

Venomous Fish Injuries along the Israeli Mediterranean Coast: Scope and Characterization

Simcha Gweta MA¹, Ehud Spanier PhD¹ and Yedidia Bentur MD²

¹Department of Maritime Civilizations and Recanati Institute for Maritime Studies, University of Haifa, and ²Israel Poison Information Center, Rambam Health Care Campus and Rappaport Faculty of Medicine, Technion-Israel Institute of Technology, Haifa, Israel

Key words: venomous organisms, marine, fish, toxic, fishermen, southeastern Mediterranean

Abstract

Background: Due to extensive activity at sea, certain human populations, especially fishermen, are exposed to direct contact with the sea's inhabitants, including dangerous marine animals.

Objectives: To characterize and assess the extent of injuries caused by marine organisms along the Mediterranean coast of Israel, their type, severity and the medical treatment given.

Methods: Data were obtained from a survey on injuries from marine organisms conducted among professional fishermen along the Mediterranean coast of Israel and from medical records reporting toxicological consultations provided by the Israel Poison Information Center.

Results: Injuries caused by marine organisms are not rare in Israel, but most cases are not severe. The most common injuries reported by fishermen were caused by stingrays (30%), weever fish (22%), rabbit fish (13%), and marine catfish (10%) – a new Red Sea immigrant. Most fishermen tend to treat such injuries themselves and sought medical help only when an unknown venomous fish was involved. Most cases of severe toxicity were due to secondary infection. Data from the IPIC indicated that 64% of the calls were from the general public and the rest came from physicians in health care facilities. Four sources of injuries were identified: cleaning and preparing fish for consumption, during leisure water sport activities, handling marine aquaria, and fishing. Most cases from the IPIC were graded as minor severity (85%) and were treated symptomatically.

Conclusions: We recommend that medical facilities be installed at the fishing anchorages and that a separate category be established for injuries by marine organisms to facilitate epidemiological data collection from health care facilities.

IMAJ 2008;10:783–788

has been an increase in the number of admissions to emergency departments of injuries caused by marine animals [3]. Yet, very limited research has been done around the world to estimate the extent of these injuries inflicted by marine organisms. One of the few examples was the attempt made in the state of Victoria, Australia, to analyze 205 cases according to data collected from 23 emergency departments [4]. It was found that fish (including stingrays) constituted the taxonomic group causing the highest rate of injury (62.9%). In the Australian study 8.3% of the cases required hospitalization, and most of the injuries occurred as a result of sport and leisure activities (65.9%). Such a survey has not been done in Israel so far. Thus, the aim of the present study was to assess the prevalence of injuries caused by marine animals along the Mediterranean coast of Israel and to describe the medical aspects of the injuries in order to identify causes of hazard and recommend strategies of prevention.

Methods

To characterize and estimate the scope of injuries caused by marine organisms, the sampled human populations that were chosen were in constant contact with the various marine dwellers. Data originated, therefore, from two sources: a) professional fishermen along the Israeli Mediterranean coast, and b) medical records of people who sought medical consultation at the Israel Poison Information Center, Rambam Health Care Campus, Haifa, following injuries by marine animals. Due to the absence in emergency departments and hospitals of a separate category (e.g., ICD-9-CM) for injuries caused by marine organisms, obtaining data from these medical sources was not feasible.

Survey among fishermen

During the 2 year period 2003–2004, 79 cases of injuries by marine organisms were collected from professional fishermen in the following anchorages (from north to south): Acre (n=11), Kishon (Haifa) (n=23), Nahsholim (n=11), Jaffa (n=14), and Ashdod (n=20). The cases are not confined to a certain period, neither are they confined to venomous creatures but encompass all injuries that professional fishermen sustained due to marine organisms during fishing activities. The fishermen from whom the information was obtained, the fishing anchorages and the interview days were chosen at random. Arrival time was early in the morning, when the fishermen at the anchorage were preparing the nets for the next day.

