

# back to nature


Jasper Kuijper goes back to the Niigata roots and researches what our koi really eat. Here's a fascinating insight into how a brand new food came about



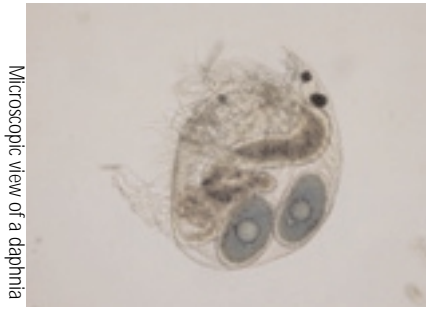
A springtime scene in Niigata – a sight to behold

**W**hen you travel in the mountains of Niigata, you become at one with nature and forget your busy life. I am always surprised how well the koi breeders work with nature. Have you ever asked yourself the question why they have no filtration on their mud ponds? Or have you been amazed by the quality of koi harvested from the ponds? It is almost as though the koi are reconditioned by the time they spend in them. Lots of fanatical koi keepers realise the benefits of these ponds and keep their koi in Japan to grow them on.

## mud pond magic

So, what magic is harnessed in these mud ponds? Well, we think it's not so much magic but the Japanese breeders' knowledge of how to work with nature. Firstly, the mud ponds are prepared by the breeders with phosphate and nitrogenous fertilisers, depending on the type of soil. Sometimes they even use mineral fertilisers to stimulate the production of phytoplankton – this limits the levels of ammonium ( $\text{NH}_4^+$ ). Why do they do this? The answer is very simple – they want to create, as quickly as possible, a very rich natural food source. So in a short space of time, by fertilising the ponds, they create zooplankton, phytoplankton, benthos, plant debris and silt. Daphnia is probably the best known zooplankton and it varies in size. The big zooplankton are highly visible and slow-swimming, therefore the favoured food for the koi, which hunt by sight. The smaller zooplankton like copepods and rotifers are faster swimmers, have a transparent body and they can also attach themselves to plants – all this makes them very difficult for larger 

Everybody who has worked on this project has been amazed by the results and, as you can see, the pictures say more than words



Microscopic view of a daphnia



Polychaete worms farmed by Dragon



Hasegawa Kohaku 4.14kgs, 60.5cm 01-12-2006



Hasegawa Kohaku 6.28kgs, 66cm 25-05-2007

koi to feed on, however this part of the food chain is very important for small fry.

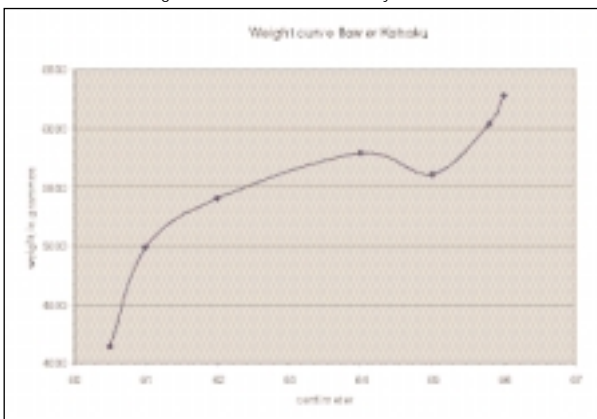
The food source for the growth of zooplankton is phytoplankton, bacteria, detritus and some small rotifers. Phytoplankton production is 10-15 times higher in a fertilised mud pond than an unfertilised one. They play an important role in the nitrogen cycle and can reduce the nitrate levels to very low levels optimising the growth of the koi. Besides that, they convert the mineral salts and dissolved carbon dioxide during their reproductive cycle. What most people don't realise is that some of the protein released from the pellets we feed is a vital food source for phytoplankton. Therefore by feeding we help to keep these levels high within our ponds. Another food group within the mud pond is

the benthos group. Benthos is a term used for animals and plants that live at the bottom of the pond. Most of the time these are worms and they turn-over/agitate the top 5cm layer of the bottom every two weeks. This helps to reduce the amount of silt and detritus and creates nutrients for other species. As we all know, koi love to forage in the mud to catch these worms, which are a food source to them. The worms are a very important food source as they have some essential fatty acids like omega 3 and 6 that help koi convert the protein intake and create improved growth rates. As well as the food sources mentioned above, koi also eat crustacea, insect larvae, snail and plants that grow in the mud ponds – in this way the koi/carp achieve the balanced diet they require.

