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Spring body condition of hen pheasants *Phasianus colchicus* in Great Britain

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In this study we sought to determine main predictors of the body condition of hen pheasants *Phasianus colchicus* in Great Britain. We collected a total of 181 hen pheasants from 21 estates throughout Britain in 1996 and 1997. Pheasants collected from shooting estates which undertook spring supplementary feeding had significantly larger fat reserves than pheasants collected from estates where supplementary feeding stopped at the end of the shooting season (1 February). Hens from estates managed for wild pheasants had larger fat reserves than hens from estates managed for reared pheasants. However, there was no difference in parasite loads of *Heterakis gallinarum*, *Capillaria* sp. or *Syngamus trachea* between pheasants from wild and reared estates, and parasite load did not influence body condition. Our results suggest that food availability is a key factor influencing body condition of hen pheasants in Britain. We recommend that game managers provide supplementary grain in breeding territories through the spring to increase food availability and maintain pheasant body condition.

Key words: body condition, Capillaria sp, Heterakis gallinarum, parasites, Phasianus colchicus, pheasant, supplementary feeding, Syngamus trachea

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The common pheasant *Phasianus colchicus* is the most abundant and widely distributed gamebird in Great Britain (Tapper 1999). In order to sustain an annual harvest of around 12 million birds, approximately 20 million juvenile artificially raised (reared) birds are released into the countryside each summer (Tapper 1999). Research into the comparative survival and breeding success of these reared birds and wild-raised (wild) pheasants indicates that survival and breeding performance of reared birds is much less than that of wild birds (Hill & Robertson 1988, Brittas, Marcström, Kenward & Karlbom 1992, Leif 1994, Woodburn 1999). Many factors have been put forward as possible causes of poor breeding success of reared birds, including poor body condition during nesting (Draycott, Hoodless, Ludiman & Robertson 1998) due to an inadequate diet (Draycott, Butler & Carroll 2000a) and high levels of parasitic infection (Draycott, Parish, Woodburn & Carroll 2000b).

In Great Britain, pheasants are often provided with supplementary wheat grain through the winter in order to hold them in required areas for shooting and to ensure that they remain healthy and in good condition throughout the winter months (Draycott et al. 1998). However, this often ceases after the shooting season, and birds are left to forage for solely natural foods (Draycott et al. 1998). This may create a 'nutritional bottleneck' for pheasants as energetic requirements increase above maintenance levels in spring in preparation for breeding (Wise 1994).

Draycott et al. (1998) demonstrated in an experimental study that by providing supplementary wheat grain in breeding territories for pheasants in spring, fat reserves of nesting hens could be maintained at prebreeding levels; in the absence of supplementary feeding, fat reserves were reduced by over 50%. Additionally, maintenance of body condition of hens by supplementary feeding in spring may lead to improvements in aspects of breeding success (Hoodless, Draycott, Ludiman & Robertson 1999). Pheasants in the UK are often prone to high levels of intestinal parasite infection in spring (Draycott et al. 2000b). It has been shown that by dosing hen pheasants with an anthelmintic in early spring to remove their intestinal parasites, their survival during incubation can be improved (Woodburn 1999). Previous research on the effects of supplementary feeding and parasites on hen pheasants were based on single study sites (e.g. Draycott et al. 1998, Woodburn 1999). However, there is large variation in pheasant management, food availability and levels of parasitic infection between estates (Draycott, Butler, Nossaman & Carroll 1997, Draycott et al. 2000b). It is therefore unclear how important these factors are at a national level. The aim of this study was to determine the impact of supplementary feeding, nematode parasites and origin of birds on spring body condition of hen pheasants from a large sample of estates in Britain.

