RESEARCH NOTES

Marked Differences in the Splanchnometry of Farm-Bred and Wild Red-Legged Partridges (*Alectoris rufa* L.)

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ABSTRACT Relative weights of heart, spleen, pancreas, and liver and the relative lengths of the small intestine and the cecum were taken from 40 farm-bred and 43 wild juvenile red-legged partridges (*Alectoris rufa* Linnaeus) in central Spain. Expressed as a ratio to head and body length, farm-bred partridges had lighter hearts (17% lighter), spleens (78%), and livers (29%) and shorter small intestines (15%) and cecae (20%), than wild birds of the same age. When expressed as a ratio to body weight, farm-bred juvenile red-legged partridges had lighter hearts (12%) and livers (23%) and shorter small intestines (9%) and cecae (12%) than wild partridges. Those differences might have been produced by diet differences (such as fiber-poor, high-energy feeds used on farms) and may affect the survival of farm-bred partridges after release.

(*Key words*: *Alectoris rufa*, gamebird-breeding, red-legged partridge, Spain, splanchnometry)

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INTRODUCTION

According to official data, more than four million red-legged partridges (*Alectoris rufa* Linnaeus) are hunted yearly in Spain (MAPA, 1993) Over three million of these are farm-reared, and despite their economic and ecological importance, little is known about the factors that determine the poor effectiveness of partridge releases (Gortázar et al., 2000).

The splanchnometry of domestic poultry is well characterized (e.g., Balog et al., 1997) including the effects of different diets (Palo et al., 1995), management practices (Dafwnag et al., 1985), and pathologies (Lubritz et al., 1995). Much less is known about the splanchnometry of wild Galliformes and the physiological differences between farm-bred and wild birds (Putaala and Hissa, 1995). Some information is available on the development of the digestive tract and how fiber ingestion influences the development of the intestine in other Phasianidae (e.g., Hewitt et al., 1997) and some tetraonid species (Leopold, 1953). Greek partridges with larger intestines survive longer after release (Paganin et al., 1993) and reproduce better (Bergero et al., 1995). Moreover, the sudden shift from commercial to natural food affects the ability to utilize nutrients (Liukkonen-Anttila et al., 1999).

There is little information on the relative size of celomic viscera other than the intestine in wild Galliformes. In the gray partridge, *Perdix perdix*, artificial rearing may affect its physiology and anatomy, including lighter relative weights of the heart, liver, and gizzard (Putaala and Hissa, 1995). Rico et al. (1977) describe the splanchnometry of *A. rufa* but do not compare captive-bred and wild birds. Thus, the aim of this study was to describe the differences in the size of different celomic viscera between farm-reared and wild red-legged partridges.

MATERIAL AND METHODS

In November 1999, 43 wild red-legged partridges were collected from hunters in central Spain in areas with no farm releases. The wild birds were 5 to 7 mo old (Sáenz de Buruaga et al., 1991; Peiró and Seva, 1993). In addition, 40 farm-bred birds (also 5 to 7 mo old) were euthanized at a traditional breeding facility[2]. Farm-bred chicks were fed a commercial starter feed with 30% protein until 6 wk of age. After this, they were kept at a density of 0.5 birds/m^2 and given a commercial pelleted feed with an ME content of 2,750 kcal/kg (11,560 kj/kg), 19% protein, 3% fat, and 3.9% fiber. In addition to the commercial pellets, an increasing amount of whole wheat was provided, decreasing the initial fiber content from 3.9% (only pellets) to nearly 2% (final third, only wheat).

All partridges were weighed to the nearest gram with a portable dynamometer, and measured (to the nearest mm) from the tip of the beak to the base of the tail (head and body length). The heart, spleen, pancreas, and liver of each bird were weighed to the nearest milligram with precision scales, after resection of any fat or connective

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tissue and after drying for a few seconds on filter paper. We also measured one cecum and the small intestine from the pylorus to the rectum (Leopold, 1953). All measurements were taken by the same observer (J. Millán).

We used ANCOVA in all cases in which the analyzed factors (origin of wild or farm-bred and sex) fulfilled the requirement of parallelism. When the condition was not fulfilled, we used an ANOVA in which the dependent variable was obtained from the residuals of the regression of the original ANCOVA covariant and the original dependent variable (Neter et al., 1985).

RESULTS

Total and relative heart, spleen, pancreas, and liver weights, and small intestine and ceca lengths are shown in Table 1.

The average weights and lengths of the six viscera in relation to length and body weight were higher in wild partridges (increments from 9 to 78%). When the relative size of the viscera was compared in relation to length, five out of six cases were more affected by bird origin than by sex. Only the pancreas was not significantly influenced by bird origin. Sex had a significant effect on the relative weights of the heart and the pancreas. Most of the interactions between the origin and sex were not significant.

When the relative weight or length of the six viscera was calculated in relation to body weight, the effect of the origin was significant for heart, liver, small intestine, and cecum. Neither the effect of sex nor the interactions between the factors were significant.

