3 Προσαρμοτισμός & κατασκευή οικοθέσης

Σταύρος Ιωαννίδης
ΙΦΕ/ΕΚΠΑ

From Paley 1802, *Natural Theology*, ch. 1-3

For this reason, and for no other, viz. that, when we come to inspect the watch, we perceive (what we could not discover in the stone) that its several parts are framed and put together for a **purpose**, *e. g.* that they are so formed and adjusted as to produce motion, and that motion so regulated as to point out the hour of the day etc. …

the inference, we think, is **inevitable**, that **the watch must have had a maker**: that there must have existed, at some time, and at some place or other, an **artificer** or artificers who **formed it for the purpose which we find it actually to answer;** who **comprehended** its construction, and **designed** its use. …

Nor, fourthly, would any man in his senses think the existence of the watch, with its various machinery, accounted for, by being told that it was **one out of possible combinations of material forms**; that whatever he had found in the place where he found the watch, must have contained some internal configuration or other; and that this configuration might be the structure now exhibited, viz. of the works of a watch, as well as a different structure.

Nor, fifthly, would it yield his inquiry more satisfaction to be answered, that there existed in things **a principle of order**, which had disposed the parts of the watch into their present form and situation. **He never knew a watch made by the principle of order**; nor can he even form to himself an idea of **what is meant by a principle of order, distinct from the intelligence of the watch-maker**. …

Neither, lastly, would our observer be driven out of his conclusion, or from his confidence in its truth, by being told that he knew nothing at all about the matter. He knows enough for his argument: he knows **the utility of the end**: he knows the **subserviency and adaptation of the means to the end**.

every indication of contrivance, every manifestation of design, which existed in the watch, **exists in the works of nature**; with the difference, on the side of nature, of being greater and more, and that **in a degree which exceeds all computation**.

From Darwin 1859, *Origin of Species*, Introduction

> In considering the Origin of Species, it is quite conceivable that a naturalist, reflecting on the **mutual affinities** of organic beings, on their **embryological relations**, their **geographical distribution**, **geological succession**, and other such facts, might come to the conclusion that each species **had not been independently created, but had descended, like varieties, from other species**.
>
> Nevertheless, such a conclusion, **even if well founded, would be unsatisfactory**, until it could be shown **how** the innumerable species inhabiting this world **have been modified**, **so as to acquire that perfection of structure and coadaptation** which most justly excites our admiration.

Naturalists continually refer to **external conditions**, such as climate, food, &c., as the only possible cause of variation. In one very limited sense, as we shall hereafter see, this may be true;

but it is **preposterous** to attribute to mere external conditions, **the structure, for instance, of the woodpecker**, with its feet, tail, beak, and tongue, **so admirably adapted to catch insects under the bark of trees.**

In the case of the **mistletoe**, which draws its nourishment from certain trees, which has seeds that must be transported by certain birds, and which has flowers with separate sexes absolutely requiring the agency of certain insects to bring pollen from one flower to the other, it is equally preposterous to account for the structure of this parasite, **with its relations to several distinct organic beings**, by the effects of external conditions, or of habit, or of the volition of the plant itself.

The author of the 'Vestiges of Creation' would, I presume, say that, after a certain unknown number of generations, **some bird had given birth to a woodpecker, and some plant to the misseltoe**, and that these had been **produced perfect** as we now see them; but this assumption seems to me to be **no explanation**, for it **leaves the case of the coadaptations of organic beings to each other and to their physical conditions of life, untouched and unexplained**.

It is, therefore, of the highest importance to gain a clear insight into the means of modification and coadaptation.

Προσαρμοτισμός adaptationism

Gould & Lewontin (1979):
The Spandrels of San Marco and the Panglossian Paradigm

Dr. Pangloss: 'Things cannot be other than they are. . . Everything is made for the best purpose. Our noses were made to carry spectacles, so we have spectacles. Legs were clearly intended for breeches, and we wear them'.

Voltaire, *Candide or Optimism*


CIVS
SCI
CHRISTI
MATH
GY
ON


SV
M2SA
CER
D O
S
ELY
+ NDEFRATINIVS
STVM + QVOD PACIA

Η κριτική των Gould & Lewontin στον προσαρμοτισμό

-**Adaptive** vs **Adaptation**
-> σημασία εξελικτικής ιστορίας πριν δώσουμε προσαρμοτιστική εξήγηση
-> δεν ισχύει ότι κάθε χαρακτήρας υπάρχει επειδή είναι χρήσιμος

-spandrels, vestigial traits (υπολειμματικοί χαρακτήρες), hitchhikers, exaptation (αλλοπροσαρμογή), developmental constraints

-Αγνόηση **μη προσαρμοστικών** εξηγήσεων
-> π.χ. σκελετική δομή άκρων τετραπόδων
-> προσαρμοτιστές -> οργανισμοί ως μωσαϊκό ξεχωριστών χαρακτήρων

-Το προσαρμοτιστικό πρόγραμμα είναι **μη διαψεύσιμο**
-> just-so stories -> how-possibly explanations

Τα είδη του προσαρμοτισμού

-> **Εμπειρικός** προσαρμοτισμός
-φυσική επιλογή η αιτία για τους περισσότερους χαρακτήρες

-> **Εξηγητικός** προσαρμοτισμός
-η εξήγηση των προσαρμογών το κεντρικό πρόβλημα

-> **Μεθοδολογικός** προσαρμοτισμός
-η μελέτη του καλού σχεδιασμού ως καλύτερη μέθοδος μελέτης των οργανισμών

Τα είδη του προσαρμοτισμού

Godfrey-Smith (2001, 336) on **empirical adaptationism**:

"Natural selection is a **powerful and ubiquitous force**, and there are **few constraints** on the biological variation that fuels it. To a large degree, it is possible to predict and explain the outcome of evolutionary processes by attending only to the role played by **selection**. No other evolutionary factor has this degree of causal importance."

Τα είδη του προσαρμοτισμού

Godfrey-Smith (2001, 336) on **explanatory adaptationism**:

"The apparent **design** of organisms, and the relations of **adaptedness** between organisms and their environments, are the **big questions, the amazing facts in biology**. Explaining these phenomena is the core intellectual mission of evolutionary theory. Natural selection is the key to solving these problems; selection is the **big answer**. Because it answers the biggest questions, selection has **unique** explanatory importance among evolutionary factors."

Τα είδη του προσαρμοτισμού

Godfrey-Smith (2001, 337) on **methodological adaptationism**:

"The best way for scientists to approach biological systems is to look for features of adaptation and good design. Adaptation is a good 'organizing concept' for evolutionary research."

Τα είδη του προσαρμοτισμού

-> ένα **εμπειρικό επιχείρημα** κατά Εξηγητικού Προσαρμοτισμού

Amundson (1998):
constraints on **adaptation** vs constraints on **form**

-τυπικό παράδειγμα: διατήρηση κοινών δομικών σχεδίων σε πολύ διαφορετικούς οργανισμούς

-Gould: 'persistence of Type' εξίσου σημαντικό πρόβλημα, που δε μπορεί να λύσει η θεωρία φυσικής επιλογής

-ΑΛΛΑ: stabilising selection / chance -> εξηγήσεις για διατήρηση;

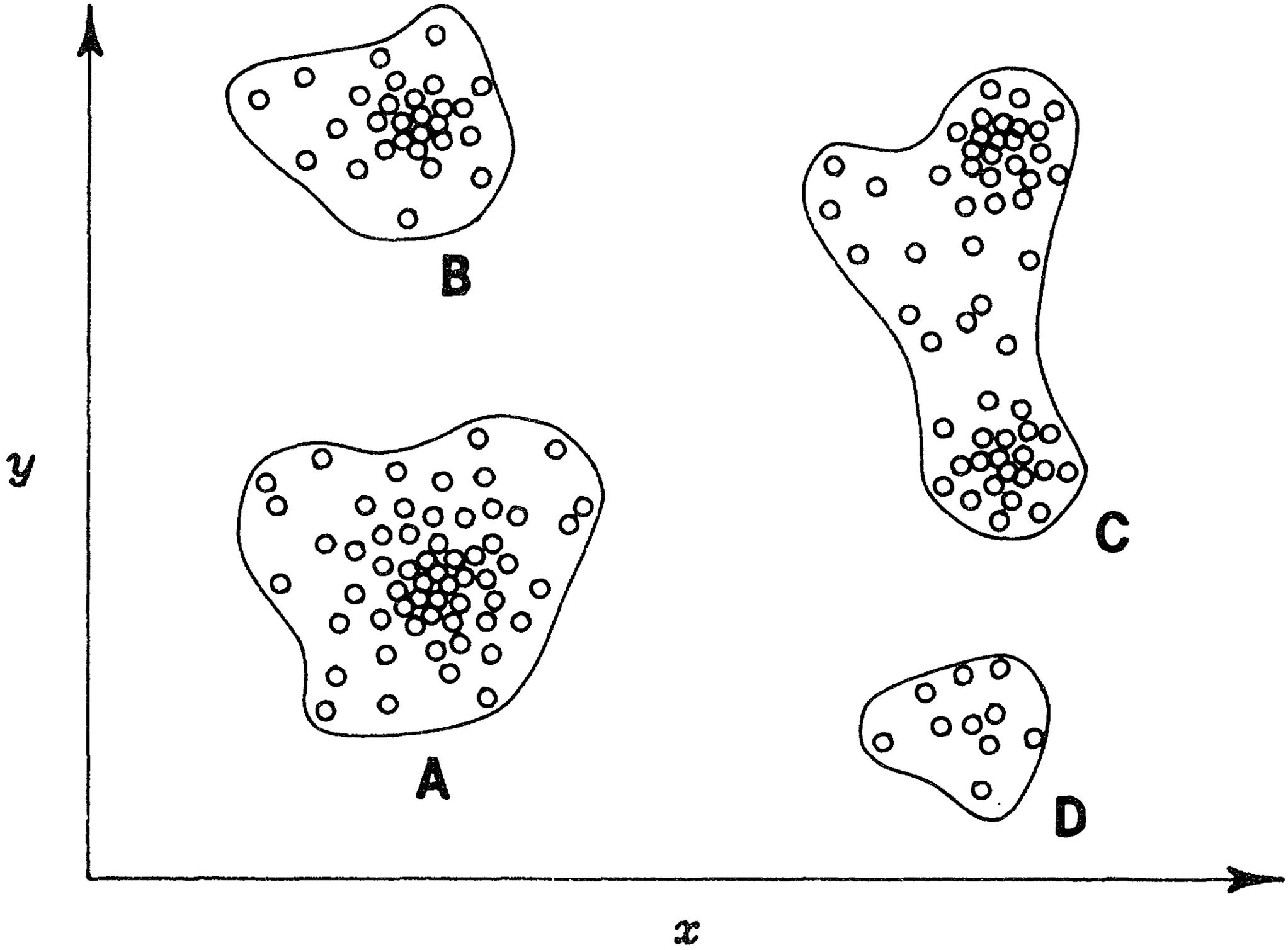


Figure 3.1. The clustering of organisms in morphospace. From P. Alberch's "Developmental Constraints in Evolutionary Processes" in J. T. Bonner, (ed.), *Evolution and Development*. Copyright © 1982 by Springer-Verlag. Reprinted by permission.