Dangerous marine organisms have always posed a challenge to maritime and coastal human societies such as fishing communities. Marine organisms that can be potentially dangerous to humans are typically classified into three functional categories [1]: venomous, poisonous, and those that bite and scratch. Venomous organisms are those capable of producing venoms in specialized tissues or glands that are connected with application structures (e.g., stings), unlike poisonous creatures that usually produce poisons in non-specialized tissues or accumulate them after ingestion of a prey or algae and may be dangerous to people who consume them [1,2]. In recent years, owing to the increased use of skin and scuba diving as leisure activities there

IPIC = Israel Poison Information Center

The survey was based on a questionnaire that referred to the following:

- Personal details, fishing methods, geographical data, and the time of injury.
- Medical aspects: a description of the clinical manifestations, the intensity of the pain, and the severity of the incident. Pain intensity was estimated according to the Visual Analogue Scale [5], where a painless injury is marked as 0 and intolerable pain as 10. To grade severity of the incident a weighted number was adjusted to each level of severity adapted according to definitions by Watson et al. [6]: no effect = 1, i.e., the injured person is asymptomatic and has not developed any clinical manifestations as a result of the exposure; minor effect = 2, i.e., the injured person developed slight manifestations that rapidly disappeared and left no marks on the body; moderate effect = 3, i.e., the injured person developed manifestations that persisted for a short time (usually hours) or were more systemic in nature, some form of treatment was necessary, but the symptoms did not pose a life threat and the injured person did not become disabled; and major effect = 4, i.e., the injured person developed life-threatening symptoms or signs that caused irreversible effects and left the person with a disability. Severity of the incident was also assessed by the need to refer the patient to a health care facility, time elapsed from injury to reach medical care, length of hospital stay, and medical treatment given.
- Identification of the injuring species, to the highest taxonomic category possible, by the fisherman, assisted by photographic guide books of dangerous marine organisms [7-10]. Kruskal Wallis and Wilcoxon statistical tests (using normal approximation) were used to detect if there were significant differences (level of significance 5%) in the pain severity of the injuries among the following categories: secondary infection, weever fish, stingray, rabbit fish and marine catfish.

Israel Poison Information Center

This part of the study used a retrospective poison center chart review methodology. Approval was attained from the Institutional Review Board of Rambam Health Care Campus, Haifa. All IPIC consultations are provided by specialized physicians. Data are recorded on a comprehensive structured form that includes caller and patient demographic details, site and circumstances of exposure, time until consultation, clinical manifestations in a system-oriented approach, evaluation (including laboratory confirmation of exposure whenever possible), treatment and follow-up recommendations. At the end of the consultation, the clinical toxicologist grades the severity of poisoning as asymptomatic, minor, moderate, major, or death, according to previously published criteria [6]. The exposure and causative agents are classified according to a previously prepared list of categories of the IPIC. Subsequently, all data are entered and stored in a database designed for it, using Access 2002 (Microsoft Corporation, USA) on an SQL server. All records are subjected to routine quality control.

The IPIC is the national poison center of Israel and the only one serving both the general public and health care facilities 24 hours a day. IPIC data are based on self-reporting. All medical records that fall under the category of biological agents ("Biological") and a classification of marine creatures ("Aquatic") between 1 January 2003 and 31 December 2004 were retrieved from the database using a computerized query followed by a manual search and retrieval. Altogether it includes 306 cases: 107 in 2003 and 199 in 2004. These particular 2 years were randomly chosen. Data pertaining to the callers, patients, exposure to the marine creature, clinical manifestations and treatment were abstracted into an electronic spreadsheet (Excell, Microsoft Corporation, USA). A computerized query of the distribution of the offending marine creature between 1997 and 2004 was also performed. All IPIC data were subjected to descriptive analysis. Chi-square analysis was performed where relevant. This method of data collection and evaluation has been previously published [11-13].

