Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 5, No. 3, p. 14-20, 2014
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Sea star (Echinodermata) species diversity and distribution in the south-east of Iran (Gulf of Oman)

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Article published on September 03, 2014

Key words: Sea star, diversity, dstribution, Intertidal, South-east of Iran.

Abstract

Echinoderms are one of the oldest and most important groups of marine organisms which play an important role in the marine ecology especially in the coral reefs. During November 2012 to August 2013, six stations were selected in intertidal zone at the north of Gulf of Oman according to sea bottom. At each station, the Sea star species of the selected area were counted in 10 m^2 with 10 replications. This study was made in three seasons namely autumn, winter and summer. According to the result, cluster analyses showed the site similarity in species abundance and diversity with the same substrata. Maximum and minimum sea star diversity was shown in winter and summer, respectively.

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Introduction

Echinoderms are an entirely marine phylum whose populations are prevalent in benthic ecosystems throughout the world's oceans.

Starfish or sea stars are echinoderms belonging to the class Asteroidea. About 1,500 living species of starfish occur on the seabed in all the world's oceans, from the tropics to subzero polar waters. Starfish species inhabit all of the world's oceans. Habitats range from tropical coral reefs, rocky shores, tidal pools, mud, and sand to kelp forests, seagrass meadows and the deep-sea floor down to at least 6,000 m. The greatest diversity of species occurs in coastal areas (Mah *et al.*, 2010; Dorit *et al.,* 1991).

The Asteroidea occupy several significant ecological roles. Starfish, such as the ochre sea star (Pisaster ochraceus) and the reef sea star (Stichaster australis), have become widely known as examples of the keystone species concept in ecology (Paine, 1971; Wagner, 2012). The tropical crown-of-thorns starfish (Acanthaster planci) is a voracious predator of coral throughout the Indo-Pacific region, and the northern Pacific sea star is considered to be one of the world's 100 worst invasive species (Menage and Stanford, 2013; Wagner, 2012).

Starfish and other echinoderms are sensitive to marine pollution (Newton and McKenzie, 1995). The common starfish is considered to be a bioindicator for marine ecosystems (Temara *et al.,* 1998). Some starfish such as Astropecten polyacanthus also include powerful toxins such as tetrodotoxin among their chemical armory (Mah, 2010).

Whereas, there is not much publication and information about the distribution of the sea stars in the Persian Gulf and Gulf of Oman (pourvali *et al.* 2014), this study was carried out in the south-east waters in Iran. Our objectives were to determine the diversity, abundance and habitat of the sea stars from Iranian waters of the Gulf of Oman.

Materials and methods

Data collecting method

During October 2011 to August 2012 the diversity, density and distribution of Echinodermata species were studied in 6 stations in intertidal zone of south-east Iranian coast according to substratum type (Fig. 1, Table 1). This present study was carried out in three seasons namely autumn, winter and summer. At each station, the abundance of sea star was counted using 1*1m² quadrat with ten replications in 10m².

Table 1. position and substrata type of site sampling.

Station	*Sea bed*	*Lat.*	*Long*
St 1	Rock	60° 36′ 22 97″ E	25° 21′ 51 95″ N
St 2	Sand	60° 36 00 36″ E	25° 20′ 57 58″N
St 3	Rock	60 °37′ 34 30″ E	25° 18′ 30 16″ N
St 4	Sand	60° 37′ 28 27″ E	25 °17′ 42 24″ N
St 5	Rock	60 °43′ 19 41″ E	25° 16′ 26 52″ N
St 6	Sand	60° 45′ 06 33″ E	25 °16′ 03 48″ N

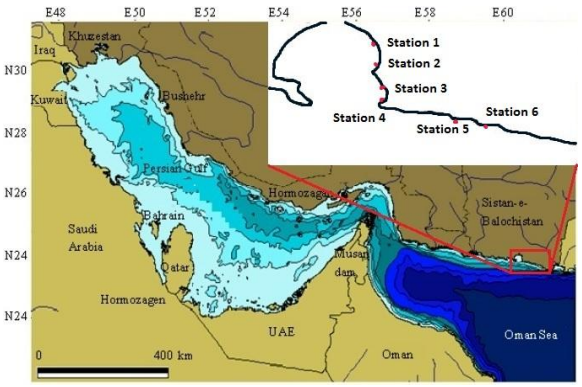

Fig. 1. Map of site sampling.

