

Reef aquariorily: a hobby for everyone? How an adequate knowledge of *Pterois volitans*' behavior and welfare can avoid risks and accidents

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Abstract. *Pterois volitans* (Linnaeus, 1758) is one of the most appreciated fish in the common reef aquariology but, unfortunately, a potentially dangerous subject due to its venom glands, which can cause injuries and envenomations. This study relays on the recording of injuries in Italian hobbyists/caretakers/retailers, enabling us to evaluate the most dangerous steps during the management of the fish. By recording *P. volitans* behavior both in aquarium and in the wild, the authors postulate that prevention of injuries in aquariology must start from the knowledge of territorial and feeding behavior of this species, and stress the revision of Italian law in order to make sellers much more responsible about *P. volitans* management and welfare, as necessary protective measures for sellers, public and buyers.

Key Words: Scorpaenidae, envenomation, aquarium fish behaviour.

Resumen. Nell'allestimento di acquari tropicali, una delle specie più ricercate ed apprezzate è senza dubbio *Pterois volitans* (Linnaeus, 1758), un pesce tanto bello quanto potenzialmente pericoloso, poiché possiede ghiandole velenose con le quali può infliggere lesioni più o meno gravi. Lo studio si è prefisso lo scopo di valutare il numero di incidenti da *P. volitans* occorsi in Italia in hobbisti, tecnici di zoo-acquari e rivenditori, con una anamnesi che ha permesso di identificare i maggiori fattori di rischio legati alla gestione delle vasche. In particolare, la conoscenza del comportamento predatorio e territoriale di *P. volitans*, valutato dagli autori sia in cattività, sia in condizioni di libertà, può rappresentare la chiave principale per la prevenzione del rischio. Gli autori si augurano che la legge italiana venga rivisitata allo scopo di rendere i venditori e/o personale che gestisce gli acquari maggiormente responsabili sulla gestione etologica della specie, come misura di protezione sia per loro stessi che per i visitatori e gli acquirenti.

Key Words: Scorpenidae, veleno, comportamento pesci ornamentali.

Rezumat. *Pterois volitans* (Linnaeus, 1758) este unul dintre cei mai apreciați pești ai acvaristicii marine, dar, din nefericire, un potențial pericol datorită glandelor sale otrăvitoare, care pot cauza răni și înveninări. Studiul de față prezintă cazurile de rănire înregistrate la hobby-iștii, îngrijitorii și vânzătorii italieni, permițându-ne să evaluăm cei mai periculoși pași în managementul acestui pește. Observând specia *P. volitans* din punct de vedere comportamental, atât în acvariu cât și în sălbăcie, autorii postulează că prevenirea rănilor în acvaristică trebuie să înceapă cu înțelegerea comportamentului teritorial și de hrănire al speciei și propun revizuirea legislației italiene în vederea obligării vânzătorilor să fie mult mai responsabili în managementul și bunăstarea speciei *P. volitans*, ca o măsură necesară de protecție a vânzătorilor, a publicului larg și a cumpărătorilor supuși riscului.

Cuvinte cheie: Scorpaenidae, înveninare, comportamentul peștilor de acvariu.

Introduction. In the last few years, aquariology gained an important role inside the pets' world; indeed, being the availability of the modern and easy-to-use technical products considerably grown, it turned to real that even people with poor or null specific expertise could approach this charming hobby, otherwise hardly successful. As regards such a subject, and although freshwater aquariums still hold a leading role, a remarkable new impulse from the media (e.g., the Disney cartoon "Nemo") has facilitated a raising diffusion of home tropical reef aquariums, thus increasing the request for invertebrate organisms and tropical sea fish. Among these fish, one of the most appreciated species

belongs to the order Scorpaeniformes, family of Scorpaenidae, genus *Pterois*: *Pterois volitans* (Linnaeus, 1758).

The genus *Pterois* includes twenty-three species (Froese & Pauly 2009), among which the *P. volitans* is almost exclusively commercialized within the ornamental aquariology as a "red" or "common" lionfish. This fish, reaching up to 35-40 cm in total length, inhabits the reefs in the Indo-Pacific Ocean and the Red Sea (Sutherland & Tibbals 2001).

