



The No.1 Aquaponics magazine
for the backyard enthusiast.

Issue 4
First Quarter 2009

Bringing Food Production Home

Backyard Aquaponics

The Yabby

Freshwater crustaceans

Worms - Clean, green, we dig them

Moonstruck - Planting by the moon

Welcome

With the world financial crisis starting to filter down from the financial institutions and large corporations into the wider population, it's now beginning to hit your average families. What was something you only heard about on the news has now started to affect people personally through job losses and downturns in production for small businesses as well as losses of superannuation funds.

Many people are beginning to realise that home food production could become more of a necessity rather than just a hobby, and what better way to grow your own food than by utilising aquaponics. Over the years I've had many people ask about the viability of

aquaponics and whether aquaponics is really only suitable as a hobby rather than a feasible method of growing your own food. This is a subject I've recently pondered, mainly because of the low production levels coming from my systems at home.

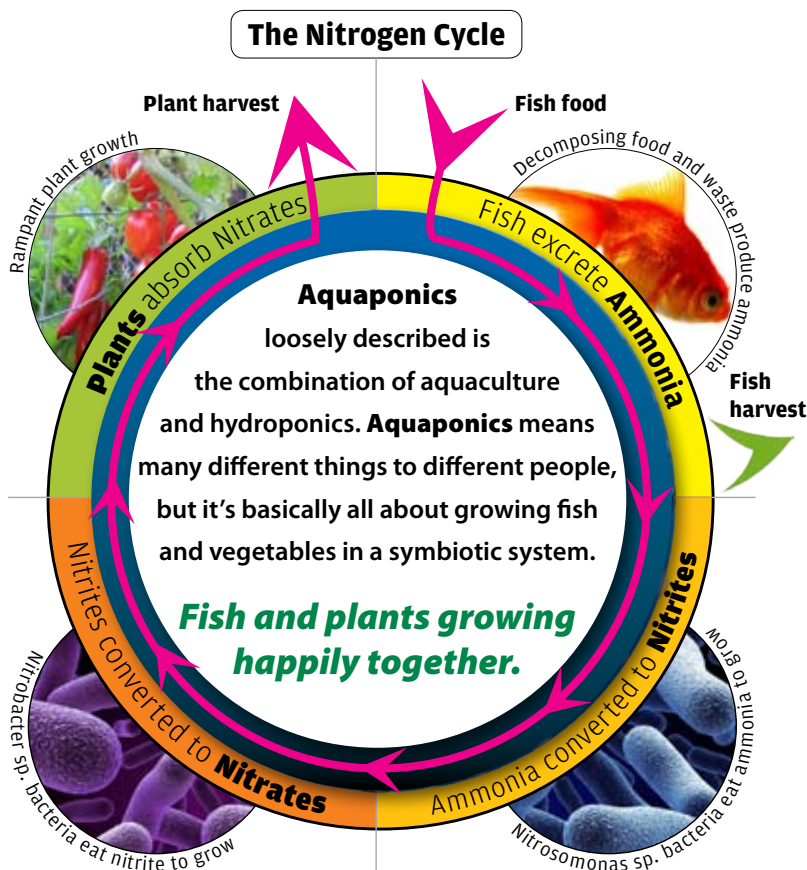
The production levels have been fairly low, but this is because my inputs and time spent on the system has also been extremely low. This is the nature of aquaponics – plant and fish growth relate directly to the amount of feed you put into the system. If you want maximum production of plants then you have to keep up the feed to your fish and regularly replant and harvest your vegetables. As you start to drop



your feed rates, plant growth rates will drop correspondingly.

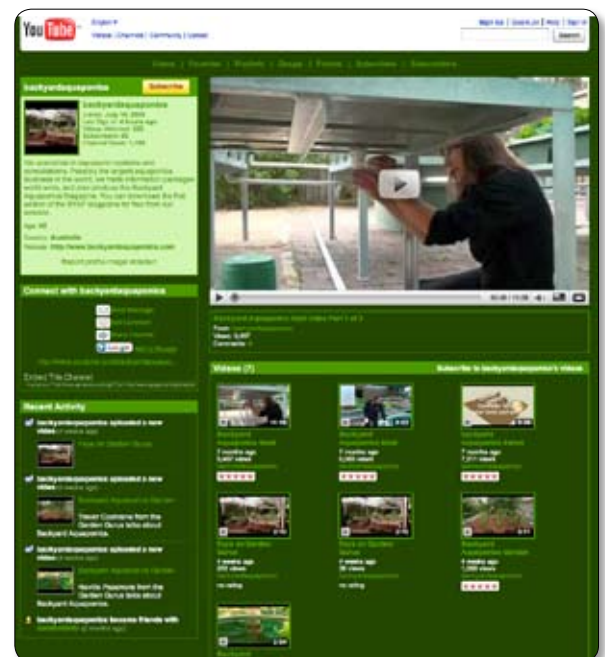
Aquaponic systems are as productive as you make them and they can be extremely prolific when well managed and intensively utilised. Systems can also be very low maintenance – one of my systems hasn't been replanted in a couple of years yet it continuously crops watercress in the growbed and the silver perch in the system only get fed small amounts once every 2-3 days – minimal production, but minimal effort. ●

Joel Malcolm, Editor



Backyard Aquaponics on the tube

There is a whole range of aquaponics videos that you can view on youtube, visit the link below and see us in action!
<http://www.youtube.com/user/backyardaquaponics>



Backyard Aquaponics



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Backyard Aquaponics Magazine

is a quarterly publication which aims to promote the ideas of Aquaponics and home food production coupled with healthy and sustainable living.

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Congratulations

to the 2008 Backyard Aquaponics Forum photo competition winner!

Dgrdalton (below) from the Backyard Aquaponics forum has been voted winner of the 2008 Photo competition. Her picture named "forgotten water main" touched the compassionate side of many forum members, most of whom could understand the feelings and emotions behind such a shot. The photo was beautifully composed and captured the essence of the moment.



Some early contributions for the 2009 competition



The 2009 photo competition is well under way already and it's shaping up to be a stiff competition. The standard of photos being submitted is quite surprising, and you can see a few of the submissions above:

Please see the Backyard Aquaponics forum site for further details.

The Yabby

A freshwater crustacean

By Joel Malcolm

Introduction

The yabbie is a common name that describes a number of different species of small to medium freshwater crustaceans including *Cherax destructor*, *Cherax albidus* and a few others. The yabby is native to the south eastern areas of Australia, and as a crustacean they share the trait of having a hard exoskeleton or shell that provides protection from their many predators.

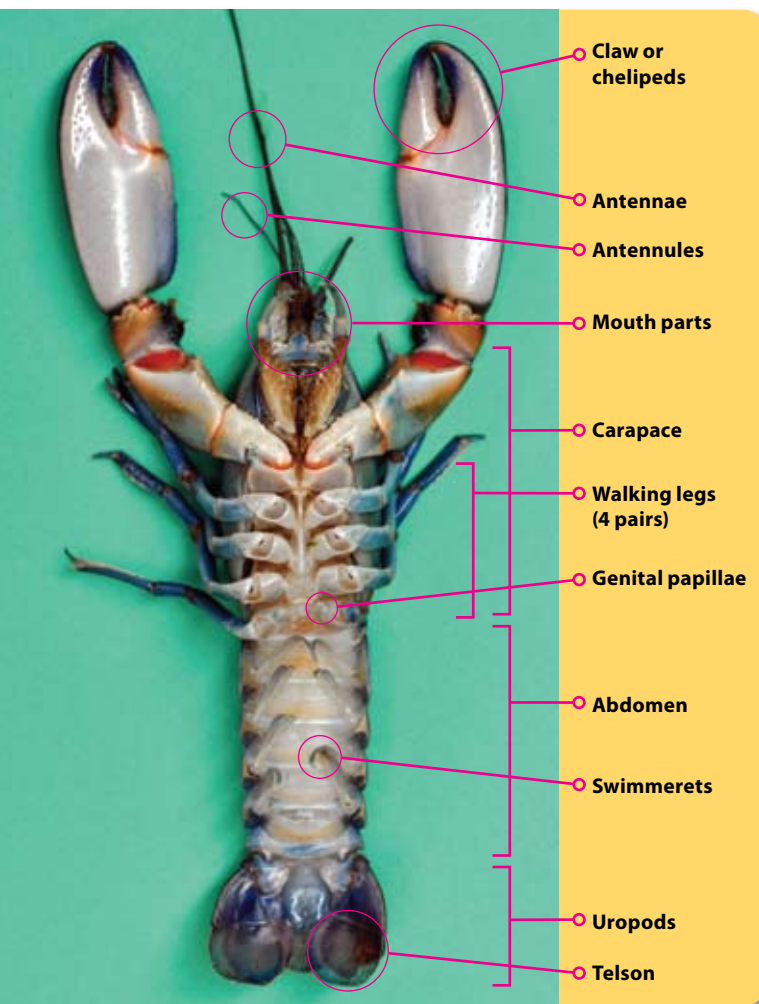
They can be found naturally in creeks, swamps, rivers and billabongs and in areas protected from high levels of pollution and over fishing. They can adapt to a wide range of water conditions and temperatures and have been known to survive in extreme temperatures from 1°C through to 35°C, however, at these extremes they do not perform well. When water temperatures drop below about 15°C their feeding and metabolism slows down to a point of almost hibernation and growth rate stops. Yabbies can survive in many different conditions, ranging from moderately saline waters of around 8ppt salt, or one quarter the salinity of sea water, through to very low levels of dissolved oxygen. Yabbies are extremely tough and the *Cherax destructor* can survive long periods of drought by burrowing deep into the ground.