εικόνες 3.1 - 3.3 από Amundson 1994

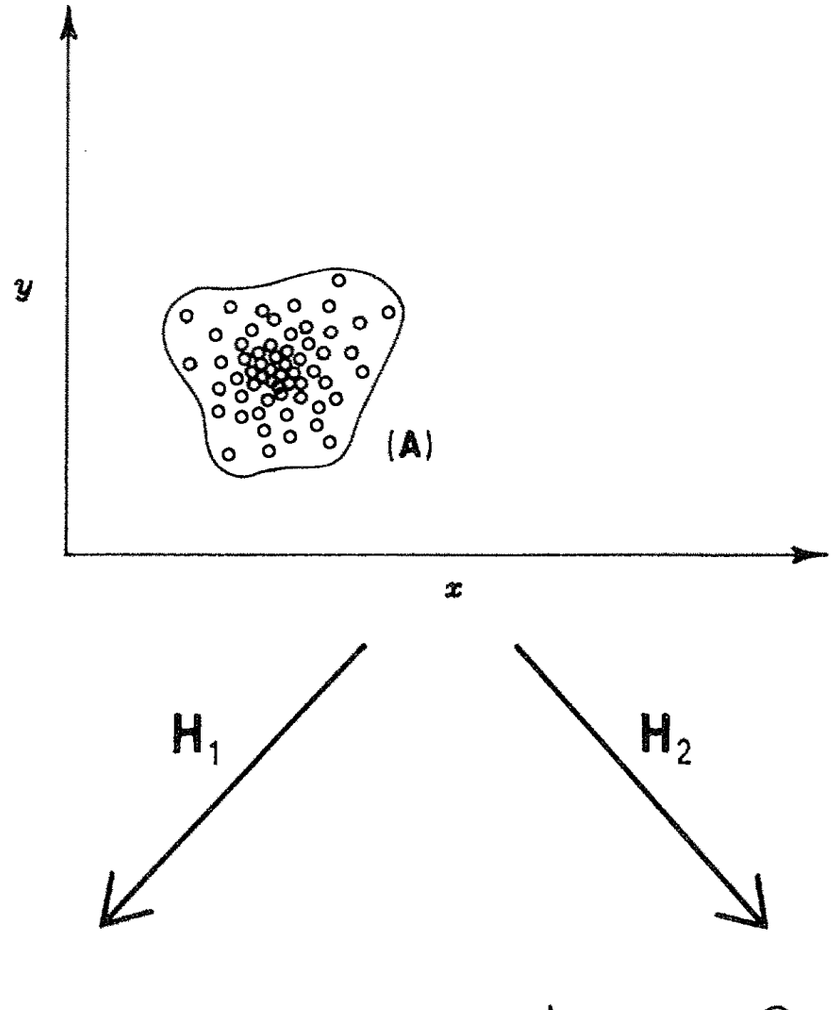


Figure 3.2. Two hypotheses on the effects of removing natural selection from a population. From P. Alberch's "Developmental Constraints in Evolutionary Processes" in J. T. Bonner, (ed.), *Evolution and Development*. Copyright © 1982 by Springer-Verlag. Reprinted by permission.

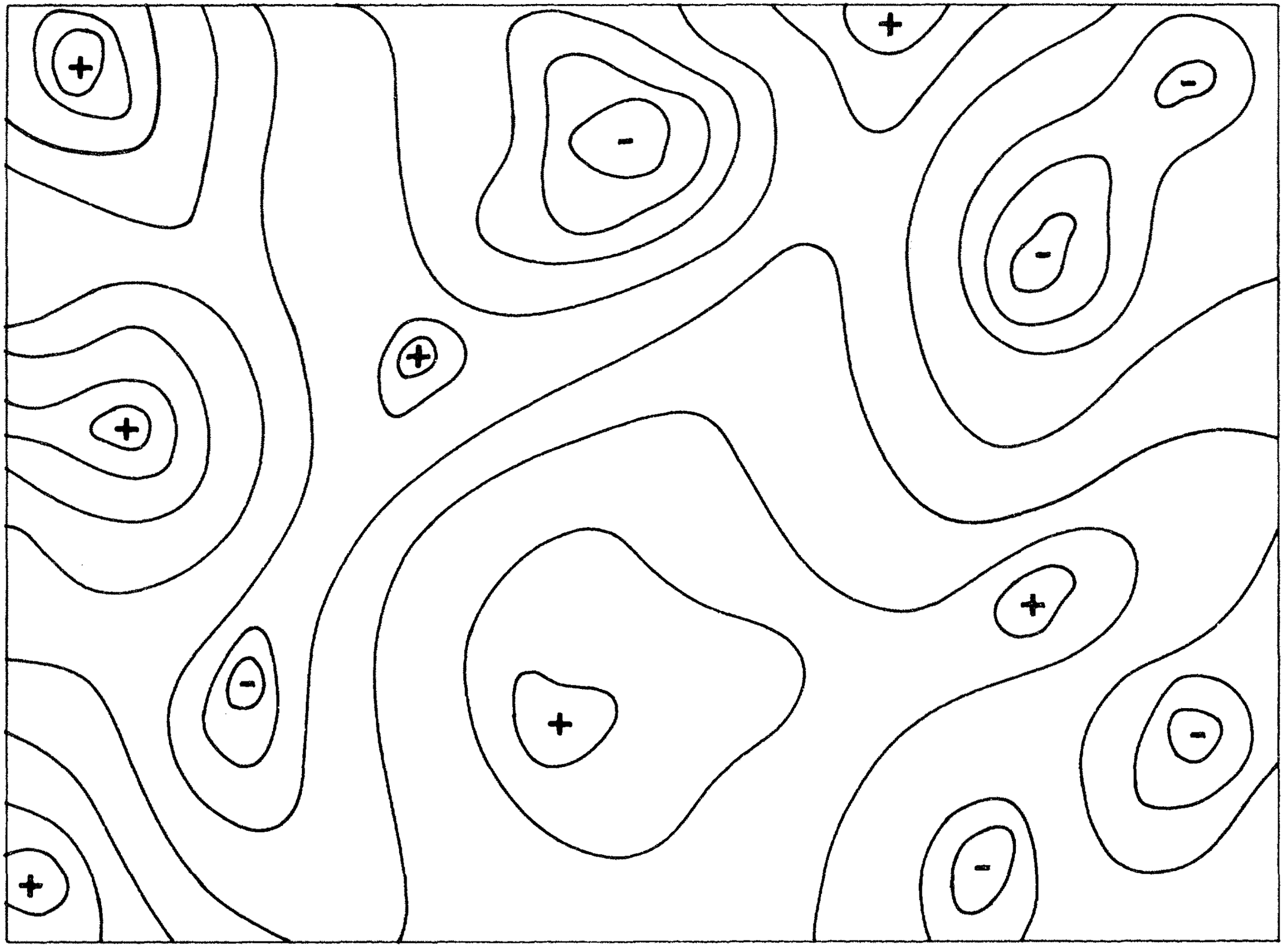


Figure 3.3. An example of an adaptive landscape in the sense of S. Wright. The x and y axes would represent genetic space. Contour lines connect points of equal adaptive value; plusses and minuses are areas of high and low adaptivity.

Τα είδη του προσαρμοτισμού

-> ένα **εννοιολογικό επιχείρημα** κατά Εξηγητικού Προσαρμοτισμού

-αναγκαίος ο **ανεξάρτητος** χαρακτηρισμός των πολύπλοκων προσαρμογών (ανεξάρτητα από φυσική επιλογή)

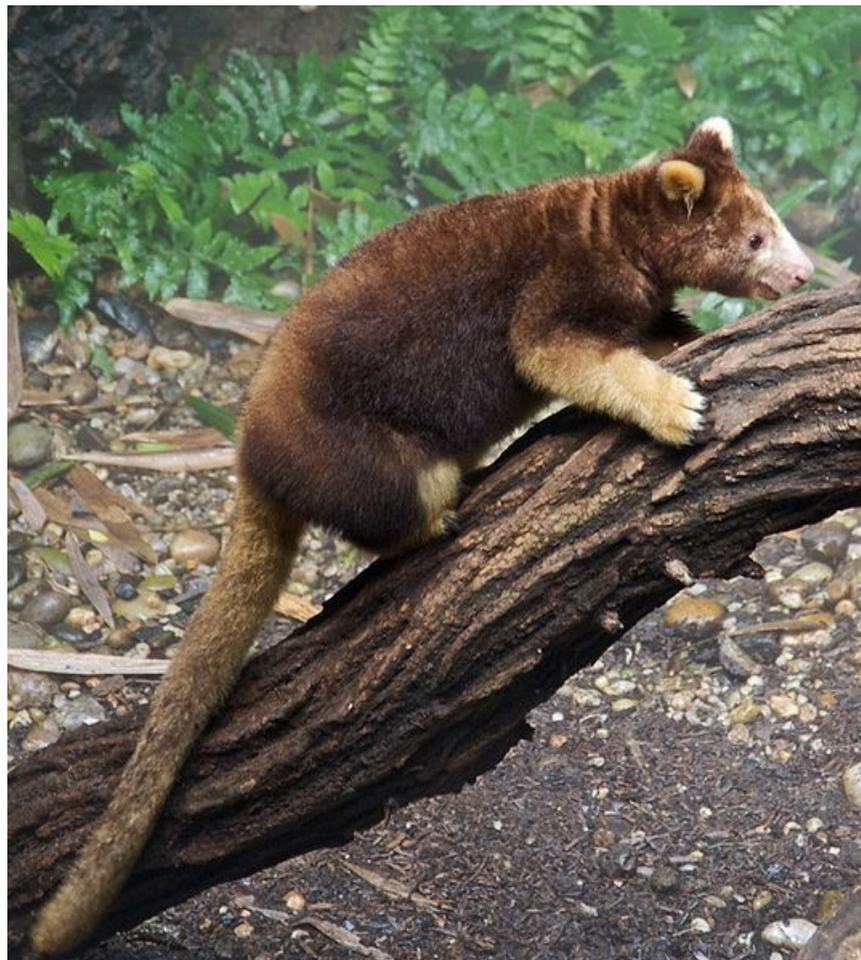
Τα είδη του προσαρμοτισμού

-> προβλήματα για <u>Εμπειρικό Προσαρμοτισμό</u>

-**επιλογή**, προηγούμενη **ιστορία** γενεαλογικής γραμμής και **τύχη** παράγοντες για εξήγηση προσαρμογών

-γιατί η επιλογή πιο σημαντική;
-και, πώς ακριβώς ελέγχουμε τέτοιους ισχυρισμούς;

