Sexual selection

Sexual selection

- Sexually reproducing animals often exhibit variance in mating success driven by choices made by potential mates, or competition with members of the same sex
- This variance has a heritable basis, and thus the conditions for selection to modify lineages are fully in play

Darwin and sexual selection

Formulated and expanded by Darwin in 1871: *The Descent of Man, and Selection in Relation to Sex*

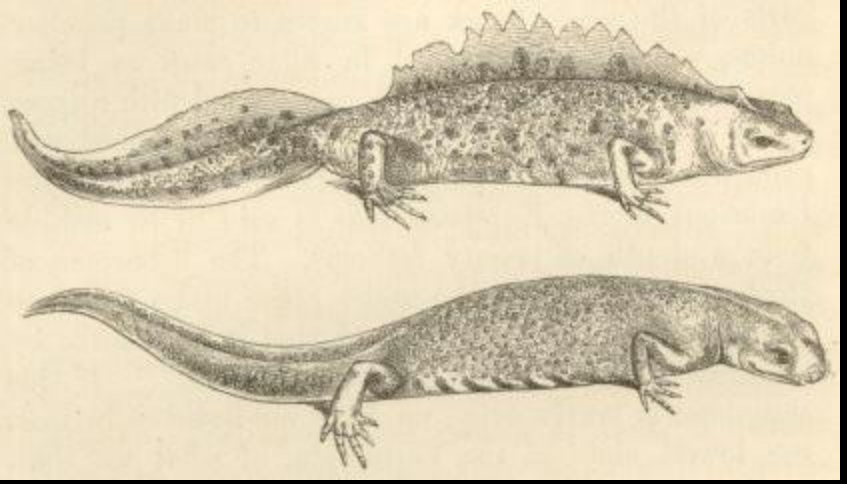


Fig. 31. *Triton cristatus* (half natural size, from Bell's 'British Reptiles'). Upper figure, male during the breeding-season; lower figure, female.

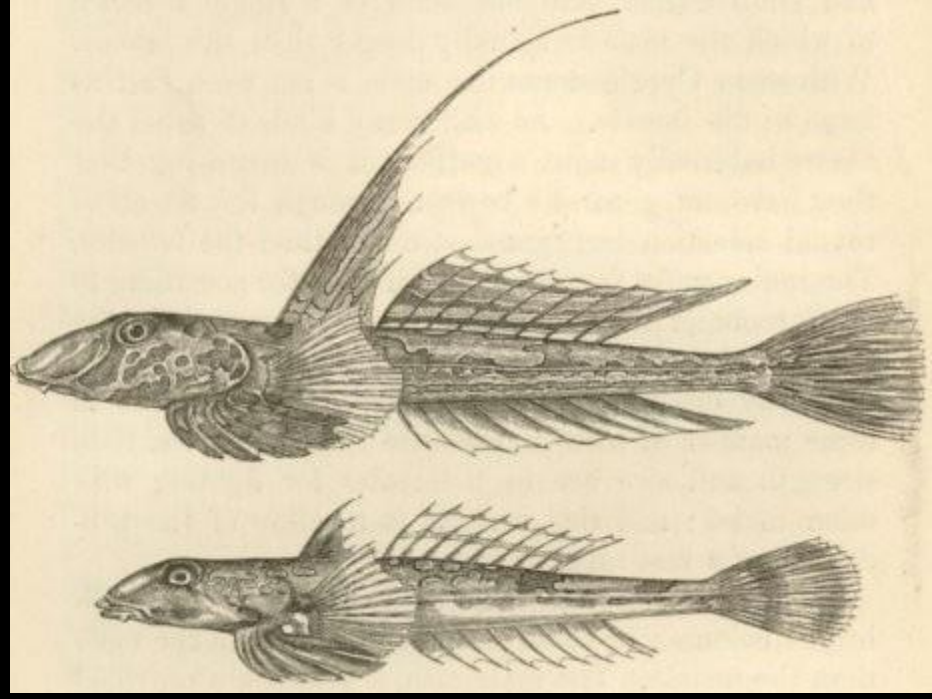


Fig. 28. *Callionymus lyra*.
Upper figure, male; lower figure, female.