Results

Survey among fishermen

The venomous fish most frequently involved in the 79 cases of confirmed injuries were stingrays (30.4%), the most frequent of which was the common stingray (popular name in Israel: "zatrukha"), *Dasyatis pastinaca* (59% of the stingray cases) [Table 1]. This was followed by weever fish (popular name in Israel: "brouli"), *Trachinus* spp., rabbit fish (popular name in Israel: "aras"), *Siganus* spp., and the stripped (eel) sea catfish, *Plotosus lineatus*. Envenomation was the highest (80.5%) in comparison with other injury categories (secondary infection 11.5%, bites 3.9% and injuries by electric fish 3.9%, causing a weak electric

Table 1. Distribution of marine organisms involved in injuries to Israeli fishermen

Organism (popular name in Israel)	No. of cases	% of cases
Stingray ("zatrukha")	24	30.4
Weever fish, <i>Trachinus</i> spp. ("brouli")	17	21.5
Rabbit fish, <i>Siganus</i> spp. ("aras")	10	12.7
Stripped sea catfish, <i>Plotosus lineatus</i>	8	10.1
Shark ("karish")	3	3.8
White grouper, <i>Epinephelus aeneus</i> ("locus")	3	3.8
Mediterranean moray, <i>Muraena helena</i> ("morena")	2	2.5
Scorpionfish (Scorpaenidae) ("akrab")	2	2.5
Crab ("sartan")	1	1.3
Flathead grey mullet, <i>Mugil cephalus</i> ("bouri")	1	1.3
Bullet tuna, <i>Auxis rochei</i> ("palamida")	1	1.3
Oilfish, <i>Ruvettus pretiosus</i>	1	1.3
Greater amberjack, <i>Seriola dumerili</i> ("intias," "arichola")	1	1.3
Grey triggerfish, <i>Balistes carolinensis</i> ("abu Khanzir")	1	1.3
Jellyfish ("meduza")	1	1.3
Orange fire worm, <i>Eurythoe complanata</i> ("tolaat zhookhit," "Fiberglass")	1	1.3
Unidentified organisms	2	2.5
Total	79	100

shock and a momentary lack of sensation with no clinical symptom except for mild anxiety). Clinically, most of the reported injuries were of moderate (53%) or minor severity (29%). There were, however, also cases of major injuries (9%) where the injured person was left with a disability (such as loss of a finger, a permanent severe scar, inability to bend a finger) and 9% with no effect at all. Most fishermen did not seek professional medical treatment (a combination of concern regarding the response of the social security authorities, hope that the injury will heal spontaneously, as in the past, and perhaps also a "macho" attitude), and tend to treat these injuries themselves (59%). Only 28% of the injured fishermen went to hospital. Nine percent of the cases turned to community clinics for medical assistance, 3% to private physicians and 1% obtained medical consultation by phone (from private physicians or medical clinics and occasionally from the IPIC). Examination of the possible association between the mean weighted severity of pain (adapted according to Watson et al. [6]) and the group of injuring fish indicated that the greatest pain severity was caused by secondary infection (3.0 ± 0.83), stingrays (2.83 ± 0.62), *Plotosus lineatus* (2.6 ± 0.50), *Trachinus* spp. (2.57 ± 0.50) and *Siganus* spp. (2.17 ± 0.73). Kruskal-Wallis test comparing the weighted degree of severity of injuries in the above five groups indicated a significant difference between at least two of the groups (DF=4, chi-square = 0.0003). Wilcoxon two-sample test indicated no significant difference between the weighted degrees of pain severity caused by secondary infection and injuries by stingrays ($Z=2.817$), between secondary infection and *Trachinus* spp. ($Z=0.0129$), between secondary infection and *Plotosus lineatus* ($Z=0.0551$), between *Siganus* spp. and *Trachinus* spp. ($Z=0.0481$), between *Plotosus lineatus* and *Trachinus* spp. ($Z=0.8395$), between stingrays and *Plotosus lineatus* ($Z=0.0477$) or between *Siganus* spp. and *Plotosus lineatus* ($Z=0.0690$). There was, however, a significant difference between the pain severity caused by the secondary infection and injuries caused by *Siganus* spp. ($Z=0.0027$), between stingrays and *Siganus* spp. ($Z=0.0003$) as well as between stingrays and *Trachinus* spp. ($Z=0.0063$). The fishermen reported maximum intensity of pain (intensity of 9–10) in 11 cases of injury by stingrays, 9 cases by *Trachinus* spp., 4 by *Plotosus lineatus* and one case of injury by *Siganus* spp. Among injuries by *Trachinus* species the maximum average pain intensity was reported for *T. draco* (8.1), followed by *T. radiatus* (7.8) and *T. araneus* (7.6). The most common injured parts of the body were, in all fish species, the hands – the injury occurring while releasing the fish yield from the nets. There were also injuries in the legs (from stepping unintentionally on fish thrown on deck), mainly stingray (9 cases), *Trachinus* spp. (2 cases), and *Siganus* spp. (one case). There was also one reported case of injury in the chest, by a stingray. Hospitalization exceeding 10 days was reported in

