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RESEARCH PAPER

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Community structure of aquatic insects in pampangan swamp, south sumatra, Indonesia

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Abstract

Aquatic insects play an important role in the life cycle of fish because they provide feed for young fish. The insect and fisheries have become linked together, and to develop the inland fisheries need some consideration given by insects. Research was conducted in Pampangan Swamp focused on determine the species composition and community structure of aquatic insects in Pampangan swamp, Ogan Komering Ilir Regency, South Sumatra Province. Aquatic insect samples were collected from waters which dominated by grasses and water lily vegetation, using submersible insecting net. Similarity and diversity indices, evenness, and species richness, and important value index were constructed based on field data. The results showed that grass vegetation in Jungkal waters has the highest species richness, 39 individuals/m^2 under nine species. Biological indexes such as diversity indexes, evenness indexes and dominance indexes were ranging from 0.24-0.75, 0.35- 0.43, and 0.19- 0.67. Important value index was ranging from 2.44 – 25.46, where the highest value is *Belostoma flumineum*. The condition of Pampangan swamp is in stable condition with the diversity pattern of aquatic insects which providing the feed for fish.

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Introduction

Aquatic insects are a member of insect class, live in aquatic environments, swim or float on the water surfaces, and their larval stadia are usually attached to the roots of aquatic plants. Aquatic insects are dominan in trophic level between primary producers and fish resource, provide feed for young fish that play an important role in the life cycle of fish (Pereira and De Luca, 2003; Pouilly *et al.*, 2006; Luz-Agostinho *et al.*, 2006; Pinto and Uieda, 2007; Dunbar *et al.*, 2010). Good community of insect larvae is usually found in undisturbed streams, where the insect has high diversity and population. Aquatic insects spend one or more stages of their life cycles in the water, with the majority living in water as eggs and larvae and moving to terrestrial habitats as adults. They play important ecological roles in both aquatic and terrestrial realms as primary consumers, detritivores, predators, and pollinators (Dijkstra, 2014).

Cafferty (1983) stated that approximately 10% of the insects are aquatic insect members of the nine orders Ephemeroptera, Odonata, Plecoptera, Trichoptera, Coleoptera, Lepidoptera, Hemiptera, Diptera and Neuroptera. Aquatic habitats can be divided into three parts, namely the surface waters macrohabitat inhabited by insects that walk on water surface and mosquito larvae, order Diptera and the order Hemiptera. The middle parts of waters column are main habitat of aquatic insects and insect drift member of order Hemiptera. The bottom part consisted of mud, sands, rocks and roots of plantsaredominated by Odonata, Plecoptera and Trichoptera (Pechenik, 2005).

Swamps are potential water bodies for expanding fish catch and culture. The swamp is one of the types of lentic water which forms link between terrestrial and aquatic ecosystem (Rahman *et al.*, 1998). Swamp marked one or more of the three following signs: 1) at least periodically covered predominantly by hidrofit; 2) dominated by substrate hidrik that will be never dry, and 3) the substrate is not saturated by land and water or covered by shallow water during a season or a few times a year.

In general, plant species in swamps tend to cluster into species-poor plant communities, or the spread of invasive plant species in the aquatic ecosystem is uneven. In fact, there was several swamp areas are just grass, just by water lily and pandanus (Ewusie, 1982).

Aquatic entomology is an interesting as well as important branch of freshwater biology and the role of insect in water bodies has recently become a matter of great concern to study. Insects are one of the most conspicuous forms of life in water bodies occuring in tremendous numbers and they form as important link in food chain of the aquatic environment.

Futher, insect and fisheries have become so much linked together that it is difficult to think of the development of inland fisheries without some consideration given to insects. Uieda and Motta (2007) reported that during the wet season, the diet for fish is aquatic insect that it shows by the predominance of insectivory in patterns of the trophic organization of tropical fish communities.

This research focused on determining the species composition and community structure of aquatic insects in Pampangan swamp, Ogan Komering Ilir Regency, South Sumatra Province.

