RESPIRATORY METABOLISM OF THREE SPECIES OF RAPTORS

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The Sparrow Hawk (*Falco sparverius*) hunts during daylight, while the Screech Owl (*Asio otus*) and the Saw-whet Owl (*Aegolius acadicus*) are active mainly at night. Hypothetically, the metabolic activity patterns of each species should correlate with these periods of hunting. Although many studies have reported on avian metabolism, King and Farner (1961) point out the scarcity of data on this subject. Graber (1962), Collins (1963), and others who have studied the metabolism of owls have not compared their findings with the metabolism of hawks. In this experiment the respiratory metabolism of five specimens of hawks and owls was studied to gain insight into the relation between their activities and metabolic rates.

Methods and Materials

Three Sparrow Hawks (2 males and 1 female), one male Saw-whet Owl, and one female Screech Owl were kept in an insulated cabinet under controlled temperature ($27.0 \pm 1.8°C$) and light conditions for 2 to 5 days prior to the experiment. Birds were in complete darkness from 18:00 to 06:00 e.s.t. and in artificial light from 06:00 to 18:00 e.s.t. Each bird was fed 30 g of ground, day-old chicks every morning. The birds were starved for a 24-hour period preceding the test, which ran from 12:00 to 12:00, 31 October to 1 November 1967.

Each bird was weighed and put in a 4-liter glass jar that served as a metabolism chamber. A screw-on lid, fitted with two copper tubes for gas exchange, was sealed on with electrical tape. Jars containing the birds were placed in the control cabinet and connected to the air supply. Cardboard separators between the jars prevented visual contact. Gases were analyzed with a Beckman Model LB-1 Infrared CO_2 Analyzer connected in parallel with a Beckman F-3 Paramagnetic O_2 Analyzer; both were calibrated using commercial gas mixtures.

Atmospheric air was supplied to each chamber at a flow rate of 1 liter per minute. Incoming air passed through a glass wool filter and alumina drying chamber, and was adjusted to cabinet temperature by a copper manifold around the control unit. A bypass in this circuit allowed sampling of incoming air. Before analysis outside-air samples, metabolism-chamber samples, and test-gas samples passed through an H_2SO_4 bubble chamber to remove water vapor. The rate of air flow (240 ml/min) to the analyzers was regulated and adjusted to standard temperature and pressure by flowmeters.

Data on O_2, CO_2, and ambient temperatures were recorded on separate channels of a Beckman Type R Dynagraph. Chambers were sampled in sequence from one to six for periods of 3 minutes each; one full cycle of sampling required 21 minutes. A Solatron Data Logger and Model 33 Teletype connected to the Dynagraph read and recorded all data in digital voltage readings at 3-minute intervals during the sampling period.

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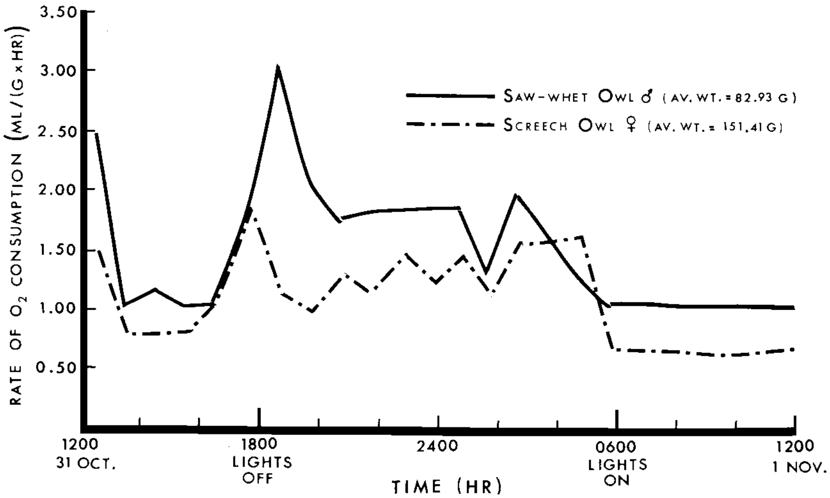

Figure 1. Rate of O_2 consumption of two owls during a 24-hour period (noon to noon).

The O_2 consumption readings, obtained from each chamber at regular intervals, showed fluctuations caused by varying degrees of activity at the instant the readings were taken. To narrow down the wide fluctuations in individual values readings were averaged by grouping to approximate hourly averages.