Statistical analyses

Cluster Analyses (CA) for comparing density of echinoderms between stations was used. This index survey similarity and differences between stations and hence put the similar stations in to the same group. Total mean values were measured for 3 seasons for each station. The Margalef species richness (d), Shannon's diversity (H'), Pielou's evenness (J) index and the density of individuals (m2) per species were calculated for each site.

Results

Five species of sea star were observed throughout all the sites sampled (Table 2). All of these species have

been previously recorded in Iranian water but there is no any survey on sea star ecology in this area.

Table 2. Diversity index for Autumn.

	St 1	St 2	St 3	St 4
Taxa_S	1	3	1	4
Individuals	31	6	5	9
Dominance_D	1	0.3889	1	0.3333
Shannon_H	0	1.011	0	1.215
Simpson_1-D	0	0.6111	0	0.6667
Evenness_e^H/S	1	0.9165	1	0.8425
Margalef	0	1.116	0	1.365
Equitability_J	0	0.9206	0	0.8764

According to the survey, the maximum abundance with 0.338± 0.052 ind. /m² and the minimum abundance with 0.283±0.063 ind. /m² were recorded for winter and autumn, respectively. Moreover, Station 1 in autumn showed the maximum abundance by 0.833±0.123 ind. /m² while the total individual accounted was 0 in station 6 during the survey (Descriptive statistics of the variables are given in Tables 2, 3 and 4; figs. 2 and 3).

Table 3. Diversity index for Winter.

	St 1	St 2	St 3	St 4	St 5
Taxa_S	1	3	1	3	1
Individuals	16	15	20	7	3
Dominance_D	1	0.4133	1	0.4286	1
Shannon_H	0	0.9701	0	0.9557	0
Simpson_1-D	0	0.5867	0	0.5714	0
Evenness_e^H/S	1	0.8794	1	0.8668	1
Margalef	0	0.7385	0	1.028	0
Equitability_J	0	0.883	0	0.8699	0

Table 4. Diversity index for Summer.

	St 1	St 2	St 3	St 4	St 5
Taxa_S	1	1	1	1	1
Individuals	28	1	25	1	5
Dominance_D	1	1	1	1	1
Shannon_H	0	0	0	0	0
Simpson_1-D	0	0	0	0	0
Evenness_e^H/S	1	1	1	1	1
Margalef	0	0	0	0	0
Equitability_J	0	0	0	0	0

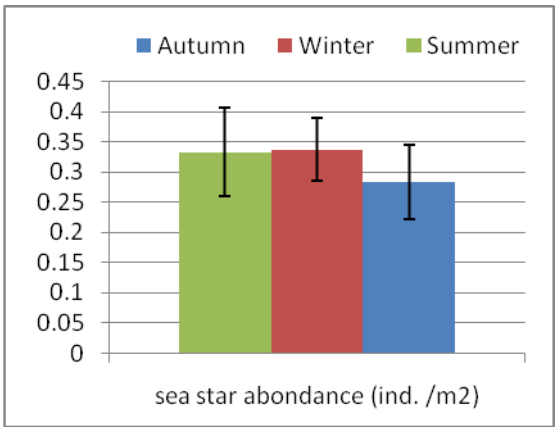

Fig. 2. total mean of sea star abundance for seasons.

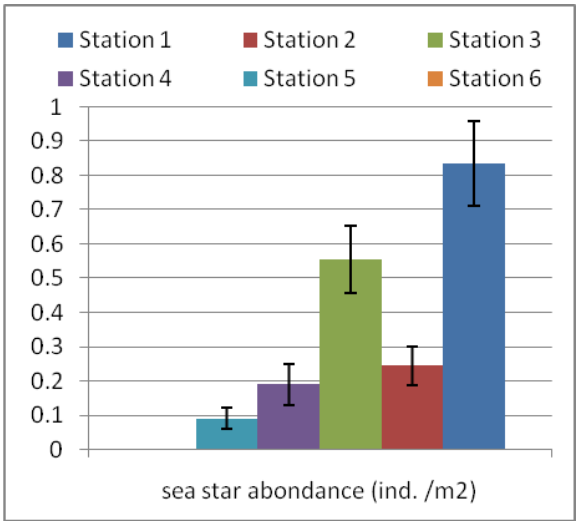

Fig. 3. total mean of sea star abundance for stations.

