3. HISTORY OF JELLYFISH ENVENOMATION

The historical aspect must first be considered under two headings, ‘biological’ and ‘medical’. These categories then necessarily merge together, as understanding of the problem of worldwide cnidarian stinging requires knowledge of biology and medicine, together with epidemiological, pharmacological, toxicological and statistical data.

3.1 Biological considerations

3.1.1. Class Cubozoa - cubozoan jellyfish

Chirodropids

Chirodropids are box-jellyfish having more than one, and up to 15 tentacles arising from each corner, or pedalium, unlike “true” jellyfish of the Class Scyphozoa, where the tentacles are radially symmetrical. The first chirodropid described was *Chiropsalmus quadrumanus* (Agassiz 1862). Other species were soon identified and Haeckel (1880) was responsible for the first major work on jellyfish classification. This classification was extended by Mayer (1910), Kramp (1961) and Southcott (1956 and 1967). However, this classification of genus and species identification was presented with some flimsy and inadequate evidence that was to be duplicated over time.

Haeckel (1880)

Haeckel identified an Indo-Pacific chirodropid in 1879 caught off the coast of Burma, and named it *Chiropsalmus quadrigatus* Haeckel 1880. The specimen was damaged and immature, having no discernible gonads. His description of the specimen is insufficient for identification purposes and has caused long-term confusion. Several species have fallen within this vague description, and although they are morphological different they have all been named *Chiropsalmus quadrigatus*. Specimens have now been collected from all over the Indo-Pacific region, including the Philippines (Light 1914), Okinawa (Shokita 1986) and Australia (Barnes 1965). All seem to have slightly different characteristics.

Mayer (1910)

Mayer continued a similar path. He attributed the name *C. quadrigatus* to all the chirodropid specimens he caught in the waters off the Philippines. However, when studied in hindsight the description of *Chiropsalmus quadrigatus* appears to be a composite of the characteristics of both *C. quadrigatus* and *Chironex fleckeri*. This has also caused confusion, but can probably be explained. Several taxonomists have since repeated this description, perpetuating the confusion.

Barnes

In 1965 Barnes visited the Smithsonian Institute in Washington DC to inspect their chirodropid specimens. He then suggested to the Royal Society of north Queensland in 1966, that Mayer had both *Chiropsalmus quadrigatus* and the jellyfish now named *Chironex fleckeri* in his collection of chirodropids from the Philippines from the years 1906-1908 (Kinsey 1986). However, *Chironex fleckeri* was not identified as a new genus and species until some 50 years later (Southcott 1956).

However, despite inspecting these specimens of *Chiropsalmus quadrigatus* named by Mayer, Barnes still used the name *Chiropsalmus quadrigatus* for a chirodropid commonly found in tropical north Queensland (Barnes 1965) which is morphologically distinct from *Chironex fleckeri.* It is also morphologically distinct from the species bearing the same name that Barnes had seen in Mayer's collection. This continued the confusion on chirodropid taxonomy. This problem of species identification is further explored below.

Hartwick

Research by Hartwick from 1975 onwards established that *Chironex* was a coastal creature (Hartwick 1987). After mating *Chironex* in a laboratory setting with Yamaguchi, they were able to identify the same polyps that later grew to the *Chironex* medusa (Yamaguchi and Hartwick 1980). Hartwick later discovered similar polyps under rocks in mangrove swamps up to five kilometres from the sea, which he grew to *Chironex* medusae, enabling him to suggest the life cycle of *Chironex fleckeri* (Hartwick 1987).

Together with Dr. John Williamson and Dr Vic Callanan he also revolutionised the first aid treatment of *Chironex,* when he showed that vinegar was the most effective (and safest) substance to use to totally inactivate the stinging cells of *Chironex*, thus preventing further life-threatening stinging (Hartwick *et al* 1980).

