Mosquitoes, Medicine, and Marshes: Malaria in the Late Medieval Low Countries: A study of the relationship between human society and the natural environment, viewed through the lens of malaria in the late medieval Low Countries

Witteman, Nina

Mosquitoes, Medicine, and Marshes: Malaria in the Late Medieval Low Countries

A study of the relationship between human society and the natural environment, viewed through the lens of malaria in the late medieval Low Countries

Nina Carola Gabriëlla Witteman

2355310

n.c.g.witteman@umail.leidenuniv.nl

Research Master thesis

Dr. Claire Weeda

July 2025

Wordcount: 24798

Preface

What first ‘infected’ me with an interest in the study of malaria in the late medieval Low Countries, was a research traineeship at Leiden University, which I undertook together with Claudia Moreira Calzadilla, under the guidance of Dr. Johannes Müller and Dr. Claire Weeda. I would like to thank them for the enjoyable and fruitful collaboration, and for the insights that served as the starting point for this thesis.[1] I am also grateful to Dr. Rachel Schats for sharing the findings of her osteoarchaeological research on the presence and prevalence of malaria in the late medieval Low Countries, and for her sharp eye in identifying the first of a number of malaria-related symptoms in the Middle Dutch sources. Furthermore, I am thankful to my family and friends for enduring my monologues on malaria, mosquitoes, medicine, and marshes, and their patience and support. Lastly, as any research project – no matter how small – comes with its share of stress, I would like to thank Cusco, Pua, Kiwi, Bacon and the deer in the Stadsboederij de Houthoeve in Haarlem for their calming and relaxing presence during my evening walks.

[1] The research traineeship led to the publication of two blogposts focusing on health, wetlands, and malaria: C. Moreira Calzadilla and N. Witteman, ‘Healing and Ruling in Medieval England’s Wetlands’, *Network in Canadian History & Environment* (blog), 2024, https://niche-canada.org/2024/05/22/healing-and-ruling-in-medieval-englands-wetlands/; C. Moreira Calzadilla and N. Witteman, ‘Hidden in Plain Sight: Mosquitoes, Malaria and Herbs in the Medieval Low Countries’, *Leiden Medievalist Blog* (blog), 2024, https://www.leidenmedievalistsblog.nl/articles/hidden-in-plain-sight-mosquitoes-malaria-and-herbs-in-the-medieval-low-countries.

Contents

Introduction

A terrible 'recurrent fever'

In the summer of the year 1237, a terrible fever struck the monks of the Bloemhof Premonstratensian monastery and its surrounding villages in Wittewierum, in what is now the Dutch province of Groningen. The abbot Menko, who narrates this episode in the *Cronica Floridi Horti*, tells us that this specific year had begun ominously, with a damp and warm winter followed by excessive heat and drought. This had completely disrupted the 'nature of the year', giving rise to corrupt air that afflicted the people with many fevers – specifically with a 'recurrent fever'.[2] By autumn, the fevers had become so severe and widespread, that 'there were barely enough healthy people to care for the sick, and infirmaries struggled to house all the fever-struck patients'.[3] The monastery faced further tragedy, when their beloved reverend father Emo was also infected by the terrible 'recurrent fever'.[4]

As will become clear in this thesis, the 'recurrent fever' that terrorised the Bloemhof monastery and the surrounding villages in 1237 was malaria. Malaria – whose aetiology is discussed more extensively in chapter 1 – is a parasitic disease transmitted through the bites of *Anopheles* mosquitoes. Its most distinctive symptom is that it causes a short period of intense fever, which recurs every two to three days. Other complications include (severe) anaemia, as well as splenomegaly (enlarged spleen), and organ failure in the kidneys, liver, and lungs, which, especially in weaker individuals, such as the elderly, the sick, and children can be fatal. *Anopheles* mosquitoes thrive specifically in wetland environments and the disease is therefore currently primarily associated with tropical regions in Africa and Asia. Indeed Africa accounts for 94 per cent of the 263 million annual malaria cases, as well as for approximately 570,000 malaria-related deaths each year.[5] However, during the premodern period and until large scale eradication efforts in the twentieth century, malaria was also present in the Low Countries. What this thesis aims to demonstrates – and what the episode in the history of the Bloemhof monastery illustrates – is that people possessed explicit knowledge of malaria and its occurrence in the late medieval Low Countries. Indeed, by analysing how contemporaries described and interpreted the disease, explained its causes, and sought ways to treat it

[2] 'Omdat het jaar [1237], zoals we hierboven gezegd hebben, was begonnen met een warme en natte winter, terwijl die eigenlijk koud en nat had moeten zijn, was de zomer vreselijk nat en koud, tot aan 1 augustus. Daarop volgde een onmatige warmte en droogt. En zo was het weer bijna het geheel jaar lang van slag af en tegengesteld aan zijn aard. […] En zo werden de mensen overal door verschillende koortsen gekweld. De derdendaagse koorts trof vooral de kloosterlingen', Menko and Emo, *Cronica Floridi Horti*, trans. H.P.H Jansen and A Janse (Hilversum: Uitgeverij Verloren, 1991), 286–87.
[3] 'Terwijl de herfst voortschreed en de kloosterlingen door velerlei koortsen werden gekweld, zozeer dat er in geheel Freisland nauwelijks genoeg gezonde mensen waren om de zieken te verzorgen en de ziekenzalen de patiënten nauwelijk konden bevatten', Menko and Emo, 288–89.
[4] '[…] in diezelfde tijd werd de eerwaarde vader Emo zaliger gedachtenis, die zeer in aanzien stond bij alle kloosterlingen en ook bij verstandige leken, door een steeds terugkerende koorts bevangen', Menko and Emo, 288–89.
[5] 'Malaria', World Health Organisation, 29 June 2025, https://www.who.int/news-room/fact-sheets/detail/malaria.

in medical compendia and other medical and non-medical sources – such as chronicles, *vitae*, and spiritual writings – it becomes evident that they had a deep and thorough understanding of malaria. Re-examining this corpus through the lens of malaria not only reshapes our understanding of the disease's historical presence in the Low Countries but also offers valuable insights into the production and circulation of medical knowledge, as well as into the complex and historical contingent relationship between human society and the environment. The contribution of this thesis becomes clear when we examine how scholars to date have constructed the history of malaria, particularly in the premodern Low Countries.

Historiography of malaria in the late medieval Low Countries

Historical research in a broader context has addressed the history of malaria from Antiquity to the present day. A particularly influential work is *The Rise and Fall of Malaria in Europe* published in 1980 by Leonard Bruce-Chwatt and Jan de Zulueta, which traces malaria's trajectory across various European regions and explores contemporary understandings of the disease.[6] More recent prominent contributions, such as *Malaria in Europe* by Mahmoud Boualam, Bruno Pradines, Michel Drancourt, and Rémi Barbieri, as well as Cheston Cunha and Burke Cunha's *Brief History of the Clinical Diagnosis of Malaria*, pursue a similar aim, offering overviews of the disease's presence and perception throughout European history.[7] These and similar studies argue that in Antiquity, there was a relatively accurate understanding of malaria – both in terms of recognising its symptoms and associating it with mosquito-prone environment. Although they identify scattered traces of malaria-related knowledge throughout the premodern period, they conclude that much of the ancient knowledge of the disease had faded during the medieval period and would only be 'rediscovered' in the nineteenth and twentieth centuries.[8]

Concurrently, when it comes to the late medieval Low Countries, historical studies to date hold there is no reliable evidence that people acknowledged the presence of malaria.[9] The most

[6] L.J. Bruce-Chwatt and J. de Zulueta, *The Rise and Fall of Malaria in Europe: Historical-Epidemiological Study* (Oxford: Oxford University Press, 1980).
[7] M.A. Boualam et al., 'Malaria in Europe: A Historical Perspective', *Frontiers in Medicine* 8 (2021): 1–12; C.B. Cunha and B.A. Cunha, 'Brief History of the Clinical Diagnosis of Malaria: From Hippocrates to Osler', *Journal of Vector Borne Diseases*, no. 45 (2008): 194–99.
[8] Boualam et al., 'Malaria in Europe: A Historical Perspective'; Bruce-Chwatt and Zulueta, *The Rise and Fall of Malaria in Europe*; R.M. Packard, *The Making of a Tropical Disease: A Short History of Malaria* (Baltimore: Johns Hopkins University Press, 2007); Cunha and Cunha, 'Brief History of the Clinical Diagnosis of Malaria'; M. Dagen, 'History of Malaria and Its Treatment', in *Antimalarial Agents: Design and Mechanism of Action*, ed. G.L. Patrick, 2020, 1–48; M.J. Dobson, ''Marsh Fever'- the Geography of Malaria in England', *Journal of Historical Geography* 6:4 (1980): 357–89.
[9] N.H. Swellengrebel and A. de Buck, *Malaria in the Netherlands* (Amsterdam: Scheltema & Holkema, 1938), 9–12; Bruce-Chwatt and Zulueta, *The Rise and Fall of Malaria in Europe*, 106. A notable exception is Otto Knottnerus's article 'Malaria Around the North Sea: A Survey', in which Knottnerus highlights a number of sources dating back to the medieval period and associated with the region of the Low Countries, which he interprets as referencing malaria. However, the cited texts were written by influential authors from other parts of Europe. Moreover, since his discussion of malaria in the Low Countries forms part of a study with a broader

prominent work on this subject is *Malaria in the Netherlands* by Nicolaas Swellengrebel and Abraham de Buck, published in 1938.[10] In their study, they argue that is impossible to positively identify malaria-related knowledge in historical records from before the nineteenth century. One of their main obstacles is the issue of terminology: the term 'malaria' stems from the eighteenth century, derived from the Italian 'mala aria' meaning bad air (which reflects the belief that the disease was caused by inhaling toxic air), and was not used in the premodern period.[11] Another challenge Swellengrebel and De Buck identify is the way disease and medical knowledge were recorded in historical sources, stating that 'we have no means of identifying malaria', as historians are unable to reliably interpret past description of diseases.[12] Because of these limitations, Swellengrebel and De Buck conclude that it is virtually impossible to confirm with certainty knowledge and understanding of malaria in premodern sources from the Low Countries.

If scholars question whether people in the premodern Low Countries recognised the presence of malaria, we can turn to archaeological research to review whether there are material traces of the disease's presence and circulation – independent of its identification by contemporaries. Archaeological research currently estimates that malaria arrived in Europe during the Neolithic period (4000-3000 BC), traveling from Africa via the Nile Valley to Greece. From there, it gradually spread across the European continent during the early centuries of the first millennium AD.[13] The moment the parasite reached the Low Countries is, however, still a subject of debate. While archaeology has helped to map the broad contours of malaria's spread through Europe, identifying its presence in the premodern Low Countries remains notoriously difficult. In rare cases, the parasite's DNA has been successfully recovered from human remains, but it more often fails to survive due to environmental conditions.[14] To address this, osteoarchaeological research done by Rachel Schats has focused on indirect skeletal indicators of the disease by examining the prevalence of *cribra orbitalia* – a condition characterised by thin and porous bone in the eye sockets – in human remains from the northern late medieval Low Countries.[15] Malaria is strongly associated with severe anaemia and because red blood

---

geographical scope, an in-depth analysis of the sources is not the primarily focus of his study. O.S. Knottnerus, 'Malaria Around the North Sea: A Survey', in *Climate Development and History of the North Atlantic Realm*, ed. G Wefer et al. (Berlin: Springer, 2002), 339–53.

[10] Swellengrebel and Buck, *Malaria in the Netherlands*.

[11] H.A. van Seventer, *The Disappearance of Malaria in the Netherlands* (Zwanenburg: A & S Foddegan, 1969), 9.

[12] Swellengrebel and Buck, *Malaria in the Netherlands*, 9–12.

[13] E.T. Piperaki, 'Malaria Eradication in the European World: Historical Perspective and Imminent Threats', in *Towards Malaria Elimination - A Leap Forward*, ed. S. Manguin and V. Dev (London: IntechOpen, 2017), 317.

[14] The presence of *Plasmodium* DNA has been confirmed in several Egyptian mummies, as well as in the skeleton of a child from ancient Italy, see: A.G. Nerlich et al., 'Plasmodium Falciparum in Ancient Egypt', *Emerging Infectious Diseases* 14:8 (2008): 1317–19; R. Sallares, *Malaria and Rome: A History of Malaria in Ancient Italy* (Oxford: Oxford University Press, 2002).

[15] R. Schats, 'Malaise and Mosquitos: Osteoarchaeological Evidence for Malaria in the Medieval Netherlands', *Analecta Praehistorica Leidensia* 45 (2015): 133–40.

cells are produced primarily in the bone marrow, the body compensates for chronic anaemia by expanding these red blood cell-producing areas. This enlargement is especially prominent in the bones around the eye sockets, resulting in *cribra orbitalia*. Schats compared the distribution of *cribra orbitalia* to the ecological landscape of the Low Countries and found the condition especially common in environments ideal for malaria-carrying mosquitoes – namely marshes, bogs and fens.[16] Based on this, she concluded that malaria was highly prevalent in certain parts of the medieval Low Countries, particularly in wetland regions near the coast.[17]

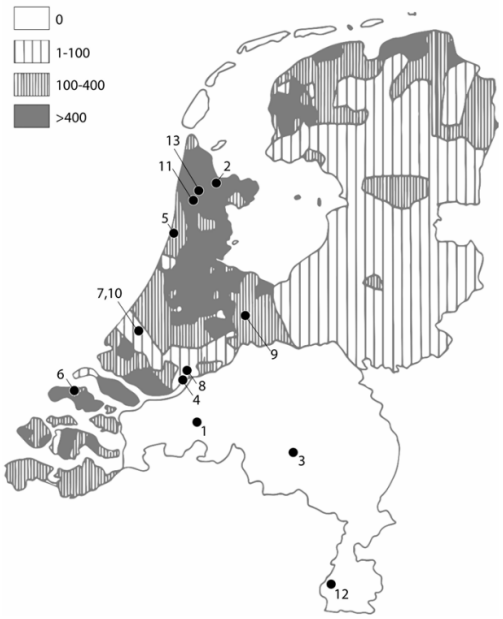

Fig. 1. Map of the Netherlands indicating mosquito density in 1938. Schats identified the skeletal remains found at sites 2, 5, 6, 9, 11, and 13 as likely malarial. Schats, 137.

The study of medical knowledge in the late medieval Low Countries

As current historiography on malaria has maintained that people in the late medieval Low Countries lacked any knowledge of malaria, the disease has so far thus been excluded from studies of medical knowledge in this period and region as well – despite the disease's prevalence. This thesis argues, however, that an overlooked method for assessing whether malaria was acknowledged in the late medieval period can be construed by analysing how various forms of medical knowledge of malaria – the way people described the disease, identified its symptoms and sought ways to treat it – was produced and circulated at the time. New ways of looking at how people understood malaria in past times receive an impetus from the emerging field of the history of knowledge – for instance, in the volume *Forms of Knowledge* by Johan Östling, David Heidenblad, and Anna Hammar.[18] These scholars emphasise that knowledge is always locally situated and that it is therefore important to take its complexity and historicity into account. Consequently, it is not knowledge itself, but the conditions of its production and circulation that are of crucial importance.[19] From this perspective, two key areas

[16] It is important to note that anaemia is not singularly related to malaria, but can be caused by many factors, such as genetic conditions and diet. As such, Schats looks to *cribra orbitalia* as a relatively reliable indirect indicator, especially in light of recent research showing a strong correlation between this condition and marshy, malaria-prone areas. Schats, 137–38.
[17] Due to lack of data on medieval malaria mosquito populations, Schats used a map of data collected in the 1930s. Although mosquito density may have shifted over time, she argues that geological conditions suggest a continuity: areas identified as malarial in the early twentieth century likely correspond to those in the medieval period. Schats, 136.
[18] J. Östling, D.L. Heidenblad, and A.N. Hammar, eds., *Forms of Knowledge: Developing the History of Knowledge* (Lund: Nordic Academic Press, 2020); J. Östling et al., eds., *Circulation of Knowledge: Explorations in the History of Knowledge* (Lund: Nordic Academic Press, 2018).
[19] Östling, Heidenblad, and Hammar, *Forms of Knowledge*, 16.

of inquiry have emerged. The first is the question of historical knowledge actors: what kinds of people are involved in the production and circulation of knowledge?[20] The second focuses on the infrastructure of knowledge, examining the spheres or contexts in which knowledge is produced and how it changes as it circulates.[21]

The study of knowledge, particularly the two key subfields, has become increasingly important in research on medical knowledge production and circulation in the late medieval period. These themes are central to the work of public health historians. Janna Coomans's book *Community, Urban Health and Environments in the Late Medieval Low Countries* explores how communities in the premodern Low Countries actively managed public health by drawing on knowledge of medicine and the human body. While such knowledge has traditionally been associated with academically trained medical elites, the *doctor medicinae*, Coomans emphasises that medical knowledge was not confined to them. Instead, it was produced and implemented by a wide range of actors, including city officials, local guild members, and neighbourhoods communities.[22] Other historians have similarly tackled the question of which historical knowledge actors were involved in the production and circulation of knowledge in the late medieval Low Countries. The volume *De inventieve middeleeeuwen*, edited by Ria Paroubek-Groenewoud and Carine van Rhijn, focuses on the creation and transmission of practical medical knowledge outside elite scholarly institutions. It demonstrates that knowledge was often local, experience-based, embedded in practice, and produced by diverse groups such as monks, farmers, artisans, and housewives.[23] This emphasis on experience-based knowledge of medicine also features prominently in works such as Michael McVaugh's 'The "Experience-Based Medicine" of the Thirteenth Century' and 'Testing drugs and Trying Cures' by Elaine Leong and Alisha Rankin. These studies examine how knowledge of medical treatments were constantly tested, validated, and refined, not only by *doctor medicinae* in university settings, but also by lay medical practitioners operating outside the academic sphere.[24] Likewise, as will become evident in the following chapter, this thesis argues – by analysing late medieval Middle Dutch medical terminology pertaining malaria, as well as adaptions of authoritative medical knowledge to local medical realities – that not only did people develop substantial understandings of the disease, but also that such knowledge circulated widely among a diverse range of historical actors, both within and beyond academic circles.

---

[20] J. Östling, D.L. Heidenblad, and A.N. Hammar, eds., *Knowledge Actors: Revisiting Agency in the History of Knowledge* (Lund: Nordic Academic Press, 2023).
[21] Östling et al., *Circulation of Knowledge*.
[22] J. Coomans, *Community, Urban Health and Environment in the Late Medieval Low Countries* (Cambridge: Cambridge University Press, 2023).
[23] R. Paroubek-Groenewoud and C. van Rhijn, eds., *De Inventieve Middeleeuwen: Praktische Kennis En Kunde van Voor Het Jaar 1000* (Hilversum: Uitgeverij Verloren, 2023).
[24] E. Leong and A. Rankin, 'Testing Drugs and Trying Cures: Experiment and Medicine in Medieval and Early Modern Europe', *Bulletin of the History of Medicine*, no. 91:2 (2017): 157–82; M. McVaugh, 'The "Experience-Based Medicine" of the Thirteenth Century', ed. J.E. Murdoch, E.D. Sylla, and W.R. Newman, *Early Science and Medicine* 14:1 (2009): 105–30.

Environmental history and the late medieval Low Countries

Tracing the history of malaria and people's knowledge of the disease in the Low Countries also offers valuable insights into the complex relationship between human society and the environment – the central subject of environment history. The foundational works within medieval environmental history include Richard Hoffman's *An Environmental History of Medieval Europe* and *An Environmental History of the Middle Ages* by John Aberth, which examine how medieval European societies shaped and were shaped by their natural surroundings.[25] Crucially, these and similar studies stress that such relationships are complex, historically contingent, and are constantly influenced by both human agency and ecological processes.[26] This dynamic interplay between people and their natural surroundings is particularly evident in landscape epidemiology, which traces the interactions between microorganisms and humans, insects, animals, and landscapes.[27] Landmark studies in medieval landscape epidemiology include Bruce Campbell's *The Great Transition: Climate, Disease and Society in the Late-Medieval World* and *Disease and the Environment in the Medieval and Early Modern Worlds*, edited by Lori Jones.[28] Both explore how human agency – settlement patterns, agricultural developments, warfare, and transcontinental networks – and environmental conditions, including climate variability, vegetation, and water systems, interacted and modified the environmental conditions which either facilitated or hindered the spread of diseases. In this regard, landscape epidemiology aligns closely with the newly developed 'One Health' approach, which recognises that human, animal, and environmental health are intrinsically connected and interdependent. Focusing particularly on zoonotic diseases, One Health demonstrates how human activity and interventions in ecosystems can profoundly affect the health and functioning of nature, with significant consequences for human and animal health.[29]

Importantly, environmental history, landscape epidemiology and One Health approaches stress that human agency – the capacity to choose and act – is shaped by cultural frameworks: the ideas,

[25] R.C. Hoffmann, *An Environmental History of Medieval Europe* (Cambridge: Cambridge University Press, 2014); J. Aberth, *An Environmental History of the Middle Ages: The Crucible of Nature* (New York: Routledge, 2012).
[26] A.C. Isenberg, 'Introduction: A New Environmental History', in *The Oxford Handbook of Environmental History*, ed. A.C. Isenberg (Oxford: Oxford University Press, 2014), 1–20; M. Carey and A.C Isenberg, eds., 'Beyond Weather: The Culture and Politics of Climate History', in *The Oxford Handbook of Environmental History* (Oxford: Oxford University Press, 2014), 23–51.
[27] L. Nash, 'Beyond Virgin Soils: Disease as Environmental History', in *The Oxford Handbook of Environmental History*, ed. A.C. Isenberg (Oxford: Oxford University Press, 2014), 76.
[28] B.M.S. Campbell, *The Great Transition: Climate, Disease and Society in the Late-Medieval World* (Cambridge: Cambridge University Press, 2016); L. Jones, 'Introduction: Diseases in Historical Environments', in *Disease and the Environment in the Medieval and Early Modern Worlds*, ed. L. Jones (London: Routledge, 2022), 1–16.
[29] M Bresalier, A. Cassidy, and A. Woods, 'One Health in History', in *One Health: The Theory and Practice of Integrated Health Approaches*, ed. J. Zinsstag et al., 2nd ed. (Oxford: CABI Publishing, 2020), 1–14.

beliefs, and knowledge systems within a society.[30] Consequently, people's interactions with their environment depend on their understanding of ecological conditions, while their responses to health consequences for humans, animals, and nature are guided by these same frameworks.[31] As highlighted in studies of the history of knowledge, such knowledge systems are neither confined to a single sphere nor are they static.[32] Rather, they are produced by and circulated among a diverse group of people – from university trained elites to lay housewives – and vary across regions and historical periods. Thus, perceptions of and responses to environmental and disease challenges are always bound by the specific social and historical context in which people live.

Similarly to studies of medical knowledge – and likewise due to the prevailing historiographic consensus regarding the history of malaria – environmental researchers, landscape epidemiologists and One Health scholars focusing on the late medieval Low Countries have largely omitted malaria from their analysis. Yet, exploring how people explained the presence of the disease and devised ways to treat and manage it in this period and region can offer valuable insights into how they perceived and navigated the complex relationship between human health and the environment.

Furthermore, incorporating malaria into environmental studies of the late medieval Low Countries can provide new insights into the consequences of people's interactions with the environment. Existing environmental studies of this region and period have largely focused on the large-scale drainage and reclamations projects of the late medieval period, such as Tim Soens's 'Floods and Money', Willem TeBrake's 'Land Drainage and Public Environmental Policy in Medieval Holland', and 'Sinking Peat Bogs' by Petra van Dam.[33] Incorporating knowledge systems into their research, these authors emphasise that environmental interactions were shaped by perceptions of the environment as providing economic, political, social, and cultural opportunities, by people across all strata of late medieval society. Consequently, studies that consider the ecological consequences of environmental interactions in this region and period have mostly remained within these contexts, leaving topics like health largely unexplored.[34]

Tracing the history malaria in relation to major late medieval reclamation projects in the Low Countries could add a new layer to this subject, offering a first insight into how large-scale landscape modifications might simultaneously have altered disease spreading patterns as well as limit people's

[30] Carey and Isenberg, 'Beyond Weather', 41; Isenberg, 'Introduction', 5, 11; Bresalier, Cassidy, and Woods, 'One Health in History'.
[31] Isenberg, 'Introduction', 5,11; M. Paulissen et al., 'Place Meanings of Dutch Raised Bog Landscapes: An Interdisciplinary Long-Term Perspective (5000 BCE Present)', *Landscape Research* 47:8 (2022): 1072.
[32] Carey and Isenberg, 'Beyond Weather', 41; Bresalier, Cassidy, and Woods, 'One Health in History', 1.
[33] T. Soens, 'Floods and Money: Funding Drainage and Flood Control in Coastal Flanders from the Thirteenth to the Sixteenth Centuries', *Continuity and Change* 26:3 (2011): 333–65; W.H. TeBrake, 'Land Drainage and Public Environmental Policy in Medieval Holland', *Environmental Review* 12:3 (1988): 75–93; P.J.E.M. Van Dam, 'Sinking Peat Bogs: Environmental Change in Holland, 1350-1550', *Environmental History* 6:1 (2001): 32–45.
[34] Some studies, such Coomans's, have focused on the consequences of water management in relation to public health, but these were limited to the urban area and do not relate directly to major reclamation projects. See: Coomans, *Community, Urban Health and Environment*.

ability to treat and manage the disease, thus affecting public health. Examining human-driven ecological transformation through the lens of malaria might thus offer a rich context for exploring the dynamic interactions between society, health, and the environment.

The sources: Middle Dutch medical compendia

In the effort to trace the history of malaria in the late medieval Low Countries, this thesis primarily relies on five medical compendia produced within the region between 1300 and 1600.[35] These manuscripts, mostly written in the vernacular, appear to have been compiled or produced by single individuals – most likely the original owners and users – and contain texts on a wide range of medical topics, including advice on recognising and diagnosing diseases, lists of treatment methods, and contemporary theories concerning health and healing. The compendia also feature navigational markings and annotations to help the reader quickly locate relevant information and share a compact format, making them easy to carry. Consequently, it is highly likely that these medical compendia were produced and used as practical handbooks by medical experts who worked directly with patients.

Who were these medical experts? Broadly speaking, the medical field in the late medieval Low Countries can be divided into three groups. At one end of the spectrum there were the highly venerated *doctor medicinae*, who had studied at the established European medical universities. Despite their extensive theoretical knowledge, *doctor medicinae* generally lacked practical experience.[36] The other end was formed by the full range of wet nurses, barber-surgeons, more or less specialised medical practitioners, and so-called quacks. This group possessed extensive practical experience and were more accessible for the general population than the *doctor medicinae*.[37] In between these two groups was the *chirurgijn*, or surgeon, who combined general theoretical knowledge of medicine and the human body with extensive practical experience gained.[38] It is unclear how many surgeons were active on average in the Low Countries during the late medieval period. It appears that cities such as Leiden, Rotterdam, and Amsterdam (in the present-day provinces of North and South Holland) had at least one *stede meester van chirurgijn* – a surgeon employed by the city authorities to care for the poor – but the total number of active surgeons in urban environments was most likely higher.[39] It should be noted that this is a broad distinction, and in practice these medical groups often overlapped and intermingled, with practitioners drawing on knowledge and techniques developed within various

[35] See appendix 1 for an overview.
[36] E. Huizenga, *Een Nuttelike Practijke van Cirurgien: Geneeskunde En Astrologie in Het Middelnederlandse Handschrift Wenen, Österreichische Nationalbibliothek, 2818* (Hilversum: Uitgeverij Verloren, 1997), 225–32, 273; R. Ladan, *Gezondheidszorg in Leiden in de Late Middeleeuwen* (Hilversum: Uitgeverij Verloren, 2012), 110.
[37] Huizenga, *Een Nuttelike Practijke van Cirurgien*, 247–59.
[38] Huizenga, 232–33; M.A Andel van, *Chirurgijns, Vrije Meesters, Beunhazen En Kwakzalvers: De Chirurgijnsgilde En de Praktijk Der Heelkunde (1400-1800)*, 2nd ed. (Den Haag: Uitgeverij Martinus Nijhoff, 1981), 41–51.
[39] Andel, *Chirurgijns, Vrije Meesters, Beunhazen En Kwakzalvers*, 6–24.

specializations.[40] Given their Middle Dutch contents, navigational annotations, portable format, and apparent function as practical handbooks, it is highly likely that surgeons played the most prominent role in producing the five medical compendia discussed in this thesis.[41] These medical compendia were thus deeply embedded both within the theoretical and the practical worlds of health and healing in the late medieval Low Countries and therefore offer valuable insights into how people in this period and region understood and interpreted infectious diseases and the environment around them.

