6. CONCLUSION

6.1 Jellyfish distribution and sting occurrence

Collection of the data from both Australia, and more recently the rest of the world, was entered into the database discussed in the text. Documented information from Australian sources and from other countries, as well as from world-wide travel by the author, has provided information on distribution of jellyfish species and details of stings. This has resulted in an increased knowledge of the distribution of jellyfish whose stings cause human mortality and morbidity, particularly the cubozoans. This information makes it possible to reach strategies on awareness and prevention of human envenomation by jellyfish in an attempt to reduce morbidity and mortality.

6.2 Taxonomy

The taxonomy of many stinging jellyfish world wide, in particular those causing mortality or serious morbidity, is inaccurate, scanty and confused. To recommend effective first aid and medical treatment it is preferable, or even essential, to be able to identify the type of jellyfish causing envenomation, even if the actual species is unknown. If the exact identity is unknown, an actual description of the jellyfish or its sting symptoms is required to enable identification of the envenomation pattern. This enables the recommended first aid and medical treatment of envenomation to be as specific and as effective as possible.

Despite reference to the main references on jellyfish taxonomy (Mayer 1910; Kramp 1961), as well as many specific taxonomy papers referred to in this thesis, it became apparent that the taxonomy, particularly of the species discussed, was somewhat lacking, and often inaccurate. This needed the author to study taxonomy in an attempt to be able to name a particular species for which the first aid or medical treatment was to be suggested: -

6.2.1 *Physalia* spp.

Uncertainty prevails concerning the taxonomy of both varieties of *Physalia* spp. Medical differentiation between the species would appear advisable to differentiate the single-tentacled *Physalia* sp. from the multi-tentacled *Physalia* sp. The former has caused only minor skin pain and nausea to date, and is not a significant medical problem – although it is a significant social problem for beach-goers all over the world. However, the multi-tentacled species described here in Australia and Pakistan, and present in many other areas of the world, especially the Atlantic Ocean, causes more serious symptoms. These include severe skin pain and systemic symptoms

such as muscle cramps, breathing difficulty, anxiety, sweating and back pains. The larger Atlantic *Physalia physalis* has now caused at least three human fatalities on the south eastern seaboard of the United States.

The author has suggested characteristics to differentiate the two types for the purpose of first aid and medical treatment. It is suggested that they are two separate species although this remains contrary to some biological sources.

6.2.2 Clinical research – the Irukandji

Published research by the author on the systemic effects known as the Irukandji syndrome, occurring after *Carukia barnesi* envenomation, and described in this thesis has broadened the knowledge the understanding of the epidemiology of *Carukia barnesi* and of the treatment of its delayed severe envenomation syndrome.

Very few people have been able to catch specimens of this tiny, yet virulent carybdeid. Two specimens caught by the author in 1986 enabled study of nematocyst discharge, proving that yet again vinegar (4-6% acetic acid) was effective as a nematocyst inhibitor, as it has been in every cubozoan tested to date. The remaining tentacles were lyophilised and sent to the United States for very early preliminary experimentation on laboratory mice by Professor Burnett. With the amount of venom extracted only a single experiment was possible, which showed elevated catecholamine levels after envenomation (J Burnett, 1986, personal communication). This finding corresponds well with the clinical syndrome, which the author felt contributed to many of the severe symptoms of envenomation in humans.

In 1995 Irukandji supplied by the author allowed preliminary work on the venom. In 1996 work by the author in techniques of trapping the tiny Irukandji allowed these jellyfish to be caught for the first time by those searching specifically for them. The unfortunate loss of most of these specimens that were caught prevented any further assessment of the venom and the production of an antivenom. Further supplies of venom for the production and testing of an antivenom are continuing research challenges.

Several of the new treatments suggested by the author and his colleagues here for the treatment of the Irukandji syndrome should prove helpful to several similar syndromes caused by other jellyfish world-wide. These include *Gonionemus* spp. in Japan and Vladivostock (Eastern Russia), and *Tamoya* spp., *Carybdea* spp. and other large carybdeids, which occur world-wide. The treatment should also be

effective for some of the envenomation symptoms of *Stomolophus nomurai* in China and *Physalia physalis* (world-wide), whose symptoms can cause human fatalities.

6.2.3 Large carybdeids

Large carybdeids first caught by the author in 1985, or those whose symptoms he treated for many years, proved difficult to identify using taxonomic literature available at that time. Neither was it possible to obtain the services of an interested biologist during the majority of the study of these carybdeids. It therefor became necessary to learn the basic anatomy and taxonomy of the carybdeid species in an attempt to classify them correctly. It still proved difficult, if not impossible to actually identify these carybdeids, realising that the species being studied did not exactly correspond with current taxonomic features, making it a possible new species, or even genus. This occurred with several species studied during this period.

The first major jellyfish group requiring attention were the large carybdeids, located mainly in north Queensland. However, similar species are often present in waters extending to the south border of Queensland, and is occasionally identified all down the eastern seaboard of Australia and even in Sydney Harbour. After some years of collecting specimens and studying these species by the author, it was become apparent that there were two different species. One having a distribution from central Queensland south, the other extending from central Queensland northwards Both were identified as a *Tamoya* spp., but a lack of biological training prevented any name suggestion. A biologist was eventually found who provided some insight into the problem and the two species were named. The southern one was identified as *Tamoya virulenta* – the same as the species first described in Japan by Kishinouye (1910), and the one extending northwards was identified as a newly-identified sub-species of *Tamoya haplonema* named *Tamoya haplonema fenneri* (Rifkin 1996 pers. comm.).