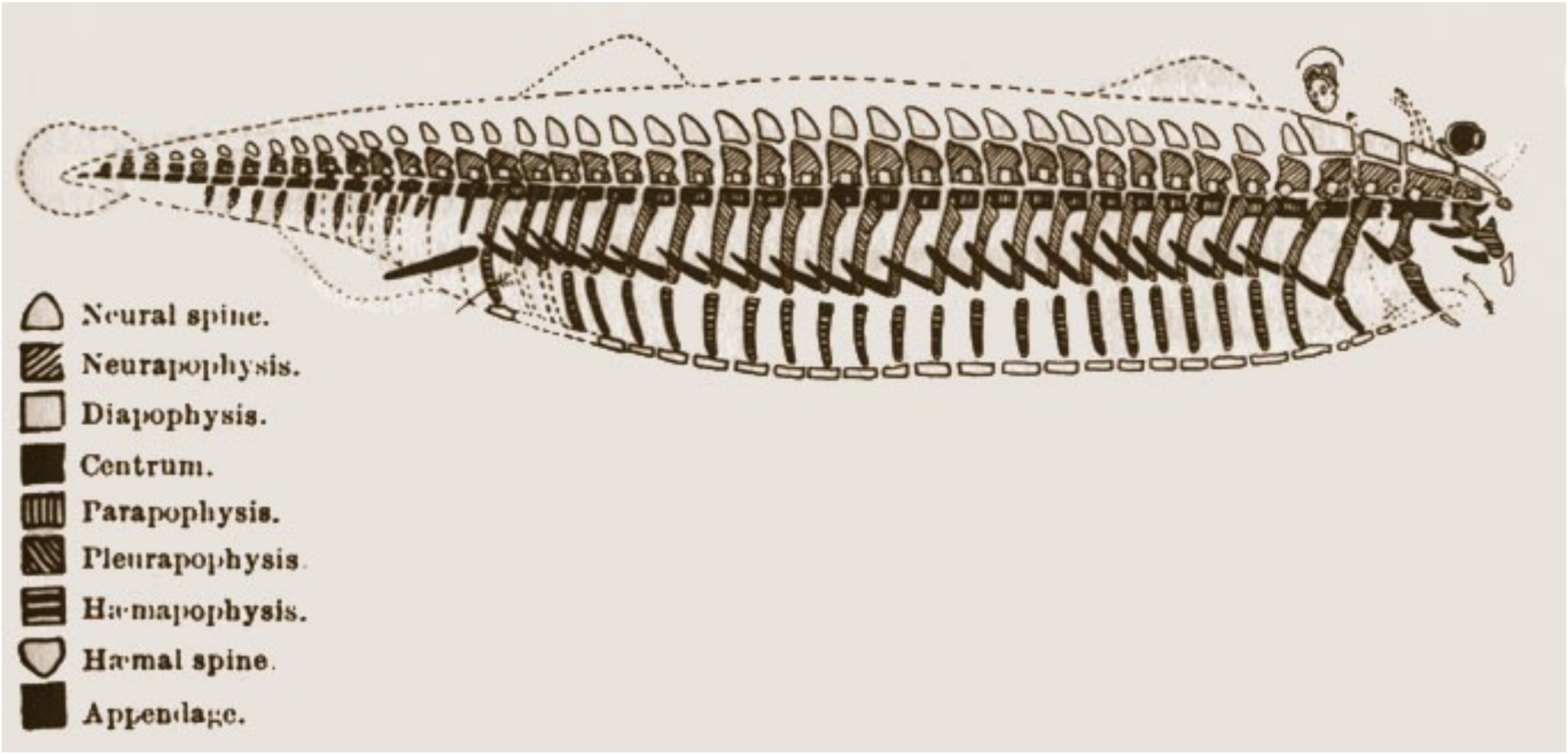
-> Sterelny & Griffiths



Δομισμός και η έννοια του Bauplan

-Bauplan - body plan - δομικό σχέδιο

-> εξήγηση μέσω ταξινόμησης



Ο σκελετός του αρχέτυπου των σπονδυλωτών από τον Owen. Στην επόμενη σελίδα, το αρχέτυπο μαζί με σκελετούς ψαριού, ερπετού, πουλιού, θηλαστικού, και ανθρώπου. Από το βιβλίο του Owen *On the Archetype and Homologies of the Vertebrate Skeleton* (London: Van Voorst, 1848), plate II.

Fig. 1 Urtheilstypus.

Fig. 2 Vogel.

Fig. 3. Reptilium

Fig. 4. Arm

Fig. 5. Arm

Fig. 6. Arm

Fig. 7.

Fig. 8.

