

2. INTRODUCTION

A glossary of medical biological terms is contained in Appendix A

2.1 The start of research into jellyfish stings

In 1980 the author became the President of the then Mackay Junior Surf Life Saving Club. As a Doctor and as the leader of this group, members asked many questions about the 'jellyfish' problem that occurred locally. Having studied Medicine at the then London Hospital, University of London, the author had no knowledge of jellyfish nor any other creature in the sea. To obtain information the author researched the subject at the local hospital medical library. However, nothing was available. After contacting the then Queensland Surf Life Saving Association he was given the contact of their 'Marine Stinger Officer', a gentleman who, despite being a welder by trade in Cairns, north Queensland, had a wide knowledge of the area. However, as he had no medical information, the author was then put in contact with Dr John Williamson, then an anaesthetist in Townsville, north Queensland. He sent the author a copy of his current book on marine envenomation (Williamson 1974).

The author then started to research the area more and started to produce articles for the local newspaper to help educate a wider audience. As John Williamson checked each of these articles, a working relationship developed. During this time a further update of the Queensland Surf Life Saving booklet on marine envenomation had been produced (Williamson 1981).

In 1984 a patient of the author was severely stung and regular communication for advice on symptoms and therapy was necessary with Dr (now Associate Professor) John Williamson. By the end of this case the author was more updated on the medical treatments, and whilst writing the case history for publication (Williamson *et al* 1984), learnt even more.

In early 1985 discussion of treatments of envenomation were expanded after discussion (Burnett & Calton 1983; 1984) and then collaboration with Professor Joseph Burnett, a leader in his field in marine envenomation. It seemed that the problem of jellyfish stinging was not so much an Australian problem, but more of a generalised problem. This relationship later extended into the International Consortium of Jellyfish Stings (see below).

In mid 1985 the author was called to collect two very large 'box' jellyfish that had been found in Mackay Harbour. The jellyfish, which were still alive, had a bell diameters of 120 and 130cms, and bell heights of 150 and 180cms respectively. They had 4 corners (pedalia) and so were cubozoans, but just a single, large tentacle in each corner, making them carybdeids. When I tried to have the species identified by expert biologists in Australia, none could agree. It seemed that it was a new species and was given the colloquial name of Morbakka, suggested by Southcott (1985). Because of these problems, and as it is advisable to identify the jellyfish species causing the sting so that treatment may be specific, it was necessary to start research into both the taxonomy of species and first aid and medical treatments. Unfortunately, the more taxonomy was researched in Haeckel (1880), Mayer (1910), Kramp (1961) and Southcott (1956; 1966), the more apparent it became that the information was sparse, inaccurate and often conflicting. Knowledge of the subject of taxonomy and distribution of species thus became another field for research in this article (see below).

In 1986 the author became the Marine Stinger Officer for Queensland Surf Life Saving, providing an ideal opportunity to expand the knowledge of marine envenomation in the State of Queensland. Monthly report forms for the 55 Surf Clubs in Queensland, which cover 2000 kilometres of the Queensland coastline were introduced that year. These forms provide the number of stings treated by the Club that month, and also gave an idea of the numbers of jellyfish seen, and which species. Surf life savers were fairly good at identification of some of the more common species, but as a part of the education process extensive trips were undertaken by the author, where lectures were held in each Surf Club on the identification and treatment of jellyfish. These lectures have been updated every two to three years to keep surf lifesavers abreast of the problem, and to give them the latest available knowledge on treatment, or identification.

In 1986, along with Dr Williamson the author established a computer database to investigate the epidemiology of jellyfish stings in Australia. Report forms were sent out to each hospital in the tropics of north Queensland and in the Northern Territory. Later this was extended to include Broome in Western Australia, and in 1996, all tropical hospitals in tropical Western Australia. This database was to form the basis of this report.

2.2 The problem of world jellyfish stings

Human fatalities after cnidarian (jellyfish) stings were first reported in the Pacific Ocean in 1906 (Old 1908). There was then very little further documentation until 1965 when two

classical publications gave an insight into both human fatalities and serious morbidity after jellyfish envenomation (Cleland & Southcott 1965), and marine envenomation in general (Halstead 1965). Apart from the extensive investigations of Flecker (1945; 1952a) and Barnes (1960; 1964; 1966) in Australia, there were no further published reports of fatalities after jellyfish envenomation for two decades, when 3 deaths from *Physalia physalis* (the Portuguese man-o'-war) were reported from the United States (Stein *et al* 1989; Burnett & Gable 1989).

