

MODULAR EVOLUTION OF THE CARNIVORAN PELVIC GIRDLE: A THREE-DIMENSIONAL MORPHOMETRIC APPROACH



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Introduction

- The pelvic girdle of mammalian carnivores connects the hind limb to the axial skeleton and anchors many important appendicular muscles.
- In contrast with other limb bones, the pelvic girdle is very conservative within carnivoran families (1) and it is weakly integrated with other limb bones (2).
- In this study we used a large sample of carnivorans (Fig. 1) to (i) explore the presence of modules within the pelvic girdle, and (ii) try to link them to either development or function.

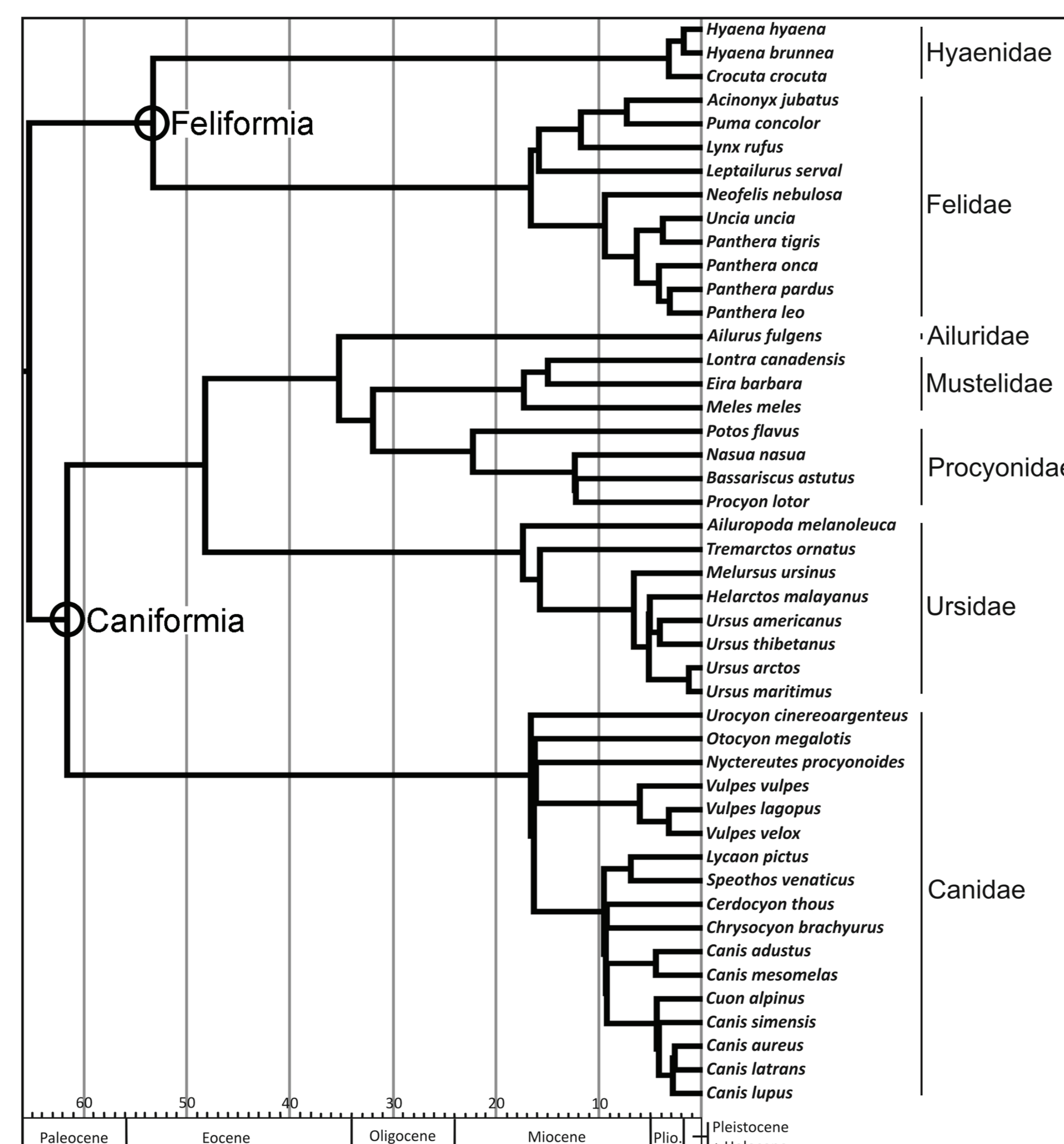


Fig. 1 Phylogenetic tree of the living carnivoran species included in the study

Results and discussion

- The 4-modules tests showed that the developmental units are real modules (Fig. 3, top).
- The tests for 3 and 2 modules showed that there is not a clear hierarchical association among them (Fig. 3, center and bottom).
- The ilium is the less integrated module for species averages (Fig. 3, left).
- The acetabulum is the less integrated module for independent contrasts (Fig. 3, right).

