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ARAŞTIRMA MAKALESİ **RESEARCH PAPER**

Mutual Living with *Pomacea maculata* and Catfish and Their Benefits for Feeding

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Abstract: *Pomacea* snails have been interested around the world due to their rich biological contents. In this study, we assessed the living condition and feeding strategies of catfish (Loricariidae) with *Pomacea maculata*. We used thirty catfish and ten *P. maculata* in three replicates for four months. There were two groups as: Control and *P. maculata* (catfish and *P. maculata* together). The body weights and lengths of catfish were measured monthly. Also feeding behavior of catfish was recorded during the trial. There were significant increases determined in last weight, total weight gain, last body length, and total body length gain in the *Pomacea* group compared to Control. It was observed that catfish in the *Pomacea* group ate the food which was lumped on the mucous of *P. maculata*. These results suggested that due to this feeding behavior of catfish, they had good progress. It can be concluded that *P. maculata* can be beneficial for ornamental fisheries.

Keywords: Catfish, feeding behavior, ornamental fish, *Pomacea maculata.*.

Pomacea maculata ile Cüce Vatoz Balığının Ortak Yaşamı ve Beslenme Açısından Faydaları

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Öz: *Pomacea* salyangozları, zengin biyolojik içerikleri nedeniyle dünya çapında ilgi görmektedir. Bu çalışmada *Pomacea maculata* ile cüce vatozun (Loricariidae) yaşam koşullarını ve beslenme stratejilerini değerlendirdik. Dört ay boyunca otuz cüce vatoz balığı ve on *P. maculata* kullanıldı. Kontrol ve *P. maculata* (cüce vatoz balığı ve *P. maculata* birlikte) olmak üzere iki grup oluşturuldu. Cüce vatoz balıklarının vücut ağırlıkları ve uzunlukları aylık olarak ölçüldü. Ayrıca deneme süresince cüce vatoz balıklarının beslenme davranışları da kayıt altına alındı. Bitiş ağırlık, toplam ağırlık artışı, bitiş canlı uzunluk ve toplam canlı uzunluk artışında *Pomacea* grubunda kontrol grubuna göre anlamlı artışlar tespit edildi. *Pomacea* grubunda yer alan cüce vatoz balıklarının *P. maculata*'nın mukusları üzerinde topaklaşan yemleri yedikleri görüldü. Bu sonuçlar, cüce vatoz balıklarının bu beslenme davranışlarından dolayı iyi bir ilerleme kaydettiklerini göstermiştir. *P. maculata*'nın süs balıkçılığı için faydalı olabileceği sonucuna varılabilir.

Anahtar kelimeler: Beslenme davranışı, cüce vatoz, *Pomacea maculata*, süs balıkları.

INTRODUCTION

Pomacea, the apple snails, are freshwater mollusks which a member of the Ampullariidae family (Cowie, 2002; Ramakrishnan, 2007; Hayes et al., 2008; Cowie et al., 2017). These snails have a slimy gland that lubricates the pathway and makes to move easier (Demirsoy, 1998). Also, it is mainly used to protect the snail foot during locomotion and maintain moisture as well as reduce friction. The mucous secreted by glands contains hyaluronic acid, coppers, metal ions, antimicrobials, glycoproteins, mucopolysaccharides, and proteoglycans (Gabriel et al., 2011). It also contains calcium and sulfate which have a great role in homeostasis. Researchers observed that the mucous gets lymphocyte proliferation and healing of the tissue wound (Harti et al., 2018). According to the kinds of literature, apple snails have been used in the food industry due to their high biological contents (Halwart, 2008; Hayes et al., 2009). Also, there are several studies about apple snails known as aquatic indicators of environmental pollutants due to their stress tolerance (Giraud-Billoud et al., 2013; Campoy-Diaz et al., 2018).