DISCUSSION

The ratios of body weight to viscera were similar to those reported for a small sample of juvenile and adult *A. rufa* of both sexes and probable farm origin in France (Rico et al., 1977). Adjustment by covariance analysis reduced variation due to body weight and total length (Brown et al., 1985).

Intensive production of broiler chickens has repeatedly been associated with cardiac troubles (Greenless et al., 1989, Lubritz et al., 1995). In the first week of age, wild red-legged partridge eat mostly invertebrates (80% proteins, see Rueda et al., 1993), whereas most commercial starter feeds contain only 25 to 30% protein. We suggest that diets on the game farm with higher energy and less protein and little physical exercise (compared to wild birds) may cause differences in the relative heart size.

Spleen size may decrease due to dietary deficiencies (Kwak et al., 1999) but also due to stress (Puvadolpirod and Thaxton, 2000), heterosis, and parasites (Møller et al., 1999). Relative spleen sizes were overdispersed in both study groups.

Liver size is influenced by feed quality (Palo et al., 1995) and availability (Plavnik and Yahav, 1998). High

TABLE 1. Average ± SD (n) fresh weights of the heart, spleen, pancreas, and liver (g); of the lengths of the small intestine and the cecum (in centimeters); and ratios of weight or length to head and body length and to body weight are given for juvenile red-legged partridges (*Alectoris rufa*)

	Farm-reared partridges			Wild partridges			Difference (%)		
	weight (g)	weight/body length	% live weight	weight (g)	weight/body length	% live weight	weight/body length	% live weight
Heart	1.36 ± 0.1 (40)	5.60 ± 0.3 (39)	0.35 ± 0.03 (38)	1.48 ± 0.6 (39)	6.71 ± 0.9 (37)	0.40 ± 0.0 (38)	+16.6[ac]	+12.5[ae]
Spleen	0.18 ± 0.1 (36)	0.74 ± 0.4 (35)	0.05 ± 0.03 (34)	0.85 ± 1.1 (23)	3.43 ± 4.6 (23)	0.21 ± 0.3 (22)	+78.5[b]	+78.0[l]
Liver	5.32 ± 0.6 (40)	21.9 ± 2.3 (39)	1.36 ± 0.2 (38)	7.39 ± 2.2 (43)	30.77 ± 7.7 (40)	1.76 ± 0.4 (41)	+28.9[a]	+22.8[a]
Pancreas	0.74 ± 0.1 (33)	3.07 ± 0.8 (32)	0.19 ± 0.04 (31)	0.90 ± 0.3 (22)	3.59 ± 1.2 (22)	0.26 ± 0.2 (24)	+14.5[l,d,g]	+22.8[f]
	length (cm)	length/body length	length/live weight	length (cm)	length/body length	length/live weight	length/body length	length/live weight
Small intestine	67.12 ± 8.6 (40)	2.77 ± 0.3 (39)	1.73 ± 0.4 (38)	81.24 ± 9.1 (43)	3.25 ± 0.4 (41)	1.91 ± 0.3 (42)	+14.8[a]	+8.9[a]
Cecum	12.79 ± 1.8 (40)	0.53 ± 0.1 (39)	0.33 ± 0.1 (39)	16.98 ± 2.2 (43)	0.66 ± 0.1 (41)	0.40 ± 0.0 (42)	+19.7[a]	+12.5[a]

Superscripts indicate the statistical significance in the effect of the origin (wild vs. farmed; [a]$P < 0.001$, [b]$P < 0.01$), effect of sex ([c]$P < 0.001$, [d]$P < 0.05$), effect of covariate ([e]$P < 0.01$, [f]$P < 0.05$), and interaction between factors ([g]$P < 0.05$). ANCOVA in all cases except in those marked with superscript 1, where we used ANOVA.

fat and low protein levels affect liver development in broiler chickens (Latour et al., 1994; Honda et al., 1995) and could also affect farm-bred partridges.

Pancreas size may vary according to different external factors in the diet (Gentles et al., 1999), but feed protein levels in the first days of life seem to have the most remarkable effect (Salado et al., 1999).

Even if other factors, such as hormones, feeding rhythm, or parasites can also affect development, fiber content of the diet seems to have a major role in determining the size of the intestine (Leopold, 1953). Wild Galliformes on higher fiber diets have increased energy uptake (McBee and West, 1969). In broiler chickens, high-fiber diets stimulate larger villi and improve the immune capacity of the intestine (Hedge et al., 1978).

Behavioral aspects (Graves, 1979; Csermely et al., 1983; Bergero et al., 1995), habitat characteristics (Brun and Aubineau, 1989), and release design (Gortázar et al., 2000) surely play a major role in the poor survival of farm-bred partridges after their release in the wild. However, some of the differences in the relative weight or size of celomic viscera suggest that farm-bred partridges may also have poorer predator avoidance (Putaala and Hissa, 1995), lower resistance to disease (Møller et al., 1999), and more difficulties in utilizing natural feed (Paganin et al., 1993) than wild birds of the same age. Current farming practices could be improved by offering a more balanced feed or by lower stocking rates. In addition, these changes may also improve animal welfare.

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