**Methodology**

**Search strategy:**

The following search terms were used in the process of identifying primary studies in the isolation of *M. avium* species over the course of 41 years (1980-2021) in the PubMed database. The key terms being:

* “Isolation of M. avium from different locations”
* “Isolation of M. avium from environmental sources”
* “Detection of M. avium from environmental sources”
* “Identification of M. avium from environmental sources”

Abstract based screening was conducted for the results obtained using these search terms to identify primary studies with relevant research in isolation, detection and identification of *M. avium* from potential sources. Both diagnosis-based results and data from environmental sources were consolidated. A total of 201 hits were obtained from the above-mentioned search terms. Further, full articles were procured for articles deemed relevant from abstract based screening, and pertinent information such as year of identification, geographical location of isolate and strains identified were compiled in supplementary table 1. The above information was mainly extracted from primary studies, google search engine etc. From a total of 201 citations captured by literature search, 81 articles were considered relevant for constructing a global map distribution of *M. avium*.

A global map was constructed from the above extracted data using (created on [https://mapchart.net/](https://mapchart.net/" \t "_blank)). The map mainly represents the countries in which *M. avium* species have been detected. Further information on the detailed year, location, *M. avium* species and source of isolation has been laid out in supplementary table 1. Few regions have been mentioned in a recent report [1]

