



# Residues of pharmaceuticals in treated effluent in an EU-wide survey and estimated environmental impact

Jerker Fick, Dep. of Chemistry,  
Umeå University, Sweden



# Overview

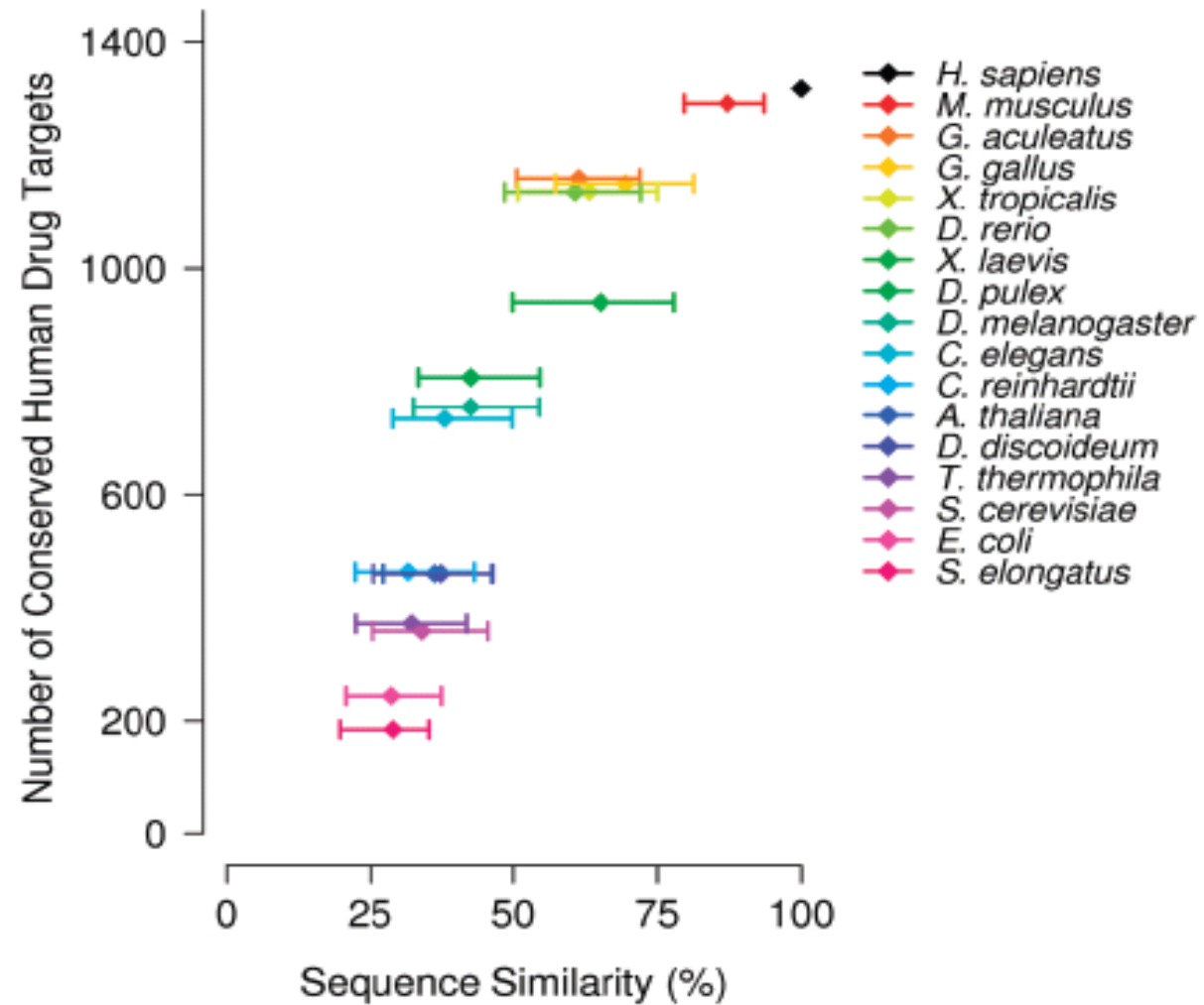
- Introduction
- EU-wide survey
- Estimation of environmental impact
- Summary