6.2.4 Chirodropids

The taxonomy of chirodropids world wide is the most confusing and inaccurate of all jellyfish taxonomy studied by the author.. However, although this is an academic problem, fortunately it has little medical impact. All chirodropids, although they may be classified as a different genus or species, appear to cause similar, if not the same symptoms. Thus the first aid and medical treatments suggested in this thesis should be effective for all medical effects resulting from envenomation or stings from chirodropid envenomation. However, further research is necessary, in particular the first aid and medical treatment of fresh stings - both fresh specimens and fresh stings

being needed to accurately assess first aid and medical treatments. With the lack of research personnel world-wide and the distribution of potentially-lethal chirodropids, mainly within third world Countries, this is not currently impossible. The International Consortium of Jellyfish stings provides an avenue for study of further stings.

Research reported here by the author and his colleagues, has necessarily been concentrated in Australia. *Chironex fleckeri*, the north Australian box jellyfish has now caused 67 deaths in tropical Australia, the most recent being in an 18-month-old Aboriginal male on Melville Island in the Northern Territory, in February 1996. Most Australian jellyfish deaths now occur in children, many of them being of Aboriginal descent.

6.3 Reduction of morbidity and mortality

Mortality rates from chirodropid envenomation in Australia has previously averaged about one per year. However, a significant reduction has been achieved in reducing this average in the past ten years. The author in his role as “Marine Stinger Officer” for Surf Life Saving Queensland has made this a principal aim, producing a simplified book called “The Marine Stinger Guide” (see Figure 9), distributed by Surf Life Saving Queensland, to provide simplified information on identification and treatment of jellyfish stings to the average first aider, or those people just visiting the beach. Also produced are jellyfish identification and treatment charts (Figure 9), jellyfish and marine envenomation videos, and jellyfish brochures described in this thesis.

PLATE 1.15
Dr Peter Fenner's *The Marine Stinger Guide*, first edition, 1990.

Other measures to bring the problem to the attention of the general population who live in risk areas in tropical Australia, or who visit these places, include talk-back radio shows, newspaper articles and interviews and all other forms of media. These initiatives through Surf Life Saving Queensland have also been adopted by State Governments in Queensland, the Northern territory and Western Australia.

Similar strategies are suggested to tackle the global problem of jellyfish stinging that causes mortality and morbidity. Current geographical locations of human death from jellyfish envenomation are shown in Tables 25 and 26 below: -

Table 25

Geographical locations – Human fatalities from chirodropid envenomation
Australia "Borneo" – inc. Brunei Indonesia (Kalimatan) Labuan Sabah Sarawak Japan Malaysia (Penang & Langkawi Is. Papua New Guinea Philippines Solomon (Bougainvillea) Is. United States of America

Table 26

Geographical locations – Human fatalities from non-chirodropid envenomation
China (east coast) – *Stomolophus nomurai* United States of America – *Physalia physalis*

6.3.1 Awareness, prevention and treatment of stings

This information on Australia jellyfish as described and illustrated in this thesis, is now being distributed by information pamphlets, illustrated charts on identification and treatment, videos, a simple book on identification and treatment and, more recently, a major text on International marine envenomation.

Co-edited and co-authored by the author, a newly published major textbook named "Venomous Marine Animals: a Medical and Biological Handbook" has been released by Surf Life Saving Queensland. It contains the latest first aid and medical information on jellyfish and all aspects of marine envenomation on a global basis.

The latest information presented in this thesis on jellyfish distribution, further envenomations and deaths, updates the previously-published knowledge on the global problem of jellyfish stings.

6.3.2 First aid and medical treatments

Treatment of chirodropid stings starting with nematocyst inhibition with vinegar has been used since 1980. Surf Life Saving principles of `retrieve and restrain', followed by vinegar dousing and then compression bandaging for major stings presented here have proved useful. Although controlled trials of verification of the role compression bandaging has not been scientifically tested, and should be, promotion by the author and his colleagues has at least produced (victim-tested) suggestive evidence that it is effective. The technique of intramuscular injection of *Chironex* antivenom originally taught to senior surf lifesavers in Queensland was taught to the Queensland Ambulance Officers by the author in 1990. At the same time a training video was made for Queensland Ambulance featuring the author discussing the identification and treatment of all jellyfish stings; this included the technique of when, how and why *Chironex* antivenom should be given. The timing of this information proved fortuitous when within a month Ambulance Officers had used the antivenom at the beach after two young boys had been stung by *Chironex.*

Research by the author and his colleagues has shown that early antivenom administration dramatically reduces skin pain, acute inflammation and subsequent scarring. It also helps reduce the respiratory and cardiac depressive effects of *Chironex* venom, despite some *in-vivo* laboratory work suggesting that there was incomplete cardiac protection. This work has recently been criticised as being poorly performed.