1 LBEM Laboratoire de Biologie et Environnement Marins

2- Laboratoire de Mathématiques Calcul Asymptotique

CADMIUM AND MERCURY IN FOUR SPECIES OF MARINE MAMMALS FROM THE FAROE ISLANDS : PRELIMINARY RESULTS OF THE MODELLING OF MERCURY BIOACCUMULMATION

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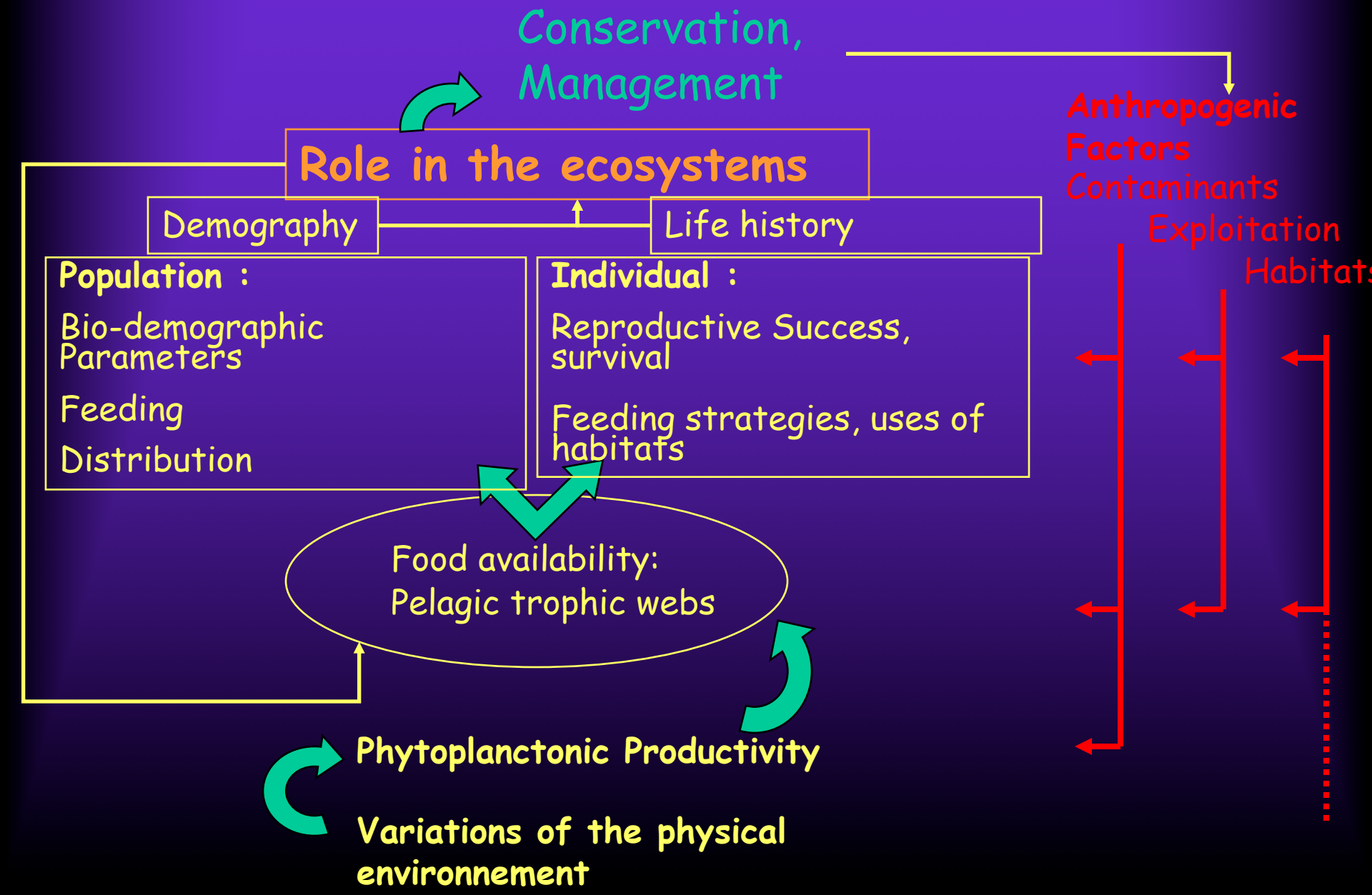
SCIENTIFIC FRAMEWORK



Metals are natural substances

and although they are now usually considered as pollutants, it 's important to know that they have always existed and they have been present in the earth crust since its formation

Long time in evolutionary terms, and there has been opportunity for the evolution of protective mechanisms against their toxic effects

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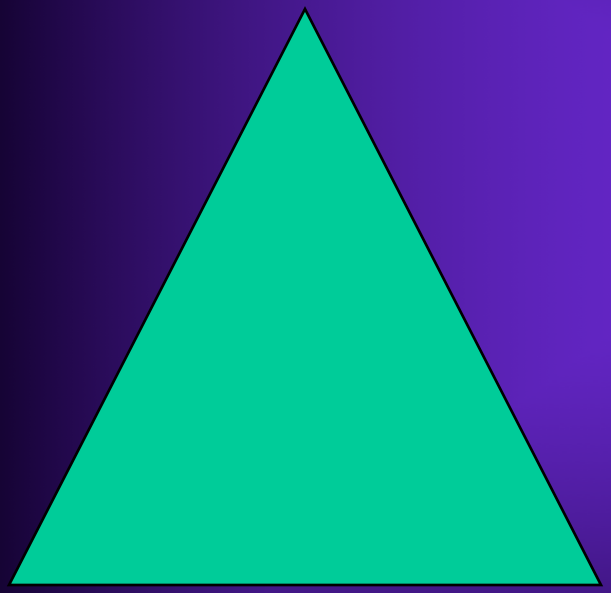
Long-lived species



Accumulate high levels of trace elements

Different factors influence bioaccumulation in marine mammals

INTER-SPECIFIC FACTORS

Feeding habits

Migratory habits

Life span

Body size

Taxonomy → Influence on metabolism

Different factors influence bioaccumulation in marine mammals

INTRA-SPECIFIC FACTORS

Age

Sex

Nutritive conditions and health status

Reproductive status

AMONG METALS, MERCURY AND CADMIUM ARE METALS OF PARTICULAR CONCERN

DIET

Hg CONCENTRATIONS

Fish >squid > crustaceans

Higher levels of Hg in fish eaters

Cd CONCENTRATIONS

squid > some crustaceans > Fish

Higher levels of Cd in squid eaters

AIM OF THIS STUDY

To model mercury and cadmium bioaccumulation

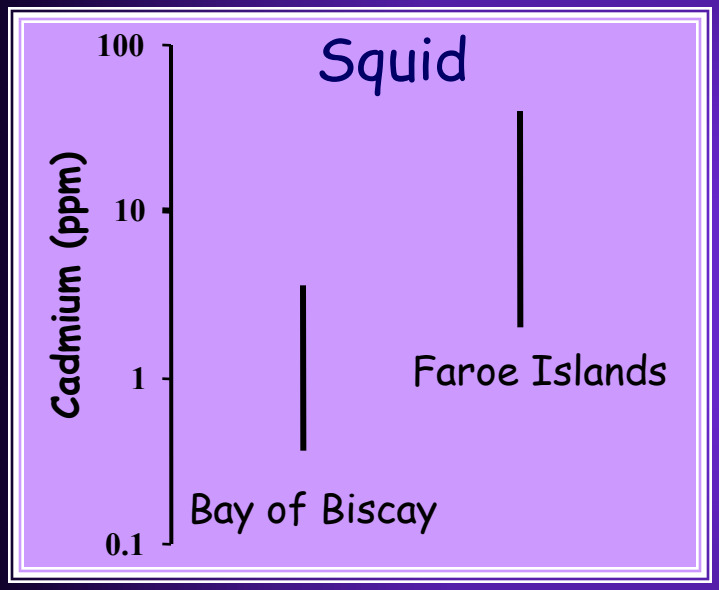
In order

To use metals as tracers of porpoise and dolphin populations or segments of populations

