

movement? It must be remembered that a diver's dress at a great depth precludes bending the back beyond a very slight degree.

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### Key Words

Death, decompression illness, occupational diving.

## PEARL DIVING THE AUSTRALIA STORY

Carl Edmonds

*Full fathom five thy father lies;  
Of his bones are coral made:  
Those are pearls that were his eyes:  
Nothing of him that doth fade,  
But doth suffer a sea change  
Into something rich and strange.*

The Tempest, Shakespeare.

### Overview <sup>1-5</sup>

Ancient Greek jewelers used fine quality pearls in their delicate workmanship. They were collected from the Persian Gulf, the waters north of Ceylon and in the tropical waters of South-East Asia. The pearl shell was collected for the nacre or mother-of-pearl.

Australian Aboriginals used mother of pearl for decoration long before the coming of the white man. In the Kimberly region of Western Australia, carved pearl shell rigars, hung from human hair belts, were worn like fig leaves by tribal warriors.

Traders from Makassa bartered with the Australian Aboriginals three centuries ago, and the Aboriginals exchanged their women, pearls, trepang and coveted turtle for various commodities such as tobacco, rice and axes.<sup>1</sup> Around the Kimberly coast these Makassa traders built fortifications on the continent for protection against Aboriginal assaults.

Pearl shell was also used as a trading item between the Aboriginal tribes. It had natural and magical qualities promoting cloud production and rain making. No medicine man could be initiated without maban, the enchanting shell, if he was to cure the sick or conduct sorcery.

Dampier, who died in 1715, discovered much of the Australian coastline. On his visit to north-west Australia he recorded the presence of pearl shell.

By the late 1850s the Ceylonese pearl grounds were depleted, permitting the development of the Australian pearl industry. At about the same time the mother of pearl became fashionable, being used in the international button industry. The female fashion for thinness required strong fasteners.

In 1850 the colonial schooner *Champion*, under the command of Lieutenant Helpman, was sent to Shark Bay, in Western Australia, to stop poaching of guano fertiliser by foreign vessels. The sailors found extensive beds of the small pearl-producing oyster *Pinctada albina*.

In 1861 the surveyor Francis Gregory led an expedition to Nickol Bay aboard the vessel *Dolphin* to explore the Pilbara. While he explored the interior, the *Dolphin*'s crew were attracted to the pearl shell rigas worn by the aboriginal warriors and collected these shells as curiosities. Several tons of pearl shell, worth 300 English pounds (100 times a weekly wage), and a number of pearls were obtained.

The traditional Aboriginal method of gathering shell was by beach combing (or dry shelling) during the 3 or 4 hours of each day when the shores were bare at low tide. When flour was offered as an inducement, there was no shortage of shell gatherers, more so when the Aboriginals became dependent on tobacco (binghi twist or niggerhead).

In 1861 a naturalist, Pemberton Walcott, discovered beds of highly prized *Pinctada maxima* or silverlip shell, at Nikol Bay. Several tons were collected. A grazier, W F Tays, approached some Aboriginals dressed only in large pearl shells and they agreed to show him the source of their adornment. The industry was firmly established in October 1866, near Roebourne, Western Australia.

The subsequent pearling at Shark Bay was a dredging, not a diving operation. In Denham, a small settlement at Shark Bay, the town was the only one in the world that had its streets paved with pearl shell. Unfortunately, in the 1960s a government roads department brought in a bitumen tanker and destroyed the towns only claim to fame.

The first lot of pearl shell from the Torres Strait, in North Queensland, was collected around 1870. This was used for mother of pearl but pearls were an added bonus. They seldom achieved the shape and lustre of those found on the west coast.

By 1885, prices were beginning to fall and there were reports of good shell grounds to be found in King Sound in the west. A decision was made by the leading

pearlers of the Northern Territory and the Torres Strait to move their headquarters to the west coast, centered in Broome.

Japanese divers moved into Australia at the end of the 19th century. The description given of them was as follows: "They are the Scotchmen of the East. They are industrious, frugal, clean, tractable and law abiding.....their frugality impels them to forward their savings to Japan instead of squandering them".

The Japanese government, conscious of its international image, rejected any contracts for its subjects to work as coolies or in lowly occupations. Pearlery however was regarded as a skilled task. Six Japanese crews were contracted on the 10th October 1883 to dive in the area. The payments were liberal, with divers, tenders, interpreter and crew receiving \$50, \$20, \$15 and \$10 a month respectively. Divers also received a bonus of \$50 for each ton of shell raised.

World War I was declared in August 1914. The presence of Japanese caused no embarrassment as Japan had aligned herself with the allies against her long standing enemy, Russia.

In the early years mother of pearl was the main product and Broome provided raw material for 80% of the shirt and trouser buttons of the world.

World War 2 depleted the pearling industry due to both the Japanese divers withdrawing and the Australian pearlers enlisting for armed service.

The industry experienced a rebirth after the war. The shell had been undisturbed for 5 or 6 years and for a few years at least, there were easy pickings. The price paid for the mother of pearl was still relatively high. Torres Strait islanders became involved in the industry at all levels, from diving to owning luggers.

The pearling industry went into a massive decline in the 1960s as plastics usurped its traditional market. Pollution from an oil tanker, disease, and changes in the weather were all blamed for diminishing catches. Torres Strait islanders, meanwhile, left to find work on large construction and mining projects across tropical Northern Australia.

With the replacement of mother of pearl by plastics, Broome faced a depressed and uncertain future. The traditional pearling industry also received a setback in 1956 when a cultured pearl venture was formed under the name of Pearls Proprietary Limited. The influential Japanese pearl culture industry was about to be introduced.

