A CHANGING CURRICULUM: PHARMACOLOGICAL TEXTS AT THE UNIVERSITY OF PARIS IN THE TWELFTH AND THIRTEENTH CENTURIES

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Over the course of the Middle Ages, pharmacology changed considerably. In the Early Middle Ages, pharmacology comprised little theory. Certain herbs treated certain ailments, but there were few theoretical underpinnings to the applications of specific herbs. With translations of Greek medical texts and their Arabic commentaries in the twelfth and thirteenth centuries, however, pharmacology became more and more theoretical and, consequently, more and more complex (1).

The theory, newly imported from the Islamic world via the Iberian and Italian peninsulas, stated that a medical simple, or individual ingredient, could be hot or cold and wet or dry; its intensity of hotness/coldness and dryness/wetness was then measured on a four-degree scale. A single drug, therefore, could be cold in the second degree and wet in the first degree. Such a drug would be used to treat a disease that was an excess of heat and dryness. This system was made more complex by the fact that simples could interact with other simples, and simples could even react differently according to the complexions of the individual patients. Still more complexity was added due to the idea that different, coexisting symptoms would require different simples of varying characteristics, which could then interact with and change each other (1). Referring to the increasing complexity of theoretical pharmacology, the historian of medicine John Riddle argues that "medieval medical theory became so complex as to be unworkable" (1).

In his article "Theory and Practice in Medieval Medicine," Riddle argues that scholastically trained physicians in the High and Late Middle Ages became more medical theoreticians than prescribers of drugs. Riddle states (1)

> A study of early fifteenth-century *consilia*, that is, medical opinions, written by very learned Italian physicians, reveals that the prestigious physicians frequently did not even see the patient… The medicine of most of our documents is more concerned with scholastic discourse than with the patient.

The university-trained medieval physician, therefore, seems to have practiced little actual medicine and focused instead on scholastic pursuits. Riddle's analysis of university-trained physicians, however, relies on *consilia*, which provide insight into the thinking of esteemed physicians but little as to the actual practices of the majority of university-trained physicians. Rather than *consilia* and treatises, which indeed show increasing pharmacological complexity, the curriculum at the University of Paris can provide evidence as to whether the *average* university-trained physician was more pharmacological theoretician or prescribing practitioner.

The curriculum at the University of Paris constitutes what a medieval medical student needed to know in order to practice medicine, the reason for which students attended lectures in the medical faculty. Although a doctorate in medicine was technically a license to teach, a doctorate was an inarguable qualification to practice

(2). Indeed, even lecturers in medicine gained most of their income through practicing medicine rather than through student fees (2). If university-trained physicians turned to the construction of theoretical arguments over practice in the thirteenth and fourteenth centuries, then one would expect that early university curricula would be less theoretical while later curricula would involve more and more theory. The statutes and the curricula at the University of Paris, however, suggest that the average practicing, university-trained physician was indeed prescribing medicines and that the required texts for students did not become more theoretical. First, statutes which required apothecaries to follow the instructions of the prescribing physicians clearly indicate that university-trained physicians were prescribing drugs. Furthermore, by comparing the University of Paris curricula from c. 1180 and c. 1270, it becomes clear that the university reacted to the increasing complexity of pharmacological theory by having its students focus less on constituents of medicines and more on predetermined compound medicines; the students, therefore, learned not the basics to concoct their own compound medicines, but instead lists of compound medicines whose ingredients had already been selected. Although some physicians busied themselves with scholarly writing, the average university-trained medical practitioner need not have worried about complex pharmacological theory and could instead prescribe compound medicines to his patient.

Practice and Curriculum

As explicated above, medical students at the University of Paris were training primarily to practice medicine. By examining the statutes of the University of Paris, it is apparent that this practice involved prescribing drugs. A 1271 statute from the *Chartularium universitatis Parisiensis* states that apothecaries must follow the instructions of licensed physicians and not prescribe their own drugs (3):

> Also, since certain manual operators make or possess some confections but totally ignore their cause and reason, nay do not even know how to administer them and the relation which medicines have to disease, especially in all particular respects, since those matters are reserved exclusively to the industry of the skilled physician… therefore we strictly prohibit that any male or female surgeon, apothecary or herbalist, by their oaths presume to exceed the limits or bounds of their craft secretly or publicly or in any way whatsoever, so that the surgeon can engage only in manual practice and as pertains to it, the apothecary or herbalist only in mixing drugs which are to be administered only by masters in medicine or by their license.

Moreover, this restriction of apothecaries to the supervision of physicians does not wane as pharmacological theory becomes more complex. In 1422, an oath required apothecaries to follow the instructions of the prescribing physicians (4):

> All herbalists existing in Paris had been summoned and swore as follows… That they will not substitute one drug for another in any prescription except by permission of the master giving the prescription, but will adhere strictly to the prescription as given, and if they do not have any herb or drug listed in the prescription, they will refer the matter to the master who ordered it, that he may see about it.

The evidence indicates, therefore, that physicians were prescribing drugs to their patients, even when pharmacological theory became "unworkable." What kind of drugs would a university-trained physician have prescribed and were prescriptions affected at all by the increasing complexity of pharmacology? The curricula at the University of Paris can provide answers to these questions.

