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Where in Europe should we look for sources of the cutaneous trematode *Collyriclum faba* infections in migrating birds?

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Abstract

Cutaneous cysts with trematodes of *Collyriclum faba* have been found in birds during their spring and post-breeding migrations in the Czech Republic. During spring migrations, *C. faba* was found in one dunnock *Prunella modularis*, two European robins *Erithacus rubecula*, three common nightingales *Luscinia megarhynchos*, one song thrush *Turdus philomelos* and one great reed warbler *Acrocephalus arundinaceus*. During post-breeding migration, the same parasite was found in one garden warbler *Sylvia borin*, one whitehroat *S. communis*, three goldcrests *Regulus regulus* and one Eurasian treecreeper *Certhia familiaris*. The newly identified hosts of *C. faba* are dunnock, common nightingale, song thrush, great reed warbler and Eurasian treecreeper. Geographical areas of the birds' infection were identified from an analysis of reports on ringed birds of the same species, the time necessary for the development of cutaneous cysts with *C. faba* and the time of their survival, and hitherto known geographical areas of endemic occurrence of *C. faba*. It is presumed that birds trapped during spring migrations were infected in some montane and submontane regions in south-western Europe (the Alps, the Apennines). Birds infected during autumn migration or post-breeding vagrancy could have been infected in the Central European Carpathians, the region of *C. faba* endemic occurrence. For migrating birds, the impact of *C. faba* infections has not been hitherto assessed.

Introduction

Adult worms of the trematode *Collyriclum faba* (Bremser in Schmalz, 1831) are found in a number of bird species in Eurasia, and North, Central and South America. The trematodes are usually found in pairs in subcutaneous cysts located mostly on the abdomen especially around the vent, on the shanks and thighs, but less frequently on the thorax, rump, wings, near the bill or eye (Literák *et al*., 2003). Reports of *C. faba* in Eurasia were formerly sporadic and this trematode was considered a rare species in birds. It has only recently been shown that *C. faba* is a common parasite in birds during summer in the Central European Carpathians (Literák *et al*., 2003).

When ringing birds during their spring and autumn migrations over the Czech Republic, cysts of *C. faba* were found in various bird species in different locations outside *C. faba* endemic foci. It was clear that the birds must have become infected during migration in locations other than where they were trapped. The aims of the present study are to monitor *C. faba* in birds during their passage over the Czech Republic and, from an analysis of ringed bird retraps, to determine the time of development and survival of cutaneous cysts with *C. faba* in already known geographical regions, and to locate those regions where migrating birds might have been initially infected. In its endemic foci, it is possible that the worm burdens of *C. faba* may induce bird mortality (Literák *et al*., 2003).

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Materials and methods

From our own records of pathological findings on ringed birds, all reports on the findings of *C. faba* in wild birds in the territory of the Czech Republic except the Carpathians, which is an endemic focus of *C. faba* (Literák *et al.*, 2003), were selected. Using available reports of amateur bird ringers on the incidence of lesions in wild birds, records unambiguously testifying the occurrence of *C. faba* in wild birds in the Czech Republic were selected. These were mainly reports of *C. faba* in birds from regions other than the Carpathians. The only record of *C. faba* from the Carpathians reported by amateur bird ringers was from an autumn passage. In all the reports, the occurrence of *C. faba* either during or outside the migration period was noted.

Using the database of the Bird Ringing Centre of the National Museum in Prague, data from 1934 to 2004 on the migration of those species whose members had been identified with a *C. faba* infection during migration were selected. As discernible subcutaneous cysts containing *C. faba* develop within 13–19 days and the time from infection to the appearance of cysts in infected juveniles is several weeks (Literák *et al.*, 2003), migration data of infected bird species are necessary for a period of 60 days prior to the discovery of *C. faba* cysts. Ringing data were invaluable in determining the approximate time of initial infection of birds with *C. faba*. Cutaneous cysts in birds do not survive for extended periods of time and if infections are not severe, contents within the cysts disintegate and cysts heal over a period several weeks, although a high intensity of infection may be fatal for the host (Literák *et al.*, 2003). To analyse post-breeding migration of goldcrests, all data on foreign retraps of these birds from the Czech Republic between August and September each year from 1979 to 2004 were used.

