dry-ashed with Mg(NO₃)₂ (Ames, 1966) before phosphate determination with Malachite Green/molybdate (Duck-Chong, 1979). Radioactivity of individual lipids was determined by liquid-scintillation counting in Ria-Luma scintillation fluid. Total sterol concentration was determined by the Lieberman–Buchard method (Lynch et al., 1963). The specific radioactivity of PtdCho and PtdEtn (Bq of ³²P/nmol of lipid P₄) was plotted as a function of time (h) from the end of the pulse. The specific radioactivity of these molecules from both temperatures rose exponentially, followed by an exponential decay. The half-lives (T₁/₂), calculated from the decay curves (Table 1), were similar for PtdCho at 5°C and 20°C. The T₁/₂ of PtdEtn was shorter than that of PtdCho, but the same at the two temperatures. Parallel curve analysis (not shown) confirmed that the rates of turnover of the two molecules are not affected by the temperature change.

It seems unlikely, therefore, that the elevated phospholipid levels in cooled roots can be explained by the effects of temperature on turnover. Other evidence, as well as that from ³²P incorporation during the pulse label, shows that synthesis increases in the cold (Kinney et al., 1982; Kinney & Clarkson, 1982), which may explain the increased phospholipid levels in cooled roots. It is, however, remarkable that phospholipid turnover should be similar in roots growing at 5°C and in those growing twice as rapidly at 20°C. Acclimatization appears, therefore, to have compensated for a 15°C difference in temperature in a process that is largely enzymic (Galliard, 1980). This suggests that there may be some versatility in the structure of the proteins themselves or in the factors that regulate their activity.

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Seasonal changes in the concentrations of thyroxine and its transport proteins in sheep plasma

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Plasma thyroxine (T₄) concentration tends to be minimal in the autumn and elevated towards midwinter during the breeding season in ewes (Annison & Lewis, 1959; Sutherland & Irvine, 1974) and in wethers (Wallace, 1979), but the relationship between T₄ and its transport proteins has not been examined in detail over a complete annual cycle. Thyroxine-binding globulin (TBG) and thyroxine-binding ‘prealbumin’ (TBPA) have now repeated over the 1981/1982 breeding season. The isolated groups.

<table>
<thead>
<tr>
<th>Expt. Period</th>
<th>No.</th>
<th>Sex</th>
<th>[TBG] (mg/ml) (mean ± S.E.M.)</th>
<th>TBG (µg/ml)</th>
<th>TBPA (µg/ml)</th>
<th>Albumin (mg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I August 1979–August 1980</td>
<td>4</td>
<td>Male</td>
<td>42.4 ± 1.7</td>
<td>19.7 ± 0.5</td>
<td>333 ± 5</td>
<td>37.1 ± 0.55</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Female</td>
<td>57.2 ± 2.3*</td>
<td>22.8 ± 0.2*</td>
<td>355 ± 9</td>
<td>36.4 ± 0.53</td>
</tr>
<tr>
<td>II September 1981–March 1982</td>
<td>4</td>
<td>Male</td>
<td>39.9 ± 1.9</td>
<td>17.9 ± 0.5</td>
<td>357 ± 8</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Female</td>
<td>59.9 ± 3.2*</td>
<td>23.0 ± 0.9*</td>
<td>293 ± 13</td>
<td>—</td>
</tr>
</tbody>
</table>

* Significantly different from male group, P < 0.001.
In examining this possibility, both TBPA and its ligand, T₄, were determined in plasma of test groups of five young intact male and female Japanese quail maintained under constant light (6L/18D*) but exposed to artificial light with changes in photoperiod three times those of the natural daily ones so that this change in concentration may directly influence plasma T₄.

In the control groups kept under constant 7L/17D photoperiod, mean plasma TBPA concentration showed no regular pattern of change but remained within the ranges of 250-320 pg/ml when the photoperiods were greater in the range 17L/1D-12L/12D corresponding to the months of May-September. In the control groups kept under constant 7L/17D photoperiod, mean plasma TBPA concentration showed no regular pattern of change but remained within the ranges of 250-475 pg/ml for the male group and 300-550 pg/ml for the female birds.

