

Disruption of Brain Development and Reproductive Behavior of Birds

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Extrapolation of xenobiotic exposure to the “real world”

- Methoxychlor, dicofol, and alkylphenols in agriculture in Yolo Co.
- Application rates and acreages available.
- Sensitivity of local species unknown



Current research on songbirds

- Altricial chicks require extended parental care
- Complex, but well understood brain neuroanatomy and physiology
- Song system is estrogen sensitive
- Brain is dimorphic



Zebra Finches

Hormonal Influence in Brain Differentiation

- Testosterone produced by neo-natal male gonads
- Uptake and aromatization by specific areas of brain
- Estrogen modulates differentiation of male specific nuclei. Mechanism uncertain, BDNF clearly involved, apoptosis?

Dosing and testing protocol

- Oral gavage
- 5-11 days post hatch
- 1 μ l / g body wt. / day in canola oil
- parental care of chicks for 30-40 days
- mixed sex juvenile cages
- Behavioral testing at 120+ days
- Behavior assessed with stimulus males and females on alternate days
- Testosterone implants to force/enable altered behavior
- Histology of brain, gonad

Effective doses given to finches

(μg /g/body wt. /day)

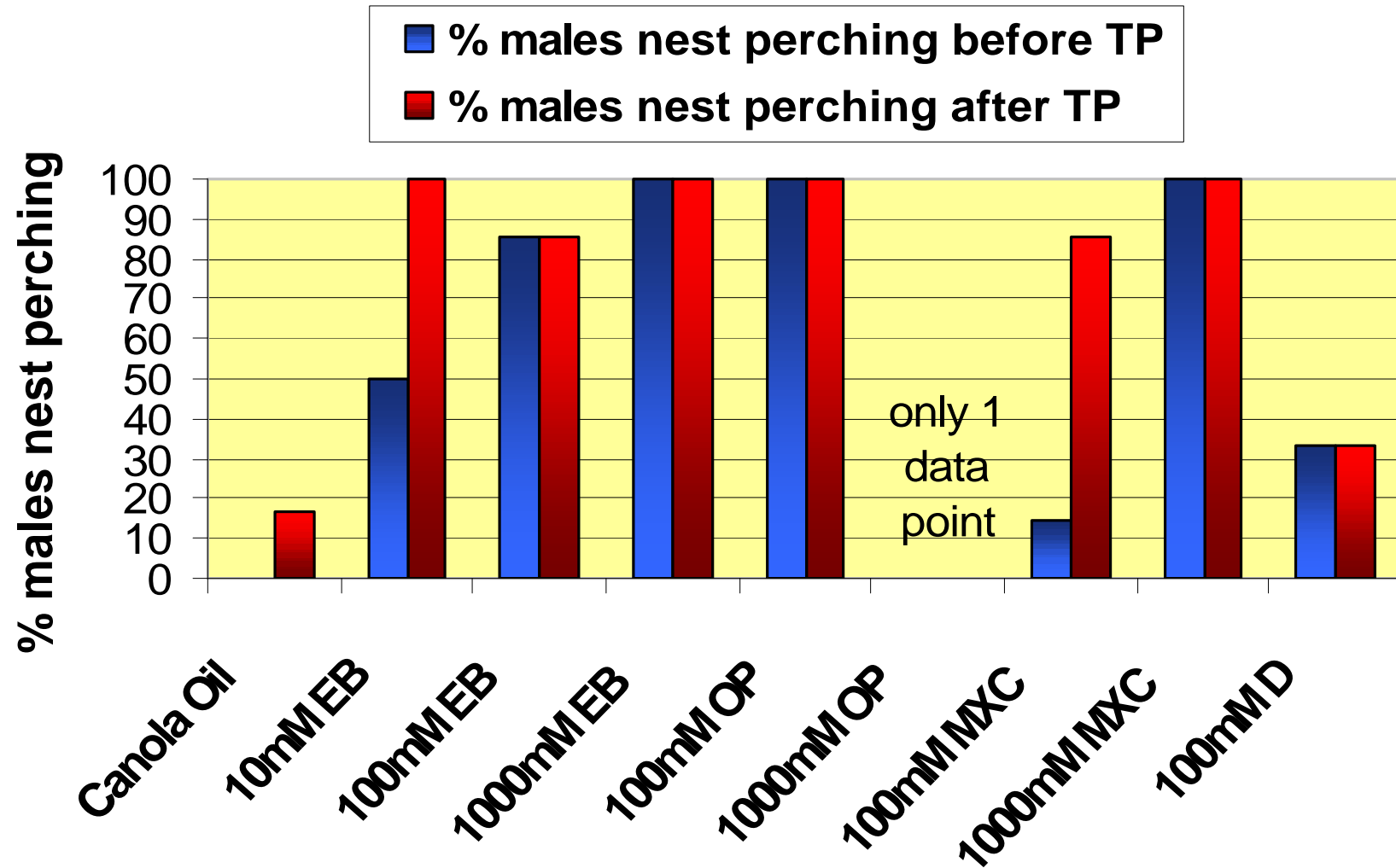
- Estradiol benzoate: 2.7
- Methoxychlor: 35
- Octylphenol: 21
- Dicofol: 37



