bosphorus, and in another study (Yokeş, 1996), *Rapana* was recorded in Bozcaada, North Aegean Sea.

However, *Rapana* had arrived to the Black Sea, and it came across with the enormous mussel population. It also increased in number and dominated the ecosystem as the predator feeding upon mussels. *Rapana* is now an importation good for Turkey, being collected by divers and trawlers on the costs of the Black Sea.

This kind of introduced alien species, or the increasing number of some species, results in biodiversity decrease. In the Princess Islands region, this is also the case. The consequences of human population increase, lead to the pollution of the seas. Some species like *Mythilus edulis* increased in abundance by filter feeding the nutrient rich water, and the ecosystem was destructed resulting with the domination of some species

4.3.2 New Recorded Species

In this study, 9 new species were recorded. The reason why they were observed today and could not be found in 1950's may be due to the fact that (i) they were there and could not be collected by previous studies, or (ii) they arrived recently to the region.

4.3.2.1 *Asterias rubens*

This sea star is named as "the common sea star" of the British and North Atlantic coasts (Hayward, 1996). It mainly feeds on mussels. It does not exist in the Mediterranean, probably because it is not resistant to water temperatures higher than 20^0C (Horton, 1998). In the catalogues that were scanned through, no evidence about the existence of this species in the Mediterranean was found. The sea around the Princess Islands is colder than 20^0C most of the year, and also, there may be some populations which could have adapted to changing conditions.

Conclusively, this species is extremely common in the Princess Island region, and it is very common in the Bosphorus Strait. It might have been carried in the ballast waters of ships from the northern seas.

4.3.2.2 *Paramuricea clavata*

This species is the gorgonian which forms the biggest colonies in the Mediterranean (Mojetta, 1996). For this coral, it seems impossible that it could not be found in the 1950's, if it was ever present. The methodology that was used before (Demir, 1952) was adequate enough to collect species like *Gorgonia verrucosa, Rhipidigorgonia flabellum* and *Pteroides griseum.* These corals all live in the same habitat, namely, encrusting on rocks.

The only possibility why it could not be found by previous methods is that, this species is sensitive to light intensity. Maybe, those years, the water permitted more light to penetrate the shallow depths and *P. clavata* was living in deeper waters. But also, this is not reasonable, because Demir (1952) could explore depths up to 150-200 metres. Thus, it may be concluded that this species is new in the region.

Öztürk (1996) mentioned that this species must be included as a speciess to be protected in the Sea of Marmara, because its habitat is destroyed by anchoring and trawling.

4.3.2.3 *Parazoanthus axinellae*

This cnidarian covers large surfaces by means of budding and sexual reproduction. It lives encrusting on other animals, partly inside them. It most commonly lives on sponges in the Princess Islands region (See Figure 4.1).

Figure 4.1 ***Parazoanthus axinellae*****, in a porifera**

Just as in the case of *Paramuricea clavata,* similar species were recorded before (Demir, 1952), but this species was not. The only reasonable explanation is that this species have arrived recently from the Mediterranean, where it is abundant.

4.3.2.4 *Cereus pedunculatus*

This large (diameter of the oral disc up to 120 mm) solitary anemone is found on muddy or sandy bottoms, strongly tied to rocks buried deep in the substrata by means of its adhesive ended long (up to 250 mm) column (See Figure 4.2). When it is disturbed, it escapes inside the mud or sand. Also, this cnidarian lives inside crevices. With previous methods, it is impossible to collect this species from the crevices. For the ones living on sand or mud, it is highly probable that it was crashed into unidentifiable pieces, as it was surfaced after trawling, because it strongly adheres to the bottom, and its body is not strong. So, Demir (1952) could not collect it, or this species must be new in the region.

Figure 4.2 The long column and wide oral disc of *Cereus pedunculatus* (Source: Campbell, 1976)

4.3.2.5 Two cnidarian species

These two species were observed by only one collected specimen each. They are extremely rare. It is probable that they were again very rare in the 1950's, and they could not be found, or they are new in the region.

4.3.2.6 *Stichopus regalis*

This sea cucumber is common on all kinds of substrata and in all depths. It has an unmistakable shape that it cannot be misidentified. It must be new in the region.

