Figure S1. AFLP Tree

Species ID

◄ T. 'black dorsal'
◄ T. 'broadmouth'
◄ T. 'chinyamwezi'
◄ T. 'chinyankwazi'
◄ T. 'gold chest'
◄ T. 'gold'
◄ T. 'gracilior'
◄ T. 'intermediate'
◄ T. 'lilac'
◄ T. 'microstoma'
◄ T. 'orange chest'
◄ T. 'red cheek'
◄ T. 'white dorsal'
◁ T. 'zimbawe'
◄ *T. tropheops*

Localitiy ID

Chiofu Bay
Mumbo Island
Otter Island/Point
Chinyamwezi
Chinyankwazi
Eccles Reef
Domwe Island
Mazinzi Reef
Makanjila Point
Thumbi West
Nantumbwi
West Reef
Zimbawe Rock

Habitat regime

— Shallow habitat dweller
— Deep habitat dweller

● Topology constraint
1. Root
2. Lake malawi, monophyletic ingroup
3. Non-mbuna - Mbuna
4. Mbuna

Node support, posterior probability:

● > 0.95
● < 0.95, > 0.85
○ < 0.75

0.2
substitutions / site

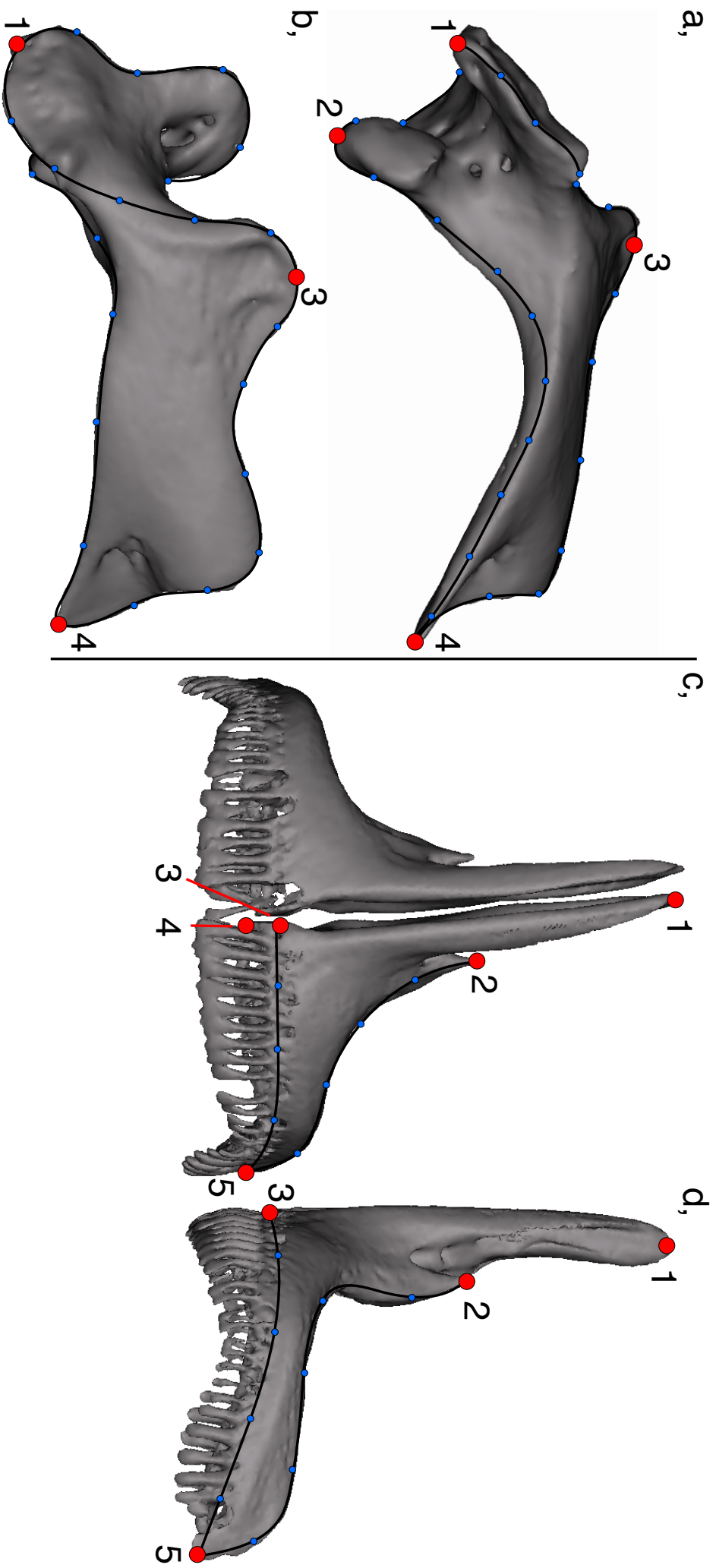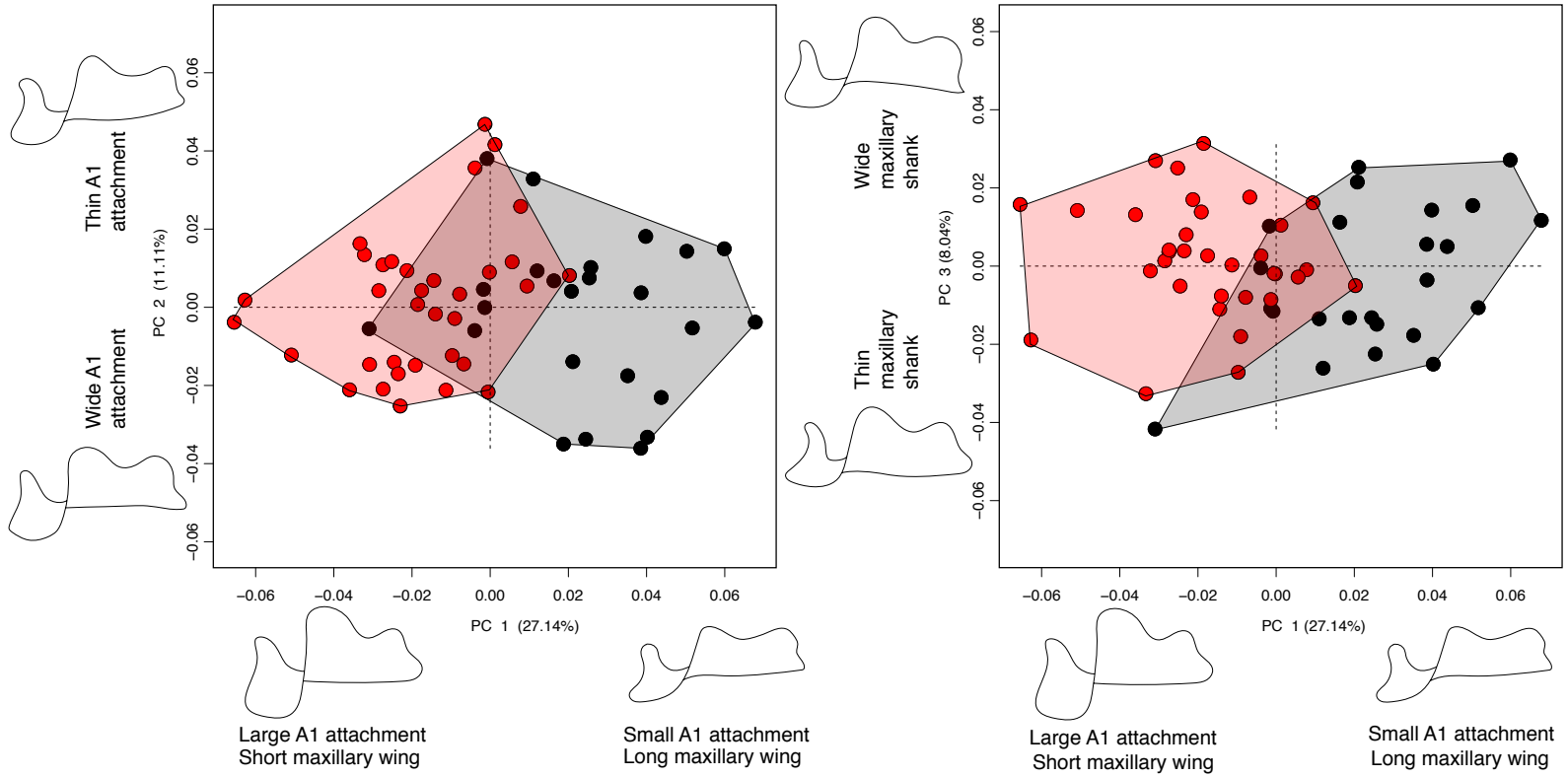**Figure S2. Maxilla and Pre-maxilla Landmarking Schemes**