Extrapolated dose to nestling songbirds

- Body wt. During sensitive period: 3-10g
- Food consumption: 1-8 g insects / day
- Dicofol @ 189 ppm,
Exposure dose is 189-1512 μ g/day
- Octylphenolpolyethoxylate @ 22ppm:
Exposure dose is 22-176 μ g/day

"Broodiness" of Male Zebra Finches



Summary of Effects on Males

- Estradiol and Xenoestrogens active orally
- Microgram per day doses cause changes in male default behavior patterns:
 - Latency for courtship song
 - Reduced copulation
 - “Broodiness”
 - Responses in both
Zebra Finches and Japanese Quail



Differentiation of brain and behavior in birds:

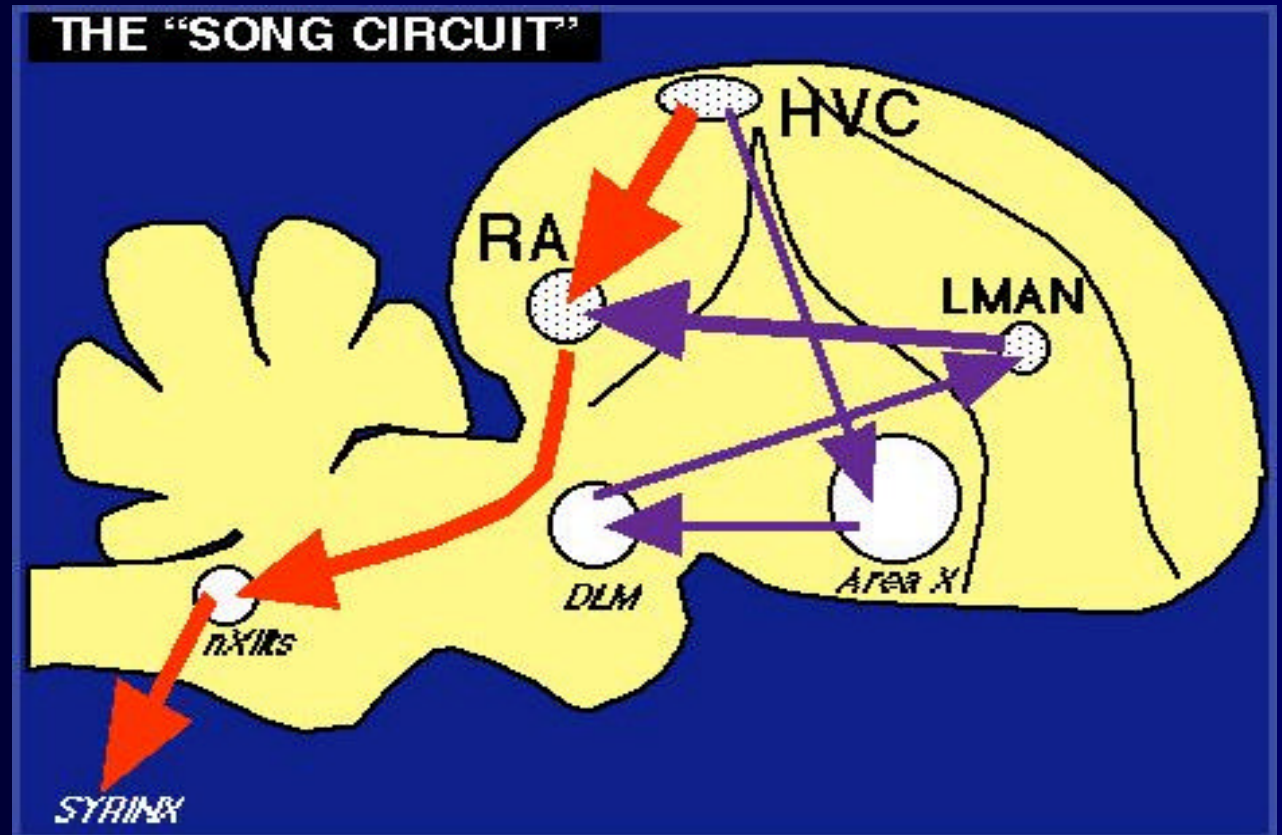
- **Song System:**
- Passerine birds only
- Species specific patterns in dimorphism
- Estrogen sensitive during post-natal development



