discrepancy between oxygen delivery and oxygen demands is a possible explanation for smaller body size in ectotherms developing at high temperatures. Alternatively, other studies have suggested advantages to large size at lower temperatures, but not necessarily to small size at higher temperatures (e.g. McCabe and Partridge 1997; Fischer *et al.* 2003; see also Chapter 7). Given substantial variation in final body size relative to environmental temperature in the field (Chown and Gaston 1999), and that mechanisms of temperature-related size variation have yet to be resolved (Berrigan and Charnov 1994; Blanckenhorn and Hellriegel 2002), this field remains interesting and productive. Recently, stoichiometric work has started providing additional insights into the implications of temperature-related body size variation. Chemical analyses of *Drosophila* species show substantial variation in nitrogen and phosphorus contents, with the N and P contents of individual species being positively correlated with each other and with the N and P composition of the breeding sites (Jaenike and Markow 2003). Moreover, a variety of cold-acclimated organisms, including *Drosophila* species, exhibit substantially increased levels of N and P, as a result of both concentration changes and larger body sizes at low temperatures (Woods *et al.* 2003). It might, therefore, be useful for herbivores to forage on plants growing in cool microenvironments.

There is an extensive literature on the temperature dependence of larval growth rates in insects (Ayres 1993; Casey 1993; Stamp 1993). Most laboratory studies have been carried out under constant temperatures, but growth may be stimulated or inhibited in a fluctuating temperature regime, which better resembles field conditions (Ratte 1985). As an example of differing thermal response curves, Knapp and Casey (1986) compared the temperature sensitivity of growth rates in two caterpillar species. Eastern tent caterpillars *Malacosoma americanum* (Lasiocampidae), which hatch early and behaviourally thermoregulate, grow at rates that are highly dependent on temperature. By contrast, those of gypsy moth caterpillars *L. dispar* (Lymantriidae), which hatch later and are thermal conformers, are independent of temperature at ecologically relevant temperatures of 25–30°C. The African armyworm *Spodoptera exempta* (Noctuidae) shows a density-dependent polymorphism resembling that of migratory locusts, and the *gregaria* phase develops much faster than the *solitaria* phase (Simmonds and Blaney 1986). Casey (1993) suggested that *solitaria* caterpillars are thermal conformers, switching to a thermoregulating strategy in the *gregaria* phase. However, Klok and Chown (1998a) found no evidence of behavioural thermoregulation in *gregaria* in the field and concluded that different development rates recorded in several studies most likely result from differences in utilization of food.

Behavioural thermoregulation (see Chapter 6) has physiological consequences for feeding, growth and reproduction, exemplified in field and laboratory studies of acridid grasshoppers. Populations of *Xanthippus corallipes* at different altitudes maintain similar metabolic rates, because smaller body mass at high elevations, which leads to relatively higher mass-specific metabolic rates, is offset by lower T_b in the field. Stabilization of field metabolic rate enhances total egg production, assessed by counting *corpora lutea* of females at the end of the reproductive season (Ashby 1998). During sunny days, *Melanoplus bivittatus* regulates its body temperature (T_b) between 32–38°C and has an essentially non-functional digestive system during the night (Harrison and Fewell 1995). The rate of digestive throughput is strongly limiting at low temperatures but this process has a high Q_{10} so growth is fast at high temperatures. Variables such as food consumption and faecal production are more temperature-sensitive (have a higher Q_{10}) than variables reflecting chewing and crop-filling rates. Within the range of preferred T_b, ingestion and processing rates are well matched. Faster growth at high temperatures is more an effect of faster consumption than of increased efficiency, and this is also true of caterpillars. In general, thermoregulating caterpillars and grasshoppers have higher Q_{10} values for feeding and growth than thermoconformers, which must be able to grow over wide temperature fluctuations in the field. Note that endothermic insects will also experience intermittent digestive benefits.

Social caterpillars in the family Lasiocampidae (tent caterpillars) show highly synchronized bouts