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Chair Grouse Group within the IUCN-SSC Galliformes Specialist Group

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Description of the parasitic community of mountain Galliformes in the Italian Alps. A large scale and long-term monitoring.

Tizzani P., Fanelli A., Chiodo E., Menardi G., Giordano O., Ficetto G., Bessone M., Lasagna A., Carpignano M.G., Molinar Min A., Peano A., Rossi L., Belleau E., Meneguz P.G.

Introduction

Galliformes is a large and diverse group of bird comprising about 70 genera and 281 extant species. Four Tetraonidae (*Tetrao tetrix tetrix*, *Lagopus muta helvetica*, *Bonasa bonasia styriaca*, *Tetrao urogallus crassirostri*) and one Phasianidae (*Alectoris graeca saxatilis*) inhabit the Italian Alps where they have a high biological value, and are of high conservation priority (Brichetti *et al.*, 1992).

Although most of these alpine Galliformes in some parts of their range, are classified as Least Concern (not at conservation risk) by the IUCN Red List of Threatened Species, many populations are red-listed at the national and regional levels because are in marked decline (Storch, 2007).

For this reason, they are included in Appendix I and II of the Birds Directive (79/409/EEC), which provides special measures for their conservation (European Parliament, 2009).

Few and not updated studies are available in literature on the sanitary status of these mountain Galliformes on the Italian Alps (Florio and Gamba 1992; Viganò et al. 2012a, 2012b, 2014; Formenti *et al*. 2013), even if recently some works partially filled a gap of information on the shared gastrointestinal parasite community of Galliformes species (Fanelli *et al*., 2020a, 2020b).

For the conservative management of Alpine Galliformes it would be essential, however, to acquire further information. In particular, there is very little data regarding their parasite community and the impact of parasites on population dynamics (Formenti *et al*., 2013). Although recent works have increased the knowledge on the epidemiology of the parasite community of some species (Formenti *et al*., 2013; Fanelli *et al.*, 2020a; 2020b), the main limitation of almost all available studies is the reduced geographical extension of the area investigated, in relation to the range covered by the different host species. Moreover, most of the studies focus very often on only one or few host species, without providing an overview of the characteristics of the parasite community as a whole and of the interactions of the "host - parasite" system of the 5 Alpine Galliformes: *A. g. saxatilis*, *T. t. tetrix*, *L. m. helvetica*, *B. b. styriaca* and *T. u. crassirostris.* Considering that, this study presents the sanitary findings derived from a long-term monitoring of Alpine Galliformes parasites, analysed at the Department of Veterinary Sciences of the University of Turin between 1984 and 2013.

Methods

Data on to the gastroenteric parasite community of 694 animals including the five Alpine Galliformes species is reported. Samples were collected from 16 different Italian provinces (Figure 1).

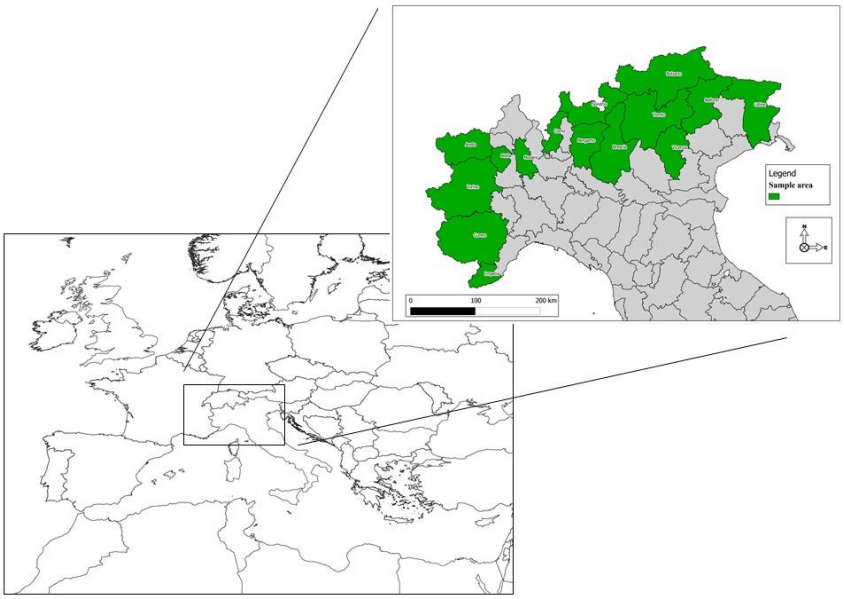

Figure 1. Study areas and administrative divisions from which the samples were taken.

