APRIL 2006
www.cosmeticsbusiness.com

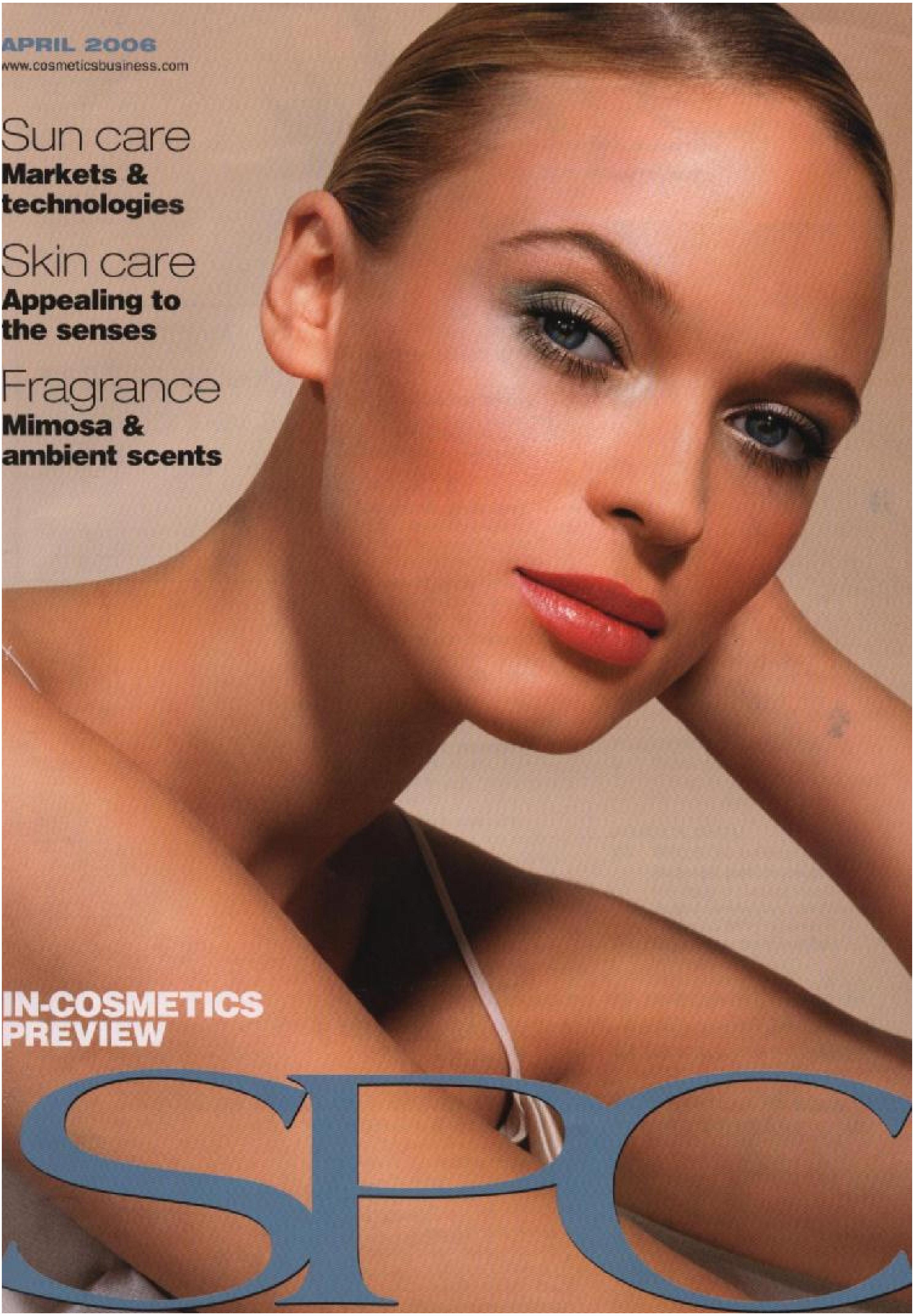
Sun care
Markets & technologies

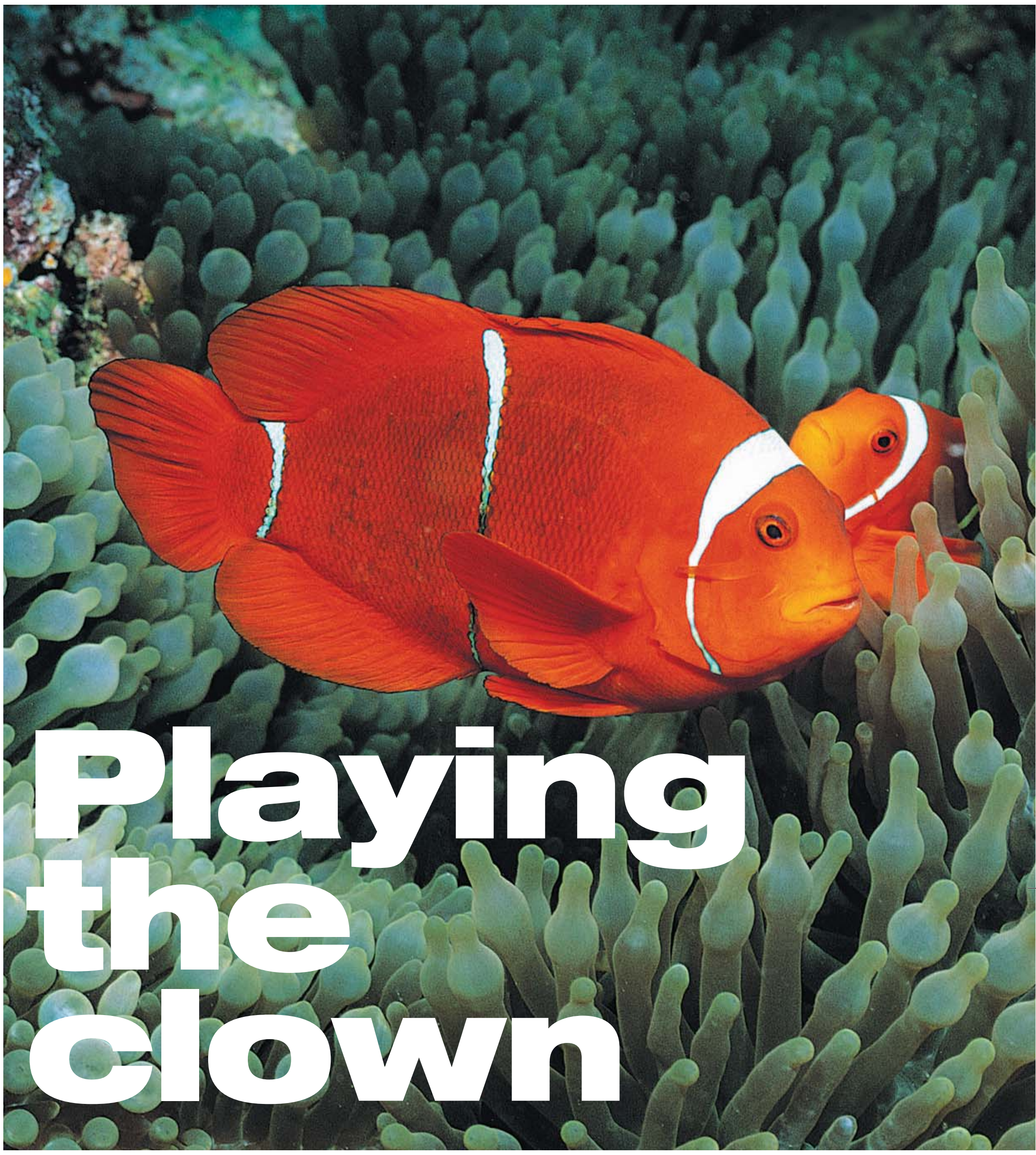
Skin care
Appealing to the senses

Fragrance
Mimosa & ambient scents

IN-COSMETICS PREVIEW

SPC





Playing the clown

A concept based on the understanding of the jellyfish stinging mechanism and clownfish protection is behind the development of dual sun/sting protection technology. Amit Lotan and Naomi Dahan explain how

The fear of jellyfish stings prevents many people from enjoying the thrill of the ocean. Over a million beachgoers face being stung by jellyfish along the east cost of the US alone. In Florida, for example, half a million people are stung annually in the area of Chesapeake Bay by thimble jellyfish, often called sea lice, which cause 'seabather's eruption'. The Mediterranean, the Caribbean and the Baltic as well as Australia, Latin America, the Pacific and Japanese waters are all infested with stinging coral and jellyfish (Figure 1 and Table 1).