3.1.2 Non-cubozoan jellyfish

Physalia

The genus *Physalia* causes some of the greatest confusion in medical discussions. Although *Physalia* is a siphonophore and not a "true" jellyfish, it is commonly regarded as jellyfish (except by biologists) and will be treated as a one throughout this thesis.

There appear to be two sets of signs and symptoms after *Physalia* stings. For this reason, medically, the genus needs to be considered under two species, or groups: -

1. *Physalia utriculus*, which has a float with a maximum length of 10cm and a single main tentacle causing moderate skin pain, often with moderate pain in the lymph glands draining the skin sting (Williamson 1985a, p.4).

2. *P. physalis,* a much larger species with a float length of up to 25cm, and with many long tentacles that may be up to 30m in length. It may cause severe systemic symptoms (Burnett *et al* 1994) and has caused 3 deaths in the United States (Burnett & Gable 1989; Stein *et al* 1989).

The genus *Physalia* was first established by Lamarck in 1816. Disagreement about the number of species in this genus was contested for many years. In 1960 Totton, after studying the large, multi-tentacled Atlantic Ocean *Physalia*, in the Canary Islands (Totton & Mackie 1960), dismissed all his predecessor's thoughts and stated

> "I believe that all *Physalia* are crested in life, and that when fully grown they all have seven or more tentacles. I have examined hundreds of living specimens of all growth stages in the Canary Islands, as well as preserved specimens from all oceans. I see no grounds for suspecting that there may be more than one species, which should bear the name *Physalia physalis* (L.)."

Totton regarded *Physalia* with the single main tentacle as immature forms of those bearing many main tentacles, However, he only makes brief reference to the specimens from other museums in the world and gives no idea on numbers or tentacles present on the specimens examined. The author, having studied specimens of *Physalia* from around the world, disputes this fact. The subject is discussed further below.

Stomolophus

Stomolophus nomurai is the only other medically important jellyfish with a questionable species identification. A jellyfish by this name causes significant morbidity and mortality in humans in one area of the East China Sea around Qingdao, China (Mingliang 1988b; Mingliang & Qin Shed 1991). Kramp (1961) states the maximum bell size of *Stomolophus nomurai* to be 180mm wide, with its distribution mainly in the Atlantic, although he makes a single reference to the occurrence of *S. nomurai* in Japanese waters (Uchida 1954). Specimens known as *S. nomurai* in the area around Qingdao are reported to have bell diameters up to 2 metres across, and have been responsible for up to 8 deaths in the area around Qingdao (Mingliang 1988b; Mingliang & Qin Shed 1991). Further research is needed in this area.

3.2 Medical considerations

3.2.1 Australia

Records of deaths from marine stings have only been kept by Europeans in tropical Australia since 1884. However, Aboriginals in north Australia knew of this problem probably thousands of years beforehand, as a bark painting several hundred years-old has been found in the Northern Territory, which clearly depicts a chirodropid - a box-shaped jellyfish with 4 obvious corners (Cleland & Southcott 1965, p.90). There have probably been many deaths that remain undocumented in the Aboriginal population in whom deaths and injuries must have occurred since time immemorial.

The first recorded death in Australia from a jellyfish sting was in 1884 in Townsville (Cleland & Southcott 1965, p.114). There have since been almost seventy recorded deaths in Tropical Australia, now all attributed to *Chironex fleckeri* (Currie *et al* 1992; Fenner, in Williamson *et al* 1996, p.70-73). Until the past decade there were, on average, one or two deaths per year, usually in aboriginal children in remote areas (Williamson 1985a). The last death in Australia was a 18-month-old Aboriginal boy on Melville Island, Northern Territory in February 1996 (B Currie, 1996, personal communication). The last non-aboriginal to die in Australia was a 4-year-old boy at Barney Point, Gladstone, Queensland in 1988 (Lumley *et al* 1988). However, there have been a number of severe envenomations where lives have only been saved by prompt medical attention (Maguire 1968; Williamson *et al* 1984; Fenner *et al* 1989; Beadnell *et al* 1992).

