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## The Effect of Different Feeding on The Growth and Colour Brightness of Glofish

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## Abstract

This study aims to evaluate the effectiveness of different types of feed, namely natural the growth and color brightness of GloFish Starfire Red. Achieving optimal color brightness and growth is essential in ornamental fish cultivation, as these factors directly impact the marketability and economic value of the fish. The research employed a Completely Randomized Design (CRD) with four treatments each replicated three times to ensure the validity of results. The parameters measured in this study included absolute weight growth, absolute length increase, and brightness in color. Color brightness was analyzed using a digital visual comparison tool to ensure objective measurement. The findings revealed that natural feed significantly enhanced both weight and length growth when compared to artificial feed. Furthermore, fish that were fed with *Chironomidae* exhibited a more pronounced improvement in color brightness than those subjected to other treatments. These results suggest that specific types of natural feed may offer superior benefits over artificial feed in promoting both aesthetic and physical development in ornamental fish like Glofish Starfire Red.

## Keywords

Brightness of Color, Chironomidae, Ornamental fish, Glofish fish, Growth

## 1. Introduction

Ornamental fish are a type of fish that are kept for visual beauty, often placed in public areas such as lobbies or living rooms. In addition to fulfilling hobbies, ornamental fish are also a business opportunity that is increasingly in demand by the public. The Ministry of Maritime Affairs and Fisheries (*Kementerian Kelautan dan Perikanan/KKP*) noted that national ornamental fish production continued to increase from 1.19 billion in 2017 to 1.28 billion with a value of IDR 19.81 billion in 2019. The pandemic situation did not hinder the increase in interest in ornamental fish, which remained high even in difficult conditions. Glofish fish are a type of ornamental fish that attract attention and are usually placed in aquascapes because of their bright and bright colors. According to Mustofa et al. (2023) glofish fish are produced through the process of developing a combination of genetic/transgenic changes, from this process fish are produced that have bright and attractive colors. Glofish fish were initially introduced in 2003 and still have many enthusiasts among ornamental fish enthusiasts from many places around the world. An important factor that affects the growth and brightness of the color of this fish is the quality of the feed, which must support energy needs and optimal growth (Khairuman, 2011).

Feed plays a crucial role in ornamental fish cultivation because it functions as the main source of energy for fish growth and health (Hoseinifar et al., 2023). Good food must be in accordance with the physiological needs of the fish, especially in supporting the brightness of the color which is the main attraction of the Glofish fish. Natural feed such as *Tubifex* sp., *Daphnia* sp., and bloodworms, are known to contain high protein and essential nutrients (Purwakusuma, 2007; Madinawati & Serdiati, 2011). Several studies have shown that providing natural feed can increase the intensity of color and growth of ornamental fish better than artificial feed (Pratama, 2021).

*Daphnia* sp., a key component of freshwater zooplankton, measures between 0.2 to 3.2 mm in length and has a bilateral, flat body covered by a transparent chitin carapace. Its body structure is almost invisible, with internal organs clearly visible due to its transparency (Bethke et al., 2024; Baumann et al., 2014). The head features compound eyes, ocellus, and two pairs of antennae that aid in swimming. Maulidiyanti et al. (2015) found that comet fish fed *Daphnia* sp. experienced faster growth. Bloodworms, rich in nutrients, are another popular natural food for fish farming. Research by To'bunga (2016) showed that fish fed bloodworms exhibited better growth than those fed commercial feed. The carotenoid content in bloodworms enhances the coloration of Glofish, making them more vibrant (de Carvalho & Caramujo, 2017; Shastak & Pelletier, 2023).

*Tubifex* sp., also known as silkworms, thrive in freshwater sediments and are valued for their nutritional content, promoting fish growth. Harpaz et al. (2007) demonstrated that *Tubifex* sp. can increase astaxanthin levels in fish meat and tail fins. Additionally, artificial feed like pellets is commonly used in ornamental fish farming for its nutritional balance, cost-effectiveness, and ease of storage. In this study, the pellets used were Akari Premium Red.

