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Diversity of Freshwater Shrimps (Atyidae and Palaemonidae) along the Continnum of Urabaru Stream, Kikaijima Island, Japan

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ANS, SH and SM designed the study and collected the samples. Article was written by ANS. BW, WAB, STQ and SS helped in writing the article.

Key words
***Macrobrachium*, Cluster analysis, freshwater shrimp, Atyidae, Palaemonidae.**

ABSTRACT

Diversity of freshwater shrimps was investigated along the continuum of Urabaru stream Kikaijima Island, Japan. Total five stations were sampled from May 2007 to December 2008 in Urabaru stream. Total twelve species including seven Atyid and five Palaemonid shrimps were observed during the study. *Macrobrachium grandimanus* and *Atypsis spinipes* are reported for first time in a stream of Kikaijima Island. *Macrobrachium japonicus*, *Macrobrachium lar* and *Caridina typus* bserved at all five stations. Higher Margalef diversity was recorded at stations 4 and 5 and lower at Stations 1, 2 and 3. Cluster analysis recorded higher similarity between Stations 4 and 5 at one cluster and Sations 1, 2 and 3 at other. Our results suggesting higher diversities at stations located near river mouth (4 and 5) and gradulay lower diversities at the stations located away from the river mouth (1, 2 and 3). Diversity of all the stations located along the continuum of Urabaru stream is mainly effected by amphidromy of the shrimps.

INTRODUCTION

Freshwater shrimps are important faunal component in tropical ecosystem (Crowl *et al.*, 2001). They often dominet the biomass in tropical streams and rivers (Covich and McDowell, 1996; Mantel and Dudgeon, 2004b; Great house and Pringle, 2006). Freshwater shrimps are shredder of the leaf litter in the stream ecosystem and they are considered as the key component of the food web as scavengers (March *et al*., 2001; Crowl *et al*., 2006). Due to their active role for maintaining the food web they are simply called the keystone species in the stream ecosystem (Pringle *et al*., 1993). They are also known for flow of energy in an ecosystem by transferring the food energy from primary producers (periphyton) and detritus to higher trophic groups (Camara *et al*., 2009; Browder *et al*., 1994; Frederick and Spalding, 1994). In whole, freshwater shrimps play vital role in the functioning and structuring of stream ecosystem.

Top down effects of individual species or species assemblages are important in determining community composition March *et al*. (2002).

There are number of factors which affect the spatial distribution of freshwater shrimps such as adult in precopula, water velocity, predation and food availability. Pakistani back water creeks have also showed the abudance of grey and white shrimp (Ayub and Ahmed, 2002). On the other hand temporal distribution of freshwater shrimps can be affected by their life cycle strategies; including reproduction, migration and larval development. Present study aims to clear the composition and distribution of freshwater shrimps in Urabaru stream, Kikaijima, Japan.

MATERIALS AND METHODS

The study was carried out in Urabaru stream Kikaijima Island, southern Japan from May 2007 to December 2008 (Fig. 1). The Urabaru is an ideal stream for the continnum studies due to its physical characters (small size; shallow depth and slow flows). Total length of Urabaru is measuring~680 meters from headwater to river mouth. Five sampling stations (1, 2, 3, 4 and 5) were sampled along the entire river continnum: St. 1 at headwater, 680 m, and 12 m altitude; St. 2 at 590-580 m from headwater; St. 3 at 400-420 meters from river mouth; St. 4 at 110-90 m ; and St. 5 at river mouth. There were three cascade along the continm of Urabaru stream, first cascade is after St. 1, second cascade is after St. 3 and third one is after St. 4. The height of each cascade was 1.5 meter (Fig. 2).

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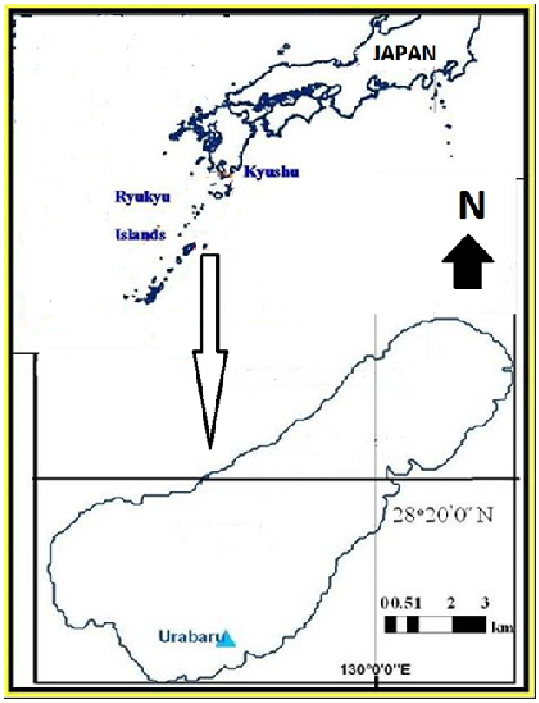

Fig. 1. Map of Kikaijima showing its location in Ryukyu Islands and the location of Urabaru stream in Kikaijima Island.