Culturing pearls was no new thing. It had been attempted for thousands of years. Kokichi Mikimoto, a

noodle vendor from Toba in southern Japan, produced the first consistent pearl crops. At Kuri Bay just north of Broome, Japanese scientists and technicians worked and produced the first round pearl in 1959.

With the development of the cultured pearl industry, and the takeover of this industry by Australian pearlers, divers, farmer and technicians, the pearling industry was again booming in the 1980s. Today there is only a small demand for live pearl shell, and that is used by the few Japanese/Australian pearl culture stations dotted around the north coast.

### The pearl<sup>1-3</sup>

Pearls are formed inside the oyster by a secretion of calcium carbonate. They are of no practical value other than as an ornament or adornment. A pearl is the only gem perfect in its natural state, the only "live" gem found in nature. Other gems are formed from ancient inorganic matter and they require artificial treatment and faceting before they create their effect. The pearl is already perfect in nature. They have been referred to as "Moon Fire of the Sea" and "Necklaces of Death".

The Southern Cross pearl was so named because of the similarity to the crucifix of the 8 to 9 baroque pearls joined together. It now resides in the Vatican. It was originally sold by a Shiner Kelly for ten pounds and a bottle of rum.

The pearl oysters are hermaphrodites. In 30-40% of the population of *Pinctada maxima* oysters may spend 6-8 years as male and then change to female. It breeds by releasing spawn when the sea water temperature reaches about 29°C in the summer months. Fertilisation occurs in the open water. Larvae develop within 8 hours and after 3 weeks they settle on the bottom as spat. At this stage they are mobile and move until they find some suitable object, such as coral, shell or stone on which to settle.

The shells grow 35-80 mm in the first year, 80-140 mm in the second and by the time they are three years old the oysters have become mature shell, 170-200 mm across. They live for 20 years or more.

A flowing current is required to bring the organic detritus on which they feed, filtering it through their systems. They can be found from waters so shallow that they are exposed at low tide, to 80 m deep at the edge of the Continental shelf.

Australian pearls are marketed as "South Sea Pearls". *Pinctada maxima* is the largest of the world's 30 species of pearl oyster. Some have reached over 30 cm diameter, and over 5 kg weight. They grow in the "plankton soup" off the north west coast, about twice as rapidly as in other

marine environments. The South Sea Pearls are from 9-16 mm diameter. Exceptional pearls may be as wide as 20 mm reaching values of \$200,000.

Mother-of-pearl also came from *Pinctada maxima*, the biggest and best mother-of-pearl shell in the world. It is found from the Exmouth Gulf of Western Australia to the Torres Straits and northern tip of the Great Barrier Reef.

Cyclones cause a good deal of shell mortality in the shallow water beds. Oysters also go into shock when they are gathered by divers and moved from one locality to another. They may be damaged by bacterial infection and other diseases, especially if they are kept in confined quarters.

A natural pearl is found in one shell out of 5,000. Pearl cleaners, also called pearl doctors or fakers, take pearls with minor blemishes and skillfully remove the layers of defective skin, often producing a marketable product. At other times, huge pearls are skinned down layer by layer until they lay in husked pieces of lime on the table, the blemish continuing through the gem. This was the fate of the largest pearl ever found in Broome. It was a spectacular 264 grains weight. J E W Tilley took the gamble and whittled it away, to become the owner of a worthless pile of peelings, suitable only for the garbage.

One of the major factors causing shell growth in the north west of Australia is the phenomenal rise and fall of the tide, ranging from 6 m at Exmouth to 12 m at King Sound. The strong tidal currents supply rich marine food. The ideal ground is called "shell bottom". This is 20-30 cm of coral or stone fragments on sandstone or limestone. The pearl rich ground was often indicated by sea snakes and turtles on the warm surface, even in winter. Predators include octopus, stingrays and man.

For cultured pearls the oyster is operated on at 3-4 years. The foreign body implant is a small piece of sacrificial mantle from another oyster and a piece of the shell of a fresh water mussel, which has the best combination of colour and hardness. These come from the Mississippi and southern US rivers and 6,000 tons of mussel shell is exported to Japan each year. In Japan the mussel shells are cut and polished into tiny perfect spheres of various sizes suited to the variety of the oyster to be seeded. Culture success rate may be as high as 83% but only a few will create valuable round pearls. The others produce pearls of lesser quality or the mis-shaped pearl known as Baroque, or "nothing at all".

It is important not to let pearls dry out and that is why it is better to wear them than to store them. The exception is when someone is ill and perspiring heavily, as this is said to have "an acidic effect".

The wearer should only apply scent, deodorant or hair spray before to putting on the pearl. Otherwise these elements can damage the sheen. Dish washing detergent may also be harmful, and pearls are best protected from nail polish, tea or coffee spills or even the ring left by a glass of orange juice or champagne. If anything is spilled over the pearl it should be rinsed immediately in fresh water and dried with a soft clean cloth or chamois leather. It should never be placed in plastic bag or airtight container. It should not be mixed with other jewelry.

### The pearlers<sup>1-5</sup>

The attraction of pearls was obvious. Fortunes could be made, and a single pearl could do it. The pearlers were the ones that gambled on this fortune, and so were a very special breed of men.

The shelling industry derived its profits from mother-of-pearl, the top quality pearl (rarely), and the smaller and baroque pearls. The north-west settlement in 1872 encompassed 75 Europeans, 350 Aboriginal natives and a few Malays.

Pearlers were always strong individuals, distrusting of potential enemies, such as thieves, poachers, divers, deckhands, government officials and other pearlers. The rugged and colourful entrepreneurs of the pearling industry were not well tolerated or regulated by the governmental authorities, especially in the boom years. This is still so.

