How achievable is creating optimal breeding conditions for clownfish:

1. Intro:

The project's main purpose is to provide optimum conditions for breeding Amphiprion Ocellaris Clownfish in a home environment. Ocellaris clownfish are very commonly kept fish for people who owns a salt-water aquarium (Thomas, 2021). However, these fish pose difficulties with breeding for roughly half of those who've invested their time and possibly money in attempting to breed these fish. And so, I will be attempting to provide the best conditions, under a student lifestyle, for these fish to breed. With a mere 46% (River, 2022)success rate for breeding these fish and a much lower 11% success rate for larvae to reach adulthood in captivity, secondary research can provide inaccurate data and information which may offset any final product of the clownfish breeding or performing sexual activities.

My depth of experience in breeding fish is limited to only some much less complex freshwater fish and only branches as far as habilitating Amphiprion Ocellaris clownfish and other marine fish in a large, three-hundred litre reef aquarium for four ongoing years. Making the project of breeding fish a new, exciting and challenging task for myself.

To create a suitable environment for clownfish to breed; they must be comfortable within their aquarium and provided experience conditions which are most conductive sexual activity (NirvanaFan, 2011). Thus, research to make them breed will focus primarily on the following factors (Ocellaris Clownfish, 2019):

- Comfortability and external factors
- Interior of aquarium
- Salinity
- Set-up/equipment
- Flow rates
- Water quality
- Feeding requirements

Additionally, I will conduct other research into my clownfish individually to understand if they would breed and what I would need to provide these fish to allow them to breed was completed first. Certain topics requiring more research were:

- Whether the clownfish needed an anemone to breed.
- Whether the clownfish can breed despite being different colours.
- Whether the clownfish are old enough to breed.
- Whether this project will be realistically achievable for me without endangering the fish.

From studying and researching what other fish keepers did to set up their clownfish with the most ideal environment for breeding, the decision to not pair the clownfish with an anemone was made early on, as from my experience, aquariums should be running for at least six months before adding an anemone. This is due to the fragility of anemones which should not be in aquariums where salinity and other parameters have drastic changes that can easily kill the anemone (Barrington, 2022).

Due to anemone's naturally occurring symbiosis with clownfish where protection for clownfish and their eggs from predators would be offered, anemones have the ability to reduce the stress of clownfish and provide comfort (W Florian Fricke, 2021). Consequently, this may affect the chances of breeding clownfish, however breeding clownfish and keeping anemones aren't mutually exclusive (Chamika, 2021)

Furthermore, research into clownfish breeding ages stated that females have to be at least two years old, and males must be above 6 months old (AZaquaculture, n.d.), which was perfect for my clownfish as I can personally confirm they're both above the minimum breeding ages as I have been keeping these clownfish for three years already. Clownfish colouration and patterns also will have no effect on whether they breed as it is common to breed clownfish of different colourations to make exquisite varieties of clownfish (Laverda, 2020).Thus, the matter of my clownfish pair being different colours has no effect on whether they will breed.



Figure 1 above shows clownfish of different patterns breeding with visible eggs attached to the top of the flowerpot.

Creating optimal conditions to increase the chances of clownfish breeding:

After checking whether these Ocellaris clownfish (also known as false clownfish) were suitable fish to breed (river, 2022) and their natural habitat/origin (Newcomb, 2023), which concluded to be in the Pacific and Australian ocean, I developed a plan to create optimal conditions for breeding these clownfish. The conditions I sought to create were based on the natural conditions that would be provided in the wild as well as suggested conditions that I have come across by fish keepers with some knowledge or experience in clownfish breeding…

- The first condition tackled was the salinity (otherwise known as specific gravity of water) needed for the aquarium. Based off of research (Fantasea Aquariums, 2017), salinity was chosen to be at a specific gravity of 1.022 which is around 29-31ppt (parts per thousand). This was used to mimic the natural salinity change in the wild which is further used as an activation for clownfish arousal levels to increase. Thus, stimulating breeding in the wild and within the aquarium. Due to evaporation occurring within the aquarium that was ongoing, salinity would increase over the week until the weekend where fresh reverse osmosed water (RO/deionised water) would be added to bring down the salinity; this is why a specific gravity of 1.020 was set for desired salinity after a water change as it could easily rise to 1.022 by the end of the week. Thus, the specific gravity was still within optimal range for breeding- as shown by the graph below of salinity from 23/1/23 to 14/2/23:

