New Data and New Questions for Crested Auklet Research

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New data and new questions for Crested Auklet research.—In our recent reviews (Hagelin 2007a, b; Hagelin and Jones 2007) of the citrusy scent of Crested Auklets (*Aethia cristatella*), we aimed to provide readers with a balanced biological evaluation of the published data available at the time. Hagelin et al. (2003) quantified the volatiles in Crested Auklet odor in μg g^{-1} feathers, which enabled us to make general comparisons with other studies. For example, some chemicals present in Crested Auklet odor have produced striking effects on ectoparasites, such as feather lice, which became moribund within seconds after very small quantities of compounds (1.0 μL) were placed on single feathers (Douglas et al. 2004). Hagelin and Jones (2007) examined whether the chemical environment on these single feathers was similar to what is found on an adult bird. Specifically, we converted the total amount (μL) of compounds used against lice to μg g^{-1} feathers by multiplying by the density of the compound used (in μg μL^{-1}) and dividing by the average weight of a single contour feather from the nape (0.0008 g, $n = 10$; see Hagelin 2007a). We then compared the result to values in Hagelin et al. (2003). We made similar calculations for tests involving auklet ticks (Douglas et al. 2004).

Douglas (2008a, b) has since reported chemical concentrations that are higher than reported by Hagelin et al. (2003). These new data indicate that the movement of a generalist tick of birds and mammals (*Amblyomma americanum*) was impaired at odorant concentrations that were equivalent to or less than average plumage concentrations of adult Crested Auklets (Douglas 2008a, b). We agree that the results are interesting, in that they also suggest that some tests used to assess chemical defense against auklet ticks (*Ixodes uriae*; Douglas et al. 2004) fell within ecologically realistic values. Crested Auklets exhibit a diverse ectoparasite fauna, as do related auklet species. Future tests of both ticks and lice that naturally occur on auklets promise to reveal comparative evidence as to whether a chemical "arms race" has occurred. One would predict, for example, that parasites occurring on Crested Auklets would be more resistant to chemical concentrations reported in Douglas (2008b) than those from more distantly related auklet species.

Douglas (2008b) and Hagelin et al. (2003) used different methods to quantify odor compounds, which we hesitate to compare without direct tests. Hagelin et al. (2003) examined the volatile components of feather samples and reported only those compounds that exhibited significant seasonal patterns. Our aim was to characterize the odor environment that birds experience when engaged in "ruff-sniff" displays. Douglas (2008b) measured the amount of compound extracted from feathers with an alcohol solvent, which, we expect, could relate more directly to the experience of parasites on feather surfaces. Regarding methods, it is important to point out that primitive field conditions in the outer Aleutian Islands allowed feathers to be stored inside sealed vials in the dark at cool temperatures (0–11°C) but prevented Hagelin et al. (2003) from freezing samples to −80°C until weeks after collection. However, the chemical results we obtained were remarkably similar to those from captive birds, which were frozen within minutes of collection (see table 1 in Hagelin et al. 2003). Our chemist collaborator also verified the efficacy of our methods by comparing our 2003 results to replicate samples of gases (L. E. L. Rasmussen unpubl. data) collected directly from auklet napes using a technique pioneered by her lab (evacuated stainless cylinders; see Perrin et al. [1996] and Rasmussen and Perrin [1999] for details on sampling live animals). Hagelin et al. (2003) had funding to chemically assess feather samples from 10 birds, and we have published data for every individual that we have analyzed.

The new data in Douglas (2008b) reveal that there is still much to be learned from the auklet system. If scent acts as a dynamic indicator trait (e.g., Hill et al. 1999) during the social interactions of Crested Auklets (see Jones et al. 2004, Hagelin 2007b, Douglas 2008b), one might expect high levels of individual, seasonal, and geographic variation in odor concentration. Preliminary analyses in our lab, for example, have detected 15- to 60-fold differences in concentration between feather samples collected at different sites during different seasons. Odor concentration also appears to vary between age classes (Sealy 2006) and between different captive populations (Douglas et al. 2001, Hagelin et al. 2003, Douglas 2008b), which suggests that scent could be linked to development or, perhaps, environmental factors such as diet. We find the prospects for research on these and other questions exciting, and we welcome productive discussions with Douglas and others on such topics in the future.—Julie C. Hagelin, *Department of Biology, Swarthmore College, 500 College Avenue, Swarthmore, Pennsylvania 19081, USA. E-mail: jhageli1@swarthmore.edu*

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