fashion to that caused by the muscle relaxant, suxamethonium. No fasciculation has been described in Irukandji stings to my knowledge and so this mechanism is only a remote possibility.

THE PLAN

ON THE BEACH

1. Early recognition of possible Irukandji stings is important. The minor nature of both pain and skin reaction immediately following the sting makes this difficult. Once recognised, it is claimed that resting the skeletal muscle may decrease the severity of the subsequent pain.

2. Vinegar application is indicated to inactivate any unfired nematocysts.

3. Seek medical aid as soon as generalised pain commences.

IN HOSPITAL

1. Pain relief by narcotic analgesics has usually been necessary. It gives good relief but needs to be maintained for up to 48 hours. A continuous infusion is the most effective mode of administration.

2. High blood pressure may need treatment. I would start treatment with an alpha-adrenergic blocking drug. eg. IV chlorpromazine in 5-10 mg increments. If a more powerful effect were required, I would use a direct vasodilating drug such as hydrallizine. Phentolamine has also been used.

3. No other effective treatment has been described.

DIRECTION OF RESEARCH

Research will not be easy because the animals are not common, and large numbers will be needed to obtain sufficient venom for study. It is not even certain which animals to collect if a group of small jellyfish can all cause a similar clinical picture!

Once the venom is available, then all of the research so far done on the venom of Chironex fleckeri will need to be repeated on the new venom. This will take a considerable time unless our methods of catching the animals improve. Clinical documentation of all of the effects observable in victims is important. The stinger phone and associated initiatives are a move in this direction and after a few years we may have a better idea of the range of effects caused by the Irukandji stinger.

We are at the beginning of the jellyfish story as it applies to its effects on victims. The full elucidation of the story will require:

1. Hard work by researchers in the field and in the laboratory.

2. Funding for that research.

3. Some luck or serendipity to shorten what will otherwise be a long haul.

It may take a considerable time, but it will be well worthwhile in the end.

Dr Vic Callanan's address is Director of Anaesthetics and Intensive Care, Townsville General Hospital, TOWNSVILLE QLD 4810, Australia.

Advice about jellyfish envenomation and its treatment can always be obtained via the National 24-hour toll-free Stinger Phone 008-015-160.

TOXIC REACTIONS TO INJURIES CAUSED BY THE SPINES OF THE CROWN OF THORNS STARFISH (ACANTHASTER PLANCI)

PJ Moran and J Williamson

SUMMARY

Information relating to the toxicity of the crown of thorns starfish, Acanthaster planci is presented. Examples are given of the different types of reactions which may occur following injury by the spines of this animal. Whilst the severity of the reactions tend to vary widely, they generally include; mild to severe pain (which may last from days to weeks), oedema, erythema enlargement of lymph glands and vomiting. The pattern of symptoms exhibited by patients may depend on the extent of the injury, the sensitivity of the patient to the toxin or toxins and the particular starfish. Responses of an allergic nature, involving extensive oedema and later itchiness, have been reported and these may cause discomfort and may last for several weeks. Present treatments are useful in relieving, over the short term, the pain experienced by some patients and preventing the onset of secondary infections. While the toxin responsible for these sometimes severe reactions has not been identified. One suggestion is that it may contain a neurotoxic component and even possess anti-coagulant properties.

INTRODUCTION

The crown of thorns starfish, Acanthaster planci, which has been recorded from many reefs throughout the Indo-Pacific region, is one of the most well known of tropical marine animals. Unlike animals such as the box jellyfish, Chironex fleckeri its notoriety does not stem from its ability to cause injury and the death of humans but rather its propensity to occur in large aggregations (commonly called outbreaks) which can cause the death of extensive areas of coral.[1] However, it is generally not known (particularly by the public) that the spines of this starfish are capable of producing a toxic reaction(s) which may be worrying to victims.

