ABSTRACT

In this thesis I present some of my main findings resulted from my research activity between 2005 and 2014, after I finished my PhD. The results are centered around three topics which are the followings: (1) the study of the function of the uropygial gland in birds; (2) the role of different physiological traits in defense against coccidians, the seasonal change of immune function and oxidative physiology in the house sparrow, and the consequences of developmental trajectory of different immune traits in the function of innate immune function in European birds; and (3) the ecomorphology and functional ecology of feathers.

The main findings of the first set of studies are: (1) The size of the uropygial gland varies seasonally in male and female house sparrows, and during breeding, females have larger gland size than males; (2) In an experiment, where house sparrows were glandoctomized we found no effect of the gland oil on the abundance of feather mites, which proves the limited role of the gland oil in the regulation of the number of ecto-symbionts living on birds; (3) Feather mites are sensitive to the change in day-length, hence they can forecast photoperiodic dependent events, like breeding and moulting. In a second experiment we found that (4) the gland oil has no effect on the abundance of feather degrading bacteria, which challenges the hypothesis stating the inhibitory role of the gland oil on these micro-organisms, and (5) the gland oil suppresses the growth of bacteria other than feather degrading, supporting the regulatory effect of this organ in the abundance of microbial community living on feathers. In a comparative study on European birds we found that (6) the size of the uropygial gland correlates with the total egg surface in a clutch, supporting the idea that the gland oil has a regulatory function on the egg-surface dwelling bacteria; (7) the size of the gland varies seasonally probably in function of the bacterial load of the environment; and the (8) ecological traits such as the migration, habitat and sociality affect the size of the gland.

In the second part of the thesis I present a set of result about the function of different immune and oxidative physiology traits in defense against parasites and about the developmental constraints of immune traits. The main results of these studies are: (1) different components of the immune system vary seasonally in the house sparrow, (2) the sexes may differ in their physiological cycling, (3) males are generally immune-suppressed during the breeding season due to the costly reproductive activity, (4) measures of oxidative physiology vary inconsistently over the year, (5) the sexes are similar in the measures of oxidative physiology, and (6) most of the immunological and oxidative physiology variables are not affected by coccidians, which are common extracellular intestinal parasites of birds. These results show, that the commonly assumed physiological

adaptation of temperate birds to the seasonal variation of environmental conditions is context dependent (i.e. it is a function of the physiological trait measured). Finally, (7) I present the results of a phylogenetic comparative analysis on 105 European bird species, which evidenced that the number of leukocytes and the levels of natural antibodies (Nabs) and complement, measured on adult birds, increased or tended to positively correlate with the length of incubation period. However, this study also found that the length of incubation and fledging periods have opposite effects on immune defence (i.e. immune parameters show a negative association with the length of fledging period). These results suggest that the contrasting effects of the incubation and fledging periods are related to the timing of the development of immune cells and of NAbs and complement, which largely mature during the embryonic phase of development. Finally, in support of the pace-of-life hypothesis, we found that the basal metabolic rate significantly or marginally negatively correlated with immune measures.

The third part of the thesis refers to the morphology and functional ecology of feathers. Feathers are a unique characteristic of birds and play a fundamental role in flight, thermoregulation, waterproofing and visual communication. The morphology of the feathers may vary depending upon their function and the aerodynamic forces they are subject to. Species differ in the amount of time they spend flying, their flight speed and flight-type, all of which expose the wing feathers to different amounts of aerodynamic forces. Besides the main aerodynamic function of the primary feathers, the water repellency and resistance to water penetration of feathers is also essential to maintain their function during flight. Water repellency and resistance to water penetration of the feather vanes is a function of width and spacing of the barbs, and of barbs and barbules, respectively. Despite of the well-known evidences regarding the function of the flight feathers in birds, we know very little about the functional morphology of feather structure and developmental constraints during moulting. I addressed these questions using observational, experimental and comparative approaches, and I found that (1) the feather structure varies within and between species and (2) it is affected by a suit of factors such as: the food supply during moulting, parasite infection, flying behaviour, migration, habitat and the time available for moulting. These results have a broad implication in the study of functional morphology of feathers, such as the evolution of physical colours under different environmental and aerodynamic constraints and may help in reconstruction of the flying mode of extinct birds.

At the end of the thesis I present some of my ideas and plans as an academic and researcher.