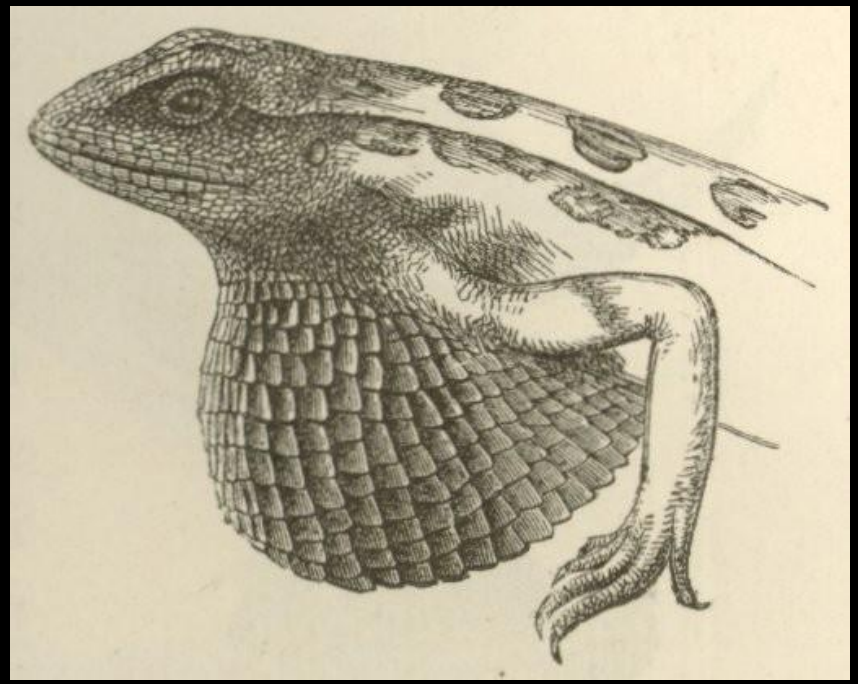


Fig. 33. *Sitana minor*. Male, with the gular pouch expanded (from Günther's 'Reptiles of India.').

Fisherian runaway

- Described in “The genetical theory of sexual selection”
- If females select males (for example) differentially then:
- Genes for selected trait and genes for preference of selected trait will be passed on
- Selected traits may be arbitrary

Sex: what’s the point?

Hemidactylus mabouia

Hemidactylus garnottii

Sex: what's the point?

- Evolution of sex advantageous in generating novelty (competition with evolving threats)
- = Red Queen hypothesis
- There is also evidence and theory predicting how sexual selection in sexually reproducing animals may "purge" a population of deleterious alleles*

*Agrawal, Aneil F. "Sexual selection and the maintenance of sexual reproduction." *Nature* 411.6838 (2001): 692-695.

Differential investment and sexual selection

- FACT: males and females often differ in reproductive investment

- Therefore: females (for example) should be choosy

Operational sex ratios and sexual selection

- Operational Sex Ratio (OSR) describes how biased the pool of potential mates is, taking into account who is actually capable of breeding in the population
- Highly biased OSR is usually correlated with high levels of sexual selection
- Factors which may affect OSR are differential survival, development rates…

Sexual selection: may take one or both of two forms

- Intrasexual selection- one sex competes with each other (physically) for a territory or mate (s)
- Intersexual selection- one sex evaluates display, courtship or some other factor and chooses who to mate with

- ALSO: mutual sexual selection (NOT as well studied!)

Intrasexual selection

- Darwin calls this the “Law of Battle”
- Basically, competition between members of the same sex for access to mates
- Often correlated with elaborate male adaptations for combat, or behaviours

Example: stag beetles

Video by Tammy Bergström: https://youtu.be/r34FSI2HKPY

Note that the “Law of Battle” does not often mean a fight to the death!

- Combat between rivals is most often ritualized
- This is best thought of as mutual signalling of quality, and an opportunity for each combatant to assess their relative strength
- “losers” of these bouts don’t just give up they may:

1. Wait- ceding to a dominant competitor temporarily may result in future mating opportunity
2. Defer to kin- if competing with close relatives, the cost in inclusive fitness by continuing to escalate may outweigh the benefit of continued struggle
3. Perform an alternative specialization (e.g. adopt a “sneaker male” strategy

West-Eberhard, Mary Jane. 1979. “Sexual Selection, Social Competition, and Evolution.” *Proceedings of the American Philosophical Society* 123 (4): 222–34