Anatomy

The yabby comprises two main body sections – the carapace or head section and the



The name yabby is derived from the word yabij from the Aboriginal language Wemba



abdomen or tail. The tail meat is of most importance to farmers and yabby growers and represents 15-20% of the total body weight.

Yabbies, like many crustaceans, are decapods, meaning that they have 10 legs. The front pair of legs of the yabby are large pincers, claws or chelipeds used for fighting and feeding, and then there are four pairs of walking legs. The primary sensory organs of the yabby are its large feelers or antennae and the smaller feelers or antennules, which act as touch and taste sensors used for locating food and sensing changing water parameters. Although the yabby has quite large eyes, they are often of little to no use because their natural environment is generally very murky and muddy, however, in clear conditions their eyesight is considered to be fairly good.

swimmerets or pleopods, although these pleopods only appear on the second to the fifth segment. The pleopods are extremely important to the female of the species as she attaches her eggs to the fine hairs which line them. The first segment closest to the carapace has no appendage, while the appendages of the sixth segment are much larger and are called uropods. These uropods, along with the very last segment of the abdomen known as the telson, make up the tail flap. This tail flap is used by the yabby to move quickly through the water – it flicks its tail using the strong tail muscle to propel itself backward with a burst of speed. The uropods and telson also help females protect their eggs and young. A question often asked about the yabby is how to tell the difference between the sexes, but it is in actual fact a very simple process. If you turn the yabby upside down, you will notice that the male yabby will have genital papillae



Juvenile yabby

The abdomen is made up of six separate segments, each encased in a hard shell and joined together by a flexible membrane which allows the ease of movement of the tail or abdomen. The underside of the tail segments have small appendages called

at the base of the fourth (rear most) legs, while the female has oviducts at the base of the second pair of walking legs.

Diet

Yabbies are omnivorous and generally live on a diet consisting of detritus. Farmed yabbies are fed pellet-based feeds because of the increased stocking densities, and to increase growth rates, these pellets are often Lucerne-based or lupin based. In fact, many small producers feed whole lupins into their ponds. Supplemental feeding of pellets to the yabbies provides extra nutrients into their environment which aids the growth of natural feeds within their environment.

Moulting

Moulting is a process that allows the yabby to grow in size. Because yabbies have a hard exoskeleton they physically can't grow in size without discarding their old shell and growing a new, larger shell. Moulting happens every few days when a yabby is young, but as they age and the growth rate decreases, the moulting process slows down to perhaps only once or twice a year. Before a yabby moults it re-absorbs some of the calcium from its old shell back into two calcareous deposits found in the stomach wall called gastroliths. The softened old shell is then discarded and often eaten to make use of the calcium. The yabby then absorbs water into its body while the new shell

is still soft, which allows it to stretch the new soft shell so that it is larger than the actual body size, giving it room for further growth. Calcium is then redeposited from its gastroliths into the shell in order to harden it and provide protection. During the period of moulting and shell hardening the yabby is very vulnerable to attack as it has lost its protection. The act of moulting can also be very stressful for the yabby and can even cause the loss of limbs.

An interesting fact about the yabby is its ability to regrow limbs. The limbs regrow with every moult and it usually takes a few moults for the limbs to reach their normal size. The yabby can regrow its legs and claws as well as its feelers.

Reproduction

Yabby breeding is dependent on both water temperature and day length, and usually occurs when water temperatures



A female yabby carefully carries her young

reach the mid-teens in late spring or early summer and day length is increasing. Reproduction increases as water temperatures increase until water temperatures reach around thirty degrees – once temperatures exceed thirty degrees reproduction is adversely affected. The female yabby becomes

sexually mature at less than one year old and when it weighs only about 20g. In nature they may spawn twice a year, occasionally even three times when conditions are right. However, yabbies have been known to spawn up to five times within a twelve month period when temperatures have been kept at optimum levels and daylight length has been kept artificially long at about 14 hours. (Mills 1983, Merrick & Lambert 1991).

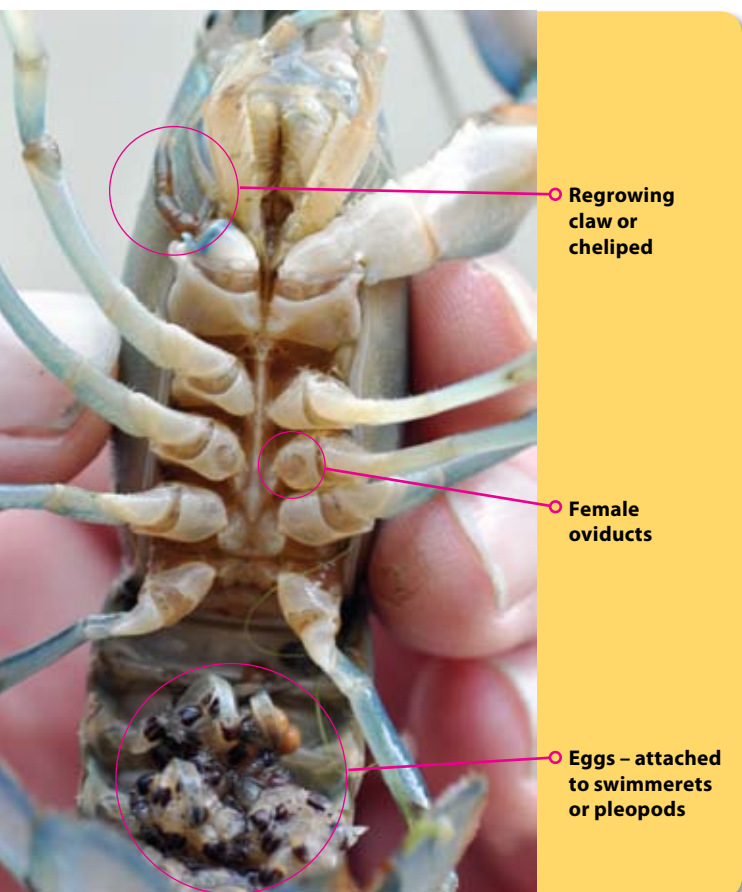
The male yabby places a spermatophore between the females fourth and fifth set of legs. The female then

cracks open the spermatophore, and as she expels eggs, the sperm is mixed in with them. She then carefully attaches the fertilised eggs to her swimmerets or pleopods under her tail. The eggs are about 2mm in length and oval to round in shape and successfully fertilised eggs are usually olive green in colour. The female yabby now protects the fertilised eggs by wrapping her tail tightly under her body and incubating the eggs for a period of between 20 and 40 days depending on water temperatures. A typical female will lay between 50 and 450 eggs, with larger females laying up to 1 200 eggs at a time.

While the female is carrying the eggs under her tail she is said to be 'in berry' or 'berried'. During this period she spends a great deal of time caring for the eggs, oxygenating them, removing debris and removing unfertilised or dead eggs. Once the eggs have hatched the juveniles stay on the female until they reach a mature stage at around four to six weeks old, when they can then move off and fend for themselves.

Production in an aquaponic system

Many people are interested in growing yabbies in an aquaponic system, however, there are a few points to keep in mind. Yabbies are very territorial and aggressive.



Regrowing claw or cheliped

Female oviducts

Eggs – attached to swimmerets or pleopods

They are cannibalistic in nature and will readily attack and kill other yabbies that have freshly moulted. If you are growing yabbies in an aquaponic system you need to be able to provide lots of hides for them. Ideal hides are short pieces of scrap PVC pipes of varying sizes. By giving them numerous hides you can stock more in your system without the worry of fighting and deaths, however, in reality you can only stock about 10-20 yabbies per square metre in the long term.

One way to increase stocking in your system is to use large shallow tanks in which to stock the yabbies, thus increasing the floor space. We have used growbeds that are 2m x 1m x 30cm deep to successfully breed and grow yabbies. Duckweed and azolla growing on the water surface consume nutrients created by the yabbies and their feed while an

air stone keeps the water oxygenated. Water quality in these simple systems remains high because the duckweed keeps sunlight off the water, and the air stone keeps the water well oxygenated. This method of growing makes use of what would normally be wasted space under the plant growing beds, while also producing large amounts of duckweed which is extremely useful for feeding to omnivorous fish, chooks, worms, other livestock, or turning into rich compost.

If you want to stock yabbies as a polyculture mixed in with your fish stock then you really need to be careful. Chances are that most fish species will consider yabbies and other crustaceans to be an ideal natural food. I have seen four or five fish aggressively gang up on a freshwater crustacean and attack its eyes from all angles. Within an hour or so the crustacean

had no eyes left and once blind it had no way of defending itself. By the morning there was nothing left but an empty shell. All the crustaceans that I had in my main fish tank would hide in the pieces of pipe, but they all had their feelers eaten off because they poked outside the pipes.

Unless you have some method of protecting the yabbies from the fish species I wouldn't recommend stocking yabbies in the same tank as large carnivorous fish. Generally they won't survive, and even if they do survive they will have a very poor quality of life. Many people are experimenting with other methods of growing yabbies and other crustaceans as a polyculture in with their fish, which seem to be moderately successful. These methods include mesh dividers mounted off the floor of their fish tank and plastic cages. ●



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By Faye Arcaro

Many people have been surprised to find worms living in the growbeds of their aquaponic system. Where did they come from and how can they live amongst clay or rock media with water flooding the bed at regular intervals? Worm eggs or young worms may have been amongst the roots of transplanted seedlings or bird droppings containing egg capsules which later hatch, however, you can add worms to the growbed yourself to hurry along the process. The water in an aquaponic system is well oxygenated as it moves through the pipes and percolates through the media and pore spaces, continually adding oxygen. Because the water is so well oxygenated worms survive even when totally submersed for long periods of time.

