Supplementary Materials

SM1 – Experimental manipulation of diet

SM2 – Characterisation of air temperatures during breeding

SM 1 - The experimental test of low and high quality plant-based diets on reproductive performance in the zebra finch

Methods

52 pairs of zebra finches (26 wild-derived and 26 domesticated) were divided into four different outdoor aviaries (4.1 x 1.85 x 2.24 m) with 13 pairs per aviary (i.e. two with wild-derived and two with domesticated). Domesticated birds were all the same age (~3 years), whilst the wild derived birds were of mixed age (between 1 and 4 years old). All the birds were fed on standard finch dry seed diet (Avigrain Red, largely comprised of panicum, millet, and canary seed) with grit and cuttle bone for six weeks before the start of the experiment. For the manipulation of diet, half the birds (in two of the aviaries – one of each origin) were maintained on only the dry seed (e.g. low-quality), while the other half (in the other two aviaries) were supplemented daily with a high-quality 'green mix' diet comprised of: 3 parts Greens & Grains (a mix of native Australian grass seeds, Elenbee bird supplies, Australia), four parts snap frozen raw green millet seed, 1 part Prima supplement (Naturally for Birds, Australia), 1/4 parts Micro Nutrients supplement (Naturally for Birds, Australia) and one part blended frozen mixed winter vegetables (Birds Eye; containing broccoli, cauliflower, carrot, green beans). This diet is a very high quality diet formulated by Gouldian finch aviculturists to sustain the Gouldian, and other nutritionally demanding Australian finch species (Evans & Fidler 2005).

After six weeks of the experimental diet, all aviaries were provided with nest boxes and nesting materials. Nests were checked daily for eggs or hatching in the morning. New eggs were weighed and returned to the nest. The third egg from each pair was collected for additional analysis and replaced by a dummy egg (for a different study). The rest of the eggs were monitored for hatching and success of fledging chicks. Once pairs had completed the

first round of breeding the nest boxes were removed, and the birds were returned to the normal diet. All work was conducted according to relevant national and international guidelines and was approved by the Macquarie University Animal Ethics Committee (Animal Research Authority 2017/54).

Statistics

All analysis was done with R v. 3.5.3 (R Core Team 2019) in the R package *lme4* (Bates et al. 2015). To investigate the impact to diet type (low or high quality) and zebra finch type (wild-derived and domesticated) we used general linear models to examine the proportion of eggs hatched and chicks fledged (logit transformed), linear models for days to hatch and egg mass (with added random effect of pair identity). Proportion of eggs hatched discounted the third egg (that have been removed from the clutch), and the proportion of chicks fledged was calculated from the number of eggs hatched and the number of offspring that survived to fledge the nest.

Results

There was no effect of diet quality in any model or on any measure (there were also no significant interactions (so they were dropped from models) (see Tables below). There was a significant impact of zebra finch type on proportion of chicks fledged, with wild derived birds (regardless of treatment) fledging more of their chicks hatched than domesticated birds (see Tables below).

Discussion

Diet quality did not impact egg mass, hatching day, percentage of eggs hatched, or the percentage of chicks fledged. There was a significant difference in the number of chicks fledged by wild derived birds, but this was likely due to the fact that the domesticated birds had never bred before and at least some of the wild derived birds had breeding experience. Domestic birds laid heavier eggs that wild derived, which is expected given they have been shown to lay larger eggs (Griffith et al. 2020).

Reference

Evans, S., & Fidler, M. (2005). The Gouldian Finch. Torbanlea. QLD, Australia: Indruss Production.

Table 1. The number of nests, hatching, fledgling nests, and fledgling offspring across the four aviaries.

Origin of birds	Diet quality	Nest with eggs	Nests with hatching	Nests with fledglings	Total number of fledglings
Domestic	High	14	12	3	8
Domestic	Low	9	7	3	7
Wild	High	12	11	8	14
Wild	Low	10	9	7	13

Table 2. The number of eggs laid, hatched, and fledglings produced (mean ± SE) across the different treatments and origins. For the number of eggs that hatched and chicks that fledged, the means have been calculated with[(A)], and without[(B)] the nests that failed completely at these stages.