This study aims to determine the effect of providing natural feed and artificial feed on the growth and brightness of the color of Glofish Starfire Red fish, which was measured through 4 samplings during the study period. By identifying the most effective feed, this study is expected to contribute to more optimal ornamental fish farming efforts. Several studies on the effect of providing natural feed and artificial feed on the growth and brightness of Glofish color are still missing and need to be done. Seeing that there has been no research, this paper is intended for readers so that they can find out about this research. Based on the description above, the study was conducted to determine the effect of providing natural feed and artificial feed on the growth and brightness of the color of Glofish tetra fish.

## 2. Research Method

This study employed an experimental method using a one-factor Completely Randomized Design (CRD) consisting of four treatments and three replications, resulting in 12 experimental units. The treatments included Akari Premium Red pellets, *Daphnia* sp., frozen bloodworms, and *Tubifex* sp. Each experimental unit used an aquarium measuring 40 x 30 x 30 cm<sup>3</sup> filled with 30 liters of water and stocked with 10 Glofish (1 fish per liter). The fish had an average initial length of 2.9 cm and an average initial weight of 0.6 grams. Feeding was conducted twice daily at 08:00 and 15:00 WIB for 40 days, with growth measurements taken every 10 days. Water quality was maintained by removing uneaten feed and waste using a sponge, with water replaced according to the volume removed. The equipment used included aquariums, fish nets, basins, digital scales, rulers, aeration stones, oxygen hoses, blowers, DO meters, pH meters, and ammonia test kits. Materials used in the study included Glofish, *Tubifex* sp., frozen bloodworms, *Daphnia* sp., and Akari Premium Red pellets. The research was conducted over 40 days, from August 21 to September 29, 2024, at the Ornamental Fish Hatchery of the Agricultural Vocational Education Quality Assurance Development Center in Cianjur, West Java. Data was analyzed using analysis of variance (ANOVA), and if significant differences were found ( $P < 0.05$ ), Duncan's multiple range test was applied to determine differences between treatments. Observed parameters included absolute length growth and absolute weight growth, calculated as the difference between final and initial values. Additionally, the color brightness of Starfire Red fish was evaluated using the RedKetchup website by comparing photographs taken every 10 days with the same phone camera, lighting conditions, and time of day. Water quality parameters measured included temperature, pH, dissolved oxygen (DO), and ammonia (NH<sub>3</sub>).

## 3. Results and Discussion

Measurements of absolute weight growth and absolute length of cultivated Glofish for 40 days showed the highest absolute weight in treatment D (*Tubifex* sp) and showed the highest absolute length in treatment B (*Daphnia* sp). The results of absolute weight growth and absolute length can be seen in Table 1 below.

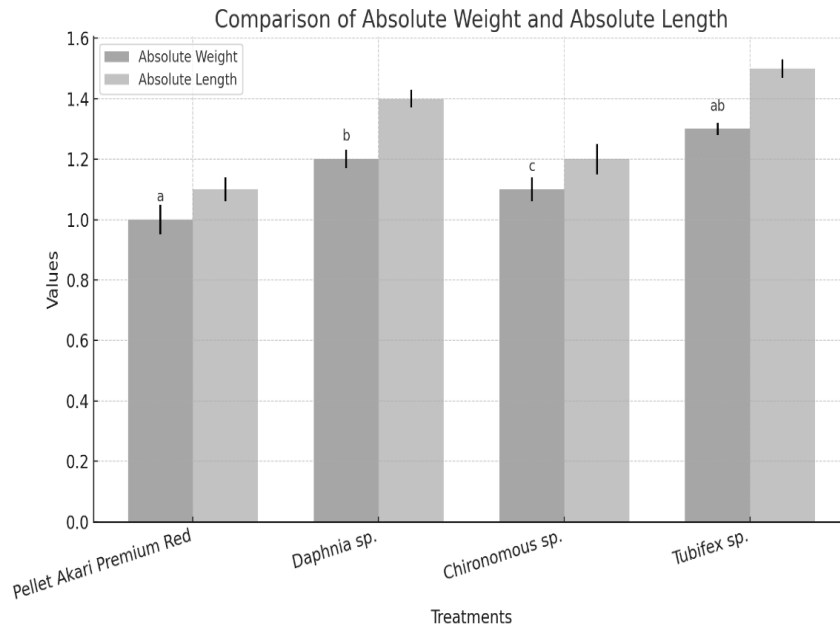
**Table 1.** Absolute Weight and Length Growth

