Potential causes for amphibian declines in Puerto Rico

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Purpose

- Summarize findings on the current status of Puerto Rican Amphibians
- Transect surveys
- Geographical monitoring
- Climate association
- Report on Disease Diagnosis – Chytrid Fungus
- Populations affected
- Incidence
- Present recent direction of our research

Three species presumably extinct!

- E. karschmidtii
  - 1976...
- E. jasperi
  - 1981...
- E. eneidae
  - 1990...

Population Effect: disappeared without re-colonization at localities in El Yunque, still abundant in other localities within the Carite Forest

Long Term Data of Transect Surveys :

<table>
<thead>
<tr>
<th>Species</th>
<th>Site</th>
<th>Years</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coqui</td>
<td>El Yunque Ghost Forest (661 m)</td>
<td>1991 – 2000</td>
<td>9 yrs</td>
</tr>
<tr>
<td>E. coqui</td>
<td>UPR campus (2), UPR campus (2), Botanical Gardens, Garden Hills, San Patricio Forest, Cuyey (2) - Elfin Forest (850 m)</td>
<td>1991 – 2004</td>
<td>13 yrs</td>
</tr>
<tr>
<td>E. coqui</td>
<td>San Lorenzo (300 m)</td>
<td>1991 – 2004</td>
<td>15 yrs</td>
</tr>
<tr>
<td>E. coqui</td>
<td>Elfin Forest (850 m)</td>
<td>1991 – 2004</td>
<td>15 yrs</td>
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</table>

Population Effect:

- Recovering in the Elfin Forest of El Yunque (850 m)
- But... still declining in the PC forest 661 m)
Lowland species are stable

- E. coqui
- E. coqui
- E. cooki
- Leptodactylus albilabris

What is going on at high elevations?
- Climate change *
- Disease *
- Introduced species and pet trade *
- Ultraviolet-B radiation
- Chemical contaminants
- Acid rain and soil
- Habitat modification or fragmentation
- Synergisms*

Significant increase in temperature of warm season (May – Oct) at El Yunque over past 30 years

Precipitation at El Yunque for the Past 30 Years

Climate change over the past 30 years?
- We observed changes that could result in stressful environmental conditions:
  - Min. Temperature has increased significantly
  - Unusually dry years in the 1970’s and early 1990’s

Chytrids (Bd) in Puerto Rico?
- Present? Past?
- Frogs examined:
  - 170 preserved specimens – KU & private in 8 species collected 1951 – 1982 (Histology-DEG)
  - ~300 free living – collected 2000—2004 in P.R. and D.R. (Histology and PCR-Pisces)
Results: Chytrids are in Puerto Rico!

In *E. coqui* from the KU museum, collected at El Yunque (1978) and present

In *E. portoricensis* collected at El Yunque (2003-present)

In the last collected *E. karlschmidtii* at El Yunque (1976)

When did chytrids (*Bd*) arrive in P.R.? Not present in samples from the 1951—1967

Temperature

Precipitation

Working Hypothesis

- Synergistic Effect:
  
  Climate change – DROUGHT = frogs could not rehydrate :

  → ENVIRONMENTAL STRESS

  →.clumping in humid patches where the CHYTRID fungus was more likely to occur

  → Epidemic

  Rapid extirpations of more vulnerable species and selected populations

These results have been published

*Current direction of our research...*
Questions:
- Will *Eleutherodactylus coqui* change their distribution pattern when stressed for water?
- Will frogs clump at diurnal retreat sites?

Experimental design:
- Six terrariums:
  - 3 Control: Water (250 mL) on all ground surface
  - 3 Experimental: Water (100 mL) in one half only
- Same retreat sites available at each side.

Data collection:
- Location of frogs was noted before water was added — every 3 days, for 2 weeks.

Results:
- Frogs moved to the humid side of the terrarium after three days without water.
- Control frogs used all the retreat sites available throughout the terrarium.
- Frog distribution differed significantly among sides in experimental terraria only ($T = 7.62, P < 0.001, n=30$).
- There was a significant treatment effect ($F_1, 35 = 13.60, P = 0.001$).

