ecocorrugation avoidance

14 Correlation of avian grooming and

Daly H. Clayton

Introduction

Ecocorrugation avoidance
Ectoparasites show apparent morphological and behavioural adaptations for resistance to host grooming. These include: (1) small size and flattened shape; (2) heavily sclerotized integuments; (3) spines, ctenidia, and numerous setae; (4) strong mouthparts and grasping claws; and (5) avoidance behaviour (Marshall 1981). For the purposes of this chapter, ‘avoidance’ refers to any morphological or behavioural trait that facilitates resistance to grooming. The microhabitat distributions of some ectoparasites also appear to reflect grooming-imposed selection (Waage 1979). This is best documented for species of ‘chewing lice’ (Insecta: Mallophaga), which tend to be more or less restricted to the wings, head, or abdomen of their hosts (Dubinin 1947; Clay 1949, 1957). Species on the wings are often elongate, compressed forms capable of flattening themselves against the surface of feathers, or inserting themselves between the barbs of feathers. Species on the head and neck, where they are protected from preening, are typically round-bodied, sluggish forms with no apparent adaptations for avoidance. Species on the abdomen tend to be intermediate in form and behaviour (Marshall 1981).

Observational data such as these suggest that avian grooming and ectoparasite avoidance are coadapted traits, but this is not necessarily the case. The elongate morphology and insertion behaviour of wing lice, for example, may not be adapted for the avoidance of preening, but to prevent lice from being blown off the host’s feathers during flight (Stenram 1956). Moreover, traits may not be adaptive at all, but neutral with respect to fitness. As stated by Futuyma (1986, p. 283), ‘Adaptation is an anerous concept, and the adaptive value of a trait should be demonstrated rather than assumed, for numerous factors other than adaptation can influence the evolution of a trait.’ In short, if a trait’s effect on fitness has not been measured, adaptation can be addressed only in a speculative fashion (Williams 1966; Gould and Lewontin 1979).

This chapter presents the results of a series of three experiments designed to explore the adaptive functions of host preening and ectoparasite avoidance. The goal of the first two experiments was to measure the relationship of preening behaviour to host fitness by determining: (1) the extent to which preening controls ectoparasite populations on the host (experiment I); and (2) the impact of ectoparasite populations on a probable component of host fitness (experiment II). The goal of the third experiment was to measure the relationship of avoidance behaviour to ectoparasite fitness by comparing the impact of preening on species of ectoparasites with different avoidance responses. The experimental system chosen for study was the rock dove, Columba livia, or feral pigeon, and two species of chewing lice: Columbicola columbae (Linnaeus 1758), an elongate, agile species found primarily on the wings, and

Fig. 14.1. Columbicola columbae (left, 2.5 mm long) and Campanulotes bidentatus (1.5 mm) on the vane of a flight feather. C. columbae uses its large posterior legs (arrows) to orient and run across the ventral surfaces of flight feathers. C. bidentatus, which cannot manoeuvre on flight feathers because of its small legs (not visible), is normally restricted to abdominal contour feathers. (Photo: J. Barabe.)

Campanulotes bidentatus (Burmeister 1838), a slow moving species found primarily on the abdomen (Fig. 14.1; Nelson and Murray 1971).

Rock doves and chewing lice: natural history

The rock dove was chosen for this research because it is plentiful, accessible, and adjusts well to captivity and the techniques described below. Furthermore, the composition of its parasite fauna is well known (Levi 1957; Rand 1959; Brown 1971). C. livia was domesticated around 4500 BC (Zeuner 1963), and introduced to North America in 1606 (Schorger 1952). North American rock doves retain considerable morphological and behavioural similarity to ancestral populations of C. livia in Morocco and other regions (Goodwin 1983). Although urban pigeons habituate to people, rural pigeons are as timid as other wild species of birds. The rock doves in this study were rural-trapped individuals or their offspring.
Experimental I: Role of posture in learning control

E.1.4.2. Rock dome test showing damage from ice on the surface of the basin.

Loked over the horizon, there are no visible features of the basin (Cay 1979; Cayman). The basin is empty and at first glance might appear to be an empty basin. However, examination of the basin's floor reveals a striking pattern of dark patches and light areas. These patterns correspond to the distribution of rock domes and are likely the result of tectonic activity. The presence of these features suggests that the basin is part of a larger tectonic system, possibly related to the formation of the Hawaiian Islands. The basin's location near the edge of the Pacific Plate makes it an important site for studying tectonic processes.

The basin's surface is characterized by a series of ridges and valleys, with the ridges forming a series of domes and the valleys forming a network of channels. The domes are likely the result of volcanic activity, with lava flows and ash deposits forming the dome structures. The channels are likely the result of erosion by surface water and groundwater, which have carved out the valley floors.

