

Marine biotechnology perspectives

Scientific and legal challenges



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CIESM Scientific Advisor
Director of IAMC, CNR



IFIB Italian Forum of Industrial Biotechnology and Bioeconomy:

From biotechnology new resources for industry

Genova, 25-26 September 2014

Conservation and sustainable use of MGRs



weaving a rope of sand?

Conservation and sustainable use of MGRs

Knowledge Gaps

MGRs socio-economic value

Nature and level of interest in MGRs

Regime of applicability of IPRs in the use of MGRs

IPRs vs. principles relevant to the conservation and sustainable use of MGRs

Level of dissemination of results of scientific research •

Existing available information

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Conservation and sustainable use of MGRs

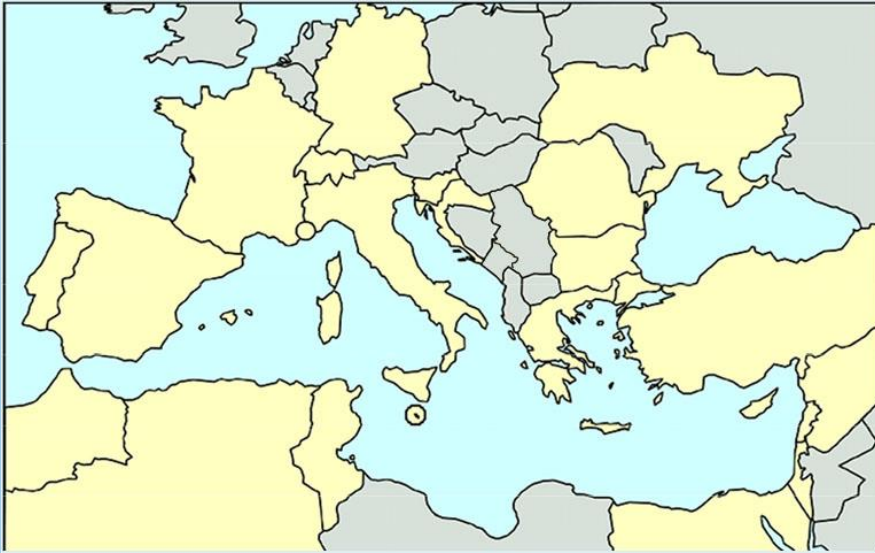
The Mediterranean Region as a case study

- ✓ **Nature and level of interest in MGRs**
- ✓ **Level of dissemination of results of scientific research •**

Mediterranean : one sea, three continents



CIESM – The Mediterranean Science Commis



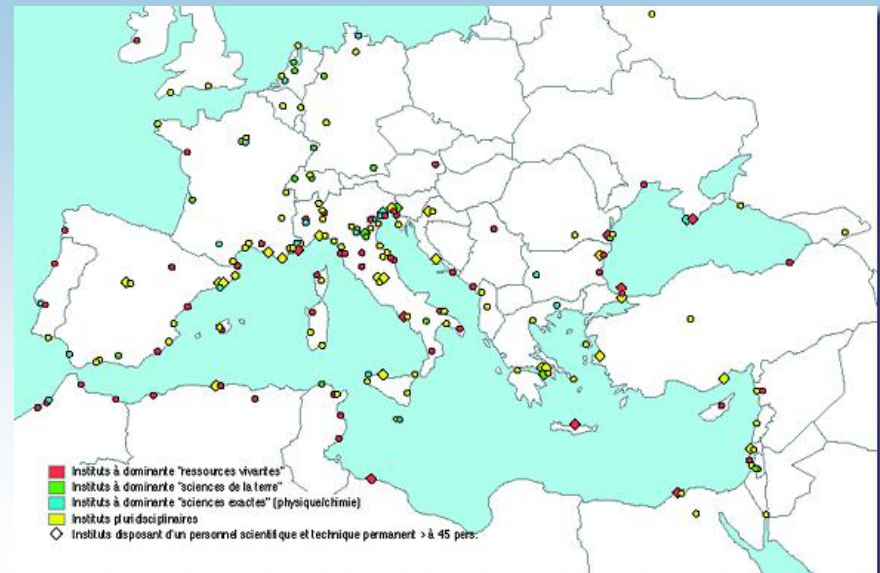
22 Member States
of which majority is non EU

CIESM – The Mediterranean Science Commis

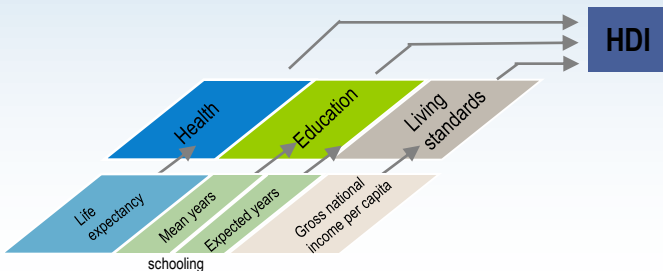
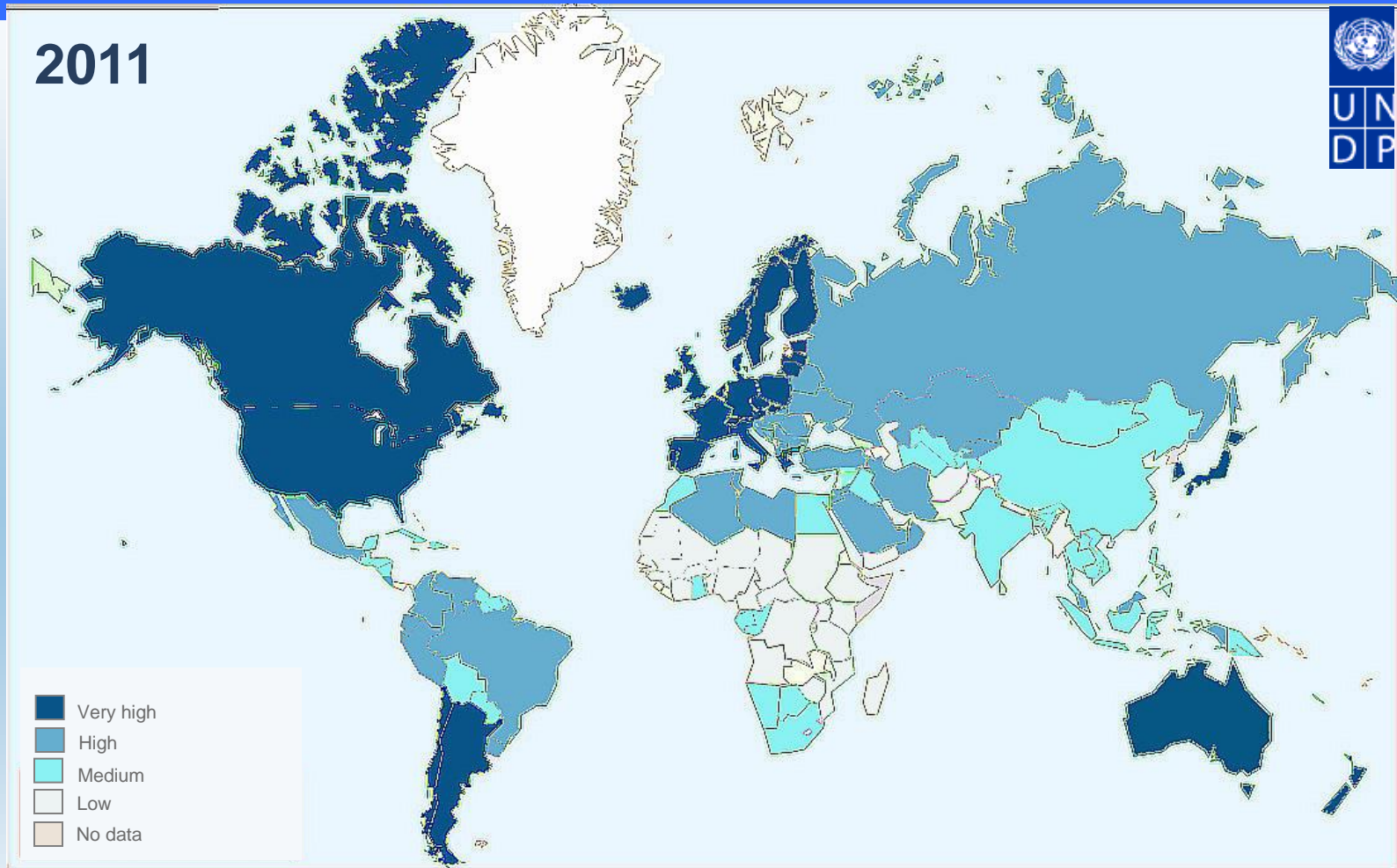


22 Member States
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*Over 4500 associate
researchers in 520
Institutes, 45 countries*

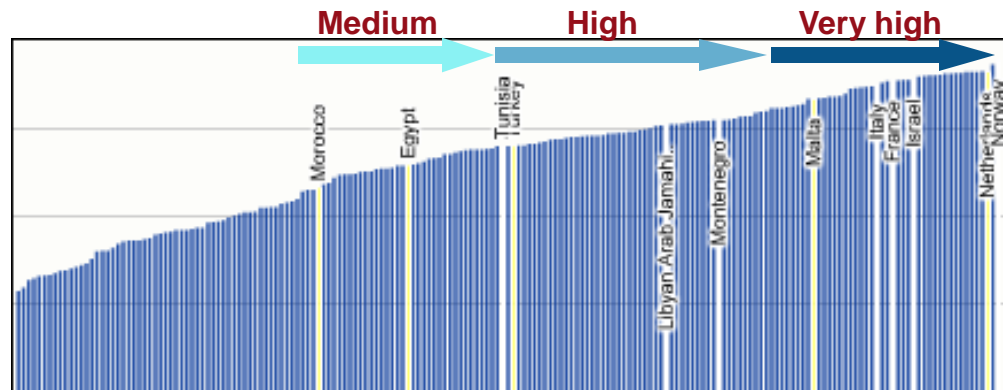
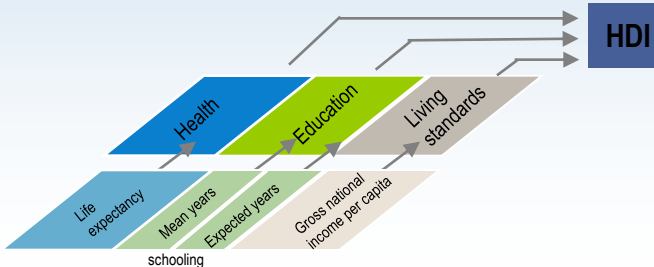
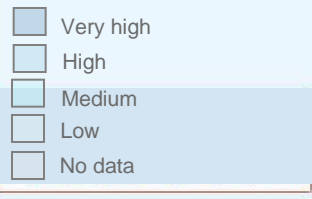
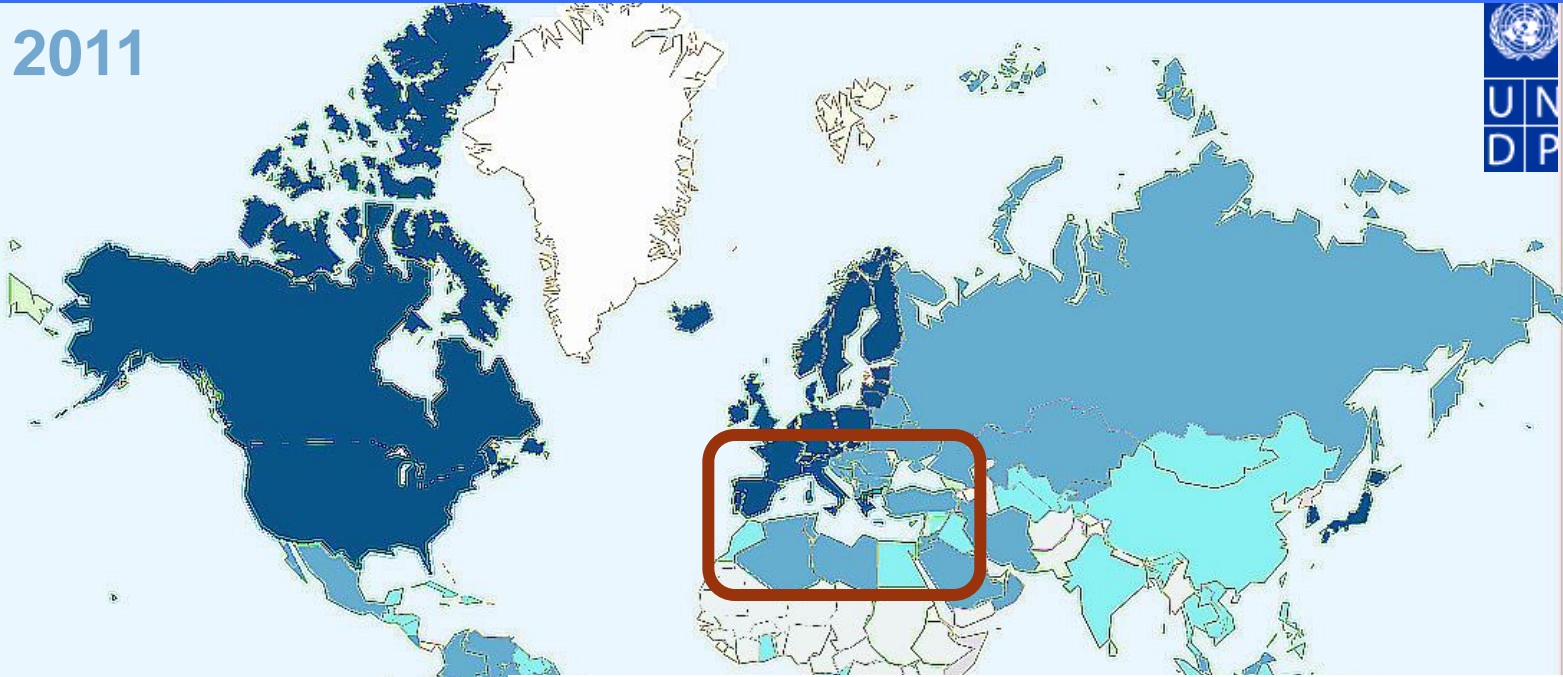


International Human Development Index (HDI)



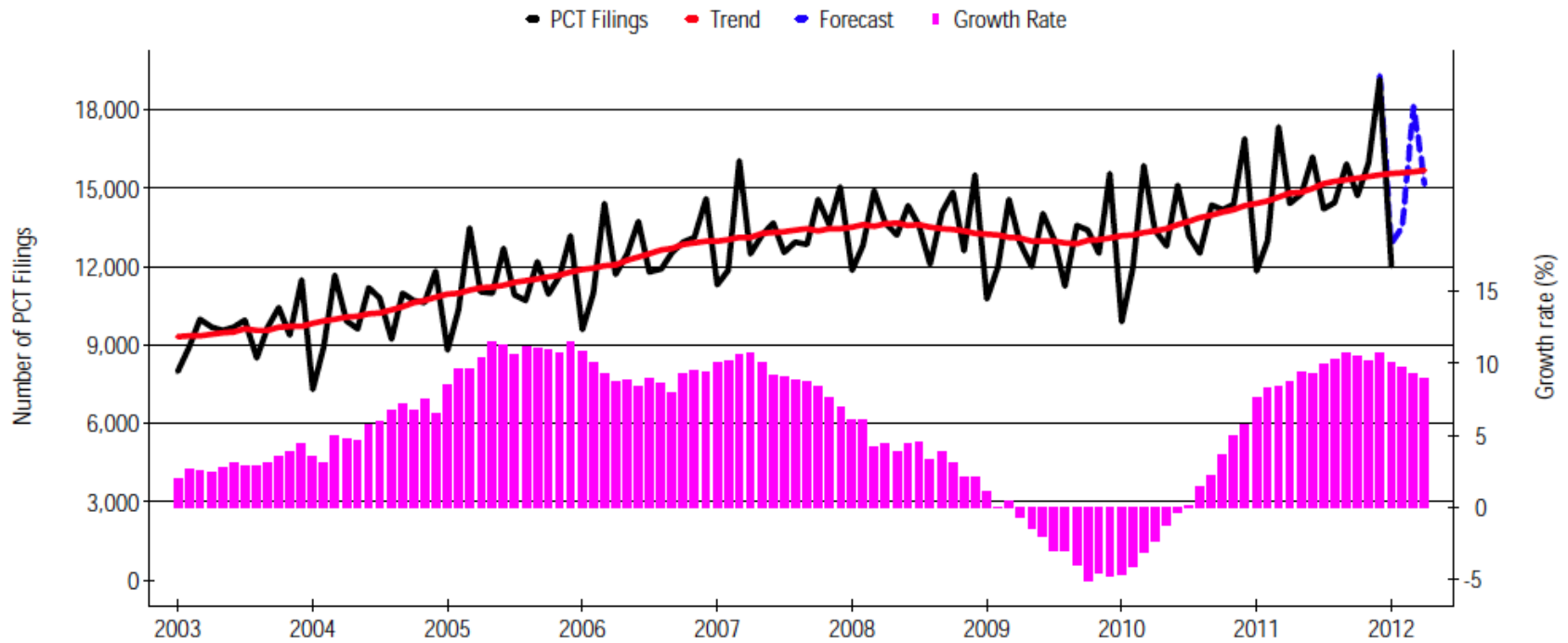
International Human Development Index (HDI)

2011



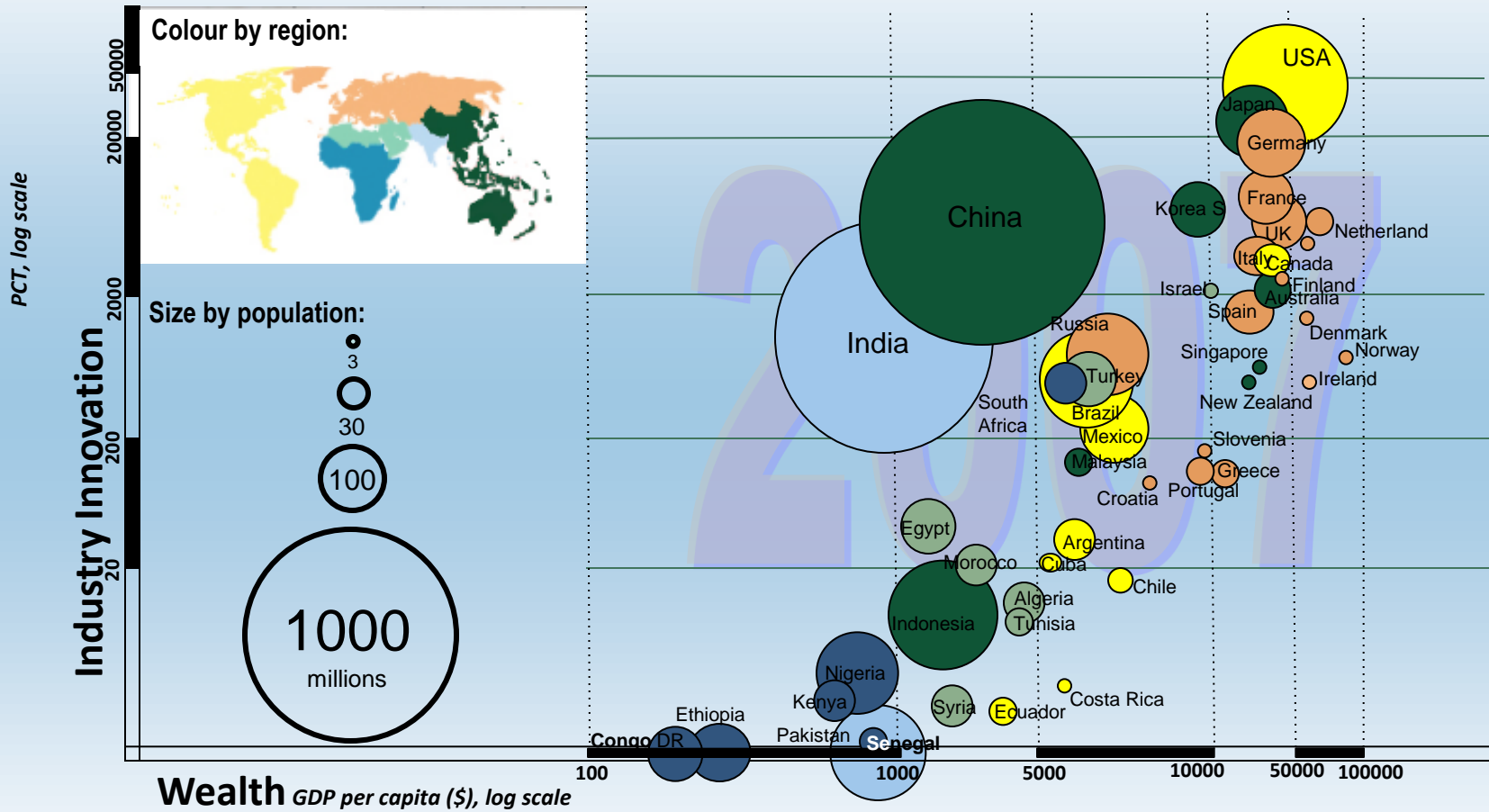
Trends in patent filings (PCT)

Proprietary regime as indicator of the economic interest/growth of knowledge based industry