Example: male combat in Neotropical Rattlesnake

Video by Allan Franco available here

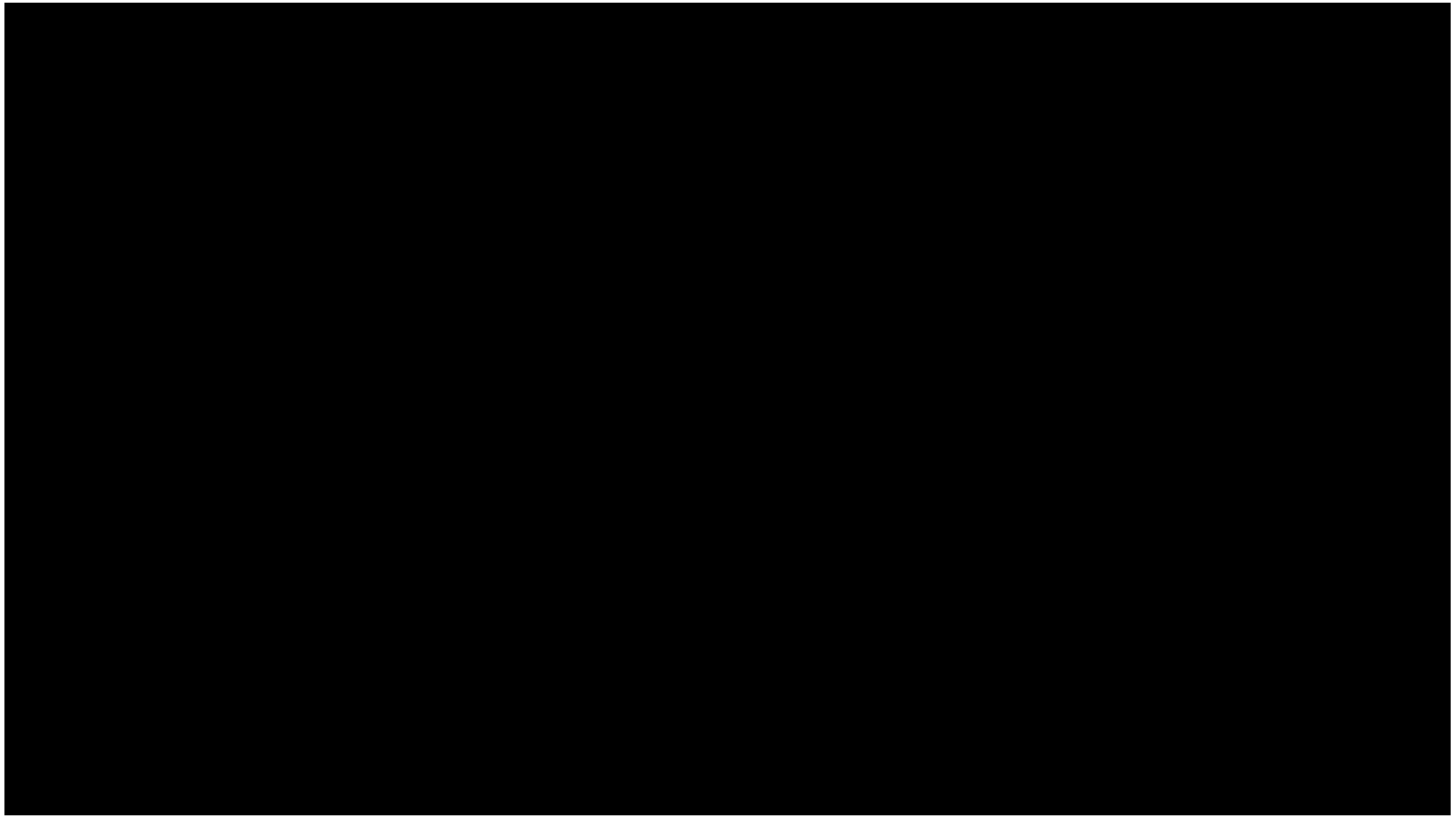
(shot at Parque Nacional de Chapada dos Guimarães, Mato Grosso, Brazil)

Intersexual selection: female choice, or choice in general

- This can operate in conjunction with or separate from the law of battle
- This topic is often given more prominence in both theory and experimentation

Example: sexual and natural selection by Cornell Lab of Ornithology

Video available here



Commonly selected attributes

- Territory size/quality
- Appearance: brightness, symmetry, size
- Display: duration, complexity, novelty (or fidelity), rate, tone

Intersexual selection is not just “female choice”

- Sex reversal of “choosy sex” occurs when the male provides the majority of reproductive effort (rearing offspring, for example)

Dendrobates tinctorius (dyeing poison dart frog)

Mutual sexual selection

- In what types of mating system might you expect mutual sexual selection?

