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Heart/body weight ratio in the Willow Grouse *Lagopus lagopus* and Rock Ptarmigan *Lagopus mutus* in Finnish Lapland

ERKKI PULLIAINEN

The Rock Ptarmigan *Lagopus mutus* typically inhabits treeless summits of fells in Finnish Lapland, while the Willow Grouse *Lagopus lagopus* usually prefers different habitats in lowlands and on the slopes of fells, i.e. lower altitudes than the former species. During the critical winter period the weather on the summits of the fells is characterized by relatively high temperatures and high wind speeds, while the temperature in the valleys is much lower, but the weather is reasonably calm (Helimäki 1974). According to the "Heart Rule" (Hesse 1921), the heart/body weight ratio in birds is higher in colder than in warmer climates (for experimental evidence, see e.g. May & Deaton 1974), and it appeared interesting to study the extent to which this holds good in these two related species.

Altogether 183 Rock Ptarmigan were caught in the communes of Inari, Sodankylä and Utsjoki, Finnish Lapland, in November—May 1967—1969, and 299 Willow Grouse in Enontekiö, Inari, Salla, Savukoski, Sodankylä and Utsjoki. For comparison, the material included two Hazel Grouse *Tetrastes bonasia*, 16 Black Grouse *Lyrurus tetrix* and 12 Capercaillie *Tetrao urogallus* caught in central and northern Finland. The whole birds, their hearts (including the blood in the auricles and ventricles) and crop contents were weighed. All the birds were examined internally to determine the sex. The age class of each bird was determined by the methods described by Weeden & Watson (1967) for the Rock Ptarmigan, Bergerud et al. (1963) and Myrberget et al. (1969) for the Willow Grouse and Helminen (1963) for the Capercaillie.

The heart/body weight ratios in the two *Lagopus* species are shown in Table 1. The relative heart weight of the Rock Ptarmigan is seen to be highly significantly greater than that of the Willow Grouse in each age class in both sexes, whereas there are no statistically significant differences between the sex and age classes of the Willow Grouse or between the sexes in the Rock Ptarmigan. Adult female Rock Ptarmigan are shown to have relatively heavier hearts than juvenile females of the same species ($t=4.560$, $P<0.001$).

Theoretically, a smaller bird needs a more efficient blood circulatory system and relatively greater heart than a larger bird to maintain its homoiothermic condition at temperatures below the critical limit, which for *Lagopus lagopus* in its winter plumage is —8.5°C (West, cited according to Irving 1972:165). However, comparison of the body weights, heart weights and heart/body weight ratios in the specimens of various tetraonid species killed in northern and central Finland (Table 2) shows that the relative heart weight is not always greater in a smaller bird. The most striking discrepancy is found when the Hazel Grouse and the Rock Ptarmigan are compared. The former is about 30 g lighter than the latter, but its heart weight and heart/body weight ratio are very much smaller. The reason for this difference must lie in the living conditions and habits of these species. The Hazel Grouse spends most of the winter day inside the snow (Andreev 1977), where temperatures are only slightly below freezing point in cold weather and there is no wind effect, whereas in the habitats of the Rock Ptarmigan in Finnish Lapland the only shelter against the almost continuous wind is that offered by stones (Solantie 1974).

The Willow Grouse is another species which seeks shelter inside the snow cover at low altitudes (e.g. Andreev 1977), and although the temperatures prevailing in its winter habitats in the valleys are mostly lower than on the summits of the fells (Helimäki 1974), the effect of the wind and the exposed roosting sites of the Rock Ptarmigan seem to make conditions more severe on the summits. This is reflected in the heart/body weight ratios of the two birds, the Rock Ptarmigan having a relatively heavier heart than the Willow Grouse (Table 1). Similarly, Carey & Morton (1976) found that the heart weights of highland birds tended to be 11 % higher than those of lowland individuals of similar size.

The mean body weight of eight male Black Grouse caught in Berlin, Germany (Hesse 1921), was 1300 g and the heart/body weight ratio 1.1 %, while the present six adult males had a mean weight of 1266 g and heart/body

TABLE 1. Heart weight as a percentage of total body weight (weight of crop contents excluded) in *Lagopus lagopus* and *L. mutus* caught in Finnish Lapland.

Sex and age class	*Lagopus lagopus* No.	Mean±*SD*	*SE*	*Lagopus mutus* No.	Mean±*SD*	*SE*	*t*-test
Adult male	104	1.60±0.29	0.03	53	2.06±0.29	0.04	9.581 (P<0.001)
Adult female	71	1.57±0.34	0.04	50	2.10±0.13	0.02	9.797 (P<0.001)
Juvenile male	56	1.59±0.31	0.04	36	2.00±0.26	0.04	6.732 (P<0.001)
Juvenile female	68	1.57±0.27	0.03	44	1.89±0.27	0.04	6.171 (P<0.001)

TABLE 2. Mean body weights (g; weight of crop contents excluded), mean heart weights (g) and heart/ body weight ratios (%) in *Tetrastes bonasia, Lagopus mutus, L. lagopus, Lyrurus tetrix* and *Tetrao urogallus* caught in northern and central Finland in winter.