For many years in the past deaths were attributed to "drowning", or "allergic reaction to a jellyfish sting." The jellyfish usually blamed was *Physalia*, the common "bluebottle". Deaths were even stated to be due to a "heart attack after a *Physalia* sting". No explanation was given to the fact that deaths occurred only in the summer months in the tropics, whereas *Physalia* was common in many months in the year, and was present in many places around Australia including the whole of the eastern seaboard (Cleland & Southcott 1965, p.35).

Australia has been fortunate to have medical men of great tenacity. Despite being far from major research facilities, through meticulous study and great practical skills they first described many serious marine envenomation syndromes, caught and identified the animals responsible, and suggested treatment principles.

Southcott

Dr Ronald Southcott was stationed with the Australian Army in 1944 in the Cairns area. He noticed and described 2 types of stings (Southcott 1959): `Type A' stings were minor with a small and insignificant skin mark. However they were followed some time later (usually between 20 to 30 minutes) by a number of severe systemic symptoms that often caused prostration, even in the fittest of troops. `Type B' stings had extreme skin pain with obvious wheal marks visible on the stung area. Although many victims became somewhat sick and lethargic, there were no deaths in this group during the study.

In 1956 in north Queensland, as a result of brilliant field work by Dr Hugo Flecker, Southcott was given a specimen of a chirodropid. He was then able to identify the jellyfish causing Type `B' stings, naming it, aptly, *Chironex fleckeri* (Southcott 1956); and in 1967, following similar brilliant field work by Dr Jack Barnes, he identified the jellyfish causing the Type `A' stings, naming it *Carukia barnesi* (Southcott 1967).

Flecker

Dr Hugo Flecker was a Radiologist in Cairns, north Queensland in 1932. On January 20th 1955, when a 5-year-old boy died after being stung in shallow water at Cardwell, north Queensland, Flecker suggested that the police net the area. Three types of jellyfish were caught, one of which was an unidentified, box-shaped jellyfish with groups of tentacles arising from each corner.

Flecker sent it to Dr Ronald Southcott in Adelaide, and on December 29th 1955 Southcott published his article introducing it as a new Genus and species of lethal box jellyfish. He named it *Chironex fleckeri*, the name being derived from the Greek `cheiro' meaning `hand', and the Latin `nex' meaning `murderer', and `fleckeri' in honour of its discoverer.

Flecker was also interested in the Type `A' stinging and published his article in the Medical Journal of Australia in 1952 naming it the `Irukandji syndrome' after the "Irukandji" tribe of Aboriginals who lived in the Palm Cove area where the stings were frequently reported (Flecker 1952b). Flecker died in 1957 without finding the jellyfish responsible for the syndrome.*****

❖ Flecker's field and experiment notebook, containing almost certainly valuable information ahead of its time, disappeared with his death. Rediscovery of this notebook would be a major historical and possibly research advance.

Barnes

Dr. Jack Barnes was a Cairns General Practitioner who then took over the quest for the "Irukandji". He surmised that the organism had to be a very small jellyfish that swam very quickly, and probably close to the surface. After calculating the most likely time and place to catch the animal Barnes lay on the bottom of the seabed in shallow water wearing his SCUBA gear.

Many hours later his persistence was rewarded when he saw a very small jellyfish swim in front of his mask. He managed to catch this, and another when he saw a fish moving in an erratic fashion which was seen to be caught in the tentacles of another of these tiny jellyfish. To see if they caused the "Irukandji syndrome" Barnes stung himself, his son Nick, and a lifesaver friend. After the characteristic 30-minute delay all three developed the "Irukandji syndrome" and had to be admitted to hospital with severe back pain, muscle cramps, nausea, vomiting and headache (Barnes 1964).

These jellyfish specimens were also sent to Dr Ron Southcott and in 1966 he described them as a new genus and species of box jellyfish called *Carukia barnesi*. The `car' from *Carybdea*, the type of single-tentacled box-jellyfish in whose Family it belonged, and the `ruk' from "Irukandji"; `*barnesi*' named after its discoverer (Southcott 1967).

