Update on Marine Medicine

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Salt Water exposure

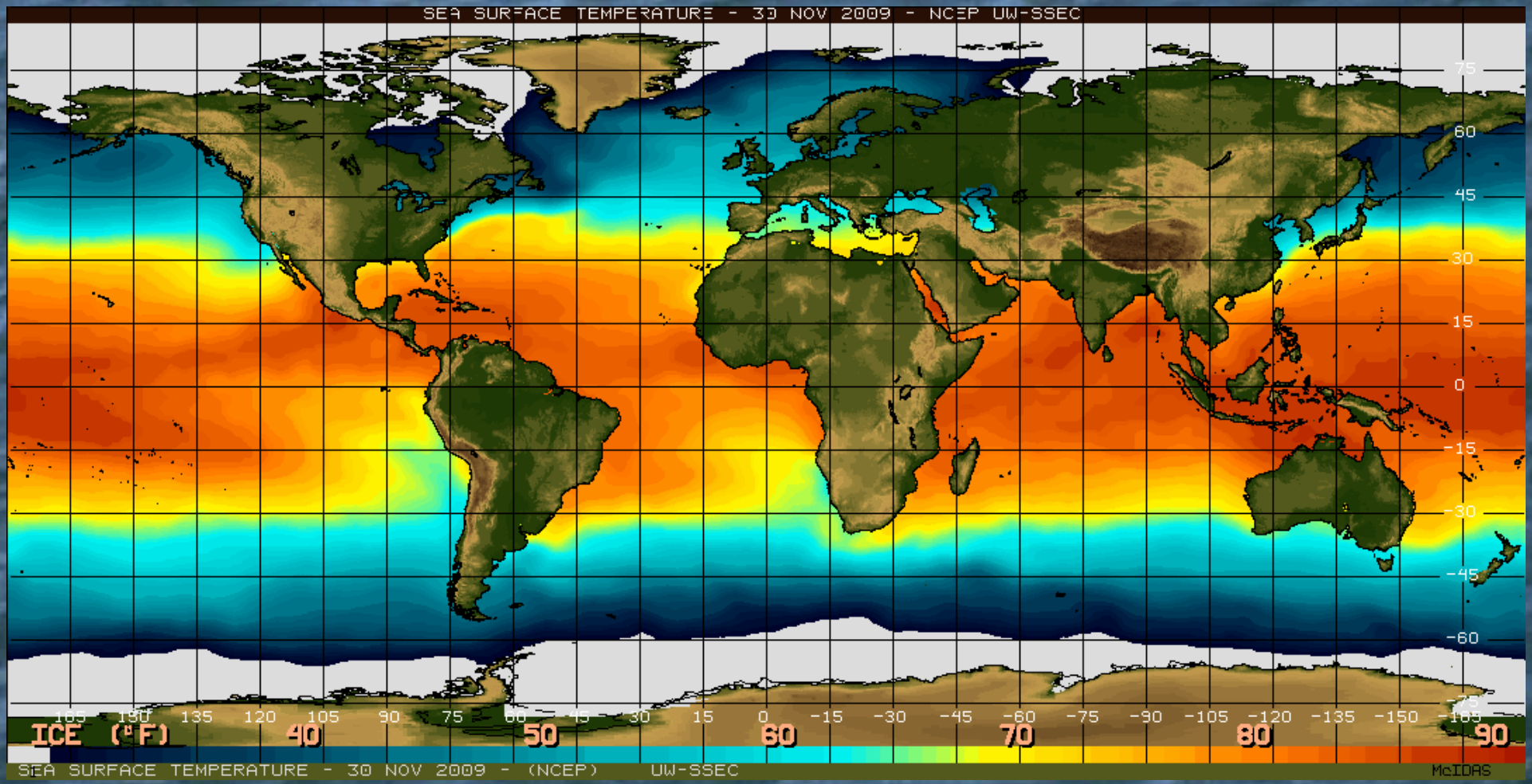
- 20% of the U.S. population reports saltwater recreation annually.
  - 48 million swim in salt water
  - 14 million snorkel
  - 4 million scuba dive

- 500,000 jellyfish stings occur annually in U.S.

1999-2002 National Survey on Recreation and the Environment, USDA Forest Service and the University of Tennessee, Knoxville, Tennessee.