There are over 3 000 different species of worms, but those that are of benefit to us in an aquaponic system are the composting worms. Earthworms which inhabit the soil are fairly free ranging and are not suited to contained environments, yet composting worms are agricultural worms which mature and reproduce slowly. They don't like to be too crowded and they tend to burrow deeply and travel far in search of food. The types which most suit our needs are the Red wigglers, Tiger worms, African night crawlers and Indian blues. These are

Worms are a rich food source as they are composed of nearly 70% protein

readily available from suppliers around the globe for stocking in worm farms.

Worms have no eyes, however, they are sensitive to light and can sense vibrations and temperature through organs in their skin. Worms like to live in a cool environment which is shaded and safe from predators. Conditions need to be moist, they need to be protected from direct sunlight and have access to plenty of organic matter – some worm species can easily consume their own weight in food every three days.

Having worms growing within the growbeds is useful for breaking down old dead roots and solids from the fish tank, however, having a separate worm farm is a great way of breaking down your vegetable scraps while producing worms that can supplement fish feed. Worm farms can be made from recycled items that you may have lying around the yard or you can buy commercial worm farms purpose built with removable layers and a tap at the bottom. Alternatively, use polystyrene boxes, wooden baskets and even old bath tubs to make an inexpensive worm farm to supply a protein source of treats for you fish.



Worms secrete a mucous through their skin that helps them remain moist and move through the soil – if their skin dries out they will die. As the food passes through their large gut running the length of their body they will absorb nutrients and pass excrement classed as worm poo or castings.

“They (the worms) literally serve as colloid mills to produce the intimate chemical and mechanical mixture of fine organic and inorganic matter which forms their castings (excretions). In the mixing, which takes place in the alimentary canal of the earthworm, the ingested materials undergo chemical changes, deodorisation and neutralisation, so that the resultant castings are a practically neutral humus, rich in water-soluble plant food, immediately available for plant nutrition.”
– (*Harnessing the Earthworm*, Thomas J. Barrett 1976, pg.9)



Worms will digest most organic debris



Producing rich organic humus

It has been found that humus can provide benefits in many different ways, including its ability to fix heavy metals in soils, preventing plants from taking up more of these compounds than they need, then later releasing them when required. Worm castings also provide

a buffering effect in pH levels that are either too high or low. As we know that certain nutrients are not available in soil when pH is at a certain level, if large amounts of humus is present, acid loving plants can still do well in alkaline conditions due to the way that humus prevents extreme pH levels making nutrients unavailable to plants. Humic acid (contained in humus) also acts as a growth stimulant for plants.

It has been found that humus can provide benefits in many different ways, including its ability to fix heavy metals in soils

The worms gut is full of beneficial bacteria that aids in building microbial activity and improving plant health while converting root matter into vermicompost, which in turn dissolves through the system, eventually being taken up by the plants growing in the beds. If you have a separate worm farm, liquid worm castings may be used as a foliar spray to build plant health and vitality. These castings are considered organic, odourless and one of the best fertilisers and natural composts available. Urine from worms leaves their body through special pores in their skin which also allows them to breathe. Their diet will consist of any organic matter that has ever lived, including leaf litter, dead or decaying roots, leaves, fruit, vegetables, as well as hair, vacuum dust, coffee grounds, egg shells, tea bags, cardboard and manure. They will also break down clothing and leave behind only inorganic material like zips or buttons. If adding manure to a worm farm, ensure that the animal the manure came from has not been treated with a wormer that would kill worms. For best results, worms should

not be fed citrus, onions, potato peel, meat or dairy products and anything treated with chemicals.

Their anatomy is very interesting as they are hermaphrodites, meaning that they have both male and female sex organs. Worms mate side by side facing opposite directions and then form a slime tube to help adhere to each other during copulation. Here an exchange of sperm happens through the joining of their clitellas (the swollen band located near their head), and this process may take as long as an hour. After they separate, each of the worms then forms an egg capsule which they lay about a week later – the egg capsules are smaller than a grain of rice and can contain 2-20 baby worms. The

eggs hatch within 14-21 days and these baby worms will take 60-90 days to reach sexual maturity themselves. They will breed to the capacity of the container they are housed in as long as there is readily available feed, and if some of the worms are removed they will begin to breed again to increase the population. ●

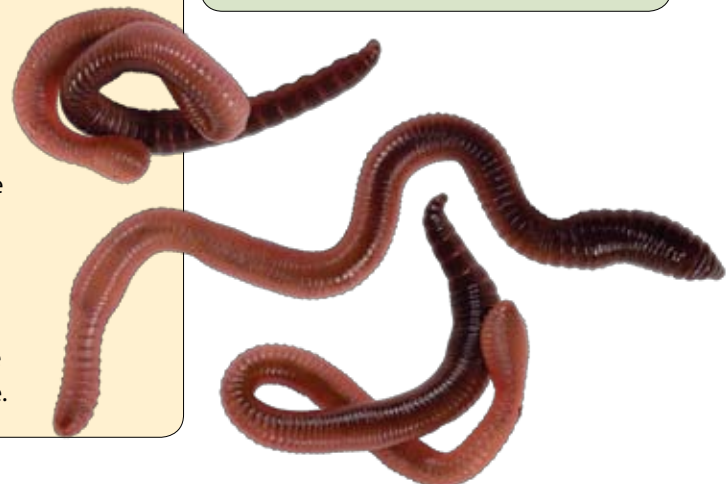
Interesting facts:

- Worms are a rich food source and are composed of nearly 70% protein.
- Worms can still live if thawed slowly from being frozen solid.
- Worms will attempt to regenerate lost segments and may be successful if they lost a tail. They will have trouble replacing a head though, and if cut behind the saddle the front end may live.

- Worms are coldblooded.
- Slime secreted by earthworms contains nitrogen.
- The longest earthworm ever found was 22 foot long and was found in South Africa.
- Castings contain a complete range of the macro nutrients NP and K as well as a range of micro nutrients.
- Castings contain beneficial micro-organisms which aid in fungal control.
- Liquid fertiliser can be made using 1 part worm casts and 10 parts water.
- Worms can reproduce every 6-8 weeks.
- A worm has five hearts.
- Many more micro organisms are present in a worm's castings than in the organic matter they consume.
- One mature earthworm can produce up to 1 500 babies in 12 months and the worm colony can double in size every two months.

Bi-products of this process include:

1. Worm castings.
2. Leachate, which is created by moisture added to the worm farm and which can be collected.
3. Worms as a high protein feed source.



Catfish dinner

By Aleece B. Landis

My large system is built around an in-ground, lined fish tank of about 600 gallons (2 270 litres). Burying the fish tank made a lot of sense in our climate as the ground temperature stays fairly constant – this helps keep the water warmer in winter and cooler in summer. There's also a 300 gallon (1 136 litres) waterfall tank which collects the returning water from the growbeds and overflows into the main tank



providing extra aeration. This main fish tank stays at a pretty constant water level.

I have four 'standard' lumber framed, plastic lined growbeds that are approximately 138 gallons (522 litres) each. There is one 'nursery' bed which is a shallow growbed only half-filled with gravel that can be used to start seeds in trays and pots, with only about 50 gallons

of gravel (190 litres) in it. Then I decided to build a 'Monster' growbed.

At just under 30 feet long, about three feet wide and one foot deep, this lumber framed bed with a pond liner holds another 600 gallons (2 270 litres) of gravel and requires its own sump pump to return water to the system. I may one day use some of the water from this sump pump to lift water to some towers or NFT troughs since it is already filtered.

Aleece and her monster bed

System summary

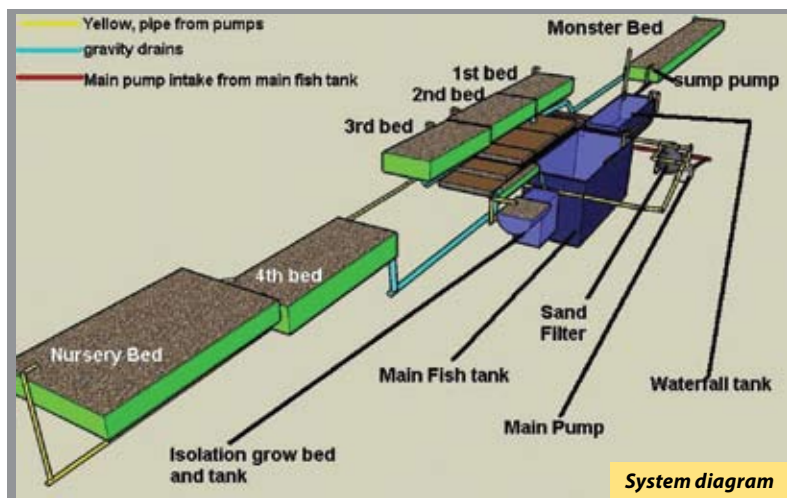
Location:

Tangerine, Florida, USA
(about 25 miles northwest of Orlando, Florida)

System stats:

- Approximately 900 gallons of fish tank (3 400 litres).
- One large in-ground, lined tank, approximately 600 gallons but it fluctuates (2 270 litres).
- One lined galvanized tank 300 gallons (130 litres). Constant height in tank.
- One 45 plus gallon storage bin tank sunk in ground as an isolation tank (170 litres).
- Approximately 1 200 gallons (4 540 litres) of gravel filled flood and drain growbed volume.
- The gravel is a mixture of ½-inch brown river rock and washed shells.
- Growbed to fish tank ratio of approximately 1,5 : 1.
- Pump: Sweetwater SHE2.4 220 Watt (60 gallon per minute at my system head).
- Sand filter: free from defunct pool.
- Sump pump: ¾ hp in end of 'Monster' growbed.
- Shade structure built from Cattle Panels, wood and shade cloth.
- Fish feeders: Two large Ergo automatic pet feeders.
- Battery backup air pump system for low water situation or power outage.
- Started research in early December 2007.
- Built Barrel-ponic system in early January 2008.
- Broke ground on big system on January 27, 2008.
- Started fishless cycling on March 4, 2008 (cycling complete March 20).
- Got 47 catfish on March 24, 2008. Mostly large fish.
- Got tilapia on May 28 (put them into the main system June on 12, 2008)

The first catfish dinner on August 9, 2008. (see picture below)



Right now the surge of water from this sump pump gives a periodic increase in water flow through the 300 gallon (1 136 litres) waterfall tank which helps move solids on through the system.

I've tried several types of auto siphons, or in one case, a flout, but I currently favour the loop siphons for adjustability and minimal space used in the growbed. I do like the one flout that I have for its ability to function under a wide range of inflow rates, but it does take up a big footprint in the growbed, thus wasting space.

The pump is an inline pump with the intake on the bottom of the main in-ground fish tank. I learnt the hard way to construct an intake screen in such a manner that fish can't get close to the strong suction. My first fish death was due to the fish getting sucked up against the pump intake. Since the pump is above the water line, I installed a swing type check valve below the low water level and the pump has a trap (priming

pot) attached. Flow from the pump is split, part goes to the growbeds with each feed controlled by a ball valve, and part is run through a sand filter. The sand filter is probably not needed but since it was there, and plumbed in, I decided it was best to use it. From the sand filter the water is piped back to the fish tank, acting as a bypass that adds extra aeration directly to the fish tank.

Then I decided to build a 'Monster' growbed

A later addition to the system is a small 45 gallon (170 litres) isolation tank and a ½ barrel growbed. This tank is meant for quarantine when needed – I can shut off the connections to the main system and use a small submersible pump to run this as a quarantine tank for new or sick fish. When not needed for quarantine and I'm comfortable that it isn't contaminated, I can open a couple of valves and remove the small pump and it's simply another small fish tank connected to the main system. Adding such an option into a system has proved to be a great idea.



The nursery bed



New plant growth

Overall I've found the experience of building and operating my own aquaponic system to be extremely fulfilling

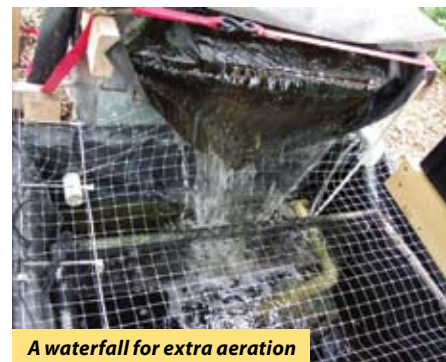
I've been growing Channel catfish and Blue tilapia in my system. The tilapia have the benefit and curse of being easy to breed, and if I can manage to control the breeding of the tilapia then I won't need to buy any more. The catfish might be too difficult to breed here in my system so they will need to be replenished from the fish farm on a regular basis.

Tomatoes and basil have been the best performing plants in my system so far. During cooler weather, lettuce was great but I had some trouble with aphids. As

the weather got too hot, the tilapia loved eating all the lettuce that had bolted. I am still trying new plants and trying failed ones again to keep some variety growing. The biggest issue I'm having is with iron not being available to the plants in the system. Since my system has so much shell in it the pH is strongly buffered to about 7.6. This is a little high for the easy uptake of certain nutrients such as iron and plants that prefer a low pH don't yet do well in my system. I would love to grow cucumbers in the system but they rarely survive, and if they do, they are pitiful plants that don't

produce. Hopefully with more maturity things will get a bit better.

Overall I've found the experience of building and operating my own aquaponic system to be extremely fulfilling. There are a few things, however, that I would change next time around if I



A waterfall for extra aeration



Having a quarantine tank is a good idea



Plant growth after four and a half months

was going to build another system – I would skip putting the shells into the growbed, and probably build a CHIFT PIST (Constant Height In Fish Tank, Pump In Sump Tank) style of system. But one thing's for sure, if I ever move house or build a new house, I'll definitely be building another aquaponic system. ●

Beetroot Relish

Ingredients

- 4 medium beetroots
- 1/3 cup (80ml) water
- 1 small brown onion (80g)
- 1/2 cup (110g) white sugar
- 2/3 cup (160ml) cider vinegar



Grate in a blender or with a hand grater



Combine beetroot with water and cook for 20 minutes

Method

Prepare by removing the tops of the beetroot and then peeling with a potato peeler. Trim the beetroot and grate coarsely. Finely chop the onion and place in a saucepan with the grated beetroot. Combine with water and cook for around 20 minutes until the beetroot is soft. Add vinegar and sugar and stir until the sugar dissolves. Continue cooking and stir occasionally until the liquid reduces and evaporates (approximately 10 minutes). Beetroot relish makes the perfect accompaniment to beef burgers, tasting plates or a ploughman's lunch.

Tips and tricks

- Beetroot relish keeps covered and refrigerated for up to three days.
- Handling beetroot can cause staining of your hands, but this can easily be removed with lemon juice. Alternatively, avoid the problem altogether by wearing gloves.

- Beetroot contains the B-group vitamin, folate, which is very important in the early weeks of pregnancy. It also contains valuable antioxidants and may also help reduce the risk of heart disease.

Growing beetroot

Beetroot grows easily in aquaponic growbeds, either from seeds or seedlings, and the leaves can be harvested for addition to salads whilst the root continues to grow until harvesting at maturity. Beetroot enjoys full sun and protection from frost and will grow year round. They are relatively pest-free, although they sometimes may be preyed upon by caterpillars which can easily be picked off and fed to the fish. ●

Layered yabby *Dip*



Recipe from Sue Ferguson

Ingredients

250g Philadelphia cream cheese – spreadable
½ white onion
Worcestershire sauce
Soy sauce
Mayonnaise
Spicy red sauce
Yabby, redclaw or marron (you may use
seafood substitute such as seafood extender
or crab sticks)
Parsley
Water crackers and/or fresh bread

Method

1st Layer

Finely chop the white onion and add to the softened cream cheese. Add a dash of Worcestershire sauce and soy sauce. Mix well and dish onto a round plate.

a nice pink colour. Spread across the bottom layer but do not go wider than the first layer.

2nd Layer

Mix half a jar of traditional mayonnaise with a dash of Worcestershire sauce and soy sauce and add spicy red sauce until the mix becomes

3rd Layer

Finely chop 230 grams of seafood flesh and sprinkle over the top of the first two layers. Garnish with finely chopped parsley and serve with plain water crackers or fresh bread. ●



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To consider *the moon or not?*

By Ivan Flower-Jones

It's an age old question and in my mind it's a 'no brainer' (excuse the pun).

I mean really, everything is influenced by the moon. One of the most basic influences of the moon which we see every day is the rise and fall of the ocean tides – here the effect of moon is quite obvious. The next quite easy influence to see is when your plants 'bolt' and have seeds ready for the full moon. Many people wonder why their immature plants suddenly bolt and go to seed, but often it's the moon's influence.

Watch the trees in your neighbourhood, notice when they are flowering and producing seed and then check the phases of the moon – you will begin to notice a correlation. Every seed is ready to be dropped, eaten and blown away by the same seasonal influence – to germinate at the optimal temperature and moisture to ensure the survival of the species.

Soon you will also notice the rains that come just after a new moon, and sometimes at the full moon, rains which 'bed' new seeds in and help them germinate. You will begin to see

the benefit of having growth of the 'root ball' and growth 'above ground' when the moon is below or above, and waxing (increasing) or waning (decreasing) in intensity.

Of course there are some who will always consider it to be coincidence, but the more you follow the natural cycles of the plants and take notice of the moon cycles, the greater the correlation you will notice.

The information below is a guide to planting in general – the optimum conditions will dictate the germination through to harvest period. Have fun and never look at the moon the same way that you did before.

PLANTING BY THE MOON was an ancient planting system known to every early culture throughout the world. Once again it is becoming popular as people search for alternatives to chemical pesticides and fertilisers and their frightening side effects. Working with the appropriate phase of the moon for all aspects of planting, cultivation and harvesting will increase quality as well as quantity in your crops. Many herbalists are using this system and

producing vastly more potent medicinal and culinary plants. Of course, you must be in the right season to get good results. Each type of seed has preferences for air and soil temperature for planting, which overrides the benefits of lunar cycles.

NEW MOON PHASE – 12 hours after Dark Moon to First Quarter

Every living thing feels an upsurge of energy – the sap is rising. A great time to plant or to start any projects, although some believe that it is better to wait until you can actually see the crescent of the New Moon.

