Plans for World Wide Public Health Risk Assessment and Regulations for Hygienic Quality of Beach Sand and Beach Water

João Brandão
A beach on the south coast of Lisbon during a misty day in the Summer
• “From a recreational viewpoint, sand beaches are sought after. Especially in higher latitudes, a significant percentage of time is spent on the beach itself rather than in the water.”

• “A number of genera and species that may be encountered through contact with sand are potential pathogens. Accordingly concern has been expressed that beach sand may act as reservoir of vectors of infection.”

Examples of infections that may be passed on by sand (to non-immunocompromised individuals)

- **Staphylococcus aureus** infection (Staph)
- Dermatomycosis by a dermatophyte (ring worm)
- Onychomycosis – nail infection by keratinophilic fungus
- Gastroenteritis
Population with increased risk without specific disorders

Children

Pregnancy

Elderly
An example of a plate of fungal analysis

Malt plates inoculated with sand wash 100 rpm/30’, 1:1 w/v (10^0 and 10^{-1} dilutions) 5 days growth at 27.5(+/2.5) °C – mainly *Penicillium* spp and *Aspergillus fumigatus* visible
Sunlight? No!

- 2009 Mika et al. showed that irradiation during day time doesn’t help reducing *E. coli* in the sand

- Fungi are very resilient, even in drier climates
<table>
<thead>
<tr>
<th>Pathologies</th>
<th>Species</th>
<th>Natural reservoirs</th>
<th>Endemic Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phaeohyphomycosis</td>
<td>Exophiala spp</td>
<td>Water, Soils with organic matter, Decaying wood</td>
<td>Worldwide</td>
</tr>
<tr>
<td></td>
<td>Sporothrix schenckii</td>
<td>Soils with organic matter, Decaying wood</td>
<td></td>
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<tr>
<td></td>
<td>Phialophora spp</td>
<td>Soils, Plants and decaying food</td>
<td></td>
</tr>
<tr>
<td>Coccidiomycosis</td>
<td>Coccidioides spp</td>
<td>Dry Soils</td>
<td></td>
</tr>
<tr>
<td>Paracoccidiomycosis</td>
<td>Paracoccidiodes brasiliensis</td>
<td>Warm-blooded animals, protein-rich and humid soils</td>
<td>American continent</td>
</tr>
<tr>
<td>Histoplasmosis</td>
<td>Histoplasma capsulatum</td>
<td>Soils contaminated with bat guano and bird droppings</td>
<td>Worldwide but more frequent in tropical areas and southern USA</td>
</tr>
<tr>
<td></td>
<td>Histoplasma duboisii</td>
<td></td>
<td>Sub-saharan Africa</td>
</tr>
<tr>
<td>Dermatophycomycosis (ringworm, onycomycosis, tinea capitis)</td>
<td>Epidermophyton floccosum</td>
<td>Warm-blooded animals</td>
<td>Worldwide</td>
</tr>
<tr>
<td></td>
<td>Trichophyton spp</td>
<td>Soil and warm-blooded animals</td>
<td></td>
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<tr>
<td></td>
<td>Microsporum spp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cryptococcosis (meningitis/respiratory and systemic infections)</td>
<td>Cryptococcus spp</td>
<td>Soils contaminated with bird faeces and decaying wood for C. gattii</td>
<td>Worldwide</td>
</tr>
<tr>
<td>Chromoblastomycosis</td>
<td>Fonsecae spp</td>
<td>Soils and decaying wood</td>
<td>Humid tropical regions</td>
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<tr>
<td></td>
<td>Madurella spp</td>
<td>Soils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cladophialophora spp</td>
<td>Soils and decaying wood</td>
<td></td>
</tr>
<tr>
<td>Salmonelosis</td>
<td>Salmonella spp</td>
<td>Animals</td>
<td></td>
</tr>
<tr>
<td>Typhoid fever</td>
<td>Salmonella tiphii</td>
<td>water</td>
<td></td>
</tr>
<tr>
<td>Gastroenteritis, Haemorrhagic fever</td>
<td>Escherichia coli, Enteric pathogenic bacteria</td>
<td>Warm-blooded animals</td>
<td></td>
</tr>
<tr>
<td>Gastroenteritis, Sepsis</td>
<td>Vibrio parahaemolyticus Vibrio vulnificus</td>
<td>Aquatic environments, seafood</td>
<td></td>
</tr>
<tr>
<td>Cholera / gastroenteritis</td>
<td>Vibrio cholera</td>
<td>Surface of plants, filamentous algae, zooplankton, Crustaceans and insects. Biofilms</td>
<td>Worldwide</td>
</tr>
<tr>
<td>Gastroenteritis, poliomyelitis, Hepatitis</td>
<td>Enterovirus, HepA virus</td>
<td>water</td>
<td></td>
</tr>
<tr>
<td>Giardiosis</td>
<td>Giardia duodenalis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cryptosporidosis</td>
<td>Cryptosporidium sp</td>
<td>Water, soil, food &amp; animals</td>
<td></td>
</tr>
<tr>
<td>Toxoplasmosis</td>
<td>Toxoplasma gondii</td>
<td></td>
<td></td>
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<tr>
<td>Helminthias</td>
<td>Helminths</td>
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</table>
Continental Portugal
There is data from most of the last century on beach sand contaminants; mainly bacterial, some fungal and some for parasites.