Figure S3. Natural Population Morphospaces

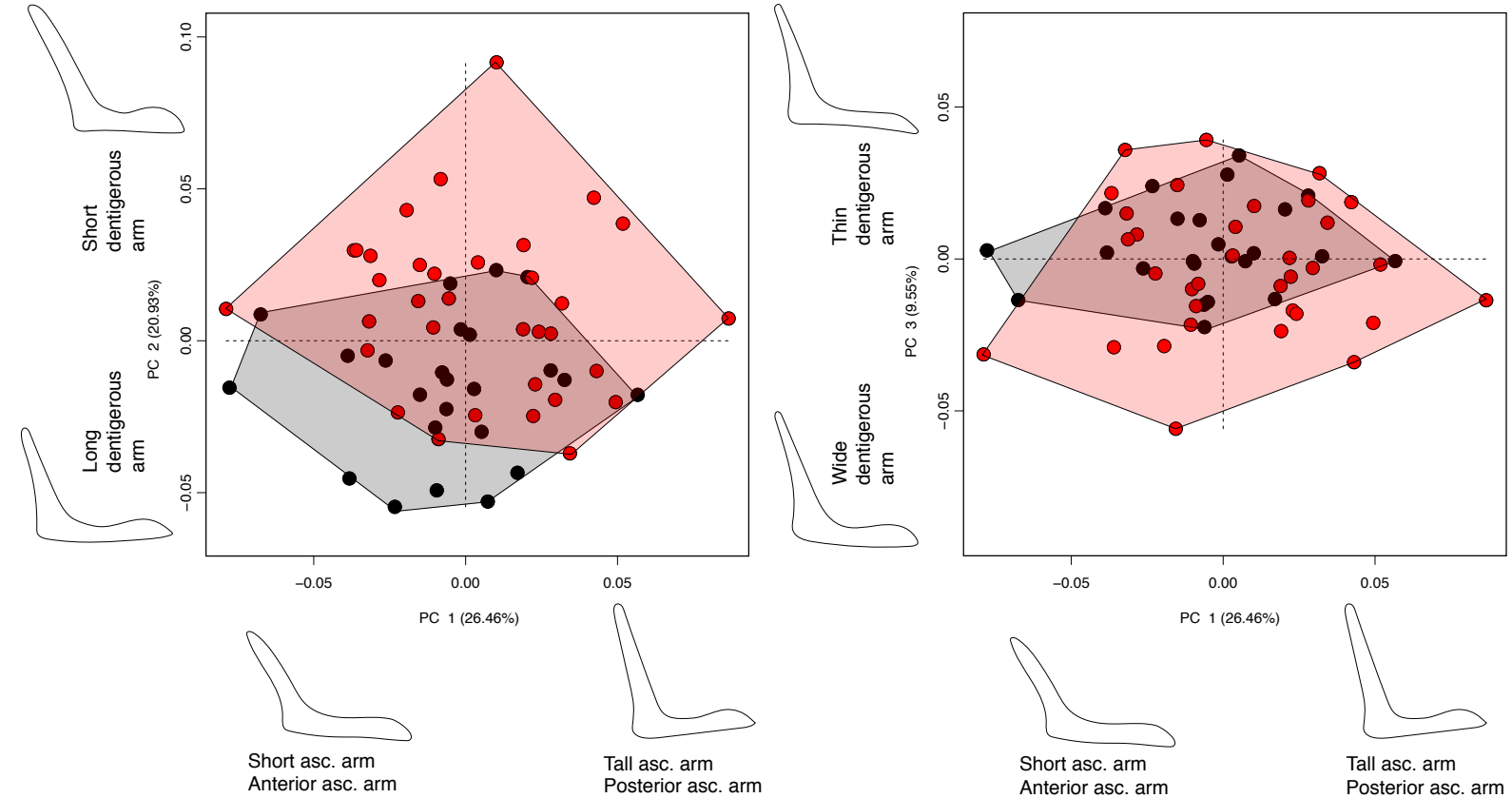a, Maxilla - Individuals

b, Pre-maxilla - Individuals

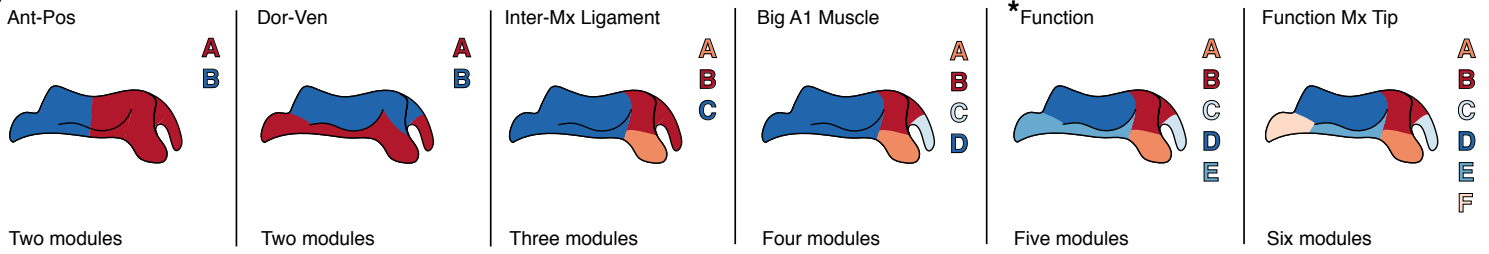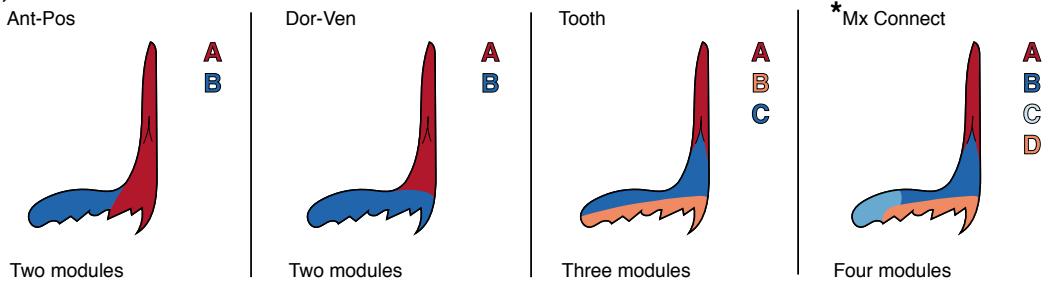# Figure S4. Schematics of Competing Modularity Models