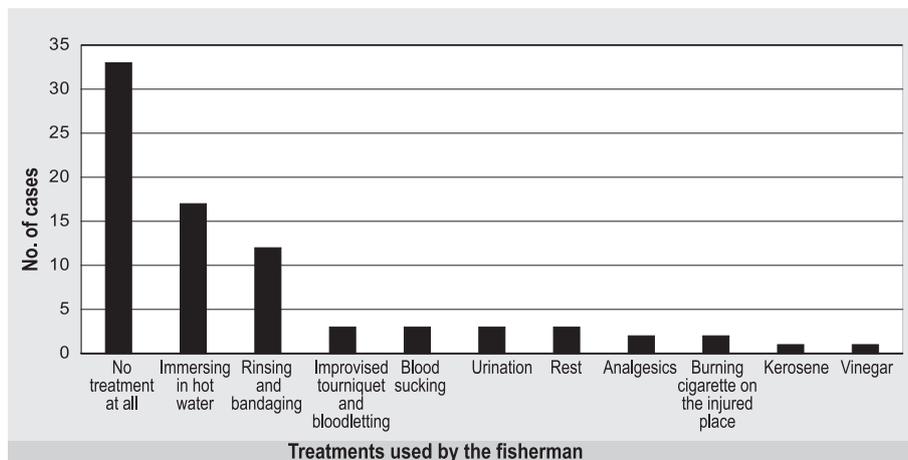


Figure 1. Compilation of the various fishermen's self-treatment following injuries by marine organisms.

three cases of secondary infection associated with injuries and in one case of injury by a stingray, *Dasyatis pastinaca*. The distribution of the actual treatments reported by fishermen is presented in Figure 1. The most common treatment was immersing the injured organ in hot water (mostly taken from the cooling system of the vessel engine) and an initial rinsing and bandaging of the injured area. Some of the treatments employed by the fishermen were considerably different from those recommended in professional medicine books, including urinating on the location of the sting, burning it with a lit cigarette, immersing it in kerosene and vinegar, and bloodletting and blood sucking. The latter are treatments described in historical sources [14]. Fishermen did not often use analgesics, in spite of suffering fierce pain.

