Te Kaha Aquaculture Station

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Cover: Long-finned eel (*Anguilla dieffenbachii*), green-lipped mussel (*Perna canaliculus*), and koura (*Paranephrops planifrons*).

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Te Kaha Aquaculture Station

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AQUACULTURE as a means of augmenting protein production is receiving increasing attention throughout the world. Despite New Zealand's abundance of clean, unpolluted fresh water, aquaculture here has mainly been associated with the cultivation of marine organisms, notably oysters and mussels, though there was earlier some interest in eel cultivation.

SUCCESS has been variable, but rock oyster farming and, more recently, mussel farming in sheltered coastal waters are now commercially successful. So far the main effort in freshwater aquaculture has been the cultivation of trout, for sporting purposes only, by the Department of Internal Affairs and Acclimatisation Societies. Because of strong opposition from anglers there has been no commercial farming of trout, but a number of companies have begun to investigate the possibility of ocean ranching of quinnat or chinook salmon (*Oncorhynchus tshawytscha*).

Eel farming was tried between 1972 and 1976 and considerable sums of money were invested by private companies in attempts to develop an industry. These ventures failed for a variety of reasons, including escalating food costs, depressed export prices, irregular supplies of glass eels, unfamiliarity with the culture requirements of the New Zealand species, and some instances of disease.

Despite these initial failures it was considered that there should be a more detailed study of the real opportunities for eel farming and that a more carefully controlled evaluation of prospects and problems should be undertaken.

This was made possible when aquaculture installations at Te Kaha were offered to the Ministry of Agriculture and Fisheries for research into farming eels and other aquatic species.

Such research seemed particularly appropriate, as New Zealand has an extensive resource of wild eels and a worth-while export market which yielded over $4 million from the 2177 tonnes exported in 1978.

The following description of the work of and plans for the Te Kaha Aquaculture Station operated by Fisheries Research Division is based on the contributions of staff both resident on the station and from the division's central laboratory at Wellington. They are Mr M. S. Astill, Dr P. M. Hine, Mr T. Johns, Mr W. S. Johnson (since resigned to manage a commercial eel farm), Dr J. B. Jones, and Mrs E. Kerei.

Description and history of the aquaculture station

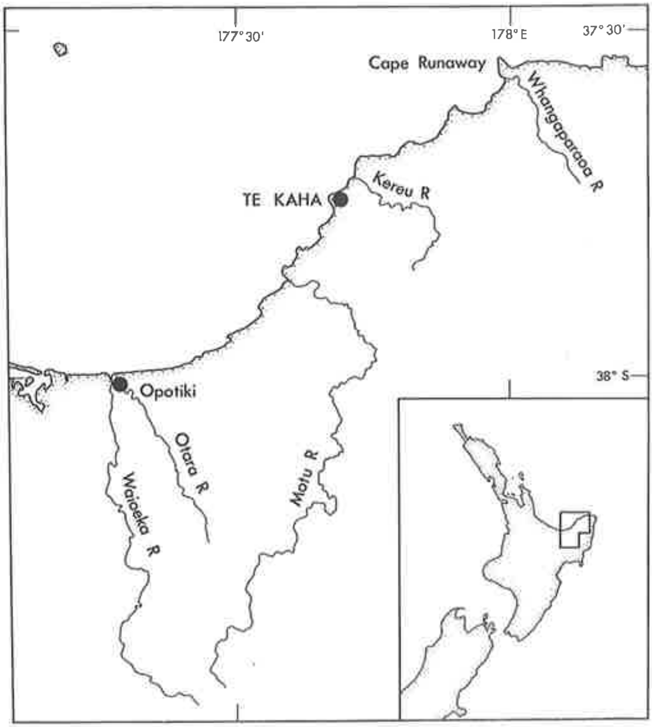
The Te Kaha Aquaculture Station is situated on the banks of the Kereu River close to the coast in New Zealand's isolated eastern Bay of Plenty.

The site, which belongs to the Maori people, was leased by Horouta Industries (a Maori cooperative) in 1973. The company, in co-operation with the Taiyo Fishing Company of Japan, built the original eel farm according to Japanese design. Taiyo withdrew from the venture in 1975 and after discussions between Horouta Industries, the Ministry of Agriculture and Fisheries, and the Fishing Industry Board the concept of using the facility as an aquaculture research and pilot production station evolved. It was agreed that it should be mainly concerned with eel farming, but could also be used as a base for other aquaculture ventures. Its situation close to the sea offered the opportunity to conduct marine as well as freshwater investigations.