E. W Streeter, of Streeter and Company, London, was a traditional dealer in pearls and mother-of-pearl shell. He describes the pearlers as "a finer but rougher set of men it would be hard to meet. They are the products of a hard, dangerous but healthy life and there is among them a written code of honour that is seldom broken.....Drinking, gambling and fighting are the favourite recreations of this bronze and stalwart class. But ... the pearlers fought fair."

The pearlers, with their sailing fleet of "luggers" were stationed mainly at Broome, Western Australia.

The area is in the cyclone belt. The cyclone season is usually from December to April. The worst of these was on March 5th 1899, when 307 men from the pearling fleet were drowned in that one blow. There have been more than 100 cyclones since 1870. In 1875, 59 men were drowned. In 1877 there were 140 men drowned. In 1883, when Krakatoa erupted in Indonesia, a ten m tidal wave submerged and altered the shapes of many offshore islands. The eruption had the strength of 3,000 atom bombs.

In 1912, 150 people were drowned with no survivors from 1 passenger ship. Many luggers were lost



**Figure 1.** Luggers at low tide among the mangroves

at the same time. 50 men were drowned in 1908, 26 luggers and 40 men were lost in 1910.

A devastating cyclone struck in 1935 and 26 of the 29 pearling luggers were sunk off the Lacepedes and 141 men drowned. One survivor from the sunken luggers was able to swim for 2 days and nights before being washed up on Eighty Mile Beach. When divers returned to the Lacepedes patch in 1936 they could not work it because of the sharks. These had gorged themselves on human flesh in the 1935 disaster, and were too aggressive.

Government intervention and regulation was needed to restrict pearling to the non-cyclone season, now usually April-November.

Family dynasties of pearlery evolved. The Streeter and Male luggers were identified by their characteristic colourings, both above and below the water line. The war disrupted the pearling industry considerably. In 1946 Sam Male had 6 luggers operating and by 1956 the fleet had expanded to 42, most of them built in Broome.

The Torres Strait islands were the other traditional area for pearl, but there the boom/bust cycle was even more pronounced. Perhaps this was due to the local

indigenous people taking over the industry; perhaps it reflected their reluctance to embrace the newer technologies.

Following World War I, Thursday Island was also booming, because when they went out and started to collect shell, they could get a ton of shell on deck a day, and they could get some in the shallows, up to 4 or 5 metres of water. Even the cook would go over the side with his swimming glass and collect shell alongside the divers. In the early 50's, they also collected a great deal of shell, just before the commercial downturn.

The Broome pearling lugger was a unique boat. It was 16-17 m in length, with a beam of about a third that. Deep keels drew 170-180 cm. There was always a silver coin under the foot of the foremast and they were still built as sailing vessels, although they became more and more dependent on engines. An important requirement was that they should be able to lie over on the mud when the tide was out, without damaging the keel.

Apart from the sea and its hazards, severe infections, scurvy, alcohol, greed, inter-racial conflict and the outback mentality ensured that only the hardy survived life as a pearler. The life was hard and the conditions

frugal. One problem was the vermin. Cockroaches were about 5 cm long and thrived on the gristle of the reeking pearl shells in the hulls of the ships. The main reason for the pearlmen leaving their boats to sleep ashore at Broome, was to avoid the cockroaches. They were more tolerant of the rats and lice.

For the first half of the 20th century, it was believed that only the Japanese had the expertise to run a successful industry, but now pearling in Australia is run entirely by Australians using the farm techniques which have been developed in this country.

By 1981 the luggers had radio, radar, depth sounders and improved crew conditions. Specially built pearling boats were designed. The use of oxygen had been incorporated for the divers to spend time at depth, to more effectively purge the nitrogen from their blood.

The Paspaley Pearling Company today harvests about 70% of the pearls that make up an industry worth \$100-150 million a year for Australia. In the 1990s Paspaley was the largest pearl fishing operation in the world with a fleet of 6 ocean going ships and a multiplicity of smaller craft. The flag ship Paspaley III is a ultra-modern vessel of 650 tonnes.

The industry, by virtue of fishing for sustainable yields from the ocean and aquaculture style pearl farms, has embraced both technology and ecology. Not always has the evolution been voluntary, indeed the necessities of survival and the imposition of regulations have complemented each other in producing a robust and growing industry.

## Divers and their equipment<sup>1-5</sup>

### FREE (BREATH-HOLD) DIVERS

In the 1860's, Aboriginal men were initially used for diving. The women were employed for chipping and cleaning the shell, searching for pearls and being responsible for finding the day's food.

One of the new pearlmen stated that "the most important part... is the picking up of niggers.... for pearling, after all, would never pay white labour".

Soon the skin diving Aboriginals extended into deeper water. The Aboriginals dived from dinghies. The men jumped in feet first, tucking the knees straight up to the chin. They then tumble turned and rapidly swam downwards. Some writers have credited them with diving to 18 m and staying under water for about 60 seconds. Most worked in the 5-8 m depth and seldom needed to go deeper. The Aboriginals were skilled swimmers.

When the shallow beds near the shore were exhausted they had the dinghies taken out to deeper water, to work from luggers. They would bring up 60 to 100 shells a day.

The demand for coastal Aboriginals to dive for pearl, rapidly outstripped the supply and "black birding" became common. As the divers had to live on board, when they returned to their families they would often find their women stolen or carried away, sometimes killed and their families scattered. Other times these divers would be landed hundreds of kilometres from their tribal grounds and it was impossible to return through an unfriendly and relatively foreign country.

It was then noted that the young women were able to remain underwater for longer periods than the men, and they allegedly possessed keener eye sight. There were many abuses and atrocities inflicted on the women, who were essentially imprisoned on the luggers.