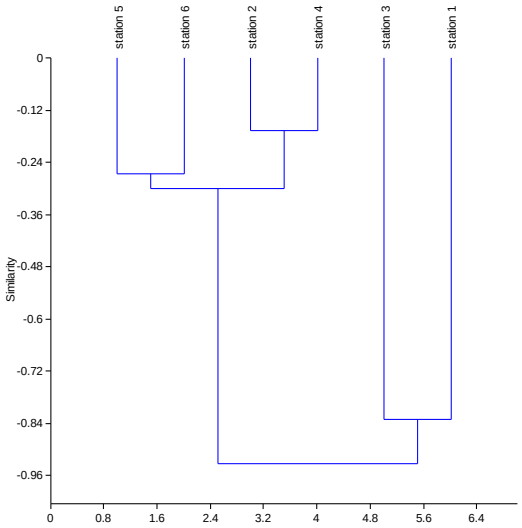

Fig. 4. cluster analyses.

Cluster Analyses

Cluster Analyses result shows 2 main groups between stations (fig. 4). First group includes stations 1 and 3, and the second main group includes stations 2, 4, 5 and 6 which this group is divided to two sub-groups. The first one contains station 2 and station 4 while the second one is included stations 5 and 6.

Diversity index analyses

Station 5 in autumn and station 6 in all three seasons did not have any accounted species during the survey; therefore, this sites was omitted from the Biodiversity parameters Tables.

Stations 1, 3 and 5 in autumn and winter and all stations in summer had only one species and consequently the dominance index and evenness index were the maximum values and the Shannon index and the Simpson index and the Margalef index were the lowest value (tables 2, 3 and 4).

Discussion

Sea star abundance

Identification of animal distribution and species diversity can help to preserve of species and also it act as basic information for ecological studies (O'Hara and Poore 2000).

In many studies (which are only published in Persian language) by MSc students in Iranian water in the Persian Gulf, the Strait of Hormuz and the Gulf of Oman, results shows that echinoderms diversity is high in cold months and low in warm months. And also the evenness in winter and spring is higher than summer and winter. One of the most important characters in every population is density which means the total individuals in specific area. Information about density, distribution and diversity can help to run the best management for nature and animal resources. Echinoderms population density in the Iranian water has a tendency to decrease in summer and decrease in winter.

Studies show that there is no difference between stations with the same substrata while station with different substrata show a statistical difference for mean of sea star density ($p<0.05$). Differences between species and density of echinoderms maybe are due to site sampling selection that explains the contrast among the different habitats (Marsh and Marisson, 2004). Study on macro-benthos biomass in Chabahar Bay showed that macro-benthos had minimum density during monsoon season (Nikouyan and Savari, 1999). Probably the reason for this contrast is due to that this study was done on macro-benthos community (including polychaeta, gastropoda, bivalvia, etc.) but this survey is only for sea star community.

Sea stars select their habitats by attending to their podia. Species with tapering tube feet in mainly founded in the sandy substrata, occasionally in muddy substrata and species with having terminal disc in tube feet are founded in rocky substrata (Ponder, *et al*. 2002). In this study, *Aquilonastra* Sp. Was founded in rocky seashore and other species were founded in sandy seashore. Defferences between the echinoderms species and abundance maybe are due to the site sampling selection that brings the habitat contrast in different sites (Marsh and Marisson, 2004).

Cluster analyses

During this study, six statins were surveyed based on substrata, three stations with sandy substrata and three stations with rocky substrata. Stations 1, 2, 3 and 4 are located in the Chabahar Bay which is preserved from directly impact of Indian Ocean conditions. As cluster analyses shows stations 1 and 3 with the same substrata have the maximum similarity in the mean of sea star and also the same result comes out for stations 2 and 4 with the sandy substrata. Stations 5 and 6 with different habitat are in the one cluster. The reason for this maybe is due to expose stations 5 and 6 in front of monsoon and Indian Ocean current, both, that can directly affected on echinoderms density and diversity.

Mucha and Costa (1999) showed that hydrodynamism appears to be a stabilizing factor for macrobenthic assemblages. Strong hydrodynamism leads to decrease in nutrient load and fostered less reducing condition, finally result in decrease in species number, biomass and diversity (Aslan-Cihangir and Pancucci-Papadopoulou 2012). The second reason backs to condition of sea bed, based on larvae settling. Settlement is the initial processes determining the structure of population (Rodrigues *et al.* 1993). Sea bed in stations 2, 4 and 6 are sandy. Physical characters of substrate such as contouring can help to success larvae settlement (Rodrigues *et al.* 1993) and maybe sandy substrate does not supply optimum condition for larvae settling.

Diversity index

There was no species in the station 6 during the sampling seasons and also station 5 in the autumn. The only one species was recorded for stations 1, 3 and 5 in the autumn and the winter; moreover, during the summer sampling season only one species was recorded for every station. It means that the Shannon, Simpson and Margalef indexes always show zero and the Dominance and Evenness indexes always will be the highest.