**Supplementary Table 1**: Detailed information on the source of isolation, year and strain of *M. avium* identified in different countries.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **Year** | **Geographical location** | **Strain** | **Source** | **Ref** |
| 1. | **2020** | Zagreb, Coatia | MAC- *M. avium M. intracellulare* | Lungs of patients with NTM pulmonary infections | [2] |
| 2. | **2020** | St. Marianna University Hospital, Japan | *M. avium* including other NTM | Intestinal fluid culture from patients, endoscopic unit environment and samples of water used in the endoscopy unit | [3] |
| 3. | **2019** | Over 36 states in the US | *M. avium* | Office and residential tap water samples from kitchen sinks, bathroom sinks, utility sinks, drinking water fountains and refrigerator-door dispensers | [4] |
| 4. | **2019** | Southern Montgomery County or adjacent regions of Delaware County suburban Philadelphia, Pennsylvania, USA (Schuylkill River and its tributaries) | *M. avium* subsp.  *hominissuis*  *M. intracellulare* | Plumbing sources from patient and control households, serviced by the same municipality water | [5] |
| 5. | **2018** | London, UK | *M. avium* type strain. | Employees of the factory who had potential exposure to aerosolised MWF (Metal working fluid) mist, samples of MWF were collected from 33 machine sumps and stored at 4°C | [6] |
| 6. | **2017** | Markets in Spain | *Mycobacterium*  *avium* subsp. *hominissu is*  *M*. *avium* subsp. *avium*  *M. avium* (subsp.  *paratuberculosis*) | Dairy products including milk, milk powder, powdered infant formula, cream, butter, cheese and yogurt.  Meat samples: packed ground meat, hamburger patties, fresh and cooked sausages, cold cuts, fresh Spanish chorizo and pâté | [7] |
| 7. | **2017** | South Australia, New South Wales, Victoria or Western  Australia | MAC | Samples of Australian commercially available pasteurized milk. | [8] |
| 8. | **2016** | United States | *M. avium* and *M. intracellulare* | Source and treated drinking water collected from 25 drinking water treatment plants (DWTPs) in the United States | [9] |
| 9. | **2016** | Six communities along two major river basins (Densu and Offin) in Ghana  The communities along the Densu River basin included: Ntabea in the East Akim district, upstream of the river; Ashongkrom in the Akwapim South district, midstream of the river; and Domesampaman in the Ga-West Municipality of the Greater Accra Region, downstream of the river  . All of the studied communities along the Offin River basin included Ntobroso and Achiase in the Atwima district, upstream and midstream of the river, respectively, and Mfantsiman in the Upper Denkyira district, downstream of the river | *M. avium* | Sites of frequent human activities, such as bodies of water utilized regularly for domestic purposes such as washing and cooking, communal bathing areas utilized by household members, school compounds (particularly playgrounds), agricultural farms, market grounds, community centers, and sources of drinking water, such as boreholes and water from storage tanks in homes, were used as reference points Samples such as soil (approximately 5 g), water (45 ml), and fungi found growing in the soil and on dead and decaying logs were collected  Snail samples, moss and vegetation | [10] |
| 10. | **2016** | Belgium | *M. avium* subspecies  *hominissuis* | Human isolates isolated from submandibular lymph nodes of Belgian pigs with lymphadenitis | [11] |
| 11. | **2016** | Center of Tuberculosis and Lung Diseases, Latvia | *M. avium* subsp.  *hominissuis*  *M. avium* subsp. *avium* | * Clinical *M. avium* samples, isolated from patients * Isolates from pig necrotic mesenterial lymph nodes | [12] |
| 12. | **2015** | Papua New Guinea | *M. intracellulare*  *M. avium* | Sputum samples of suspected tuberculosis cases aged 15 years or older | [13] |
| 13. | **2015** | Beijing and Fujian province | *M. avium* subsp.  *hominissuis* | Sputum samples of pneumonia patients | [14] |
| 14. | **2014** | Brno Czech republic | *M. avium* subsp.  *paratuberculosis* | -Samples of moss, fungi, and algae from the pond and herb from sites on the pasture  -tissues from the gastrointestinal tract were buried at 60 cm of depth in two locations, after 2 years samples of soil, leaves (aerial parts of plants), and roots were collected | [15] |
| 15. | **2014** | Province of Quebec, Canada | *M. avium* subsp. *paratuberculosis* strains | Samples from dairy herds | [16] |
| 16. | **2014** | Southern Alberta, Canada | *M. avium* | Hospital water distribution system | [17] |
| 17. | **2014** | -Mubende district in the central area of the UCC (Uganda cattle corridor)   * Karamoja in the North eastern part of the UCC   pastoral communities (Karamoja, Nakasongola, Masindi and Mbarara), Uganda | *M. avium* subsp.  *hominissuis*  *M. avium* subsp. *avium* | -Cervical lymph nodes of slaughter pigs  -isolates from cervical lymph node biopsies of patients  - lesion samples in slaughtered cattle | [18] |
| 18. | **2014** | Osaka, Japan | *M. avium* | Biofilm samples were collected from 5 sites in each of 40 residences, The 5 sites were bathroom drain, kitchen drain, bathtub inlet and outer and inner surfaces of showerhead. | [19] |
| 19. | **2014** | Veterinary Research Institute, Brno, Czech Republic. | *M. avium* subsp.  *hominissuis*  *M. avium* subsp. *avium*  and *paratuberculosis* | Field isolate obtained from infected swine | [20] |
| 20. | **2013** | Water distribution system in Mexico City; the water which includes groundwater (pumped from wells) and surface water from the Cutzamala and Magdalena rivers | *M. avium* | Potable water samples collected from both the “main house faucet” and kitchen faucet of the test households. | [21] |
| 21. | **2013** | -Seattle, USA  -Montreal, Canada  -New England region, USA  -Netherlands  -Sao Paolo, Brazil  -Southern California region, USA  Italy | *M. avium* | Archived genomic DNA isolates of *M. avium* | [22] |
| 22. | **2013** | Patients part of the long term studies at University of Texas Health Science Center at Tyler (UTHSCT)  United States | *M. intracellulare* in respiratory isolates Household water: *M. chimaera*  Other MAC isolates | * Patients with mycobacterial sinusitis (sputum) and from their household water were included for study   water samples and/or swab cultures of bathroom and kitchen faucet filters and pipes and showerhead filters and showerhead pipes, as well as samples from any other potential sites (e.g., air filters, hot tub filters, and bathtub inlet pipes, etc., when available | [23] |
| 23. | **2013** | Multiple areas of a U.S. medical center | *M. avium* with other amoeba isolates | Water samples, biofilm samples, patient rooms- interior surface of the showerhead, sink and faucet,drain   * -Hospital pool: tile floor surrounding the pool, two water filters, the pool water, and a water dispenser used to feed water into the pool | [24] |
| 24. | **2012** | Two abattoirs in Korea (in Gyeonggi and Chungbuk) South Korea | *M. avium* subsp.  *hominissuis* | Tissue samples of 234 animals with suspected TB lesions were collected isolated from a Korean native cattle from bronchial lymph nodes and lung, Hanwoo   * (Bos taurus coreanae) | [25] |