Plant, graft and transplant annuals that produce above ground, especially those of a leafy kind that produce seeds outside the fruit. Also a great time for cereals and grains.

Don't pick anything as it rots too easily at this time – plants also tend to need more oxygen at this time.

The moon rises and sets with the sun at this time, and for the first day or two it is invisible. Every night she sets approximately one hour later and can first be seen as a waxing crescent (increasing in light), close to the sun at sunset.



FIRST QUARTER PHASE – First Quarter to 12 hours before Full Moon

The energy (and the sap) is still fresh and rising – this is a good phase for starting anything. Plant, graft and transplant annuals that produce above ground, especially the vine-type with seeds produced inside (such as beans, peas, peppers, squashes and tomatoes).

Plant cereals and grains. All activities listed for the New Moon phase are just as successful if done now. The last two days of this phase, just before the Full Moon, are considered optimum for planting, and grafts take best if done at this time.

By the First Quarter phase the moon is rising at noon and setting at midnight. She slowly grows in light, illuminating the first half of the night sky.

FULL MOON PHASE – 12 hours after Full Moon to Last Quarter

There is a peaking of the electromagnetic energy of all living things at the exact time of the Full Moon, and then a slow withdrawal of energy for the next two weeks as the moon wanes.

Plant perennials, biennials, bulb and root

The most basic influence of the moon that we see is the rise and fall of the ocean in its tidal patterns

crops and anything that produces below ground. The sap flow is downwards into the roots. Pruning is most successful now, and it is an excellent time to harvest all crops. Medicinal herbs and plants are most potent when picked now. This is a great time for sprouting seeds to eat, but not so good for sprouting seeds for planting, as there is a good initial growth spurt with only spindly follow through.

The Full Moon rises brilliant and full at sunset, illuminating the sky for the whole night. It will rise later and later in the evening as it moves through its waning phase.

LAST QUARTER PHASE – Last Quarter to 12 hours before Dark Moon

This is a barren phase, where it is most appropriate to rest or to prepare for the next New Moon. It is great for cultivation – pulling weeds, pruning, spraying. Apply

organic fertilisers any time during the Waning Moon, from Full Moon onwards.

This is the best phase for harvesting crops that you want to store for a period of time without rotting or losing flavour. Transplant close to the end of this period for an easy recovery with little trauma.

Weeds pulled now have no strength to sprout again.

The Last Quarter Moon rises at midnight in the beginning of the phase, showing us her slowly vanishing crescent in the early morning eastern sky. She then moves closer to the sun until she becomes visible for the last day or two of the phase. The cycle is complete.

The old-time gardeners say, "With the waxing of the moon, the earth exhales." When the sap in the plants rises, the

force first goes into the growth above ground, thus you should do all activities with plants that bear fruit above ground during a waxing moon. With the waning of the moon, the earth inhales, then the sap primarily goes down toward the roots. Therefore, the waning moon is a good time for pruning, multiplying, fertilising, watering, harvesting and controlling parasites and weeds.

According to astrological calendars, the star signs appear throughout the lunar cycle, and as such have their own best timing.

FIRE SIGNS – FRUIT, SEED GROWTH

Aries, Leo, Sagittarius

When you plant in a fire sign, the moon's influence is channelled into the fruit and seed of the plant. Plant wheat, corn, tomatoes, beans, squash, peas and all fruit.

Plant now to get quality seeds for next year. Harvest fruit and seed crops as well. The very best seeds are obtained from a fire sign during Full Moon. This is an excellent time for any cultivating or tilling. Plant garlic, leeks, onions, peppers or chicory if you are looking for an exceptionally spicy crop.

AIR SIGNS – BLOSSOM GROWTH

Gemini, Libra, Aquarius

When you plant in an air sign, the moon's influence is channelled into the blossom growth. Plant all flowers and flowering plants (except cauliflower and broccoli which do better in a water sign). Plant now if you want fragrance and beauty. The moon in Gemini is good for flowering herbs, while the moon in Aquarius is good for planting or harvesting hybrids (although hybrids don't respond well to lunar planting methods). This is also a good time for

cultivation, weeding or eliminating pests. If you can't plant now, plant in a fire sign.

EARTH SIGNS – ROOT GROWTH

Taurus, Virgo, Capricorn

When you plant in an earth sign, the energy of the moon is focused into the roots of the plant. Carrots, beets, turnips, potatoes and all tubers are ideal. Plant now to produce strong, hardy, well-anchored plants. The moon in Capricorn will produce an exceptionally hardy plant which will last through dry weather spells. When the moon is in Virgo, put your garden in order – tie up plants and apply organic fertilisers. The earth signs are considered to be extremely fertile, so if you can't figure out what sign you should be using, or can't possibly organise your time for a specific sign, then plant in an earth sign or a water sign. The best day to cut grass is in this sign

in the waning moon. Turn compost heaps.

WATER SIGNS – LEAF GROWTH

Cancer, Scorpio, Pisces

When you plant in a water sign, the energy will go into the leaves. Lettuce, spinach, grass, cabbage, cress and any leafy growth will thrive if planted now. This is considered to be the most productive sign, even more so than earth. It is a very good time for fertilising and irrigating as well as for starting composts heaps. Don't harvest now as your crops will decay too soon. Plant melons, grapes and any fruit with a high water content as these will do well at this time. ●

*Acknowledgements and references:
The Permaculture Association of South Australia's 1988 Calendar and Canopus Academy Astrology.*

2009 moon calendar



January						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

February						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

March						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3	4	5	6
7	8	9	10	11	12	13
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28	29	30	31			

April						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
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11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

May						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
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24	25	26	27	28	29	30

June						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
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23	24	25	26	27	28	29

July						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
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16	17	18	19	20	21	22
23	24	25	26	27	28	29

December						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
2	3	4	5	6	7	8
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16	17	18	19	20	21	22
23	24	25	26	27	28	29

November						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
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October						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
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23	24	25	26	27	28	29

September						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

August						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
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16	17	18	19	20	21	22
23	24	25	26	27	28	29

OBO's

Aquaponics Journey

By Colin Donaghy

I started my first aquaponic system in early October 2007 and what a journey it has been. From a 200 litre bathtub and PVC pipe system, through to my 8 000 litre (and growing) current system, it has been an interesting education.

I found out about aquaponics while browsing the internet looking at hydroponic systems. Due to the very poor soil that Kalgoorlie has, growing vegetables in the ground is quite labour intensive and requires a lot of water and fertiliser. Aquaponics sounded like the perfect way to grow veggies and fish so I dived in and began with a very simple system using recycled materials.

The original system

A 1 000 litres per hour pump was used in a bathtub to pump the water through 13mm poly pipe to an irrigation filter, then around a 110mm PVC pipe which was cut in half. The free end was pointed back into the bathtub with a tap on the end so that the flow could be regulated and for some extra aeration. A mixture of goldfish and guppies, simple aquarium fish, were used.

The poly pipe had little holes punched in it with a 3mm drill bit under the pipe, pointed down at the grow media, about two feet apart – any more and the channels got too full and overflowed. This

system was run on a timer, 15 minutes on, 15 minutes off overnight, and 15 minutes on, two hours off during the day.

A month later



Water temperatures in the peak of summer (45°C days) were hitting high 30s, until a shade cover was added. This was

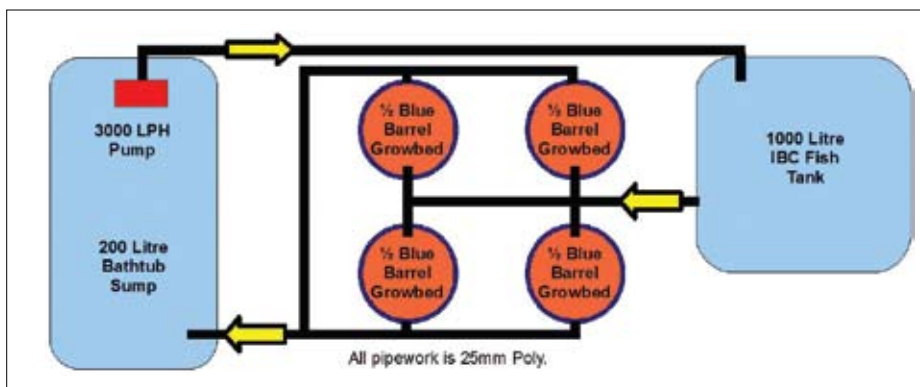


The average water usage for this system is less than 100 litres per week, and power consumption is around \$5 per month



the proof of a concept system which had several shortcomings that became very obvious later on.

The 13mm poly pipe became constricted with bio-film and the 3mm holes became blocked daily. The roots from the plants filled up the PVC pipe and caused overflows, usually resulting in the bathtub being nearly empty every day. The pumping was reduced to a minimal level to compensate for this, but eventually the system had to be changed.



The cut in half PVC system never really reached full production due to the problems with water flow – it was a struggle at times just to keep everything alive. It had, however, proved that the aquaponics worked, and worked well.

I converted the bathtub system to a CHIFT PIST (Constant Height In Fish Tank, Pump In Sump Tank) system, by utilising the existing pump and bathtub as the sump and adding a 1 000 litre IBC as the fish tank. The fish tank overflows into the top of the blue barrels and drains out of the opposite side of the barrels at the bottom, back to the sump bathtub. All pipe work was upgraded to 25mm poly pipe at the same time. This system runs as a constant flow, i.e. the pump runs all the time. Winter water temperatures get below 5°C in the morning and up to 15°C by late afternoon. The 1 000 litre per hour pump was replaced with a 3 000 litre per hour shortly afterwards.