Acanthaster planci was first reported in the scientific literature by Rumphius in 1705[2] and classified by Linnaeus in 1758.[3] Several papers around that time made reference to the toxic nature of this starfish. Madsen,[4] in reviewing these sometimes conflicting reports, concluded that it was not known whether the animal was itself toxic as such wounds may have become infected. Concurrent with the first documented outbreaks in the late 1950's and early 1960's, further reports of the toxic nature of Acanthaster planci came to hand. In general, these reports reinforced the view that specimens of Acanthaster planci were capable of not only inflicting

a painful wound but of having a toxic effect on victims.[5,6,7]

The aim of this paper is to draw on more recent information to discuss several aspects of the toxicity of Acanthaster planci. These include descriptions of: its morphology and habitat (directed towards defining the potential danger that this animal poses to people who use the Great Barrier Reef); its spines; its toxicity; the symptoms experienced by victims; treatment of patients. To date these topics have not been extensively discussed elsewhere and a knowledge of them may be helpful in treating both the physical and emotional needs of victims.

MORPHOLOGY AND HABITAT

Acanthaster planci (Figure 1) is a carnivorous starfish which has been reported on reefs only in the Indo-Pacific region. At the beginnings of outbreaks individuals normally range in size from 250 to 350 mm in diameter,[8] although starfish up to 700 mm in diameter have been reported.[9] This makes it one of the biggest, and potentially most dangerous, starfish in the world.

It is multi-coloured and individuals may vary from purplish blue with red tipped spines through deep red with orange tipped spines, which is the normal colour variation on the Great Barrier Reef, to green with yellow tipped spines.[10] Adults normally possess from 9 to 23 arms, or rays, which may be up to 150 mm in length.

Studies on the distribution of this animal have indicated that adult specimens prefer more sheltered environments such as lagoons and leeward slopes, and deeper water, more than 3 m, on the windward slopes of reefs.[9] During outbreaks they threaten the well-being of both recreational and professional divers. As large numbers of adults, and more recently juveniles, have been reported periodically in shallow water, generally when the weather conditions are calm, they constitute a danger to people, eg. tourists walking on the reef. They may also be a hazard occasionally to fishermen as individual starfish have been dredged up in nets from deep water between reefs.[9]

SPINES

Acanthaster planci is easily recognised in the field by the plethora of large, sharp spines which cover much of its body (Figure 1). There are about 6 different types of spines on the aboral (upper surface) and oral (lower surface) surfaces of this starfish and these have been described by Caso.[11] Studies using a scanning electron microscope have revealed that each spine is composed of a single crystal of magnesium calcite, of porous structure, which makes it relatively strong but light in weight.[12] Those projecting from the

