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Variation of heterophil-to-lymphocyte ratio in the Great Tit *Parus major* — a review

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Abstract. Permanent changes in the surrounding environment cause long-term stress in birds, which, when lasting days or weeks, affects the activity of the immune system and increases susceptibility to diseases, leading to changes in the levels of haematological parameters. The heterophil-to-lymphocyte ratio (H:L-ratio) is generally considered an independent and robust indicator of stress level in birds. This parameter allows in a simple way to evaluate activity of the immune system and individual health state of adult and nestling birds. It also enables assessing a body response to short- and long-term stress induced by, among others, the surrounding environment, social stress, blood parasites or a greater energy expenditure of females during breeding. Under conditions of field work the determination of the H:L-ratio is not difficult because what is only needed to conduct a blood smear test is a drop of blood that can be easily obtained even from birds of a small body mass. Moreover, an increase in the H:L-ratio is observed after about an hour from the moment of catching a bird contrary to other measurements like the determination of a baseline level of corticosterone.

In this article available literature that discusses the impact of various factors on the H:L-ratio in the Great Tit as a species of 'fast-paced' life is reviewed. In adult and nestling birds the H:L-ratio is influenced by various factors — ecological and ecophysiological ones. In some cases the same factor, e.g. brood size manipulation or a type of habitat, can significantly influence the level of the discussed stress indicator as well as it may not show any impact at all. While interpreting the H:L-ratio one must take into account an impact of various ecological and ecophysiological factors on health state, such as habitat, phase of the annual cycle, differences between brood attempts, sex, age as well as on relations with other indicators of condition e.g. body mass or total blood haemoglobin concentration.

Key words: H:L-ratio, stress, *Parus major*, physiological stress, haematological parameter, hole-nesting passerine

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INTRODUCTION

The heterophil-to-lymphocyte ratio (H:L-ratio), commonly used as a haematological index, is a relatively simple evaluation of the efficiency of the immune system and individual health state of birds (Ots & Hõrak 1996). Moreover, this parameter allows for assessing the body response to short- and long-term stress, induced by the surrounding environment (Gross & Siegel 1983, Maxwell 1993). The stress level is not only manifested by increasing heterophil numbers — heterophilia (Harmon 1998), but also by decreasing lymphocyte numbers — lymphopenia (Krams et al. 2013a), both of these phenomena were proven in studies on poultry and wild birds, including adult passerines and their nestlings.

Heterophils are non-specific cells that proliferate to the tissues during a body response to inflammatory processes (Ots et al. 1998) and kill of pathogens (Stabler et al. 1994). Heterophils play a major role in an innate immune response (Krams et al. 2012) and their number grows in response to long-term bacterial and fungal infections as well as irregularities related to diet and stress (Gross & Siegel 1983, Maxwell & Robertson 1998). In one cubic millimeter of blood in adult domestic or captive birds the number of heterophils fluctuates within 3,000–12,000, which accounts for 40–75% of the total number of leukocytes (Buczek et al. 1999). In turn, lymphocytes are leukocytes taking part in acquired immune responses (Ots & Hõrak 1998, Pap et al. 2010), humoral (B-cells, develop in the bursa of Fabricius) and cell-mediated (T-cells, develop in the thymus) (Sharma 1991, Davison et al. 2008). In birds lymphocytes represent the largest group of cells of the immune system and account for between 20 to 50% of all white blood