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## WESTERN AUSTRALIAN PEARL DIVERS' DRIFT DIVING

Robert M Wong

### Abstract

This is a report on pearl diving out of Broome, in Western Australia, from 1991 to 1994. The mode of diving in earlier days has been reported elsewhere.<sup>1</sup>

Despite popular misconception and the "cow-boy" image perceived by conventional commercial divers, the incidence of decompression illness (DCI) amongst the pearl divers has been less than 0.01% and the type of DCI has been confined to the musculo-skeletal system.

The reasons for this low incidence of DCI are discussed and has been reported elsewhere.<sup>2</sup> It is believed that the contributing factors are:-

- a slow rate of ascent;
- b appropriate depth of decompression;
- c use of oxygen in decompression;
- d suitable between dive (surface) intervals.

### Pearling in Western Australia

The pearling industry of Western Australia now employs some 600 people. Of these, 142 are divers (based on the records of medical examinations conducted in 1994) and only 90 or so of these are pearl divers engaged in drift diving. The others are pearl farm divers.

The drift divers harvest wild oysters (*Pinctada maxima*) which are then seeded by highly skilled technicians and placed on panels and immersed in water in pearl farms. The farm divers attend to these oysters, since 1985 they have dived according to the USN Dive Tables.

### Pearl divers

Unlike the past, when most of the divers were Japanese, Malays and Koepangers, nowadays virtually all are Caucasian Australians and New Zealanders.

Divers usually enter the industry as a qualified recreational diver holding the Open water certificate or higher. The industry has an induction course conducted by its Safety Officer and Chamber Operator who is an ex-pearl diver. All potential pearl divers have to pass the course before they are accepted into the Industry. Most work initially in the farm sector, while a smaller number are employed as drift divers.



Figure 1. Drift divers getting ready for a dive.

The drift divers are well paid. They receive a retainer plus \$3-\$5 per shell collected, so there is competition among the divers to do drift diving.

All divers are required to undergo an annual Diving Medical Examination in accordance with the Australian Standard for Occupational Diving AS2299,<sup>3</sup> which includes a long bone survey.

The average age of the pearl divers was 27.7 years in 1994, with a range of 18 to 48 (Table 1). The younger and the older divers are mainly farm divers.

The stay of a diver in the industry varies. Those who do not collect many shells, so not making much money, tend to leave the industry after about 3 years, while others who are successful divers tend to stay on, a 10 year stay as a diver is not uncommon. Some stay in the industry to become skippers of pearling vessels or managers of pearl farms and some join the companies as administrative or managerial staff.

Of the 142 divers, 18% admitted to having experienced DCI. Of those with more than 5 years of pearl diving experience, 34% have experienced DCI, whereas 6% of those with less than 5 years experience in the Industry had suffered DCI. Most experienced DCI while diving on the farms or in other industries and not from drift diving.

**TABLE 1**

**AGES OF WESTERN AUSTRALIAN PEARL DIVERS IN 1994**

Age in years	Percentage
under 20	6%
20 - 24	20%
25 - 29	41%
30 - 34	22%
over 35	11%

**Drift diving season**

The season starts in February each year and usually ends by August. From November to January weather is cyclonic and unsuitable for drift diving. As is common in the northern parts of Australia, Broome is subject to large tidal variations, and the divers only dive during the neap tides, which have an average variation of up to 6.5 m. During the spring tides, aside from the larger tidal variations and fast movement of water, the visibility is poor and makes pearl diving a nearly impossible task, necessitating divers going to deeper waters.

**Pearling vessels**

The vessels are usually 25 metres long; either custom built or converted from trawlers. They all have a drogue at the stern to retard the speed of the drift. On either side near the stern are hydraulic booms from which gas (air and oxygen) hoses and weighted lines (shot lines) are suspended (Figure 2). Work lines run from the shot lines and drag behind them.

**Mode of diving**

The aim of the drift diving profiles is to achieve maximum bottom time in a 12 hour daylight working day.