In the 1870's Bishop Gibbley, at Lagrange Bay, wrote in his journal "When the natives gather at night I was surprised to hear the heart rending wail that went up from the crowd. It was related to the deaths of divers, black birded into the pearling boats....Aboriginal women were forced to dive in the last stages of pregnancy and divers whose fingers had been crushed by blows from heavy objects (probably a sculling oar) for clinging to the side of their dinghy too long between dives. Many of the divers were boys and girls, little more than children."

Governor Weld intervened with the Pearl Shell Fishery Regulations Act of 1875, as a result of which: Women were no longer allowed to be employed as divers; divers were not allowed to work in the cold weather months between April and October; diving depth was limited to 6 fathoms (11 m or 36 feet); they had to be signed on before a magistrate and returned at the end of the season to the place they had come from. The pearlmen cried "ruin". That is when they commenced recruiting Koepangers from Timor and Malaya.

The loss from the industry of women divers, who were nearly as numerous as the men, resulted in a disastrous shortage of labour.

Thus Malay crews were used instead of Aboriginals and in late 1875 there were 989 Malays to 493 Aboriginals on the 57 vessels licensed out of the Roebuck port of Kossack, Western Australia. The Malays were not as hardy as the Aboriginals and many died.

One participant described his experiences on the pearling vessel *Emma* in 1884 as follows: "The Malays lived in the main hold on a platform of planks. The few white men, together with their provisions, lived in the small aftercabin. There were swarms of cockroaches on

board. We carried 4 dinghies, each 16 feet (5 m) long, each with 4 oars and a conch shell for bailing. There were 8 divers and 1 white overseer. The divers dropped off the boat one by one, feet first, and turning when 5 or 6 feet underwater, swimming towards the bottom. Once they were all down I then let the boat drift with the tide on the surface to correspond with the movements of the divers who were swept along the coral bottoms by the tide till the first and then another appeared around the dinghy. They would then swim to the boat. Their rapid breathing gave evidence of the great exertion. After a few minutes rest the operation was repeated until sundown, when a return was made to the main vessel. This was usually some 3 to 4 miles back. Divers who did not bring sufficient shell were punished by being made to clean the oysters, while the others had their evening meal."

The tide swept the divers along the bottom at the rate of 3 or 4 or even 6 miles an hour. They had to be very astute in seeking and grabbing any shell within their reach. They had no goggles. A difficulty during the ascent was that if the diver released air from the lungs, the ascent was abruptly halted and he would then start to sink. Then the white man, or one of the natives directed by him, would plunge in and rescue the victim.

The Pearling Act of 1884 stipulated that no alien could own a boat or be issued a license for pearl shelling. This was to protect the white mans' interests, but was overcome when he illegally leased his vessel to Japanese, bringing to an end the era which had seen him dominate the industry.

#### HARD HAT (STANDARD DRESS) DIVERS

##### *Japanese*

In 1868 three vessels arrived, manned by South Sea Islanders, which did little to assist in the safety of the divers, as they brought with them the new German standard (compressed air) diving dress. The Seibe-Gorman diving suits were among the earliest used on the West Australian coast. The short air line prevented divers from moving any distance while the strong tides and currents unbalanced the men, resulting in many serious accidents.

The Pearling Act of 1875 specifically forbade skin diving between April and October, thus forcing them to dive in the warmer waters, from November to March but this was also the time of the dreaded cyclones. The introduction of the helmet enabled the pearlery to work the safer winter months and to lay up in the mangroves for overhaul and refit during the unpredictable summer cyclone season.

Acceptance of the "standard dress" and helmet diving, in 1884, resulted in the disappearance of

Aboriginals as a major workforce from the fleet. They could not handle the technical complexity of the helmet and suit and they had an understandable dread of being shut-up inside the claustrophobic copper helmet. They had none of the boat handling skills of the Malays or the Japanese.

In 1884 only 2 vessels, the *Lily* and the *Emma*, were operating with helmet diving. By 1887 all but 2 of the 30 vessels were using helmet divers.

The first helmet divers were European, but very soon the divers of Manila and Japan took over. The latter came to dominate the diving industry. Folklore asserted a firm belief in the racial superiority of the Japanese, when it came to diving and detection of shell.

Hamaguchi, on 26th August 1915, described his typical diving activities. He used two suits of pyjamas of the finest flannel, each fitting tightly around the neck and ankles. Two pairs of thick woolen socks reaching up to the knees and an extra flannel, 18" x 49", wound around the abdomen. A large pair of heavy woolen drawers, reaching from the ankle to well above the waist, a heavy woolen sweater covered from the neck and wrists well down to the thighs. Two pairs of heavy woolen stockings came right up to his thighs and then the tough canvas diving dress covered his body and even enclosed the feet. The sleeve cuffs were greased, and of the finest rubber. They produced a very tight fit as he thrust his hands through them. A similar situation occurred around the neck. The great boots with the lead sole weighed 14 lbs. A copper corslet was screwed around the rubber collar, with butterfly nuts. The helmet was screwed on to this. The air line and the life line was separate, with the latter attached to the divers chest. The rope or lifeline was also a communication system. A series of rapid, frantic tugs indicated disaster and to "pull till the rope breaks".

The dive was to 18 fathoms (32 m or 108 ft). On reaching the bottom the signal would be given and the slack removed from the life line. Then the air pipe is called in, to produce just enough slack for the diver to work comfortably and safely. He would have to walk with the tide.

When two divers were underwater, the technique of speaking is by standing close together, touching helmets. With the air escape valve shut they could talk and hear each other. The length of conversation is determined by the associated inflation of the dress and the increasing buoyancy. By allowing air to escape they could come together again and resume conversation.

Sundays were always the traditional rest days and that was when the new divers would try out their skills in the harbour, equipment would be cleaned and maintained, and survival would be appreciated.