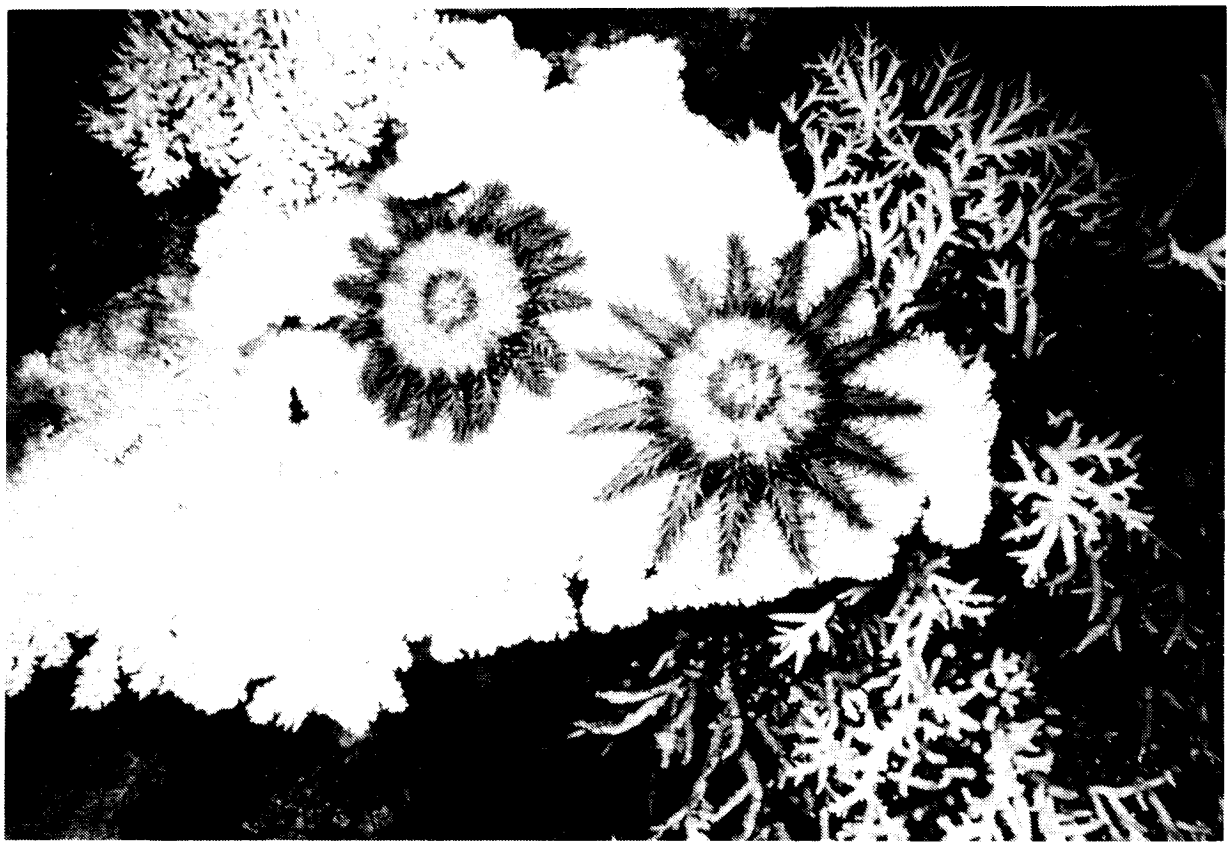

Figure 1. The crown of thorns starfish on recently killed coral (white area).

upper surface of the starfish, are the largest and may be up to 40 to 50 mm in length. All the spines are articulated at the base (diameter 1 to 2 mm) and are extremely sharp, their tips have three raised edges which assist in "cutting" through tissue.[12] Therefore the spines are able to penetrate wet suits, heavy gloves and other underwater protective clothing. Extreme care should be taken whenever handling, or in close proximity to a specimen of Acanthaster planci. Figures 2, 3 and 4 show a recent injury from a crown of thorns starfish spine.

TOXICITY

Contrary to general opinion, there is no evidence to suggest that a toxin or venom is actively injected into a victim after being wounded by a spine.[13] A number of potentially toxic compounds have been isolated from the tissue overlying the spines.[14,15] All form part of the group of compounds termed saponins which are derived from steroids and are known to be toxic to a variety of marine organisms.[13] At present it is not known whether the symptoms shown by patients are a direct result of these compounds. Studies concerned with isolating and identifying such chemicals have indicated that they may be present in insufficient quantities to cause these sometimes severe reactions.[14] Despite not knowing what causes these reactions, it has been suggested that the toxin or toxins would probably act in a neurotoxic manner,[16] although this has not been confirmed as yet. Results from other studies have indicated that reactions to injuries from Acanthaster planci may be the result of a series of different processes. For example, crude extracts of material isolated from the surface of spines have been demonstrated to have a haemolytic effect on human red blood cells.[17] In addition, other studies have indicated that the inflammation that may occur around a wound may be mediated by the activities of histamine-like compounds.[17] Given the copious flow of blood which may come from the relatively small wounds produced by spines, it would appear that the toxin involved also has anti-coagulant properties.[16]

SYMPTOMS

There are now a number of reports[4] concerning the injuries sustained by people who have come in contact with a crown of thorns starfish. These date back to 1705. Two conclusions can be drawn on the information now available. Firstly, the majority of injuries occur on the fingers, hands and feet of individuals. Secondly it would appear that while this starfish is indeed toxic the reactions of victims may be quite variable.

The first, and often most severe, symptom recorded by victims who have been injured by a spine is pain, which is usually felt immediately after the injury. Reports suggest that the pain can be very intense and may be likened to a burning sensation.[16] This, often throbbing, sensation may last for several hours after which it fades to a dull ache. Multiple punctures or wounds into joints may prolong this period of more intense pain. Injuries experienced by PJM to the side of a knee and to the tip of a finger were still very tender and uncomfortable (Figures 2, 3 and 4) for about a month after they occurred.