Faroe Islands : area of heuristic value

High levels of cadmium in the food webs

Four species of predators with different diet have been studied



Globicephala melas

Hyperoodon ampullatus

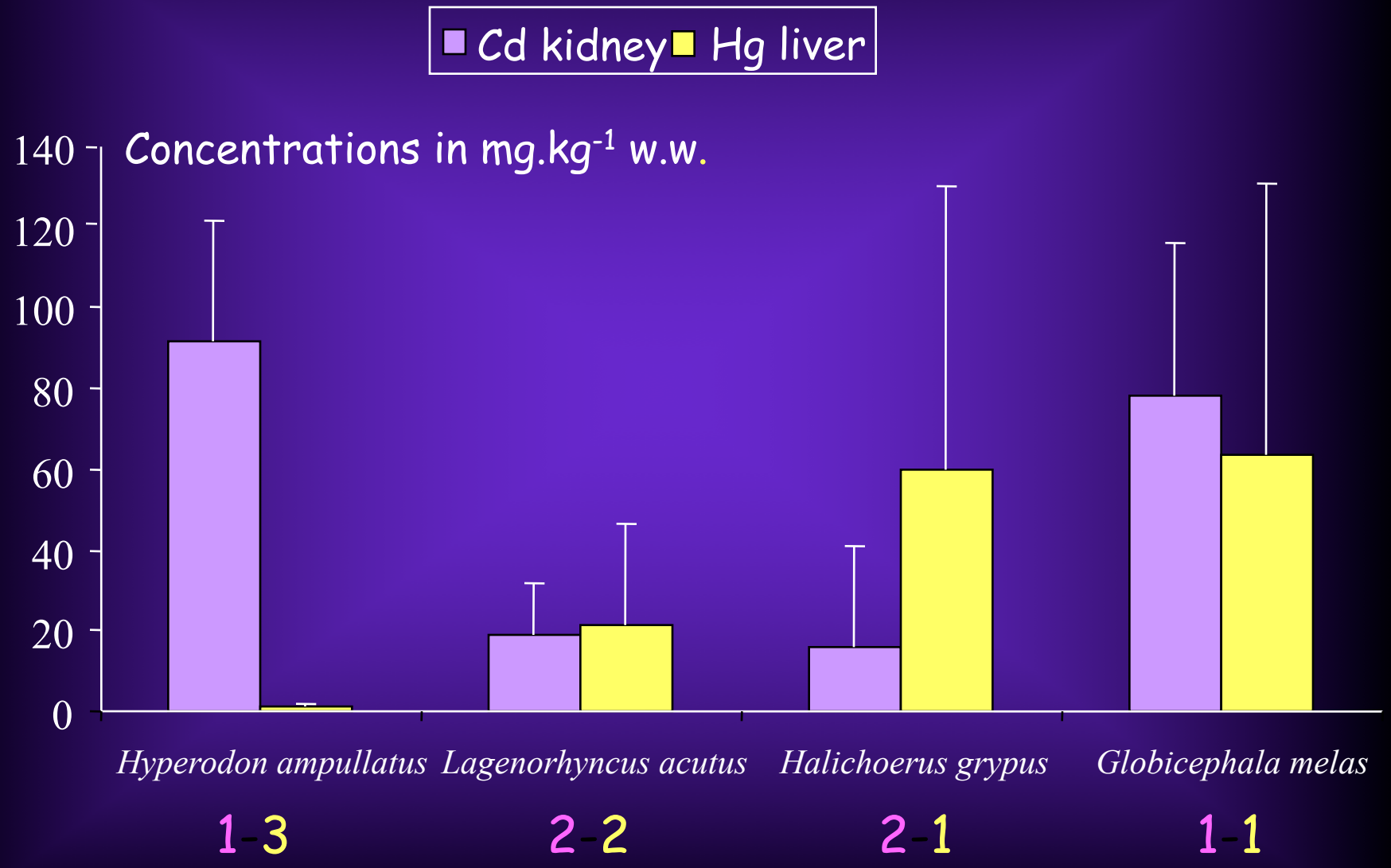
Mainly squid eaters

Mainly fish eaters

Halichoerus grypus

Lagenorhyncus acutus

Cadmium concentrations in kidney and mercury concentrations in liver of different species off the Faroe Islands



Model for marine mammals growth, energetic, and accumulation of mercury in the liver

Laird-Gompertz model for growth (cm)
$L=L_0*\exp(A0/\alpha*(1-\exp(-\alpha*t)))$

↓

Mass equation (Kg)
$W=\beta *L\hat{}\gamma$

Field metabolic rate (KJ/d)
FMR=528*W^0.77
(according to Franeker, 1992)

Energy density of food
6000 KJ/Kg for fish-3000 KJ/kg for squid
(according to Evans, 1987)

Food intake to suffice FMR (Kg/d)

X

Total mercury concentration in preys (0.3 mg/kg w.w. for fish-0.06 for squid)

X

The absorption rate (0.95 for fish-0.5for squid)
(Cappon & Smith, 1982)

Mercury daily intake (mg)

X

Fraction of the daily intake taken up by the liver f=0.05 (according to WHO, 1990 for blood)