As shown in Figure 3, the divers hang on to the work lines (drag ropes) and drift along the seabed to pick up oysters which they put into their neck bags. When the neck bags are filled, they go forward towards the shot line at the front of the drag rope and empty the catch into large net bags which are then floated with compressed air to the surface and emptied onto the deck of the vessel.

At the end of each drift, the divers surface slowly by coming up the shot rope hand over hand and decompress in accordance with the particular profiles in use. They then rest on deck while the vessel turns around to sail against the tide and then turns to drift again with the tide.



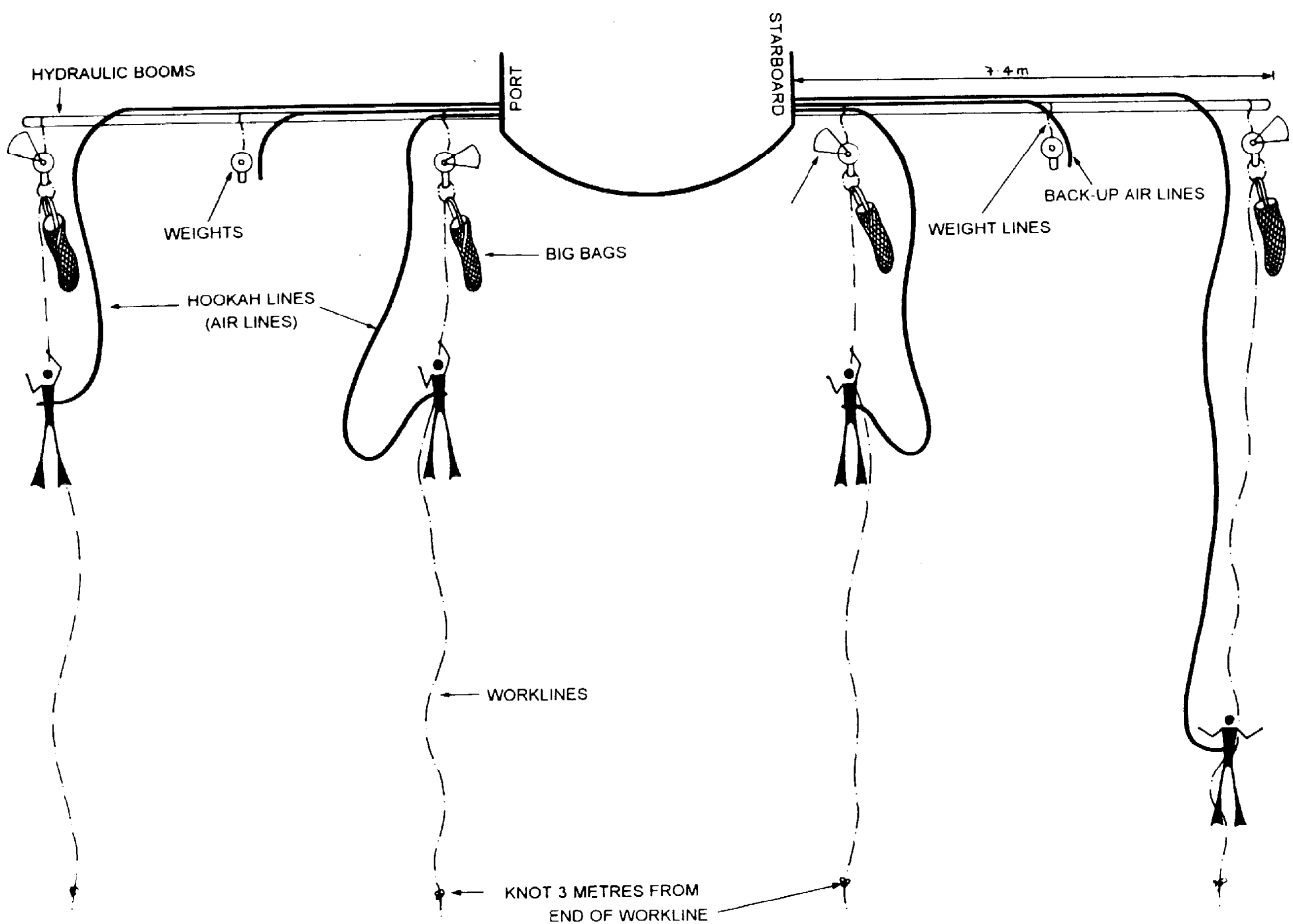
**Figure 2.** Modern Pearl fishing boat

years and they had developed faith in the profiles. A previous scientific analysis by Le Messurier and Hills<sup>4</sup> was based on the Okinawan divers operating around the Torres Strait where deep dives to depths of 45 fathoms (82 m or 270 ft) (1 fathom is 6 feet) were performed. These investigators noted the deep decompression stops used (for dives deeper than 35 fathoms (63 m or 210 ft), staging was done at 30, 23-25, 15 and 7 fathoms (54, 42-45, 27 and 12 m or 180, 138-150, 90 and 42 ft)) and the slow rate of ascent of 25 ft/minute. Of the 468 dives studied, 31 cases of bends were recorded (6.6%), and 29 of those had dived deeper than 35 fathoms, nonetheless, the symptoms were mainly joint and skeletal pains.

The current mode of diving is a refinement of the technique handed down over the years from the turn of the century. It involves repetitive dives of up to 10 dives a day and multi-day diving for up to 8 consecutive days. Due to the tidal variations, diving frequently involves doing the deep dive in the middle of the day or at the end of the day. This pattern of diving is considered to be of high risk in conventional diving. The pearl divers profiles are not based on any scientific calculations, they dive in that manner because the profiles had worked for them over the

**Fishing area**

Pearl diving is done off the coast of Broome, Chart 324 - Lacepede Islands and Bedout Islet, usually in areas some 9-11 hours steaming time south west of the township. Some areas north in the Lacepede Channels and another area just west of the township are also fished. There are areas which are some 16 hours away, but these are seldom fished nowadays.