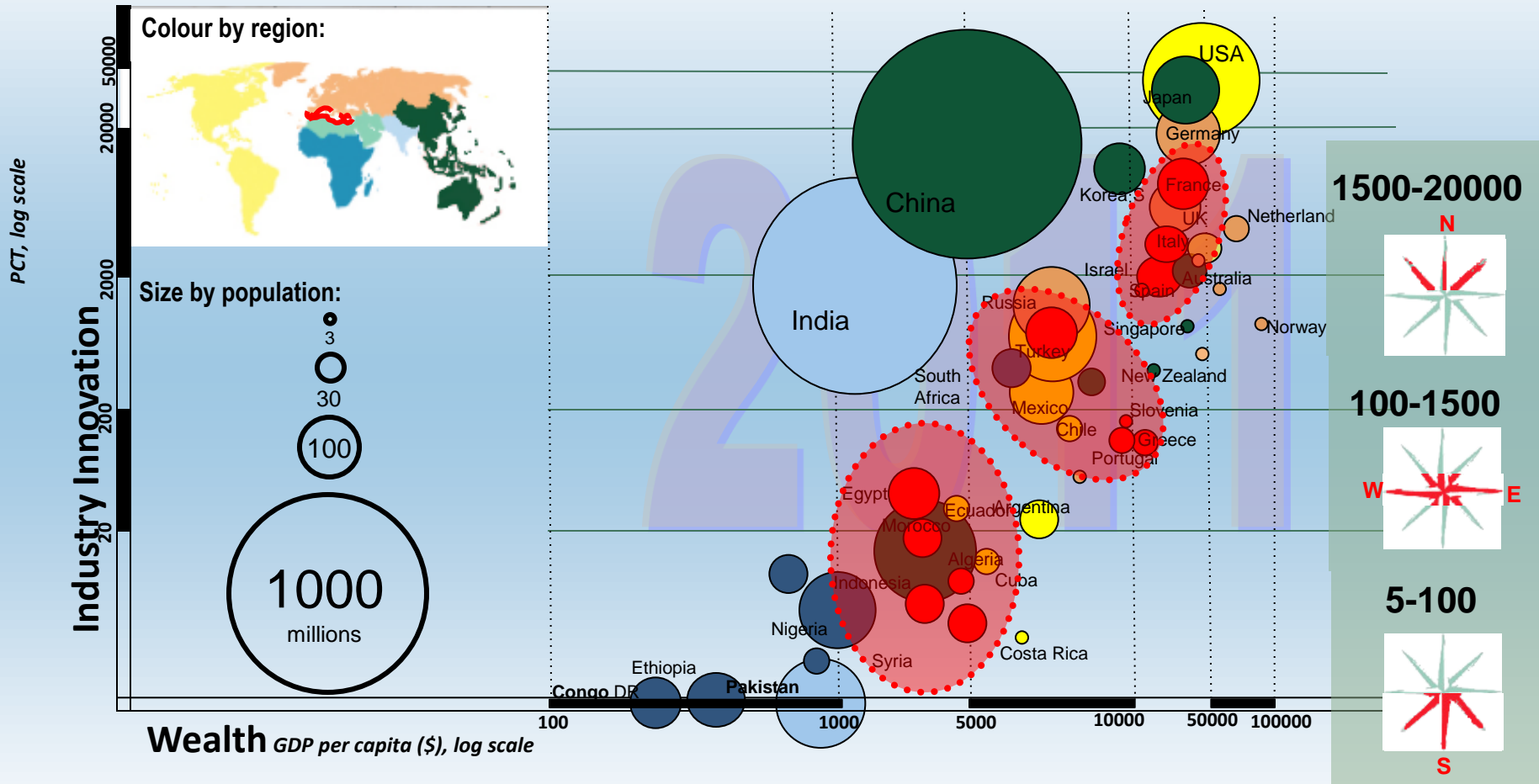


Source: WIPO Statistics Database, April 2012

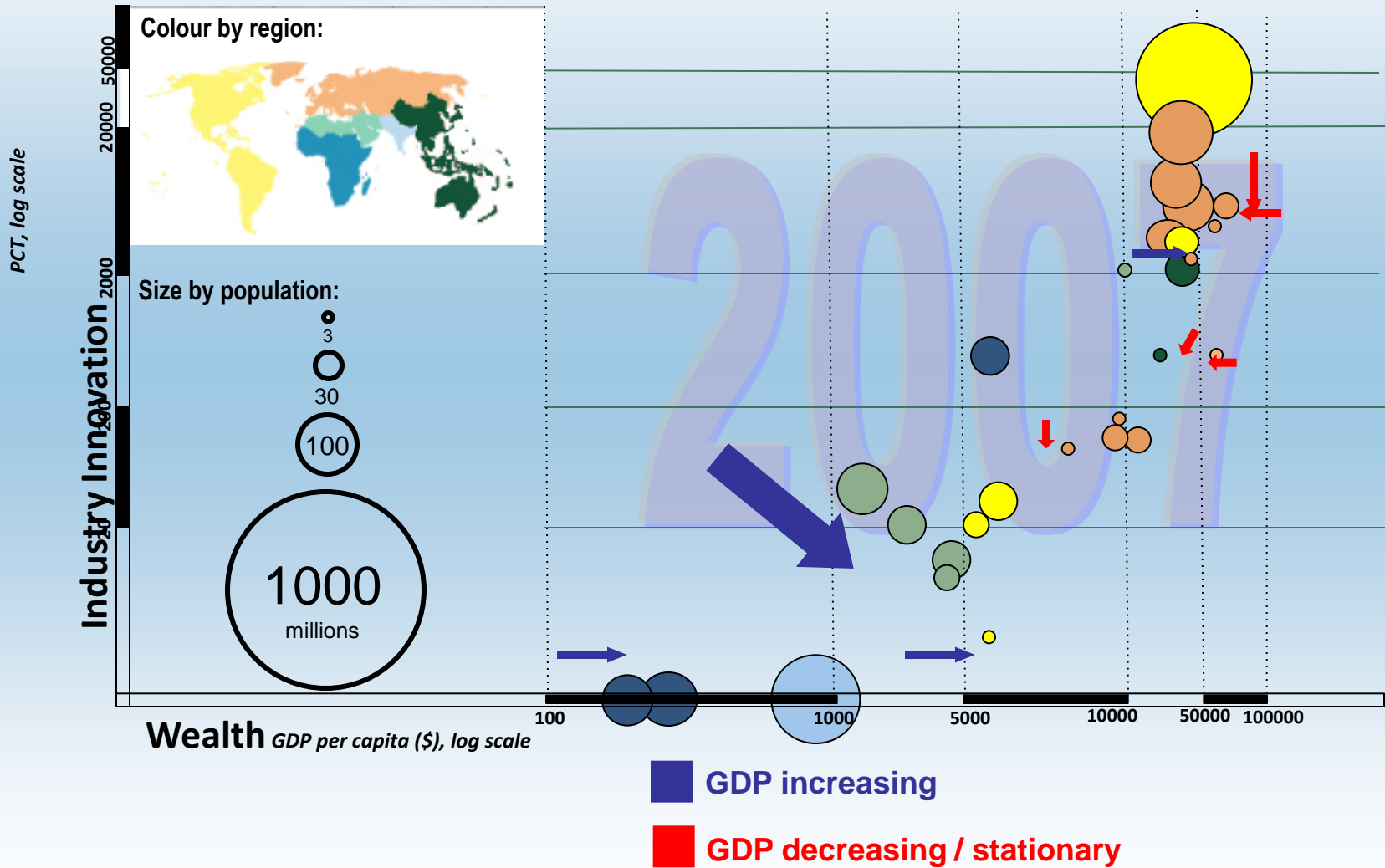
Trends in patent filings (PCT)



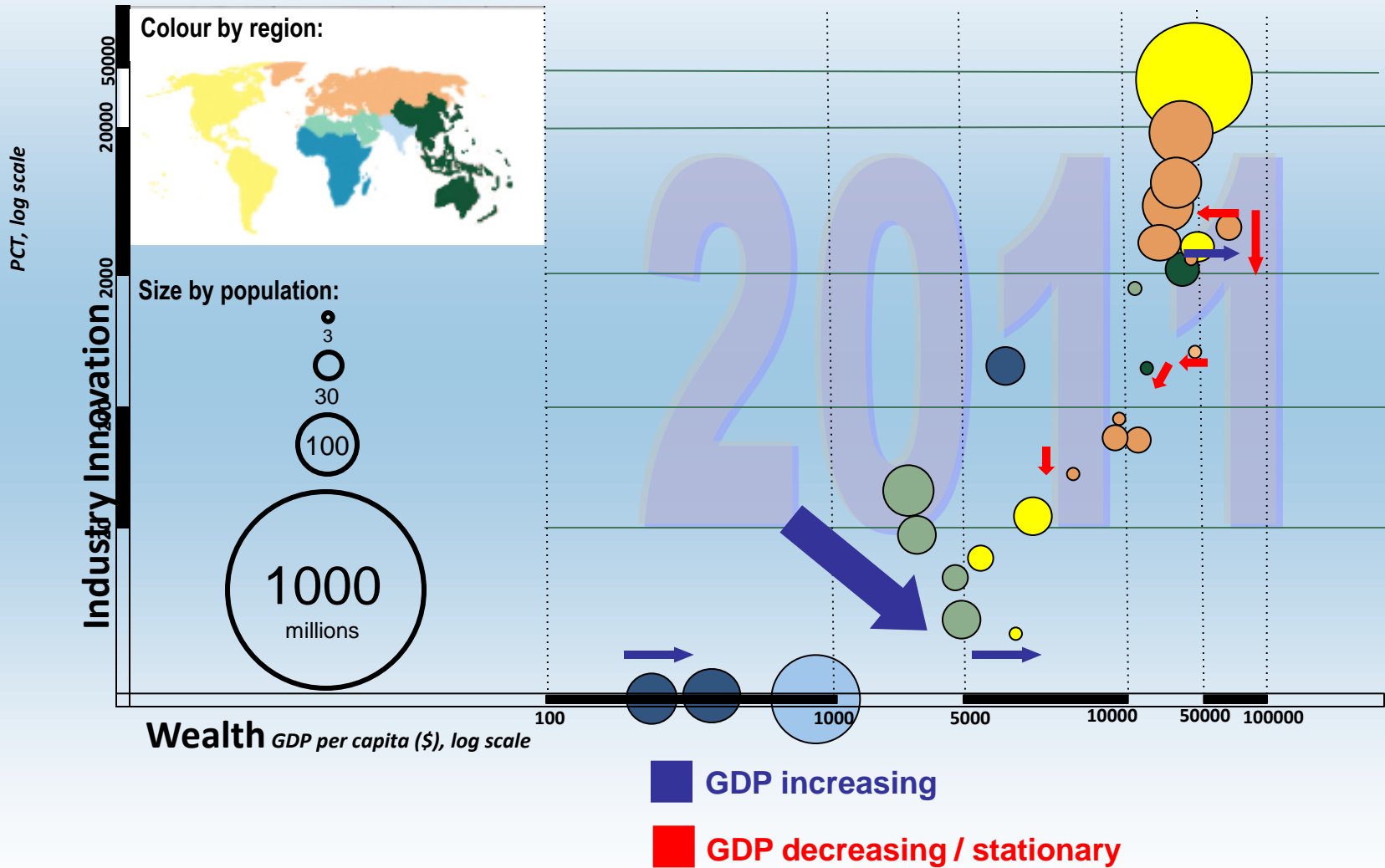
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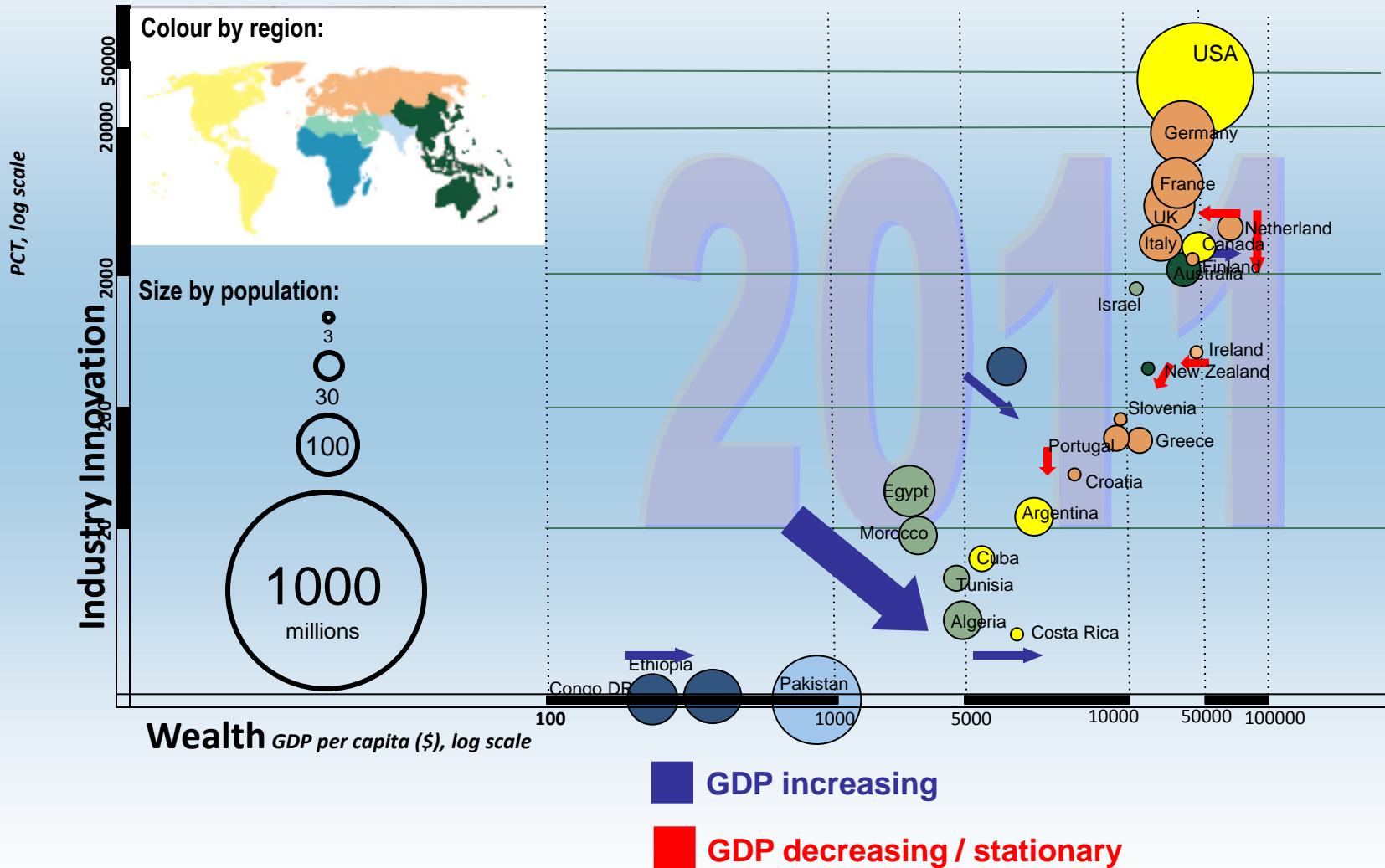
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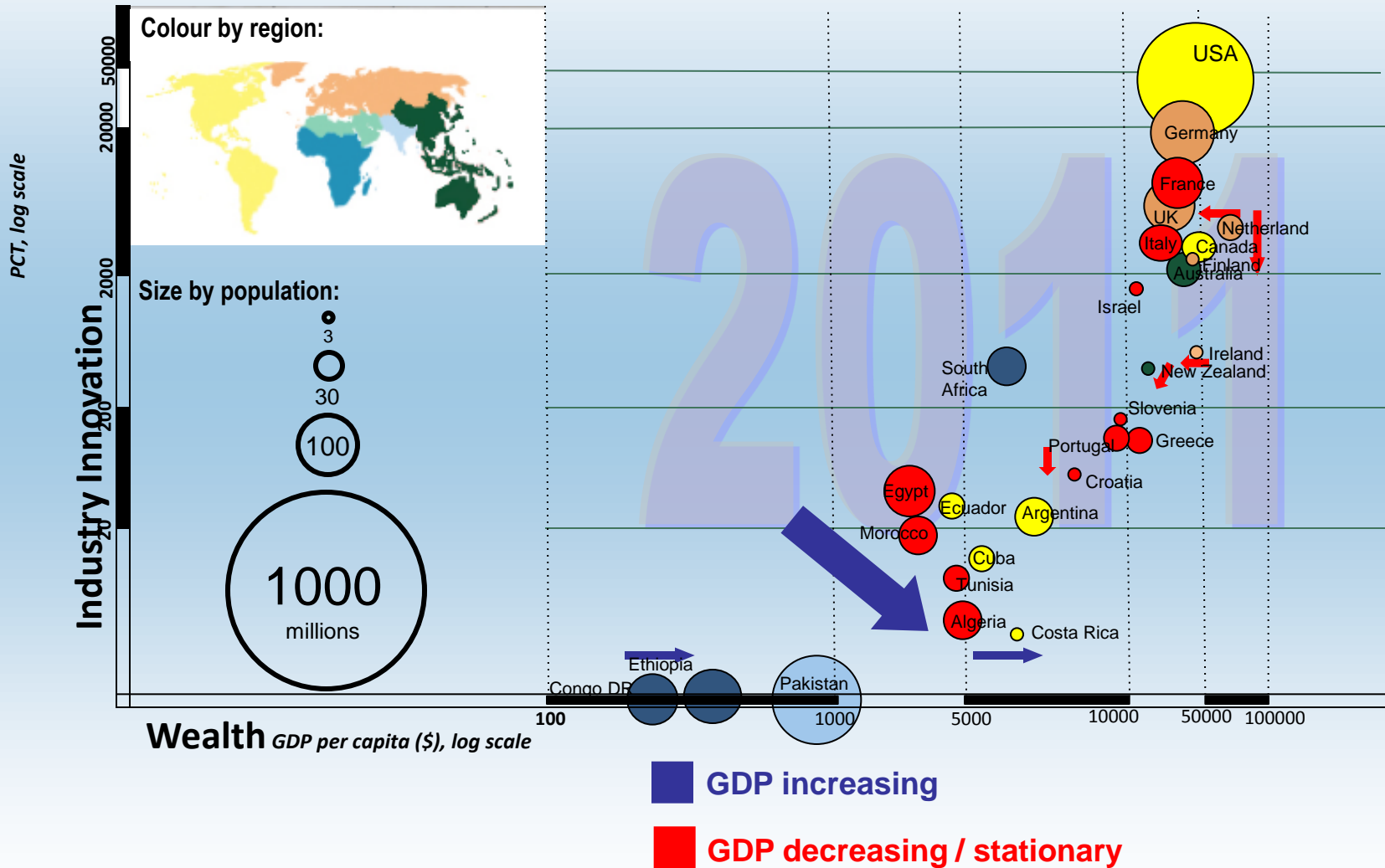
Trends in patent filings (PCT)



