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The effects of Fairy Shrimp *Phallocryptus spinosa* (Branchiopoda: Anostraca) as live food on reproduction performances and color of freshwater ornamental fish prawns

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Abstract: Fairy shrimps are freshwater Anostracans which have a great importance to provide live food for cultured sturgeon, trout and ornamental fish due to high nutritional value, high individual biomass, rich carotenoid pigments and potential for bioencapsulation with PUFA, Vitamins and drugs for delivery into the recipient organism and adaptation to freshwater. Prawn ornamental fish genera, including Angel Fish, Green Tailor, Severum, Gourami, Corydoras, Flower and Afra after adaptation were fed with two test groups, granulated concentrate supplemented with cow heart and spinach as manual diet and granulated concentrate supplemented with fairy shrimp (*Phallocryptus spinosa*) as live food. Each treatment was performed in three replicates and conducted in one month. The standard culture, propagation condition and physico-chemical factors of water were provided at optimal condition for each group. In all fish genera, feeding with fairy shrimp showed a significant higher fecundity and hatching percentage compared to manual diet ($p<0.05$). In all groups fed with fairy shrimp the duration of spawning time were reduced 5-12 days and their colors were significantly changed.

Key Words: *Phallocryptus spinosa,* Prawn Ornamental Fish, Reproduction performance

Introduction

Nowadays, the production and trade of ornamental fish is a profitable sector in aquaculture. Despite the economical importance of this trade, there is little information available on ornamental fish nutritional requirements. Food items including bovine heart and liver, tubifex worms, *Artemia* nauplii and mosquito larvae are offered to improve the reproductive maturation and spawning of most freshwater ornamental fish (Velasco-Santamaria and Corredor- Santamaria, 2011).

Fairy shrimps are freshwater relatives of brine shrimp *Artemia*. These creatures have the potential to be used as a live food for ornamental fishes (Prasath *et al*., 1994). Also, their cysts and nauplii may be beneficial in

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larval culture of these aquatic species.

The benefits of fairy shrimps as live food includes high nutritional value, high individual biomass, rich carotenoid pigments and potential of bioencapsulation with PUFA, Vitamins and drugs for delivery into the recipient organism (Munuswamy, 2005). Both larvae and adult fairy shrimps can be used as a suitable live food in freshwater aquaculture especially, *Macrobrachium rosenbergii* and ornamental fish (Munuswamy, 2005; Mura, 1992; Sriputhorn and Sanoamuang, 2011). Fairy shrimp cysts contain 45-50 % protein and 5-6 % lipids (on dried weight basis) that are suitable for larval stages nutritional requirements. Also, their biomass can be used as food for growth and matured aquarium fishes. Fairy shrimps nutritionally compete with *Artemia* and enjoy carotenoprotein complexes, astaxanthin, canthaxanthin and antheraxanthin (Munuswamy, 2005; Velu *et.al*., 2003). However, due to their coloration and longevities of nearly one year, some species of fairy shrimps are important as ornamental fish themselves (Munuswamy, 2005). Species like *Streptocephalus torvicornis* and *S. proboscedeus* have a life span of nearly one year (Dumont and Munuswamy, 1997). It has proven that enrichment of live food with n3 highly unsaturated fatty acids (n3- HUFA), especially eicosapentenoic acid (EPA) and docasahexenoic acid (DHA) and also, Vitamin C to be helpful in nutritional value of feed (Lavens *et al*., 1999; Velu *et al*., 2003; Munuswamy, 2005). *Artemia* and Rotifers are naturally poor in n-3 HUFA and especially DHA. This can be compensated by feeding with n-3 HUFA enriched products (Noshirvani, 2006; Azari Takami *et al*., 2005). Fairy shrimp feeding with algae, bacteria and nutrients of their habitat can ingest lipids and increase their HUFA content significantly. Also, enrichment of fairy shrimps with DHA-SELCO increased the DHA (1.92 %) and EPA (11.29%) contents in 3 hours incubation in the enrichment medium (Munuswamy, 2005). This study was conducted to compare the effects of Fairy shrimp (*Phallocryptus spinosa*) and manual diet on reproductive performance (e.g. egg number and hatching rate) of some freshwater ornamental fish prawns to provide a high nutrient food and increase the quality and quantity of obtained eggs and enhance health and marketable desirability of cultured ornamental fish.