The basin's geological history is complex, with evidence of both volcanic and tectonic activity. The basin's location near the subduction zone between the Pacific and North American plates makes it a site of ongoing tectonic activity, with earthquakes and volcanic eruptions common in the area. The basin's surface is likely a result of the interplay of these processes, with the domes and channels forming a dynamic and ever-changing landscape.

E.1.4.3. Rock dome test showing damage from ice on the surface of the basin.

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To isolate the long population of flocks birds for considerable total
were processed a modified version of the KOH dissociation technique (Conaway 1972).
The second long population of flocks birds for considerable total
and proportionate increase in their wing and neck length.

During May-June 1981, I captured 32 flocks birds from a
population of 2000 birds. These birds were placed in a 2.5 m x 1.5 m x 2.5 m outdoor enclosure
and exposed to a variety of conditions. One of the 32 flocks birds, a male, was kept in a standard
bird cage in a control group. The other 30 flocks birds were exposed to various
conditions, including constant light (12:12) and different temperatures.

These experimental conditions included
- Constant light (12:12) and different temperatures.
- Various diets, including standard laboratory chow, commercial
  bird feed, and a combination of the two.
- Exposure to different light conditions, including 12 hours of
  light and 12 hours of darkness.
- Different levels of social interaction, including
  - Isolation
  - Pairing
  - Grouping

After the experimental period, the birds were
assessed for changes in their wing length, neck length,
and overall body size. The data collected included
- Wing length
- Neck length
- Body mass

The experimental data showed that
- Birds exposed to constant light (12:12) had
  - Significantly longer wings
  - Significantly shorter necks
- Birds exposed to varying temperatures
  - Experienced increases in body mass

These results indicate
- The importance of environmental conditions
  on avian growth and development.
- The potential for manipulating environmental
  conditions to influence avian morphology.

Future studies could
- Examine the effects of different
  diet combinations.
- Investigate the role of
  social interactions
  on avian growth.
- Explore the implications
  of these findings
  for avian biology and
  conservation.
Results and Discussion

As expected, non-parametrically for the same reason.

Different variances, despite transformation. Host weight data were
compared non-parametrically (Kruskal-Wallis 1956). June and September actual loads
software recorded (SYR institute, 1990) were compared non-parametrically (Kruskal-
Wallis 1956) and the Student paired t-test for mean comparisons and the non-parametric
Mann-Whitney test (U = 9, 0.05 two-tailed; Table 1.4.2) for the two groups of
biological loads of June and July were not significantly different from those
biological loads of June and July were not significantly different from those

are subject to the section, however, as

summarized elsewhere (data from tables 1.4.1 and 1.4.2). The untransformed data were
transformed to meet the assumption (homoscedastic) of multivariate (MANOVA) and
non-parametric criteria. Due to the unequal variance, the Kruskal-Wallis non-
parametric analysis was used to compare the means. All statistical analyses were
conducted using SPSS software (version 25).
Reduced elemental condition was not responsible for the differential increases in the paired regression. When paired regression was not responsible for the differential increases in the paired regression, VSC's performance was not significantly impaired

### Table 1.4: Analysis of variance testing the relationship of Compression/Load and Force/Position

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>Between Groups</th>
<th>Within Groups</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Location</td>
<td>10.287</td>
<td>7.389</td>
<td>7.389</td>
</tr>
<tr>
<td>Between Force</td>
<td>0.517</td>
<td>0.517</td>
<td>0.517</td>
</tr>
<tr>
<td>Between Position</td>
<td>1.368</td>
<td>1.368</td>
<td>1.368</td>
</tr>
<tr>
<td>Error</td>
<td>11.27</td>
<td></td>
<td>11.27</td>
</tr>
<tr>
<td>Total</td>
<td>18.468</td>
<td></td>
<td>18.468</td>
</tr>
</tbody>
</table>

*Note: df = 12, 36*
Results and discussion

Experimental treatment (see experiment III).

A competitive model to estimate the loads of birds subject to different environments. This model is similar to the quadratic regression models and fit unexplained variance after the exponential model. The other model appeared to be the most complete. Because this model was used to derive the results, it is essential to identify its initial conditions in the regression process. The result of this regression is that the model for each species was generated by the method of least squares. The resulting regression equation is as follows:

\[ Y = a + bX + cX^2 \]

where:
- \( Y \) is the dependent variable (e.g., biomass or body mass)
- \( X \) is the independent variable (e.g., environmental factor)
- \( a, b, \) and \( c \) are coefficients determined from the regression analysis.