In 1982 knowledge of the epidemiology of jellyfish envenomation was at a standstill after the pioneering work of Flecker (1945; 1952a; 1952b) and Barnes (Barnes 1960; 1964; 1965; 1966). Williamson was expanding and updating knowledge of the treatment of Australian marine stings from his early Surf Life Saving Booklets on marine envenomation (Williamson 1974; 1981) to the more comprehensive Marine Stinger Book (Williamson 1985a), but little was known of the epidemiology, either of the jellyfish themselves, or their envenomations. Even less information was known on the epidemiology of jellyfish stings world-wide, with Cleland and Southcott's work (1965) only touching the surface of a vast reservoir of jellyfish problems world-wide.

2.3 The need for further research

It is helpful for the development of treatments if the actual species of jellyfish causing the envenomation is known. This will mean that a standard first aid and medical treatment plan can be followed. However, after the extension of the author's study into jellyfish identity in 1985, it became apparent that there were many areas of contradiction and confusion in the identity of jellyfish species, even amongst experts, (Haeckel 1880; Mayer 1906; Kramp 1961; Southcott 1967).

Therefore my research necessarily had to be expanded to include the biology and biological identification of jellyfish, together with their historical origins of identification and naming of their species. Then, using my own assessment of the specimens that I have been able to catch, those I was able to obtain from other areas of the world, and those I was able to study in museums and Universities in my travels, I was more likely to be able to identify a jellyfish to which I had to refer. Also, I was likely to be more accurate in identifying jellyfish causing similar symptoms in human envenomation, enabling the treatment to be symptom-specific, although not necessarily species-specific. Symptoms should thus be able to be controlled quickly and efficiently, preventing complicating morbidity, or even fatality.

Research into the problem of world jellyfish stinging has been as comprehensive as possible during the past 9 years. Research has been of both personal and collaborative work on the identity of jellyfish and their stings causing human morbidity and mortality around the world. However, it is by no means complete and further epidemiological work is needed in both the biological and medical areas.

Biologically, cnidarians (soft-bodied animals) may be divided into 4 Classes:

1. Hydrozoans (mainly hydroids, but including *Physalia* and hydromedusae)
2. Scyphozoans (the 'true' jellyfish)
3. Cubozoans (box-jellyfish)
4. Anthozoans (sea anemones and corals).

In this thesis *Physalia* spp. have been treated and referred to as 'jellyfish', as they are common stings and the public (to whom the first aid and species recognition need to be taught) regard them as jellyfish. *Physalia* are actually a siphonophore colony living in symbiosis.

For the purpose of this thesis, and to simplify medical treatment as a whole, the author has elected to group the jellyfish into a 'medical classification', rather than a biological classification. The medical classification recognises two main groups:

1. 'non-cubozoan' jellyfish (ie. those that are not in the box-jellyfish family) in the classes Scyphozoa and Hydrozoa)
2. Cubozoan jellyfish ('box' jellyfish) in the class Cubozoa. These are then further separated into two sub-groups, as their effects are usually medically distinguished by their envenomation patterns, although treatment is surprisingly similar on occasions:
 - a) Chirodropids - 'box-jellyfish' with more than one tentacle in each corner (pedalium).
 - b) Carybdeids - 'box-jellyfish' with just one tentacle arising from each pedalium (except the genus *Tripedalia*, whose pedalia may have either two or three branches, with a single tentacle arising from each branch.

Although the problem of jellyfish envenomation is global, other than the extensive studies of Burnett in the United States (listed Appendix B), most of the study into jellyfish and their envenomation syndromes, including that of the author, has been in Australia. For this

reason alone, the data gathered on the subject by the author, and then the available data of the global problem as a whole, is presented under the headings of 'Australia' and 'the rest of the world', although it is accepted that this classification is a little 'one-sided'.

In 1989, at the Vth International Conference into Jellyfish Envenomation, the author and Professor J Burnett met. As a result of this meeting, and of further discussions with a few interested people, the International Consortium of Jellyfish Stings was created (Burnett 1990). In the beginning there were just ten members with Burnett, Williamson and the author as the active members. A newsletter is now produced monthly by Burnett and circulated by Internet, to some 150 interested people around the world.

