thermoneutrality, i.e. the zone of BMR. The difference between BMR and oxygen consumption at −20°C (Fig. 1C) represents compensatory heat production at −20°C [2] and again shows a seasonal rhythm with low values at short and high values at a long photoperiod. In both diagrams B and C the values for December and June differ significantly (t-test, $p < 0.001$).

In outdoor aviary studies where birds are exposed to both a changing photoperiod and changing temperatures, a seasonal variation in BMR is in most cases not apparent [3]. On the other hand, in the laboratory with constant photoperiod, adaptations to low ambient temperatures result in an elevation of the BMR [4]. These seemingly conflicting data can be combined in the hypothesis that short photoperiods depress the BMR while low ambient temperatures elevate the BMR, and that these two effects tend to cancel each other out in the natural winter situation; hence no seasonal rhythm of BMR is observed under field conditions.

On the assumption that in the birds kept at constant ambient temperatures and in seasonally changing photoperiods deep body temperature did not change, and in view of the fact that their body weight remained constant (the annual mean being 85 g), the seasonal variations in heat production can be interpreted as reflecting variations in overall insulation of the birds.

The data reported here support the hypothesis that changes in metabolic rate typical for winterbirds, are induced by a short photoperiod [1]. The results do not permit differenciation between a direct influence of short photoperiod on metabolism or a synchronizing effect on a circannual rhythm in metabolism.

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Migratory Fattening Endogenous Control and Interaction with Migratory Activity

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Recent studies of warblers demonstrated that the annual timing of migration is endogenously controlled by a circannual rhythmicity [1]. Moreover, there is evidence suggesting that even the temporal course of fall migration is endogenously preprogramed [1, 2]. Following these results it was tested whether the same holds true for migratory fattening and whether the intensity of migratory activity depends on the amount of fat deposited.

In 10 garden warblers (*Sylvia borin*), hand-reared in a constant 10:14 light/dark cycle and kept there throughout their first fall migratory period, fat deposition was temprarily reduced by starvation (Fig. 1). The behavior of these birds was compared with that of a control group (10 birds) which was fed ad lib throughout the experiment. The following results were

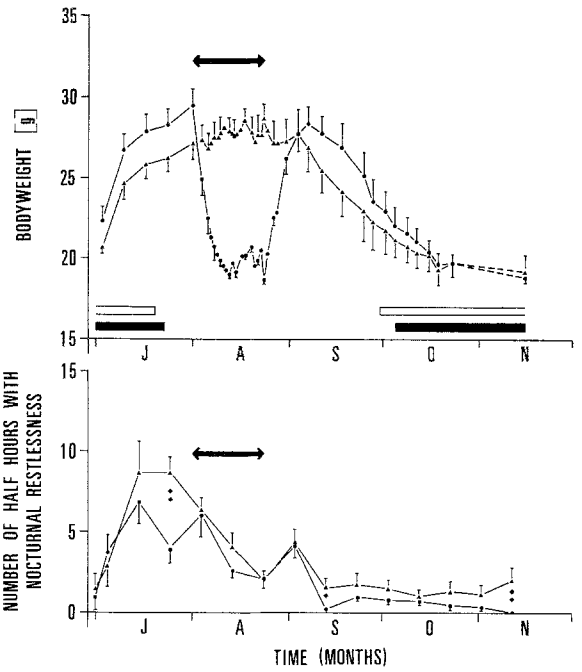

Fig. 1. Temporal course of fall migratory (nocturnal) restlessness and body-weight changes in *Sylvia borin* with and without an interposed period of starvation. ● Experimental group, ▲ control group, ↔ period of starvation, horizontal bars: molt (■ experimental group, □ control group), vertical bars: standard errors, ◆ probably significant difference ($p < 0.05$), ❖ significant difference ($p < 0.01$)

obtained: 1. Temporary reduction of migratory fat depots by starvation resulted in neither a subsequent exaggeration of fat depots nor in a prolongation of the period of fattening. 2. During starvation there was no reduction of migratory acitivity. From these results it is concluded that in *Sylvia borin* not only the temporal course of migratory activity but also that of migratory fattening is endogenously controlled. In addition, these results indicate that the internal programs of migratory activity and of migratory fattening are largely independent of each other. The results also suggest that free-living birds may start long nonstop flights across the Mediterranean and the Sahara even if their fat depots are low. Hence, food shortage, e.g. as a result of excessive insecticide use, may permit initiation but not completion of long nonstop flights and may, in addition to other factors, account for recent declines in long-distance migrants [3].

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Spontaneous Recombinations of Vocal Patterns in Parrots

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In the course of investigations on the mechanisms which underly and control the variable behavior of birds we have studied both the conditions and the consequences of vocal learning in grey parrots (*Psittacus erithacus*) [1]. Individuals of