a, Maxilla

Ant-Pos

A
B

Two modules

Dor-Ven

A
B

Two modules

Inter-Mx Ligament

A
B
C

Three modules

Big A1 Muscle

A
B
C
D

Four modules

*Function

A
B
C
D
E

Five modules

Function Mx Tip

A
B
C
D
E
F

Six modules

b, Pre-Maxilla

Ant-Pos

A
B

Two modules

Dor-Ven

A
B

Two modules

Tooth

A
B
C

Three modules
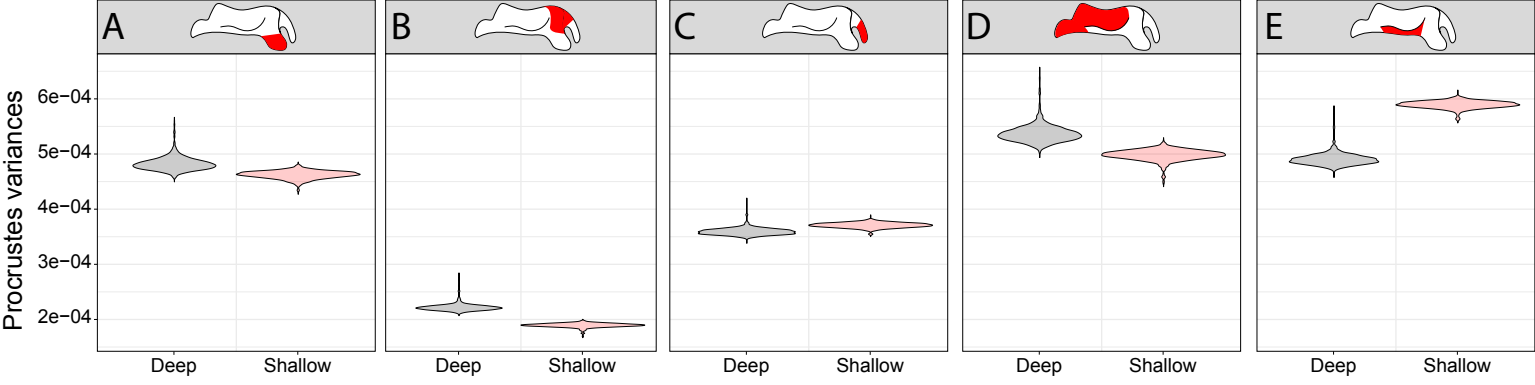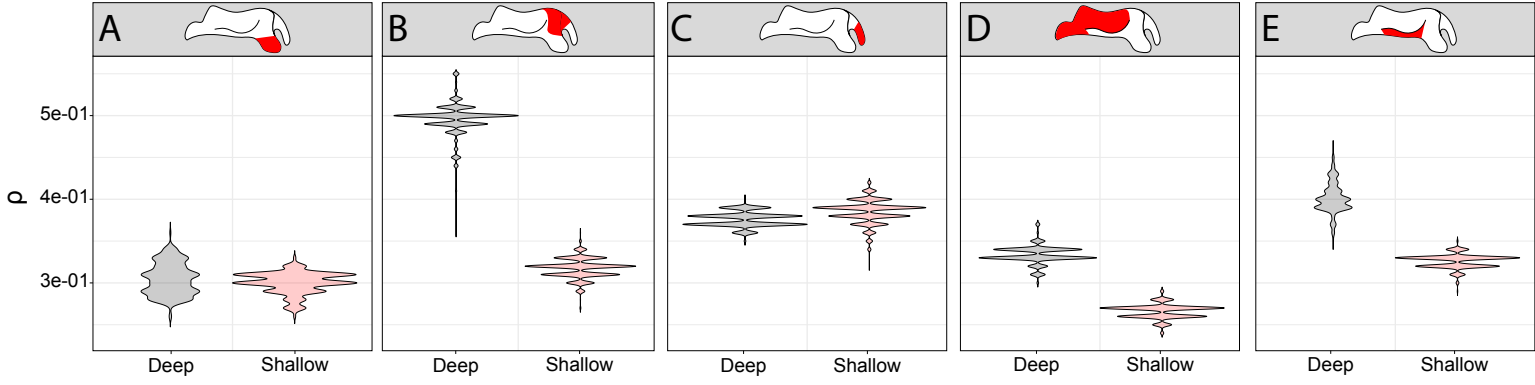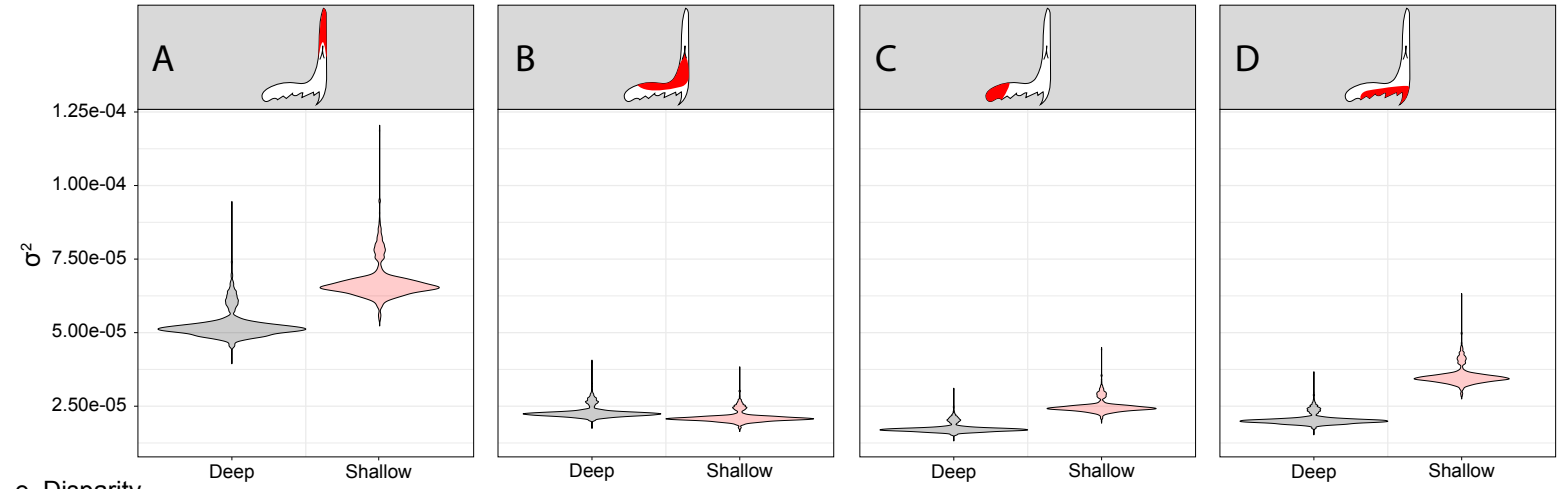
*Mx Connect

