Now You See Me, Now You Don’t: Colorful Strategies for Surviving in Nature

Dr. Molly Cummings
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Now You See Me: Now You Don’t

Dr. Molly Cummings
Why the grand diversity in color?

- To communicate with Predators?
- To hide from Predators?
- To communicate to others of its own kind?
- Some combination of all three?
Why the grand diversity in color?

- To communicate with Predators?
- To hide from Predators?
- To communicate to others of its own kind?
- Some combination of both Natural & Sexual Selection?

Photos by J.L. Brown
Image of all sorts of Animal Eyes

Yellowjacket
Fly
Dragonfly
Owl
Jumping Spider
Ant Lion
Crocodile
Dynamics of Light

• Brightness: How much light there is

• Color: Wavelengths of light

• Polarization: Direction of vibrating light waves
Why the grand diversity in color?

- Is it to communicate with predators?
- Is it to hide from predators?

Natural Selection

To Hide or Not to Hide....

- Hide (not be detected)
- Advertise your nastiness

Leaf Insect
Arctic Fox
Coral Snake
Skunk
Poison Dart frogs use their bright colors to communicate to predators that they are toxic ("aposematism" or warning coloration).

How do poison dart frogs get their name?
Capt. Charles Cochrane described the effect (1825): “A tiger when hit, runs ten or a dozen yards, staggers, becomes sick, and dies in 4 or 5 minutes.”
How do poison dart frogs get their poisons?

By eating toxic Bugs!
The famous strawberry poison frog

One of the most colorful animals on earth
Strawberry Poison Frog

Are the different colors communicating different information?
Brighter populations are more toxic.

Birds (major predators) can see this relationship.

Maan & Cummings 2012
Brightness is an indicator of Toxicity

• Frog populations on islands with few toxic prey, became less toxic, and became less bright.

• Frog populations on islands with LOTS of toxic prey, became MORE toxic, and BRIGHTER.
Do birds really pay attention to these warning colors?
Naïve Chickens (unfamiliar with poison frogs) don’t avoid the poison frog.
But experienced chickens...
But experienced chickens do avoid their local poison frogs.
Experienced chickens *also* avoid novel, *bright* colored frogs.
Why are there so many different colors?

Natural Selection

1) Brightness informs predators how nasty the frogs are

2) Once they’ve learned that one bright color is nasty, they also avoid OTHER bright colors
SEXUAL SELECTION

Animals have to attract mates

Animals evolve traits that make them attractive
Frog Mate Choice Arena
Females prefer brighter males
Natural & Sexual Selection Operating Together

- Colors/Brightness indicate Toxicity
  - Less Toxic Frogs -> HIDE
  - More Toxic Frogs -> ADVERTISE

- Predators GENERALIZE their avoidance to new colors

- Mates may drive the evolution of Brighter colors

Less Toxic & Cryptic

More Toxic & Conspicuous
Now You See Me: Now You Don’t
Dynamics of Light

- Brightness
- Color
- Polarization
Two places on earth where light is LARGELY polarized
What if YOU could see polarized light?
Many animals can see polarized light and some use it to communicate.
MANY animals can see polarized light & some use it to communicate

Video: Viktor Gruev
SEXUAL SELECTION

Degree of Linear Polarization

85%

25%

Diffusion Tank

Polarizer

Diffusion Tank

Diffusion Tank
SEXUAL SELECTION

Degree of Linear Polarization

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Diffusion Tank

Polarizer

Diffusion Tank

Polarizer
SEXUAL SELECTION

What a Handsome Polarized Gentleman!

Females prefer males with polarized ornamentation.
Why the grand diversity in color?

To hide...........

- **Hide (not be detected)**
Why the grand diversity in color?

To hide.........but in the ocean?
NATURAL SELECTION
How do you hide in the polarized light field of the open ocean?

- High Noon === Easy === act like a mirror

![Diagram of light field and angle measurements](image)
How do you hide in the polarized light field of the open ocean?

- Sunset
- More Complex
- Mirror won’t work

Brady et al. 2013
Has nature conquered this problem?

• (1) Build a Videopolarimeter (Dr. Parrish Brady)

• (2) Go SCUBA diving with it

• (2) Measure fish
Field measurements in the Florida Keys and in Curaçao
Measuring the Biological Response to the Polarized Underwater Light Field Curacao 2012
We took 1000s of measurements.
Who is going to win the Camouflage Contest? Mirror vs Fish
NATURAL SELECTION

Who is going to win the Camouflage Contest?

Mirror vs Fish
Who is going to win the Camouflage Contest?
Fish vs Mirror

NATURAL SELECTION

Fish WINS!

Mirror Man WINS!
NATURAL SELECTION

And the Winner is......
NATURAL SELECTION
And the Winner is...... The FISH!!!
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THANK YOU
Molly Cummings is a professor at UT Austin. Her research examines how communication traits evolve in animals, using fieldwork and behavior experiments to discover what drives such communications. She has initiated studies examining how animals achieve crypsis in a dynamically changing aquatic environments at a molecular level, and with particular emphasis on the polarized light field. Her lab is also developing experimental techniques to characterize real-time dynamic camouflage in the lab and field as well as identify the internal coordination of the cells involved in orchestrating camouflage (melanophores, chromatophores and iridophores) along with the neutral color of their movements.