No	Type of Feed	Absolute Weight	Absolute Length
1.	Akari Premium Red Pellets	1.03±0.11 <sup>a</sup>	1.26±0.05 <sup>a</sup>
2.	<i>Daphnia</i> sp.	1.26±0.05 <sup>b</sup>	1.63±0.05 <sup>c</sup>
3.	<i>Chironomous</i> sp.	1.16±0.05 <sup>ab</sup>	1.16±0.05 <sup>a</sup>
4.	<i>Tubifex</i> sp.	1.40±0.10 <sup>c</sup>	1.40±0.10 <sup>b</sup>

Table 1 shows that the type of feed given has a significant effect on the absolute weight and length growth of the fish. *Tubifex* sp. resulted in the highest weight gain, at 1.40±0.10, and was statistically significantly different from the other treatments. *Daphnia* sp. came in second with a weight gain of 1.26±0.05, followed by *Chironomous* sp. at 1.16±0.05, which was not significantly different from either *Daphnia* sp. or the commercial feed Akari Premium Red Pellets. Akari produced the lowest weight gain, at 1.03±0.11. In terms of absolute length growth, fish fed with *Daphnia* sp. showed the highest increase, at 1.63±0.05, and was significantly different from all other treatments. *Tubifex* sp. resulted in a length growth of 1.40±0.10, which was significantly different from the other two feeds, Akari and *Chironomous* sp., both of which showed no significant difference with values of 1.26±0.05 and 1.16±0.05, respectively. Overall, natural feeds such as *Tubifex* sp. and *Daphnia* sp. were shown to produce better growth performance compared to commercial feed, with *Daphnia*

sp. being more effective in promoting length growth and Tubifex sp. being more effective in enhancing weight gain..

With each treatment, there was an increase in weight growth and growth in different lengths over time. Increased weight growth and length growth in each treatment reached a climax at day 40 observation. From this data, an average graph of the increase in the brightness of fish color every ten days is obtained as shown in Figure 1 below.



**Figure 1.** Growth of Glofish Tetra (Starfire Red) fish for 40 days

Figure 1 showed the comparison of absolute weight and absolute length growth of Glofish Tetra (Starfire Red) reared for 40 days with four different types of feed: Akari Premium Red Pellets, *Daphnia sp.*, *Chironomous sp.*, and *Tubifex sp.* The horizontal (X) axis represents the types of feed treatments, while the vertical (Y) axis shows the average growth values. The chart includes two parameters: absolute weight (represented by light gray bars) and absolute length (represented by dark gray bars). Each bar is accompanied by error bars indicating the standard deviation, along with statistical notation letters (a, b, c, ab) denoting significant differences between treatments based on a significance level of  $P < 0.05$ .

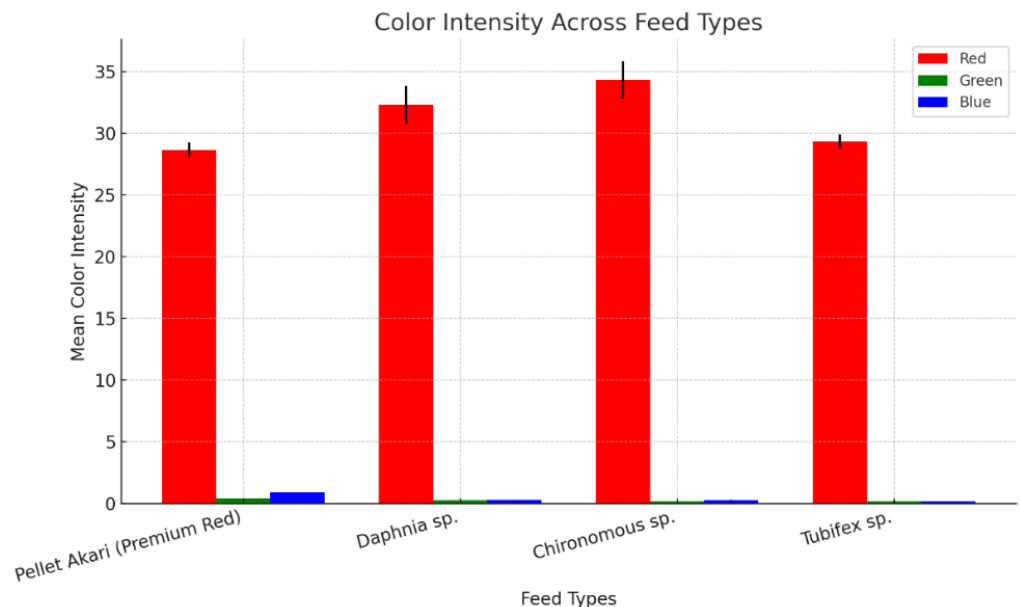
From the chart, feeding with *Tubifex sp.* resulted in the highest weight gain (around 1.4), with the letter "c" indicating a statistically significant difference from the other treatments. *Daphnia sp.* led to the highest length growth (around 1.63), also marked with the letter "c", showing a significant advantage in terms of length increase. Akari Premium Red Pellets, as a commercial feed, resulted in the lowest values for both weight and length, with the notation "a", indicating no significant difference from other treatments with the same letter. *Chironomous sp.* showed moderate growth results in both weight and length and was marked with the letters "ab" and "c", indicating a mid-range effectiveness among the feeds.

