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Why Natural Selection Differs from Sexual Selection: Exceptions from Reptiles

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Abstract: ***The distinction between natural selection and sexual selection represents a fundamental concept in evolutionary biology, yet their interaction remains complex and context-dependent. Natural selection primarily promotes traits that enhance survival and ecological fitness, whereas sexual selection favours traits that increase reproductive success, often at the cost of survival. This study examines the conceptual differences between these two mechanisms and explores their interaction in reptiles, a group in which sexual selection is generally considered limited. By integrating principles of evolutionary ecology with morphological observations, particularly in crocodilians, this paper highlights how natural and sexual selection may operate simultaneously. The case of Gavialis gangeticus demonstrates a unique overlap where feeding adaptations driven by natural selection are modified by sexually selected traits for mate attraction. These findings suggest that, although sexual selection is less pronounced in reptiles, specific ecological and evolutionary conditions can facilitate its emergence and significance.***

Keywords: Natural selection, sexual selection, reptiles, evolutionary ecology, crocodilians, morphological adaptation

1. Introduction

Theodosius Dobzhansky's assertion that nothing in biology makes sense except in the light of evolution underscores the importance of evolutionary theory in explaining biological diversity. Evolution refers to the gradual change in heritable traits within populations over time, often resulting in speciation under varying ecological and genetic influences. Among the mechanisms driving evolutionary change, natural selection and sexual selection are particularly significant. Although sexual selection is often regarded as a subset of natural selection, the two differ in their operational dynamics and evolutionary consequences. Natural selection is primarily concerned with survival and adaptation to environmental conditions, whereas sexual selection is driven by differential reproductive success through mate choice and competition. This distinction becomes especially intriguing in reptiles, where sexual selection is often assumed to be weak due to ecological and physiological constraints. The present study aims to clarify these differences and examine notable exceptions within reptilians.

2. Materials and Methods

This study is based on a qualitative synthesis of evolutionary theory and comparative morphological observations in reptiles, with particular emphasis on crocodilian taxa. Relevant literature on natural selection, sexual selection, and evolutionary ecology was reviewed to establish a conceptual framework. Morphological traits such as rostral elongation and secondary sexual characteristics were analysed in relation to ecological function and reproductive behaviour. Special attention was given to extant crocodilian species, including *Crocodylus palustris* and *Gavialis gangeticus*, to evaluate the interaction between feeding adaptations and sexually selected traits. The approach integrates theoretical interpretation with comparative analysis to assess evolutionary patterns.

3. Results

Natural selection in reptiles is predominantly associated with ecological adaptation, particularly in traits linked to foraging strategies, habitat utilization, and survival efficiency. In the crocodilians, rostral morphology exhibits clear variation corresponding to dietary specialization, with longirostral forms adapted for ichthyophagy and broader snouts associated with generalist feeding or durophagy. In contrast, evidence of sexual selection is comparatively limited but becomes apparent in specific cases. In *Gavialis gangeticus*, adult males develop a distinctive supra-narial cartilaginous protuberance at the tip of the snout, commonly referred to as the "ghara." This structure functions as both a visual display and an acoustic resonator during mating, indicating a role in sexual selection. The coexistence of ecological specialization and reproductive signalling in this species illustrates the simultaneous influence of natural and sexual selection.

4. Discussion

The findings highlight a fundamental distinction between natural selection and sexual selection while also demonstrating their potential interaction. Natural selection favours traits that enhance survival under environmental pressures, leading to adaptive morphological and physiological changes. In contrast, sexual selection promotes traits that increase reproductive success, even if they impose survival costs (Evolutionary trade-offs). In reptiles, the relative scarcity of pronounced sexual dimorphism and elaborate display traits suggests that sexual selection is generally constrained, possibly due to predation risks, energetic limitations (varies in different species from Ectothermic Heterothermy, Mesothermy and Inertial Homeothermy & Gigantothermy), and lower metabolic rates. However, the case of provides a compelling exception in which a sexually selected trait is superimposed upon an ecologically adaptive external structure. This indicates that

sexual selection can operate effectively when it does not significantly compromise with adaptive fitness for population survival. Furthermore, the interaction between specialist and generalist species, such as gharials *Gavialis gangeticus* and mugger crocodiles *Crocodylus palustris*, reflects ecological species competition in sympatry and potential ecological species turnover rather than strict coevolution. These dynamics emphasize the importance of ecological context in shaping evolutionary outcomes.

5. Conclusion

Natural selection and sexual selection represent distinct yet interconnected mechanisms of evolution. While natural selection primarily drives ecological adaptation and survival, sexual selection influences reproductive success through mate choice and competition. In reptiles, sexual selection is generally less prominent; however, notable exceptions demonstrate that it can play a meaningful role under specific conditions. The example of *Gavialis gangeticus* illustrates how sexually selected traits can evolve alongside ecologically adaptive features, highlighting the complexity of evolutionary processes. Understanding these interactions provides deeper insight into the diversity and adaptability of extant reptilian lineages.

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Male *Gavialis gangeticus* with distinctive supra-narial cartilaginous protuberance at the tip of the snout.

The Female Gharial basking in the Alipore Zoological Park, Calcutta, West Bengal. India.