Materials and methods

Prawn ornamental fish genera, including Angel Fish (*Pterophyllum scalare*), Green Tailor(*Aequidens rivulatus*), Severum (*Heros severus*), Gourami (*Trichopodus trichopterus*), Corydoras (*Corydoras aeneus*), Flower and Afra(*Cynotilapia afra*) after adaptation were fed with two test groups, granulated concentrate supplemented with cow heart and spinach as manual diet (treatment 1) and granulated concentrate supplemented with fairy shrimp

Tab. 1: Physico-chemical factors of water for various ornamental fish prawns

	Water Tem. (° C)	pH	TSS (mg/l)
Angel Fish	29-30	7	350-450
Green Tailor	28	7	350-450
Severum	29	6.5	350-450
Gourami	26	7	350-450
Corydoras	25	-	350-450
Flower	28-29	-	350-450
Afra	27-28	7	350-450

(*Phallocryptus spinosa*) as live food (treatment 2), daily for one month. Each treatment contains a pair of ornamental fish prawn with three replicates. They did not have any mortality during the test period. The culture and propagation condition and physico-chemical factors of water were maintained at optimal condition for each group and the same in all treatments (Table 1). Treatment 1 and 2 groups were daily fed with manual diet (cow heart and spinach) and fairy shrimp (15 *Phallocryptus spinosa* per each pair of prawns) at 8 A.M. and 8 P.M., respectively. All prawns were fed granulated concentrate at 12 P.M to provide amino acid requirements. Live fairy shrimps at the size of 15-20 mm were captured from a natural vernal pool around Khasellou region using 150 micron mesh size trap and directly fed to prawns. The number of eggs and hatching percentage of obtained eggs were compared by one way ANOVA, t-test. Also, the intervals of laying eggs in test groups were determined.

Results

Mean ± SE of egg number and hatching percentage of different ornamental fish prawns fed with fairy shrimp and manual diet was compared in Table 2.

Egg laying intervals of prawns were shown in Table 3. Prawns in group 1 and group 2 mainly laid eggs every 15 and 8-10 day intervals, respectively. In group 2, that fed with a diet containing fairy shrimps, number of eggs and egg hatching significantly were higher than group 1 ($P<0.05$). Also, fairy shrimp application in group 2 improved fish skin brightness and coloration (Table 3).

Discussion

Culture of ornamental fish is a developing industry and its worldwide export trade is growing fast. Use of live food is one of the prerequisites of larval stage culture of most aquatic animals and providing of nutritional feeding sources and meanwhile economically cost effective. Common live foods used in economic rearing of ornamental fish larvae are usually confined to macro and micro-live food included Moina, Daphnia, *Artemia* nauplii, Tubifex, bloodworm, mosquito larvae and rotifers. Regarding the increased worldwide *Artemia* cyst price, in order to reduce reliance on *Artemia*, researchers and most of larvicu-

Tab. 2: Mean ± SE of egg number and hatching percentage of different ornamental fish prawns fed with fairy shrimp and manual diet.

	Prawn weight	Prawn total length	Number Egg		Percentage Hatching	
	(g)	(cm)	group 1	group 2	group 1	group 2
Angel Fish	50±2.5	15±1.5	398.0±3.0^a	694.8±5.5^b	71.0±1.0^a	83.1±0.6^b
Green Tailor	150±1.5	15±1	1001±1.0^a	1493.1±5.6^b	80.5±0.5^a	93.1±0.6^b
Severum	140±2	16±1.5	700±1.0^a	893.5±6.9^b	65.5±0.5^a	74.2±0.7^b
Gourami	30±0.5	7±0.5	1002±2.0^a	1982.7±9.2^b	80.5±0.5^a	90.5±0.6^b
Corydoras	25±1	5±0.5	405.5±5.5^a	591.1±6.7^b	80.0±0.0^a	84.4±0.2^b
Flower	50±0.5	20±1	1001.0±2.0^a	1485.6±8.3^b	52.5±1.5^a	69.8±2.5^b
Afra	60±1.5	8±0.3	400.0±3.0^a	698.6±2.4^b	90.0±0.0^a	94.3±0.4^b

Common letters indicate no significant difference and non common letters indicate a significant difference ($p<0.05$). Group 1: fed with manual diet Group 2: fed with fairy shrimp.

