

## Unlocking the secrets of South Pacific tropical freshwater eels

*Tim Pickering*

*Inland Aquaculture Specialist, Secretariat of the Pacific Community (timp@spc.int)*

*Research to uncover the remaining big secrets of freshwater eels in the tropical Pacific was the topic of a week-long workshop held in Moorea, French Polynesia, in December 2013. Convened by fish parasitologist Pierre Sasal and hosted by the CNRS-CRIOBE (Centre de Recherches Insulaires et Observatoire de l'Environnement) research centre located at the head of Baie d'Opunohu, the meeting brought prominent international eel scientists from France, Japan, and New Zealand together with local and regional experts, and representatives of French Polynesian civil society. Attendance of invited participants at the meeting was supported by the Fonds Pacifique (French Pacific Fund) and by the IRCP (Institut des Récifs Coralliens du Pacifique).*

The meeting's programme of speakers addressed both natural-science and cultural heritage aspects of freshwater eels, which served to emphasise just how iconic a fish the eel is to Pacific peoples. For example, in French Polynesia the eel is so intimately linked to humans in mythology and folklore that it is not treated as a resource for consumption, but as a cultural treasure.

In contrast to the unfolding discoveries over the last decade about migration and deep-sea spawning among North Pacific eels, the life cycles of the three main South Pacific tropical eels — *Anguilla marmorata*, *A. obscura* and *A. megastoma* — are still very much shrouded in mystery. Information fundamental to the conservation and management of any fishery, such as knowledge of where and when the fish spawn, how many discrete breeding stocks exist, how long they live before the onset of sexual maturity, and the ability of new recruits to replenish exploited or threatened populations, is very scarce for the South Pacific tropical eels.

### Progress in North Pacific eel research

Exhaustive oceanographic research in recent years by experts like Prof. Katsumi Tsukamoto, Dr Jun Aoyama and Dr Shun Watanabe (among others) have resulted in discovery of the spawning grounds of the Japanese eel, on a seamount at the southern end of the West Marianas Ridge. The location is a critical one for the spawning eels. Ocean-current modeling shows that if the parents were to spawn too far north, south, east, or west of this location, then the hatching leptocephalus larvae would not be able to pick up the Kurushio Current for their 300-day trek back to Japan and would be swept away to oblivion.

The meeting heard from Prof. Tsukamoto that the successful spawning and rearing of the Japanese eel in captivity has been achieved. Since the initial breeding

success in large, specially-designed eel brood stock conditioning tanks, those first offspring have themselves been reared to breeding size and have spawned again, and so on, such that there are now three generations of eels that have been entirely reared in captivity. The aquaculture process is able to produce glass eels<sup>1</sup> (a commodity desperately sought by eel farmers everywhere) at a cost per eel of JPY 10,000 (USD 100). If the breeding and rearing process can be fine-tuned to the stage where each glass eel costs only JPY 100 (USD 1.00) then it will be very worthwhile to pursue. Until then, the world's capture-based eel aquaculture farmers will continue to compete with each other and pay exorbitant prices for dwindling glass-eel capture-fishery catches from wild resources which are threatened, not just by overfishing, but also by habitat degradation, pollution, and barriers to migration in river catchments.

### Big knowledge gaps for South Pacific eels

South Pacific eel research differs from North Pacific eel research in that it has several dozen fewer scientists and several million dollars less in research budgets. Don Jellyman of New Zealand (now retired, and also present at the meeting) has done his best over many years to answer similar research questions for the temperate eels of New Zealand and Australia, *A. australis*, *A. dieffenbachii*, and *A. reinhardtii*. Through limited (by budget) use of pop-up tags on some migrating silver eels leaving New Zealand rivers, and modeling of ocean currents based on estimated age of recruiting glass eels, his best guess is that New Zealand's eels most probably head towards a spawning ground in the South Fiji Basin, between Fiji and Vanuatu.

But for the three tropical South Pacific eels *A. marmorata*, *A. obscura* and *A. megastoma* there has been

<sup>1</sup> A glass eel is an eel in its transparent, postlarval stage.

scarcely any ongoing and systematic research at all, apart from three years of daily glass eel sampling by Pierre Sasal at the mouth of the Opunohu river in Moorea, and three months of data from a similar but uncompleted glass eel study at Navua in Fiji by University of the South Pacific MSc candidate Chintaka Hewavitarane in 2006. It is hypothesised, but not yet known for certain, that the tropical eels may also spawn in the South Fiji basin. They may have more than one spawning ground.