Pomacea maculata Perry 1810 (*P. maculata*), was one of the native species that was initially named by Cowie on the Official List of Generic Names in Zoology (Cowie, 1997; Rawlings et al., 2007). *P. maculata* can live in freshwater as an amphibious snail that is distributed from Asia and the Pacific (Cowie, 2002). They are also aquatic vegetation and can reproduce rapidly (Cowie, 2002; Estebenet & Martin, 2002). Researchers reported that *P. maculata* can live for one or two years in laboratory conditions at 25 °C. It was determined that *P. maculata* snails can eat detritus and plankton suspended in water (Caglar, 1973). Jong-Brink et al., (1983) observed that reserves of the snails' eggs can accumulate surrounding the oocyte as a perivitelline fluid which has a role in development and reproduction. Also, Heras et al., (2007) showed that eggs of *P. maculata*'s are provided by perivitellin fluid complex with polysaccharides and glyco-lipo-carotenoprotein. The perivitelline fluid was noted as a protein source and has a role in the defense system against stressors and predators. Several studies reported the administration of perivitelline fluids or *Pomacea* for humans as well as animals such as rats and chickens (Diomandé et al., 2008; Giglio et al., 2016; Radzki et al., 2017). However, to our knowledge, there is no data exist of regarding the use of native *P. maculata* for ornamental species. Also, there has been no data about the slimy gland of *Pomacea* for feeding strategy.

Ancistrus (catfish) is the largest family in Loricariidae which has been accepted as a peaceful fish spice. They are known as tank cleaners in the aquarium trade (Regan, 1904). In addition, they can live in different water characteristics and a wide range of pH. Although their tiny structure, they are good vegetative eaters than other species. The mouth structure of catfish is fitted for grazing on flat surfaces in water (Burgess, 1989). They can be fed by herbal feeds such as cucumber, spirulina, boiled spinach and etc. However, feeds in small sizes (flours, meals, or crumbles) and required nutrients are very important for feeding (Robinson et al., 2001). It was observed that pellets and pellet binders do not require for catfish feeding whereas gelatinization could be used for this purpose. It was also reported that depending on the species, pellets can be formed in smaller sizes. Interestingly, catfish have some special sensory organs that assist them to perceive food and nonfood substrats. However, there is limited study about this ornamental fish, and its behavioral differences and nutrition.

In this study, we focused on the edibility of small particle feeds (as microns) to catfish. Also, it aimed to observe the living condition of catfish and *P. maculata* together. We hope this study will simplify our knowledge of the utility of *P. maculata* in ornamental fisheries.

MATERIAL AND METHOD

Animals and Experiment: The animals were housed under standard laboratory conditions. The daily pH, salinity, Total dissolved solids (TDS), conductivity, and aquarium temperature were measured by the Extech Instrument (Extech Instrument, PH100 model number; Table 1). Humidity and environmental temperature were measured by Thermo Hygro (Instrukart Holdings, India). The oxygen concentration was determined by commercial JBL kits (GmbH & Co. KG, Dieselstraße 3,67141 Neuhofen, German).

Table 1. Water quality parameters.

Water Quality Parameters	Mean ± SD
Salinity (g/kg)	336.60±9.23
Total Dissolved Solids (mg/l)	561.40±4.45
Aquarium temperature (°C)	26.96±0.27
Environmental temperature (°C)	27.88±0.13
Humidity (%)	60.40±1.82
pH	8.04±0.03
Oxygen concentration (mg/l)	8.00±0.001
Conductivity (µs)	687.40±7.22

For the filter system, a pipe filter was used. It siphoned the accumulated waste in the aquariums every two days and exchange water with the same temperature as the aquarium during the trial. In the trial, 12 hours light and 12 hours dark photoperiod were applied in aquariums with a body length of 33*30*40 cm.

Thirty *Ancistrus punctatus* L182 (catfish, Loricariidae) were studied in the trial. All groups of catfish (Loricariidae) were fed a commercial diet, including trout food with a dimension of 300-500 microns. The ten apple snails *P. maculata*, which were produced in laboratory conditions, were put in aquariums in group *P. maculata* (Picture 1A).