Female Zebra Finch

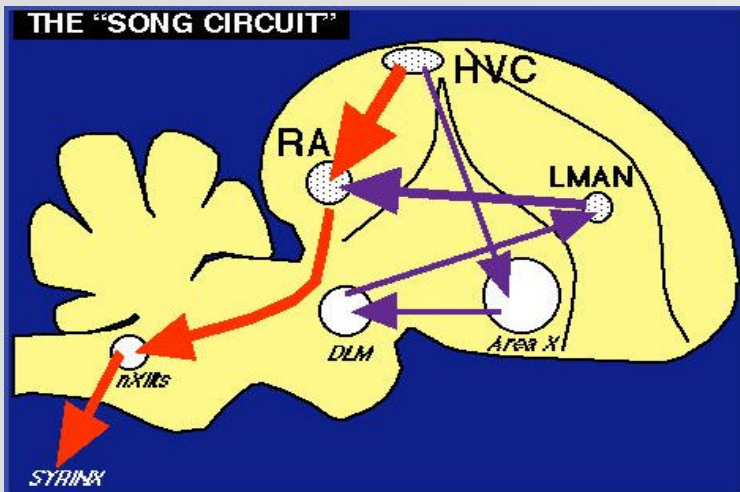
Zebra Finch “Song Circuitry”

- Learning and memory pathways in blue
- Motor pathway in red
- Males sing, females do not

