THERMAL BIOLOGY OF THE HONEY BEE: AMAZING TRANSFORMATION FROM POIKILOTHERMY TO HOMEOTHERMY

Summary

Animals show various strategies of thermal regulation. Lower vertebrates and invertebrates are classified as poikilotherms. Some insects, however, are endothermic (they can maintain a high body temperature by internal heat production) when they are active. In contrast, at rest they become ectothermic and their body temperature changes parallel to ambient temperature. Such a strategy, similar to that used by small mammals and birds, is referred to as heterothermy. Most insects can use a variety of behavioural responses to escape from both cold and hot microenvironments, so they are able to prevent excessive changes in body temperature. Both physiological and behavioural mechanisms are extremely well developed in honey bees. In the cold, an isolated bee is able to warm up its thoracic flight muscles by simultaneous contractions of the antagonistic muscles. Because the thorax is covered by furry scales the generated heat is retained in the body. In the heat, an active bee needs to dissipate excessive amount of heat generated by flight. This is achieved through evaporative cooling and increased heat convection, resulting from circulation of blood between the thorax and the abdomen. Because bees live in colonies consisting of thousands individuals, behavioural thermoregulatory responses of a single bee serve not only its own body temperature, but that of the entire colony as well. Such a social behaviour results in a permanent thermal stabilization of the colony. In the colony the majority of bees are no longer heterothermic individuals since, from the thermal biology viewpoint, the group as a whole behaves like a mammal or a bird. Even small groups of bees (10–20 individuals), placed in a thermal gradient system, behave like a mammal. Both a mammal and a group of bees for night sleep choose a slightly warmer environment than for their diurnal activity. To reduce surface heat transfer at night bees cluster together and a mammal curls up. Such behavioural responses of the honeybee swarm are obviously superior to those available to a single mammal. Therefore, the swarm can be regarded as a homeothermic superorganism.