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Comparative performans studies of *Pomacea glauca* and *Pomacea canaliculata* different on Macrophyte

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Abstract

Apple snails, *P. canaliculata* and *P. glauca* are the two most successful invaders of many macrophytes especially rice in many countries of the world particularly Southeast Kalimantan Indonesia. Many studies have been conducted on management and ecology of *Pomacea canaliculata* and *Pomacea glauca*, but little is known about edacious *Pomacea* sp especially a bog macrophytes. . Therefore, comparative performans studies *Pomacea glauca* and on different macrophyte was conducted for determine the importance of the fresh water snail behavior in selecting the type of cattails most preferably so that it can be used to control the harmful effects of *Pomacea canaliculata* in rice seeds, and needs to be done to improve biodiversity in paddy fields. Results suggested *Pomacea canaliculata* and *Pomacea glauca* who consumption duckweed showed significantly higher growth, feed preferences, fecundity, eggs diameters and hatchability, followed consumption of water hyacinth> lotus>field paddy> plant attractants.

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Introduction

South Kalimantan has an area of 3,737,743 hectares with geography mostly swamp which covers 800,000 hectares. This swamp area allows agriculture in South Kalimantan to take place throughout the year especially in the tidal swamp and is a potential habitat for growth and development of freshwater water snail. The fresh water snail "Kalambuai" is the local animals are numerous in South Kalimantan swamp waters. Besides having the potential as a swamp animal feed "Kalambuai" is also one of the most disturbing water snails for agricultural lands in South Kalimantan. The disruption resulted in some agricultural areas in South Kalimantan region experienced a crop failure due fresh water snail breeding very fast (Dharmawati, 2006).

The *Pomacea glauca* is fresh water snail species generally do not harm agricultural land compared *Pomacea canaliculata* species. In fact, this species has been handed down for generations by farmers in south Kalimantan as Alabio duck feed. The populations of the *Pomacea glauca* species swamp are now beginning to decline, this may be due to slower breeding and less competing with the *Pomacea canaliculata* species. Based on the morphological structure of his body is not much different from the mulberry conch and spread evenly in almost every water in South Kalimantan Indonesia. Based on the survey and identification results (2004 - 2016), the swamp conch present in the South Kalimantan swamp waters consists of two species, which are greenish or brownish with three brownish lines surrounding the shell in the regional language called kalambuai (*Pomacea glauca*).

Second, golden yellow with a thinner shell and transparent and does not have a circular line, so that the inside looks (*Pomacea canaliculata*) is known by the name of a golden snail. The conch is tolerant in a variety of habitats and extreme environments. According Osorio (1998) snails that live in the waters are usually tolerant to various types of climate, have very fast growth ability and are herbivorous. These snails live in tropical and sub-tropical regions; some members of this genus have been introduced in various countries and become serious problems on wetland farms, especially on rice and taro farms (Cowie, 1995, Naylor, 1996, Cowie 2002).

The results of previous studies of fresh water snails that live in nature developed quite rapidly has the number of eggs 200 to 1300 grains and each m2 can accommodate 20-30 adult fresh water snail with an average weight of 65 grams per head for adult individual of the cycle (Dharmawati, 2006).

The results of previous studies of fresh water snails that live in nature developed quite rapidly has the number of eggs 200 to 1300 grains for adult individual of the cycle (Dharmawati, 2006). The fresh water snail "Kalambuai" a local animal has characteristics that are very attractive, especially with the nature of eating. The results of Dharmawati and Firahmi (2015) obtained information that fresh water liked water plants such as paddy, especially young paddy, duckweed, taro and water hyacinth.

The fondness of the fresh water snail against the plant is because the plant stem structure is softer and softer. The rate of fresh water snails consumption ranges from 3-5 kg/week with the number of individuals with a range of 100-250 tail/m2. Water plants and attractants such as lotus, water hyacinth, briers, jackfruit and papaya skin less favored fresh water snail, presumably because the structure of the plant stems are harder and the plant is only used as a refuge for the snails.