The Consortium provided an ideal organisation to collect information on stings from many areas of the world. It was discovered that the problem was indeed a global problem. Some of the more severe cases were unusual enough to warrant early publication (Williamson *et al* 1988). It also provided information on many jellyfish species throughout the world, allowing for expansion of this knowledge. This was of particular interest when the work of Mingliang was discovered with his publications in China on the deaths and severe envenomations from *Stomolophus nomurai* in China (Mingliang 1987; Mingliang 1988a & 1988b; 1992; Mingliang & Qin Shede 1990; 1991; 1992), death and severe envenomation from *Chiropsalmus quadrigatus* in Okinawa, Japan (Y Araki & Y Tomihara, 1993, personal communication), death from *Chiropsalmus quadrumanus* in the United States (Bengston *et al* 1991) and severe envenomations from *Gonionemus* spp in Vladivostock (Yakovlev & Vaskovsky 1993) and Japan (Otsuru *et al* 1974). Reports of jellyfish and/or their stings are all investigated for their authenticity before being entered on the database. No 'vague' or possibly inaccurate reports are included, thus maintaining as far as possible the accuracy of the information available from the database.

Jellyfish identification

Many swimmers stung by jellyfish do not see the causative jellyfish. Identification of the responsible species is made frequently by knowledge of the predominant jellyfish found in the area at that time, and from the symptoms and skin signs exhibited by the patient when envenomated.

It has been shown that victims produce relatively specific anti-jellyfish IgM after the initial exposure and later, within several weeks, significant amounts of immune specific IgG appear (Gaur *et al* 1981). Serological techniques were shown to be effective in determining the antibody response in envenomated patients (Burnett *et al* 1983). In addition to jellyfish species identification in clinical cases using known

jellyfish antigens tested against unknown sera, species identification against unknown jellyfish forms is made possible (Burnett & Gould, 1971).

The author joined with a number of colleagues who collected material from various jellyfish species. Serum was also collected from as many patients as possible, most of the Australian victims being traced through details collected for the database (see 5.5). These immunological techniques increased our ability to diagnose coelenterate stings and aid in the understanding of the pathogenic reactions exhibited by the envenomated patient (Burnett *et al* 1988).

Irukandji antivenom research

The author has tried, unsuccessfully, for the past fourteen years, to obtain financial assistance from the Australian Research Council. The only practical experience came from a friend who was a professional fisherman who searched the waters off Mackay whenever he was out net fishing.

In 1996, assistance was provided by the Australian Venom Research Unit, under Associate Professor Struan Sutherland, which made it possible to design equipment and develop techniques to catch Irukandji. The result was that members of Surf Life Saving Queensland could be used more efficiently to safely hunt and catch Irukandji.

2.4 Aims of research

The aim of the research is to expand and promote the knowledge of jellyfish envenomation and jellyfish distribution and to optimise its management. For this, the following areas needed to be explored:-

1. Knowledge of jellyfish distribution in Australia and the world. This was achieved first through contact with scientists and doctors throughout Australia, then later from around the world as the International Consortium of Jellyfish Stings allowed contact with a wide distribution of people in the field of jellyfish study. Jellyfish identity, distribution and stings were entered into the database (see 5.5).
2. Knowledge of jellyfish identity. As there were so many unknown, or inaccurate areas, a sound knowledge of the taxonomy of a number of jellyfish species was necessary,

including new research by the author (see 5.1). The collection of specimens by the author and his contacts was necessary to achieve this aim.

3. Exploration of new methods of investigating jellyfish and their envenomation. Only a limited time was spent in this area but collaborative investigation into serology after jellyfish envenomation proved useful.
4. A sound knowledge was necessary of the pharmacology of various treatments used in the past, those tried by the author or his colleagues and any other treatments that were used on other envenomations (eg scorpion and funnel web spider envenomations).

A better understanding of the distribution of various fatal, potentially fatal or serious stinging jellyfish could be obtained. This information would enable the knowledge of awareness and prevention of jellyfish envenomation to be expanded. First aid and medical treatments were assessed. All this information should then allow suggestions to be made so that first aid and medical treatments of jellyfish envenomation could be suggested that were simple, and as uniform and effective as possible.