The only problem left with this system is that the single overflow point from the IBC can (and has) become blocked with a careless goldfish, causing the IBC to overflow and empty the sump. This will



be fixed by adding another overflow – one for each of the two blue barrel rows.

The average water usage for this system is less than 100 litres per week and power consumption is around \$5 per month. ●

Outbackozzie's Top Tips:

- Do:** Use the biggest water pipe work that you can the first time around – it gives you more water flow and allows headroom for more growbeds later.
- Do:** Add overflows to your tanks and growbeds – its cheap insurance.
- Do:** Have some sort of back-up power supply.



Philip and Rowena's *Welsh Adventure Story*

By Rowena and Philip Mansfield

Anglesey is a predominantly Welsh speaking island situated off the northwest coast of Wales (United Kingdom) and is connected to the mainland of North Wales by two bridges spanning the Menai Straits. With an area of 276 square miles (715km² – 20 miles x 17 miles), Anglesey is the largest Welsh island and the fifth largest island surrounding the mainland of Great Britain.

Anglesey has an essentially maritime climate, characterised by weather that is often cloudy, wet and windy but mild. Temperatures can range from 7°C in January to 16°C in July

(45 to 61°F) and 1 600 hours a year of sunshine are recorded on average on Anglesey, but gales can also be expected on 27 days or more in a typical year. On Anglesey the annual rainfall is around 843mm (33 inches), and there is relatively little seasonal variation in rainfall, except that the late spring and early summer, from March to June, tends to be the driest part of the year. Roughly half



the annual rainfall usually comes between October and February.

Traditionally the mainstay of the island's economy has been agriculture and even today 70% of the land is dedicated to permanent grassland and arable farming.

Rowena and Philip Mansfield have been growing for over forty years. Initially they started by growing vegetables and the like for home consumption and lately growing field grown market garden produce and herb plants for sale. Philip started experimenting growing



Cae Gwyn in Wales

hydroponically and also set up a simple aquaponic unit with goldfish growing water cress.

On hearing of our hydroponic experiences we were approached by our local Enterprise Agency to set up a Demonstration Hydroponic Unit to show farmers and others just what could be grown in this way – from flowers, herbs, salads and strawberries to brassicas and other vegetables. This unit was opened in 2006 and shortly afterward four other growers on the island set up small units and started growing hydroponically.

All this produce is sold locally and can be in the shop or home within eight hours of picking and packing. At the time of

writing – November 2008 – we were still supplying shops with salad leaves, mustard, mizuna, tatsoi, minutina, herbs, chard, black kale and water cress. The produce is sold to a local firm run by one of the hydroponic growers, who collects orders twice weekly for delivery. She takes a percentage of the price she sells the produce for and the grower gets the rest. Customers can also come at weekends and pick their own produce under supervision.

Such was the hydroponic interest that we were then asked to set up a similar Aquaponic Unit, and this was up and running during late summer of 2008 – with Rainbow trout in tanks and salad crops, brassicas and herbs in the growbeds. There is no heating in this

unit due to financial constraints and native freshwater fish are to be grown. Many plants can tolerate a cool growing temperature and we are researching to find out for how long a season we can grow and have edible produce for sale.

The aquaponic building has been built with many clear plastic roofing sheets and side panels so that there is enough sunlight for the plants. Dark green gazebo type shelters are over the trout fish



Philip testing the water

tanks so that they have some shading. Any waste water is channelled into a nearby greenhouse.

This project in particular has been very much a case of trial and error, and without all the help and encouragement from the folks at Backyard Aquaponics, we would have stumbled along for much longer and would probably have made far more errors along the way. Having said that, we still have much to learn and this is part of the excitement of growing fish and plants.

It was beneficial that we had some previous experience in hydroponics and this has helped with the growing aspect, but looking after fish (and trout can be quite finicky to look after) has been very much a learning curve and we have discovered an awful lot in a short space of time.

As our adventure continues we do hope that we have encouraged young and old alike to think about the food supply



The first setup



The second adventure on the right



Rowena cleaning-up

The sourcing of materials initially was quite a problem – where in the UK can you buy fish tanks and growbeds? There appeared to be no-one with aquaponic equipment! There were firms with giant aquacultural materials but these were not quite suitable for what we wanted and were also very expensive. Ebay and Koi Carp equipment suppliers were watched carefully in case anything suitable for our purposes was found!

The growbeds finally came from a hydroponic supplier but these were not deep enough and we had to build untreated wooden frames covered in black plastic to make the required depth for

the clay ball growbeds. We found some fish tanks and purchased three large ones holding 850 gallons/3 825 litres and three smaller ones holding 350 gallons/1 575 litres. Unfortunately the larger tanks, which were made of thick black vulcanised rubber, did not have flat bottoms (perhaps due to the way they were made), but we have managed to make do with them.

Two of the large fish tanks support eight growbeds, and the third large tank is holding, at the time of writing, 500 Rainbow trout fingerlings. The smaller tanks are used for quarantine purposes and to hold water ready to be put into



Designed by Rowena Mansfield

Drawing not to scale = building 45' x 45'

the larger tanks when a water change is done. It is anticipated that in 2009 we will also have common carp in the tanks and be growing water cress (for which there is an increasing demand). The purpose of both these units is to enable interested parties to see that produce can be grown to feed the locality without too much expense, and to hopefully help with the demand for locally grown food.

Much of the initial funding has come through the Welsh Assembly Government as an agri-innovation grant. The rest has come from us, not only with money but with the many man-hours spent in research and development, trialing the different systems and finding out through trial and error what would grow in our temperate climate without adding to the cost of heating and lighting in the winter and cooling in the summer months.



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Trials using different systems – from NFT (nutrient film technique), drip feed, floating beds and growbeds

Through speaking to some urban regeneration groups, whilst grants may be available for setting up small to medium-sized aquaponic units in urban areas, the cost of running such units once in place must be found by the groups by sale of produce, etc. Money needs to be found or raised to sustain the running costs of each unit. There are just the two of us running our Hydroponic and Aquaponic Units, but we are always willing to teach and accommodate anyone interested in helping us.

We have tried growing in many different types of systems – from NFT (nutrient film technique), drip feed, floating beds, growbeds, aeroponic systems and others using rockwool, perlite, clay balls and recycled crushed glass. We try to use mediums that can be sterilised and re-used where possible and to use homemade systems using materials found lying around. Our demonstration units show not only shop bought systems but also the sorts of systems that most people could manage to make and put together themselves. Many people have remarked that, “Oh yes, I have something similar lying around – I could use that!”

Our motto is: “Make better use of what you have!”

We have also been commissioned to write an instructional manual on hydro and aquaponics and to run workshops. We are planning on holding four two-day workshops in 2009, mainly on hydroponic growing but with an introduction to aquaponics. Details can be found on www.herbsfromwales.co.uk and any enquiries can be made through that site.

There will also be three Open Day events in 2009 when the public have the chance to be shown around our units. As our grown-up children all live far away in southern England, we are helped by friends and neighbours who turn up to support us at these events and give a hand.

To help with finances Philip teaches Tai Chi and Qigong to groups around the island, and Rowena keeps busy collecting herbs for use in her Herbal Ointments and Balms which she makes and which are sold worldwide. She also acts as a herbal consultant and makes other herbal balms

under contract. She also wrote the first bilingual (Welsh and English) herb book – a taster of the wild herbs to be found growing in this part of the world.

As our adventure continues we do hope that we have encouraged young and old alike to think about the food supply, where food comes from and how it is produced and how to grow in a sustainable way. In a world with an ever-increasing population reliant on those of us with the skills and knowledge of growing food, we must endeavour to educate and help as many people as possible in the ways of sustainable food production so we can all meet the challenges that lay ahead. And the first step starts at home! ●



Fish *sense*



By John Burgess

Have you ever wondered how your fish seem to know when you're coming to feed them? We have a closer look at how fish sense the environment around them.

Successful survival in any environment depends upon an organism's ability to acquire information from its environment through its senses. How do fish cope with their environment? How do they breathe, why don't they sink, do they feel pain, do they distinguish colours, how do they see the world?

Hundreds of thousands of years ago, long before man appeared on the earth, fish were already swimming in the oceans. At that time they were the most highly developed form of life in existence. With a

few exceptions, fish have survived in an environment completely different from ours – in water.

Like all other living organisms, fish have survived by acquiring information about the environment through their senses – senses of sight, smell, taste and touch – and a few other special senses that help them live underwater.

The brain of a fish is poorly developed. The cerebrum, which in humans is the centre of thought and reasoning, is missing entirely, though a fish has a sensitive nervous system. So just how do

your fish know when you're coming to feed them?

Senses in fish

Fish have the same five senses man has – they can see, smell, touch, hear and taste. But they have developed some senses that we don't have, such as electro reception and the ability to sense light, chemicals, vibrations and electricity as well using what's known as the 'Lateral Line', which is their sixth sense.

In fish, the importance of each sense is

different compared to us humans. I will briefly describe them here.

Sight – Vision under water poses many special problems. The most significant is the small amount of light available in all but the uppermost layers of water. Underwater vision is limited to a few yards at best and fish do not use this as one of their primary senses.

Smell – In most fish the sense of smell is highly developed and is probably used more in the location of food than sight.

Hearing – It has been shown that fish can hear, but its full function is still not understood.