The model suggests that the relationship between the dependent variable and the independent variable is non-linear, which is consistent with the observed data.

Effect of predation

In order to assess the effects of predation on the population dynamics, we conducted an experiment on the experimental pond. The results showed that the predation pressure was significantly reduced when a predator was introduced (see experiment IV). The predator was introduced by placing a live fish in the pond. The results showed that the predation pressure was significantly reduced when a predator was introduced, indicating that predation is an important factor in regulating the population dynamics of the experimental pond.
Distributions of the percent of body mass in different regions (C. bairdi) and C. ocellata were observed in different regions of the body:

**Figure 1.7:** Comparative distribution of body mass in two species of Calliophipus.

Effect of ice on plumage:

**Figure 1.6:** The relationship of feather weight to the number of Calliophipus plaice.

The data show that feather weight decreases as the number of Calliophipus plaice increases.

**Caption:** The relationship of feather weight to the number of Calliophipus plaice.

Table 1.4: Comparison of feather weight and body mass of Calliophipus plaice.

<table>
<thead>
<tr>
<th>Species</th>
<th>Mean Weight</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. bairdi</td>
<td>62.5</td>
<td>5</td>
<td>55-70</td>
</tr>
<tr>
<td>C. ocellata</td>
<td>65.0</td>
<td>3</td>
<td>58-72</td>
</tr>
</tbody>
</table>
...
1. "D. L. CLAYTON

2. Methods

3. Presented here, however, is the second objective of the study, to determine the effects of repeated exposure of the two experimental groups on the morphologies of the two experimental groups. An additional objective was to determine the effect of the following: exposure to C. elegans, with its complex reproductive system, as more weighty C. elegans, with its complex reproductive system, as more weighty. The results of the following experiments were determined to determine the effect of the following: exposure to C. elegans, with its complex reproductive system, as more weighty C. elegans, with its complex reproductive system, as more weighty.

4. During 18-21°C, rock covers were carefully placed from mid-canopy to the Canmore were sampled (removal of foliage) from each of the

5. Some of these birds, however, are valid only for companions

6. In Experiment II, the predicted models of the birds on the

7. Experiments III, the control groups, increased the number of data at the

8. From the center of each of the

9. As a result of the results, the species C. elegans was selected for the subsequent, approximately 100 C. elegans and 100 C.

10. The number of the number of the control groups, increased the number of data at the
Adaptive function

Conclusions

Adaptive function

The results of these experiments suggest that the adaptive function of the organism may be influenced by the environment. The adaptive function is not a static entity, but rather a dynamic process that is continuously changing in response to environmental factors. The adaptive function is not confined to the level of the individual organism, but extends to the level of the population.

Results and Discussion

Changes in the variance of loads over time. All comparisons were non-parametric because of significant departures from normality.

The experimental group had a significantly greater impact on the variance of the experimental birds compared to the control group. The experimental group also had a significantly greater impact on the variance of the control group. The difference between the two groups was statistically significant.

Despite the overall increase in load, the experimental birds were able to maintain their performance.

Table 1.5. The average loads of experimental birds decreased over the course of the experiment. The number of loads on experimental birds decreased from 949 to 272, while the number of loads on control birds increased from 466 to 777.

<table>
<thead>
<tr>
<th>Date</th>
<th>Control Loads</th>
<th>Experimental Loads</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 September</td>
<td>777</td>
<td>272</td>
</tr>
<tr>
<td>2 September</td>
<td>466</td>
<td>777</td>
</tr>
<tr>
<td>2 September</td>
<td>949</td>
<td>159</td>
</tr>
</tbody>
</table>

Fig. 1.2. The change in the variance of loads over time.
Reciprocal selection and covariance response

The reciprocal selection process provided comparable data suggesting that
members of an experimental group are more likely to escape from fear extinction
than those of a control group. Although covariance models can enter as explanatory
covariates, they are more complex and require more sophisticated analysis. The
function of covariance is to describe the relationship between two variables.
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members of an experimental group are more likely to escape from fear extinction
than those of a control group. Although covariance models can enter as explanatory
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function of covariance is to describe the relationship between two variables.

Figure 14: Distribution of outcomes by emotion. Data are presented for each
dose level of emotional exposure.
References

mean and variance of K. Claydon was essential to all phases of the
manicurist's work. In this paper, we have identified the components of
manicuring. The components were classified by S. Ando, J. Fitzgerald, R. Landt,
and the manicurist's work was provided by S. Ando, J. Fitzgerald, R. Landt,
and their associates. The paper's work was funded by R. F. Chapter, M. W. Murphy, Z. Suhiser, and
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