FAUNAL COMMUNITY OF AHLYAT INTERTIDAL MUDFLAT UNDER ANTHROPOGENIC STRESS

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Abstract

Anthropogenic stress of Ahlyat intertidal mudflat was studied on exploited and reserved area at central Mon coastal area from January 2016 to December 2018. During the study period, species composition, diversity, evenness, and richness of mudflat fauna communities were not commonly disturbed but the species abundance were relatively common. Based on correlation index, regression coefficient, habitat loads and total biotic-abiotic factors of different habitats were negatively correlated. The prey species and predators were balanced at higher dominance level. Faunal structures of study area showed top-down scheme and affected the diversity of community negatively.

Keywords diversity indices, faunal community, mudflat, stress, structure.

Introduction

Ahlyat is one of the mudflat ecosystem structures in central Mon coastal area which covers mangrove fringe, saltmash grasses, sand dune beach, inlet creeks and huge mydflat shore. Species community structures were exploited by coastal population who live in intertidal zones. Nowadays, production of fishery sectors and over utilization of natural ecosystems have related for climate impact and pollution damage on coastal resources (de Boer *et.al.*, 2001). The community structure of tropical waters provided various functions, stresses and loads on mudflat habitats and diversity.

In nature, anthropogenic activities and estuarine ecosystems have increased the impact on diversity of mudflat fisheries, vertebrates and invertebrates' fauna. The problematic correlation of natural and human impacts was altered the community structures of functional areas. Soft bottom communities like mudflat ecosystems and bare areas were supported trophic activity for avian fauna and many aquatic epi and infauna (Clarke and Warwick, 1994). Some correlation of functional procresses and human impacts of coastal systems are affected on hypotheses of anthropogenic structure of mudflats (Cyr *et.al.*, 1997 a, b).

Soft bottom habitats have always been considered to be not only food sources but also especially ecosystems strengthening and to support the coastal qualities. In study areas, a vast assemblage of different forms lived in or on mudflat while the tidal period. Others preferred sandy mauflat where they burrowed into the sandflat during ebb tide. Many liked nothing better than a muddy bottom, and blacker and stickier the better. Some lived only in the fringe of mangrove, tolerating no environmental stress at all; whereas others seemed to like it better where the water was brackish and bare area, often thriving best in partially polluted areas.

The objectives of this study are: 1) to know the spcies community and diversity of Ahlyat intertidal mudflat relationship with anthropogenic stress loads, 2) to test the comparison of species composition-abundance, density-size-weight relationship of regression analysis of mudflat community structure, 3) to analyze the null hypothesis between the ecosystem data and statistical components, and 4) to know the species dominance and relative value of mudflat community in study areas.

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Materials and Methods

Study area

The mudflat of Ahlyat intertidal area (Lat. 16˚30′ N, Long. 97˚21′ E) is located in the central Mon coast (Fig. 1). Annual rainfall is 203.5 in (5.17 m) and mean air temperature is 27˚C. The water temperature ranged from 21˚- 33˚C. This study was divided into two different sites such as Site I and II faced to Gulf water of Martaban. The Site I is close to coastal population consumed by finfish and shellfish daily but the Site II is not directly accessed by local people because natural barriers like tidal creeks. Both areas have dense mangrove fringe and saltmarsh grass beds, extensive mudflats, sandflat and channels, respectively.