Israel Poison Information Center data

Analysis of the IPIC database for the years 1997–2004 indicates that most referrals to the Center were due to injuries by various fish, followed by jellyfish [Table 2]. According to the survey data (years 2003–2004) it appears that the circumstances of injuries by marine and aquatic animals can be broadly divided into four main categories: injuries as a result of cleaning and preparing fish for consumption (52%); those associated with leisure activities at the seaside such as swimming, diving, surfing, etc. (39%); injuries as a result of handling aquaria (4%); and fishing (4%). The most common fish in the first category were St. Peter's fish (popular name in Israel: "musht"), (cichlids – *Tilapia* species and similar genera) (72 records), the carp (popular name in Israel: "carpion"), *Cyprinus carpio* (20 records), and the gilthead sea bream (popular

Table 2. Distribution of injuries by marine organisms as reported to the Israel Poison Information Center between 1997 and 2004

Marine organism	1977	1998	1999	2000	2001	2002	2003	2004
Jellyfish	40	25	44	52	41	39	24	30
Fish	102	93	102	79	89	71	62	132
Unknown	20	21	20	17	9	18	21	37
Total	162	139	166	148	139	128	107	199

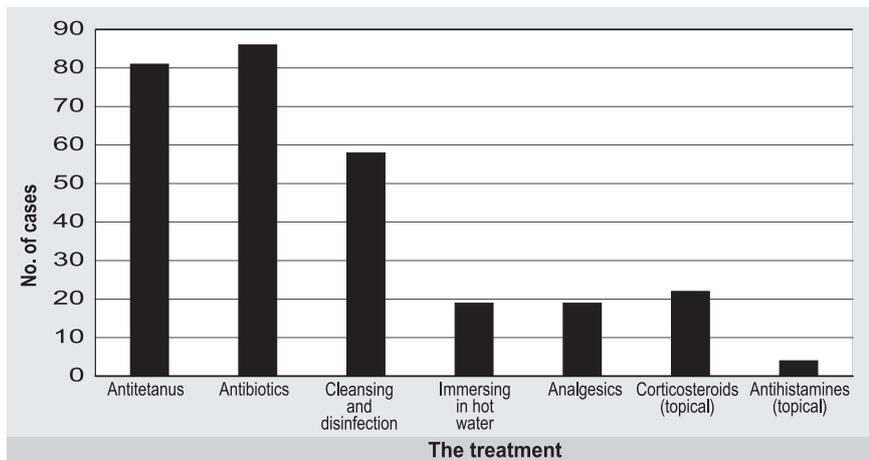


Figure 2. Treatments for injuries by marine organisms recommended by the Israel Poison Information Center

names in Israel: "Denis," "chipura"), *Sparus aurata* (12 records). In 64% of the cases, the request for consultation came from the general public, in comparison with 36% referred to by health care professionals (physicians 33%, nurses 2.6%, veterinarians 0.3%, medics 0.3%). The age of the patients was > 18 years in 76.1% of the cases, and 13–18 years, 6–12 years and < 6 years in 7.5%, 6.9%, and 3.3%, respectively. Age was unknown in 6.2% of the cases. Injuries associated with leisure activities at the seaside appeared in all age groups though in different frequencies, while most injuries occur among people aged 25–44. This age group also represented the highest frequencies of injuries associated with handling aquaria, fishing and preparing fish for consumption. The latter category was also fairly common among the age group 45–64 years. Frequency of injuries increases from the age group 0–5 years to the age group 25–44 years and then declined towards the age group > 65. Most injuries were concentrated in the three age groups of adults between the ages of 18 and 64. However, the rate of moderate injuries (the more severe category in the present survey) reported was high for the age groups 6–12 and 25–44 years. In 55% of the cases consultation with the IPIC was conducted within 2 hours; in 9.5%, 16.4% and 12.1% consultations were held within 2–8 hours, 8–24 hours and > 24 hours, respectively. Of injuries associated with preparing fish for consumption 62% consulted the IPIC within less than one hour from the injury compared to only 22% of injuries associated with leisure activities at the seaside. The opposite relationship was observed regarding delayed consultation (more than 24 hours after the injuries) when the first category was represented by 7% and the second by 40%. The severity of marine injuries reported to the IPIC was graded by the clinical toxicologists as minor in 85.6% of the cases; 5.2% were graded as asymptomatic severity, 2.6% as moderate and 6.5% as unknown. No significant association was found between the distribution of severity and the time elapsed until consultation with the IPIC. Distribution of the various treatments recommended by clinical toxicologists is presented in Figure 2. In case of stinging by venomous fish, immersing the injured limb in hot water appears to be a common treatment.