Fig. 9. Mammale

Fig. 10. Bein

Fig. 11. Bein

Fig. 12. Bein

Fig. 13. Bein

Fig. 14. Bein

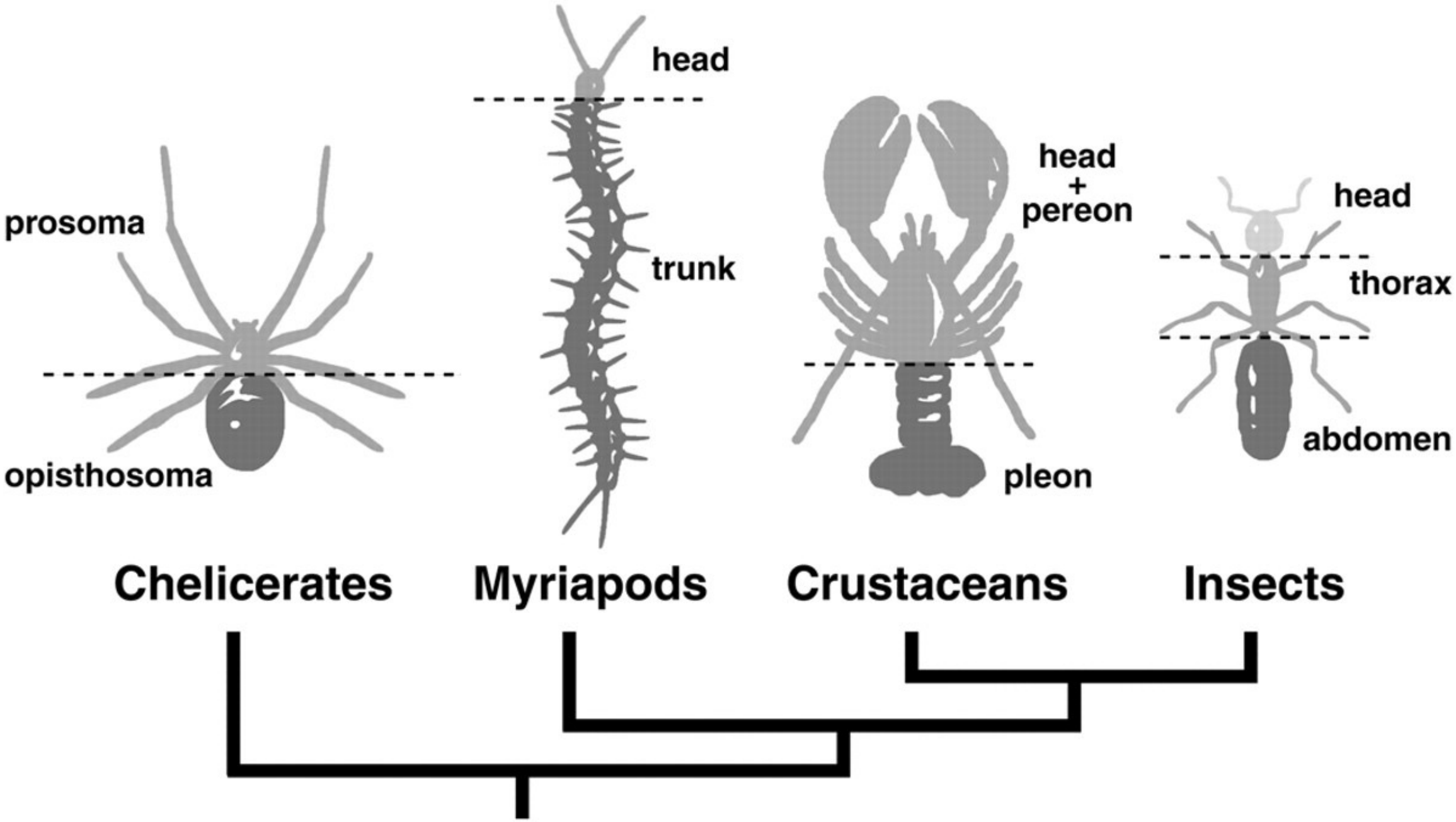
Fig. 15. Bein

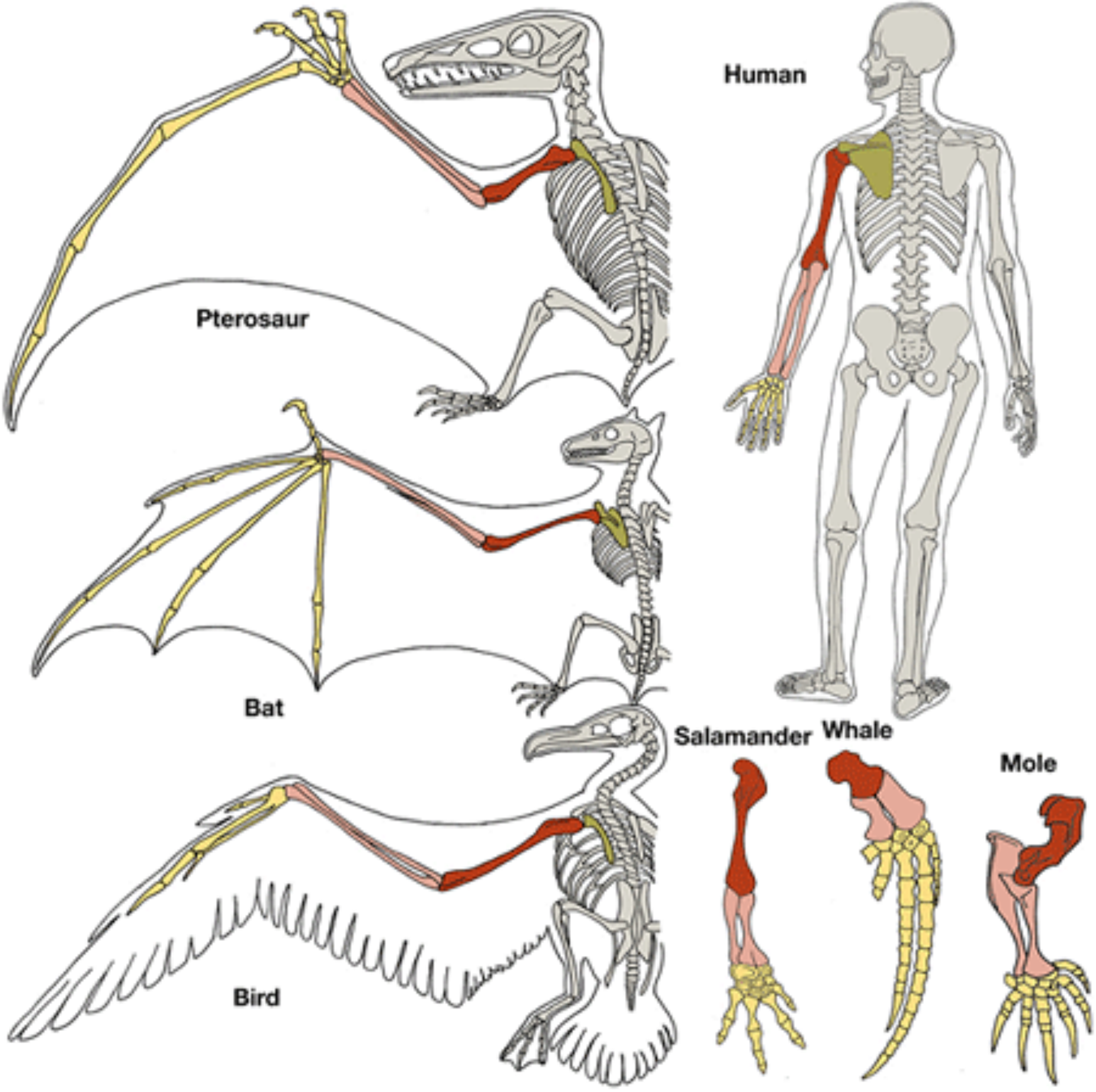
Fig. 16. Bein

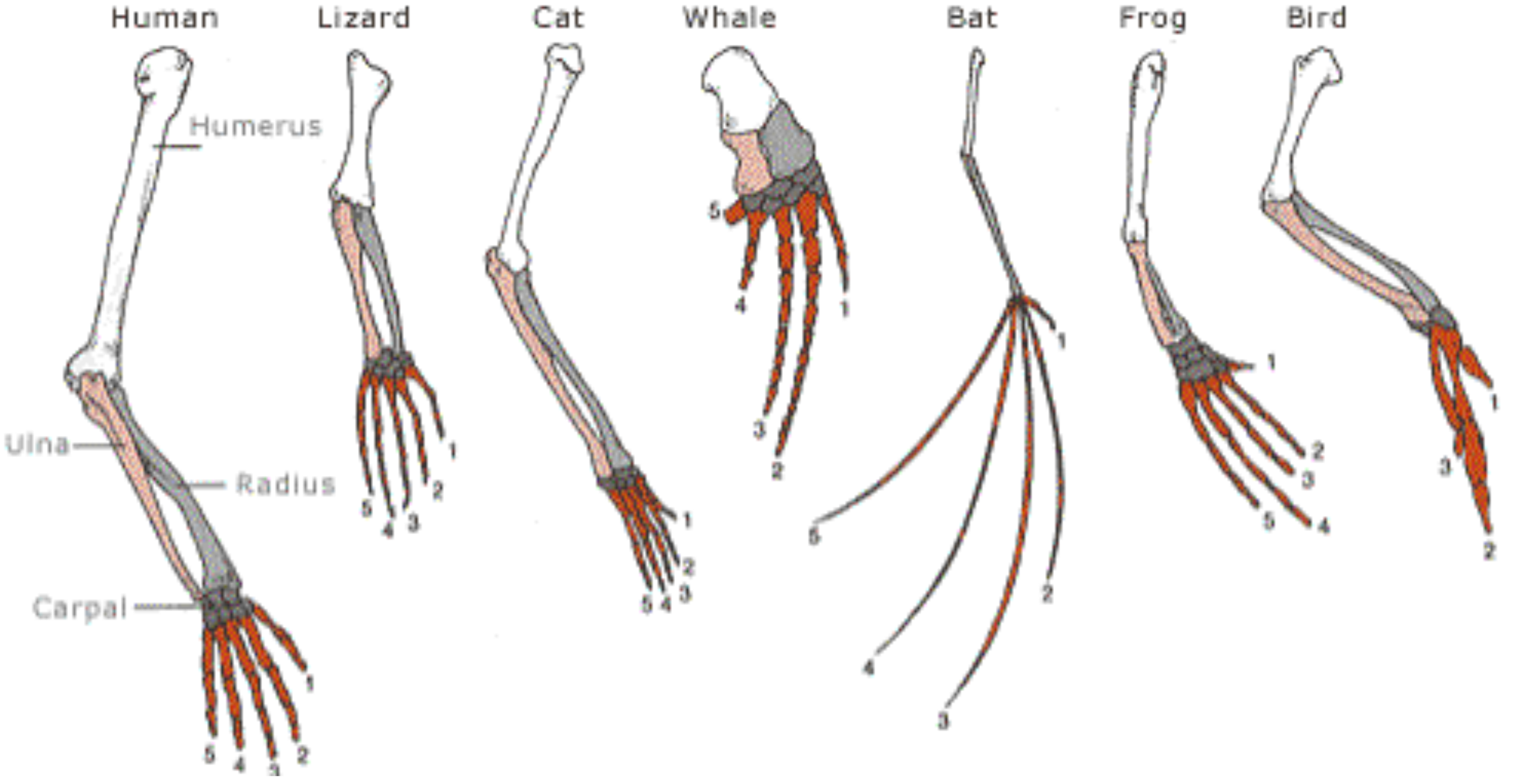
Fig. 17. Bein

Fig. 18. Bein

Fig. 19. Bein


prosoma
opisthosoma
head
trunk
head
+
pereon
pleon
head
thorax
abdomen
Chelicerates
Myriapods
Crustaceans
Insects