Unfortunately, the steady strong commercial request for the *P. volitans*, justified by its remarkable beauty, clashes with the fish's potential risk: being a venomous fish indeed, the *P. volitans* secretes a venom from specialized glandular structures, with distinct venom glands and venom ducts, and is equipped with traumatogenic devices (spines) to deliver those noxious substances. The venom can be injected by the thin plugs placed in the upper part of the eighteen rays forming the dorsal, anal and pelvic fins (Saunders & Taylor 1959) (Fig. 1): it can be extremely harmful, since it should cause immobilization or death of a prey or a predator. In mice, the LD50 from a *P. volitans* was estimated to be 42.5 µg/kg body weight (Balasubashini et al 2006); in humans, the consistent accidents and poisoning case events, due to the stings, are not only possible in scuba divers but also in hobbyists. The injuries can cause various physical consequences, even the subject's death which, although extremely rare, has however been recorded (Halstead 1988).

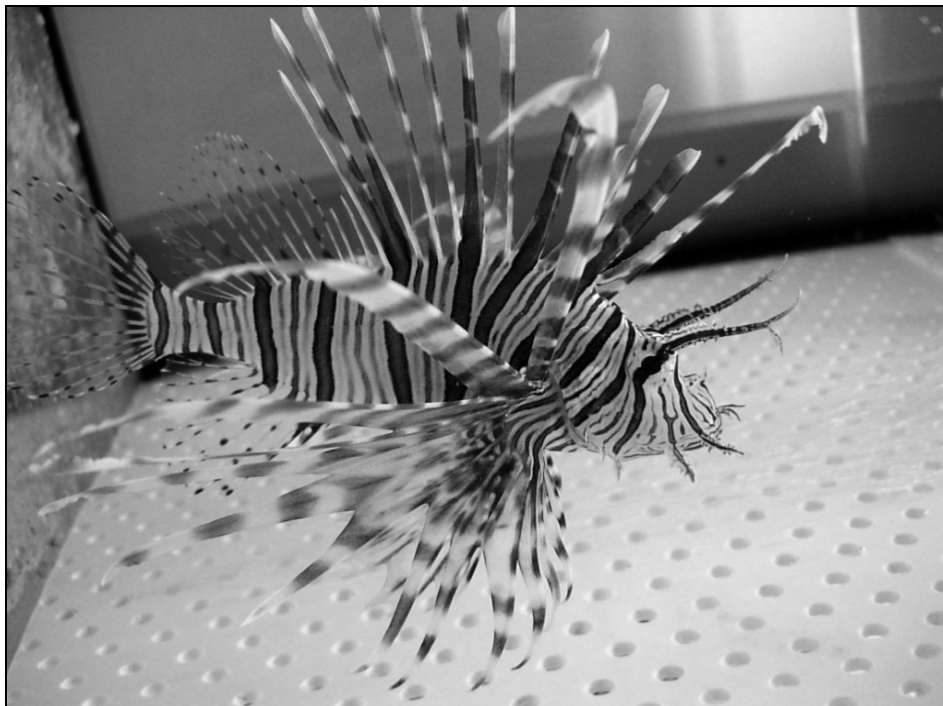


Figure 1. A specimen of *Pterois volitans* showing wide dorsal, pelvic and anal fins with venomous stings (Arbuatti 2009).

Thanks to the support of a few main national associations of aquariology, zoos-aquariums and the main Italian websites devoted to such a subject, this study considers the Italian episodes of accidents linked to a *P. volitans*, aiming at evaluating, besides any medical consequence, the echo-ethological causes that give rise to the behavior of this species, together with an analysis of the possible criteria for injuries prevention in hobbyists, aquarium caretaker, veterinarians and keepers.

Material and Method. The echo-ethological measurement of *P. volitans* behavior was carried out by observing eleven subjects housed in local aquarium shops and one in the authors' tank, as well as by analyzing some video supports from scuba divers in order to

compare lionfish in captivity and in the wild. Then, the location of injuries was considered. In brief, by asking the main associations of Italian aquariology, ten zoos-aquariums and the major Italian aquariology websites, we were able to reach an audience as wide as possible; in effect, such a choice had a tactical value, being the aquaristic groups widespread across all the national regions as well as the websites daily visited by thousands and thousands of hobbyists (the hypothesis was that few traumatic injuries caused by a *P. volitans* could certainly have happened among this audience and, therefore, they could have been brought to light). Each recorded, wounded person was reached by phone or by e-mail and was asked to fill and send back a questionnaire about his own accident experience. The evaluation grid included the following items: year when the injury occurred, age, sex, and type of work, main parameters of the tank, gestures and hand position during the attack, anatomic stung area, first aid applied, symptomatology (type and length) and required hospitalization. Finally, these people were further reached by phone or in person when more information was needed.