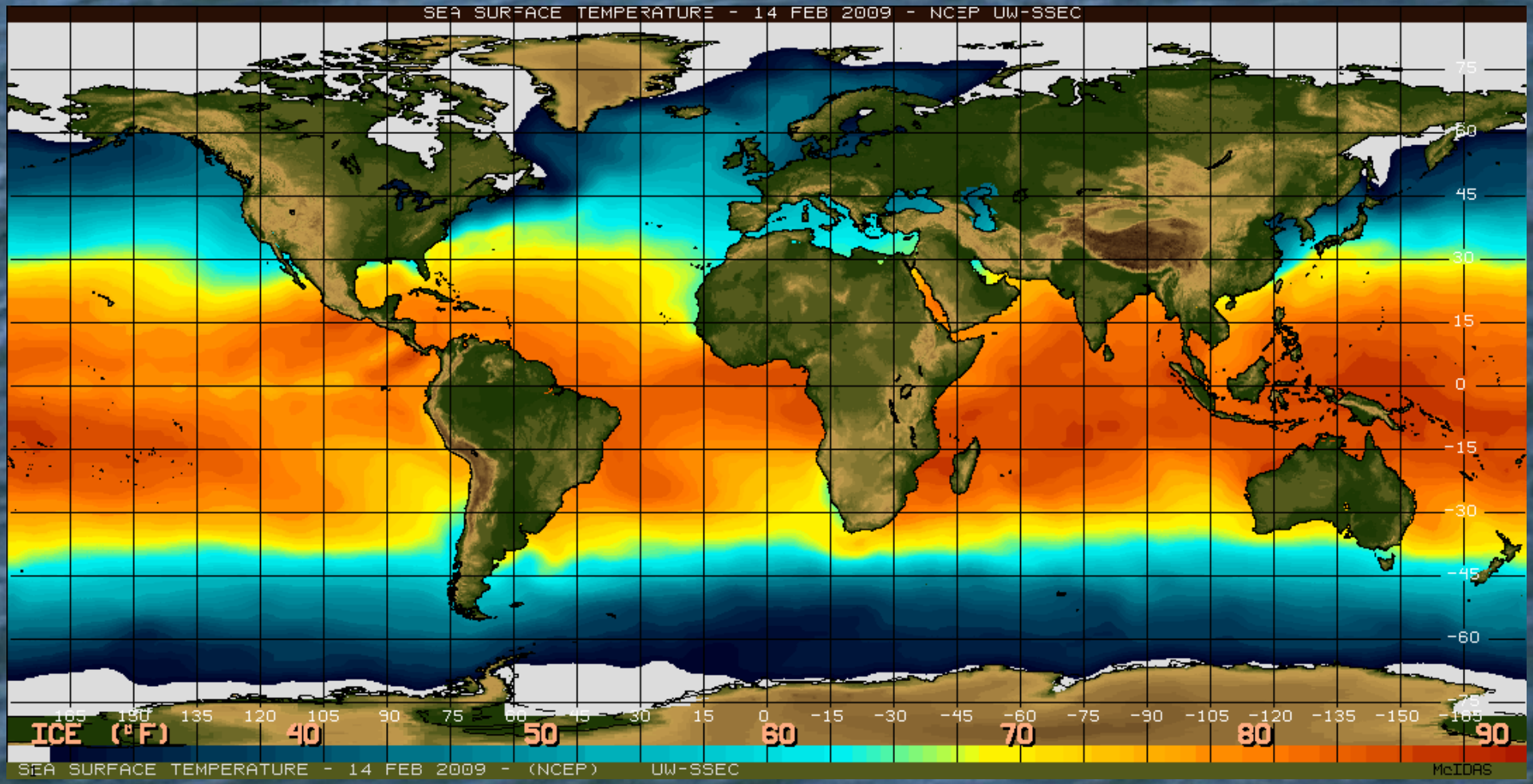
Influence of Seasonal Climate

Ocean Surface Temperatures 30 November 2009



Water in Thailand remains 27-30^{o}C year round

14 February 2009



Water in Thailand remains 27-30^{o}C year round

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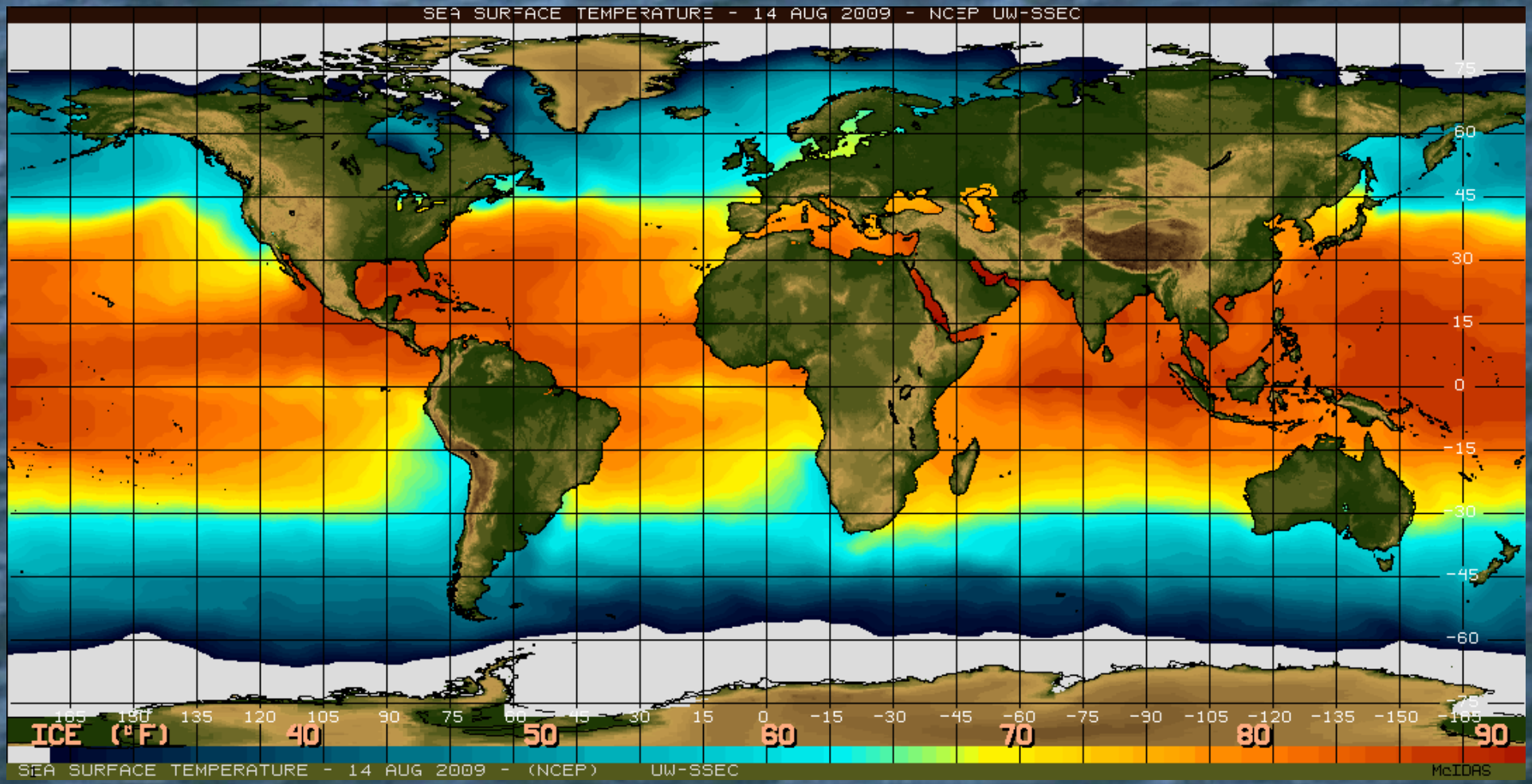
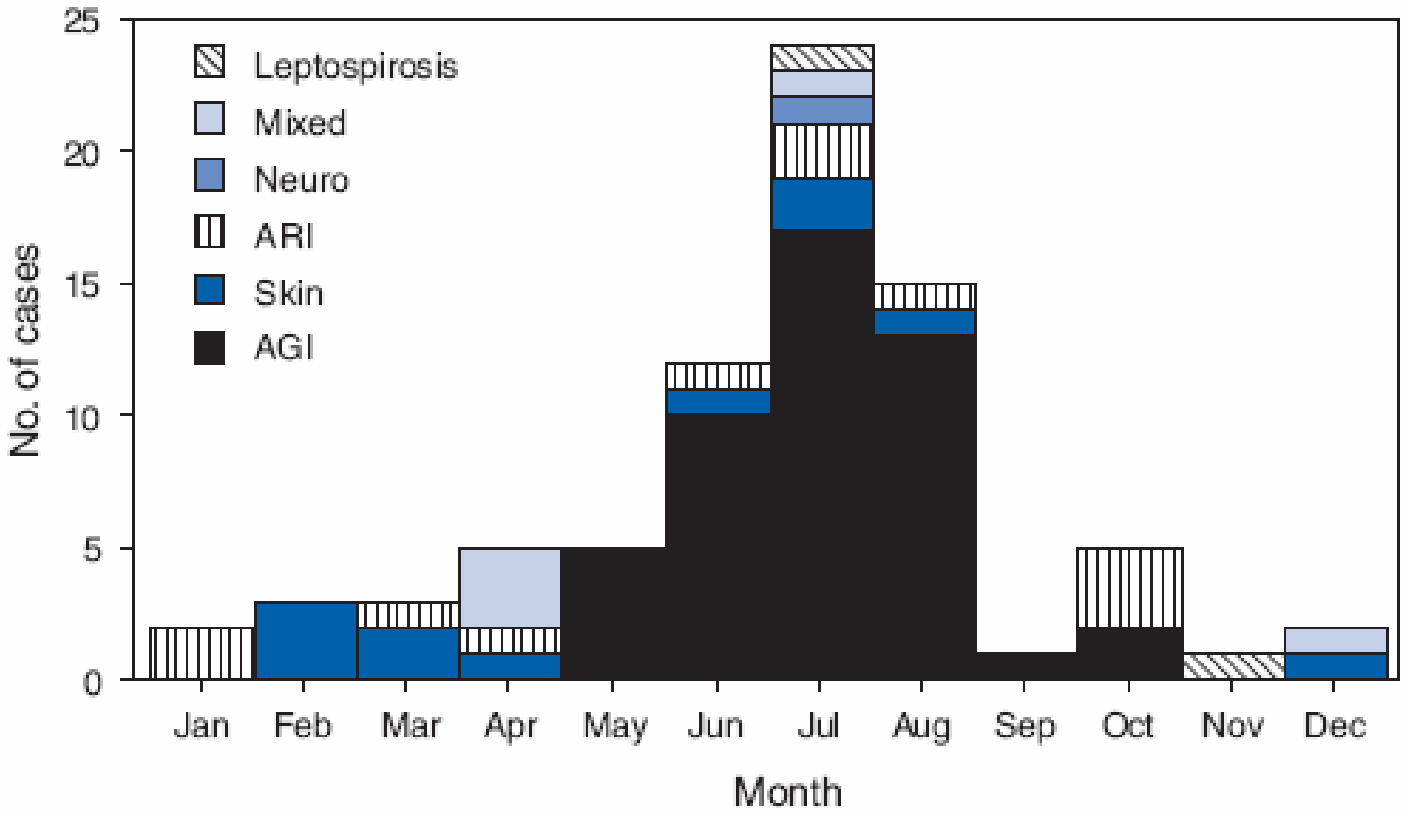


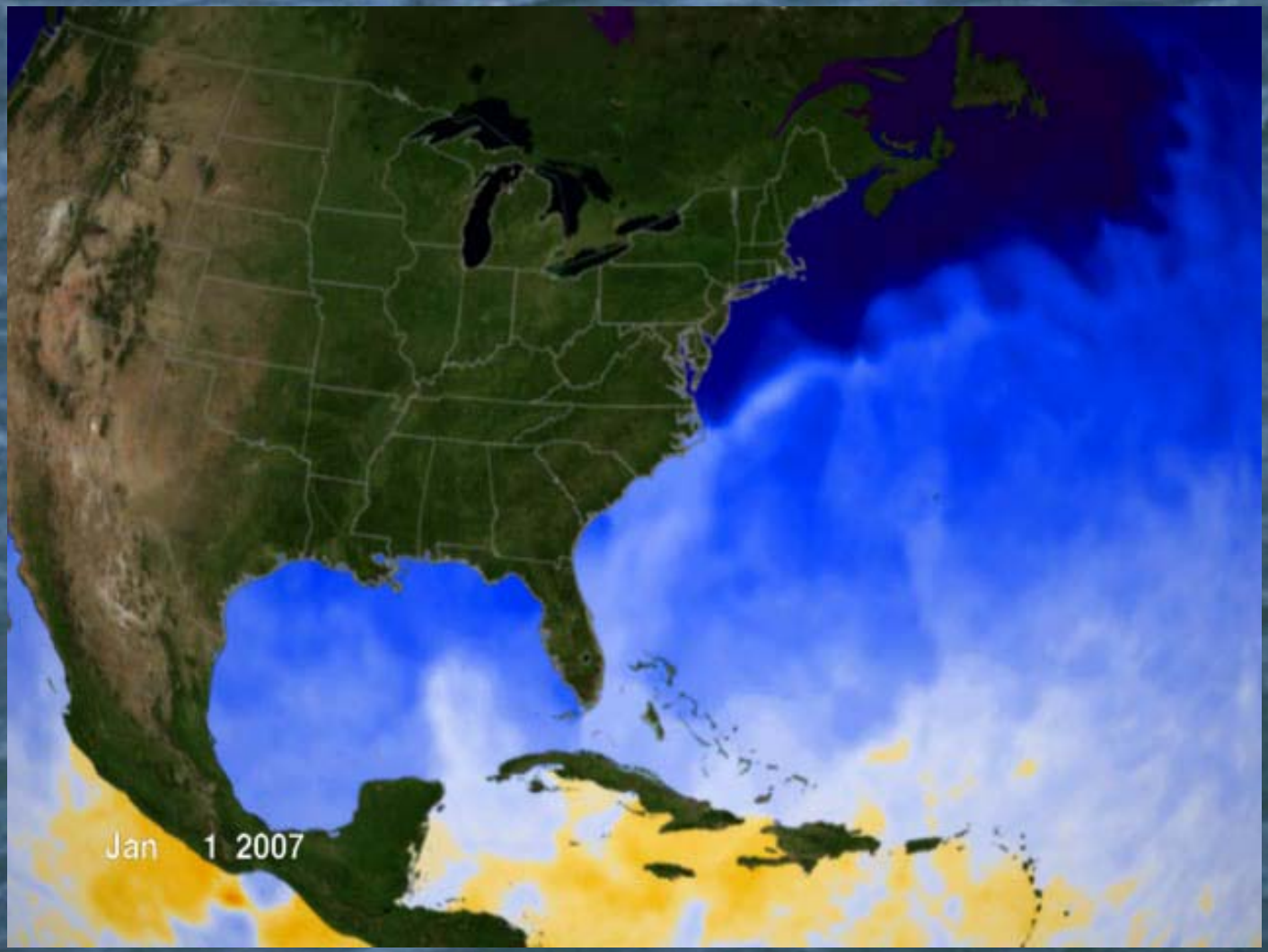
Water in Thailand remains 27-30^{o}C year round

