Ecological Effects of Transgenic Crops

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Disclosure

- **Those engaged in the dialog on biotechnology should fully disclose their relationships and opinions “up front” so that audiences can consider the context.**

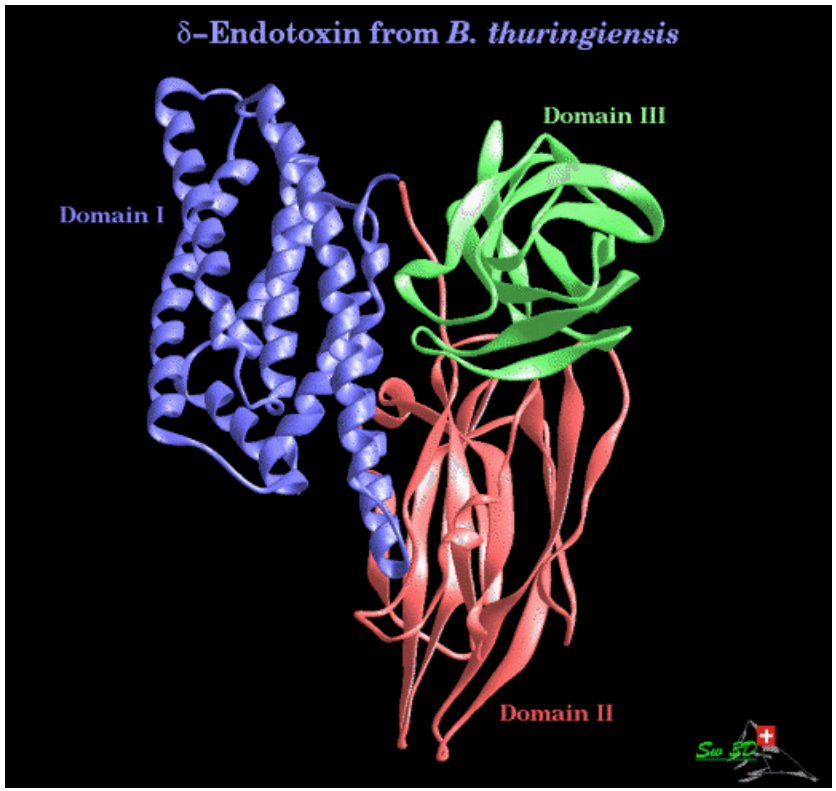
- **Partial support for my research comes from companies with interests in biotechnology.**

- **The balance of support comes from state and federal sources of competitively available public funds.**

Disclosure (continued)

- **Biotechnology and its products are neither inherently good nor bad.**
- **The specific process and each of its products should be scientifically and independently evaluated.**

Science or Emotion?



- **Proponents and opponents of biotechnology have made ample use of both.**
- **However, emotion tends to rule in the court of public opinion.**