Jellyfish sting symptoms range from annoying and slightly painful rashes to severe systemic afflictions and, very occasionally, death.

The objective of the study presented here is to describe a sunscreen formulation with technology that exploits biochemical mechanisms to neutralise the stinging of jellyfish tentacles and thereby inhibit jellyfish stings. Although jellyfish will still contact people whose skin has been coated with the sunscreen, the stinging mechanism of many tentacles will not be activated. The sunscreen is intended to diminish the intensity of, or prevent entirely, a stinging episode. It is not, however, an after-sting (treatment) product.

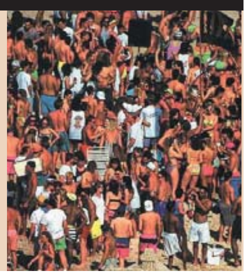
Sting mechanism

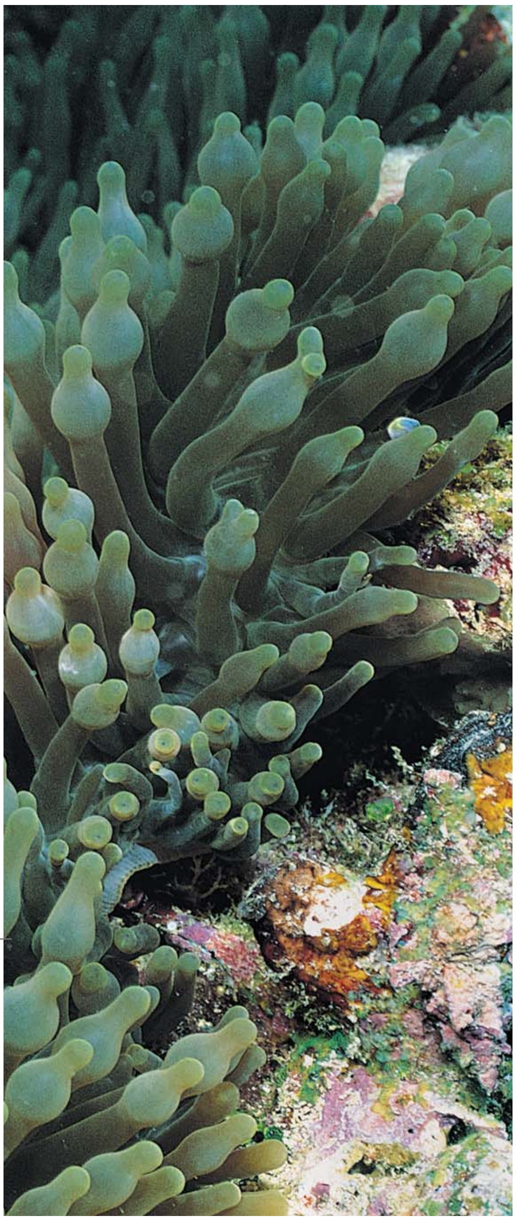
Jellyfish have in many respects remained remarkably simple organisms for more than 700 million years of evolution. They lack muscles, bones and the ability to hear or see, but their complex stinging mechanism makes them fearsome ocean predators. A single jellyfish tentacle is loaded with a massive number of clusters of stinging cells (Figures 2A and B). Each cluster consists of hundreds of stinging cells (Figure 2C). A single stinging cell contains a dense capsule within which is a highly folded 'needle' (Figure 2D). As a jellyfish stings, the needle discharge from the caps penetrates the skin and delivers poison (Figure 2E). Over 2000 needles will penetrate one square millimetre (over a million per square inch) of human skin during contact with the jellyfish tentacle. The mass penetration of poison needles will generate pain and inflammation.