The groups as follows:

1th Group: Control (only fed by commercial standard diet)

2nd Group: *Pomacea* (fed by commercial standard diet, and added ten *P. maculata* to each aquarium)

The experimental catfish (Loricariidae) were divided into two groups with three replicates. The total experiment protocol was maintained for four months.

***Morphological Measurements*:** The morphological parameters (weight and body length) of catfish (Loricariidae) were measured in all groups monthly during a four-month day trial. The weight and body length gains were also evaluated. Nevertheless, the feeding behaviors were recorded by photos and videos.

***Statistical analyses*:** Statistical analyses were performed with SPSS (Version 20.0). The values were grouped and calculated as mean ± standard error.

Independent sample two test was applied to all parameters to examine the difference between groups that were considered at P < 0.05.

RESULTS

Our results showed that body weights and lengths of catfish (Loricariidae) increased in group *Pomacea* compared to Control during four months as shown in Figure 1. The last body weights of catfish in the Control and *Pomacea* groups were found 0.84±0.06 g and 1.11±0.05 g respectively (P: 0.001; Table 2). The total weight gain was 0.57±0.05 g and 0.90±0.05 g in the group respectively Control and *Pomacea* (P < 0.0001). The last body length (P: 0.005; 4.15±0.11 and 4.57±0.09, Control and *Pomacea* groups respectively) and body length gain (P: 0.008; 1.34±0.13 and 1.80±0.10, respectively Control and *Pomacea* groups) were found significantly.

Nevertheless, the feeding behaviors of catfish (Loricariidae) were photographed that shown in Picture 1B. The fish ate the food particles that adhered to the snail's saliva.

DISCUSSION

In the present study, we assessed the living and feeding condition of catfish (Loricariidae) with *P. maculata*, and identified the utility of *P. maculata* for ornamental fisheries. We provided that four months of life of *P. maculata* and catfish (Loricariidae) together friendly.

Catfish (Loricariidae) belonging to the Loricariidae family has a functional mouth that functions to scrape the algae found in fresh water in nature, especially in rock-like areas. Also, their mouths allow them to hold themselves on the ground or in desired areas (Buck & Sazima, 1995). It was reported that the formulation of feeds is important for catfish's digestion. In aquariums, when they are fed as an ornamental fish, they can eat vegetables predominantly such as spinach, carrot or spirulina which also are in smaller formed pellets. In addition, prepared feeds and mixtures have been used successfully for the growth and health of this spice. However, the catfish producers try to optimize the profits of feed to avoid waste due to the insensitivity of catfish culture. Feeding catfish (Loricariidae) may be almost difficult and expensive. So, either alternative protein sources or feeding strategies are crucial (Robinson et al., 2001). In the present study, where also multiple culture trials were studied, catfish (Loricariidae) and *P. maculata* lived together in an aquarium friendly (Picture 1A). Besides no mortality, the weight and body length gains were increased in group *Pomacea* compared to Control ones during four months (p<0.005; Table 2, Figure 1). This result indicated that this friendship may be an alternative multicultural instance for feeding strategy and protein sources.

Nevertheless, except for feeding from hanging on the water surface normally, catfish (Loricariidae) showed an interesting feeding behavior. In all groups, catfish (Loricariidae) were fed by 300-500 micron-sized trout feed pellets. Besides that, they ate the foods lumped with mucous of *P. maculata* in the *Pomacea* group (Picture 1B). It was observed that the lumpy included mucous and foods in dimensions 300-500 microns may make it easy to collect and eat. Because of this feeding, higher growth parameters of catfish (*Loricariidae*) were found in group *Pomacea* compared to Control ones significantly.

Table 2. Utility of *P. maculata* on body weight and body length parameters of catfish (Loricariidae) for four months. All data are presented as the mean ± SE (n=30).