- Has been demonstrated in FEW taxa, mostly monogamous species with biparental care

Why sexual selection? 1: Direct benefits

Selection of attractive partners has a direct fitness benefit (e.g. provision of a nuptial gift, living in a good territory)

Kokko, Hanna, Robert Brooks, Michael D. Jennions, and Josephine Morley. 2003. "The Evolution of Mate Choice and Mating Biases." *Proceedings of the Royal Society of London B: Biological Sciences* 270 (1515): 653–64. doi:10.1098/rspb.2002.2235.

Calypte anna (Anna's Hummingbird)

Anthidium manicatum (European wool-carder bee)

Pisaura mirabilis male carrying a silk-wrapped nuptial gift. (Photo by Ferran Turmo Gort, licensed under CC BY 2.0

Why sexual selection?
2. Indirect benefits: Reconciling Fisher and Zahavi

- Fisherian runaway suggests that “arbitrary” characters may by chance be preferred (i.e. the benefit is in having “sexy sons”
- Zahavi: the “handicap principle”, later the “good genes hypothesis”. Display is an honest signal of genetic quality
- These are not mutually exclusive: if both attractiveness and fitness are heritable and genetically variable, they should become correlated

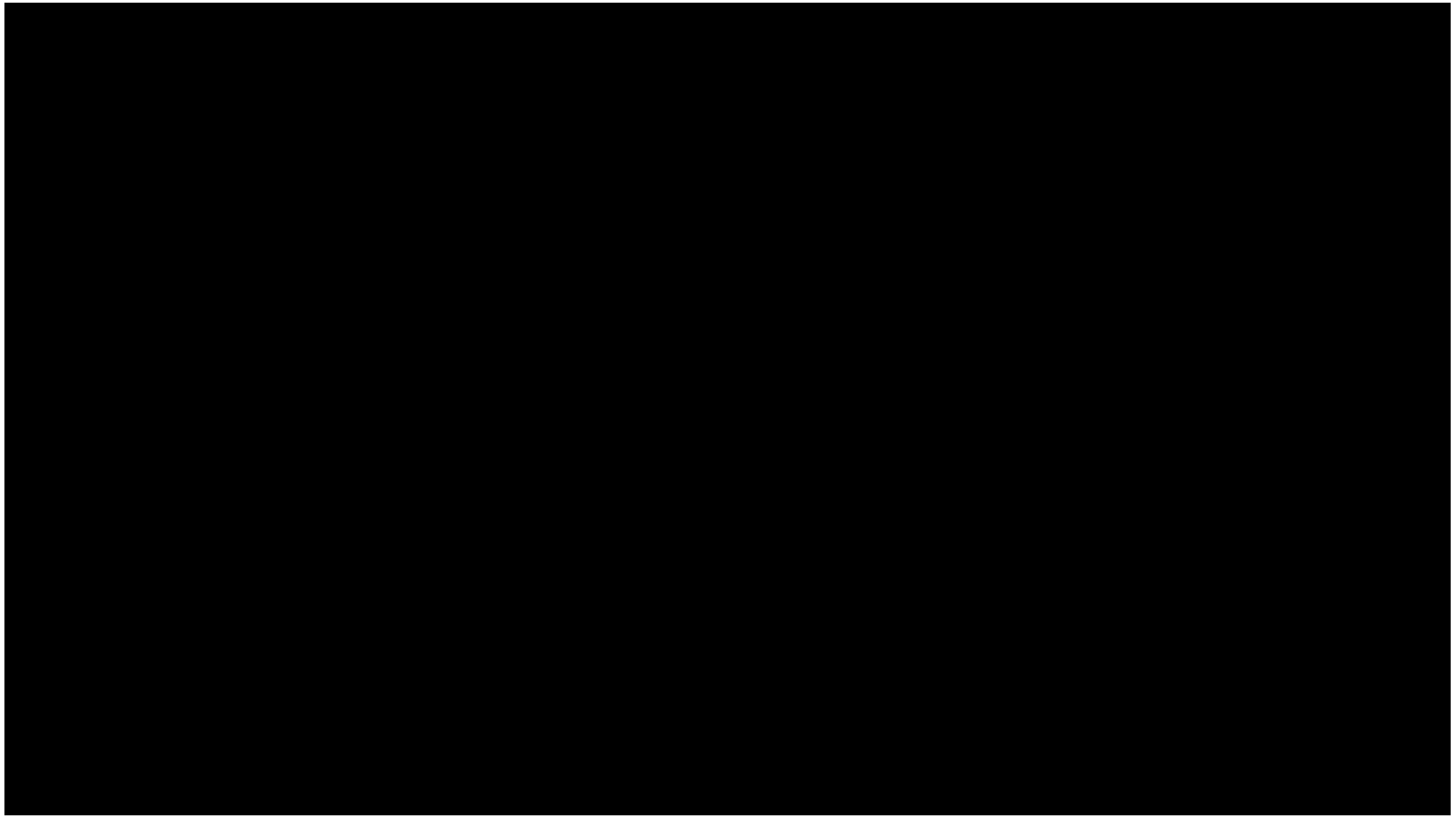
Zahavi, A. 1975 Mate selection: a selection for a handicap. *J. Theor. Biol.* **53**, 205–214.