Origin	Diet quality	Clutch size	Eggs incubated	Hatched[A]	Hatched[B]	Fledged[A]	Fledged[B]
Domestic	High	5.14 ±0.34	4.14 ±0.34	3.14 ±0.45	3.67 ±0.33	0.57 ±0.31	2.67 ±0.33
Domestic	Low	3.80 ±0.33	2.90 ±0.28	1.90 ±0.38	2.43 ±0.30	0.78 ±0.40	2.33 ±0.33
Wild	High	3.42 ±0.23	2.58 ±0.19	2.17 ±0.30	2.36 ±0.24	1.16 ±0.30	1.75 ±0.25
Wild	Low	3.50 ±0.27	2.60 ±0.22	2.10 ±0.28	2.33 ±0.17	1.30 ±0.33	1.86 ±0.26

Table 3. The effect of the diet and origin of zebra finches on egg mass (± SE) and the percentage of eggs and nestlings that hatched/fledged respectively (mean ± SE). These mean values are for all nests, and therefore include nests in which no eggs hatched, or broods where no nestlings fledged.

Origin	Diet Quality	Egg Mass (g)	Hatch %	Fledge %
Domestic	High	1.06 ±0.01	75.5 ±9.5	22.7 ±12.4
Domestic	Low	1.04 ±0.02	64.8 ±13.7	39.3 ±18.8
Wild	High	1.01 ±0.02	81.9 ±9.1	60.0 ±12.7
Wild	Low	1.00 ±0.02	81.7 ±10.7	59.2 ±13.1

Table 4. The model outputs for the effect of diet and origin on reproductive success for the values/ means presented in Table 2 and 3. These statistics are run with(A) or without(B) the nests that failed completely at each given stage. With(A) nests therefore include nests in which no eggs hatched, or broods where no nestlings fledged.

	Diet Quality					**Zebra Finch Origin**				
	Est	**SE**	**df**	**z-value**	**P**	**Est**	**SE**	**df**	**z-value**	**P**
Clutch size[A]	-0.13	0.15	42	-0.87	0.38	-0.30	0.15	42	-1.99	**0.05**
Hatched[A]	-0.28	0.20	42	-1.41	0.16	-0.20	0.19	42	-1.02	0.31
Hatched[B]	-0.22	0.20	36	-1.10	0.27	-0.29	0.19	36	-1.51	0.13
Fledged[A]	0.18	0.31	42	-0.58	0.56	0.62	0.32	42	1.92	0.05
Fledged[B]	-0.01	0.31	18	-0.03	0.97	-0.33	0.32	42	-1.02	0.31
% Hatch[A]	-0.48	0.41	42	-1.17	0.24	0.69	0.43	42	1.60	0.11
% Fledge[A]	0.46	0.40	42	1.17	0.24	1.38	0.39	42	3.53	**< 0.001**
	Est	**SE**	**df**	**t-value**	**P**	**Est**	**SE**	**df**	**t-value**	**P**
Egg Mass (g)	-0.01	0.02		-0.77	0.44	-0.05	0.02		-2.78	**0.006**

SM2 – Characterisation of minimal and maximal air temperatures during breeding

For two sites that have been the focus of long-term study we characterised the minima and maxima temperature recorded over 13 years of climate data. This range of data was taken as 2005 was the first year that the Automated Weather Station run by the Australian Bureau of Meteorology was operational (during the spring). The data for Fowlers Gap was gathered by BOM from the AWS which is positioned within about 15km from the site of the breeding population of zebra finches that has been the focus of long-term research as first described in Griffith et al (2008). The BOM data can be publicly accessed through the BOM website http://www.bom.gov.au/

The data for Oxford also came from a publicly open source, and comes from the Radcliffe Observatory in the centre of Oxford, and a similar distance from the long-term study population of great tits in Wytham Wood.

https://www.geog.ox.ac.uk/research/climate/rms/daily-data.html

The normal breeding season of the great tit was taken from Joys & Crick (2004). First egg dates are 10th April and the last fledglings are on the 26th June.

The normal breeding season of the zebra finch was taken from Griffith et al (2008) and was defined as a period from the first eggs that are typically on around 1st September with the last fledglings leaving the nest on around 31st January.

References

Griffith SC, Pryke SR, & Mariette M (2008) Use of nest-boxes by the Zebra Finch (*Taeniopygia guttata*): Implications for reproductive success and research. Emu, 108, 311-319.

Joys, A. C., and H. Q. P. Crick. (2004) Breeding periods for selected bird species in England. BTO research report (2004)