| 25. | **2012** | Japan | *M. avium* subsp.  *hominissuis* | Samples of sputum and the bronchoalveolar lavage fluid   * Patient’s bathroom-bathtub, shower tap | [26] |
| 26. | 2009-  2011  **2012** | Isfahan, Iran | MAC along with other mycobacterium isolates (NTM) | Water samples were gathered from swimming pools, dentistry units  ,hemodialysis water ,offices water coolers   * ,drinking tap water ,undrinkable tap water, different mineral waters for sale, fountains and city pools , river, and drinking water with temperature near to boiling point. | [27] |
| 27. | **2011** | Oslo, Norway  Norwegian Veterinary institute | *M. avium* subsp.  *hominissuis* | Formalin fixed, paraffin embedded cervical and mesenterial lymph nodes from tuberculin positive Serbian imported pigs of the Lithuanian herd   * - Samples from the herd facilities-tapwater, peat, saw dust, water pipe. | [28] |
| 28. | 2008-  2009  **2011** | Mubende and Nakasongola districts located in central Uganda  the cattle corridor in Uganda  - The sub-counties were Madudu and Kiyuni in Mubende and Nabiswera and Lwampanga in Nakasongola. | MAC | * Samples from water, soil and animal faeces collected from different households. | [29] |
| 29. | **2011** | Six fattening farms located in Central Spain. | *M. avium* subsp.  *hominissuis* isolates | Granulomatous lesions in submandibular and mesenteric lymph nodes of pigs Environmental source: feed, sawdust and water from different locations, and from several humidified cellulose sheets acting as   * filters in cooling systems. | [30] |
| 30. | **2010** | Midwest region of the United States | *M. avium*  *M. intracellulare*  *M. avium* subsp  *paratuberculosis* | Drinking water biofilms to investigate   * kitchen faucet from diff households receiving water from duff public systems (groundwater, surface water or both- chlorinated) | [31] |
| 31. | **2010** | Patient from Czech Republic Patient from Slovakia | *M. avium* subsp.  *hominissuis*  *M. avium* subsp. *avium* | Tissue samples from Patients with cervical lymphadenitis  - To identify possible sources of infection, seven samples from the patient’s environment-residence, soil samples from garden   * -home garden, greenhouse, hen house. | [32] |
| 32. | **2010** | Majorca (Balearic Islands, Spain) | *M. avium* spp. *avium* | From the tissue samples with lesions of  -common kestrel (Falco tinnunculus   * scops owl (Otus scops) * barn owl (Tyto alba) * long-eared owl (Asio otus * peregrine falcon (Falco peregrinus) * booted eagle (Hieraaetus pennatus) | [33] |
| 33. | **2010** | Central Veterinary Institute of Wageningen UR, Lelystad, The Netherlands | *M. avium* | * Post-mortem mandibular lymph node inspection was performed on two separate deliveries of slaughter pigs from a single farm | [34] |
| 34. | **2009** | 1.Sawangi District Wardha, 2. Karanji Bhoge District Wardha,  3. Nandori District Wardha, 4. Wakhed District Wardha and 5.Wani District Chandrapur, India | *M. avium* with other NTM | Environmental samples viz. soil, drinking water, and water from other sources were collected from the household and work area of five AIDS patients in whom NTM were isolated from clinical samples like blood and stool   * -samples collected from 5 villages | [35] |
| 35. | **2008** | Han river, Seoul, Korea | MAC | Surface water samples collected monthly from the Han River and tap water samples at   * the terminal sites of the distribution system. | [36] |
| 36. | 2002-  samplin g  **2008** | New York city, USA | *M. avium, M. intracellulare* | Samples collected from the residence’s bathroom  The regularly used shower head was unscrewed and sediment was transferred to a sterile container and the biofilm collected with a cotton swabs   * Hot and cold water samples from bathroom taps | [37] |
| 37. | **2008** | Netherlands | 70%) were caused by  *M. avium* subspecies *avium hominissuis* | Lymph node aspirates or surgically obtained tissue biopsies from children affected with lymphadenitis  - Materials of pet birds from two patients diagnosed with M. avium-associated lymphadenitis were collected   * Swabs were collected from the cloacae of the parakeets, and faeces were scraped from the bottom of the cages | [38] |
| 38. | 2004-  2005  **2008** | Kathmandu, Nepal | *M. avium* complex | * Sputum from HIV infected patients | [39] |
| 39. | **2008** | TB units of Moroto and Matany hospitals  in the Karamoja region of Uganda | *M. avium*  *M. intracellulare*  *M. avium* subsp.  *hominissuis* | * Lymph node biopsies from patients with with cervical lymphadenitis | [40] |
| 40. | **2008** | 15 ecological zones of Texas | Johnne’s bacilli- *M. avium* subsp *paratuberculosis* | Serum samples were collected from cattle- sampling cattle in herds, cattle presented to a market, and cattle recognized to be clinically   * ill | [41] |
| 41. | **2007** | Elazig province (located in Eastern Anatolia, Turkey) | *M. avium*  *M. intracellulare* | * DNA extracted from tuberculosis patients | [42] |
| 42. | **2007** | The Norwegian Institute of Public health | *M. avium* subsp.  *hominissuis* | *M. avium* isolates collected from –humans (immune compromised patients with/without   * HIV, non-immunecompromised patients | [43] |
|  |  | The National Veterinary Institute of Norway | *M. avium* subsp. *avium* | * including children with lymphadenitis, adults with pulmonary disease. Pigs from slaughter houses and wild birds |  |
| 43. | **2007** | Olive View – UCLA Medical Center, Southern California | *M. avium*  *M. intracellulare* | MAC isolates were provided by Olive View   * – UCLA Medical Center. One hundred and sixty-three isolates were obtained from patient and environmental sources, and identified as *M. avium, M. intracellulare* Patient isolates, drinking water isolates, food isolates | [44] |
| 44. | **2006** | Austria | *M. avium* subsp. *avium*  *M. avium* subsp.  *hominissuis*  *M. avium* subsp.  *paratuberculosis* | * Austrian free-ranging red deer (*Cervus elaphus hippelaphus*. | [45] |
| 45. | **2006** | Commercial dairy operations, 40 miles from Copenhagen, Denmark  National Animal Disease Center, Ames IA, USA (US) | *M. avium* subspecies  *paratuberculosis* | * Blood samples (non-stimulated leukocytes) isolated from sub-clinical paraTB infected cows. | [46] |
| 46. | **2006** | Veterinary Research Institute, Brno, Czech republic | *M. avium* subsp.  *avium*-serotype 1  *M. avium* subsp. *hominissuis* serotype 4,8,9 | Tissue and feacal samples from birds- little egrets (*Egretta garzetta*), buff-backed herons (*Bubulcus ibis*), great white egret (*Egretta alba*), bittern (*Botaurus stellaris*) & birds of the family Threskiornithidae: sacred ibises (*Threskiornis aethiopicus*) ,spoonbills (*Platalea leucorodia*). further sample from the environment surrounding the aviaries   * that housed these infected birds | [47] |
| 47. | 2**006** | Mycobacterial Clinical Service at the National Jewish Medical and Research Center, Denver, Colorado, US | *M. avium* and *M. intracellulare* | Two commercial potting soils were purchased and used in this study, Both contained sphagnum peat moss along with other ingredient   * Mycobacterial isolates from respiratory specimens were obtained in the course of routine patient care * potting soil samples collected by the individual patients with gardening history | [48] |
