

## A Decade of Data: *E. coli* Presence in Europe's Wild Bird Species – an epidemiological study

### Un deceniu de date: Prezența *E. coli* la speciile de păsări sălbatice din Europa - un studiu epidemiologic

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**Cuvinte cheie:** *Escherichia coli*, păsări sălbatice, Europa, epidemiologie.

#### Abstract

Over the past decade, understanding the presence and dynamics of *Escherichia coli* in Europe's wild bird species has emerged as a critical area of research. This article synthesizes a comprehensive analysis of *E. coli* prevalence among wild bird populations across Europe from 2011 to 2022. Beginning with an overview of *E. coli* research in wild birds from 1997 to 2024, the review explores the evolution of scientific interest in this topic and highlights trends in publication frequency. A focused examination of publications reveals a surge in research activity, reflecting growing concerns about antimicrobial resistance and environmental health. Furthermore, the review presents a detailed analysis of *E. coli* isolates from wild birds, examining the annual distribution of cases and identifying patterns across different European countries. Additionally, the review identifies the top five bird species most frequently studied in relation to *E. coli* presence, providing insights into the focal points of research efforts. By synthesizing a decade's worth of data, this review contributes to a comprehensive understanding of the epidemiology and dynamics of *E. coli* infections in Europe's wild bird populations.

#### Rezumat

În ultimul deceniu, înțelegerea prezenței și a dinamicii *Escherichiei coli* la speciile de păsări sălbatice din Europa a devenit un domeniu de cercetare esențial. Acest articol sintetizează o analiză cuprinzătoare a prevalenței *E. coli* în rândul populațiilor de păsări sălbatice din Europa în perioada 2011-2022. Începând cu o prezentare generală a cercetărilor privind *E. coli* la păsările sălbatice din 1997 până în 2024, analiza explorează evoluția interesului științific pentru acest subiect și evidențiază tendințele în ceea ce privește frecvența publicațiilor. O examinare concentrată a publicațiilor relevă o creștere bruscă a activității de cercetare, reflectând preocupările crescânde privind rezistența antimicrobiană și sănătatea mediului. Se prezintă o analiză detaliată a izolatelor de *E. coli* de la păsările sălbatice, examinând distribuția anuală a cazurilor și identificând modele în diferite țări europene. În plus, analiza identifică primele cinci specii de păsări cel mai frecvent studiate în ceea ce privește prezența *E. coli*, oferind o perspectivă asupra punctelor centrale ale eforturilor de cercetare. Prin sintetizarea unui deceniu de date, această analiză contribuie la o înțelegere cuprinzătoare a epidemiologiei și dinamicii infecțiilor cu *E. coli* în populațiile de păsări sălbatice din Europa.

#### Introduction

Compared to 2021, the total number of reported isolates increased from 366 794 to 392 602.

The most commonly reported bacterial species in 2022 were:

- *Escherichia coli* (39.2%), followed by
- *Staphylococcus aureus* (22.1%),

- *Klebsiella pneumoniae* (12.3%),
- *Enterococcus faecalis* (8.2%),
- *Pseudomonas aeruginosa* (6.1%),
- *Enterococcus faecium* (5.9%),
- *Streptococcus pneumoniae* (3.7%) and
- *Acinetobacter* spp. (2.5%).

This ranking differed from 2021, with *P. aeruginosa* and *S. pneumoniae* one rank higher in 2022 [10].

The genus *Escherichia* contains five species: *albertii*, *coli*, *fergusonii*, *hermannii*, and *vulneris*; the species *blattae* has recently been moved into the *Shimwellia* genus. *Escherichia* is the type genus of the Enterobacteriaceae family, with *coli* the type species of the genus. *Escherichia coli* is the only species that includes important pathogens of animals.

Many *E. coli* are commensals of the intestinal tract, especially the large intestine; however, many are opportunistic or primary pathogens too. Pathogenic *E. coli* are broadly divided into diarrheagenic and extraintestinal strains. Diarrheagenic *E. coli* are economically important pathogens of neonatal piglets, calves, and lambs.