# Introduction







Gunnarsson et al. 2008, EST



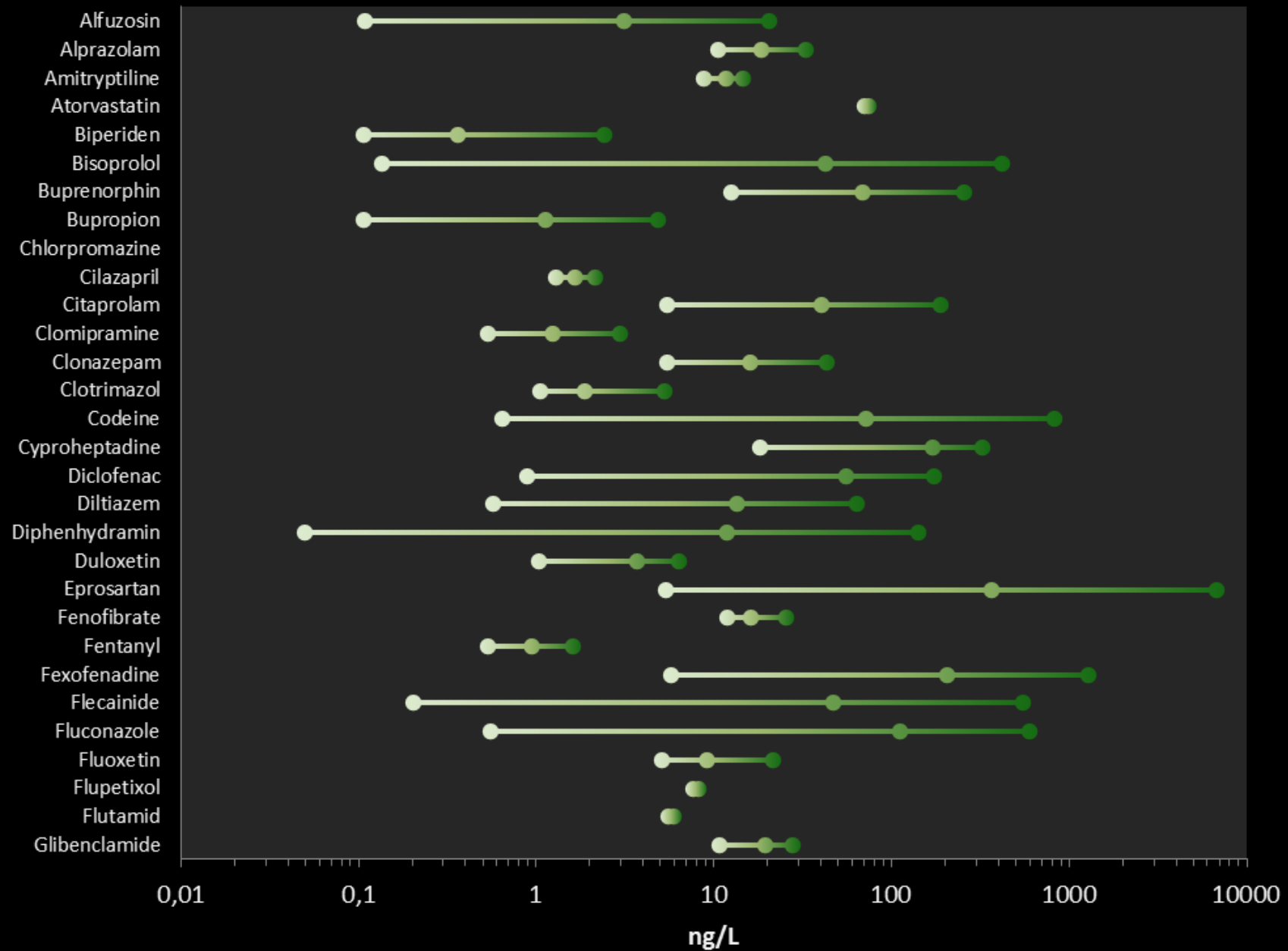
# EU-wide survey