The medical curricula at the University of Paris are known for c. 1180 and c. 1270. The earlier curriculum is provided in the *Sacerdos ad altare*, a text which Charles Haskins ascribes to Alexander Neckam, a student and teacher at Paris in the last decades of the twelfth century (5). On the required medical texts, Neckam states (6):

> Whoever desires to undertake the study of medicine—so very useful to the needs of the children of Adam—let him hear [lectures on] Joannitius and both the *Aphorisms* and *Prognosis* of Hippocrates, and the *Tegni* of Galen and the *Pantegni*. The author of this book is Galen, but the translator is Constantine. He should also read the *Particular Diets* as well as the *Universal Diets* of Isaac, as well as the *Book of Urines* [of Isaac?] and the *Viaticum* of Constantine, along with the *Book of Urines* [of Theophilus] and the *Book of Pulses* [of Philaretus], and Dioscorides and Macer, who discuss the natures of herbs, and the books of Alexander [of Tralles].

This above excerpt provides seventeen texts which the medical student in Paris needed to learn. This list of texts can then be compared with the curriculum from c. 1270, provided in a statute in the *Chartularium universitatis Parisiensis* (7, 8):

> This is the form of licenciating bachelors in medicine… The form as to texts heard is that he should have heard twice in ordinary lectures the art of medicine and once cursorily except the *Urines* of Theophilus, which it is enough to have heard once

> ordinarily or cursorily; the *Viaticum* twice in ordinary lectures, the other books of Isaac once in ordinary, twice cursorily, except the *Particular Diets* which it is sufficient to have heard cursorily or ordinarily; the *Antidotarium Nicholai* once. The *Verses* of Egidius are not on the form. Also he should have read one book of theory and another of practice. And to this he should swear; if, moreover, anyone is convicted of perjury of lying he can be refused the licentiate.

In the above statute, the "art of medicine" refers to seven canonical texts, and the "other books of Isaac" refers to four texts by Ishaq al-Isra'ili, known as Isaac Judeus in the Latin West (9). The two curricula are compared in Table 1.

As is shown is Table 1, the curriculum was relatively unchanged: ten of the fourteen texts prescribed c. 1180 were retained in the c. 1270 statute, and only three texts were added (10).

When one examines only the pharmacological texts, however, a very different picture emerges. Two pharmacological texts are prescribed for medical students c. 1180: the texts of Dioscorides and Macer. The c. 1270 statute requires neither of these, replacing them with the pharmacological *Antidotarium Nicolai*. Furthermore, when one examines the structure and content of these texts, it becomes clear that the *Antidotarium Nicolai* is a very different type of pharmacological text than those of Dioscorides and Macer.

Table 1. A comparison of the medical curricula at the University of Paris, c. 1180 and c. 1270.

Text	**c. 1180**	**c. 1270**
Isagoge of Joannitius	yes	yes ("art of medicine")
Hippocratic *Aphorisms*	yes	yes ("art of medicine")
Hippocratic *Prognosis*	yes	yes ("art of medicine")
Hippocratic *De regimine acutorum*	no	yes ("art of medicine")
Tegni of Galen	yes	yes ("art of medicine")
Pantegni of Haly Abbas (9)	yes	no
Universal Diets of Isaac Judeus (Ishaq al-Isra'ili)	yes	yes ("other books of Isaac")
Particular Diets of Isaac Judeus	yes	yes ("other books of Isaac")
Book of Urines of Isaac Judeus	yes	yes ("other books of Isaac")
Fevers of Isaac Judeus	no	yes ("other books of Isaac")
Viaticum of Isaac (Ibn al-Jezzar) (9)	yes	yes
Book of Urines of Theophilus	yes	yes ("art of medicine")
Book of Pulses of Philaretus	yes	yes ("art of medicine")
Books of Alexander of Tralles	yes	no
Dioscorides	yes	no
De viribus herbarum of Macer (9)	yes	no
Antidotarium Nicolai	no	yes

The Texts

The text Alexander Neckam describes as "Macer" undoubtedly refers to the Latin poem *De viribus herbarum*, which describes the medicinal properties of individual herbs, i.e. medical simples (9). For example, the entry for garlic, or Allium, is 35 lines and begins thus (11):

> In Latin the Greek Scordeon argive is called Allium,
> Experienced physicians place its hot and dry virtues
> In the fourth degree. By itself or when mixed
> It cures bites which snakes and scorpions inflict.
> When applied with honey, it cures dog bites,
> And when it is ground up poisonous worms are driven away by its odor...

While garlic has "hot and dry virtues," another herb, purslain or Portulaca, is described as having the opposite properties:

> Andrachne in Greek is what is called Portulaca in Latin
>
> It is usually spoken of by most people as chicken-foot.
>
> Its virtue is said to be humid and cold, for
>
> It has humor in the third degree, coldness in the Second (11).