The whole equipment weighed over 100 kg but the diver normally drifted with the lugger, almost buoyant, his boots brushing the bottom with some slack line in his hand. When he sighted shell he would let out the slack. When he collected the shell, he would drop it in the bag clipped it to the end of his line and then collect the slack again.

From early 1890's until 1957 the majority of the divers and crew in Western Australia came from fishing villages along the 20 mile strip of coast line in the Wokayama Prefecture in Japan, south west of Tokyo. In season they hunted the whale, but otherwise lived by fishing and bartering. Tolerance to death by the sea, typhoons, etc. made them suitable applicants for pearling. In the 1890's many went to either Thursday Island or Broome.

They would work on the sea bed from dawn until dark. They experimented with the diving dress and, in the Torres Strait, soon chose to work only with a corslet and helmet. Each lugger had two corslets and as soon as one diver surfaced the helmet was removed and immediately screwed on to the waiting man to descend. The previous diver would then rest before returning to the bottom.

In time nearly half the divers and tenders were Japanese. Because of this a Royal Commission was held in 1897. By 1913 there were 1,166 Japanese employed in the pearling fleet, 634 Malays, 99 Koepangers, 7 Chinese and 1 South Sea Islander. The Japanese were never bettered as helmet divers and they were also excellent carpenters, engineers and crew, unlike most of the other nationalities.

In between World War I and World War II Oku was the chief diver and would take an average of 10 tons a year.

The last helmet diver worked out of Broome in 1975.

### *Europeans*

In 1912, twelve ex-Royal Navy divers and tenders were brought from England to take over the diving from the Asians, whose presence conflicted with the "White Australia" policy in force at the time. William Webber, perhaps one of the world's most famous divers, headed the group. Before the season was over, Webber, the most reliable of all divers, was dead. Another was paralysed, one had suffered partial paralysis, and all had withdrawn from the pearling fleet. The Japanese and Malay divers, and their employers, were jubilant. The Navy divers felt bitter and betrayed. At the subsequent Royal Commission, one of the Navy divers stated that they had been sabotaged, and that they were often taken to areas where the shells were depleted. That may have been true, but the Asian diver had to raise eight times as much shell as the Englishman, for the same wage.

Nowry, the second in charge of the Royal Navy divers, recalled "We did well around the Banks group, but at depths I had never reached before, about 170 foot (51 m). I had a good shift and was back on deck, with the next run not being due for another 2 hours. My arms and shoulders began to ache with intense pain such as I had never experienced before. I went down 50 foot (15 m) or so and hung on by shot line. Gradually the pains left me, as the Malay skipper said they would. But I had diver's paralysis and could not walk. Six months in hospital and I was back on my feet again, feet that could not get me back to civilisation quick enough."

He subsequently died from decompression sickness in Victoria, testing out a new diving suit.

There was also a migration of Greek divers, in 1956. Unfortunately 2 weeks later the lugger that they were using came back carrying the body of Kristos Kondogiannis, the chief diver and head of the Greeks. The death was described by the coroner as "Asphyxia, due to the sudden damage to the lungs when the propeller cut the airline. The accident was caused when the lugger, proceeding at a very slow pace, was forced backwards by 3 heavy and unexpected waves, thus fouling the airline which was in its normal position protruding from the stern".

Although no evidence of carelessness or negligence was made, the Japanese knew that it would not have happened with a Japanese crew. The Greeks showed inexperience with the strong tides and drifts in the Broome area, so different from the Mediterranean where the tides are barely noticeable. After this tragedy the 8 remaining Greeks abandoned pearling.

### SURFACE SUPPLY BREATHING APPARATUS (SSBA)

The scene changed worldwide in the 1960s. Working divers in other industries such as the abalone fishing, were using new equipment very successfully. SSBA still used air compressors on the surface, with air pumped down a line to a scuba-type regulator. The new divers used wet suits and flippers. It took far less time to prepare for a dive and they were infinitely more mobile than the lead-booted helmet divers. It also cost less.

Commander Batterham, RAN, spoke to Dale Chapman, a prominent Victorian diver, in 1971 and a trial was arranged with Australian divers. They first went to Broome and experienced the same mirth that greeted the English divers, years before. It was assumed that the "Australian Experiment" would end the same way as the "British Experiment".

The Japanese believed that the SSBA would not work as only a suit could allow them to spend the chilling hours underwater. It had taken them 90 years to perfect

their system and why should they change now? No challenger had come near them for almost a century.

But these divers were different. They were Australian champion spear fishermen, most had been professional abalone divers and they were all young and fit. They had modern equipment. The first group included Alan Badger, Bruce Farley, Alan Nunn, Dale Chapman and John Monk. They started poorly and it did take them some months to modify the collection system. They changed the drift system, used weights and lift bags and by the end of the season their catch was greater than that of the Japanese.

One of the traditions was to have Sundays off, so that the crews could wash their clothes and visit other vessels. The Australians decided to break with this. As they were only out for 10 days or so on a neap tide, it did not seem logical to miss out on the good conditions by sailing back to Broome and wasting diving days.

In the 1972 season the Australians made a mockery of the Japanese catch figures. It was not that the individual divers who were better, it was the system and the gear. Nevertheless, the theory of Japanese diving supremacy was debunked. Australian divers had no difficulty in "seeing" pearl shells as well or better than the Europeans or Asians.

By this time the vessels had changed out of all recognition. They had deck houses for the steersman and helmsman, wheel steering instead of rope tackles and a tiller. Sails were seldom used and there were permanent awnings. Radar, echo sounders and modern radio equipment had taken over.

Alan Badger stated that pearl diving was never easy, and probably never will be. "We aim to be wet 500 minutes of the day, that's bottom time not just lurking around in a wet suit. The day begins before dawn and ends after sunset."