| 48. | 2**005** | Northern Ireland | *M. avium* subsp.  *paratuberculosis* | * untreated water entering nine water treatment works (WTWs) over a 1-year period | [49] |
| 49. | **2005** | The University of Sydney, Camden, Australia | *M. avium* subsp.  *paratuberculosis* | the survival of the organism was studied in 250 liters of dam water and sediment in large water troughs that were placed in either a semiexposed location or in a shaded   * location and compared to survival in fecal material and soil in the shaded location | [50] |
| 50. | **2005** | Wyoming State Veterinary  Laboratory, Laramie, USA. | *M. avium* | from enteric lymph nodes sampled at   * necropsy of a Shih Tzu-Poodle-cross. | [51] |
| 51. | **2005** | Veterinary Research Institute  ,Brno, Czech Republic | *M. avium* subsp. *avium*  *M. avium* subsp.  *hominissuis* | * Tissue samples from pig organs fed with peat contaminated with *M. avium* and environment samples. | [52] |
| 52. | **2005** | Texas, US | *M. avium* subspecies  *paratuberculosis* | * Blood collected from purebred cattle of 115 beef ranches. | [53] |
| 53. | **2005** | From various farms in  Switzerland | *M. avium* ssp.  *paratuberculosis* | Faecal samples from commercial dairy   * herds. | [54] |
| 54. | **2004** | Veterinary Research Institute, Brno, Czech Republic | *M. avium* subsp. *hominissuis*-serotype 6,8 | * Lymph node samples from pigs Environmental samples-sawdust used as bedding material, drinking water | [55] |
| 55. | **2004** | Ohio State University, Wooster, Ohio 44691, USA | *M. paratuberculosis*  *M. avium-M. intracellulare* complex | Fecal and tissue samples from both captive and free-ranging wild animal species throughout the United States were submitted   * for radiometric mycobacterial culture | [56] |
| 56. | 1996-  1998  **2003** | Hospital de Clínicas, Universidade Estadual de Campinas (HC-UNICAMP), Campinas, SP, Brazil | *M. avium* | * Blood samples from AIDS patients exhibiting disseminated disease | [57] |
| 57. | **2001** | St. Louis USA | *M. avium* complex | The air above the pool (public warm water therapy pools) was sampled, liquid from the swirling aerosol collectors were also   * sampled, pool environment | [58] |
| 58. | **2000** | Department of Pulmonary Medicine, National Dohoku Hospital, Hokkaido, Japan. | *M. avium* complex | * Sputum and gastric juice samples of patients with lung disease, dyspnea | [59] |
| 59.. | **2000** | 68 districts of the Czech republic  The Holstein herd, imported from Denmark  Limousine herd imported from Hungary | *M. avium* subspecies *paratuberculosis* strains | * Necroscopy specimens, tissue and facecal samples from wild ruminants | [60] |
| 60. | **1999** | France | *M. avium* | * Isolates from infected patients. | [61] |
| 61. | **1999** | Department of Respiratory Medicine, National Kumamotominami Hospital, Kumamoto 869-0524, Japan | *M.intracellulare* | * Sputum samples from patients suffering from lung disease. | [62] |
| 62. | **1998** | in Tokai, Kinki and Chugoku districts, Japan | *M avium*  *M. intracellulare*  MAC like organisms  *M. avium* serovars- 4,8,9,3, Darkin, 1 | soil samples collected   * isolates from sputum, stool and blood and AIDS patients | [63] |
| 63. | 1994-  1995  **1997** | Bellevue Hospital Center in New York City | *M. avium* complex | Patients were included in this study if they had at least one positive culture for M tuberculosis from a pulmonmy source and two or more sputum cultures of MAC on at   * least two separate occasions. | [64] |
| 64. | **1994** | Department of Clinical Microbiology, Westmead Hospital, New South Wales, Australia. | MAC subtypes Serovar 1,8, 21  Mixed seovars 1-21 | * Specimens from blood, bone marrow, sterile sites, faeces, urine and respiratory specimens from AIDS patients | [65] |
| 65. | **1993** | Brno, Czech republic | *M. avium* serotype 2 | Samples collected from free living birds, and the environment from 6 poultry rearing   * farms | [66] |
| 66. | **1993** | Brno, Czech republic | *M. avium* | * 218 organs and intestinal specimens of the collared turtle-doves and 22 specimens of turtle-doves taken in habitats with different epidemiological setting | [67] |
| 67. | **1993** | 11 different locations in Brno, Czech republic | *M avium* | * House-sparrows (*P. domesticus*) and mountain-sparrows (*P. montanus*) | [68] |
| 68. | **1993** | Brno, Czech republic | *M. avium* | Pheasant (*Phasianus colchicus*) and   * partridge (*Perdix perdix*) | [69] |
| 69. | 1982-  1991  **1992** | Indiana, Boston, new York, California, Albany, San Francisco, Denver, Philadelphia, Chicago, Baltimore, Columbus,Washington DC, Texas, Ohio | MAC serovar 4>8>1>9>6>14>2 | * Cultures of samples from almost everybody site was obtained was patients with and without AIDS, respiratory sites, sterile body sites-blood, bone marrow, kidney, liver, lung, lymph nodes, spleen, cerebrospinal fluid | [70] |
| 70. | **1991** | Tokyo | *M. avium* complex  *M. kansasii* | Sputum from patients with pulmonary   * disease | [71] |
| 71.. | **1988** | Southeastern coastal region of Madagascar | *M. avium* | * A total of 18 sphagnum samples were collected | [72] |
| 72. | **1989** | Kekerengu, Marlborough,  NewZealand | *M. avium* | Soil, tree debris, silage pits, water samples   * collected from deer farms | [73] |
| 73. | 1985-  1986  **1989** | Commercial swine herds, Davis, California | MAC serovars-1, 4, 8, 9, the dual serovar 4/8, and an untypable serovar | * Tissue samples from pigs and their and their associated environment | [74] |
| 74. | **1988** | Department of Anaesthesia, Harvard Medical School,  Boston, MA | *M. avium*-type 4 serovar | cold water taps and hot water taps, including shower heads of two temporarily vacant   * hospital floors | [75] |
| 75. | 1968-  1978  **1981** | Transkei, Kwazulu, Gazankulu, Ciskei, Bothuthatswana, Lebowa- South Africa | 792 strains of the *Mycobacterium avium- intracellulare* complex | Samples from South African swine, feed material, bedding, from surrounding plants and soil   * Samples were isolated from sputa of healthy adults in random-sample surveys undertaken in rural, black-homeland areas of South Africa | [76] |
| 76. | **1980** | basin of the Fitzroy River and its tributaries in central Queensland, coastal city of Rockhampton, southeastern Queensland city of Toowoomba | *Mycobacterium intracellulare and M. avium* | * Isolated from rainwater tanks situated in the basin of the Fitzroy River and its tributaries in central Queensland, 7 of 32 tanks situated in the hinterland of the coastal city of Rockhampton, and 2 of 32 tanks sampled repetitively in the southeastern Queensland city of Toowoomba | [77] |
| 77. | **2014** | Germany | *M. avium* (MAH) | * poultry, Humans, dogs | [78] |
| 78. | **1982** | Hungry | *M avium*, NTM | * birds, animals, humans NTM bacteria   (Crohns Disease) | [79] |
| 79. | **2004** | Italy | *M avium* (MAH) | * *patients* | [80] |
| 80. | **1989** | Sweden | *M avium* (MAH) | * *patients* | [81] |
| 81. | **2015** | Russia | *M avium* (MAH) | * *patients* | [82] |