Tab. 3: Comparison of egg laying intervals (day) and skin color improvement indices of studied ornamental prawns.

	egg laying intervals (day)		skin color improvement indices of group 2
	group 1	group 2	
Angel Fish	15±0.9^a	8±0.4^b	colorfulness
Green Tailor	18 ±0.8^a	11±0.5^b	Existence of green stripes on the head, redness of tail , dorsal and pectoral fins
Severum	19±0.5^a	11±0.7^b	Colorfulness, Existence of red pink stripes on the head
Gourami	12±0.1^a	7±0.7^b	Existence of black wavy distinct spots, snaky skin
Corydoras	23±0.25^a	11±0.12^b	Existence of black wavy distinct spots, snaky skin
Flower	15±0.9^a	10±0.1^b	Colorfulness, Existence of red and green stripes, redness of fins
Afra	11±0.1^a	6±0.5^b	Existence of black stripes on the head, redness of tail, dorsal and pectoral fins

Common letters indicate no significant difference and non common letters indicate a significant difference ($p<0.05$). Group 1: fed with manual diet Group 2: fed with fairy shrimp

lture centers try to find an alternative to live food and use dry food or captured zooplankton from pools to larvae culture (Rurangwa *et al*., 1993; Gonzales *et al*., 2008). Fairy shrimp species such as *Streptocephalus sirindhornae* and *B. thailandensis* have cultured successfully (Saengphan *et al*., 2006). Also, they have used as live food for freshwater and ornamental fish feeding (Sriputhorn and Sanoamuang, 2011). Decapsulated cysts and adults of fairy shrimp *Streptocephalus dichotomus* as a diet was successfully used to goldfish *Carassius auratus (*Velu and Munuswamy, 2007), angelfish *Pterophyllum scalare* larvae (Velu and Munuswamy, 2003) and juvenile fish *Oreochromis mossambicus (*Prasath *et al*., 1994), respectively. Also, *S.proboscideus* nauplii were used for larvae rearing of Persian

sturgeon, *Acipenser persicus* by Imanpour *et al*., 2007) and tilapia *Oreochromis aureus* by Ali and Dumont, (1995). The results of these studies showed a 0.35 and 0.39 FCR Values compared to 0.36 FCR value for nauplii of *Artemia*. Furthermore, *B. thailandensis* was demonstrated to contain a higher protein content of 64.9% (Saengphan *et al.*, 2006) compared to 56.4% in *Artemia* (Tunsutapanich *et al*., 1993). Akbari (2013) studied the effects of commercial dry food, *Artemia* nauplii and ground cow heart on growth and reproductive of *Pterophyllum scalar* and revealed that in *Artemia* nauplii diet females reached a maximum fecundity (first spawning 461 eggs) and percent of fertilization (55.53%). The same author observed a significant difference between *Artemia* nauplii and other diets and no significant difference between commercial dry food and cow heart diets.

This study revealed that egg number of ornamental fish prawns fed with fairy shrimp *Phallocryptus spinosa* i.e. Angel fish (694.8±5.5), Green Tailor (1493.1±5.6), Severum(893.5±6.9), Gourami (1982.7±9.2), Corydoras (591.1±6.7), Flower(1485.6±8.3) and Afra (698.6±2.4) enjoyed a higher Egg number Mean±SE) compared to those fed with manual diet i.e. 1001±1.0, 700±1.0, 1002 ±2.0, 405.5±5.5, 1001.0±2.0, 400.0±3.0, respectively. Also, hatching percentage of obtained eggs from ornamental fish prawns fed with fairy shrimp *Phallocryptus spinosa* i.e. Angel fish (83.1±0.6), Green Tailor (93.1± 0.6), Severum (74.2±0.7), Gourami (90.5± 0.6), Corydoras (84.4±0.2), Flower (69.8±2.5) and Afra (94.3±0.4) were significantly higher than those fed with manual diet i.e. 71.0±1.0, 80.5±0.5, 65.5± 0.5, 80.5± 0.5, 80.0±0.0, 52.5±1.5, 90.0±0.0, respectively. These data revealed that fairy shrimp is a suitable food source to improve fecundity and fertilization of ornamental fish prawns.