In the 1980's it is was no longer necessary to go to 35 or 45 m depth for the large shell. The 10-15 cm young shell required for pearl culture was plentiful at a depth of 18 m or less off the Eighty Mile Beach. Badger's log showed an average of 7.2 hours diving per man per day for the 103 days of the diving season.

Helmet divers had traditionally worked drifts below a moving lugger. Bruce Farley devised a system with multiple air lines, boom collection bags and weights, which would set the pattern for the future. The lugger drifted down wind or down tide, its speed controlled by a canvas drogue at the stern. The divers were towed a metre above the bottom, spaced out by wide booms on either side of the vessel, their depth controlled by a weight travelling just above the bottom. They breathed from surface supply hoses.

Ejiri and Takata, two very famous helmet divers, continued to dive until 1975 but by 1980 the remaining Japanese were using modern equipment identical to the Australians.

Most luggers at that stage (1981) were not using oxygen. This was introduced when they decided to extend into the deeper fields, again because of the universal fisherman's tendency to over exploit and deplete fishing stocks.

Divers then did 6-8 dives a day with a duration of no more than 40 minutes a drift. At the end of the first dive they purged for 5 minutes at 9 metres on oxygen, from a separate demand valve. By the final dive the purge time might be increased to as much as 20 minutes. The maximum safe working depth was considered to be 35 m, but they often went deeper.

In 1993 off the West Australian Coast, 74 pearl shell divers completed 21,452 dives and spent 15,000 hours underwater. Also more than 8,000 hours of diving were logged from 13 licensed pearl farms, turning and tending the shells.

The Australians had reclaimed their industry.

### **The dangers**<sup>1-10</sup>

It was inevitable that many accidents would occur, related either to the environment or the equipment.

A recent survey<sup>10</sup> showed the relative incidence of diseases experienced by pearl divers over the 1988-91 seasons were DCS 45%, ear problems 15%, salt water aspiration syndrome 10%, marine animal injury 7% and respiratory infections 6%.

### **THE BENDS - DECOMPRESSION SICKNESS (DCS)**

#### *Early cases*

On February 6th 1892 The Lancet published a letter by a naval surgeon, P W Bassett-Smith, aboard HMS PENGUIN, which was surveying the north-west coast of Australia, the centre of the pearl oyster fishery industry.<sup>6</sup> Several cases of "Diver's Paralysis" became known to him. He described a situation in which the, mostly Japanese divers, would spend many months a year at sea, diving from 10 to 25 fathoms (18-45 m or 60-150 ft) for periods of 4 to 5 hours per day.

He described the disorder as coming on rapidly but usually recovering completely. He also described a case of a 30 year old Japanese diver, who had worked at 32 fathoms (58 m or 192 ft), which was considered a



dangerous depth, dying at sea after developing his divers' paralysis. He also described a previous case, with a far better outcome.

Dr Graham Blick,<sup>7</sup> the District Medical Officer in Broome, WA, from 1900 to 1908, looked after some 400 pearl divers, diving from 7 to 20 fathoms (13-36 m or 42-120 ft), but occasionally as deep as 25 fathoms (45 m or 150 ft). Diving occurred several days sail from port and he observed many serious and often fatal cases of "diver's paralysis".

Blick noted that most of the diving was carried out safely, by virtue of the very slow ascent rate to the surface, compared to divers elsewhere.

Nevertheless, not counting the "diver's rheumatics" (presumably musculoskeletal decompression sickness) he had seen approximately 200 cases of diver's paralysis, 60 dying and having postmortem examinations.

Of the 140 cases who did reach port alive, 11 subsequently died from renal infections with septicaemia and sometimes supervening meningitis. Most of the rest recovered, with only about 10% being permanently affected by slight paraesis, especially of the anterior muscles of the legs. The initial presentation of these patients was with paraplegia and an inability to urinate.

Although some patients had the paralysis on a number of occasions, clinically there was no subsequent extensive degeneration of the cord even though there was extensive degeneration in the postmortem cases.

He noted that with this form of paraplegia, nature was kinder than usual. He was astonished at the way apparently hopeless paraplegics could recover in the course of many months.

In some cases the paralysis of the bladder and loss of ability to micturate was practically the only symptom calling for attention. Some patients walked to the hospital asking for catheterisation. They often carried urinary catheters on the diving boats.

The usual history was that the divers had extended their exposure longer or deeper than customary, and/or that he had hurried to the surface. Soon after removing the diving dress the symptoms appeared, either gradually or suddenly. Deaths could occur within an hour or up to a day or two after the incident.

The 60 autopsies performed, all presumably many days after death, showed a "larger evolution of gasses and greater dissension of tissues than is the case with other bodies after equally sudden death". Almost invariably the heart, lungs and large veins were engorged with dark liquid blood. The spinal cord showed a characteristic "teased"

appearance and minute haemorrhages were present, together with free blood in the dural canal. The thoracic viscera and large veins of the neck were engorged with dark liquid blood. Section of the brain was generally negative, although sometimes "the blood points seemed rather larger than usual". Only once was haemorrhage found in the brain, and this was a very small one in the internal capsule. Haemorrhages were found throughout the cord.

"Teasing" of the cord was meant to imply that the face of the section looked as if it had been stippled with a fine knife or needle, a semi-disintegrated appearance. It was nearly always associated with haemorrhage, of greater or lesser extent. Occasionally there were large haemorrhages practically cutting the cord in two and forming clots of more than an inch long.

He noted that the divers started working at about March and then there were practically no cases of paralysis before September and these continued then until the end of November, when the cases came in almost daily. One explanation for this was that they were working further out in the deeper water, having collected the shell from the shallower ones in the earlier part of the season.