Jack Barnes was also very interested in all the large "box jellyfish" in his area and in 1965 identified another cubozoan as *Chiropsalmus quadrigatus*. It was similar to *Chironex*, but although the sting was intensely painful, it was not lethal, and did not cause as much scarring as *Chironex*. Although Barnes' identification of this jellyfish was *Chiropsalmus quadrigatus* it was probably incorrect and is another, yet unnamed, Australian species.

Barnes - as the Medical Adviser to the Surf Life Saving Association introduced `pantihose' as an effective protective barrier preventing a serious *Chironex* sting. It was thick enough to prevent penetration and consequent envenomation by the thread tubes of the stinging cells of *Chironex*. It became a common site in north Queensland to see Surf lifesavers wearing pantihose on patrol. One pair was worn as usual on the lower half of the body with the feet cut out and taped around the ankles, the other pair had a small hole cut in the crutch and they were pulled over the head with the arms put in the leg part, and the hands free. They were able to safely enter the water to drag long mesh nets through the shallows to see if *Chironex* were present, allow safer bathing for the general public. The idea was not to rid the area of dangerous jellyfish, but to detect their presence so the beach could be closed to prevent envenomation.

In 1964 Barnes introduced methylated spirits and tourniquets as the first aid treatment for *Chironex* stings. It was another 11 years before further work suggested vinegar and compressive bandages were more effective (Hartwick *et al* 1980). Barnes also published effective medical treatments for severe envenomation by both *Chironex* and "Irukandji", which still form the basis for current hospital treatments of these marine envenomation cases (Barnes 1966).

In 1967 Barnes developed his brilliant venom collection technique, which led to production of the Commonwealth Serum Laboratories' box-jellyfish antivenom (Barnes 1967). Using a small vacuum flask with an amniotic membrane (`borrowed' from the local Hospital’s Maternity Ward!) stretched across the neck and secured with elastic bands, he applied gentle suction through a side arm, to pull the membrane slightly downwards. Into this centre dip were placed fresh, live *Chironex* tentacles. A small electric current was then passed across this membrane through electric terminals secured underneath the elastic bands holding the amnion to the side of the container, causing nematocyst discharge through the membrane. This venom collected in the container and was then extracted with water. This venom was then injected into sheep to make the antivenom. It was the first effective treatment for a severe *Chironex* sting and further research is only now showing us ways to improve production of Chironex antivenom.

Williamson

Dr John Williamson is a member of the Medical Advisory Committee to Surf Life Saving Australia and in 1974 he produced their small booklet called `Some Australian Marine Stings and Envenomations'. This was updated in 1981 and called “Some Australian marine stings, envenomations and poisonings” and then "The Marine Stinger Book" as the third edition in 1985. He is the Chief Editor of the greatly enlarged new edition of this book, now called "Venomous and Poisonous Marine Animals: a Medical and Biological Handbook” (Williamson *et al* 1996).

3.2.2 Indo-Pacific

The widespread occurrence of chirodropids (ie. cubozoans with multiple tentacles in each corner of the bell) jellyfish in tropical waters has been recognised since the end of the last century (Agassiz 1862; Haeckel 1880) but there was no documentation of deaths or morbidity until 1908, when Old (1908) reported deaths in the Philippines. Even then, information on jellyfish stings in this and other parts of the world remained sketchy until Cleland and Southcott's study in the 1960's (Cleland & Southcott 1965). Apart from the extensive investigations of Flecker (1945; 1952a; 1952b) and Barnes (1966) in Australia, nothing else was published about clinical effects of jellyfish envenomation in the Indo-Pacific until the author and his colleagues became interested in this field, starting in 1980.