4.3.2.7 Sea cucumber species

This species is rare in the Princess Islands region now. By the previous methods, it is impossible that it could not be collected. Another possibility is that, this species was rare and could not be found during Demir's research in 1950's.

Also, this species resembles its Mediterranean relative, *Holothuria tubulasa*, with shorter papillae. It might have been misidentified. Otherwise, it is new in the region.

4.3.2.8 *Atrina fragilis*

This bivalve mollusc is very similar to its larger (up to 500 mm in length) relative *Pina nobilis*, which was common in the 1950's. It is now rare in the Princess Islands coasts. It might have been misidentified before (Demir, 1952), or it is new in the region.

4.3.3 Probable Extinctions

Due to over population in İstanbul, underwater habitat in the area was fragmented and destroyed. Many species could not be recorded in the dives, so one may talk about extinctions.

Among the four chosen phyla, which reflects the demersal invertebrate biodiversity change, many probable extinctions were recorded (See Table 4.1). Most of the sponges were extinct. This may be due to the nature of these organisms. Since they feed by filtering the water, pollution might have affected these animals. Echinodermata and cnidaria were reduced to nearly half. Mollusca is studied in detail.

Table 4.1 Number of species in 1952 and 1998 in comparison in the 4 phyla (# of = number of, r. s. = recorded species)

Phylum	# of r. s. in 1952	# of r. s. in 1998	# of new species
Cnidaria	18	10	5
Echinodermata	27	15	3
Mollusca	118	50	1
Porifera	12	3	0

In the following sections, the lists of the species which used to exist in the area, but that could not be observed any more are presented. They were classified according to phylum.

4.3.3.1 Cnidaria

Cnidaria had 18 anemon and coral species recorded in the 1950's. During our dives we could record only 10 species, in addition, 5 new species were recorded (See Table 4.2).

Table 4.2 Probably extinct cnidarian species

Species	Abundance in the 1950's
Lucernaria campanulata	VR
Clavularia crassata	VC
Muricea macrospina	VR
Rhipidigorgonia flabellum	VR
Pennatula phosphorea	VC
Pteroides griseum	VR
Cophobelemnon leuckartii	VC
Sagartia ?	VC

4.3.3.2 Echinodermata

In this phylum there were 27 described species in the 1950's. During our dives we could report only 15 of them, and 3 new species were recorded (See Table 4.3). One of them is the common sea star of the North Atlantic Ocean and the British Isles and it is now very common in the region. They may be carried out in the ballast waters of the ships. The two others are two sea cucumbers.

Table 4.3 Probably extinct echinoderm species

Species	**Abundance in the 1950's**
Hacellia attenuata	R
Pentagonaster placenta	VR
Luidia ciliaris	VR
Echinaster sepositus	C
Ophiura lacertosa	VC
Ophiura albida	C
Amphiura squamata	VC
Stylocidaris affinis	VR
Centrostephamus longispinus	VR
Echinus acitus	VC
Sphaerechinus granularis	VC
Echinocyamus pusillus	VR

4.3.3.3 Mollusca

The bigger phylum Mollusca had 118 species, and we could report only 50 of them. The pina shell which is common in the Mediterranean was newly recorded (See Tables 4.4, 4.5 and 4.6)

Table 4.4 Probable extinctions in the phylum mollusca

Taxon	**# of r. s. in 1952**	**# of probable extinctions**
Archeogastropoda	24	16
Mesogastropoda and Neogastropoda	15	8
Opistobranchia	16	12
Bivalvia	57	36
Cephalopoda	6	6

Cephalopods are the class of octopi, squids and cuttle fish, which have high commercial value. Also, these animals are the most complex invertebrate animals, which have a true brain. They have high sensitivity to pollution. All the cephalopods which were recorded by Demir (1952) could not be recorded during our study.

