Draft report assessing the impact of importing live *Tridacna crocea* (Boring giant clam)

1. Summary of the proposed activity

This application is to allow the importation of giant clams cultured in Solomon Islands for use in the Australian aquarium trade. The activity is designed to provide an income-generating alternative livelihood for the rural poor of the nation and is based around a giant clam hatchery, run by the WorldFish Center in Western Province of Solomon Islands. WorldFish Center is a not-for-profit organisation that aims to assist in reducing poverty in less developed countries by fostering sustainable use of marine resources. Giant clam seed is produced at the Worldfish hatchery from hatchery-reared parent stock, and are grown to a market size by village farmers who then sell the clams into the aquarium trade via a licensed exporter.

2. Guidelines for keeping, transporting and disposing of the animal

Animals will be shipped to Australian aquarium dealers by air from Solomon Islands, wrapped in damp paper. They will be cleaned prior to leaving Solomon Islands. On arrival at the aquarium dealer they will be immersed in seawater at the required temperature and maintained in a reticulating seawater system until a quarantine period of 1 week has elapsed. After this they will be sold into aquarium product retailers. Animals that die or show signs of sickness or parasitic infestation during the quarantine period should be incinerated to avoid any risk of disease.

3. Taxonomy of the species

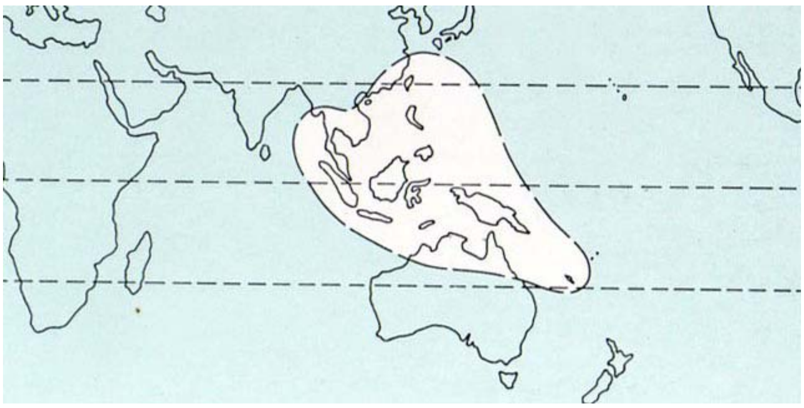
Tridacna crocea, the boring giant clam, is a member of the family Tridacnidae. The Tridacnidae sit within the super-family Cardiaceae in the order Veneroidea. Tridacnidae includes two genera, *Tridacna* and *Hippopus*, which have six and two species respectively.

4. Status under CITES

All giant clams (genera *Tridacna* and *Hippopus*) are listed under CITES, Appendix II. Solomon Islands is not yet a signatory of CITES, but all giant clams are similarly protected under Solomon Island law. It is forbidden to sell or export giant clams or giant clam products in Solomon Islands, except where those clams are certified as cultured and for which an export permit is available. All batches of exported clams will be cultured animals and provided with certification from the appropriate Solomon Island authorities to this effect, such as the Marine Aquarium Council.

5. Ecology of the species

Tridacna crocea has a tropical distribution centred on Papua New Guinea, as shown in the map below.



Map 1. Distribution of *Tridacna crocea*

T. crocea is a reef animal, and occurs down to depths of 15 m, though its need for light means that it rarely penetrates much deeper. Its habit is to bore into large coral boulders, and typically only the vividly coloured mantle tissue is visible, flush with the coral surface. It can filter feed to some extent, but relies heavily on symbiotic algae living inside the flesh of the mantle.

Giant clams can live for decades, and many of the larger clams may be 30 years old or more. They require full strength seawater, or close to this (though they can survive for short periods in slightly reduced salinities.

Clams are mass broadcast spawners, and given their fecundity the recruits generated per spawning is exceedingly small. Most are probably lost in the short lived planktonic larval stage, or as juveniles after settlement onto the reef. A particular reason for the low larval survival, and what may prove a limit to the ability of the clam to "invade" new areas is the need for larvae to ingest at an early stage the symbiotic zooxanthellae that are essential to long term survival.

Based on hatchery observations, gametes remain viable in water for 15-30 minutes. Although older clams are hermaphrodite, self fertilisation seems to rarely result in viable larvae. Fertilised eggs reach the trochophore stage within 24 hours, and veligers within 48 hours. Planktonic stages are short-lived, and veligers begin to settle after approximately 1 week. After settling, the clams spend approximately 10 days metamorphosing into juveniles. In all, larvae are actively planktonic for 1 week, poorly attached benthic larvae for 2 weeks, and increasingly static juveniles from then on. Juvenile clams have a tendency to cluster, but clams are individuals with no metabolic links to other clams. Juveniles are quite mobile, retaining an active foot up to a size of approximately 25 mm. This appears to be primarily to find the type of crevice that the clams prefer to settle into. Adults effectively lose the ability to move, but are capable of slight positional movements, for example to right themselves should they be knocked over.