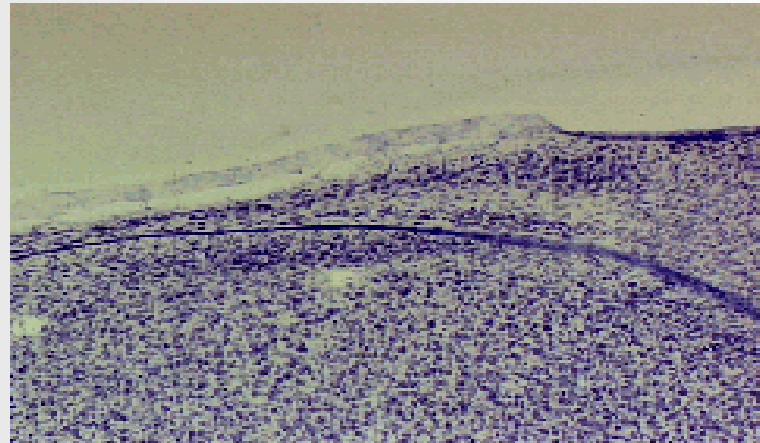


David Clayton, Univ Illinois

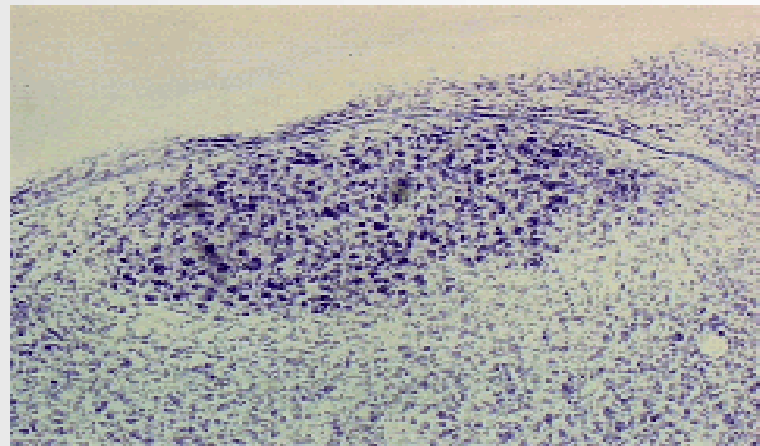
HVC



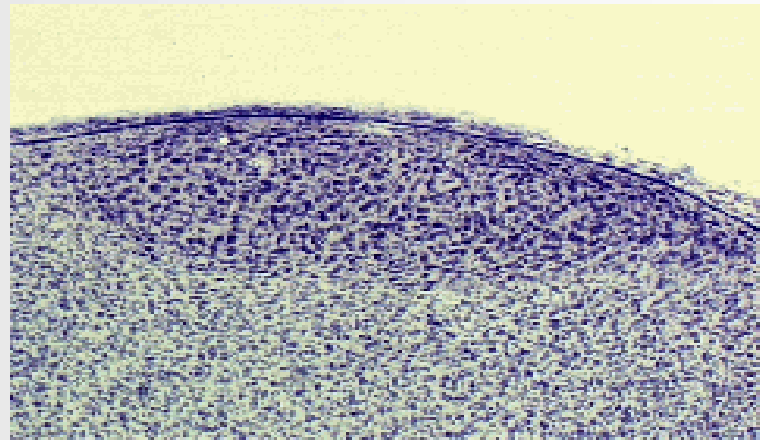
Threshold for enabling
song is about $125\mu\text{m}^3$



*Canola Oil
Female*

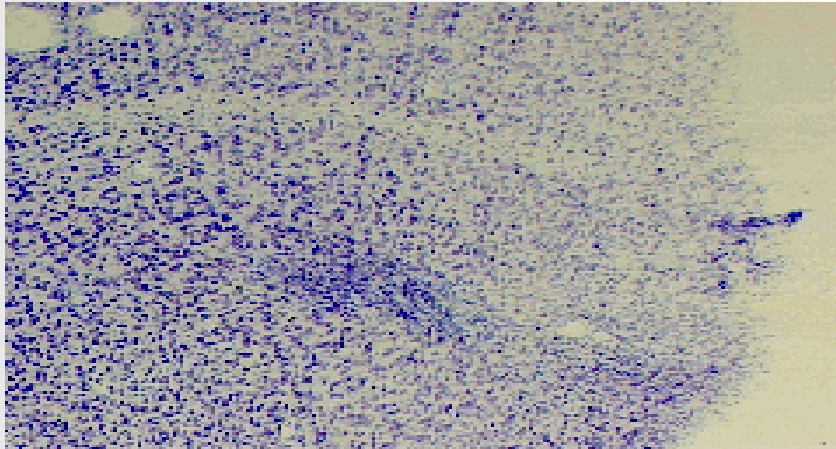
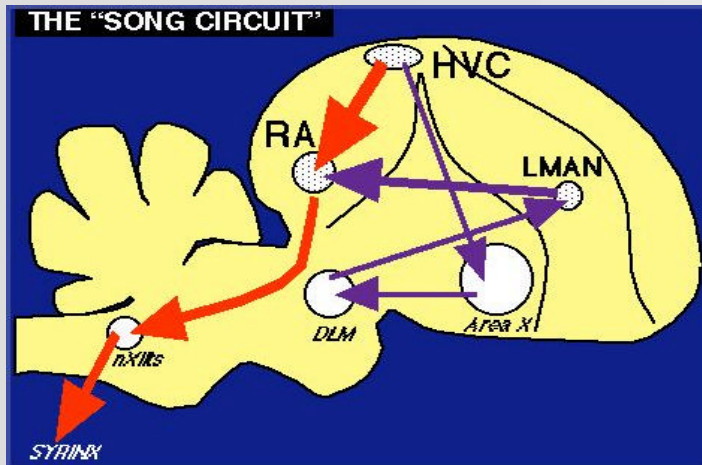