Conclusions:
- Coqui frogs tend to clump in humid patches when water is limited.
- Sharing of humid patches as retreat sites represents a potential for contamination and spread of chytrid fungi.
- Next: infection experiments
GAA report 2004:
- 32.5% of the Amphibians are threatened worldwide—far more than birds (12%) or mammals (23%).
- 56.8% of rapidly declining species occur in tropical montane forests.
- Causes: Overexploitation, habitat loss and "Enigmatic declines"
- "Enigmatic declines" mostly in LA and Australia
- From a regional perspective the Caribbean is the most threatened - 87% species

What about Chytrids in other Greater Antilles?
- Dominican Republic?
- Cuba?
- Jamaica?

Dominican Republic: Cordillera Central
Two localities:
- 1. Ebano Verde
  - 1440 m
- 2. Valle Nuevo
  - 2500 m

Chytrids in Dominican Republic!

Incidence of Present Chytrid Infection

<table>
<thead>
<tr>
<th>Locality</th>
<th>Species</th>
<th>Total No. samples</th>
<th>Incidence %</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR – El Yunque (661 m)</td>
<td>E. coqui</td>
<td>102</td>
<td>22</td>
</tr>
<tr>
<td>PR – El Yunque (850 m)</td>
<td>E. coqui, E. portor...</td>
<td>30, 9</td>
<td>10, 55</td>
</tr>
<tr>
<td>DR – Ebano Verde (1440 m)</td>
<td>E. pitinus, H. vasta</td>
<td>2, 4</td>
<td>100, 100</td>
</tr>
<tr>
<td>DR – Valle Nuevo (2500 m)</td>
<td>E. patriciae</td>
<td>4</td>
<td>100</td>
</tr>
</tbody>
</table>

¿If coquis have chytrids why are they still alive?
- Synergy between climate and disease may play important role in the prevalence of the pathogen
  - Dry/cool months disease thrives - populations crash
  - Wet/warm months - survivors carry disease at low levels - populations recuperate
  - Disease prevails
- Australia as a case study: (Retallick et al. 2004)
- Ecology generalists versus specialists
In summary:
- Current status of Puerto Rican Anurans:
  - 3 extinct species (k, j, e)
  - Declining populations in 7 species (c, p, r, l, w, g, Pl)
  - Population effect?
- Climate change in the past 30 years:
  - Min. Temperature has increased significantly;
  - Unusually dry years in the 1970's and early 1990's
- Chytrid infections: in *Eleutherodactylus* as early as 1976 – is one possible explanation for the declines
- Prevalence of disease: study in progress
- Exotic anurans: represent a threat as potential competitors and disease carriers

We know the chytrid is in El Yunque.

**How can we prevent the spread?**

- 10% chlorine bleach solution

Is it in Patillas?

- **YES!**

Incidence:
- *E. coqui*: 50%
- *E. wightmanae*: 44%

Earthwatch volunteer involvement
- Monitor populations of *E. m* and *E. c* at "Casa de La Selva"
- Determine density of juveniles and adults in two 50 x 3 m forest transects
- Evaluate impact of forest management on amphibian populations
- Determine sex ratio
- Investigate population fluctuations between summer and winter months
  - Frog density
  - Reproductive activity
  - Incidence of Chytridiomycosis

Acknowledgments
- Many students at UPR –Río Piedras and Cayey Dept of Biology at UPR –Río Piedras
- Toyota Foundation
- US Fish and Wildlife Service
- Fideicomiso de Conservación de P.R.
- DNA of Puerto Rico
- DAPTF
- RANA

Preliminary Data

**Summer 2004**: Max.
- *E. coqui*: 68 indiv (48% juv)
- *E. wightmanae*: 161 indiv (38% juv)

**Winter 2004-2005**: Max.
- *E. coqui*: 33 indiv (60% juv)
- *E. wightmanae*: 195 indiv (59% juv)

No significant difference in density or diversity of amphibians has been observed between disturbed and undisturbed areas of the transect – Thus, there is no observable impact of "La Selva’s" forest management on amphibians.