A
B
C
D

Four modules

Figure S5. Maxilla

a, Rates of morphological evolution
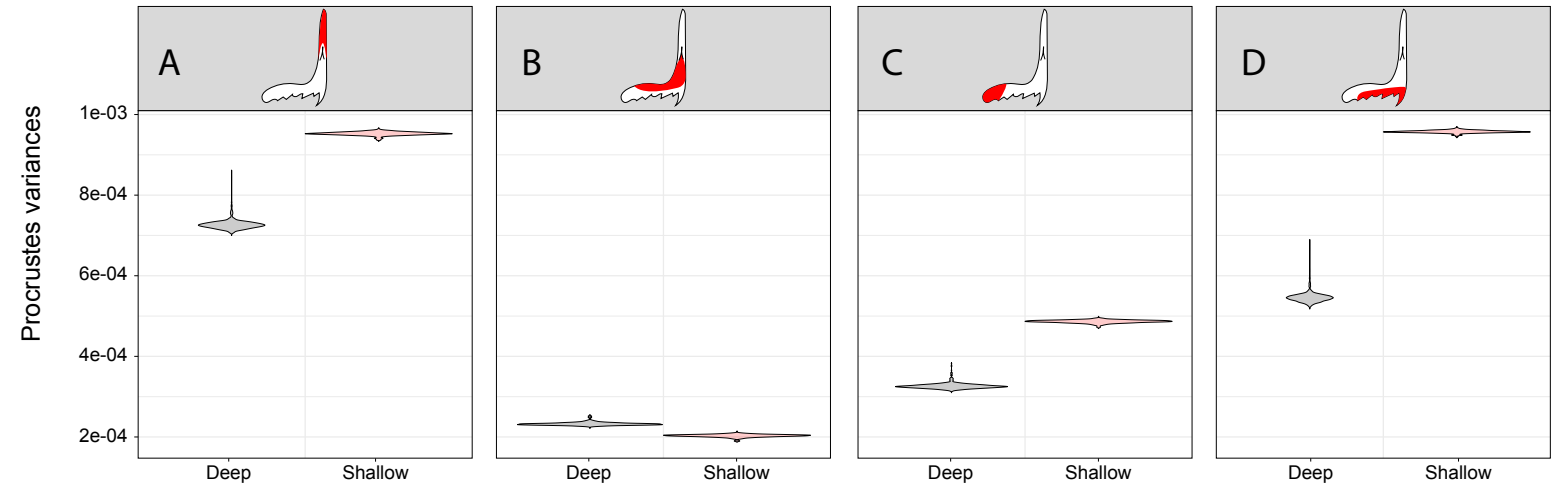

b, Disparity

c, Integration