The Shannon and Simpson indexes will increase when the number of species increases. Shannon index will increase too much but not more than 5 in biological communities (Krebs, 1999). Station 2 with 1.011 had the highest amount for Shannon index in the autumn and station 4 had the maximum amount for Simpson index by 0.666 in the autumn.

Margalef index shows the highest amount for station 4 in the autumn. Diversity is one of the most important parts of the ecosystems health and indicator for preserved habitat (Price *et al.*, 2002).

Result in this study show that the sea star diversity index has the minimum amount in the summer and maximum amount in the winter.

References

Aslan-Cihangir H, Pancucci-Papadopoulou AM. 2012. Spatial and temporal variation of echinoderm assembages from soft bottoms of the Canakkale Strait (Turkish Strait System) with a taxonomic key of the genus Amphiura (Echinodermata: Ophiuroidea). *Turkish Jornal of zoology*. **36(2),** 147-161.

Barnes RD. 1969. *Invertebrate zoology*. W. B. Saunders Company: 605- 650.

Basson PW, Burchard JE, Hardy JT, Price ARG. 1997. *Biotopes of the Western Persion Gulf: Marine life and Environments of Saudia Arabia*. Armaco: Dhahran.Saudi Arabia.284 pp.

Bhamrah HS, Juneja K. 1999. *A text book of invertebrates*. Anmol publications PVT. LTD. 775 pp

Castro P, Huber M. 2003. *Marine Biology. Mc Grow Hill*, America: 142- 145.

Clarck AM, Rowe FEW. 1971. *Monograph of shallow-water Indo-west pacific echinoderms*. 238 pp. *London, British Museum* (Natural History).

Dorit RL. Walker WF, Barnes RD. 1991. *Zoology*. Saunders College Publishing. p. 782. ISBN 978-0-03-030504-7.

Feder HM, Jewett SC, Blanchard A. 2005. Southeastern Chukchi Sea (Alaska) epibenthos. *Polar Biology*, **28,** 402-421.

Gislen T. 1940. *Echinoderm from the Iranian Gulf*. In: Danish Scientific Investigation in Iran. part II .Einar Munksgaard, Copenhagen: 55-137.

Mah C, Nizinski M, Lundsten L. 2010. "Phylogenetic revision of the Hippasterinae (Goniasteridae; Asteroidea): systematics of deep sea corallivores, including one new genus and three new species". *Zoological Journal of the Linnean*

Society **160 (2),** 266–301. doi:10.1111/j.1096-3642.2010.00638.x.

Mah C. 2010. "Sea star defense".*The Echinoblog*. Retrieved 2013-05-30.

Mc Cain JC, Tarr AB, Carpenter KE, Coles SL. 1984. Marine ecology of saudia Arabia. A survey of coral reefs and reef fisheries in the northern area, Persian Gulf, saudia Arabia. *Fauna of saudia Arabia*. 284 pp.

Menge BA, Berlow EL, Balanchette CA, Navarrete SA, Yamada SB. 1994. The keystone species consept: variation in interaction strength in a rocky intertidal habitat. *Ecol*gical *Monographs*. **64,** 249-286.

Menge BA, Sanford E. 2013. Ecological role of sea stars from populations to meta-ecosystems, in: Lawrence, J.M. (Ed.) (2013). Starfish: Biology and ecology of the Asteroidea. pp. 67-80

Mortensen T, Heding SG. 1940. *Echinoderm from the Iranian Gulf*. In: Danish Scientific Investigation in Iran. Part II .*Einar Munksgaard, Copenhagen:* 55-137.

Mucha AP, Costa MH. 1999. Macrozoobenthic community structure in two Portuguese estuaries: relationship with organic enrichment and nutrient gradients. *Acta Oecologica*. **20(4),** 363-376.

Newton LC, McKenzie JD. 1995. "Echinoderms and oil pollution: A potential stress assay using bacterial symbionts". *Marine Pollution Bulletin* **31 (4–12),** 453–56.Doi: 10.1016/0025-326X(95)00168-M.

Nikouyan A, Savari A. 1999. Distribution and biomass of macrobenthic fauna in the CHabahar Bay (North eastern Sea of Oman). *Iranian Journal of Fisheries Science*. **1(2),** 23-39.

Nybakken JW, Bertness MD. 1997. *Marine Biology: An Ecological Approach*. Addison-Wesley Educational Publishers. p. 174. ISBN 978-0-8053-4582-7.