Results and Discussion. During the data collection, no report was sent by zoos-aquariums regarding lion fish accidents. On the contrary, among the hobbyists, eight cases of envenomation were found, starting from the mid-1980s to 2008 (Table 1). All these people were males, ageing from 27 to 60; four out of eight were owners of aquarium shops (cases 3, 5, 6, and 8), with three of them being stung during their own routine practice, and the fourth (case 8) wounded at home; the other three occurrences concerned private hobbyists at home (cases 1, 4, and 7), while the last one was a fish shop assistant (case 2). In the cases we recorded, the tanks housing *P. volitans* were of different water capacity: two of them were 50 L tanks with no reef or any other environmental enrichment, used for selling fish only; all the others were definitive tanks from 120 to 400 L.

All the occurrences of this survey were stung on hands – in particular, cases 1 and 8 on the right thumb and the right middle finger respectively. Injuries often occurred during the common aquarium management – namely, the **hand feeding** of fish (cases 2, 3, 5, and 6) or the tank cleaning (case 7); in case 8, the attack took place while removing a dead fish from the water, and in case 1 while placing an anemone on a rock. In case 4 only, the accident occurred when the owner was handling the fish into a net to move it into another tank.

First aid commonly included topical application of a heat source (Atkinson et al 2006), but this self-medication was not applied in cases 3, 4, and 8; as regards the other five occurrences, it included the use of hot water or a cigarette, both placed close to the fish's spines contact. The clinical signs of *P. volitans* injuries were similar in all the cases examined: indeed, intense but localized symptoms such as erythema, acute pain, heat, and tissues' hypersensitivity in and all around the wounded area were recorded.

These clinical reports are commonly classified as "first grade" injuries in a medical scale used for the grading of the localized wounds caused a by *P. volitans* (Vetrano et al 2002).

Symptoms lasted variably, from 30 min (case 5) up to 7 days (case 2). Only three hobbyists needed hospitalization (cases 3, 4, and 8), but it must be kept in mind that none of them had previously applied a correct first aid; as a consequence, they needed a short-time hospitalization during which the patients have been clinically monitored and, in case 3, corticosteroids have been administered. In another case (1), the person reported a superficial pain that lasted for about one year together with a high sensibility in the hand and the arm affected, after the *P. volitans* aggression.

Table 1

Questionnaire submitted to Italian aquariology societies, zoo aquariums and websites

	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	CASE 6	CASE 7	CASE 8
Occurrence	2008	2006	2003	2000/01	1990	1988	1985	1985
Gender	M	M	M	M	M	M	M	M
Age	27	45	60	50	35	55	41	24
Position	private owner	shop assistant	retailer	private owner	retailer	retailer	private owner	retailer
Tank capacity	120 L	200 L	50 L	120 L	150 L	400 L	267 L	50 L
Action	reef placing	hand feeding	hand feeding	<i>P. volitans</i> transferring via fish basket	hand feeding	hand feeding	tank cleaning	dead fish harvesting
Affected area	right hand (thumb)	right hand (back)	right hand	hand	left hand	right hand	right hand	right hand
Self medication	warm water	cigarette	no	no	cigarette	cigarette	warm water	no
Symptoms	local phlogosis	local phlogosis caustication arm tremor	local phlogosis	local phlogosis panic attack	local swelling	local phlogosis	local phlogosis	local phlogosis
Length	2 days	7 days	2 days	Not remember	30 min	5-6 hours	Not remember	Not remember
Hospital	no	no	yes	yes	no	no	no	yes

Conclusions. The wide spreading of aquariology, together with the growing easiness to buy imported subjects of *P. volitans*, give rise to some important considerations about the correct management of this species, above all if the potential risk of injuries is considered. The first aspect to analyze, actually, is the possible hazard of wounds caused by the contact with a series of fin stings having, on their upper parts, little protuberances working as syringes. Each of these injectors – 13 in the dorsal, 2 in the pelvic, and 3 in the anal fin – contains two little grooves connected to a venom gland (Morris et al 2008). As regards the effect, literature tells us that *P. volitans* venom produces dose-dependent and endothelium-dependent relaxation in porcine coronary arteries, that are potentiated by atropine, but are significantly attenuated by the nitric oxide synthase inhibitor NoLA (N^W-nitro-L-arginine) and the SFAV (the trade name of the stonefish antivenom raised in horses; Weiner 1959), or by the removal of extracellular calcium (Sivan 2009). Church & Hodgson (2002) suggest that *P. volitans* venom causes its own cardiovascular activity primarily by acting on muscarinic cholinergic receptors and adrenoceptors: as a matter of fact, since SFAV inhibits many *P. volitans* venoms responses, but does not attenuate the contractile response observed in porcine coronary artery, the presence of a non-proteinaceous component, that acts most likely on muscarinic receptors, is evident. On the other hand, evidence of the presence of acetylcholine in *P. volitans* venom had already been confirmed (Cohen & Olek 1989) but the presence of other transmitters in the venom cannot be ignored (Sivan 2009).