The Government approved the establishment of the station in September 1976 and it was reopened in early 1977. Initially it was serviced and operated by Fisheries Management Division, but in 1978 the responsibility for the station was transferred to Fisheries Research Division.

Since its acquisition by the ministry the station has been substantially upgraded and some

Location map showing Te Kaha Aquaculture Station and places mentioned in the text.



changes have been made to allow more experimental work. A small aquarium room and a large store have been built as well as a laboratory and office block, and the water supply system has been improved by construction of a 450 000-litre reservoir on high ground above the station. Water is pumped to this from the river and is then fed by gravity through the various ponds. The ponds vary in size from 100 to 10 000 square metres and have sand-covered clay bottoms and walls lined with concrete, Fibrolite (asbestos cement), or timber planking. There is sufficient space available for building other smaller ponds which can be used for feeding trials, evaluating different construction methods, and for pilot-scale commercial trials. Circular concrete tanks and some polyvinyl chloride (PVC) pools have been assembled for use either as "training ponds" for glass eel feeding or for experiments in freshwater crayfish (koura) culture.

Two staff houses have also been built on site.

Te Kaha Aquaculture Station. Water is pumped from the river on the left to the reservoir on the extreme right. From there it siphons back to the ponds.

Research programmes

The initial aims for the Te Kaha station were:

1. To develop techniques for the culture of eels from glass eel to commercial size and to assess the economic feasibility of commercial eel farming.

2. To study koura with particular reference to growth, reproduction, and feeding behaviour as a basis for assessing their potential for commercial culture.

3. To investigate the practicality of cultivating the green-lipped mussel on a semi-exposed coastline.

4. To disseminate information as appropriate and, where possible, to train personnel in aquaculture practices.

More recently aim 1 has been modified so that, with aim 4, it is proposed that some eels may be grown to the elver stage and then supplied to local farmers for culture in their own ponds. This would be a development towards a type of cottage industry in which the farmers supplied the fully grown eels back to Horouta Industries for final processing and sale.

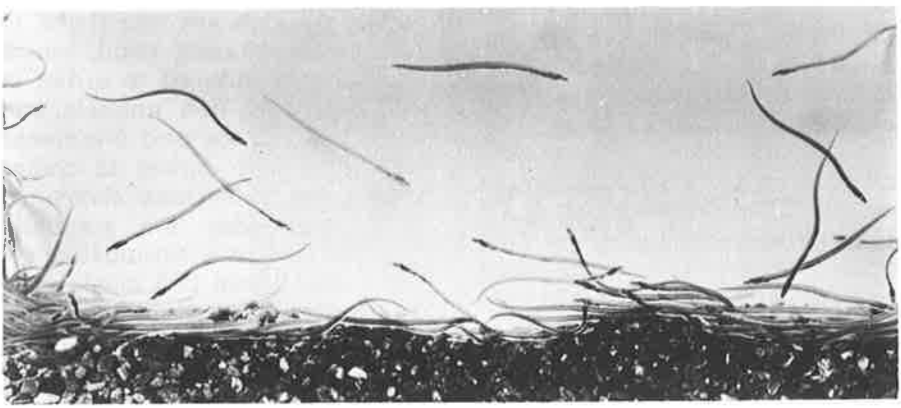
Progress in each of the three culture programmes is discussed in the following pages.

