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Protected areas: reservoir of cryptic biodiversity.

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Protected areas are key sites for promoting long-term species conservation and to study biodiversity and evolution of species outside human pressure. In such areas, biodiversity and density of some species can reach extremely high values due to the fact that ecosystems evolved naturally for years (i.e. butterflies, PASCHE et al. 2007). Therefore, these areas also offer a high opportunity to collect and to detect cryptic species. In most biodiversity studies as well as in monitoring projects, correct taxonomic assessment is a fundamental prerequisite to understand, manage and preserve the natural world, especially in the face of the actual biodiversity crisis. Nevertheless, cryptic species, which are morphologically hardly distinguishable (BICKFORD et al. 2007), represent a major challenge to assess correct species identification and a potential bias in biodiversity surveys and conservation plans. We present below an example related to our long-term studies on red wood ants within the Swiss National Park.

Mound building red wood ants (species of the *Formica rufa* group) belong to one of the most studied groups of ants in Europe (see COTTI 1963, 1995, 1996; CHERIX et al. 2006). Red wood ant species - so called because of their reddish and brown coloration and because of their preference for forested habitats have fundamental roles and positive effects in forest ecosystems of the northern hemisphere: they reduce the density of pest species and other invertebrates of the forest floor thanks to their super-predator behaviour (PAVAN 1959, 1981); they are major seed disperser and improve soil aeration processes, favouring plant colonization and growth; they modify their habitat by hunting many other invertebrates and by structuring ant communities (SAVOLAINEN & VEPSÄLÄINEN 1988; SAVOLAINEN et al. 1989); they cultivate and protect honeydew-producing homopterans, which benefit to other species like honeybees (WELLENSTEIN 1960); they are key component of the diet of other animals like the European brown bear (GROSSE et al. 2003); their nests provide an excellent habitat for numerous other species (LAAKSO & SETALA 1997, 1998); they take part to nutrient cycles, like phosphorus and carbon mineralization, by stimulating the transformation of soil organic matter (DOMISCH et al. 2008); they increase soil heterogeneity and are crucial to the functioning of forest ecosystems (JURGENSEN et al. 2008). Therefore, red wood ants are considered among the most promising species in forest ecosystems monitoring (GÖSSWALD 1990). Because of their importance, these species are protected by law in many European countries (GÖSSWALD 1989), including Switzerland (*Loi fédérale du 1er juillet 1966 sur la protection de la nature et du paysage, modifiée le 19 juin 2000*). However, despite this protection, some species are included on the red list of threatened species edited by the International Union for Conservation of Nature (IUCN) (WELLS et al. 1983; AGOSTI 1994; HILTON-TAYLOR 2000) and on the red list of some particular countries like Switzerland (AGOSTI & CHERIX 1994).

One good example of key site for biodiversity studies is the Swiss National Park (SNP), Created in 1914, the SNP is a strict nature reserve (Category Ia IUCN) located in the east of Switzerland in Engadin Valley, Canton of Grisons. It is the largest natural reserve in Switzerland and, until now, its unique national park. It covers a surface of 172,4 km2, from which 100 km2 are forests and alpine and subalpine meadows. It is crossed by 80 km of trails, which are the only accessible places. The SNP and its surrounding area is probably one of the most suitable places for studying red wood ants in Switzerland and in the Alps. All red wood ant species are present within this region and these ants are indeed very abundant within the Park with a density of 1.8 nest/ha in forested habitat (CHERIX et al. 2007). In addition, the Park offers the unique opportunity to study the evolution of red wood ant populations in unmanaged forests.

Our researches showed that the recently described new species of wood ant (*Formica paralugubris* SEIFERT 1996) was found to be also present within the SNP. In addition, a multidisciplinary approach (based on molecular, chemical and behavioural analyses) on red wood ants revealed the existence of an unknown cryptic species in the same area. To date this species has never been observed outside this region. This could indicate that the SNP is either the last refugium or a focus point for a new colonization. These results are of great interest for biodiversity and at the same time for the conservation of these ants.

Our works also highlighted that other potential cryptic species could be hidden in the alpine region and further studies would be useful to verify our hypotheses. Species of the *F. rufa* group should be particularly analyzed in the alpine region. Some authors have indeed highlighted the existence of scattered ice-free areas located within the Alps or at their periphery during the last glacial maximum. In particular, high levels of endemism have been found in the southern, southeastern, easternmost and northeastern Alps (TRIBSCH 2004). Numerous alpine plant and animal species persisted and developed independently in these refugia, which are now seen as centres of alpine species diversity and endemism (STEHLIK 2000; STEHLIK 2003; TRIBSCH 2004; SCHÖNSWETTER et al. 2005; LATALOWA & VAN DER KNAAP 2006; HAUBRICH & SCHMITT 2007; PARISOD & BESNARD 2007; PARISOD 2008; TOLLEFSRUD et al. 2008). Considering this particular situation and thanks to technical advances, more cryptic species of red wood ants might be discovered in alpine valleys in the future.

Therefore, multidisciplinary approach of supposed well-known groups of invertebrates can improve our knowledge of local biodiversity, giving new insights for management of alpine protected areas.

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