The fresh water snails engage in grazing activities that begin by cooperating with the sensor devices on each side of the mouth to search by the shredded tongue or radula and jaw, then the feed are placed in the oral cavity with fangs and then chewed with movement such as cutting (Owen, 1966; Purchon, 1978). The fresh water snails engage in grazing activities that begin by cooperating with the sensor devices on each side of the mouth to search by the shredded tongue or radula and jaw, then the feed are placed in the oral cavity with fangs and then chewed with movement such as cutting (Owen, 1966; Purchon, 1978). It's they are herbivores and are very fond of water plants such as paddy, especially young paddy, duck weed, and water hyacinth. Some researches were reports mention that fresh water snail was greedy and very fond of water plants, especially paddy.

The invasiveness of Pomacea so is based on their unique morphological and physiological characteristics such as high reproductive potential with rapid growth, polyphagous feeding habits, amphibious respiration and aestivating or hibernating potential (Cowie, 2002; Estebenet and Martin, 2002). All of these character is tics help them to survive under adverse environmental conditions and reproduce aggressively.

In their native habitats, they caused only minor economic losses (Cazzaniga, 2006), included in South Kalimantan the fresh water snails are the used for animal feed, but on the other it has potential as animal feed fresh water snail "Kalambuai" is also one water snails were very disturbing for agricultural land in the region of South Kalimantan (Borneo).

Field observations indicate that these snails not only prey on young rice but also capable of consuming bog plants which is fodder or forage for swamp buffalo (*Bubalus bubalis*). So that there are competition between the snail swamp with swamp buffaloes in terms of obtaining forage and quite disturbing for breeders. The results Burlakova *et al*., (2009); Qiu and Kwong (2009) that the freshwater snail *Pomacea canaliculata* kind of appetite complex and flexible in the use of aquatic plants. Also according to Sanico *et al*. (2002) that the snail has the ability to damage the rice plants, especially in infancy.

It was also reported that the freshwater snail *Pomacea canaliculata* types are not only able to prey on rice plants but also can damage water plant prey on other weed plants (Okuma *et al*., 1994). Furthermore, Zao *et al*. (2012), stated that the rice plant is not a favorite food of freshwater snail *Pomacea canaliculata* types. Apart from these swamps edacious the water plant, the snails potential as a source of protein for poultry, especially waterfowl. That its presence must be maintained. Culturing the aple snails are risk relatively high if not controlled because of the ability to live> 1 year, are omnivores and very greedy mainly on aquatic plants, besides snails is one of the host parasites such *Angioastrongyluss cantonnensis* that can dangerous for human nervous with dizziness, stiff face and meningitis (Hollingsworth and Cowie, 2006).

The fresh water snail contained pigments such as carotenoids, and derivatives zeaxanthine chlorofil, have ability secrete enzymes such as protease, lipase and amiilase, have a high enough population of bacteria in the gastrointestinal tract so as to consume cattails (Malek, 1980). It's unique the fresh water snail is its ability to digest forage. Based on the theory of this ability is estimated related to the type of bacteria contained in the gastrointestinal tract which has high cellulase activity.

The results of Dharmawati and Firahmi (2015) reported that in the fresh water snail gastrointestinal tract there are bacteria that have the ability to digest forage. The bacteria in question are *Bacillus* sp, *Chromabacterium, Actinobacillus* sp This study aims to determine the type of fresh snail performance of *Pomacea canaliculata* and *Pomacea glauca* feed different forages swamp on a laboratory scale. The results of this study emphasize the importance of knowing the behavior of snails in selecting the type of cattails most preferred so as to control the harmful effects of *Pomacea canaliculata* in rice seeds, so it needs to be done to improve the macrophytes biodiversity in paddy fields.

Materials and methods

This research was carried out for 8 months the manufacture of treatment is done in the Applied Laboratory Agriculture Faculty Islamic University Kalimantan Banjarmasin.

Materials

The materials used in the research fresh water snail (*P. Canaliculta* and *P. glauca*) obtained from wetlands and Hulu Sungai Utara South Kalimantan. The macrophyte the used are Kayapu (*Salvinia* sp), lotus (*Nymphaea* sp), water hyacinth (*Eichornia crassipers*), the rice plant (*Oryza sativa*) and plant attractants. The quality of the waters where the maintenance for snails at pH 6.5 containing ± 0.9, BOD 8.50 ± 0.57mg / liter, COD 15.50 ± 0.81mg / liter, CO2 3.85% ± 0.25 and with Fe content of 1.38 mg / L ± 1, 12.