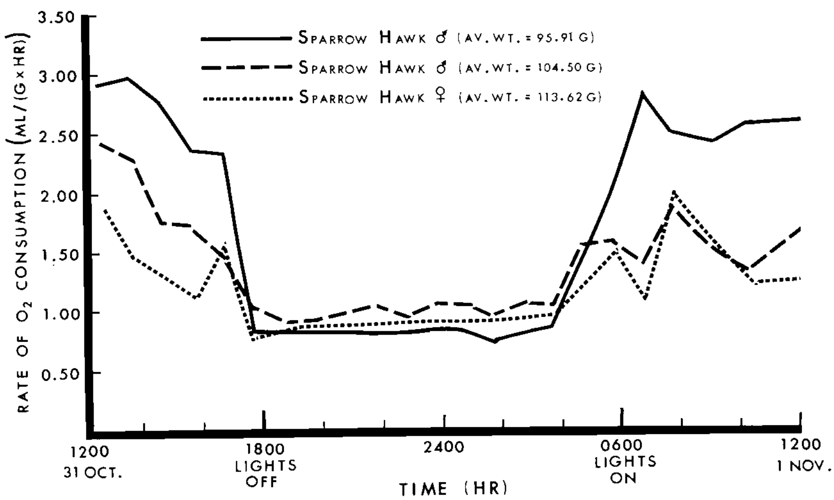

Figure 2. Rate of O_2 consumption of three hawks during a 24-hour period (noon to noon).

TABLE 1

MEAN O_2 CONSUMPTION AND TOTAL CALORIC EQUIVALENT USAGE BY EXPERIMENTAL HAWKS AND OWLS DURING THE 24-HOUR TEST PERIOD

		Day		Night		Overall	
Bird	Weight (g)	O_2 cons. ml/ (g × hr)	Cal. eq. kcal/ bird/ 12 hr	O_2 cons. ml/ (g × hr)	Cal. eq. kcal/ bird/ 12 hr	O_2 cons. ml/ (g × hr)	Cal. eq. kcal/ bird/ day
Saw-whet Owl	82.93	1.109	5.240	1.782	8.380	1.445	13.62
Screech Owl	151.41	0.839	7.240	1.329	11.678	1.084	19.918
Sparrow Hawk	95.91	2.384	13.031	0.980	5.115	1.682	18.146
Sparrow Hawk	104.50	1.566	9.351	1.092	6.471	1.329	15.822
Sparrow Hawk	113.62	1.322	8.561	0.969	6.227	1.146	14.788

RESULTS

The average respiratory quotient (R.Q.) values for each bird ranged from 0.74 to 0.78, indicating that all birds were in the postabsorptive state, metabolizing mainly fats, a prerequisite condition for measuring standard or resting metabolism (Dukes, 1955).

Hawks and owls displayed regular patterns in O_2 consumption plotted against time (Figures 1 and 2). The mean rate of O_2 consumption of owls was higher ($P < 0.10$) during the night than the daytime. Hawks consumed higher amounts of O_2 during periods of light than dark (Table 1). Peaks of O_2 consumption by owls occurred near nightfall. Major peaks of consumption came at 17:00 to 18:00 for the Saw-whet and 18:00–19:00 for the Screech Owl, with minor peaks at 02:00–03:00 and 02:00–05:00 hours respectively (Figure 1). Periods of maximum O_2 consumption by hawks occurred from 06:00–11:00, but were not so distinct as peaks shown by the owls (Figure 2).

DISCUSSION

The nocturnal owls showed a pattern of higher O_2 consumption during the night as was expected. The Saw-whet Owl had a higher resting metabolic rate per g body weight and nocturnal rate of O_2 consumption than the Screech Owl (Table 1). This difference in intake may be caused by the necessity of a higher metabolic rate for maintenance of homeothermy. The hawks showed the same relation between body size and metabolic rate.

The influence of body size and/or taxonomic differences is evident in comparing these two families. The kcal production was higher for the hawks (16.25) than for the Saw-whet Owl (13.62), but was lower than for the Screech Owl (19.92). Daily caloric equivalents for all birds (Table 1) are similar to those given by Lasiewski and Dawson (1967).

Periods of highest metabolism in both families occurred at the times when they are normally most active. The owls exhibited a major peak in the first few hours of darkness and a minor one before the lights came on again. A peak for the hawks prior to darkness was indistinct, possibly because of excitation in the new environment, but metabolic rates did drop abruptly before the lights went off. Their metabolic rates increased shortly before the lights were turned on in the morning, and reached a peak from 07:00–08:00. All of the above observations agree with those of Graber (1962).

Respiratory quotients for all birds, except the Saw-whet Owl, showed fluctuating patterns similar to those of O_2 consumption. Average R.Q.'s for light and dark periods indicate diurnal differences in metabolic activity, and may be used to determine derivation of energy produced by metabolic processes. The Sparrow Hawks had average R.Q.'s of 0.76 by day and 0.74 at night; the higher day R.Q. indicates they metabolized more carbohydrate than at night (Yapp, 1960). The Screech Owl had a higher R.Q. at night (0.83) than during the day (0.76). As the higher R.Q.'s correspond to periods of activity, perhaps carbohydrate metabolism is more important than fat when the birds are not resting (George and Berger, 1966).

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