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### Short Communication

# Some Examples of the Triver's Hypothesis in Birds

Ignacio GARCÍA PEIRÓ\*

Department of Ecology & Hidrology. Faculty of Biology. Univesity of Murcia. ES-Spain

\*Corresponding Author:

Ignacio GARCÍA PEIRÓ, C/ El Salvador, 17-4D. 03023 Elche (Alicante), ES-Spain.

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Orcid number: <https://orcid.org/0000-0002-0084-9958>

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### Abstract

The seminal works of Robert Trivers can be summarised in three theories: parental investment, reciprocal altruism and sexual selection. These three theories provide a framework for contemporary biology, and their relevance to birds is evident in the context of optimal clutch size, parental nestling investment, and sexual selection in dimorphic species. This concise article aims put examples of the aforementioned arguments in the context of birds, incorporating select examples derived from recent literature. The articles and hypotheses of Robert Trivers have been drivers of great research, which have served to form new branches of biology and above all to resolve gaps on natural selection and sexual selection left by Charles Darwin.

### Introduction

Robert Trivers, with 82 years old, is a historian who holds a PhD in Biology. In the early 1970s, he made a significant contribution to the field of biology with two articles, the first of which [1] focused on the concept of reciprocal altruism and has been cited over 16900 times in Google Scholar (<https://scholar.google.es/> access on 2nd February 2025) and the second one together with Dan Willard [2] with 4808 searches, but which was of greater importance later on. This last article, based on Fisher's initial models [3], explains how natural selection regulates offspring in humans. Subsequent refinements and improvements to the theoretical framework were provided by the contributions of [4, 5], who built upon the work of Robert Trivers. David Lack, a British ornithologist, was a pioneering figure in the field of population ecology, particularly in the context of birds. His research, as outlined in his seminal work on the population ecology of birds [6], introduced key concepts that resonated closely

with Trivers' later theories on parental investment. A seminal aspect of Lack's research was the emphasis on the importance of parental care in birds and its profound impact on reproductive success. The key insights from Lack's research are threefold:

1. *Parental investment*: Lack proposed that the amount of care provided by parents is crucial for the survival of offspring, which is a central tenet of Trivers' parental investment theory.
2. *Optimal clutch size*: Lack's studies on clutch size in birds suggested that parents optimize their reproductive output based on environmental conditions, reflecting the economic models of resource allocation that Trivers later elaborated.
3. *Sexual selection*: Lack's observations on sexual dimorphism in birds provided early evidence for the role of sexual selection, which is a key component of Trivers' theories.

## Results

These three findings will be unravelled in turn. For each of them, the most important studies in birds will be presented:

### *Parental investment*

Perhaps the first paper to be published following the formulations of Trivers' hypothesis was that of [7], based on the subject of nest defence in stonechats (*Saxicola torquata*). The study examined the begging calls made by parents when an intruder approached the nests and found that, on average, male and female calling rates were similar, but varied greatly depending on the distance of the intruder from the nest and at different stages of the nesting cycle. A rapid escalation in calling rates was observed after hatching, which correlated most closely with the cumulative total number of parental visits to feed the nestlings. Birds that suffered nest predation had lower calling rates prior to the event than equivalent successful birds, suggesting that calling reduces predation risk, providing a direct test of parental investment as it measures the level of parental effort in relation to offspring development. Subsequently, a significant number of scientists have contributed to a substantial body of research on Trivers' hypothesis, with notable contributions from Clutton-Brock et al. [8, 9] and others Wingfield [10]. This body of work has been further developed by subsequent researchers, including [11-16]. Trivers' work in the field of game theory has been instrumental in the development of mathematical models. More recently, an interesting paper on a well-studied avian model, the reed wader (*Acrocephalus scirpaceus* [17], points out that inferences made by researchers in bird nests have no effect on nestling survival or nest defence. This may have important implications for parental investment. Magnificent article by [18] remarks the importance of interspecific competition in foraging behaviour in Thruses and Warblers bird families with underlying implications in parental investment.

### *Optimal clutch size*

Optimal clutch size refers to the number of offspring that maximizes the reproductive success of parents while balancing the costs associated with raising them. This concept is central to life-history theory, which examines how organisms allocate resources to growth, reproduction, and survival. Optimal clutch size is a complex interplay of parental investment, individual quality, and environmental

factors. Understanding these dynamics can provide insights into evolutionary strategies and reproductive success across species.

The key factors influencing clutch size are:

1. *Parental investment*: The resources and energy parents allocate to their offspring can significantly affect clutch size. Increased parental care can lead to higher offspring survival rates, but it may also impose survival costs on the parents themselves.
2. *Survival costs*: Research indicates that while larger clutches can enhance offspring survival, they may also reduce parental longevity. For instance, a meta-analysis revealed that experimental increases in brood size often resulted in decreased parental survival, suggesting a trade-off between reproductive effort and survival.
3. *Individual quality*: The quality of individual parents plays a crucial role. Higher-quality individuals tend to produce larger clutches and also exhibit better survival rates. This positive correlation suggests that individual fitness can mask the negative effects of increased reproductive effort. In the field of ornithology, the preponderance of research on this subject has been focused on Great Tits (*Parus major*), primarily due to the ease with which these birds can be studied in controlled environments, particularly in relation to their nesting behaviour in nest boxes [19].

### *Sexual selection*

Trivers' hypotheses were primarily based on mammals, but in birds there are many examples of parental investment conditioned by sexual selection due to sexual dimorphism [20-23].

## Conclusion

The articles and hypotheses of Robert Trivers have been drivers of great research, which have served to form new branches of biology and above all to resolve gaps on natural selection and sexual selection left by Charles Darwin.

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## Conflicts of Interest

No conflict of interest was declared by the authors.

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