Time of Water borne Illness in U.S.

FIGURE 4. Number of recreational water-associated outbreaks (n = 78), by predominant illness* and month — United States, 2005–2006

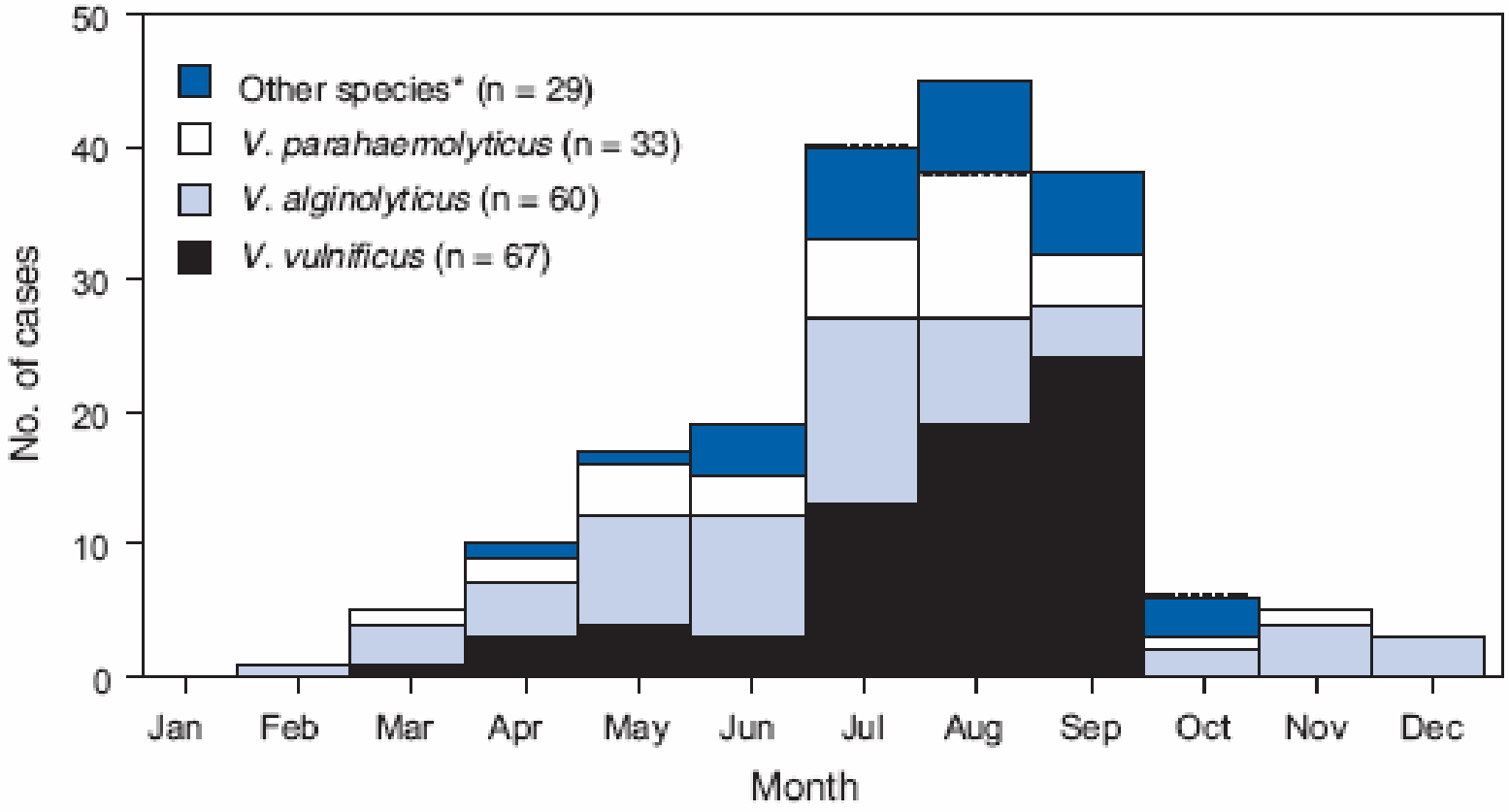


Surface Temperatures 2007



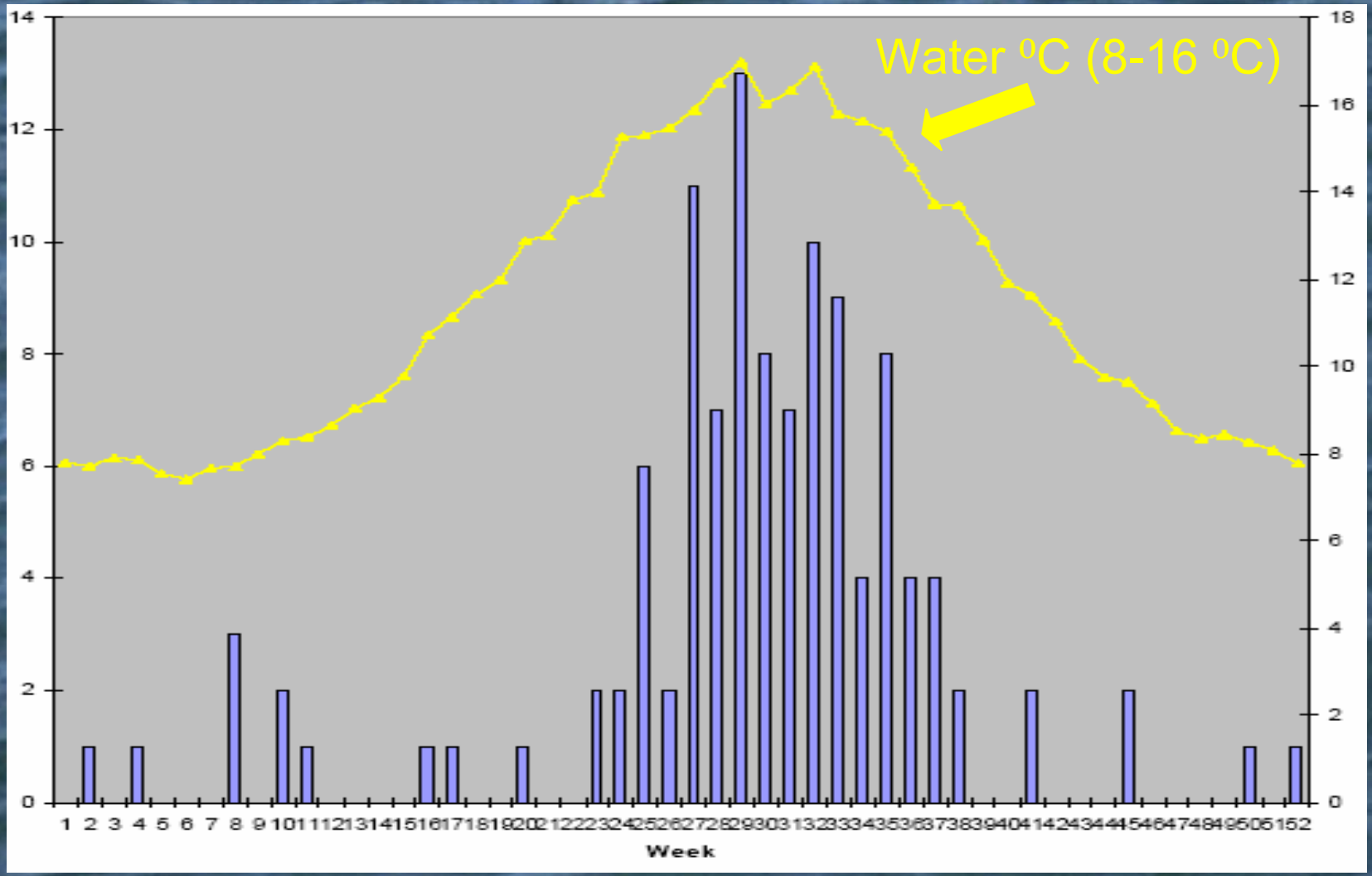
Vibrio Infections in U.S.