*100mM EB
Female*

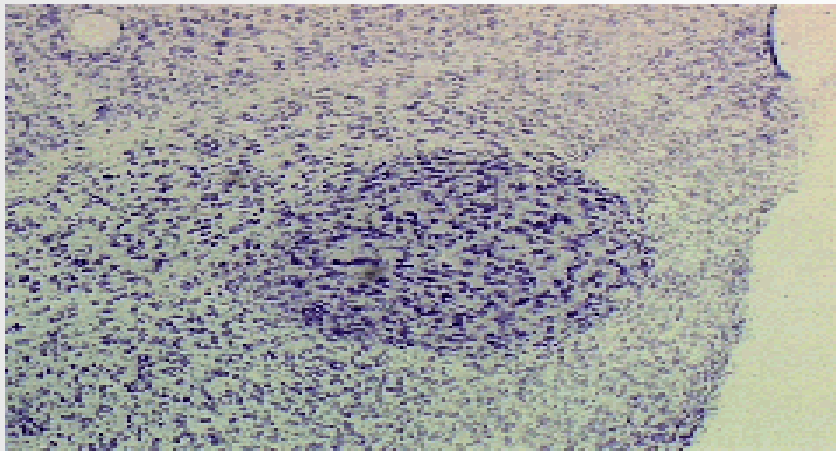


*Canola Oil
Male*

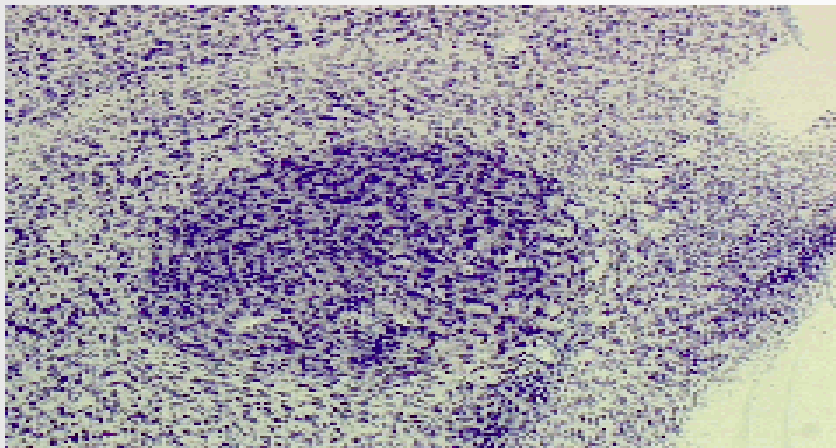
RA



*Canola Oil
Female*



*100mM EB
Female*



*Canola Oil
Male*

Vocalizations of captive Zebra finches

- Male Zebra Finch

-  Distance Calls

-  Chatter (“tet” call)