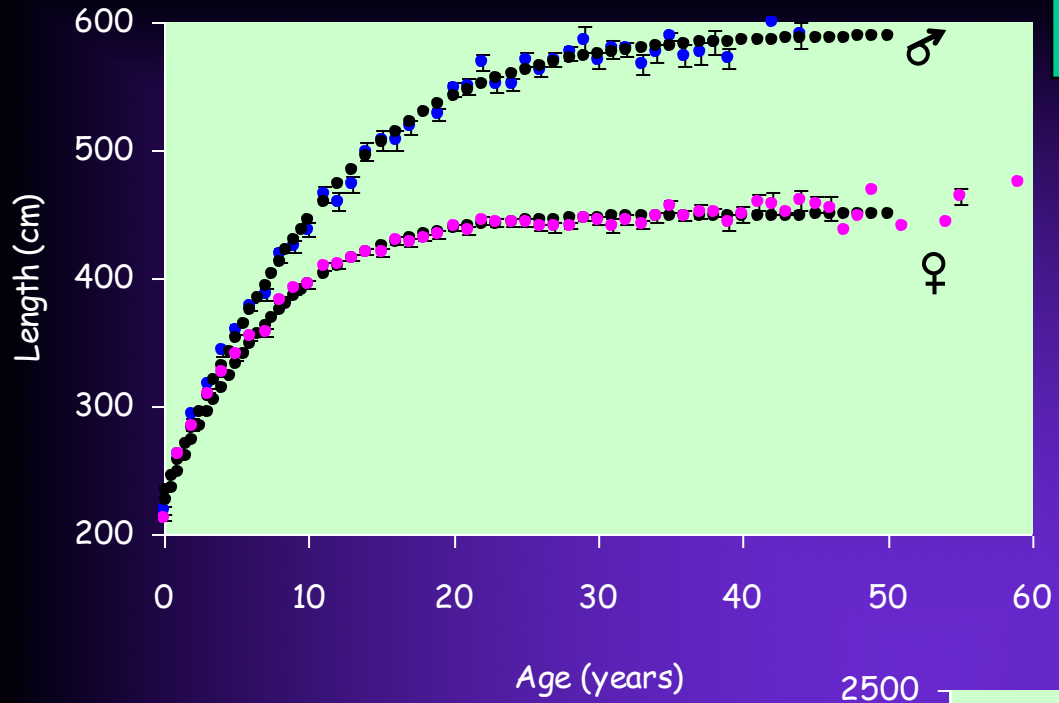
X

W*ratio of liver weight to body weight

= Age integrated mercury concentration in the liver

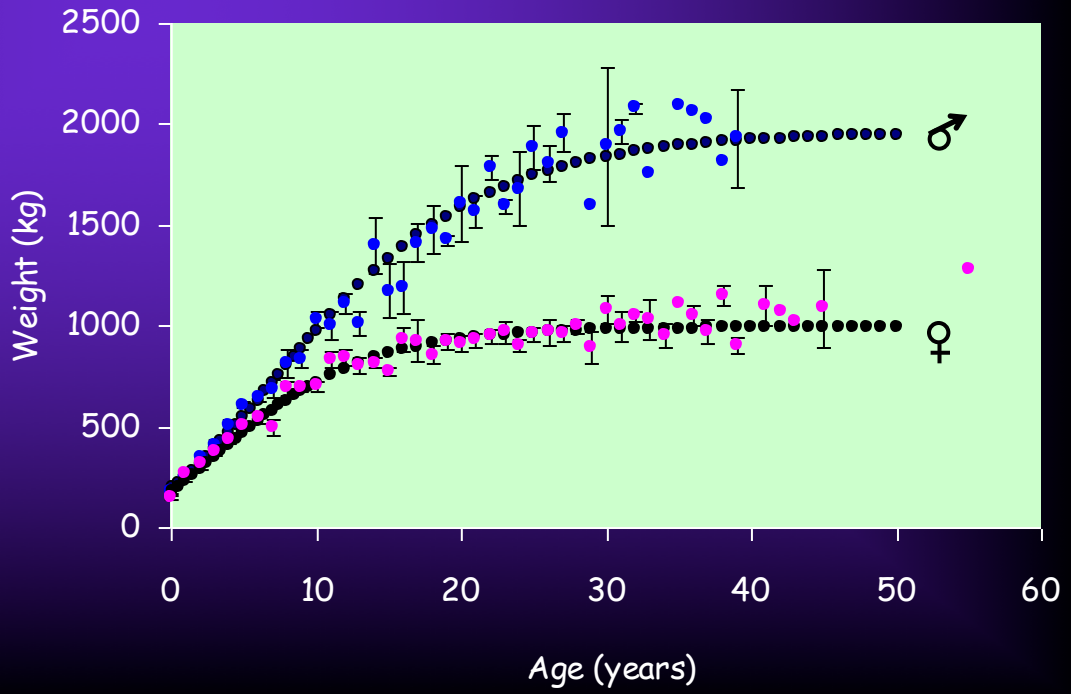
Growth

(Bloch, Lockyer & Zachariassen, 1993)