**Table 2.** RGB Colour Analysis

Type of Feed		Colour (Red)	Colour (Green)	Colour (Blue)
Akari Pellets (Premium Red)		28.66±0.57 <sup>a</sup>	0.40±0.00 <sup>a</sup>	0.90±0.00 <sup>a</sup>
<i>Daphnia</i> sp.		32.33±1.52 <sup>b</sup>	0.23±0.00 <sup>b</sup>	0.27±0.01 <sup>b</sup>
<i>Chironomus</i> sp.		34.33±1.52 <sup>b</sup>	0.17±0.01 <sup>c</sup>	0.26±0.01 <sup>b</sup>
<i>Tubifex</i> sp.		29.33±0.57 <sup>a</sup>	0.16±0.05 <sup>c</sup>	0.15±0.00 <sup>c</sup>

Based on Table 2, feeding from the four treatments provides a significant difference ( $P < 0.05$ ) to the color of red, green, and blue fish. Color brightness is an essential economic trait in ornamental fish. Glofish, genetically modified from species like *Danio rerio* and *Gymnocorymbus ternetzi*, express fluorescent colors through inserted jellyfish and coral genes, with expression influenced by environmental factors, including diet and water quality (Singh et al., 2015). In this study, *Chironomus* sp. resulted in the highest red brightness ( $34.33 \pm 1.52$ ), followed by *Daphnia* sp. ( $32.33 \pm 1.52$ ), *Tubifex* sp. ( $29.33 \pm 0.57$ ), and Akari Pellets ( $28.66 \pm 0.57$ ). The superior redness from *Chironomus* sp. likely stems from its high carotenoid levels (de Carvalho & Caramujo, 2017; Shastak & Pelletier, 2023). Pratama (2021) also noted that *Daphnia* sp. enhances coloration with natural pigments, while Mustapa (2017) reported an increased astaxanthin in fish fins from bloodworm consumption. Interestingly, Akari Pellets recorded the highest green ( $0.40 \pm 0.00$ ) and blue ( $0.90 \pm 0.00$ ) color values, likely due to synthetic additives, though natural feeds proved superior in enhancing the red pigmentation desired in Starfire Red Glofish.

In each treatment there is a different color increase over time. The increase in color in each treatment reached a climax on the observation of the 40th day. From this data, an average graph of the increase in the brightness of fish color every ten days is obtained as shown in Figure 2 below.



**Figure 2.** Brightness changes of Glofish Tetra (Starfire Red) fish for 40 days

Figure 2 provides a comprehensive look at the impact of various feed types on the color intensity of GloFish Tetra (Starfire Red) over a 40-day period, focusing on the enhancement of red, green, and blue pigmentation. The graph highlights four feed types—Pellet Akari (Premium Red), *Daphnia* sp., *Chironomus* sp., and *Tubifex* sp.—and their effects on the fish's coloration, with measurements taken as an average