Methods

The research was conducted in the village of Bitin Bake Lake District of Hulu Sungai Utara. The fresh water snails reared in the swamp in which clay substrate by making a plot with size of 1m x 1m and maintained up to spawn. Babirik village chosen because this location is the largest habitat for the snails

After laying two clumps of eggs taken for fekundiy calculated using the gravimetric method in accordance with the reference Effendi (1979). From eggs obtained fekundity calculated by the formula M: m = Q: q. where: M = mass of the cluster of eggs, m = mass number of eggs, Q = the number of eggs that will be searched and q = the number of eggs retrieved. A number of 30 eggs were taken as samples was measured by using a micrometer to calculate the diameter of the eggs and viewed under a microscope with a magnification of 10x5. Clumps of hatched eggs left to hatch naturally. Furthermore, marsh snails hatching results then allowed to grow after the marsh snail weighing 20 ± 0.55g/tail with the male female ratio of 1: 1 was transferred to the aquarium made of fiber with a size of 30 cm x 20 cm x 15cm (Seuffert *et al*, 2010.). On the inside of the tank mounted stainless wire, tank bottom sludge and glass bersubstrat which aims to accommodate the remnants of feed-soluble and dirt snail swamp.

Only active snail riding or attached to the wall of the aquarium that is used everywhere each experimental unit consisted of 6 snails. Furthermore, each unit of the feed materials incorporated treatment kayapu (*Salvinia* sp), lotus (*Nymphaea* sp), water hyacinth (*Eichornia crassipers*), the rice plant (*Oryza sativa* L. forma spontaneous Poaceae) and plant attractants.

Table 1. Characteristics of chemistry Macrophyte for experiment.

Macrophyte	Protein	P	Cellulose	Lignin	Fiber
Kayapu (*Duckweed, Salvinia minima)*	15.90	0.02	21	25.38	16.80
Water hyacinth (*Eichornia crassipers)*	16.25	0.66	18.31	51.65	17.38
Lotus (*Nymphaea* sp)	16.2	0.45	20.70	1.13	15.5
Field paddy (*Oryza Sativa)*	5,36	0,02	33	7,21	32,5
Plant attractant	9,35	0,01	29	6,95	30,52

Source: Analysis carried out in the laboratory of applied Agriculture Faculty Islamic University Kalimantan Banjarmasin,

Before the feed given for fresh water snail done by weighing and calculated based on the weight of fresh and dry weight. Ad libitum feeding and feed intake calculated cumulatively that is based on the amount of feed given less the residual feed in grams/tail. Implementation of the research was conducted independently and stand alone among the fresh water snail species *Pomacea canaliculata* and *Pomacea glauca* with assuming that there is no relationship between the type of snail by macrophyte different parameters to be observed so deemed not affect each other given the nature of the two types of snails somewhat different. The design used in this study is completely randomized design (CRD) with single-factor and repeated 10 times.

Furthermore, the data were analyzed using analysis of variance and if there are differences among the treatments then followed by Duncan's multiple range test.

Results and discussion

Feed preferences

The average of the fresh water snail feeding preferences are presented in Table 2. The average of the highest feed preferences contained in the fresh water snail consumes kayapu, both in species *Pomacea canaliculata* (16.67g) as well as on the species *Pomacea glauca* (16.05g). Preferences lowest for the feed fed fresh water snail attractant plants.

Table 2. The average Feed Preferences of *Pomacea canaliculata* and *Pomacea glauca* Consuming Different macrophysics.

Macrophyte	Average Feed Preferences (g/tail)	
	Pomacea canaliculata	*Pomacea glauca*
Kayapu (*Duckweed, Salvinia minima)*	16.67± 0.03^{e}	16.05±0.07^{e}
Water hyacinth (*Eichornia crassipers)*	15.76± 0.07^{d}	15.43±0.13^{d}
Lotus (*Nymphaea* sp)	10.10 ± 0.04^{c}	14.42±0.03^{c}
Field paddy (*Oryza Sativa)*	6.18 ±0.03^{b}	3.09±0.04^{b}
Plant attractant	3.84 ± 0.04^{a}	2.62±0.07^{a}

Description: The figure followed by the same letter show no significant difference in Duncan Multiple Range Test 5%.