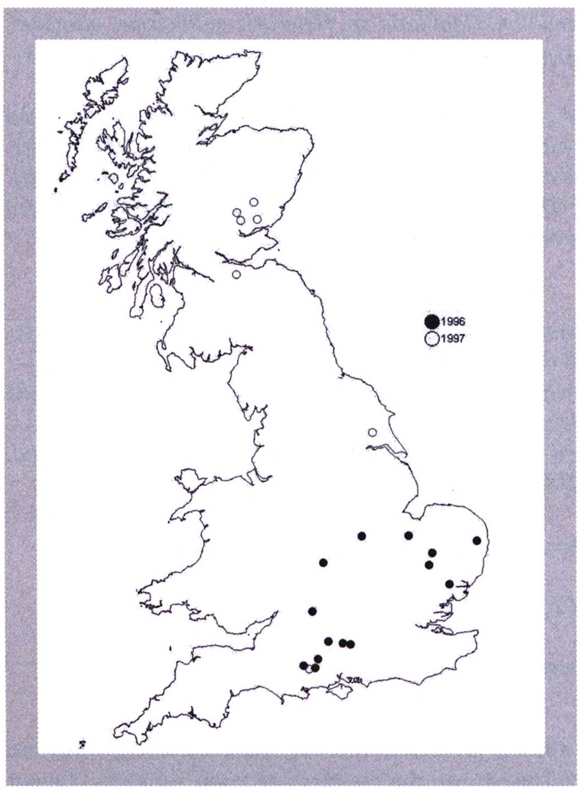

Figure 1. Location of the 21 study sites in Great Britain. All sites were lowland shooting estates, and 5-18 hen pheasants were collected for analysis on each estate in April in either 1996 or 1997.

Study sites

We conducted field work on 16 study sites in England and five in Scotland (Fig. 1). All sites were lowland, arable farming estates, growing predominantly winter cereals and oil-seed rape and ranging in size within 300-10,000 ha with varying proportions of woodland. Active pheasant management took place on all estates, though the type and intensity varied considerably. On some estates management was concerned solely with the wild stock of pheasants on the estate, while on others management concentrated on reared birds. Releasing density of reared birds varied considerably between estates. Supplementary feed, in the form of wheat, was provided for pheasants on all estates during winter. However, on some estates feeding ceased at or soon after the end of the shooting season (1 February). On other estates feeding continued well into spring (at least until 1 April) in the breeding territories of pheasants.

Methods

To assess the body condition and worm burden of pheasants, a sample of 5-18 hen pheasants were killed on each estate (under licence from English Nature and Scottish Natural Heritage) at the end of April just prior to incubation in either 1996 or 1997. Hens were humanely shot by professional game managers while foraging in open fields shortly after dawn.

We dissected the carcasses according to Draycott et al. (1998), except that we used cloacal fat rather than total body fat as an indicator of body condition (Carroll, Robertson & Draycott 1997). We also measured the *pectoralis major* (breast muscle) mass from one side of the hen to provide an indication of body condition (Brittas & Marcström 1982, Tompkins, Draycott & Hudson 2000). We measured tarsal length to estimate variation in body size of the pheasants (Robertson, Hill & Raw 1985, Draycott et al. 1998). There were no differences in tarsal length between estates ($P = 0.18$), type of bird (wild or reared; $P = 0.28$), year ($P = 0.99$) or presence or absence of supplementary feeding ($P = 0.95$). Therefore we did not correct for body size in our analyses. All parasite data were log(n+1) transformed which successfully normalised data distribution as data were not highly aggregated. Pheasants were examined for the presence of the caecal nematode *Heterakis gallinarum* using the method outlined in Draycott et al. (2000b) and also for the presence of the tracheal worm *Syngamus trachea* and thread worms *Capillaria* sp.

Each estate was classified as 'fed' or 'unfed' and as 'wild' or 'reared'. Fed and unfed corresponded to presence or absence of spring supplementary feeding, respectively, and estates feeding after 1 March were considered to be feeding in spring. For the body condition analysis we used the categorical variables 'reared' and 'wild' depending on whether or not hens were currently released on the estates. For the parasite analysis, estates were categorised differently because active larvae of the parasite *H. gallinarum* can remain viable for long periods (Lund 1960) and annual release of birds in the same location is likely to increase worm burdens year by year (Draycott et al. 2000b). When there is a transition to wild bird management there may be a 'carry over' effect with worm burdens remaining high for several years. Therefore we categorised estates for the parasite analysis according to whether or not pheasant releasing had taken place within four years of our survey. These explanatory variables were then used, along with year of sampling to investigate differences in the mean body condition and parasite burdens of hens between estates using ANOVA. The factors we were investigating were applied at the estate level. Therefore we conducted analyses using mean values for each estate. As the number of individual birds sampled between estates varied, mean values were weighted according to the number of individuals sampled per estate. Finally, to investigate the effect of nematode worm burden on body condition, we used nested ANCOVAs at the individual bird level with estate as a blocking factor and incorporating the other categorical estate variables. All data were analysed using the statistical package Systat 9.0 (SPSS Inc. 1999).