The Middle Dutch medical compendia were selected from the online database *Digitale Bibliotheek voor de Nederlandse Letteren*, using keywords related to the symptoms associated with malaria (discussed further in chapter 1).[42] From the resulting materials, five manuscripts were selected for their geographical distribution – representing both the northern and southern Low Countries and their dating between the fourteenth and sixteenth century. Two of selected medical compendia are Hs. 697 of the Ghent University Library and Hs. 6838 A of the National Library in Paris.[43] HS. 697, dating to the fifteenth century, was produced in the present-province of South Holland. The manuscript includes an almanac, a list with medicinal recipes and treatments, and information on the healing properties of plants and herbs. A note of folio 1v identifies its owner and compiler as Heyndric van den Doeren.[44] Manuscript Hs. 6838, dated to 1305, was produced somewhere in West Flanders. It consists primarily of Latin texts on medicinal herbs, with vernacular recipes added in the final folios. It was written by a single, anonymous scribe, and both commissioner and original owner remain unknown. In addition, this thesis draws on Hs. 1272 of the Ghent University Library and Hs. Sloane 345 in the British Museum in London.[45] Hs. 1272 dates to around the mid-fifteenth century and was produced by a single anonymous scribe from the region between Ghent and Aalst, in present-day West Flanders. Only the final folio contains notes written in a different hand. Like the other two compendia,

[40] Huizenga, *Een Nuttelike Practijke van Cirurgien*, 272–73.
[41] Although no studies to date have focused specifically on the primarily producers of Middle Dutch medical compendia, manuscript research in other European regions have pointed to surgeons as the most likely compilers and users of such works. See: E. Leong, 'Learning Medicine by the Book: Reading and Writing Surgical Manuals in Early Modern London', ed. J. Poskett, *BJHS Themes: The History of Science and the 'Big Picture'* 5 (2020): 93–110.
[42] Important keywords were Middle Dutch variations of the words 'fever', 'intermittent fever', 'third-day fever', and 'fourth-day fever', 'Digitale Bibliotheek Voor de Nederlandse Letteren', 20 June 2025, https://www.dbnl.org/.
[43] Hs. 697 (olim Serrure 14) of the Ghent University Library and Manuscript latin 6838 A of the National Library Paris. See appendix 1. This thesis relies on transcriptions of these two manuscripts made by Dutch linguist and codiologist Willem Lodewijk de Vreese. W.L. de Vreese, ed., *Middelnederlandsche Geneeskundige Recepten En Tractaten, Zegeningen En Tooverformules* (Gent: A. Siffer, 1894).
[44] Folio 1v reads: 'ghebonden zekerts 1409 Vanden Doeren Heyndric', indicating that Heyndric van den Doeren either commissioned someone to compile this manuscript or did so himself.
[45] Hs. 1272, Ghent University Library, Hs. Sloane 345, British Museum in London. See appendix 1. This thesis relies on transcriptions of these two manuscripts made by Belgian historian and folklorist Willy L. Braekman. W.L. Braekman, *Middelnederlandse Geneeskundige Recepten: Een Bijdragen Tot de Geschiedenis van de Vakliteratuur in de Nederlanden* (Gent: Koninklijke Vlaamse Academie voor Taal- en Letterkunde, 1970); W.L. Braekman, ed., *Medische En Technische Middelnederlandse Recepten: Een Tweede Bijdrage Tot de Geschiedenis van de Vakliteratuur in de Nederlanden* (Gent: Secretariaat van de Koninklijke Academie voor Nederlandse Taal- en Letterkunde, 1975).

this manuscript compiles various texts, including a medieval surgical treatise by the authoritative surgeon Lanfranc of Milan (1245-1306), a treatise on urine, and numerous medical recipes and treatments. Manuscript Hs. 345, written by a single anonymous hand likely from the region of the present-day province of Utrecht, was compiled between the fifteenth and sixteenth centuries. It contains both Latin and vernacular texts on a wide range of medical topics, along with various treatment methods. Lastly, this research makes use of Hs. 15624-41, held at the Royal Library of Brussels.[46] Produced in 1351, somewhere in the present-day province of Brabant, the manuscript was compiled and written by a single scribe, who identifies himself on folio 28r as Johannes de Altre. It contains vernacular texts on disease diagnosis, a treatise on urine, a herbal, and works by the authoritative surgeon Jan Yperman (c. 1260-1332) from Ypres in present-day West Flanders.

Besides these five medical compendia, this research also draws on a range of other late medieval sources from the Low Countries which contain references to malaria: a Middle Dutch translation of *De proprietatibus rerum* by the Franciscan scholar Bartholomaeus Anglicus (before 1203-1272), the *Vita* of Saint Lidwina of Schiedam (1380-1433), the *Cronica Floridi Horti* of the Premonstratensian monastery of Bloemhof in Wittewierum, and the spiritual writings of influential mystic Jan van Ruusbroec (1293-1381).[47] These have been found in the same database and were selected via the same system as the five medical compendia. It is important to note that, although this method has opened up a new corpus of sources relevant to the history of malaria, large portions of the late medieval source material from the Low Countries have not been digitalised in the database *Digitale Bibliotheek Voor de Nederlandse Letter* and were therefore not consulted.[48] Besides these sources that specifically reference malaria, other materials such as a Middle Dutch translation of an Italian health regimen, a chronicle of abbey of Rolduc (located in what is now the province of Limburg), and the history of a convent just outside of Leiden, in the current province of South Holland, have been analysed. Furthermore, this thesis draws on a range of texts produced by medical authorities from the ancient period. These sources are discussed in more detail in the relevant chapters.

Ongoing debates within environmental history approaches often focus on which types of source, methodologies, and concepts are best suited to study human-environmental interactions. Scholars emphasise that since these relationships span multiple contexts, environmental history must also span multiple disciplines and domains in order to capture the complex human-environmental

[46] Transcriptions of the various texts in this manuscript were provided by J. Munk, ed., *Leringhe van Orinen* (Den Haag: Sdu Uitgevers, 1998); Jan Yperman, *Medicina, Boek van Medicinen*, ed. L. Elaut (Den Haag: Sdu Uitgevers, 1998); J.L. Vandewiele, ed., *De 'Liber Magistri Avicenne' En de 'Herbarijs'. Middelnederlandse Handschriften Uit de XIVe Eeuw (Ms. 15624-15641 Kon. Bibliotheek Te Brussel)* (Den Haag: Sdu Uitgevers, 1998).

[47] Bartholomaeus Anglicus and Jacop Bellaert (trans.), *Van Den Proprieteyten Der Dinghen*, ed. E.M. Versélewel and H. de Witt, 2009; L. Jongen and C. Schotel, eds., *Het Leven van Liedewij, de Maagd van Schiedam*, second edition (Hilversum: Uitgeverij Verloren, 1994); Menko and Emo, *Cronica Floridi Horti*; Jan van Ruusbroec, *Die Chierheit Der Gheestelijker Brulocht*, ed. F. Erens, 1917.

[48] See appendix 1 for an overview of all the source material found thus far in the database which reference malaria.

interactions. This thesis incorporates interdisciplinary findings, including archaeological research into medieval skeletal remains, botanical studies of biodiversity, and ecological analyses of human impact on ecosystems. Yet, I would argue that traditional historical sources, like the ones examined in this thesis, can also offer fresh insights into the complex and historically contingent interactions between society and the environment.

The thesis's structure

This thesis is situated at the intersection of environmental history, landscape epidemiology and One Health approaches, and the study of medical knowledge in the context of the late medieval Low Countries. It's main goal is to examine how the disease malaria was understood and perceived in the late medieval Low Countries by looking at Middle Dutch medical compendia, in order to explore the complex and historically contingent relationship between human society and the natural environment. To this end, this thesis is divided into three parts.

The first chapter examines malaria's prevalence in the context of the late medieval Low Countries as well as how contemporaries understood and perceived the disease. Drawing on both archaeological research as well as comparative studies of other European regions, it first outlines malaria's presence. Subsequently, it challenges the current historiography – which assumes people in the late medieval Low Countries lacked knowledge and awareness of malaria – by closely analysing the way people described diseases, identified symptoms and classified illnesses within five medical compendia, alongside other medical and non-medical sources.

The second chapter seeks to understand how people understood the relationship between human health and the environment by examining explanations for causes and treatment methods for malaria. The first section focuses on how medical experts such as surgeons linked the presence of malaria to the environment, specifically wetland areas. It then considers how these same practitioners turned towards the environment – through the application of herbal medicine – in their attempts to treat and manage the disease. Moreover, by tracing the incorporation of numerous vernacular plant names, new interpretations of already well-established medicinal plants, and the application of new botanical ingredients, the five Middle Dutch medical compendia demonstrate that these concepts were shaped not only by classical theory but also by locally developed, experience-based knowledge systems.

The last chapter uses malaria as a lens to look at the how late medieval reclamation projects in the Low Countries might have shaped the disease spreading patterns as well as limit people's ability to treat and manage the disease. It maps the spatial distribution of the five medical compendia and other non-medical sources, comparing it to the ecological transformations in this region and period – suggesting there might be a correlation. Moreover, it examines how the ecological transformation

might have influenced the availability of herbal remedies – thereby hindering surgeons in their ability to treat and manage malaria.

By examining the overlooked history of malaria and contemporary knowledge of the disease in the late medieval Low Countries, this thesis contributes to our understanding of the complex and historically contingent relationship between human society and the environment. Subsequently, it offers a first step toward including malaria in studies of medical knowledge in this period and region, provides new insights into how people perceived the relationship between health and their natural surroundings, and highlights malaria as a valuable case study for exploring how human-driven ecological transformation can shape public health.

1. Mosquitoes and Malaria

Knowledge, understandings and perceptions of malaria in the late medieval Low Countries

This first chapter seeks to situate malaria in the context of the Low Countries during the late medieval period as well as examine contemporary knowledge of the disease. First, drawing on archaeological research as well as studies of malaria in other European regions, it provides a preliminary overview of malaria's potential presence and impact in this region and period. It then turns to the existing historiography on malaria, which generally holds that people in the late medieval Low Countries – contrary to medical experts in Antiquity – lacked knowledge and understanding of the disease. However, by examining five medical compendia, as well as other medical and non-medical texts, I argue that people did possess knowledge of malaria and its presence, both within the medical field and beyond. To this end, the chapter takes a close look at how authors described diseases, identified symptoms, and classified illnesses in medical and non-medical sources from the late medieval Low Countries. But before turning to these aspects, it is worth diagnosing the disease itself: what exactly is malaria?

What is malaria?

Malaria is a mosquito-borne disease caused by a parasite of the genus *Plasmodium*. Once inside the human body, the parasite follows a complex life cycle, which varies slightly depending on the species. Generally, after being injected into the blood stream, the parasites invade the red blood cells, where the organisms multiply and mature. After two to three days, the infected blood cells burst open and new malaria organisms are released into the blood stream. This triggers the immune system which causes chills, fever, sweating, fatigue, headaches, nausea, and vomiting. When the parasites retreat back into the red blood cells to reproduce again, the symptoms subside. This life cycle is responsible for the most characteristic symptom of malaria, namely intermittent fevers that return every two or three days – depending on the specific malaria parasite. Malaria causes various other complications, ranging from mild to severe. The disease is associated with splenomegaly (enlarged spleen), severe anaemia, and organ failure in the kidneys, liver, and lungs, which is caused by inflammation and blocked blood vessels. Some parasite species can even lead to life-threatening complications, as the infected red blood cells obstruct blood flow to the brains, resulting in seizures, coma, and, in extreme cases, death.[49] Direct malaria transmission from human to human is rare, as direct blood contact is necessary for the parasite to spread to other humans, although it happens occasionally. Besides a small number of instances of human-to-human transmission, however, the most important vector for malaria is human-mosquito interaction.

[49] Dagen, 'History of Malaria and Its Treatment', 1.

Malaria mosquitoes and the marshes

There are currently between 40 and 45 mosquito species, all belonging to the *Anopheles* genus, capable of contracting and spreading the malaria parasite.[50] In the Netherlands and Belgium, up until the nineteenth century, two of these were among the most significant vectors in spreading malaria – and they are, in fact, still present in the region today. Although a new outbreak remains theoretically possible, it is unlikely malaria will be reintroduced here. First, the malaria eradication programmes initiated in the twentieth century, which made extensive use of insecticides like DDT, significantly reduced the mosquito population in the Netherlands. Additional measures, such as the installation of mosquito screens on windows and doors and the sealing of houses by closing gaps in walls, floors, and roofs, prevented mosquitoes from entering living spaces. Furthermore, improved drainage technologies reduced the suitable habitats for the malaria-carrying mosquitoes, thereby limiting their ability to breed and thrive.[51] These interventions, still in effect today, continue to curtail human-mosquito interactions. Furthermore, modern medicine has provided effective antimalarial drugs, both for prevention and treatment, which significantly reduce the risk of infection and transmission. Lastly, public health institutions in the Netherlands, such as the Rijksinstituut voor Volksgezondheid en Mileu (RIVM), and at the European level, the European Centre for Disease Prevention and Control (ECDC), closely monitor potential malaria cases.

In the premodern Low Countries, two mosquito species were the most important vectors for malaria transmission: *Anopheles* atroparvus and *Anopheles* messae.[52] *A*. atroparvus thrives in freshwater environments but, unlike most mosquito species, is also capable of breeding in coastal zones with brackish water – a combination of fresh and salt water.[53] Contrary to other mosquitoes, this species is also adapted to temperate climates and can survive and reproduce during the cold European winter months. *A*. messae can survive in a range of habitats, but prefers freshwater environments with dense vegetation, such as bogs and marshes.[54] It is incapable of breeding in brackish environments, but, similar to *A*. atroparvus, this species remains active during the winter months and can transmit and spread malaria even at colder temperatures.[55]

The premodern Low Countries provided an ideal habitat for these malaria-carrying mosquitoes. Like other mosquito species, *A*. atroparvus and *A*. messae prefer stagnant and slow-moving bodies of water – such as canals, puddles, ponds, and pools – where their eggs have the highest chances of survival. The landscape of the Low Countries, characterised by rivers, canals, lakes,

[50] M. Bertola et al., 'Updated Occurrence and Bionomics of Potential Malaria Vectors in Europe: A Systematic Review (2000–2021)', *Parasites & Vectors* 15:88 (2022): 1–34.
[51] Knottnerus, 'Malaria Around the North Sea', 339.
[52] Knottnerus, 340.
[53] Bertola et al., 'Potential Malaria Vectors in Europe', 7.
[54] Bertola et al., 13.
[55] Knottnerus, 'Malaria Around the North Sea', 340.

marshes, bogs, and regularly flooded areas, provided optimal conditions for these mosquito species to thrive.[56]

Malaria in the late medieval Low Countries

Osteoarchaeological research by Schats has confirmed malaria's presence in the late medieval Low Countries. However, it remains challenging to determine the extent to which the disease affected and debilitated human society. This is largely because malaria in this region and period has so far received little scholarly attention. Consequently, unlike other premodern European regions that have been substantially researched, there are few studies of the effects of malaria on the population in the Low Countries in the late medieval period. Nonetheless, based on research on the disease's significance in other regions in the premodern period and combined with archaeological evidence provided by Schats, it is possible to construct a preliminary overview of malaria's potential effects on infected communities in the late medieval Low Countries.

Before doing so, however, it is important to note that most malaria species present in premodern Europe generally did not cause death directly. While some forms of malaria are highly dangerous and can lead to severe anaemia, organ failure, seizures, coma, or even death, the parasite species most prevalent in Europe at that time, *Plasmodium* vivax and *Plasmodium* malariae, are generally less immediately life-threatening.[57] Rather then rapidly killing their human hosts, these parasites cause an acute phase of intense symptoms after initial infection – typically from late spring to early autumn. After this acute phase, however, the parasite subsides and lays dormant, only to be reactivated the following spring.[58] Around this time, rising temperatures and renewed activity of malaria-carrying mosquitoes causes the disease to relapse, triggering another period of intense symptoms before the parasite becomes dormant again.[59]

Nonetheless, even if most malaria species in premodern Europe did not generally cause death directly, the parasite did pose a serious, life-threatening danger to those without prior exposure – particularly infants, young children, and newcomers to malaria-prevalent regions.[60] Indeed, historian Mary Dobson, in her study on malaria in the late medieval and early modern English marshes, found that mortality rates these groups in these areas were significantly higher that in surrounding regions,

[56] R. Schats, 'Developing an Archaeology of Malaria. A Critical Review of Current Approaches and a Discussion on Ways Forward', *International Journal of Paleopathology*, no. 41 (2023): 33; Schats, 'Malaise and Mosquitos', 136.
[57] T.P. Newfield, 'Malaria and Malaria-like Disease in the Early Middle Ages', *Early Medieval Europe* 25:3 (2017): 255.
[58] Dobson, 'Marsh Fever', 373–74; Sallares, *Malaria and Rome: A History of Malaria in Ancient Italy*, 12.
[59] Dobson, 'Marsh Fever', 341.
[60] Sallares, *Malaria and Rome: A History of Malaria in Ancient Italy*, 223–24; Newfield, 'Malaria and Malaria-like Disease in the Early Middle Ages', 275.

with contemporary writers linking this elevated death rate to the mysterious 'intermittent fevers'.[61] Furthermore, those who survived initial infection still suffered from the disease's debilitating consequences, which could seriously undermine a person's health and vitality, and thus impact population levels.[62] According to historian Robert Sallares, in his extensive research on malaria in ancient Italy, intermittent fevers 'enormously increased mortality levels, sharply reduced life expectancy at all ages, and significantly altered the age-structures of human populations in Europe in the past'.[63] Even individuals who survived both initial infection and its chronic effects would often remain permanently weakened and debilitated and were thus severely hindered in their daily lives and work. Moreover, malaria hindered human reproduction as it lowered fertility rates and diminished overall economic production by reducing physical strength and endurance, and depleting the labour force. Indeed, as historian Timothy Newfield has observed in his study of malaria in the early Middle Ages, malaria 'can exercise a debilitating effect so profound that it defines regions'.[64]

The question is whether communities living in and around malaria-prone wetlands in the medieval Low Countries experienced consequences of malaria infection similar to those observed in other regions. In this context, Schats's archaeological research on *cribra orbitalia* again proves useful. Beyond confirming malaria's presence in the Low Countries, her study provides insights into the disease's impact on population health. Indeed, Schats suggests that the disease may have been a significant health burden in malaria-prone areas of this region, likely affecting on average up to ten per cent of the population.[65] However, it should be noted that *cribra orbitalia* develops only after prolonged exposure to the parasite, meaning that the true prevalence of the disease among malaria-infected populations was probably much higher than the skeletal record alone indicates. From these findings follows that communities infected with malaria in the medieval Low Countries, given their high disease prevalence, also experienced the broader social, cultural, and economic consequences observed in other premodern regions.

Malaria in the historical record

Notwithstanding malaria's prevalence and apparent impact on society in the late medieval Low Countries, studies of the history of malaria in this region and period hold that there was no contemporary knowledge of the disease. As noted in the introduction, this is largely due to the source material, which, according to malaria scholars, does not provide reliable evidence of such knowledge. However, this source bias regarding premodern sources from the Low Countries becomes problematic

[61] Dobson, 'Marsh Fever', 359; M.J. Dobson, *Contours of Death and Disease in Early Modern England* (Cambridge: Cambridge University Press, 1997), 295.
[62] Sallares, *Malaria and Rome: A History of Malaria in Ancient Italy*, 218.
[63] Sallares, 267.
[64] Newfield, 'Malaria and Malaria-like Disease in the Early Middle Ages', 251.
[65] Schats, 'Malaise and Mosquitos', 137–38.

when compared to historic studies of malaria in the ancient period. Among historians, there is a widely accepted assumption that people in Antiquity did have knowledge of malaria and, furthermore, recognised it a specific type of disease with identifiable symptoms and causes.[66] In fact, Bruce-Chwatt and De Zulueta assert that 'there are many references to what are unmistakably malaria fevers in [...] classical medical writers'.[67] One of these classical medical authors is the influential Greek thinker Hippocrates of Cos (460-370 BC). His work *Epidemics* (a collection of medical case studies) and *On Airs, Waters and Places* (a medical treatise on the influence of environmental factors on human health) contain several 'undoubtable cases of malaria'.[68] Other Greek medical authorities, such as Pedanius Dioscorides (40-90 AD) and Claudius Galen of Pergamon (129-216 CE), also produced extensive and 'reliable' descriptions of the disease.[69] In Latin literature, texts which 'described malaria with great accuracy', such as *De Medicina* by Aulus Cornelius Celsus (25 BC- 50 CE) and Pliny the Elder's *Naturalis Historia* (23-79 CE) also give evidence of the authors' thorough knowledge of the disease.[70] These and other sources have convinced historians of malaria not only of the disease's presence and prevalence in the ancient world, but also that this was recognised as such by contemporary medical authorities.[71]

Considering the source criticism put forward by historians dealing with malaria, how are scholars then confident in confirming without doubt knowledge and understanding of the disease in Antiquity? What sets these ancient sources, which provide historians with 'reliable', 'accurate' and 'unmistakable' evidence, apart from Middle Dutch sources that apparently only give vague descriptions? The most important argument is that these classical texts describe the disease alongside its unmistakable symptoms of intermittent fevers, rigors, headaches, sweating, and enlarged spleen, which 'are so accurately described that they leave no doubt in the mind'.[72] Hippocrates' understanding of malaria, for example, was so advanced that he could differentiate between different types of the disease based on the periodicity of the fevers, a variation dependent on the species of the *Plasmodium* present in the body.[73] Another argument put forward focuses on the awareness among ancient authors of malaria's association with wetland environments. As discussed above, the *Anopheles* mosquito thrives especially in wetlands such as swamps, marshes, and fens. Although the connection between mosquitoes and the transmission of the parasite was not discovered until the twentieth century, ancient

[66] Boualam et al., 'Malaria in Europe: A Historical Perspective', 1; Cunha and Cunha, 'Brief History of the Clinical Diagnosis of Malaria'.
[67] Bruce-Chwatt and Zulueta, *The Rise and Fall of Malaria in Europe*, 19.
[68] Bruce-Chwatt and Zulueta, 18; J.J. van der Kaaden, 'Geschiedenis van de Inheemse Malaria in Nederland', *Infectieziekten Bulletin* 14:10 (2003): 388.
[69] C.M. Poser and G.W. Bruyn, *An Illustrated History of Malaria* (New York: Parthenon Publishing Group, 1999), 6, 75; Bruce-Chwatt and Zulueta, *The Rise and Fall of Malaria in Europe*, 89.
[70] Dagen, 'History of Malaria and Its Treatment', 3.
[71] See for an extensive research project on the presence of malaria and its impact on ancient society, Sallares, *Malaria and Rome: A History of Malaria in Ancient Italy*.
[72] Bruce-Chwatt and Zulueta, *The Rise and Fall of Malaria in Europe*, 18.
[73] Cunha and Cunha, 'Brief History of the Clinical Diagnosis of Malaria', 195; Boualam et al., 'Malaria in Europe: A Historical Perspective', 3; Kaaden, 'Geschiedenis van de Inheemse Malaria in Nederland', 388.

authors did already relate malaria cases to wetland environments.[74] Hippocrates, for example, recognising the relationship between malaria and proximity to stagnant water, identified the marshes outside Athens as dangerous hotbeds for infection.[75] Indeed, the Greek term used to describe the disease, *elonosia*, literally means 'the disease of the marsh'.[76] Roman writers also noted the link between the spreading pattern of malaria and the presence of stagnant, slow moving water, with various Latin texts warning of the dangers of the swamps.[77] As such, the accurate clinical description and the recognition of wetlands as disease breeding grounds in these classical works have led malaria scholars to argue that the ancient world was acutely aware of the disease's presence.

Malaria in Middle Dutch medical compendia

According to historians of malaria, ancient sources thus provide detailed and unmistakable descriptions of malaria – a clear contrast to the historiography on malaria in the late medieval Low Countries. But does this prevailing view regarding Middle Dutch sources accurately reflect the historical reality, or is it instead the result of misinterpretations? This calls for an in-depth approach to the source material that considers how authors interpreted disease, described symptoms, categorised illnesses, and understood causation within the intellectual, medical, social, and cultural context of the medieval Low Countries. To do so, this thesis draws upon the five medical compendia produced in the Low Countries between 1300 and 1600, discussed in the introduction.

In two Middle Dutch medical compendia – Heyndric van den Doeren's Hs. 697 dating to the fifteenth century and produced in South Holland and Hs. 6838 produced in west Flanders in 1305 – we find over fifteen mentions of two specific types of fevers. One medicinal recipe states that 'against the *derden dach curts*, take four plants of plantain and the *colen* [flower bud?] of chamomile, crush them together, mix with consecrated water, and drink this water three times a day'.[78] Another recipe against this 'third-day fever' gives a slight variation, advising the patient to take a potion mixed with 'the juice of chamomile, three leaves of dandelion, three leaves of plantain, and the *cole* [flower bud?] of chamomile'.[79] This *derden dach curts* is also called *tertiane*, *tercia* and *terciaen*, along with many

[74] Cunha and Cunha, 'Brief History of the Clinical Diagnosis of Malaria', 195; Bruce-Chwatt and Zulueta, *The Rise and Fall of Malaria in Europe*, 89.
[75] Cunha and Cunha, 'Brief History of the Clinical Diagnosis of Malaria', 196.
[76] Boualam et al., 'Malaria in Europe: A Historical Perspective', 1.
[77] Sallares, *Malaria and Rome: A History of Malaria in Ancient Italy*, 55.
[78] Hs. 697, 'Jeghen den derden dach corts, neemt .iii. planten van weghebreeden, ende colen van der materne, ende stampet te gadre; ende temperet met ghewiden watre, ende dies waters drinct .iii. werf sdages', Vreese, *Middelnederlandsche Geneeskundige Recepten En Tractaten, Zegeningen En Tooverformules* r. 83, p. 29. *Weghebreeden* has been identified as *Plantago major*, (greater) plantain or waybread in English. More on this plant in chapter 2. *Materne* refers to *Matricaria chamomilla* or commonly known as chamomile. It is unclear what part of the plant is meant by *colen*.
[79] Hs. 6838, 'Jeghen den derden dach curts, nem tsap van maternen, ende .iii. blade papencruuts, c. ende .iii. blade weghebreden, ende die cole van der materne. ende dit stampt ende temperet ute met watere ende drinct .iii. daghe', Vreese r. 557, p. 138. *Papencruut* has been identified as *Taraxacum officinale Mönch*, or dandelion in common English.

other variations.[80] The two manuscripts also describe remedies against a *vierden dach curts*, advising to take 'twenty hands of common rue in a flask of wine, and set it to boil' and to give the concoction to the patient 'when the fever comes'.[81] If rue is not available, to combat fourth-day fever one can also take the 'juice of wormwood and oil, make it lukewarm, and smear it on your body'.[82] Besides *vierden dach curts*, this disease is also called *quarteyn*, *quartana*, or *quartein.*[83]

Similar medical recipes against third- and fourth-day fevers are found in manuscripts Hs. 1272, produced in the mid fifteenth century in the region between Ghent and Aalst, and Hs. 345, from the region of Utrecht, compiled between the fifteenth and sixteenth centuries. In case someone is plagued by third-day fever, these manuscripts – similar to Hs. 697 Hs. 6838 – advises one to drink the juice of plantain. Otherwise 'parsley juice drank with old beer might help'.[84] In treatment against fourth-day fever, these manuscripts advise the use of juice of the plant wormwood, which, lukewarm, mixed with oil and applied to the body, should cure the patient.[85] Otherwise, the juice of sage was also believed to be beneficial in curing fourth-day fever.[86]

What are these mysterious *derden dach curts* and *vierden dach curts*? The answer can be found in *Van den proprieteyten der dinghen*, a Middle Dutch translation of *De proprietatibus rerum* by the thirteenth century Franciscan scholar Bartholomaeus Anglicus. *De proprietatibus rerum*, an kind of early forerunner of the encyclopaedia seeks to explain a wide variety of natural and supernatural phenomena, among which the elements, qualities, and workings of the human body. Contrary to the medical compendia discussed above, which were likely used as practical handbooks by medical practitioners, *De proprietatibus rerum* was more often used as a reference work for scholars in educational settings, providing the reader with the theoretical and theological frameworks for

[80] In addition to the terms '*tertiane*', '*terciaen*' and '*tercia*', the sources use several other variations. For simplicity, this research will use '*terciaen*'.
[81] Hs. 6838, 'Item [against the fourth day fever] siet .xx hantvul ruten in een suster van wine, dest es gheseten toete .iii. stopen; ende alse die curts coemt, ghevet hem drinken', Vreese, *Middelnederlandsche Geneeskundige Recepten En Tractaten, Zegeningen En Tooverformules* r. 454, p. 122. *Ruten* has been identified as *Ruta graveolens*, or common rue.
[82] Hs. 6838, Jeghen den vierden [dach corts] nem sap van hartemesien, ziet ende maect laeu met olien, ende smerter mede uwen lechame', Vreese r. 453, p. 122. The plant *hartemesien* is difficult to identify. Most likely the manuscript refers to *Artemisia,* a genus of plants known for their medical properties. More on this plant species in chapter 2.
[83] Of the numerous variations on the term '*quarteyn*', '*quartein'*, or '*quartana*' used in the medieval Middle Dutch sources, this research will use *quartein*.
[84] Hs. 1272, 'Item breweghe ghedronken verdriuet den rede terciaen. Item alant ghedronken met roden wijn benimt den rede terciaen. Item keruel ende pieterceli sap ghedronken met ouden bier helpt', Braekman, *Middelnederlandse Geneeskundige Recepten* r. 883. *Breweghe* is most likely a local variant of *weghebreeden*, a plant identified as *Plantago major*, (greater) plantain or waybread in English. More on this plant in chapter 2. *Pieterceli* is *Petroselinum crispum*, also known as parsley.
[85] Hs. 1272, 'Nemt sap van arthimesien ende maket laeu ende minghet met olien ende salueter mede uwen lichame, ghi sult ghenesen', Braekman r. 287. *Arthimesien* has been identified as *Artemisia,* a genus of plants known for their medical properties. In other medical sources we find various *Artemisia* species, such mugwood (*A. absinthium*) southern wormwood (*A. abrotanum*), and mugwort or wormwood (*A. vulgaris*). More on this species in chapter 2.
[86] Hs. 345, 'Recipe wilde salye die men men heet ambrosia, ende stampse ende macter vater af […] ende genest den corts ende quartaen', Braekman, *Medische En Technische Middelnederlandse Recepten* r. 761. *Salye* has been identified as *Salvia officinalis*, sage in modern English.

understanding human health. *De proprietatibus rerum* quickly gained widespread recognition, and copies and translations started circulating throughout Europe from the fourteenth century onwards. In the Low Countries, Bartholomaeus Anglicus' work was translated into *Van den proprieteyten der dinghen*, which was published by the Dutch printer Jacop Bellaert in 1485 in Haarlem, in the present-day province of North Holland.[87]

In *Van den proprieteyten der dinghen*, the mysterious third- and fourth-day fevers are discussed, with the text stating that the sign of a *terciaen* fever is 'that he suffers every day with pain, at first only with vomiting and shivering, but from the third day onwards, more severely.'[88] On this third day, the patient experiences 'fevers, swelling of the head, bitterness in the mouth, thirst, tingling in the ears and much restlessness', but after twenty-four hours, a period of rest begins during which the fever subsides.[89] *Vierden dach curts* or *quartein* fever, on the other hand, plagues the patient on the fourth day, causing pain, fever, shivering, exhaustion, restlessness, a sour taste in the mouth, severe headaches, vertigo, and stomach-aches. After this episode, the symptoms are alleviated for a period of forty-eight hours.[90]

According to *Van den proprieteyten der dinghen*, third-day and fourth-day can thus be identified by causing a short period of fever-like symptoms which recurs every third or fourth day. This pattern of intermittent fevers is the most distinctive characteristic of the disease we now identify as malaria. But do these descriptions mean that medieval medical authors were dealing with malaria? Considering the source criticisms put forward by scholars of malaria history, these descriptions might be too vague or ambiguous to definitely confirm knowledge and understanding of this specific disease. Indeed, a number of other diseases, conditions, and disorders can also produce periodic fevers and discomfort at regular interval.[91] For this reason, a closer examination of descriptions of *terciaen* and *quartein* fevers in Middle Dutch medical compendia is necessary to determine whether people in the late medieval Low Countries were indeed dealing with and had knowledge of the disease we now recognise as malaria.