Observations in the field fresh water snail likely of aquatic plants in the form of kayapu (Duckweed) and water hyacinth (Water hyacinth). The fresh water snails to macrophyte such as the structure of the plant stem is soft and delicate. Particularly preferred plants are the leaves where the leaves kayapu and hyacinth relatively softer than the lotus plant, rice and plant attractants. In general, almost all aquatic plants like these snails. Attractant plants given in this study of jackfruit skin and less favored snails, because its structure is toughness and astringent taste.

Some study reported that the *Pomacea* spp. abatable on macrophytes and liked either fresh or leaves or dacaying leaves. The snails are very palatabel for the macrophyte and is capable of stimulating nature of feeding depends on the hardness of the plant, dry matter, content of phenols and alkaloids (Lodge, 1991; Newman, 1991, Burks and Lodge, 2002; Burks *et al*, 2006, Erhard, Pohner and Gross, 2007).

The physical condition of the plant and the chemical composition of the macrophyte and habitat conditions are affecting levels fresh water snails feed preferences (Eiger, de Boer and Hanley, 2007; Li and Dugeon, 2008). *Pomacea canaliculata* capable of consuming plant available in the water and the leaves many species of macrophytes (Estebenet, 1995; Lach *et al*, 2000, Burkalova 2009, Baker, *et al*, 2010, Wong *et al*, 2010) According Tarupay *et al.*, (1991), the snails are eating everything and liked the rice leaves. But in this study turned out to be less favored rice fresh water snail. This is presumably because the stems and leaves of rice has a structure which is toughness.

As it is known that the rice plants located in South Kalimantan agricultural land is largely a local paddy which has an average age of 8 months. In general, local paddy has a tougher stem structure compared to hybrid paddy. So the results of the survey in the field fresh water snail attacks against rice is much lower. Snail prefers swamp bog plants such as *hydrilla* sp, kayapu, Ipomae aquatica and water hyacinth. In general, fresh water snails prefer refined foods easier to digest.

Plants that are harder and algae are also eaten as long as they could undermine it by using radular (rough tongue). Although the system radular on each of the different species, some types of snails have teeth stronger and greater in radulanya compared to other species. Species with thin and tiny teeth (like *Pomacea bridgesii*) cannot penetrate the thick plants and in particular on dead plants and smooth. When the food is insufficient in water, marsh snails utilize such amphibious ability to leave the water to search for food.

Interesting strategy of fresh water snail is the way these animals obtain food that will be consumed by way of approaching food float on the water surface. Usually fresh water snails will swim and crawled out of the stem to the leaf surface by using existing holes in the legs will catch the food on the surface. To attract more food that floats, snails make similar movement on legs like walking with its front legs.

The middle and back legs conch is used to capture the object on the side or surface waters. When the pit is full, snails will bring the particles and distribute it to the head and then eat the food that has been collected is known as "ciliary feeding".

This indicates the water surface usually presents proteins derived from the layer provided on the surface of the water. This thin layer is often seen as a reflection of oil on the surface of the water and the materials produced and microorganisms contained in water.

Body Weight

The average body weight fresh water snails are presented in Table 3. Body weight is highest in the fresh water snail consumption kayapu, both in species *Pomacea canaliculata* (68.58 g/head) as well as on the species *Pomacea glauca* (16.05 g/bird). Preferences lowest for the feed fed on attractant plants. The results of this study indicate that the fresh water snails consume kayapu tend to have a higher body weight.

The *Pomacea glauca* weigh relatively higher (74.45g/bird) compared with *Pomacea canaliculata* (68.58g/bird).

The protein content of the macrophytes plays an important role for the growth of the animals including invertebrates, such as snails. In this study of plant protein content of the water used is relatively high in the range of 5.36% - 16.25%. The protein content was lowest for the rice crop, which is 5.36%, According to Qiu *et al*, (2009); Matson *et al*. (1980) water plant protein in the form of N was an essential element for support metabolic processes. In addition to protein, the levels of phosphorus in aquatic plants also play a role in protein synthesis.

Table 3. The average Body Weight *Pomacea canaliculated* and *Pomacea glauca* have given of Different Macrophyte.