FIGURE 7. Number of illnesses associated with *Vibrio* isolation and recreational water (n = 189), by species and month — United States, 2005–2006



Vibrio parahaemolyticus Infections vs. Water Temperature

Vancouver, British Columbia 2001-2006 Data



Khaira G, Galanis E. Canada Communicable Disease Report 2007

Hazardous Marine Life

Contact Toxins

Injected Toxins

Predators

Contact Toxins

Sponge

Sea Urchin

Jellyfish

Coral


Photos by Peter Melchert, M.D.

Contact Toxins

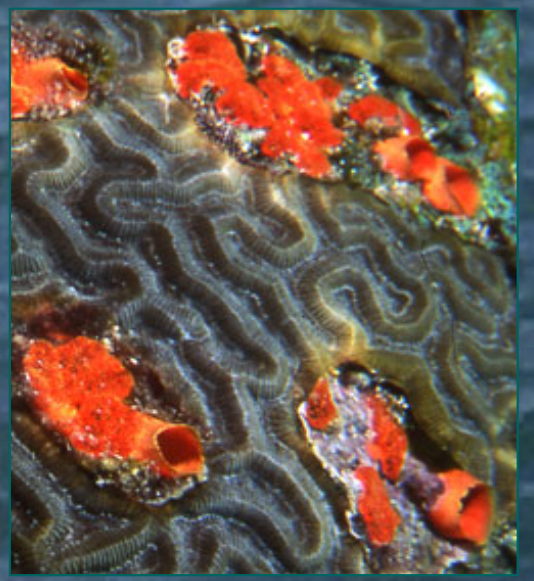
Sponge

Symptoms: Redness and edema, arthralgia

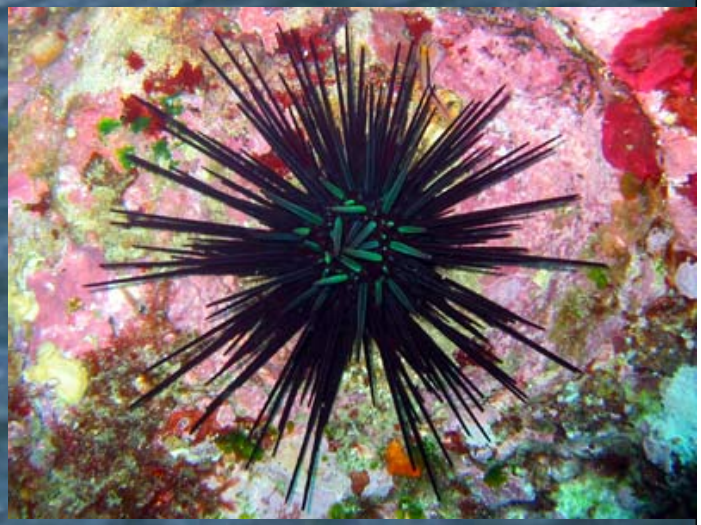
Can be rather severe = sponge dermatitis

Treatment :

- Rinse and dry
- Lift skeletal spikes with adhesive tape
- Apply topical steroid and benadryl
- Systemic doses of prednisone for more severe reactions (similar to contact dermatitis, e.g. poison ivy)
- Tetanus prophylaxis



Contact Toxins



Sea Urchins (Echinoderms)

- multiple small slender spikes that may be:
  - venom filled, can puncture skin, and
  - break off

Symptoms: immediate pain

May leave dark pigment area in dermis

Pigment remaining longer than 48 hours likely represent retained foreign body

Treatment: remove spines and cleanse wound

soak in hot water

consider topical antibiotics and tetanus


Crown of Thorns


Anemone

Anemone

Coral

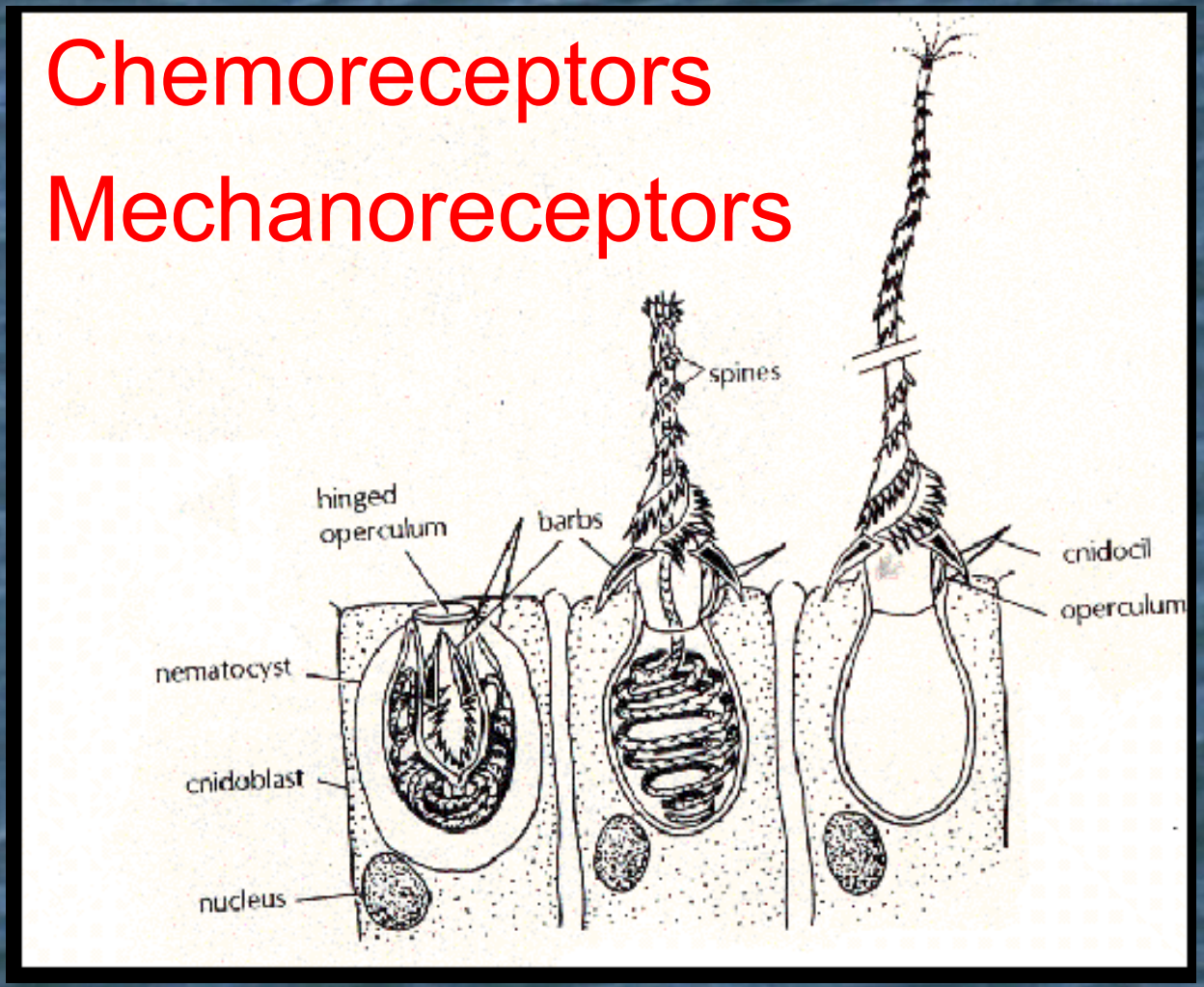
Severity of Nematocyst Envenomation

Jellyfish

Nematocysts

Chemoreceptors

Mechanoreceptors



Stages of nematocyst discharge (Biology of the Invertebrates, Jan A.Pechenik p79)

Contact Toxins

Anemone

- sting with nematocysts

Symptoms: Red rash , localized swelling

Treatment:

-Remove tentacles

-Rinse thoroughly with sea water

-Apply ice for pain

-Topical hydrocortisone PRN

- Benadryl PRN


Coral

Contact Toxins

Coral

- Possess nematocysts
- Injury via skin lacerations and abrasions which easily become infected