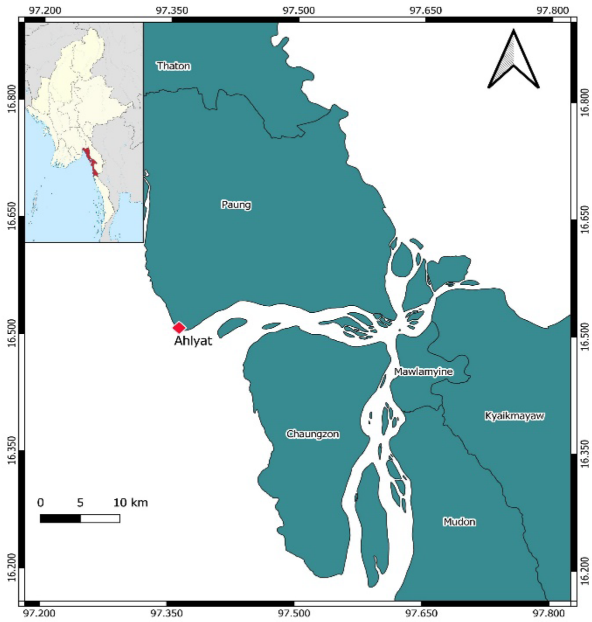

Figure 1 Map showing the collection site of Ahlyat coastal area

Sampling

The abundance and biomass of the different species were recorded from January 2016 to December 2018. In this study, quantitative analysis was used by the quadrat (50 cm × 50 cm) which was divided into a (10 cm × 10 cm) grid made of aluminium for light and durability. For each site, at least 5 transects of 125 m in length are lined perpendicularly to the shore at the interval of 50 m for each site (Fig. 2).

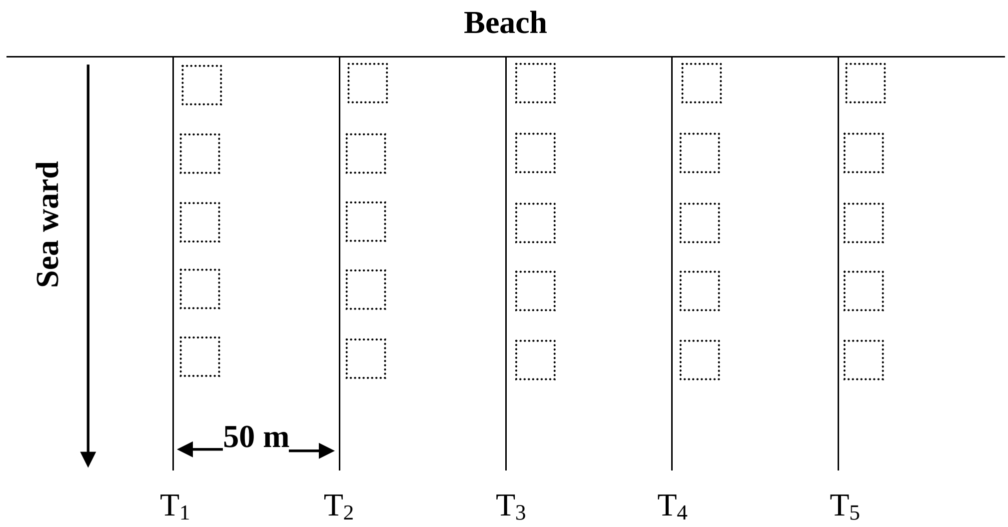

Figure 2 Systematic sampling in Ahlyat coastal area

In Ahlyat mudflat area, stress factors were analyzed by Best Professional Judgement (BPJ) as nominal values (0: no stress, 1: intermediate stress, 2: high stress) (Hyman and Leibowitz, 2001)

Statistical analysis

The species diversity, evenness, and richness indices were measured by The Shannon-Wiener species richness ($R' = S-1/\ln N$), and diversity ($H' = -\sum(Pi \ln Pi)$), Simpson's Dominance Index of Diversity ($D = 1-(\sum n_i(n_i-1)/N(N-1))$) and Pielou's evenness ($J' = H'/\ln S$). According to Clarke and Warwick (1994), the multiple dimensional scaling (MDS) was calculated by the data analysis tools with non-parametric test. Species density, biomass and similarity of all organisms were calculated by average density per sampling month and Bray-Curtis similarity coefficients. The relative abundance, dominance and combination of all taxonomic groups were tested by regression analysis with an ABC graph (Abundance/Biomass Comparison) (Seys *et.al.*, 1994). The W-test was analyzed the relative biomass to the disturbance system ranged of -1 to +1, being used for over exploited or unexploited species within the study areas.

