# Life-history evolution in a *Drosophila* community along a deforestation gradient[1]


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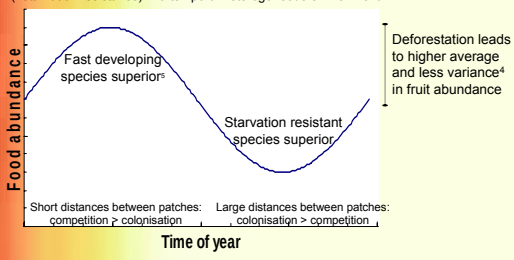
## 1) Background information

### a) Life-history traits and coexistence

Competition ability (~development time) versus colonisation ability (~starvation resistance) in a temporal heterogeneous environment[2,3,4]




### b) Single species lab experiments

**Single environmental cue:**

| | Phenotypic effects | Genetic effects |
|---|---|---|
| Temperature ↑ | Body size ↓<br>Development time ↓<br>Starvation resistance ↑ ↓ (depending on study) | Body size ↓<br>Development time ↑<br>Starvation resistance ? |
| Crowding ↑ | Body size ↓<br>Development time ↑<br>Starvation resistance ↑ | Body size ?<br>Development time ↓<br>Starvation resistance ↑ |

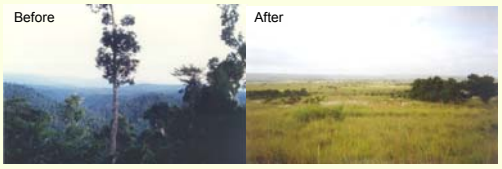
**Correlations:**

| Trait combination | Selection experiments | Other methods | Phenotypic | Latitudinal | Interspecific |
|---|---|---|---|---|---|
| Body size - development time | 0 or + | (-) or ± | + | - | ? (+) |
| Body size - starvation resistance | 0 or + | ? | 0 | 0 | + |
| Development time - starvation resistance | 0 or + | 0 | ? | 0 | + or 0 |

## 2) Research questions

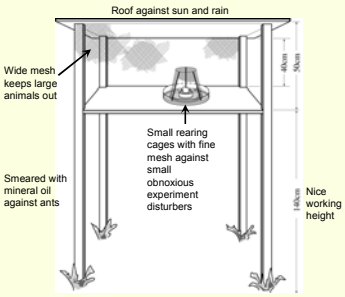
- **Can we measure *Drosophila* life-histories in the field?** ***(yes)***
- **What is the effect of deforestation on:**
  - **-Body size?**
  - **-Development time?**
  - **-Starvation resistance?**

  **With regard to:**
  - **-Genetic differences?**
  - **-Environmental variation?**
  - **-GxE interactions?**
- **Phenotypic/genetic/interspecific correlations between traits:**
  - **Within species?**
  - **Variation across species?**
  - **Variation across habitats?**
- **Are Genetic correlations a barrier to adaptation?**




## 3) How?

### a) Field setup:




### b) Location:

- **Panama Canal zone**
- **2 transects with 3 collection locations each: Closed canopy, Intermediate, Grassland**

### c) Field experiments:

- **Estimated development time, starvation resistance and body size of flies reared in:**
  - **Their own collection locality (12 species)**
  - **Transplanted to a different habitat within their own transect (4 species)**
  - **Common environment in laboratory (12 species)**

### d) Genetic experiments:

- **Three species**
- **Two collection locations**

| | Design | Traits measured | Populations (families) and species |
|---|---|---|---|
| 1 | Full-sib (1 male: 1 female) | As below (2) plus starvation resistance | **One** population of *D. equinoxialis* (23), **one** of *D. malerkotliana* (16), and **one** of *D. saltans* (26). |
| 2 | Nested half-sib /full-sib (1 male: 4 females) | Development time, dry weight, fat-free dry weight, fat weight, fat percentage | **Two** populations of *D. equinoxialis* (50, 50), **one** of *D. malerkotliana* (-, 38), and **two** of *D. saltans* (48, 50) |

## 4) Field results

### a) Metrics:

- **Field experiment 1: expression of life-history traits in the original collection habitat**
  - **12 species, 5941 individuals**
- **Field experiment 2: transplantation experiment**
  - **4 species, 5629 individuals**
- **Common environment experiment: expression of life-history traits in the laboratory environment**
  - **12 species, 15802 individuals**

### b) Combined results:

| Trait | Environmental variation? | Genetic variation? | Genetic Environmental GxE |
|---|---|---|---|
| Body size | **Yes, but no clear pattern** | **Yes, but no clear pattern** | **32.7 %**<br>**35.8 %**<br>**31.4 %** |
| Development time | **Yes, disturbance ↑ → development time ↓** | **Yes, disturbance ↑ → development time ↓** | **19.8 %**<br>**40.9 %**<br>**39.4 %** |
| Starvation resistance | **Yes, disturbance ↑ → starvation resistance ↓** | **Yes, disturbance ↑ → starvation resistance ↑** | **9.0 %**<br>**58.0 %**<br>**33.0 %** |

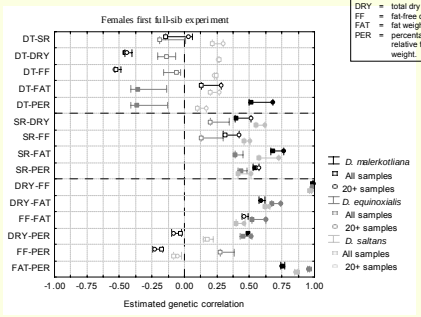
### b) Interpretation:

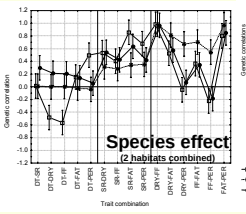
- **Body size: no consistent effects**
- **Development time: deforestation decreases food abundance fluctuations and that increases overall crowding, i.e. increased competition**
- **Starvation resistance: opening the canopy increased midday temperature and that drives the observed changes; changes might be incomplete**

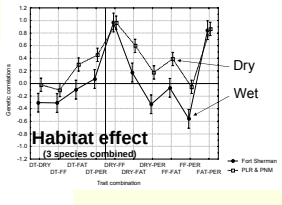
## 5) Genetics: correlations

**Key:**

DT = development time
SR = starvation resistance
DRY = total dry weight
FF = fat-free dry weight
FAT = fat weight
PER = percentage fat relative to total dry weight.




Summary:

| Trait combination | Phenotypic correlation | Genetic correlation | Interspecific correlation |
|---|---|---|---|
| Body size - Development time | - | 0 | + |
| Body size - Starvation resistance | + | + | + |
| Development time - Starvation resistance | - | 0 | + |

## 6) Synthesis

1. **Development time and starvation resistance show correlated response to a change in the environment; body size is less sensitive**
2. **Genetic correlation between DT and SR is absent:**
   - **Transplantation experiment: independent change in opposite direction**
   - **Full-sib design: non-significant results around zero**
3. **Therefore, adaptation to a changing environment is not hampered by genetic correlations; $h^2$ for DT and SR low or absent and potential limitation for adaptation[6]**
4. **Different species show similar responses:**
   - **At phenotypic level**
   - **At genetic level**
   - **At genetic correlation level**
5. **Extrapolating results is difficult:**
   - **Genetic correlations: different between locations and species**
   - **Extensive GxE components**


1. van der Linde, K (2005) *Testing Drosophila life-history theory in the field: local adaptation in body size, development time and starvation resistance* (Ph.D. thesis, Leiden University, Leiden).
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