The metabolizable energy of chicken scratch, the rhizomes of Carex lyngbei, and timothy grass to swans
R. McKelvey

Introduction
The study reported here was undertaken as part of an investigation of the ecology of Trumpeter Swans (Cygnus buccinator) wintering at Comox, BC. The major components of that study have been reported in McKelvey (1981). One of the main objectives of that study was to determine the food habits of swans wintering on the estuaries at Comox and at Port Alberni. Food habits per se, however, say nothing of the relative nutritive or energy values of each food item (Sugden 1971). Metabolizable energy (ME), the amount of energy an animal extracts from its food, is a much better expression of the food value (Hill 1964, Sugden 1971).

In the spring of 1978, an opportunity became available to assess the digestive efficiency of several captive swans at the Animal Care Facility of the University of British Columbia (UBC). I encountered problems in working with the swans, but the data acquired may be of use to others engaged in or contemplating studies of feeding efficiency with captive swans.

Information is presented here on the metabolizable energy of the maintenance diet (chicken scratch) fed to the swans, and of rhizomes of Carex lyngbei, an emergent plant that forms part of the diet of Trumpeter Swans wintering at Comox and Port Alberni (McKelvey 1981). I also conducted tests using fresh timothy grass to simulate a recently acquired winter diet of pasture grass at Comox (McKelvey 1981).

Methods
The feeding trials involved captive, semi-tame swans at UBC in April and May 1978. Two adult Trumpeter Swans (one male and one female) and one adult, female Tundra Swan (Cygnus columbianus) were obtained from the George C. Reifel Migratory Bird Sanctuary, Delta, BC, and two immature female Trumpeter Swans from aviculturalists R.B. Trethewey. All swans were maintained on commercially available chicken scratch while not on feeding trails, with water and gravel continually available.

The feeding trials took place in “metabolic cages”, constructed of 2.5 cm x 5.0 cm weldwire, measuring 1.2 m square by 2.4 m high. The cages were elevated 10 cm above the building floor on wooden blocks. Sheets of heavy waxed paper placed under the cages collected all spilled food and excreta. Trials lasted for 3 or 4 days. During each trial, I presented a measured amount of food, and the unused, spilled portions and excreta were collected once every 24 hours.

Results and discussion
The average ME and mean digestibility of chicken scratch, rhizomes of Carex lyngbei, and timothy grass to swans is shown in Table 1, and the nutritive composition of the tested foods in Table 2. All birds ate during the chicken-scratch trial, but only three swans ate the rhizomes, and only two ate the grass.

The dry weight of food consumed varied greatly, but was generally low, and all birds lost weight, except the Tundra...
Swan, which gained weight during the chicken-scratch feeding trial. Nitrogen balance was positive during feeding trials with chicken scratch, but negative for trials with rhizomes and grass.

The nitrogen-corrected ME of chicken scratch was just within the range of ME values (3.12 ± 0.01 to 3.60 ± 0.02) reported by Sugden (1971) for various grains fed to Mallards (Anas platyrhynchos). Swans probably digest grains with approximately the same efficiency as Mallards, and perhaps even better (cf. other waterfowl). Because the chicken scratch was a mixture of wheat and cracked corn, some differences in digestion efficiency, ME, and metabolizable energy might need to be considered. The swans were apparently not able to extract much energy from the timothy grass. That was probably a result primarily of the small amount of the grass used. The original intention had been to simulate the quality of the grass that swans had recently begun to consume on dairy pastures at Comox (McKelvey 1981). That was not possible, however, because of the time of year at which this project was conducted. Higher MEs might be expected to result from a grass diet lower in fibre and higher in protein, although increased feeding efficiency might not.

Trumpeter Swans grazing on dairies at Comox have an almost unlimited food source of good quality, so that they need not digest the grass food with much efficiency to be able to extract an adequate amount of energy. The existence energy for a 10 kg swan feeding on timothy grass with a ME of 1.46 kcal/g would require the consumption of 392 g dry weight of grass per day, or 1.8 kg wet weight per day. McKelvey (1981) calculated a daily consumption of 4.5 to 5.5 kg wet weight of grass per bird per day from dairy pastures near Comox. Given that the swans grazing on pastures at Comox would use much more energy, through flight, than the existence energy calculated here, and that there could have been more efficient use of the pasture grass, an ME of 1.46 kcal/g for timothy does not appear unreasonable.