In our study, even though the accidents we analyzed showed mostly a local symptomatology, although sometimes really intense, the risk of *P. volitans* poisoning should never be underestimated, as the venom has proved to be able to cause, besides the local vesicles (Auerbach et al 1987), vomiting, fever, hypotension, and even rare cases of death (Halsted 1988).

The first self-aid is an important aspect that should always be administered after an injury by a *P. volitans*, and the immersion of the affected area in some water previously heated up to 45°C for a unspecified period of time, until the disappearance of local symptoms, should also be considered. This provisional medication is extremely useful, due to the heat-sensitivity of *P. volitans* poison, although some cases of ineffectiveness of this treatment have been reported (Vetrano et al 2002).

Among the data we collected, the wounded area of three cases (2, 5, and 6) came in contact with the heat exhaled from a cigarette, a choice that is not reported in literature and that probably may have worked just because of the scarcity of the inoculated venom.

The whole cases' history, together with a further accident occurred in a pet shop, that was not taken into account due to the lack of data, shows that, whenever a first self-medication was not applied, the subject was always forced to go to the hospital for indispensable treatments. American authors recommend, in case of most serious symptomatology, the patient to be hospitalized and careful monitored – especially if previously affected by other pathologies – X-rays of the injured area, tetanic toxoid administration and corticosteroids injections up to symptoms remission (Garyfallos et al 2005). The SFAV may be used in the clinical management of severe envenomation by a *Pterois* spp. (Church & Hodgson 2002).

According to our inquiry, a quite peculiar situation comes out: on the one hand, it can be noticed that the strong trading of this species is completely out of control; on the other, it could be concluded that almost all the affected subjects knew the self-aid treatment to be applied once the poison was injected, but they did not know the correct way to **prevent** the attacks. It is evident that the knowledge of the phylogenetic behavior of the animal could have prevented a reasonable number of accidents.

As a matter of fact, the biology of this species is peculiar: *P. volitans* shows, in the wild, typical nocturnal habits, although Meister et al (2005) reported that a couple of subjects released on the Atlantic coasts of the US not only adjusted themselves to the new surroundings, but were also able to breed and showed a considerable trend to move and hunt by daylight as well, as occurs in captivity. In the wild, adult subjects of *P. volitans* lead solitary life in the tropical reefs, where they establish their own territory. The social contact, normal for young lionfish that are accustomed to move in small

groups, is uncommon for grown-up individuals: however, it can only regard adult subjects during the mating period, when observing single, adult males with several females around becomes possible. During this time, the typical ceremonial of *Pterois* species (Morris et al 2009) reproduction, never obtained in captivity, can be recorded: the female – at first climbing towards the surface, then descending again – releases her eggs, quickly followed by the male that spreads the sperm onto the eggs; these are transported by the sea currents in pelagic habitats, where they will hatch and the young fish will grow until they return to the coral reefs (Wood 2007).

The reproductive period is also the best moment to recognize sexual differences in lionfish (otherwise not appreciable): a darker coloration of the vertical bands characterizes the male, while the female exhibits an increased abdominal mass together with a white-silver coloration of the ventral and pharyngeal areas (Wood 2007).

As regards the feeding behavior in the coral reef, *P. volitans*, being ichthyophagous, is placed on the top of the alimentary levels among the Actinopterygii fish. The lionfish mostly hunts starting from the sunset, when the activity of other fish species, reef invertebrates and crustaceans increases. The typical white and dark striped coloration allows a complete mimicry in the reef environment and this aspect, together with a slow swimming style and the use of the pectoral fins, make easier for *P. volitans* to approach the prey and, after a quick burst, to suck it into the mouth. In addition to this fishing, a surface hunt technique has been reported, with a subject catching little fish escaping from different predators (Fishelson 1975); in the wild, *P. volitans* can be described as “opportunistic” predators, being able to expand their stomach 30 times when piscine prey are plentiful and, on the contrary, to withstand starvation when food is scarce (Fishelson 1997; Morris et al 2009).