Species	*N*	Body weight Mean	Range	Heart weight Mean	Range	Heart/body weight ratio
Tetrastes bonasia	2	449.5	411—488	1.95	1.9— 2.0	0.434
Lagopus mutus	183	481.6	348—609	9.64	4.5—13.0	2.001
Lagopus lagopus	299	585.2	433—774	9.70	5.0—20.0	1.658
Lyrurus tetrix	16	985.7	542—1360	12.82	9.4—19.2	1.300
Tetrao urogallus						
— females	5	1464.0	726—1762	17.68	5.9—24.3	1.208
— juvenile males	3	2896.5	2578—3102	34.07	24.2—43.0	1.176
— adult males	4	4019.1	3800—4387	39.80	37.1—49.0	0.990
— all	12	2673.8	726—4387	29.15	5.9—49.0	1.090

weight ratio of 1.3 %. The corresponding values for four German and four Finnish Capercaillie are 4504 g — 0.91 % and 4019 g —0.99 %, respectively. In both cases the birds from the more northerly area have relatively heavier hearts.

The adult female Rock Ptarmigan appeared to have relatively heavier hearts than the juvenile females of the same species, although on average they weighed 16 g more than the juveniles. In Alaska the sexes are separated spatially in the Rock Ptarmigan (Weeden 1964), and in the Willow Grouse the juvenile females migrate farthest to the south from their nesting ground (Irving et al. 1967). Some sex and age class segregation of this kind might also explain the difference observed here, with the adult females spending their winters on the summits and the juvenile females at lower altitudes, where they can roost in the snow; in the mountains of NE Siberia the Rock Ptarmigan rest in cavities in the snow (Andreev 1975). However, so far there is no evidence of such behaviour in Finnish Lapland (see also Pulliainen 1970: 298—299).

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Selostus: Riekon ja kiirunan sydämen ja ruumiin painon välisestä suhteesta Suomen Lapissa

Inarista, Sodankylästä ja Utsjoelta pyydystettiin 183 kiirunaa ja Enontekiöstä, Inarista, Sallasta, Savukoskelta, Sodankylästä ja Utsjoelta 299 riekkoa marras—toukokuussa 1967 —1969. Lisäksi tutkittiin Suomen keski- ja pohjoisosista pyydystettyjä metsoja (12), teeriä (16) ja pyitä (2). Kaikilta linnuilta punnittiin kokonaispaino (kuvun sisältö poislukien) ja sydämen paino. Lintujen sukupuoli ja ikäluokka määriteltiin.

Kussakin ikäluokassa ja sukupuolessa kiirunoilla oli suhteellisesti suurempi sydän kuin riekoilla (taul. 1). Ns. sydänsäännön mukaan (Hesse 1921) kylmemmässä ilmastossa linnuilla on suhteellisesti suurempi sydän kuin lämpi-

mässä. Kun tuntureiden lakialueilla on usein talvella lämpimämpää kuin alhaalla laaksossa, voisi kiirunalla odottaa olevan suhteellisesti pienempi sydän, mutta tunturien lakialueilla huomattava tuulisuus ja se, että kiirunat eivät voi hakeutua lumikieppiin yöpymään/lepäämään, tehnee olot ankarammiksi kuin tunturien rinteillä ja laaksoissa elävillä riekoilla on ympärillään (mm. kiepissä). Tutkitut kaksi pyytä olivat keskimäärin vain n. 30 g kevyempiä kuin kiirunat, mutta niillä oli todella pieni sydän kiirunaan verrattuna. Pyyt viettävätkin talvipäivät hyvin halukkaasti lumikiepeissä, silloin kun eivät ole ruokailemassa. Suomen metsoilla ja teerillä oli suhteellisesti suurempi sydän kuin saksalaisilla yksilöillä (taul. 2).

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Mid-winter feeding activity of Siberian Tits *Parus cinctus* and a Great Tit *Parus major* at a feeding site north of the Arctic Circle

ERKKI PULLIAINEN

The Great Tit *Parus major* and the Siberian Tit *P. cinctus* are diurnal birds which usually awake in the twilight before sunrise and retire to roost at sunset or shortly afterwards (e.g. Franz 1943, 1949, Kluijver 1950, Haftorn 1972). In wintertime they sleep in natural cavities in trees or nest-boxes. In mid-winter in areas north of the Arctic Circle the time available for feeding is a short period around noon. Data on the activity times of tits at and north of 67° N have been published by Franz (1942, 1943, 1949) and Haftorn (1972). On 1—7 January 1980 an opportunity arose to study the feeding activity of the Great Tit and at least three Siberian Tits at a feeding site in the yard of the Värriö Subarctic Research Station (67° 44′ N, 29° 37′E). The nearest inhabited house was 6.6 km away, and no carcasses of ungulates were available in the immediate vicinity of the Research Station.

The light intensity was recorded every quarter of an hour from darkness to darkness, and the air temperature monitored at the Meteorological screen in the yard. The sun was above the horizon at noon, but not visible even under cloudless conditions, owing to the fells to the south of the site. Two chunks of