Mecanismo e função da bioluminescência em fungos

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Research | what have we been doing?

**bioluminescent fungi**

**field work**
- species survey
- mushroom collection/identification
- mycelium/mushroom growth (in lab)
- expertise: mycologists
- function
- green-LED traps
- insect collection/identification
- statistics on collected specimens
- expertise: entomologists

**lab work**
- mechanism
- substrate/enzymes identification
- synthesis mechanistic studies
- expertise: (bio)chemists
- bioassay
- improve: detection, repeatability, signal
- increase number of substances tested
- expertise: toxycologists

**expertise**:
- mycologists
- entomologists
- (bio)chemists
- toxycologists

**species survey**
- function
- statistics on collected specimens
- synthesis mechanistic studies
- bioassay
- increase number of substances tested
- expertise: toxycologists
Jungles
Episode 3 of 6

Jungles provide the richest habitats on the planet - mysterious worlds of high drama where extraordinary animals attempt to survive in the most competitive place on earth. Flooded forests are home to caiman-hunting jaguars and strange dolphins that swim amongst the tree tops, while in the dense underworld, ninja frogs fight off wasps and flying dragons soar between trees. Acrobatic indri leap through the forests of Madagascar, while the jungle night conceals strange fungi and glow-in-the-dark creatures never filmed before.
Overview | organization of this presentation

1. Introduction
2. Field work and species survey
3. Mechanism of light emission
4. Biological function of bioluminescence
Morphology and number of species

- **Mycelium**
- **Hyphae**
- **Pileus** (cap)
- **Stipe** (stem)
- **Lamelae** (gills)
- **Spores**

**Functions**

**1. Introduction**

- **Basidiomycetes** (100,000 species)
- **Order Agaricales**

- 70% (100,000 species)
- 21%
- 9%
- 0.1%

Fungi Kingdom

- 9,000
- 102
Bioluminescent fungi | distribution

1. Introduction

2. Field work

3. Functions

North America
- Mycenoid: 17
- Lucentipes: 8
- Armillaria: 3
- Omphalotus: 2

Central America
- Mycenoid: 7
- Lucentipes: 5
- Armillaria: 1
- Omphalotus: 2

South America
- Mycenoid: 23
- Lucentipes: 19
- Armillaria: 2
- Omphalotus: 1

Europe
- Mycenoid: 31
- Lucentipes: 26
- Armillaria: 3
- Omphalotus: 2

China
- Mycenoid: 38
- Lucentipes: 34
- Armillaria: 3
- Omphalotus: 2

Japan
- Mycenoid: 7
- Lucentipes: 4

Malesia
- Mycenoid: 9
- Lucentipes: 4

Australasia
- Mycenoid: 26
- Lucentipes: 22
- Armillaria: 3
- Omphalotus: 1

Other regions
- North America
- Pacific Island
- Central America
- South America
- Africa
- Malesia
- SE Asia
- S Asia
- SE Asia
- Japan
- China

Regions
- North America
- South America
- Central America
- Pacific Island
- Africa
- Malesia
- SE Asia
- S Asia
- Japan
- China

Colors
- Mycenoid
- Lucentipes
- Armillaria
- Omphalotus
Bioluminescence | basic principles

Bi•o•lu•mi•nes•cence |ˌbīˌöōməˈnesəns| (BL) the biochemical emission of visible light by living organisms such as fungi, fireflies and deep-sea fishes.

1. Introduction

Functions

Functions

Field work

Field work

1. Introduction
Fungi collection

102 species of bioluminescent fungi currently described in 4 distinct evolutive lineages: Omphalotus, Armillaria, Lucentipes e Micenoid

15 out of 102 species (~15%) were described by our group since 2001
How do fungi emit light?

Overall mechanism:

1. Introduction
2. Field work
3. Functions
4. Mechanism

hispidin + NAD(P)H + O₂ + H⁺ → hispidin-OH + NAD(P)⁺ + H₂O

- soluble protein
- cofactor: NADH or NADPH
- MW = 35 kDa

hispidin-OH + O₂ → oxyluciferin + hv

- membrane protein

How do fungi emit light? | mechanistic proposal
How do fungi emit light? | mechanistic proposal

Highlights
* fungal luciferase is a promiscuous enzyme
* it is possible to modulate color with substrate
* first bioluminescent system with endoperoxide
* luciferin is present in plants, like orchids!
Why do they emit light?

- a 24h-rhythm is called circadian
- circadian rhythm keeps constant with temperature
Why do they emit light? | rhythm

- luciferin concentration and expression/activity of enzymes also follow a circadian rhythm
Why do they emit light? | hypotheses

**Probable**

- to attract fungivores for spore dispersal
- to attract predators of fungivores
- to repel photophobic insects
- as warning signal


**Improbable**

- ambience illumination
- heating light
- aircraft taxing

Pixar’s *A Bug’s Life* © (1998)
Why do they emit light? | hypotheses

Coconut Forest

Neonothopanus gardneri
Why do they emit light? | hypotheses

Atlantic Rainforest

Mycena luxaeterna
Why do they emit light? | hypotheses
Why do they emit light? | hypotheses

Atlantic Rainforest

- higher biodiversity than Babaçu Forest
- more frequent on LED traps: flies, aphids, beetles, spiders and crickets
- large insects such as cockroaches and spiders cannot be captured
Why do they emit light? | hypotheses

Coconut Forest

- lower biodiversity than Atlantic Rainforest
- more frequent on LED traps: flies, ants, beetles and aphids
- large insects such as cockroaches and spiders cannot be captured
Why do they emit light? | hypotheses
Why do they emit light? | IR videos | Coconut Forest

- Click beetles visit mushrooms in pairs
  2 females (?)

- Earwigs live inside mushrooms

- Spiders eat cockroaches

- Cockroaches eat mushrooms

- Ants seem lost and wander in circles
Collaborators

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Forest Guide