In avian species, *E. coli* is an important cause of air sacculitis, pneumonia, septicemia, and omphalitis. Zoonotic infections with Shiga toxin-producing *E. coli* (STEC) and host-specific diarrheagenic and extraintestinal infections are of major importance in human medicine.

**Reservoir and Transmission:** Strains of *E. coli* capable of producing disease reside in the lower gastrointestinal tract and are abundant in environments inhabited by animals. Transmission is through the fecal-oral route. The lower intestinal tract has been termed the “primary habitat” and the environment outside the animal, the “secondary habitat” of *E. coli*.

This reflects the importance of the lower intestine in providing the necessary nutrients and warm temperatures for *E. coli* (a mesophile) to be in a positive growth state, and also the need for it to exit one host in order to enter a new one to complete its “life cycle” [22].

The primary objective of this study was to determine the prevalence of *E. coli* in the feces of wild birds across Europe in the last decade.

## Materials and Methods

A systematic literature review of the available publications describing the presence of *Escherichia coli* in wildlife was performed using a rigorous search strategy in the online version of the PubMed (<https://pubmed.ncbi.nlm.nih.gov>) [29], where we searched from 2013 until 2024 for articles using the combination of terms ‘*E. coli*’, ‘wild birds’ and ‘Europe’.

The last search was done in March 2024. We made no restrictions regarding language or types of articles. All available titles and abstracts were reviewed. The focus of this search was to find publications that contained *Escherichia* isolates from wild birds in the last decade in Europe.

All the publications from literature search were analysed in two steps: (i) firstly, titles and abstracts were analysed and the publications which did not fill the inclusion criteria (e.g., focus on *E. coli*, wild birds, Europe countries) were excluded; and (ii) secondly, the full text was analysed and the relevant information was extracted. All query results were verified manually before excluding duplicates.

Finally, results for all articles were imported into a bibliographic referencing tool (Zotero Desktop 6.0.23). All publications were included with the following variables extracted: year of publication, location of analysed samples, animal data, bacterial data and citation.

## Results and Discussion

From the literature search, a total of 54 publications were obtained.

This number was reduced to 34 after the first step of analysis (title and abstract) and, after the second step of analysis (full text), only 22 publications remained.

Publications focusing on *Escherichia coli* from wildlife are relatively recent and date from 1997. The first publication, in 1997, with the title “Enteropathogenic Bacteria in Migrating Birds Arriving in Sweden”, reported that they did not isolate *Escherichia coli* in any of the bird stools examined from 151 wild birds (50 gulls and 101 passerines) in Sweden, but their data do not exclude the possible existence of a bird reservoir of this bacteria in that year [25].

From a different perspective, Guenther et al. reported in 2010 that a total of 201 putative *E. coli* isolates were cultured from 275 samples collected from 226 birds. These samples were obtained from various sources including feces

(n=160), heart (n=6), liver (n=9), lung (n=13), spleen (n=6), and kidney (n=7).

Furthermore, they identified *E. coli* in 40 out of 55 avian species tested at the individual bird species level [14].

The number of publications on this topic has grown since 1997 until now, but the largest number of publications is concentrated in 2010–2019.

These data represents the number of publications about the studied subject over the years.

There is a fluctuating pattern in the number of publications over time, with varying counts from year to year.

