# The use of a pulse-expansion module to increase the efficiency of natural feeding of fish by flying insects on artificial ponds

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**Abstract.** The article deals with the problems of providing feed in artificial ponds and fish farms, increasing the proportion of live feed in the fish diet due to flying insects of the base of internal artificial reservoirs. A review of equipment for feeding fish with flying mosquitoes and insects, in which different color stimuli, a fan and PWM are used to attract them, is carried out. The use of this electrical equipment leads to an increase in the productivity of artificial ponds and a reduction in the cost of artificial fish feed. UV LED strip. Thanks to RGB LEDs, the regulation of the chromaticity of their radiation is possible in a wide range by changing the currents passing through R-, G-, B-crystals by specialized PWM drivers of LEDs. The ambient air temperature is controlled by a digital temperature sensor.

## 1. Introduction

One of the most significant sectors of the Republic of Uzbekistan's food industry, fishery artificial complexes produce fish products for the Republic's people and safeguard the nation's food security. Full-fledged proteins and several vitamins are found in fish, which helps the body's normal functioning of functions like growth, metabolism, nervous system repair, reproductive function, and cognition [1].

The amount of fish now extracted in Uzbekistan is insufficient to meet the population's annual consumption requirements for fish products (18–22 kg per person). The creation of fish farms is one way to guarantee a supply of excellent and, most importantly, reasonably priced fish. The shortfall that has developed in the market can be eliminated by fish breeding businesses built on the foundation of Republican reservoirs. Low production profitability is caused by the difficulty of supplying farms with feed and the sparse fish planting [2].

The role of feed in the cultivation of fish in artificial ponds Feeding fish with dipole feed in a complex of intensification measures is a decisive factor of natural feed [3, 4].

The feeding of fish with artificial feed is resorted to in those cases when per unit area of the pond fish are planted for fattening much more than there is natural food available to ensure the normal growth of fish [5-11].

The productive effects of feed depend largely on the conditions under which the fish are reared. Water temperature and oxygen regime, chemical composition and degree of water pollution by organic substances have a significant impact on metabolism in fish, as a result of which the productive effects of feed can increase or decrease, and fish growth can be inhibited or enhanced [12-14].

It is scientifically proved that at planting of carp annuals of 2.0-2.5 thousand pieces/ha the share of natural food in the diet is 20-25 %, at 3.5 thousand pieces/ha and higher - it decreases to 10 %, respectively, the influence of artificial feed increases.

With the transition to industrial methods of fish farming when growing fish with high planting densities, the role of natural food practically becomes negligible, and the entire growth of fish occurs at the expense of fodder introduced into the ponds. Therefore, fish yield per unit pond area can only be increased by supplementary feeding. The total

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amount of feed introduced into the pond is calculated according to the formula specified in the recommendations on the organization of rational feeding of carp in the conditions of pond farms. K=(n*v*N)/(100*1000) кг,
Total amount of feed applied to the pond where:
K - amount of feed introduced into the pond, kg;
n - number of fish in the pond (minus waste), pcs;
V - average weight of fish, g;
N - norm of feeding in % of weight at given temperature.
Carp digest food best when the water temperature is 20-25°, at this temperature the feeding coefficient is the lowest. At this time, with minimum feed consumption, the highest growth of fish is obtained.

## 2. Materials and Methods

Locust meal is unrivaled in nutritional value: it surpasses all existing animal proteins used in feed. The facts are astonishing: pork and lamb have 17% protein content, fish has 21%, and locusts have 78%. In order to produce 1 kg of conditional protein, a cow needs 8 kg of forage, or only 300 grams of locusts.
Insects have a higher protein content than traditional soy and fish meal. Insects are an important link in the food chain as they have an important composition of proteins, fats and carbohydrates for good fish growth and are a useful natural supplementary feed to the main feed. If the food does not contain all the essentials, the fish will grow slowly and get sick. Fish farming is one of the key directions of agro-industrial complex based on cultivation of marketable fish in natural and artificial reservoirs. For small fish farms located at a distance from the existing electrical networks, autonomous power plants with a capacity of up to 10 kW are required. Diesel and gas-electric power plants require the organization of fuel reserves and frequent maintenance. These circumstances indicate the relevance of the use of renewable energy sources. In the conditions of fish farms in the Tashkent region, it is advisable and promising to use solar photovoltaic installations. However, electrical safety must be observed.