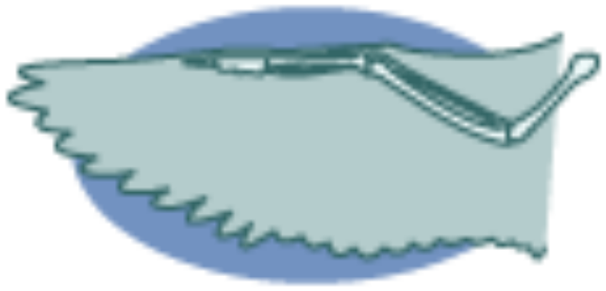

Pterosaur
Human
Bat
Bird
Salamander
Whale
Mole


Human
Lizard
Cat
Whale
Bat
Frog
Bird
Humerus
Ulna
Radius
Carpal

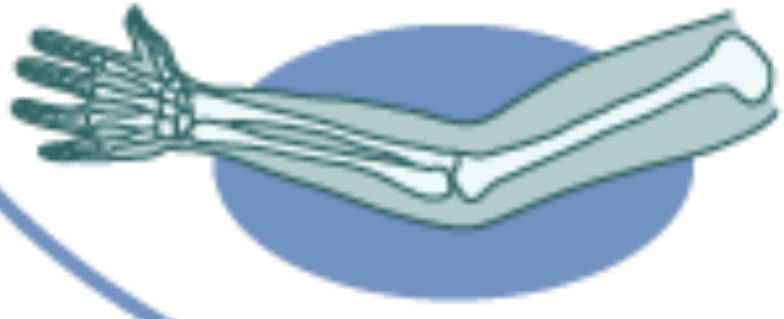
Homologous

lizard

bird



human

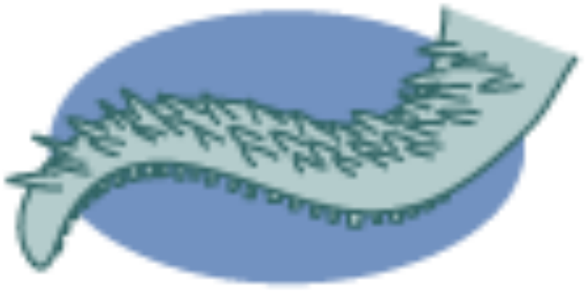


whale

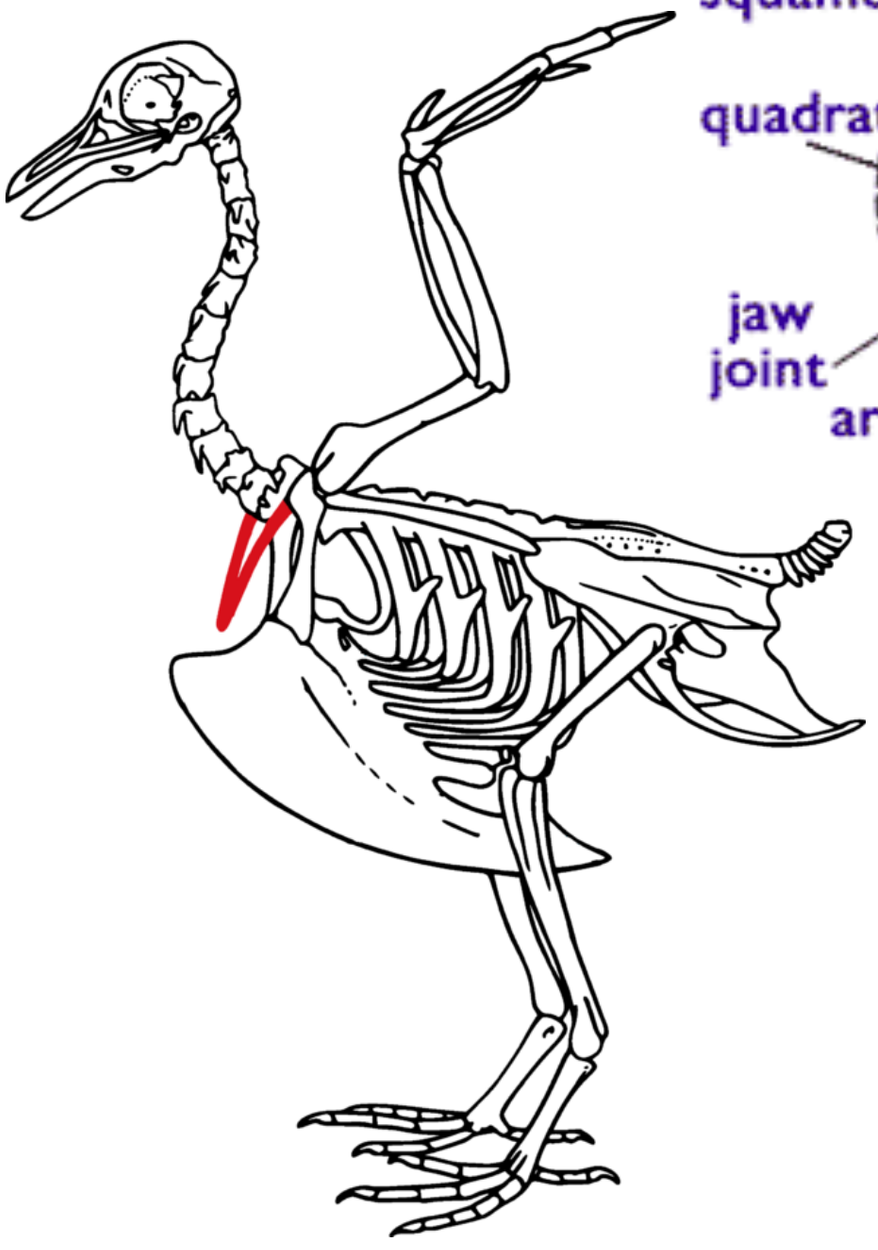
Not homologous

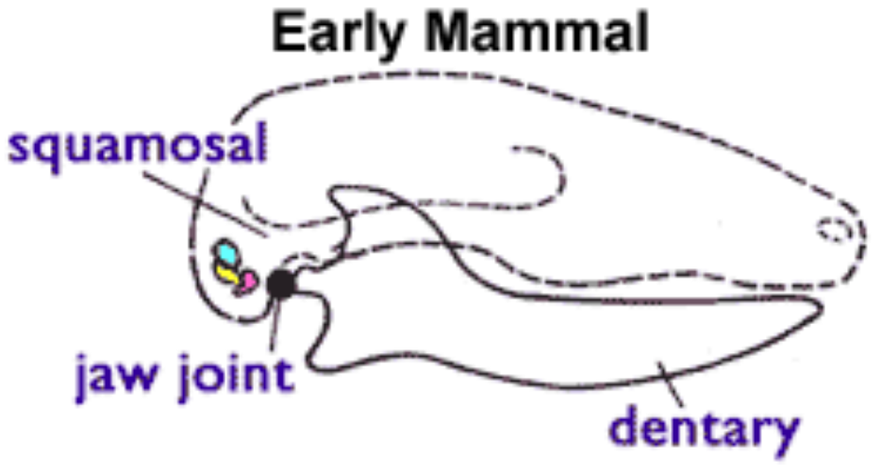
octopus

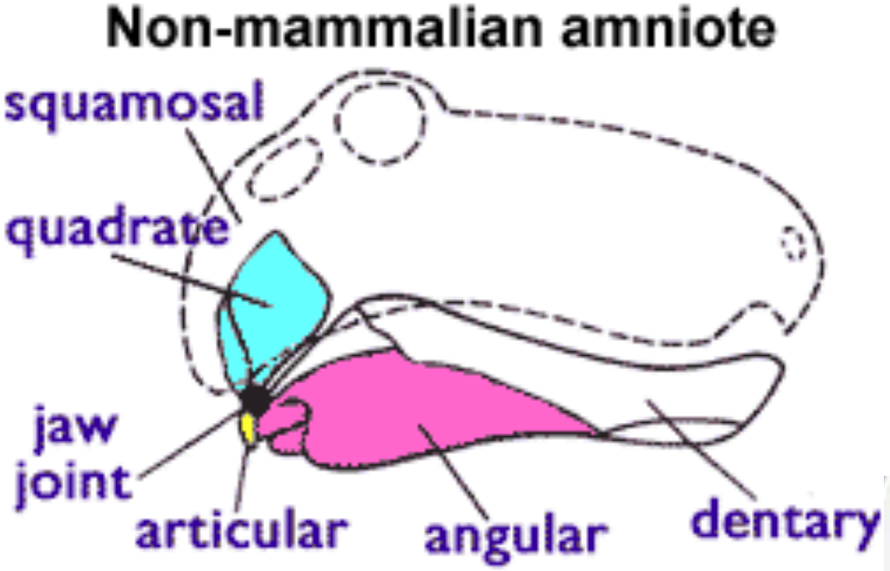
sea star

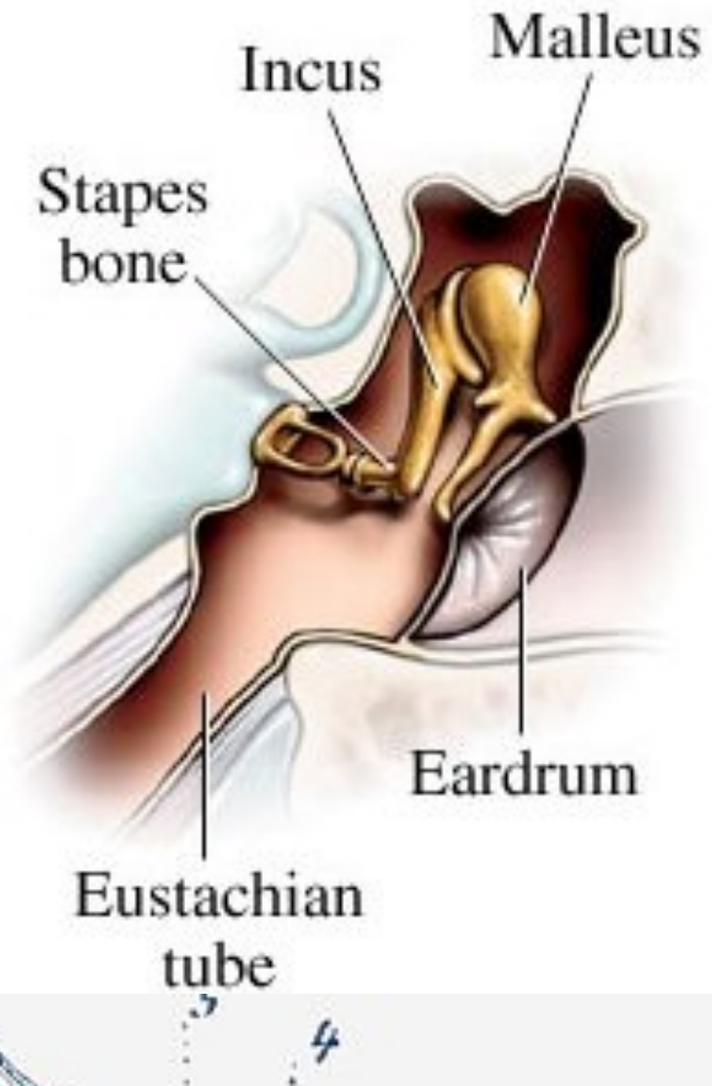


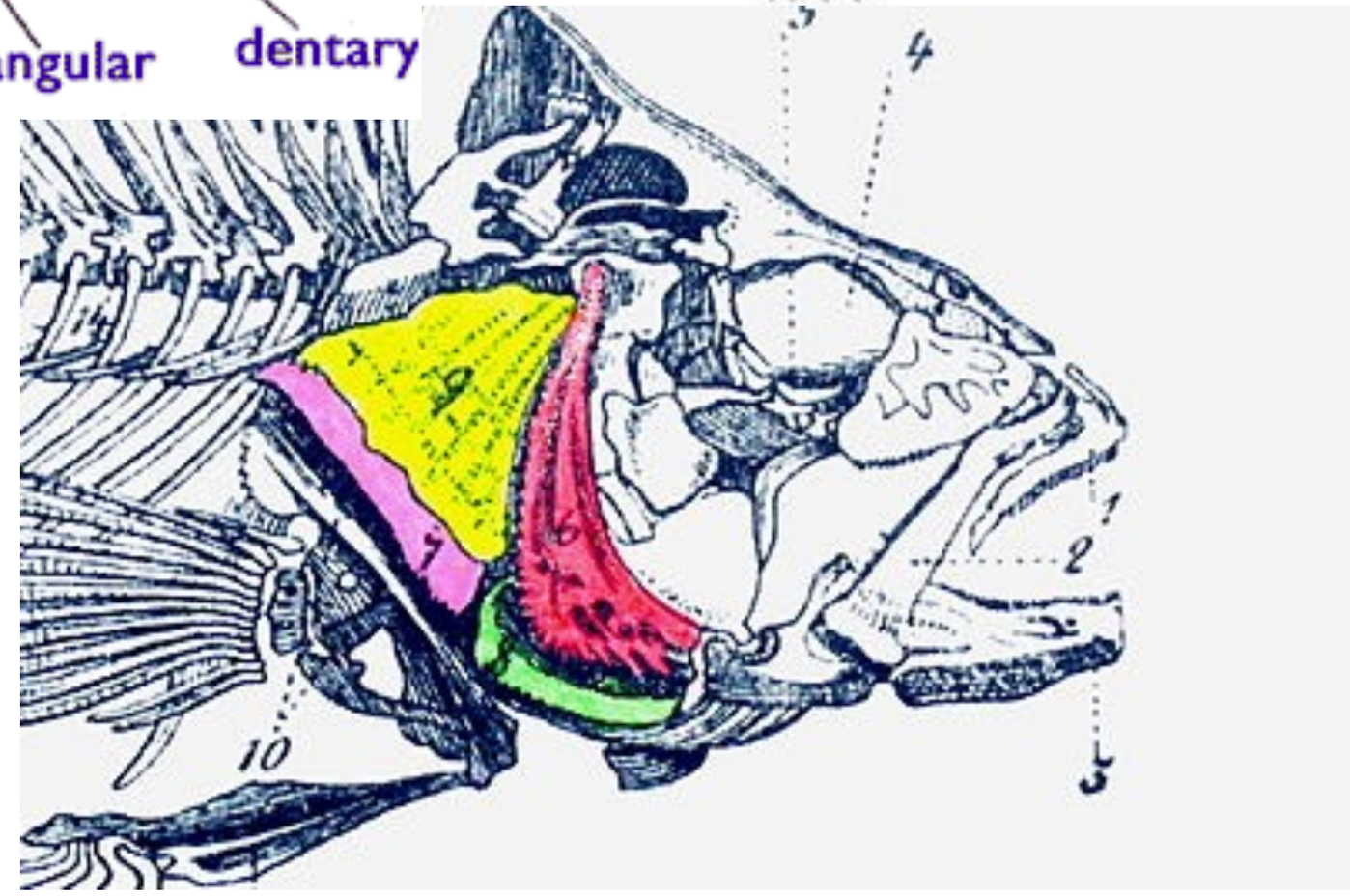
grasshopper




Early Mammal
squamosal
jaw joint
dentary


Non-mammalian amniote
squamosal
quadrate
jaw joint
articular
angular
dentary


Malleus
Incus
Stapes bone
Eardrum
Eustachian tube


4
1
2
10

It is generally acknowledged that all organic beings have been formed on two great laws-**Unity of Type** and the **Conditions of Existence.** By unity of type is meant that **fundamental agreement in structure**, which we see in organic beings of the **same** class, and which is **quite independent** of their habits of life. On my theory, unity of type is explained by **unity of descent.** The expression of conditions of existence, so often insisted upon by the illustrious Cuvier, is fully embraced by **the principle of natural selection.** For natural selection acts by either **now adapting** the varying parts of each being to its organic conditions of life; or by **having adapted** them in long-past periods of time.

Hence, in fact, the law of the Conditions of Existence is the **higher law;** as it includes, **through the inheritance of former adaptations**, that of Unity of Type.

