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Are Oxpeckers Friends or Foes? Evaluating a Symbiotic Relationship

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Introduction

Oxpeckers are birds that live in African savannas and are known for resting on the backs of large herbivores and consuming the ticks residing on them. Both oxpecker species—red-billed oxpeckers (*Buphagus erythrorhynchus*) and yellow-billed oxpeckers (*Buphagus africanus*)—have a variety of possible hosts but have been observed to prefer Cape buffalo, impalas, greater kudu (Bishop & Bishop, 2014; Tarakini *et al.*, 2018), giraffes (Peron *et al.*, 2019), and white rhinoceroses (Ndlovu & Combrink, 2015).

The relationship between the oxpecker and its host is a symbiotic relationship; that is, they live and interact closely together. The term "symbiosis" is sometimes mistakenly used synonymously with "mutualism," but there are three main types of symbiosis: mutualism, parasitism and commensalism. The interaction between oxpecker and host is often described as mutualism; that is, both host and bird benefit from the relationship because oxpeckers obtain food and the large herbivores have fewer parasites. A relationship is parasitic when one species benefits but the other is harmed, such as ticks consuming blood from vertebrates. Finally, if one species benefits but the other is neither positively nor negatively affected, such as a bird building a nest on the branches of a tree, then it is commensalism. For the oxpecker, this relationship is obligate, meaning that they require this relationship to survive, but it is not obligate for the host species (i.e., it is facultative, beneficial but not required for survival).

Although this relationship is often considered to be a classic example of mutualism, oxpeckers occasionally act as parasites, pecking at open wounds on the host's hide or creating new wounds and consuming tissue and blood. This parasitic relationship occurs more often with domesticated cattle—which did not co-evolve with oxpeckers—than with native species (Diplock *et al.*, 2018). Oxpeckers can feed on the tissue and blood of cattle frequently enough that the presence of oxpeckers does not change the number of ticks and increases how long it takes for wounds to heal (Weeks, 1999; Weeks, 2000). Domesticated cattle also appear to have less tolerance for oxpeckers and shake them off more often than other large herbivores (Diplock *et al.*, 2018), although a few native species, such as waterbucks and impalas, also frequently shake them off (Bishop & Bishop, 2014). Oxpeckers select their host species based on a variety of host traits (Mikula *et al.*, 2018; Nunn et al., 2011), including which ticks are present on the host. If a large herbivore has few parasites of a preferred tick species, oxpeckers may still use the individual as a host but are more likely to eat the host's tissue and blood (Plantan *et al.*, 2013). Overall, species interactions are complex. Rather than considering mutualism and parasitism as two interaction types, it is more realistic to place them on two ends of a continuum and recognize that where two species fall on that continuum may vary across environments provided by hosts (Leung & Poulin, 2008).

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Part I – Mutualistic or Parasitic?

Section A: Preferences

Below is a list of questions regarding native host species traits, including individual tick abundance (i.e., the number of ticks on a host), hide thickness, and host body mass, all of which influence red-billed and yellow-billed oxpecker host preferences. For each question, identify and describe how oxpecker preferences for various host species' characteristics predict if oxpeckers are on the parasitic or mutualistic end of the continuum.

Questions

1. If oxpeckers are more parasitic, then how should oxpecker host preference compare to individual tick abundance? Choose one of the following options and then explain your reasoning.
   a. Oxpecker preference should increase as individual tick abundance increases.
   b. Oxpecker preference should decrease as individual tick abundance increases.
   c. There should be no correlation between oxpecker preference and individual tick abundance.

2. If oxpeckers are more parasitic, then how should oxpecker preference compare to hide thickness? Choose one of the following options and then explain your reasoning.
   a. Oxpecker preference should increase as hide thickness increases.
   b. Oxpecker preference should decrease as hide thickness increases.
   c. There should be no correlation between oxpecker preference and hide thickness.

3. If oxpeckers are more parasitic, then how should oxpecker preference compare to host body mass? Choose one of the following options and then explain your reasoning.
   a. Oxpecker preference should increase as host body mass increases.
   b. Oxpecker preference should decrease as host body mass increases.
   c. There should be no correlation between oxpecker preference and host body mass.