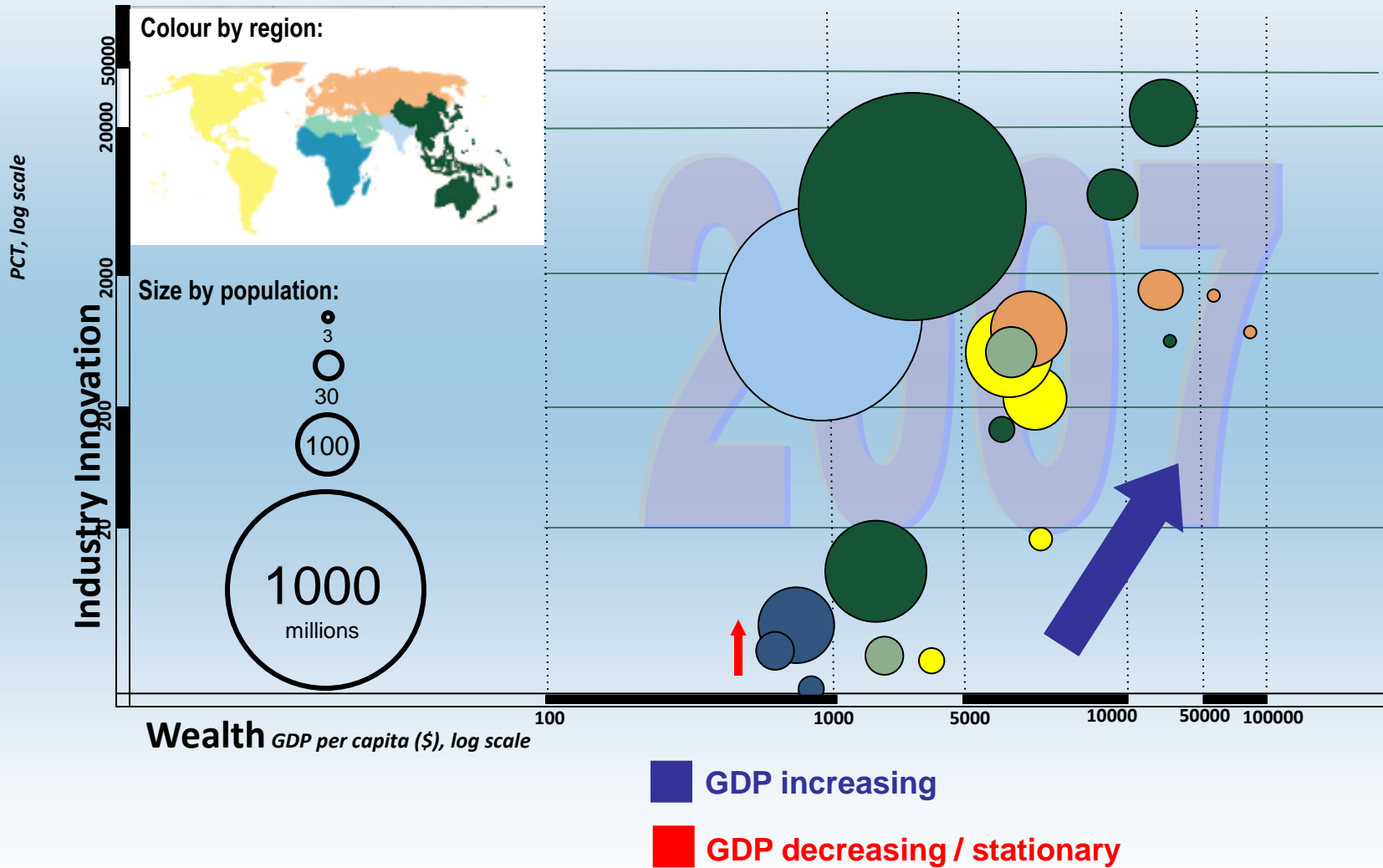
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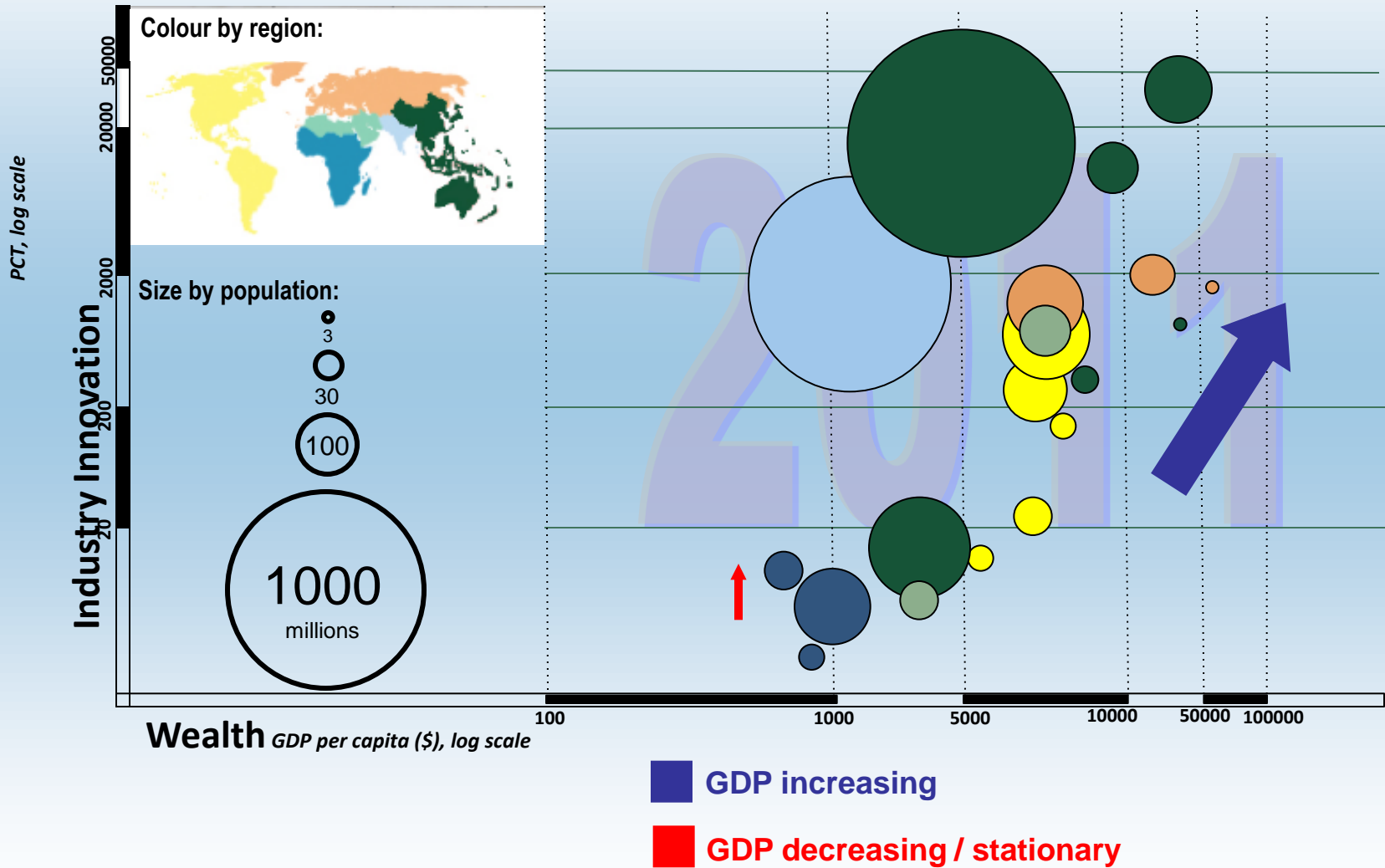
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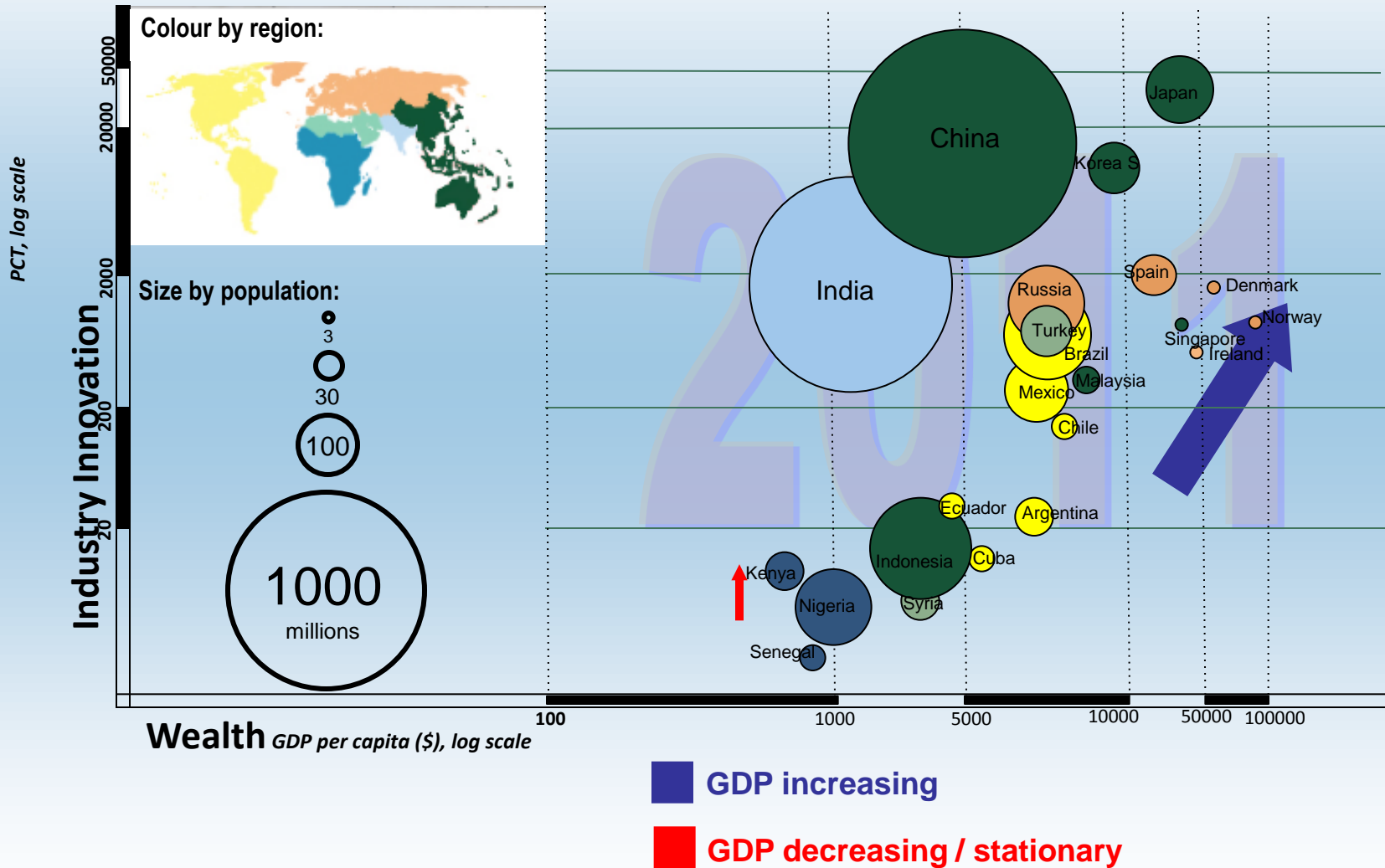
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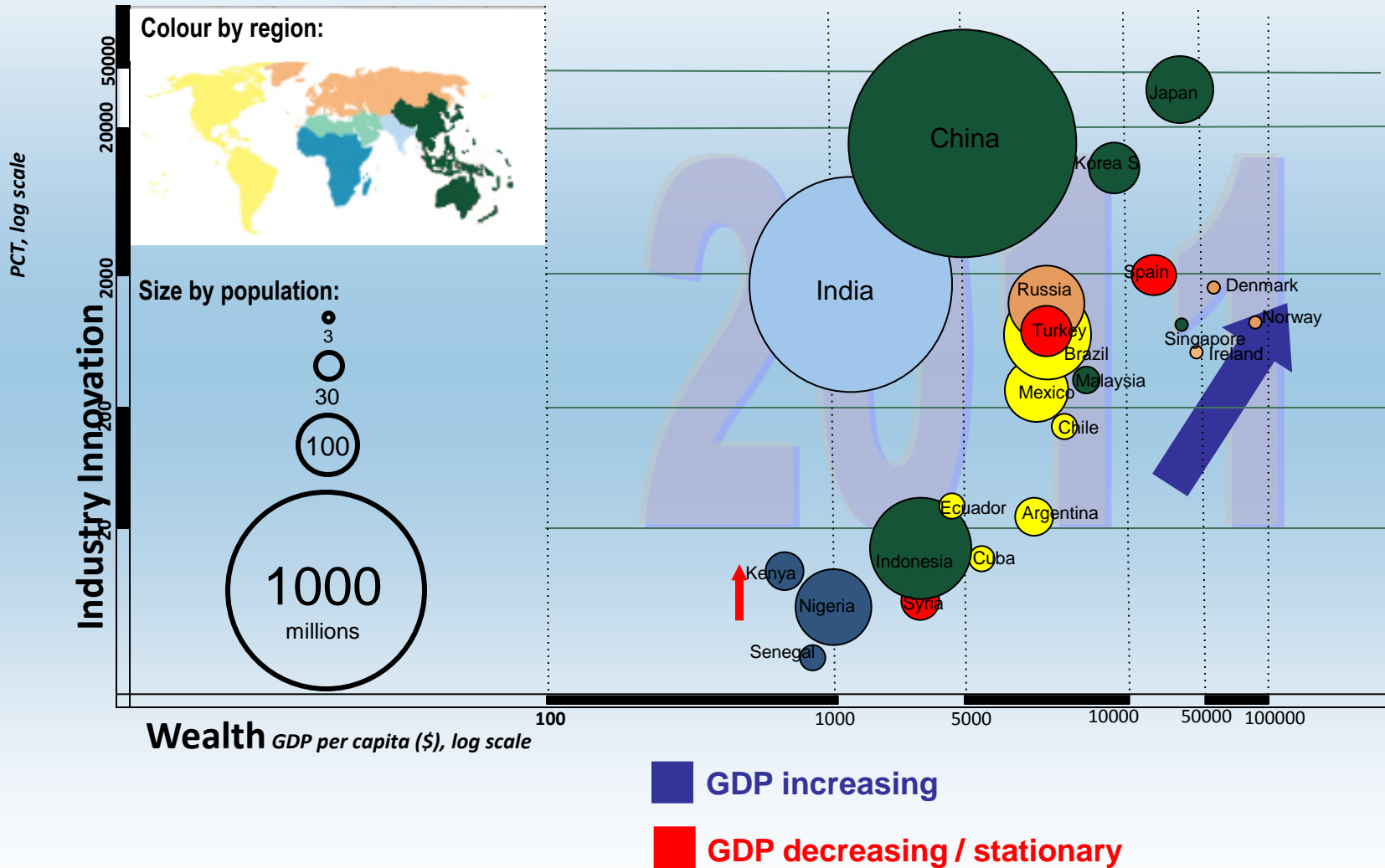
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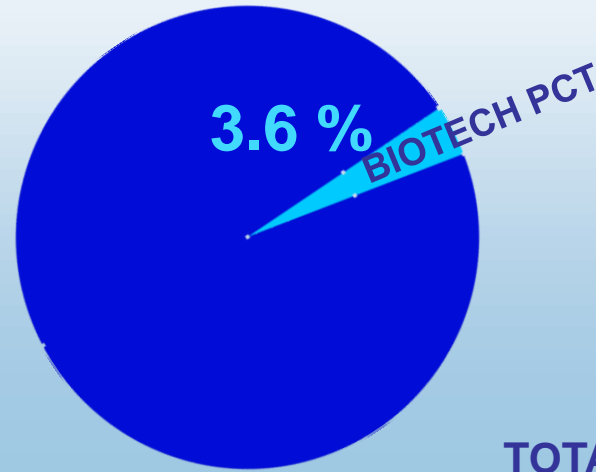
Trends in patent filings (PCT)



Trends in patent filings (PCT)



Trends in biotechnology patent filings (PCT)



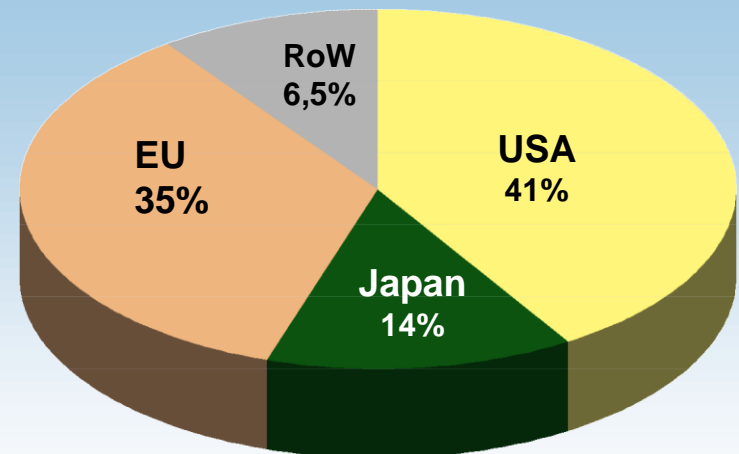
TOTAL = 5390 (2006)

Biotechnology patent filings (PCT) - Country

Colour by region:

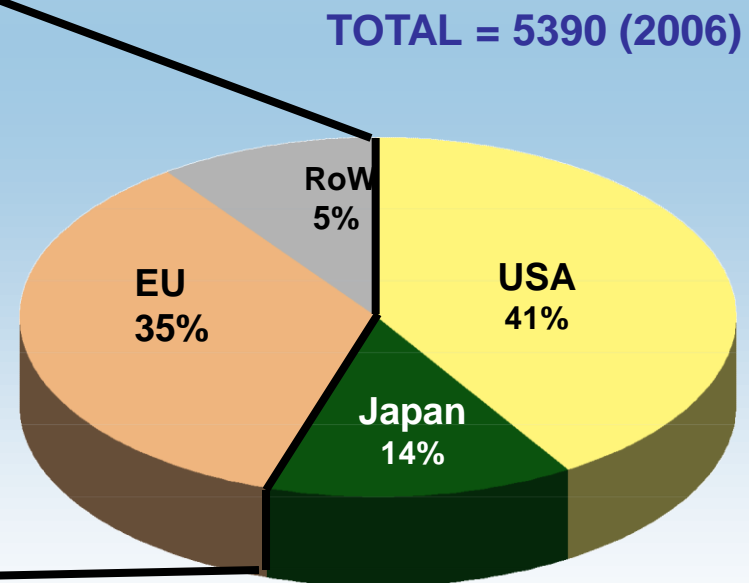
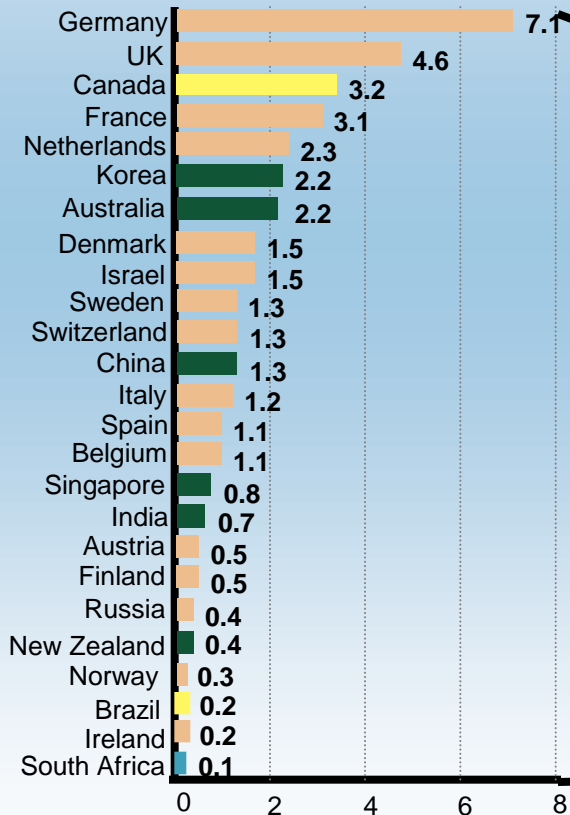


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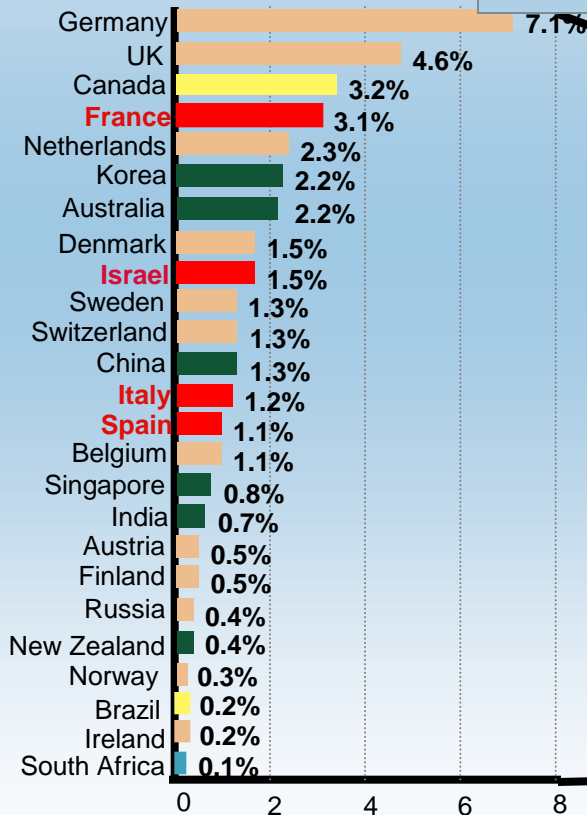


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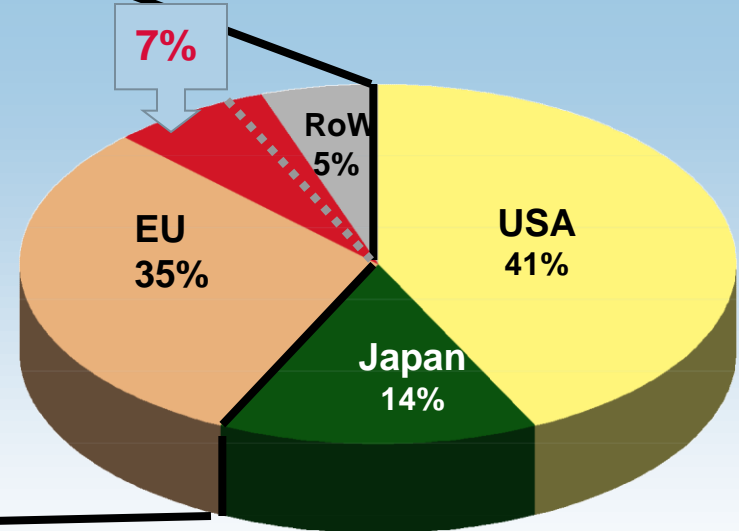
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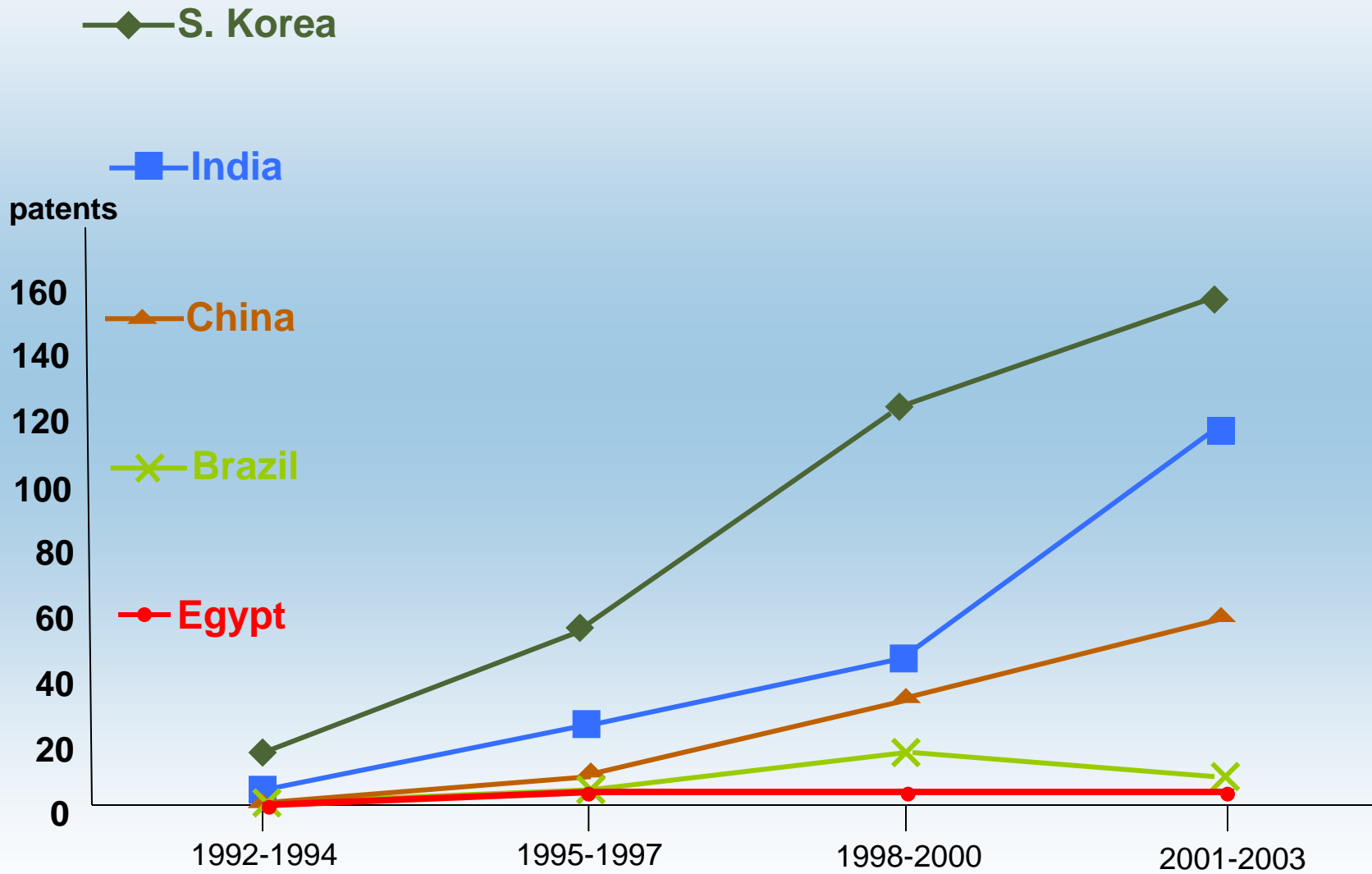
ZOOM on MED Countries