References:

1. Shin J-I, Shin SJ, Shin M-K. Differential Genotyping of Mycobacterium avium Complex and Its Implications in Clinical and Environmental Epidemiology. *Microorganisms*. 8(1) (2020).

2. Marušić A, Kuhtić I, Mažuranić I, *et al.* Nodular distribution pattern on chest computed tomography (CT) in patients diagnosed with nontuberculous mycobacteria (NTM) infections. *Wiener klinische Wochenschrift*. , 1–8 (2020).

3. Satta Y, Yamashita M, Matsuo Y, *et al.* Non-tuberculous mycobacterial pseudo-outbreak of an intestinal culture specimen caused by a water tap in an endoscopy unit. *Internal Medicine*. , 5188–20 (2020).

4. Donohue M, King D, Pfaller S, Mistry J. The sporadic nature of Legionella pneumophila, Legionella pneumophila Sg1 and Mycobacterium avium occurrence within residences and office buildings across 36 states in the United States. *Journal of applied microbiology*. 126(5), 1568–1579 (2019).

5. Lande L, Alexander DC, Wallace Jr RJ, *et al.* Mycobacterium avium in community and household water, suburban Philadelphia, Pennsylvania, USA, 2010–2012. *Emerging infectious diseases*. 25(3), 473 (2019).

6. James PL, Cannon J, Barber CM, *et al.* Metal worker’s lung: spatial association with Mycobacterium avium. *Thorax*. 73(2), 151–156 (2018).

7. Sevilla IA, Molina E, Tello M, Elguezabal N, Juste RA, Garrido JM. Detection of mycobacteria by culture and DNA-based methods in animal-derived food products purchased at Spanish supermarkets. *Frontiers in microbiology*. 8, 1030 (2017).

8. Adhikari S, Tohme TC, Whiley H. Investigation of Mycobacterium avium complex (MAC) in Australian commercial milk using qPCR. *The Journal of dairy research*. 84(1), 89 (2017).

9. King DN, Donohue MJ, Vesper SJ, *et al.* Microbial pathogens in source and treated waters from drinking water treatment plants in the United States and implications for human health. *Science of the Total Environment*. 562, 987–995 (2016).

10. Aboagye SY, Danso E, Ampah KA, *et al.* Isolation of nontuberculous mycobacteria from the environment of Ghanian communities where Buruli ulcer is endemic. *Applied and environmental microbiology*. 82(14), 4320–4329 (2016).

11. Vluggen C, Soetaert K, Duytschaever L, *et al.* Genotyping and strain distribution of Mycobacterium avium subspecies hominissuis isolated from humans and pigs in Belgium, 2011–2013. *Eurosurveillance*. 21(3), 30111 (2016).

12. Kalvisa A, Tsirogiannis C, Silamikelis I, *et al.* MIRU-VNTR genotype diversity and indications of homoplasy in M. avium strains isolated from humans and slaughter pigs in Latvia. *Infection, Genetics and Evolution*. 43, 15–21 (2016).

13. Ley S, Carter R, Millan K, *et al.* Non-tuberculous mycobacteria: baseline data from three sites in Papua New Guinea, 2010–2012. *Western Pacific surveillance and response journal: WPSAR*. 6(4), 24 (2015).

14. Wei G, Huang M, Wang G, *et al.* Antimicrobial susceptibility testing and genotyping of Mycobacterium avium isolates of two tertiary tuberculosis designated hospital, China. *Infection, Genetics and Evolution*. 36, 141–146 (2015).

15. Kaevska M, Lvoncik S, Lamka J, Pavlik I, Slana I. Spread of Mycobacterium avium subsp. paratuberculosis through soil and grass on a Mouflon (Ovis aries) pasture. *Current microbiology*. 69(4), 495–500 (2014).

16. Sohal JS, Arsenault J, Labrecque O, *et al.* Genetic structure of Mycobacterium avium subsp. paratuberculosis population in cattle herds in Quebec as revealed by using a combination of multilocus genomic analyses. *Journal of clinical microbiology*. 52(8), 2764–2775 (2014).