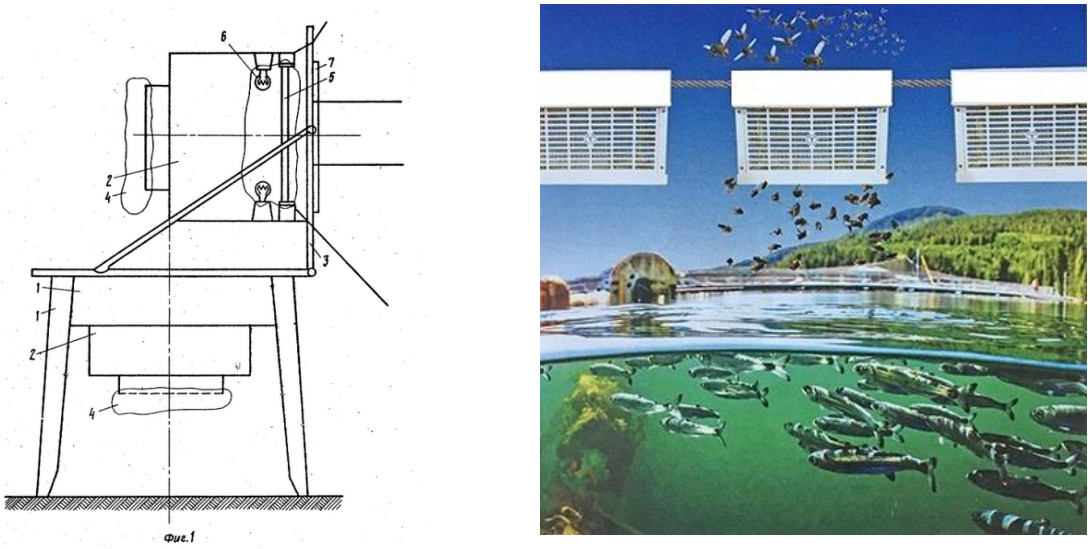


**Fig. 1.** Autonomous electrical installation for feeding fish with flying insects

The way of application of the autonomous electrical installation over the pond stretches a strong rope, on which the required number of devices is suspended, having previously removed the bottom trays to ensure quick ingress of collected insects into the water (the number of devices depends on the power of the lamps and the area of the pond).
Stand-alone electrical installation shown in Fig. 1, is designed to power light installations to attract mosquitoes with ultraviolet lamp, which affects the visual organs of mosquitoes, attracting them to the fan. Close to it is located PWM regulators (pulse width modulators) 3 (Fig. 1), which creates a change in motor speed and light intensity of the lamp. Mosquitoes, attracted by the light, approach the installation and the fan presses the flying insects to the surface of the reservoir with the air flow [5],
During the peak mosquito season, an ultraviolet LED source 2 is present in the electrical installation (Fig. 1) and is activated in the morning and evening. It is powered by a 60Ah rechargeable battery that is recharged by solar module 1 during the day. The optimal chromaticity coordinates (xOPT=0,2294; yOPT=0,2366), which correspond to the maximal phototaxis effect, are set for the radiation that attracts mosquitoes.

The main devices are installed in a stainless-steel housing. Inside the device there are highly efficient UV-LED lamps with the necessary wavelength to lure away insects, PWM regulators, a fan and RGB LED strip, which does not leave insects a chance to survive [9], The design of the device provides easy and quick cleaning. The device remains safe for humans.

## 3. Results and Discussion

Numerous external climate elements, including air temperature and humidity, wind speed, natural light intensity, and others, have an impact on insects. Environmental circumstances are continually changing while electrical equipment is in use feeding fish with flying insects. This has an impact on how insects' motor responses to light stimuli express themselves. It was discovered that the temperature of the surrounding air significantly affects the ideal radiation color that attracts mosquitoes [8]. The optimal chromaticity coordinates (x=0.5330... 0.1862, y=0.3073... 0.1437) significantly change within the range of air temperatures of 14... 38 °C corresponding to active flight of mosquitoes: as air temperature increases, the optimum chromaticity is shifted from orange-red to blue-violet hues (Fig. 2) [9].

Influence of temperature of surrounding air on chromaticity of attracting mosquitoes is taken into account in construction of electrotechnical installation with adjustable chromaticity of radiation and change of a kind of lamp with different illuminations for feeding of fish with flying insects and mosquitoes [6]. As sources-attractants used powerful RGB-LED strip mark SMD5050 which is controlled by remote control and autonomous power supply 3.7 volts DC, in addition there is a UV lamp mark 5050 SMD m 395-405nm waterproof UV beam, there are 60 LEDs per 1 m

UV LED strip. Thanks to RGB LEDs, the color of their emission can be adjusted in a wide range by changing the currents passing through the R-, G-, B-crystals, by specialized PWM LED drivers. Ambient air temperature is controlled by a digital temperature sensor. General control of unit operation is carried out by a microcontroller, which performs regulation of emission chromaticity; provides switching the emitter on and off during evening and morning phases of active mosquito flight, as well as its switching off at air temperatures outside the 14 ... 38 °C range. For autonomous operation of the unit a rechargeable battery is used together with a solar module.