Velu *et al.* (2003) showed that *Streptocephalus dichotomus* contained a high amount of total carotenoids (114.3 µg/dry wt.) compared with that of *Moina micrura* (29.5 µg/dry wt.). Cooked fairy shrimp are also consumed by people in North East Thailand (Sanoamuang and Dumont, 2000). Fairy shrimps for example, *S. dichotomus* contained all essential amino acids and fatty acids, 50 % protein and 10% fat considered as a suitable live food. Also it enjoys high amounts of reproductive hormones (Nithya and Munus-wamy, 2002).

Fairy shrimp can be used as a gastrointestinal stimulator in artificial pellet diets for fish larvae and crustacean (Velu and Munuswamy, 2007).

Thus, fairy shrimp may be a suitable alternative for larviculture. Sriputhorn and Sanoamuang (2011) used adult fairy shrimp *S. sirindhornae* as live food with high nutritional value and preserving good water quality to enhance growth and carotenoid content of

freshwater prawn *Macrobrachium rosenbergii*. These authors showed that feeding the adult prawn *M. rosenbergii* with live adult *S.sirindhornae* improved growth performance and carotenoid content of the prawn compared to dry food. They noted that the prawns fed with pure fairy shrimp showed the highest total carotenoid which was 2.8 times more than that of those fed with pure dry diet. The improvements in coloration of studied ornamental fish prawns of group 2 may be attributed to carotenoid pigments in fairy shrimp. Also, Velu and Munuswamy (2008) demonstrated that feeding the *M. rosenbergii* post larvae with *S. dichotomus* nauplii which were rich in protein, lipid, essential amino acids and essential fatty acids, increased length, weight and survival percentage. Seidgar *et al*. (2007) studied the geographical distribution of fairy shrimps in East Azarbaijan province of Iran and showed that various species of fairy shrimps enjoyed a wide distribution in that province and contained high amounts of n-3 HUFA, EPA, DHA, and Linolenic acid.

In ornamental fish, body color is an important factor affecting the market price. Velu and Munuswamy (2007) reported the existence of major carotenoid pigments including canthaxanthin (45.73%), astaxanthin (30.17%) and β-carotene (8.78%) in *S. dichotomus*. Laboratory studies have shown that consumption of fairy shrimp as live food improved pigmentation in prawn larvae and goldfish (Dumont and Munuswamy, 1997), adult prawns (Sriputhorn and Sanoamuang, 2011) and flower horn fish (Sanoamuang *et al*., 2006). The color of fairy shrimp is likely due to the deposition of carotenoids from their natural food sources (Sriputhorn and Sanoamuang, 2011). As ornamental fish prawns cannot form or convert intermediary precursor pigments to carotenoids, diets rich from carotenoids must be fed and carotenoids will be stored in their tissue. Carotenoids have a great role in enhancing body coloration, reproduction, immunity, survival and antioxidants (Miki, 1991; Velu *et al*., 2003). Therefore, in this study, feeding with fairy shrimps has improved brightness and body color enhancement, such as colorfulness, existence of green, red pink or black stripes on the head, redness of tail, dorsal and pectoral fins of studied ornamental fish prawns and probably higher market prices of group 2 comparing with prawns fed with manual diet.

This study revealed that feeding of various ornamental fish prawns with a diet containing fairy shrimp *Phallocryptus spinosa*, significantly increased fecundity, hatching percentage of obtained eggs, reduced the duration of spawning time and enhanced their body coloration compared to manual diet.

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