---

[87] Jacop Bellaert's *Van den proprieteyten der dinghen* is an incunable, a book printed during the early stages of the development of the printing press. This research makes use Ned. Inc. 29a housed at the University Library of Amsterdam. Bartholomaeus Anglicus and Jacop Bellaert (trans.), *Van Den Proprieteyten Der Dinghen*.

[88] 'dat hi alle daghe quellet ende pinet eerst mit hesikinghe ende na mit hetten mer vanden derden inden derden dage swaerliker', Bartholomaeus Anglicus and Jacop Bellaert (trans.) f. 414r.

[89] 'hi quelt van den derden dage inden derden ende machtelicste bi terci tijt dat is bijder derder vren vanden daghe eerst mit hesekinghen daer na mit hetten mit sweringhen des voerhoefts mit bitterichedeen des mondes mit dorst mit tintelinghe der oren mit veel wakens […] xxiiij. vren te meesten mach hi hebben inden arbeyde ende xxiiij. inden rusten', Bartholomaeus Anglicus and Jacop Bellaert (trans.) f. 414r.

[90] Bartholomaeus Anglicus and Jacop Bellaert (trans.), f. 141v.-142r.

[91] A couple of examples of diseases and disorders with cyclic fevers are Relapsing Fever, caused by Borrelia bacteria and transmitted through lice and ticks; Dengue Fever, a virus spread via mosquitoes; and Adult-onset Still's Disease, an inflammatory disorder.

Diagnosing malaria: tracing its symptoms in medical compendia

In addition to the intermittent period of fever, the medieval medical sources mention another characteristic symptom of malaria, namely discoloration of the patient's urine. In the medieval period, urine analysis was an important component of disease diagnostics and studying the colour, odour, and other characteristics was believed to provide important clues about a person's health.[92] In *Van den Proprieteyten der dingen* the urine of someone infected with *derden dach curts* or *vierden dach curts* is described as 'red or reddish, and somewhat dark', in other instances it is noted to be 'darkly with saffron coloured foam'.[93] The author of manuscript Hs. 6838 also expresses concern for the colour of the patient's urine warning that if the 'urine of a woman is the colour of rusty iron, she has the fourth-day fever, meaning she will die on the third day'.[94] The author also warns about pale urine, stating that 'urine, white and greasy, […] means that the fourth-day fever approaches'.[95] Similarly, according to *Van den Proprieteyten der dingen*, after an episode of the fourth-day fever passes, the urine is 'pale, white and thin'.[96] Similarly, the urine of patient suffering from third-day fever turns pale after the shivers and heat have subsided.[97]

This attention to the relationship between the pattern of the disease and the colour of the patient's urine is also reflected in Middle Dutch medical compendia Hs. 15624-41, produced in 1351 somewhere in Brabant. Notably, this manuscript includes a *Leringhe van orinen*, a treatise on urine. One excerpt reads:

> 'In elderly and children, red and thin urine indicates third-day fever. In young people, it suggests a simple third-day fever, but in elderly individuals with a phlegmatic temperament, it points to a double third-day fever, which lasts for a long time […] Such urine also indicates an irregular fourth-day fever.'[98]

---

[92] L.E. Demaitre, *Medieval Medicine: The Art of Healing, from Head to Toe* (California: Praeger, 2013), 45–47; N.G. Siraisi, *Medieval and Early Renaissance Medicine: An Introduction to Knowledge and Practice* (Chicago: University of Chicago Press, 1990), 125–26.

[93] 'die vrijn is middelbaer root of rodelachtich ende bouen een luttelken doncker', 'is die vrijn meer gheuerwet mit enen soffranigen scwm', Bartholomaeus Anglicus and Jacop Bellaert (trans.), *Van Den Proprieteyten Der Dinghen* f. 141r-141v.

[94] Hs. 6838, 'Orine van wiven die hevet vaerwe alse scurlinghe van ysere, heft soe den vierden dach curts, betekint datsoe salsterven ten derden daghe', Vreese, *Middelnederlandsche Geneeskundige Recepten En Tractaten, Zegeningen En Tooverformules*.

[95] Hs. 6838, 'Orine wit ende vet alse die guene die es van naturen verscheden, betekint den vierden dach corts nakende, Vreese, 115.

[96] 'vrijn is naden acces dat is naden toeganck ghelu of wat gheluwe ende inden middel daghen als hy rustet so is si raeuwachtich bleke ende onderbleke dat is min dan bleke wittachtich ende dun', Bartholomaeus Anglicus and Jacop Bellaert (trans.), *Van Den Proprieteyten Der Dinghen* f. 141v.

[97] 'hi quelt ende pinet eerst mit hesekinghen daer na mit tragher hetten tusschen die vre dat colera gheroert wert ende der vren van fleumen die vrijn is gheel ende middelbaer dun', Bartholomaeus Anglicus and Jacop Bellaert (trans.) f. 141r.

[98] Hs. 15624-41, 'Mer in kindren ende in ouden lieden so .b. rode orine ende dunne die eenpaerlike tertiane. Ende in jongen lieden die simple tertiane. Mer si .b. in ouden lieden die fleumaet siin dobble tertiane ende durende langen tijt. Ende.b. oec dat de levere es verhit. Dus gedane orine .b. oec die ongerechte quarteine. ende sonderlinge in den herfste. ja die van verbernden bloede comt of van verbernder coleren. Mer die gerechte

What does this change in colour and consistency of urine have to do with third- and fourth-day fevers? In modern medicine, darkening of the urine is considered a key indicator of malaria and is directly linked to the life cycle of the parasite. In the first stages of infection, the parasite nestles inside the red blood cells to reproduce. After a day or two, these cells burst open and release the parasites into the bloodstream – at which point the immune system kicks into action and symptoms flare up. The destroyed red blood cells are filtered out through the body and end up in the urine, turning it a dark red colour. Furthermore, the cyclical pattern of the urine changing colour, described in detail in the medical sources, can be explained by the parasite's lifecycle: after a fever episode, when the parasite retreats back into the cells to again reproduce, the destruction of red blood cells is halted. This would lead the urine to again take on a more yellowish or white colour. Indeed, as noted by *Van den Proprieteyten der dingen* and the author of manuscript Hs. 6838, white and greasy urine signals a temporary retreat of the fever, which will surely return again.

Another symptom which in modern medicine is strongly linked to malaria is splenomegaly, or an enlarged spleen. This organ, which sits just below the left rib cage, has the important function of storing and filtering blood cells and plays a crucial role in the immune system. When the body is infected with the malaria parasite, the spleen becomes actively involved in removing and filtering the ruptured red blood cells. Furthermore, repetitive exposure to the parasite leads the spleen to periodically produce large numbers of immune cells to support the immune system. If left untreated, malaria infection can place great strain on the spleen, resulting in inflammation and splenomegaly.[99]

Splenomegaly in also noted in the medieval medical sources. According to *Van den Proprieteyten der dingen*, fourth-day fever causes the body to become heavy, sluggish, intolerant, bloated, with heaviness in the sides, 'the patient also experience pains in the loins and the lower abdomen near the spleen, with swelling of the spleen and a reduced appetite'.[100] While the author does not elaborate further on the relationship between intermittent fevers and the spleen, this correlation is addressed in another Middle Dutch source, the *Medicina, boek van medicine* by Jan Yperman.[101] This work can be found in Hs. 15624-41, the same manuscript which contains *Leringhe van orinen* and was assembled and produced by Johannes de Altre. Jan Yperman wrote his *Medicina* while he was active as a surgeon at the hospital Godhuis Belle in Ypres, in current-day West Flanders.[102] The *Medicina*

---

quarteine comt van melancolien', Munk, *Leringhe van Orinen* f. 24rb. This texts has many more passages which relate the darkening of urine to third-day and fourth-day fever, see especially f. 24va.

[99] A. Muacevic and J.R. Adler, 'Hyper-Reactive Malarial Splenomegaly Syndrome (HMSS)', *Cureus* 4:11 (2012).

[100] 'ende van des lichaems wegen is daer swaricheit traecheit onuerduwelicheit opblasinghe swaricheit der siden […] ende die sieke crijcht oec zericheit inden leynden ende bijden lufteren onderscote omtrent der milten mit heffinge der milten starcheit des appetijts', Bartholomaeus Anglicus and Jacop Bellaert (trans.), *Van Den Proprieteyten Der Dinghen* f. 142r.

[101] Jan Yperman, *Medicina, Boek van Medicinen*.

[102] The two work Jan Yperman produced during his life – the widely copied *Cyrurgie* and the lesser-known *Medicina* – are regarded as especially remarkable within the medieval medical source corpus, as they bridge the

explains that one can recognise intermittent fevers by the patient complaining of pain in the left side and that, moreover, this indicates that the fevers originate from the spleen.[103] Jan Yperman goes on to state that 'the fourth-day fever comes when the spleen is filled with melancholic material' which, if the patient is not purged, will spread through the body.[104]

This perceived relationship between intermittent fevers and the inflammation and swelling of the spleen led treatment of *derden dach curts* and *vierden dach curts* to also focus on bringing relief to this organ. Jan Yperman recommends a patient with fourth-day fever to first take oil of chamomile and *dyanteide* (perhaps *dianthus*, carnation) and butter, and rub this mixture on the spleen.[105] Then make a *plaester* (poultice), with 'pig fat, dog fat, and oil of violets, and let this boil with the roots of the marshmallow plant and hogweed' and place this warm on the spleen'.[106] If this failed a warm poultice of the root of radish, raw honey, and rye flour could also be applied.[107] The medical treatments in *Antidotarium Nicolaï* in Johannes de Altre's Hs. 15624-41 – the same manuscript which contains *Leringhe van orinen* and Jan Yperman's *Medicina* – also focuses on curing the spleen. This *Antidotarium Nicolaï* is a translation of a Latin work by an unknown medical experts active at the medical school in Salerno written somewhere between the eleventh and thirteenth centuries.[108] The text was intended as a prescription book for students, physicians, and pharmacists, and was regarded as the authoritative work on pharmacy. Copies and translation circulated widely throughout medieval Europe.[109] The Middle Dutch translation in Hs. 15624-41 (which also contains the Latin text) provides the reader with over thirty medical recipes meant to cure or sooth third-day and fourth-day fevers. In

---

gap between practical medical knowledge, acquired by hands-on trained *chirugijnen*, and the theoretical medical frameworks embodied by the university educated *doctores*.

[103] Hs. 15624-41, 'Ende comt die quarteine van der milten. dwelke gi moget kennen bi der orinen. want si es in den bodem aschachtech. & dat cleuende an den orinael. entie zieke claget dier slinke side', Jan Yperman, *Medicina, Boek van Medicinen*, 41.

[104] Hs. 15624-41, 'Ende menechwerf so geuallet dat die quarteine comt bi dat die melte es veruult van melancolenser materien. dewelke haer rechte stede es. & si hare niet en mach purgieren bi haren rechten wege dats omme dat si onder es besloten & bouen open so ontfaet si meer dan si mach deliuereren dus so meret di melancolie in hare', Jan Yperman, 42.

[105] Hs. 15624-41, 'smere sine melte met olyen van camomillen. & dyanteide. & botere van elken euen vele geminct tegadere', Jan Yperman, 41. It is unclear what plant or herb is meant by dyanteide. Perhaps it refers to *dianthus* (carnation), or perhaps *Theriaca diatessaron* or *Dictamnus albus*.

[106] Hs. 15624-41, 'Ende daerna solegge optie melte dit plaester. Nemt swinen smout & honden & olye van vyoletten & doet zieden & die wortele van hoemsce & branca vrcina. Of die wortele allene geminct metten vorseiden smoute & olye. & dit so legt optie milte al warm.' Jan Yperman, 41. *Vyoletta* is Middle Dutch for the genus of plants *Viola*, or violets. *Hoemsce* is a local variation on the word *heems(sch)e*, currently known as *Althaea officinalis*, the marshmallow plant. *Branca vrcina* is a corrupted form of a Latin term meaning bear's claw, the literal translation of the Dutch *berenklauw*, in English hogweed (*Heracleum branca-ursina*).

[107] Hs. 15624-41, 'Ende en helpt dit plaester niet. so nemt den wortel van radeke. & zeem & ruggen mele. dit stoot wel tegadere. ende daer af maect .1. plaester Jan Yperman, 41. *Radeke* is likely a local variation and latin corruption of *radicem*, radish in modern English. *Zeem* is not a plant species. The author might have meant *honichzeem* or raw honey, honey that has not been heated or processed and thus retains its natural nutrients and antioxidants. *Rugge mele* could have been a local variation of *roggemeel*, rye flour.

[108] The original Latin *Antidotarium Nicolaï* was based for a large part on the *Antidotarium* by Constatine the African, which itself is a compilation of knowledge and texts gathered from older Arabic works.

[109] W.S. van den Berg, ed., *Antidotarium Nicolaï (Ms. 15624-15641. Kon. Bibl. Te Brussel)* (Leiden: Brill, 1917), xvii.

one recipe, after listing a number of ingredients and preparation instructions, the authors states that this concoction is good against fourth-day fever and *magis spleneticis*, an enlarged spleen.[110] Another treatment states that the recipe is effective against both third-day and fourth-day fevers and ailments of the spleen.[111]

Emphasis on the spleen in these medical sources is not unusual as it was considered an important organ within the human body. Its workings, or rather its inability to properly function, was often viewed as the cause for disease and illness.[112] The fact that the spleen is mentioned in relation to third-day and fourth-day is thus consistent with medieval ideas surrounding health and the working of the body. Yet, these medical excerpts do not simply point to the spleen as a possible culprit: they make specific reference to its increase size and inflammation and the discomfort it brings to the patient. At the same time, treatment was both focused on curing intermittent fevers and soothing and healing the spleen.

Knowledge of malaria: from Antiquity to the late medieval Low Countries

The Middle Dutch medical compendia thus provide us with three characteristic symptoms of *terciaen* and *quartein* which correlate directly with our current clinical understanding of malaria – namely intermittent fevers, discoloured urine and splenomegaly. Yet, to what extent do these sources reflect the actual practiced medical knowledge, beliefs, and theoretical frameworks in this region in the later Middle Ages? In the late medieval Low Countries, medical knowledge relied in large upon Graeco-Roman authoritative texts. After the disintegration of the Roman Empire, a new intellectual climate gradually emerged during the early Middle Ages. Monks and literate laypeople across Europe actively sought out a broad range of texts, among which ancient medical works, which were subsequently preserved, copied, and commented on within various types of knowledge institutes, most notably monastic institutions and, later, universities.[113] During the high Middle Age, a second major stream of ancient medical knowledge flowed into Europe. As Islamic Caliphates expanded their sphere of influence into former Roman territories during the seventh and eight centuries, Arabic-speaking scholars came into contact with Graeco-Roman medical knowledge, integrating them with medical insights from Persia, India, and their own Islamic traditions.[114] Beginning in the eleventh century, the

[110] Hs. 15624-41, 'Conficitur sic cum melle: avellane bene pulverisate et dispumato melle ad ignem decoquantur. deinde pulvis specierum admisceatur. quod valet quartanariis et magis spleneticis', Berg, *Antidotarium Nicolaï* r. 3, p. 41.
[111] Hs. 15624-41, Musa a peritissimo philosopho inventa: faciens ad omnes accessiones periodice febris in quotidiane tertiane quartane […] ydropicis spleneticis et colicis subvenit', Berg r. 57, p. 93.
[112] G.K. Paraskevas et al., 'Knowledge of the Anatomy and Physiology of the Spleen throughout Antiquity and the Early Middle Ages', *Anatomical Science Journal* 91:1 (2016): 43–55.
[113] Paroubek-Groenewoud and Rhijn, *De Inventieve Middeleeuwen*, 15–16.
[114] Siraisi, *Medieval and Early Renaissance Medicine*, 11.

Islamic commentaries and translation were (re)introduced into Europe via trade routes, intellectual centres, and diplomatic exchanges that connected the Arabic world with the European continent.[115]

In late medieval Europe, these two streams of Graeco-Roman medical knowledge – one preserved within Europe and the other reintroduced through Islamic contact – merged and were copied, translated, commented on, expanded upon, and taught at knowledge institutions – such as the renowned University of Salerno in present-day Italy.[116] Until recently, little was known about the transmission of Graeco-Roman texts and ideas from these knowledge centres to medical practitioners in the late medieval Low Countries, but recent research has begun to shed light on this process. University registration records show that between 1380 and 1500, more than one hundred individuals originating from the Low Countries enrolled in the faculty of medicine at the universities of Louvain and Cologne, in present-day Belgium and Western Germany – suggesting a direct channel through which medical knowledge was transmitted to this region.[117] Within the Low Countries, these ancient Graeco-Roman medical theories were subsequently disseminated further through urban schools and other educational institutes by teachers and headmasters who had often studied at foreign universities. In addition, these bodies of knowledge circulated through copies and commentaries written both in Latin and in the vernacular, enabling access to a wider, non-Latinate audience.[118]

The ideas, concepts, and frameworks found in Graeco-Roman texts were subsequently incorporated in Middle Dutch medical compendia. The influence of ancient texts is evident, for instance, in the terminology used in these medical compendia: *terciaen* and *quartein*, along with numerous variations, are corrupted forms *tertiana* and *quartana*, terms which originate from works of ancient authorities such as Hippocrates and Pliny the Elder. As discussed above, there is a general consensus among scholars on malaria history that the ancient period possessed a thorough awareness and relatively accurate understanding of malaria and its symptoms. Given the prominence and authority of these classical bodies of knowledge in the late medieval Low Countries, the question arises: did Midde Dutch medical compendia merely reproduce descriptions of *terciaen* and *quartein* fevers – including their symptoms, treatments, and theories of causation – from ancient sources? According to this interpretation, any reference to *terciaen* and *quartein* fevers in a Middle Dutch manuscript should be read not as evidence of contemporary awareness and understanding of malaria, but rather as a uncritical reproduction of ancient knowledge.

---

[115] I. Ormos, 'The Theory of Humours in Islam', *Quaderni Di Studi Arabi* 5/6 (1988): 601–7; J. Stannard, 'Medieval Herbalism and Post-Medieval Folk Medicine', *Pharmacy in History* 55:2/3 (2013): 116.
[116] Siraisi, *Medieval and Early Renaissance Medicine*, 11–14, 116; Stannard, 'Medieval Herbalism and Post-Medieval Folk Medicine', 70.
[117] Weeda's research on university registrations lists have not been published yet. The sources she used are available for consultation: Keussen, *Die Matrikel der Universität Köln* and Reusens, Wils, Schillings, *Matricule de l'Université de Louvain*.
[118] W. Claire, 'Mercury's Children: Urban Schools, Pedagogy and Health Literacy in the Low Countries, c. 1200-1500', *English Historical Review*, Forthcoming.

However, such a reading overlooks the ways in which late medieval medical authors of medical compendia engaged with and adapted ancient medical knowledge, combining it with their own experiences and knowledge of health and healing. It is likely that these medical compendia functioned as practical handbooks for surgeons during their day-to-day medical practice and subsequently contained not only theoretical knowledge of health, healing, and the human body, but also provided practical information on how to diagnose and treat a wide range of diseases. Indeed the incorporation of practically acquired experience is reflected in the terminology used: besides the Graeco-Roman term *terciaen* and *quartein*, the medical compendia also incorporate terms like *derden dach curts* and v*ierden dach curts*, along with numerous local variations. This terminology is clearly of Middle Dutch origin. As such, even if the authors relied extensively on ancient terms and knowledge in their works, the medieval surgeons saw a clear connection between the *terciaen* and *quartein* fevers they encountered in classical texts, and the third-day and fourth-day fevers they encountered themselves in daily practices. The incorporation of practical acquired experienced surrounding intermittent fevers is also underscored by the fact that these medical compendia often offered extensive lists of recipes and treatments against *derden dach curts* and v*ierden dach curts* from which a medical practitioner could select remedies based on their effectiveness.[119] Indeed authors often recommend alterative remedies in case the first (few) proved ineffective.[120] Lastly, as these manuscripts were intended as practical handbooks, it was important that they contained detailed information useful for a practising surgeon. In light of the costs, effort and time necessary to assemble and combine manuscripts, authors were unlikely to incorporate descriptions, symptoms, and treatments of diseases they did not understand or considered irrelevant for their medical practice. Descriptions of intermittent fevers in late medieval medical compendia are thus not simple, uncritical reproductions of Graeco-Roman texts on the *terciaen* and *quartein* fevers. Rather, the incorporation of Middle Dutch terminology, along with detailed accounts of symptoms associated with third- and fourth-day fevers and extensive lists of possible remedies in these sources, demonstrates that late medieval surgeons possessed a thorough understanding of the disease we now recognise as malaria.[121]

Malaria in late medieval daily life

Thus far, the focus of this research has been primarily on texts found in Middle Dutch medical compendia most prominently produced by surgeons. It is important to acknowledge that these sources primarily reflect the medical world and, as such, omit the experiences and understandings of the

[119] Demaitre, *Medieval Medicine*, 57.
[120] See for example, Jan Yperman, *Medicina, Boek van Medicinen*, 'Ende en helpt dit plaester niet', p. 41.
[121] Besides the sources discussed above, numerous additional references to *terciaen* and *quartein* appear in medieval medical texts (over one hundred mentions of remedies against intermittent fevers in total). Due to space constraints, these have not been included here. An overview of the Middle Dutch sources analysed can be found in appendix 1.

broader population of *derden dach curts* and *vierden dach curts*. In what follows, I hope to remedy this lacune by providing several examples of sources which contain references of *terciaen* and *quartein* outside the medical framework. The aim is not to provide an extensive overview of all materials, but to showcase awareness and understanding of malaria in late medieval daily life.

The introduction to this thesis opened with an excerpt from a thirteenth-century chronicle describing the history of the Premonstratensians monastery Bloemhof in Wittewierum, in present-day Friesland. This *Cronica Floridi Horti*, written by three successive abbots, starts with the founding of the monastery in 1200 and ends with the death of the last anonymous author in 1296 and contains political events and natural disasters occurring in that period, as well as various theological and philosophical discussion. The second part, written by the abbot Menko, opens with the description of the year 1237, which – with a wet and warm winter, followed by a wet and cold summer and succeeded by heat and drought – brought a year 'intemperate and contrary to nature'.[122] This resulted in the corruption of the air, leading to disease and fevers in those who inhaled it.[123] Menko further observes that, while everyone was tormented by fevers, it were the monks who were 'especially devasted by the fourth-day fever', because 'the Lord punishes the sons He loves, and He scourges every son He receives'. [124] In medieval thought, suffering and disease were understood as acts of divine will that purified the soul and brought individuals closer to God. For Menko, then, the afflictions caused by the fourth-day fever fitted within this tradition of suffering as a form of spiritual purification. Although the chronicle does not provide a highly detailed description of *quartein* fever, the characteristic symptom of recurrent episodes of fever is clearly noted.

Mentions of *terciaen* and *quartein* also appear in the *Vita* of the Saint Lidwina of Schiedam.[125] After a severe fall while ice skating at the age of fifteen, Lidwina became bedridden for most of her life. During her prolonged illness, she was believed to have performed numerous miracles, which led to her canonization and which were recorded in her *Vita* shortly after her death.[126] *Vitae* – biographies of male and female saints – testified to their saintliness, served as moral examples, and emphasised the power of religion and God.[127] These texts were often compiled by clergy members or university-

[122] 'Omdat het jaar [1237], zoals we hierboven gezegd hebben, was begonnen met een warme en natte winter, terwijl die eigenlijk koud en nat had moeten zijn, was de zomer vreselijk nat en koud, tot aan 1 augustus. Daarop volgde een onmatige warmte en droogt. En zo wat het weer bijna het geheel jaar lang van slag af en tegengesteld aan zijn aard', *Cronica Floridi Horti*, 286–87.
[123] The concept of toxic air as a cause of disease is explored further in the second chapter.
[124] 'En zo werden de mensen overal door verschillende koortsen gekweld. De derdendaagse koorts trof vooral de kloosterlingen misschien omdat zij koud voedsel gebruiken, maar waarschijnlijker, omdat 'God de zonen, die Hij liefheeft, straft en omdat Hij iedere zoon, die Hij aanneemt, kastijdt", *Cronica Floridi Horti*, 286–87.
[125] The edition used for this research is from: Jongen and Schotel, *Het Leven van Liedewij, de Maagd van Schiedam*. They based their text on three different manuscripts: HS. 1080 produced in Brabant and held at Gent University Library; HS. 71 H 9, from the Royal Library at Den Haag and produced in Holland; and HS. 92 G 5 produced in Brabant and currently at the Museum Catharijneconvent, Utrecht. All manuscripts were produced in the fifteenth century, shortly after Lidwina's death.
[126] Jongen and Schotel, 16.
[127] C.W. Bynum, 'Fast, Feast, and Flesh: The Religious Significance of Food to Medieval Women', *Representations* 11 (1958): 4; P.J.A. Nissen, 'De Heiligen Vriend Gods Sint Eusebius: Nederlandse

educated theologians but also incorporated local and regional narratives surrounding the saint and the miracles they performed. The *Vita* of Lidwina records that from 1414 to her death in 1433, she suffered greatly from *derden dach curts*, which alternately brought her extreme heat followed by intense cold.[128] In her first year of enduring third-day fever 'an angel came and asked if she would bear the disease longer so she could release her friends from purgatory'.[129] Upon her confirmation, the angel declared Lidwina would carry this burden until her death and thus 'she endured this fever so severely that no one could image or describe it.'[130] From 1421 onwards, Lidwina was also plagued by *vierden dach curts*, during which she 'greatly desired to receive communion, especially during the two days in which the *quartein* subsided'.[131] As in *Cronica Floridi Horti*, this *Vita* describes Lidwina enduring *terciaen* and *quartein* as a form of spiritual purification – this time both for herself and on behalf of her friends suffering in purgatory. Furthermore, much like the chronicle of Bloemhof, the *Vita* of Saint Lidwina of Schiedam unambiguously describes a characteristic symptom of *terciaen* and *quartein*, namely the recuring episodes of fever returning every couple of days.

Whereas the *Vita* of Saint Lidwina of Schiedam and the *Cronica Floridi Horti* explicitly mention *derden dach curts* and *vierden dach curts*, incorporating them into the narrative to convey a moral message of spiritual suffering, these texts do not offer elaborate insight into the specific meaning of the disease within religious, cultural, and social frameworks. For a more comprehensive understanding, one can turn to Jan van Ruusbroec and his *Die chierheit der gheestelijker brulocht*.[132] Born in Ruisbroek, Flemish Brabant, Jan van Ruusbroec was an Augustinian monk and one of the most important writers on Christian mysticism in the medieval Low Countries.[133] Writing in Middle Dutch rather than in Latin, he aimed to make his work accessible to a broader audience, engaging not only the university-educated elite but also the wider literate population.[134] One of his more famous,

---

Mirakelboeken Uit de Late Middeleeuwen, in Het Bijzonder Het Arnhemse Mirakelboek van Sint Eusebius, Als Bron van Volksgeloof', *Volkskundig Bulletin* 12:2 (1986): 283; G. Mensching, *Das Wunder Im Glauben Und Aberglauben Der Völker* (Leiden: Brill, 1957), 85.

[128] 'Dese voerseyden VII jaren leet sij groote corts over den derden dach ende quam haer yerst aen met grooter hitten, ende daer na volchde groote coude, ende danweder hette ende daer na coude. Ende dese verwandelinghe duerde omtrent een halft jaer. Daerna had si die selve corts yerst met grooter couden ende daer na volghede groote hitte', Jongen and Schotel, *Het Leven van Liedewij, de Maagd van Schiedam*, 28.

[129] 'Ende doe ghevielt, dat haer dinghel vraechde, of sij den corts noch mee woude lijden om haer vriende te verlossen uuten vagheviere', Jongen and Schotel, 30.

[130] 'Sy antworde dat sijt gheerne woude lijden. Doe seyde dinghel, dat sij die corts totter doot soude lijden. Ende daermede soude sij verlossen vanden vagheviere alle die haer aen ghinghen toten neghende lede toe, ende oec mede ander ontallijke zielen. Ende dese corts leet sij also swaerlijc, dathet gheen mensche en soude moghen dincken of spreken', Jongen and Schotel, 30.

[131] 'Vandier tijt voert tot harer doot toe hadde si ghemeenlic die corts over den vierden dach ende by wilen alle daghe om die zielen uut den vaghevier te verlossen. Ende si plach van grooter begheerten te ontfanghen dat Heileghe Sacrament twee daghe na malcandere die sij in die quarteyn plach quijt te gaen,', Jongen and Schotel, 54.

[132] Jan van Ruusbroec, *Die Chierheit Der Gheestelijker Brulocht*.

[133] Mysticism refers to the late medieval pursuit of a direct and personal connection with the divine, which is often practiced through meditation, prayer, and contemplation. Jan van Ruusbroec's work focuses on establishing a personal union with God, which greatly influenced later spiritual and mystical thought.

[134] Jan van Ruusbroec, *Die Chierheit Der Gheestelijker Brulocht*, xiii.

influential, and most often translated works is *Die chierheit der gheestelijker brulocht*, which describes the spiritual journey towards a union between the human soul and God. In *Die chierheit der gheestelijker brulocht*, as Jan van Ruusbroec describes the various obstacles hindering people in connecting with the God, the manuscript delves into various 'kinds of fevers that can harm humans'. According to Jan van Ruusbroec, the fever that 'comes every other day', and which is especially worrisome, manifests itself in two ways: one is 'found is some good people; for when they are touched by God or have been touched by Him, but then abandon him, they often become inconstant. Today they choose one way, and tomorrow another. […] If, therefor, this person is to overcome inconstancy, they must learn to rest above all virtues in God and in the supreme unity of God'.[135] The other type of fever is

> 'found in all people who strive towards God while at the same time seeking and pursuing something else in a disordered way. […] These people now choose one way and then reject it for another; today they wish to confess and seek counsel from one person for their entire life, and tomorrow they choose another. […] These people walk on the edge of hell – one step further, and they fall in'.[136]

From this second type, Jan van Ruusbroec continues, sometimes develops a *quartein* fever, 'that is an estrangement from God, from themselves, from truth, and from all virtues. In this state, a person falls into confusion, no longer knowing how they feel or what they should do'.[137] This fever is especially dangerous as those who contract it 'can scarcely be healed; for they become reckless and indifferent to everything necessary for eternal life'.[138]

---

[135] 'De tweede soort koorts komt om den anderen dag. Die heet ongestadigheid. Al laat zij zich langer wachten, zij baart dikwijls meer zorgen. Deze koorts is tweeërlei: de eene komt van ongeregelde hitte, en de andere van koude. Die welke van de ongetemperde hitte komt, die hebben sommige goede lieden; want wanneer zij van God worden aangedaan of aangedaan zijn geweest, maar dan van God verlaten worden, dan vallen zij dikwijls in ongestadigheid. Vandaag kiezen zij de eene wijze en morgen de andere. […] Zal daarom deze mensch die ongestadigheid overwinnen, dan moet hij leeren rusten boven alle deugden in God en in de hooge eenheid Gods', Jan van Ruusbroec, 112–13.