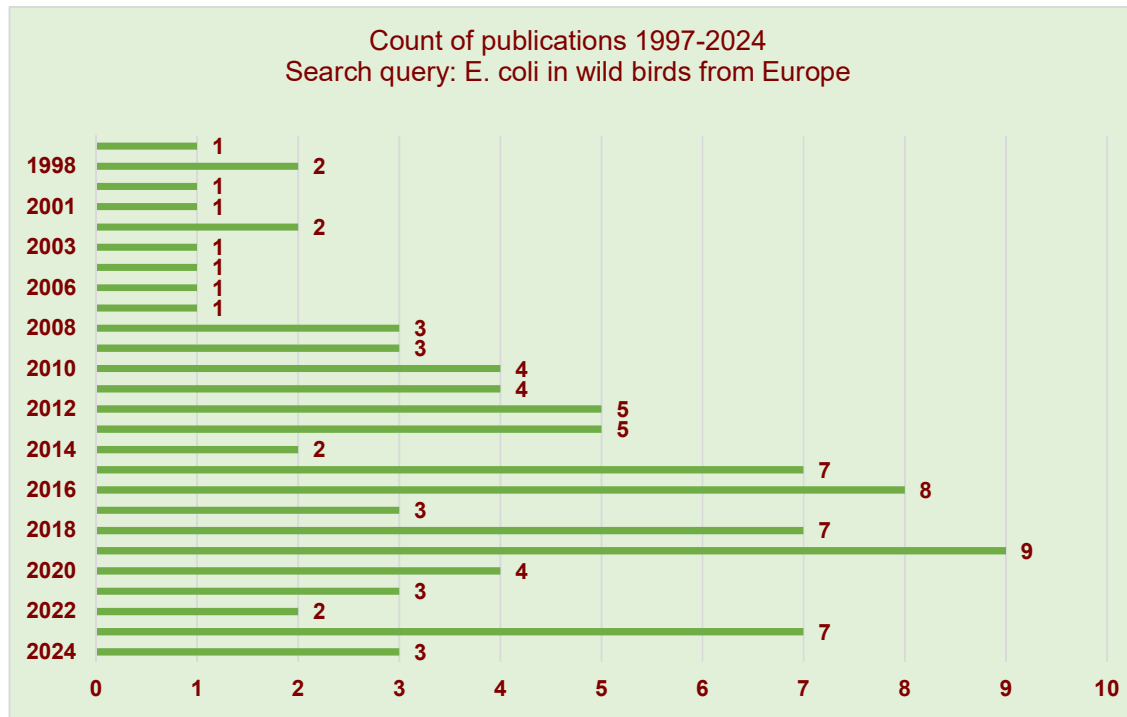


Figure 1. Publications *E. coli* reported in wildbirds since 1997 [PubMed]