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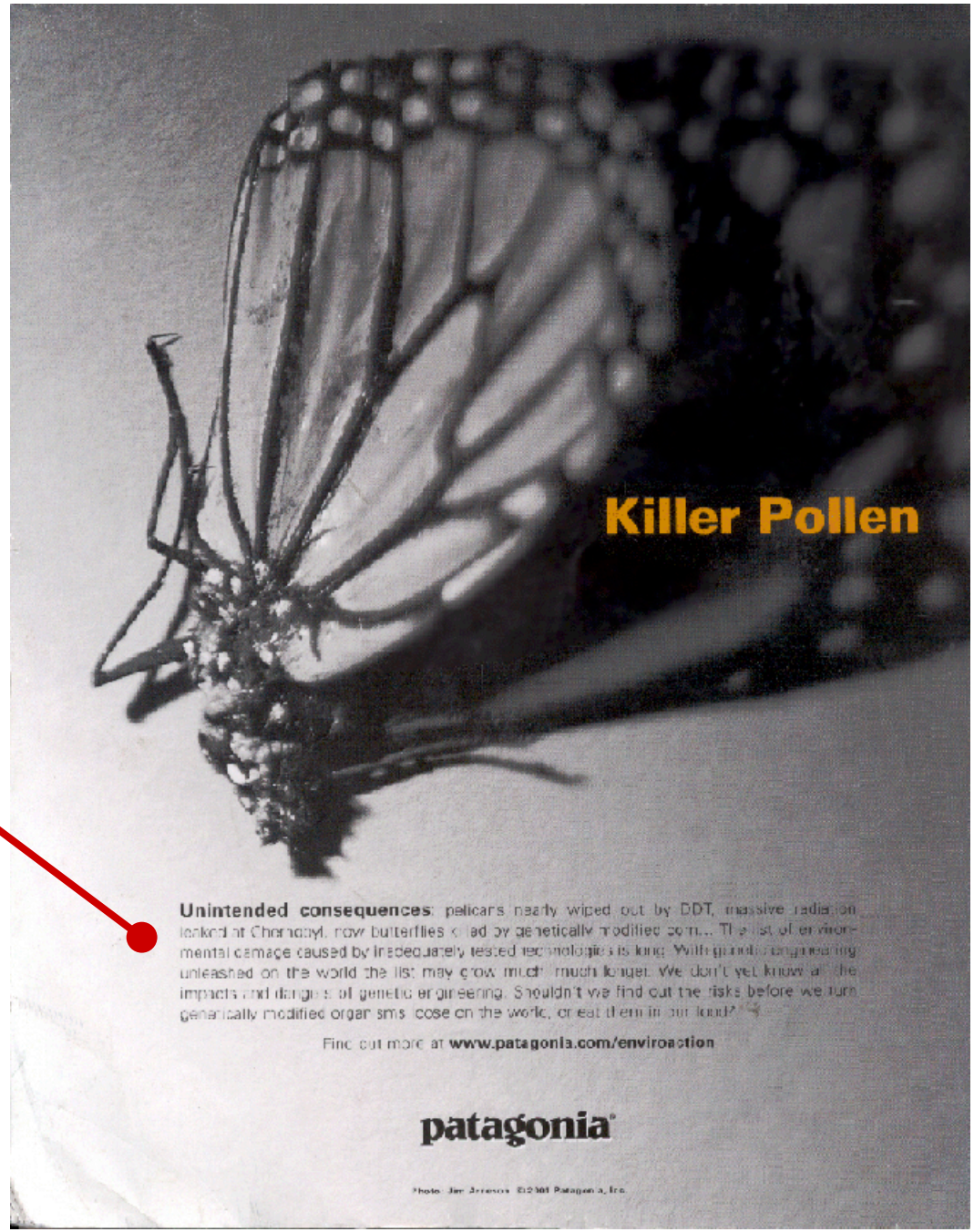
Public Opinion

- **“Unintended consequences: pelicans nearly wiped out by DDT, massive radiation leaked at Chernobyl, now butterflies killed by genetically modified corn…”**



Full page back cover of “blue” magazine; Patagonia, 2001

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Public Opinion

- **"… The list of environmental damage caused by inadequately tested technologies is long. With genetic engineering unleashed on the world the list may grow much, much longer. We don't yet know all the impacts and dangers of genetic engineering. Shouldn't we find out the risks before we turn genetically modified organisms loose on the world, or eat them in our food?"**

Public Opinion

"Our species, as yet unable to see the whole, or to know how it works, now stands poised...

...with an X-Acto blade to cheat the outcome: to solve the puzzle by reshaping its pieces to our own devising."