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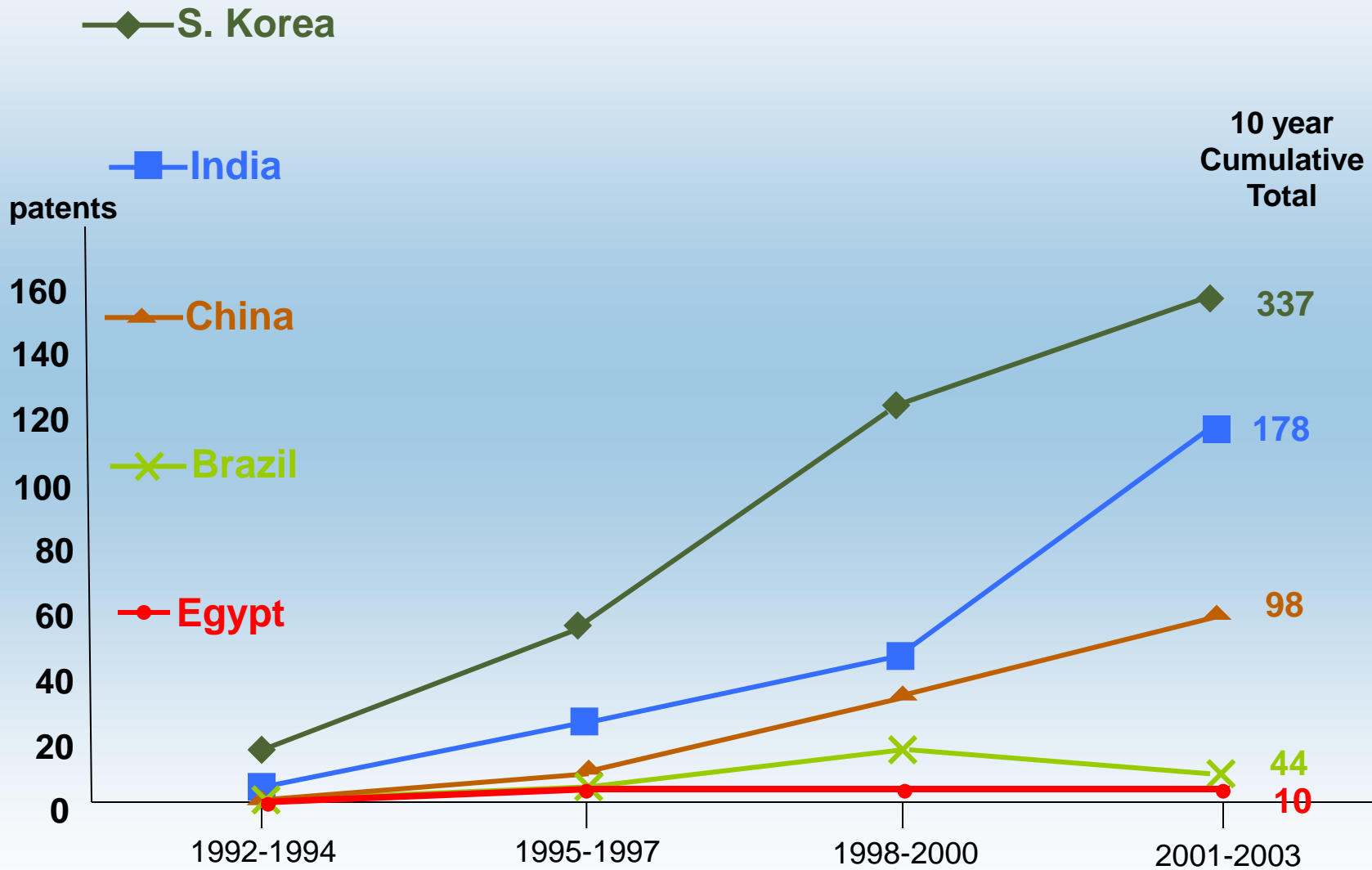


Biotech patenting in developing countries



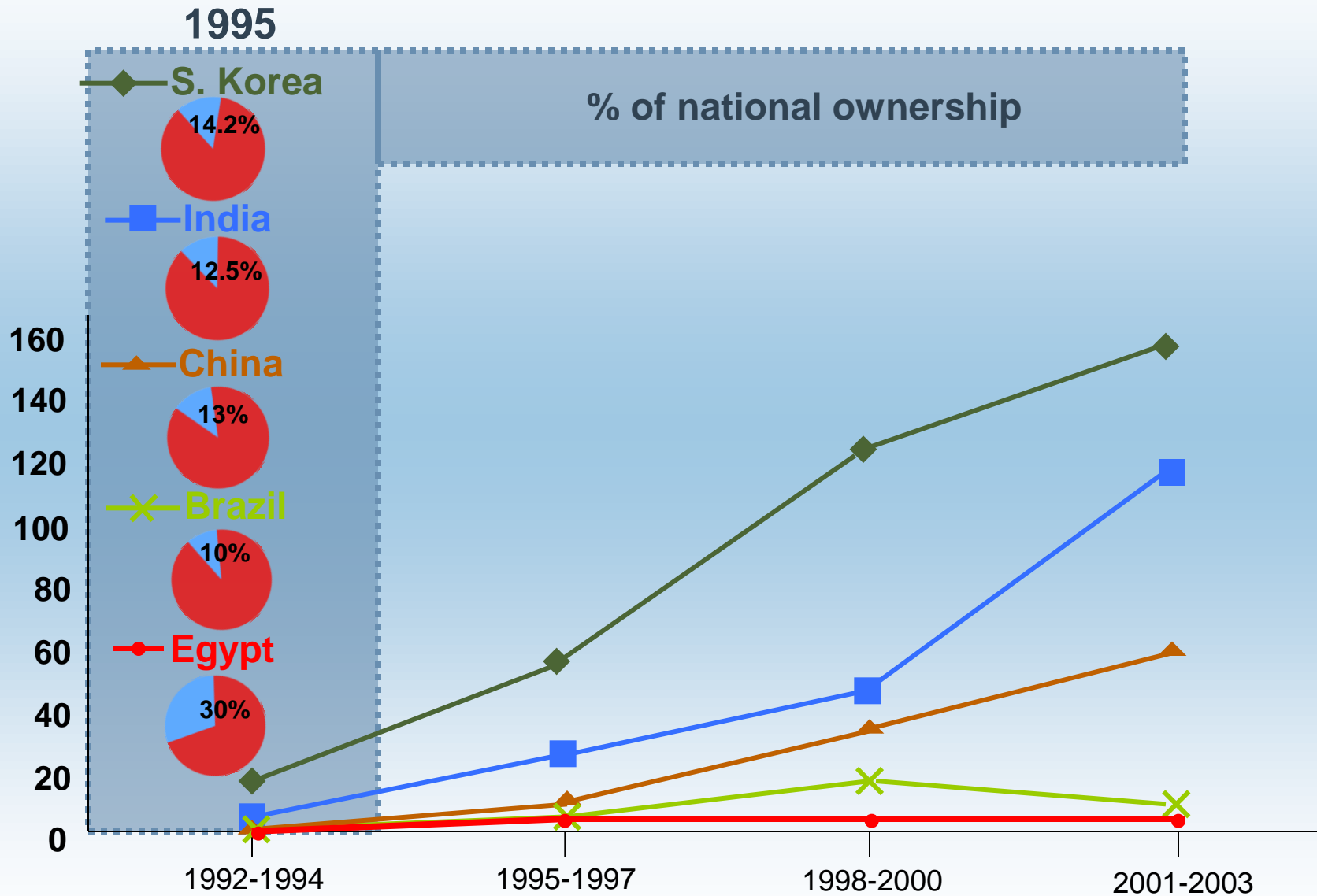
Source: Quach *et al.*, *Int. J. Biotech.* 8 (2006)

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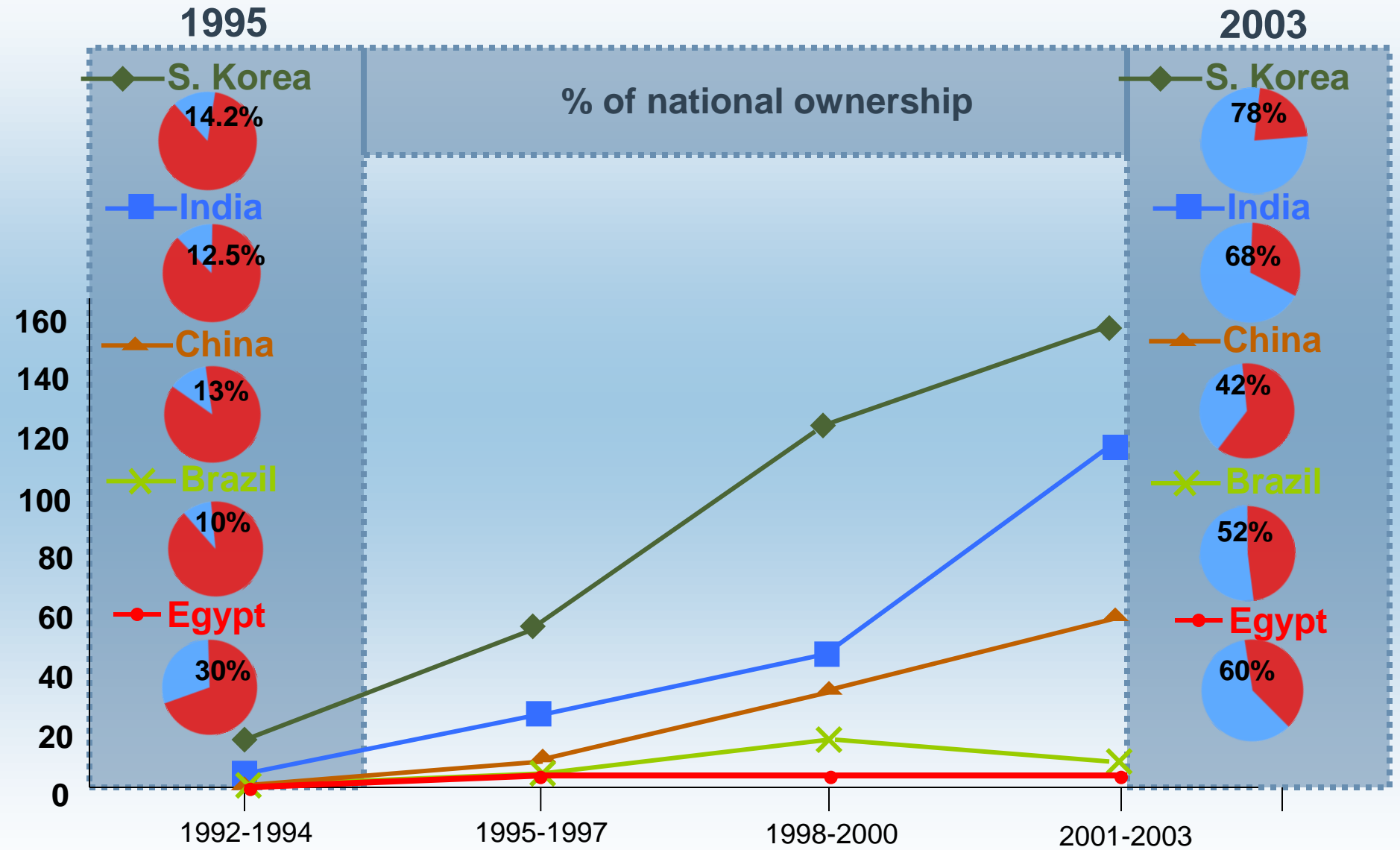
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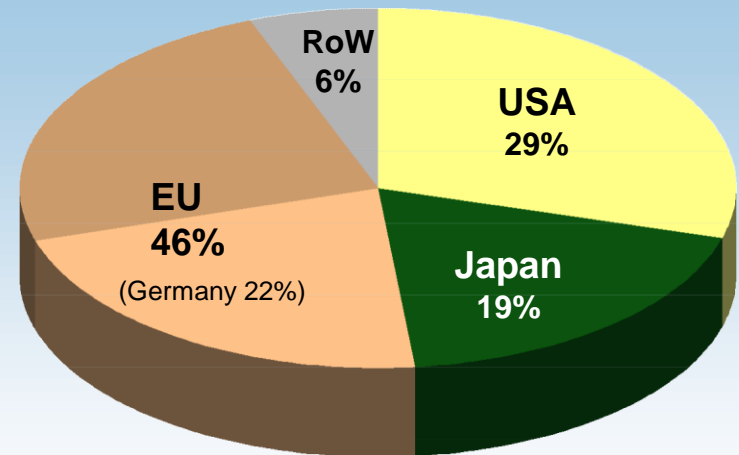
Source: Quach *et al.*, *Int. J. Biotech.* 8 (2006)

Marine Biotechnology Patent filings (PCT) - Country

Colour by region:



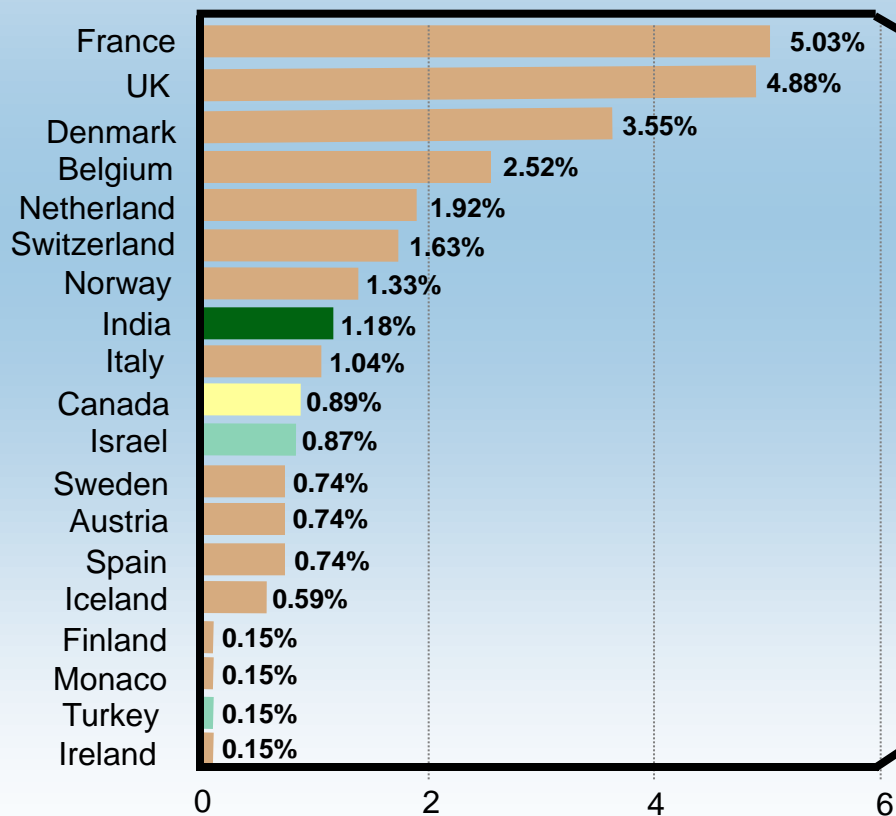
TOTAL = 677 (2010)



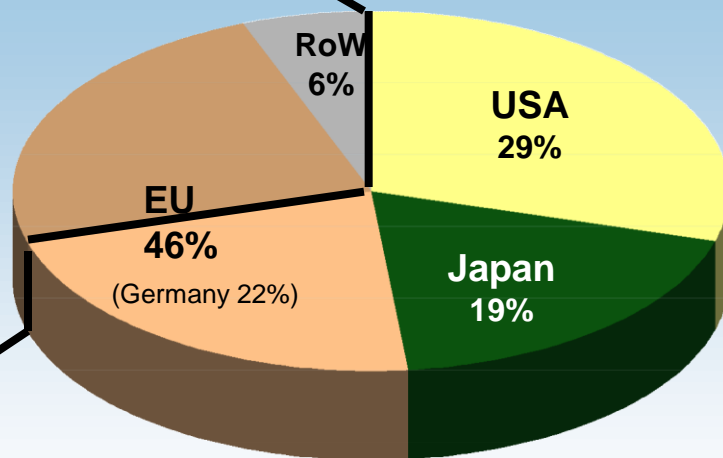
Source: Arnaud-Haond *et al.*, Science (2011)

Trends in marine biotechnology patent filings

Colour by region:



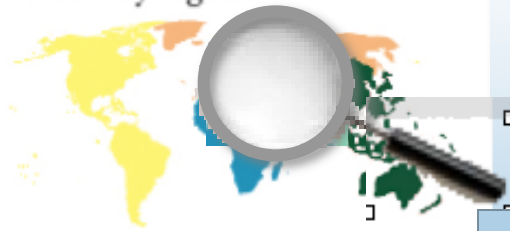
TOTAL = 677 (2010)



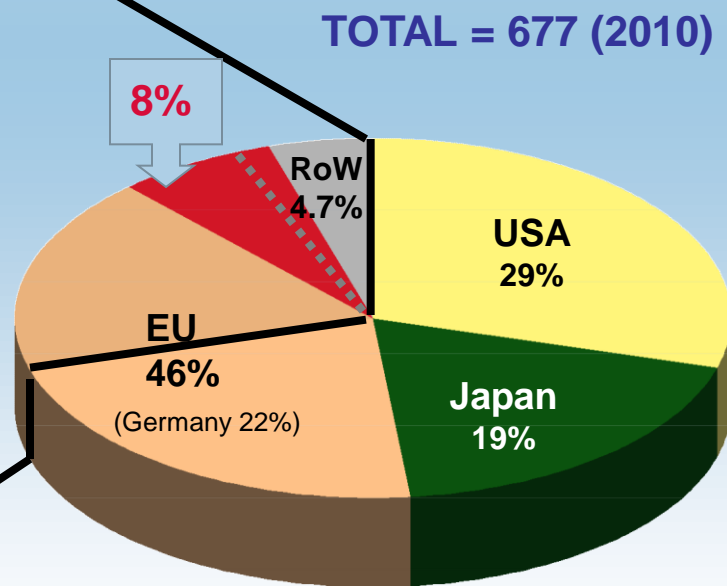
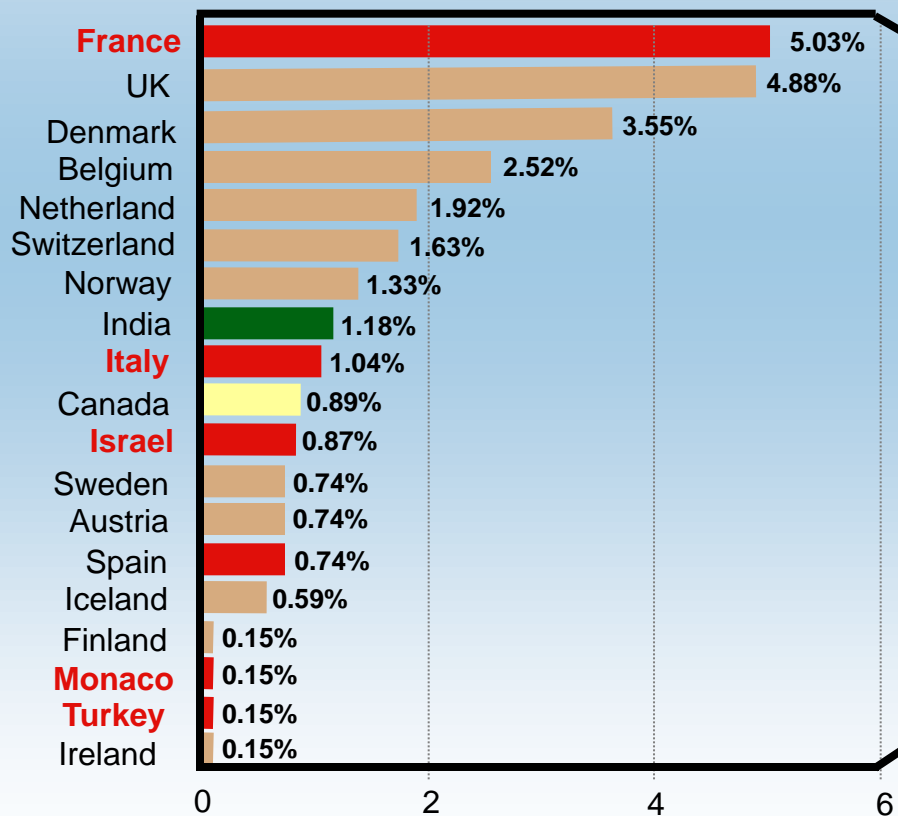
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Trends in marine biotechnology patent filings