Materials and methods

Study Site

Pampangan swamp, located on the eastern part of Sumatra in Ogan Komering Ilir Regency, South Sumatra Province, is a fishing area that gave the highest production of freshwater fish for the district.

The research was conducted at two villages that the swamp water has black color influenced by peat soils with acidic reaction inundated by rain water ie; Jungkal and Deling villages of Pampangan sub district, Ogan KomeringIlir Regency, South Sumatra Province. On this research site, swamp was covered by grass and aquatic weed and become habitat of many species of fish collectively called black fish. During wet season some deeper water areas become swampy fool (Fig. 1).

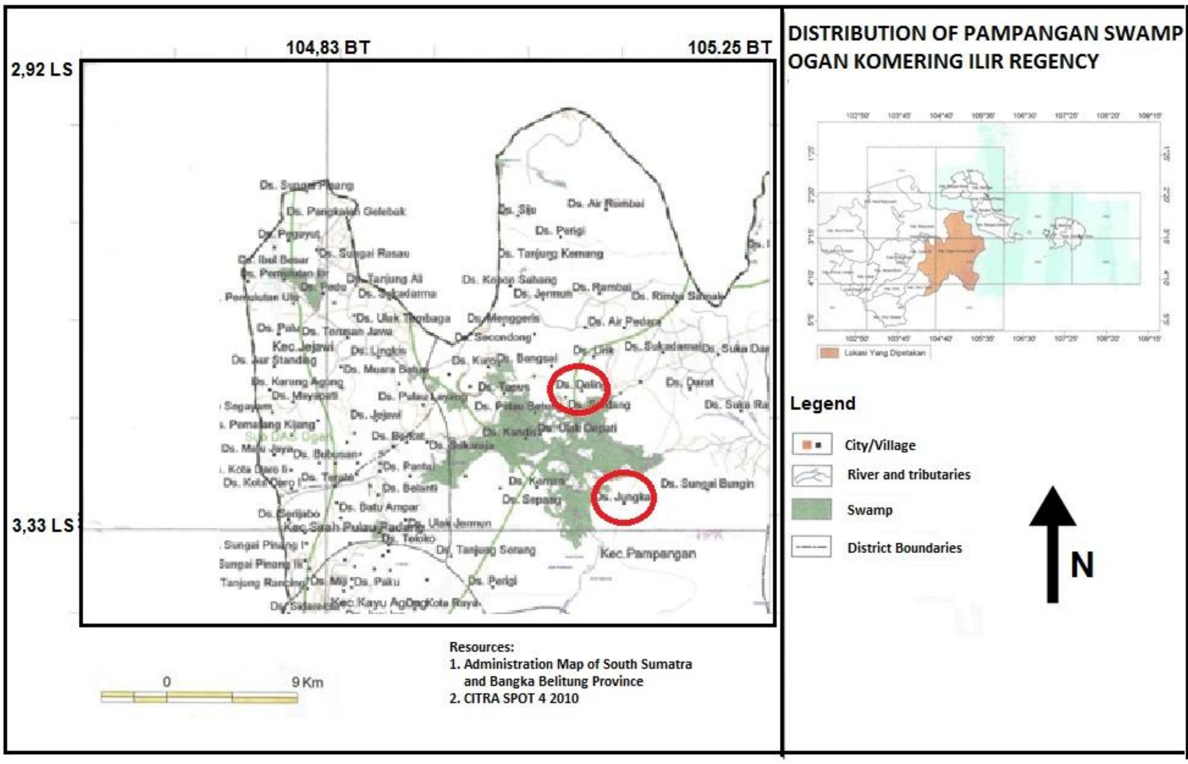

Fig. 1. Map of location research.

Field Sampling

Collecting insect samples was carried out every month during dry season of June to October 2012 using insecting net sinked around submerged parts of plants in 5 plots (1 m x 1 m) every 10 meters and replicated for three times were made in grasses vegetation area and in water lily vegetation area. Samples of insect were preserved by addition10 drops of 10% formaline in 10 ml of water, and the samples labeled according to location and date of collection. Identification was conducted in laboratory by comparing morphology of insects to the determination key on the books of Borror (1989) and Cafferty (1983).