3.3 The present state of knowledge

The International Consortium of Jellyfish Stings was discussed by Burnett, Williamson and Fenner in 1989 and promoted in 1990 (Burnett 1990)(see above). Although the original three remain the main active members (recently with the support of the Australasian College of Tropical Medicine), one result of this Consortium was that people from around the world who were interested in venomous or poisonous marine animals in any specialty were contacted and communication lines established. It provided the opportunity for biologists and medical practitioners to interact, something that had not occurred before. Most of the reports on jellyfish identity, epidemiology and actual envenomation reports from outside Australia that have been entered into the database have come through these contacts.

Knowledge has increased dramatically with the recent publication of “Venomous and Poisonous Animals; a Medical and Biological Handbook” (eds. Williamson, Fenner, Burnett and Rifkin,1996). Much of the author’s original research was included in this book as well as the most up-to-date knowledge contributed by 38 other authors from the fields of biology, medicine, art, and other people including field workers interested in this area. This was the result of the continued quest for details on any jellyfish stings, the biology of species, distribution of jellyfish species and locations of envenomations.

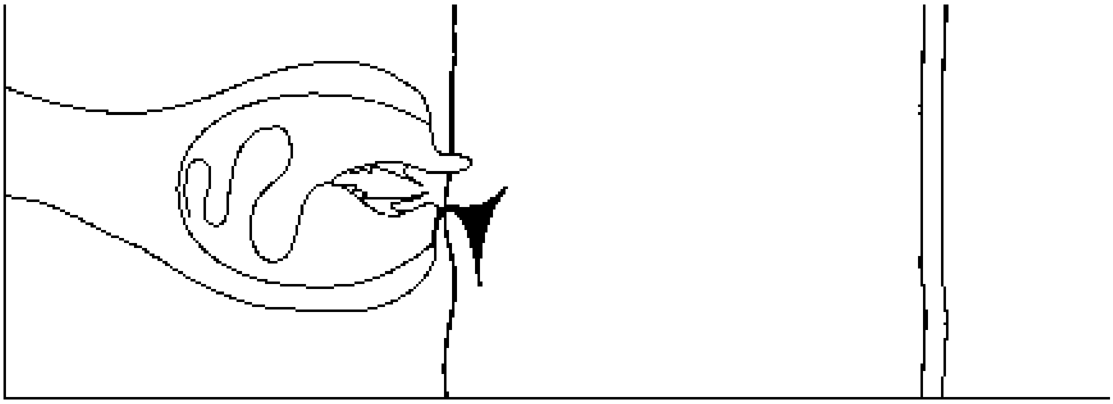
3.3.1 Method of envenomation

The method of envenomation is often misunderstood. Envenomation is by nematocyst, the “stinging cell”. Millions of these nematocysts are present in the tentacles of a jellyfish, and less often on the actual bell. Within the nematocyst cell is a nematocyte, the actual delivery device for venom. Each nematocyte has a thread tube that is tightly coiled inside. On the outside on top of the nematocyte is the operculum, or lid, which also has a “trigger” (Figure 1).

Figure 1 – diagrammatic representation of a single nematocyte: -

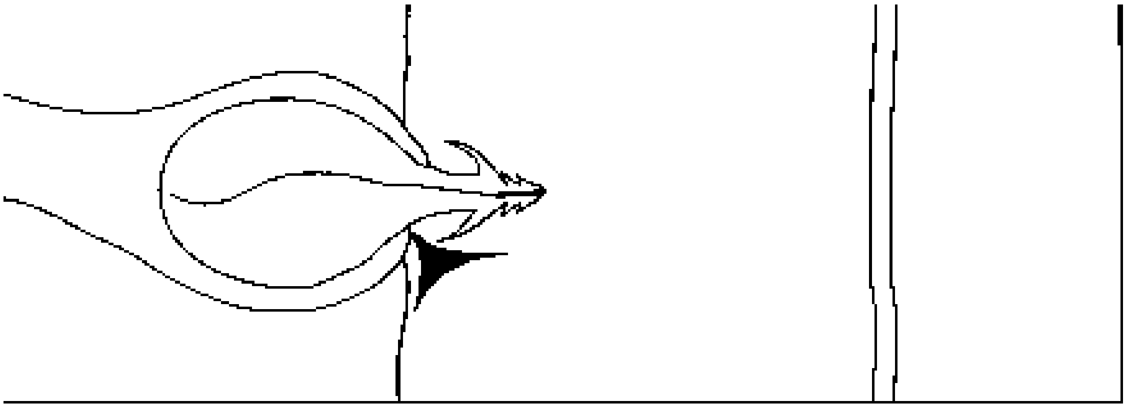
When this trigger is stimulated by <u>both</u> chemical and tactile stimuli, it allows the lid of the nematocyte to open (Figure 2).