Macrophyte	The average Body Weight (g/tail)	
	Pomacea canaliculata	*Pomacea glauca*
Kayapu (*Duckweed, Salvinia minima)*	$68,58^{c}$±0,94	$74,45^{e}$±0,67
Water hyacinth (*Eichornia crassipers)*	$60,83^{b}$±0,42	$68,29^{d}$±0,90
Lotus (*Nymphaea* sp)	$59,87^{b}$±0,40	$63,25^{c}$±0,88
Field paddy (*Oryza Sativa)*	$61,55^{b}$±1,39	$60,48^{b}$±0,47
Plant attractant	$50,24^{a}$±0,27	$54,15^{a}$±0,65

Description: The figure followed by the same letter show no significant difference in Duncan Multiple Range Test 5%.

The high body weight species *Pomacea glauca* allegedly not only because of the type of feed is also closely related to genetic factors and adaptability of the conch on the environment. One of the factors that determine the survival of the biota is the high

Adaptability in freshwater (Gregoric, 2007, Miranda and Silva, 2006; Derraik, 2008). Marsh snail prefers freshwater and the observation that snail black swamp has long lived in the swamp South Kalimantan compared with yellow snail (apple snail).

Fecundity

The average fecundity yellow snail (*Pomacea canaliculata*) and black snail (*Pomacea glauca*) are presented in Table 4.

The mean fecundity fresh water snails presented in the study were taken from the maintenance, using artificial ponds environmental conditions tailored to his native habitat.

Fecundity average of cluster eggs species *Pomacea canaliculata* are relatively higher than the fecundity *Pomacea glauca*.

The results showed that the average fecundity *Pomacea canaliculated* higher better than *Pomacea glauca* are influenced by the type of forage consumed. The average value obtained at the highest fecundity snails that consume kayapu (*Duckweed* sp) on the species *Pomacea canaliculata* 874 ± 2.71 eggs and 768 eggs ± 4.57 in *Pomacea glauca*.

Table 4. The average fecundity *Pomacea canaliculated* and *Pomacea glauca* to have given of Different Macrophyte.

Macrophyte	Fecundity	
	Pomacea canaliculata	*Pomacea glauca*
Kayapu (*Duckweed, Salvinia minima)*	874 ± 2,71^{c}	768 ±4,57^{c}
Water hyacinth (*Eichornia crassipers)*	779 ± 2,001^{c}	634±2,97^{a}
Lotus (*Nymphaea* sp)	754 ± 1,47^{b}	749±1,47^{c}
Field paddy (*Oryza Sativa)*	656 ± 1,96^{a}	649±1,96^{a}
Plant attractant	725 ± 1,98^{b}	716±1,98^{b}

Description: The figure followed by the same letter show no significant difference in Duncan Multiple Range Test 5%.

The high value of fecundity in these snails that consume kayapu, allegedly closely associated with nutrient contribution and the level of preference on the type of macrophyte are so inclined produce value higher fecundity. One of the factors that affect the value of fecundity is the food factor is the protein content. The Kayapu protein content (*Duckweed* sp) is relatively high compared to other macrophyte used in this study with a range of 16.67%, has the essential amino acids that is high enough.

Value fecundity of both types of snail still within reasonable limits. Riani research results (2011) fecundity fleshy yellow snails on average 848 eggs and black snail much as 775 eggs. Furthermore, the results of research Dharmawati (2015) that the number of clumps of snail eggs ranges between 267-1200 eggs.

According Estebenet and Martin (2002) on freshwater *Pomacea canaliculated* able to lay eggs three times a week throughout his life, and the average - average 3000 grain spawn within 140 days.

Eggs Diameter

The average eggs diameter of the snail eggs are presented in Table 5. The mean diameter of snail eggs fed marsh types kayapu and water hyacinth leaves relatively higher in the range of 2.13 to 2.24mm on *Pomacea canaliculata* and 2.05 to 2.09mm on the species *Pomacea glauca*. The results showed that the eggs diameter of the snail in the swamp in South Kalimantan to have higher egg diameter compared with the results of research Marwoto (1988) and Suwignyo and Riani (1992) with egg diameter 1.5 to 2.0mm. High egg diameter is because of the diversity of the feed contained in the swamp of South Kalimantan

Table 5. Eggs Diameter *Pomacea canaliculated* and *Pomacea glauca*to have given of Different Macrophyte.