Severe injuries involving multiple punctures may result, not only in intense pain, but also nausea and protracted vomiting. The latter may continue for several days. In such cases, localised suppuration may occur.

Reports also indicate that the wound turns a purplish blue colour soon after an injury has been sustained. Often this grows larger and is surrounded by an area of tissue which is light red in colour.[18] This region of erythema may persist for several days if not weeks. This may cause some victims to think that a portion of spine has remained in the wound. In addition to erythema, some victims may suffer from extensive oedema. Multiple punctures to a hand or foot may result in oedema occurring over the entire surface. This condition may last for up to a week during which time the wounds may leak serous fluid, numbness of the extremities may be felt[16] and swelling of the lymphatic glands may occur.[8] In such cases, victims

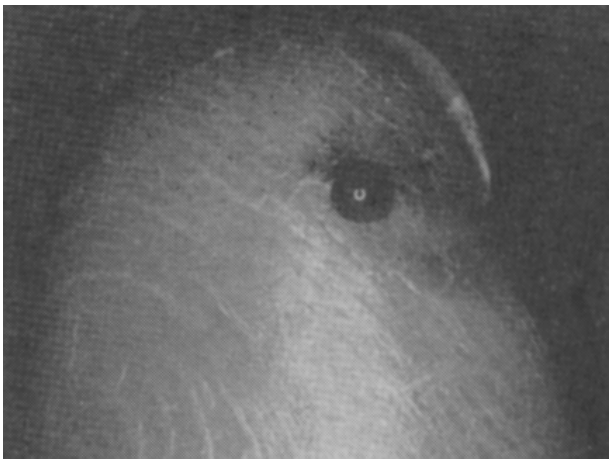

Figure 2. Injury to finger from crown of thorns starfish spine showing bleeding entry wound on pulp.

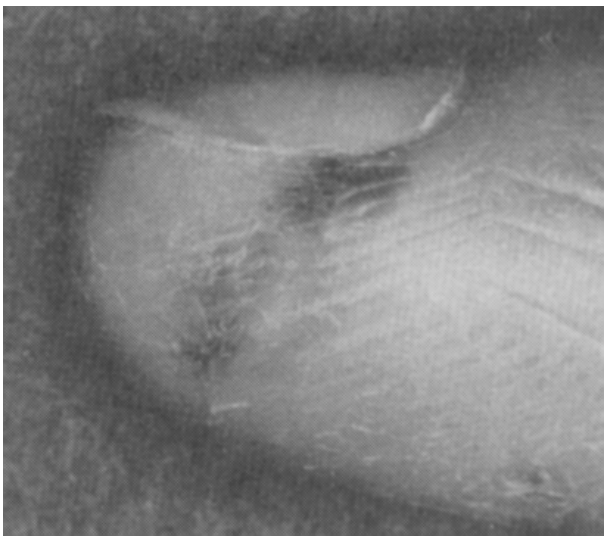

Figure 3. Injury to finger from crown of thorns starfish spine (side view).

Figure 4. Injury to finger from crown of thorns starfish spine seen from above.

also may find it difficult to move the injured limb and the area around the wound may become extremely itchy whilst the oedema persists. These symptoms, experienced by PJM, suggest that certain susceptible victims respond in an allergic manner to injuries from the crown of thorns starfish. Odom and Fischelmann[16] have suggested that there was even the potential for anaphylactic reaction in susceptible persons.

It should be emphasised that victims may differ quite widely in their reactions to injuries from crown of thorns starfish. This is probably for a number of reasons. Firstly, it depends on the site and extent of the injury that is sustained. Secondly victims appear so display differing sensitivities to the toxin or toxins present in the starfish. Finally, the animal itself may differ in its ability so produce a toxic reaction in victims. For example, observations indicate that injuries from small starfish are not nearly as painful or uncomfortable as those from much larger specimens.