[136] 'De andere koorts der ongestadigheid, die van de koude komt, die hebben alle menschen, welke naar God streven, maar te gelijk iets anders op ongeregelde wijze zoeken en nagaan. Deze koorts komt van de koude; want daar is klein de hitte der liefde, waar vreemde dingen met God de werken der deugden drijven en opwekken. […] Deze menschen kiezen en verwerpen nu de eene wijze en dan de andere; nu willen zij bij den eenen te biechten en te raden gaan voor geheel hun leven en morgen kiezen zij een anderen. […] Eene natuurlijke neiging tot zich zelven, en eene verborgene hoovaardij maakt hen ongestadig. Deze lieden wandelen op den rand van de hel: een pas meer en zij vallen daar in', Jan van Ruusbroec, 113–14.

[137] 'Uit deze koorts van ongestadigheid komt somwijlen bij zulke menschen de vierdedaagsche koorts. Dat is eene vervreemding van God, en van zichzelf, van de waarheid en van alle deugden. En zoo valt de mensch in dwaling, waarin hij niet weet hoe hij het heeft of wat hij moet doen', Jan van Ruusbroec, 14.

[138] 'Deze ziekte is gevaarlijker, dan eenige van de andere. Uit deze vervreemding valt de mensch somwijlen in eene koorts, die heet de dubbele vierdedaagsche koorts, dat is de onverschilligheid. Dan wordt de vierde dag verdubbeld en dan kan hij nauwlijks genezen; want hij wordt roekeloos en onverschillig voor alles, wat noodig is tot het eeuwige leven', Jan van Ruusbroec, 114.

In these excerpts, Jan van Ruusbroec places *terciaen* and *quartein* fevers within a moral and religious context. In the late medieval period, disease and illness were often understood through a combination of medical, philosophical, and religious thought. Within this framework, illness was often linked to a person's moral and spiritual state. Physical ailments, then, were viewed as a form of divine chastisement intended to punish and correct disobedience and sinful behaviour.[139] For Jan van Ruusbroec, *terciaen* and *quartein* fevers fit within this moral and religious framework: the fever that arises every third day plagues those who have abandoned God, whereas *quartein* afflicts those who have completely estranged themselves from God, from themselves, from truth, and from all virtues, even becoming indifferent to their spiritual salvation. Furthermore, the fever's very nature overtakes the patient's behaviour and personality: like the recurrent episodes of fever, the afflicted person is 'overcome by inconstantly', wavers between choices, unable to commit to a single action, and is caught between fluctuating emotions and thoughts. *Terciaen* and *quartein* fevers, then, do not merely afflict the body but drastically reshapes ones personality and sense of self.

This moral and religious interpretation of *terciaen* and *quartein* was by no means unique, but fitted within medieval understandings of the relationship between disease and a patient's personality, behaviour, and their moral and spiritual state.[140] What is important to note here is the fact that third-day and fourth-day fevers were part of the repertoire of Jan van Ruusbroec in his discussions of humanity's obstacles and hurdles in reaching union with God. He was thoroughly aware of the symptoms and characteristics of *terciaen* and *quartein*, emphasising in great detail the recurrent episodes of fever and adapting their meaning to fit his own narrative. Furthermore, it is possible to assume that a layperson and reader of *Die chierheit der gheestelijker brulocht* was also very much familiar with the fevers this text describes. The work was intended as an instructional guide. As such, it was important that *Die chierheit der gheestelijker brulocht* was rooted in the experiences and interpretations of its readers. Given that the work was written in Middle Dutch, and was thus meant to reach audiences beyond the university-educated elite, show that the even the reading laity had a thorough understanding of *terciaen* and *quartein* so vividly described by Jan van Ruusbroec.

This brief exploration of the *Cronica Floridi*, the *Vita* of Saint Lidwina of Schiedam, and the *Die chierheit der gheestelijker brulocht* offers valuable insight into the interpretations of *terciaen* and *quartein* beyond the medieval medical field. While medical sources explicitly detail the symptoms, causes and treatment of intermittent fevers, the *Vita*, the chronicle, and the work of Jan van Ruusbroec focus on a specific characteristic of third-day and fourth-day fevers – namely, the recurrent episodes of fever – and place this within a religious and moral framework that aligns with their narrative goals.[141]

---

[139] R.A. Scott, *Miracle Cures: Saints, Pilgrimage, and the Healing Powers of Belief* (California: University of California Press, 2010), 70–72; F. Wallis, ed., *Medieval Medicine: A Reader* (Toronto: University of Toronto Press, 2010), 47.
[140] Scott, *Miracle Cures*, 71.
[141] The emphasis in these non-medical sources on the pattern of recurrent episodes of fever is likely because this symptom of *terciaen* and *quartein* fevers is the most visible and recognisable.

What becomes clear is that the interpretations and understanding of *derden dach curts* and *vierden dach curts* were not confined to the medical practitioners. As shown by these non-medical sources, it was an ailment with which the priests of a monastery in Friesland; those acquainted with the live and death of Saint Lidwina of Schiedam; and readers of Jan van Ruusbroec's works were familiar. These sources thus demonstrate that the broader population, too, was had knowledge of the *terciaen* and *quartein* fevers.

To conclude: mosquitoes and malaria

This first chapter has aimed to situate malaria within the context of the late medieval Low Countries and to examine contemporary knowledge of the disease and its presence. Drawing on archaeological evidence and studies form other European regions, it was suggested that malaria may have significantly impacted society in this period and region. Nonetheless, the prevailing scholarly consensus holds that people in the Low Countries during the Late Middle Ages lacked knowledge of the disease. This chapter challenged that view through a close reading of five medical compendia produced by surgeons and other non-medical sources between the fourteenth and sixteenth centuries, analysing how they interpreted disease, described symptoms, and categorised illnesses.

These five medical compendia contain references to *derden dach curts* and *vierden dach curts*, as well as descriptions of the fevers returning every few days, discoloured urine, and splenomegaly – symptoms that closely resemble modern clinical understandings of malaria. While these compendia drew on classical medical knowledge, they also contain information grounded on practical acquired experiences. As such, late medieval surgeons did not simply and uncritically copy ancient medical works on *terciaen* and *quartein* fevers, but rather merged these bodies of knowledge with their own observations and experiences of malaria, acquired through their day-to-day medical practice. These Middle Dutch medical compendia – with their detailed descriptions of *terciaen* and *quartein* fevers – thus demonstrate that the late medieval medical field did indeed possess knowledge of malaria. Furthermore, knowledge of intermittent fevers went beyond the medical field, as evidenced by texts such as the *Cronica Floridi*, the *Vita* of Saint Lidwina of Schiedam and the *Die chierheit der gheestelijker brulocht*, which not only detailed symptoms of malaria, but also fitted it within a broader cultural and religious context. This suggest that the broader population, too, was familiar with the disease we now recognise as malaria.

Having situated the disease malaria as well as its presence and perception in the late medieval Low Countries, the following chapter explores how people in this period and region understood its causes and sought to treat it. Primary, it examines how the disease was framed within broader contemporary ideas about the relationship between human health and the natural environment.

2. Medicine and malaria

Knowledge of the relationship between human health and the natural environment in the Low Countries during the late medieval period

The previous chapter situated the disease malaria within the context of the late medieval Low Countries and aimed to examine contemporary knowledge of the disease. This second chapter uses the disease malaria as a lens to explore how people in this region and period understood and navigated the complex relationship between human health and the environment. It explores first how medical experts such as surgeons explained the presence and spread of *terciaen* and *quartein* fevers, and how these intermittent fevers were closely associated with specific environments, particularly wetlands. Next, the chapter examines how surgeons not only saw the natural surroundings as a source of disease but also valued it as a source of health and healing, particularly through the use of herbal medicine. By tracing the application of specific medicinal plants from antiquity to their use in the five Middle Dutch medical compendia, it becomes clear that surgeons drew not only on classical medical theory, but also on regionally developed, experience-based knowledge.

The soul and the body: malaria and its causes

How was the presence of malaria, *terciaen* and *quartein* fevers, explained in the medical framework of the late medieval Low Countries? The late medieval medical world was a complex cumulation of religious, philosophical, and classical thought. Firmly rooted in Christian theology, the most influential and overarching belief was that all diseases, ailments, and afflictions suffered by humanity were the consequence of the Fall of Man. Within this religious framework, physical ailments were closely connected to an individual's moral and spiritual state. Consequently, conditions such as sexually transmitted infections, leprosy, and various mental illnesses were often understood as visible manifestations of a person's moral and religious failings.[142] Punishment could also occur on a more communal scale. For example, epidemics such as the plague, tuberculosis, or smallpox were interpreted as divine punishments for collective sins or widespread disobedience. Healing, then, was aimed at purifying the soul and centred on abandoning one's sinful ways, asking for forgiveness, and rediscovering the true faith in God.[143]

As with disease in general, there existed a religious interpretation to explain the presence and spread of intermittent fevers. The authors of the non-medical texts discussed in the previous chapter placed third- and fourth-day fevers within the moral and religious framework that interpreted the disease as a form of divine punishment. Especially the work of Jan van Ruusbroec, underscores that the detrimental state of an individual's soul is the reason that he or she is plagued by *terciaen* and

[142] Scott, *Miracle Cures*, 71; Siraisi, *Medieval and Early Renaissance Medicine*, 8.
[143] Siraisi, *Medieval and Early Renaissance Medicine*, 9.

quartein fever.[144] The chronicle of the monastery Bloemhof in Wittewierum, the *Cronica Floridi Horti*, and the *Vita* of Saint Lidwina of Schiedam also place the cause for malaria within a religious and spiritual context, with both emphasising that intermittent fevers are a form of divine retribution meant not only to punish the sinful, but also to bring a Christian closer to God.[145]

However, this spiritual interpretation did not mean that medical remedies that centred on the physical body were non-existent.[146] On the contrary, the abundance of medical recipes in medical compendia targeting *terciaen* and *quartein* fevers which focused on the physical body illustrate that healing not only involved the immortal soul but also the mortal body. Central to this more bodily-orientated approach were the works of various Graeco-Roman authors, most notably Hippocrates and, later, Galen. Building upon earlier medical traditions from Ancient Egypt and Mesopotamia, Hippocrates formulated the *humoral theory*, which proposed that human health was determined by the balance between four bodily fluids or 'humours': blood, yellow bile, black bile, and phlegm.[147] Each of these humours had distinct qualities: blood was considered to be hot and wet, whilst phlegm was believed to be cold and wet; yellow bile was hot and dry, and black bile cold and dry. While minor fluctuations in humoral balance were considered harmless, serious health issues arose when one or more humours became excessively dominant or deficient. Hippocratic medical treatments aimed to restore the balance through various methods, including dietary or lifestyle changes, bloodletting, environmental adjustment, and the use of numerous medicinal remedies. In the second century A.D., the Graeco-Roman physician Galen built upon Hippocrates' humoral theory and further expanded it. One of Galen's key contributions was his *theory of opposites*, which held that humoral imbalances could be corrected by introducing substances or treatments with opposing qualities. Galen also refined therapeutic practices by introducing new dietary guidelines, expanding the use of herbal treatments, and developing more precise methods of bloodletting.

Hippocrates' and Galens' theory of the four bodily humours played a central role in the late medieval medical world.[148] Medical experts such as surgeons grounded their knowledge and practices in classical concepts like the humoral theory. A striking example is Johannes de Altre's medical compendium Hs. 15624-41, compiled and written in Brabant in 1351.[149] It contains a Middle Dutch of the *Liber Magistri Avicenne*, a compilation of various theories by the influential Arabic physician Avicenna (c.980-1037), who built upon the ideas of Hippocrates and Galen. The opening folio of this Middle Dutch *Liber Magistri Avicenna* – which outlines the basic principles of medicinal knowledge and practice – states that man is composed of four humours, which together determine bodily

[144] Jan van Ruusbroec, *Die Chierheit Der Gheestelijker Brulocht*, 112–13.
[145] See: Menko and Emo, *Cronica Floridi Horti*, 286; Jongen and Schotel, *Het Leven van Liedewij, de Maagd van Schiedam*, 16, 30, 54.
[146] Siraisi, *Medieval and Early Renaissance Medicine*, 8.
[147] Demaitre, *Medieval Medicine*, 16; G.E.R. Lloyd, ed., *Hippocratic Writings*, trans. W.N Mann et al. (London: Penguin Books, 1983), 262.
[148] Demaitre, *Medieval Medicine*, 38.
[149] Vandewiele, *De 'Liber Magistri Avicenne' En de 'Herbarijs'*, 45.

health.[150] The text goes on to explain that medical experts are expected to recognise that each individual has 'one of the four humours in excess', and should be able to identify this as their dominant quality.[151] However, if this humoral equilibrium is disrupted – if 'these humours become to abundant, too scarce, or are obstructed in the veins' – then a person becomes ill.[152]

Although various medieval authors give their own interpretation on the humoral theory and its exact relation to the disease progression, there was a broad consensus that two humours were the primary factor in bringing on intermittent fevers: black and yellow bile. For example, according to the Middle Dutch translation of Bartholomeus Anglicus' work, the *Van den proprieteyten der dinghen* (printed in 1485 in Haarlem), *terciaen* fever 'arises from yellow bile that is located outside the veins and does not gather into an abscess'. *Quartein*, on the other hand, 'arises from black bile, that has rotted outside the veins and has not gather into an abscess'.[153] Works like the *Liber Magistri Avicenne* and the *Medicina* by Jan Yperman – found in Johannes de Altre's medical compendium Hs. 15624-41 – similarly point to an excess in yellow and black bile in explaining the cause of third-day and fourth-day fevers.[154] According to these medical compendia, the humours arise and cumulate inside the body, blocking various bodily functions, which the body 'cannot purge through its natural way', thereby causing the individual to become ill.[155]

What caused this accumulation of yellow and black bile in the body, resulting in intermittent fevers? One of the explanation for excess production of black and yellow bile was an individual's lifestyle, most prominently their diet.[156] In the late medieval period, different foods were believed to posses distinct qualities – hot, cold, wet or dry – and could thus stimulate the production of specific humours. Excessive consumption of certain food items could lead to an overproduction of the associated humour, resulting in various physiological consequences. It was believed that yellow bile

---

[150] Demaitre, *Medieval Medicine*, 42; Coomans, *Community, Urban Health and Environment*, 36–37.
[151] HS. 15624-41, 'al es de mensce beset met .4. humoren. het es te wetene dat elc mensce vanden enen vanden vieren meest heeft'. Vandewiele, *De 'Liber Magistri Avicenne' En de 'Herbarijs'*, 45.
[152] HS. 15624-41, 'Avicenna die wise meester seit dat de mensce es gemaect van der aerden. Ende es beset met .4. humoren Alse heet. cout. droge ende versch. Ende dit siin si. sanguis. colera. fleuma. Melancholia […] Ende wet alse dese humoren overtullech werden of vorttech of versmacht in die adren. so wert de mensce ziec'. Vandewiele, 45.
[153] 'Quartana dat is die coerts vanden vierden daghe diemen quarteyn hiet ende dese coemt van melancolien die verrot is buten den vaten ende niet vergadert tot enighen aposteme', Bartholomaeus Anglicus and Jacop Bellaert (trans.), *Van Den Proprieteyten Der Dinghen*, f. 141v.
[154] HS. 15624-41, 'Nv hoort van den derden dage simpel of versceden. die derde dach corts. […] Die warachtege comt onderwilen van naturliker colera', 'Die .4. dach comt van naturliker melancolien die in die adren siin', Jan Yperman, *Medicina, Boek van Medicinen*, 34, 38.
[155] HS. 15624-41, 'Ende menechwerf so geuallet dat die quarteine comt bi dat die melte es veruult van melancolenser materien. dewelke haer rechte stede es. & si hare niet en mach purgieren bi haren rechten wege dats omme dat si onder es besloten & bouen open so ontfaet si meer dan si mach deliuereren dus so meret di melancolie in hare', Jan Yperman, 42. Note in particular that black bile was associated with the spleen, 'which is its proper place'. The previous chapter already discussed the late medieval link between *quartein* and *terciaen* fevers and discomfort in the spleen, as well as modern medicine's recognition of the spleen's role in malaria. Also note that yellow bile was thought to originate in the gall bladder, an organ situated just beneath the spleen. For more information on the humours and their associated organs, see: Demaitre, *Medieval Medicine*, 16.
[156] E. Huizenga, *Bitterzoete Balsem: Geneeskunde, Chirurgie En Farmacie in de Late Middeleewen* (Hilversum: Uitgeverij Verloren, 2004), 11.

could cumulate in the human body if too much hot and dry substances were consumed, whilst black bile was associated with cold and dry food items.[157] In addition to diet, the environment and surrounding climate was also considered crucial in determining the four humours. Among the various environmental factors medical experts believed could influence health, the most significant was the presence of toxic, pestilential air or *kwade lucht*.[158] These harmful vapours were thought to infect the human body, corrupting the humoral balances and bringing on various types of afflictions and ailments, among which fevers.[159] Medieval sources consistently emphasis this link between fevers and harmful air. The *Cronica Floridi Horti* for instance states that the year 1237 – beginning with a wet and warm winter, followed by a wet and cold summer, and ending in heat and drought – produced *aer corruptus* that spread a terrible 'recurrent fever'.[160] Jan van Ruusbroec also identifies corrupt and toxic air as the principle cause of fevers, stating that it fills 'those who are not careful to become prone to harmful humours that fill the stomach, making them unhealthy and leading to various diseases. […] From the excess of humours come weakness and fevers, causing many to waste away and sometimes die.'[161]

The marshes: 'stinking and unclean' and full of 'evil vapours'

The presence of toxic and corrupt invisible vapours was thus a central and widely accepted explanation for the spread of fevers. But what gave rise to this *kwade lucht*? Medieval medical experts proposed various theories to explain the origin and dissemination of this dangerous air. A particular constellation of planets and stars, for example, was believed to corrupt the atmosphere and generate foul, toxic vapours.[162] Similarly, earthquakes were thought to release poisonous gases that had accumulated deep within the earth, thereby contaminating the environment and spreading dangerous air.[163] The most prominent theory for the generation of *kwade lucht*, however, centred on the presence

[157] Demaitre, *Medieval Medicine*, 51.
[158] Coomans, *Community, Urban Health and Environment*, 4, 34.
[159] Coomans, 4.
[160] 'Omdat het jaar [1237], zoals we hierboven gezegd hebben, was begonnen met een warme en natte winter, terwijl die eigenlijk koud en nat had moeten zijn, was de zomer vreselijk nat en koud, tot aan 1 augustus. Daarop volgde een onmatige warmte en droogt. En zo was het weer bijna het geheel jaar lang van slag af en tegengesteld aan zijn aard. […] En zo werden de mensen overal door verschillende koortsen gekweld. De derdendaagse koorts trof vooral de kloosterlingen', Menko and Emo, *Cronica Floridi Horti*, 286–87.
[161] 'want nu in dezen tijd van het jaar dag en nacht gelijk zijn, zoo gaat de zon omlaag en koelt het weder af. En zoo laden zulke menschen, die niet op hunne hoede zijn op zich kwade sappen, die de maag vullen, en ongezond maken en aanbrengen menigerlei ziekte. Zij bederven den eetlust en den smaak in alle goede spijzen, en aan zulke menschen brengen zij den dood. Door de kwade sappen ontaarden vele menschen, worden waterzuchtig, waardoor zij langen tijd kwijnen en sommigen sterven. Van de overtollige sappen ontstaan verslapping en koortsen, waar door vele menschen kwijnen en somwijlen sterven', Jan van Ruusbroec, *Die Chierheit Der Gheestelijker Brulocht*, 109.
[162] J.N. Hays, *The Burdens of Disease: Epidemics and Human Response in Western History* (New Brunswick: Rutgers University Press, 2009), 45; Demaitre, *Medieval Medicine*, 62.
[163] Coomans, *Community, Urban Health and Environment*, 36.

of bodies of water.[164] There existed an important distinction between wholesome and healthy water sources, on the one hand, and unwholesome dangerous waters on the other.[165] Clean, beneficial water was flowing, cold, clear and odourless – suitable for drinking, cooking, and irrigation. Its opposite – standing, obstructed, dark and foul-smelling water – was considered dangerous and needed to be avoided. A good example of this concept can be found in the Middle Dutch *Tregement der ghesontheyt* published in Brussels in 1514 and a translation of the 1482 *Regimen sanitatis* by the Milanese physician Magninus (died 1368).[166] These health regiments, copied and translated throughout the Christian sphere of influence, provided practical guidance on how to best preserve one's health. In the chapter that discusses the various healthy and harmful qualities of water, the *Tregement der ghesontheyt* states,

> 'first we must consider the source of water, which should not lie in foul-smelling or metal-rich ground. We can observe that stagnant water, such as pools, wells, and riverbanks are not suitable. Better are springs with flowing water that pass through sandy or stony soil. The water should not be dirty, foul-smelling, or corrupted'.[167]

It is these stagnant, foul-smelling bodies of water, the *Tregement der ghesontheyt* continues, that makes the air, 'stinking and unclean' and full of 'evil vapours'.[168] In the late medieval period, then, unwholesome and corrupted water infected the air, creating hotspots of corruption, disease and fever.[169]

In densely populated urban environments, unwholesome bodies of water – accumulating in small streams running through the streets; in buckets left between buildings; and in puddles on market squares – were considered particularly serious health hazards. Historians such as Coomans have shown for the late medieval Low Countries that urban authorities and citizens took the health risks posed by these dangerous vapours very seriously. Concerned with maintaining and promoting economic prosperity, political stability, and social cohesion, city officials, local guild members, neighbourhoods, and laypeople implemented a wide range of health policies. These efforts focused on

---

[164] Importantly, it was widely believed that all corruption ultimately stemmed from divine will. God was thought to have ordained the universe – the planets and stars, the earth and the air – to produce harmful vapours, which in turn brought corruption and affliction to humans. Demaitre, *Medieval Medicine*, 62.
[165] Coomans, *Community, Urban Health and Environment*, 39.
[166] *Tregement Der Ghesontheyt* (Brussels, 1514).
[167] 'Daerom moeten wij inden eerst te considereren dat den oorspronck des in loeslijcke eerden: niet stinckenden noch mijnachtig doirts salmen mercken de gheen staede wateren en sijn ghelijc poelen, putten, oever. Maer fonseynen watereren loopende doer santachtige eerde oft steenachtich. Maer geen vuyl noch stinkende ghecorompeerlick ende si selen loopende sijn na doosten oft na dnoerden mair de watren die na tzuiden of na dwesten loopen die sijn quaet', *Tregement Der Ghesontheyt*, chap. 38.
[168] *Tregement Der Ghesontheyt*, chap. 39.
[169] Coomans, *Community, Urban Health and Environment*, 39.

creating clean living environments and improving sanitary conditions, and aimed to prevent the production and spread of pestilential air.[170]

Being outside the urban environment and away from its smelly, damp, and narrow streets, did not mean one was safe from the dangers of unwholesome waters. The rural landscape, dotted with larger bodies of waters such as bogs, fens, and marshes, posed its own risks. Beyond the obvious hazard of drowning, these waters were also believed to be capable of producing toxic vapours and spreading fevers. Especially dangerous were environments with marshy, stagnant, foul-smelling ,and overgrown bodies of water. *Van den proprieteyten der dingen*, for instance, emphasises the danger of wetlands, stating that 'vapours from foul-smelling marshes corrupts the air, leading to widespread death or illness among both humans and animals'.[171] A chronicle of the abbey of Rolduc, located in what is now the province of Limburg, similarly exemplifies the dangerous nature of marshy areas. This *Annales Rodenses* traces the history of the abbey from 1104 till 1157, but also covers important historical and political events in the wider region. According to the *Annales Rodenses*, in 1127, a small group of people find themselves in marshland area near Worms, where they had come to ask the Bishop of Worms assistance in the founding of a new monastery. But 'when they had all gathered in that marshy place, they were affected by the foul air of the surrounding swamp and gradually became seriously ill. One by one they left', abandoning their plans to build a new religious institution.[172] Just outside Leiden, in the present-day province of South Holland, another religious collective, the Sint-Margaretha convent, similarly fell victim to the marshy nature of their surroundings. In 1464 they ask permission of the Pope and the count of Holland to relocate, in part due because 'the convent is situated in a place that is very damp, rheumatic, and watery, and as a result, many of the religious sisters living there frequently contract and suffer from various illnesses'.[173]

Although these Middle Dutch sources do not explicitly link *terciaen* and *quartein* fevers to marshy environments, it is highly likely that the authors nonetheless associated intermittent fevers with such wetland areas. Indeed, surgeons explained the presence of third- and fourth-day fevers as arising from the overproduction and accumulation of certain bodily humours – which in turn was believed to be caused by *kwade lucht* emanating from dangerous waters such as bogs, marshes, and

---

[170] Coomans, 4–6.

[171] 'Item so wanneer een aentreckinghe wordt der corrumpeerder wazemen van broeken of van vuliken of anderen dingen so coemt inder substantien der wolken van hare incorporerignthe ende een grote sterfte of corrupci onder die menschen ende onder die beesten', Bartholomaeus Anglicus and Jacop Bellaert (trans.), *Van Den Proprieteyten Der Dinghen*, f. 210r.

[172] 'Toen hij daar met de zijnen geruime tijd had doorgebracht zonder voorspoed, presenteerde hij zich en de zijnen aan Burchard, de bisschop van Worms, door wie hij aan de overzijde van de Rijn geplaatst werd op een pas ontgonnen en moerassige plek, die aan alle kanten omgeven was door een groot bos. Toen zij op die moerassige plek bijeengekomen waren, werden zij aangetast door de bedorven lucht van het hen omringende moeras en werden langzamerhand ernstig ziek. De één na de ander ging weg van de meester die tenslotte ook is weggegaan, zodat de stichting zonder leider achterbleef', L. Augustus and J.T.J. Jamar, eds., *Annales Rodenses. Kroniek van Kloosterrade* (Maastricht: Datawyse Boekprodukties, 1995), 142–45.

[173] M.D. van Luijk, 'De Tweede Religieuze Vrouwenbeweging Te Leiden. Het Convent van Sint-Margaretha of Roomburg', *Ons Geestelijk Erf* 74:1-2 (2000): 59.

fens. Furthermore, Middle Dutch texts do connect wetlands to the presence of fevers in general, a category which would have included intermittent fevers. According to the more bodily orientated approach within the late medieval medical world, then, the presence and prevalence of malaria was probably strongly associated the natural surroundings of the late medieval Low Countries, most prominently, wetland environments.

As stated in the introduction and the previous chapter, current historiography and archaeological research on the late medieval Low Countries similarly associated malaria's presence with wetland environments in this region. Indeed, according to modern medicine, wet areas like marshes, fens, and bogs, provide the ideal breeding ground for malaria-carrying mosquitoes. Interestingly, medieval thinkers also noted a correlation between wetlands and the presence of insects like mosquitoes.[174] Their understanding was framed within the dominant scientific, philosophical and religious paradigm of the time, which encompassed the idea that insects and vermin emerged not through sexual reproduction, but through spontaneous generation.[175] According to this theory, concoctions of moist, corrupt, and putrefied matter, gave rise to a variety of pests and unclean creatures, including mosquitoes. Wetlands, with their stagnant, foul-smelling waters rich in decaying organic material, were then imagined as the ideal sites of pestilential generation. These environments thus not only brought forth pestilential air, but were also the breeding grounds for noxious creatures. Despite these associations, a direct link between the prevalence and spread fevers like *terciaen* and *quartein* and the presence of insects does not appear to have been made in the medieval period. Instead, unclean tiny creatures were seen as the indicators and signs of disease, rather than active agents in disease transmission.[176] Nonetheless, the relationship between noxious creatures and the toxic airs, and their shared association with wetlands, further underscores how these environments were seen as breeding grounds for corruption, decay and disease.

Thus, for people in the late medieval Low Countries, the environment was understood to have an important role in determining human health. Indeed, the marshy and wet areas could bring on various diseases, among which intermittent fevers. Yet as will become clear in the next section of this chapter, medical experts like surgeons also saw the natural environment around them as bringing health and healing. Consequently, it is necessary to turn to medical treatments for intermittent fevers in the five medical compendia from the late medieval Low Countries.

---

[174] C. Weeda, 'Pestilential Insects and Public Health in Europe c. 1100-1600: Ideas, Practices, Programs', forthcoming.

[175] The theory of spontaneous generation originates from the works of Aristotle (384-322 BCE) and his *History of Animals* and *On the Generation of Animals*. Through Judaic, Christian, and Islamic influences, it became part medieval European ideas surrounding the origin of tiny creatures and vermin, such as worms, rats, mice, lice, flees, locusts, and other parasites and microorganisms. See: H. Harris, *Things Come to Life: Spontaneous Generation Revisted* (Oxford: Oxford University Press, 2002).

[176] Aberth, *An Environmental History of the Middle Ages*, 207, 209, 224; Weeda, 'Pestilential Insects and Public Health in Europe'; E. Hempelmann and K. Krafts, 'Bad Air, Amulets and Mosquitoes: 2,000 Years of Changing Perspectives on Malaria', *Malaria Journal* 12 (2013): 2.