Results

Composition

The MDS plot of five different sampling types in two study sites showed the difference in species composition (Fig. 3). Both study sites, the total stress factor was lower than 0.09 and composition of one-way similarity showed ($R = 0.504$, $p < 0.02$, $n = 10$). For benthic invertebrates, 50% dissimilarity was decreased 29% dissimilarity especially small bivalves and gastropods (*Dosinia angulosa* (Philippi, 1847), *Tellina palatum* (Iredale, 1929), *Bulla ampulla* Linnaeus, 1758 *B. striata* Bruguière, 1792 and *B. vernicosa* Gould, 1859).

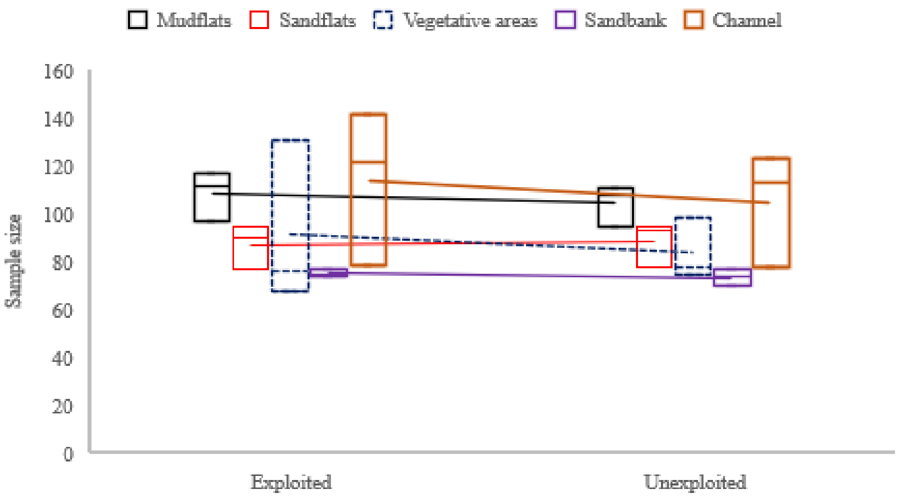

Figure 3 The multiple-dimensional scaling plot of different substrates

The total number of species per taxonomic group as shown in (Table 1). The species components of benthic substrate were highest number of sample size in Site I. The low mean diversity (*H´* of 1.7 ± 0.5 against 2.0 ± 0.3) was found in Site II (Table 2) but this result was not affective (Mann-Whitney U = 8; n = 10, p > 0.10). The highest species diversity was found in the mangrove fringe of Site I (*H´* = 2.35) and the mudflats of Site II (*H´*= 2.49). In Site I and II, the evenness and dominance factors were typically sharp at sandbank areas. The significant diversity changed positive relationship between richness with evenness and negative with dominance appeared (Spearman rank > 0.78, n = 10, p < 0.01).

The size-abundance relationship

The size-abundance relative plots did not show the differences between the two areas (Fig. 4). Regression data showed a clearly significant negative relationship between body size and abundance (for Site I: F = 501, p < 0.0001 adjusted-R^2 = 0.711, n = 203 and for Site II: F = 372 and p < 0.0001, adjusted-R^2 = 0.672, n = 181). The 95% confidence intervals for the coefficient were respectively 1.9 ± 0.2 and 2.1 ± 0.3 for Site I and Site II and for the intercept -1.4 ± 0.1 and -1.3 ± 0.2.

Table 1 The total number of species per taxonomic group

Substrates	Quantitative sample								
	Birds	**Fish**	**Bivalves**	**Gastropods**	**Crustaceans**	**Saltmarsh grass**	**Plankton**	**Others**	**Species**
Site I Exploited									
Mudflats	31	33	14	4	11	0	12	7	112
Sandflats	30	16	17	5	5	0	13	4	90
Mangrove fringe	20	20	7	2	11	0	12	4	76
Sandbank	26	18	8	3	4	0	13	2	74
Channel	32	49	13	9	10	2	14	13	142
Qualitative sample	43	59	33	15	22	2	15	14	
Mean	27.8	27.2	11.8	4.6	8.2	0.4	12.8	6	98.8
S.D	4.9	13	4.2	2.7	3.4	0.8	0.8	4.3	28.5