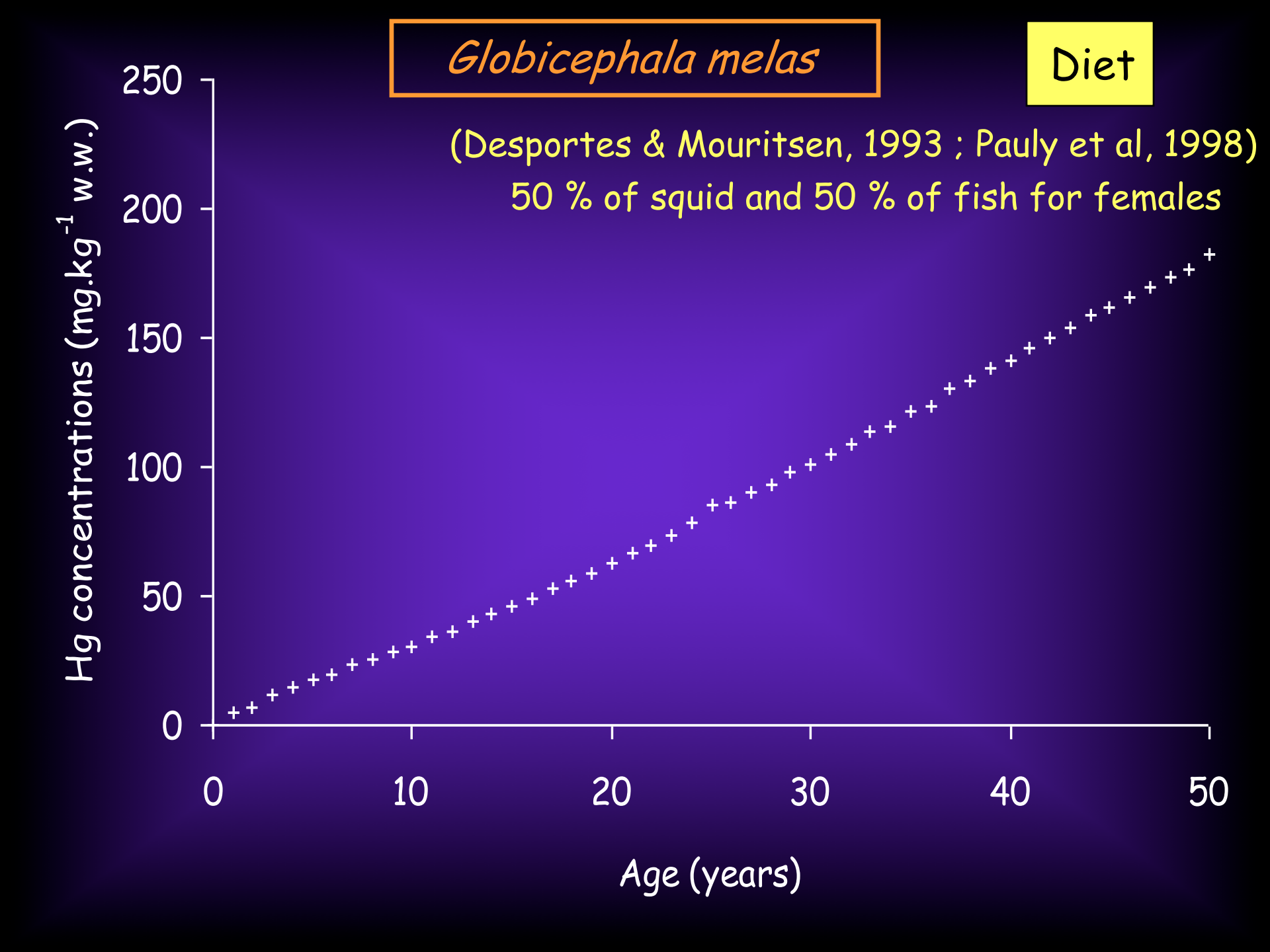


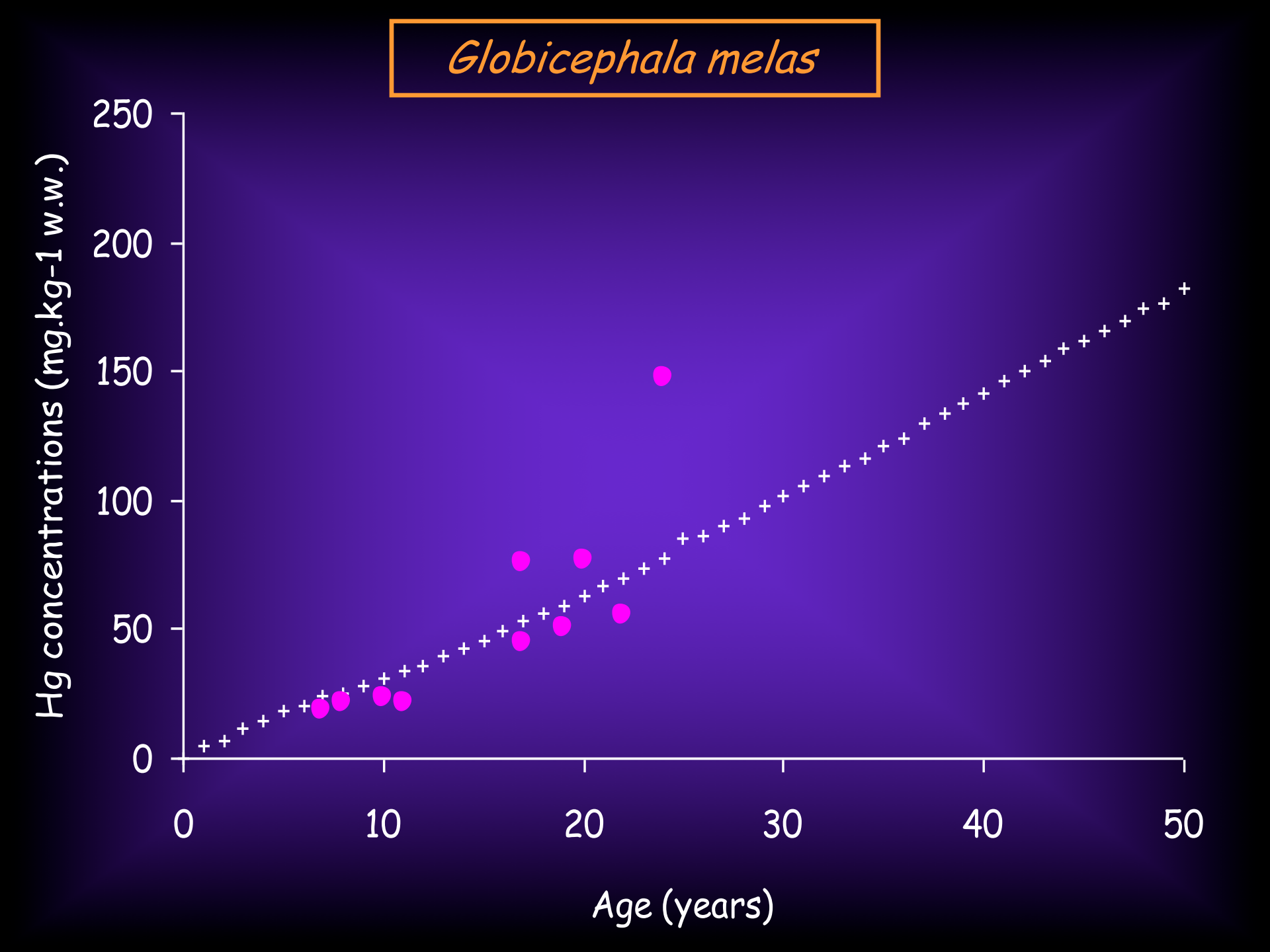
L_o	223.69	232
A_0	0.1172	0.112
α	0.168	0.12