From www.patagonia.com/enviroaction; Patagonia, 2001

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Powerful Imagery

Mad Cow Disease

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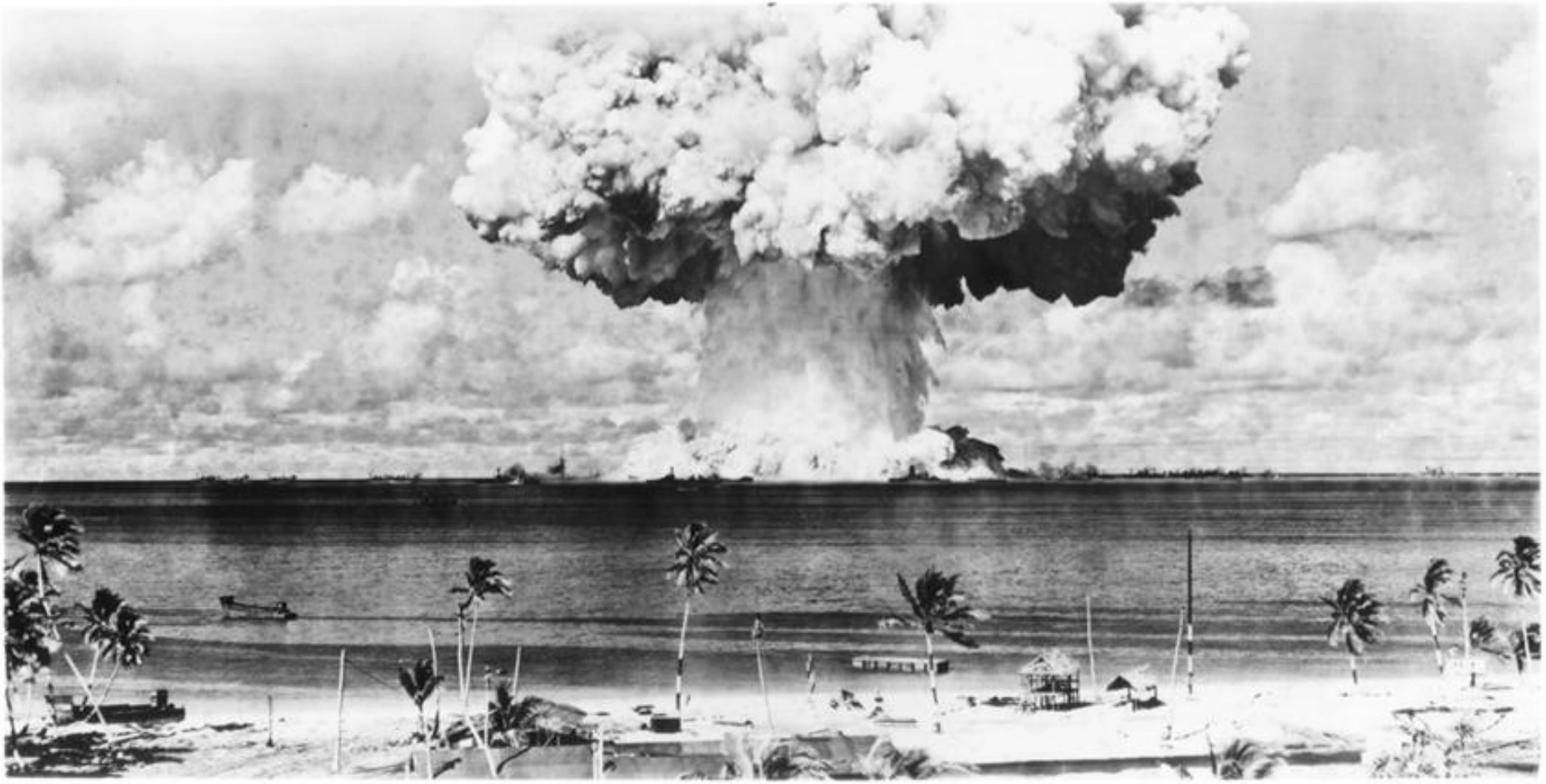
Powerful Imagery