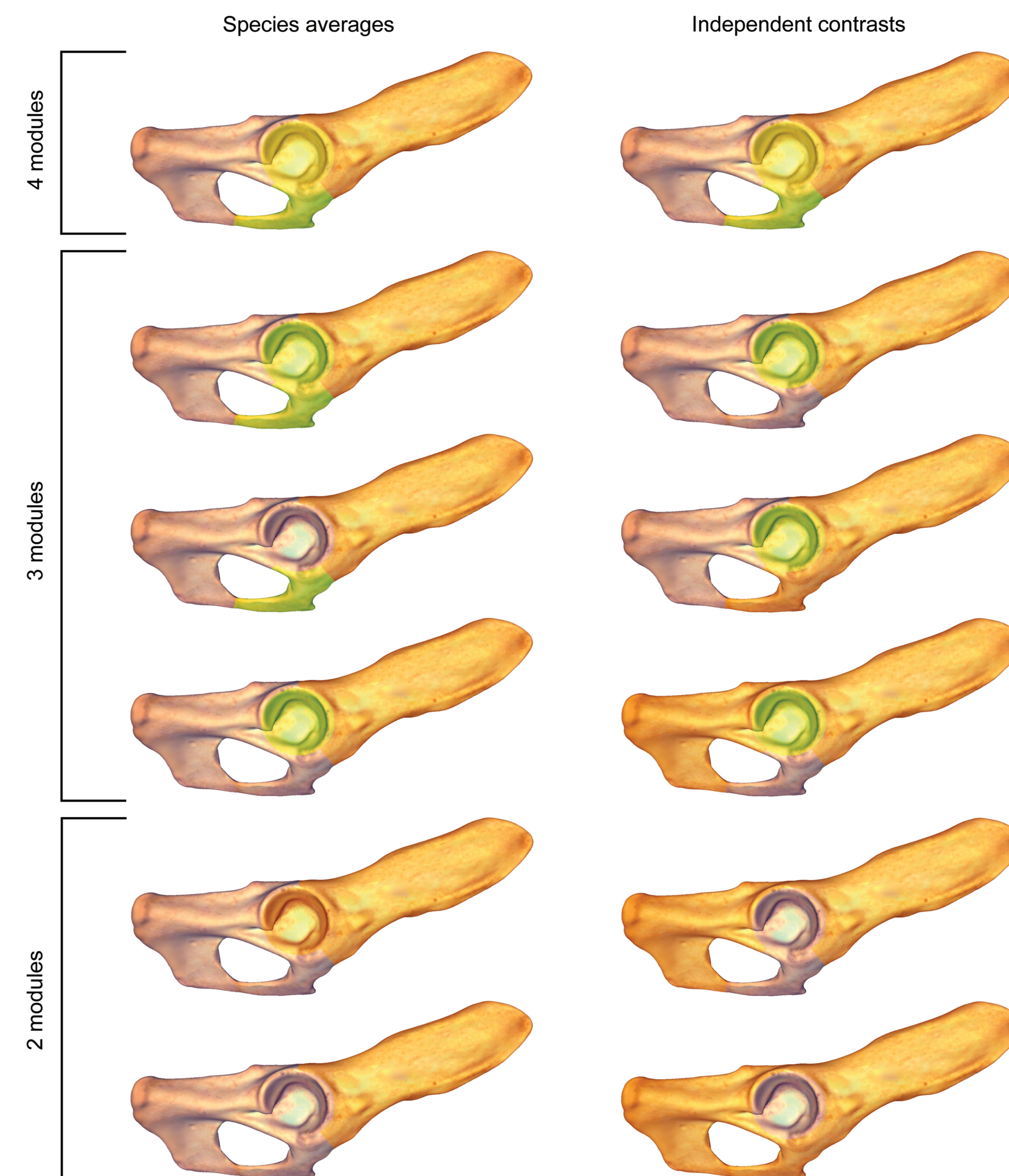


Fig. 3. Modular hypotheses with a level of significance below 0.01. Left, size-free species averages. Right, size free independent contrasts.