Symptoms:

-Pain, erythema, weeping

-burning, itching

Treatment

-Routine wound care

-Remove embedded coral by:

- rinsing or scrub brush

-Tetanus prophylaxis and topical antibiotics

Coral Dermatitis

- Chronic eruption
- Combination of:
  - Coral fragment foreign bodies
  - Chemical irritant from nematocysts
  - Inflammatory response of wound itself
- Thickened, red, weepy and painful,
- May develop bullous lesions initially
- Can take weeks to heal
- May leave hyperpigmentation

Coral Dermatitis

- Prevention:
  - Don’t touch coral
- Treatment
  - Rinsing, scrub brush debridement
  - Topical steroids (after foreign-bodies removed)
  - Watch for secondary infection
- Duration
  - May last weeks to months
    - especially if retained foreign body

Contact Toxins

Fire Coral

- not a true coral

- has nematocysts and sharp calcified exterior skeleton

Symptoms: Immediate burning sensation

Treatment:

-Rinse with seawater (NOT freshwater)

-Apply vinegar or isopropyl alcohol to wound to deactivate non-discharged nematocysts

-Apply topical hydrocortisone 2-3x daily


JELLYFISH

Contact Toxins

Jellyfish

- Phylum: *Cnidaria*
- Powerful nematocysts in floating tentacles
- Oceans world-wide → venom of Indo-Pacific species more severe than Atlantic.
- There is a great deal of inter-species variation

In Thailand

- Box jellyfish present in Thai waters
- Multiple species

- Occasional Deaths
  - April 2008 -- 10 year old girl at Ko Lanta
  - 8-9 August 2002 -- 23yo F, 34yo M in at Koh Pha Ngan

NEMATOCYST VENOM COMPONENTS

- Bradykinin
- Hemolysin
- Serotonin
- Histamine
- Prostaglandins
- ATP
- Hyaluronidase
- Nucleosidases
- Alkaline protease
- Acid protease
- Phosphodiesterase
- Acid phosphatase
- Fibrinolysin
- Leucine aminopeptidase
- RNAase
- DNAase
- Membrane Attack Complex


Palau

Contact Toxins

Jellyfish Sting

Symptoms: rapid onset of pain

- Red, swollen, hot rash → usually linear and blotchy
- Can have pustule and vesicle formation
- Severe stings → may develop skin necrosis and systemic symptoms : muscle cramps, fever, chills, vomiting, resp distress and CV collapse
- Venom of Indo-Pacific jellies produce systemic toxicity.
- Type-I Anaphylaxis is rare.
  - There is direct toxicity of venom
- Type-IV hypersensitivity ?more common in Atlantic species of Jellyfish.

Contact Toxins

Treatment : Jellyfish (Nematocyst) sting

1. Remove any visible tentacles
2. Use shaving cream and razor to remove any remaining particles (credit card)
3. Rinse repeatedly with vinegar, rubbing ETOH or Windex™ (may cause Man O' War nematocysts to fire)
4. Apply topical hydrocortisone and benadryl for mild disease. More severe events may require systemic prednisone course.
5. In field management of shock or CPR
6. Antivenin for box jellyfish available in some locations.
7. Ongoing Thai Randomized Treatment Trial


?
To Pee, Or Not to Pee?

Nematocyst Envenomation

Results from the sting of phylum *Cnidaria* organisms
- Anemone
- Coral
- Jellyfish

Nematocysts are activated by both chemical and contact mechanisms

Do NOT rub affected area
Do NOT rinse with freshwater
Do NOT urinate on wound

DO “fan” affected limb immediately underwater
DO rinse copiously with SEAwater
DO urinate in a porcelain receptacle (toilet)

Jellyfish stings

- The nematocysts require stimulation by both chemical and tactile stimuli to fire
  - Evolutionary makes sense
  - Don't want to sting self or inanimate objects

- Can you prevent the sting?

Pantin CF. Excitation of nematocyst *Nature* 1942; 149: 109.

Clown Fish

Clown Fish within the Sea Anemone

- Clown Fish live within sea anemones.
  - Don't get stung by anemone's nematocysts
- Why?
  - Clown Fish have a mucous coating which protects them.
    - Species dependent protection
    - The mucous coating protects them in several ways:

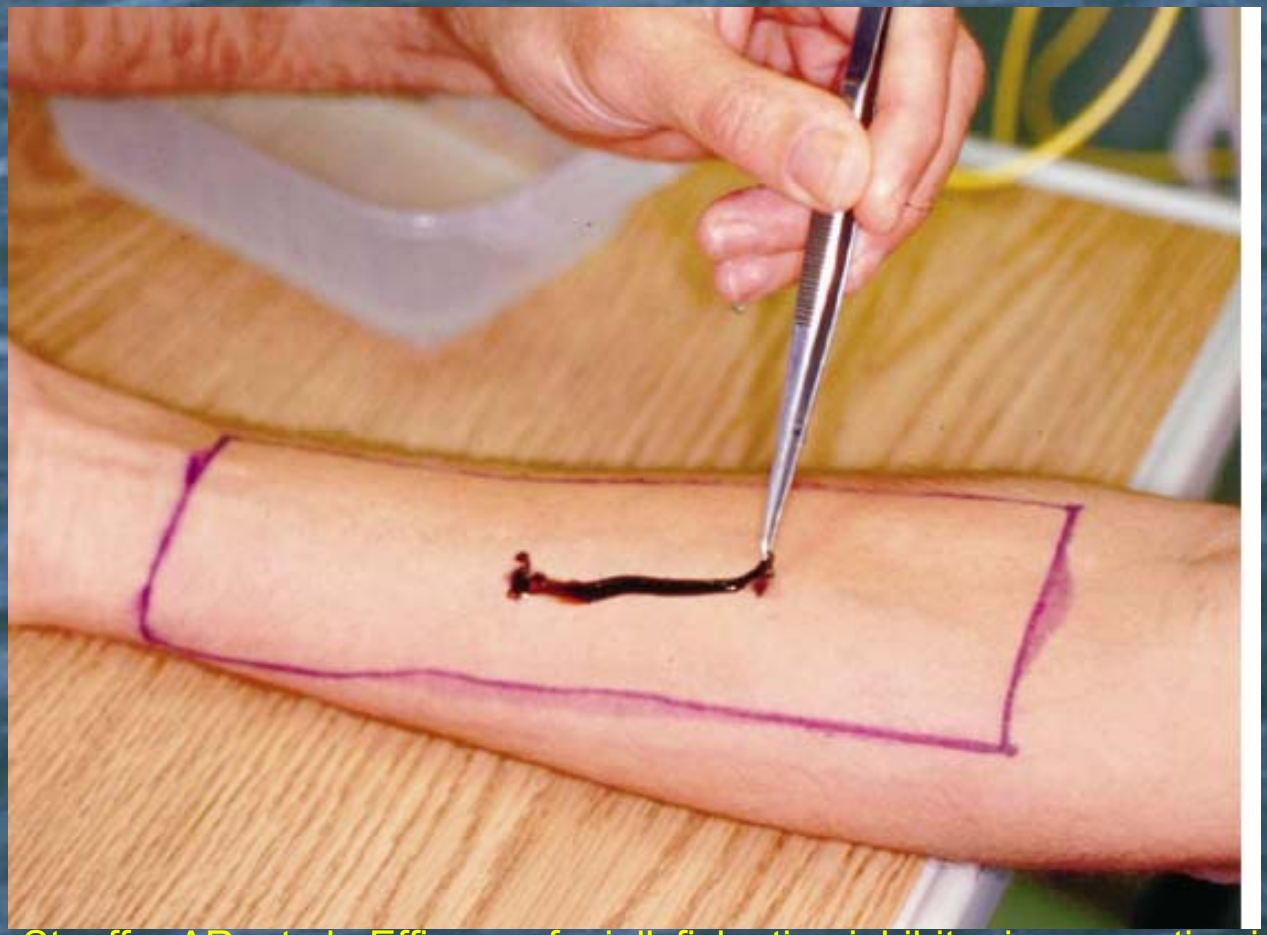
Jellyfish Sting Inhibitor: Mechanism of Action

Clown Fish within the Sea Anemone

1. **Highly hydrophobic**
   - Decreases tentacle contact with the skin
   - Increases difficulty of envenomation.
2. **Glycosaminoglycans mimic the composition of the jellyfish's bell.**
   - Confuses self-recognition system
   - Interferes with nematocysts firing.
3. **Competitive antagonist to nonselective chemoreceptors**
   - Receptors bind amino acids and sugar secretions from prey
   - Sensitize the nematocysts to enable firing upon contact.
4. **Ca^{2+} and Mg^{2+} block transmembrane signaling**
   - Reduce the osmotic force within the nematocyst capsule
   - This is necessary to create the firing force.