Seeking a cure: malaria and herbal medicine

The first part of this chapter discussed the various late medieval frameworks that explained the presence of *terciaen* and *quartein* fevers in the Low Countries. Following these various frameworks, people also applied various methods to attempt to cure the intermittent fevers. Within the more spiritual and religious interpretations of malaria, healing focused on spiritual salvation, by enduring punishment, seeking forgiveness, and returning to the true faith, a malaria-infected 'apostate' could reintegrate into the Chrisitan community and thus receive both spiritual and physical healing. At the same time, people also interpreted intermittent fevers as a divine reward bestowed by God on his most devout believers, as shown in non-medical Middle Dutch sources such as the work of Jan van Ruusbroec, the *Vita* of Saint Lidwina of Schiedam and the *Cronica Floridi Horti*. Rather than seeking a cure, saints and other pious individuals welcomed intermittent fevers as signs of their sanctified soul, spiritual status, and closeness to the divine.

Simultaneously, there existed a more bodily-orientated approach to treat and cure *terciaen* and *quartein* fevers. As stated above, medical experts like surgeons drew on the humoral theory – which encompassed the idea that diseases like intermittent fevers were caused by an imbalance between the four bodily fluids: blood, yellow bile, black bile, and phlegm. Consequently, in order to combat third- and fourth-day fevers surgeons focused on restoring the balance between the four humours.[177] This could be achieved through various methods. One commonly used method was bloodletting, which involved draining excess bodily fluids from specific parts of the body, restoring the humoral balance. For treating a third-day fever, for instance, one remedy in the medical compendium Hs. 1272, produced in the region between Ghent and Aalst around the mid fifteenth century, involved bloodletting 'from the hand, next to the little finger, at the moment when the heat of the fever comes and the chills have passed'.[178] A person's lifestyle was also thought to influence the humours and contribute to the development of intermittent fevers. By modifying habits, diet, and sleeping patterns, or promoting certain forms of exercise, the production of certain bodily fluids could be stimulated or reduced, thereby rebalancing the humours. Surgeons especially considered diet an important factor. The *Liber Magistri Avicenne* in Johannes de Altre's medical compendium Hs. 15624-41 advises anyone plagued by *terciaen* fever to eat cold and fresh substances, such as fruits like plums, sour cherries, and pears, and vegetables such as spinach and lettuce.[179] A person suffering from *quartein* fever, on the other hand, was recommended to eat warm and fresh food items, like chicken, young

[177] Demaitre, *Medieval Medicine*, 24–26.
[178] Hs. 1272, 'Die boete wille hebben jeghen alle cortse sonder den vierden dach, doe hem laten vp die hant naest den cleenen vinghere ter maghe adren, inden tijt dat hem die hitte comt ende coude wech es', Braekman, *Middelnederlandse Geneeskundige Recepten* r. 417.
[179] HS. 15624-41, 'Haer spise sal siin cout ende versch. Alse crumen van brode in couden borne. Ende hi sal eten fruut alse prumen. krieken ende peren. […] hi sal eten coude cruden. alse spinacia. portulaca. latuwe cucurbite', Vandewiele, *De 'Liber Magistri Avicenne' En de 'Herbarijs'*, 53–54.

hens, swine meat and strong wine.[180] Furthermore, as discussed above, medical experts considered the environment a crucial factor in determining and influencing bodily health. Based on the belief that certain landscapes produced pestilential air responsible for disease and fevers, medical experts could recommend that patients relocate to areas with different climate, vegetation, temperature, or weather conditions.[181]

In addition to these methods, herbal medicine also played a vital role in restoring humoral balances and thereby combating intermittent fevers. In fact, according to historian J. Stannard, who conducted extensive research into medieval herbal remedies and botany, herbal medicine was one of the most fundamental components of medieval medical practice – employed by medical practitioners ranging from university-trained elites to lay housewives. Given the vast number of plant and herb species recorded in medical sources as well as the wide range of their applications and usages, Stannard argues that 'medieval medical care can justly be described as herbalistic in nature'.[182] This high regard for herbal remedies is also evident in the surgeons' Middle Dutch medical compendia which offer treatments for *terciaen* and *quartein* fevers. Of the more than one hundred recorded remedies found thus far – both in the five selected compendia as well as those not discussed in this thesis – only about ten do not incorporate some form of herbal ingredient.[183] Moreover, one excerpt in Jan Yperman's *Medicina*, collected in Johannes de Altre's Hs. 15624-41, which provides a step-by-step guide for treating fourth-day fever across its various phases, mentions over twenty-five distinct plant and herb species – alongside various concoctions and preparations, which themselves also consist of numerous botanical ingredients.[184] For surgeons, herbal remedies thus occupied an important role in treatments focused on curing *terciaen* and *quartein* fevers.

Herbal medicine, however, was anything but simple. First, a surgeon had to be familiar with a wide range of plant and herb species and know their inherent qualities, medicinal properties, as well as potential side effects. Similar to prevalent medical ideas about the human body, vegetation was understood to possess one or more of the four inherent natural qualities, namely hot, cold, wet, and dry. These qualities were believed to correspond directly to the four bodily humours and could thus be applied to help restore the disrupted humoral balance and treat intermittent fevers.[185] Moreover, medical experts like surgeons regarded not simply the whole plant itself, but also its different parts – the seeds, fruits, petals, leaves, stems, roots, buds, oils, and juices – to possess specific inherent qualities and medicinal properties that had to be carefully selected according to their intended use.[186]

---

[180] HS. 15624-41, 'Haer diete sal siin heet ende versch alse kiekenen ende ionge hinnen met comine […] swinen vleesch sal men eten Ende starken wiin sal men drinken', Vandewiele, 55.
[181] Demaitre, *Medieval Medicine*, 227–28.
[182] Stannard, 'Medieval Herbalism and Post-Medieval Folk Medicine', 47.
[183] See for the Middle Dutch sources found thus far that offer remedies against *terciaen* and *quartein* fevers, appendix 1.
[184] HS. 15624-41, Jan Yperman, *Medicina, Boek van Medicinen*, 40–41.
[185] Huizenga, *Bitterzoete Balsem*, 40; Stannard, 'Medieval Herbalism and Post-Medieval Folk Medicine', 50.
[186] Huizenga, *Bitterzoete Balsem*, 37.

Johannes de Altre's medical compendium Hs. 15624-41 recommends a concoction against third-day fever that includes a mixture of pulverised 'orache seed or goosefoot seed, lettuce seed and purslane seed, or of dill seed and rapeseed'.[187] For fourth-day fever, the advice was to make a syrup from the roots of fennel, parsley, and asparagus, as well as the flowers of borage (also known as starflower), chamomile, and violets.[188] Furthermore, botanical components could be prepared in numerous ways. The recipe against third-day fever in Hs. 15624-41 described above recommends pulverising seeds into powders, but boiling, cooking, infusing, or distilling were also common methods of preparation.[189] Medical experts such as surgeons believed that these processes extracted and enhanced the inherent qualities of the plants and herbs, but they also made the components easier to dissolve in fluids such as wine, beer, vinegar, honey, and milk, and incorporate them into poultices, ointments and salves. Moreover, after a concoction of herbs and plants was successfully prepared, it still had to be administered the correct way, otherwise the remedy might stimulate the wrong bodily humours, and thus be futile or, worse, detrimental to the patient's health.[190]

In the late medieval period, much of this botanical knowledge surrounding herbal medicine was preserved in a specific genre known as *herbarijsen*, or herbals. These texts, usually written in the vernacular, catalogued plant species in alphabetical order, describing their appearance, inherent natural qualities, preferred habitat, and medicinal and poisonous properties. Due to their detailed descriptions and practical medical guidance, herbals were indispensable tools for medical experts like surgeons and were therefore frequently incorporated in medical compendia.[191] For instance, Johannes de Altre's compendium Hs. 15624-41 contains a *Herbarijs*, indicating that for him, a herbal was a fundamental and essential part of his medical practice. Yet these texts still required a certain degree of basic knowledge on the readers' part. In fact, according to Stannard, medieval herbals often did not include a rationale for the application of specific substances or information on their precise workings, as such details were considered 'common knowledge'.[192] Consequently, texts like the *Herbarijs* functioned more as reference materials, intended for trained and educated medical practitioners who already possessed a solid understanding of the foundation of herbal medicine. Thus, even though surgeons like

[187] HS. 15624-41, 'Of met sape van vliedere of van adeke. of puluere milte saet. latue saet & porceleine saet. of dille saet & raepsaet', Jan Yperman, *Medicina, Boek van Medicinen*, 35. *Vliedere* and *adeke* likely refers to *Sambucus nigra*, elderflower tree. The meaning of *milte* is unclear; it may denote a group of plants belonging to the spinach and beet family. *Lutue* belongs to the *Asteraceae* family and is known in English as lettuce. *Porceleine* refers to *Portulaca sativa*, also known as common purslane. *Dille* is dill in English (*Anethum graveolens*), and *raep* is *Brassica rapa*, commonly known as turnip.
[188] HS. 15624-41, 'Nemt die wortele van venkele. van persine. van sparago […] bloemen van boragien. van camomillen. van elken .s o. bloemen van vyoletten', Jan Yperman, 40. *Venkele* is *Foeniculum vulgare*, known in English as fennel. *Persine* refers to *Petroselinum crispum*, or parsley, while *sparago* likely denotes *Asparagus officinalis*, known as asparagus in English. *Boragien* is *Borago officinalis*, which is called borage or starflower in English. *Camomillen* refers to *Matricaria chamomilla* – commonly known as chamomile – and *vyoletten* is a plant of the *Violaceae* family, known in English as the violets.
[189] Huizenga, *Bitterzoete Balsem*, 39.
[190] Stannard, 'Medieval Herbalism and Post-Medieval Folk Medicine', 48.
[191] J. Stannard, 'The Herbal as a Medical Document', *Bulletin of the History of Medicine* 43 (1969): 212.
[192] J. Stannard, 'The Theoretical Bases of Medieval Herbalism', *Medical Heritage* 1 (1985): 1.

Johannes de Altre made extensive use herbals, they still required comprehensive knowledge of a wide variety of plants and herbs in order to practice herbal medicine.

Herbal medicine: something old, something new

To properly employ herbal medicine and treat intermittent fevers, surgeons thus required both a solid understanding of the humoral theory as well as extensive knowledge of a wide variety of plants and herbs and their inherent qualities, medicinal properties, and correct methods of preparation and application. But where did this knowledge surrounding herbal remedies for intermittent fevers in the late medieval Low Countries originate? Herbal medicine – like the wider corpus of medieval knowledge of health, healing, and disease – was rooted in classical antiquity.[193] As discussed in previous chapters, it were influential Graeco-Roman thinkers, building on earlier medical traditions, who developed and formulated the humoral theory. This then formed the basis for the medical and theoretical framework that held that plants and herbs possessed one or more inherent qualities (hot, cold, wet and dry) which corresponded to the four bodily fluids, and which defined herbal practice in the later Middle Ages. However, the influence of ancient works on medieval herbal medicine ran even deeper, as in the Graeco-Roman medical world herbal medicine already played a crucial and vital role. Indeed, classical texts provided detailed descriptions of the medical properties and usages of a vast array of plants and herbs, laying the basis for later medieval herbal medicine.[194] Medical authorities in the ancient period thus firmly believed that the natural world that surrounded them could be harnessed as a source of healing and medicine.

The previous chapter discussed how such classical theories and concepts reached late medieval Europe through two mains channels – one preserved within European knowledge institutions and the other through Arabic contacts – and how they were further disseminated to the Low Countries by individuals who studied at foreign educational institutes where these classical Graeco-Roman bodies of knowledge were preserved, translated and adapted. These individuals then incorporated this knowledge into their own curricula and scholarly writings. Medical experts such as surgeons subsequently placed classical concepts like the humoral theory and herbal medicine – and thus the idea that the natural surroundings could bring health and healing – at the foundation of their medical knowledge and practices.

However, the late medieval surgeon did not rely solely and blindly on the classical texts for their medical practice. Indeed, historian McVaugh's study of academic physicians, *doctor medicinae,* at the University of Montpellier demonstrates that ancient bodies of knowledge were not uncritically adopted. Rather, medical experts rigorously tested and observed the effects of medicine and remained

[193] A. van Arsdall, *Medieval Herbal Remedies: The Old English Herbarium and Anglo-Saxon Medicine* (New York: Routledge, 2002), 68.
[194] Arsdall, 68–69; J. Stannard, *Herbs and Herbalism in the Middle Ages and Renaissance*, ed. K.E. Stannard and R. Kay (Ashgate: Ashgate Publising Limited, 1999), x.

cautious about accepting ancient theories without empirical verification – a practice McVaugh terms 'experience-based medicine'. Importantly, this 'experience-based medicine' also allowed room for the development of new remedies which were not found in ancient authorities but developed on a regional scale, and which were subsequently merged into the broader body of knowledge of health and healing.[195] According to historians Leong and Rankin, such experience-based practices extended beyond the academically trained *doctor medicinae* to a wide array of professional and semi-professional groups involved in medical care, including surgeons, monks, farmers, artisans, and housewives.[196] In the late medieval Low Countries a similar process of 'knowledge-creation' took place, which borrowed from classical theories as well as from regionally developed and practically acquired experiences. This merged body of knowledge was subsequently transmitted through both oral tradition and as well as written texts, like the surgeons' medical compendia. In what follows, a close examination of the botanical ingredients used in recipes for intermittent fevers in Middle Dutch medical compendia, will demonstrate how surgeons incorporated regionally developed and experienced-based knowledge and ancient classical theories on into their herbal medical practices.

A frequently used herbal ingredient in Middle Dutch medical compendium to treat intermittent fevers was the plant genus *Plantago*, better known today as plantain. A recipe in manuscript Hs. 697 (dating to the fifteenth century and produced in the southern Low Countries) recommends collecting three plants of *plantayen* – a corruption of the Latin *Plantago* – and 'drink when one shivers' to cure third-day fever.[197] The medicinal use of *Plantago* for various ailments including intermittent fevers was already well established in the ancient period. The Greek medical authority Dioscorides advised the use of *Plantago* for third- and fourth-day fevers in his *De materia medica*, stating 'three roots (taken as a drink with three cupful's of wine and as much water) help a fever with recurrent paroxysms, and that four roots (help) a quartain fever'.[198] Dioscorides also noted that the name *Plantago* was of Latin origin, whereas in Greek the plant was called *arnoglosson*. In the Middle Dutch *Herbarijs* in Johannes de Altre's medical compendium Hs. 15624-41, the influence of authoritative Graeco-Roman texts like these is clearly visible, as the plant is recorded under both its Latin and Greek name (the latter written as *arnaglossa*) and is likewise marked as effective against intermittent fevers. Besides these classical terms, however, the *Herbarijs* also emphasises that the plant was more commonly known by a different name: *wegebrede*.[199] Other medical compendia similarly give

[195] McVaugh, 'The "Experience-Based Medicine" of the Thirteenth Century'.
[196] Stannard, 'Medieval Herbalism and Post-Medieval Folk Medicine', 47; Leong and Rankin, 'Testing Drugs and Trying Cures'.
[197] Hs. 6838, 'Jeghen den derden dach curts, nem .iii. planten van plantayen, achter de scijnte van der zonne, ende sech .i. pater noster ende drinct alse ghi bevet', Vreese, *Middelnederlandsche Geneeskundige Recepten En Tractaten, Zegeningen En Tooverformules* r. 450, p. 121.
[198] Dioscorides, *De Materia Medica*, trans. T.A. Osbaldeston (Johannesburg: Ibidis Press, 2000), 279.
[199] 15624-41, 'Arnaglossa. of plantago dat es wegebrede', Vandewiele, *De 'Liber Magistri Avicenne' En de 'Herbarijs'*, 182.

variations of this name such as *weegbree, weghebreeden*, and *wegerick*, among others.[200] Unlike *Plantago* or *arnaglossa*, this word is of Germanic rather than classical origin, being a compound of *wege* (meaning 'road' or 'path') and *brede* meaning ('broad' or 'wide') – which likely refers to the plant's broad leaves.[201]

Fig. 2. Two species of *Plantago*, or *wegebrede* in a Middle Dutch herbarium. Rembert Dodoens, *Crŭÿde boeck* (Antwerp: Jan vander Loe, 1563), p. 83.

Another botanical ingredient often used in late medieval Middle Dutch medical compendia is *Artemisia absinthium*, more commonly known as wormwood. Similar to *Plantago*, this plant was already well established as a medicinal herb in Antiquity. In *De materia medica* Dioscorides notes its use against a wide variety of ailments, such as stomach and urinary aches, slow digestion, and kidney disorders, whilst Hippocrates in his *Nature of Women* praises the use of *Artemisia absinthium* for

[200] 15624-41, Jan Yperman, *Medicina, Boek van Medicinen*, 36; Hs. 697, Vreese, *Middelnederlandsche Geneeskundige Recepten En Tractaten, Zegeningen En Tooverformules* r. 83, p. 29; r. 557, p. 138.
[201] P.A.F. van Veen and N. van der Sijs, *Etymologisch Woordenboek: De Herkomst van Onze Woorden*, 2nd ed. (Utrecht: Van Dale Lexicografie, 1997) s.v. 'weegbree'.

female health.[202] Its application against third- and fourth-day fevers, however, was less common and may even have been subject to debate: Dioscorides, in his long list on medicinal herbs, does not mention it at all as a possible remedy for intermittent fevers, whilst Pliny the Elder, in his chapter on medicinal plants in *The Natural History*, warns that it 'must never be administered in fevers'.[203] In the Middle Dutch sources, *Artemisia absinthium* is also recognised as a medicinal ingredient, and is – much like in classical medicine – praised for its effectiveness in treating ailments of the stomach and intestines, as well as issues related to female health.[204] However, while in Antiquity *Artemisia absinthium* does not appear to have been used as a remedy for intermittent fevers, in the late medieval Low Countries this plant does feature in medical recipes against *terciaen* and *quartein* fevers. Medical compendia HS. 1272, for instance, advises that for treating fourth-day fever, one should take the 'juice of *arthimesien*', heat it, mix it with oil, and apply it to the patient's body.[205] According to the *Herbarijs* in Johannes de Altre's Hs. 15624-41 the plant was also known as *alsene*, variously written as *aslen*, *alsene*, or *alsine*.[206] Indeed, a recipe in medical compendia HS. 679 (dating to the fifteenth century and produced in the southern Low Countries) uses the term *alsen* to refer to *Artemisia absinthium* which, when mixed with wine, was helpful against *terciaen* and *quartein* fevers.[207] *Alsene* might be a corruption of the Ancient Greek

Fig. 3. *Artemisia absinthium*, also know as *alsene* in a Middle Dutch herbarium. Rembert Dodoens, *Crŭÿde boeck*, p.3

[202] Dioscorides, *De Materia Medica*, 768–69; Hippocrates, *Hippocrates, Volume X: Generation. Nature of the Child. Diseases 4. Nature of Women. Barrenness*, trans. P. Potter (Cambridge: Loeb Classical Library, 2012), 316–17, 234–35, 304–5, 314–15.
[203] Pliny the Elder, *The Natural History*, trans. J. Bostock, H.T. Riley, and B.A. Ed (London: Taylor and Francis, 1855), 27.28.
[204] Hs. 15624-41, Vandewiele, *De 'Liber Magistri Avicenne' En de 'Herbarijs'*, 185–86.
[205] Hs. 1272, 'Nemt sap van arthimesien ende maket laeu ende minghet met olien ende salueter mede uwen lichame, ghi sult ghenesen', Braekman, *Middelnederlandse Geneeskundige Recepten* r. 287, p. 168.
[206] Hs. 15624-41, 'Abcincium. Dats alsene', Vandewiele, *De 'Liber Magistri Avicenne' En de 'Herbarijs'*, 185. *Abcincium* (also written here as *absincium*) refers to the specific species of the genus *Artemisia*, namely *Artemisia absinthium*.
[207] Hs. 697, 'Item aldus maect men wijn van alsen: stampt alsen ende duwet ute met wine; ende dat maect claer of neemt een zuver vat, ende doet den wijn daerin staen: dats wijn van alsen, ende heeft alle die selve macht, ende verdrijft den reede tercia ende quarte', Vreese, *Middelnederlandsche Geneeskundige Recepten En Tractaten, Zegeningen En Tooverformules*, 44.

aloxinum, referring to a bitter substance, as the plant was known for its bitter taste.[208] Yet, in the late medieval Low Countries, this plant species was also referred to by a different name, namely *wermoede* – also written as *wermoet*, *wermode*, and *wermoede*.[209] Like *wegebrede*, *wermoede* is of Germanic origin, and numerous variations of the word abounded in Old English, Old Saxon and Old German languages.[210]

Whilst the medicinal use of the plants *Plantago* and *Artemisia absinthium* had a long precedent, dating back to the Graeco-Roman period, this is not the case for the plant *Centaurea jacea*, known as knapweed.[211] Although some species of the genus *Centaurea* were known in Antiquity – Dioscorides mentions a few in his *De materia medica* – the sources researched thus far do not show any evidence that the specific plant *Centaurea jacea* was known or recognised in Graeco-Roman medicinal texts.[212] Indeed, the term '*jacea*', denoting a particular species within this genus, does not appear to have originated in classical antiquity but seems to have emerged in a later period.[213] Conversely, in the Middle Dutch medical sources, this plant species features a number of times and appears to have been a fundamental part of the corpus of herbal ingredients believed to cure a variety of ailments. The *Herbarijs* in Hs. 15624-41 describes *Centaurea jacea* – also named *matefelloene* – as effective against wounds both outside and inside the body, and for treating complications in infants.[214] Besides explaining the

Fig. 4. Centaurea jacea, also know as *Jacea nigra* or *materfilon* in a Middle Dutch herbarium. Rembert Dodoens, *Crŭÿde boeck*, p. 99.

[208] M. Philippa et al., *Etymologisch Woordenboek van Het Nederlands* (Amsterdam: Amsterdam University Press, 2003) s.v. 'alsem'.
[209] The plant might also have been known as *byvoet* or *bivoet*, but it is unclear whether this term specifically refers to *Artemisia absinthium* or – as is more likely – to *Artemisia vulgaris*. The two plants are closely related species. The *Liber Magistri Avicenne* mentions *byvoet* as a herbal remedy against third-day fever. Vandewiele, *De 'Liber Magistri Avicenne' En de 'Herbarijs'*, 55.
[210] The current English name for this plant, 'wormwood', is an alteration of Old English *wermod* of the same etymological family as *wermoet*, *wermode*, and *wermoede*.
[211] In referencing this plant, Middle Dutch sources use a variety of names, including the hybrid form '[Centaurea] *jacea nigra*'. It remains unclear whether this name refers to *Centaurea jacea* (brown knapweed) or *Centaurea nigra* (black knapweed), as the word combines the two (see: Vandewiele, *De 'Liber Magistri Avicenne' En de 'Herbarijs'*, p. 333). *C. jacea* and *C. nigra* are two closely related species of knapweed that grow in similar habitats and are capable of hybridising. Indeed, some debate exists as to whether *C. nigra* should be considered a subspecies of *C. jacea* or a distinct species. For the sake of simplicity, I refer to the plant as *Centaurea jacea*.
[212] Dioscorides mentions *Centaurea radix*, *C. benedicta*, *C. cyanus*, *C. crocodylium*, and *C. verutum*, Dioscorides, *De Materia Medica*.
[213] It is unclear when the word was first introduced. So far, it appears to have developed during the High or Late Middle Ages, as the earliest known sources found thus far mentioning the name date from this period.
[214] Hs.15624-41, 'Ende beide heilen si wonden buten ende binnen Ende siin goet in wonden dranke. Ende siingoet gedronken jegen quetsure binnen ende heylense. Ende siin goet gedronken dien die gescoort siin. Ende kinderen in den navel', Vandewiele, *De 'Liber Magistri Avicenne' En de 'Herbarijs'*, 333–34.

medicinal uses of the plant, the *Herbarijs* also provides more extensive botanical information on *Centaurea jacea*, noting two distinct variations of the species as well as their vernacular names and their appearance. According to the *Herbarijs*, the plant occurs in two forms: a black *matefelloene* and a white *matefelloene*, 'with the white version also called *tremorseke* or *duivelsbete*'.[215] Noteworthy is, that the names *tremorseke* (or *cremorse*) and *duivelsbete* (or *duvelsbete)*, also appear in Middle Dutch recipes against intermittent fevers. Indeed, according to medical compendia Hs. 679, a concoction of '*cremorse* or *duvelsbete*' relieves a number of ailments, among which *quartein* fever – but only if drank for four days straight.[216] Similar to the names *weegbrede* and *wermoede*, the various vernacular names for *Centaurea jacea* (*matefelloene*, *tremorseke*, *duivelsbete*) are from the Germanic language family.

What does the late medieval application and descriptions of these three botanical ingredients – *Plantago*, *Artemisia absinthium*, and *Centaurea jacea* – in remedies against *terciaen* and *quartein* fevers reveal about the bodies of knowledge that influenced surgeons in the late medieval Low Countries? First, the use of vernacular botanical names illustrates the incorporation of regional linguistic traditions and botanical knowledge in late medieval medical practice. Names such as *wegebrede*, *wermoede*, and *matellfoene*, which derive from the Germanic language family and have no etymological connection to Latin or Greek, originated from regionally developed and orally transmitted vocabularies for vegetation. This is further evidenced by the large number of variations in plant and herb names which are found across Middle Dutch medical compendia. *Plantago* was known by various vernacular names such as *wegebrede*, *weegbree, weghebreeden*, or *wegerick*. In some cases, a single plant had a number of entirely distinct vernacular names, as with white *matellfoene*, which was also known as *tremorseke* and *duivelsbete* in the sources. Far from being mere spelling mistakes or scribal errors, these variants reflect the development of regional botanic knowledge which was subsequently incorporated into herbal medicine and Middle Dutch medical compendia.

Secondly, the development of additional medicinal applications of plants and herbs – already known for their healing properties in the classical medical tradition – as remedies against *terciaen* and *quartein* fevers demonstrates how regional botanical knowledge was actively integrated into the medical practice of surgeons. *Artemisia absinthium*'s healing properties were already well-established in Antiquity, appearing in the works of Dioscorides and Hippocrates as a remedy for gastrointestinal and gynaecological ailments. In the late medieval Low Countries, the classical medicinal use of *Artemisia absinthium* – more commonly known as *alsene* or *wermoede* – was continued. However,

[215] Hs. 15624-41, 'IAcea nigra es van .2. manieren. wit ende swert. Entie witte scelden sulke tremorseke. of duvels bete. Entie swarte scelt men matefelloene. Ende beide heilen si wonden buten ende binnen Ende siin goet in wonden dranke. Ende siin goet gedronken jegen quetsure binnen ende heylense. Ende siin goet gedronken dien die gescoort siin. Ende kinderen in den navel. Die matefellone dats jacea nigra Ende duvels bete dats witte matefelloene', Vandewiele, 333–34.
[216] Hs. 697, 'cremorse, of groet duvelsbete [cures] quaerteinne, diet vier daghe dronke', Vreese, *Middelnederlandsche Geneeskundige Recepten En Tractaten, Zegeningen En Tooverformules* r. 416, p. 112.

whereas Graeco-Roman authors generally did not include *Artemisia absinthium* among remedies for intermittent fevers (Pliny even advised against its use for fevers in general), Middle Dutch medical sources did regard the plant as effective against *terciaen* and *quartein* fevers. Notably, modern research, particularly the work by pharmaceutical chemist Tu Youyou, has demonstrated that some *Artemisia* species do in fact possess antimalarial properties, which raises the possibility that the late medieval use of *Artemisia absinthium* as a remedy for malaria might have had some therapeutic effect.[217] This is not to suggest that late medieval herbal remedies were consistently affective; rather, it demonstrates how certain uses of medicinal plants may have emerged through experience-based medical practices developed at a regional scale. In any case, whether *Artemisia absinthium* was affective or not, the adoption of *alsene* or *wermoede* for malaria treatments in medical compendia reflects the ways in which surgeons drew upon regionally cultivated knowledge of the environment and its medicinal resources.

Lastly, the incorporation of new medicinal botanical ingredients for treating intermittent fevers – which were most likely unknown in the Ancient period – in Middle Dutch medical compendia similarly shows how regional knowledge was integrated into the medical practice of surgeons. The medicinal use of two variations of the plant *Centaurea jacea* – also known as black *matefelloene* and white *matefelloene* – is thus far not attested in classical herbal remedies. Indeed, aside from some general references to the genus *Centaurea*, the specific species *Centaurea jacea* appears to be absent from Graeco-Roman sources. Instead, its recognition as a medicinal plant, as well as its incorporation into the corpus of botanical ingredients useful against intermittent fevers, appears to have emerged independently in the medieval Low Countries. It is noteworthy that research conducted in 2005 by phytochemists Kamel Medjroubi, Fadila Benayache, and Jaime Bermejo into the pharmacological properties of the genus *Centaurea* has demonstrated that certain species can significantly reduce the presence of the malaria parasite *Plasmodium falciparum* in the body.[218] It remains unclear whether the specific species *Centaurea jacea* possesses such properties. Nevertheless, the application of *matefelloene* in treatments for intermittent fevers again demonstrates how surgeons drew upon regionally cultivated knowledge of the environment and its medicinal resources.

These three examples thus illustrate how late medieval medical experts such as surgeons drew not only on authoritative works from Antiquity but also on regionally, experience-based knowledge when treating intermittent fevers. What does this reveal about late medieval ideas about the healing properties of the natural environment in the Low Countries? The classical medical corpus taught that the natural environment – the plants and herbs – could yield remedies for disease. This idea was subsequently incorporated into late medieval medical thinking. Yet, the Middle Dutch medical

[217] Y. Rao, D. Zhang, and R. Li, *Tu Youyou and the Discovery of Artemisinin: 2015 Nobel Laureate in Physiology or Medicine* (Singapore: World Scientific Publishing, 2017).
[218] K. Medjroubi, F. Benayache, and J. Bermejo, 'Sesquiterpene Lactones from Centaurea Musimomum. Antiplasmodial and Cytotoxic Activities', *Fitoterapia* 76:7-8 (2005): 744–46.

compendia show that medical practitioners like surgeons did not simply replicate ancient knowledge. Rather, they integrated into their medical practice experience-based, regionally developed insights about the medicinal possibilities of the natural environment. Furthermore, as discussed above, herbal medicine was no easy matter and above all required substantial botanical knowledge on the part of medical practitioners. Indeed, late medieval works on herbal remedies, like the *Herbarijs* in Johannes de Altre's medical compendium Hs. 15624-41, functioned primarily as reference materials and presupposed a comprehensive understanding of the medical properties of a wide variety of herbs and plants on the part of their readers. Medical practitioners like surgeons therefore were required to possess extensive knowledge of the medicinal properties of vegetation and, subsequently, understood that the natural world around them could provide health and healing. Moreover, the Middle Dutch medical compendia which contained knowledge of the healing properties of the environment were not solely prescriptive. As theorised in the first chapter, these compendia were most likely produced by surgeons with direct patient contact, and who incorporated insights gained through everyday medical practice into these works. The remedies the medical compendia record thus also have a descriptive component: they reveal how surgeons actively engaged with their natural surroundings in efforts to treat and combat *terciaen* and *quartein* fevers. As such, for late medieval medical practitioners such as surgeons, the natural surroundings were a vital source for healing intermittent fevers.