O'Hara T, Poore GCB. 2000. Patterns of distribution for southern Australian marine echinoderms and decapods. Journal of Biogeography, **27,** 1321–1335.

Paine RT. 1966. Food web complexity and species diversity. *American Naturalist* 100 (190): 65–75.Doi:10.1086/282400. JSTOR 2459379.

Pawson DL. 2007. *Phylum Echinodermata*. *Zootaxa* 1668: 16, 749–764.

Pechnik JA. 2005. *Biology of the invertebrates*. Fifth edition. Mc Grow hill international publication. 590 pp.

Piepenburg D, Vob J, Gutt J. 1997. Assemblages of sea stars (Echinodermata: Asteroidea) and brittle stars (Echinodermata: Ophiuroidea) in the Weddell Sea (Antarctica) and off Northeast Greenland (Arctic): a comparition of diversity and abundance. Polar Biology. **17,** 305-322.

Ponder W, Hutchings P, Chapman R. 2002. Overview of the conservation of Australian marine invertebrates. A report for environment Australia. Australia museum. pp. 588

Pourvali N. 2013. New Report of Sea Star, *Aquilonastra samyni* (Echinodermata, Asteroidea), from the Strait of Hormuz, the Persian Gulf. *World Journal of Zoology*, **8(4),** 415-416, 2013.

Pourvali N, Nabavi MB, Rezai H, Doraghi AM, Mahvari AR. 2014. Echinodrmata, species diversity and distribution in Hormuz Island (the Persian Gulf), I. R. Iran, *Middle-East Journal of Scientific Research*, **21(4),** 583-587,2014

Price ARG. 1981. Studies on the echinoderm fauna of the western Gulf. *Journal of Natural History*, **15,** 1-15.

Price ARG. 1982. Echinoderm of Saudi Arabia. Comparison between Echinoderm faunas of Arabian Sea, SE Arabia, Red Sea, Gulfs of Aqaba and Suez. *Fauna of Saudi Arabia*, **4,** 3-21.

Price ARG. 1983. Echinoderms of Saudi Arabia. Echinoderm of the Gulf, *Fauna of Saudi Arabia*, **5,** 28-108.

Price ARG. 2002. Simultaneous 'hotspots' and 'coldspots' of marine biodiversity and implications for global conservation. Marine Ecological Progress. Series. **241,** 23–27.

Price ARG, Izsak C. 2005. Is the Gulf really such a lowspot of biodiversity?: Scaling effects and management implications. *Aquatic Ecosysytem Health & Management*, **8(4),** 363-366.

Rodriguez SR, Ojeda FP, Inestrosa NC. 1993. Settlement of bentic marine invertebrates. *Marine Ecology Progress Series*. Vol. **97,** 193-207.

Rowe FEW, Richmond MD. 2004. A preliminary account of the shallow-water echinoderms of Rodrigues, Mauritius, western Indian Ocean. *Journal of Natural History*, **38,** 3273 – 3314.

Russell EF, Nagabhushanam R. 1996. The venomous and poisonous marine invertebrates of the Indian Ocean. *Oxford & IBH publishing. CO. PTV.LTD*. pp. 271

Shepherd C, Price ARG, Roberts C. 1992. Marine ecology of the Arabian region. Paterns and processes in exterime tropical environments. *London, Academic press*. 359 pp.

Temara A, Skei JM, Gillan D, Warnau M, Jangoux M, Dubois Ph. 1998. "Validation of the asteroid *Asterias rubens* (Echinodermata) as a bioindicator of spatial and temporal trends of Pb, Cd, and Zn contamination in the field". *Marine Environmental Research* **45 (4–5),** 341–56.doi:10.1016/S0141-1136(98)00026-9.

Trumpey JE, Schlager N, Thoney DA. 2004. *Grzimek's animal life encyclopedia. Protostomes*. 2nd ed. Pp. **569**, 355-432.

Tyagi R, Shukla AN. 2002. *Encyclopaedia of echinodermata. Comparative anatomy of echinodermata*. **Vol.1.** Anomol. Publication, PTV. LTD. 405 pp.

Tyagi R, Shukla AN. 2002. *Encyclopaedia of echinodermata. Physiology and ecology of echinodermata*. Vol.2. Anomol. Publication, PTV. LTD. 329 pp. 329 pp.

Tyagi R, Shukla AN. 2002. *Encyclopaedia of echinodermata. phylum echinodermata*. Vol.3. Anomol. Publication, PTV. LTD. 513 pp.

Wagner SC. 2012. "Keystone Species". Nature Education Knowledge. Retrieved 2013-05-16.