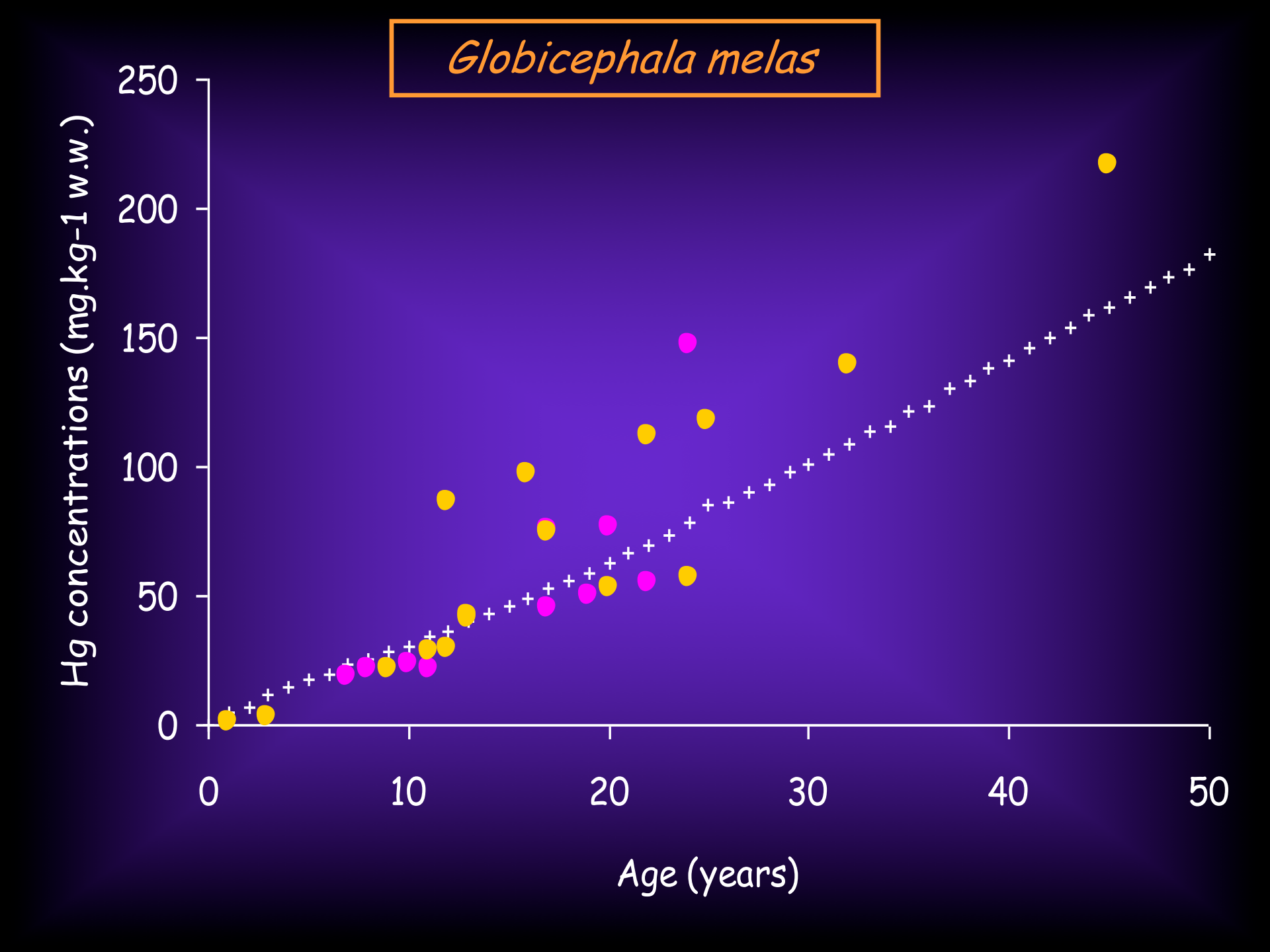
β	0.00023
γ	2.501

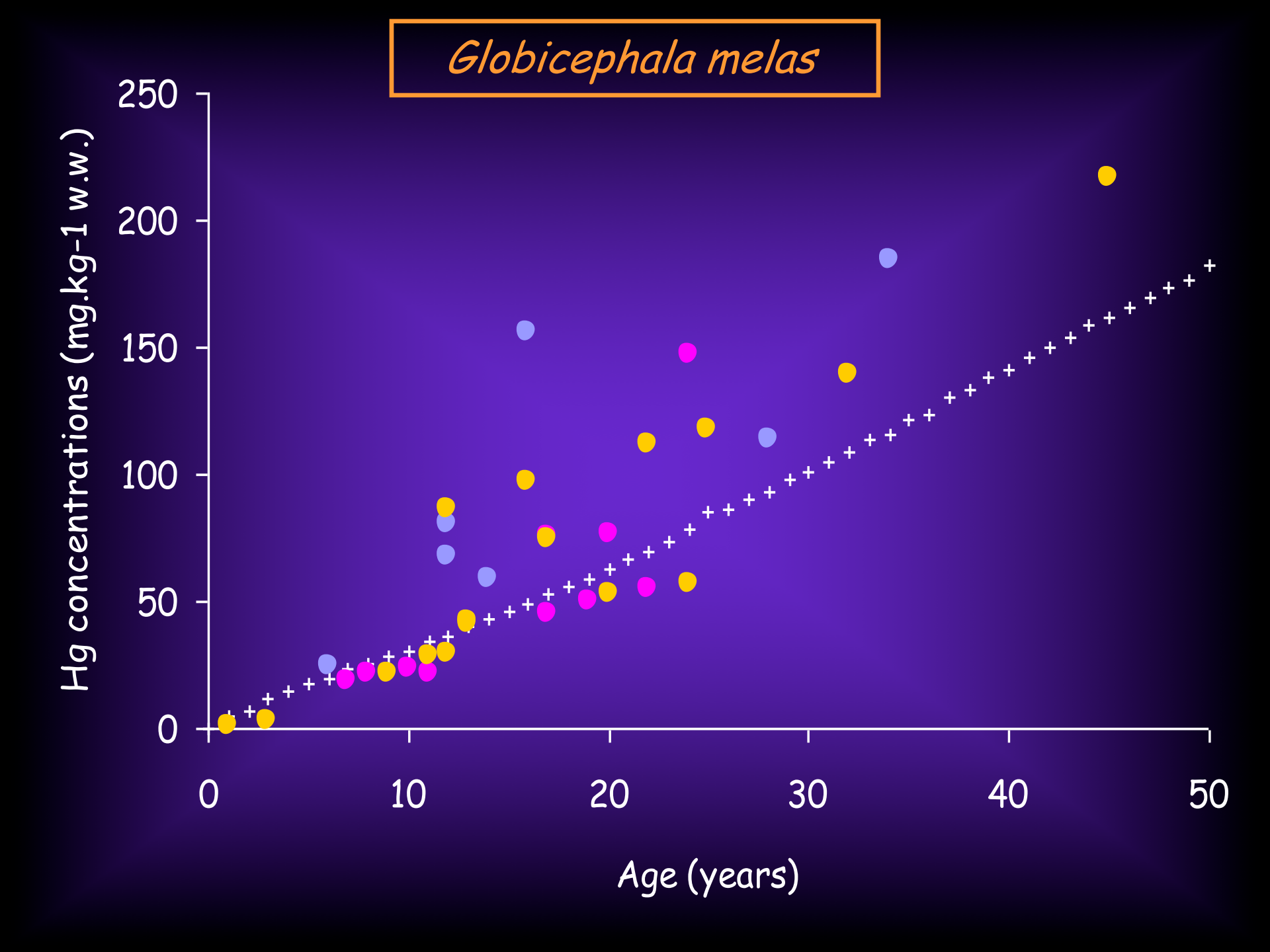


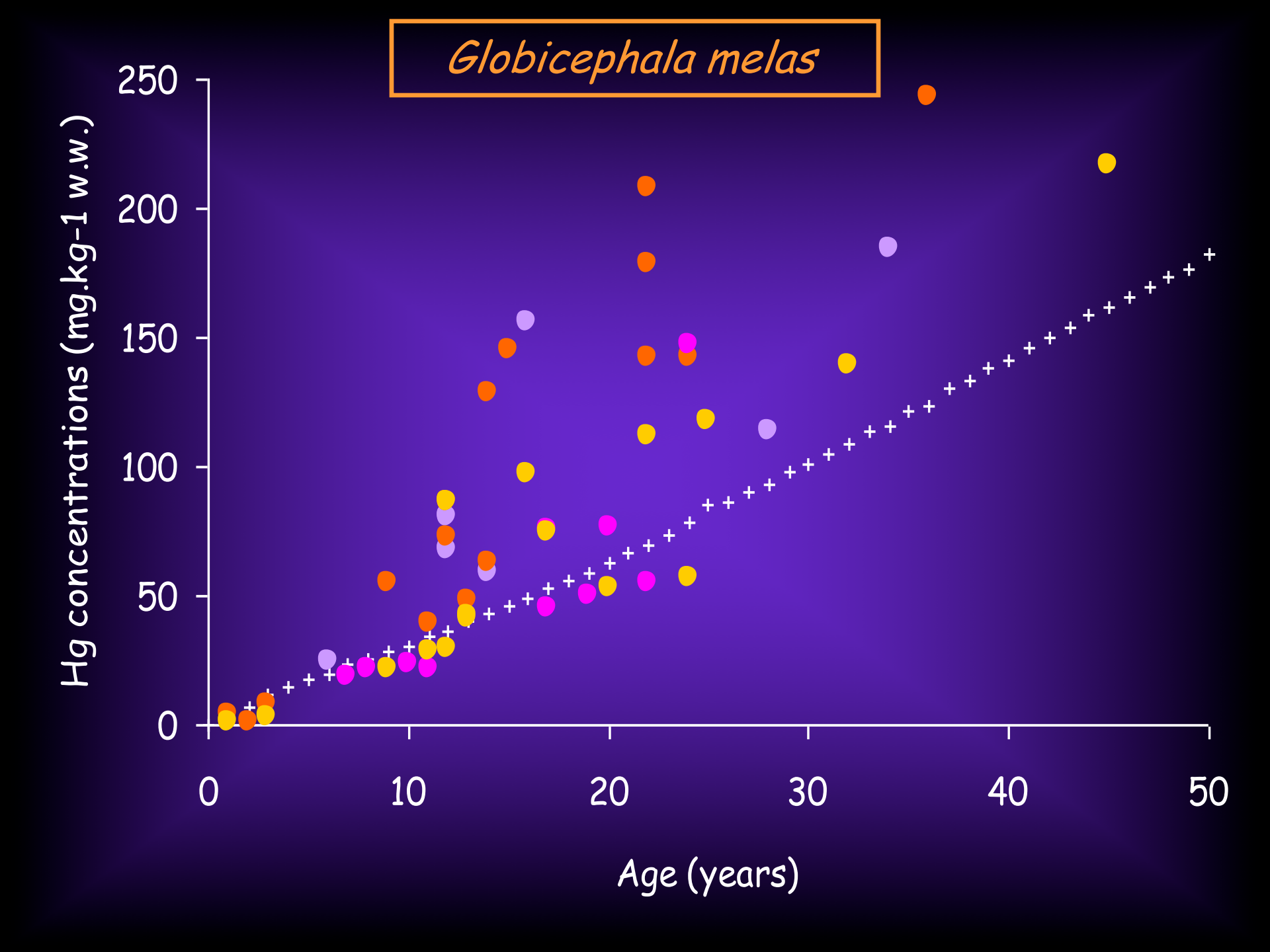
Globicephala melas

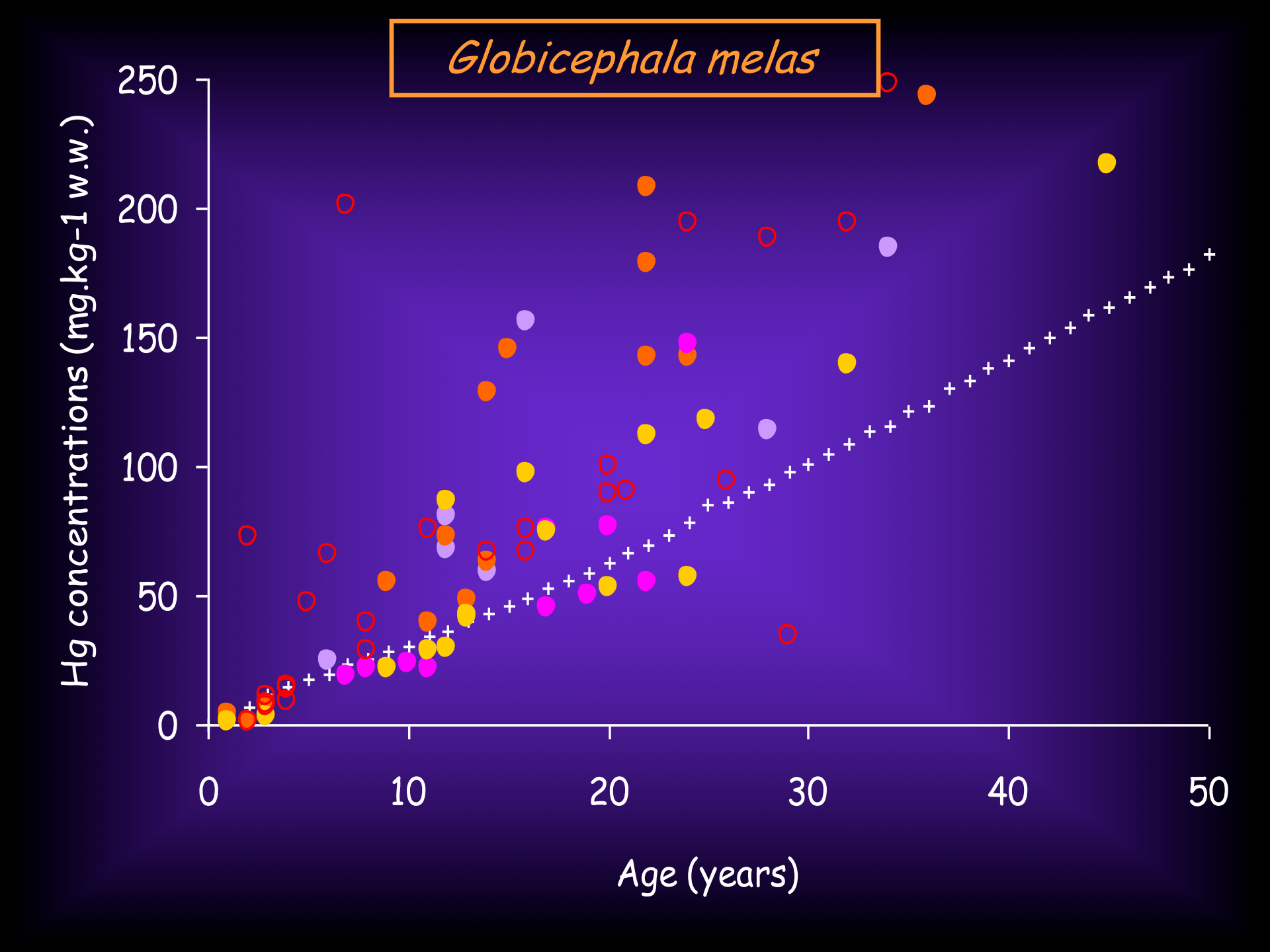

Globicephala melas
Diet
(Desportes & Mouritsen, 1993 ; Pauly et al, 1998)
50 % of squid and 50 % of fish for females
Hg concentrations (mg.kg-1 w.w.)
250
200
150
100
50
0
0
10
20
30
40
50
Age (years)


Globicephala melas
Hg concentrations (mg.kg-1 w.w.)
250
200
150
100
50
0
0