Concluding remarks: medicine and malaria

This second chapter aimed to provide insights into how people perceived the complex relationship between human health and the natural environment. To this end, the first part examined how people in the late medieval Low Countries explained the presence and spread of malaria. The more bodily-orientated approach held that intermittent fevers were caused by an imbalance between bodily humours. The most important factor in such imbalances was *kwade lucht* – toxic, harmful air believed to emanate from corrupted, dangerous bodies of water. Middle Dutch sources explicitly link the prevalence of fevers to wetlands such as marshes, fens, and bogs, demonstrating an association between these environments and malaria in the late medieval Low Countries. At the same time, medical experts such as surgeons believed that the natural environment could also bring health and healing in the context of intermittent fevers. This belief was partly based on classical theories that held that plants and herbs possessed medicinal properties useful for treating *terciaen* and *quartein* fevers. Yet, these ideas were also shaped by 'experience-based medicine' developed on a regional scale within the Low Countries. This was evidenced by the incorporation of vernacular names (along with their numerous variations) as well as new interpretation of already well-established medicinal plants and the application of new botanical ingredients in Middle Dutch medical compendia. Importantly, these medical compendia were not merely prescriptive texts; rather they incorporated the practically

acquired knowledge of surgeons and thus demonstrate how these medical practitioners actively engaged with the natural surroundings in their efforts to cure intermittent fevers.

In the late medieval Low Countries, medical experts like surgeons thus had a complex understanding of the relationship between human health and the natural environment. On the one hand, they understood the environment to bring forth diseases like intermittent fevers. On the other, the environment could simultaneously bring health and healing in relation to *terciaen* and *quartein* fevers. Yet, as will become clear in the next chapter, the natural environment of the late medieval Low Countries was also interpreted through economic, political, and cultural lenses – perspectives that had consequences for how the landscape was managed, used, and exploited.

3. Marshes and malaria

Human-driven landscape transformations and its impact on human health in the late medieval Low Countries

The previous chapters examined contemporary knowledge of malaria in the late medieval Low Countries and used the disease as a lens to explore how people understood the relationship between human health and the environment. This chapter looks at the how the large-scale reclamation efforts in the late Medieval Low Countries might have contributed to the prevalence of malaria as well as limit people's ability to treat and manage it. First, by mapping the production locations of the five medical compendia – as well as other non-medical sources – and comparing them to the ecological transformations in this period and region, I suggest a correlation may have existed between areas undergoing drainage and embankment and the presence and spread of malaria. Next, it is hypothesised that these reclamation efforts limited the ability of surgeons to treat and manage the disease. A study of the plants and herbs used in remedies for intermittent fevers, alongside their preferred habitats, indicates that many of these medicinal resources may not have survived the ecological shifts brought about by reclamation. To understand this interplay between human society, health, and environment, however, it is first necessary considered what motivated wetland reclamation. This chapter therefore begins by exploring how religious, economic, cultural, and political perceptions of wetlands in the late medieval Low Countries influenced human agency to drain and embank these areas.

Wetlands: danger and opportunity

Wetlands were imagined by medical experts such as surgeons as dangerous for human health. The stagnant and corrupted bodies of water in these places emanated toxic and unhealthy air, that could infect those who ventured near with diseases and fevers. These health concerns were part of a broader late medieval framework that combined spiritual, religious, economic, and political ideas about wetlands in this region. Within this context, wet and marshy environments were understood to be 'liminal' spaces. Bogs, marshes, and fens, often vast, desolate, and baren, were neither fully water nor fully land, but an ambiguous merging of the two.[219] According to environmental geographers Maurice Paulissen, Roy van Beek, and Edward Huijbens in their 'How Bogs Made for Borderlands' – a study on the wetlands of the premodern eastern Low Countries – this paradoxical nature imbued wetlands with complex and contradictory meanings. For instance, on the one hand these environments were

[219] J. Lund, 'Thresholds and Passages: The Meanings of Bridges and Crossings in the Viking Age and Early Middle Ages', *Viking and Medieval Scandinavia* 1 (2005): 119; A. O'Sullivan, 'Europe's Wetlands from the Migration Period to the Middle Ages: Settlement, Exploitation, and Transformation, Ad 400–1500', in *The Oxford Handbook of Wetland Archaeology*, ed. F. Menotti and A. O'Sullivan (Oxford: Oxford University Press, 2012), 27.

perceived as natural and physical barriers – difficult and dangerous to cross and circumvent due to their treacherous terrain and frequent flooding. On the other, they simultaneously functioned as important economic and political passageways, as evidenced by archaeological finds such as landmarks, bridges and walkways – which showcases their importance for the movement of people, animals, and goods.[220] The complex and contradictory meaning also comes to the fore in spiritual and religious ideas on wetlands. Medieval religious authors interpreted marshes, bogs and fens as sites inhabited by evil forces and demonic powers, posing a threat to the spiritual well-being of all individuals who entered them.[221] At the same time, however, these mysterious and remote spaces were seen as places of divine encounter, where saints and martyrs might dwell and perform acts of healing, whilst in folktales, hagiographies, and chronicles, wetlands often served as dramatic settings for visions, conversions, and miraculous events.[222]

The ambiguous status of marshes, bogs, and fens is reflected in how people interacted with wetlands. Though these environments were considered hazardous to an individual's health – both the physical and spiritual – they were also an integral part of daily life.[223] Wetlands offered rich socioeconomic opportunities.[224] Peat exploitation, for instance, was vital to the economy of the medieval Low Countries, a region dominated by vast peat deposits.[225] Although peat was already used during the early medieval period, exploitation intensified from the eleventh century onwards, largely driven by a growing population that marked the beginning of the high Middle Ages. Demographic growth increased demand for peat, which was not only used for heating and cooking, but also powered important industries such as brickmaking and brewing.[226] Both regional and local authorities, as well as peasants and workers, depended economically on the exploitation of peatlands.[227] Wetlands also served as important food sources. Here, people hunted birds, trapped fish, and collected edible plants. Wetlands provided seasonal grazing grounds for livestock – animals that not only produced meat, but also milk, leather and wool.[228] In addition, wetlands provided local peasants with raw materials, such

[220] M. Paulissen, R. van Beek, and E.H. Huijbens, 'How Bogs Made for Borderlands: The Eastern Low Countries, c. 670 – c. 1900 Ce', *Environment and History* 30:2 (2024): 213, 221–26.
[221] O'Sullivan, 'Europe's Wetlands', 27; S. Pihura, 'Conceptions, Uses, and Transformations of Wetland Environments in England c.1000-1400' (For the degree of Doctor of Philosophy, Montreal, McGill University, 2022), 31–33.
[222] O'Sullivan, 'Europe's Wetlands', 27–28; S. Rippon, 'Human Impact on the Coastal Wetlands of Britain in the Medieval Period', in *Landscapes or Seascapes? The History of the Coastal Environment in the North Sea Area Reconsidered*, ed. E. Thoen et al. (Turnhout: Brepols, 2013), 341–44.
[223] Paulissen, Beek, and Huijbens, 'How Bogs Made for Borderlands', 214; O'Sullivan, 'Europe's Wetlands', 28, 43.
[224] Sallares, *Malaria and Rome: A History of Malaria in Ancient Italy*, 180.
[225] Paulissen et al., 'Place Meanings of Dutch Raised Bog Landscapes', 1071; M. Paulissen et al., 'Dire Necessity or Mere Opportunity? Recurrent Peat Commercialisation from Raised Bog Commons in the Early Modern Low Countries', *International Journal of the Commons* 15:1 (2021): 100–118.
[226] Paulissen, Beek, and Huijbens, 'How Bogs Made for Borderlands', 230.
[227] Paulissen et al., 'Place Meanings of Dutch Raised Bog Landscapes', 1078.
[228] B. van Bavel, *Manors And Markets: Economy and Society in the Low Countries 500-1600* (Oxford: Oxford University Press, 2010), 132.

as wood for construction and reed for thatch, roofs, and baskets.[229] Near the coast, wetlands with their high salinity were exploited for salt production, which expanded and increased from the eleventh and twelfth centuries onwards – again due to demographic growth.[230] Peat extraction, salt production, and other forms of wetland exploitation required people to live in or near the bogs, marshes, and fens. For instance, peat workers and their families often settled in special communities close to extraction sites, and in some areas, so-called 'peat colonies' emerged directly within the wetlands themselves.[231] Thus, while wetlands were understood to be dangerous places that posed a threat to both the physical and spiritual health of those who neared them, they were nevertheless an integral part of daily life and served crucial socioeconomic functions for both local communities and more regionally oriented authorities.

From the eleventh century onwards, wetlands in the Low Countries were not only exploited, but also increasingly reclaimed. Although small reclamation efforts had already been part of early medieval landscape use, it was not until the High Middle Ages that such projects intensified both in scale and extent.[232] Unlike exploitation, reclamation involved more intensive and permanent transformations of bogs, marshes, and fens through the construction of embankments and drainage systems.[233] In the area spanning the present-day Netherlands, the most intensive drainage projects took place in the western parts of the country, the coastal areas in Zeeland, Groningen, and Friesland, as well as more inland in present-day Brabant.[234] For what is now Belgium, reclamation projects mostly focussed on the province of Flanders.[235] These large-scale reclamation projects drastically altered the landscape and ecology, impacting both the flora and the fauna of the Low Countries.[236] This new development was, again, largely driven by population growth. As the population in the Low Countries expanded, so did the demand for new land – not only to accommodate new settlements and communities but also to support the accompanying growth in agriculture, livestock grazing, and peat and salt extraction.[237]

The primary drivers behind wetland reclamation were secular and ecclesiastical authorities.[238] For religious authorities, the newly reclaimed lands could house peasant populations and support

[229] A. O'Sullivan and R. van de Noort, 'Places, Perceptions, Boundaries and Tasks: Rethinking Landscapes in Wetland Archaeology', in *Archaeology Form the Wetlands: Recent Perspectives. Proceedings of the 11th Annual WARP Conference*, 2007, 82.
[230] Soens, 'Floods and Money', 345; Bavel, *Manors And Markets*, 149–50; O'Sullivan, 'Europe's Wetlands', 40.
[231] Paulissen, Beek, and Huijbens, 'How Bogs Made for Borderlands', 213, 228; R. van Beek, G.J. Maas, and E. van den Berg, 'Home Turf: An Interdisciplinary Exploration of the Long Term Development, Use and Reclamation of Raised Bogs in the Netherlands', *Landscape History* 36:2 (2015): 11.
[232] T. Soens, E. Thoen, and P. Brassley, *Struggling with the Environment: Land Use and Productivity* (Turnhout: Brepols, 2015), 6–13.
[233] O'Sullivan, 'Europe's Wetlands', 33.
[234] Soens, Thoen, and Brassley, *Struggling with the Environment*, 16. See also figure 5 and 6 below.
[235] Soens, 'Floods and Money'.
[236] O'Sullivan, 'Europe's Wetlands', 33.
[237] O'Sullivan, 46; Soens, Thoen, and Brassley, *Struggling with the Environment*, 6; Paulissen, Beek, and Huijbens, 'How Bogs Made for Borderlands', 230.
[238] Beek, Maas, and Berg, 'Home Turf', 11.

agricultural production, increasing the power, wealth, and influences of the new ecclesiastical landlords.[239] Secular authorities were similarly driven by power, prestige, and economic gain in their efforts to drain and reclaim wetlands. In the early medieval period, wetlands and other forms of 'wilderness' were typically considered part of the royal domain or the next highest authority. However, by the mid-ninth century, local authorities increasingly usurped dominance of bogs, marshes, and fens.[240] Through drainage, they transformed these landscapes into arable lands, integrating them into their estates and expanding their control. The reclaimed lands could be rented out to loyal subjects, labourers, and farmers – further enriching the treasury.[241]

In addition to these elite actors, local peasant communities and labourers were also actively involved in the cultivation and transformation of wetlands. For them, reclamation meant increased property rights, new opportunities for exploitation, and economic stimulation at the local level.[242] Moreover, for both the local communities and religious and secular authorities, embanking and drainage projects provided greater control over the regional water management, helping to regulate water discharge and reduce the risk of flooding.[243] Thus, although wetlands had already been exploited in earlier centuries, it was not until the eleventh and twelfth centuries that large-scale reclamation projects intensified interaction with the landscape of the Low Countries. The question that follows is what were the ecological consequences of these large-scale drainage efforts?

Wetland reclamation

Many historians have already examined the ecological consequences of drainage in the premodern Low Countries. Scholars have showed how large-scale reclamation efforts drastically transformed the landscape and the environment, posing challenges for the communities living there.[244] As land was increasingly embanked and drained, the soil – which had until then remained waterlogged – was exposed to the air. This exposure caused the soil to dry out, oxidise, and compact, leading to a gradual sinking of the land, a process known as soil subsidence. As a result, reclaimed lands were constantly threatened by encroaching water. Peat exploitation – which required wetlands to be embanked and drained before peat could be cut away, leaving the remaining land even lower – exacerbated these problems. Similar to embanking and draining, centuries of peat digging led to widespread soil subsidence and water encroaching, posing serious water management problems for local and more regional orientated water boards – institutions tasked with supervising and inspecting water levels and

[239] N. Brooks, 'Romney Marsh in the Early Middle Ages', in *The Evolution of Marshland Landscapes*, ed. R.T. Rowley (Oxford: University of Oxford Department for External Studies, 1981), 53–55; Pihura, 'Conceptions, Uses, and Transformations of Wetland Environments', 53–58; O'Sullivan, 'Europe's Wetlands', 28.
[240] O'Sullivan, 'Europe's Wetlands', 33.
[241] W.H. TeBrake, 'Land Drainage and Public Environmental Policy in Medieval Holland', 83.
[242] Soens, Thoen, and Brassley, *Struggling with the Environment*, 7; W.H. TeBrake, 'Land Drainage and Public Environmental Policy in Medieval Holland', 81–82.
[243] Beek, Maas, and Berg, 'Home Turf', 21.
[244] W.H. TeBrake, 'Land Drainage and Public Environmental Policy in Medieval Holland', 84.

the maintenance of dykes, drains, and ditches.[245] To avoid water re-entering the newly colonised lands – much of which had been converted into farmland or settlements – more intensive drainage projects were implemented, simultaneously stimulating the development of windmills and pumps.[246] Soil subsidence, however, remained a vicious cycle – the more drainage was needed to prevent flooding, the more the soil dried, compacted, and sank – unless the underlying causes of the gradual sinking were addressed. As such, wetland reclamation, though initially yielding impressive and extremely profitable results, increasingly began to strain the available capital, resources, and labour of both the local communities and regional authorities.[247]

What has received less attention in historical scholarship on the consequences of large scale embankment and drainage projects are its public health effects. While historians of urban water management have frequently addressed the health implications of city authorities' attempts to control water flow and maintain water quality, this topic is often not incorporated into studies of wetland reclamation – focusing often more on the environmental, social, economic, and political dimensions.[248] Only occasionally is an indirect connection established between drainage and public health. For instance, it is generally acknowledged that as drainage projects impacted the environment and landscape, this indirectly also affected living conditions, and thus public health. Soil subsidence, for example, made agriculture increasingly difficult. From the thirteenth century onwards, as water management systems struggled to keep pace, fields became more prone to waterlogging and flooding, making it increasingly harder for both communities and crops to thrive and survive.[249] Furthermore, especially in coastal areas, exploitation of embanked lands led to erosion, which in turn destabilised the local ecosystem. Sand from nearby dunes, no longer held down by vegetation and natural barriers, was prone to drift, covering farmlands and even complete settlements – reducing the viability of these regions for both agriculture and habitation.[250] Thus drainage projects could in the long run, as they threatened food security, contributed to malnutrition, and diminished living conditions, indirectly affect public health. Drainage projects may have had another indirect health effect. Wetlands are among the most important ecosystems for storing Co_2. According to recent research on present-day Dutch wetlands, the drainage and drying out of marshes, bogs, and fens leads to the release of these stored greenhouse gases, contributing approximately 3 to 5 per cent of the current Netherlands' total

[245] W.H. TeBrake, 84; Soens, 'Floods and Money', 342–43; Soens, Thoen, and Brassley, *Struggling with the Environment*, 11.
[246] W.H. TeBrake, 'Land Drainage and Public Environmental Policy in Medieval Holland', 86–87; Soens, 'Floods and Money', 343.
[247] Soens, 'Floods and Money', 341.
[248] See for research into urban water and health management: Coomans, *Community, Urban Health and Environment*; J. Coomans, 'The King of Dirt: Public Health and Sanitation in Late Medieval Ghent', *Urban History* 46:1 (2019): 82–105.
[249] Soens, 'Floods and Money', 339.
[250] Soens, 343.

CO_2 emissions.[251] While it is difficult to determine the precise impact of late medieval drainage and embankment efforts on historical greenhouse emissions, it is highly likely that the large-scale reclamation projects significantly contributed to increased CO_2 emission – the consequences of which are still unfolding today.

Importantly, however, late medieval land reclamation also had more direct implications for public health in the Low Countries. At first glance, one might assume that wetland drainage improved health conditions for those living in or near these areas – particularly in light of studies done on urban health programmes in the late medieval Low Countries. As Coomans has shown in her work on public health in urban settings, drainage was often part of broader efforts to manage waste, control disease, and improve the urban environment.[252] In light of this, one might assume that drainage and wetland reclamation similarly ameliorated the health of surrounding communities. However, in the case of the late medieval Low Countries, the relationship between drainage of wetlands and public health was more complex. Indeed, as the next section will show, large-scale drainage projects did not necessarily improve public health. Rather, it is likely that wetland reclamation projects in the late medieval Low Countries contributed to the prevalence and spread of malaria.[253]

A changed ecological landscape

To investigate how wetland reclamation projects might have negatively influenced population health in the late medieval Low Countries, this following section will examine the production locations of the five medical compendia as well as other non-medical sources discussed in the previous chapters. Before doing so, however, it is essential to first visualise the ecological transformation of the ecological landscape of the Low Countries during the late medieval period. Figure 5 and figure 6 illustrate the ecological transformations of the northern Low Countries (the present-day Netherlands) between 800 and 1250 A.D. Particularly noteworthy are the coastal areas in present-day Groningen, Friesland, and Zeeland. During the High and Late Middle Ages, these areas underwent drastic transformations – from landscapes dominated by water, marshes, and floodplains into drained and embanked terrain. A similar transformation took place in large parts of present-day Brabant, in the centre of the northern Low Countries, where the floodplains and tributaries of the Meuse River were drained and embanked. In what is now North and South Holland, the figures show a significant reduction in peatlands, largely the result of intensive peat exploitation. Some of these exploited areas

[251] T.H.G. Wils et al., 'Measures to Reduce Land Subsidence and Greenhouse Gas Emissions in Peatlands: A Dutch Case Study', *Land Use Policy* 152 (2025): 1–18.
[252] Coomans, *Community, Urban Health and Environment*; Coomans, 'The King of Dirt'.
[253] Schats, 'Malaise and Mosquitos', 134–35; Knottnerus, 'Malaria Around the North Sea', 346; Swellengrebel and Buck, *Malaria in the Netherlands*, 6.

became waterlogged through encroaching saltwater from the sea, while others (not shown in these figures) were reclaimed through drainage efforts.[254]

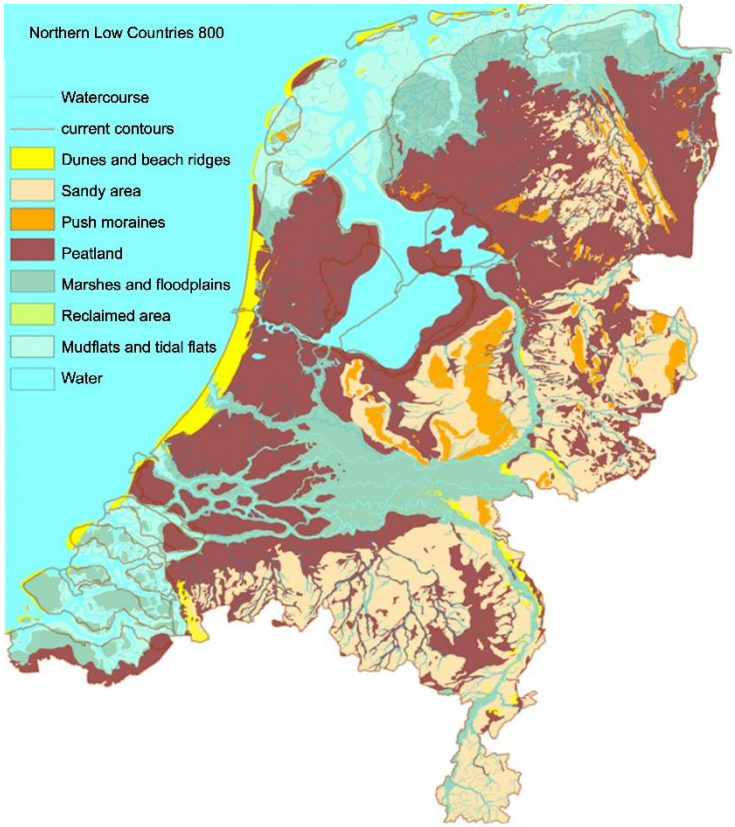

Fig. 5. Soil textures in the Northern Low Countries around 800 A.D. P. Vos et al., *Atlas van Nederland in het holoceen. Landschap en bewoning vanaf de laatste ijstijd tot nu*, 2018.

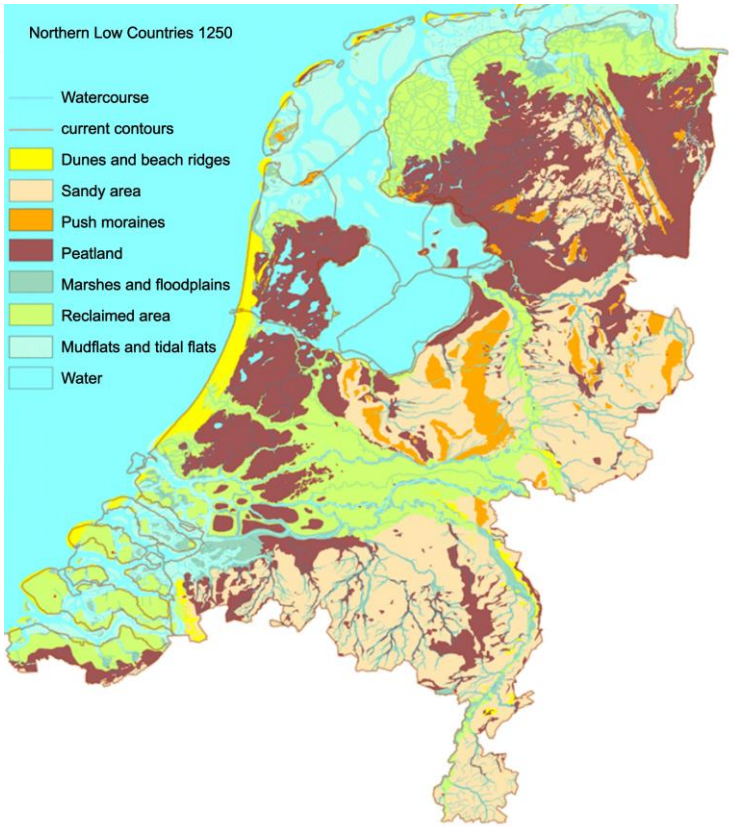

Fig. 6. Soil textures in the Northern Low Countries around 1250 A.D. P. Vos et al., *Atlas van Nederland in het holoceen*.

As discussed earlier, these reclamation projects were driven by a growing population, and the newly reclaimed areas were increasingly settled by more and larger communities. Historian Willem H. TeBrake has studied the growth of settlements in western coastal areas in the northern Low Countries. According to him, in the Rijnland alone – an area now spanning South Holland and parts of North Holland – eight new settlements had emerged on former wetlands during the eleventh century. By the mid-thirteenth century, this number had quadrupled and by the fourteenth century only a small number of sections of undrained wetland remained.[255] Similar developments, albeit on different scales and at different paces, occurred in the coastal regions of Friesland, Groningen, and Zeeland, as well as in inland Brabant.[256]

[254] W.H. TeBrake, 'Land Drainage and Public Environmental Policy in Medieval Holland', 82.
[255] W.H. TeBrake, 82.
[256] N.J.G. Pounds, 'Population and Settlement in the Low Countries and Northern France in the Later Middle Ages', *Revue Belge de Philologie et d'Histoire* 49:2 (1971): 369–402.

Fig.7. The spatial distribution of Middle Dutch sources referencing malaria. ● Indicates medical compendia. ● Indicates other medical and non-medical sources. See appendix 1 for an overview of the source material indicated in this map. Original map: P. Vos et al., *Atlas van Nederland in het holoceen*.

Figure 7 above shows the spatial distribution of late medieval sources referencing malaria found thus far. When comparing figures 5 and 6, to figure 7, a significant correlation emerges. Many of the areas that were the focus of large-scale reclamation projects in the High and Late Middle Ages were also the sites where written sources mentioning malaria were produced and where the individuals who owned these texts were active. This is especially evident in the peatlands of present-day North and South Holland, and the drained and embanked floodplains of Brabant. By contrast, in the eastern parts of the Low Countries where marshes, bogs and fens were less present and where significant reclamation only

began in earnest in the sixteenth century – no malaria-referencing manuscripts and documents have been found.

In the southern Low Countries (present-day Belgium), we can see comparable pattern. The area most extensively drained and reclaimed was the medieval County of Flanders. According to archaeologists Gerben Verbrugghe and Wim De Clercq, and geographer Veerle Van Eetvelde, it was particularly these reclaimed areas that saw a marked increase in settlement from the High Middle Ages onwards.[257] Furthermore, the spatial distribution of the source material found thus far corresponds with these reclaimed and settled areas: most production sites of sources referencing malaria are located in or just around the County of Flanders, while no malaria-referencing documents have thus far been identified in the southeast of present-day Belgium (figure 8).

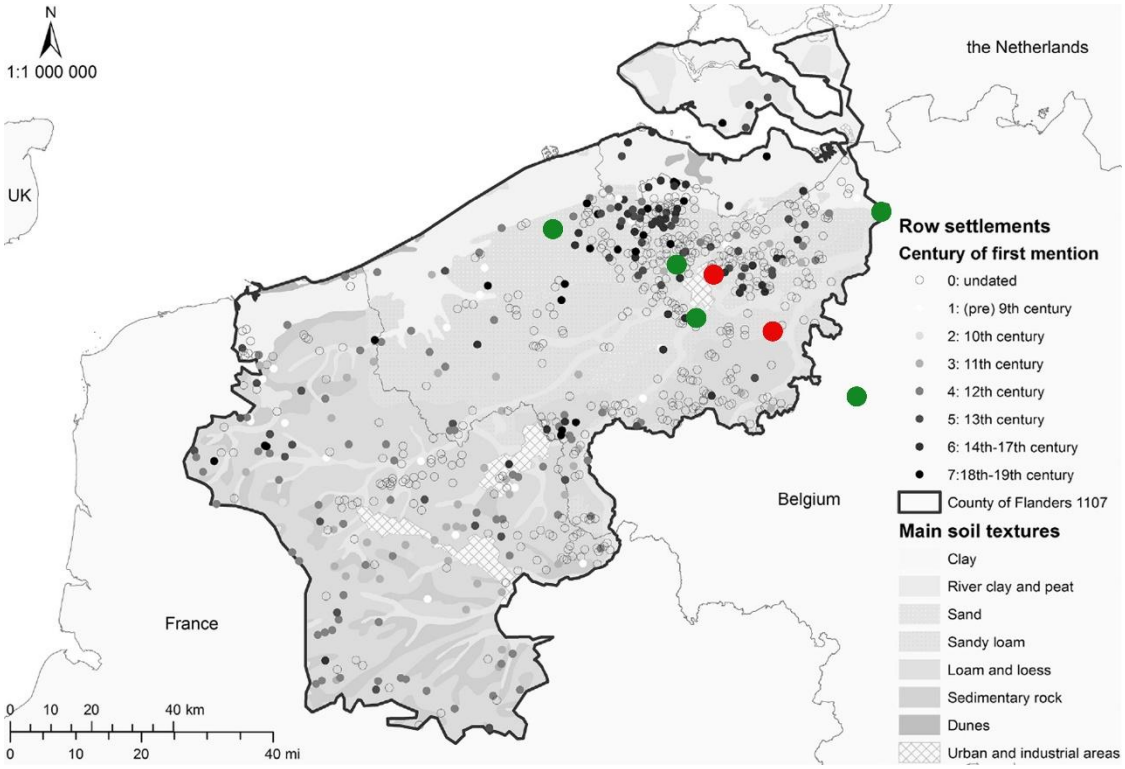

Fig. 8. The spatial distribution of Middle Dutch sources referencing malaria. 🔴 Indicates medical compendia. 🟢 Indicates other medical and non-medical sources. See appendix 1 for an overview of source material indicated in this map. Original map provides a visualization of row settlements in relation to the main soil types in the County of Flanders: G. Verbrugghe, W. De Clercq, and V. Van Eetvelde, 'Row Settlements and Landscape Reclamations in the Medieval County of Flanders', 58.

What insights do these maps of the ecological landscape and the spatial distribution of sources referencing malaria offer regarding the possible public health effects of drainage projects? The figures suggest a potential correlation between large-scale wetland reclamations and the prevalence of malaria. However, it is important to note that multiple factors might have played a role in the distribution of the source material. During the later Middle Ages, the cultural, political, and economic

[257] G. Verbrugghe, W. De Clercq, and V. Van Eetvelde, 'Row Settlements and Landscape Reclamations in the Medieval County of Flanders', *Journal of Historical Geography* 70 (2020): 47–64.

centres were concentrated in the County of Flanders, the County of Holland, and the Duchy of Brabant – roughly corresponding to their modern namesakes. In tandem with this, in these areas, most prominently within urban environments, knowledge production and circulation flourished.[258] As a result, these areas may be overrepresented in the surviving source material simply because more documentation was produced here – and thus preserved. The absence of malaria-referencing sources from other parts of the Low Countries might simply reflect lower levels of documentation, rather than the absence of the disease itself.