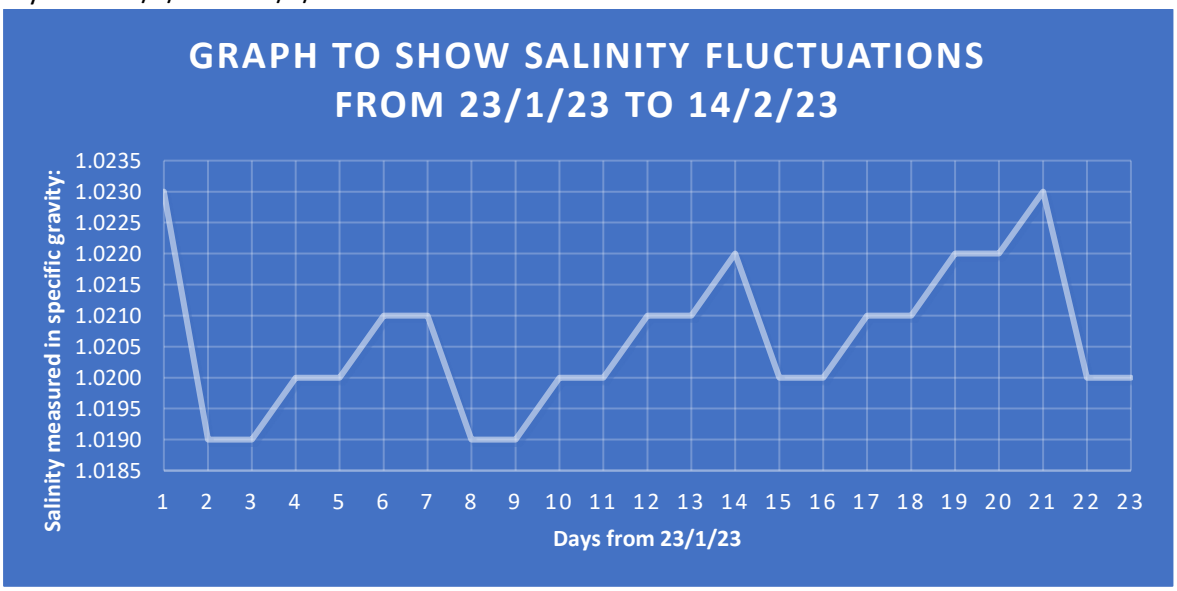


Figure 2 above shows how the salinity fluctuates over time due to evaporation rates increasing the specific gravity within the aquarium.

As shown by figure 2, fluctuations occur on a weekly basis as a certain amount of water would evaporate over each week. This caused a lot of problems for me as fluctuations of roughly 0.0025 in specific gravity every week firstly is very unnatural in comparison to the wild which should show a straight line of around y≈1.021 (depending on specific habitat location). Thus, the fluctuations could have caused negative effects on the breeding possibility of the clownfish. On top of this, the evaporation rates would vary depending on the humidity and temperature of the air around the aquarium, thus causing the rate of evaporation to vary slightly each week (see. These factors made impossible for me to add an exact amount of deionised water extra each week. Resulting in the "base" salinity (salinity after a water change) to also alter each week. This is illustrated in figure 2 where the base salinity has fluctuated by 0.001 specific gravity within approximately three weeks.

- Temperature was another important aspect of maintaining the right conditions of the aquarium. With research consistently stating temperatures from 23 to 26 degrees Celsius (Maidenhead aquatics, n.d.), I placed the heater in close proximity to the filter's output so that energy dispersion will spread throughout the water column more evenly, thus providing consistent temperatures. Whilst I was at the fish store, Porton Aquatics, I interviewed Chris, one of the front-line advisors at the shop about marine life, on what heater to use for my aquarium. This recommended heater (Porton aquatics, n.d.) that I bought should work for aquariums up to ~100 litres and so will undoubtably be capable of the 60-litre breeding tank. Additionally, there was a two-year guarantee which would provide assurance for the duration of my project.