Parameters	Groups		
	Control	**Pomacea**	***P* values**
Initial body weight (g)	0.25±0.01	0.25±0.01	0.753
Final body weight (g)	0.84±0.06	1.11±0.05*	0.001
Total weight gain (g)	0.57±0.05	0.90±0.05*	< 0.0001
Initial body weight (g)	2.80±0.04	2.79±0.03	0.849
Final body weight (g)	4.15±0.11	4.57±0.09*	0.005
Total weight gain (g)	1.34±0.13	1.80±0.10*	0.008

* *P* < 0.05 ; Pomacea versus Control group

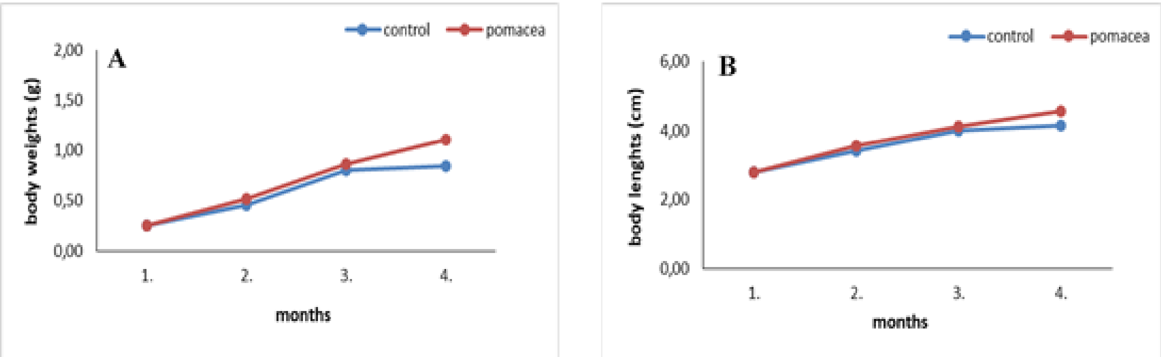

Figure 1. Utility of *P. maculata* for four months on body weight (A) and body length (B) parameters of catfish (Loricariidae). All data are presented monthly, and as the mean ± SE (n=30).

Picture 1. 1A; The *P. maculata* and catfish (Loricariidae) living together shown in an aquarium. 1B; The mucous of *P. maculata* which were eaten by catfish (Loricariidae).

P. maculata was accepted as a protein source in the aquarium industry due to their size, rapid growth, quick adaptability, and high reproductive rate by researchers (Naylor, 1996; Cowie, 2002). It was reported that the mucous of *P. maculata* includes protein, glycoproteins, calcium, phosphorus and achatin. According to the literatures, there are several effects of *P. maculata* such as analgesic, antibacterial, antimicrobial, and antifungal effects (Gabriel et al., 2011; Santana et al., 2012; Harti et al., 2018; Nantarat et al., 2019). Belong to these effects, apple snails and their vitelline fluids were introduced as the most popular alternative protein sources for humans and also industrialized consumption (Reporter, 2012; Dreon et al., 2014; Pitt et al., 2015; Giglio et al., 2016; Giglio et al., 2018). Chimsung and Tantikitti (2014) showed that fermented golden apple snails could be a protein source for tilapia. Also, some researchers observed that oral administration of apple snail egg's perivitellin fluid to rats promoted the intestinal mucosa, and thereby increased growth rate due to protein and rich contents (Dreon et al., 2014). On the other hand, there are some contradictory results about snails reducing growth in rats and chickens (Diomandé et al., 2008; Radzki et al., 2017).

CONCLUSION

In the ornamental aquarium trait, there are several important ecological considerations. The production systems, natural environment, nutrition and harvest of fish are sounded important in principles of aquarium. In other words, the needs can be understood and taken for a well aquarium as well as fish health. In the study, we attempted to explain the association of catfish (Loricariidae) and *P. maculata* with evaluating feeding and growth. It can be said that lumpy of *P. maculata* can be used for ornamental fisheries for better feeding. However, further investigations are needed to fully evaluate the utilization of *P. maculata* and its lumpy with different ornamental species.

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