Besides this issue of documentation, it is also crucial to examine the types of sources incorporated into these maps. Most dots representing manuscripts that reference malaria are black (in figure 7) and green (in figure 8). As appendix 1 shows, these are mostly non-medical sources, such as chronicles, *vitae* and devotional literature. Such works were typically produced by educated elites who had studied at universities or other scholarly institutions, where Graeco-Roman texts – which include concepts and ideas about malaria – were incorporated into curricula and writings. As argued in the previous chapters, this did not mean that people in the late medieval Low Countries had no knowledge of malaria – as shown by a close examination of both medical and non-medical sources. Still, since these authors belonged to learned circles already familiar with malaria-related concepts, it is unclear whether the disease was truly present in the regions where they were active or if their writings simply reflect the fact that ideas about malaria had reached educational elites in those areas. Therefore, the black and green can not definitely indicate which areas were afflicted by malaria.

Figures 7 and 8 also incorporate the spatial distribution of the five medical compendia, indicated with the red dots. Similarly to the non-medical sources, these most prominently originated from the recently reclaimed areas. However, as noted in the introduction and first chapter, medical compendia differ fundamentally in function and authorship compared to works like chronicles, *vitae*, and devotional literature. Written in the vernacular, with annotation marks, containing practical instructions on how to recognise and treat disease, and produced in small, portable formats, these texts most likely functioned as practical handbooks for surgeons. As such, it was essential that they included information necessary for day-to-day medical practice. Furthermore, surgeons, drawing not only from theoretical knowledge but also from practically acquired experience, were deeply embedded within the local and regional concerns surrounding health and healing. Consequently, their geographical origins are more likely to reflect the actual medical realities of the regions in which they lived and worked. As such, the five medical compendia offer valuable insights into the possible health effects of large-scale reclamation projects in the late medieval Low Countries. Indeed, their spatial distribution suggests that malaria was particularly present in those regions that had recently undergone drainage and reclamation.

[258] B. de Munck and H. de Ridder-Symoens, 'Education and Knowledge: Theory and Practice in an Urban Context', in *City and Society in the Low Countries, 1100–1600*, ed. B. Blondé, M. Boone, and A.L. van Bruaene (Cambridge: Cambridge University Press, 2018), 220–54.

Draining the swamp, breeding disease: human agency and its health consequences

Figures 7 and 8 thus suggest a correlation between large-scale drainage projects and the prevalence of malaria. To understand this, it is important to reiterate scholarly debates within environmental history about the relationships between human society and the natural environment. As noted in the introduction, these interactions are complex, historically contingent, and shaped not only by environmental conditions but also by human agency. The dynamic interplay is particularly evident in the field of landscape epidemiology, which traces the interactions between microorganism, vectors, and hosts, within their environments. Importantly, works within this field – such as Marcia Inhorn and Peter Brown's influential volume *The Anthropology of Infectious Disease* – emphasise especially the role of human agency in shaping the presence and prevalence of infectious diseases. In particular, it is human-driven changes in the 'relationship among infectious disease agents, their human and animal hosts, and the environment in which the host-agent interaction takes place' which is the driving force behind the spread of disease.[259] In the late medieval Low Countries then, how might human agency – the reclamation efforts – affect the relationship between host, agent, and environment, have contributed to the spread of malaria?

First, the large-scale reclamation efforts of the late medieval period in the Low Countries appear to have created the ideal habitat for the malaria-carrying *Anopheles* mosquito. Although drainage projects did reduce surface water, premodern technologies were not sufficiently advanced to achieve complete drainage.[260] Consequently, the drainage and embankment of marshes, bogs, and fens typically resulted in the creation of small canals, watercourses, and ditches.[261] In addition, the vicious cycle of soil subsidence and the over-exploitation of peat made reclaimed land increasingly vulnerable to encroaching water, rendering the soil marshy. Moreover, due to the Low Countries' proximity to the sea, this encroaching water was often saline, turning many recently reclaimed areas into brackish zones.[262] As discussed in the first chapter, *Anopheles* mosquitoes mostly thrive in small, stagnant, and brackish bodies of water. Thus, drainage projects might have inadvertently created the ideal breeding grounds for the malaria-carrying mosquito.[263]

Secondly, reclamation projects facilitated and intensified interactions between the *Anopheles* mosquito and the human population. Prior to the expansion of drainage efforts, human engagement with wetlands occurred on a smaller, more localised scale, with small communities living in close contact with marshes, fens, and bogs for generations.[264] Research has shown that individuals who

[259] M.C. Inhorn and P.J. Brown, eds., *The Anthropology of Infectious Disease: International Health Perspectives* (London: Routledge, Taylor & Francis Group, 1997), 32.
[260] Knottnerus, 'Malaria Around the North Sea', 350–51.
[261] Knottnerus, 346; Packard, *The Making of a Tropical Disease*, 12–13.
[262] Swellengrebel and Buck, *Malaria in the Netherlands*, 6.
[263] Schats, 'Malaise and Mosquitos', 134; Swellengrebel and Buck, *Malaria in the Netherlands*, 6.
[264] W.H. TeBrake, 'Land Drainage and Public Environmental Policy in Medieval Holland', 81–82.

survive the disease in childhood, acquire a degree of immunity to malaria.[265] Consequently, these local communities living in or near malarial zones would have likely built up some level of resistance. The limited and localised nature of earlier interactions between host and vector may have helped to contain the malaria's presence and prevalence. However, as noted, the large-scale drainage projects of the eleventh century prompted the settlement of newer and larger non-immune communities in recently reclaimed areas. This likely contributed to intensified contact between malaria-carrying *Anopheles* mosquitoes and potential human host populations.

From the eleventh century onwards large-scale wetland reclamation projects in the Low Countries may have thus fundamentally reshaped the relationship between malaria agent, mosquito vector, human host, and the environment. Premodern drainage and embanking efforts produced a landscape marked by small ditches, watercourses and puddles filled with brackish water – the ideal breeding grounds for the malaria-carrying agent. Simultaneously, these projects stimulated dense new human settlement in these recently reclaimed areas, thereby intensifying contact between malaria carrying mosquitoes and human hosts. In this way, reclamation efforts – human agency – could have contributed to the prevalence and spread of malaria in these regions.

In certain cases, people appear to have been aware that these reclaimed environments continued to pose a risk to bodily health. Take for instance the *Annales Rodenses*, the chronicle of the abbey of Rolduc located in the present-day province of Limburg and discussed in the previous chapter. As it recounts the story of a small group of people who find themselves in a marshland near Worms, the *Annales Rodenses* emphasises that this area had been 'recently drained'. Yet, it appears the moist conditions – and thus its dangerous nature – persisted as the 'foul air' in this area caused the members of the party to become ill.[266] Yet, aside from this isolated example, no sources have thus far been identified that suggest knowledge of the possible link between drained and embanked lands and the spread and prevalence of malaria specifically.

Healing in an altered landscape: wetland reclamation and biodiversity

The previous section considered the possible consequences of large-scale drainage projects from the eleventh century onwards for the spread and prevalence of malaria. Besides enabling the transmission of disease, the ecological transformations brought about by these reclamation efforts may have also posed challenges to medical practitioners in their attempts to manage and treat malaria. As noted in the

[265] K.F. Kiple, ed., *The Cambridge World History of Human Disease* (Cambridge: Cambridge University Press, 1993), 858; Sallares, *Malaria and Rome: A History of Malaria in Ancient Italy*, 198–99, 223; Dobson, *Contours of Death and Disease*, 352–66.

[266] 'Toen hij daar met de zijnen geruime tijd had doorgebracht zonder voorspoed, presenteerde hij zich en de zijnen aan Burchard, de bisschop van Worms, door wie hij aan de overzijde van de Rijn geplaatst werd op een pas ontgonnen en moerassige plek, die aan alle kanten omgeven was door een groot bos. Toen zij op die moerassige plek bijeengekomen waren, werden zij aangetast door de bedorven lucht van het hen omringende moeras en werden langzamerhand ernstig ziek. De één na de ander ging weg van de meester die tenslotte ook is weggegaan, zodat de stichting zonder leider achterbleef', Augustus and Jamar, *Annales Rodenses*, 142–45.

previous chapter, late medieval health care in the Low Countries was deeply rooted in the natural environment. Medical practitioners such as surgeons relied heavily on the use of herbal remedies, not only in premodern medicine generally, but also specifically in the treatment of *terciaen* and *quartein* fevers. This next section explores how ecological changes – brought about by wetland reclamation – may have disrupted access to medicinal plants, and thus challenged existing therapeutic practices.

In order to understand how ecological changes may have affected late medieval medicinal practices in the Low Countries, let us turn again to the five Middle Dutch medical compendia. These manuscripts offer an extensive overview of a wide range of plants and herbs believed to be effective against intermittent fevers. Yet a key question remains: were the plants and herbs mentioned in these medical texts actually present in the late medieval Low Countries? Given that these sources relied heavily on botanical information drawn from authoritative classical texts, one could argue that the Middle Dutch texts reflect the biodiversity of Antiquity rather than that of the late medieval Low countries. However, as noted in the pervious chapter, while medical compendia were rooted in Graeco-Roman medical traditions, they also incorporated regionally cultivated knowledge of health, healing, and the local biodiversity. Furthermore, they were most likely produced by surgeons who combined theoretical knowledge with practical experience, and were therefore not necessarily prescriptive but rather descriptive – demonstrating how surgeons applied herbal medicine in their daily medical practices. As such, these medical compendia can offer valuable indirect evidence of late medieval biodiversity in the Low Countries.[267]

When looking solely at remedies believed to be effective against malaria, the medical compendia reference the use of approximately one hundred distinct plant species. Of these, I have been able to identify around fifty with reasonable certainty, including the previously mentioned *Plantago*, *Artemisia absinthium*, and *Centaurea jacea* – as shown in appendix 2.[268] Moreover, numerous recipes for treating *terciaen* and *quartein* fevers recommend complex preparations such as *drieakele* and *ydrocopion* – well-known medicinal compounds used for various ailments – composed of multiple botanical ingredients which adds even more plant and herb species to the list.[269] The species mentioned – where they can be reliably identified by their Middle Dutch names – are

[267] In recent years, scholarly attention has been devoted to the vegetation and biodiversity of the late medieval Low Countries. However, existing research has largely taken the form of highly localized case studies, often centred on specific regions, ecological niches, or archaeological sites. As a result, a comprehensive overview of biodiversity patterns across the late medieval Low Countries remains lacking. This thesis, together with the data presented in appendix 2, may offer a first preliminary insight.

[268] See appendix 1 for an overview of the sources which reference remedies against intermittent fevers.

[269] Hs. 1272, 'Die boete wille hebben jeghen alle cortse sonder den vierden dach, doe hem laten vp die hant naest den cleenen vinghere ter maghe adren, inden tijt dat hem die hitte comt ende coude wech es, ende ete fine drieakele .iij. werf nuchteren, hi sal ghenesen', Braekman, *Middelnederlandse Geneeskundige Recepten*.
Hs 15624-41, 'Ydrocopion esgoet properleke iegen den .4.den dach+corts. ende iegen dageliken corts. die bi nachte comt. Men saelt geven ene wile vor den acces also groet als .1. haselnot met lauwen watere. Dat .15.ste deel es .1. ƀb. Nemtcynamomi.3.ʒ. ende.1.℈. ende .16. granen. soffraen .3.ʒ. wierooc. naerdi. mirre. opii. mandragore. ameos. macropiperis. anijs. beilde. lijnsaet1). silleris. elx .2.ʒ. ende .8. granen. zeem dats gnouch si. Men saelt geven met wermen watere', Berg, *Antidotarium Nicolaï*, 84. The species incorporated into medical preparations are not included in appendix 2.

associated with wide a range of natural habitats. Various species of the genus *Plantago*, for instance, are adapted to diverse environments, but they commonly thrive particularly well in moist areas and damp soils such as wetlands, bogs and marshes. In contrast, *Artemisia absinthium* is adapted to dry, well-drained soils, typically growing in rocky or sandy terrain. *Centaurea jacea*, meanwhile, favours habitats with moderate moisture levels, such as meadows and grasslands. Other botanical ingredients found in medical recipes against intermittent fevers prefer, broadly speaking, similar habitats, ranging from wetlands and swamps to dry soils.[270] Given the central role of medicinal plants in treatments for intermittent fevers, it is clear that the environments in which this vegetation thrived played a crucial role in treating and managing intermittent fevers in the late medieval Low Countries.

What happened to the habitats of the diverse range of species – particularly those well-adapted to wet conditions – in the late medieval Low Countries following the large-scale drainage and embankment projects? Although the primary goal of reclamation efforts was to turn wetlands such as fens, bogs, and marshes into dry, arable, and liveable lands – premodern drainage and reclamation technologies were not sufficiently advanced enough to achieve complete drainage.[271] Moreover, the overexploitation of peatland and the vicious cycle of soil subsidence meant that water was constantly encroaching into recently reclaimed lands.[272] In addition, reclamation projects generally resulted in the creation of small canals, watercourses and ditches.[273] Consequently, the moist and wet conditions in these areas remained – or in certain cases returned – to a certain extent.

Nonetheless, the process of embankment and drainage could have still greatly impacted the biodiversity and ecology of wetlands, even when moist and wet conditions persisted. Particularly vulnerable plant species well-adapted to wetlands, but unable to cope in other types of environments, may have struggled in these altered conditions. Moreover, the artificial regulation of water levels would likely have disrupted the natural water flow and nutrient transport, limiting the ability of native wetlands species to thrive. Indeed, following Barkman's extensive study on plant communities in bogs in the Low Countries, even superficial drainage drastically alters the species composition in these areas.[274] Perhaps most influential and impactful, however, was the rise in salinity. Discussed in the previous section, the Low Countries' close proximity to the sea meant that drainage efforts often led to the encroachment of saltwater, not only in recently reclaimed wetlands, but also in surrounding areas.[275] Insightful in this context is the research conducted by Sija Sofberg, Agata Klimkowka, Maurice Paulissen, Jan-Philip Witte, and Sjoerd van der Zee in their article 'Effects of salinity on

[270] See appendix 2.
[271] Knottnerus, 'Malaria Around the North Sea', 350–51.
[272] Swellengrebel and Buck, *Malaria in the Netherlands*, 6.
[273] Knottnerus, 'Malaria Around the North Sea', 346; Packard, *The Making of a Tropical Disease*, 12–13.
[274] J.J. Barkman, 'Plant Communities and Synecology of Bogs and Health Pools in the Netherlands', in *Fens and Bogs in the Netherlands: Vegetation, History, Nutrient Dynamics and Conservation*, ed. J.T.A. Verhoeven (Dordrecht: Kluwer Academic Publishers, 1992), 223–24.
[275] Swellengrebel and Buck, *Malaria in the Netherlands*, 6; S.F. Stofberg et al., 'Effects of Salinity on Growth of Plant Species from Terrestrializing Fens', *Aquatic Botany* 121 (2015): 83.

growth of plant species from terrestrializing fens', which examines the effect of salinity on plant populations in freshwater wetland environments. Their findings show that while most freshwater plant species can tolerate slight to moderate salinity, once salt levels surpass a certain threshold, nearly all species fail to survive.[276] Considering the increased salinity levels following late medieval reclamation projects, their findings imply that substantial portions of the freshwater plant population – and thus the overall wetland biodiversity – in the late medieval Low Countries would have been impacted.

What did the reclamation projects and their ecological consequences for the biodiversity of wetland environments, mean for people's efforts to treat and cure intermittent fevers in the late medieval Low Countries? As far as they can be relatively reliably identified by their Middle Dutch name, approximately thirty of the botanical ingredients mentioned in remedies for intermittent fevers thrive in moist to moderately moist soils.[277] For instance, various plants from the genus *Plantago* prefers wet environments. Likewise, plants such as marshmallow (*Althaea officinalis*) and common hogweed (*Heracleum sphondylium)* – both cited in recipes for third- and fourth-day fevers – are also known to grow in areas such as marshes, bogs and fens.[278] Moreover, nearly all plant and herb species used in remedies for intermittent fevers are non-saline. Following the research by Sofberg, and others, on the effect of salinity on vegetation, this means that these plants would have been unable to survive in environments where salinity surpasses a certain threshold. Drainage and embankment projects – by drastically altering the water table, reducing soil moisture, and increasing salinity – might therefore have significantly diminished the availability of medicinal plants used in treating intermittent fevers. As such, it is highly likely that the ecological and environmental transformations brought on by reclamation projects would have posed challenges to medical practitioners such as surgeons in their efforts to manage *terciaen* and *quartein* fevers.

To conclude: marshes and malaria

This chapter has explored how the large-scale reclamation efforts in the Low Countries during the late medieval period might have affected public health both in spreading the disease malaria as well limiting people's ability to treat and manage the disease. It began by tracing the development of human interaction with wetlands during the high and late medieval periods. Although wetlands were often viewed as dangerous to both physical and spiritual well-being, they remained integral to local life, providing important socioeconomic functions on a small and local scale. From the eleventh century onward, however, these landscapes were increasingly exploited and reclaimed, driven by the

[276] Stofberg et al., 'Effects of Salinity'.
[277] See appendix 2.
[278] HS. 15624-41, '[Against fourth-day fever] Nemt swinen smout & honden & olye van vyoletten & doet zieden & die wortele van hoemsce & branca vrcina,' Jan Yperman, *Medicina, Boek van Medicinen*, 41. *Hoemsce* refers to *Althaea officinalis*, or marshmallow. *Branca vrcina* is *Heracleum sphondylium* or common hogweed in English.

political, economic, and social opportunities perceived by both secular and religious authorities, as well as local communities.

While recent scholarship has focused on the ecological consequences of these projects, their impact on public health has remained understudied. This chapter examined the possible health effects of reclamation by comparing the spatial distribution of five medical compendia to regions undergoing intense ecological transformation. This comparison suggested a strong correlation between areas of heavy reclamation and the presence and spread of malaria. The chapter then considered how these reclamation efforts may have impaired the ability of surgeons to treat the disease. Although drainage projects often failed to fully dry out bogs, fens, and marshes, they did drastically alter local ecologies, most prominently by increasingly salinity. An analysis of herbal ingredients in the compendia suggests that a significant portion of the medicinal plants used against intermittent fevers likely struggled to survive in the changed landscape.

As such, this chapter has shown how large-scale, human-driven environmental interventions may have shaped not only the distribution of malaria, but also the capacity of late medieval communities to respond to the disease.

Conclusion: Mosquitoes, Medicine, Marshes, and Malaria

This thesis opened in the summer of 1237 – the ominous year that the Bloemhof monastery in Wittewierum and the surrounding villages where struck by a terrible 'recurrent fever'. As the days grew shorter and the weather turned colder, the fevers intensified and spread. Not even the beloved reverend father Emo was spared, and by November first, his strength had begun to wane.[279] Yet, while the feverish glow steadily drained his strength, his mind remained sharp and in the brief respites between the fevers' attack, he would rarely allow himself to rest, but continued to care for his conglomeration with unwavering devotion.[280] On 15 December, however, the terrible recurrent fever became too much for him to bare, and that nigh Emo departed the mortal world.[281] At the end of this thesis, we can conclude that the recurrent fever that struck the monastery, the surrounding villages, and father Emo was what we now recognise as the mosquito-borne disease malaria.

Whilst historical and archaeological research has mapped the broad contours of malaria's presence in Europe, it was not until Schat's osteoarchaeological study that the disease was identified in the late medieval Low Countries, particularly in the coastal wetland regions. Yet despite the disease's prevalence, historians have maintained that people in the premodern Low Countries lacked knowledge of malaria and its presence. This thesis aimed to challenge that view. Indeed, by re-examining both medical as well as non-medical sources through the lens of malaria, I argued that contemporaries possessed a deep and thorough understanding of malaria. Not only does this reshape our view of the disease's historical presence in the Low Countries, but it also establishes malaria as a possible new case study that can yield valuable insights into the production and circulation of medical knowledge and into the historically contingent relationship between human society and the environment in the late medieval Low Countries.

The core of this study focused on five medical compendia produced in the Low Countries between 1300 and 1600 – each compiled or owned by surgeons, medical practitioners who worked directly with patients – and which contain references to malaria and its associated symptoms. This

[279] '[…] in diezelfde tijd werd de eerwaarde vader Emo zaliger gedachtenis, die zeer in aanzien stond bij alle kloosterlingen en ook bij verstandige leken, door een steeds terugkerende koorts bevangen, waardoor hij omstreeks het feest van Allerheiligen [1 Nov] langzaam begon weg te kwijnen', Menko and Emo, *Cronica Floridi Horti*, 288–89, 328–29.
[280] 'Maar toch, hoewel hij door de koortsige gloed, die zijn krachten sloopte, zo achteruit ging, werden zijn geestkracht en zijn nog heldere verstand wonderlijk gesterkt door de zalige beschouwing van de hemelse dingen, door de vooruitziende zorg voor het tijdelijke ne door de waakzame zielzorg, zozeer dat hij zelf in deze dagen, waarin hij onder de hitte van de koorts leed na afloop van een aanval van koude, slechts zelfden op bed ging liggen, maar rondging als een echter herder: nu eens bezocht hij de zieken, een andere keer verstrekte en bemoedigde hij de in de klooster aanwezigen door zijn leer en leven', Menko and Emo, 288–89.
[281] '[…] in dat jaar [1237] heeft de eerwaarde vader Emo zaliger gedachtenis bij God en mensen, in de nacht van heilige Lucia [13 Dec], de maagd die hij die hij altijd in het bijzonder had bemind en gediend door op haar vigilie te vasten en iedereen zoveel hij kon op te wekken haar te eren, toen haar feest naderde en de ziekte verergerde, die maagd gesmeekt of hij, als het naar Gods verordening was dat hij dat jaar zou sterven, in diezelfde nacht door haar gebeden zou mogen heengaan', Menko and Emo, 328–29.

research also drew on non-medical sources – a chronicle, a *vita* and spiritual writings – that mention intermittent fevers. The first chapter situated malaria in the context of the late medieval Low Countries by closely analysing how the five medical compendia described the disease, defined its symptoms and classified the illness. The manuscripts demonstrated that surgeons had a detailed awareness malaria, named *terciaen* and *quartein* fevers, recognizing the cyclical nature of the fevers, the discoloured urine, and splenomegaly – hallmark symptom of malaria in modern medicine. Rather than simply copying classical theories on malaria, surgeons merged Graeco-Roman bodies of knowledge with their own observations acquired during their daily medical practice. Moreover, knowledge of intermittent fevers spread beyond medical circles into broader cultural, religious, and moral framework, suggesting that the wider population of the late medieval Low Countries were also familiar with malaria.

Having established the presence, knowledge, and perceptions of malaria, the second chapter examined how people in the late medieval Low Countries understood its causes and sought to treat it – thus illuminating contemporary views on the relationship between human health and the environment. Medical experts such as surgeons linked the spread of malaria to the environment – to the presence of *kwade lucht* emerging from marshes, fens, and bogs. At the same time, surgeons turned to the environment to treat and manage malaria through the application of herbal medicine. Although rooted in classical theory, this practice was strongly shaped by regionally developed 'experience-based medicine', as evidenced by the incorporation of numerous vernacular names, new interpretations of already well-established medicinal plants, and the application of new botanical ingredients in the five medical compendia. In this way, the compendia reveal that surgeons perceived the environment as both a source of disease and of healing.

The final chapter explored how large-scale reclamation projects in the Low Countries – undertaken from the eleventh century onwards by secular and religious authorities and peasant communities – my have influenced both the spread of malaria and surgeons' ability to treat it. The geographical distribution of the five medical compendia suggests a correlation between drainage efforts and the presence of malaria: drainage and embankment may have inadvertently contributed to the prevalence of the disease. Simultaneously, the reclamation efforts drastically altered local ecological conditions and may therefor have limited surgeons' treatment ability. An analysis of herbal ingredients in the medical compendia indicates that a portion of the medicinal plants used against intermittent fevers would likely have struggled to survive in the altered landscape of the late medieval Low Countries.

The goal of this thesis was to investigate how malaria was understood and perceived in the late medieval Low Countries, in order to explore the complex and historically contingent relationship between human society and the natural environment. At the same time, situated at the crossroads of medieval medical knowledge studies, environmental history, landscape epidemiology, and One Health approaches, this research has also aimed to make three key contributions to these fields. First, by

situating malaria and contemporary knowledge and perceptions of the disease in the late medieval Low Countries, this thesis has introduced malaria as a possible new lens which might enrich scholarship on late medieval medical knowledge in this region. Second, investigating how people explained the cause of malaria as well as devised ways to treat and manage the disease has offered valuable insights into how people perceived the complex relationship between human health and the environment. Third, this study provides a first insights into how large-scale ecological transformations might have directly shaped human health, demonstrating that malaria offers a rich context for exploring the dynamic interplay between society, health, and the natural world.

At the same time, this research contributes to the ongoing debates among environmental history scholars regarding source materials and methodology. While drawing on diverse disciplines such as osteoarchaeological research, botanical biodiversity studies, and ecological analyses of human impact, this research also relied extensively on traditional historical written sources: Middle Dutch medical compendia and non-medical texts. In doing so, this thesis demonstrated that this source corpus, already well known among historians, can offer new insights into the complex, historically contingent interactions between society and the environment, and thereby contribute to environment history.

While this research has yielded new perspectives on the history of malaria in the premodern Low Countries, much work remains to be done. As stated in the introduction, the source corpus used in this research was selected from the online database *Digitale Bibliotheek Voor de Nederlandse Letter*. Although this approach revealed new materials relevant to the study of malaria's historical presence in the Low Countries, large parts of the late medieval source corpus remain unexplored, as much of the material has not (yet) been digitalised in this database. Future research into non-digitalised sources, as well in sources in other databases, may therefore uncover new and more varied materials, further expanding upon the findings of this study. The methodology developed in this thesis – analysing how people described the disease, identified its symptoms, and classified the illness – could aid in locating additional material that sheds light on malaria's presence in the premodern Low Countries.

Ultimately, this thesis aimed to demonstrate that research into malaria in the context of the late medieval Low Countries offers new perspective on the dynamic and historic contingent relationships between human society, health, and the environment. While rooted in the past, such insights are also relevant today. Indeed, the goal of environmental historians is to understand how reactions and interactions with the natural surroundings have shaped – and continue to shape – the ecological conditions that affect human, animal, and environmental health. Above all, scholars hope these historical perspectives can help us navigate the environmental challenges we face today – and those in the future. By tracing the history of malaria – a disease situated at the intersection of human society and the environment – and exploring the way people understood, attempted to treat, and perhaps even exacerbated it, this thesis hopes to make a small contribution to this ongoing effort.

Appendix 1

Overview of the Middle Dutch sources referencing malaria in the Low Countries.

These sources were found on the online database *Digitale Bibliotheek voor de Nederlandse Letteren*, using keywords related to malaria and its associated symptoms. Although this method has opened up a new corpus of sources relevant to the history of malaria, large portions of the late medieval source material from the Low Countries have not been digitalised in this database and were therefore not consulted. The production locations of the sources have been identified on figure 7 and 8.

Middle Dutch manuscripts containing medical remedies against terciaen *and* quartein *fevers*. *Most likely, medical compendiums made by or meant for medical experts working directly with patients. Identified by red dots on figures 7 and 8.*

Hs. 1272, Ghent University Library. produced by a scribe from the region between Ghent and Aalst. Mid-fifteenth century, shortly after 1450.[282]

Hs. Sloane 345, British Museum in London. Produced in the region of Utrecht. Between fifteenth and sixteenth century.[283]

Hs. 697, Olim Serrure 14, Ghent University Library. Produced by Heyndric van den Doeren in present-day South Holland. Fifteenth Century.[284]

Hs. Lat. 6838 A, National Library in Paris. Produced by a single anonymous scribe, somewhere in West Flanders. 1305.[285]

Hs. 15624-41, Royal Library of Brussels. Produced or commissioned by Johannes de Altre somewhere in present-day North-Brabant. 1351.[286]

Van den proprieteyten der dinghen*, Middle Dutch copy of* De proprietatibus rerum *by Bartholomaeus Anglicus. Identified by black and green dots on figures 7 and 8.*

Hs. Ned. Inc. 29a, University Library of Amsterdam. Produced by Jacop Bellaert in Haarlem, in present-day province of North Holland. 1485.[287]

[282] Braekman, *Middelnederlandse Geneeskundige Recepten*.
[283] Braekman, *Medische En Technische Middelnederlandse Recepten*.
[284] Vreese, *Middelnederlandsche Geneeskundige Recepten En Tractaten, Zegeningen En Tooverformules*.
[285] Vreese.
[286] Jan Yperman, *Medicina, Boek van Medicinen*; Vandewiele, *De 'Liber Magistri Avicenne' En de 'Herbarijs'*.
[287] Bartholomaeus Anglicus and Jacop Bellaert (trans.), *Van Den Proprieteyten Der Dinghen*.

Middle Dutch manuscripts containing medical remedies against terciaen *and* quartein *fevers. Explicit purpose of text unknown*. *Identified by black and green dots on figures 7 and 8.*

Hs. II 2106, Royal Library of Brussels. Produced by the church of Sint-Catharina, Dordrecht, in present-day South-Holland. Around 1455.[288]

Hs. 80 MS. Med. 3, Murhard Library of Kassel University. Produced in southeast of Ghent. Mid-fourteenth century.[289]

Hs. Olim Loan 29/332 / Add. 70515, British Library, London. Most likely produced somewhere in the present-day province of Gelderland. Fourteenth century.[290]

Hs. 408, City Library Bruges. Produced perhaps by Clays van den Walle, somewhere around Bruges. 1487-1550.[291]

Hs. IV 958. Royal Library of Brussels. Produced somewhere between Brussels and Bruges. Late-fifteenth century.[292]

Middle Dutch convent and monastery chronicles referencing terciaen *and* quartein *fevers*. *Identified by black and green dots on figures 7 and 8.*

H. Mon 81, Bavarian State Library in Munich. Produced in the monastery Windesheim in Zwolle, in the present-day province of Overijssel. Fifteenth century.[293]

Hs. 116 K, University of Groningen Library. Produced in the convent of Bloemhof in Wittewierum, in the present-day province of Groningen. Thirteenth century.[294]

Middle Dutch manuscripts containing the Vita of Saint Lidwina of Schiedam. [295] *Identified by black and green dots on figures 7 and 8.*

BHSL. Hs. 1080, Ghent University Library. Produced in Brabant. Between 1475-1480.