Initial Lab Study

- 24 subjects, 2 sites
- Arms treated with tentacles for 30-60 sec



Kimball AB, Arambula KZ, Stauffer AR, et al. Efficacy of a jellyfish sting inhibitor in preventing jellyfish stings in normal volunteers. *Wilderness Environ Med.* 2004; 15:102-8.

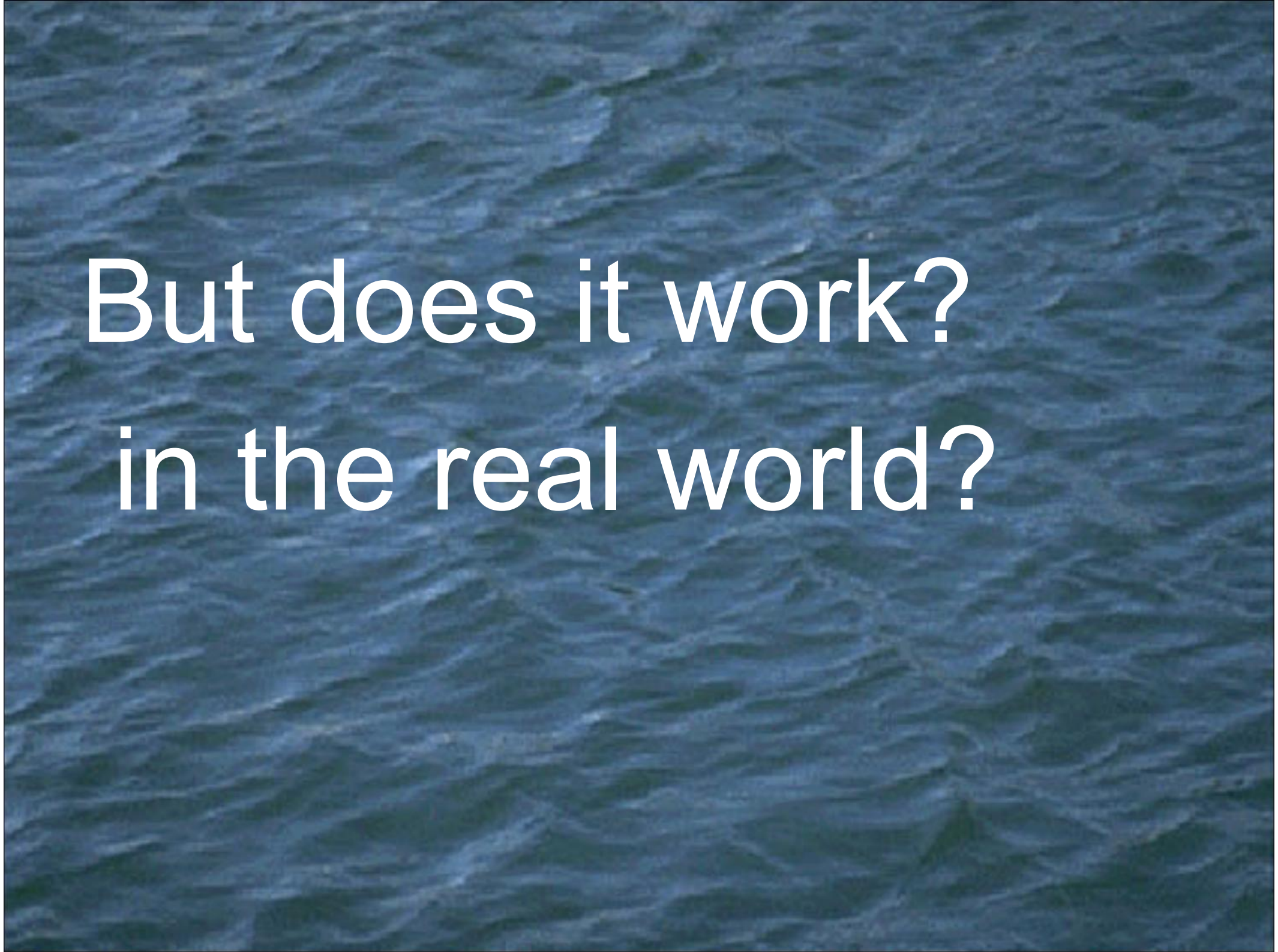
Lab Trial Results

- Prevention
  - 100% of *Chrysaora fuscescens* stings
  - 70% of *Chiropsalmus quadrumanus* stings

Subject No.	Total contact Time (s)	Inhibitor				Placebo			
		Max pain		Max reaction		Max pain		Max reaction	
		Amount of pain	Time (min)	Amount	Time (min)	Amount of pain	Time (min)	Amount	Time (min)
1	10	0	0	0	0	1	0	1	30
2	10	0	0	0	0	1	15	1	90
3	20	0	0	0	0	1	15	2	120
4	10	0	0	0	0	1	15	1	120
5	10	0	0	0	0	1	60	1	60
6	20	1	15	0	0	1	30	2	30
7	10	0	0	0	0	1	0	0	0
8	10	1	0	0	0	0	0	0	0
9	20	0	0	0	0	1	30	1	30
10	20	1	15	1	90	0	0	0	0
11	30	0	0	0	0	1	60	2	60
12	10	0	0	0	0	1	15	1	30
Median	10	0	0	0	0	1	15	1	30
Mean	15	0.3	2.5	0.1	7.5	0.83	20	1	47.5
P value						<.05		<.01	

* Max, maximum; min, minimum.

Kimball AB, Arambula KZ, Stauffer AR, et al. Efficacy of a jellyfish sting inhibitor in preventing jellyfish stings in normal volunteers. *Wilderness Environ Med.* 2004; 15:102-8.


But does it work?
in the real world?

Field Trial

- Participants: Healthy volunteers planning to snorkel for 30 to 45 minutes.

- Outcome: incidence of jellyfish stings

- 2 sites
- 6 individuals each site
- 6 day sessions
- 82 observations

Locations

- Dry Tortugas National Park, Florida
  - April 24-30, 2004

- Sapodilla Cayes, Belize.
  - January 24-30,2005

Intervention

- Masked 26 g samples were provided.
  - Safe Sea™ SPF15 (Nidaria Technology, Israel)
  - Coppertone® SPF15 (Schering-Plough)
- 10 min prior to swimming
  - Participants applied Safe Sea to one side of their body and
  - Coppertone® to the contralateral side as placebo control.
- The subjects and observers were blinded.
- Application was observed.

Field test to evaluate the protection of Safe Sea against Jellyfish Stings and Sea Lice.

Warning: Do not take part if you are under 18 years old, pregnant, or have suspected allergic reaction topical products, or have history of severe reaction from jellyfish sting.

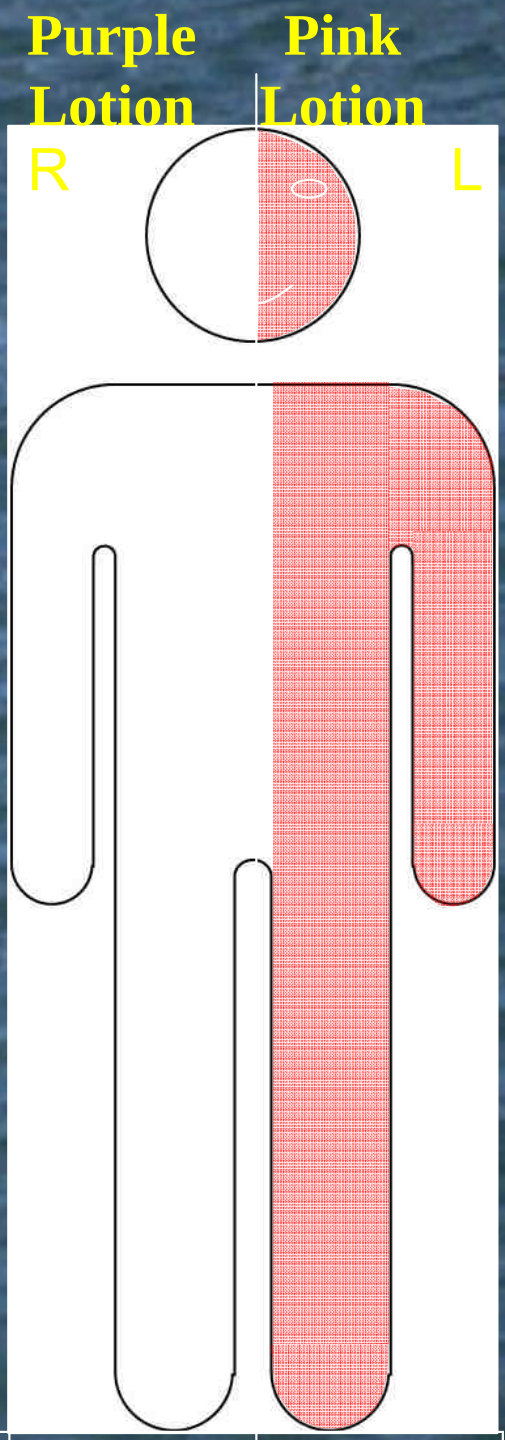
Direction: With your right hand apply “Pink” lotion over the left side of the body as in the picture, and “Purple” lotion over the right side.