Available literary sources were used to identify endemic (stationary) foci of *C. faba* in Europe in an effort to establish whether any assumed or documented endemic foci of *C. faba* were identical with areas over which infected bird species migrated, and whether the birds may have become infected there.

Results

The occurrence of C. faba *in migrating birds in the Czech Republic*

On 24 March 2001, an adult male dunnock *Prunella modularis* with one small cyst with trematodes *C. faba* at the vent was trapped in Záhlinice (49°17′N, 17°30′E).

On 3 April 2003, an adult female European robin *Erithacus rubecula* trapped in Moravský Písek (48°59′N, 17°20′E) harboured two cutaneous cysts with *C. faba* on the left crus. On 3 May 2003, an adult female robin trapped in Tovačov (49°26′N, 17°17′E) had one cutaneous cyst with *C. faba* on each shank.

In May 2001 and 2002, cutaneous cysts characteristic of *C. faba* were found at the vent in three male common nightingales *Luscinia megarhynchos* trapped at different sites several km from each other in the northern part of the Czech Republic. These lesions, when compared with those caused by *C. faba* on the blackcap *Sylvia atricapilla* and the grey wagtail *Motacilla cinerea* and photographed formerly, corresponded in size and shape with cysts caused by *C. faba*. In May 2001, an adult male nightingale trapped at Dolní Bousov (50°26′N, 15°08′E) had 1–2 cysts immediately next to the vent, compressing the vent opening. A plug of dry faeces which had formed in the vent opening was removed, the vent washed with water, and the bird ringed and released. On 18 May 2002, an adult male nightingale trapped at Stará Studénka (50°26′N, 15°15′E) had four cutaneous cysts immediately next to the vent. The vent outlet was deflected by the cysts. The bird was in good condition and sang to announce its presence at the location. On 15 May 2002, an adult male nightingale trapped at Koprník, 2 km from Stará Studénka had one cutaneous cyst at the vent. The same bird, in good condition was trapped again on 6 June 2002, and the lesion at the vent had healed and was no longer visible.

On 27 March 1988, an adult male song thrush *Turdus philomelos* trapped in Přerov (49°27′N, 17°27′E) harboured two cutaneous cysts with *C. faba* at the vent.

On 6 May 2002, an adult male great reed warbler *Acrocephalus arundinaceus* trapped in Záhlinice harboured 30 *C. faba* trematodes in cutaneous cysts around the vent. The entire vent outlet area was covered with cysts, and the tissues were swollen.

On 16 September 1977, a male garden warbler *Sylvia borin* with eight large cutaneous cysts on its featherless belly was trapped in Záhlinice. The cysts contained *C. faba*.

On 22 August 2004, a juvenile whitethroat *Sylvia communis* trapped at the pond Heřmanický Rybník (49°52′N, 18°20′E) had two cutaneous cysts characterized by the presence of *C. faba* on the left shank. Although 660 birds of 32 species were examined in that location in August 2004, no other case of *C. faba* infection was found.

On 14 October 2000, a goldcrest *Regulus regulus* trapped in the Brdy Mountains (49°50′N, 14°06′E) had one cutaneous cyst with *C. faba* in the rump area (Brinke & Literák, 2001). Between 15 January 2000 and 7 November 2000, another 39 goldcrests were netted in that location, but none were infected with *C. faba*. On 15 October 2001, a fully-grown goldcrest trapped in Javorník (50°23′N, 17°01′E) had a cutaneous cyst 5 mm in size above the coccyx in the medial line of the body. The cyst protruded from the plumage and its size, shape, colour and location matched those of the cyst with *C. faba* described by Literák *et al.* (2003). The bird was ringed and released. A young male trapped on 26 September 2003 in the Beskydy Mountains (Western Carpathians) (49°36′N, 17°03′E) had a markedly swollen spot 10 mm in diameter caused by *C. faba* over the coccyx. The central rectrices were missing. The tail consisted of only five outside rectrices. The bird was ringed and released.