Results

Fat reserves of pheasants collected from estates which continued to provide feed after the shooting season had significantly larger fat reserves than pheasants collected from estates which ceased feeding after the end of the shooting season (Table 1). Hens collected from

Table 1. Body condition of hen pheasants expressed as least square means (LSM) on shooting estates in Great Britain in April 1996 and 1997 in relation to supplementary feeding and type of pheasant management.

		No of estates	LSM (g)	SE	$F_{1,14}$	P
Cloacal fat						
Type	Wild	8	17.21	3.21	9.791	0.007
	Reared	13	9.04	2.57		
Feeding	Fed	14	16.25	2.59	7.114	0.018
	Unfed	7	9.99	3.09		
Year	1996	14	15.39	2.56	3.831	0.071
	1997	7	10.85	3.08		
	Type × Feeding				3.471	0.084
	Year × Type				0.018	0.896
	Year × Feeding				0.240	0.632
Breast muscle						
Type	Wild	8	82.58	5.49	1.036	0.326
	Reared	13	78.04	4.38		
Feeding	Fed	13	82.15	4.42	0.837	0.376
	Unfed	8	78.48	5.28		
Year	1996	14	85.51	4.41	6.903	0.020
	1997	7	75.12	5.27		
	Type × Feeding				0.009	0.925
	Year × Type				0.001	0.973
	Year × Feeding				0.833	0.377

Table 2. Parasitic worm burdens of hen pheasants expressed as least square means (LSM) on shooting estates in Great Britain in April 1996 and 1997 in relation to supplementary feeding and type of pheasant management.

		No of estates	LSM[b]	SE	$F_{1,14}$	P
Heterakis gallinarum						
Type[a]	1	4	3.08	0.55	3.490	0.083
	2	17	4.22	0.22		
Feeding	Fed	13	3.89	0.32	0.604	0.450
	Unfed	8	3.42	0.50		
Year	1996	14	3.87	0.29	0.406	0.534
	1997	7	3.44	0.556		
	Type × Feeding			1.508	0.240	
	Year × Type			0.036	0.853	
	Year × Feeding			1.373	0.261	
Capillaria sp.						
Type[a]	1	4	1.84	0.24	2.601	0.129
	2	17	2.26	0.09		
Feeding	Fed	13	2.07	0.14	0.013	0.912
	Unfed	8	2.04	0.21		
Year	1996	14	1.91	0.12	0.998	0.335
	1997	7	2.20	0.24		
	Type × Feeding			2.514	0.135	
	Year × Type			0.233	0.637	
	Year × Feeding			0.419	0.528	
Syngamus trachea						
Type[a]	1	4	0.02	0.12	1.593	0.227
	2	17	0.18	0.05		
Feeding	Fed	13	0.12	0.07	0.030	0.865
	Unfed	8	0.09	0.11		
Year	1996	14	0.14	0.06	0.223	0.644
	1997	7	0.07	0.12		
	Type × Feeding			0.102	0.754	
	Year × Type			0.569	0.463	
	Year × Feeding			0.437	0.519	

[a] Type 1 = Wild estates with no recent history of release; Type 2 = Estates where pheasants had been released within four years of our study.
[b] Parasite data are expressed as log(n+1) values.

estates with reared hen pheasants had significantly smaller fat reserves than hens from estates with wild hen pheasants (see Table 1). There were no significant interaction effects, and none of our measured variables influenced breast muscle mass except year (see Table 1).

None of our measured variables significantly influenced the infection levels of *H. gallinarum*, *Capillaria* sp. or *S. trachea* (Table 2). However, the mean worm burden of all the parasite types tended to be higher on estates where pheasants had been released within four years of our survey than on estates where no pheasants had been released within four years (see Table 2).

Neither of our body condition predictors (cloacal fat mass and breast muscle mass) were significantly influenced by parasitic worm burden. The test results for the effect on cloacal fat were: *H. gallinarum*: $F_{1,150} = 0.54$, $P = 0.46$; *Capillaria* sp.: $F_{1,149} = 0.04$, $P = 0.85$; *S. trachea*: $F_{1,163} = 0.48$, $P = 0.49$. Test results for the influence of parasitic worm burden on breast muscle mass were: *H. gallinarum*: $F_{1,150} = 2.26$, $P = 0.14$; *Capillaria* sp.: $F_{1,149} = 0.02$, $P = 0.89$; *S. trachea*: $F_{1,165} = 0.38$, $P = 0.54$. There were also no significant interaction effects on cloacal fat or breast muscle mass.