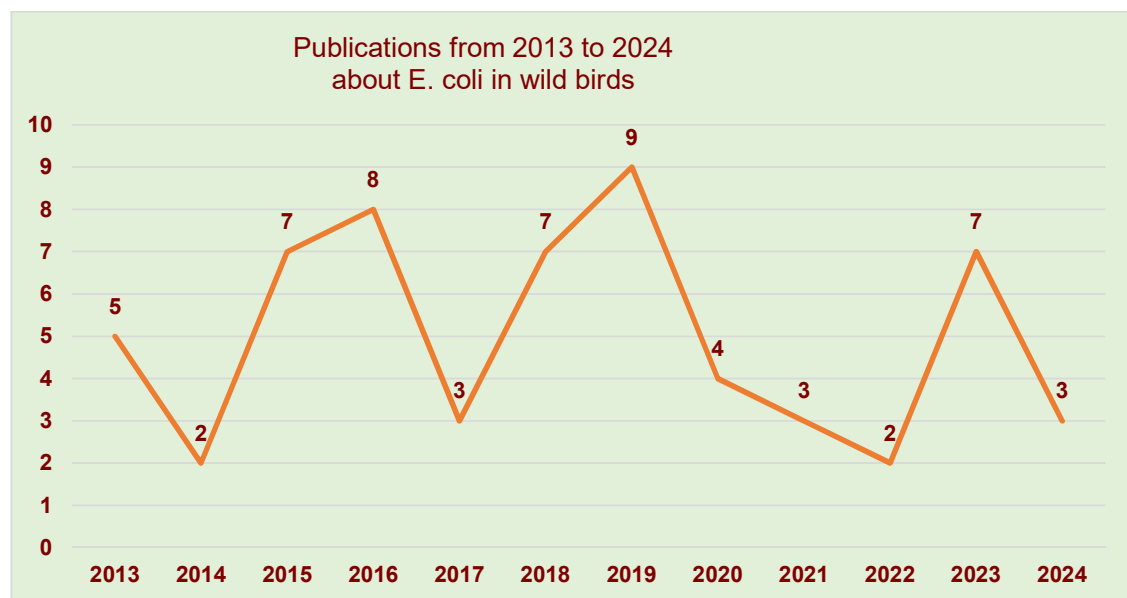


Figure 2. Trends of publication *E. coli* reported in wildbirds 2013-2024 [PubMed]

The highest number of publications was recorded in 2019, with 9 publications, followed by 2016 and 2018, with 8 and 7 publications, respectively.

From 2007 to 2015, there seems to be a relatively stable number of publications, with counts ranging from 1 to 7.

There are fewer publications in the earlier years (before 2000), with counts mostly ranging from 1 to 3.

The lowest counts are observed in 2004, 2006, 1999, 1997, and 2001, with only 1 publication each.

Overall, the data suggests fluctuating interest or research activity in the studied subject over the years, with some years experiencing higher publication rates than others.

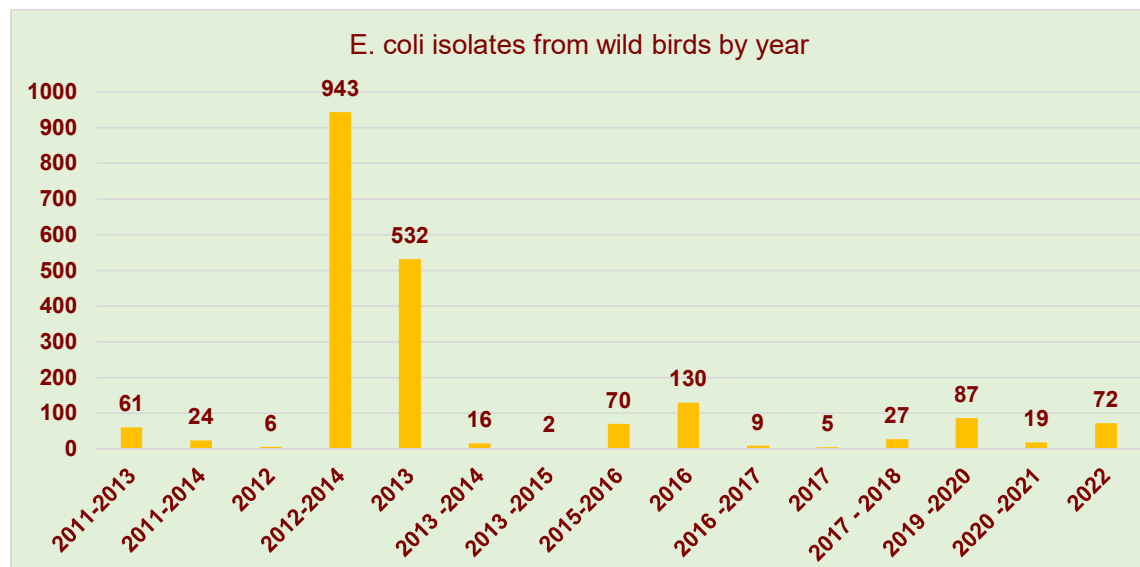


Figure 3. *E. coli* isolates by year from Europe 2011-2022.

The data suggests variations in the reported number of *E. coli* isolates from wild birds over the years, indicating fluctuating prevalence rates.

Some years exhibit higher prevalence than others.

- Between 2012 and 2014, there was a significant increase to 943 isolates [19].
- In 2013, there were 532 reported isolates, indicating a high prevalence [4, 8, 13, 18].
- From 2013 to 2014, the number decreased to 16 isolates [1, 16].
- From 2013 to 2015, only 2 isolates were reported [3].
- In 2015-2016, there was a slight increase to 70 isolates [12, 24].
- In 2016, the number increased significantly to 130 isolates [5, 7, 23].