Giant clams tolerate a degree of exposure at low tide, but have no specific ability to withstand drought, as would be expected of a genuine marine animal.

Predators of young clams include gastropods (tritons in particular), crabs, other predatory invertebrates and fish. The boring habit of *T. crocea* means that few

The other main predator of giant clams has been man. For this reason, in many areas giant clams are rare or endangered, and this has justified their inclusion in CITES list and has spawned ongoing efforts to rear them in hatcheries for restocking purposes. The programme that this application relates to retains 5% of all clams produced for re-stocking purposes.

6. Provide information on the reproductive biology of the species.

The age at which giant clams become mature is somewhat controversial. Our hatchery experience is that mature *Tridacna* can be obtained at 7-8 years, though reproductive output will continue to increase with age. The optimum spawning time seems to be September-December though potentially ripe clams can be found year-round. Conflicting reports suggest that there may be a lunar cycle to spawning, with peak spawning occurring at 1-2 weeks after the new moon. Despite considerable hatchery work, there is no consensus on how often a clam will spawn. When spawning does occur, a large clam can produce over a million eggs.

So far as we are aware, no hybridisation has occurred between giant clam species, nor with species of other genera.

7. Provide information on whether this species has established feral populations, and if so, where those populations are.

To the best of our knowledge, giant clams have neither established feral populations, nor have they ever assumed any degree of nuisance, within or without their natural range.

8. Provide information on, and the results of, any other environmental risk assessments undertaken on the species both in Australia and overseas.

To the best of our knowledge, no such studies have been undertaken.

9. Provide information on all other Commonwealth, State and Territory legislative controls on the species.

Beyond the requirements of CITES, mediated through the Department of Environment and Heritage, we know of no other legislative controls on the species.

10. Assess the likelihood that the species could establish a breeding population in the Australian environment should it ever be released from effective human control.

Given that the species is native to Australia, it is highly likely that any animals that escaped from human control and reached a habitat where it could survive, could form a new breeding population or mingle with the existing breeding groups. Only should two animals reach any new habitat could a new population develop, since the animals are not self-fertile nor do they have the capacity for asexual reproduction. New habitats that could perhaps support the species and do not already, could include artificially warmed seawaters, for example those associated with cooling water from industrial facilities, though in these habitats the coral rocks that the clams typically bore into would not be available.

11. Provide a comprehensive assessment of the potential impact of the species should it establish feral populations in Australia.

For introduced specimens to impact on the Australian environment, either they would need to introduce a disease, to establish breeding populations that displaced the native con-specifics, or would need to expand the range of the species. Given the relatively large distance between the site of origin and Australia, it is feasible that some diseases might be present in the source location that are not present in Australia. We do not, however, believe this to be a problem, as there has been no outbreak of any disease that has led to notable mortality to our knowledge.

The short larval life of clams suggests that genetic exchange between distant populations will be slow. Because of this, it is reasonable to assume that Solomon Island populations will carry different gene frequencies than Australian ones. Thus introduction of large numbers of exotic clams to the wild breeding population could affect same. However, the chances of this happening are slight. While aquarium animals are often disposed of thoughtlessly, a clam will need to have been kept for at least 6 years before it is sexually mature, or will have to survive this long in the wild if disposed of at an earlier age. Even then it will need to be disposed of in favourable habitat, in close proximity to other clams for it to interbreed. The alternative would require a group of imported clams to be released together into favourable habitat. The small number of “foreign” gametes likely to be introduced to fertile regions would seem to argue that the likelihood of significant impact is extremely low.

Given that the species is native to Australia, we suspect that within the natural distribution the clam has occupied all of those locations where it can. Of the few locations where clams could establish new populations, artificially warmed waters are the most likely. However, the animal’s requirement for warm water would mean that their ability to expand away from this specialised habitat would be small. The animals slow growth and need for light would make them an unlikely candidate for the common problem of such locations, that is fouling and blockage of intake pipes.

A remaining risk is that which comes from the accidental introduction of any animals or plants that are resident on the animal’s shells. Since the animals are grown out in ocean nurseries, this is a real risk – one that applies to all aquarium imports to some degree. However, it can be minimised by careful cleaning of the animals prior to shipping and good water management by the importer and the aquarists.

12. What conditions or restrictions, if any, could be applied to the import of the species to reduce any potential for negative environmental impacts?

We believe that the greatest risk from the import is the introduction of infectious diseases or parasites of the animal, or from introduction of “hitchhikers” – animals or plants that are accidentally introduced with the clams. Less risk is posed by obligate commensal or symbiotic organisms than by those simply living on the shell. We suggest that this is mitigated against by cleaning of the animals and holding them in tanks of running seawater for at least 1 week prior to dispatch, and a 1 week quarantine period in Australia prior to distribution to retail outlets.