Even though jellyfish tend to avoid potential collisions with people, they are poor swimmers and sometimes can't avoid bumping into unlucky bathers. A chemical in the skin of humans and other creatures triggers stinging cells located on jellyfish tentacles (Figure 3A). Hydrostatic, fluid, pressure of 150 atmospheres is developed within the capsule just prior to the act of

Table 1 - World jellyfish distribution

Area	Jellyfish type	Sting level
Mediterranean: French Riviera, Italy, Spain, Turkey, Greece	Pelagia Rhisostoma Rhopilema	Pain & inflammation
Caribbean, Bahamas	Sea-lice, sea-wasp (Box jellyfish)	Rush - highly toxic
Florida	Sea lice, Portuguese Man O War	Rush - highly toxic
Hawaii	Box jellyfish	Highly toxic
East Cost US	Sea nettle	Pain & inflammation
Baltic Sea, UK & the Atlantic	Lion jellyfish, sea nettle	Pain & inflammation
Australia, Thailand	Box jellyfish	Highly toxic





stinging (Figure 3B). The capsule is forced open by this pressure, allowing the needle to be released (Figure 3C). During discharge, needle acceleration reaches 40,000 times the force of gravity and penetrates the skin of a human or other prey with a force similar to that of a bullet fired from a gun. The jellyfish poison is injected into the skin within a fraction of a second (Figure 3D), making a jellyfish sting one of the most rapid mechanical events found in nature.

Figure 1 - World jellyfish distribution

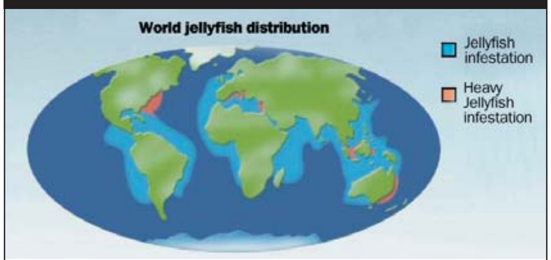
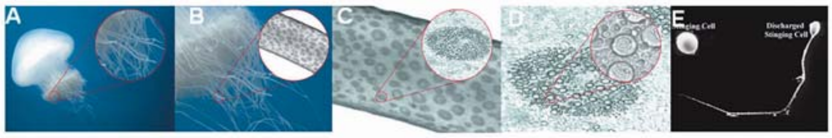
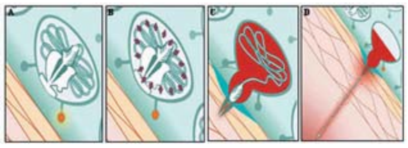


Figure 2 - Jellyfish stinging mechanism



A Jellyfish and jellyfish tentacles
B Tentacles and stinging clusters
C Clusters with hundreds of stinging mechanisms
D Cluster with stinging capsules and folded needles
E Resting and discharge stinging mechanism

Figure 3 - Activation of marine stinger



A Stimulants from the skin initiate discharge process
B High internal pressure of 200 atmosphere is built into the capsule
C With 40,000xg of acceleration the needle drills a hole into the skin
D The needle injects poison into the body

The symbiotic relationship between the clownfish and the sea anemone is the unlikely inspiration for anti-sting sunscreens

Sting prevention

The symbiotic relationship between the clownfish and the sea anemone has attracted scientists and films makers alike; take the starring role of the clownfish in Disney's *Finding Nemo* for example. The clownfish is using the sea anemones arms as a sea haven against predators. The tentacles of poisonous stinging sea anemones, a relative of the jellyfish, are loaded with the same stinging mechanism as jellyfish tentacles. Moreover, the sea anemone is a predator that uses its stinging cells to prey on fish in the coral reef environment. Thanks to a protective layer of mucous, the clownfish is not recognised by the sea anemone as prey. Wiping the clownfish mucous layer off would expose the fish to the stinging mechanism of the sea anemone and a clownfish without its layer of protection would be stung straightaway. It is this mucous that forms the basis of the new sunscreen to prevent jellyfish stings.

Understanding the jellyfish stinging mechanism, its chemical and cellular pathway and the events that lead to needle discharge paves the way for the development of inhibitors to prevent jellyfish stings. The inhibitors were formulated into waterproof sunscreen to deactivate jellyfish stinging cells at several stages of the stinging process (Figure 4). First, active compounds in the sunscreen mimic the self-recognition system of the jellyfish and interfere with the transduction signal, triggering the sting. Cations in the lotion reduce the osmotic pressure involved with needle release and thus inhibit the firing of the stinging needle.