17. Crago B, Ferrato C, Drews S, *et al.* Surveillance and molecular characterization of non-tuberculous mycobacteria in a hospital water distribution system over a three-year period. *Journal of Hospital Infection*. 87(1), 59–62 (2014).

18. Chuchaona W, Khamrin P, Yodmeeklin A, *et al.* Detection and characterization of a novel human parechovirus genotype in Thailand. *Infection, Genetics and Evolution*. 31, 300–304 (2015).

19. Ichijo T, Izumi Y, Nakamoto S, Yamaguchi N, Nasu M. Distribution and respiratory activity of mycobacteria in household water system of healthy volunteers in Japan. *PLoS One*. 9(10), e110554 (2014).

20. Kaevska M, Lvoncik S, Slana I, Kulich P, Kralik P. Internalisation of mycobacteria in plants confirmed by microscopy, culture and quantitative real time PCR examination. *Applied and Environmental Microbiology*. (2014).

21. Perez-Martinez I, Aguilar-Ayala DA, Fernandez-Rendon E, *et al.* Occurrence of potentially pathogenic nontuberculous mycobacteria in Mexican household potable water: a pilot study. *BMC research notes*. 6(1), 1–7 (2013).

22. Dirac MA, Weigel KM, Yakrus MA, *et al.* Shared Mycobacterium avium genotypes observed among unlinked clinical and environmental isolates. *Applied and environmental microbiology*. 79(18), 5601–5607 (2013).

23. Wallace RJ, Iakhiaeva E, Williams MD, *et al.* Absence of Mycobacterium intracellulare and presence of Mycobacterium chimaera in household water and biofilm samples of patients in the United States with Mycobacterium avium complex respiratory disease. *Journal of clinical microbiology*. 51(6), 1747–1752 (2013).

24. Ovrutsky AR, Chan ED, Kartalija M, *et al.* Cooccurrence of free-living amoebae and nontuberculous Mycobacteria in hospital water networks, and preferential growth of Mycobacterium avium in Acanthamoeba lenticulata. *Applied and environmental microbiology*. 79(10), 3185–3192 (2013).

25. Decaro N, Lorusso A. Novel human coronavirus (SARS-CoV-2): A lesson from animal coronaviruses. *Veterinary microbiology*. , 108693 (2020).

26. Taga S, Niimi M, Kurokawa K, Nakagawa T, Ogawa K. A case of environmental infection with pulmonary Mycobacterium avium complex disease from a residential bathroom of a patient suggested by variable-number tandem-repeat typing of Mycobacterium avium tandem repeat loci. *Kekkaku:[Tuberculosis]*. 87(5), 409–414 (2012).

27. Youse HA, Kazemian A, Sereshti M, *et al.* Effect of Echinophora platyloba, Stachys lavandulifolia, and Eucalyptus camaldulensis plants on Trichomonas vaginalis growth in vitro. *Advanced biomedical research*. 1 (2012).

28. Agdestein A, Johansen TB, Polaček V, *et al.* Investigation of an outbreak of mycobacteriosis in pigs. *BMC Veterinary Research*. 7(1), 1–7 (2011).

29. Kankya C, Muwonge A, Djønne B, *et al.* Isolation of non-tuberculous mycobacteria from pastoral ecosystems of Uganda: public health significance. *BMC Public Health*. 11(1), 1–9 (2011).

30. Alvarez J, Castellanos E, Romero B, *et al.* Epidemiological investigation of a Mycobacterium avium subsp. hominissuis outbreak in swine. *Epidemiology & Infection*. 139(1), 143–148 (2011).

31. Chern EC, King D, Haugland R, Pfaller S. Evaluation of quantitative polymerase chain reaction assays targeting Mycobacterium avium, M. intracellulare, and M. avium subspecies paratuberculosis in drinking water biofilms. *Journal of water and health*. 13(1), 131–139 (2015).

33. Millán J, Negre N, Castellanos E, *et al.* Avian mycobacteriosis in free-living raptors in Majorca Island, Spain. *Avian Pathology*. 39(1), 1–6 (2010).

34. van Ingen J, Wisselink HJ, van Solt-Smits CB, Boeree MJ, van Soolingen D. Isolation of mycobacteria other than Mycobacterium avium from porcine lymph nodes. *Veterinary microbiology*. 144(1–2), 250–253 (2010).

35. Narang R, Narang P, Mendiratta D. Isolation and identification of nontuberculous mycobacteria from water and soil in central India. *Indian journal of medical microbiology*. 27(3), 247 (2009).

37. Falkinham III JO, Iseman MD, de Haas P, van Soolingen D. Mycobacterium avium in a shower linked to pulmonary disease. *Journal of water and health*. 6(2), 209–213 (2008).

38. Kriz P, Jahn P, Bezdekova B, *et al.* Mycobacterium avium subsp. hominissuis infection in horses. *Emerging infectious diseases*. 16(8), 1328 (2010).

39. Dhungana G, Ghimire P, Sharma S, Rijal B. Tuberculosis co-infection in HIV infected persons of Kathmandu. *Nepal Medical College journal: NMCJ*. 10(2), 96–99 (2008).

40. Oloya J, Opuda-Asibo J, Kazwala R, *et al.* Mycobacteria causing human cervical lymphadenitis in pastoral communities in the Karamoja region of Uganda. *Epidemiology & Infection*. 136(5), 636–643 (2008).