Figure S5. Pre-maxilla

d, Rates of morphological evolution

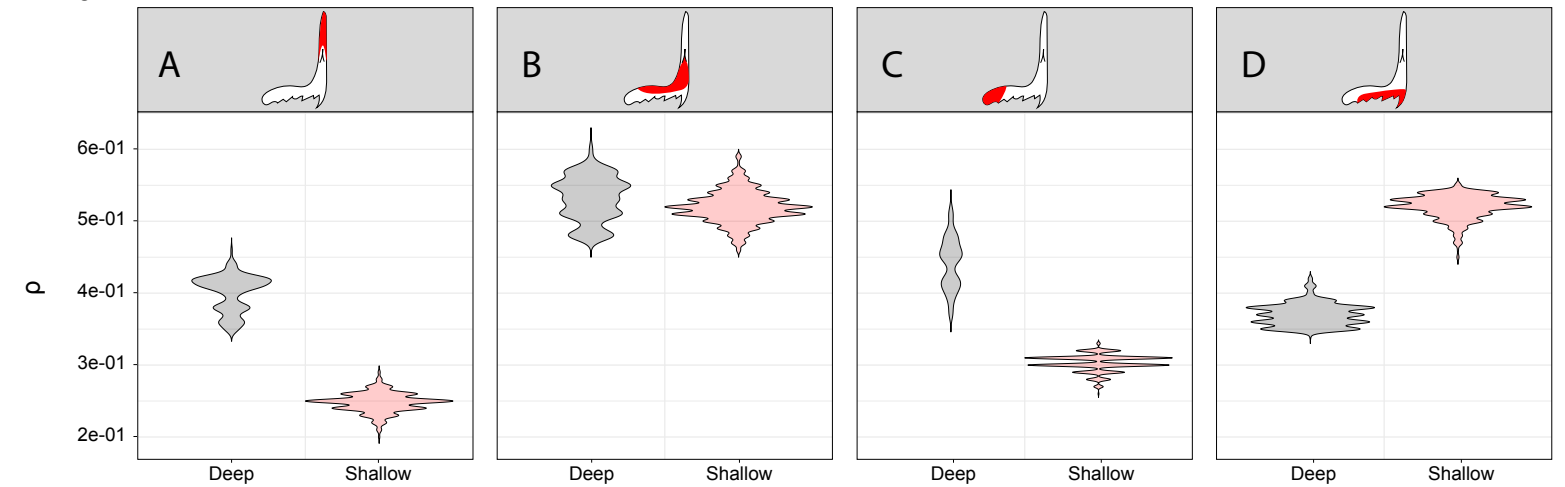
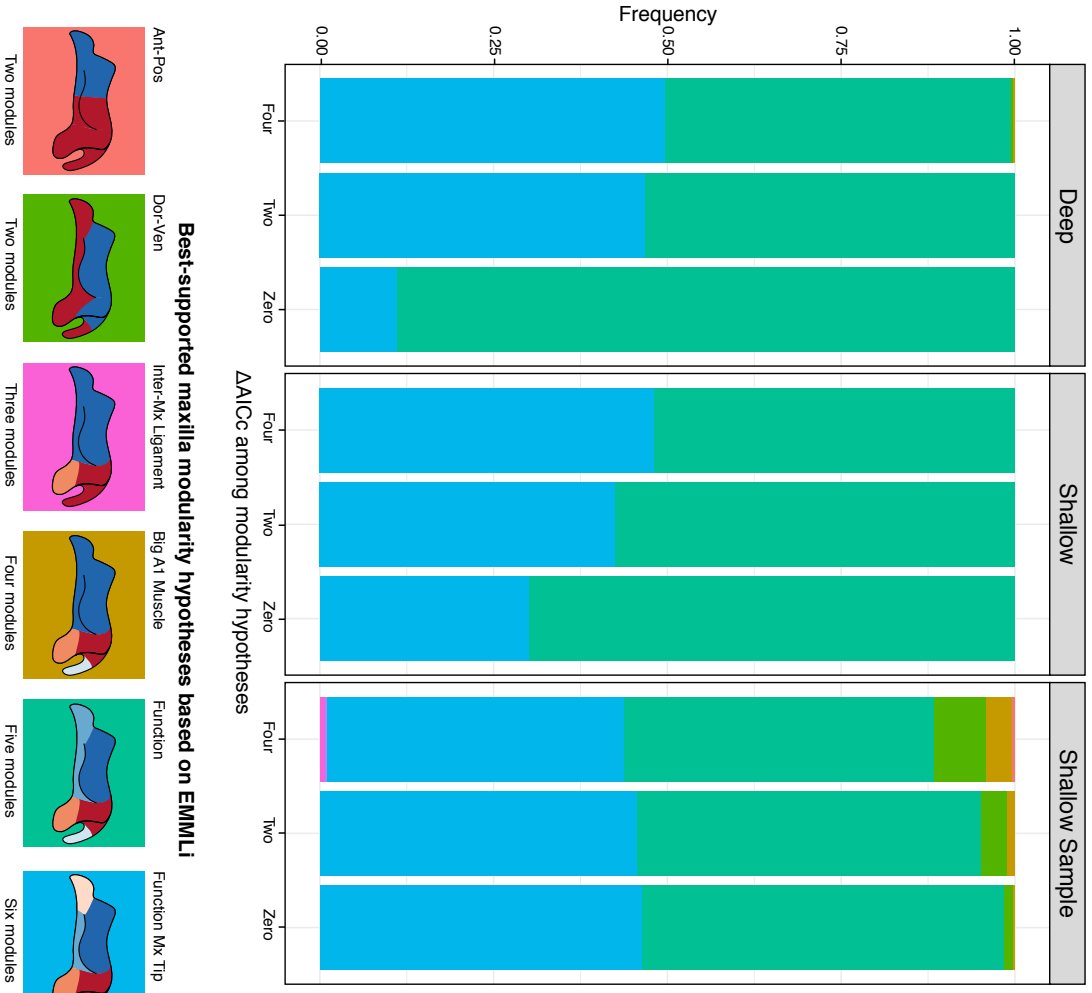## e, Disparity