Marine injuries accounted for 0.73% of total poisoning exposures reported to the IPIC, compared with 5.15% of injuries inflicted by terrestrial organisms. Injuries inflicted by marine organisms were responsible for 12.4% of all animal injuries recorded. The distribution of severity was similar in marine and terrestrial organisms (88.2% and 90.5% symptomatic victims, respectively).

Discussion

The present study is a first attempt to assess the extent of injuries caused by marine organisms along the Israeli Mediterranean coast and to characterize them, based on the data collected. It appears that injuries caused by marine

organisms in our region are a relatively common occurrence. Most of the cases reported by the fishermen were of moderate severity, few were graded as major severity, and most cases resolved without any medical intervention. Based on the IPIC database it appears that most of the cases were of minor severity. Although this possibly reflects the true severity, it might also underestimate it as consultations could have been held before clinical manifestations reached their peak effect. It should be noted, however, that the data of the American Association of Poison Control Centers also show that most exposures to marine organisms are of minor severity [6].

The fishermen are in daily contact with marine organisms, some of which are potentially harmful, especially fish. The group of fish that inflict the most injuries are stingrays, of which *Dasyatis pastinaca* is at the top of the list in the present study. Stingrays are considered the most common group of fish causing venomous injuries to humans at sea [15], occasionally with a fatal outcome (e.g., the tragic recent death of popular Australian wildlife celebrity Steve Irwin [16]). For example, along the east coast of the USA, *Dasyatis americana* is considered the venomous organism most frequently injuring humans. Relatively severe clinical manifestations were actually reported following a secondary infection as a result of stinging by fish that were not necessarily venomous such as the Bullet tuna (popular name in Israel: "palamida"), *Auxis rochei*, the Grey triggerfish (popular name in Israel: "abu Khanzir"), *Balistes carolinensis*, the white grouper (popular name in Israel: "locus"), *Epinephelus aeneus*, and the flathead grey mullet (popular name in Israel: "bouri"), *Mugil cephalus* [15]. In most cases they were injuries that were not treated in time and were assumed to heal without treatment but often became complicated and were defined as a major effect. In cases of secondary infection, hospitalization may be longer, with irreversible damage due to delay in seeking or providing medical care, or due to a rapidly progressive course of the infection. In three of the secondary infection cases among fishermen in our study, hospitalization was longer than a week, unusual for injuries by marine organisms. In one case of infection the fisherman stepped on the venomous sting of a stingray

tail after it had been thrown on the sand, probably resulting in secondary contamination. In some cases it may be hard to differentiate between the inflammatory or toxic effect of the venom and that of the infection, resulting in delayed antibiotic treatment. The relatively small number of patients in the IPIC data precludes drawing any conclusion regarding the association between time elapsed until consulting the clinical toxicologist and the severity of the injury.