1989 - Mycology group looking into fungi in sand (joint study with Portuguese National Directorate of Health).

For 10 years, several beach sands were screened for fungi, following different approaches.
Project # 1 & 2

Structure/Methods/Parameters/Standards

2000 – 2002
&
2002-2006
Project 1: Structure beach sand quality analysis including parameters and associated methods:

“Microbiologic Quality of Coastal Beach Sands”

Participants:

- Portuguese Blue Flag Association,
- The National Institute of Health Dr. Ricardo Jorge,
- The General Directorate of Health (DGS),
- The Environmental Institute (APA),
- The Water Institute (INAG),
- The City Hall of Cascais,
- The City Hall of Viana do Castelo
5 Regions – Bimonthly sampling during 13 months

3 beaches per region:
1 Beach awarded with the Blue Flag
1 Beach with no direct human interference
1 Beach with documented poor water quality

210 sand samples
105 water samples
Distribution of fungal abundance in sea water, dry sand and wet sand

Observation: Despite the direct sunlight on sun surface and high temperature in the summer, fungi seem resilient enough to be still found mainly on dry sand.
Project 2: ICREW – “Improving Coastal and REcreational Waters for all”

EU funding (8M€), 5 EU countries, 19 institutions*,
7 pilot actions**

Report available available at:

http://www.interreg-atlantique.org/upload/resultats/ICREW_FINAL_REPORT.pdf
**Pilot Actions:**

- PA 1 - Sampling and data review
- PA 2 - Resolving diffuse pollution
- PA 3 - Developing pollution source tracking
- PA 4 - Forecasting bathing water quality
- PA 5 - Re-identification of recreational waters
- PA 6 - Sustainable sewage solutions
- PA 7 - Understanding and managing algae
Mycological parameters for sand quality assessment

- Yeasts (a): Faecal contamination indicators
- Potentially pathogenic and allergenic molds (b)
- Dermatophytes (c): Indicators of animal presence, including humans
Reference values for sand quality assessment based on national means

<table>
<thead>
<tr>
<th>Mycology Parameters:</th>
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<tbody>
<tr>
<td>1. Yeasts</td>
</tr>
<tr>
<td>2. Potential pathogenic moulds (filamentous fungi)</td>
</tr>
<tr>
<td>3. Dermatophytes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bacteriology Parameters:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total coliforms</td>
</tr>
<tr>
<td>2. <em>E. coli</em></td>
</tr>
<tr>
<td>3. <em>Enterococci</em></td>
</tr>
</tbody>
</table>
Project # 3

Parameter consistency/Reference Values
“Sand quality monitoring programme”

Promotion: Blue Flag Association
Laboratories: Portuguese NIH and APA
Duration: 2006-2010
Nr of beaches monitored: 61 in 2006 till 81 in 2010
Nr of samples of sand analyzed: 1206
Nr of beaches monitored during the 5 years consecutively: 33
(corresponding to 495 of the 1206 samples)
Some results

• 60.4% of the samples were positive for the reference fungal species
• 25.2% were positive for the three bacterial groups
• 33.3% were negative for all the parameters
• 20.2% were positive for both fungal and bacterial parameters
• Yeasts and dermatophytes tend to increase along the sampling periods
• Interesting relationships were found (i.e. Scopulariopsis spp and Dermatophytes, between yeasts and coliforms)
Pathogenic fungi: An unacknowledged risk at coastal resorts? New insights on microbiological sand quality in Portugal

Raquel Sabino, Cristina Veríssimo, Maria Ana Cunha, Bela Wergikoski, Filipa C. Ferreira, Raquel Rodrigues, Helena Parada, Leonor Falcão, Laura Rosado, Catarina Pinheiro, Eleonora Paixão, João Brandão

A National Institute of Health Dr. Ricardo Jorge, Av. Padre Cruz, 1619-016 Lisboa, Portugal
b Portuguese Environmental Agency, Apartado 7585, 2611-865 Amadora, Portugal

Whilst the potential impact on beach users from microorganisms in water has received considerable attention, there has been relatively little investigation into microbial contaminants in sand. Thirty three
Proposed values for sand quality assessment based on the high 95 percentile

**Mycology Parameters:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CFU/g</th>
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<tbody>
<tr>
<td>1. Yeasts</td>
<td>15</td>
</tr>
<tr>
<td>2. Potential pathogenic moulds (filamentous fungi)</td>
<td>17</td>
</tr>
<tr>
<td>3. Dermatophytes</td>
<td>8</td>
</tr>
</tbody>
</table>

**Bacteriology Parameters:**

<table>
<thead>
<tr>
<th>Parameter</th>
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<tbody>
<tr>
<td>1. <em>E. coli</em></td>
<td>25</td>
</tr>
<tr>
<td>2. Enterococci</td>
<td>10</td>
</tr>
</tbody>
</table>
Beach managers were instructed on how to control contaminant levels.