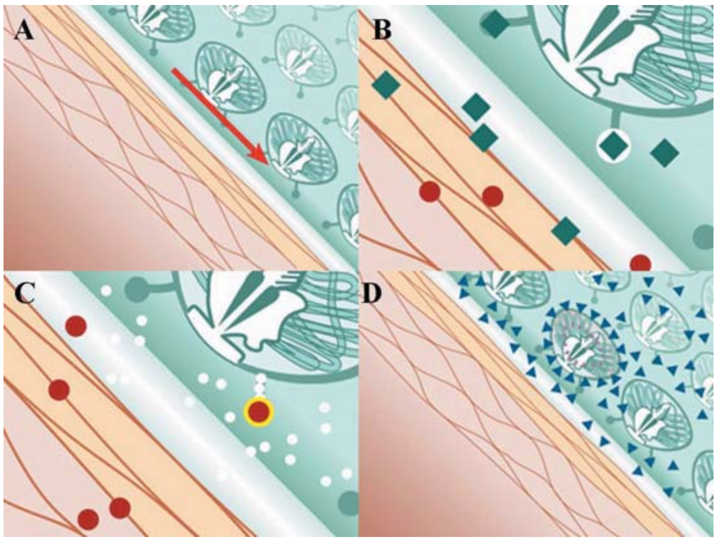
Clinical evidence

To evaluate the protection level of the sunscreen against different

Table 2 - Clinical test results from sea nettle jellyfish

	Sunscreen inhibitor		Sunscreen placebo	
Subject	Max pain Amount	Max reaction Amount	Max pain Amount	Max reaction Amount
1	0	0	1	2
2	0	0	1	1
3	0	0	1	2
4	0	0	1	1
5	0	0	1	1
6	0	0	1	2
7	0	0	1	2
8	0	0	1	1
9	0	0	1	1
10	0.5	0	1	2
11	0	0	1	1
12	0	0	1	1
p value	<0.01	<0.01		

Figure 5 - Topical sunscreen deactivates stinging cells in several biochemical sites



A **Reduces tentacle skin attachments**
B **Mimics jellyfish self-recognition**
C **Blocks stinging cells activation site and interferes with cellular signal**
D **Reduces internal osmotic pressure in the stinging capsule**

types of jellyfish sting, a testing protocol was developed. Subjects were randomised in a double-blind fashion to receive application of either the sunscreen with jellyfish inhibitors (Safe Sea SPF15) or placebo sunscreen. An area of 18cm x 6cm was marked on each subject's forearm and the inhibitor sunscreen lotion and placebo sunscreen were applied identically in a thin layer. The substances were allowed to dry for ten minutes. Tentacles were removed from live jellyfish in storage tanks and held vertically in the air to allow for the draining off of excess water. Then 5cm of the tentacles were placed on the skin and left in contact with the forearm for 10 to 30 seconds before being removed with tweezers.

Subjects were asked to note any discomfort and medical evaluation took place at 0, 15, 30, 60, 90 and 120 minutes after completion of tentacle application. Pain was scored on a 0 (no pain), 1 (pain) scale. Additionally, the degree of inflammation was evaluated by a dermatologist according to the following criteria: 0 (no change), 1 (skin colour change only), 2 (edema), 3 (blister or ulcer formation). These measurements were taken at the same time points.

All 12 arms pre-treated with the placebo sunscreen demonstrated erythema and all 12 subjects noted discomfort in that arm (Table 2). In contrast, no arm pre-treated with the jellyfish sting inhibitor had clinically evident skin changes ($p<0.01$). Two subjects noted some discomfort in the arm treated with the sting inhibitor and in both cases this discomfort was rated as less than in the placebo-treated arm ($p<0.01$).

The results of this clinical test are considered to demonstrate that the new sunscreen provides effective protection against jellyfish stinging. Similar clinical tests were conducted on different types of jellyfish in several medical centers in California, Florida and the Mediterranean.

For the first time sunscreen can provide dual protection from the sun and jellyfish stinging. This concept is based on the understanding of the jellyfish stinging mechanism and the clownfish's ability to protect itself when near sea anemones. The sunscreen efficacy in preventing jellyfish sting has been demonstrated in several clinical tests.

Author

Amit Lotan, Nidaria Technology Ltd, Israel
Tel +972 4 6751 943
Fax +972 4 6750 367
E-mail lotan@nidaria.com