Vanishing endemic frugivorous birds and endangered plants in the islands of Eastern Polynesia (South Pacific): an extinction cascade?

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Introduction.
The biodiversity crisis...is on islands!

- Relatively high species richness
  (10-20% of all species on only 3% of the world land area)
- Very high endemism (89% for the flowering plants in Hawaii, 75% in New Caledonia, 65% in French Polynesia)
- Spectacular adaptative radiations (e.g. Galápagos finches, Hawaiian honeycreepers & lobeliads)

45 endemic honeycreepers
(endemic subfamily Drepanidinae)

Vestiaria coccinea

110 endemic lobeliads
(6 endemic genera, Campanulaceae: Lobelioidae)
- **Massive extinction events following human colonization** (80% of all extinct birds since 1600)

- **Endangered biota** (90% of all the threatened birds, 2.5 x more threatened plants on islands)

- **10 of the 34 “Biodiversity Hotspots”** (areas with high endemism and high level of threat)
Extinction cascades

- **Chains of extinction** = one of the “Evil Quartet” (Diamond 1989)

- **Disruption of plant-animal interactions** (e.g. pollination, seed-dispersal, Kaiser-Bunbury *et al.* 2010)

- **Keystone species** (e.g. feeding guilds) critical for natural ecosystem functioning

- **Extinction of ca. 2,000 bird species in the tropical Pacific Islands** since human occupation (Olson & James 1982, Steadman 2006)

- **“Are large seeds still being dispersed in the Tropical Pacific?**” (McConkey & Drake 2002)
Case study.

Birds & plants in Eastern Polynesian islands

- No fruit bats & flying foxes (except in the Cook Is.) ⇒ frugivorous birds as keystone seed dispersers
- Bird fossils relatively well studied for the last 20 years (Steadman, 1985-2006)
- Archipelagoes as a model system (each island can be considered as a sample)
One of the most remote archipelago on Earth

- A “galaxy” of ca. 135 small volcanic island (0.03-30 M yrs old)
- > 5,000 km from the nearest continents
- Disseminated over 5 million km² of ocean
- Human occupation 2,000 years ago
Three waves of extinction

- **Prehistoric/Polynesian period**: over-hunting, forest clearance and fire, introduction of domestic animals (dogs, pigs, Pacific rat…)
- **Historic/European period (250 years ago)**: over-exploitation of natural resources, introduction of grazing mammals, predatory animals, invasive plants…
- **Contemporary/Modern period**: the “globalization era”, more habitat loss and alien species invasion, the threat of climate change…

- Pacific rat *Rattus exulans*
- Deforestation and mining, Makatea island (Tuamotu)
- Swamp harrier *Circus approximans*
- Over-hunting
Contemporary extinction or decline of monarchs (flycatchers) *Pomarea* caused by ship rats *Rattus rattus*

Extinct birds and feeding guilds

- **Plant-eaters**: rails *Gallirallus*, swamphens *Porphyrio*, sandpipers *Prosobonia*
- **Seed-eaters**: parakeets *Cyanoramphus*, ground-doves *Gallicolumba*
- **Nectarivores**: lorikeets *Vini*
- **Insectivores & molluscs**: crakes *Porzana*, kingfishers *Halcyon*, monarchs *Pomarea*, reed-warblers *Acrocephalus*
- **Frugivores & seed dispersers**: cuckoo-doves *Macropygia*, fruit-doves *Ptilinopus*, imperial-pigeons *Ducula*, starlings *Aplonis*
Extinct and Extant Landbirds in the Marquesas Is.
(modified after Steadman, 2006. P = Prehistoric ; H = Historic ; M = Modern)

<table>
<thead>
<tr>
<th>Islands (Marquesas)</th>
<th>Nuku Hiva</th>
<th>Hiva Oa</th>
<th>Ua Huka</th>
<th>Tahuata</th>
</tr>
</thead>
<tbody>
<tr>
<td>HERONS</td>
<td>1 M</td>
<td>1 M</td>
<td>1 M</td>
<td>1 M</td>
</tr>
<tr>
<td>RAILS</td>
<td>2 P + 1 M</td>
<td>2 P + 1 M</td>
<td>3 P</td>
<td>2 P + 1 M</td>
</tr>
<tr>
<td>SANDPIPERS</td>
<td>0</td>
<td>0</td>
<td>1 P</td>
<td>0</td>
</tr>
<tr>
<td>PIGEONS, DOVES</td>
<td>2 P + 1 H + 2 M</td>
<td>3 P + 1 H + 1 M</td>
<td>5 P + 1 M</td>
<td>3 P + 1 M</td>
</tr>
<tr>
<td>PARROTS</td>
<td>2 P + 1 M</td>
<td>2 P</td>
<td>2 P + 1 M</td>
<td>3 P</td>
</tr>
<tr>
<td>SWIFTS</td>
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<td>KINGFISHER</td>
<td>0</td>
<td>1 H</td>
<td>1 P</td>
<td>1 M</td>
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<td>WARBLERS</td>
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<td>1 M</td>
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<tr>
<td>MONARCHS</td>
<td>1 H</td>
<td>1 H</td>
<td>1 M</td>
<td>1 H</td>
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<tr>
<td><strong>Total species</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>M + H + P</strong></td>
<td><strong>15</strong></td>
<td><strong>15</strong></td>
<td><strong>18</strong></td>
<td><strong>15</strong></td>
</tr>
<tr>
<td><strong>Today !</strong></td>
<td><strong>7</strong></td>
<td><strong>5</strong></td>
<td><strong>6</strong></td>
<td><strong>6</strong></td>
</tr>
</tbody>
</table>
Bird extinction in Eastern Polynesian islands

- 7 archipelagoes and 29 islands
- 4 frugivorous taxa (*Ducula, Ptilinopus, Macropygia, Aplonis*)
- 25 of the 50 known bird species are currently extinct

Mangaia (Cook Is.) has lost all of its 6 Columbidae

![Ducula galeata, Nuku Hiva (Marquesas Is.)](image)
Large-fruited endemic plants

- SE Polynesia endemic woody species
- Threatened species (IUCN Red List) or Rare (unpub. data & pers. obs.)
- 12 genera (70 taxa) with large fleshy fruits > 1 cm diam./longest axis

- **Ochrosia** (Apocynaceae)
- **Ixora** (Rubiaceae)
- **Psychotria**
- **Hernandia** (Hernandiaceae)
- **Cyrtandra** (Gesneriaceae)
- **Santalum** (Santalaceae)
- **Neisosperma**
- **Nesoloma** (Sapotaceae)
- **Planchonella & Pouteria**
- **Pritchardia** (Arecaceae)
Mean number of threatened large-fruiting taxa

- Small island sample (29/135)
- Small plant sample (12 genera, 70 endemics, native plants not included)
- Lack of paleontological data in many islands for both birds and plants!

**n.s.** (Kruskal-Wallis test, p = 0.078)
Conclusions

- No seed dispersal = No seedling recruitment
  - The importance of seed predation by rats
- Conservation of “living-dead” plant species?
- Maintenance of the natural ecosystem functioning in island forests?
- Bird diet shift towards alien invasive plants!
  - (E. Spotswood, this symposium)
- Taxon substitutions as functionnal replacements or ecological analogues for extinct species?
  - (C. Griffiths, this symposium)
- “Increased collaborations between ecologist and paleontologist would promote a better understanding on natural ecosystem processes” (James 1995)
Thanks a lot for your attention,
merci beaucoup, maururu roa...

Tahiti, the « Silent Island »?