Section B: Data

Nunn *et al.* (2011) compared data across several studies of 14 ungulate host species to examine which native host traits yellow-billed and red-billed oxpeckers prefer. Figure 1 below contains a series of three graphs: one graph for each trait discussed above. Read the caption for Figure 1 and then answer the two questions on the next page (Question 5 and 6) to determine if oxpeckers are more parasitic or mutualistic.

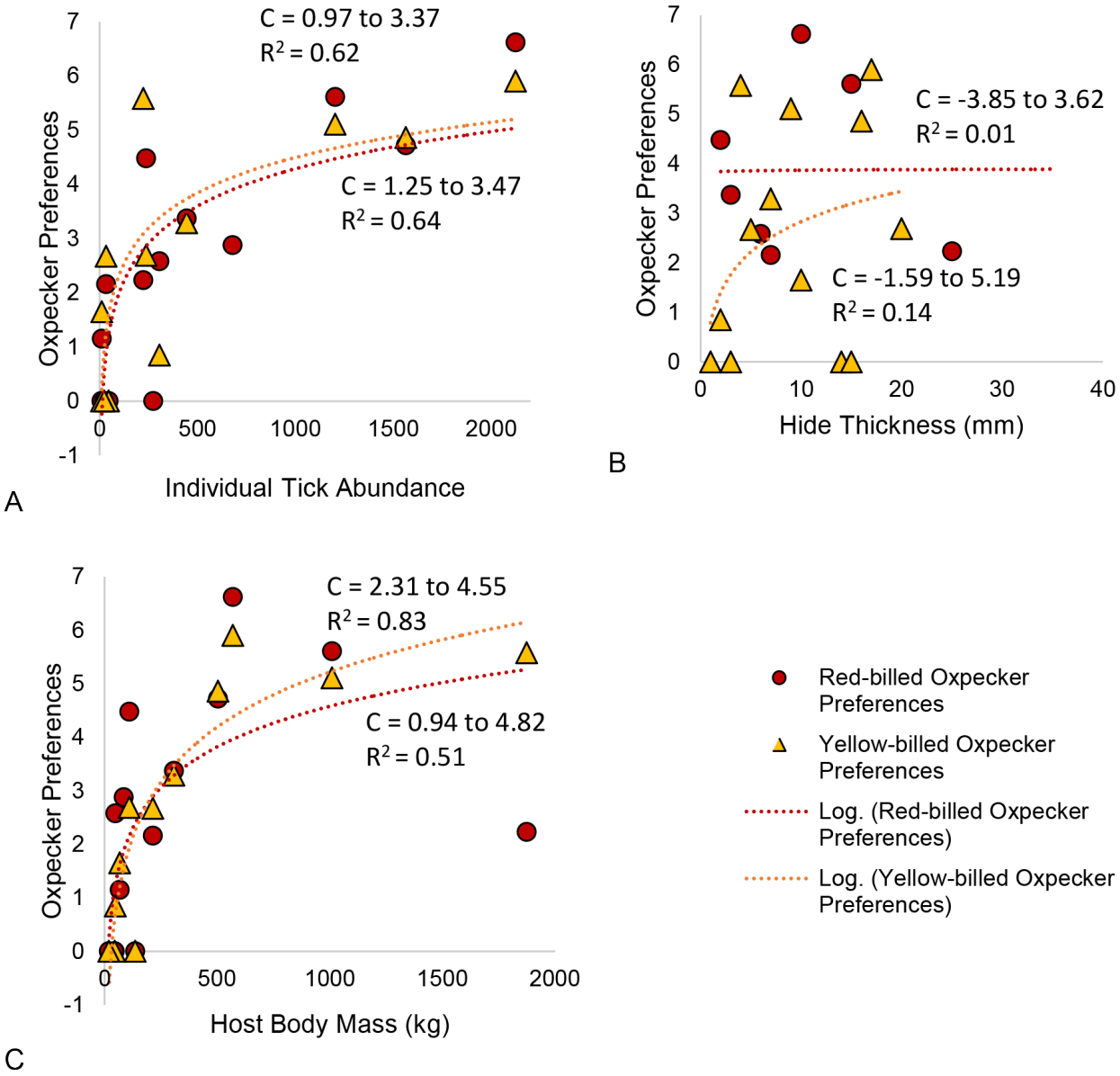

Figure 1. Red-billed (represented as red circles) and yellow-billed (yellow triangles) oxpecker preferences according to A) individual tick abundance per native species, B) native host species average hide thickness, and C) native host species average body mass (data from Nunn *et al.*, 2011, Appendices 1 and 2). Oxpecker preference (values 0 through 7) is based on a log-transformed host preference index, which was averaged across all studies and calculated by the number of oxpeckers on all individuals of one host species divided by the total number of present hosts, and multiplied by 1000. C and R^2 are provided for each line. C is "credible interval slope" and any ranges that do not contain 0 are statistically significant. R^2 (pronounced "R-squared") measures goodness of fit of the line; values range from 0 to 1, with 0 being no fit to the data and 1 being that the line perfectly fits the data.

Questions

4. According to the graphs in Figure 1, which trait(s) correlate with oxpecker preferences?

5. Use Figure 1 and your answers to the previous questions to explain if oxpeckers have a more parasitic or mutualistic relationship with their native host species in this study.

Figure 2. Red-billed oxpecker on giraffe.
Credit: © Riaanvdb | Dreamstime.com, ID 9178548.

Figure 3. Red-billed oxpeckers on impala.
Credit: © Andreanita | Dreamstime.com, ID 132922217.

Part II – Other Scenarios

As mentioned in the introduction, species interactions are complex and the extent to which a relationship is parasitic or mutualistic may vary according to environmental factors. Each question below provides a new scenario that applies the concept of the parasitism-mutualism continuum to various ecological concepts. Predict what would happen in each scenario. These are all hypothetical scenarios, so there is no absolute "correct" answer. Rather, each prediction should be biologically plausible based on the information provided in the scenario and the concepts reviewed in this case.

Questions