Eel culture

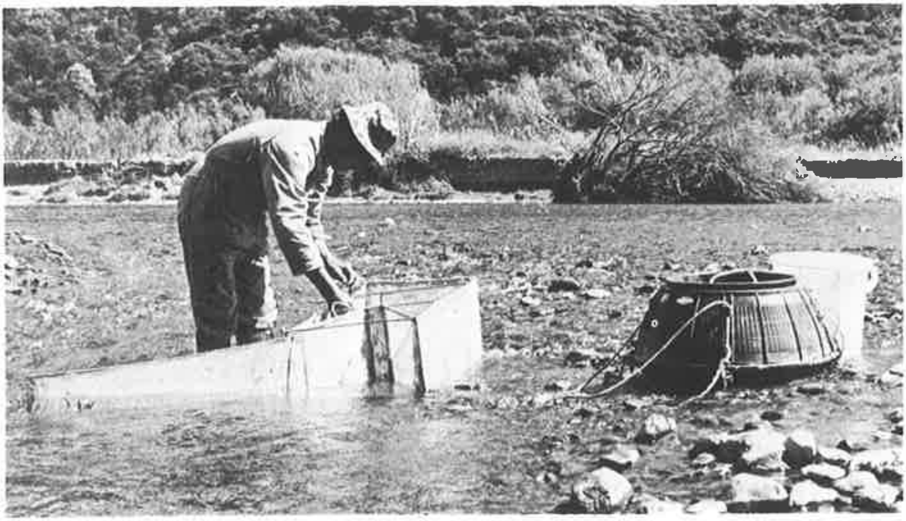
There are two species of freshwater eel in New Zealand—the short-finned eel (*Anguilla australis*) and the long-finned eel (*Anguilla dieffenbachii*). Adults of both species migrate to sea to spawn, but the area of the Pacific Ocean where the eggs are laid and hatched is unknown. After hatching the larvae drift with the ocean currents and slowly change from their initial transparent leaf shape to become more elongated and eel like. When they reach the New Zealand coast they are small and transparent, 60–70 millimetres long, and called glass eels. They enter fresh water between August and December, and schools usually swim up stream during the night.

Only four rivers near Te Kaha are known to have large runs of glass eels. These are the Waioeka and Otara Rivers near Opotiki, the Motu River, and the Whangaparaoa River at Cape Runaway.

Local people issued with fishing permits use nets similar to whitebait nets to catch the glass



Glass eels.



Catching glass eels with a net. The black container is a plastic "dreema" of Japanese design used to hold live eels. Most glass eels are caught at night.

eels, which are then sold to the station. They are held in the small concrete tanks where any that are injured, and other fish such as whitebait and bullies, can be removed. The glass eels are then treated in an antiseptic bath of either methylene blue or "Furanace" (Dainippon) to kill any disease organisms with which they may have been infected before being caught. It is important that the young glass eels are transferred to the station as soon as possible after they enter fresh water because it has been found that when they arrive from the sea they are virtually free of parasites and diseases, but can quickly become infected after entering the rivers.

After 24 hours in the concrete tanks the fish are transferred to the larger training pond, where they are introduced to a diet of finely minced fish, mussels, and liver. During the next few weeks the glass eels darken in colour and grow to become elvers. At this stage they are gradually weaned on to a formulated eel food made from fish meal, grain products, vitamins, minerals, and fish oil.

From the training pond elvers which are feeding actively (usually about 10 to 20 percent) are removed to a larger growing-on pond, where they are left for 3–4 months to grow. (Those which are not feeding actively are removed and killed.) At the end of that period these young elvers are graded into different sizes, weighed, and then stocked into fresh ponds. Any weighing under 10 grams are culled.

As the eels grow they are fed three times a day in the warmer months (January to March) and then twice a day until they become inactive. This usually happens when water temperatures drop below 12°C. The ration of food is determined by the number and size of the eels in the pond and is based on 10 kilograms per day of food per 100 kilograms of eels.

Feeding the eels. The food is placed in a net suspended below the feeding stage.

Graded eels, each of about 100 grams. In 6 months these will be ready to market.

Most of the fish can reach a marketable size of 180–200 grams in 18–24 months from the time of arrival at the station, but in the wild this may take 10–15 years.

The ponds are fertilised with phosphate fertilisers to encourage a phytoplankton bloom which aids in the breaking down of waste products in the water as well as providing cover for the eels. Mechanical paddle wheels are used to aerate the water, especially at night when oxygen levels drop, and to create currents in the water during feeding. These serve to draw the fish to the feeding site.

Spreading lime on the pond floor after the pond has been drained. Lime helps to break down the nutrient-rich mud left on the pond floor and kills any eels which remain in the mud.

The dimensions of the large growing-on ponds have been found to be of little importance, but the training and treatment ponds for the glass eels must be narrow and quite small so that all parts of the pond can be easily seen and reached. If dead and dying glass eels cannot be readily seen and removed, the risk of spreading infection is increased. To minimise this risk the ponds are concrete lined and can be completely drained for thorough cleaning and, if necessary, sterilisation.

All waste water from the ponds is conveyed through gravel filters to an oxidation pond so that water eventually discharged back to the Kereu River is of high quality.

Koura culture

The species being cultured at Te Kaha is *Paranephrops planifrons.*

Koura are bottom-dwelling animals and do not swim, though by violently flexing the tail they can propel themselves backwards through the water as a method of escape.