On 18 September 2000, a male Eurasian treecreeper *Certhia familiaris* trapped in Přerov had two cysts with *C. faba* under the wings near the body.

Migrations of infected bird species

Dunnocks from the Czech Republic overwinter mainly in south-western France and northern Italy. Their spring migration peaks between 21 and 31 March (Hudec, 1983).

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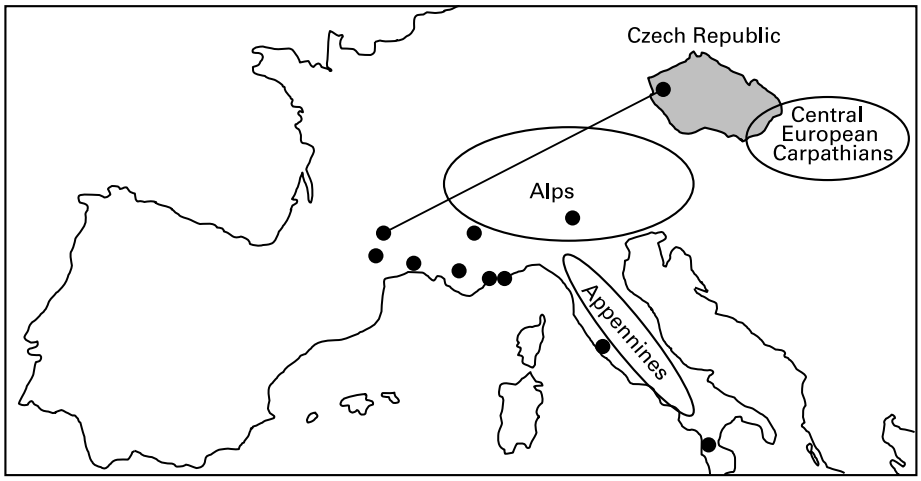

Fig. 1. An overview of dunnock retraps (●, $n = 10$ from 24 January to 27 March from 1934 to 2004) during spring migration in the Czech Republic. The continuous line indicates a direct passage.

The Prague Bird Ringing Centre database contains ten records of dunnock retraps between 24 January and 27 March (fig. 1) in southern France and in Italy. There is a record of a direct passage suggesting migration over the Alps; passage over the Alps and the Appennines can also be assumed from other records.

The Eurasian robin is an almost exclusively migrating species in the Czech Republic and its wintering grounds extend over south-western Europe including the western Mediterranean and the African coast. Its spring migration peaks in March, and the last migrating birds were observed between 21 and 30 April (Hudec, 1983). The Prague Bird Ringing Centre database contains 20 records of Eurasian robin retraps between 3 February and 3 May (fig. 2). There are three records of a direct passage documenting migration over the Alps.

The common nightingale returns to the Czech Republic in April, with the migration peak between 11 and 20 April. Common nightingales migrate from the Czech Republic in a south-westerly direction. Some will overwinter in the Mediterranean, but the remainder will winter in tropical Africa (Hudec, 1983). The Prague Bird Ringing Centre database contains four records of common nightingale retraps between 2 March and 19 May (fig. 3). One bird was ringed on 14 April 1959 in the Swiss Alps.

Song thrushes are migrating birds in the Czech Republic and arrive mostly in March. They overwinter