41. Pearce BH, Fosgate GT, Ward MP, *et al.* Comparison of three methods of surveillance with application to the detection of Johne’s disease seropositivity in Texas cattle. *Preventive Veterinary Medicine*. 86(1), 1–7 (2008).

42. Ağaçayak A, Bulut Y, Seyrek A. [Detection of Mycobacterium species distribution in the sputum samples of tuberculosis patients by PCR-RFLP method in Elazig province]. *Mikrobiyoloji bulteni*. 41(2), 203–209 (2007).

43. Johansen TB, Olsen I, Jensen MR, Dahle UR, Holstad G, Djønne B. New probes used for IS1245 and IS1311 restriction fragment length polymorphism of Mycobacterium avium subsp. avium and Mycobacterium avium subsp. hominissuis isolates of human and animal origin in Norway. *BMC Microbiol*. 7, 14–14 (2007).

44. Pfaller S, Aronson T, Holtzman A, Covert T. Amplified fragment length polymorphism analysis of Mycobacterium avium complex isolates recovered from southern California. *Journal of medical microbiology*. 56, 1152–60 (2007).

45. Glawischnig W, Steineck T, Spergser J. Infections caused by Mycobacterium avium subspecies avium, hominissuis, and paratuberculosis in free-ranging red deer (Cervus elaphus hippelaphus) in Austria, 2001–2004. *Journal of Wildlife Diseases*. 42(4), 724–731 (2006).

46. Skovgaard K, Grell SN, Heegaard PM, Jungersen G, Pudrith CB, Coussens PM. Differential expression of genes encoding CD30L and P-selectin in cattle with Johne’s disease: Progress toward a diagnostic gene expression signature. *Veterinary Immunology and Immunopathology*. 112(3–4), 210–224 (2006).

47. Dvorska L, Matlova L, Ayele W, *et al.* Avian tuberculosis in naturally infected captive water birds of the Ardeideae and Threskiornithidae families studied by serotyping, IS901 RFLP typing, and virulence for poultry. *Veterinary microbiology*. 119(2–4), 366–374 (2007).

48. De Groote MA, Pace NR, Fulton K, Falkinham JO. Relationships between Mycobacterium isolates from patients with pulmonary mycobacterial infection and potting soils. *Applied and environmental microbiology*. 72(12), 7602–7606 (2006).

49. Whan L, Ball HJ, Grant IR, Rowe MT. Occurrence of Mycobacterium avium subsp. paratuberculosis in untreated water in Northern Ireland. *Applied and Environmental Microbiology*. 71(11), 7107–7112 (2005).

50. Whittington RJ, Marsh IB, Reddacliff LA. Survival of Mycobacterium avium subsp. paratuberculosis in dam water and sediment. *Applied and environmental Microbiology*. 71(9), 5304–5308 (2005).

51. O’Toole D, Tharp S, Thomsen B, Tan E, Payeur J. Fatal mycobacteriosis with hepatosplenomegaly in a young dog due to Mycobacterium avium. *Journal of veterinary diagnostic investigation*. 17(2), 200–204 (2005).

52. Matlova L, Dvorska L, Ayele WY, Bartos M, Amemori T, Pavlik I. Distribution of Mycobacterium avium complex isolates in tissue samples of pigs fed peat naturally contaminated with mycobacteria as a supplement. *Journal of Clinical Microbiology*. 43(3), 1261–1268 (2005).

53. Roussel AJ, Libal MC, Whitlock RL, Hairgrove TB, Barling KS, Thompson JA. Prevalence of and risk factors for paratuberculosis in purebred beef cattle. *Journal of the American Veterinary Medical Association*. 226(5), 773–778 (2005).

54. Garred P, Brygge K, Sorensen C, Madsen H, Thiel S, Svejgaard A. Mannan‐binding protein—levels in plasma and upper‐airways secretions and frequency of genotypes in children with recurrence of otitis media. *Clinical & Experimental Immunology*. 94(1), 99–104 (1993).

55. Matlova L, Dvorska L, Palecek K, Maurenc L, Bartos M, Pavlik I. Impact of sawdust and wood shavings in bedding on pig tuberculous lesions in lymph nodes, and IS1245 RFLP analysis of Mycobacterium avium subsp. hominissuis of serotypes 6 and 8 isolated from pigs and environment. *Veterinary microbiology*. 102(3–4), 227–236 (2004).

56. Motiwala AS, Amonsin A, Strother M, Manning EJ, Kapur V, Sreevatsan S. Molecular epidemiology of Mycobacterium avium subsp. paratuberculosis isolates recovered from wild animal species. *Journal of clinical microbiology*. 42(4), 1703–1712 (2004).

57. Panunto A, Villares M, Ramos M. IS1245 restriction fragment length polymorphism typing of Mycobacterium avium from patients admitted to a reference hospital in Campinas, Brazil. *Brazilian journal of medical and biological research*. 36(10), 1397–1401 (2003).

58. Angenent LT, Kelley ST, Amand AS, Pace NR, Hernandez MT. Molecular identification of potential pathogens in water and air of a hospital therapy pool. *Proceedings of the National Academy of Sciences*. 102(13), 4860–4865 (2005).

59. Sato K, Matsumoto H, Ogasa T, *et al.* Three cases of Mycobacterium avium lung disease in an iron foundry. *Nihon Kokyuki Gakkai Zasshi= the Journal of the Japanese Respiratory Society*. 38(9), 697–701 (2000).

60. Pavlik I, Bartl J, Dvorska L, *et al.* Epidemiology of paratuberculosis in wild ruminants studied by restriction fragment length polymorphism in the Czech Republic during the period 1995–1998. *Veterinary microbiology*. 77(3–4), 231–251 (2000).