Site II Unexploited									
Mudflats	15	28	21	6	6	0	12	9	97
Sandflats	21	13	10	7	6	0	15	5	77
Saltmarsh grass bed	21	30	24	11	16	1	16	12	131
Sandbank	15	14	6	5	10	0	20	5	75
Channel	8	15	13	9	7	0	17	10	79
Qualitative sample	24	45	33	16	21	1	22	19	
Mean	16	20	14.8	7.6	9	0.2	16	8.2	91.8
S.D	5.3	8.2	7.5	2.4	4.2	0.4	2.9	3.1	23.6

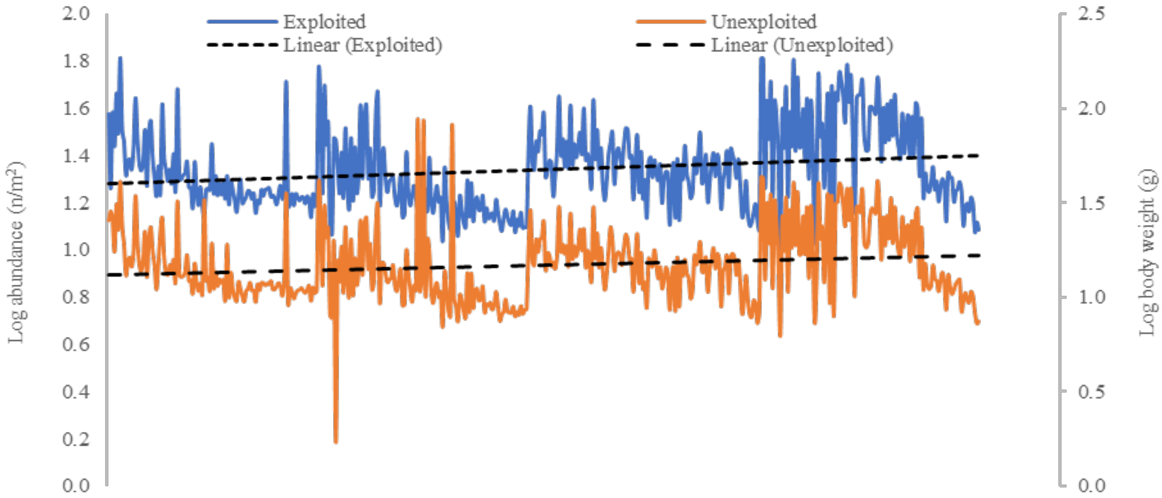

Figure 4 The log body weight (g) against the log abundance of each individual's species (n/m^2) in the study area

Table 2 Species diversity, evenness, dominance, and richness in study sites

Substrates	Diversity *H'*	Evenness *J'*	Dominance D	Richness *R'*		
				2016	2017	2018
Site I Exploited						
Mudflats	2.17	0.46	0.25	3.95	2.14	0.08
Sandflats	1.19	0.26	0.53	1.9	1.42	0.04
Mangrove fringe	2.35	0.54	0.17	5.92	3.31	0.14
Sandbank	1.33	0.31	0.39	2.58	1.8	0.05
Channel	1.49	0.3	0.5	2.01	1.44	0.03
Mean	1.71	0.37	0.37	3.27	2.02	0.07
S.D	0.52	0.12	0.16	1.69	0.78	0.04
Site II Unexploited						
Mudflats	2.49	0.54	0.21	4.82	2.34	0.12
Sandflats	1.88	0.43	0.31	3.24	1.92	0.08
Saltmarsh grass bed	2	0.41	0.24	4.2	2.9	0.06
Sandbank	1.59	0.37	0.39	2.59	1.71	0.06
Channel	1.99	0.45	0.34	2.9	1.74	0.09
Mean	1.99	0.44	0.30	3.55	2.12	0.08
S.D	0.32	0.06	0.07	0.93	0.50	0.02

Abundance-biomass comparison

Sandflats or tidal channels in Site I and mudflats or saltmarsh grass beds in Site II were showed the disturbed and undisturbed sediments abundance-biomass pattern by the W-statistic varying from - 0.052 to + 0.078 and – 0.033 to + 0.028 for the ten substrate types (Fig. 5). Benthic substratum is subjected to coastal exploitation pressures and other stress loads.