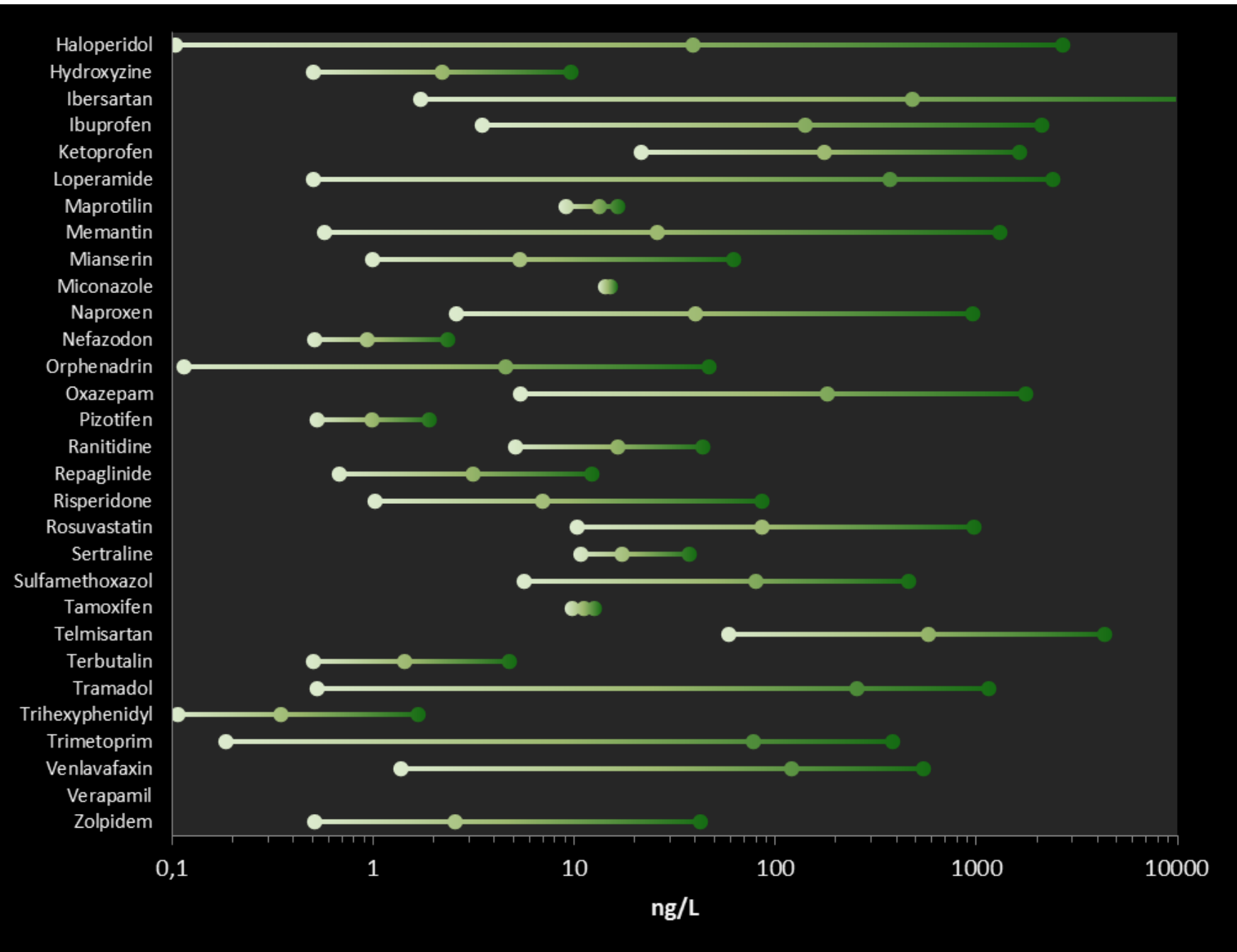
# EU-Wide Monitoring Survey

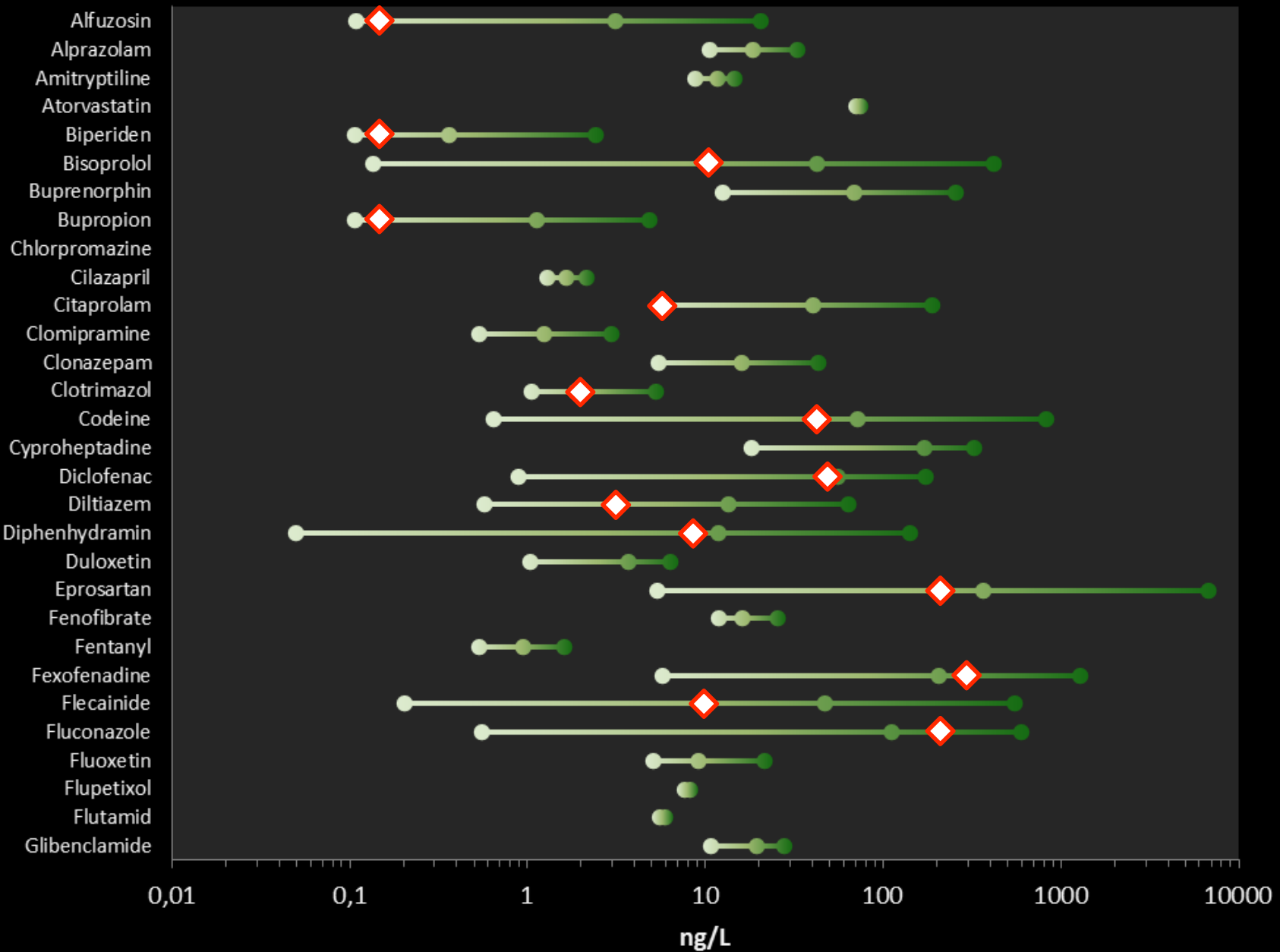
- 90 STPs (P.E. 2558 – 1 900 000)
- 18 Countries
- Several different tech.
- 72 Pharmaceuticals
- 60 detected
- 0.1 – 17 000 ng/L