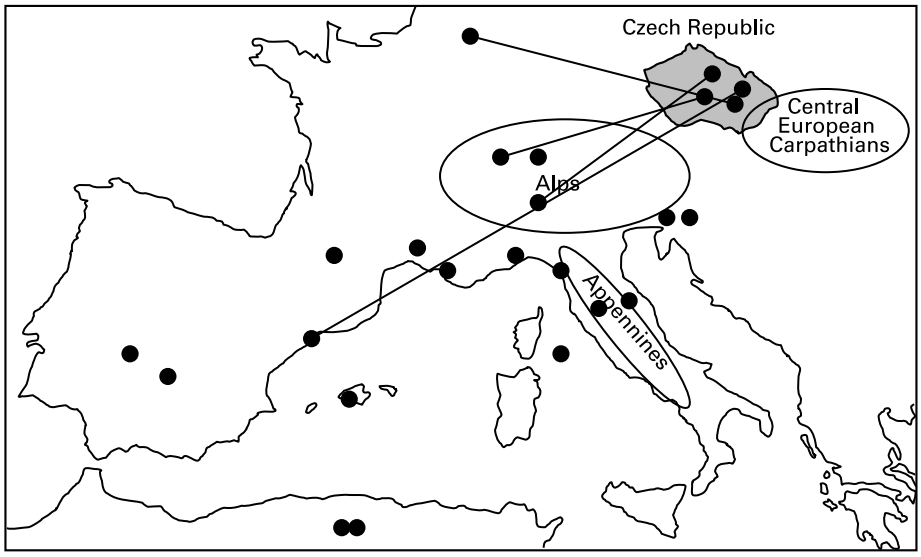

Fig. 2. An overview of Eurasian robin retraps (●, $n = 20$ from 3 February to 3 May from 1934 to 2004) during spring migration in the Czech Republic. The continuous line indicates a direct passage.

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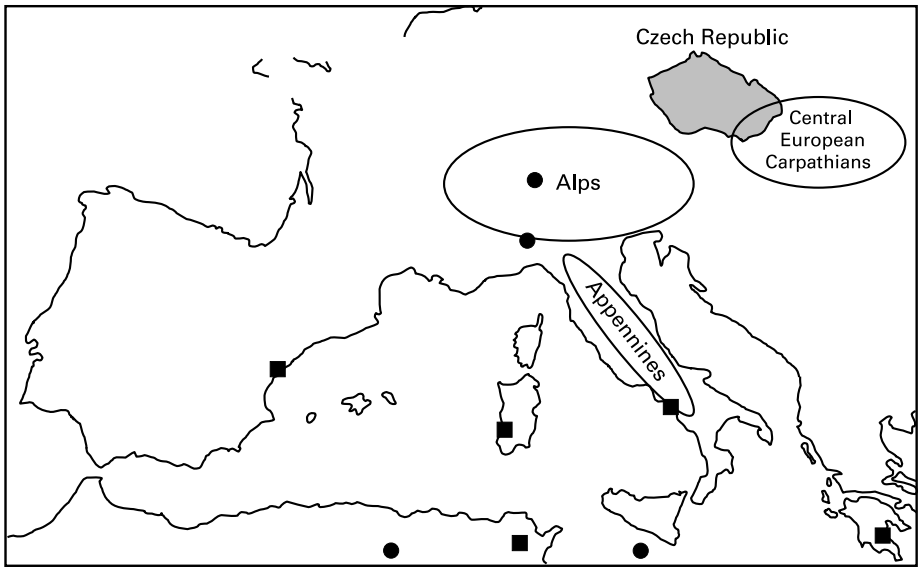

Fig. 3. An overview of common nightingale retraps (●, $n = 4$ from 18 March to 19 May from 1934 to 2004) and great reed warbler retraps (■, $n = 5$ from 6 March to 8 May from 1934 to 2004) during spring migration in the Czech Republic.

in south-western Europe and north-western Africa, whereas thrushes from the eastern part of the Czech Republic overwinter mainly in central and northern Italy (Hudec, 1983). The Prague Bird Ringing Centre database contains 250 records of song thrush retraps between 27 January and 27 March (fig. 4). On their return from wintering grounds to their nesting sites in the Czech Republic, they must overcome the Alps or the Appennines, and some of the retraps were indeed made in the foothills of the two mountain ranges.

Czech populations of great reed warbler migrate to wintering grounds mainly in southerly and south-southeasterly directions (Hudec, 1983; Petro *et al.*, 1998). Their return from wintering places in Africa in a south-southwesterly direction has been documented by a great reed warbler ringed in Tunisia on 30 April 1967 and found at the nesting grounds in the Czech Republic on 22 June 1967; most of them reach the Czech Republic in the second half of April and in early May (Hudec, 1983). The Prague Bird Ringing Centre database contains five records of great reed warbler retraps between 6 March and 8 May (fig. 3). The sighting of the birds in south and southeast Europe suggest that birds returning to the Czech Republic need to fly over the Alps or the Appennines.