-  Courtship song



Vocalizations of female zebra finches

- Normal Females

🔊 “tet” call

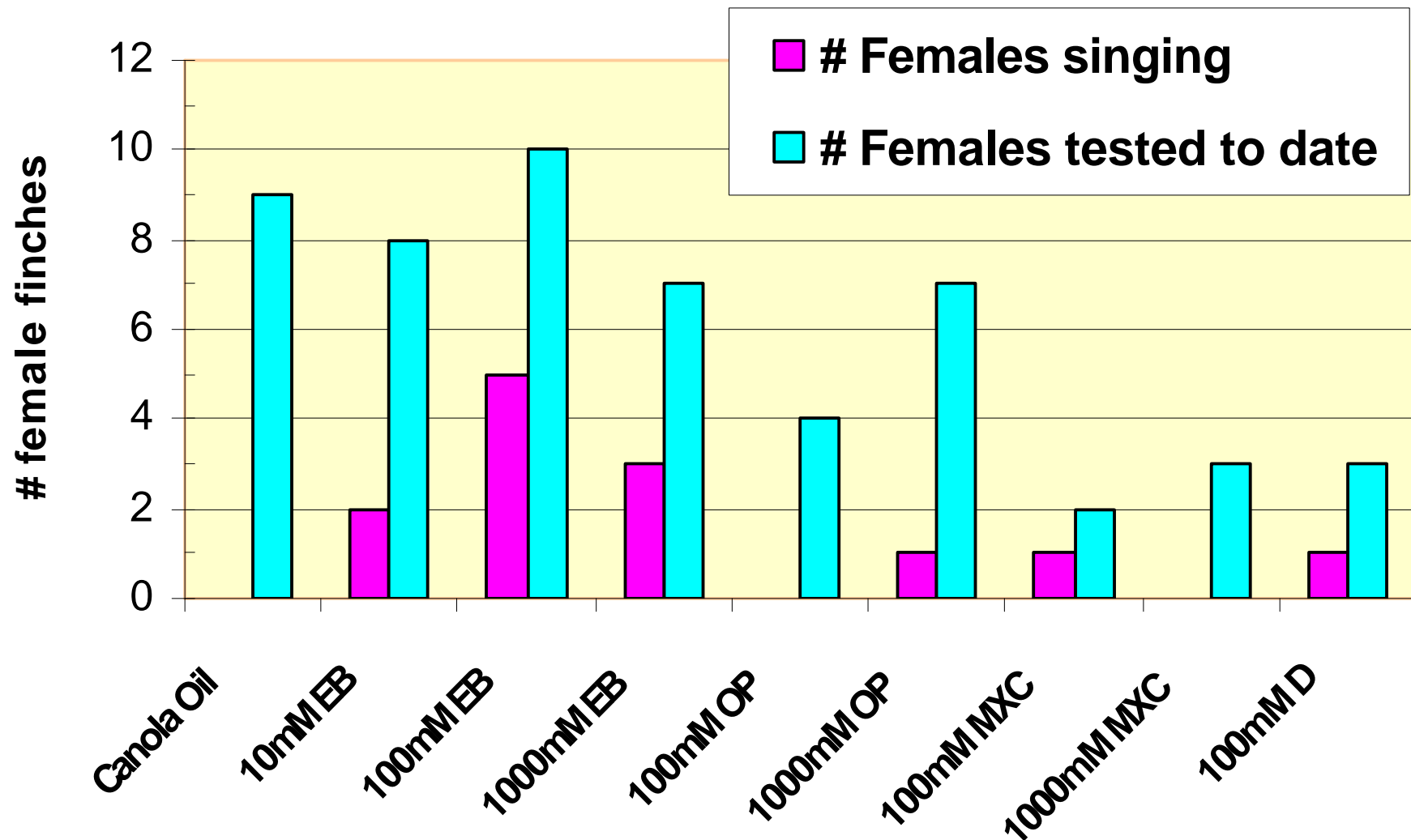
🔊 distance call

🔊 “Male type” songs by

🔊 sensitive exposed females



Female Finches Singing Courtship Song



Estrogen and xenoestrogen induced changes in female finches

- Sexually dimorphic brain nuclei induced (retained? / enhanced?)
- Singing enabled in exposed females
- Aggressive behavior in many females
- Significant phenotypic variability by family



Reproductive Performance Tests

- Neonatal Dosing of zebra Finches, days 5-11
 - Estradiol benzoate $27\mu\text{g/gBW/day}$
 - Octylphenol $21\mu\text{g/gBW/day}$
- Group caging: 6 pair per cage
- Dosed males and females together
- Dosed birds with control mates
- Reproductive activity from Day 140

Reproductive Activity:

- Estradiol females lay eggs, clutch size similar
- No eggs hatch from treated group
 - dosed males and females together
 - eggshell thinning in most females
- Mixed pair trials in progress:
 - some fertility and hatching success.