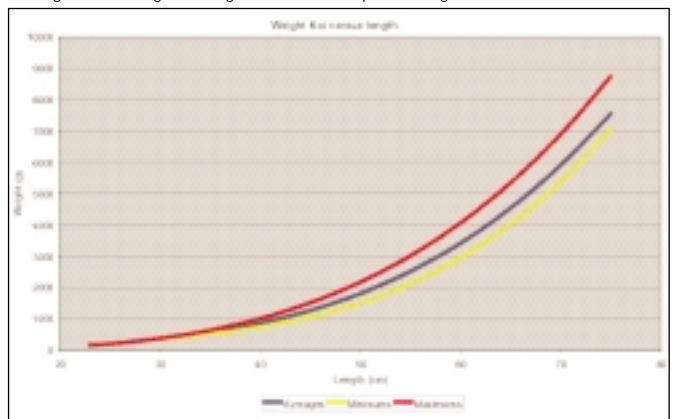
**natural filtration**

Today we are more aware that nature creates its own filtration. To give you an example: zooplankton belong to the filter feeders' group – a large daphnia (2.5-5mm) can filter 50-80ml of water in 24 hours. But you need up to 5,000 rotifers or 8 million ciliates to do the same job. A rotifer can filter 100,000 times its own volume in one hour and can eat particles of up to 10 micron. Vorticella can do 10,000 times its own volume per hour and can eat particles up to 5 micron. So, nature creates its own filter using zooplankton, phytoplankton and benthos and at the same time it's a food source for koi. Simulating nature in this way is always going to be difficult to copy in an artificial pond. When a koi has hikui (skin abnormality usually on the red skin (beni),

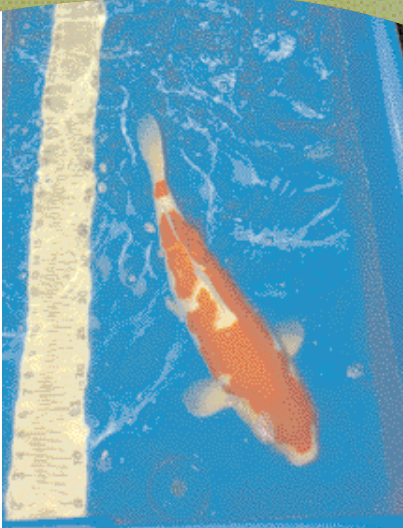
The Kohaku lost weight at 65cm when it was only fed 0.35%



A diagram showing the weight of a koi at a specific length



Just making a good food is not enough for koi keepers – they also want good water clarity too



Hasegawa Kohaku 2.16kgs, 50cm 01-12-2006



Hasegawa Kohaku 3.32kgs, 57cm, 25-05-2007



Weighing the koi with accurate scales

the breeders will often put it back into the mud pond to recondition the koi. Then, when they harvest the koi in autumn, the hikkui is invariably gone. We deduce that natural food is very important and something we should try to emulate to keep koi in the best condition.

**how to design a new food**

Firstly you need to think outside the box and come up with a different way of thinking – in this case we decided to copy as closely as possible the natural food source of koi/carp. The first thing we did is to collate all the known research on koi/carp's diet and physiology requirement. Unfortunately, there are large gaps in the existing data. We did find however, some scientific research for koi. For example, all the research for the digestibility of different types of protein was described very well, including the necessary amount of protein. As well as that information, we also discovered some old scientific reports about the Butt Sensor, which is a sensory organ in mouth of koi that quickly senses if the pellets are too hard to take in and if they need to grind them first.

However, there was information missing

like weight versus length and how much to feed per day. So, we needed to set up a new research program to prove or disprove our new thinking.

**research program**

It is always important to have a starting point of what you would like to achieve. The first consideration was we wanted to make a new food for koi that didn't contain fishmeal. We wanted to copy nature as much as possible and that meant creating a food emulating what koi normally eat in a mud pond. And that meant we needed to remove the fishmeal because koi in general don't eat fish. As well as this we needed to compare this theory with other koi foods on the market: so we selected a cross section of popular koi foods from the marketplace. We also have the data collected over years of trailing foods generally.

To conduct the trials we placed koi from several different breeders and different ages into ponds of the same volume with identical filtration. This was not an easy task because we wanted to have the same amount of total body mass in each pond and preferably the same total length. My colleagues Harvey Leeming and Daniel Power suggested a method to achieve this. The solution was to put all the koi in a holding tank – they were individually selected for each pond after measuring, sexing, aging, photographing and weighing them. This was a lot of work because we had to anaesthetise the koi to weigh them accurately. This is critical if you want to assess the conversion rate of the different foods.

At the start we had a total body mass of 33.06 kgs in each pond with a difference of less than plus or minus 30 grammes. The

total length difference was much bigger in each tank, but this was less important if you want to calculate the food conversion rate for each group of koi. The biggest koi in the ponds was 69.5cm and the smallest one was 23cm. We were especially interested to see if the bigger koi would grow because most of them had reached a plateau in growth development.

During the more recent trials we worked very closely with the team at Dragon Feeds. This company farms polychaete worms at their facility in South Wales. They also produce specialist aquaculture feeds that contain these worms and hold a world-wide patent on their use. They are also pioneers in the cold processing method. Dragon treats each ingredient very carefully and minimises the use of heat at all times during the manufacturing process. This ensures all the goodness within each ingredient is not lost and nature is allowed to do its job. The food that we have developed together is now manufactured at Dragon's plant in South Wales.