1. Let's say the symbiotic relationship between the oxpecker and the Cape buffalo began as a parasitic relationship but later evolved toward a mutualistic relationship. Describe a possible scenario that explains (a) how the behavioral trait of tick consumption first appeared in the population, and (b) how tick-eating oxpeckers came to make up a higher percentage of the population. In your explanation, include how the biological fitness of oxpeckers and Cape buffalo played a role in the evolution of this behavioral trait. Note that "biological fitness" refers to an individual's survival and reproductive success.

2. Consider the following hypothetical scenario: One population of oxpecker birds only eats parasites on rhinoceroses (i.e., they are obligate specialists). Another population of oxpecker birds eats non-parasitic insects found in the habitat in addition to the rhinoceroses' parasites (i.e., they are facultative generalists). Which of these two populations would most likely be affected by an environmental change, such as a decrease in food availability for the hosts, which increases competition among the hosts? Explain your reasoning.

3. Some habitats may provide more resources than others, and individuals choose habitats based on resource availability. A preference for one habitat over another is referred to as "habitat selection." What is considered a "habitat" can vary, and when referring to oxpeckers, it can even include their hosts. Oxpeckers may survive by using a variety of hosts (a component of their fundamental niche), but they may choose only specific species due to intraspecific (i.e., within a species) and interspecific (i.e., between species) interactions, which limits their realized niche. Keep this information in mind as you consider the following hypothetical scenario: You observe that a population of oxpeckers prefer to eat parasites on zebras over rhinoceroses. An investigation of the parasite load on these two species suggests that zebras have bigger tick species than rhinoceroses, but it takes more time to find each parasite due to thicker fur. Using this information and habitat selection concepts, explain why oxpeckers prefer the parasites on zebras over rhinoceroses.

4. In African savannas, land is continuously converted from native habitat to livestock fields. Read through the introduction of this case study again and predict how this habitat change (i.e., toward livestock fields) will influence oxpecker behavior. Will they be more of a parasite or mutualist? Explain your reasoning.

Figure 4. Yellow-billed oxpeckers on Cape buffalo.
Credit: © ndp | Dreamstime, ID 214462653.

Figure 5. Red-billed oxpeckers on horse, lake Ziway, Ethiopia.
Credit: © David Havel | Dreamstime, ID 219263421.

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