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Supplementary material

Supplementary material Appendix 1

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1. State-of-the-art in correlates of feather hole counts

Table A1. State-of-the-art in correlates of feather hole counts. Studied avian species (Sp.): "BS" barn swallow *Hirundo rustica*, "BW" black wheatear *Oenanthe leucura*, "GT" great tit *Parus major*, "HS" house sparrow *Passer domesticus*, "WP" Wilson's storm petrel *Oceanites oceanicus*. Other abbreviations: "NDVI" normalized difference vegetation index, "CORT" corticosterone.

Source	Results	Species	References
Extrinsic variables			
year	hole count was repeatable within and between years	BS	1,2
time	hole count increased during 40 or 60 days of breeding	BS	3,4
	time between consecutive moults did not affect the hole load	GT	5
environment	activity at dairy cattle farm did not correlate with the number of holes	BS	6
	African NDVI two winters before breeding had positively or non-significantly correlated with feather holes in males and females, respectively	BS	7
	spring temperature and rainfall over a 23 years period did not explain feather hole abundance	BS	8
	classical ringing procedure significantly reduced the increase in hole load during one month as opposed to an abridged ringing (i.e. ringing and hole counting without biometry measurements)	BS	9
	birds that fledged later in the season and had more siblings had feathers with higher hole burden	GT	10
mate	pairs were not similar in hole load, thus they did not mate assortatively according to hole load or their common environment (nest) did not lead to the convergence of the hole load of the pair	BS	1,2,11
Intrinsic variables			
sex	adults had no sex-specific hole loads	BS	2,11
	adults did not differ in hole abundance according to sex, while juvenile males had more holes than juvenile females	GT	5
	adults had no sex-specific hole loads	HS	12
age	the abundance of holes was repeatable across ages	BS	1
	in males, adults had fewer holes than juveniles	BS	13
	the number of holes decreased during the transition of 1→2 year age	BS	13

	feather hole number was related to age as a U-shaped function meaning that middle-aged birds had the lowest burden, while senescent birds were as holey as juveniles	BS	14
	adults had fewer holes than juveniles	GT	4,10
	adults had fewer holes than juveniles	HS	15,16
	adults had fewer holes than juveniles	WP	17
genotype	variation in feather hole numbers had an additive genetic component	BS	11
Morphology and condition			
morphology	tail length of females was unrelated to feather hole abundance	BS	2,18
	wing and tarsus length were unrelated to feather hole abundance	BS	2
	body size (PC1 of a PCA on 3 size measures) was unrelated to feather hole abundance	HS	19
	wing span and tail length were unrelated to feather hole abundance	BS	20
	tarsus length was unrelated, while wing length was inversely related to feather hole abundance	GT	5
feather quality	birds with feathers with larger rachis outer diameter had fewer holes	GT	5
	barbule density was unrelated to feather hole abundance	GT	5
	the presence of fault bar and the degree of feather wear were both positively related to feather hole abundance	GT	5
	albino plumage colouration anomaly was not associated with the number of holes	HS	19
	holes were more likely to be positioned on the white tail spots of tail feathers than expected from the relative area of the white spots	BS	21
condition	nestling condition was unrelated to feather hole abundance	BS	2
	condition (expressed as residuals of mass on tarsus length OLS regression) was not associated with hole load	GT	5
	body mass was not associated with hole load	HS	22
	birds in better condition (expressed as scaled mass index*) bare fewer feather holes on their flight feathers	HS	23
	feather hole load was smaller when the uropygial gland size was larger	HS	12,22,23
	within-individual increase in uropygial gland size between years was not associated with changes in hole count	HS	12
	birds with surgically extirpated uropygial gland had more holes compared to controls	HS	24
Sexual characters and sexual displays			
male ornament	streamer (outer tail feather) length was mostly inversely related, but sometimes unrelated to hole abundance	BS	1,2,4,18,21,25,26
	white tail spot size was inversely related to hole abundance	BS	18
	white wing-bar length and area were inversely related to hole abundance	HS	19,27