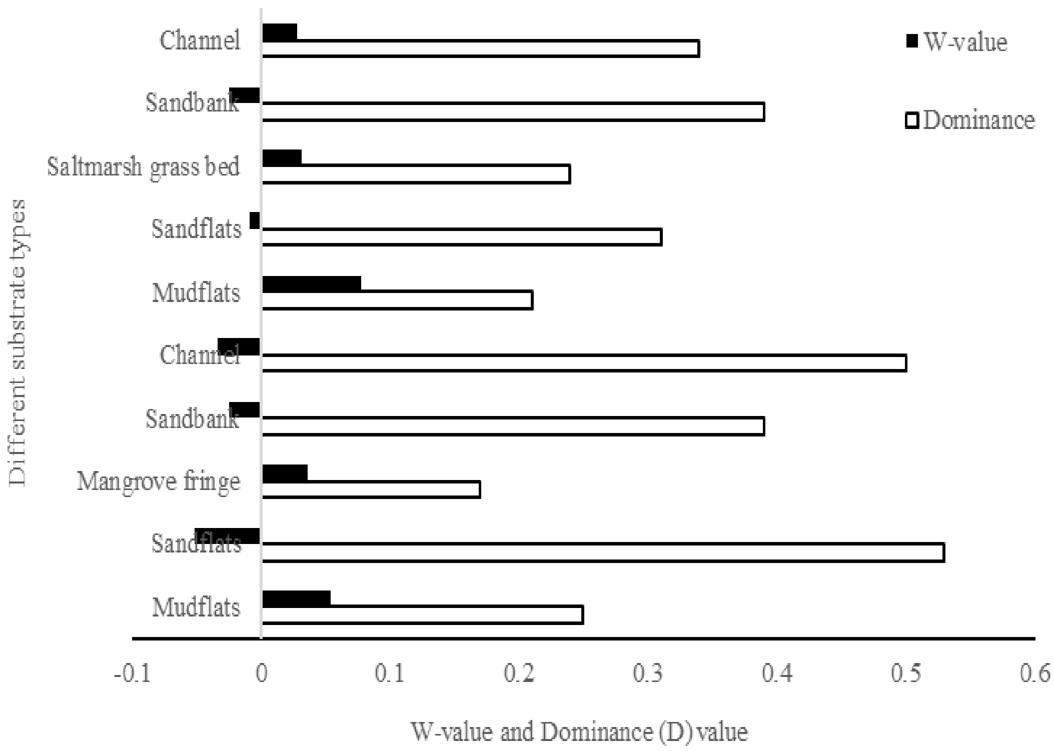

Figure 5 The Abundance-Biomass Comparison (ABC) graph of different substrate types

Table 3 The relative value of different stress factors in Site I

Stress factors	**Exploited**				
	Mudflat	**Sandflat**	**Mangrove**	**Sandbank**	**Channel**
Human exploitation	1	1	2	1	2
Human trampling	1	2	1	2	2
Human fisheries	0	0	0	0	1
Habitat heterogeneity	0	1	0	2	0
Desiccation	0	1	0	2	0
Grain size suitability	0	1	0	2	0
Excessive exposure	0	0	1	1	0
Storm damage	0	0	0	0	0
Hypersalinity	0	0	1	1	0
Low salinity	2	2	2	2	2
Irregular exposure	2	1	0	0	2
High water currents	0	0	0	2	2
Sedimentation	1	0	2	1	1
Low OM sedimentation	0	1	0	2	1
Shear stress	0	0	0	2	0
Substrate unpenetrability (debris etc.)	0	1	1	0	2
Low water table	0	0	1	2	2
Oxygen stress	2	2	2	0	1
OM-supply nutrient rich bay water	2	2	2	2	2
Saltmarsh grass nutrient shortage	1	1	1	1	0
Mangroves nutrient shortage	0	0	0	0	0
W-value	0.054	-0.052	0.036	-0.025	-0.033