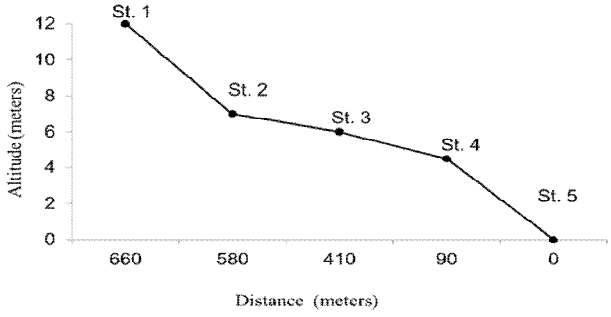

Fig. 2. Continuum of Urabaru stream, with location, altitude and distance of all five stations.

Monthly sampling was carried out with scoop net (1 × 1 mm) via the sweep method, sweeps were counted to calculate the relative abundance (Soomro *et al*., 2010). For mentaining the conservation, live shrimps were observed at the spot and were released back to their native habitat.

Statistical analysis

Relative abundance of each species was calculated according to Soomro *et al*. (2010).

$$\text{Relative abundance} = \frac{\text{Total number of specimens collected}}{\text{Number of sweeps}}$$

Spatial differences in diversity between the sampling stations of the Urabaru stream over the study period were analyzed using the Shannon-Wiener *H´* index (Shannon and Wiener, 1963), was calculated as follows:

$$H' = -\sum_{i=1}^{S} pi \ln(pi)$$

where *p*i is the proportion of total samples belonging to i^{th} specie

Margalef diversity index mainly stress on the quality or number of species in the sample was calculated as per formula given below.

$$Ma = S - 1 / \text{Ln } N$$

Where, S is the number of species, N is the total number of individuals.

This diversity index is based on the species richness. Margalef index can be calculated high if more number of species is present in the sample.

Hierarchical cluster (Ward's 1963 squared Euclidean distance method) was constructed using SPSS.

RESULTS

Species composition and relative abundance at different stations

Total twelve species of freshwater shrimps in three genera of family Atyidae and in single genus of family Palemonidae were observed from headwater to river mouth in Urabaru stream.

Family palaemonidae consisted of five species in single genera and family Atyidae represented the three genera and seven species. (Table I). Family Atyidae included *Paratya compressa*, *Atyopsis spinipes*, *Caridina typus*, *C. sakishimensis*, *C. multidentata*, *C. serratorostris*, *C. leucosticta*. Family Palaemonidae included *Macrobrachium japonicum*, *M. lar*, *M. formosense*, *M. australe*, and *M. grandimanus* (Table I).

Among atyid species *C. typus*, occured at all five stations whereas *C. sakishimensis* at Stations. 1, 3 and 4. The occurence of *C. multidentata* was seen at St. 1-4, with low abundance as compare to *C. Sakishimensis* and *C. typus*. The atyid *P. compressa* was restricted at St. 5 (river mouth) only, on the other hand *A. spinipes* was restricted to St. 4 only. Species like *C. serratirostris* and *C. leucosticta* were only found at St. 4 and 5 (Table I).

Table I.- Occurrence and relative abundance (Mean±SD) on shrimps at all five stations of Urabaru stream.

Shrimps	Stations				
	1	2	3	4	5
Caridina typus	1.39±1.81	2.55±2.75	6.39±5.62	1.97±1.25	0.52±0.93
Caridina sakishimensis	0.66±0.71	--	0.005±0.01	0.007±0.01	--
Caridina multidentata	0.12±0.16	0.03±0.11	0.03±0.08	0.01±0.06	--
Caridina serratirostris	--	--	--	0.40±0.39	0.19±0.20
Caridina leucosticta	--	--	--	0.1±0.04	0.02±0.08
Paratya compressa	--	--	--	--	0.30±0.61
Atyopsis spinipes	--	--	--	0.002±0.01	--
Macrobrachium japonicum	0.32±0.23	0.52±0.56	0.34±0.36	0.51±0.22	0.39±0.63
Macrobrachium lar	0.04±0.04	0.04±0.05	0.02±0.04	0.05±0.11	0.01±0.03
Macrobrachium formosense	--	--	0.01±0.06	0.11±0.19	0.07±0.09
Macrobrachium australe	--	--	--	0.03±0.15	--
Macrobrachium grandimanus	--	--	--	--	0.01±0.02

Among the atyid shrimps *C. typus* being the most abundant species occuring at all five stations , and its maximum denisty was observed at St. 3 (mid stream reaches), and the lowest abundance was recorded at St. 5 (Table I).

The relative abundance of *C. sakishimensis* was high at St.1 only while its very low abundance was obserevd at Stations 3 and 4 and totally absent on other stations.

The relative abundance of *C. multidentata* was low at all stations whereas all other atyid species (*C. serratirostris*, *C. leucosticta*, *P. Compressa* and *A. Spinipes*) were also less abundant (Table I).