Figure 2 – the opening of the operculum, or lid



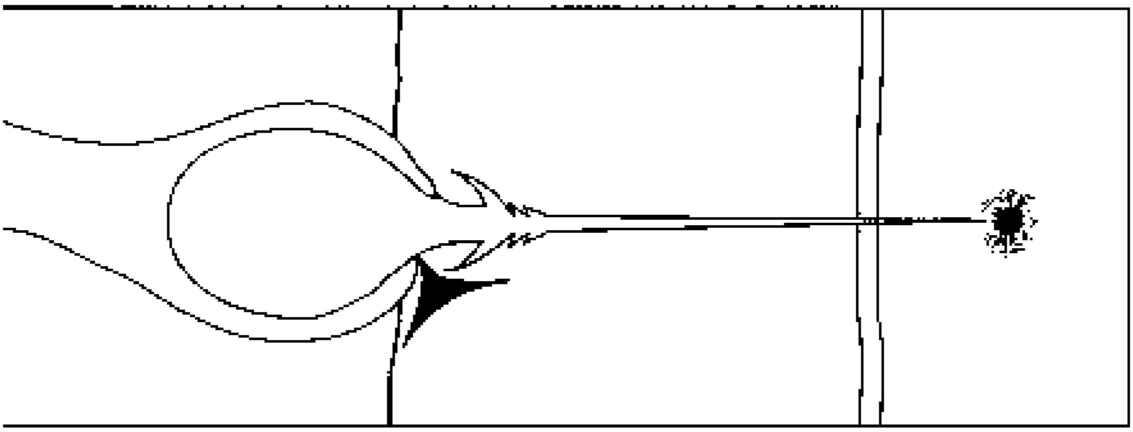
The thread tube then everts itself in milliseconds, driving through the integument of its victim. The first part of the tube to emerge has `butt’ spines. These lock into the outer layer of the integument, giving the thread tube a stable base to rapidly pierce the integument with tremendous force (Holstein and Tardent 1984), comparable to a missile penetrating an armour-plating (Burnett, in Williamson *et al* 1996, p.132).

Figure 3 – the eversion of the thread tube



The length of the thread tube is usually sufficient to reach the dermis in normal human skin where envenomation occurs (Figure 4). However, the skin on the palms of the hands or the soles of the feet may be sufficiently thick to prevent the full trajectory of the thread tube from reaching the underlying dermis, thus averting envenomation.

Figure 4 – nematocyst envenomation



Venom is contained within the actual nematocyst. Thus the whole thread tube is bathed in venom, both on the inside and outside of the thread tube. Both animal experiments and actual histological sections from post-mortem skin have now demonstrated thread tubes piercing micro blood vessels (Rifkin & Endean 1988). As the tube is everting itself venom is present on the outside of the thread tube. When it pierces a blood vessel, even a tiny capillary, venom can be introduced directly intra-vascularly, presumably accounting for the rapid onset of symptoms including unconsciousness and respiratory or cardiac arrest on the beach, within minutes of a massive chirodropid envenomation.

Further venom is then extruded through the end of the hollow thread tube where it is deposited in the dermis, presumably to be collected by lymph vessels, thus reaching the blood stream more slowly. No data exists on how the venom is absorbed and circulated in human victims.