Symbols: 0 (no stress), 1 (intermediate stress), 2 (high stress)

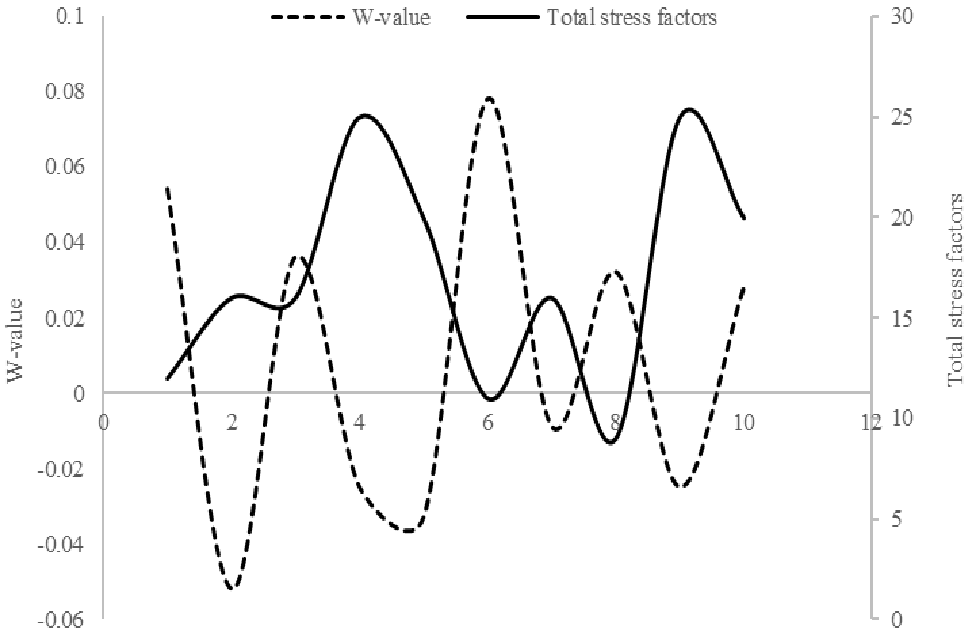

Figure 6 The total stress load compared with the W-statistics

Table 4 The relative value of different stress factors in Site II

Stress factors	Unexploited				
	Mudflat	**Sandflat**	**Saltmarsh grass**	**Sandbank**	**Channel**
Human exploitation	0	0	0	0	0
Human trampling	0	0	0	0	0
Human fisheries	2	2	2	2	2
Habitat heterogeneity	0	1	0	2	1
Desiccation	0	1	0	2	0
Grain size suitability	0	1	0	2	1
Excessive exposure	0	0	1	1	0
Storm damage	1	1	1	1	1
Hypersalinity	0	0	0	1	0
Low salinity	0	0	0	0	0
Irregular exposure	2	1	0	0	2
High water currents	1	1	1	2	2
Sedimentation	1	1	1	2	2
Low OM sedimentation	0	0	0	1	1
Shear stress	0	1	0	2	0
Substrate unpenetrability (debris etc.)	1	2	1	2	2
Low water table	0	1	0	2	2
Oxygen stress	2	2	1	0	1
OM-supply nutrient-rich gulf water	0	0	0	0	0
Saltmarsh grass nutrient shortage	0	0	0	1	1
Mangroves nutrient shortage	1	1	1	2	2
W-value	0.078	-0.009	0.032	-0.025	0.028

Symbols: 0 (no stress), 1 (intermediate stress), 2 (high stress)

In tables 3 and 4 show a half-quantitative summary of the stress factors for the ten substrate types. These tables indicated that the negative or positive W-value similar with ABC graphs of total stress factors identical disturbance levels. The comparison of human stress on Site I and II characterized by habitat community structures, the total stress load per substrate type was compared with their W-statistic (Fig. 6). As expected, the larger the total stress load, the lower their W-value ($F = 5.867$, $p < 0.05$, $n = 10$, $R^2 = 0.42$).