Why sexual selection?
3. Sensory Drive

- Also known as sensory exploitation, sensory bias etc.
- Some aspect of the selected display arose due to bias in sensitivity in an environment- e.g. the colour of male display similar to the colour of a resource or danger
- In a general sense, the environment and the signal must be considered together
- This is good for mechanistic explanation, but also can provide the initial impetus for Fisher-Zahavi processes
- Much research on sensory exploitation models currently underway with jumping spiders
- Q: how do widow sexual displays square with sensory drive?

Sensory drive in action: Puerto Rican Anoles

Video from bioGraphic available here (California Academy of Sciences)



Sexual selection and natural selection: at odds?

- Often so: the cost to males of exaggerated characteristics or displays is likely increased predation
- Costs to females: must balance benefits of choosiness with the potential cost of forgoing mating opportunities

Issues with studying sexual selection: sensory non-overlap

- Our sensory world and that of other animals do not often overlap
- We may fail to appreciate significant variation because we cannot detect it
- The bases of potential sexual selection and often of natural selection may therefore be unclear
- Examples: colour capabilities, low light vision, vibration detection, acoustic mapping, faster reflexes….
- CHEMICALS!

Issues with studying sexual selection: time, space, distance

- Courtship and mating events may be extremely difficult to observe, and take place at accelerated or decelerated time scales compared to what we are able to appreciate
- The inter-generational products of selection (change in offspring, and offspring's fitness) may be impossible to track

So why? Why study something so difficult?

- It is interesting!
- Has important evolutionary implications, may help lead to speciation

What can we do?

- Consider very carefully the sensory modalities of the organism in question
- Analyse the environment: what cues might be maximally transmissible? Which cues are unlikely?
- Which types of display might be arbitrary, which might honestly signal quality in mates?
- Are we assuming too much by jumping to female choice?

What can we do?

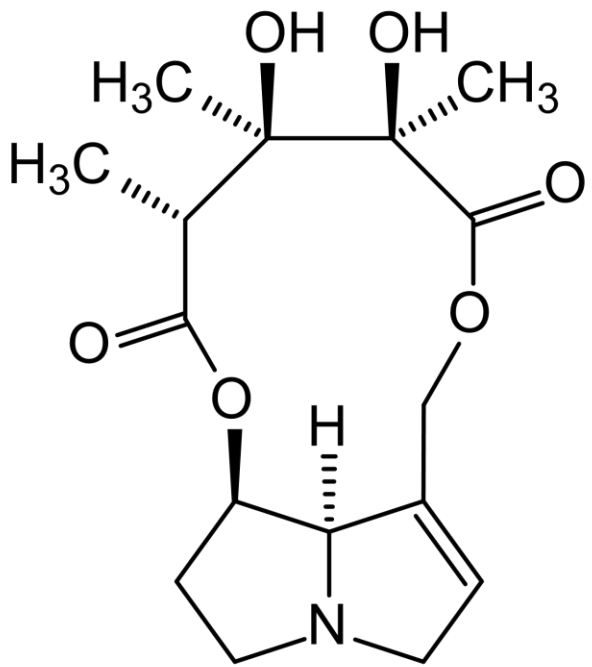
- Consider using technology to aid observation: high speed cameras, multispectral imaging, chemical analyses…
- Observe and consider animals behaving in their environment wherever possible

Take a break!