Among the Palaemonidae *M. japonicum* and *M. lar* both species occured at at all five Stations along the river continnum. However, *M. japonicum* was the only species, recorded with high relative abundance where other species showed low relative abundance (Table 1). *M. formosense* was observed at Stations 3, 4 and 5. On the other hand, *M. australe* was found at St. 4 and *M. grandimanus* occured at St. 5 only.

Species diversity and richness

Shannon-Winner diversity index showed (1.13, 1.17 and1.2) higher diversities at Stations 1, 4 and 5, with trend of higher to highest repectively. Diversity H´ at Stations 2 and 3 was low (Table II). Highest margalef diversity was 0.99 at St. 4 whereas it was 0.78 at St. 5. Margalef diversity low values on the otherhand, were 0.38, 0.48, and 0.57 at stations 2, 1, and 3, respectively (Table II).

Similarity between five stations of Urabaru stream

Hierarchical cluster (Ward's 1963 squared Euclidean distance) based on the present/absent data of species revealed closness between Stations. 4 and 5 in first cluster. On the otherhand stations. 1 and 2 were close in second cluster, while St. 3 remained in second cluster with slight distance.

Table II.- Shannon-Wiener H´ diversity and Margalefs diversity index calculated at all five stations of Urabaru stream Kikai-jima Island, Southern Japan.

Sample	Shannon Wiener H´	Margalefs D-Index
Sta. 1	1.13	0.48
Sta. 2	0.81	0.38
Sta. 3	0.51	0.57
Sta. 4	1.17	0.99
Sta. 5	1.2	0.78

DISCUSSION

Total twelve shrimp species were documented at Urabaru stream during the study. Previously 11 species are reported from five streams of Kikaijima Island Soomro *et al.* (2010) however the shrips *M. grandimanus* and *A. spinipes* are reported for first time from the study area.

Coexistance of *C. typus*, *M. japonicum* and *M. lar* at all five stations suggests that all these species have no competition for food and space and can freely migrate along the river continuum. Furthermore, *C. typus*, *M. japonicum* and *M. lar* have similar life cycles (diadromous). A same pattern of distribution of these species exhibited in Indo-west pacific region (Shokita,

1979; Cai and Husana, 2009; Soomro *et al*., 2011).

Restricted distribution of *M. formosense*, *M. australe* and *M. grandimanus* in the lower reaches of Urabaru can be attiributed to theie life cycle, habitat preference and specific food availibily. Restriction in distribution of shrimps to lower or upper reaches of river was attributed to avoidance of predation and life cycle strategies Soomro *et al.* (2013). Previously *M. formosense* was reported as an amphidromous species (Mashiko and Shy, 2008; Chen *et al*., 2010).

Among the atyid *C. sakishimensis* was mainly present at St. 1, with rare occurrence at St. 3 and St. 4. The species exhibits a restricted moment along the river continuum. A strong preference to particular habitat was suggested previously (Soomro *et al*., 2013). Sporadic distribution of *C. sakishimensis* was evident at the Islands with particular geological and geographical characters like Coral origin of the island and Kurushio current in the area Soomro *et al.* (2010).

Caridina typus was found at all five stations with high abundance, indicating a free movment of the species from headwater to river mouth. The distribution of *C. typus* along the continuum of Urabaru stream is attributed to cosmopolitan nature (De Silva, 1982; Soomro *et al*., 2010, 2011), and its diadromous life cycle (Suzuki, 2001).

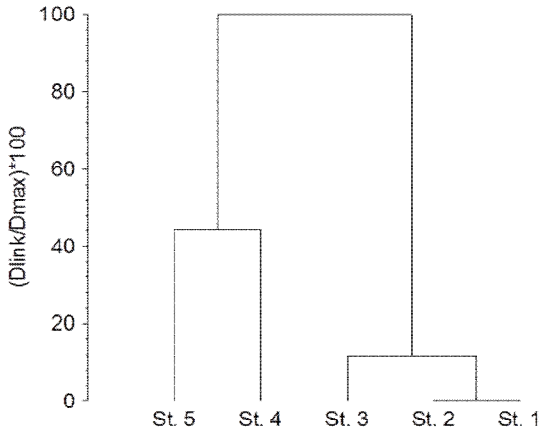

Fig. 3. Hierarchical clustering (Ward's 1963 squared Euclidean distance method) of the sampling stations based on the presence/absence data for shrimp species in the Urabaru stream, Kikaijima Island, southern Japan.

Hierarchical cluster based on the qualitative data showed similarity between St. 4 and St.5 and Sts. 1, 2, and 3 were close to each other in other cluster. On the other hand Margalef diversity also indicates the higher diversity on St. 4 and St. 5. Results of diversity indices showed the higher diversities at the station near river mouth (downstream). Higher diversities near river mouth could be the result of downstream spawning migration of shrimps as well as recruitment, such phenomena can be confirmed by studying the migration studies of the species in Urabaru stream.

Our study suggests that the diversity of freshwater shrimps varied from headwater (St. 1) to river mouth along continumm of Urabaru stream. The difference of biodiversity can mainly be attributed to the life cycle strategies of the shrimps.

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