10
20
30
40
50
Age (years)


Globicephala melas
Hg concentrations (mg.kg-1 w.w.)
250
200
150
100
50
0
0
10
20
30
40
50
Age (years)

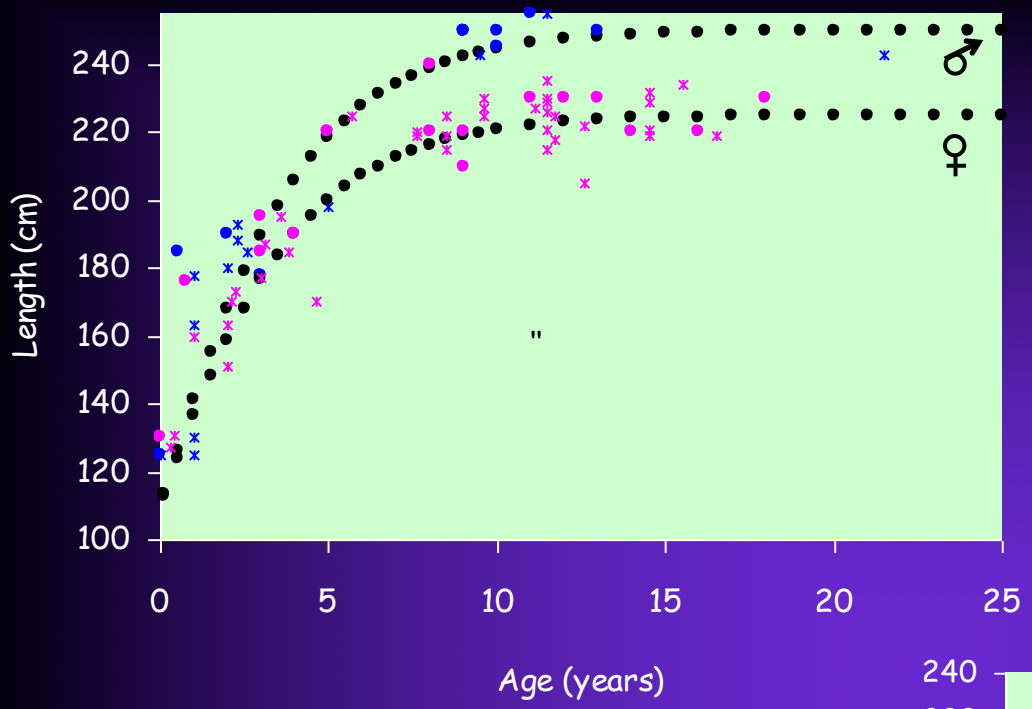

Globicephala melas
Hg concentrations (mg.kg-1 w.w.)
250
200
150
100
50
0
0
10
20
30
40
50
Age (years)


Globicephala melas
Hg concentrations (mg.kg-1 w.w.)
250
200
150
100
50
0
0
10
20
30
40
50
Age (years)


Globicephala melas
Hg concentrations (mg.kg-1 w.w.)
250
200
150
100
50
0
0
10
20
30
40
50
Age (years)