Most of the gastropods are nocturnal and most of the bivalves live buried in the mud or sand. Since our dives were not night-dives and sand and mud bottoms were not explored in detail, these might have caused us not to be able to record the mollusca properly. The biggest mollusca in the whole Mediterranean, *Atrina fragilis*, the pina shell, which can reach to 400 mm in length, could not be recorded earlier, but they are common below 30 meters in the region now. One can hardly conceive that even a single species could not be taken out of water by Muzaffer Demir's trawls. It is concluded that the species which is common between 10 m to 30 m in the Aegean Sea, is new in the area

Table 4.5 Probably extinct molluscs, classis Gastropoda

Species	Abundance in the 1950's
Acanthochiton discrepans	C
Acanthochiton fascicularis	C
Chiton marginatus	C
Fissurella mediterranea	VR
Fissurella graeca	VR
Emarginula conica	R
Emarginula cancellata	R
Capulus hungaricus	C
Acmeaea unicolor	R
Vermetus triqueter	VC
Gibbula maga	C
Calliostoma granulatus	C
Astralium rugosum	VC
Phasianella speciosa	VC
Truncatella truncatula	VC
Turritella communis	R
Neritina fluviatilis	VC
Natica intricata	VC
Nassa incrassata	VC
Conus mediterraneus	C
Aporrhais pes-pelicani	C
Erato laevis	C
Cerithium rubestre	R
Cassidaria echinophora	C
Umbrella mediterranea	VR
Scaphander lignarius	VR
Haminea navicula	C
Gastropteron Meckelii	C
Pleurobranchaea Meckelii	VC
Elysia viridis	C
Limapontia nigra	VC
Doris tuberculata	C
Marionia Blainvillea	C
Doto coronata	VC
Tergipes despecta	C
Calma caviolinii	VC

Table 4.6 Probably extinct molluscs, classis Bivalvia and Cephalopoda

Species	Abundance in the 1950's
Teredo navalis	VC
Pholas dactylus	VC
Gastrochaena dubia	C
Solen ensis	VC
Saxicava rugosa	C
Saxicava arctica	C
Mactra subtruncata	C
Anomia ephippium	VC
Pecten glober	VC
Avicula hirundo	VC
Modiolaria marmorata	VC
Lithodomus lithophagus	C
Chama gryphoides	VC
Arca lactea	VC
Arca diluvii	VC
Arca noe	R
Leda fragilis	C
Leda pella	VC
Nucula nitida	C
Nucula sulcata	C
Nucula nucleus	C
Cardium mucranatum	C
Cardium paucicostatum	C
Lucina reticulata	R
Lucina spinifera	VC
Lucina leucoma	VC
Isocardia cor	R
Venerupio irus	VC
Gouldia minima	C
Cytherea rudis	C
Venus ovata	C
Tapes aureus	VC
Petricola lithopaga	C
Tellina exigus	VC
Neaera cuspidata	R
Syndesmya alba	VC
Elodone moschata	VC
Octopus vulgaris	C
Sephia officinalis	C
Sephiola Rondalettii	R
Loligo vulgaris	C
Ommatostarephes seittataus	VR

4.3.3.4 Porifera

Porifera, sponges are a comparably small phylum in the area. In Muzaffer Demir's book 12 were recorded but the following 9 of them are extinct (See Table 4.7).

Table 4.7 Probably extinct porifera species

Species	Abundance in the 1950's
Leucosolenia vaiabilis	C
Sycandra raphanus	VC
Gellinus ?	VC
Prusuberites epiphytum	C
Haliochondria panicea	VC
Halioclona limbata	VC
Halioclona montagui	C
Geodia barreti	VR
Stellata ?	VR

5. CONCLUSION

This study tried to cover the gap in marine demersal invertebrate explorations. The studies conducted through years since 1952, seems very insufficient, although Yassıada and Sivriada have attractive and frequent diving cites, which are preferred by many divers from İstanbul, because of their colourful underwater habitat and being very close to the diving centres in İstanbul.

Over 100 dives were made in various cites in the Princess Islands region to examine the habitat. Observations were noted, pictures taken, and specimens collected through two years. A great amount of literature was studied through, and at the end, some results were obtained.

The ecosystem around the islands had been changed through years. The ecosystem was dominated by three species, one of which was even not recorded by Demir (1952). Results part includes descriptions and pictures of these species. Comparative tables included the abundance of the species at the time of Demir (1952). Also, in this thesis, the materials and methods were completely different. Nine new species that were not mentioned before (Demir, 1952) were recorded. Their descriptions with photographs were included in the Results part. Extinctions were noted throughout the study. Out of 175 species of cnidarians, echinoderms, molluscs and sponges, only 78 species were recorded. The remaining 97 seems to become extinct. These extinctions could be resulted by the factors of human impact, the bottom structures of the islands, and chains of extinctions.

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