(Darwin 1859, 206)

Δομισμός και η έννοια του Bauplan

Evo-devo

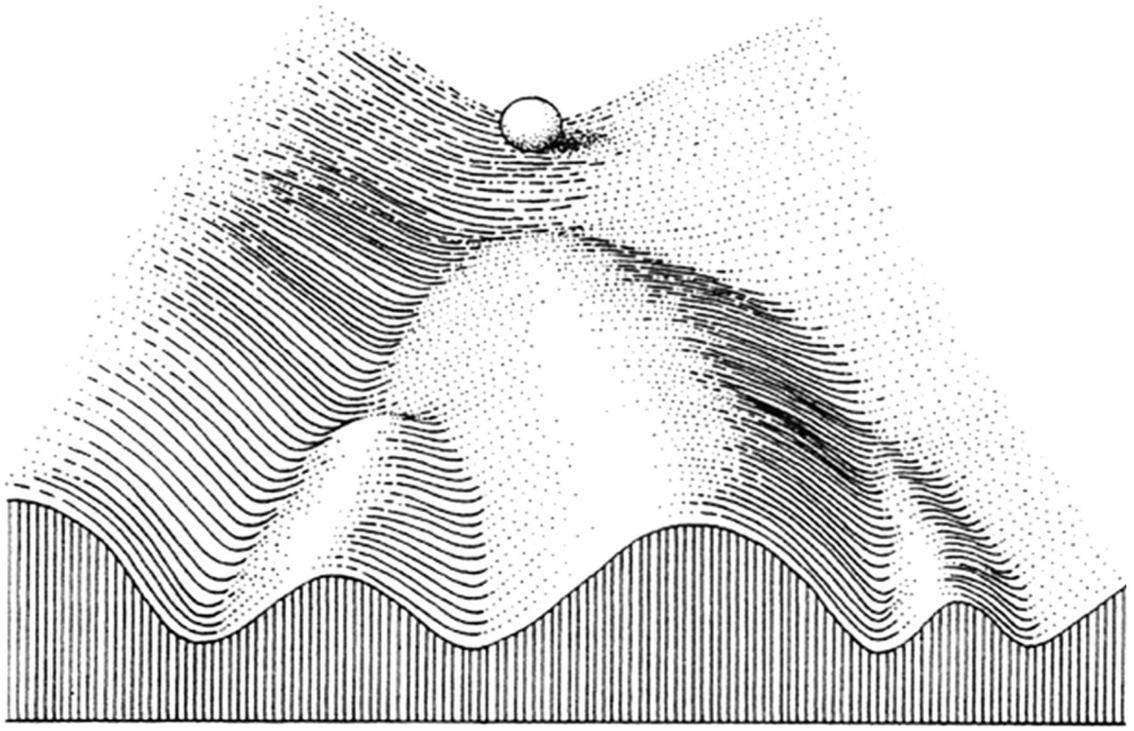
-Amundson: ξεκίνησαν ως προσαρμογές, αλλά διατηρούνται για μη-προσαρμοτιστικούς λόγους

-> αναπτυξιακή βιολογία σημαντική
- **developmental constraints**

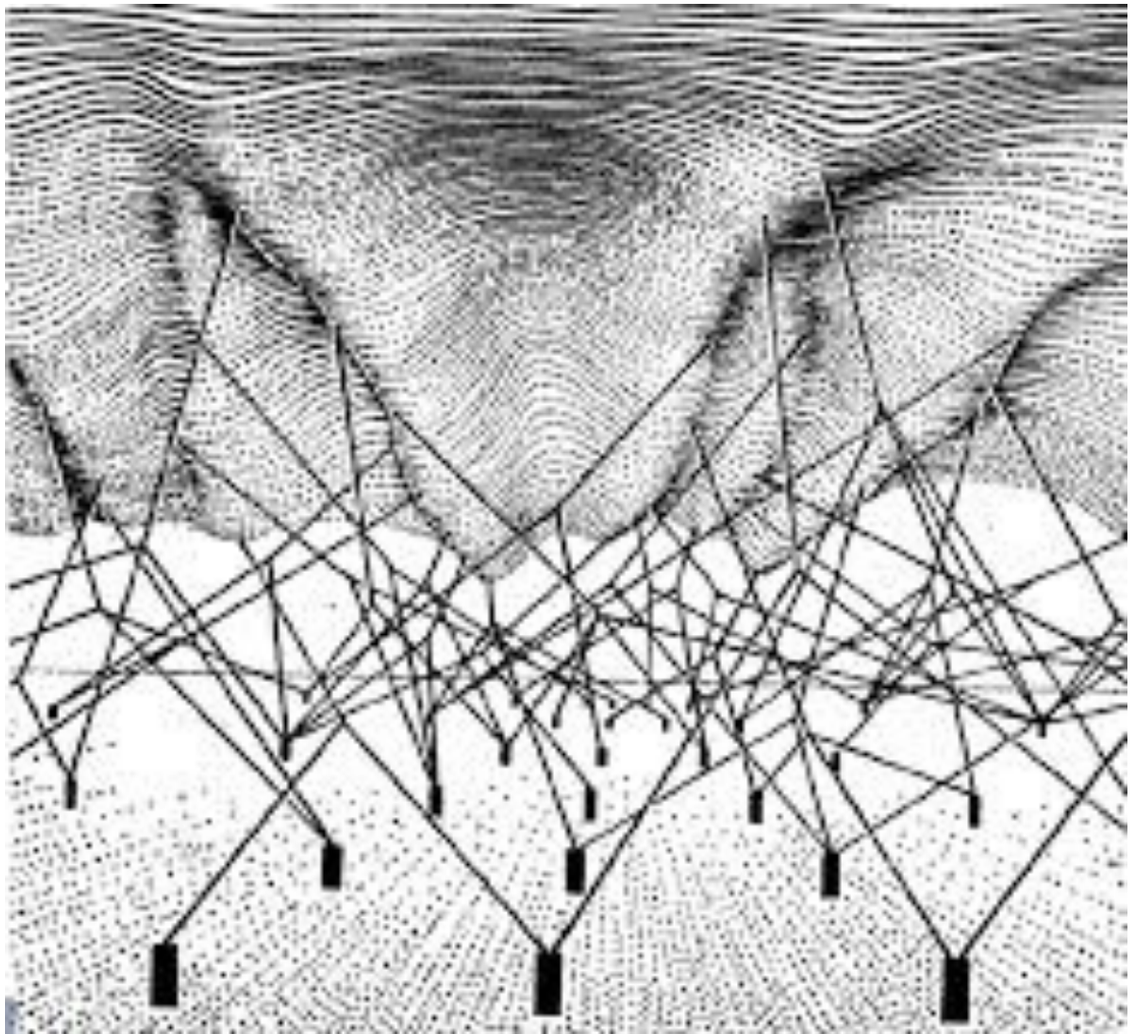
-χαρακτήρες που διατηρούνται όχι λόγω συγκεκριμένου περιβάλλοντος και ΦΕ, αλλά λόγω του τρόπου ανάπτυξης του δομικού σχεδίου