Result: Drastic reduction of contaminant levels from the first sampling (pre-bathing season) to the following two (during bathing season) after the first year of the project (2006)
Overall recommendations
Factors that positively influence the quality of beach sand

• Garbage removal - Frequent removal of litter and garbage from sand and neighbouring areas;

• Garbage receptacles - Number of garbage receptacles appropriate for the length of the beach;

• Sand treatment - based on experience of one region with weekly iodine spraying (this statement does not express the point of view of the authors);

• Surroundings - Identification and treatment of neighbouring contaminated areas
Factors that negatively influence the quality of beach sand

• Over-use of beach
• Admission of pets
• Accumulation of garbage
• Abandonment of remains from fishing
• Rodents and prowling animals
Education of the public

NA AREIA
deixe apenas a sua pegada

O lixo que deixa na areia faz com que se desenvolvam fungos e bactérias prejudiciais para a saúde humana e influencia o Ambiente.
Education of the public
Timeline

• Blue Flag monitoring programme 2006-2010 Reached 25% of all the beaches of Portugal

• September 2011 – Workshop in Michigan City to prepare a review paper on all published on sand and water microbial interaction and related public health threats (submitted)

• 2011-2013: INSA – Molecular analysis and detection of virus and parasites (delayed due to financial contingencies)

• 2012 Workshop to debate parameters and indicators (published in Science of the Total environment)

• 2013 Launch of inter-lab network with yearly meetings for discussion of results and approaches to technical issues
Currently?

- We provide the service to the community.

- Doing research in order to implement molecular detection for faster results of some parameters.

- Extension of the analysis to specific fungal and bacterial pathogens, viruses (wet sand) and parasites (both wet and dry sand), especially foreign and as result of importing renourishing sands from abroad.

- Networking with other research groups around the world.

- Preparing an **international white letter/recommendation**, by scientists as a deliverable of an international meeting that will take place in Lisbon, PT, in September: [www.temph2014.com](http://www.temph2014.com)
Introduction
Environmental microbiology is an evolving science. This is in part driven by changes and development of new analytical techniques that are becoming more varied and powerful. Before application, emerging issues and technical need to be discussed among scientists, technical professionals, practitioners, and students. The TEMPH will provide a forum to discuss emerging pathogens, microbial toxins and resistance genes in air, water, sand and foodstuff in an environmental exposure context. Join us in Lisbon on September 18-21 for the inaugural session of this independent meeting – TEMPH2014.

“BRINGING TOGETHER KNOWLEDGE IN ENVIRONMENTAL MICROBIOLOGY”
Europe
Data from Europe

- UK (Coast)
- Italy (Coast)
- Austria (Inland beach)
- Canary Islands – Spain
- Continental Spain
- Azores (Açores) - Portugal
- Madeira – Portugal
- Greece (One island)
- France (Old data – coast)
USA

• A lot of data on bacteria (several states), mainly FIB data especially from the great lakes and Pacific regions but not only! (E.g. MLRS hospital strains types found in intertidal sand and water in Washington 2009 (Soge et al.))

• Prof. Fujioka published many papers on soil and sand contamination-one of the leading experts world-wide.

• Yeasts and parasites also (Miami)
Rest of the World

• Algeria – Bacteria
• Maroco - Fungi
• Iran – Bacteria
• Brasil – São Paulo – Bacteria
• Malasia – Fungal analysis
Remarks

• WHO has yet to recommend sand monitoring. Why???

• It’s time to implement and regulate

• Scientists world-wide are organising themselves but can only recommend. Regulatory agencies need to step in!!
White Letter Members

- Brandão, J – NIH Lisbon, PT
- Edge, T – Environment Canada, CA
- Fujioka, R – HI Univ/WRRC. HNL, USA
- Kay, D – Aberystwyth Univ. Wales, UK
- Hagen, F – CBS, The Netherlands
- Harwood, VJ – USF, USA
- McLellan, S – UWM – WI, USA
- Rodrigues, R – NIH Lisbon, PT
- Sabino, R – NIH Lisbon, PT
- Samson, R - CBS, The Netherlands
- Sato, MI – CETESB – S. Paulo – BR
- Solo-Gabriele, H – Univ.Miami, USA
- Taylor, H – Brighton Univ. Brighton, UK
- Veríssimo, C – NIH Lisbon, PT
- Viegas, C – ESTSEL, Lisbon, PT
- Whitman, R – USGS, IN, USA
- Wither, A – NOC, Liverpool, UK
Waikīkī beach
Algarve – Southern coast of Portugal