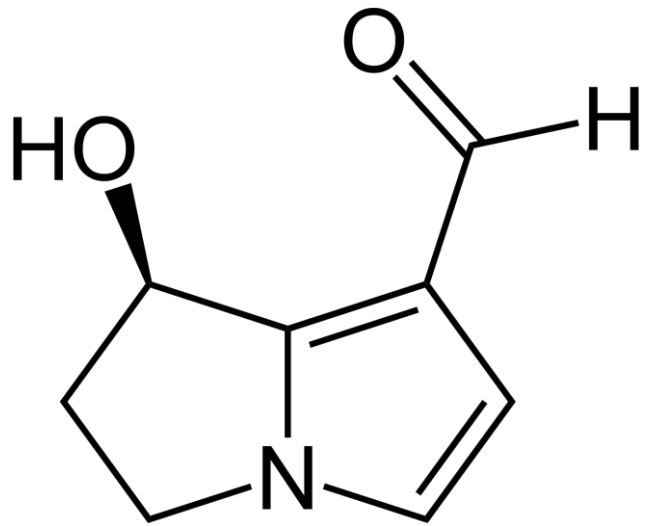
Eisner and Meinwald, 1995

Photo by Mark Yokoyama used under a CC-NC-ND-2.0 licence

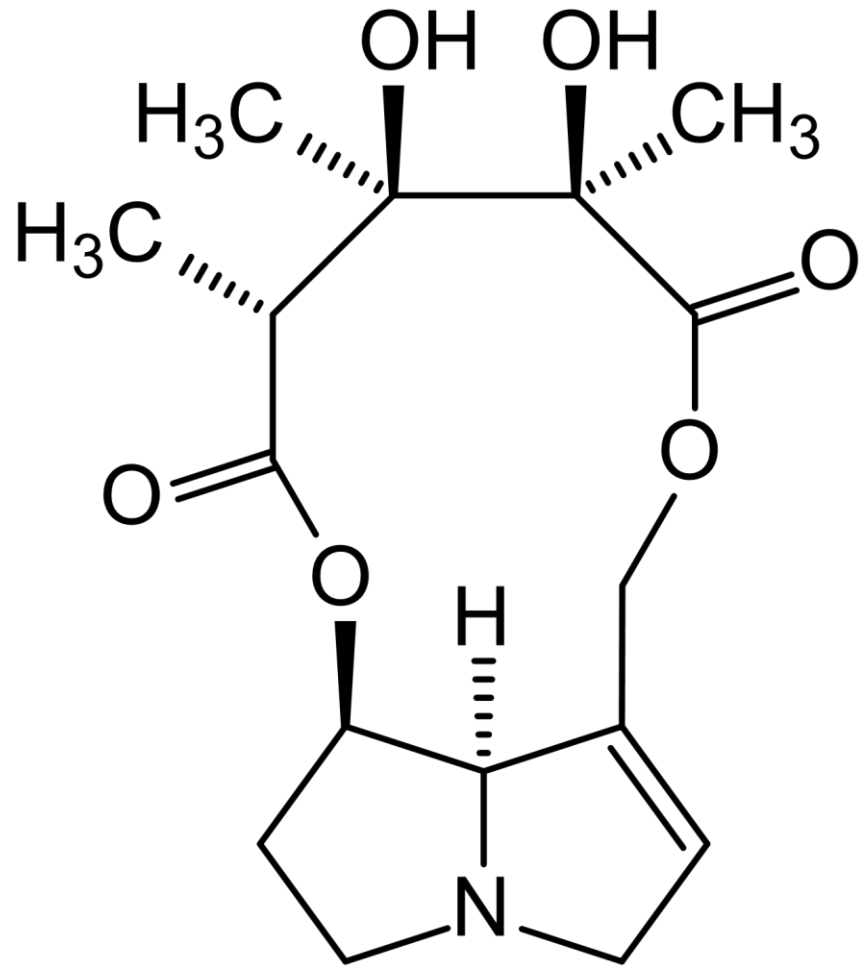
Utetheisa ornatrix (Lepidoptera, Erebidae)



Monocrotaline



Hydroxydanaidal



Monocrotaline

Nephila clavipes Golden-silk Orbweaver

Argiope aurantia (yellow garden spider)

Pyrrolizidine alkaloids

- Hepatoxic, present in many plant families
- Also known to be used by *Danaus glippus* males in formation of sex pheromone

Hydroxydanaidal: an honest signal?

- See Conner et al. 1990