**Figure 3.** Plan view of pearl fishing operation

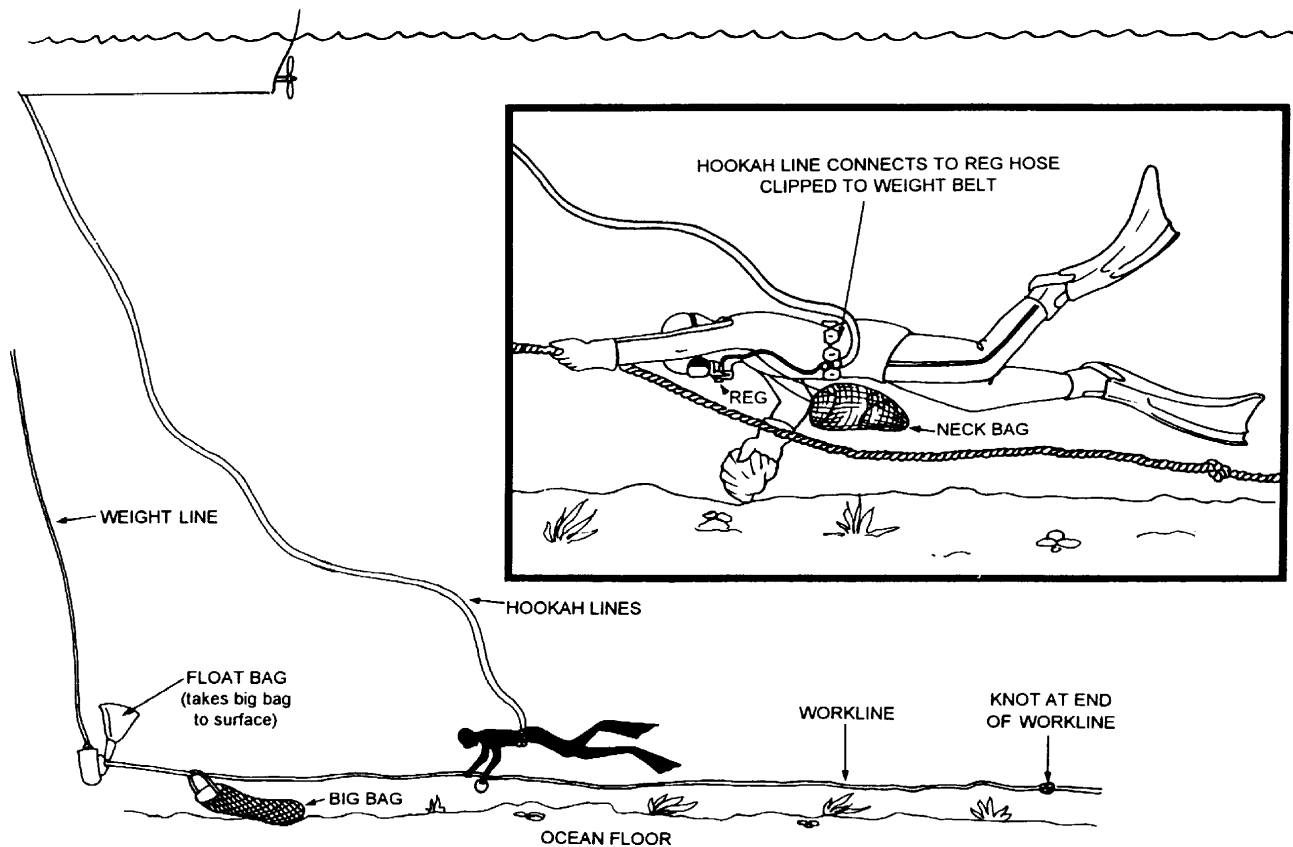


Figure 4 . Side view of pearl fishing operation.

Unlike the past, thanks to improved communications and transport, injured divers could be retrieved by 2 seaplanes based in Broome.

### Climatic conditions

The climatic conditions are tropical. There are essentially 2 seasons, the dry with a temperature range of 28-30°C and humidity of 44%. The wet season has temperature of 33-34°C and humidity of 54 -75%.

### Tides

As is common to the northern parts of Australia, Broome is subjected to large tidal variations. During spring tides, the maximum water depth range is from -0.1 m to 9.3 m; whereas, during neap tides, minimum water depth range is from 3.8 m to 5.6 m. (Mean high water spring - 9.4 m; mean low water spring - 1.1 m; mean high water neap - 6.4 m; mean low water neap - 4.3 m).

### Water temperature

The temperature varies from 32°C in summer months to 18°C in winter months.