The nematocysts (comprising the `cnidom') of *Chironex fleckeri* have been extensively investigated (Hartwick *et al* 1980; Rifkin & Endean 1983 & 1988; Endean 1988). Studies have also looked at the nematocysts of *Chiropsalmus quadrumanus* (Calder & Peters 1975) and the Australian population of *Chiropsalmus quadrigatus* (Kingston & Southcott 1960; Kinsey 1986) but no other chirodropid to date.

3.3.2 Factors influencing envenomation

When a *Chironex fleckeri* tentacle is contracted, it is similar to the appearance of the layers of the human dermis with the nematocysts in approximate `banks' of three (Figure 5). When the tentacle makes contact with the victim, although most nematocysts inject venom, others act like `grappling irons' and pull the tentacle closer and closer to the skin, bringing in the second and third layers of nematocysts, causing an increase in envenomation - the longer that the tentacle is in contact with the skin, the greater the envenomation. This influences the first aid treatment, especially of chirodropids, as prevention of this effect by removal of the tentacle, or chemical treatment to inactivate remaining nematocysts will reduce the overall envenomation.

Figure 5 - Nematocysts in `banks’ three deep in contracted chirodropid tentacle - the nematocysts are the long, thin, mauve-coloured cells in the top of each “flower” arrangement seen in the figure (photo ex R. Hartwick)

When a chirodropid is feeding, swimming through the water "fishing" for its prey, the tentacles are fully extended (relaxed) and may be up to ten times the length of the contracted tentacles (up to 3 metres in length in the adult *Chironex*). This presents only one layer of nematocysts. Thus most of the nematocysts are potentially available to cause envenomation and may cause a more severe envenomation. Unfortunately many human envenomations occur when people enter the water too quickly, where in very shallow water the chirodropid may be feeding, swimming along with tentacles extended, yet almost totally invisible. Such entanglement with these extended tentacles may cause extensive human envenomation with rapid demise.

However, with such envenomation many of the tentacles start to contract – a normal response from the jellyfish to “pull” its “prey” closer to the stomach. This mixture of tentacle contact makes the severity of envenomation difficult to predict from the skin marks. Rubbing or handling the tentacles, or the use of incorrect or inappropriate chemical solutions on adherent tentacles in a vain attempt to prevent further nematocyst discharge, will actually cause discharge and lead to greater envenomation (Lumley *et al* 1988)..

Other factors that influence the amount of venom injected: -

- the closeness of contact between the skin and the nematocysts - body hair can prevent the tentacle `locking on’ effectively to the skin. The thickness of the skin (keratin) in the stung area also has an influence on the envenomation – e.g. tentacles can be picked off the skin with the fingers, as the pads of the fingers and the palm are usually too thick for the nematocyst thread tube to be able to penetrate fully. This way only a harmless prickling effect will be felt. This is often seen in envenomation of children, who will usually stand in the water where they are stung trying to pull the tentacles off. Their forearms and backs of the hands are stung, thus increasing the envenomation, whereas the hands do not usually suffer stings. This too has a bearing on the recommended first aid management, as the first line of treatment is the retrieval of the child from the water and restraint of the hands, trying to prevent further envenomation.

- The number of nematocysts in the "fire-ready" position (Rifkin & Endean 1988). In *Chironex*, and possibly all cubozoans, the nematocysts are held in place by a special `basket’ of cells. These can lift the nematocyst to the surface so that the `trigger’ is exposed and the nematocysts can discharge when it touches any prey.

This basket can also retract the nematocyst so the `trigger' is not exposed, and discharge cannot take place. For discharge to occur both chemical and tactile stimuli must be present, this being a mechanism to prevent needless discharge of nematocysts against inanimate objects (ie not food) in the water. This effect is probably centrally controlled by a `nervous system' in the jellyfish (Rifkin 1988).

- The length of time since the animal last fed (Rifkin, in Williamson *et al* 1996, p.159). This again, may be a nervous control preventing needless depletion of nematocysts, or possibly that previously discharged nematocysts have not yet been replaced.