Bikini Atoll



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Asbestos

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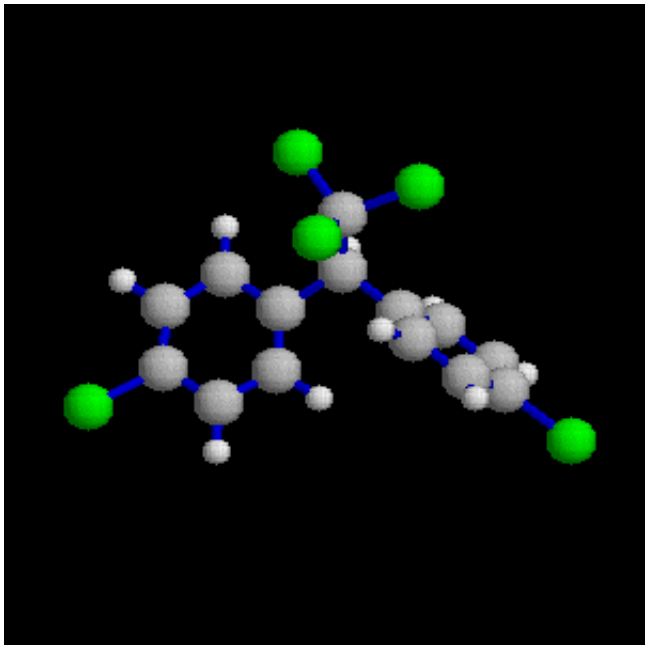
Brown Pelican & DDT



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Thalidomide Babies

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Powerful Imagery

“And we now have a solid modern history of stuff that’s come out of labs that should have stayed there.”

Patagonia, 2002

So What Is The Story?

- **Monarch Butterfly, symbol of nature and “wildness” in North America.**

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Incredible Annual Migration!

h/UA

Monarchs Feed on Milkweed

Bt Corn Sheds Pollen

- **Some of which may fall on milkweed plants that serve as hosts for Monarchs.**

- **Bt corn pollen may contain some quantity of the Bt endotoxin.**

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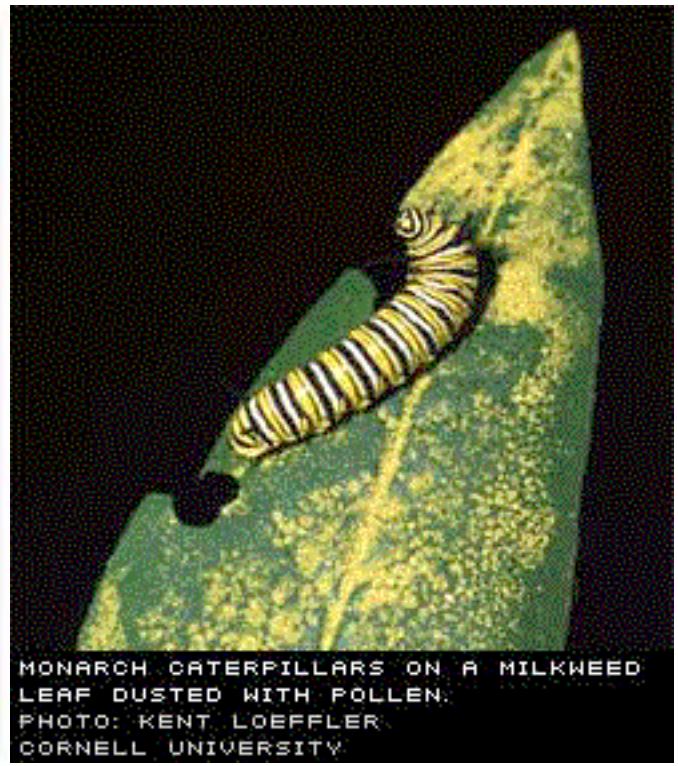
Monarchs Are Killed?