### Drift diving dive schedules

There were 13 pearling companies each with their own drift diving profiles. In 1990, under the umbrella of the Pearl Producers Association Inc. (PPA), they agreed to dive to a "fixed common schedule" as printed in their Code of Practice. In 1991 all divers from all companies dived to similar schedules. In the same year, a recompression chamber was purchased by the PPA and donated to the Health Department of WA. It is located in the Broome District Hospital. The same year Doppler ultrasound equipment was purchased to initiate a study of the diving profiles.<sup>5</sup>

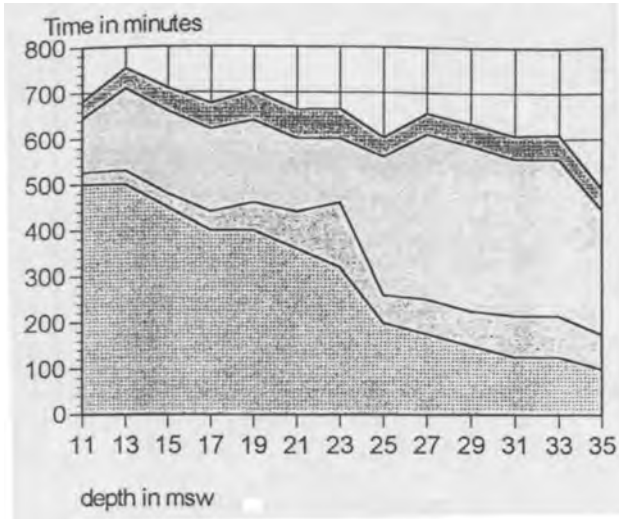
The pearl divers still speak of shallow water, mid-water and deep-water diving as in the old days.<sup>1</sup> But examination of the profiles will reveal that there are 2 types of dive schedules.<sup>5</sup>

- 1 Non-rotational profiles for depths less than 23 m;
- 2 Rotational profiles for depths deeper than 23 m and up to 35 m.