Data Analysis

A. Diversity Index (Shannon-Weaver Index) (Magguran, 1988):

$$H' = \sum_{i=1}^{S} Pi \ln Pi$$

where,

H' = Diversity Index

pi = Proportion Ratio of species i

S = Number of species found

Diversity Index was grouped by the H' values as:

$H' \leq 2$	: Low diversity
$2 < H' \leq 3$	: Moderately diversity
$H' > 3$	: High diversity

B. Equitability Index (Magurran 1988):

$$E = \frac{H'}{H_{maks}}$$

where,

E = Equitability index;

H_{maks} = Ln S

S = Number of species found.

Equitability index has values 0 to 1(Krebs, 1972):

$0 < E \leq 0.5$	: Community in pressure
$0.5 < E \leq 0.75$	: Community in labile
$0.75 < E \leq 1$	: Community in stable

C. Dominance Index (C)

$$C = \sum_{i=1}^{S} (Pi)^2$$

where,

C = Dominance Index;

Pi = Proportion of species i;

S = Total species found.

Dominance index was grouped according the value in 3 criteri as:

$0 < C \leq 0.5$: Low Dominance

$0.5 < C \leq 0.75$: Moderately Dominance

$0.75 < C \leq 1$: High Dominance

D. Important Value Index (Mueller-Dombois and Ellenberg, 1974)

$$INP = KR + FR$$

where,

INP = Important Value Index

KR = Relative Density (Percentage of density species A in every species density)

FR = Relative Frequency (Percentage of Frequency species A in every species frequency).

Results and discussion

Results

In Pampangan swamp, it isfound about 19 species of aquatic insect belonging to 18 families and five orders. Order Coleoptera was the richest with 6 species (Appendix 1). Fig. 2 shows the percentage of family in each order. The aquatic insect composition comprised of five orders (Diptera, Coleoptera, Hemiptera, Lepidoptera, and Odonata). Hemiptera and Coleoptera dominated the numerical relative abundances (five families) with 28%, followed by Diptera (16 families) with 22%, Lepidoptera and Odonata (each two families) with 11% of the total density number. Station 1, in Jungkal village, swamp with grass vegetation has the highest species richness with 39 individu/m^2 under nine species, where *Pelocoris femoratus* is the most important species, while in station 2 in Deling village, swamp with grass vegetation has lower species richness with 21 individu/m^2 under seven species where *Belostoma flumineum* is the most important species. Station 3, in Jungkal village with water lily vegetation has the lowest species richness composed only by four species of insect, while in station 4, in Deling village with water lily vegetation occupied by five species of insect.

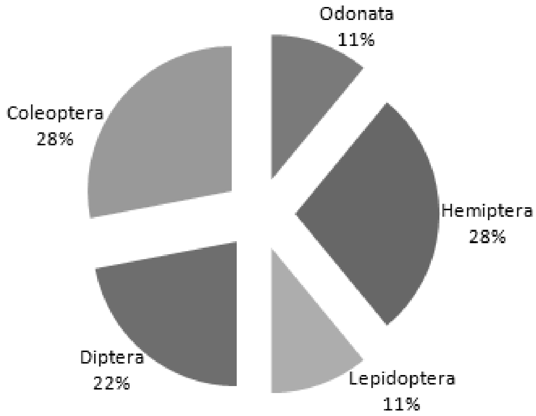

Fig. 2. Percentage number of families in each order.

Table 1 shows the value of diversity index, evenness, species richness dan dominance index. Dominance index ranged from 0.19-0.67 mean low to moderate the dominance of aquatic insect.