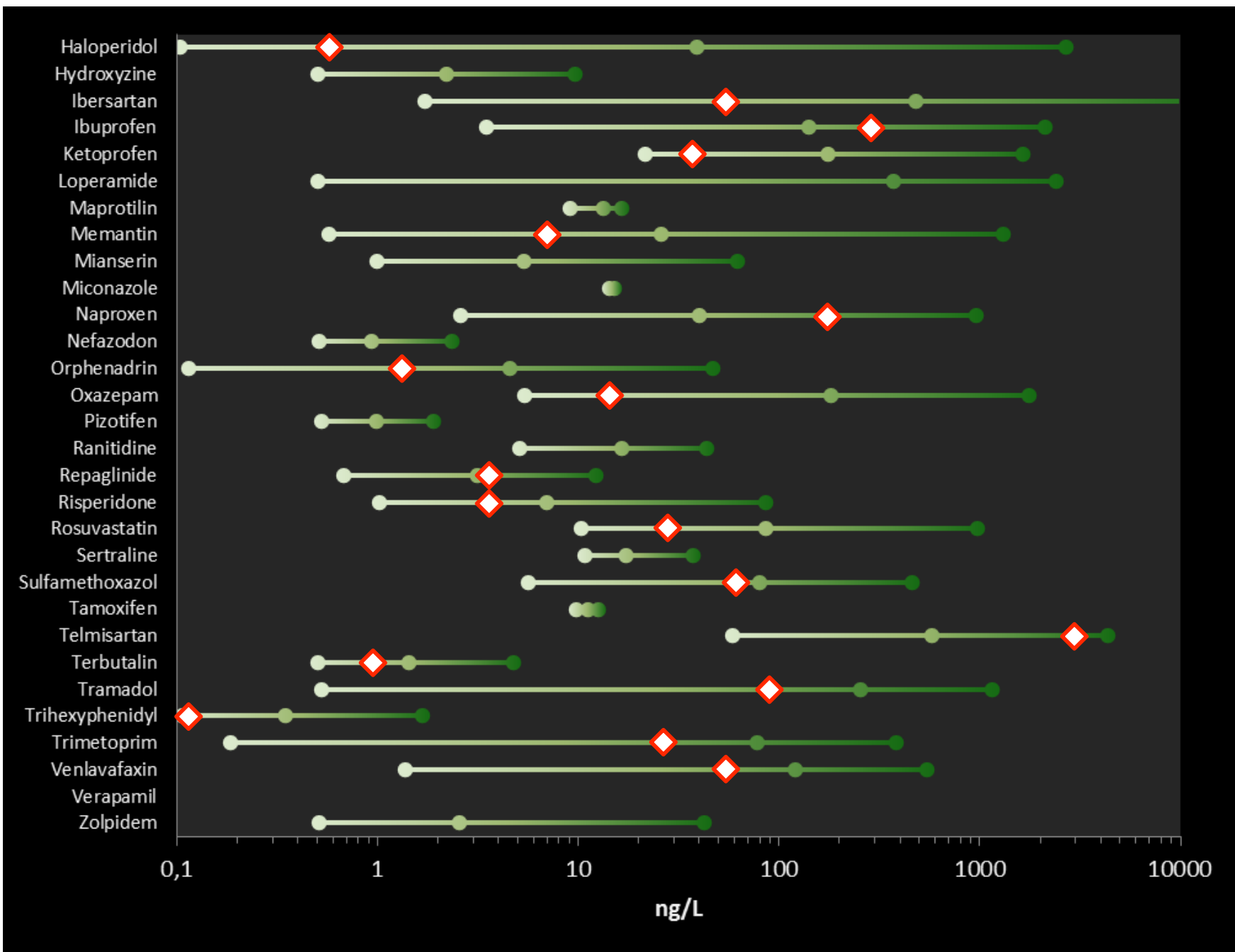














## Limassol WWTP

- 32 Pharmaceuticals detected (72)
- 0.1 – 3400 ng/L
- Average 150 ng/L
- Median 14 ng/L
  