Figure 3 to the left shows the heater in front of the pump, allowing warm water to circulate around the aquarium.



Figure 4 to the right displays the current output where ripples that break the surface tension of the water are present. To prevent stagnation of water for bacteria and algae to manifest on.

- Flow rates are easier for me to replicate within the aquarium. This is because the clownfish were added to the aquarium after the pump was inputted and so the clownfish could choose where they wish to nest/lay eggs in response to the temperature and flow, that was already present in the aquarium, as the flow circulation maintains constant temperatures around the aquarium. Variations of intensity of flow and temperature within the aquarium were deliberately created by me to develop micro-climates that allow the clownfish to choose a specific location of optimal conditions for maturing clownfish eggs. This is why I have used only one pump so that the flow can have full ranges of strength. Clownfish need enough flow to prevent any debris build-up or pathogens to develop on the eggs, (Nightingale, 2014) or around the nest due to stagnation of water and for the surface of water to have breaking ripples to prevent sheets of pathogens, such as bacteria, developing and toxifying the water, whilst not so much flow that it damages the eggs (Nightingale, 2014). Therefore, without the correct flow rate, clownfish won't breed as there would be no suitable nesting site.
- Due to the location of the aquarium being within a busy home, lighting was one of the more improvised parameters as I used my own experience on fishkeeping followed by previous advice from other fish keepers (Lucastank, 2022) around light schedules for marine life, not specifically

breeding clownfish, and evaluated that a longer, more consistent time schedule is much more adequate than a more idealistic time schedule that's smaller that has systematic errors. This is because if I were to have a time schedule that allowed the light to turn on later, for example 07:00, then exterior lights would wake the fish up at earlier times in the morning. Such as 6:30 on a Tuesday. However, if I had a time schedule that woke the fish up at 06:20, then the clownfish would always be woken by the light at 6:20am, thus improving their light schedule as it's a very consistent wake-up time. Consequently, improving the clownfish' security as there's no sudden wake ups. In response to this, I also allowed the lights to turn off at 21:00 so that the clownfish were able to gradually go to sleep as lighting around the house slowly got dimmer up until 22:30 when everyone's in bed.

- Interior was another more lenient variable for breeding fish. After watching videos (Nightingale, 2014) (Barn, 2020) it seemed reasonable for me to assume that there were many different inanimate objects I could use that may act as a nest for these clownfish. One of the most affordable and common objects used was a ceramic flowerpot. Consequently, I retrieved two from our garden and gave them a thorough wash with deionised water to remove any dirt or organic materials lingering within the pot. These two pots were added to the aquarium just before the clownfish were added to the aquarium so that the clownfish would choose the best option for them before entering the aquarium and choosing an inferior location to nest.
- Furthermore, aquatic plants from my larger reef tank were removed and placed into the breeding tank to compete for nutrients against algae that grows (Aquarium Info, 2016). This helped keep the area clean so that the clownfish might breed as if there's too much algae than the algae could grow over the eggs and prevent them from hatching Thus, discouraging the clownfish from breeding. For this project I chose my fastest growing plant from my larger reef tank as it will absorb nitrates (Oklahoma State University, 2015) and phosphate (Elliot, 2023) from the water column, which is a product of the breakdown of ammonia and other organic substrates such as uneaten fish food. Nitrates and phosphates are vital for plant growth and so the kelp that was added to the aquarium will reduce the concentration of phosphates and nitrates in the water column which will in turn reduce unwanted algae growth (Aquarium Info, 2016).