Future studies would benefit from the use of hand-reared birds. The swans in this study, being used to the presence of the plants and could not account for the decrease in weight loss data available for only two birds, three birds were used in the trial.

Two possible source of error, which might have caused an artificial high estimate of the ME of Carex rhizomes, was the length of time allowed the swans to adapt to the Carex diet. Calculated MEs of test foods can be adversely influenced by the preceding diet. However, it seems likely that the adapted to a relatively easily digested food, such as chicken scratch, would initially digest a lower quality diet with depressed efficiency. As the gut adapted to the new diet, the efficiency of digestion would be expected to rise, as would the ME of the diet. Although some of the swans in this study fed on rhizomes during the feeding trial, they consumed very little, and two swans would not take rhizomes at all.

Following the calculations of Burton et al. (1979), one can calculate the amount of Carex rhizomes a free-living swan would require for its existence energy requirements. At 0.1C, the existence energy is calculated by log M = 0.6372 + 0.3500 log W, where M is the energy expenditure per bird per day and W is the weight of the bird in grams (Kendegr C.S. 1970). The existence energy for a 10-kg swan would be 572 kcal/day. At 0.48 kcal/g, this energy requirement would be met by 230 kcal dry weight of rhizomes per day, or approximately 1.6 kg wet weight. That estimation falls within the range that McKelvey (1981) reported, where consumption was estimated by measuring

### Table 1

<table>
<thead>
<tr>
<th>Food</th>
<th>Amount consumed (g)</th>
<th>Mean weight* change (%)</th>
<th>ME (kcal/g)</th>
<th>Digestibility (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken scratch</td>
<td>226.7 ± 31.4 (n = 18 days)</td>
<td>-2.3 ± 0.14</td>
<td>3.05 ± 0.10</td>
<td>75.8 ± 1.9</td>
</tr>
<tr>
<td>Rhizomes</td>
<td>25.2 ± 4.5 (n = 12 days)</td>
<td>-8.5 ± 0.32</td>
<td>2.48 ± 0.22</td>
<td>56.3 ± 4.5</td>
</tr>
<tr>
<td>Grass</td>
<td>10.6 ± 1.4 (n = 5 days)</td>
<td>-7.9 ± 0.05</td>
<td>1.46 ± 0.42</td>
<td>39.5 ± 8.5</td>
</tr>
</tbody>
</table>

* Calculated from weight before and after the trial.

### Table 2

<table>
<thead>
<tr>
<th>Food type</th>
<th>Dry matter (%)</th>
<th>Crude protein (%)</th>
<th>Fibre (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken scratch</td>
<td>86.0 ± 0.7 (n = 5)</td>
<td>12*</td>
<td>3.6*</td>
</tr>
<tr>
<td>Rhizomes</td>
<td>14.7 ± 0.6 (n = 45)</td>
<td>7.1 ± 0.31</td>
<td>7.8 ± 1.7</td>
</tr>
<tr>
<td>Grass</td>
<td>22.2 ± 0.1 (n = 4)</td>
<td>2.6 ± 0.1</td>
<td>36.4</td>
</tr>
</tbody>
</table>

* Supplier's analysis. Based on data in McKelvey (1981) for Carex rhizomes from Port Alberni.

### Acknowledgements

Many people helped with various aspects of this study. I thank N. Verbeek, senior adviser for my thesis work, and H. Norden for making the Animal Care Facility available. The British Columbia Waterfowl Society and R. B. Trethewey supplied the swans, and A. Tepper and the late A. Bottrel assisted in caring for them during the study. My thanks also go to P. Whitehead, E. McEwan, and R. Savard for many helpful discussions, and to H. Boyd and L. Sugden for reviewing earlier drafts.