- Telmisartan 3400 ng/L
- Diclofenac 60 ng/L





Name	ng/L	Name	ng/L
Telmisartan	3400	Bisoprolol	11
Naproxen	270	Diphenhydramin	9.5
Fluconazole	230	Flecainide	9.2
Eprosartan	210	Memantin	6.0
Fexofenadine	120	Citaprolam	5.8
Ibuprofen	120	Diltiazem	3.6
Tramadol	98	Repaglinide	2.3
Diclofenac	57	Risperidone	2.1
Ibersartan	55	Clotrimazol	1.7
Venlavafaxin	51	Orphenadrin	1.4
Sulfamethoxazol	50	Terbutalin	0.9
Codeine	44	Alfuzosin	0.6
Ketoprofen	36	Bupropion	0.6
Rosuvastatin	26	Haloperidol	0.3
Trimetoprim	24	Trihexyphenidyl	0.1
Oxazepam	16	Biperiden	0.1



# Estimation of environmental impact



$$\text{CR} = \frac{\text{H}_T\text{PC}}{\text{F}_{SS}\text{PC}}$$

**Huggett et al. 2003,  
Hum. Ecol. Risk Assess. 9:1789–1799**



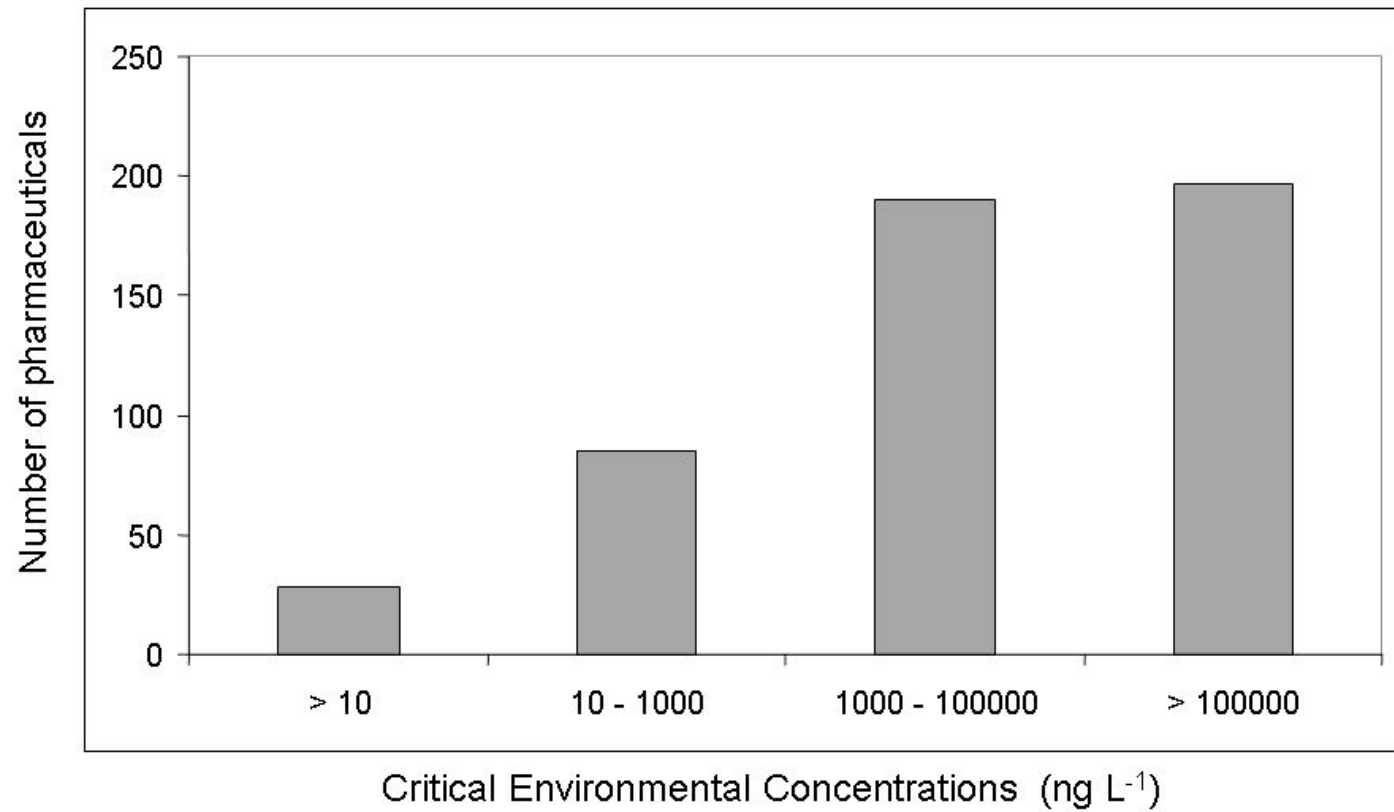
# Critical Environmental Concentration (CEC)