- Other possible effects that have been suggested are the water salinity (Barnes 1966), the available food supply (Hartwick 1987), and the physiological state of the animal at the time (Endean 1988).

3.3.3 Speed of envenomation

The amount of venom injected is divided into millions of tiny doses deposited over a large area of tissue, allowing faster local absorption. This is in contrast to the large amount of venom deposited, mainly at one tissue site, by a biting venomous animal e.g. sea snakes.

Multiple nematocyst envenomation presents a huge surface area of venom for absorption through the microvasculature already damaged by the toxin injected. Victims have collapsed and died on the beach within 3-4 minutes of major envenomation in the absence of effective resuscitation (Lumley *et al* 1984). This speed of absorption will also be increased by vigorous skeletal muscle contraction in the stung limbs (the "muscle pump" effect), which often occurs in an unrestrained victim distraught and running or rolling around with the savage pain. This also has a bearing on the first aid treatment suggested, which states that the victim should be restrained, to prevent such activity, and also to the suggestion for compression immobilisation bandages, if there is sufficient time, and sufficient personnel.

The first aid treatment for chirodropid envenomation covers both children and adults stung when it states that victims should be “retrieved and restrained” and a compression immobilisation bandage applied over the stung area (after previous nematocyst inhibition with vinegar dousing for 30 seconds to inactivate remaining, unfired nematocysts).

In major stings, high or lethal blood levels of venom may develop within a few minutes of chirodropid envenomation. This has been shown both in Australia (Maguire1968; Williamson *et al* 1980; Lumley *et al* 1988; Currie *et al* 1992) and other areas of the world (Bengston *et al* 1991). It is a particular problem in children (Williamson 1983; 1985a) because of their correspondingly smaller body mass compared to the amount of venom injected, and possibly because of their thinner skin.

The speed of the clinical onset of systemic effects is faster than can be explained by simple subcutaneous absorption of venom and is probably due to many nematocyst thread tubes puncturing small vessels under the skin causing direct intra-vascular venom injection, as described above.

3.3.4 Assessment of tentacle contact

The extent of tentacle contact on the skin can help correlate with the victim's clinical condition. The following factors can be used to assess the extent of contact (Fenner *et al* 1989): -

- Total length of tentacle marks. These can be measured using a tape or piece of string. The smaller the victim, the greater the risk (Williamson 1983). An eighteen-month-old aboriginal child died in the Northern Territory of Australia in February 1996 from just 1.2m of *Chironex* tentacle contact.

- Width of tentacle marks. This gives an idea of the size of the chirodropid involved, and the likely total dose of venom. A tentacle width greater than 6mm indicates a large, adult animal and is associated with several fatality reports (Barnes 1966; Williamson, in Williamson *et al* 1996 p.275).

- The area stung - eg. any sting occupying the equivalent body surface area of equal to, or greater than, one half of one limb (upper or lower and fully encircled) is potentially a serious threat to the victim (Fenner *et al* 1989).

Any sting that produces impairment of consciousness and/or disturbances of heart action, heart rate, breathing, or circulation must be treated as potentially life threatening, irrespective of the apparent sting size (Lumley *et al* 1988; Fenner *et al* 1989). It is also important to realise that if a sting victim who was loudly distraught and physically active suddenly becomes quiet, that it may be due to decrease in the level of consciousness from increasing systemic venom levels (Williamson *et al* 1980). This is aggravated by the prior muscular activity acting as a "muscle pump" effect (Williamson 1985a). Obviously, if resuscitation is necessary, it takes priority over any other aspect of the first aid or medical treatment.

Chirodropid venom exhibits both toxic and immunologic (including allergic) effects (Freeman 1974; Crone 1976; Williamson 1985a; Burnett & Calton 1987a). The toxic effects are clinically important but the antigenicity of the venomous components has enabled an antivenom to be made for use in *Chironex fleckeri* envenomation (Barnes 1967).