Δομισμός και η έννοια του Bauplan

Waddington
-> developmental canalization

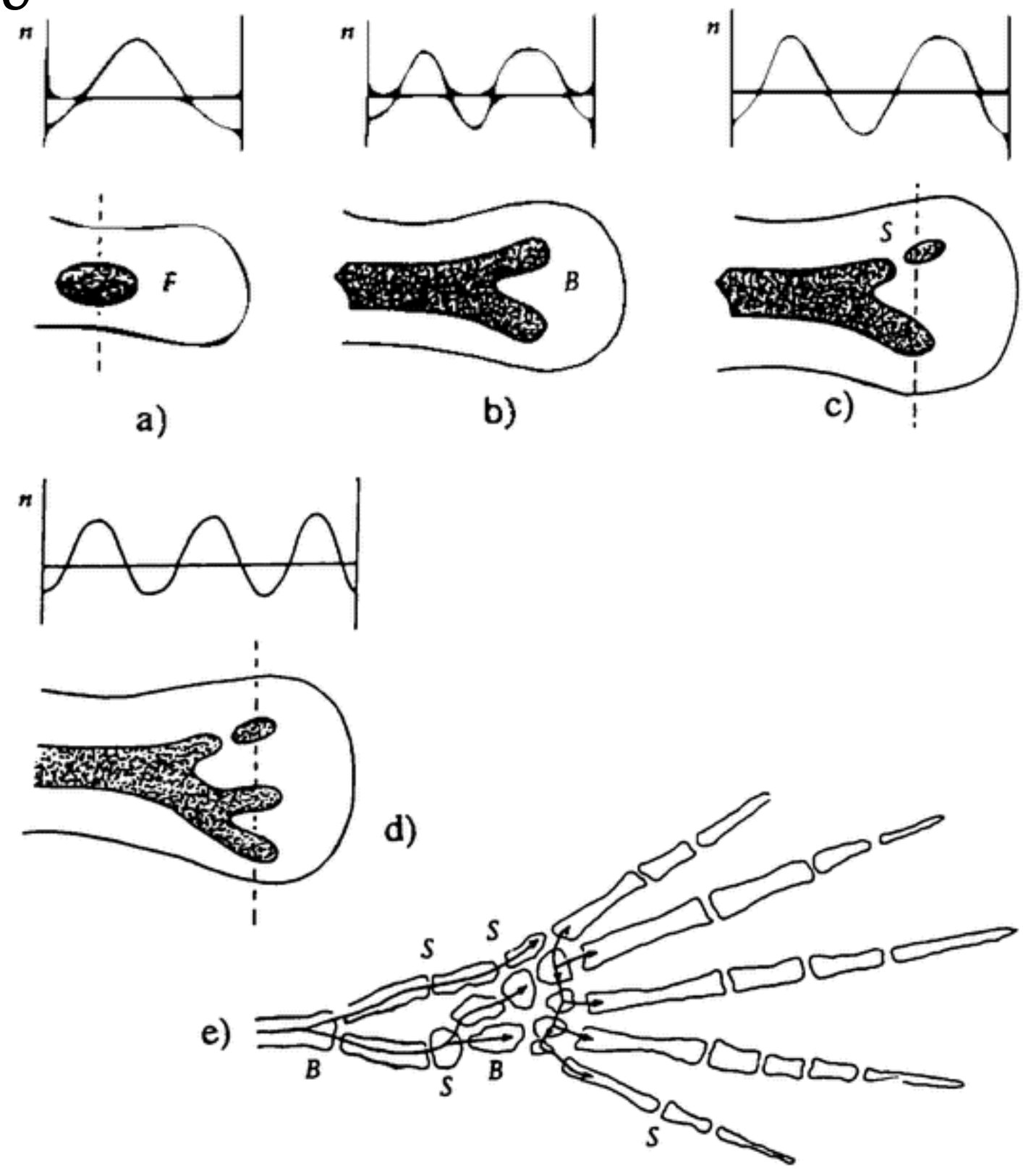


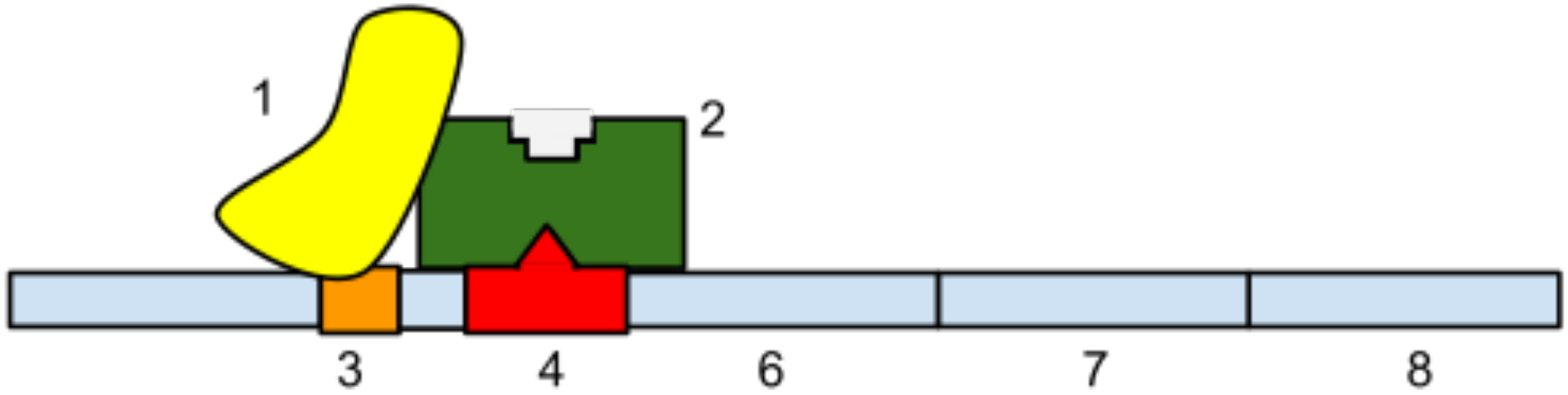
Wimsatt
-> generative entrenchment

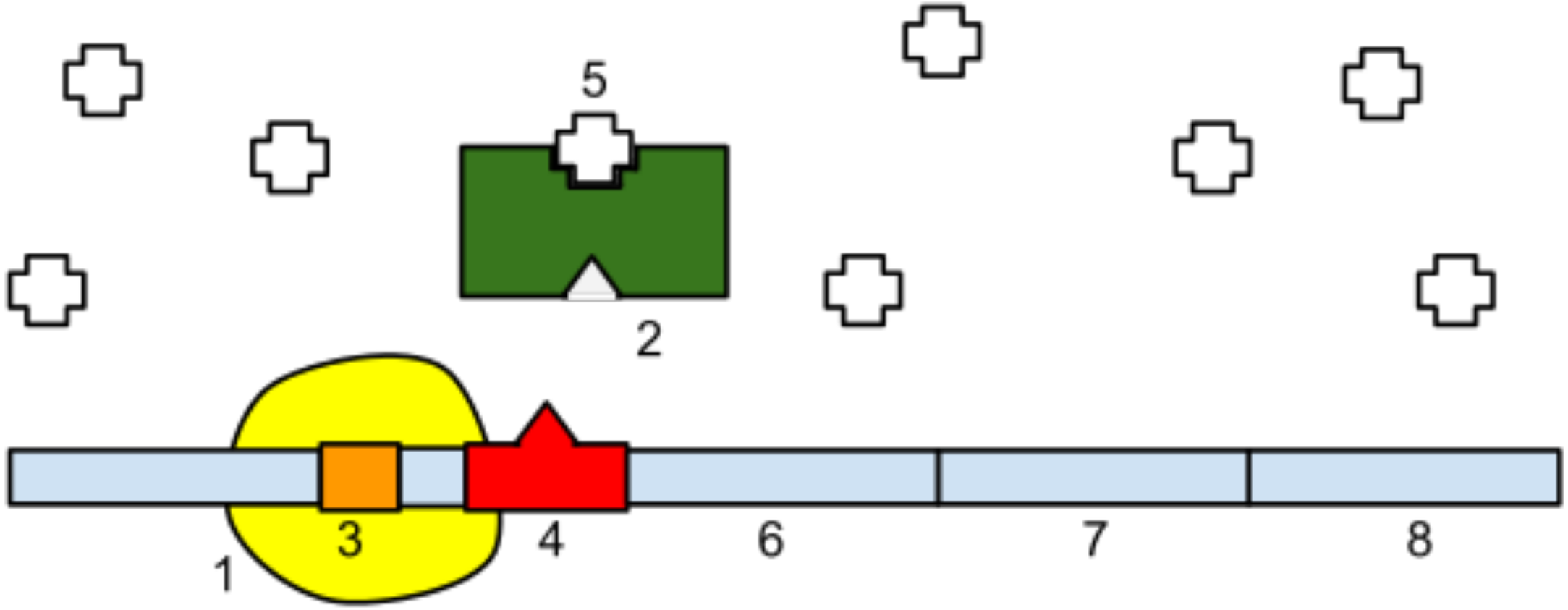


Δομισμός και η έννοια του Bauplan

-process structuralism




1
2
3
4
6
7
8


5
2
1
3
4
6
7
8

Marine

Freshwater

★ 9.0× coverage

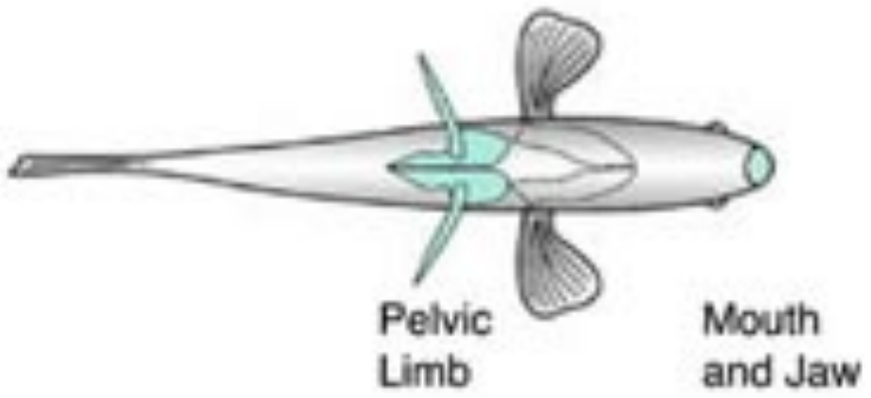
○ 2.3× coverage

Ocean predator

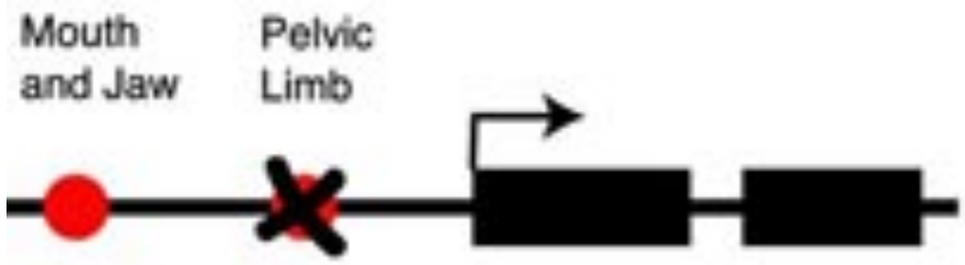
Freshwater predator

Marine Stickleback Pitx1 Gene

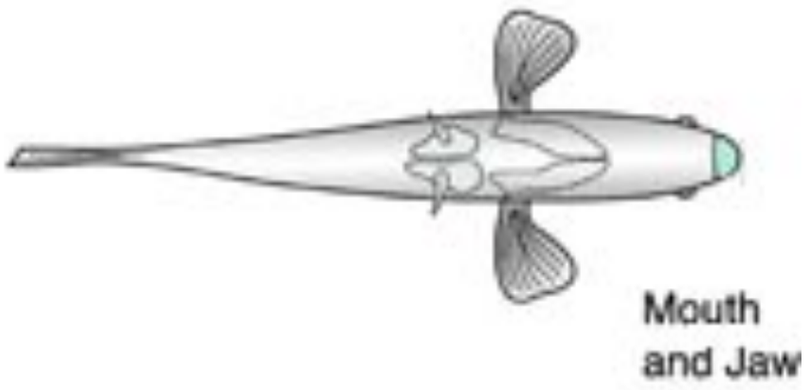
In Marine Sticklebacks Pitx1 Gene is turned on