increase in brightness every ten days. The red color intensity shows a dramatic rise across all feed types, reaching its peak by the 40th day. Specifically, Pellet Akari (Premium Red) and *Chironomus* sp. lead with the most significant enhancement, both achieving an average red color intensity of approximately 35 units, indicating their superior efficacy in boosting the fish's vibrant red hue. *Daphnia* sp. and *Tubifex* sp. also contribute to a notable increase in red coloration, though slightly less pronounced, with both reaching around 30 units by the end of the experiment. In stark contrast, the green and blue color intensities remain negligible throughout the 40 days, consistently hovering near 0 units for all feed types, suggesting that these feeds have little to no effect on enhancing green or blue pigmentation in the GloFish Tetra. This disparity underscores the targeted effect of the feed on the red spectrum, likely due to the presence of pigments like carotenoids in the feed compositions, which are known to enhance red and orange hues in ornamental fish. The consistency in the low green and blue values across all feeds further emphasizes that the genetic modification of GloFish Tetra for red fluorescence (Starfire Red variant) is selectively amplified by these dietary inputs, making them highly effective for aquarists aiming to intensify the red coloration of their fish.

One of the factors that can increase the growth and brightness of fish color is to monitor water quality parameters during the cultivation process. The water quality parameters in question are temperature, pH, dissolved oxygen and ammonia. The data from the water quality measurement results of each treatment during the study can be seen in the following Table 3:

**Table 3.** Water Quality

Parameters Quality	Water	Akari Pellets (PR)	Range of Numbers <i>Daphnia</i> sp	<i>Chironomous</i> sp	<i>Tubifex</i> sp
Temperature (°C)		26.0-29	26.1-29	26.0-29	26.9-29
Degree of Acidity (pH)		6-8	6-8	6-8	6-8
Oxygen /DO (ppm)	Dissolved	4.0-5.6	4.0-5.6	4.1-5.7	4.0-5.6
Ammonia (mg/l)		0-0.25	0-0.25	0-0.25	0-0.25

Based on Table 3, growth and coloration are shaped by nutrient composition and environmental conditions. Proteins, lipids, vitamins, and pigments like carotenoids and xanthophylls play essential roles in tissue development and visual appeal (Effendi, 2003). Natural feeds offer comprehensive nutrients that better support both growth and aesthetics than artificial feeds. Water quality was well-maintained in this study, with temperature (26.0–29°C), pH (6–8), dissolved oxygen (4.0–5.7 ppm), and ammonia (0–0.25 mg/L) kept within optimal ranges for tropical fish, supporting digestion, respiration, and reduced stress, thus maximizing feed utilization. Low ammonia levels indicate effective system management, preventing toxicity that could hinder development (Mandal et al., 2015). Stable water parameters across treatments support sustainable aquaculture practices for Glofish, with both natural and artificial feed options.

Growth is a vital indicator in ornamental fish farming, reflecting feed effectiveness in promoting weight and length increases, which directly influence market value, especially for species like Glofish. This study revealed that *Tubifex* sp. (Treatment D) produced the highest absolute weight growth ( $1.40 \pm 0.10$  g), highlighting its superior nutritional content. Rich in protein and easily digestible, *Tubifex* sp. supports optimal tissue development (Chittapun et al., 2013; Mi'raizki & Chilmawati, 2015). This result aligns with Khairuman and Amri (2002), who emphasized that natural feeds such as *Tubifex* sp. stimulate appetite and growth during early developmental stages. Its high protein content and soft texture likely

enhance nutrient absorption, resulting in greater weight gain. Conversely, *Daphnia* sp. (Treatment B) achieved the highest absolute length growth ( $1.63 \pm 0.05$  cm), suggesting its effectiveness in structural elongation. Its nutrient profile, including protein, fiber, and carotene, contributes to tissue growth and overall fish health (Sayuti, 2003; Pratama, 2021). Rahmadani and Setiawan (2022) also reported accelerated growth in betta fish fed with *Daphnia* sp., reinforcing its suitability for ornamental fish farming.

*Chironomus* sp. (bloodworms, Treatment C) yielded an absolute weight of  $1.16 \pm 0.05$  g, slightly less than *Daphnia* sp., yet still better than artificial feed. While bloodworms are rich in protein and fat, variability in nutrient absorption or palatability may limit their growth impact (Chittapun et al., 2013; To'bungan, 2016). Meanwhile, Akari Premium Red Pellets (Treatment A) recorded the lowest growth performance with  $1.03 \pm 0.11$  g in weight and  $1.26 \pm 0.05$  cm in length. Although formulated with balanced nutrients, their dry texture and lower attractiveness reduce consumption by Glofish (Madinawati & Serdiati, 2011; Anggraeni & Abdulgani, 2013). These findings affirm the superiority of natural feeds—especially *Tubifex* sp. and *Daphnia* sp.—in supporting physical development. For ornamental fish farmers, incorporating natural feeds can enhance production efficiency and fish quality, aligning with the economic goals proposed by Khairuman (2011) and Lucas et al. (2015).