The garden warbler is a migrating species that winters in the African tropics. It leaves the Czech Republic for its wintering grounds in southerly to south-westerly directions (Hudec, 1983). Its autumn migration peaks between 21 and 31 August, and in mid-September the number of migrating garden warblers is markedly reduced. With reference to northerly populations, two garden warblers on their autumn migration from Finland were trapped in the Czech Republic (Hudec, 1983).

In their post-breeding migration, Central European populations of goldcrest from regions east of 10°E take south-southwesterly to south-southeasterly directions (Hudec, 1983). In an analysis of the direction of post-breeding migration of the goldcrest, 22 records of retraps were used. In the Czech Republic, two directional trends are discernible in their post-breeding migration (fig. 5). A part of the Scandinavian population migrates in southerly to south-easterly directions. Another part of the population migrates in a westerly direction, and one goldcrest was even found to migrate in a northerly direction.

Although Eurasian treecreepers belong to non-migrating species in Central Europe they are also known for post-breeding vagrancy and have occasionally been found many kilometres away from their nesting grounds (Hudec, 1983).

Endemic foci of C. faba *in Europe*

Collyriclum faba is endemic in the Central European Carpathians (Literák *et al.*, 2003). In this area cutaneous cysts of *C. faba* were found in birds from the end of May to mid-September, with the prevalence peaking in July and August in years 2000 and 2001. The prevalence in individual foci of the infection varied from 1 to 16%. Ten species of passerine birds were infected including the European robin and the goldcrest.

The Central European Carpathians is the only clearly defined area in Europe where *C. faba* is endemic. There are, however, a number of sites in south-western Europe where *C. faba* has been demonstrated in birds of various species. If papers reporting on the findings specify their date, then the date and information on the bird species affected may help to determine whether or not it is proof of an endemic focus. The proof of an endemic focus may be the occurrence of *C. faba* mainly in July and August, but also in June and even in September. Conclusive evidence of such foci is the finding of *C. faba* in resident birds. Such findings have been frequent in the Alps and their foothills.

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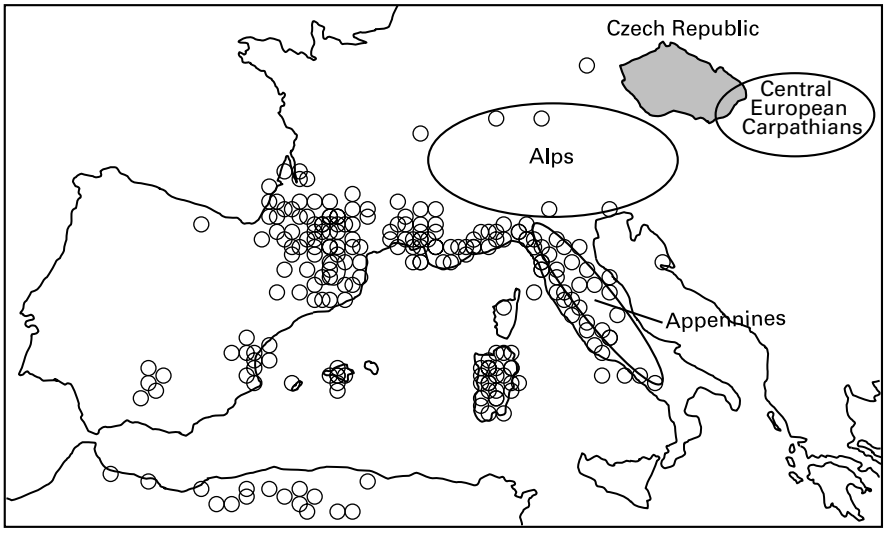

Fig. 4. An overview of song thrush retraps (○, $n = 250$ from 27 January to 27 March from 1934 to 2004) during spring migration in the Czech Republic.