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ZOOM on MED Countries

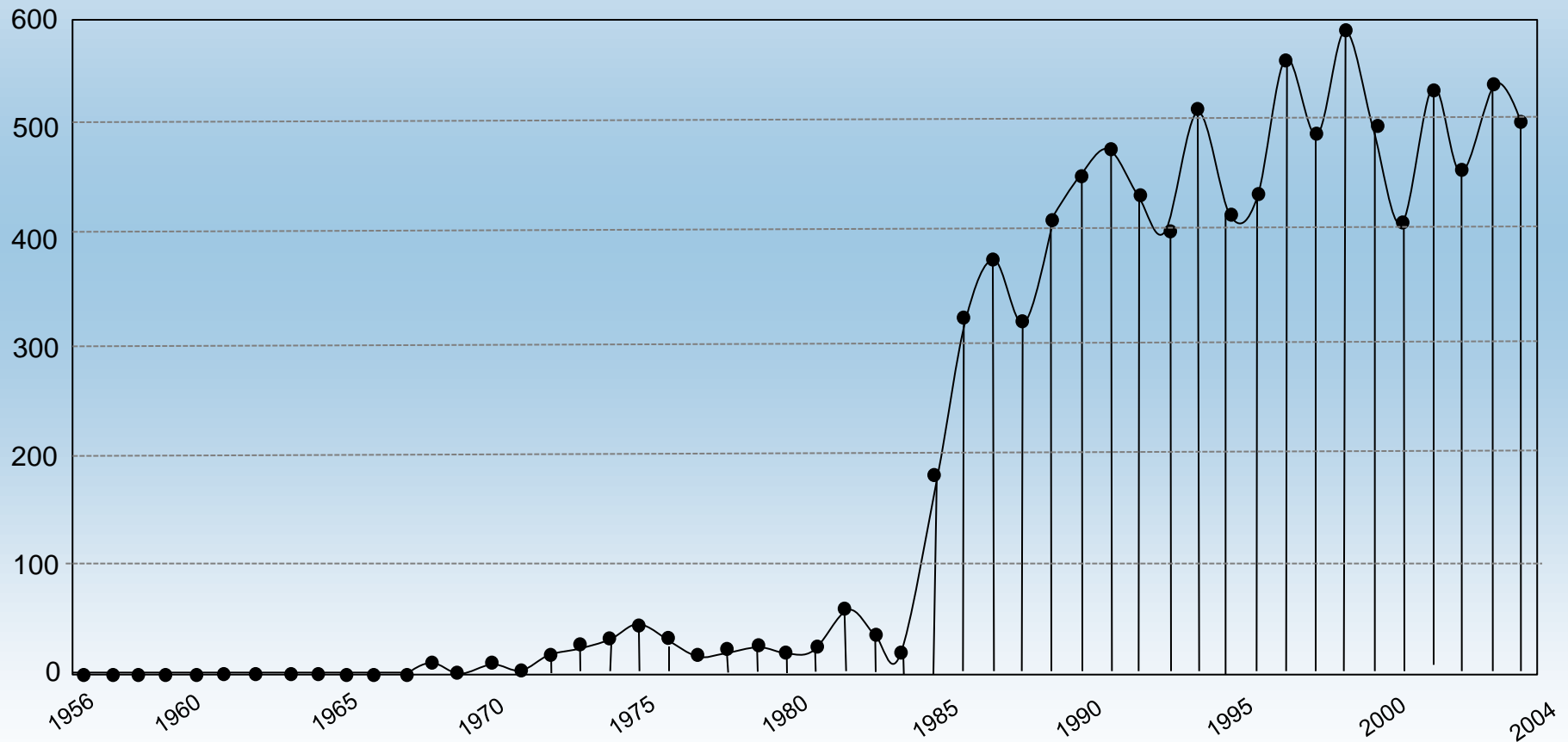


Source: Arnaud-Haond *et al.*, Science (2011)

Marine Natural Products

1956 - 2004

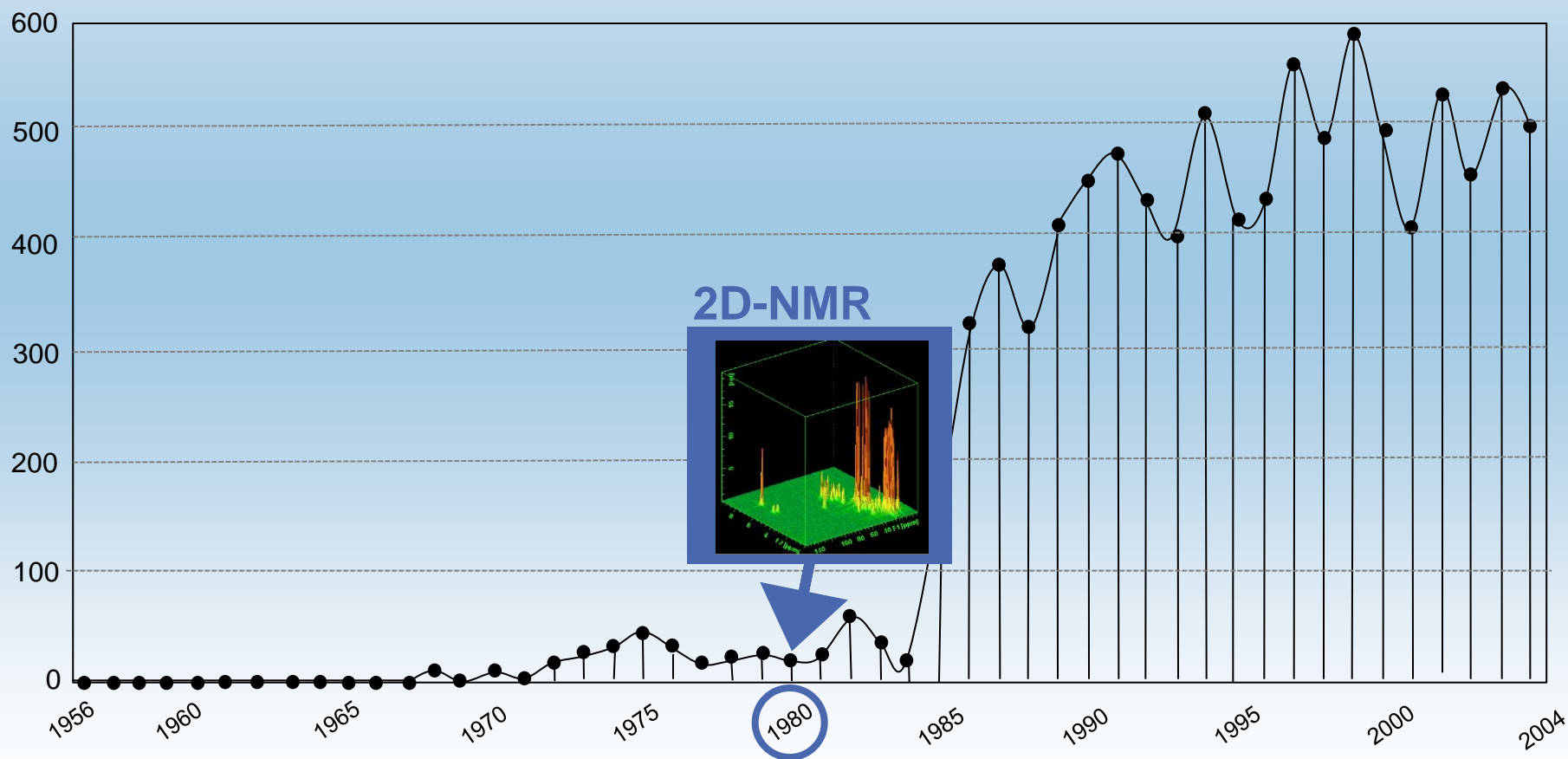
nearly 20,000 novel compounds described to date



Source: Hu *et al.*, *Mar. Drugs* (2011)

Marine Natural Products

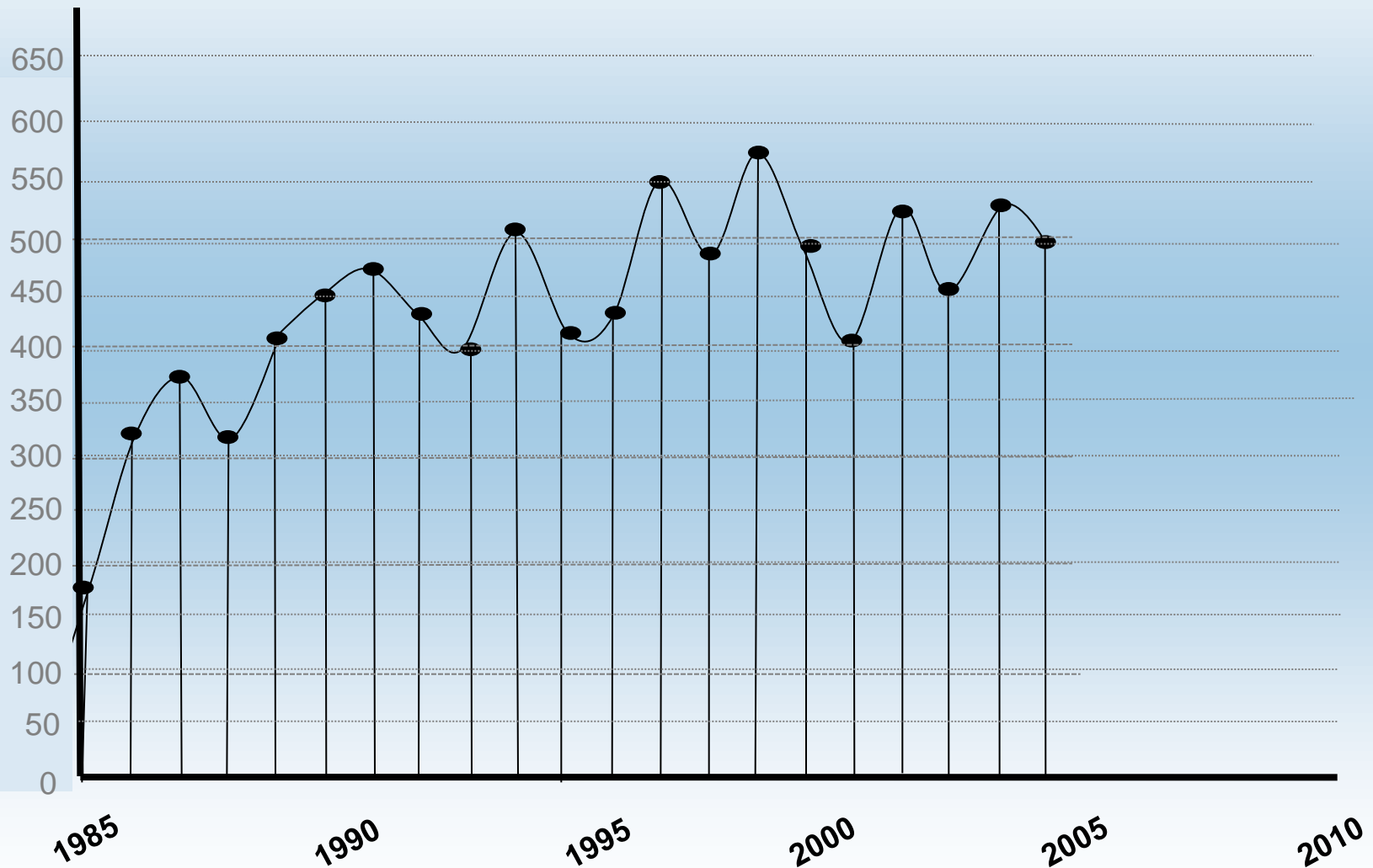
1956 - 2004



Source: Hu *et al.*, *Mar. Drugs* (2011)

Marine Natural Products

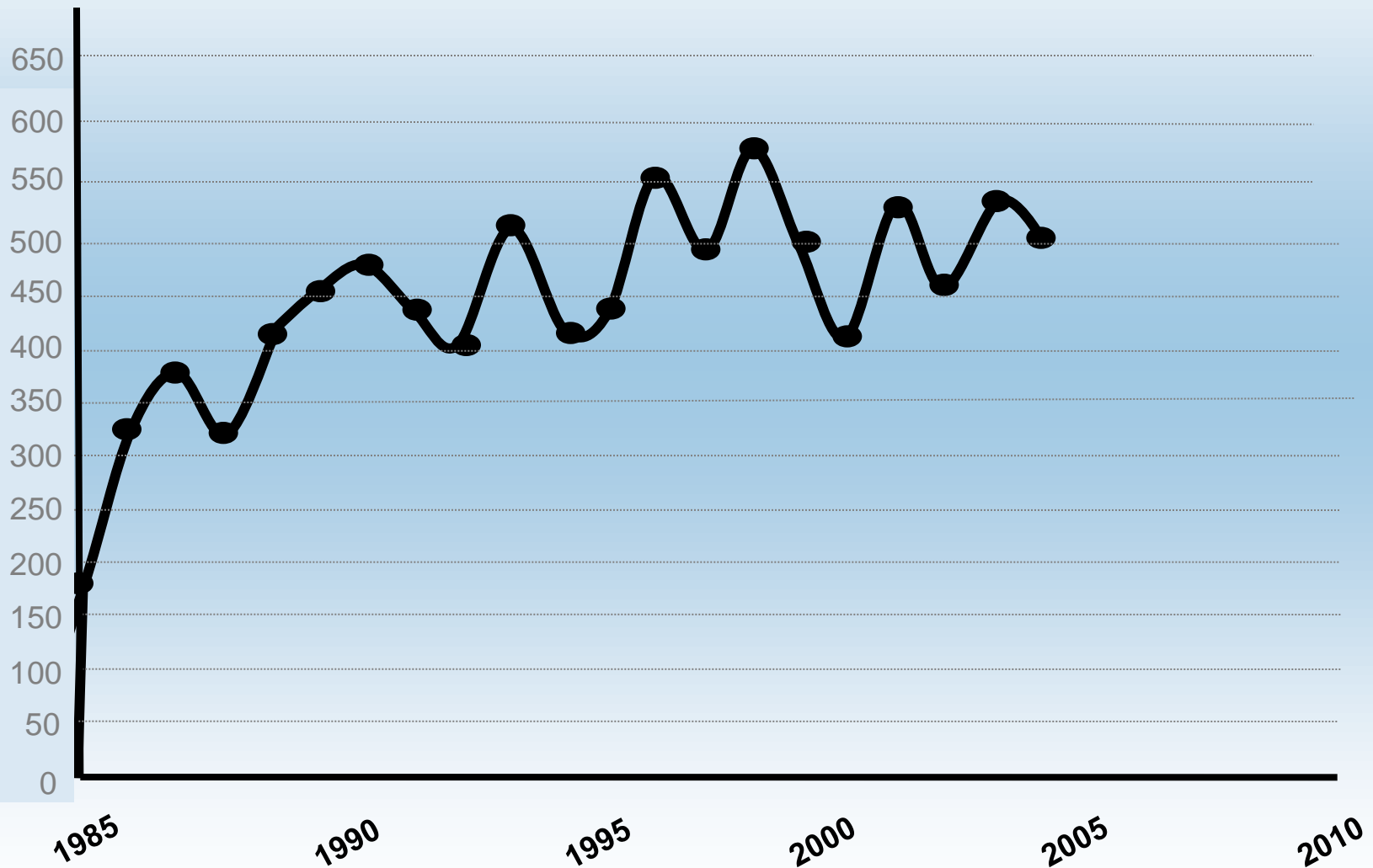
1985- 2010



Data source: Blunt *et al.*, Nat. Prod. Rep. (2010)

Marine Natural Products

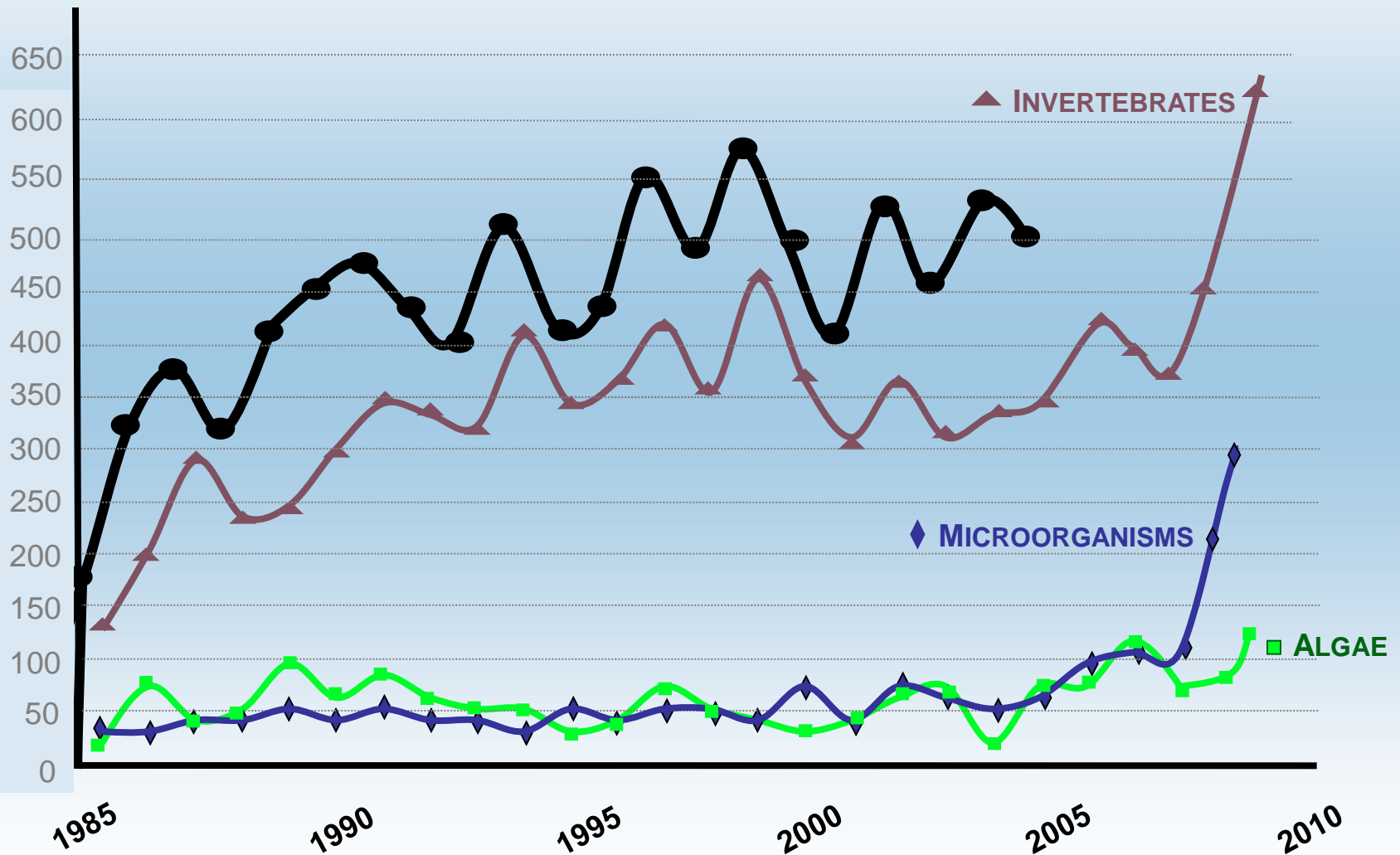
1985- 2010



Data source: Blunt *et al.*, Nat. Prod. Rep. (2010)