Taste – Taste buds in fish are located in the mouth and also in the skin covering the head, body fins, barbels and lips. It's entirely probable that fish can taste

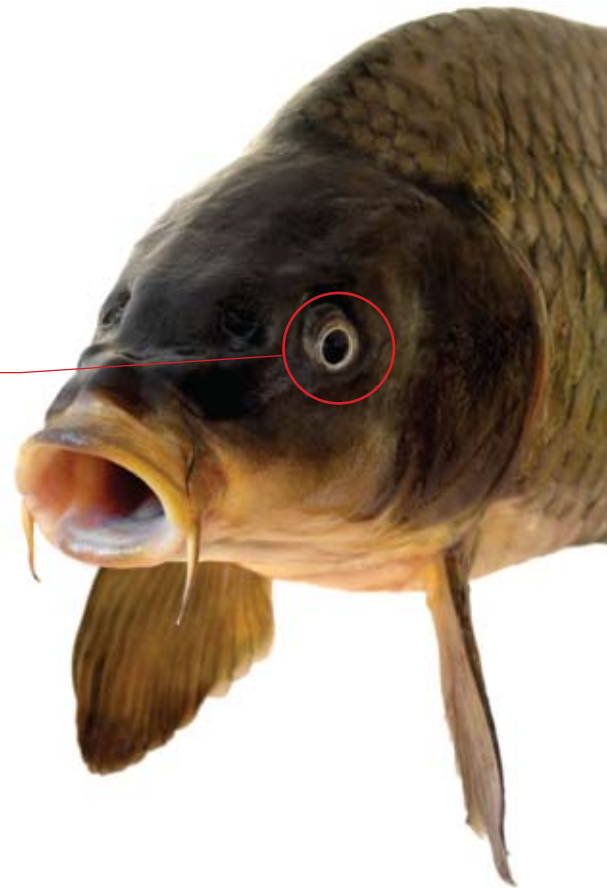
food well before it enters their mouth.

Touch – Fish also have an elevated tactile sense which is shown none better than in certain catfish who use their barbels as extensions of their body.

Sight

Fish eyes work in much the same way that human eyes do, similar to a camera. There are some differences through. The eye is similar to that of other backboned animals. Fish don't have eyelids or tear ducts, and they don't have an iris that adjusts to different amounts of light. Fish are usually nearsighted but it is thought that they can distinguish colours.

Fish eyes are sensitive to movement. They have plenty of special cells called rods that alert them to movement and



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contrast and each eye can detect these on their own. Because fish have eyes on the sides of their heads, they are able to see almost all around themselves.

But like our own eyes, the two eyes must work together to enable the fish to see in three dimensions, allowing the fish to determine distance from an object. And because the eyes are on opposite sides of their head, fish only have a narrow area of this 'binocular vision' – directly in front and above their snouts. This makes fish relatively nearsighted – while they can make out movement and images at a distance, they can't see them clearly or judge the distance or depth.

Scientists believe that freshwater fish can see colour. Most researchers think that fish have three sets of cells called cones in the eye that allow for colour perception. They think that two sets of cones are sensitive to colour while the third picks up ultraviolet light, which we can't detect with our naked eyes.

No matter how good your eyesight and how clear the water, the underwater world looks hazy, distorted and sometimes downright murky to humans. This is because when you're under water, the cornea isn't nearly as good at bringing light to a focus as it is on land. Fish have special adaptations that allow them to see underwater and at great depths.

Because of the way light is refracted in water, fish have a wide 'cone of vision' of about 83 degrees. It is like looking up from the base of an imaginary funnel. As a fish goes deeper, his window to the outside world grows. Even more interesting, if the water surface is

relatively smooth, a fish can look up and see a mirror-like image of the bottom. This allows him to be aware of either prey or predators beneath him.

Most fish, because they cannot turn their heads, can see to the right and to the left at the same time. This gives them all-round vision. To allow them to judge distances they have a small area in front in which they can focus on with both eyes.

Fish also lack eyelids. Since the role of eyelids in land animals is to keep the eyes moistened and to protect them from harsh sunlight, there doesn't seem to be much need. Fish's eyes are kept moistened by the flow of water and there is seldom any bright sunlight to hurt their eyes. However, in an aquarium, sudden bright light can frighten them or

damage their eyes. It is best to introduce light gradually by turning on a room light first before turning on the aquarium light. Be sure to also provide plenty of hiding places.

Fish have a very keen sense of vision, which helps them to find food, shelter, mates and avoid predators. Fish vision is on par with our own vision; many can see in colour and some can see in extremely dim light.

Fish eyes are different from our own in that their lenses are perfectly spherical, which enables them to see under water because it has a higher refractive index to help them focus. They focus by moving the lens in and out instead of stretching it like we do. They cannot dilate or contract their pupils because the lens bulges through the iris.

As the depth at which fish are found increases, their eye sizes increase in order to gather the dimmer light. This process continues until the end of the photic zone, where eye size drops off as there is no light to see with.



Understanding how your fish relate to their world will help you provide them with the best care

Nocturnal fish tend to have larger eyes than diurnal fish. Just look at a Squirrelfish, and you will see a good example of this. Some fish have a special eye structure known as the Tapetum lucidum, which amplifies the incoming light. It is a layer of guanine crystals which glow at night. Photons which pass the retina get bounced back to be detected again. If the photons are still not absorbed, they are reflected back out of the eye. On a night dive, you may see these reflections as you shine your light around.

Smell

Fish have a very sensitive sense of smell. How sensitive? They can detect concentrations of chemicals as low as one part per trillion. That's the equivalent of one ounce of chocolate syrup in a million railroad cars full of milk. Salmon can detect smells from the waters where they were born from hundreds of miles away – it stands to reason then that a trout can smell a tasty night-crawler from a few yards.

The sense of smell, or olfactory sense, is located in a fish's nostrils, which are actually called nares. There are two pairs of nares on both sides of the snout which are lined with nerve tissue that is highly sensitive to odours from substances in the water.

For humans, smells are detected by sensing chemicals dissolved in air. Fish detect these chemicals in water. As water flows through the nares, the dissolved materials trigger the olfactory organ, which in turn transmits signals to the brain.

A nostril at the front of each nare allows water to enter the pouch and pass over the tissue, then to leave the pouch through a nostril at the back. Unlike

humans, however, there is no connection between the nostrils and the throat. Some fish, like salmon, use their sense of smell when migrating or travelling from one place to another.

Just like in humans, taste and smell work together through nostrils and taste buds located in the mouth. However, many fish have taste buds located on the their heads, on the barbels and on the outside of the body. These taste buds have the ability to distinguish the difference between sweet, sour, salty and bitter.

Chemoreception is very well developed in fish, especially in sharks and eels which rely upon this to detect their prey. The olfactory rosette is the organ that detects the chemicals. The size of the rosette is proportional to the fish's ability to smell.

Hearing

We take sound for granted while moving through the blanket of air we called the atmosphere, but we hear very little under water. Fish have ears, too, although you can't see them. Fish do not have external ears, but sound vibrations readily transmit from the water through the fish's body to its

internal ears. They are located within their bodies as well as in the Lateral Line system.

Fish can hear sounds in the water and can probably hear sounds made on shore if they are loud enough. What makes them able to hear under water is that they have no outer ears or eardrums to receive sound vibrations.

Sound vibrations are first transmitted from the water through the fish's body to its internal ears, which are divided into two sections:

- **An upper section (pars superior)** – The pars superior is in turn subdivided into three fluid-filled semi-circular canals, which provide the fish with a sense of balance. It is fluid-filled with sensory hairs which detect the rotational acceleration of the fluid. The canals are arranged so that one gives yaw, another pitch and the last one, roll.
- **A lower section (utricle)** – The utricle provides the fish with the ability to hear. It contains two large otoliths (ear stones) that vibrate with sound and stimulate surrounding hair cells.

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The movement of sound waves through the water is integral to a fish's sense of hearing and to its overall survival. Fish count on two different organs working together to locate and sense sounds. On both sides of most fish you will find a line of pores called the Lateral Line.

The pores are the opening of tiny tubes that go through the scales into the body and end near a large nerve, which travels to the brain. At the end of each tube are tiny hairs that vibrate when sound waves pass over them. The moving hairs stimulate the Lateral Line nerve. Because tubes point in different directions, fish can accurately locate the area from which a vibration emanates.

Fish also have an inner ear, similar to humans. The inner ear aids in balance and hearing. The part of the inner ear involved in sound interpretation is called the otolith, or ear bone. Hair movement in the fluid-filled sack surrounding the otolith is what stimulates the attached nerves. Sound waves move through a fish's body, almost as if it were not there, and reach the otoliths, making them move.

When a baitfish or a lure or fly imitating food moves through the water, it gives off vibrations, which a fish can detect

yards away. These vibrations can be heard and felt.

Taste

Again, similar to humans, fish have taste buds. We have about 10 000 on our tongues but fish have even more and they are found on the lips and mouth.

Some fish – like catfish – even have taste buds on their skin and barbels. They have more taste buds on their skin than we have on our mouths and since the water is carrying dissolved materials to them, they don't even need to touch something to taste it. Some species of catfish can taste things from 15 feet away. Goatfish can be seen digging through the sand with their barbels looking for invertebrate worms to eat and can taste them before they even reach their mouths.

Touch and the Lateral Line System (the sixth sense of a fish)

If you've ever watched fish swimming in an aquarium, you've probably noticed that they rarely bump into anything. They may be swimming directly towards the side of the aquarium, but at the last second they make an abrupt turn and swim merrily on their way.