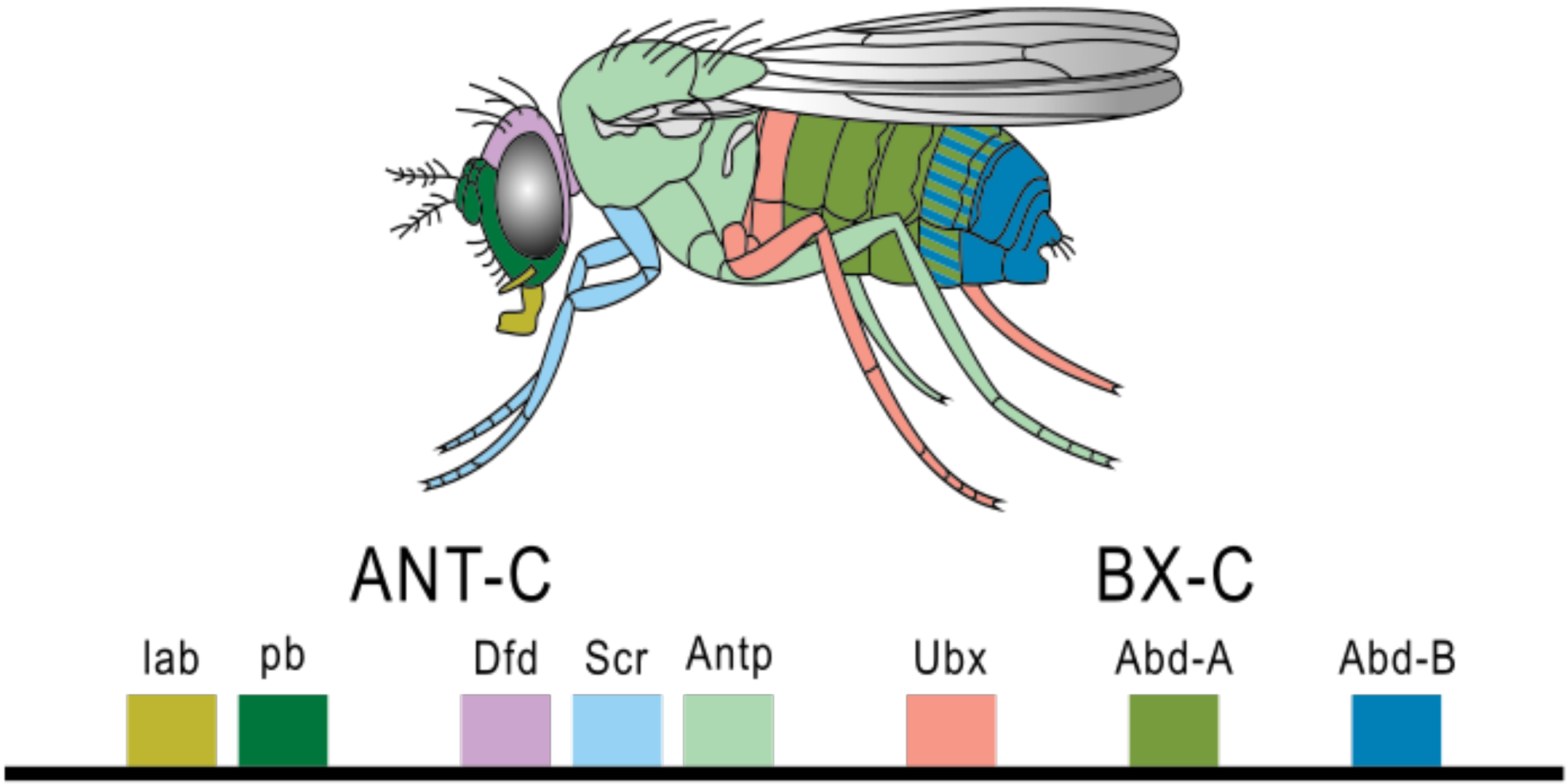


Freshwater Stickleback Pitx1 Gene



In Freshwater Sticklebacks Pitx1 Gene is turned on




ANT-C
BX-C
lab
pb
Dfd
Scr
Antp
Ubx
Abd-A
Abd-B

lab pb Hox3 Dfd Scr ftz Antp Ubx abd-A Abd-B

Euperipatoides

Archegozetes

Phalangium

Cupiennius

Centruroides

Glomeris

Lithobius

Strigamia

Porcellio

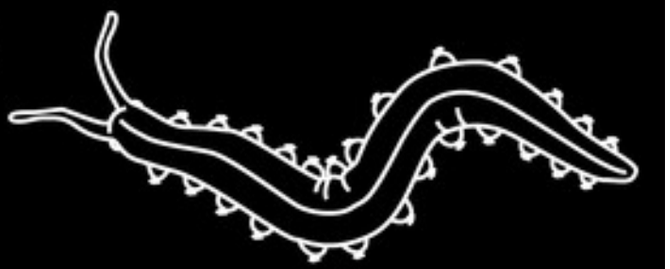
Artemia

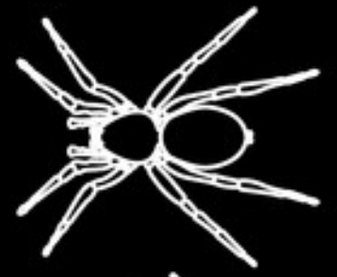
Thermobia

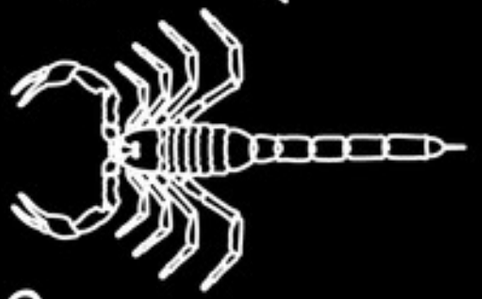
Oncopeltus

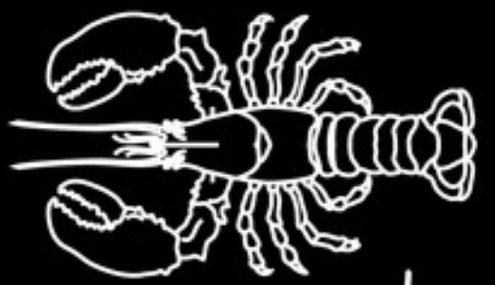
Tribolium

Drosophila









Urchins

Hemichordates

Urochordates

Cephalochordates

Teleost fish

Tetrapods

Flies

Polychaetes

lab
Hox 1

antp

abd-B
Hox 13

aa
ab
ba
ab
ca
??

A
B
C
D

?

?

?

PHYLOGENY

GENES FOUND

KNOWN EXPRESSION

Κατασκευή οικοθέσης

Κατασκευή οικοθέσης (niche construction)

-οργανισμοί ως παθητικοί και ως ενεργοί

-> οι οργανισμικές προσαρμογές ως **λύσεις** των οργανισμών στα **προβλήματα** που θέτει το περιβάλλον

-> ‘organisms construct every aspect of their environment themselves’ (Lewontin 1983, 104)

-> οι οργανισμοί ως **ενεργοί παράγοντες** κατά την ίδια τους την εξέλιξη

Κατασκευή οικοθέσης (niche construction)

$$O_{t+1} = f(O_t, E_t)$$

παραδοσιακή άποψη

$$E_{t+1} = g(E_t)$$

vs

κατασκευή οικοθέσης

$$O_{t+1} = f(O_t, E_t)$$

$$E_{t+1} = g(O_t, E_t)$$

Κατασκευή οικοθέσης (niche construction)

Τρεις τύποι φαινομένων:

-> οι οργανισμοί διαλέγουν τον οικότοπό τους

-> σημασία περιβαλλοντικών παραγόντων ανάλογα με τον τύπο του οργανισμού

-> μετασχηματισμός του περιβάλλοντος (πχ οξυγόνο στην ατμόσφαιρα)

Κατασκευή οικοθέσης (niche construction)

-> η κατασκευή οικοθέσης ως σημαντικός αλλά υποτιμημένος παράγοντας στην εξελικτική βιολογία

-ΚΟ (κατασκευή οικοθέσης) και εξελικτική εξήγηση:

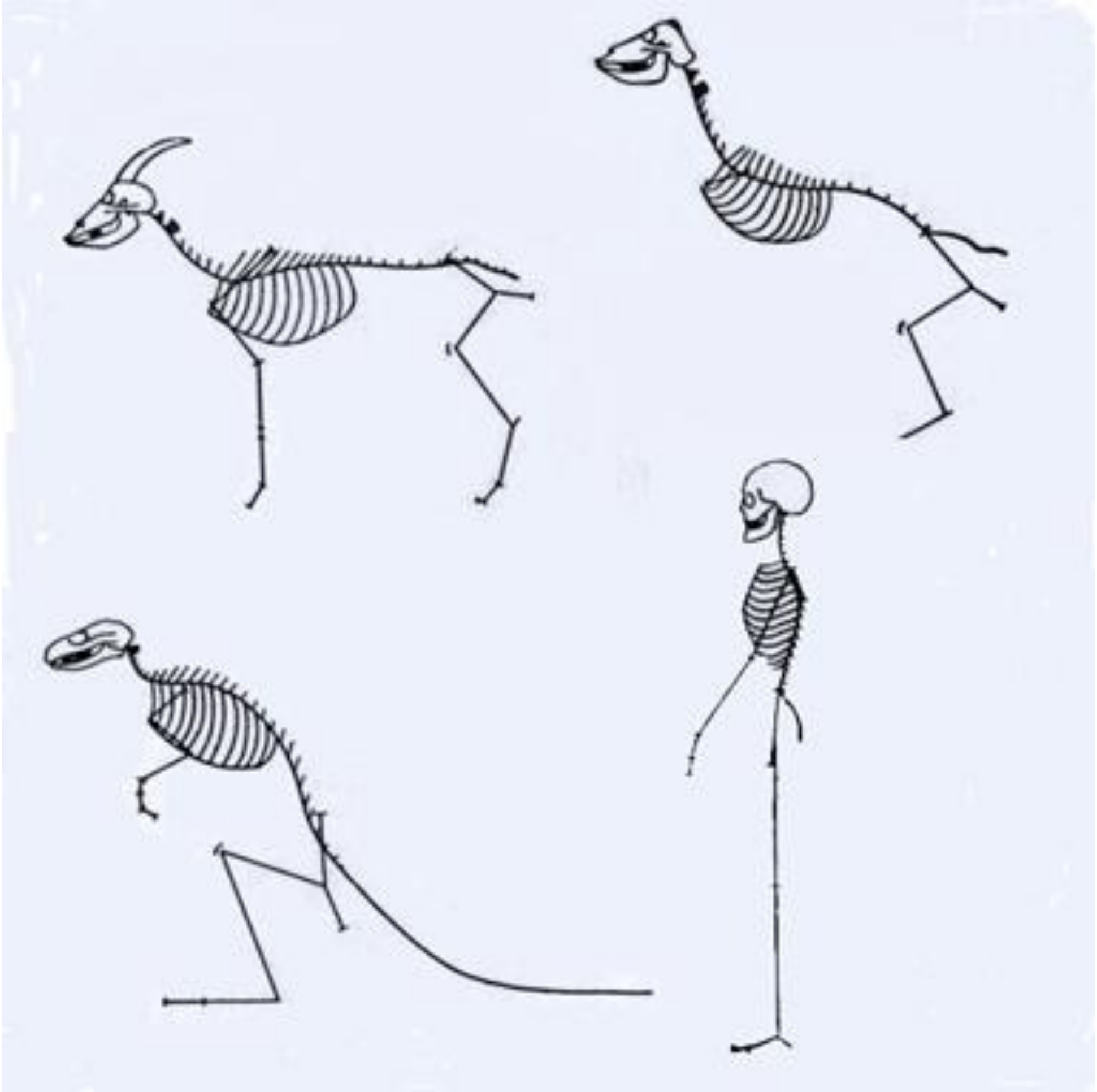
-> η επιρροή των οργανισμών στο περιβάλλον ως κληρονομικό σύστημα (inheritance system)

-> GS: 'the actions of organisms on their environment at one time affect what mutation can give rise to later' (GS, 58).

-> West-Eberhard & εξελικτική καινοτομία (innovation)

'For these reasons I consider genes followers, not leaders, in adaptive evolution' (West-Eberhard 2005, 6547).

-> ξεχωριστό επιχείρημα από ΚΟ -> βασικά σημεία: **προτεραιότητα** στην εξελικτική αιτιότητα - **ενεργοί** vs **παθητικοί** παράγοντες στις βιολογικές διαδικασίες



Slijper’s goat

From West-Eberhard, *Developmental plasticity and evolution*

Phenotypic plasticity enables organisms to develop functional phenotypes **despite** variation and environmental change via **phenotypic accommodation** -- adaptive mutual adjustment among variable parts during development **without genetic change**. (51)

Responsive phenotype structure is the **primary source** of **novel** phenotypes. (503)

Για περαιτέρω μελέτη:

-Godfrey-Smith, *Φιλοσοφία της Βιολογίας*, κεφ. 4

-Sterelny & Griffiths, *Sex & Death*, κεφ. 10

- cambrian explosion
- vendian
- evolutionary developmental biology , evo-devo
- Hox genes / master genes
- Arthur / Sean Carroll