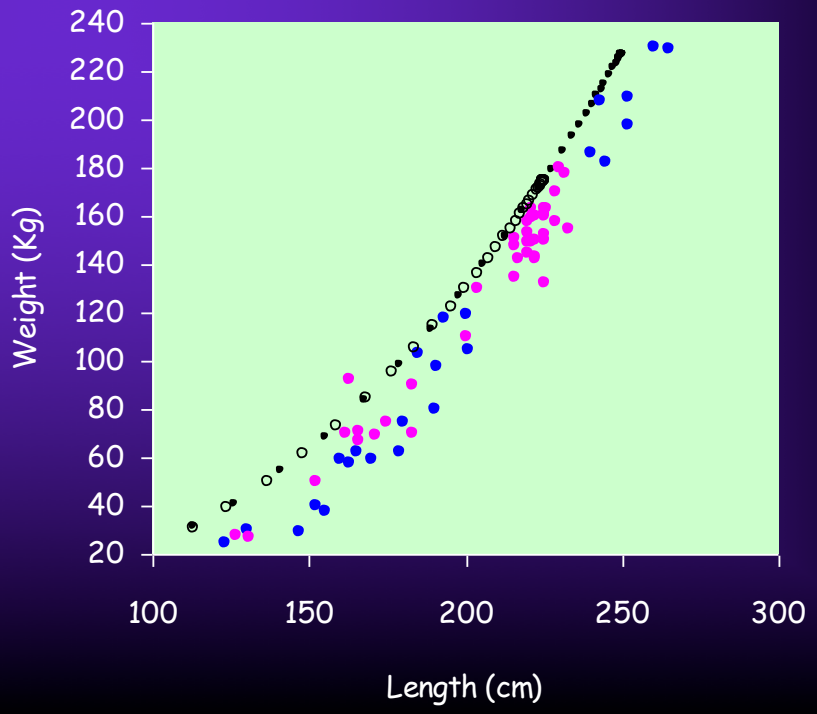
Growth

(Sergeant et al., 1980 ; our data)

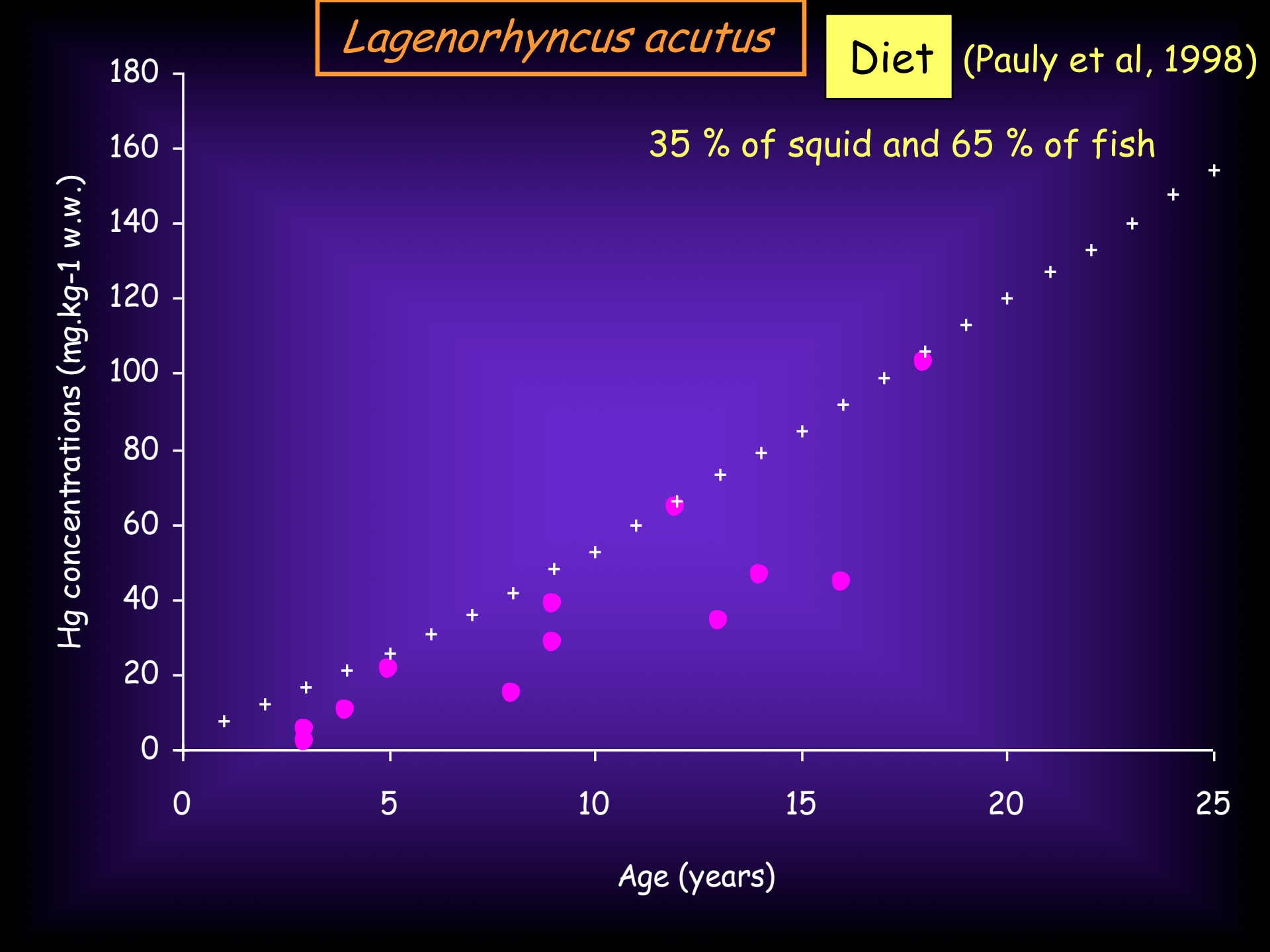


L_o	110	110
A_0	0.2576	0.2956
α	0.36	0.36

β	0.00023
γ	2.501

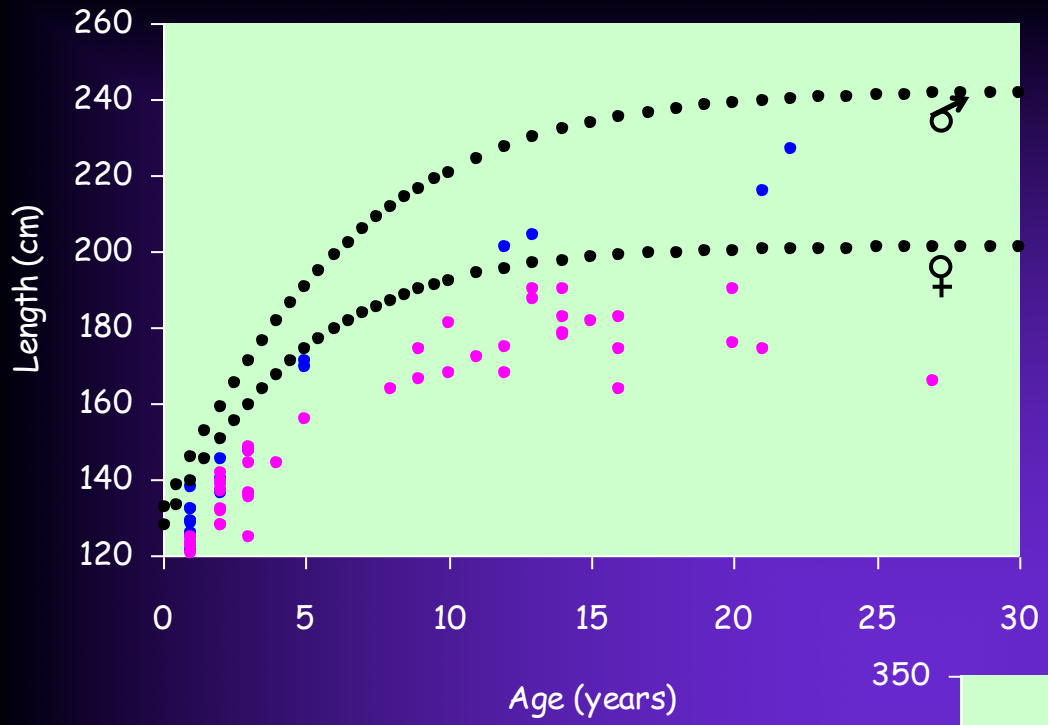


Lagenorhyncus acutus


Lagenorhyncus acutus
Diet
(Pauly et al, 1998)
35 % of squid and 65 % of fish
Hg concentrations (mg.kg-1 w.w.)
180
160
140
120
100
80
60
40
20
0
0
5
10
15
20
25
Age (years)