The higher value shows the dominated biota but if it is nearest to zero indicated that there is no dominated aquatic insect. It is usually followed by high evenness index. On the other hand, if the dominance index is close to one, it represents that only one aquatic species dominated and usually followed by a low value of evenness index. The diversity index ranged between 0.24 to 0.75 mean diversity at the four stations was low (H <2) and evenness index (E) ranged between 0.35 to 0.43 mean the depressed communities (E <0.5).

The smaller of the evenness index, the smaller the population uniformity, and it shows the distribution of the individual number is not the same. It shows that there are tendency of one biota to dominate the community. The larger of evenness index describes the number of each organisms are the same or not too different. Fig. 3 showed the important value ranges between 2.44-25.46, where the highest is *Belostoma flumineum*. The higher the importance value index means the higher role of the species in the community.

Table 1. Biological indexes of diversity index, evenness, species richness dan dominance index in each location site.

No.	Location	Biological Index	Time				
			Jun	Jul	Aug	Sep	Oct
1	Jungkal waters dominated by grass	Diversity index	0.75	0.65	0.73	0.67	0.60
		Equitability index	0.42	0.40	0.41	0.42	0.43
		Dominance index	0.19	0.25	0.21	0.22	0.25
2	Deling waters dominated by grass	Diversity index	0.67	0.28	0.56	0.30	0.46
		Equitability index	0.42	0.40	0.41	0.43	0.42
		Dominance index	022	0.56	0.31	0.50	0.36
3	Jungkal waters dominated by water lily	Diversity index	0.58	0.24	0.30	0.45	0.54
		Equitability index	0.43	0.35	0.43	0.41	0.39
		Dominance index	0.28	0.53	0.50	0.67	0.33
4	Deling waters dominated by water lily	Diversity index	0.28	0.46	0.45	0.68	0.24
		Equitability index	0.40	0.42	0.41	0.42	0.40
		Dominance index	0.56	0.36	0.38	0.22	0.56