The first record of *C. faba* was in a great tit *Parus major* in Austria in the early summer, maybe June, of 1823 (Bremser in Schmalz, 1831). Other findings in Austria were made in July (a year was not specified) in a wood warbler *Phylloscopus sibilatrix* and a grey wagtail (Diesing, 1850) and in June 1983 in a common starling *Sturnus vulgaris* (Prosl & Loupal, 1985). In southern Germany, *C. faba* was found in a willow warbler *Phylloscopus trochilus* in June 1831 (Creplin, 1839). In France, *C. faba* infections in areas adjacent to the Alps were found in a Eurasian jay *Garrulus glandarius* in September 1897 (Railliet, 1898) and in domestic turkeys in June 1926 (Marotel, 1926). In Switzerland, *C. faba* was found in four house sparrows *Passer domesticus* and a European serin *Serinus serinus* in July and August 1838 in Basel (Miescher, 1838). *Collyriclum faba* was also found in a house sparrow

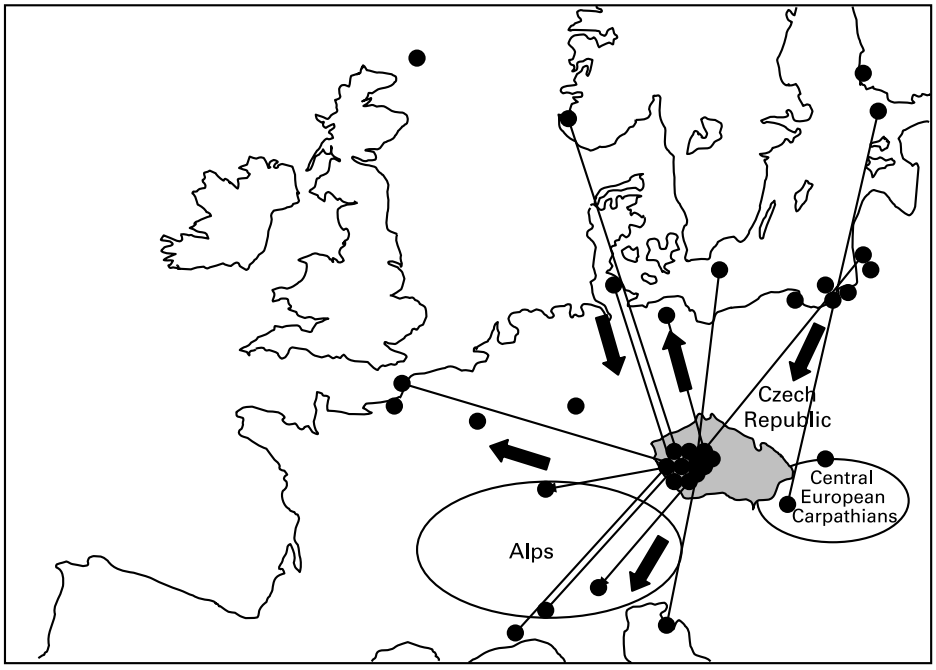

Fig. 5. An overview of goldcrest retraps (●, $n = 22$ from August to October from 1979 to 2004) during post-breeding migration in the Czech Republic. The continuous line indicates a direct passage, arrows the direction of migration.

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in June 1849 in Basel (Kossack, 1911) and also in house sparrows, a common redstart *Phoenicurus phoenicurus*, a spotted flycatcher *Muscicapa striata* and a chaffinch *Fringilla coelebs* (Jegen, 1917), and in a house sparrow and a goldcrest in summer 1988 (Denzler & Lobsiger Molliet, 1991). The occurrence of *C. faba* in a house sparrow has also been reported from a vicinity of the Alps in Slovenia (Brglez, 1977). *Collyriclum faba* may not be very frequent in the Alps region, but in some locations there it is probably endemic. One of the endemic foci is the Swiss city of Basel and its surroundings.

The finding of *C. faba* in a northern wheatear *Oenanthe oenanthe* in September 1889 near Genoa (Kossack, 1911) and in a house sparrow in the Bologna environs (Gavoni *et al.*, 1987) indicate the possibility of endemic foci in the mountains and foothills of the Italian Appennines. In this context, a remarkable finding of *C. faba* in a cirl bunting *Emberiza cirlus* was made in June 1882 in Sardinia (Parona, 1886).

