Every year, millions of passerine birds fly distances of several thousand kilometers in their twice-annual migrations. Most of bird migration time and energy is spent during stopovers, and only approximately a third of the total energy, and a seventh of the total migration time is spent in flight. In the Western Palearctic region many of these migration journeys include flights over the belt of deserts of Southwest Asia and North Africa which are characterized by both low food and water availability. Thus, successful migration depends on optimal management of time and energy. Prior to commencing the migration flight over deserts, where feeding (or refueling) is limited or even impossible, birds must accumulate large quantities of fuel. However, not only fuel but also water and its availability appears as an important factor limiting the performance of migrating birds, during both flight and stopover. When ambient temperature exceeds body temperature, as in desert areas, the only way to dissipate heat is to evaporate water from body surfaces, and it is suggested that whole animal performance is limited by its capacity to dissipate heat. Effective heat dissipation is necessary to avoid detrimental consequences of hyperthermia resulting from strenuous, energy demanding activities during migration at high ambient temperatures. Keeping in mind that many small Temperate Zone passerines migrate to their African over-wintering areas across hot and dry deserts and move by active flapping flight, it is important to know whether successful migration of small birds is constrained by the ability to effectively dissipate heat and the need to conserve water. We hypothesize that small passerine birds face a physiological and ecological conflict between the need to conserve water on migration and the need to effectively dissipate heat, especially while crossing the inhospitable dry and hot deserts *en route*. This becomes more of a problem when results of recent studies on the biological consequences of global climate change are brought into the picture. Global change increases the likelihood of heat waves, reduces freely accessible water in many areas of the world and increases the burden on maintaining the water balance. Observed population decline in many long-distance migrants is largely unexplained, yet may be associated with the increasing problem of migration across a growing ecological barrier under more often extreme temperature conditions. It is still not known whether small migrating birds evolved mechanisms which would allow for both, effective heat dissipation when active, and water (and energy) conservation when resting. We predict that small passerine birds reduce their resting evaporative water loss (EWL) and resting metabolic rate (MR) when acclimatized to heat or desiccating conditions, or both, while maintaining the effective heat dissipation during migration effort. The results of our study will provide mechanistic explanations for problem of maintaining energy and water homeostasis during migration, as well as will provide deeper understanding of the limits posed by global climate change to birds living in the Temperate Zone, which twice a year cross the belt of deserts along the migration route. The results of the proposed research will be of interest to students of comparative and evolutionary physiologists as well as for those interested in mechanistic explanations for the observed changes in avian ecology and demography. To the best of our knowledge, it will be the first study describing flexible changes in avian physiology along the migration route, with the special emphasis on heat dissipation capacity.