Stay in the shade or cool area for at least 10 Min.

Go swim or snorkel for up to 45 minutes.

15 minutes after the swim mark on the picture spots where inflammation or itch developed

Write below the sums of marked spots. Indicate if rash develops during 24 hours post exposure.



Number of Spots		
Rash @ 24 hours		

Activity: Snorkeling

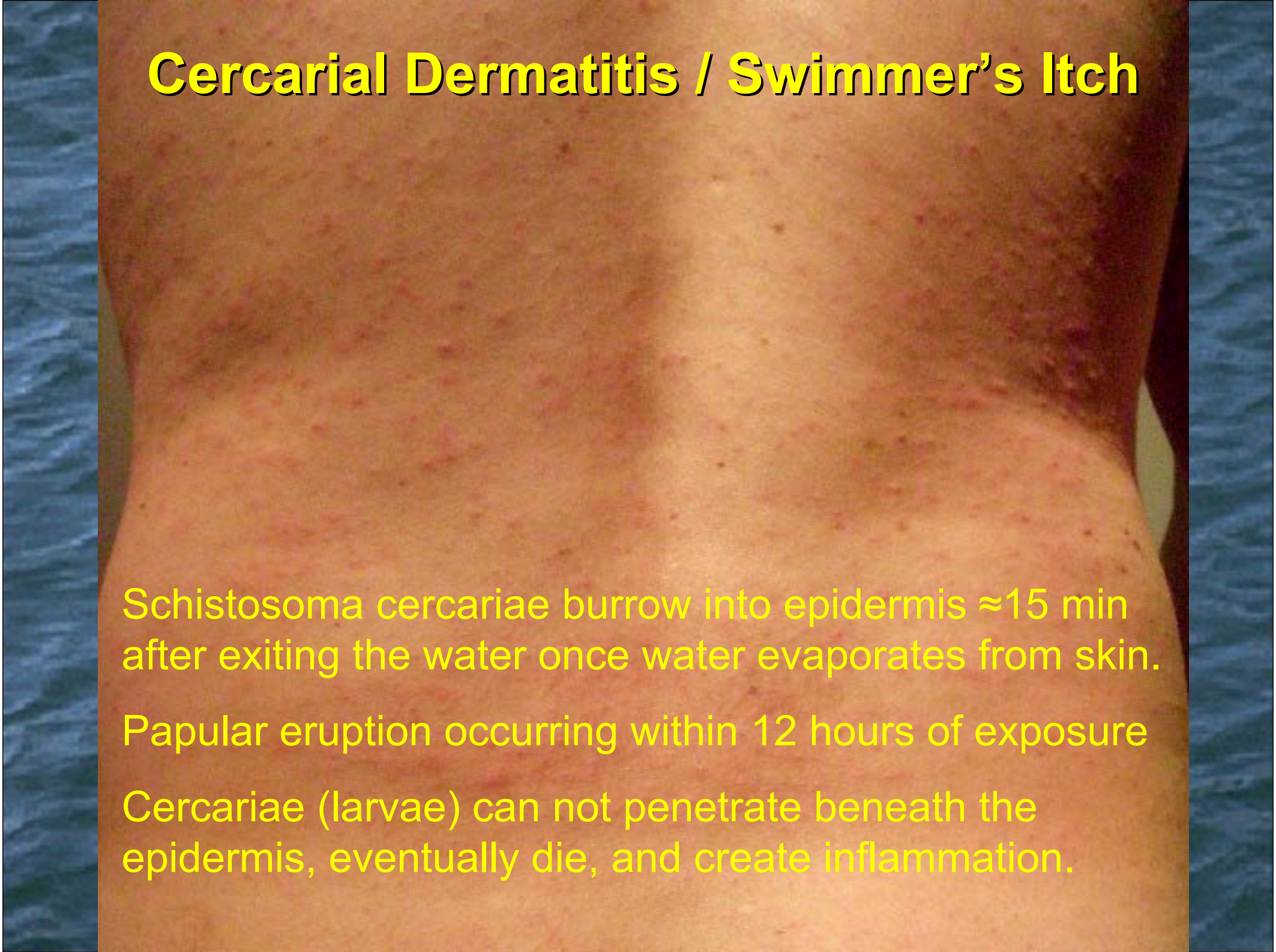
Results

Participant	Exposures	Safe Sea Stings	Placebo Stings	Hair Density
1	14	1	4	2
2	7	0	0	0
3	13	1	2	3
4	8	0	1	2
5	7	0	1	1
6	6	0	0	0
7	6	0	0	1
8	7	0	1	2
9	7	0	0	0
10	7	0	2	1
Total	82	2	11	
Mean	8.2	0.2	1.1	
P-value		0.011		0.053

Boulware DR. Field study of the prevention of jellyfish stings with a topical sting inhibitor. J Travel Med 2006

Problems

- Need dense application. 2 mg/cm^2
- In unpublished work, it did not work against *Chironex fleckeri* (Box Jellyfish).


Cercarial Dermatitis / Swimmer's Itch
Schistosoma cercariae burrow into epidermis ≈15 min after exiting the water once water evaporates from skin.
Papular eruption occurring within 12 hours of exposure
Cercariae (larvae) can not penetrate beneath the epidermis, eventually die, and create inflammation.

Marine Envenomations

- Swimmer's Itch
  - Caused by non-human schistosomas
- Sea Bather's Eruption
  - Caused by the larvae of thimble jellyfish
  - *Lunuche ungulate* (Atlantic Ocean)

Sea Bather's eruption

Area under a SCUBA weight belt on the flank.

Seabather's Eruption

Caused by the larvae of thimble jellyfish (*Lunuche ungulate)*

- Larvae get trapped under swimwear

Seabather's Eruption

- Jellyfish larvae discharge as they dry out
- Initiates a Type IV hypersensitivity reaction
  - Rash shows up 24-48 hours later
  - Afflicts up to 20% of ocean goers in Florida
  - Prior sensitization increases likelihood
  - Showering with scrubbing, changing out of swim wear decreases risk
  - Alternatively, wearing abbreviated swim wear

Hazardous Marine Life

Contact Toxins

Injected Toxins

Predators

Injected Toxins

Scorpionfish

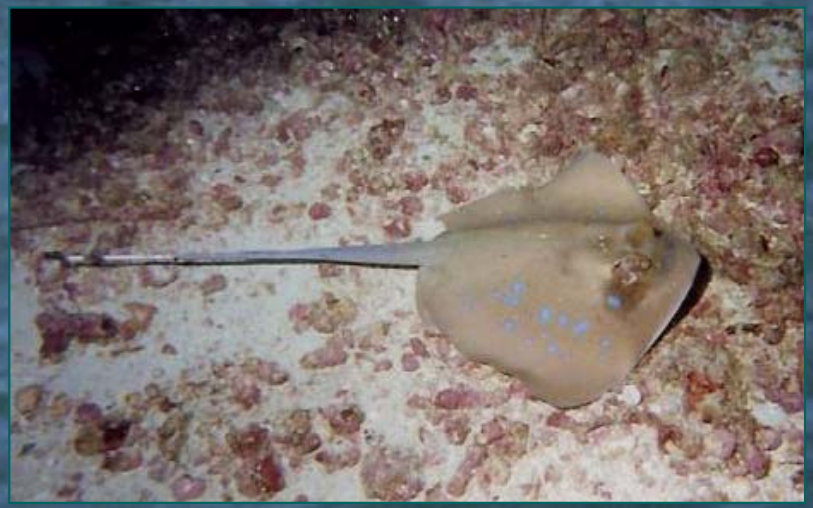
Stingray

Cone snail

Injected Toxins

Stingray

- serrated bony spine at base of tail which injects venom
- commonly occurs when stepped on in shallow water
- toxin is heat labile and induces vasoconstriction
- Symptoms: Intense pain and local ischemia
  - Jagged wound
  - Salivation, sweating, vomiting
  - Cardiovascular collapse



- Treatment: Irrigate the wound
  - Soak in hot water (115 degrees) for 30-90 min.
  - May need local infiltration of anesthetic or nerve block
  - Be prepared to support cardiovascular status

Injected Toxins

Scorpionfish

- Lionfish and Stonefish species which sport poisonous spines
- Stonefish and scorpion fish toxins can be deadly
- Toxin is heat labile, similar to stingray
- symptoms: Severe pain and local ischemia

  Progresses to vomiting, hypotension, delerium and CV collapse
- treatment: Irrigate wound

  Soak in hot water for 30 to 90 min

  Analgesia – local anesthetic or n. block

  Antibiotics and tetanus prophylaxis

  Scorpionfish antivenin is available

Injected Toxins

Cone snail

- phylum mollusca

- two component toxin – causes sustained muscular contraction and inhibits excitatory nerves