For each animal, we opened the gastrointestinal tract with a longitudinal incision, and the content of the individual sections (proventriculus, gizzard, small and large intestine) was analyzed following the common parasitological standard techniques. Adult worms were counted under a stereoscope (MAFF 1986). We identified parasites at genus level with a light microscope and the identification key provided by Euzeby (1981; 1982) and Skrjabin (1954). Epidemiological characteristics including prevalence (percentage of infested host individuals in each sample), parasite richness (number of parasite species per host) and geographic distribution were calculated for each parasite.

Results

Five parasite genera were detected: three nematodes (*Ascaridia* sp., *Capillaria* sp., and *Heterakis* sp.), one trematode (*Corrigia* sp.) and one cestode (species not identified).

The distribution of the parasite at host level is presented in table 1. *A. g. saxatilis* resulted to be the host species with highest parasite richness (five parasites), while *T. t. tetrix* the one with lowest richness (three parasites).

Table 1. Parasite species reported by affected host species (1= species affected; 0=species not affected)

	Ascaridia	Capillaria	Heterakis	Corrigia	Cestode
A. g. saxatilis	1	1	1	1	1
T. t. tetrix	1	1	0	0	1
B. b. styriaca	1	1	0	1	1
L. m. helvetica	1	1	0	1	1
T. u. crassirostris	1	1	0	1	1

The prevalence of positive animals for each gastrointestinal section is provided in table 2. *T. u. crassirostris* resulted to be the host species with higher global parasite prevalence, followed by *A. g. saxatilis*. Also in this case *T. t. tetrix* was the host species presenting the lower values. In term of gastroenteric tracts, most of the parasites were detected in the small intestine, while the detection of parasites in the other sections was very rare (no parasites were found in proventriculus).

Table 2. Prevalence of parasite species reported by host. Overall prevalence, and prevalence by gastrointestinal sections are reported along with confidence intervals (CI).

	Overall prevalence (CI)	Gizzard (CI)	Small intestine (CI)	Large intestine (CI)
A. g. saxatilis (180)	36.1 (34.8-37.4)	0.6 (0.6-0.6)	27.2 (26.3 – 28.1)	10.0 (9.8-10.2)
T. t. tetrix (295)	10.8 (10.7 – 11.0)	0	10.8 (10.7–11.0)	1.0 (0.9-1.0)
B. b. styriaca (27)	18.5 (17.1 – 19.9)	0	18.5 (17.1–19.9)	0
L. m. helvetica (163)	23.9 (23.1 – 24.7)	0	23.9 (23.1–24.7)	0
T. u. crassirostris (29)	79.3 (73.3 – 85.3)	0	79.3 (73.3–85.3)	0

Finally, the geographic distribution of the positive animals (prevalence values) by host species is provided in Figure 2. The highest prevalence was found in the central and western part of the Italian Alps.