- From 2016 to 2017, there were 9 isolates reported [9].
- In 2017, the number decreased to 5 isolates [17].
- From 2017 to 2018, there was a slight increase to 27 isolates [21].
- From 2019 to 2020, there was a notable increase to 87 isolates [15].
- From 2020 to 2021, the number decreased to 19 isolates [11].
- In 2022, there were 72 reported isolates [6].

Austria and the Czech Republic have the highest number of reported *E. coli* cases in wild birds between 2013 and 2023, with 473 and 470 cases, respectively.

This indicates a relatively high prevalence of *E. coli* infections among wild bird populations in these countries during the specified period.

Sweden follows closely behind, with 415 reported cases, suggesting a significant presence of *E. coli* infections in wild birds within the country. Spain has a lower but still notable number of reported cases, with 300 instances of *E. coli* infections in wild birds.

Ireland and Hungary have fewer reported cases compared to the previously mentioned countries, with 87 and 72 cases, respectively.

Poland, Italy, Germany, the Netherlands, and Ukraine have even fewer reported cases, ranging from 55 to 19 cases each.

Switzerland and France have the lowest number of reported cases, with only 6 instances of *E. coli* infections in wild birds each.

Eastern Slovakia has reported 5 cases during the specified period (Table 1).

Overall, these data suggest variations in the prevalence of *E. coli* infections among wild bird populations across different countries.

Factors such as habitat, environmental conditions, and human activities may contribute to these differences.

Further investigation may be needed to understand the underlying factors influencing the occurrence of *E. coli* infections in wild birds in each country.

**Table 1.**

Number of reporting *E. coli* in wildbirds per country.

Country	<i>E. coli</i> cases 2013-2023
Austria	473
Czech Republic	470
Sweden	415
Spain	300
Ireland	87
Hungary	72
Poland	55
Italy	40
Germany	24
Netherlands	23
Ukraine	19
Switzerland	6
France	6
Slovakia	5



Source: World Bank (boundaries), Simple maps (points)

**Figure 4.** Europe map (made it with Flourish) representing the number of *E. coli* positive isolates from wild birds per country. The number of publications per country are color-coded as per the index and the top left of the figure [28].