Discussion

The results from this synoptic study suggest that the body condition of nesting hen pheasants in Britain is influenced by the availability of supplementary food in spring. Hen pheasants collected from estates where supplementary feeding continued into spring had larger fat reserves than hens from estates where supplementary feeding ceased after the end of the shooting season (see Table 1). The recorded levels of fat reserves of hen pheasants on estates which continued feeding in spring are comparable to fat reserves typically found in hen pheasants in winter (Carroll et al. 1997, Draycott et al. 1998), when supplementary feeding is common (Robertson, Woodburn & Hill 1993, Draycott et al. 1998). Therefore, our results imply that in the absence of spring supplementary feeding fat reserves may be reduced by approximately 40% of their winter levels. The results of our study imply that spring supplementary feeding is critical for maintaining pheasant condition at a time when hens should be accumulating energy reserves in preparation for the breeding season (Anderson 1972, Wise 1994, Draycott et al. 1998).

The provenance of the pheasants, i.e. whether they came from estates where hens were released or where the hens were wild, significantly influenced fat reserves.

Fat reserves were higher on wild estates than on reared bird estates (see Table 1). This could be due to habitat differences between these types of estates. For example, on estates where there is an emphasis on wild bird management, there is likely to be a higher level of natural food availability due to better quality habitat provision as these estates are reliant on the productivity of the wild population. Without this positive management, natural availability of grains and seeds in spring on modern farms is very low (Campbell, Avery, Donald, Evans, Green & Wilson 1997, Draycott et al. 1997). It is also possible that reared birds may not be able to either find or assimilate natural foods as well as wild birds (Putaala & Hissa 1995, Liukkonen-Anttila 2001).

Breast muscle mass was not influenced by any of the measured variables (see Table 1), and is often used by researchers (as an indicator of total body protein) to estimate body condition (Brittas & Marcström 1982, Tompkins et al. 2000). The fact that we found large differences in fat levels but no differences in protein levels between estates is indicative of a diet deficient in high energy foods rather than a deficiency in high protein foods. Indeed, previous research by the authors confirmed that it was food types with a high-energy component (e.g. grains and seeds) which were deficient in the diet of pheasants in spring (Draycott et al. 2000a).

H. gallinarum is widespread and abundant in pheasant populations (Draycott et al. 2000b). Although none of our measured variables significantly influenced parasite numbers (see Table 2), the mean parasite burdens of *H. gallinarum* and *Capillaria* sp. on estates where pheasants had been released within four years of our study tended to be higher than on estates with no history of pheasant releasing. It is likely that there has been a steady increase in the numbers of these worms in the environment due to the annual release of pheasants into the same location (Draycott et al. 2000b). As we found no effect of supplementary feeding on parasite burdens, it does not appear from our results that provision of grain via feed hoppers increases the susceptibility of pheasants to parasites.

We found no effect of *H. gallinarum*, *Capillaria* sp. or *S. trachea* on the body condition of pheasants, and our results thus are in agreement with Tompkins, Dickson & Hudson (1999) who also found no effect of *H. gallinarum* on the condition of pheasants. However, Woodburn (1999) showed that by dosing pheasants with an anthelmintic in spring to remove parasites, survival of hens was improved during the incubation period. It appears from the results presented in this paper that the improved survival of pheasants shown by Woodburn (1999) was probably due to factors other than reduced body condition. One possible factor could be increased scent emission of incubating hens when subject to intestinal worm infestation, as was suggested for red grouse *Lagopus lagopus scoticus* by Hudson (1992). It is also possible that there is an interaction between quality of diet, body condition and parasite burden, but this could not be identified in our analyses.

In order to maintain or improve condition of breeding hen pheasants, we recommend that availability of high-energy foods in spring is increased. This can be achieved by providing grain in spring breeding territories and through planting of wild seed food plots. Future research is required to determine the impact of improved body condition due to supplementary feeding on the survival and breeding success of pheasants.

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