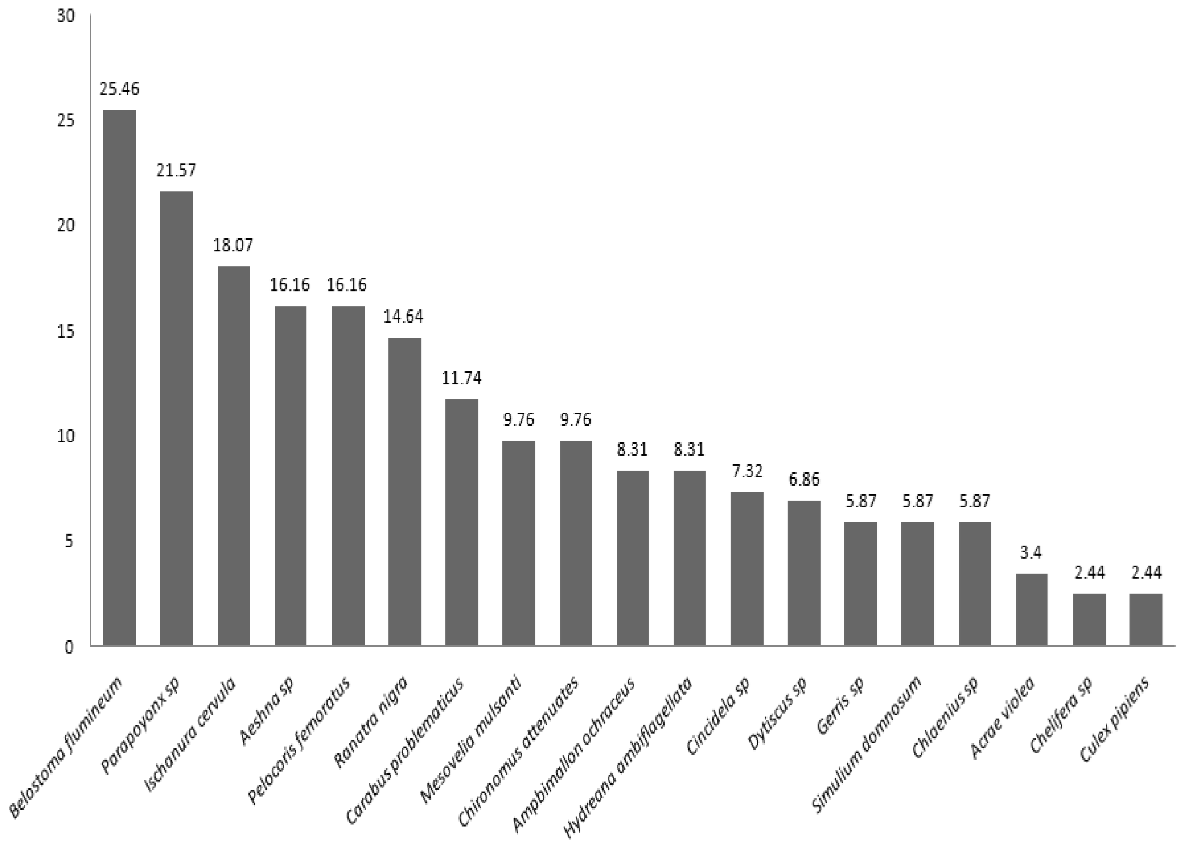

Fig. 3. Important Value Index of each aquatic insect at research station in Pampangan Swamp.

Discussion

This finding shows that grass vegetation with long leaves erected from bottom soils and emergence to the air were more suitable for life of aquatic insect while water lily with broad leaf covering surface water less suitable for aquatic insect life. Muthmainnah and Dahlan (2015) reported that in Pampangan swamp is inhabited by 23 species of aquatic plants. These plants have important role in supplying food for aquatic animals by its allochtonous organic matter (Graca and Canhoto, 2006). This study did from June to October that it was dry session. Annual variation in flood frequency and hydroperiod during the vegetation season has ecological impacts on the floodplain biota. Although many insect groups may have a lower emergence during a flood event, it is poorly known how annual emergence of insects in temporary wetlands is related to the variation in hydrology. The hydroperiod covering up to 40% of the vegetation season has a significant negative effect on the emergence of most taxa and that only a few taxa occurring in the temporary wetlands are actually favoured by a flood regime with recurrent and unpredictable floods (Vinnersten *et al*., 2014).

Balenghien *et al.* (2010) studied the total annual emergence of nuisance flood water mosquitoes will increase with increasing number of floods during the vegetation season. Schlosser (1982) mentioned that benthic insect density fluctuations influenced be annual habitat variation due to rainfall, while Batzer (1998) stated that abundance of midges is influenced by availability of cattail litter. This research also found that aquatic ecosystem with grass vegetation has higher amount of insect individual compare to those in water lily vegetation. Wallwork (1970) stated that the species composition on the habitat is a good indicator to reveal microhabitat quality of an aquatic or terrestrial ecosystem.

Primary productivity in floodplains is usually high due to nutrient exchange between the aquatic and terrestrial phases in the moving littoral zone (Junk and Wantzen, 2004). Vinnersten *et al.* (2014) studied about insect emerge in relation to the flood, and found that the reduced annual insect emergence in relation to increased hydroperiod provided no evidence for an over compensation of insect emergence following a flood. Diptera and Hymenoptera were the orders with the highest relative abundance, and both had significant reduced number of emerged insects in relation to hydroperiod.

Vinnersten *et al.* (2010) whose study on insect production from temporary flooded was indicated that the flooding pattern is a major structuring force for the insect fauna, and that insect production is reduced during floods. Floodplains are inhabited by a wide range of species adapted to either the aquatic or the terrestrial phases, and whereas the aquatic species colonise the wetlands during floods the terrestrial species inhabit the floodplain during droughts. Adis and Junk (2002) stated that immigrating species from non-flooded uplands may suffer high mortality during unpredictable flood pulses, and the floods may also act as a hinder on the development of species adapted to terrestrial conditions (Junk *et al*., 1989). The length of hydroperiod in temporary flooded wetlands seems to negatively affect the emergence of aquatic wetland insect fauna. Vinnersten *et al.* (2010) reported that the Chironomus family of Diptera had an overall increase of emergence in relation to hydroperiod. These taxa have aquatic or semi-aquatic larvae, and especially floodwater mosquitoes are well adapted to recurrent floods with short hydroperiods, and they can be extremely abundant in the swamp. Flood and drought conditions are not the only factors trigging insect emergence, since other factors such as temperatures and timing of flood may be of importance, and may mask the relationship between hydroperiod and emergence over the season.