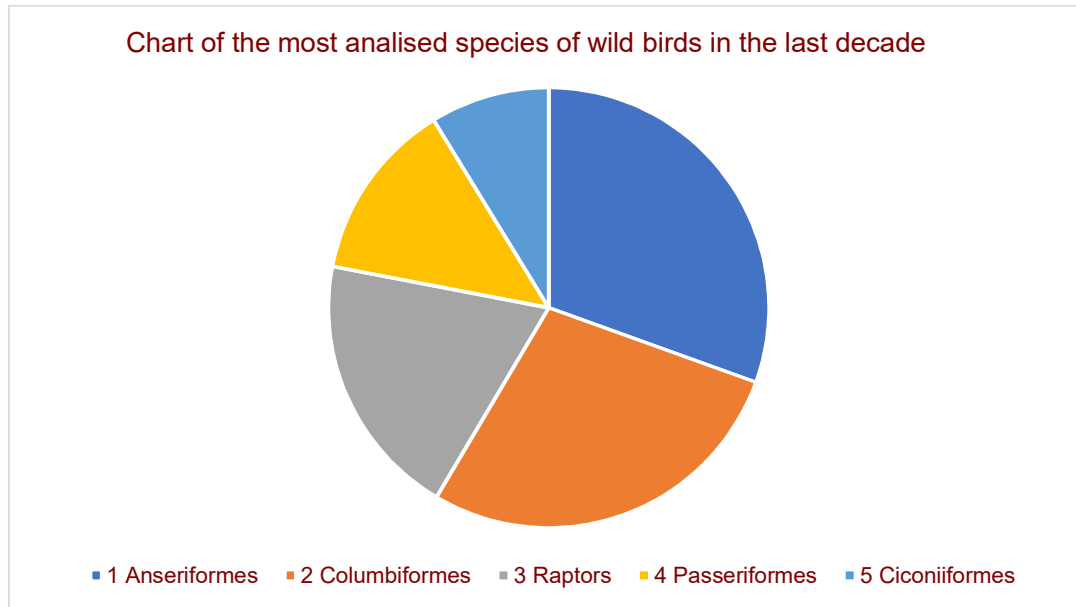


Figure 5. Top 5 wild birds species with reported *E. coli* occurrence.

### Wildlife of Birds

Anseriformes, including wild ducks and waterfowl birds are the most commonly mentioned species in scientific articles related to the isolation of *E. coli* from wild birds, with a total of 491 mentions in the last decade. Pigeons (*Columbiformes*) rank second in terms of frequency, with 451 mentions in these articles. Birds of prey (*Accipitriformes*, *Strigiformes* and *Falconiformes*) follow in third place, with 314 mentions. *Passeriformes*, which include a variety of birds, are in fourth place with 213 mentions. Storks (*Ciconia Ciconia*) are at the bottom of the short list of the most frequently mentioned species in these articles, with 141 mentions.

Diurnal birds of prey identified in the reviewed studies included Griffon vulture (*Gyps fulvus*), Black kite (*Milvus migrans*), Red kite (*Milvus milvus*), Golden eagle (*Aquila chrysaetos*), Eurasian sparrowhawk (*Accipiter nisus*), Northern goshawk (*Accipiter gentilis*), Common buzzard (*Buteo buteo*), Common kestrel (*Falco tinnunculus*), European honey buzzard (*Pernis apivorus*), Booted eagle, Black vulture, Bonelli's eagle and Egyptian vultures, with a total of 302 mentions.

Nocturnal birds of prey - the owls - including Barn owl (*Tyto alba*), Long-eared owl (*Asio otus*), Eurasian scops owl (*Otus scops*),

Tawny owl (*Strix aluco*) and Eurasian eagle-owl (*Bubo Bubo*), were mentioned 12 times collectively.

These findings indicate that *Anas platyrhynchos* (Mallard) are the most studied and observed species in studies focusing on the isolation of *E. coli*, followed by Pigeons, Raptors, and Passerines. Storks are less frequently mentioned in these studies compared to other bird species.

Among gulls such as *Larus marinus*, *Larus argentatus*, *Larus canus* and *Croicocephalus ridibundus*, Herring gulls, Lesser black-back gulls, *Larus michahellis* - yellow-legged gull, were next in terms of the number of positive isolates, totaling 127 cases.

### Conclusions

In conclusion, our analysis reveals a comprehensive overview of the distribution of *E. coli* isolates among various wild bird species in research conducted over the past years.

The analysis of publication counts from 1997 to 2024 reveals a growing interest in the study of *E. coli* in wild bird populations over time.

This reflects the recognition of *E. coli* as a significant pathogen in avian ecology and highlights the importance of continued research in this area.

A focused examination of publications from 2013 to 2024 indicates a significant surge in research activity during this period. This heightened interest may be attributed to concerns about antimicrobial resistance, environmental health, and the potential zoonotic transmission of *E. coli* from wild birds to humans.

Analysis of yearly isolate counts reveals fluctuations in the number of *E. coli* cases isolated from wild birds over the past decade. These variations may be influenced by factors such as changes in environmental conditions, migratory patterns, and surveillance efforts.

Mallards, pigeons, raptors, and passerines emerge as the most frequently studied and observed species in relation to *E. coli* isolation, highlighting their significance in research efforts.

Overall, these conclusions highlight the diverse roles of various bird species in *E. coli* research and underscore the importance of understanding their contributions to the epidemiology of *E. coli* infections in wild bird populations.

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