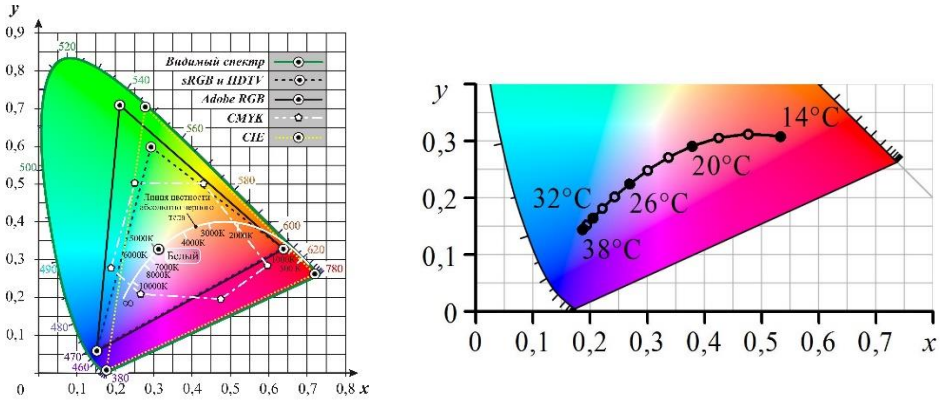


**Fig. 2.** Changes on the CIE 31 chromaticity atlas from air temperature and chromaticity line from RGB

The use of an electrical installation that uses a color stimulus for insects can increase the efficiency of attracting mosquitoes by 21...44% [6, 9].

These units require regular cleaning and replacement of the line, fan, and transmitter. Shading of the radiation source by insects reduces the efficiency of the unit. The proximity of this installation to the water for feeding the fish allows to simplify the operation of this installation by performing only seasonal cleaning of the sealed RGB-LED strip [7].

**Table 1.** Dependence of the number of attracted insects on the speed of rotation of the fan, providing the appropriate pressing them to the water

| Fan speed r/min | (p) Power | The number of insects | % |
|---|---|---|---|
| 2400 | 100 | 350 | 19 |
| 1000 | 44 | 1100 | 55 |
| 800 | 37 | 1800 | 100 |
| 650 | 28 | 1200 | 71 |

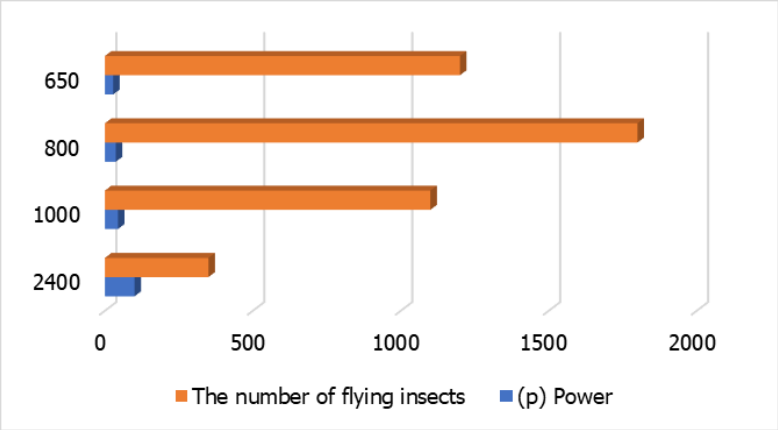


**Fig. 3.** Dependence of the number of attracted flying insects on the fan rotation

Figure 3 highlights the power, number of revolutions and insects of the experiment of the device. According to the experiment it was seen from 19:30 to 20:30 the number of flying insects is more than the rest of the time of the evening, in addition, it depends on the power and rotation of the fan. All equipment is connected to the battery
The analysis of mosquito attractiveness reveals that green and blue-violet, which are monochromatic hues in the middle of the spectrum, are well perceived by mosquito eyes. Like all insects, mosquitoes are highly sensitive to UV light, and their eyes are also more sensitive to red radiation. A wide variety of optical wavelengths, particularly colored ones, are also well-susceptible to many different flying insects.
When using RGB and ultraviolet tape in the source-attractants, therefore, the influence of water chromaticity on the deviation of the source-attractant chromaticity coordinates should be investigated.

## 4. Conclusions

At present, fish breeding industry has problems connected with provision of additional fodder to farms for artificial fish breeding in inland water bodies. One of the ways to improve the quality of fish feeding ration is to increase the share of live feed available to the natural food base of water bodies. For this purpose, it is advisable to use autonomous electro-technical installations for feeding fish with flying insects. In electrical installations, LEDs are used as attractant sources, with which you can create different illuminances and radiations of different colors, in addition, PWM regulators are used to change the illumination and speed of rotation of the electric fan to increase the efficiency of attracting flying insects. Convenient to operate is to change the height of the unit in any environment.
The results of the study show that the fan speed affects the number of flying insects, by experiment science has proven that fan rotation of 800 revolutions per minute is optimal.
Increasing the proportion of live food in the fish diet has a positive effect on fish health and development, resulting in increased pond productivity and lower costs for artificial fish feed.

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