#### *DCS Statistics*

Initially the depths were limited by the capacity of the hand driven air pumps, introduced in 1884. Even then, as the shell became depleted by over harvesting the divers were enticed to go deeper and stay longer, with the further development of "the diver's bends".

In 1890 in the rich Cygnet Bay area, divers had become more daring and were moving into deeper water than those in the Torres Strait. With the water from 19-24 fathoms (34.5-43.6 m or 114-144 ft) deep, there were unexpected depths and the bay became known as Graveyard. The *Bulletin* reported that it was a common sight to see a dead diver brought the surface and divested of his diving dress, so that another man could use it at once. On some boats the black flag is run up so often that no one takes any notice. One owner lost 8 men in 8 days.

In 1912 the Royal Navy brought with them the engine driven compressors, which replaced the hand pumps and allow deeper excursions. This directly led to the increased fatalities. The engine pumps allowed the divers to descend to 40 m (133 ft), where they found magnificent virgin beds of huge untouched shell. Then they reached 60 (200 ft), and then 80 m (264 ft).

The Japanese cemetery in Broome and the divers cemetery on Thursday Island have a forest of grave stones which tell their own story. From 1907 to 1917, 145 helmet divers died working out of Broome. In 1914 alone, 33



**Figure 2.** The Japanese cemetery, Broome.

divers died from divers' paralysis. Fourteen Japanese divers died on one patch of shell alone, the notorious Darnley Deep. The Government closed the area, as being too dangerous, but divers would still sneak in and reach the rich shell beds. The total from all the Australian pearl ports from over the years may have reached 1,000. Most of the deaths were caused from the "bends".

In 1915 a Broome Pearlery Association report described a deplorable loss of life that had occurred from divers' paralysis, 21 men having died in that season. The reason for the reduction from 33 to 21 was because half the fleet were out of commission due to World War I. Two recompression chambers, one for each of the pearling areas, were gifts from 2 firms, Heineken and Company and Siebe Gorman Ltd. This was an attempt to reduce the death rate. The chambers not only saved many lives but prevented many men from spending their life as paraplegics.

One of Lou Marshall's divers set a grim record in the 1930's. He was brought up badly paralysed, and became unconscious. He was sent back to the bottom with a companion diver to work his exhaust valve and was nursed through the hours of darkness. He spent 36 hours underwater before he could be brought back on deck. Nevertheless the diver's life was saved.

In 1981 the death rate was down to 1, the lowest on record for over a hundred years.

#### *Traditional treatments*

The Japanese divers endurance was exceptional. In the 1980's two of the divers had become legends in their own time, Shoji Takata and Noritsugu Ejiri were both head men. The traditional diving that they performed was well in excess of the Royal Navy or US Navy tables.

Takata stated "We did 8 dives a day to 25 fathoms (45.5 m or 150 ft). We would spend about half our time on the bottom, and then come up slowly, spend about 10 minutes on deck between drifts, and then down again." They decompressed below the boat after each dive, and at the end of the day for about an hour below the lugger. The tenders would strip off the suit and the gear, and then a very important ritual followed. "We would sit for one hour. Sit very still. Not move an arm or a leg. Hardly even our eyelids. Just look over the sea." If at the end of that time the diver felt no twinges in his joints, he would cautiously raise himself to have his dinner, a welcome cigarette and perhaps a glass of port wine to keep out of the chills and the rheumatics. Divers were always cold at night, no matter how warm the water. As soon as he had eaten he would return to his bunk, dog tired. He would lay down, praying that he would not be wakened by the pains. "Usually the shoulder first, then you know." If the pain increased the diver would have to struggle back into the suit and hang underneath the lugger until the pains went and decompression was complete. Sometimes he would look forward to the next morning when he could resume his diving, and also get rid of the pain while he was underwater and under pressure.

Takata said, "I had the bends maybe 40 times. One time I had no feeling down my left side. No feeling in scalp, arm, leg, the whole of the left side of my body. That lasted maybe 2 years. I was all right. OK underwater though. My diving was not affected."

Ejiri, on the other hand, had never had a bend in his life. Most were afraid to dive with him because of his incredible endurance.

The Asian and Japanese divers often were not interested in the concept of staging, as they hated hanging from the boat, being jerked and tossed in their harness below the lugger, dangling in mid-water. Gradually the value of staging became evident. The old truculents retired, became crippled and were pensioned off, or were carried off to the graveyard.

A Thursday Island diver described the problem as follows: "When you are all anchored at night, and you hear a boat engine starting, you know some poor bugger has got the bends. They could hang him at night. They put him down at depth on the buoy anchor, he sits on it and we gradually stage him up."

"It was only shallow, 20-25 fathoms (36-45.5 m or 120-150 ft), and the first diver felt the air pressure wasn't coming through the airline properly, so he came up and he said to pull his brother up. I gave the signal, and instead of him coming up shortly, he just closed his clip. Once you close your clip in a dress, you come up like a balloon. And up he came. And as soon as we put him on deck he turned purple, and this is what they call heartcrush. He started

vomiting and then became semi-unconscious. We tried to put him over the side again. We took him down, by putting him upright, and standing on his diving boots, as far as we can, and we leave him there. No sooner had we surfaced, when he came up too. We finally we got a bit of fishing line and put a clove hitch in his air clip, and that kept him down. We kept him, and we hanged him three days, and three nights.”

“He just came to the surface to eat and drink now and again. The only thing he couldn’t do was pass water. So we put the tube in and drew blood, so we had to bring him in to Thursday Island. We left him in the hospital in Thursday Island and went out to work at that neap. When we came back he was ready to come out with us again, to work”.