The pearl divers from Broome, as agreed by all members of the PPA, no longer dive deeper than 35 m. At the time of writing February 1996), it is not possible to dive to 23 m with the non-rotational procedure. Most companies use the rotational technique for this depth.

FIG 5

PPA PROFILES 11-35 m SHOWING TOTAL WORKING TIME



From the bottom of the graph the shaded areas represent bottom time, oxygen decompression, surface interval, and ascent times.

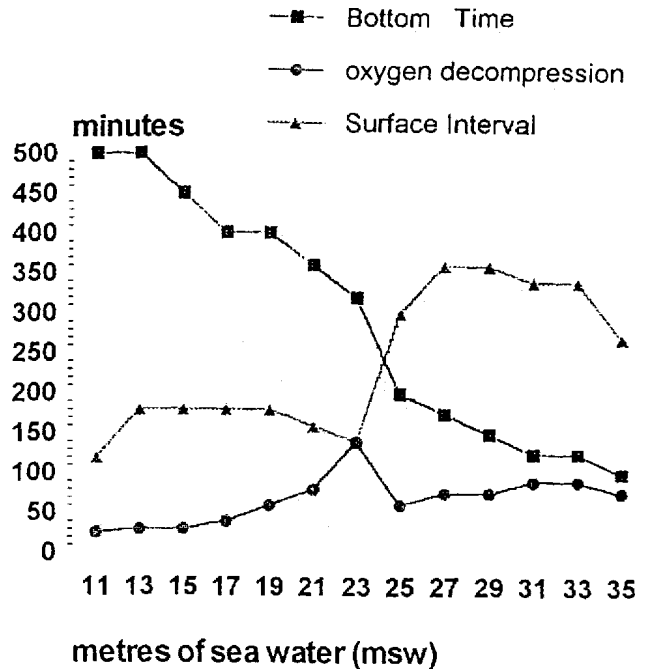
Non-rotational profiles means that each diver dives every dive of the profile. For dives of up to 13 m, the aim is to achieve a maximum bottom time of 500 minutes for the day. With increasing depths, the bottom time decreases accordingly in an empirical fashion e.g. 400 minutes for 19 m. Figure 5 shows the relationship of bottom time, oxygen decompression time, surface interval and ascent time of each dive schedule. All decompression stops are done on oxygen at 9 m, except for the 11 m profile where decompression is at 6 m. Up to the 19 m profile, decompression stops are only done on every other dive. Surface intervals for the non-rotational profiles are 15 minutes for the 11 m profile and 20 minutes for the other profiles. Each profile consists of 10 dives except for the 21 m one which only has nine and the 23 m one which has 8.

Rotational profiles are schedules deeper than 23 m and involve 2 teams of divers. With these profiles, each diver dives every second dive. Every dive requires a decompression stop.

The rotational profiles (deeper than 23 m) have variable surface intervals, increasing with each dive so that for the 35 m profile, surface intervals range from 80 minutes after the first dive to 100 minutes after the 3rd dive. From 23 to 33 m the profiles have five dives but the 35 m profile only has four dives. Figure 6 shows the PPA schedules where oxygen time increases empirically as the depth of the dive increases and surface intervals remain

FIG 6

PPA PROFILES 11-35 m TIMES ON BOTTOM, OXYGEN DECOMPRESSION AND SURFACE INTERVALS.



reasonably constant, accepting that the non-rotational and rotational profiles have different surface intervals.

The original ascent rate for deep water was set at 5 m/minute to 21 m. From 21 m to the surface, the ascent rate was pegged at 3 m/minute. After decompression at 9 m, the ascent rate was slower, 0.3-0.5 m/minute.