- has detachable dart-like tooth which penetrates the foot

Symptoms: Puncture wound with localized ischemia

Can progress to respiratory distress and paralysis

Treatment: Immobilize the limb

Apply a pressure dressing

Analgesics and tetanus prophylaxis

Be prepared to support respiratory status

Principles

Nematocysts

- When in doubt – rinse first with salt water
- Then rinse with vinegar

Injected toxins or puncture wounds

- Soak in hot water

Hazardous Marine Life

Contact Toxins

Injected Toxins

Predators

Predators

Predators

Barracuda

- Of 22 species, only the Great Barracuda has been reported to attack humans

- Attracted to shiny objects

- Attacks seem isolated to spearfisherman and provocation

- Biggest danger to humans via ciguatera

Predators

Moray Eel

- Found in shallow water and in crevices of reefs

- Attacks humans only when provoked

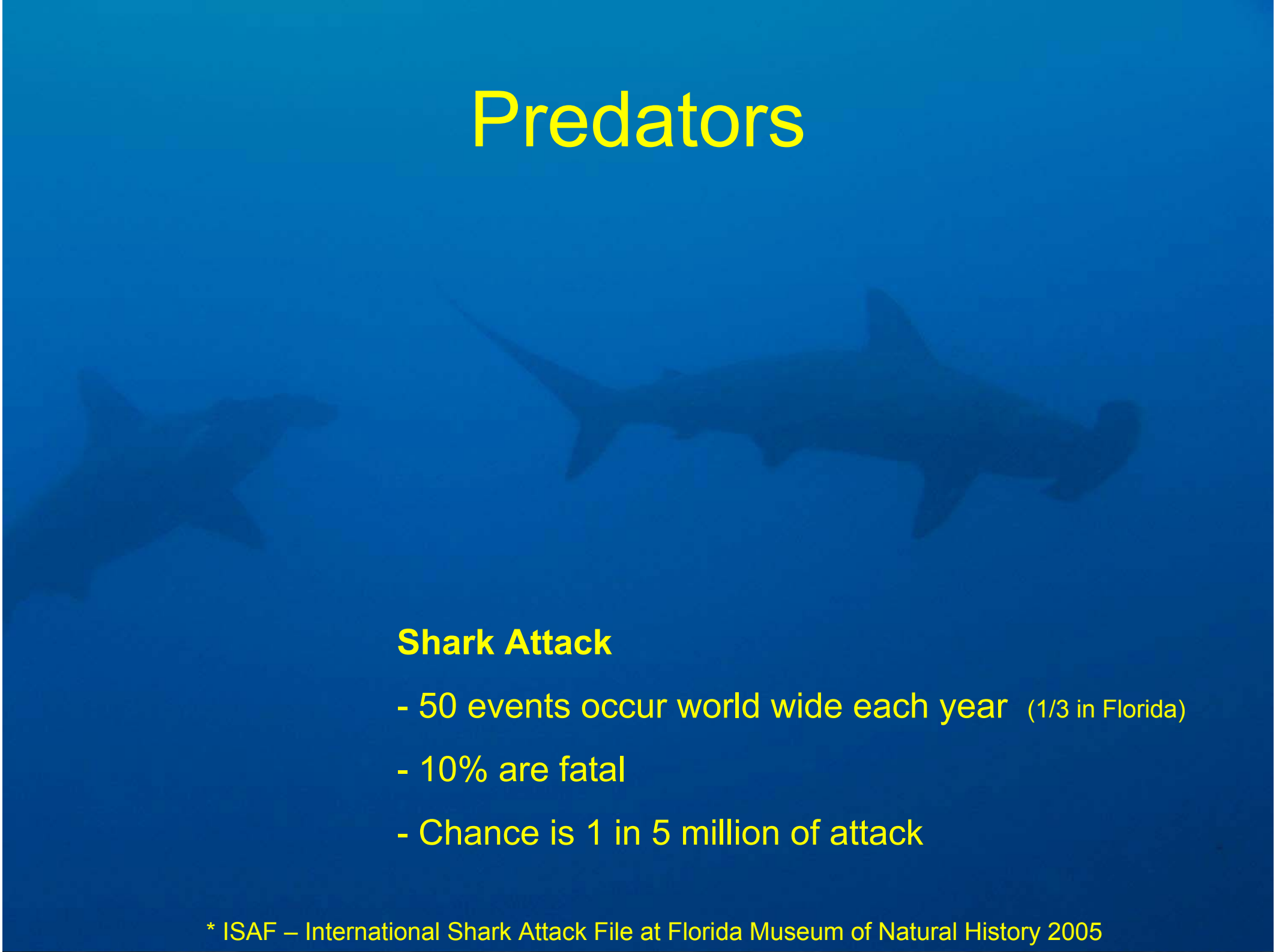
- Large jaws and sharp teeth that can cause significant soft tissue and even bony damage

Predators

Shark

- Species known to attack humans
    - Great White, Tiger, Bull, Oceanic White Tip and Hammerhead
- Attracted to fish blood and signs of distress
- No evidence that menstruation is a risk factor
- Injuries to fisherman handling sharks caught in nets are more common
- Wounds have high propensity for infection due to presence of seawater, sand, plant debris and shark mouth flora

Predators



Shark Attack

- 50 events occur world wide each year (1/3 in Florida)
- 10% are fatal
- Chance is 1 in 5 million of attack

* ISAF – International Shark Attack File at Florida Museum of Natural History 2005

Predators

Sea snakes

- 32 species off N. coast of Australia / Indo-Pacific
- Air breathers, inquisitive, non aggressive
- HIGHLY toxic venom → causes paralysis and myolysis
- Bites with multiple sharp non-fang teeth
- Bite may or may not be envenomated

Predators

Sea snakes

-sx: After 30 min develop stiffness, muscle aches

Soon blurred vision, ptosis, opthalmoplegia or limb weakness

Followed by lethargy and resp paralysis

May develop hemaglobinuria, no coagulopathy

- tx: Get to an ER

Hold site below rest of body

Apply a pressure bandage

Administer sea snake antivenom only if signs of envenomation

Can use polyvalent land snake antivenin if not available or consider dialysis

Marine Infections

Acinetobacter
Actinomyces
Aeromonas
Alcaligenes
Bacillus
Bacteroides
Chromobacterium
Clostridium
Enterobacter
Erysipelothrix
Legionella
Mycobacterium
Pasteurella
Proteus
Pseudomonas
Salmonella
Staphylococcus
Streptococcus
Vibrio

*Organisms found in marine water, organisms and marine acquired wound cultures

Marine Infections

Acinetobacter
Actinomyces
Aeromonas
Alcaligenes
Alteromonas
Bacillus
Bacteroides
Chromobacterium
Clostridium
Deleya
Enterobacter
Erysipelothrix
Legionella
Mycobacterium
Pasteurella
Proteus
Pseudomonas
Salmonella
Staphylococcus
Streptococcus
Vibrio

*Organisms found in marine water, organisms and marine acquired wound cultures

Marine Infections

Erysipelothrix rusiopathaie

- gram + rod
- found in wild and domestic animals , birds and fish
- occupational hazard for fisherman, fish handlers
- inoculation by abrasion or puncture
- pain, burning and stiffness of adjacent joints
- hard swelling with irregular violaceous color
  → spread peripherally with central clearing
- can disseminate to endocarditis
- tx: penicillin, clindamycin or cephalexin x 3 weeks

Marine Infections

Mycobacterium marinum

- atypical mycobacterium
- grows well in pools, aquaria and seawater
- wound in contact with aquarial or seawater, fish, crustacean or turtles
- 2-8 week incubation period
- suppurates and develops organized granulomas with ulceration
- diagnosis by biopsy, culture and acid fast staining
- treatment: ethambutol plus rifampin, tetracylines, quinolones or sulfa
  minimum 4 - 6 week course

Marine Infections

Vibrio vulnificus

- gram (-) rod
- diarrhea (enteral exposure via raw oysters)
- wound infections in immunosuppressed
    - cirrhosis, renal disease, chemotherapy patients and HIV
- inoculation by puncture from shellfish or wound contaminated by seawater
- rapid progressive cellulitis with characteristic bullous lesions
    - necrotizing vasculitis, myositis, DIC or sepsis
- diagnosis made by stool, wound or blood cultures
- tx: debridement of wounds

  antibiotics = tetracyclines, 3rd gen cephalosporins or imipenem

Marine Infections

Vibrio parahemolyticus

- acute food poisoning scenario
- abd cramping, explosive watery diarrhea and dysentery
- also can cause wound infections
- usually self limited

Wound Infections

Acinetobacter
Actinomyces
Aeromonas
Alcaligenes
Alteromonas
Bacillus
Bacteroides
Chromobacterium
Clostridium
Deleya
Enterobacter
Erysipelothrix
Legionella
Mycobacterium
Pasteurella
Proteus
Pseudomonas
Salmonella
Staphylococcus
Streptococcus
Vibrio

*Organisms found in marine water, organisms and marine acquired wound cultures