TREATMENT

Despite the fact that injuries caused by the crown of thorns starfish may be distressing there are no treatments presently available (ie. specific antivenoms) which are effective in neutralising the symptoms experienced by a victim. The most useful measures have been listed recently by Williamson[19] and are the same as those used to treat stonefish injuries. The experience of PJM is that submerging the wounded area in hot water (or cold water) somewhat relieves pain for short periods of time (up to an hour). Application of antihistamine creams or similar topical drugs did not appear to alleviate any of the symptoms (particularly oedema and itchiness). Longer term relief of pain may be obtained using more potent analgesics. As the starfish produces a mucus over its exterior, it is necessary to wash the wound carefully and to check whether any fragments of spine are still embedded in it. A xeroradiograph of the injury should be performed if it is suspected that spine fragments have been retained in the wound. These treatments are necessary to reduce the occurrence of secondary infections. Apart from treating the physical symptoms apparent in patients it is also important to alleviate their concern, given that the reactions may be severe and occur over relatively long periods of time.

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The address of Dr Peter Moran, PhD is Australian institute of Marine Science, Cape Ferguson, PMB2, TOWNSVILLE QLD 4810, Australia.

Dr John Williamson's address is MSO Box 5695, TOWNSVILLE QLD 4810, Australia.

IMMUNOLOGY AND JELLYFISH VENOMS

John Williamson

Jellyfish envenomation is a worldwide occurrence, producing effects ranging from mild local skin irritation[1] to rapid endotoxic[2] or less commonly, anaphylactic death.[3]

TOXIC REACTIONS

Jellyfish venoms are complex mixtures of polypeptides and enzymes, structurally akin to the venoms of snakes, insects and spiders, that are pathogenic to man by toxic or antigenic mechanisms. That the principal clinical reactions to jellyfish envenomation appear to be toxic, rather than allergic, is suggested by the following evidence:

(a) no immune resistance has so far been reported

(b) repeated stings cause no difference in symptoms

(c) venom injections into different mammals induce similar clinical results

Most human toxic reactions are also characterised by a direct correlation between the total venom dose (ie. size of the sting) and the severity of the clinical effects. Such toxic reactions include:

immediate skin pain with tentacle contact
acute inflammatory skin reactions, up to actual skin death and scarring
localised and regional tissue oedema
regional lymphadenopathy
muscle pains
vomiting
breathing distress
impairment of consciousness
respiratory failure

Other severe documented effects that have been labelled as toxic are:

gangrene
haemolysis
renal failure
myocardial failure

Modern immunological research techniques are beautifully applicable to the study of both the toxic and allergic mechanisms of jellyfish venoms. The techniques include:

skin biopsy
immunofluorescence
radioallergosorbent test (RAST)
enzyme-linked immunosorbent assay (ELISA)
immunochromatography using monoclonal antibodies

Using such techniques, the following information has been revealed to date:

1. Partially purified extracts from the venoms of Hair Jelly (Cyanea capillata), Portuguese Man-O'War (Physalia physalis), Sea Nettle (Chrysaora quinquecirrha) and the Northern Australian Box jellyfish (Chironex fleckeri) have demonstrated cardiotoxicity to spontaneously beating cultured chick cardiocytes.[4,5]

2. The cardiotoxic components of venoms from Physalia physalis, Chrysaora quinquecirrha and Chironex fleckeri have their actions significantly intercepted by the presence of the calcium antagonist verapamil.[6,7]

3. The composition of some jellyfish venoms may alter with the climactic seasons of a single year.[8,9]

4. Several common world jellyfish venoms (Chrysaora, Physalia and Pelagia noctiluca (Mauve Stinger)) generate antibodies in humans that exhibit some cross-reactivity; further, it appears that the venoms of Chrysaora and Physalia, the brown recluse spider (Loxosceles reclusa), and purified cholera toxin all share common antigenic sites.[9,10]

ALLERGIC REACTIONS

It is of interest that the scientific study of allergic disease actually began with the use of coelenterate protein,[11] when Pertier and Richer in 1902 induced anaphylaxis in dogs with injections of coelenterate venoms. Despite this early clue, over the ensuing decades repeated documentation and apparent contradiction occurred concerning so-called "harmless" jellyfish stings from different parts of the world, and the "unexpected" systemic nature, severity, and/or persistence of the clinical effects. It was really only with the demonstration in the serum of stung patients, of immune-specific and cross-reacting antibodies to Chrysaora and Physalia venoms taken from the Atlantic Ocean, in 1980, 1981 and 1983,[12,13,14] that the allergenic potential of jellyfish venoms was given