The sexes are separate. The male has genital openings on the bases of the last pair of walking legs; the female openings are on the second pair. Fertilisation takes place externally when the female releases her eggs into a gelatinous sperm mass that the male deposits under her tail. The eggs stick to several small appendages under the tail and are carried there for between 5 and 6 months before hatching. Once hatched, the young cling to the female, where they undergo two moults. At the second moult they change into tiny crayfish, which soon leave the mother. A female crayfish, depending on her size, can carry between 20 and 400 eggs.

Crayfish become sexually mature after 2 years and will then lay their first batch of eggs. They reach a commercially harvestable size of 100 millimetres total length after 3–4 years, though experiments are in progress to see whether this period can be reduced.

It has been found at Te Kaha that fertilised crayfish eggs can be stripped from the female and artificially hatched in tanks of flowing water. This increases the survival rate of eggs, which in nature is variable and can be very low on some females.

Food, provided once a week, consists of a commercial eel food mixed with lucerne. Lucerne pellets may also be fed and the crayfish supplement their diet by scavenging on organic debris in the tanks.

Shelter is provided in the form of concrete blocks and PVC pipes. The animals spend most of the day in these, but leave them at dusk to feed. Plenty of shelter is necessary, as crayfish are particularly aggressive and will fight each other at every opportunity unless they are able to hide.

One pond and several tanks were initially set aside for crayfish culture. The large pond was stocked twice in August 1977 and August 1978, with 300 and 600 crayfish respectively. Unfortunately, predation by eels (which escaped from other ponds) was severe, and in 1979 pond culture was abandoned in favour of tank rearing. Once loss through predation was controlled a high and so far unexplained death rate was revealed. Work to overcome this is continuing.

Mussel culture

The mussel being cultivated is the green-lipped mussel (*Perna canaliculus*). In the Te Kaha area this mussel has two spawning peaks in April and September. The larval mussel, less than 0.25 millimetres long, drifts with the water currents while growing and developing. After 3–4 weeks it is ready to settle as a spat by attaching itself to a firm surface, preferably where there is sufficient water movement to bring a good supply of food and remove waste products. Mussels feed by filtering minute particles (plankton and detritus) from the sea water.

The first 12 months of the project were taken up in designing a raft and anchorage system suited to the exposed conditions of the local coastline. The first raft, of 5 by 2.5 metres, was placed in position in February 1978. It was constructed of treated timber with polystyrene floats. A second raft of similar design, but 7 by 3 metres, was anchored in the same area, 300 metres off shore in front of the Horouta Industries factory, in February 1979.

A spat collector made of PVC pipe and coir twine is suspended in the sea some 2 metres below the surface. The twine is changed weekly, and any material that has settled on the rope is washed off into a series of sieves. The contents of the sieves are then examined under a microscope. When spat are detected, growing ropes are hung beneath the raft for attachment of the spat. If ropes are suspended before the spat are settling, other organisms will foul them and interfere with the mussel settlement.

After 2 months the young mussels can clearly be seen on the ropes, and when they reach 15–20 millimetres long they are thinned out and bound on to new ropes by use of a rayon mesh which breaks

Mussel raft anchored off the coast at Te Kaha. The raft is small and is anchored at only one end to withstand the rough seas during the winter months. A mussel rope is being lifted for examination.

down after 1 week in salt water. At this stage the mussels have firmly attached themselves to the rope. The thinned mussels continue to grow, and they reach 75–90 millimetres in 12–18 months.

Future prospects

The eel, koura, and mussel culture programmes are still in an early evaluation stage, the work on eels having shown the greatest progress so far, with 2 tonnes of farmed eels being exported in May 1980. These were well received on both Japanese and European markets. Now that the practical problems of rearing the young eels have been overcome, more effort will be devoted to improving diets and assessing the economics of this type of production.

Koura culture is likely to take longer to develop and may be economically less attractive. However, it may be possible to use koura as scavengers in the eel ponds and so produce a second cash crop.

Until recently mussel culture has been confined to enclosed waters, but the use of open coasts could greatly extend the total production and at the same time reduce pressure on the sheltered bays and inlets for which there are other user demands. As with koura culture, the problems are both biological and technical.

The combined research and developmental work at Te Kaha is still in its early stages, but it could lead to increased production from the aquatic environment and provide a basis for local regional development.

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