61. Pestel-Caron M, Graff G, Berthelot G, Pons JL, Lemeland JF. Molecular analysis of Mycobacterium avium isolates by using pulsed-field gel electrophoresis and PCR. *J Clin Microbiol*. 37(8), 2450–2455 (1999).

62. Shimazu K, Iinuma Y, Aman K, Ebihara M, Nakagawa Y. [Pulmonary infection induced by Mycobacterium intracellulare in 2 sisters: a biomolecular study of the isolates]. *Nihon Kokyuki Gakkai zasshi = the journal of the Japanese Respiratory Society*. 37(11), 893–897 (1999).

63. Saito H, Kai M, Kobayashi K. Geographical distribution of Mycobacterium avium complex in environment and serovars of Mycobacterium avium complex isolates from patients with and without AIDS. *Kekkaku:[Tuberculosis]*. 73(5), 379–383 (1998).

64. Epstein MD, Aranda CP, Rom WN, Bonk S, Hanna B. The significance of Mycobacterium avium complex cultivation in the sputum of patients with pulmonary tuberculosis. *Chest*. 111(1), 142–147 (1997).

65. Chew W, Sorrell T, Gilbert G. Subtyping of Mycobacterium avium complex (MAC) isolates by thin-layer chromatography–distribution of subtypes from patients with AIDS compared with clinically non-significant isolates. *Epidemiology & Infection*. 112(3), 543–549 (1994).

66. Hejlicek K, Treml F. The occurrence of avian mycobacteriosis in wild birds during various epizootic conditions of tuberculosis in poultry. *Veterinarni medicina*. 38(5), 305–317 (1993).

67. Hejlícek K, Treml F. Epizootiology and pathogenesis of avian mycobacteriosis in doves (Streptopelia sp.). *Veterinarni medicina*. 38(10), 619–628 (1993).

68. Hejlicek K, Treml F. Epizootiology and pathogenesis of avian mycobacteriosis in the house sparrow (Passer domesticus) and tree sparrow (Passer montanus). *Veterinarni medicina*. 38(11), 667–685 (1993).

69. Hejlicek K, Treml F. Epizootiology and pathogenesis of avian mycobacteriosis in the ring-necked pheasant (Phasianus colchicus) and the Hungarian partridge (Perdix perdix). *Veterinarni medicina*. 38(11), 687–701 (1993).

70. Tsang AY, Denner JC, Brennan PJ, McClatchy JK. Clinical and epidemiological importance of typing of Mycobacterium avium complex isolates. *Journal of clinical microbiology*. 30(2), 479–484 (1992).

71. SHIMOIDE H, FUKUI T, ANZAI E, MIZUTANI S. Studies on epidemiology of nontuberculous mycobacteriosis on the regional difference of the incidence of pulmonary diseases due to M. kansasii and M. avium complex in Tokyo area. *Kekkaku (Tuberculosis)*. 66(10), 671–677 (1991).

72. Schröder K-H, Kazda J, Müller K, Müller H. Isolation of Mycobacterium simiae from the environment. *Zentralblatt für Bakteriologie*. 277(4), 561–564 (1992).

73. Prosser B. Methods used to investigate a possible environmental source of Mycobacterium avium‐intracellulare‐scrofulaceum (MAIS) infection in farmed deer. *Journal of applied bacteriology*. 66(3), 219–226 (1989).

74. Gardner I, Hird D. Environmental source of mycobacteriosis in a California swine herd. *Canadian Journal of Veterinary Research*. 53(1), 33 (1989).

75. du Moulin GC, Stottmeier KD, Pelletier PA, Tsang AY, Hedley-Whyte J. Concentration of Mycobacterium avium by hospital hot water systems. *Jama*. 260(11), 1599–1601 (1988).

76. Nel EE. Mycobacterium avium-intracellulare complex serovars isolated in South Africa from humans, swine, and the environment. *Reviews of infectious diseases*. 3(5), 1013–1020 (1981).

77. Tuffley R, Holbeche J. Isolation of the Mycobacterium avium-M. intracellulare-M. scrofulaceum complex from tank water in Queensland, Australia. *Applied and environmental microbiology*. 39(1), 48–53 (1980).

78. Lahiri A, Kneisel J, Kloster I, Kamal E, Lewin A. Abundance of M ycobacterium avium ssp. hominissuis in soil and dust in Germany–implications for the infection route. *Letters in applied microbiology*. 59(1), 65–70 (2014).

79. Kalich R, Käppler W, Fischer P, Vandra E, Kozma D. Lung diseases caused by non-tuberculous mycobacteria in East Germany and Hungary. *Pneumologie (Stuttgart, Germany)*. 43(3), 169–172 (1989).

80. Rindi L, Garzelli C. Increase in non-tuberculous mycobacteria isolated from humans in Tuscany, Italy, from 2004 to 2014. *BMC infectious diseases*. 16(1), 1–5 (2015).

81. Thegerström J, Romanus V, Friman V, Brudin L, Haemig PD, Olsen B. Mycobacterium avium lymphadenopathy among children, Sweden. *Emerg Infect Dis*. 14(4), 661–663 (2008).

82. Zhuravlev V, Solovieva N, Inozemceva A, Gavrilov P, Starshinova A, Yablonskii P. Antimicrobial susceptibilities of mycobacterium avium pulmonary disease from patients in St. Petersburg, Russia. *Eur Respir J*. 48(suppl 60), PA2755 (2016).