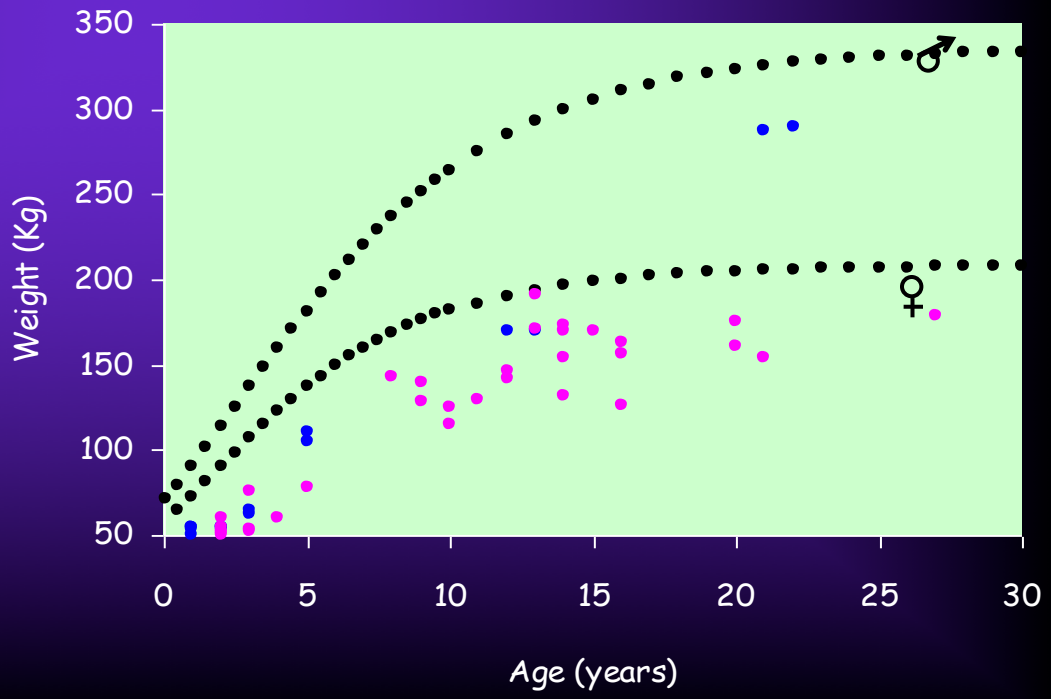
Growth

(Murie & Lavigne., 1992 ; our data)

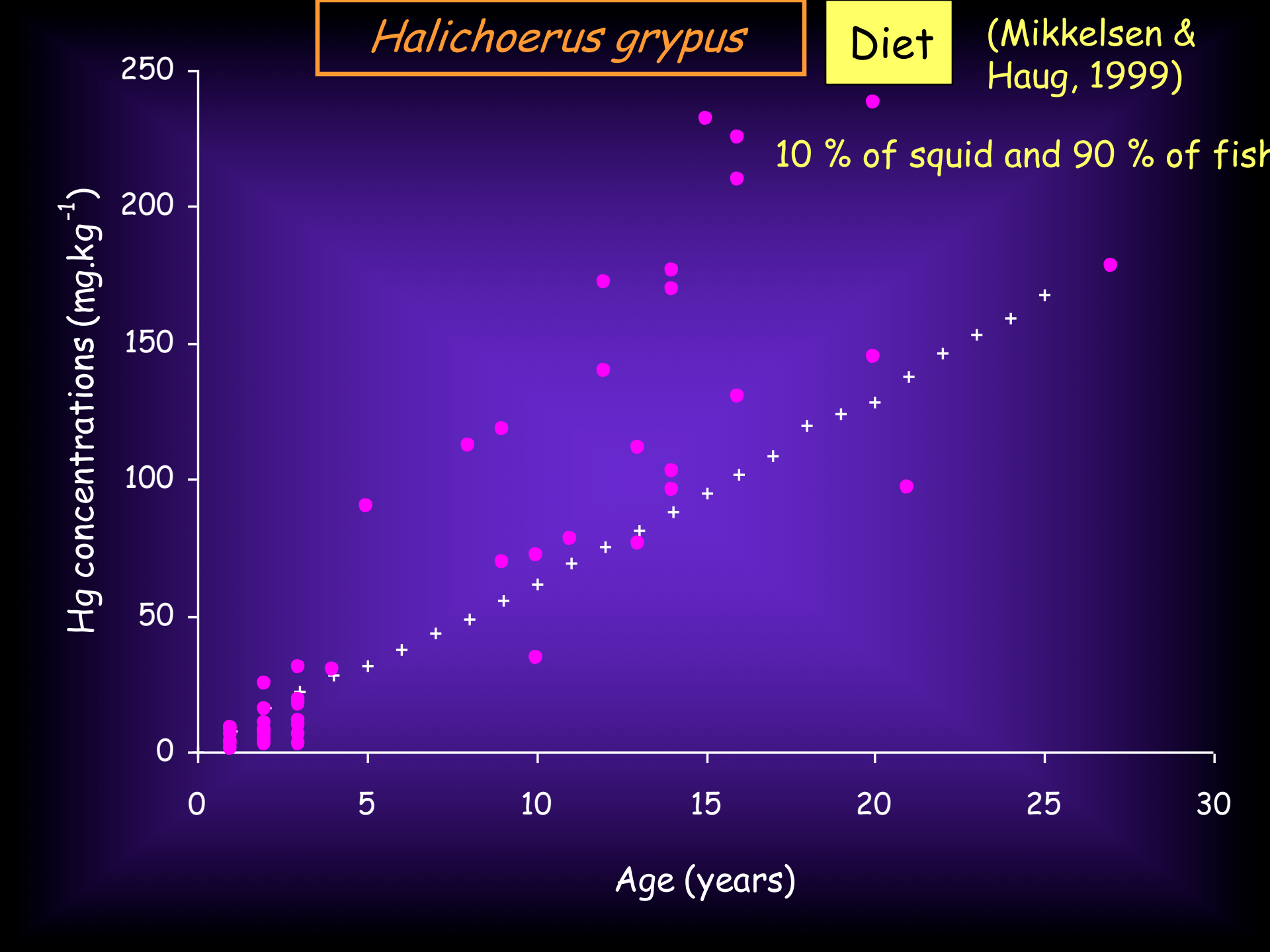


L_o	127	131
A_0	0.1074	0.1162
α	0.232	0.232

β	0.00025
γ	2.57



Halichoerus grypus


Halichoerus grypus
Diet
(Mikkelsen & Haug, 1999)
10 % of squid and 90 % of fish
Hg concentrations (mg.kg-1)
250
200
150
100
50
0
0
5
10
15
20
25
30
Age (years)

CONCLUSION and PERSPECTIVES

The processes taken into account lead to a model not very far from the reality and this approach is promising. Cadmium modelling will be carried out as well.

Species from the Faroe Islands are a good opportunity to carry out this modelling

CONCLUSION and PERSPECTIVES

- Pilot whales for which growth is well known can allow to improve the model, especially by taking into account the gestation and lactating periods
- The growth model for Atlantic white-sided dolphins must be improved, but the proportion of fish in the diet is probably underestimated.
- Grey seals, which are probably the only resident species can also be a good opportunity to improve the model, especially since diet is known in details in the Faroe Islands

CONCLUSION and PERSPECTIVES

Role of marine mammals in the ecosystems

Heavy metals = a complementary tool to

Diet analysis

Stable isotopes

BIOCET PROGRAM