The subjects usually on sale in the aquarium shops are exclusively adults that have been captured while in the wild and then carried away from their natural coral reefs, by using chemical compounds which are discharged directly into the reef cracks; usually, only young animals are imported, but sometimes it is possible to find the grown-ups on sale as well (Balboa 2003).

Taking into account the etho-ecological needs of the lionfish and what we reported in this study, three typical dangerous situations for the hobbyists can be considered: i) territorial aggressiveness, ii) fearful aggressiveness, when the animal is unable to hide (this is particularly true both for young fish and for older subjects stressed by the capture in the wild), and iii) predatory attack during the **hand feeding**, that can be exhibited by subjects of any age, as far as it is similar to the hunting behavior. On the basis of our data this latter factor, since it regards the alimentary behavior, can be recognized as the main cause of injuries; however, in our investigation we have noticed that almost 40% of the cases of accident (three out of eight) occurred in moments different from the feeding time. As regards this specific issue, it can be stressed how the lack of knowledge and recognition of the behavioral response of *P. volitans* is more dangerous than the venom itself.

In our opinion, cases 1, 7, and 8 are attributable to the territorial and cryptic behavior of the species (Fishelson 1975): in fact, the habit of *P. volitans*, used to live in reef fissures, makes it possible to assume that the major risks are taken by keeping lionfish in tanks of small dimensions (for example, of 120 L) a model that unfortunately is becoming more and more widespread among the hobbyists or, worse, in tanks lacking of suitable enrichment as quarantine tanks. All these situations exponentially increase the possibility of an attack during the routine operations, when the hand of the hobbyist is seen as an intruder whose intentions are unknown and, therefore, elicit an aggressive, very fast, response of type i) and ii). The dynamics in the case 7 accident has been further verified by a phone interview: the owner reported he had paid no attention to the *P. volitans* because frightened by a specimen of *Murena* spp. living with him inside the reef aquarium. Therefore, the threatening behavior, which usually includes the spreading of all the fins and a slow approach close to the intruder, was not noticed and the person suffered the consequent injury. Referring to the third situation as described above, our investigation allowed us to confirm that the feeding time of *P. volitans* results the most

critical moment for the hobbyists, due to the typical hunting behavior of the fish, although the scarcity of data do not allow a statistical approach.

The observations recorded in pet shops, in our own aquarium, and thanks to the scuba divers' and video supports, showed that *P. volitans* exhibit a hunting behavior made up of three different stages: at first, there is a prey-searching, with the fish keeping his pectoral fins parallel to the seabed. Once the victim has been identified, the pectoral fins are raised to 90° respect the previous display to border them in a narrow space while the dorsal, anal and pelvic fins are simultaneously extended. This exhibition could be frequently seen in any aquarium, when *P. volitans* are feeding on alive food, or when the owner offers food by his own hand, as occurred in four out of the eight cases described in our paper.

The last phase of the hunting behavior shows that the *P. volitans* stops close to the prey, and then suddenly bends his pectoral fins caudally, and the attack follows at once. This is a topic phase, since at any moment the dorsal fin can strike the hand of the feeder. By virtue of this aspect, **hand feeding** results highly dangerous and should be avoided; on the contrary, live food to be dispensed into the tank, or the use of water pliers for direct feeding should be encouraged.

Considering that all the envenomation cases we studied derives from home aquarium and pet shops and not from zoos-aquariums, we suggest, without giving cause for useless alarmism, that only putting pressure on the retailers and makes them aware of their responsibilities, we can reach the target of an adequate ethological and managerial culture about *P. volitans*. Such information can be easily transferred to all the private buyers, thus correctly preventing injuries by lionfish. To deal with the harmful ignorance about *P. volitans* and other different marine creatures as dangerous as the lionfish, it should be necessary that all the local health authorities become involved in a complete informative program – for example, by printing posters for pet shops, organizing meetings or binding the sellers to attend training courses about the risks of housing poisonous species. If these goals could not be achieved via a correct informative campaign, it could be extremely desirable to make appropriate laws with the possible extent of such provisions to other aquatic animals different from the *Pterois* species as well.

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