**how much do we need to feed?**

This is a question most koi keepers would like answered. The answers they receive are often confusing. If you're involved in the aquaculture business you'll know how much to feed the fish at certain temperatures. Even the weight at each length for the species that is farmed will be documented. This is one of the problems when we come to feed koi – we don't know the exact weight versus length. This is important otherwise we can't be accurate as to how much to feed. To overcome this problem we weighed and measured many koi at our test facility, our holding facility and at customers' premises. This allowed us to create a graph where you can find the average weight of koi by length – it is only a guide but valid ▶

Water Temp	Daily Feed (g)
5°C - 12°C	0.25%
13°C - 15°C	0.5%
16°C - 20°C	1.0%
21°C - 25°C	1% - 1.5%

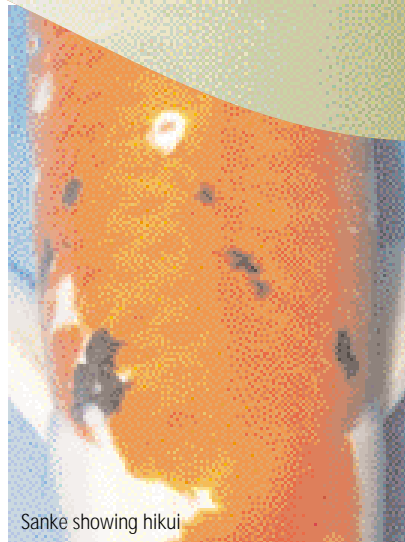
We wanted to copy nature as much as possible and that meant creating a food emulating what koi normally eat in a mud pond

for most of our koi. If you have a lot of male koi you can use the minimum weight line on the graph. Only if you have a female koi with a lot of weight should you use the maximum weight line. In this way it is now simple to find out how much to feed your koi. For example, let's talk about a individual single koi if it weights 3.5 kgs (3500 grammes) and you want to feed 1% of its body weight you will feed 35 grammes a day to this koi. But if you only wish to feed .5% at lower temperatures for example, you would feed 17.5 grammes. A further example is that we have found that at 21°C water temperature, the koi require .5% just to maintain their weight but if you only feed 0.35% then the koi could actually lose weight. However, if you feed 1% you will get phenomenal growth rates with our new feed.

In the diagram on page 60 you can see the weight versus length performance of a Hasegawa Kohaku. You can clearly see the weight loss when we reduced the daily feed to 0.35% for a month. Temperature has a big influence on the percentage of bodyweight we need to feed per day. This is because koi can't convert the protein as efficiently at lower temperatures. To keep it simple we have made a recommendation chart that explains how much you need to feed at certain pond water temperatures. This will help guide you as to how much to feed per day.

**how often should I feed?**

We always thought feeding little and often was better for the water quality and for the koi. We have to say, our thoughts on this have changed. More recent research in aquaculture has reported that two feeds a day could be better than multiple feeds. This is because the koi can convert and absorb the protein more efficiently, and the phosphor intake is better. Another interesting fact was the amount of waste generated by multiple feeds was higher than with the two feeds a day. The reports recommend feeding in the morning and the evening. When we spoke with Shintaro, a well know koi breeder in Niigata about this he said this was what he did – two feeds: one at the beginning and one at the end of the day. If you're a carp fisherman then you will probably have experienced the periods in the morning and evening when carp are most actively looking for food. So, if we listen to nature again, it seems to tell us that feeding twice a day is best.



Sanke showing hikui



Broken tail of the Sanke that jumped – it healed in a very short space of time

**health – added benefits**

In our ponds we had a few koi that were older and had developed hikui. This is a type of skin abnormality usually affecting the red skin (beni). We were surprised to notice that after feeding our new food the hikui had disappeared! The same thing happened when there was a broken fin or a wound on the body – with our new food the koi seemed to heal in a very short time. We even had a big Sanke that jumped out of the pond and split its tail and lost several scales. We removed some of the damaged scales and put it back in the water without any treatments. The Sanke has recovered very well and we didn't need to use any antibiotics. We feel that this could be the same compounds acting that allow the polychaete worms to re-generate parts when they are severed.

**clarity**

Just making a good food is not enough for koi keepers – they also want good water clarity too. This has been achieved by making a good food conversion rate which creates less waste. Then it was important to make the pellet with the correct texture. If the pellet is too hard the koi will grind the pellet in their throat for a long period of time. This can cause small particles to escape into the water. We had to adjust a few small things in the food to get the best clarity. To measure the clarity we used special NTU equipment which measured the clarity of the water – many measurements were recorded so the data we collected was accurate.

**end result**

The growth rate of the tested koi has been extreme as you can see in the picture. The total body mass in the pond with the EA One food is now 52kg and we started with 33kg. The white skin of the koi has improved dramatically and the skin quality is amazing. Everybody who has worked on this project has been shocked by the results and

as you can see, the pictures say more than any words.

We still feel that even today koi keepers probably don't feed their koi enough and underestimate the total weight of their collection. Hopefully now with the help of our graph this can be more accurately estimated. With EA One your koi will be closer than ever to their natural environment – the mud pond. 鯉



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