Injuries resulting from attacks or bites by a shark, or the Mediterranean moray eel, *Muraena helena*, were reported less often than injuries as a result of penetration of venom or an infection. These findings agree with those of a similar study conducted in Australia [4]. Some fishermen who had been injured by marine animals in the past reported that every year, mainly in winter, the pain recurs, although less intensely. This phenomenon is also referred to in the professional literature [17]. Most fishermen tend to treat these injuries themselves and only in extreme cases that require treatment in the emergency department do they seek medical help. The number of cases in which fishermen turned to clinics is relatively smaller than those in which they sought treatment in hospitals. These may support the assumption that fishermen seek medical care only in emergencies and sometimes too late. Their tendency to avoid professional medical care can be explained by their impression that the first stage of the injury is mild and might resolve spontaneously, absence of medical insurance, and possibly, fear of reporting to the authorities. The most common treatment practice by fishermen is hot water immersion. This is a common and effective treatment in case of a sting by a venomous fish, which is recommended also in the professional literature [3,7]. It refers to a temperature of 42–45°C, for 30–90 minutes. Halpern and colleagues [18] claim that hot water immersion is efficient but there might still be a need to supplement it with an analgesic. The IPIC practice is to use hot water immersion in every case involving a venomous fish, in addition to topical treatments, antitetanus and antibiotics, as required. The latter is sometimes used prophylactically [19], mainly for wounds suspected to be contaminated with the virulent *Vibrio* bacterium. Another study indicated that hot water immersion was effective in 73% of the cases, especially when supplemented with an analgesic and appropriate antibiotics [20].

In most cases, the injured organs are, as expected, the hands – the organs with which the fishermen sort the yield. However, in the case of stingrays, a chest injury was reported as well. Feet injuries are commonly associated with weever fish and stingrays. The relatively high number of such injuries by the latter may stem from fishermen's custom to put these fish on deck, and they get stung as they move around without due care. One of the fish that the fishermen reported recently is the striped sea catfish, *Plotosus lineatus*. This venomous fish migrated from the Red Sea into the Mediterranean, probably via the Suez Canal, in the process known as Lessepsian migration [21], and has established stable populations in the southeastern Mediterranean. It was actually first sighted in 2001 [22], but Israeli trawl fishermen reported a rise in the prevalence of injuries and concern over their severe effects only from 2003–2004 and onwards. Most

injuries from this economically worthless fish occurred when the fishermen removed them from the catch with unprotected hands. The intensity of pain inflicted by this fish was high, sometimes described as intolerable and causing the fishermen to seek medical attention.

Limitations of the study included its retrospective design, inability to access all fishermen, possible recall bias of fishermen and their tendency not to seek medical attention, and reliance of the IPIC on self-reporting. These limitations are common to similar previously published studies, especially poison center studies. Since this is the first study of its kind in Israel, it is hoped that it will stimulate prospective studies and lead to defining a special ICD-9-CM code for marine injuries, thus enabling a better understanding of the scope of this problem.

Conclusions

The number of injuries caused by marine organisms does not constitute a significant morbidity problem. A wide variety of marine organisms was involved and in a range of injury circumstances. Most of the cases were clinically graded as minor. However, injured fishermen tend to treat themselves without medical advice, and hence in some cases complications may ensue. A considerable and significant part of the injuries stem from the penetration of a foreign body, which causes an infection, a complication that should be considered in every case of injury by marine organisms. Thus it is imperative to offer early and adequate medical aid. Special care must be taken to remove every part of the venomous spine that was left in the body of the injured person, without further tissue damage. Hot water immersion is suggested in venomous marine injuries by fish but not jellyfish, sea urchins and other invertebrates.

Installing proper medical facilities in the main fishing anchorages should be considered. Effective educational activities on this subject among professional fishermen are necessary. In order to assess the extent of the phenomenon of injuries by marine organisms objectively, there is a need to maintain an organized database. Until today no separate category existed for injuries by marine organisms, neither in the various hospitals and emergency rooms nor in the ICD-9-CM coding system. Therefore it is impossible to detect those cases of injury that were admitted to emergency departments and not reported to the IPIC. Such a database will supplement the IPIC database and provide a more accurate perspective on the extent and severity of the problem.

Acknowledgment: This research was partially supported by the Maurice Hatter Fellowship for Maritime Studies to S. Gweta.

References

- Spanier E. Dangerous marine organisms in the coastal waters. In: Nezer Y, Epstein Y, eds. The Way Out, the Skill to Survive. Tel Aviv: Israel Ministry of Defense Publishing Office, 1987:235–74 (Hebrew).
- Russell FE. The Venomous and Poisonous Marine Invertebrates of the Indian Ocean. Enfield, NH: Science Publishers Inc. 1996: 1–14.