Macrophyte	Diameter eggs (mm)	
	Pomacea canaliculata	*Pomacea glauca*
Kayapu (*Duckweed, Salvinia minima)*	2.24± 0.016^{c}	2.09±0.012^{c}
Water hyacinth (*Eichornia crassipers)*	2.13 ± 0.01b^{c}	2.05±0.008^{bc}
Lotus (*Nymphaea* sp)	2.09 ± 0.01^{b}	1.96±0.011^{b}
Field paddy (*Oryza Sativa)*	1.89 ±0.007^{a}	1.84±0.007^{a}
Plant attractant	1.99 ± 0.01^{ab}	1.94±0.01^{b}

Description: The figure followed by the same letter show no significant difference in Duncan Multiple Range Test 5%.

Eggs diameter *Pomacea canaliculated* and *Pomacea glauca* has a range that is not significantly, though on the species *Pomacea canaliculated* has a diameter of yolk that is longer than the species *Pomacea glauca*. More length eggs diameter species *Pomacea canaliculated* is presumably related to the nature of the snails eat the swamp where snail species *Pomacea canaliculated* tend to be greedy and are omnivores, while the species *Pomacea glauca* are more herbivores. Eat nature also affect the egg ssnail diameter and is closely connected with the process of the formation of the yolk (vitelogenesis), so that the snail has a voracious nature tend to have a diameter larger eggs. Diameter snail eggs were lowest for the snail swamp rice consumed either in species or species *Pomacea canaliculated* and *Pomacea glauca*.

The low diameter snail eggs that consume rice because of the nature of the feed which is relatively harder and has a coarse fibers and their higher lignin, making it rather difficult to eat snails. Rice used in this study using local paddy where the structure of the stem is much harder than hybrida paddy. The average eggs diameter *Pomacea canaliculated* and *Pomacea glauca* have a range that is not much different, though on the *Pomacea canaliculated* has diameter of yolk that is longer than the species *Pomacea glauca*. More length eggs diameter *Pomacea canaliculated* is presumably related to the nature of the snails eat the swamp where *Pomacea canaliculated* tend to be greedy and are omnivores, while the species *Pomacea glauca* are more herbivores. Eat nature also affect the eggs diameter and is closely connected with the process of the formation of the yolk (vitelogenesis), so that the snail has a voracious nature tend to have a diameter larger eggs.

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Rice used in this study using local rice plants where the structure of the stem is much harder than rice hibbrida.

Hatchability

The average hatchability fresh water snails are presented in Table 6. Average of hatchability of eggs is highest in the fresh water snail consumes kayapu, both in species *Pomacea canaliculated* (82.12%) as well as on the species *Pomacea glauca* (70.57%). Hatchability of eggs was lowest for the snails fed plant attractants. The snail is presented in Table 6. Average of hatchability of eggs is highest in the snail consumes kayapu, both in species *Pomacea canaliculated* (82.12%) as well as on the species *Pomacea glauca* (70.57%). Hatchability of eggs was lowest for the snails fed plant attractants.

Table 6. The Average Hatchability *Pomacea Canaliculated* and *Pomacea Glauca* to have given of different Macrophyte.

Macrophyte	Hatchability (%)	
	Pomacea canaliculata	*Pomacea glauca*
Kayapu (*Duckweed, Salvinia minima)*	82.12± 0.42^{b}	70.57±0.07^{d}
Water hyacinth (*Eichornia crassipers)*	82.01± 0.27^{b}	70.59±0.06^{d}
Lotus (*Nymphaea* sp)	80.45± 0.049^{b}	69.58±0.087^{c}
Field paddy (*Oryza Sativa)*	79.75±0.22^{b}	68.06±0.22^{b}
Plant attractant	76.17± 0.27^{a}	45.52±0.23^{a}

Description: The figure followed by the same letter show no significant difference in Duncan Multiple Range Test 5%.

Table 6 showed that hatchability of eggs snail species *Pomacea glauca* tend to be lower compared to the species *Pomacea canaliculated*. The results of field observations indicate that the species *Pomacea glauca* compete with *Pomacea canaliculated*, where snails swamp of this type tend to be more aggressive and better able to survive in extreme habitats.

According to Yoshida *et al* (2014) found *Pomacea canaliculated* have a pretty high tolerance to temperature environments including low-temperature environments up to 0°C

Conclusion

The macrophyte favored by *Pomacea canaliculated* and *Pomacea glauca*are kayapu (*duckweed; Salvinia* sp) with indicated Preferences feed, body weight, fecundity, egg diameter and hatchability the higher.

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