MNPs : The potential of different taxa

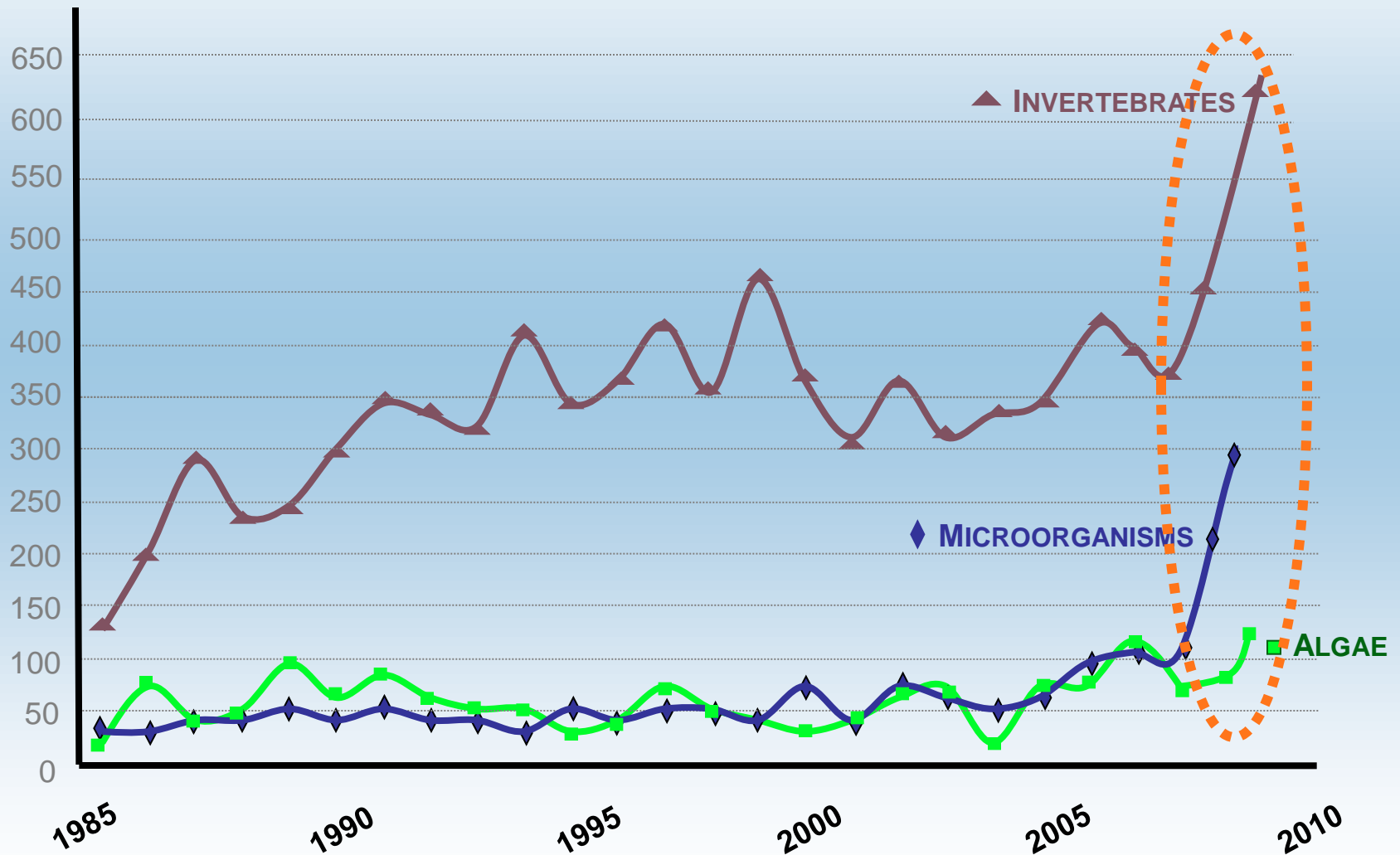
1985- 2010



Data source: Blunt *et al.*, Nat. Prod. Rep. (2010)

Global trends in MNPs from marine organ

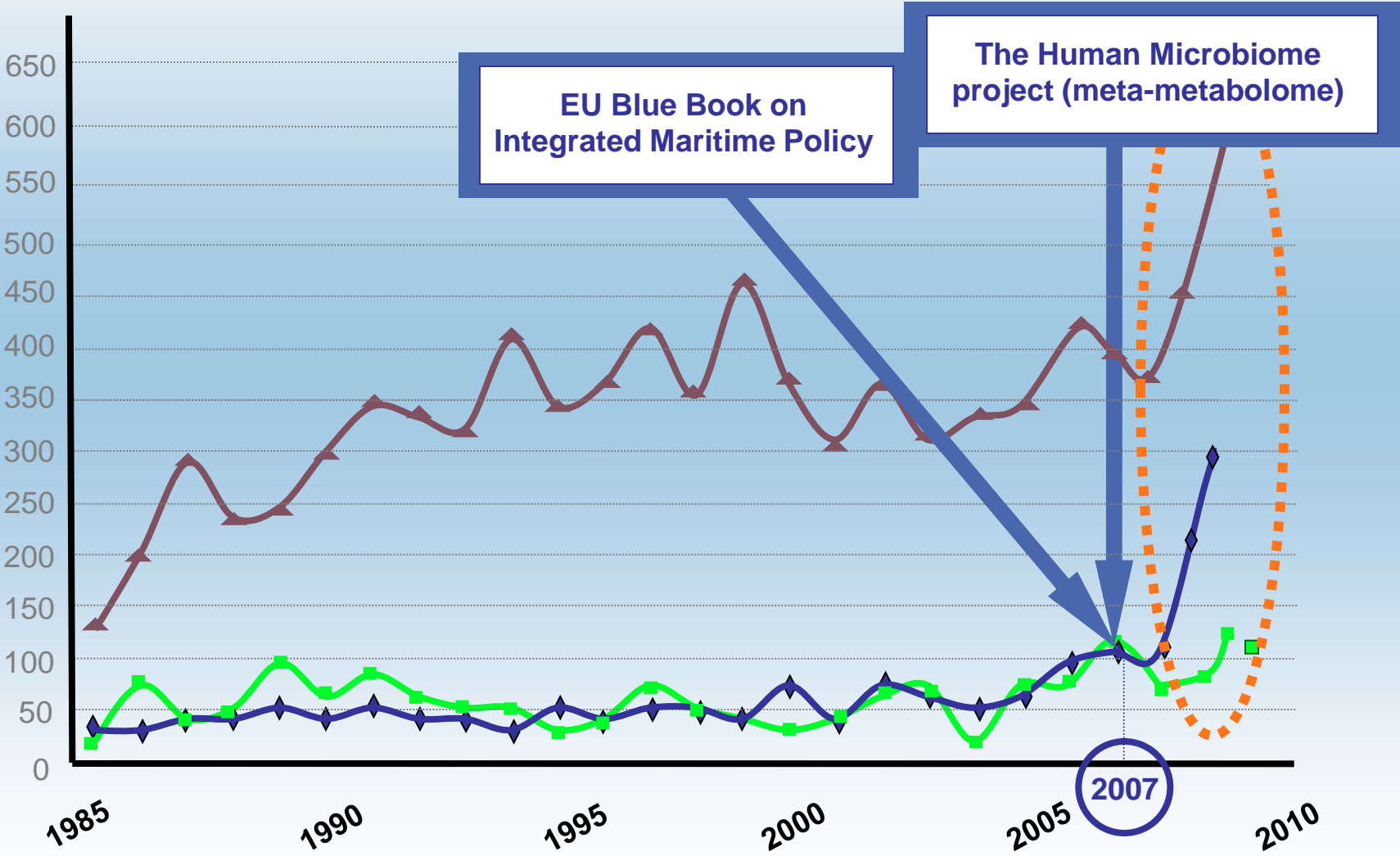
1985- 2010



Data source: Blunt *et al.*, Nat. Prod. Rep. (2010)

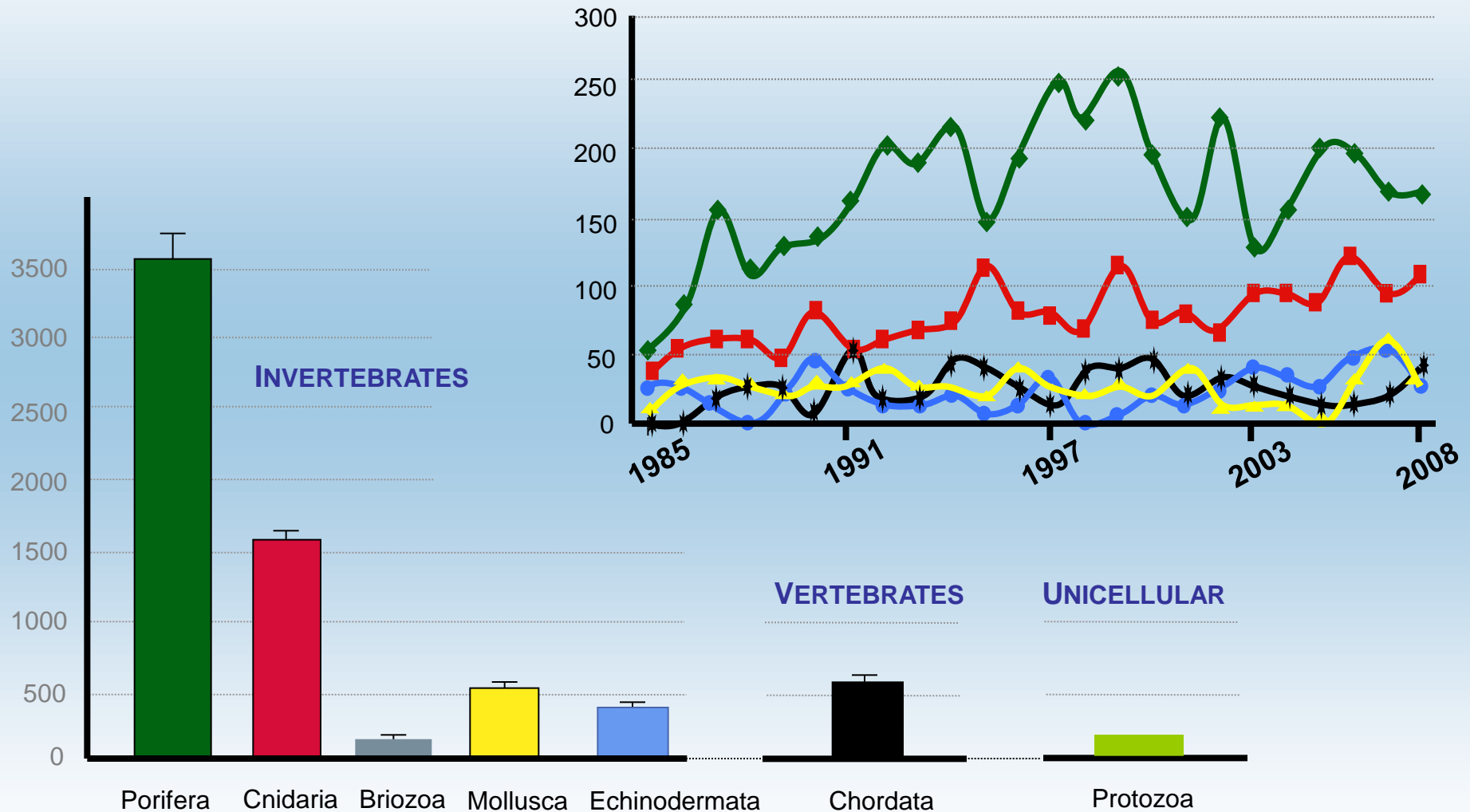
Global trends in MNPs from marine organ

1985- 2010



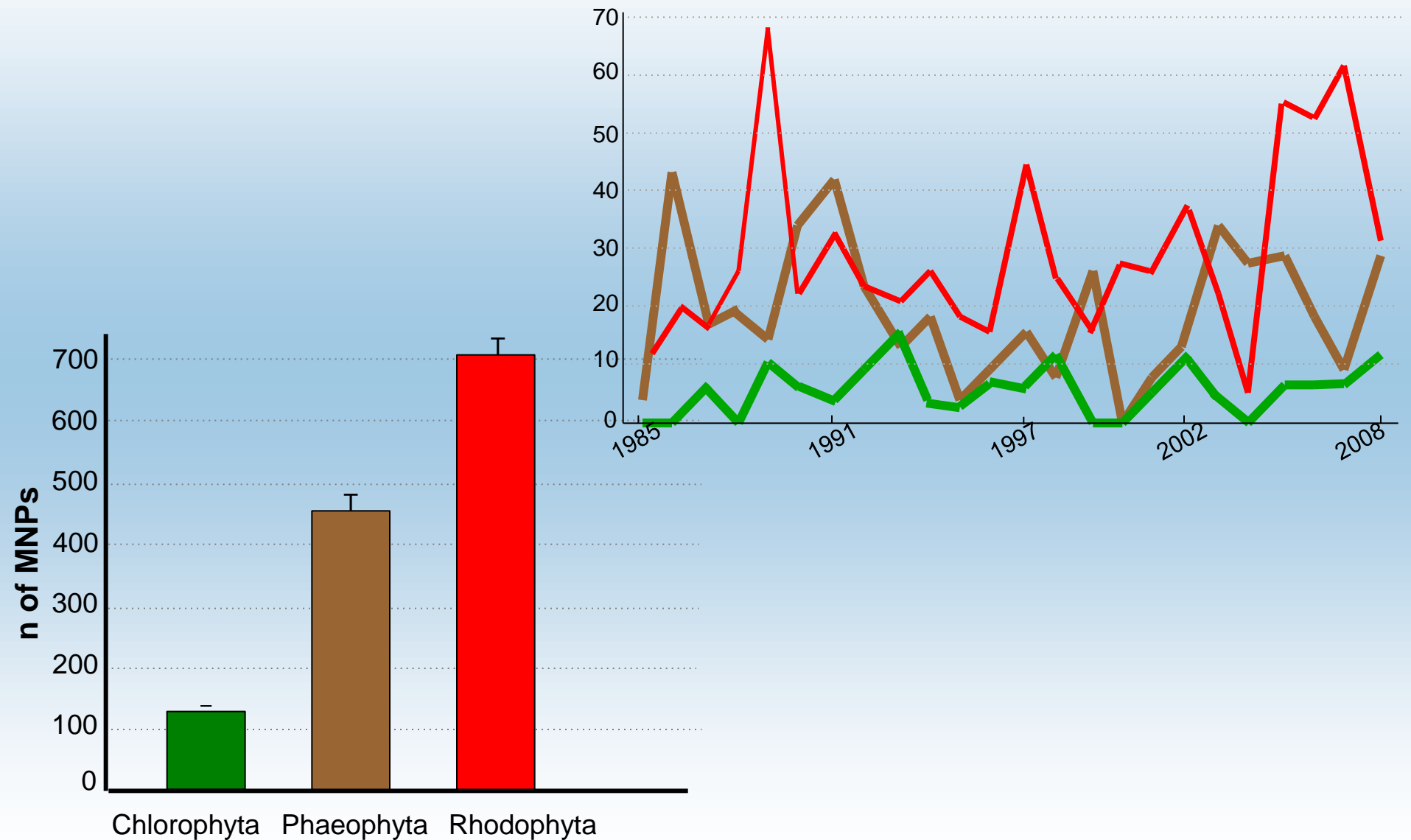
Data source: Blunt *et al.*, Nat. Prod. Rep. (2010)

Trends in MNPs from marine animals



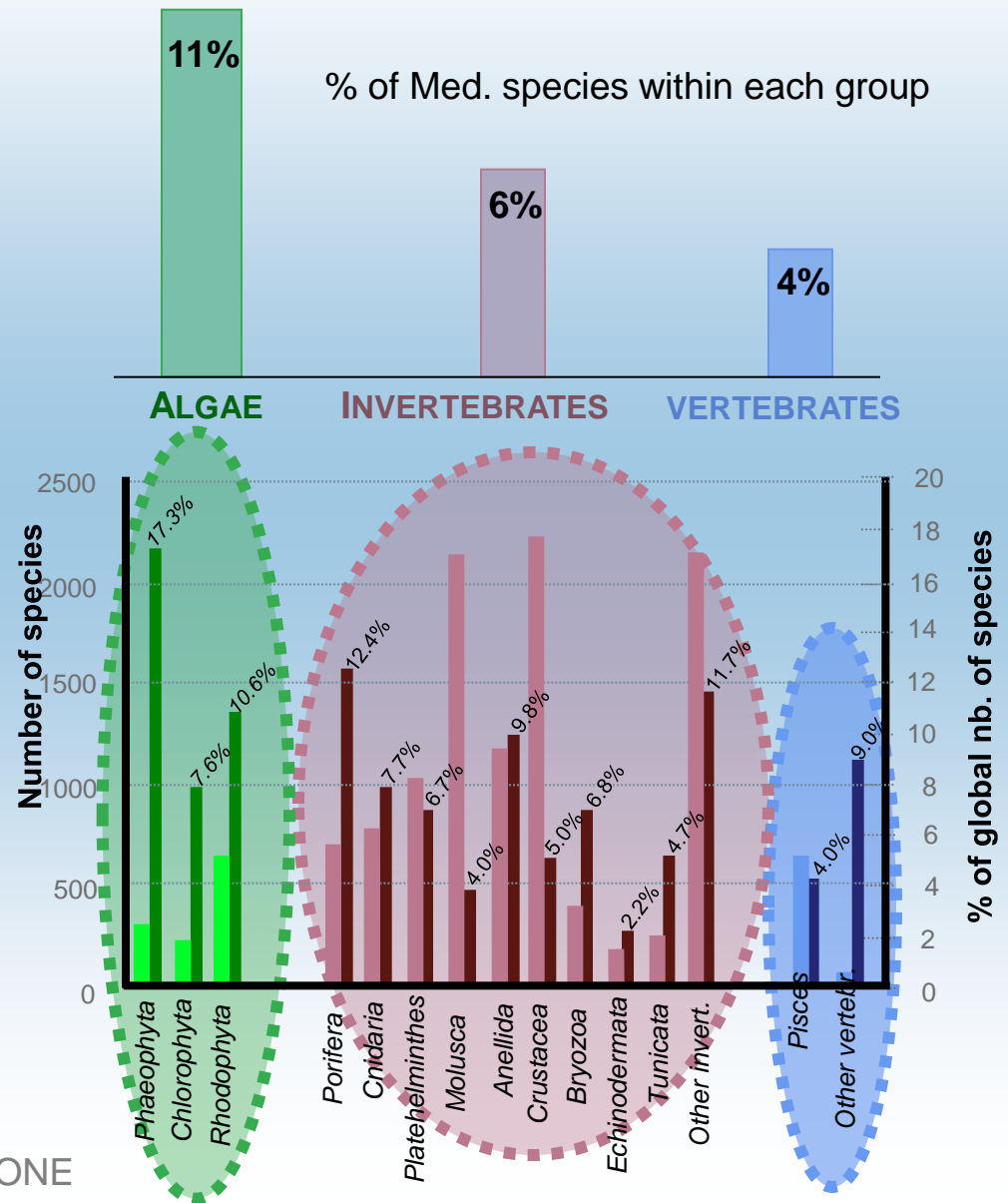
Source: Hu *et al.*, Mar. Drugs (2011)

Trends in MNPs from marine algae (1985-2008)



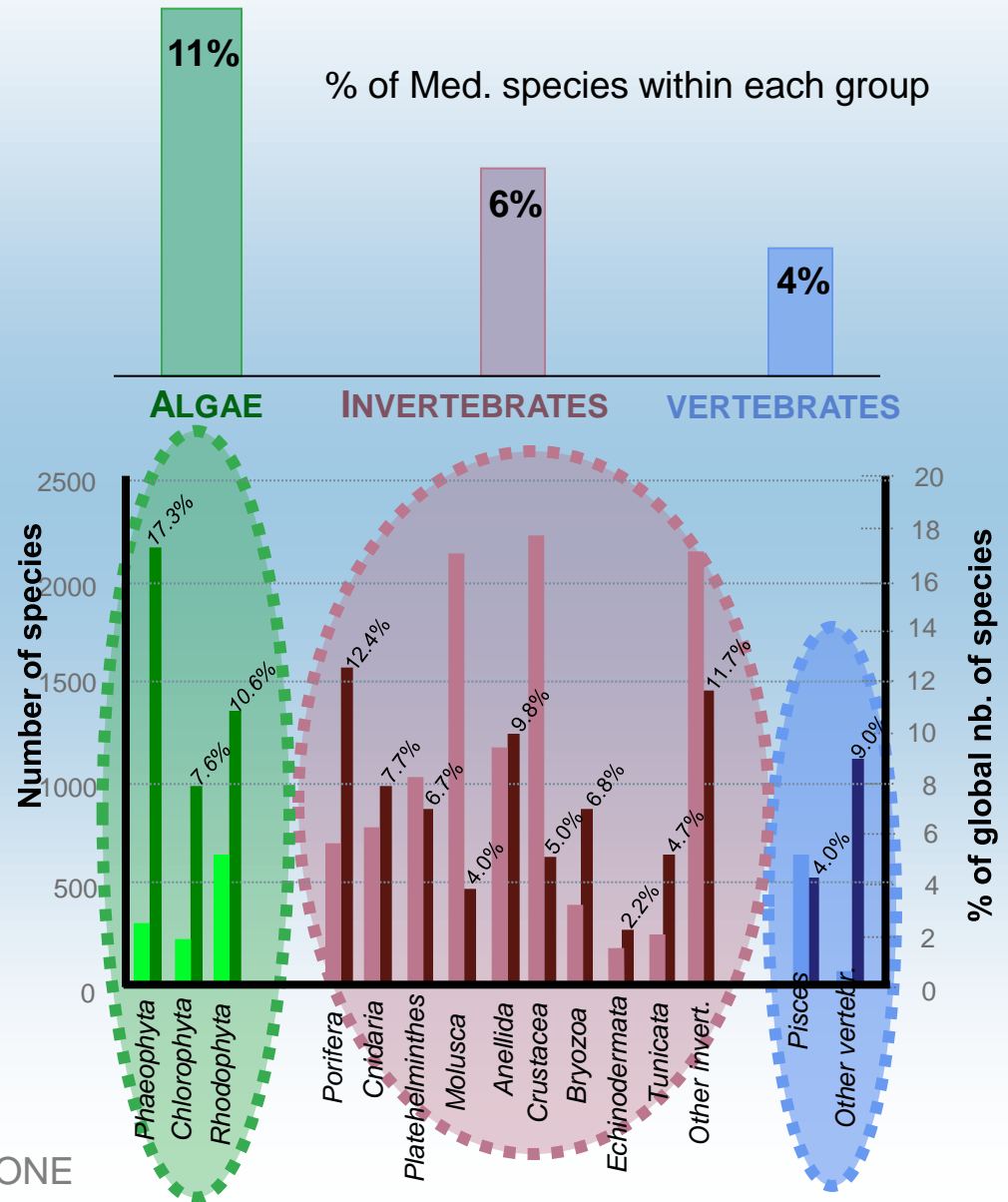
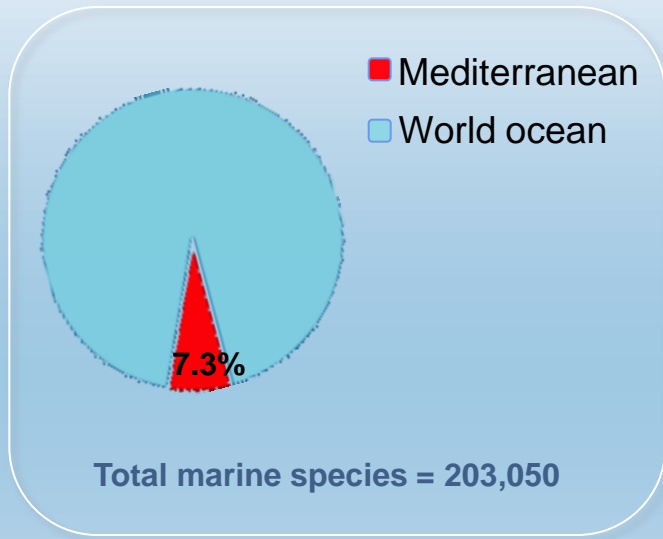
Source: Hu *et al.*, Mar. Drugs (2011)