Hs. 71 H 9, National Library of the Netherlands, The Hague. Produced in Holland. Late-fifteenth century.

Hs. 92 G F, Museum Catharijneconvent, Utrecht. Produced in North-Brabant. Late-fifteenth century.

---

[288] Braekman, *Middelnederlandse Geneeskundige Recepten*.
[289] Braekman, *Medische En Technische Middelnederlandse Recepten*.
[290] W.L. Braekman, 'Het Liber de Vinis van Arnaldus de Villlanova in Het Middelnederlands', *Verslagen En Mededelingen van de Koninklijke Academie Voor Nederlandse Taal- En Letterkunde* 74 (1974): 275–318.
[291] W.L. Braekman, *Middeleeuwse Witte En Zwarte Magie in Het Nederlands Taalgebied* (Gent: Koninklijke Academie voor Nederlandse Taal- en Letterkunde, 1997).
[292] Braekman.
[293] K. Grube, ed., *Des Augustinerpropstes Johannes Busch: Chronicon Windeshemense Und Liber de Reformatione Monasteriorum* (Halle: Otto Hendel, 1886).
[294] Menko and Emo, *Cronica Floridi Horti*.
[295] Jongen and Schotel, *Het Leven van Liedewij, de Maagd van Schiedam*.

Middle Dutch manuscripts containing the work of Jan van Ruusbroec which incorporates references to terciaen *and* quartein *fevers*. [296] *Identified by black and green dots on figures 7 and 8.*

Hs. 1165-67, Royal Library of Brussels. Produced in Brussels. 1510.

Hs. 19295-97, Royal Library of Brussels. Produced in Brussles. Around 1380-1420.

Middle Dutch sources with moral tales incorporating terciaen *and* quartein *fevers*. *Identified by black and green dots on figures 7 and 8.*

Hs. 170 E 26 [2], National Library of the Netherlands, The Hague. Perhaps produced around Gouda, Present-day South-Holland. 1481.[297]

Die evangelien vanden spinrocke, Produced near Antwerp. 1510-1530.[298]

[296] Jan van Ruusbroec, *Die Chierheit Der Gheestelijker Brulocht*.
[297] Gheraert Leeu, *Dialogus Creaturarum Dat Is Twispraec Der Creaturen*, ed. H. Rijns, 2015.
[298] Insituut voor Nederlandse Lexicologie, ed., *Evangelien Vanden Spinrocke* (Den Haag: Sdu Uitgevers, 1998).

Appendix 2

An overview of medicinal herbs mentioned in medicinal recipes against *terciaen* and *quartein* fevers in medical compendia Hs. 1272, Hs. 345, Hs. 697, Hs. 6838, Hs. 15624-41. The list is restricted to those that I have been able to identify around with reasonable certainty.

Nr.	Middle Dutch name	Moderne Dutch name	Latin name	English name	Preferred habitat
1.	Arthimisien, alsem, hartemesien, wermode	Alsem, absintalsem	*Artemisia absinthium*	Wormwood	Dry soils
2.	Ruten, rute	Wijnruit	*Ruta graveolens*	Common rue	Well-drained soils
3.	Plantayen, weegbree, Hontsribbe, hontsrebbe	Grote weegbree	*Plantago major*	Plantain	Moist soils
4.	Latuwe, latue	Sla	*Lactuca sativa*	Lettuce	Moderately moist soils
5.	Wilgen	Wilg	*Salix spp.*	Willow	Moist soils
6.	Wilde Saly, ambrosia	Salie	*Salvia officinalis*	Sage	Dry soils
7.	Vliedere, adec, adik	Vlier	*Sambucus nigra*	Elderberry tree	Moist soils
8.	Titimallorum	Wolfsmelk	*Euphorbia*	Spurge	Dry to moderately moist soils
9.	Camomillen	Kamille	*Matricaria chamomilla*	Matricaria / chamomile	Dry to moderately moist soils
10.	Termentille	Tormentil	*Potentilla erecta*	Tormentil	Moist soils
11.	Brionie, bryonia	Heggenrank	*Bryonia dioica*	Bryony	Dry soil
12.	Jacea nigra	knoopkruid	*Centaurea jacea / Centaurea nigra*	knapweed	Moderately moist soils
13.	Matefelloene	Duivelsbetel	*Scopolia carniolica*	Scopolia	Moist soils
14.	Violette	Viooltje	*Violaceae*	Violets	Moderately moist soils
15.	Papencruuts	Paardenbloem	*Taraxacum officinale*	Dandelion	Moderately moist soils
16.	Porceleine, porceleynkruy	Postelein	*Portulaca oleracea*	Purslane	Well-draining soils
17.	Dille	Dille	*Anethum graveolens*	Dill	Well-draining soils
18.	Raep, raap, rape	Raap	*Brassica rapa*	Turnip	Moist, well-drained soils
19.	Anijs	Anijs	*Pimpinella anisum*	Anise	Moist, well-drained soils
20.	Asarabattere	Wilde gember	*Asarum europaeum*	European wild ginger	Moist soils
21.	Rosarum	Roos	*Rosa spp.*	Rose	Well-drained soils
22.	Popelieon	Populieren (zalf)	*Populus*	Poplar (ointment)	Moist soils
23.	Nachtschade	Belladonna	*Atropa belladonna*	Deadly nightshade	Moderately moist soils

24.	Venkel	Venkel	*Foeniculum vulgare*	Fennel	Moist soils
25.	Persine, Persijn	Peterselie	*Petroselinum crispum*	Parsley	Moist, well-drained soils
26.	Sparago	Asperge	*Asparagus officinalis*	Asparagus	Well-drained soils
27.	Corisicorie	Cichorei	*Cichorium intybus*	Chicory	Dry soils
28.	Buglossa	Gewone ossentong	*Anchusa officinalis*	Alkanet	Dry soils
29.	Pentafilon	Vijfvingerkruid	*Potentilla reptans*	Creeping cinquefoil	Moist soils
30.	Gramminis	Gras	*Poaceae spp.*	Grass	Varies widely
31.	Ceterac	Schubvaren	*Asplenium ceterach*	Rustyback fern	Dry soils
32.	Capillis veneris	Venushaar	*Adiantum capillus-veneris*	Maidenhair fern	Moderately moist soils
33.	Boragien	Bernagie, ossentong	*Borago officinalis*	Borage	Moderately moist soils
34.	Cuscute	Warkruid	*Convolvulaceae*	Dodder	Parasitic on host plants
35.	Enula	Alant	*Inula*	Inula	Moist soils
36.	Campana	Klokje	*Campanula*	Bellflower	Moderately moist soils
37.	Ligua canis	Hondstong	*Cynoglossum officinale*	Hound's tongue	Dry soils
38.	Hoemsce, hoemsch	Heemst	*Althaea officinalis*	Marshmallow	Moist soils
39.	Branca urcina	Berenklauw	*Heracleum sphondylium*	Hogweed	Moist soils
40.	Popple	Populier	*Populus*	Poplar	Moist soils
41.	Mercuriael	Bingelkruid	*Mercurialis*	Mercurialis	Moist, well-drained soils
42.	Averone	Citroenkruid	*Artemisia abrotanum*	Southernwood, southern wormwood	Moderately moist, well-drained soils.
43.	Mente	Munt	*Mentha*	Mint	Moist soils
44.	Byvoet, sint Janskruid	Bijvoet	*Artemisia vulgaris*	Mugwort	Well-drained soils
45.	Apien, apie, eppe	Moerasscherm, juffrouwmerk	*Apium*	Apium	Moist soils
46.	Centaure, santorie	Duizendguldenkruid	*Centauria erythraea*	Common centaury	Well-drained soils
47.	Endivia	Andijvie	*Cichorium endivia*	Endive	Well-drained soils
48.	Scariola	Kompassla, wilde sla	*Lactuca serriola*	Prickly lettuce	Well-drained soils
49.	Catapusia, sporie	Gewone spurrie	*Spergula arvensis*	Corn spurry	Moist, well-drained soils
50.	Polypodium	Gewone eikvaren	*Polypodium vulgare*	Common polypody	Moist, well-drained soils
51.	Verbena, iserhart, isercruut	IJzerhard	*Verbena officinalis*	Common vervain	Well-drained soils
52.	Amandel melk	Amandelboom	*Prunus dulcis*	Almond	Dry soils
53.	Mandragora	Mandragora	*Mandragora officinarum*	Mandrake	Dry soils

Primary sources

Augustus, L., and J.T.J. Jamar, eds. *Annales Rodenses. Kroniek van Kloosterrade*. Maastricht: Datawyse Boekprodukties, 1995.

Bartholomaeus Anglicus and Jacop Bellaert (trans.). *Van Den Proprieteyten Der Dinghen*. Edited by E.M. Versélewel and H. de Witt, 2009.

Braekman, W.L. 'Het Liber de Vinis van Arnaldus de Villlanova in Het Middelnederlands'. *Verslagen En Mededelingen van de Koninklijke Academie Voor Nederlandse Taal- En Letterkunde* 74 (1974): 275–318.

———, ed. *Medische En Technische Middelnederlandse Recepten: Een Tweede Bijdrage Tot de Geschiedenis van de Vakliteratuur in de Nederlanden*. Gent: Secretariaat van de Koninklijke Academie voor Nederlandse Taal- en Letterkunde, 1975.

———. *Middeleeuwse Witte En Zwarte Magie in Het Nederlands Taalgebied*. Gent: Koninklijke Academie voor Nederlandse Taal- en Letterkunde, 1997.

———. *Middelnederlandse Geneeskundige Recepten: Een Bijdragen Tot de Geschiedenis van de Vakliteratuur in de Nederlanden*. Gent: Koninklijke Vlaamse Academie voor Taal- en Letterkunde, 1970.

'Digitale Bibliotheek Voor de Nederlandse Letteren', 20 June 2025. https://www.dbnl.org/.

Gheraert Leeu. *Dialogus Creaturarum Dat Is Twispraec Der Creaturen*. Edited by H. Rijns, 2015.

Grube, K., ed. *Des Augustinerpropstes Johannes Busch: Chronicon Windeshemense Und Liber de Reformatione Monasteriorum*. Halle: Otto Hendel, 1886.

Hippocrates. *Hippocrates, Volume X: Generation. Nature of the Child. Diseases 4. Nature of Women. Barrenness*. Translated by P. Potter. Cambridge: Loeb Classical Library, 2012.

Insituut voor Nederlandse Lexicologie, ed. *Evangelien Vanden Spinrocke*. Den Haag: Sdu Uitgevers, 1998.

Dioscorides. *De Materia Medica*. Translated by T.A. Osbaldeston. Johannesburg: Ibidis Press, 2000.

Jan van Ruusbroec. *Die Chierheit Der Gheestelijker Brulocht*. Edited by F. Erens, 1917.

Jan Yperman. *Medicina, Boek van Medicinen*. Edited by L. Elaut. Den Haag: Sdu Uitgevers, 1998.

Lloyd, G.E.R., ed. *Hippocratic Writings*. Translated by W.N Mann, J. Chadwick, I.M. Lonie, and E.T. Withington. London: Penguin Books, 1983.

Luijk, M.D. van. 'De Tweede Religieuze Vrouwenbeweging Te Leiden. Het Convent van Sint-Margaretha of Roomburg'. *Ons Geestelijk Erf* 74:1-2 (2000): 50–67.

Menko, and Emo. *Cronica Floridi Horti*. Translated by H.P.H Jansen and A Janse. Hilversum: Uitgeverij Verloren, 1991.

Munk, J., ed. *Leringhe van Orinen*. Den Haag: Sdu Uitgevers, 1998.

Pliny the Elder. *The Natural History*. Translated by J. Bostock, H.T. Riley, and B.A. Ed. London: Taylor and Francis, 1855.

Rembert Dodoens, *Crŭÿde boeck* (Antwerp: Jan vander Loe, 1563).

Tregement Der Ghesontheyt. Brussels, 1514.

Vandewiele, J.L., ed. *De 'Liber Magistri Avicenne' En de 'Herbarijs'. Middelnederlandse Handschriften Uit de XIVe Eeuw (Ms. 15624-15641 Kon. Bibliotheek Te Brussel)*. Den Haag: Sdu Uitgevers, 1998.

Vreese, W.L. de, ed. *Middelnederlandsche Geneeskundige Recepten En Tractaten, Zegeningen En Tooverformules*. Gent: A. Siffer, 1894.

Secondary literature

Aberth, J. *An Environmental History of the Middle Ages: The Crucible of Nature*. New York: Routledge, 2012.

Andel, M.A, van. *Chirurgijns, Vrije Meesters, Beunhazen En Kwakzalvers: De Chirurgijnsgilde En de Praktijk Der Heelkunde (1400-1800)*. 2nd ed. Den Haag: Uitgeverij Martinus Nijhoff, 1981.

Arsdall, A. van. *Medieval Herbal Remedies: The Old English Herbarium and Anglo-Saxon Medicine*. New York: Routledge, 2002.

Barkman, J.J. 'Plant Communities and Synecology of Bogs and Health Pools in the Netherlands'. In *Fens and Bogs in the Netherlands: Vegetation, History, Nutrient Dynamics and Conservation*, edited by J.T.A. Verhoeven, 173–136. Dordrecht: Kluwer Academic Publishers, 1992.

Bavel, B. van. *Manors And Markets: Economy and Society in the Low Countries 500-1600*. Oxford: Oxford University Press, 2010.

Beek, R. van, G.J. Maas, and E. van den Berg. 'Home Turf: An Interdisciplinary Exploration of the Long Term Development, Use and Reclamation of Raised Bogs in the Netherlands'. *Landscape History* 36:2 (2015): 5–34.

Berg, W.S. van den, ed. *Antidotarium Nicolaï (Ms. 15624-15641. Kon. Bibl. Te Brussel)*. Leiden: Brill, 1917.

Bertola, M., M. Mazzucato, M. Pombi, and F. Montarsi. 'Updated Occurrence and Bionomics of Potential Malaria Vectors in Europe: A Systematic Review (2000–2021)'. *Parasites & Vectors* 15:88 (2022): 1–34.

Boualam, M.A., B. Pradines, M. Drancourt, and R. Barbieri. 'Malaria in Europe: A Historical Perspective'. *Frontiers in Medicine* 8 (2021): 1–12.

Bresalier, M, A. Cassidy, and A. Woods. 'One Health in History'. In *One Health: The Theory and Practice of Integrated Health Approaches*, edited by J. Zinsstag, E. Schelling, L. Crump, M. Whittaker, M. Tanner, and C. Stephen, 2nd ed., 1–14. Oxford: CABI Publishing, 2020.

Brooks, N. 'Romney Marsh in the Early Middle Ages'. In *The Evolution of Marshland Landscapes*, edited by R.T. Rowley, 74–94. Oxford: University of Oxford Department for External Studies, 1981.

Bruce-Chwatt, L.J., and J. de Zulueta. *The Rise and Fall of Malaria in Europe: Historical-Epidemiological Study*. Oxford: Oxford University Press, 1980.

Bynum, C.W. 'Fast, Feast, and Flesh: The Religious Significance of Food to Medieval Women'. *Representations* 11 (1958): 1–25.

Campbell, B.M.S. *The Great Transition: Climate, Disease and Society in the Late-Medieval World*. Cambridge: Cambridge University Press, 2016.

Carey, M., and A.C Isenberg, eds. 'Beyond Weather: The Culture and Politics of Climate History'. In *The Oxford Handbook of Environmental History*, 23–51. Oxford: Oxford University Press, 2014.

Claire, W. 'Mercury's Children: Urban Schools, Pedagogy and Health Literacy in the Low Countries, c. 1200-1500'. *English Historical Review*, Forthcoming.

Coomans, J. *Community, Urban Health and Environment in the Late Medieval Low Countries*. Cambridge: Cambridge University Press, 2023.

———. 'The King of Dirt: Public Health and Sanitation in Late Medieval Ghent'. *Urban History* 46:1 (2019): 82–105.

Cunha, C.B., and B.A. Cunha. 'Brief History of the Clinical Diagnosis of Malaria: From Hippocrates to Osler'. *Journal of Vector Borne Diseases*, no. 45 (2008): 194–99.

Dagen, M. ‘History of Malaria and Its Treatment’. In *Antimalarial Agents: Design and Mechanism of Action*, edited by G.L. Patrick, 1–48, 2020.

Demaitre, L.E. *Medieval Medicine: The Art of Healing, from Head to Toe*. California: Praeger, 2013.

Dobson, M.J. *Contours of Death and Disease in Early Modern England*. Cambridge: Cambridge University Press, 1997.

———. ‘’Marsh Fever’- the Geography of Malaria in England’. *Journal of Historical Geography* 6:4 (1980): 357–89.

Harris, H. *Things Come to Life: Spontaneous Generation Revisted*. Oxford: Oxford University Press, 2002.

Hays, J.N. *The Burdens of Disease: Epidemics and Human Response in Western History*. New Brunswick: Rutgers University Press, 2009.

Hempelmann, E., and K. Krafts. ‘Bad Air, Amulets and Mosquitoes: 2,000 Years of Changing Perspectives on Malaria’. *Malaria Journal* 12 (2013): 1–14.

Hoffmann, R.C. *An Environmental History of Medieval Europe*. Cambridge: Cambridge University Press, 2014.

Huizenga, E. *Bitterzoete Balsem: Geneeskunde, Chirurgie En Farmacie in de Late Middeleewen*. Hilversum: Uitgeverij Verloren, 2004.

———. *Een Nuttelike Practijke van Cirurgien: Geneeskunde En Astrologie in Het Middelnederlandse Handschrift Wenen, Österreichische Nationalbibliothek, 2818*. Hilversum: Uitgeverij Verloren, 1997.

Inhorn, M.C., and P.J. Brown, eds. *The Anthropology of Infectious Disease: International Health Perspectives*. London: Routledge, Taylor & Francis Group, 1997.

Isenberg, A.C. ‘Introduction: A New Environmental History’. In *The Oxford Handbook of Environmental History*, edited by A.C. Isenberg, 1–20. Oxford: Oxford University Press, 2014.

Jones, L. ‘Introduction: Diseases in Historical Environments’. In *Disease and the Environment in the Medieval and Early Modern Worlds*, edited by L. Jones, 1–16. London: Routledge, 2022.

Jongen, L., and C. Schotel, eds. *Het Leven van Liedewij, de Maagd van Schiedam*. Second edition. Hilversum: Uitgeverij Verloren, 1994.

Kaaden, J.J. van der. ‘Geschiedenis van de Inheemse Malaria in Nederland’. *Infectieziekten Bulletin* 14:10 (2003): 388–93.

Kiple, K.F., ed. *The Cambridge World History of Human Disease*. Cambridge: Cambridge University Press, 1993.

Knottnerus, O.S. ‘Malaria Around the North Sea: A Survey’. In *Climate Development and History of the North Atlantic Realm*, edited by G Wefer, W.H. Berger, K.E. Behre, and E. Jansen, 339–53. Berlin: Springer, 2002.

Ladan, R. *Gezondheidszorg in Leiden in de Late Middeleeuwen*. Hilversum: Uitgeverij Verloren, 2012.

Leong, E. ‘Learning Medicine by the Book: Reading and Writing Surgical Manuals in Early Modern London’. Edited by J. Poskett. *BJHS Themes: The History of Science and the ‘Big Picture’* 5 (2020): 93–110.

Leong, E., and A. Rankin. ‘Testing Drugs and Trying Cures: Experiment and Medicine in Medieval and Early Modern Europe’. *Bulletin of the History of Medicine*, no. 91:2 (2017): 157–82.

Lund, J. ‘Thresholds and Passages: The Meanings of Bridges and Crossings in the Viking Age and Early Middle Ages’. *Viking and Medieval Scandinavia* 1 (2005): 109–35.

McVaugh, M. ‘The “Experience-Based Medicine” of the Thirteenth Century’. Edited by J.E. Murdoch, E.D. Sylla, and W.R. Newman. *Early Science and Medicine* 14:1 (2009): 105–30.

Medjroubi, K., F. Benayache, and J. Bermejo. ‘Sesquiterpene Lactones from Centaurea Musimomum. Antiplasmodial and Cytotoxic Activities’. *Fitoterapia* 76:7-8 (2005): 744–46.

Mensching, G. *Das Wunder Im Glauben Und Aberglauben Der Völker*. Leiden: Brill, 1957.
Moreira Calzadilla, C., and N. Witteman. 'Healing and Ruling in Medieval England's Wetlands'. *Network in Canadian History & Environment* (blog), 2024. https://niche-canada.org/2024/05/22/healing-and-ruling-in-medieval-englands-wetlands/.
———. 'Hidden in Plain Sight: Mosquitoes, Malaria and Herbs in the Medieval Low Countries'. *Leiden Medievalist Blog* (blog), 2024. https://www.leidenmedievalistsblog.nl/articles/hidden-in-plain-sight-mosquitoes-malaria-and-herbs-in-the-medieval-low-countries.
Muacevic, A., and J.R. Adler. 'Hyper-Reactive Malarial Splenomegaly Syndrome (HMSS)'. *Cureus* 4:11 (2012).
Munck, B. de, and H. de Ridder-Symoens. 'Education and Knowledge: Theory and Practice in an Urban Context'. In *City and Society in the Low Countries, 1100–1600*, edited by B. Blondé, M. Boone, and A.L. van Bruaene, 220–54. Cambridge: Cambridge University Press, 2018.
Nash, L. 'Beyond Virgin Soils: Disease as Environmental History'. In *The Oxford Handbook of Environmental History*, edited by A.C. Isenberg, 76–107. Oxford: Oxford University Press, 2014.
Nerlich, A.G., B. Schrout, S. Dittrich, T. Jelink, and A.R. Zink. 'Plasmodium Falciparum in Ancient Egypt'. *Emerging Infectious Diseases* 14:8 (2008): 1317–19.
Newfield, T.P. 'Malaria and Malaria-like Disease in the Early Middle Ages'. *Early Medieval Europe* 25:3 (2017): 251–300.
Nissen, P.J.A. 'De Heiligen Vriend Gods Sint Eusebius: Nederlandse Mirakelboeken Uit de Late Middeleeuwen, in Het Bijzonder Het Arnhemse Mirakelboek van Sint Eusebius, Als Bron van Volksgeloof'. *Volkskundig Bulletin* 12:2 (1986): 283–317.
Ormos, I. 'The Theory of Humours in Islam'. *Quaderni Di Studi Arabi* 5/6 (1988): 601–7.
Östling, J., D.L. Heidenblad, and A.N. Hammar, eds. *Forms of Knowledge: Developing the History of Knowledge*. Lund: Nordic Academic Press, 2020.
———, eds. *Knowledge Actors: Revisiting Agency in the History of Knowledge*. Lund: Nordic Academic Press, 2023.
Östling, J., E. Sandmo, D.L. Heidenblad, A.N. Hammar, and K. Nordberg, eds. *Circulation of Knowledge: Explorations in the History of Knowledge*. Lund: Nordic Academic Press, 2018.
O'Sullivan, A. 'Europe's Wetlands from the Migration Period to the Middle Ages: Settlement, Exploitation, and Transformation, Ad 400–1500'. In *The Oxford Handbook of Wetland Archaeology*, edited by F. Menotti and A. O'Sullivan, 26–53. Oxford: Oxford University Press, 2012.
O'Sullivan, A., and R. van de Noort. 'Places, Perceptions, Boundaries and Tasks: Rethinking Landscapes in Wetland Archaeology'. In *Archaeology Form the Wetlands: Recent Perspectives. Proceedings of the 11th Annual WARP Conference*, 79–89, 2007.
Packard, R.M. *The Making of a Tropical Disease: A Short History of Malaria*. Baltimore: Johns Hopkins University Press, 2007.
Paraskevas, G.K., K.N. Koutsouflianiotis, Z. Nitsa, T. Demesticha, and P. Skandalakis. 'Knowledge of the Anatomy and Physiology of the Spleen throughout Antiquity and the Early Middle Ages'. *Anatomical Science Journal* 91:1 (2016): 43–55.
Paroubek-Groenewoud, R., and C. van Rhijn, eds. *De Inventieve Middeleeuwen: Praktische Kennis En Kunde van Voor Het Jaar 1000*. Hilversum: Uitgeverij Verloren, 2023.
Paulissen, M., R. van Beek, and E.H. Huijbens. 'How Bogs Made for Borderlands: The Eastern Low Countries, c. 670 – c. 1900 Ce'. *Environment and History* 30:2 (2024): 211–40.
Paulissen, M., R. van Beek, S. Nekrassoff, E.H. Huijbens, and T. Spek. 'Dire Necessity or Mere Opportunity? Recurrent Peat Commercialisation from Raised Bog Commons in the Early Modern Low Countries'. *International Journal of the Commons* 15:1 (2021): 100–118.

Paulissen, M., R. van Beek, M. de Wit, M. Jacobs, and F. Huisman. ‘Place Meanings of Dutch Raised Bog Landscapes: An Interdisciplinary Long-Term Perspective (5000 BCE Present)’. *Landscape Research* 47:8 (2022): 1071–86.

Philippa, M., F. Debrabandere, A. Quak, T. Schoonheim, and N. van der Sijs. *Etymologisch Woordenboek van Het Nederlands*. Amsterdam: Amsterdam University Press, 2003.

Pihura, S. ‘Conceptions, Uses, and Transformations of Wetland Environments in England c.1000-1400’. For the degree of Doctor of Philosophy, McGill University, 2022.

Piperaki, E.T. ‘Malaria Eradication in the European World: Historical Perspective and Imminent Threats’. In *Towards Malaria Elimination - A Leap Forward*, edited by S. Manguin and V. Dev, 316–35. London: IntechOpen, 2017.

Poser, C.M., and G.W. Bruyn. *An Illustrated History of Malaria*. New York: Parthenon Publishing Group, 1999.

Pounds, N.J.G. ‘Population and Settlement in the Low Countries and Northern France in the Later Middle Ages’. *Revue Belge de Philologie et d’Histoire* 49:2 (1971): 369–402.

Rao, Y., D. Zhang, and R. Li. *Tu Youyou and the Discovery of Artemisinin: 2015 Nobel Laureate in Physiology or Medicine*. Singapore: World Scientific Publishing, 2017.

Rippon, S. ‘Human Impact on the Coastal Wetlands of Britain in the Medieval Period’. In *Landscapes or Seascapes? The History of the Coastal Environment in the North Sea Area Reconsidered*, edited by E. Thoen, G.J. Borger, A.M.J. De Kraker, T. Soens, D. Tys, L. Vervaet, and J.T. Henk, 333–51. Turnhout: Brepols, 2013.

Sallares, R. *Malaria and Rome: A History of Malaria in Ancient Italy*. Oxford: Oxford University Press, 2002.

Schats, R. ‘Developing an Archaeology of Malaria. A Critical Review of Current Approaches and a Discussion on Ways Forward’. *International Journal of Paleopathology*, no. 41 (2023): 32–42.

———. ‘Malaise and Mosquitos: Osteoarchaeological Evidence for Malaria in the Medieval Netherlands’. *Analecta Praehistorica Leidensia* 45 (2015): 133–40.

Scott, R.A. *Miracle Cures: Saints, Pilgrimage, and the Healing Powers of Belief*. California: University of California Press, 2010.

Seventer, H.A. van. *The Disappearance of Malaria in the Netherlands*. Zwanenburg: A & S Foddegan, 1969.

Siraisi, N.G. *Medieval and Early Renaissance Medicine: An Introduction to Knowledge and Practice*. Chicago: University of Chicago Press, 1990.

Soens, T. ‘Floods and Money: Funding Drainage and Flood Control in Coastal Flanders from the Thirteenth to the Sixteenth Centuries’. *Continuity and Change* 26:3 (2011): 333–65.

Soens, T., E. Thoen, and P. Brassley. *Struggling with the Environment: Land Use and Productivity*. Turnhout: Brepols, 2015.

Stannard, J. *Herbs and Herbalism in the Middle Ages and Renaissance*. Edited by K.E. Stannard and R. Kay. Ashgate: Ashgate Publising Limited, 1999.

———. ‘Medieval Herbalism and Post-Medieval Folk Medicine’. *Pharmacy in History* 55:2/3 (2013): 47–54.

———. ‘The Herbal as a Medical Document’. *Bulletin of the History of Medicine* 43 (1969): 212–20.

———. ‘The Theoretical Bases of Medieval Herbalism’. *Medical Heritage* 1 (1985): 1–9.

Stofberg, S.F., A. Klimkowka, M. Paulissen, J.P.M Witte, and S.E.A.T.M van der Zee. ‘Effects of Salinity on Growth of Plant Species from Terrestrializing Fens’. *Aquatic Botany* 121 (2015).

Swellengrebel, N.H., and A. de Buck. *Malaria in the Netherlands*. Amsterdam: Scheltema & Holkema, 1938.

Van Dam, P.J.E.M. ‘Sinking Peat Bogs: Environmental Change in Holland, 1350-1550’. *Environmental History* 6:1 (2001): 32–45.

Veen, P.A.F. van, and N. van der Sijs. *Etymologisch Woordenboek: De Herkomst van Onze Woorden*. 2nd ed. Utrecht: Van Dale Lexicografie, 1997.

Verbrugghe, G., W. De Clercq, and V. Van Eetvelde. ‘Row Settlements and Landscape Reclamations in the Medieval County of Flanders’. *Journal of Historical Geography* 70 (2020): 47–64.

Wallis, F., ed. *Medieval Medicine: A Reader*. Toronto: University of Toronto Press, 2010.

Vos, p. et al., A*tlas van Nederland in het holoceen. Landschap en bewoning vanaf de laatste ijstijd tot nu*, 2018.

Weeda, C. ‘Pestilential Insects and Public Health in Europe c. 1100-1600: Ideas, Practices, Programs’, forthcoming.

W.H. TeBrake. ‘Land Drainage and Public Environmental Policy in Medieval Holland’. *Environmental Review* 12:3 (1988): 75–93.

Wils, T.H.G., J.J.H. van den Akker, M Korff, G. Bakema, D.L.T. Hegger, R. Hessel, M.A. van den Ende, M.M.W. van Gils, and D. Verstand. ‘Measures to Reduce Land Subsidence and Greenhouse Gas Emissions in Peatlands: A Dutch Case Study’. *Land Use Policy* 152 (2025): 1–18.

World Health Organisation. ‘Malaria’, 29 June 2025. https://www.who.int/news-room/fact-sheets/detail/malaria.