The mean plasma total T₄ concentration in the test groups also tended to change in parallel with TBPA, showing correlation coefficients (r) of 0.88 and 0.89 (n = 24) for male and female quail respectively. The values for short-day samples were in the range 10-7 ng/ml for the former and 12-8 ng/ml for the latter group, but declined to the narrower range of 5-6 ng/ml over the longer photoperiods corresponding to the months of November-December in both male and female groups.

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The effect of photoperiod on thyroxine transport in Japanese quail

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The concentration of free thyroxine (T₄) available to tissues of birds is dependent on the bound form transported in plasma attached mainly to thyroxine-binding prealbumin (TBPA) with a small proportion bound to albumin (Robbins et al., 1978). The concentration of total T₄, however, undergoes seasonal variations in the chick (Reineke & Turner, 1945) and transitory stimulation in intact Japanese quail transferred from short (6L/18D) to long photoperiods (18L/6D) (Baylé & Assenmacher, 1967; Follett & Riley, 1967; Sharp & Klandorf, 1981). Recently, the plasma concentration of TBPA was found to vary inversely with length of photoperiod, whereas that of albumin remains virtually unchanged in Japanese quail throughout the annual light cycle (El-Sayed et al., 1980). The TBPA concentration in the longer photoperiods of late spring and summer is only about half that of the short-day peak values in winter, and this change in concentration may directly influence plasma T₄ concentration.

In examining this possibility, both TBPA and its ligand, T₄, were determined in plasma of test groups of five young intact male and female Japanese quail maintained under constant temperature (21°C) but exposed to artificial light with changes in photoperiod three times those of the natural daily ones so that the annual cycle was completed in 4 months. Birds so treated also show cyclic changes in TBPA comparable with those observed in the annual cycle (Heaf et al., 1982). All birds were reared under short days (7L/17D) and at 6 weeks old placed on experiment. Control groups were maintained on short days throughout. Blood samples (400 μl) were taken from alternate wing veins into heparinized capillary tubes each week for 6 months (≈14 annual cycles). After separation of the blood cells the plasma was stored at −20°C until required for analysis. T₄ was first extracted (Murphy, 1965) and determined by radioimmunoassay using poly(ethylene glycol) as precipitating agent (Ratcliffe et al., 1974) and TBPA by radial immunodiffusion (Mancini et al., 1965), with all samples from each bird being run simultaneously.

The mean plasma concentration of TBPA for each test group changed inversely in relation to length of photoperiod. It was 530-450 pg/ml at the outset, with short photoperiods from 7L/17D to 12L/12D as occur in the months of November-March in both male and female groups, and declined to 250-320 pg/ml when the photoperiods were greater in the range 17L/1D-12L/12D corresponding to the months of May-September. In the control groups kept under constant 7L/17D photoperiod, mean plasma TBPA concentration showed no regular pattern of change but remained within the ranges of 250-475 pg/ml for the male group and 300-550 pg/ml for the female birds.

The mean plasma total T₄ concentration in the test groups also tended to change in parallel with TBPA, showing correlation coefficients (r) of 0.88 and 0.89 (n = 24) for male and female quail respectively. The values for short-day samples were in the range 10-7 ng/ml for the former and 12-8 ng/ml for the latter group, but declined to the narrower range of 5-6 ng/ml over the longer photoperiods corresponding to May-September in both groups. Thyroxine concentration in the plasma of the control groups showed no correlation with TBPA in the male birds (r ≈ 0.14) and was just significant in the female quail (r = 0.48 (P < 0.02, n = 25)) and tended to remain more uniformly high within the range 7-12 ng/ml.

Gonadal development in Japanese quail occurs with photoperiods of 11L/13-11D as in March-April, when the concentration of TBPA declines more rapidly. The mean T₄ level also declined over this period towards its minimum value in June, where it remained until September/October, by which time the gonads are known to regress. The reduction in T₄ level could arise either through reduced production or increased utilization of the hormone or perhaps by limiting the concentration transported from the thyroid via its carrier proteins, particularly TBPA. An immediate change from short to long days appears to cause initially an increased production of T₄ (Sharp & Klandorf, 1983).