Mediterranean species richness

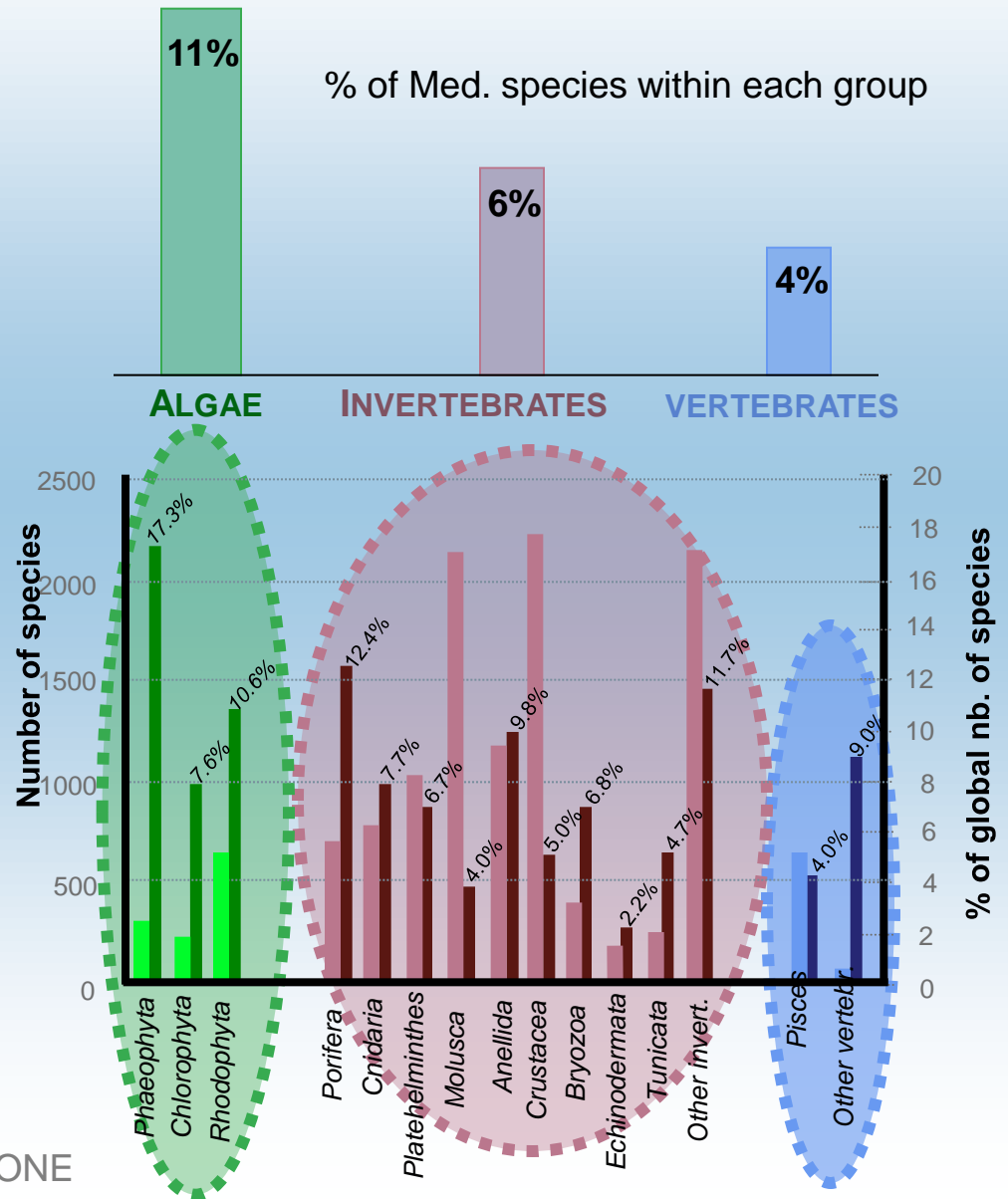
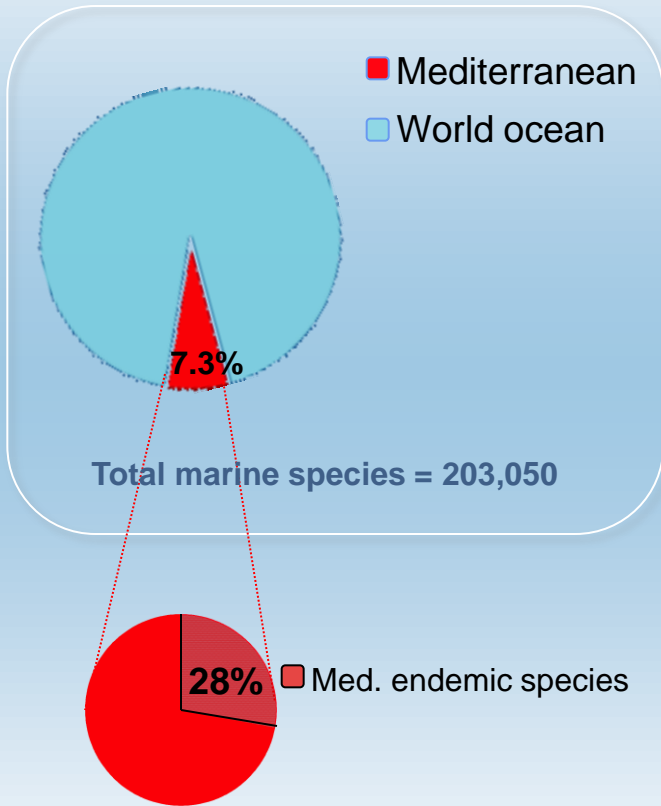


Source data: Coll *et al.* (2010) PLoS ONE

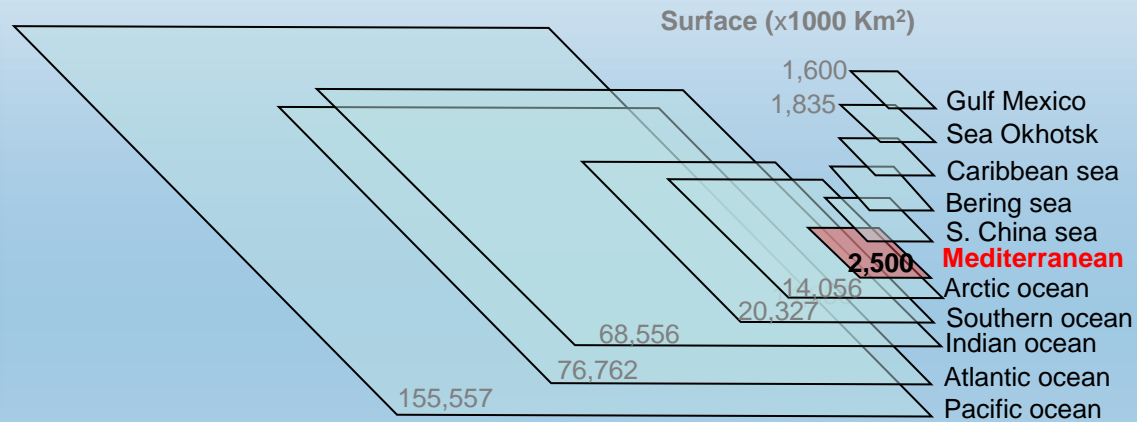
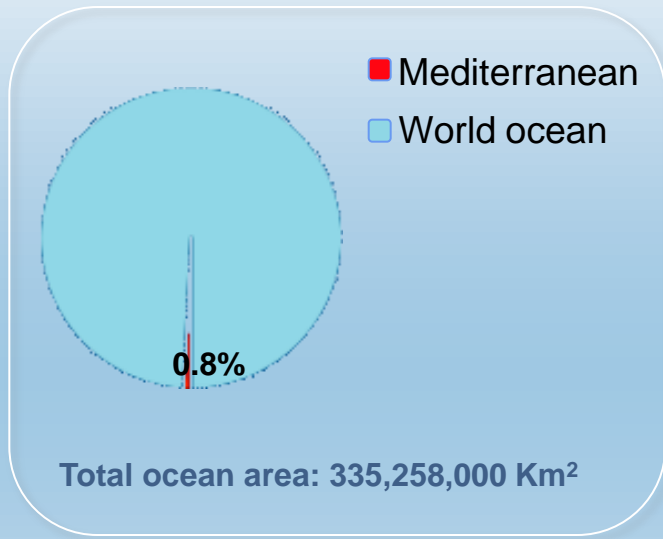
Mediterranean species richness



Mediterranean species richness



The Mediterranean Sea potential for bioprospecting



Mediterranean : a complex mosaic

Geological, geodynamic, geographical and physico-chemical gradients

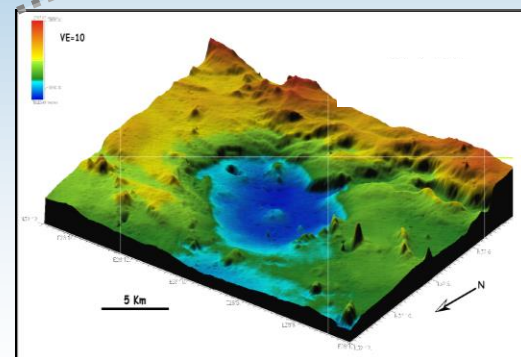
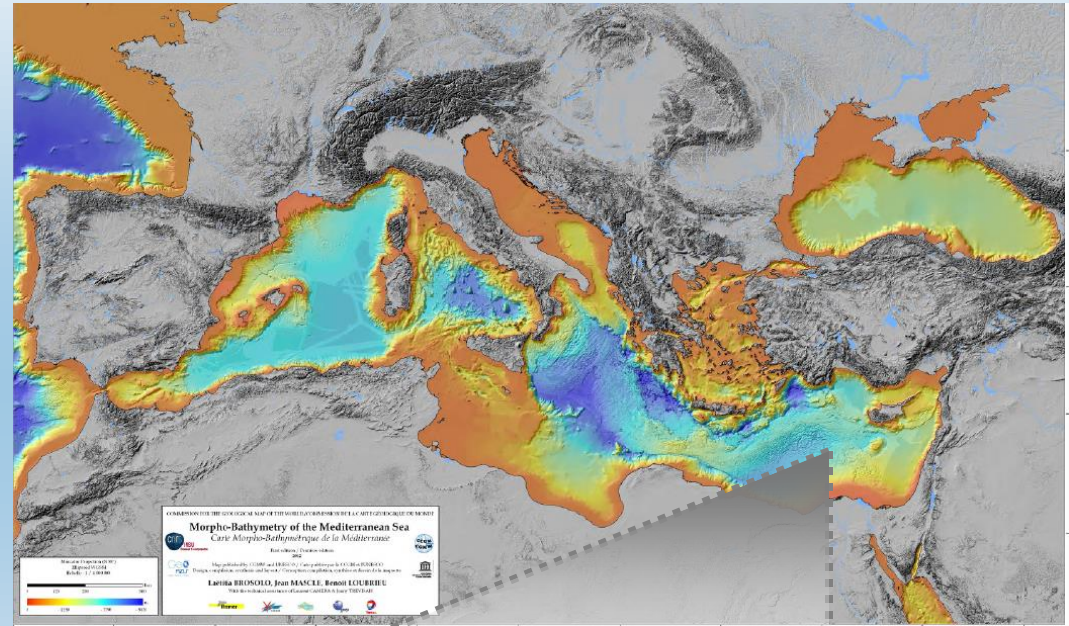
■ *Water column*

Various scales hydrology (including eddies)
NW - SE trophic gradient
Vertical temperature patterns / seasonality
Low renewal rates (contamination, endemism)

■ *Bottom*

Geological patterns (paleo-tectonics) and related bathymetric features with a high variety of extreme environments

Biodiversity drivers in the Med



Menes caldera
A highly active site of brine seepage

Huguen *et al.* (2009) *Mar. Geol.*

Hot spots of novel microbial communities

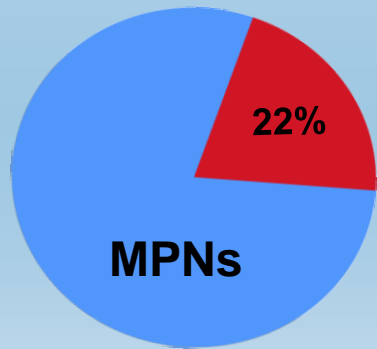
'Site' oriented bioprospecting

- Warm abysses: novel pressure-adaptation
- Active volcanoes: T resistance, metabolic pthws
- Corals: pharmaceuticals, nano-structures
- Anoxic hypersaline BP: cosmetics



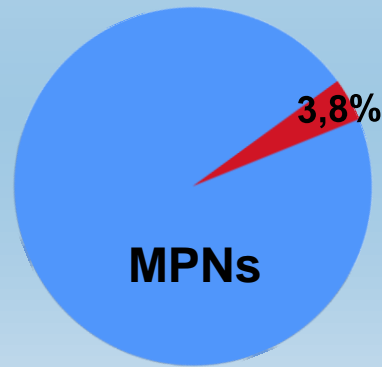
Med contribution to authorship

■ Mediterranean origin



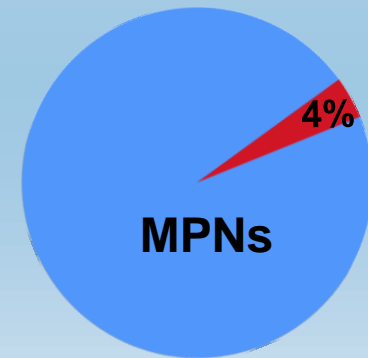
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ALGAE



total number:612

INVERTEBRATES

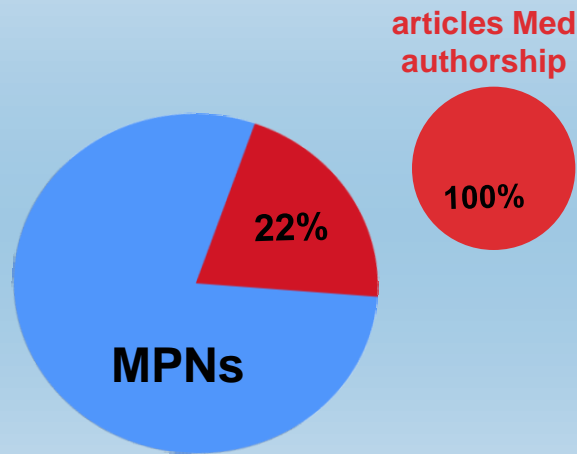


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MICROORGANISMS

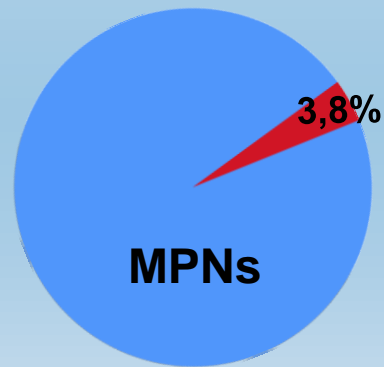
Med contribution to authorship

■ Mediterranean origin



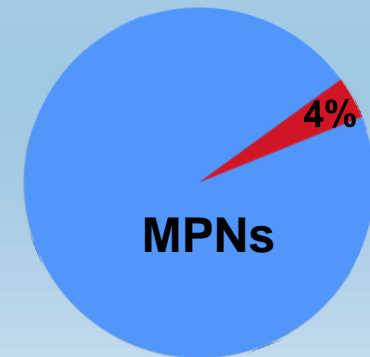
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ALGAE



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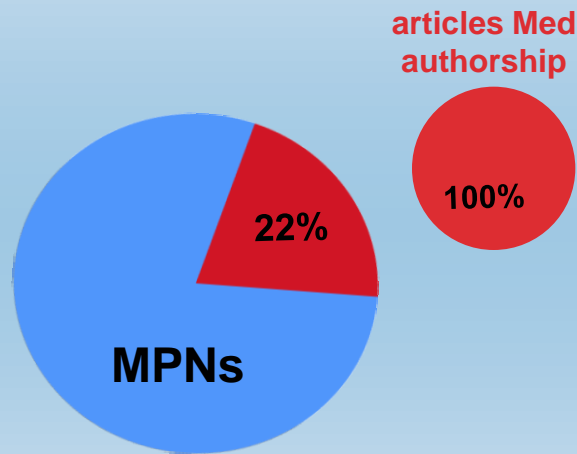


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MICROORGANISMS

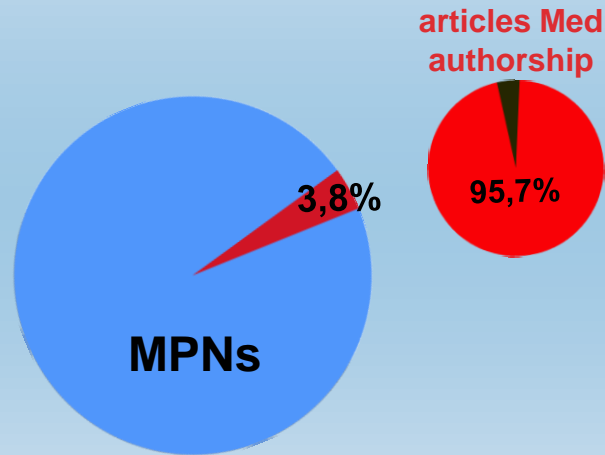
Med contribution to authorship

■ Mediterranean origin



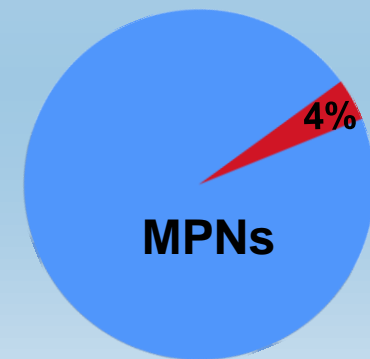
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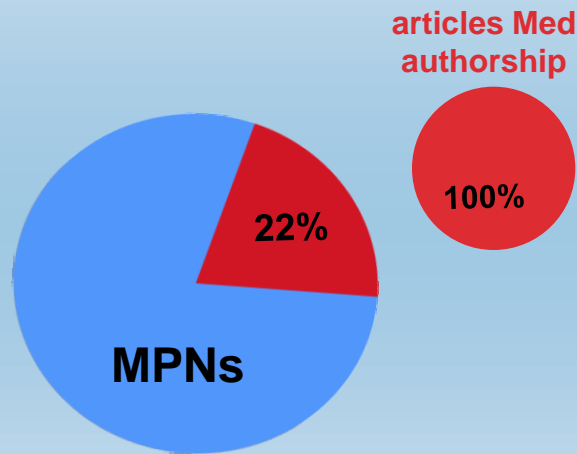