	the size of eumelanin-based throat patch (status badge) was unrelated to hole abundance	HS	19
male display	males with fewer holes had longer song duration feather hole burden did not relate to the number and weight of stones carried by displaying males	BS BW	13 28
Performance traits			
behaviour	parental activity was independent of feather hole count birds with higher hole load had higher percentage of flapping flight time to take-off and wingbeat frequency were unrelated to the number of feather holes preening activity was independent of feather hole count	BS BS BS BS	2 20 20 29
moult	females with more holes had lower moult score, while males with more holes had lower speed of moult (measured by raggedness) moult onset was independent of feather hole count moult was faster in birds with higher feather hole abundance moult reduced the number of holes moult reduced the number of holes	BS HS HS GT HS	30 22 22 10 23
physiology	immunoglobulin concentration and leukocyte counts were unrelated to feather hole count testosterone implantation had positive effect on feather hole abundance natural testosterone titre was unrelated to feather hole count body temperature was unrelated to feather hole count yolk androstenedione concentration was unrelated to feather hole count concentration of natural antibodies and complement were unrelated to feather hole count size of the bursa of Fabricius was larger in birds with larger hole count plasma triglyceride concentration of adults was unrelated to the number of feathers with feather holes plasma protein concentration of adults was inversely related to the number of feathers with feather holes plasma hue was negatively related to the number of feathers with feather holes packed cell volume (haematocrit %) was unrelated to the number of feathers with feather holes plasma health markers of the nestlings were unrelated to the number of feathers with feather holes peak CORT titres of the nestlings during stressful conditions (food shortage) was positively related to the number of feathers with feather holes	BS BS BS BS BS BS HS WP WP WP WP WP WP	25 25 25 31 32 33 34 17 17 17 17 17 17
parasitism	abundance of feather-degrading bacteria was positively correlated with hole load	HS	23

fitness components	arrival time (sometimes expressed as first capture date) was positively correlated with hole load, that is birds with more holes arrived later to the breeding grounds	BS	7,25
	arrival time was positively correlated with hole load in males, but unrelated to hole load in	BS	35
	females	BS	29
	territory preference did not correlate with hole load	BS	1
	males with more holes on their feathers acquired a mate later	BS	1,25
	probability of being bonded or engaged in extra-pair affairs decreased as a function of hole count	BS	1
	preference for social and extra-pair males were smaller in case of males with more holey feathers	HS	27
	females preferred males with smaller hole count	BS	2
	onset of breeding attempt was later in the season in birds with larger hole load	BS	2
	clutch size, brood size and breeding success were not correlated with feather hole numbers	BS	8
	annual production of fledglings decreased by larger hole abundance	BS	2
	annual survival potential (return to breeding ground) was smaller in females with more holes, but		
	the survival of males was independent of the number of feather hole	GT	10
	survival probability of yearlings was unrelated to feather hole count	BS	13
	survival prospects of yearling males was unrelated to feather hole count		
Other correlates			
	the frequency distribution of feather holes in breeding colonies was less skewed	BS	2,3
	holes were either absent or present on nestlings	BS	3,29,35
	feather holes were much likely positioned farther from calamus and closer to flight feather tips	GT	5
* Equation 2 in: Peig, J. and Green, A. J. 2009. New perspectives for estimating body condition from mass/length data: the scaled mass index as an alternative method. – Oikos 118: 1883–1891.			

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2. Mites as putative agents of feather holes

Some studies report that mites might gnaw holes on feather vanes of their avian hosts. Some studies indicate plumicole mites as hole-makers (e.g. Dunn et al. 1994, Lombardo and Thorpe 2000), others the syringicole mites (e.g. Casto 1974). Syringicolous mites are thought to induce miniature holes (i.e. "pinhole"), however we know next to nothing about these damages. Holes of the size category of pin pierces are hard to be studied in wild-living avian hosts because of hard detection and erroneous counting by the naked human eye. This makes the question even more obscure than that of clearly visible holes what I addressed in this Point-of-View. However, I shortly address here the case of syringicolous mites and provide the main literature about both plumicole and syringicole mites for those who are interested in.

Syringicolous mites were suspected to induce hole-like feather damages because their feeding habit is piercing the quill wall. Though I consider that this mite group is unlikely to cause feather hole damages as shown on the Fig. 1 in the article due to the followings. First, Casto (1974) analysed several house sparrow feathers. Although infestation prevalence by *Syringophiloidus minor* was quite high (85%), no structural alteration on the feathers was detected. Second, Kethley (1971) reported the population dynamics of the same Syringophilid mite species and found that each feather quill growing during the autumn moult is colonised by a single fertilized female (foundress). The population then increases within quill to 120–130 mites after two generations, till next winter or spring. Since the feather becomes fully unsheathed by this time, quill wall piercing by quill mites is unlikely to influence the structure of the vanes of already fully-grown feathers. Finally, neither Skoracki (2011) mentioned any adverse impact of quill mites on hosts feather structure in his huge monograph about Syringophilid mites. Moreover, he questions the parasitic nature of quill mites in the sense that they does not considerably reduce host's condition and fitness. Dorrestein et al. (1997) described severe feather malformations in canaries due to quill mite infestation, however Skoracki (2011) emphasizes that these alterations are reduced to poultry and captive pet bird populations. Although Proctor and Owens (2000) label Syringophilid mites as parasitic because they consume the medulla of the quill and these mites "… could thus weaken the feathers". However, there is no empirical evidence neither about feather damaging by quill mites (see above) not about their negative fitness consequences. All in all, evidence still does not exist to support that Syringophilid mites are able to create holes on the vanes of flight feathers.

The impressive list of hole-inducing parasites in Principato et al. (2005) is not bolstered by statistics and/or literature.

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