Figure 5 above shows the kelp taking hold within the substrate and neighbouring obstacles

- Feeding these clownfish required a variety of supplements to provide nutrients of ample amounts whilst the female is laying. From the use of the log, I can get an understanding of feedings that occurred throughout the project overtime. Lifestyle issues of being a student made it hard for every feeding to be met on time, however in general the clownfish were fed at least once a day. Rarely would they only be fed every other day. Through primary research of understanding personal favourite foods of my clownfish, I devised a feeding regime that incorporated three major food samples. The most important was the NT labs pro-f

probiotic marine pellets (Labs, n.d.) which was fed most often as I believed it was the most beneficial for keeping the fish alive and healthy due to the more artificial make-up of the food, it had higher concentrations of vital minerals and nutrients to keep the clownfish alive. Whilst frozen mysis shrimp (Porton aquatics, n.d.) and frozen brine shrimp (also referred to as artemia) with garlic juice (Porton aquatics, n.d.) to help clownfish immune systems were fed to the fish every couple day to provide variety for a more balanced diet. Clownfish would also regularly eat algae growing on rocks or the glass of the aquarium also.

Summary of project:

Creating the optimum conditions for breeding clownfish in a home environment was complex, which in turn makes it hard to decipher what the key aspects of management over the tank was not done correctly for eggs to be laid. In late January and into early February the clownfish were mating regularly, which I believe was due to all the parameters of the water aligning. Furthermore, in Christmas I discovered that the metal supports to the acrylic lid was made from iron and not aluminium, causing steady stream of rust had been flowing into the tank would have led to increased algae growth (Mayo, 2018) as well as direct effects of high iron concentrations on the fish's health (Andromeda, 2019). Unfortunately, I could not test specifically for the iron concentrations in the water and had to clean out the water quickly to prevent further damage to the fish. So, I cannot definitively say whether iron levels were affecting the conditions for mating of the fish.



Figure 6 shows two of the six iron supports coated in rust above the aquarium holding up the acrylic lid.

Evaluation of project:

My personal budget was limited to £60 for extra equipment I had not already owned. Which consisted of a heater, a filter, and a 60-litre second-hand aquarium. That being said, the clownfish did undergo sexual activity thus the conditions were favourable for breeding for at least one month or so. Unfortunately, there were no resulting eggs due to an unknown factor that could be fertility of the clownfish for example, however the determining factor(s) are uncertain; I believe that there were no laid eggs as the conditions fluctuated too much and thus causing too much stress on the clownfish.



Figure 7 above shows the Tunze Osmolator's (A Tunze auto top off system) sensors and control box.

And if I were to complete this project again, I would have had a greater emphasis on developing consistent parameters with smaller fluctuations. As during the late period of January into February the conditions were ideal considering fluctuations were consistently averaging at the perfect parameters for salinity as well as nutrient levels being lowered due to slow algae

growth. Which in turn may have been the driving factor for the increase of sexual activity between the clownfish at the time.

A piece of equipment that would have helped if I were to repeat this experiment would be an auto top off system with sensors to measure the water level of the aquarium to pump deionised water from a reservoir. This means that the fluctuations that occurred within the salinity due to evaporation (shown in figure 2) would not happen. Making the conditions much more adequate for breeding as salinity levels in their natural habitat would not fluctuate so dramatically. Unfortunately, a set up including an auto top off system would have greatly increased costs of equipment. As a good auto top off system is easily over £80, which is above my budget for this project.

Furthermore, the water added to the aquarium during a water change originates from a tap outside that produces the deionised water at sub 10 degrees Celsius regularly. Thus, adding 5-8 litres to the aquarium of that could water mixed with a salt remedy would drop the aquarium temperature by 3-4 degrees rapidly and then take some hours to rise to the resting temperature of 25 degrees Celsius. Whilst having a second heater to heat up the newly made saltwater would prevent the temperature disturbance that was occurring throughout the project, allowing for more stable conditions.

Surrounding sound and light pollution from people, electronic components and the sun forced me to alter the system to run on at 06:20am so that the blue light would consistently wake the clownfish up in the mornings. Which is undesired as a direct light over the fish tank should not be on for over 12 hours (Sharp, 2020).Thus, the lighting would turn off at 6:20pm, causing the fish to have hours of light disturbance in the evening when they should be sleeping as the TV and room lights are on for roughly another 4 hours. However, this is the best option as by being woken at 6:20am, the fish will be consistently woken at that time without altercations. As lighting in the morning varies from day to day, with lights room lights turning on from 6:30am to 8:00am depending on the day of the week.

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