## Bestäuberverhalten und Pflanzenevolution

"aktuelle Stunde" Populations und Evolutionsbiologie, 4.2.04 Florian Schiestl

### Orchid pollination

## rewarding species deceptive species



Gymnadenia

Platanthera





Thelymitra

Calochilus

Important features of pollination by sexual deception:

- Floral odour is most important for attracting the pollinator sex pheromone mimicry.
- Pollination is highly specific.

## Basic concept of (Batesian) mimicry

Wickler (1968)



Mimic (imitates model-signals)

#### Questions:

- 1) Mechanisms of pollinator attraction
- 2) Evolutionary dynamics between orchids and pollinators: impact of orchids on pollinators
- 3) Odour communication and speciation

**Methods:** Gas chromatography with electroantennograpic detection (GC-EAD); gas chromatography – mass spectrometry (GC-MS)



#### Behavioural tests with pollinator-insects



- 1) Mechanisms of pollinator attraction
- Sex pheromone of the pollinator species
- Attractive orchid odour
- 2) Evolutionary dynamics
- 3) Speciation

Where is the female sex pheromone of *N. cryptoides* produced?



# Which are the electrophysiologically active compounds in the odour samples?



### Compound identification



2-ethyl-5-propyl-1,3-cyclohexandione - "Chiloglottone"

# Chiloglottis - bioassay: attractiveness of Chiloglottone



#### Summary 1

- In the thynnine wasp *N. cryptoides,* the female sex pheromone consists of only one (!) compound, which is produced in the head.
- The orchid *Chiloglottis trapeziformis* produces the same compound in its floral odour.

Europe: *Ophrys,* pollinated by solitary bees



- *O. sphegodes:* Flowers attract pollinator with 14 compounds (alkanes and alkenes).
- Female bees produce the same compounds, in similar proportions, as sex pheromone.

(Schiestl, Ayasse et al. 1999)

- 1) Mechanisms of pollinator attraction
- 2) Evolutionary dynamics impact
- How pollinators avoid sexually deceptive orchids.
- What are the impacts for orchid and pollinator fitness?
- 3) Speciation

## Wasps do not avoid individual flowers but locations with flowers



Orchids (presented sequentially in the same spot)

- Are pollinator-males able to discriminate between their females and orchid flowers?
- Are males able to find their wingless females in the presence of orchids?

# Can males discriminate between sex pheromone and orchid floral odour?



## Can males discriminate between sex pheromone and orchid floral odour?





#### Do males pick up females that call in an orchid patch?



#### Arms race!

| <br>selection on increased discrimination in operator |
|---|
| <br>refinement of signals in mimic;                   |

#### Summary 2

- Europe: pollinators avoid individual flowers; Australia: pollinators do not avoid individual orchids, but the areas where orchids flower; they are unable to discriminate between the odour of orchid flowers and their females.
- Orchids may harm their pollinators, since males are not able to find their females within an orchid patch. Arms race scenario.

- 1) Mechanisms of pollinator attraction
- 2) Evolutionary dynamics impact
- 3) Odour communication and speciation
- how is evolutionary change imaginable?

Important features for speciation:

- Species are interfertile: specificity in pollination is responsible for reproductive isolation.
- Odour is the key stimulus for specific pollinator attraction: it is directly linked to reproductive success and isolation.

## Tow allopatric (with non-overlapping distribution) orchids with the same pollinator species:



Chiloglottis trapeziformis



Chiloglottis valida

GC-EAD recordings using floral odour of two allopatric orchid species with one pollinator (*Neozeleboria cryptoides*)



## Two closely related, sympatric (overlapping distribution) orchids with distinct pollinator species



Chiloglottis trilabra

Chiloglottis reflexa

GC-EAD recordings with floral odour of the two sympatric orchid spp. with two pollinators



#### Summary 3

- Allopatric orchids with the same pollinator species may emit the same attractive odour.
- Sympatric orchids with different pollinators may share active compounds but produce distinct compounds as well.
- Small changes in odour emission may trigger speciation – radiation in orchids may have been a quick process via "stepwise acquiring of new pollinators".