Wildlife Elective Course Essay

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# The photoperiods influence on the Svalbart ptarmigan, *Lagopus mutus hyperboreus*.

Svalbard, 79° N, is a part of the arctic, defined by the 10° isotherm for the warmest summer month. Animals here are exposed for extreme climates both in temperature and variation in daylight throughout the year. The Svalbard ptarmigan is the only resident bird that lives permanently at such high latitudes. Here the sun stays below the horizon for two months and cause total darkness from mid of November to February, while in the summer the sun stays above the horizon permanently and gives continuous daylight. It has been necessary for the svalbard ptarmigan to develop some adaptions for surviving in such a hash climate, like behavioural changes and deposition of huge stores of fat. It is therefore interesting how the photoperiods influence on the svalbard ptarmigans FI (food intake) and BW (body mass) throughout the year.

The university in Tromsø has done some research on these subjects, where they've tested the bird's reactions to light and measured the concentration of plasma melatonin, which is a hormone that usually is low during the day and high during the night. The blood sample was collected 5-6 times over a 24h period once a month for 13 months.
There have also been done some research where some birds were kept in continuous light from July 1984 to September 1985, some were transferred from winter days to continued light from November 1984 to November 1985, and some were exposed to short winter days from December 1984 to October 1985. The birds were kept in light-controlled rooms where the light was switched on and off by a timer, their food was weighed before and after sampling period and corrected for spillage. In another experiment they recorded the birds feeding activity, each time the birds crossed an infrared beam across the food box it was recorded.

The melatonin concentration was lowest in the summer and November/ December. The birds produced more melatonin during the spring than during the autumn, while in the summer the production is almost like zero, in November and march the concentration was on its highest night level.
The birds that were exposed to continue light from July one year, to September the next year, the BW increased from July to November, thereafter it remained stable for 10 months. FI the opposite. The birds that were transferred from winter to continuous light started to decrease their BW, thereafter a steady state for two months before they began to rebuild their fat stores, and kept them high for at least 9 months. FI the opposite.
BW decreased in the birds that were kept in long winter days while FI increased slowly. Thereafter the FI remained steady.
In the study were they recorded the birds feeding activity for one year it showed that the birds feeding activity was intermitted from the middle of November to the end of January, and from early April until the beginning of September (Reierth and Stokkan). The most intense period was in the summer, and males was particular intense from late April to mid June. From October until March the birds started to be night active, especially around midnight. In the early autumn when the sun starts to sink below the horizon the birds starts to feed around

sunrise, and ended their activity in the evening with sunset. As the night becomes longer out through the autumn the birds follow this pattern, but when the sun disappears totally from mid November to February, and in the summer when the sun stays above the horizon 24h their feeding activity was intermitted continuous around the clock.

A hypothesis that have been developed by an German biologist, Bunning, says that each day the animals have one light sensitive period when they are sensitive to light, most often its in the evening but in the arctic winter it's known to occur during the night, the animals do not react on the amount of light they receive but when it happens (p.267 Arnoldus Schytte Blix (2005), Arctic Animals, Tapir Academic Press). Melatonin is released after this photo stimulation, the concentration is low during the active part of the day, and high through the night, and seem to function as a clock by increasing when the birds is lesser active, and decreases towards the birds activity period. A funny phenomenon is that in the mid winter, November/ December when it's darkest, and the mid summer when it's lightest, the melatonin concentration is very low and the birds are active and feed continued around the clock. It seems like the decreased melatonin concentration makes the birds loose their clock, this at the part of the year when there is no kind of stimulation in form of variation in their environment. In the rest of the year the birds melatonin concentration increase towards the evenings, while their feeding activity goes in the opposite direction, and when the melatonin concentration turns their activity do the same. Except from the mid winter and mid summer the birds are most active in the morning twilight and the evening twilight, like they are preparing for an long and inactive night, and in the morning they are hungry after the long night.

The birds feeding activity can be seen in connection with the concentration in plasma melatonin, when the concentration is low the birds are active, and when the concentration is high the birds are inactive. High in the night gives low activity and low concentration in the day and they have high activity. The concentration of melatonin decreases in the spring, and increases in the autumn, also here the birds feeding activity follow the same pattern. In the birds BW keeps stabile throughout the hole summer, indeed it's easy the assume that it should increase because since the birds feed continues Ely, but the BW doesn't start to increase before in the end of the summer. In the end of the summer their BW increase, they builds up a fat storage, preparing for a long and hard winter. The birds keep their fat storage constant for the hole winter, it's first in the spring when the days becomes longer they'll sate to loose it, and then keeping a low BW through the summer. This fat storage is a reservoir the birds keep in case of emergency in the winter.
The birds live in a climate where there can be huge snow fall over several days, snow storms and very cold, and the ptarmigan is known to have than ability to go in "dock", they make a simple burrow in the snow where they can lay for several days. In this period when they can't feed they have their fat reservoirs. It has been showed that this reservoir can keep the bird alive for 16 days and that the Svalbard ptarmigan unlike most other birds do not respond to starvation with increased activity ( p.225, Arnoldus Schytte Blix (2005), Arctic Animals, Tapir Academic Press). After the bird has been starving it'll overeat just to replenish its fat resaves to the level it was before the starvation.

The birds that were kept in continuous light increased their BW and decreased their FI like they would have done after the summer. Then both the BW and the FI were kept constant for ten months, just like they would have done in a "real" winter.

The birds that were introduced to long days behaved just like they would have done in the spring, and then behaved like they do in the summer for nine months. They didn't show any signs to start building up their BW, preparing for the winter. The birds that were kept in short winter days decreased their BW and increased their FI slowly, and then kept it stabile the rest of the study. In all these experiment the birds did just what they would have done in the nature, prepared for the winter or the summer depending on the amount of light they were exposed to, but none of them showed the opposite changing. Neither BW nor FI is directly dependent of the changing in the amount of daylight, but is rather an effect of the seasonal changing, and since none of the birds were exposed to seasonal changing they didn't do what they naturally would have done.

It seems like the link between the birds and the photoperiod is the production of melatonin, which serves both as a calendar and a clock. Day light inhibits the production and the light-dark cycle synchronic the biological clock which drives the melatonin rythmicity. Animals which lives in such environments like there is in the arctic, with no clear distinction between day and night for many months of the year need a circadian (24h) mechanism that help the animals to fin out when it's night and when it's day. But in the mid wither and the mid summer there is no defined resting period. The rest of the year they are most active early morning and in the evening, they have a resting period in the lightest period of the day, maybe to reduce the chance to get eaten. It is possible the birds feeding activity in the morning is a result of hunger after a long night, but one shouldn't rule out that it is a response to the coming light, and since the animals starts to get active before the sunset there must be a mechanism inside the animal itself. Since their rhythm repeat themselves with 24 hours periodicities, it must be synchronised by the external environment as well.

**References:**

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Articles:

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