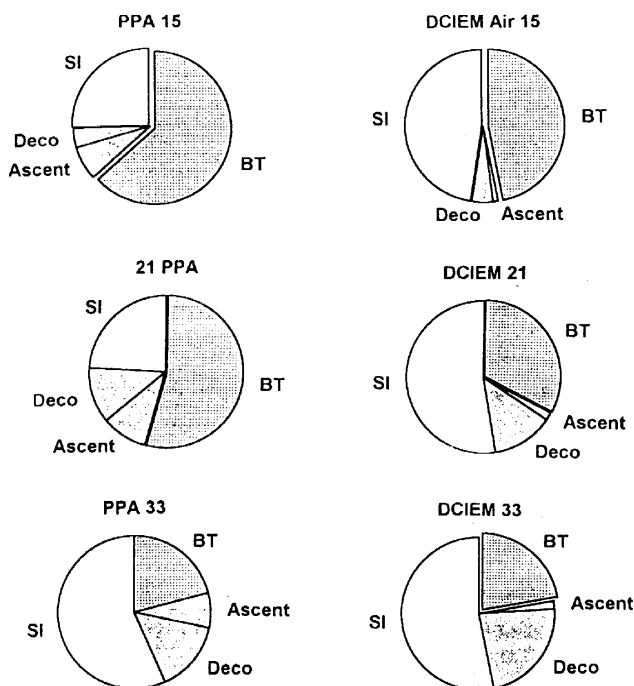
Originally, decompression was not required for the 11 m profile. For the 13 m profile, decompression was on air at 5 m. The other profiles call for decompression stops on oxygen at 9 m, but not for every dive in the shallower profiles.

With modifications of the profiles, the ascent rate was changed to a uniform rate of 3 m/minute for all depths of dives. Decompression stops were also introduced to all depth profiles.

Figure 7 and Table 2 show the comparison of the DCIEM Decompression Tables with the PPA profiles. The pie-graphs shown are not identical in times, they represent what could be achieved in a 12 hour working day using the respective profiles. It can be seen that the PPA profiles allow for more bottom time at the 11 m and 21 m depths. The 33 m profile shown was calculated using the same bottom time for both the PPA and the DCIEM Tables. It is interesting to note that the time taken for the slow ascent rate of the PPA schedules together with their staging time

**FIG 7**

**COMPARISON OF PPA PROFILES TIMES AND DCIEM TABLES**



The three pairs of pie charts show total of bottom time, ascent time, decompression time and surface intervals for depths of 15 , 21 and 35 m for PPA and DCIEM schedules.

(decompression time) are comparable to the required decompression time of the DCIEM Decompression Table.

**Decompression illness and its management**

Before 1990, dive profiles varied from company to company. There was no uniformity in the profiles. The incidence of DCI was not accurately known. Most cases were treated at sea by in water recompression on oxygen, some also used air. Only serious cases which did not respond were referred to conventional treatment in Perth.

**Current dive profiles**

The dive profiles are constantly being modified to improve diving safety.<sup>5</sup> The modifications of the profiles are discussed elsewhere.

It can be seen that the 1994 profiles are quite different from those printed in the Code of Practice.<sup>5</sup>

**TABLE 2**

**COMPARISON OF PPA PROFILES AND DCIEM TABLES AT 15, 21 AND 33 m**

Table	Depth (m)	Bottom time	Total time
PPA	15	450	710
DCIEM	15	315	672
PPA	21	360	663
DCIEM	21	240	738
PPA	33	125	700
DCIEM	33	125	562

**Medical problems affecting the pearl divers**

Apart from DCI, other problems include marine animal stings, salt water aspiration, ear and sinus barotrauma.

**Acknowledgments**

I would like to thank all those who have provided information used in this paper, especially members of the pearling industry, the Pearl Producers Association Inc. WA, pearl divers and the R&D Corporation, Fisheries Department, Western Australia.

**Key Words**

Decompression illness, occupational diving, oxygen, tables.

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