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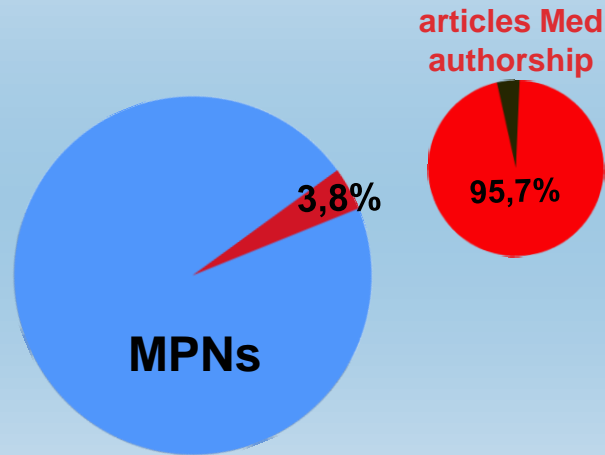
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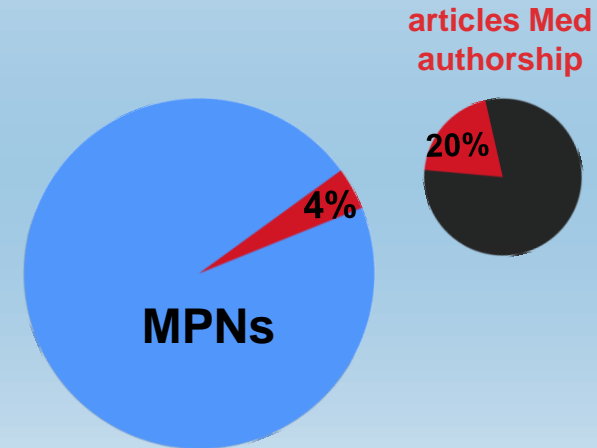
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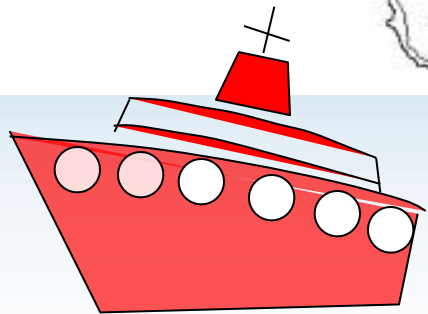
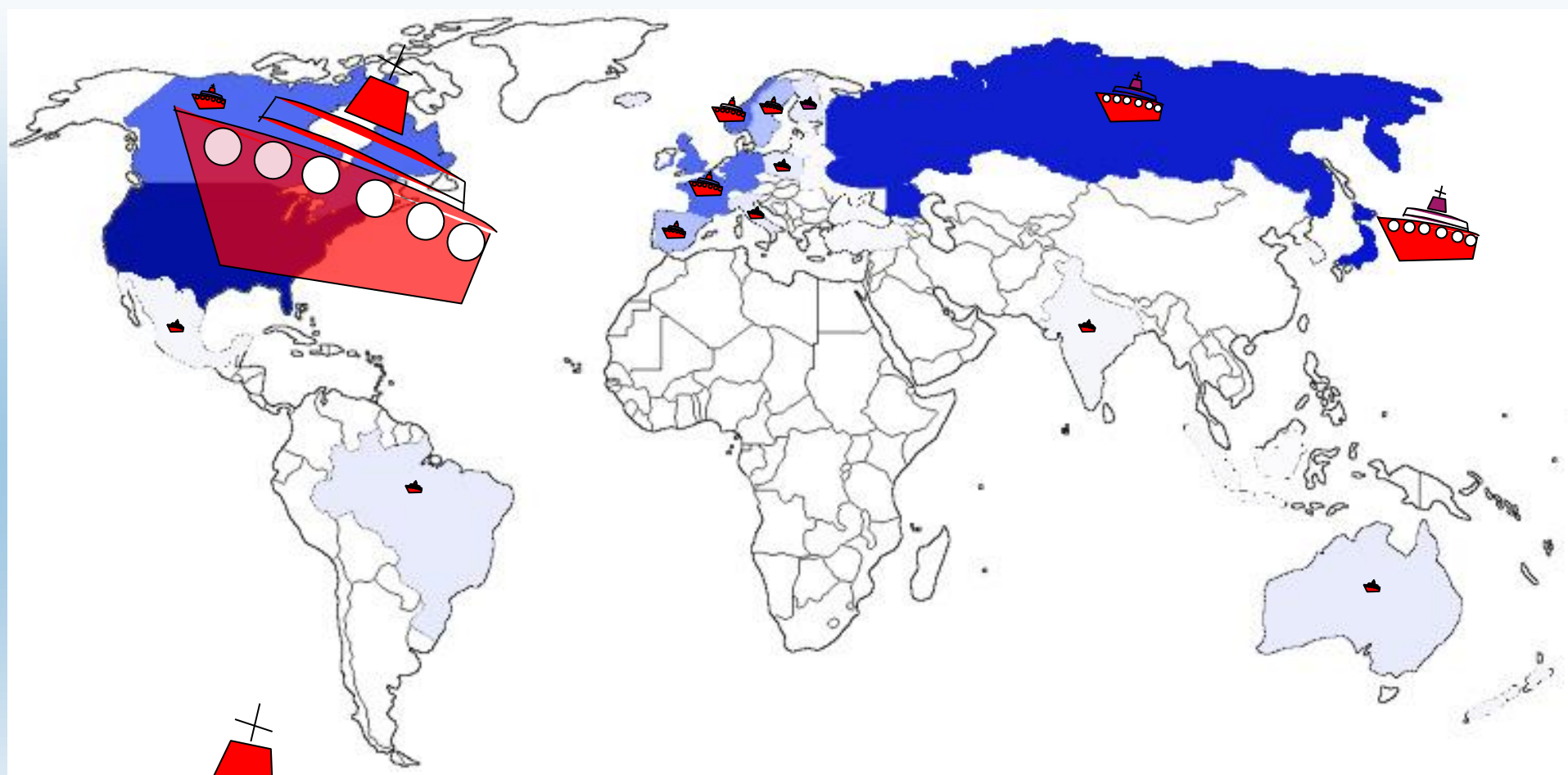
INVERTEBRATES



total number:292

MICROORGANISMS

Number of research vessels



98



36



20-24



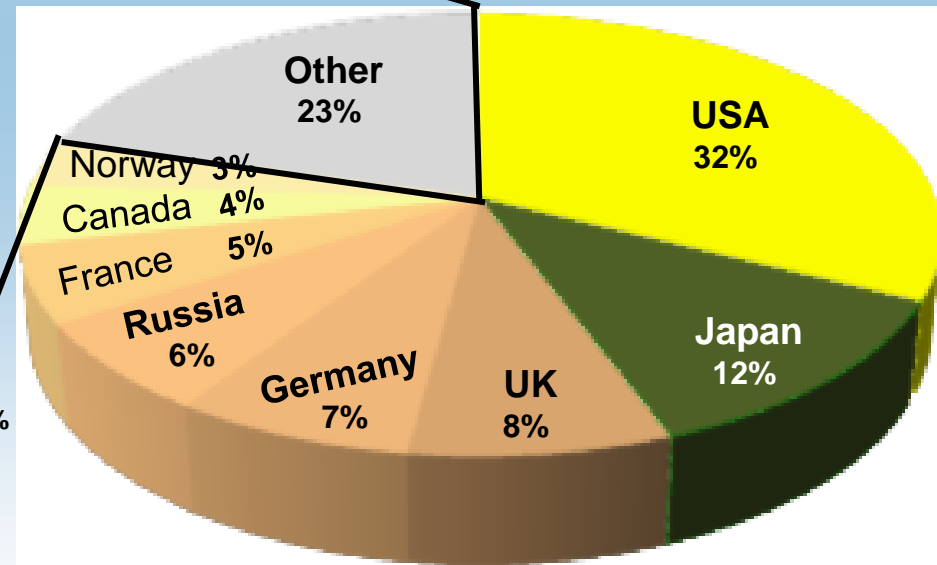
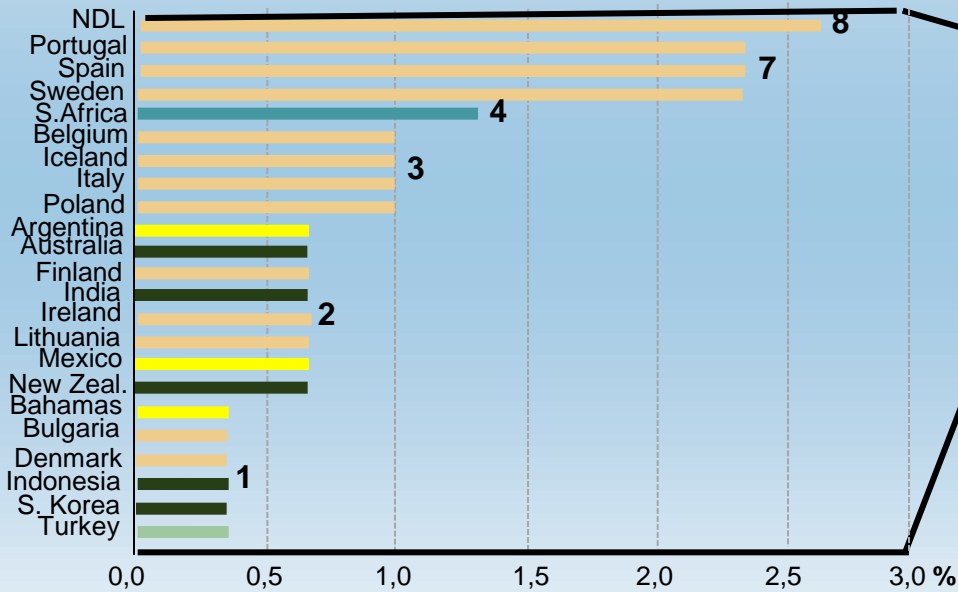
7-17



1-3

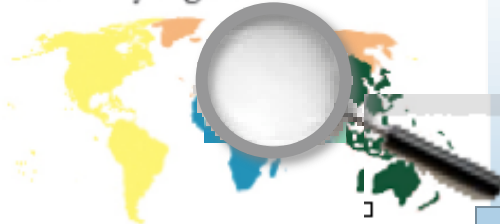
Country share of research vessels

Colour by region:

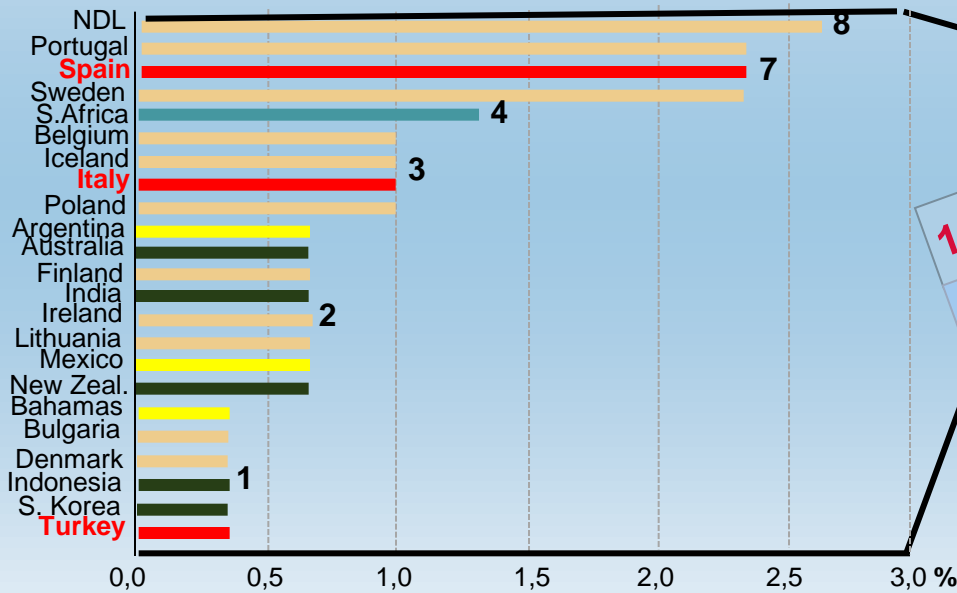


Country share of research vessels

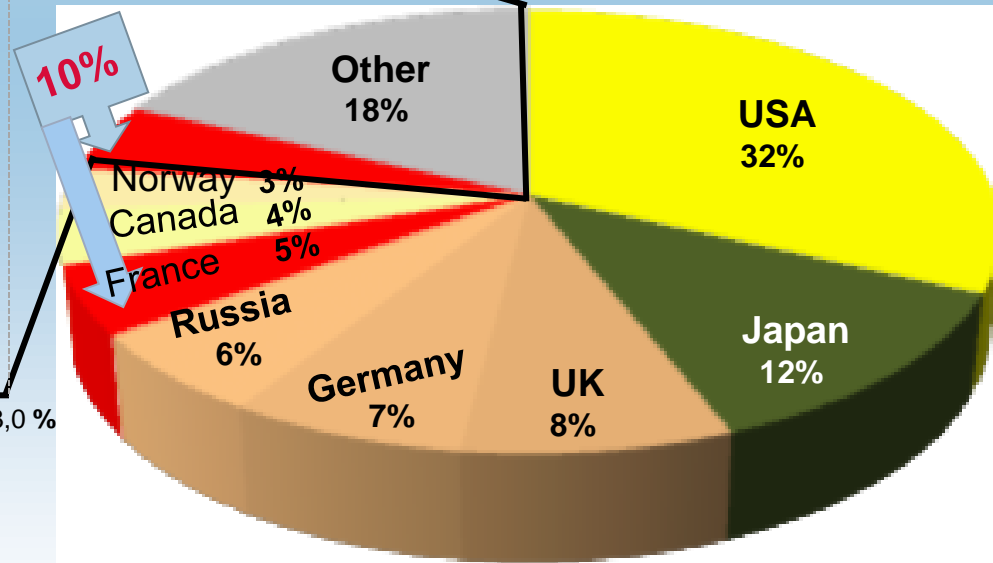
Colour by region:



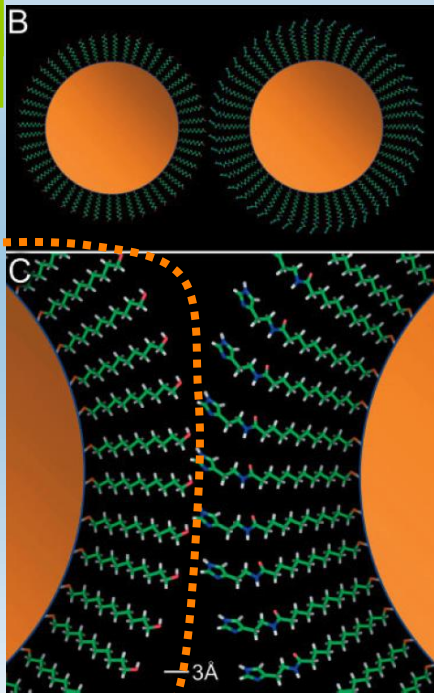
ZOOM on MED Countries



TOTAL = 307 (2012)



Med endemic species: some success sto



Reactive compound
(reactive silanol)

polycondensation



Silica

Precursor (silicon alkoxide)

Marine sponges 'inspire' silica synthesis

Marine sponges show the singular ability to actively synthesize their siliceous skeleton enzymatically. The responsible enzymes (*silicateins*) have inspired low temperature non-biological synthetics. Applications for sensors, electronics (i.e. computer microchips) and medicine are being explored.

Andre, R. *et al.*
Gutenberg University, DE - *FEBS Journal* (2012)

Med endemic species: some success sto



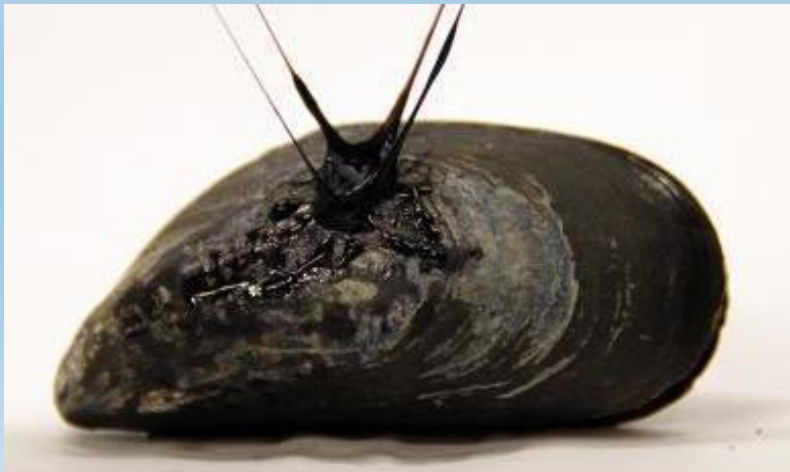
Tethya aurantium



*'Fifty percent of marine materials
originate from sponges'*
(Brummer, 2008)

Med endemic species: some success sto

New materials: Mussel Sticky Gel



Taking a cue from the sticky substance that mussels use to anchor themselves to rocks in pounding ocean surf, scientists have created a synthetic sticky substance for use as an adhesive or coating for underwater machinery, in biomedical settings as a surgical adhesive, or as a bonding agent for implants.

Holten-Andersen, Lee et al.
University of Chicago, US (PNAS, Jan 2011)

Med endemic species: some success sto



Mytilus galloprovincialis



Med endemic species: some success sto



Poseidonia oceanica



'A total of 51 natural products with geographic variation (environment-related) production patterns
(Brummer, 2008)

Exclusive Economic Zones (EEZs) in the M



Exclusive Economic Zones (EEZs) in the M

1981 - Morocco

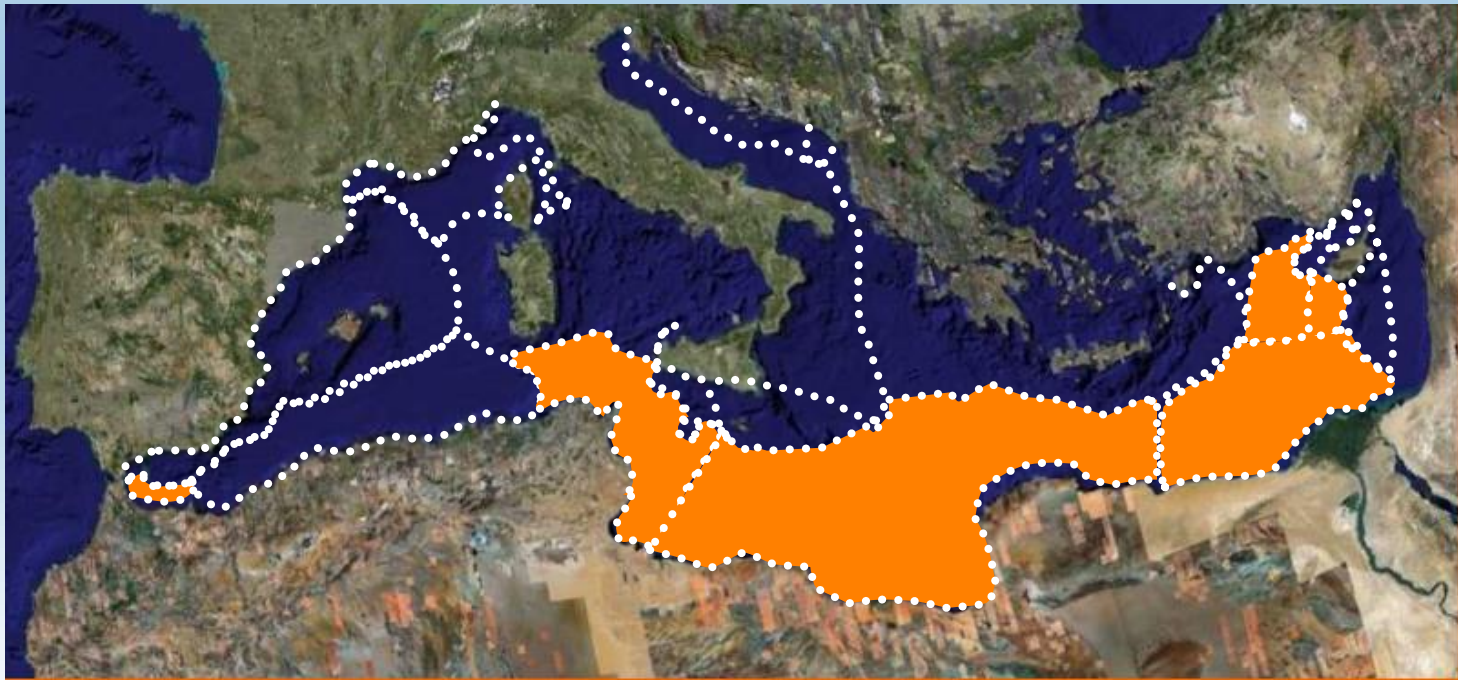
1981 - Egypt

2003 - Syria

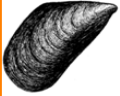
2004 - Cyprus

2005 - Tunisia

2009 - Libya



Cross-frontier species



Mytilus galloprovincialis



Poseidonia oceanica



Tethya aurantium

Cross-frontier species



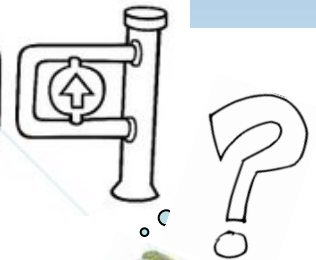
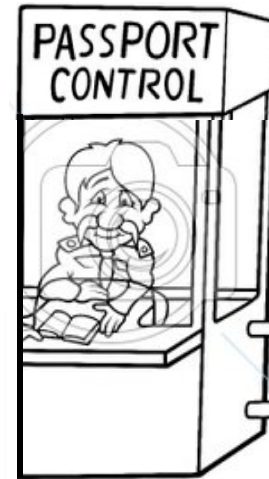
Mytilus galloprovincialis



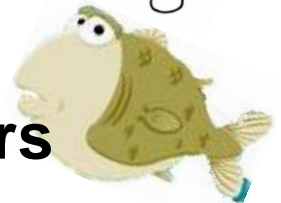
Poseidonia oceanica



Tethya aurantium



Marine organisms do not respect political frontiers



Conclusions on the Mediterranean region

MB patenting

Very low level standards (only few exceptions) - an increase in the tendency for North African Countries

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Political frontiers are not consistent with geographic distribution of MGRs – ‘co-ownership’?

Multi-lateral approaches targeting MGRs as commons shall be the way forward

Cross-frontier issues

CIESM Marine Peace Parks



תודה
Dankie Gracias
Спасибо شكراً
Merci Takk
Köszönjük Terima kasih
Grazie Dziękujemy Děkojame
Ďakujeme Vielen Dank Paldies
Kiitos Täname teid 谢谢
Thank You Tak
感謝您 Obrigado Teşekkür Ederiz
Σας Ευχαριστούμ 감사합니다
ขอบคุณ
Bedankt Děkujeme vám
ありがとうございます
Tack