- Atkinson PRT, Boyle D, Hartin D, Mcauley D. Is hot water immersion an effective treatment for marine envenomation? *Emerg Med J* 2006;23:503–8.
- Taylor D, Ashby K, Winkel KD. An analysis of marine animal injuries presenting to an emergency department in Victoria, Australia. *Wilderness Environ Med* 2002;13:106–12.
- Persson HE, Sjoberg GK, Haines JA, Pronczuk de Garbino J. Poisoning severity score. Grading of acute poisoning. *J Toxicol Clin Toxicol* 1998;36:205–13.
- Watson WA, Litovitz TL, Klein-Schwartz W, et al. 2003 annual report of the American Association of Poison Control Centers Toxic Exposure Surveillance System. *Am J Emerg Med* 2004;22(5):335–404.
- Edmonds C. Dangerous Marine Creatures, Field Guide for Medical Treatment, Flagstaff (AZ): Best Publishing, 1995:1–90.
- Halstead BW. Poisonous and Venomous Marine Animals of the World. 2nd revised edn. Princeton, NJ: Darwin Press, 1988:1–40, 701–1029.
- Halstead BW, Auerbach PS, Campell DR. A Colour Atlas of Dangerous Marine Animals. Ipswich, UK: Walfe Medical Publication, W.S. Cowell Ltd., 1990.
- Golani D, Darom D. Handbook of the Fishes of Israel. Jerusalem: Keter Publishing 1997:108–230.
- Bentur Y, Cohen O. Dipyron overdose. *J Toxicol Clin Toxicol* 2004;42(3):261–5.
- Bentur Y, Raikhlin-Eisenkraft B, Lavee M. Toxicological features of deliberate self-poisonings. *Hum Exp Toxicol* 2004;23(7):331–7.
- Bentur Y, Raikhlin-Eisenkraft B, Galperin M. Evaluation of antivenom therapy in *Vipera palaestinae* bites. *Toxicon* 2004;44(1):53–7.
- Mettler CG, Mettler FA. History of Medicine, Philadelphia: Blackstone, 1947.
- Auerbach PS. Wilderness Medicine: Management of Wilderness and Environmental Emergencies. 3rd edn. St. Louis: Mosby, 1995.
- Clark R, Girard R, Rao D, Ly B, Davis D. Stingray envenomation: a retrospective review of clinical presentation and treatment in 119 cases. *J Emerg Med* 2007;33(1):33–7.
- Dekker CJ. Chronic pain and impairment of function after a sting by the great weever fish (*Trachinus draco*). *Ned Tijdscht Geneesk* 2001;145(18):881–4.
- Halpern P, Sorkine P, Raskin Y. Envenomation by *Trachinus draco* in the eastern Mediterranean. *Eur J Emerg Med* 2002;9(3):274–7.
- Meyer PK. Stingray Injuries. *Wild Env Med* 1997;8:24–8.
- Isbister GK. Venomous fish stings in tropical northern Australia. *Am J Emerg Med* 2001;19(7):561–5.
- Spanier E, Galil BS. Lessepsian migration: a continuous biogeographical process. *Endeavour* 1991;584(3):102–6.
- Golani D. The Indo-Pacific striped eel catfish, *Plotosus lineatus* (Thunberg, 1787), (Osteichthyes: Siluriformes) a new record in the Mediterranean. *Sci Mar* 2002;66(3):321–3.

Correspondence: Dr. E. Spanier, Dept. of Maritime Civilizations and Recanati Institute for Maritime Studies, University of Haifa, Mt. Carmel, Haifa 31905, Israel.
Phone: (972-4) 824-0782
Fax: (972-4) 824-0493
email: spanier@research.haifa.ac.il