Muthmainnah *et al.* (2014) reported the result of research to evaluate the fish biodiversity in Pampangan Sub-district and the number of 9,723 fishes corresponding to 46 species were collected, the fish categorized into 16 families belonging to five orders. It shows that this location has high biodiversity of fish and indicates that the role of aquatic insect is very important to provide the feed especially for young fish. Aquatic insect has a great ability to colonize different types of substratum, such as leaves, bulks, stones and macrophytes (Fulan and Henry, 2006) and this wide distribution of aquatic insect makes easy for feeding by fish.

Although Pampangan swamp is encountered with many anthropogenic pressures (deforestation, intensification of agriculture, and soil erosion in the swamp area), and these factors have direct and indirect impact on the diversity of aquatic insects, but as stated by Varandas and Cortes (2010) that many aquatic insect species are good indicators in terms of anthropogenic disturbance and habitat quality. The conservation and management of the swamp is very important for proper functioning of the ecosystem. The freshwater must be recognized as the blood of society (Wetzel, 2000), it is essential to know how aquatic ecosystem function in order to manage them successfully. Furthermore, management of swamp must be clearly determined which one the priority and purpose in conservation for keeping the sustainability of swamps' aquatic resources.

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Appendix 1. Composition of aquatic insects at four research locations.

Order	Family	Species	Local Name	Station																			
				1					2					3					4				
				Jun	Jul	Aug	Sep	Oct	Jun	Jul	Aug	Sep	Oct	Jun	Jul	Aug	Sep	Oct	Jun	Jul	Aug	Sep	Oct
Odonata	Aesnidae	*Aeshna* sp	Capungloreng	3	3	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Coenagrionidae	*Ischnuracervula*	Capungjarum	0	2	1	1	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0
Hemiptera	Naucoridae	*Pelocorisfemoratus*	Kepik air perayap	2	1	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nepidae	*Ranatranigra*	Kalajengking air	1	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Mesoveliidae	*Mesoveliamulsanti*	Kepik air pejalan	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0
	Belostomatidae	*Belostomaflumineum*	Kepik air raksasa	0	0	0	0	0	1	0	3	1	2	0	0	0	0	0	2	2	2	1	0
	Gerridae	*Gerris*sp	Kepik air langkahpanjang	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0
Lepidoptera	Pyralidae	*Parapoyonx*sp	Ngengatrumputmoncong	2	0	1	0	0	0	0	0	0	0	2	3	0	2	3	0	0	0	0	0
	Nymphalidae	*Acraeaviolea*	Kupu-kupuberkakisikat	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	*Chironomus attenuates*	Angas-angas	0	1	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0
	Empididae	*Cheliferasp*	Lalatmenari	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Culicidae	*Culexpipiens*	Nyamuk	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	Simulidae	*Simuliumdomnosum*	Lalathitam/Agaskerbau	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0
Coleoptera	Hydrophilidae	*Amphimallonochraceus*	Kumbang air	0	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Carabidae	*Carabusproblematicus*	Kumbangtanah	2	1	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		*Chlaenius*sp	Kumbangtanah	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0
	Dytiscidae	*Dytiscus*sp	Kumbangpenyelam	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0
	Cincidelidae	*Cincidela*sp	Kumbangharimau	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
	Hydreanidae	*Hydraenaambiflagellata*	Kumbanglumutkecil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	2

Description:

1 = Jungkal waters dominated by grass

2 = Deling waters dominated by grass

3 = Jungkal waters dominated by water lily

4 = Deling waters dominated by water lily

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