f, Integration

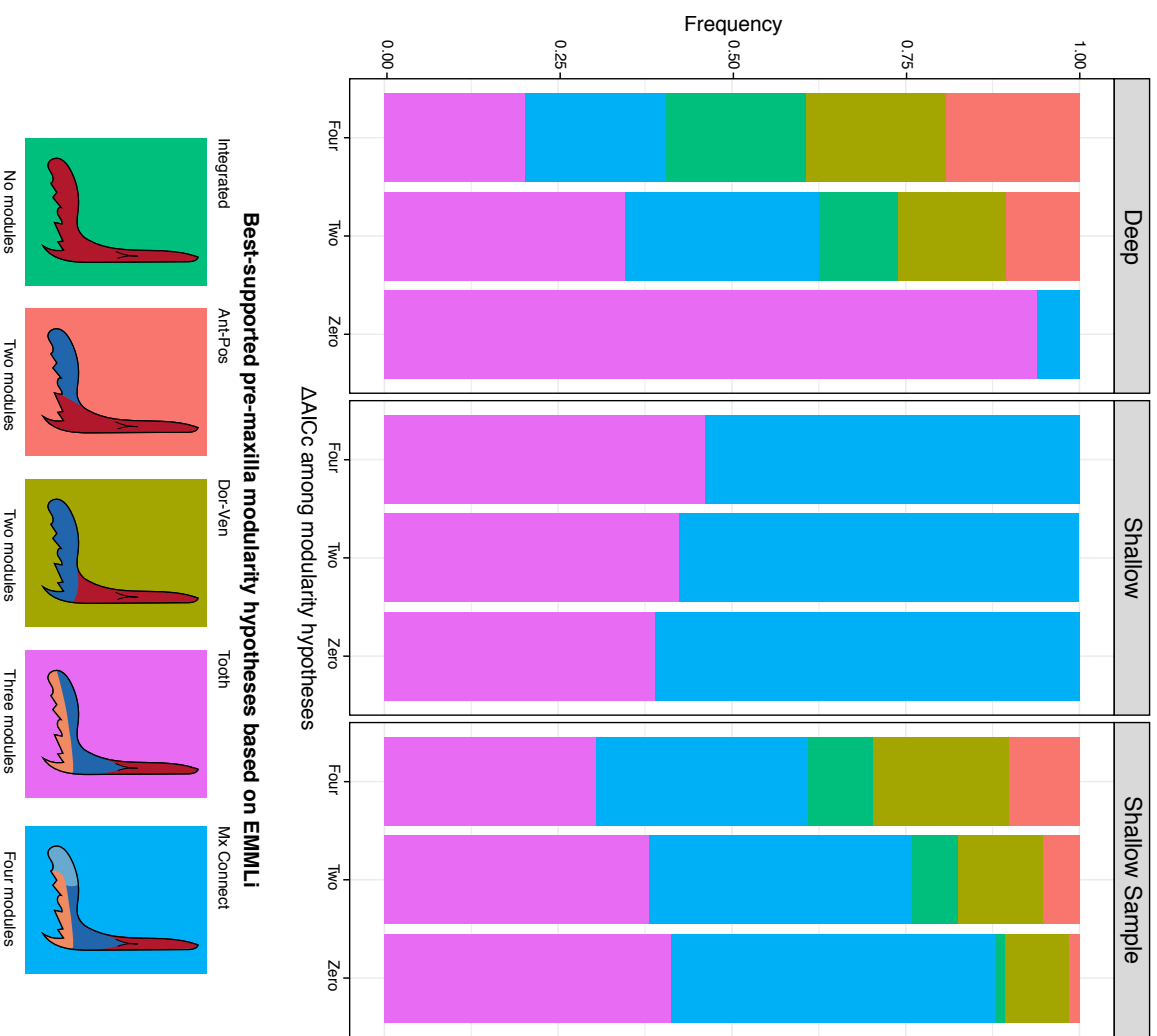**Figure S6. Selection Frequency of Competing Modularity Models**

a, Maxilla

b, Pre-maxilla

Figure S7. Experimental Morphospaces

a, Maxilla - Experimental

Wide intermax. attach.

Thin intermax. attach.

PC 2 (13.69%)

PC 1 (18.98%)

Thin A1 attachment

Wide A1 attachment

Long intermax. attach.

Short intermax. attach.

PC 3 (8.88%)

PC 1 (18.98%)

Thin A1 attachment

Wide A1 attachment

b, Pre-maxilla - Experimental

Long dentigerous arm

Short dentigerous arm

PC 2 (16.55%)

PC 1 (32.45%)

Short asc. arm

Tall asc. arm

Wide dentigerous arm

Thin dentigerous arm

PC 3 (11.01%)

PC 1 (32.45%)

Short asc. arm

Tall asc. arm