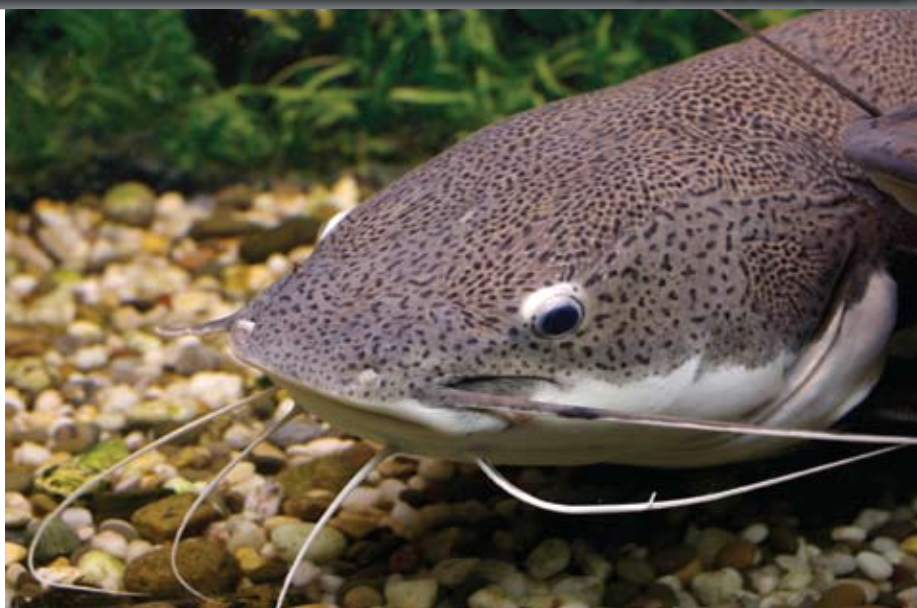
What you are observing is the result of their special sense organ, the Lateral Line system, which provides fish with information about its external world. The Lateral Line consists of a series of scales, each modified by a pore, which connects with a system of canals containing sensory cells and nerve fibres. It runs in a semi line from the gills to the tail fin. These pores are not restricted to the Lateral Line, however, but are also distributed all over the fish, particularly on the head.

The pores serve to detect pressure changes in the surrounding water. A fish sets off his own pressure wave in the water that is detected by other fish. He also sets up a pressure wave in front of himself, and when he swims near a rock or the wall of the aquarium, these pressure waves are distorted, and changes are quickly detected by the Lateral Line system, enabling the fish to swerve or to take another suitable action. It is this ability that allows a school of fish to change direction at the same time without bumping one another.

Not all pores, however, come in contact with the water. Some are arranged linearly to form Lateral Lines to give the

fish an actual sense of touch. Nerve endings throughout the skin react to the slightest pressure and change of temperature.

The Lateral Line can easily be seen in fish as a band of darker looking scales running along the side. It has been shown to be a very important sensory organ in fish and it can detect minute electrical currents in the aquarium water and also functions as a sort of echo-location process that helps the fish identify its surroundings.



Electricity

Sharks and rays possess special organs for detecting electrical potential (voltage). A set of pits comprise the electro receptive system called the 'Ampullae's of Lorenzini'.

These are canals in the skin filled with a gelatin-like material that also contain sensory cells. Movements or disturbances near the shark change the voltage along the canals, which allow the shark to sense other organisms nearby.

These sensors are so sensitive that if there were not any other distortions a shark could detect the heartbeat of a fish 500 miles away! They can detect muscular contractions of struggling prey and even the earth's magnetic field (which sharks use for navigation). ●

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Aquaponics *in the Philippines*

By Travis Hughey

I recently made a trip to Quezon City in the Philippines to build an aquaponics system there as a training and demonstration tool. Margie Tajon, CEO of Althea Med (a pharmaceuticals company) sponsored my trip. She contacted me and asked if I would come and I made the trip there at the beginning of January.

I took along a complete hardware kit on the trip to make sure that we were actually able to get the system built, but was hoping to bring it back home with me. I am happy to say that I did have to bring it back with me as we managed to source local materials for the entire project.

This trip was a little different to most as the funding was not from outside of the country – it's a wonderful thing when the people of a country take the initiative to bring in new technologies on their own!

Margie did an excellent job of hosting me and showing me around as much of the country as time permitted. I stayed in her home and experienced life with her family and she made me feel as if I was a family member as well. Her efforts were greatly appreciated and meeting everyone there was a wonderful experience.

I am extremely excited about the potentials of aquaponics in the Philippines. Everyone I met there is committed to bringing this technology to the people of the Philippines so that they are able to have better access to healthy, pesticide-free food.



Travis answering questions at the press conference and next to him is Margie Tajon

The Filipino people are very gracious and hospitable. Margie also set up a press conference to promote "The Hughey System" for aquaponics, complete with radio, newspaper and TV coverage. She had the press club and photographer follow us around everywhere and document the building process.

If this trial goes well I will be building a much larger commercial scale system

there in the future as well as doing further promoting of aquaponics in the Philippines.

On the opposite page you will see some photographs of the prototype of "The Hughey System" for aquaponics in the Philippines. I even got the chance to meet a couple members of the barrelponics Yahoo group which I moderate. ●



Putting the finishing touches on the fish tank



Positioning the growbed framework



An aerial view of the completed aquaponics system

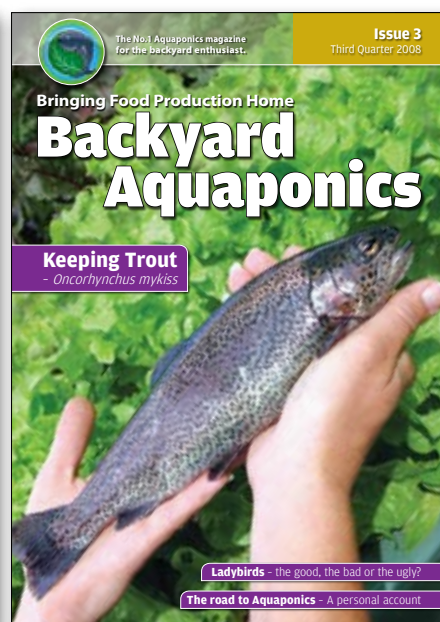
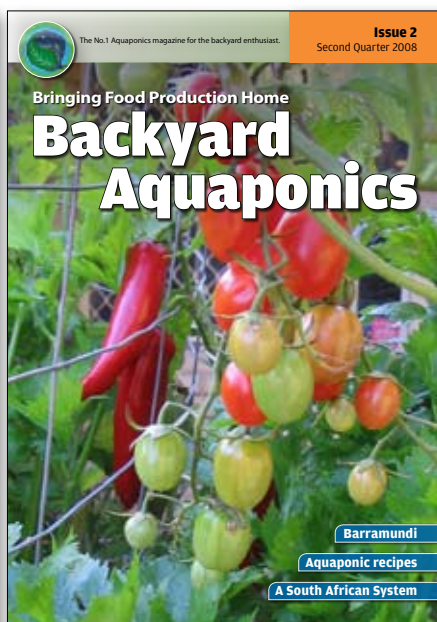
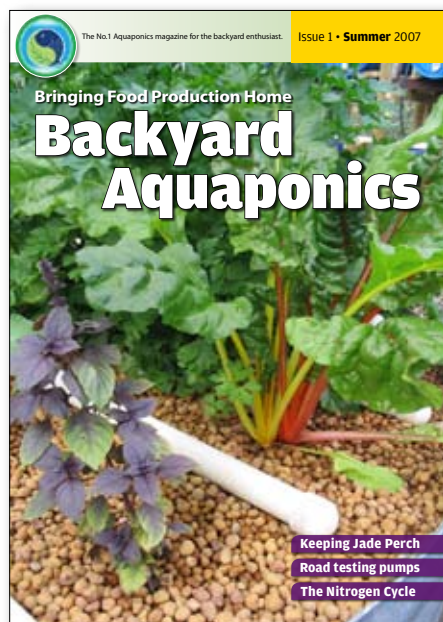


Cleaning the gravel for growbeds :-)



Travis and the crew who built 'The Hughey System' aquaponics system in the Philippines. On Travis's left and from the rear is Margie Tajon (the sponsor of the project), Evelyn (who will be operating it) and Marlee (Margie's assistant). On Travis's right from the rear are Renee and Danny, the construction guys who supervised the workers, and next to Danny is Bob and Dave and at the front is Sonny (Margie's driver).

More information, visit www.fastonline.org



Backyard Aquaponics Magazine

Future Editions and Subscriptions

Work is well under way on the **fifth edition** of the Backyard Aquaponics magazine. Amongst other articles, we will be showcasing more systems that belong to members of the online discussion forum, there will be information about fish feed and fish diseases, and we'll take an in-depth look at another fish species suitable for use in aquaponic systems. One of the new items to look forward to in the next issue is a question and answer section where we will take some of the most commonly asked questions about aquaponics and provide you with straightforward answers from experienced aquaponic system operators.

It promises to be an exciting issue, packed full of information, pictures and diagrams and we hope that you will enjoy reading it.



The **Backyard Aquaponics magazine** can be purchased and downloaded from the Backyard Aquaponics magazine website, either as individual issues, or as a yearly subscription. Alternatively, we can mail you a copy of the magazine on CD-Rom, or DVD.

If you have any queries, please don't hesitate to contact us.

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