Discussion

Outside the Czech Republic, goldcrests infected during their autumn migration have so far been found only at the foothills of the Swiss Alps (Beaud, 1993). In the 1980s, 1950 goldcrests were tested there during autumn migrations and *C. faba* was found in 16 (0.8%). Most of the infected goldcrests were found in October, especially in the second half of the month. These migrating birds must have been infected elsewhere. Given the westerly direction of bird migration from the Czech Republic, it is possible that these goldcrests were infected in the Central European Carpathians.

Three infected goldcrests trapped during the autumn migration in the Czech Republic were probably also migrating birds which had been infected elsewhere. Because goldcrests in Central Europe are a partially migrating species, it is difficult to differentiate autumn migration from flights that goldcrests frequently make, together with other species of tits, throughout the winter period (Hudec, 1983). The goldcrest migration, however, peaks in October when their density in suitable locations in the Carpathians is the highest compared with other autumn or winter months (Pavelka, 1987). In Europe, goldcrests migrate on different routes in southerly to westerly directions in autumn, and Scandinavian populations may even travel in a south-easterly direction. Goldcrests are also known to cover relatively large distances in a short time, e.g. in October 1974 a goldcrest covered 800 km in 18 days (Hudec, 1983). When in post-breeding migration infected birds move in the Czech Republic in a westerly direction, the most likely region where infection is initiated is the Central European Carpathians, where goldcrests are an abundantly nesting species (Hudec, 1983). *Collyriclum faba* infection in goldcrest in the Slovak Carpathians has been found as early as the end of July and the beginning of August (Literák *et al.*, 2003).

Eurasian treecreepers nest mainly at medium or higher altitudes in the mountains, and only rarely in the lowlands. However, they turn up in the lowlands more frequently outside the nesting period. Přerov is situated in the lowlands near the western edge of the Central European Carpathians, and endemic foci of *C. faba* have been demonstrated in the relatively nearby region of the Czech Carpathians (Literák *et al.*, 2003). Presumably the Eurasian treecreeper became infected with *C. faba* in the nearby Carpathians and strayed to Přerov on its post-breeding vagrancy where it was trapped.

The garden warbler and whitethroat were trapped only 20 and 30 km, respectively, west of the western edge of the Central European Carpathians. The south-westerly direction of their post-breeding migrations suggests that they were initially infected in that region.

The occurrence of *C. faba* in birds migrating over Europe in spring is mentioned only by Bychovskaya-Pavlovskaya (1974), without analysing where a European robin, a common redstart and a garden warbler may have become infected.

It is thus hypothesized that the occurrence of *C. faba* in its endemic foci in the Central European Carpathians will be different from that in more southerly (and thus also warmer) areas of south-western Europe. The difference lies in the earlier onset, i.e. infection in sensitive birds will manifest itself earlier and it may also be linked with more frequently occurring, but thus far unknown intermediate hosts. Assuming the onset to be 1 or 2 months earlier, infection would take place in March and April, i.e. the time when avian species are found with *C. faba* during their spring migration over the Czech Republic period, and this includes the dunnock, European robin, common nightingale, song thrush and great reed warbler, which all pass over the Alps or the Appennines. Infected birds of the above species are likely to become infected in *C. faba* endemic foci in the mountains (foothills) in the south-west of Europe, i.e. in the Alps and the Appennines.

The effect of *C. faba* infections on migrating birds depends on the worm burden. A small number of cysts may not be a serious problem but high intensities of infection may have fatal consequences (Literák *et al.*, 2003). Cysts around the vent opening can result in plugging with dried feces, as in the case of one common nightingale. The plug was manually removed, the vent was washed with water, the nightingale was ringed and released. If the plugs are not removed, it is likely that birds would not survive. A similar case of life-threatening plugging of the vent opening caused by *C. faba* infection has been reported in a grey wagtail (Literák *et al.*, 2003). Therefore, for migrating birds, the trematode *C. faba* infection can potentially induce bird mortality.

In conclusion, it should be noted that *C. faba* has been reported for the first time in the dunnock, common nightingale, song thrush, great reed warbler and Eurasian treecreeper.

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