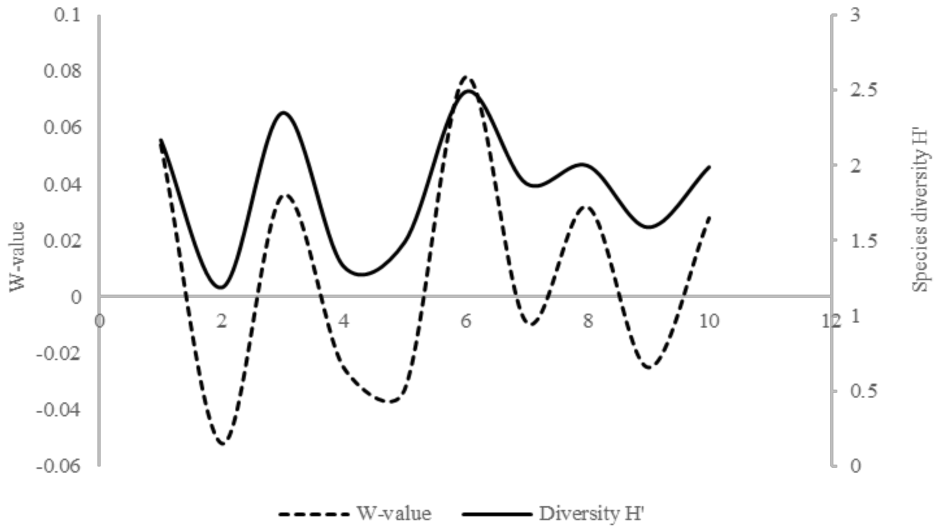

Figure 7 The correlation between the species diversity and W-statistics

Species diversity was significantly and positively related to the W-value (Fig. 7: Spearman rank = 0.967, $p < 0.0001$, $n = 10$), indicating that the highest species diversity was obtained at the highest W-value; or lowest levels of disturbance. The similar substrates (mudflats, sandflats, sandbanks, and tidal channels in both areas) were included in a Wilcoxon matched-pair test on pooled data for each substrate in each area, a significant decrease in species diversity, a decrease in evenness, and an increase in dominance in the exploited area were confirmed ($z > 2.52$, $n = 8$, $p < 0.02$).

Discussion

The settling or changing of species composition factor in the multi-factorial analysis was not easy to assess the entire study areas. The significant negative correlation between the abundance and the weight of the species as shown in (Fig. 4). The correlation of pronounced community level apparent in the taxonomic group being exploited. The relationship between the log body weight-abundance of benthic structure was negatively significant for the Site II ($F = 4.83$, d.f. = 1 and 87, $p < 0.05$), and not significant for the Site I ($F = 3.16$, d.f. = 1 and 82, $p < 0.10$).

When comparing the different benthic components, no change in species level could be statistically confirmed with different ABC plot and homogeneous equitability indices. At both sites, the composition of species assemblages was similar under exploitation to the MDS graph analysis (Fig. 3 and 7). Biomass and standing stock of shellfish covered in exploited areas due to mean annual offtake was < 5%. This mean that the exploitation rate was probably sustainable.

Minimun dissimilarity and maximum similarity indices in study areas mainly attributed to small size of gastropods and bivalves. Further study needed to check the increase or decrease of opportunistic species is being caused by the sediment disturbance which people create by merely walking or digging. The total stress load of the substrate in each area is reflected in the W-value (Fig. 6). The total stress load was increased and significantly correlated with decreasing species diversity, increasing dominance, and decreasing evenness. The W-value is probably a good indicator of stress load and offers new opportunities as an independent variable in impact studies.

Conclusion

Faunistic structure of Ahlyat intertidal mudflat is strongly related with anthropogenic stress and abiotic stress factors. Benthic components and human exploitation were balanced under the structuring of top-down process in study areas. The biological indicators and ecological systems of Ahlyat mudflat were stated that intermediate disturbance hypothesis seem to hold in communities comprising mobile aquatic invertebrates.

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