$$\text{CEC} = \frac{H_T \text{PC}}{\text{CR} \times P_{\text{Blood:Water}}}$$

$$\log P_{\text{blood:water}} = 0.73 \times \log K_{ow} - 0.88$$

$$\text{CEC} = 1$$





Fick et al. 2010, RTP



$$\text{CR} = \frac{\text{CEC}}{\text{MEC}}$$



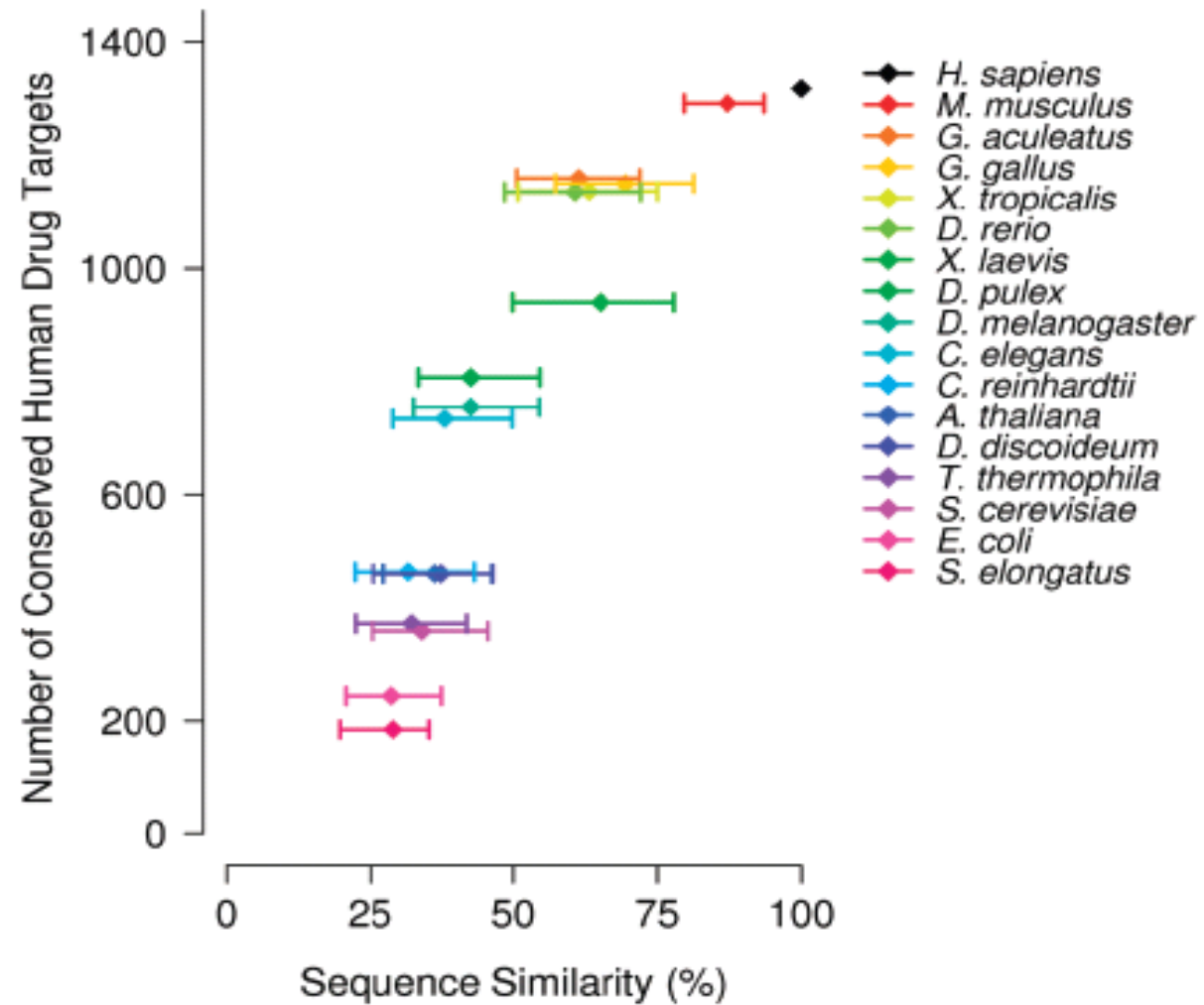
<b>Name</b>	<b>CR</b>	<b>Name</b>	<b>CR</b>
Telmisartan	0.00021	Memantin	370
Eprosartan	0.32	Codeine	610
Ibersartan	0.90	Trihexyphenidyl	700
Repaglinide	1.5	Biperiden	800
Haloperidol	24	Orphenadrin	1200
Citaprolam	24	Ketoprofen	1400
Rosuvastatin	46	Ibuprofen	1600
Tramadol	49	Alfuzosin	1700
Risperidone	60	Oxazepam	1900
Diclofenac	80	Terbutalin	2800
Venlavafaxin	120	Naproxen	3100
Fexofenadine	170	Diltiazem	7700
Bupropion	210	Fluconazole	22000
Diphenhydramin	210	Trimetoprim	140000
Flecainide	210	Sulfamethoxazol	3000000
Bisoprolol	310	Clotrimazol	