### *Oxygen decompression*

In recent years<sup>3,8,10</sup> the use of oxygen has greatly improved the divers capability of eliminating nitrogen from the fast tissues of the body, reducing the likelihood of severe decompression sickness. This, in turn, has resulted in divers sometimes extending the depths - but with the possible greater risk of dysbaric osteonecrosis (“bone rot”).

By 1982 vast beds were discovered in 20 to 26 m (66 -87 ft). These were obviously the areas the Japanese used to work in. Alan Badger stated that the 1983 counterparts logged many hours in excess of those recommended by the dive tables. “We get by with careful decompression and by breathing straight oxygen for the last few minutes in the water.” The use of oxygen has made a marked difference in keeping the older divers on the active list. Broome lies 10 hours of lugger travel from the pearling grounds and for a sick man this can be a lifetime. Badger stated “Its a hard decision to make, turning back to Broome when you are on a good shell, but sometimes it has to be done”.

By the 1990’s the industry had combined to form the Pearl Producers Association, and bought a recompression chamber installed at Broome Hospital for a cost of \$180,000. By 1994 it was claimed that the decompression sickness had been reduced to an all time low. From divers in 1993 there were only 3 minor cases, all treated at sea. “We have not had to decompress a diver in the chamber since 1992” (David Appleby personal communication 1994).

### OTHER DIVING ACCIDENTS

Many diving problems developed from contaminated air supply, entanglement of hoses, trauma from the boats and their propellers, entanglements between divers, etc.

Marine animals abounded and so did injuries from them. On November 21st 1993 Peter Richard Bisley was working on a pearl farm in 14 m (46 ft) of water at Roebuck Bay, when he was taken by a Tiger Shark. Although there was considerable alarm and amazement expressed at the time, there had been many such previous cases. Roebuck Bay had always been a bad place for shark accidents and numerous ones occurred there last century. There are also many other areas in which shark attacks occurred, but were often not documented in the medical literature.

In the Torres Straits the divers were more concerned with giant groupers than sharks.

In earlier days there were large number of deaths from crocodiles, in all three main areas, the North-West, Darwin and the Torres Straits. With increasing crocodile numbers and their ability to swim many miles from land, we can anticipate more in the future.

Even manta rays, gentle beasts with no malicious intent, would get hooked up on the air lines and cause accidents. Whales were sometimes a problem as they would tend to rub themselves against the air hose, possibly to remove barnacles.

Also present in the area were sea snakes and some injuries from these have been recorded. Stone fish proliferate throughout the area as do “dream fish”. Stings are common and sometimes severe.

Other causes of death included cone shells, marine infections and coral cuts.

Perhaps the most worrisome and numerous injuries come from the jelly fish known as Irukandji (*Carukia barnesi*) and this has caused abandonment of many diving operations. The stings tend to be more common in the early part of the season, March-May. The severe abdominal pain and disorder of consciousness that occurs with these cases, makes them an acute medical emergency, with the potential of being fatal.

### Acknowledgments

This history is a synopsis, with many verbatim quotes, of the documentation of three brilliant historians Mary Bain, Hugh Edwards and Ion Idriess.

The diving practices are also described by them, the Australian Broadcasting Commission programs on Thursday Island pearlery and the excellent physiology researchers who have learnt from the divers, Dr Hugh LeMessurier,<sup>11</sup> Dr Brian Hills<sup>12</sup> and Dr Robert Wong.<sup>13-15</sup>

The author's own visits to Thursday Island, Darwin and Broome between 1962 and 1989, to socialise with the divers, both new and old, swap yarns and to dive the pearl grounds, were meant not only to collate information but also to collect traditional diving know-how. If, at the same time, he found a unique and priceless gem that would set him up for the rest of his life, then so be it.

### Key Words

Decompression illness, deaths, history, occupational diving

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## PEARL DIVING FROM BROOME

Robert M Wong

### Abstract

Pearl diving in Australian waters began towards the end of 19th Century. Over the years the current mode of diving has evolved.<sup>1</sup> This paper traces the modifications to diving from drifting vessels (drift diving) which have led to the current practise in pearl diving in Broome.

### Historical perspective

Broome, a town in Western Australia 2,600 km northwest of the city of Perth, is well known for its pearling industry. The areas fished are the seas off the Eighty Mile Beach down to Port Hedland. This area has large tidal variations. The mean high water spring tide is 9.4 m, mean low water spring tide is 1.1 m, while mean high water neap tide is 6.4 m and mean low water neap is 4.3 m.

For those with a limited acquaintance with the sea, neap tides are small tidal ranges which occur twice a month when the tide producing forces of the sun and moon are in opposition. Spring tides are large tides which occur when the sun and moon are acting in conjunction, around the time of full and new moon. The tidal range for both is measured from half tide level.

The colourful history of Broome and its divers is very well covered by a number of authors.<sup>2-4</sup> Some of the historical aspects of this article comes from H Edward's book "Port of Pearls" and is reproduced here with the author's permission.

Pearl fishing in Western Australia dates back as far as 1861 when the British colonists first noticed the necklaces made from pearl shells worn by the local Aboriginal population. The Mother of Pearl (*Pinctada maxima*) shells were obtained by breath-hold diving in Roebuck Bay, off Broome, by the indigenous population. The birth of the pearling industry in Western Australia was breath-hold diving around Broome. In the early days of the pearling industry, the local Aborigines were "engaged", with little choice, for breath-hold diving.

However, when compressed air diving, using a hand powered pump with a canvas suit and brass helmet, was introduced, the divers were brought in from afar. They were mainly Japanese, Malays, Koepangers (from Indonesia) and Arabs. It is believed that the first Japanese divers were brought to work in Port Darwin in 1884.<sup>2</sup> Nowadays days, the divers are mainly Caucasian Australians and New Zealanders.