Fish feed is generally classified as natural or artificial, each with unique benefits. Natural feeds like *Tubifex* sp., *Daphnia* sp., and *Chironomus* sp. are high in protein, digestible, and contain natural pigments such as carotenoids, enhancing fish coloration (Khairuman & Amri, 2002). These feeds are particularly beneficial during early growth stages due to their alignment with fish physiology. Artificial feeds, including Akari Premium Red Pellets, are enriched with balanced nutrients, vitamins, minerals, and color enhancers like astaxanthin and spirulina for consistency and long shelf life (Tacon, 2000). However, digestibility and effectiveness depend on formulation and fish preference. Effendi (2003) noted that natural feeds generally outperform artificial ones in promoting rapid growth and vibrant coloration, which is consistent with this study's outcomes. Nonetheless, certain artificial feeds fortified with natural pigments can enhance coloration, as shown by Widodo and Ardiansyah (2018), suggesting that feed selection should consider specific aquaculture objectives such as growth rate, appearance, or cost-efficiency.

Glofish color variation is influenced by genetics, diet, and environment. Stress, health, and water quality can cause temporary color changes, while carotenoids from natural feeds intensify pigmentation (Harpaz & Padowicz, 2007; Mustofa & Djutalov, 2023). The notable red enhancement from *Chironomus* sp. and length growth from *Daphnia* sp. suggest that combining natural feeds could optimize growth and visual quality. These findings have strong economic implications, as larger and more colorful Glofish command higher prices. Farmers can apply strategic feeding—using *Tubifex* sp. for weight gain, *Daphnia* sp. for length, and *Chironomus* sp. for color enhancement—to boost profitability. Further research is encouraged to develop hybrid feeding regimes combining natural and artificial feeds, aiming for balanced growth and coloration at a commercial scale (Marzuqi et al., 2012). Future studies should also examine the long-term effects of such feed combinations on fish health and environmental sustainability to support scalable ornamental fish production.

## **5. Conclusion**

Feeding with treatment A, which used *Tubifex* sp., showed the most significant result in terms of absolute weight growth, reaching  $1.40 \pm 0.10$  grams. This indicates that *Tubifex* sp. is highly effective in supporting body mass development in Glofish.

The high protein content, soft texture, and ease of digestion make this feed suitable for promoting efficient nutrient absorption and tissue development. As a result, fish fed with *Tubifex sp.* experienced faster and more optimal weight gain compared to those fed with other types of feed. Meanwhile, the highest absolute length growth was obtained from treatment B, where *Daphnia sp.* was used as feed. The fish reached an average body length of  $1.63 \pm 0.05$  cm. This suggests that *Daphnia sp.* plays a crucial role in supporting structural growth in ornamental fish. The nutritional composition of *Daphnia sp.* is known to benefit not only tissue development but also overall health, thereby enabling fish to grow in length more efficiently throughout the maintenance period. Its fibrous content also helps improve digestion, allowing for better utilization of nutrients essential for elongation.

In terms of coloration, particularly the red pigment intensity at the base of the tail, the most noticeable improvement was observed in fish that received treatment C, which used *Chironomus sp.* as the feed. The fish showed a color brightness score of  $34.33 \pm 1.52$  after a 40-day feeding period. This result emphasizes the role of certain natural feeds in enhancing pigmentation in ornamental fish. The natural pigments found in *Chironomus sp.* contribute significantly to the development and deepening of the red coloration, making the fish visually more striking. The enhanced coloration is not only aesthetically pleasing but also adds economic value to the ornamental fish in the market. These findings highlight that each type of feed used in the treatments offers distinct advantages: *Tubifex sp.* for weight gain, *Daphnia sp.* for length growth, and *Chironomus sp.* for color enhancement. This underscores the importance of selecting feed based on the specific growth or aesthetic target in ornamental fish cultivation.

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