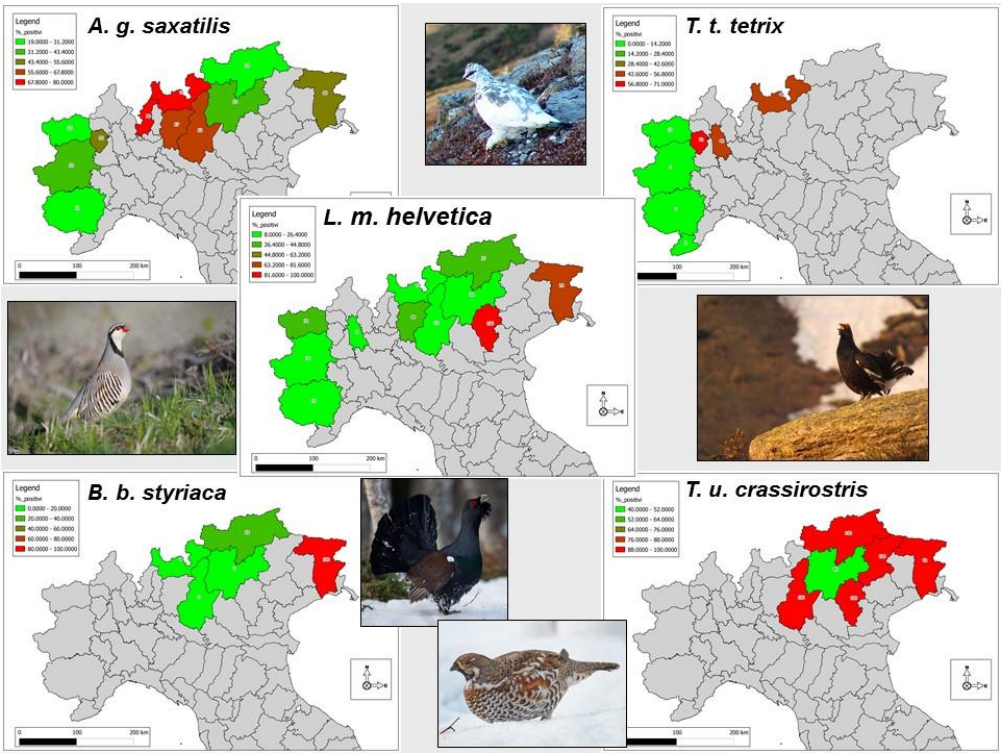

*Figure 2. Geographic distribution of overall parasite prevalence by host species. Credits for the photos: Beltrando Fulvio (*T. u. crassirostris*) Giordano Omar (*A. g. saxatilis and T.t. tetrix*), Lasagna Angelo (*L. m. helvetica*), Zanini Stefano (*B. b. styriaca*).*

Discussion

This paper, even if very descriptive, provides interesting information on the parasite community of wild Galliformes in the Italian Alps. The paper includes data from a relevant number of animals, sampled from a large study area, and aims to fill a gap of information on the sanitary status (even if limited to parasites only) of these birds on the Alps. Moreover, it provides a unique comparative monitoring of the parasite community in the Alpine Galliformes, covering bird species with different biology, ecological needs, conservation status and population densities. The only work in some way comparable with the current one, is the study carried out by Fanelli *et al.* (2020a), that described the parasite community in the Eastern Italian Alps.

Only few parasite species have been detected, with *A. g. saxatilis* being the species with the highest parasite richness. The low parasite richness detected is in line with the recent finding of Fanelli *et al.* (2020a) and with previous studies carried out in Italian Alps (Viganò *et al.*, 2012a,b; Formenti *et al.*, 2013).

T. u. crassirostris resulted to be the species with highest prevalence, with almost 80% of the birds positive for at least one parasite. Considering the current conservation status of this last species in the Western Alps, these findings are quite worrisome. However, considering the unbalanced sample size for the different host species, and the very different environmental, climatic and human-related factors occurring through the Alps, these conclusions have to be carefully evaluated. A more uniform distribution of the sampling effort, by host and by province, would help to better understand the role of each Galliformes species in the epidemiology of the parasite community.

Parasites were mostly reported in the small intestine, confirming also in this case the findings of previous works (Viganò *et al.*, 2012a,b; Formenti *et al.*, 2013; Fanelli *et al.* 2020a;).

Finally, the geographic distribution of the parasite prevalence highlighted the presence of cluster, with most of the cases reported in the central and western part of the study area. The presence of geographic gradient in parasite distribution is in line with the data reported by Fanelli *et al.* (2020a).

The spatial variation of parasitism degree might reflect the influence of different factors like the sanitary management and sanitary status of game birds released in the different provinces, or the influence of environmental conditions. In particular, some studies highlighted that geographic variation in parasite distribution can be seen as a proxy for of the climatic and environmental conditions required for

the development of free-living stages of nematodes (Fanelli *et al*., 2020a, 2020b; Sanchis-Monsonís *et al*., 2019).

Further study should be carried out to better explore the sanitary status of Alpine Galliformes, focusing not only on parasites but also on other diseases that may impact the population dynamics. A better understanding of the health status of these species should be achieved to improve any future management and conservation actions for Alpine Galliformes.

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