Material and methods

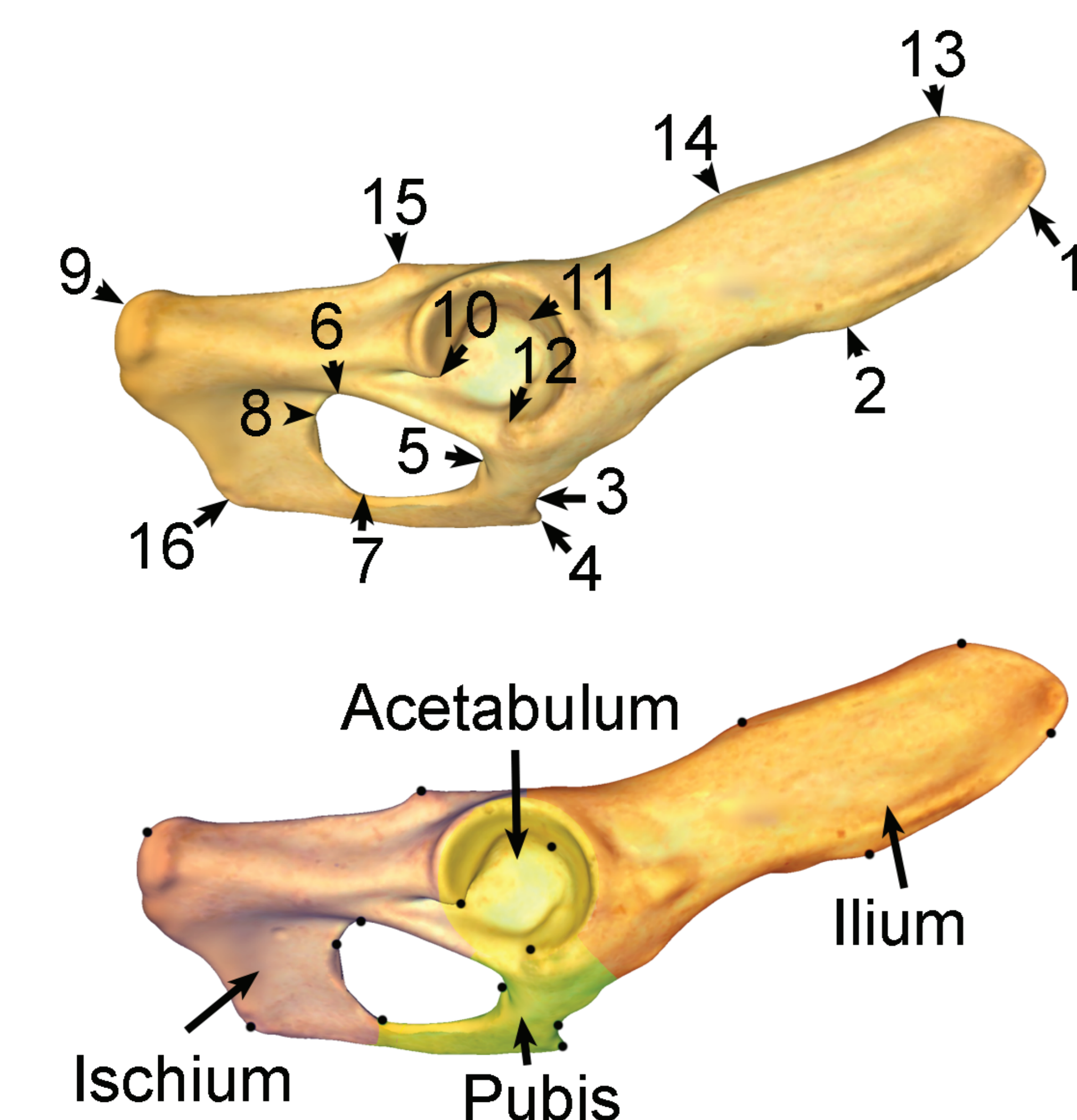


Fig. 2. Pelvis morphometrics. Top, 3D landmarks located in the hemipelvis. Bottom, the four developmental units that compose the pelvis.

- The shape of the pelvis girdle was captured using 3D landmarks on one hemipelvis (Fig. 2, top).
- The hemipelvis was divided into four developmental units (Fig. 2, bottom).
- The modular hypotheses were obtained by the combination of these four units.
- For each hypothesis, the RV coefficient was computed and tested against a null distribution of random RV coefficients (3).
- Allometric effects and phylogeny were also taken into account (2).

Conclusions

- The morphological evolution of the carnivoran pelvic girdle is highly influenced by developmental processes, as the four developmental units are also modules.
- No functional signal related to biomechanics or muscle connections can be hypothesized from these results.
- The fact that the acetabulum is the most independent module when accounting for phylogenetic signal may be due to its close association with the femoral head (4).

References

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Author contributions

AMS, BF, FS and PP designed research; AMS, BF and FS performed research; AMS and BF analyzed data; and AMS, BF, FS and PP prepared the poster.