# Limassol WWTP

- 3 Pharmaceuticals CR below 1
- Telmisartan!
- 21 CR above 100





Gunnarsson et al. 2008, EST



Specie	Ang II Rec		K Channel 1	K Channel 2
<i>G. gallus</i>	x		x	x
<i>X. tropicalis</i>	x		x	No Ortholog
<i>X. laevis</i>	x		x	No Ortholog
<i>G. aculeatus</i>	x		x	x
<i>D. rerio</i>	x		x	x
<i>D. melanogaster</i>	No Ortholog		No Ortholog	No Ortholog
<i>D. pulex</i>	No Ortholog		No Ortholog	No Ortholog
<i>C. elegans</i>	No Ortholog		No Ortholog	No Ortholog
<i>A. thaliana</i>	No Ortholog		No Ortholog	No Ortholog
<i>C. reinhardtii</i>	No Ortholog		No Ortholog	No Ortholog
<i>D. discoideum</i>	No Ortholog		No Ortholog	No Ortholog
<i>S. cerevisiae</i>	No Ortholog		No Ortholog	No Ortholog
<i>T. thermophila</i>	No Ortholog		No Ortholog	No Ortholog
<i>E. coli</i>	No Ortholog		No Ortholog	No Ortholog
<i>S. elongatus</i>	No Ortholog		No Ortholog	No Ortholog



# Summary



# Summary

- Early indication
- Interpretation
- Limit of quantification





## Soil?

- Fish plasma model vs. Plant uptake
- Target present
- Physico-chemical properties
  
- Antibiotic resistance genes



**Thank you for your attention!**

**MistraPharma**

**MISTRA**  
STIFTELSEN FÖR MILJÖSTRATEGISK FORSKNING