- **Scientists have shown that larvae are killed when fed milkweed “dusted” with Bt corn pollen.**
- **But how realistic was this study?**



MONARCH CATERPILLARS ON A MILKWEED LEAF DUSTED WITH POLLEN.
PHOTO: KENT LOEFFLER
CORNELL UNIVERSITY

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PNAS: Temporal & Spatial Distribution of Monarchs…

- **Per plant densities of larvae, similar among habitats (i.e., ag. vs. non-ag. lands)**
- **For upper Midwest, most Monarchs are, in fact, produced on agricultural lands!**
- **Regardless of Bt corn, other agricultural practices like foliar insecticide use and weed control could have large impacts on populations of Monarchs**

From Oberhauser et al., 2001

PNAS: Corn Pollen Deposits on Milkweed…

- **Average 171 pollen grains per sq. cm. in corn fields**
- **Average 14 pollen grains per sq. cm. 6 ft outside of the corn field**
- **One rain removes 54-86% of the pollen**
- **Youngest leaves, the preferred food, have 50-70% lower pollen density than older leaves**

From Pleasants et al., 2001

PNAS: Toxicity of Bt Proteins & Corn Pollen

Bt Toxin	1st instars on diet	1st instars on pollen on discs
Cry1F	Non-Toxic	Non-Toxic
Cry9C	Non-Toxic	Non-Toxic
Cry1Ac	Toxic	Non-Toxic
Cry1Ab	Toxic	Toxic (Event 176 only)

From Helmich et al., 2001

PNAS: Field Mortality of Monarchs…

- **50% of Monarch larvae died in the first 24 hrs**
  - **NONE related to proximity to Bt corn**

- **But slower growth of Black Swallowtails <u>likely</u> related to pollen exposure**
  - **for Event 176 (Novartis) <u>only</u>**

From Zanger et al., 2001

PNAS: Field Impact of Cry1Ab (3 events)…

Exposure Density & Duration	Cry1Ab Event 176	Cry1Ab Bt11	Cry1Ab Mon810
22 gr. / sq. cm.	Weight loss (-18%)	--	--
67 gr. / sq. cm.	Weight loss (42%) & mortality (40%)	NOE	--
97 gr. / sq. cm.		NOE	--
500+ gr. / sq. cm.		NOE	--
In-field feeding for 14-22 d		NOE	NOE

Compared to lambda-cyhalothrin which killed most Monarch larvae

From Stanley-Horn et al., 2001

PNAS: A Risk Assessment...

Hazard = Acute toxic effects of pollen

X

Exposure = Probability of larvae being exposed to toxic levels in and around corn fields

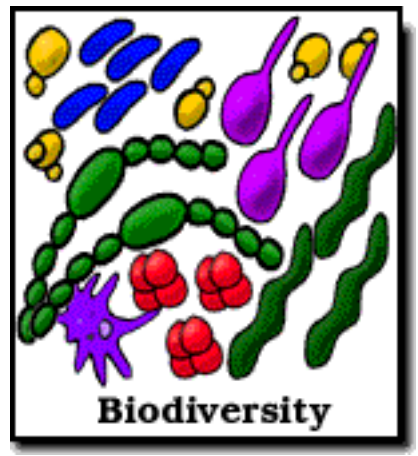
↓

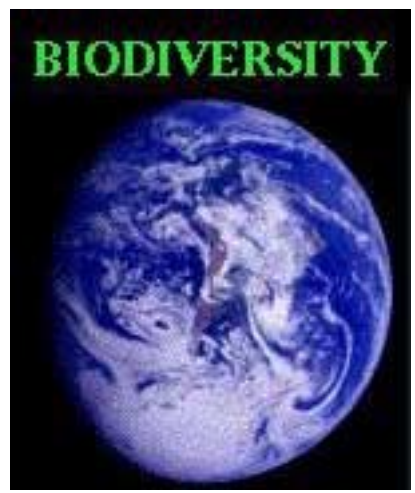
Risk = "This two year study suggests that the impact of Bt corn pollen from current commercial hybrids on Monarch Butterfly populations is negligible."

From Sears et al., 2001

Non-Target Organisms (NTO)

- **Search for unintended consequences of technology (e.g., Bt cotton) on biodiversity.**
- **Through direct effects, i.e., toxic effects on non-target species,**
- **Or through indirect effects, i.e., through non-target species feeding on intoxicated hosts.**





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