### High status, but facing threats

The anguillid eels have high status in the SPC countries and territories, where they are either revered in mythology or are highly prized as delicacies in inland areas where there has always been a shortage of fresh fish.

In addition there are increasing number of enquiries from Asian businesses who want to capture and export glass eels to stock farms in China or Korea, or send juveniles alive by air freight to market. At a local level, catchment developments like deforestation, pollution, and construction of dams and weirs are already making an impact.

Yet for many Pacific peoples the situation is serious if rivers no longer have eels in them. This is summed up by a saying in Tahitian that “A river without eels is a dead river”.



*The workshop on tropical eels in Moorea was refreshing for its unusual learning approach whereby it was the instructor Pierre Sasal of CRIOBE (on the left) who got wet, while all the trainees in glass eel net deployment (on the right) were able to remain dry (image: Tim Pickering).*

Taking all this into account, the timeliness of new efforts to gain biological knowledge fundamental to Pacific eel conservation and management becomes easily apparent.

### Research goals for the new Eel Network for the South Pacific

The meeting participants resolved to prioritise and coordinate South Pacific eel research in a way that addresses regional needs and can also benefit from the well-supported eel research initiatives in other places. This can begin with pure science research on eels, but also should incorporate research on the economic and applied aspects (such as eel fisheries and aquaculture) and the cultural aspects. Traditional knowledge and culture surrounding eels is important to study for its own sake, and can reveal insights about eel biology.

Fundamental to conservation and management of South Pacific eels is information about:

- spawning in the oceans and recruitment of glass eels back to the adult populations on land; and
- escapement of mature (silver) eels from land to the spawning grounds in the oceans for breeding.

Knowledge of spawning grounds is needed to conserve and protect them, to monitor them, to know the conditions there, and to use this knowledge to predict future recruitment. Knowledge of recruitment underpins both fisheries management, and climate change



*Timiri Hopu'u of the French Polynesian Service for Culture and Heritage handles a live Anguilla marmorata specimen, caught by electro-fishing in a demonstration of eel population research methods for Pacific Island streams. (image: Tim Pickering).*

adaptation. For example, we need to know the vulnerability of local fisheries to interruptions in recruitment, especially if it is discovered that they are a long way from the spawning grounds.

Knowledge of fish age and the conditions for silver eel escapement is vital to avoid possible extinction of eels, but many questions remain about how best to ensure that escapement is possible. Many Pacific Islanders assume that eels breed in the same places they live and feed. There is very low awareness that eels undertake long migrations out to sea for spawning, and that big eels need to be able to escape. In contrast, a strategy now being adopted to avoid extinction of the Japanese eel is to set up sanctuaries where there is no fishing at all for eels. In New Zealand, harvest of eels larger than 4 kg is now banned.

There will be an opportunity in 2015 to replicate the type of research that led to the discovery of the Japanese eel's spawning grounds. The University of Tokyo research vessel Hakuho-Maru plans to make a cruise to the South Pacific. It has the capability to deploy fine-mesh mid-water trawl nets to sample for newly-hatched eel *leptocephalus* larvae, or even to find unhatched eel eggs in the plankton.

But first, it is necessary to narrow down the possible ocean area where South Pacific eel spawning takes place. This can be achieved during 2014 if there is coordinated sampling of glass eels using nets in river mouths in at least four countries or territories. This coordinated sampling would involve different teams of researchers catching glass eels in all four places at the same time. Using otolith analysis to find out the age of the glass eels, and genetic tools to estimate the probability that they came from the same or different spawning aggregations, it may be possible to back-track using ocean current data to find out the most likely general location where the collected eels were spawned and hatched.

Based on present knowledge, the best places to carry out this glass eel sampling are in rivers of Fiji, Vanuatu, New Caledonia, and French Polynesia. The newly formed Eel Network for the South Pacific intends to make links with regional fisheries departments and universities to carry out this sampling in a coordinated way during 2014. This will be a first step toward solving one of the long-standing big riddles of natural science in the Pacific — “Where do eels spawn?”



*Pierre Sasal and Tahitian PhD candidate Herehia Helme demonstrate tag and release methods for eel population study using electro-fishing gear to stun the fish before capture (image: Tim Pickering).*