De viribus herbarum similarly describes 74 other plants, explicating their medicinal "virtues" and uses, occasionally providing their transliterated Greek names, and even espousing appeals to ancient authorities (12). *De viribus herbarum* goes further in that it describes how to prepare the simples as well. The reader is instructed to cook (13), boil (14), grind (15), and even combine the simples with other ingredients (16).

The poem was attributed to a Macer Floridus, though the name has more to do with the content of the poem than with the actual identity of the author (17). The author most likely wrote the poem between 1070 and 1112, and he was probably a physician who lived near Meung, not far from Paris where students would study his work (17).

While the text Neckam refers to as Macer is clear enough, the text associated with Dioscorides is much less certain. Dioscorides was a Greek physician in the first century CE known mostly for his extensive pharmacological work *De materia medica,* which was translated into Latin in either the late Roman period or the Early Middle Ages. This Latin rendering of *De materia medica*, however, is certainly not the text Neckam is referencing since there are no extant manuscripts of this text after the tenth century (18). Two texts are much more likely candidates: *Ex herbis feminis* and the Latin Alphabetical Dioscorides.

Ex herbis feminis is a relatively short pharmaceutical treatise describing 71 herbs. Written in the fifth or sixth century, its author was not actually Dioscorides, though it was attributed to him in the Middle Ages; the author certainly used Dioscorides's *De materia medica* as a source, however. The author was most likely from southwestern Europe because the majority of the 71 herbs described are native to that region (19). Like *De viribus herbarum*, *Ex herbis feminis* presents medical simples, the building blocks of more complex compound medicines.

The second possible text of Dioscorides, the Latin Alphabetical Dioscorides, also presents medical simples, though it contains many more simples than *Ex herbis feminis*. With 696 entries, the Latin Alphabetical Dioscorides describes almost 10 times as many simples as *Ex herbis feminis*, and the work is more directly based on Dioscorides's *De materia medica* as well (18). Composed in Salerno in the late eleventh or early twelfth century, the Latin Alphabetical Dioscorides is a Latin rendering of Dioscorides's *De materia medica* (18). Its Salernitan author brought the text up to date by adding commentary to certain entries and sometimes even adding entirely new entries; Riddle estimates that about 30% of the Latin Alphabetical Dioscorides is new content (18).

It is difficult to tell which text Neckam is referring to when he mentions Dioscorides; both *Ex herbis feminis* and the Latin Alphabetical Dioscorides were available and circulating at the time. Despite this uncertainty, one aspect that both texts, and indeed even Macer's *De viribus herbarum*, have in common is that all describe medical simples, not compound medicines. Thus, it is clear that the pharmacological curriculum c. 1180 for medical students in Paris comprised the study of medical simples. University-trained physicians of the twelfth century, therefore, needed to either administer simples alone or devise their own combinations of simples.

Conversely to Neckam, the c. 1270 statute was explicit about which pharmacological text medical students needed to learn: the *Antidotarium Nicolai*. Composed between 1125 and 1130 at Salerno, this text would have been relatively new c. 1270 (20). The text was based on the *Antidotarium Magnum*, a massive text of over twelve hundred remedies compiled at Salerno c. 1100. The *Antidotarium Magnum* was an assemblage of local remedies, i.e. those from southern Italy, and remedies from both Byzantine and Arab traditions (20). The *Antidotarium Nicolai* is a distillation of the larger tome, reproducing around 150, or about an eighth, of the remedies presented in the *Antidotarium Magnum* (20).

The *Antidotarium Nicolai* comprises compound medicines, i.e. medicines with multiple ingredients. For example, one recipe in the *Antidotarium Nicolai* is for the Great Rest which is composed of 17 ingredients (21):

> It is called rest because it offers rest to patients, and it offers periodic sleep especially to those suffering daily, tertian, quartan, and very acute fevers. Six parts are made from one pound. Take three drams each of roses and violets; one dram and a half each of opium, henbane, meconium of white (opium) poppy, mandrake, wild lettuce, seeds of purslane, fleawort, nutmeg, cinnamon, and sugar. Two scruples and five grains of white and red and citric sandalwood, ash, and tragacanth. Give with violet syrup to patients suffering acute fever; we can give it to them intermittently mixed with honey. It is given to those suffering quartan fevers with warm wine when the fever is

> acute or severe, and to these suffering tertian fever with warm water or syrup. The Rest is an opiate that is cold. It is especially good for inducing sleep when an amount of the size of a chestnut is given… It should also be added that from the different ingredients of this medicine a syrup is made that is very good for inducing sleep. And of course some ingredients they boil in water, crush, strain, and add sugar to make a syrup. This also can be given to those suffering from acute fevers for inducing sleep.

Other compound medicines in the *Antidotarium Nicolai* are similar, containing multiple ingredients and explicitly stating the amounts needed for the construction of the recipe. The text additionally provides information about the preparation (22) and administration of the recipe and the recipe's basic properties, but it is silent on the properties of the recipe's constituents. The recipe for the Great Rest only mentions the properties of the constituents vaguely: some ingredients of the Great Rest can be used to make a syrup. Without delimiting which ingredients are necessary for the syrup, the recipe does not so much provide information on the ingredients as it provides another method of preparing the same compound medicine. As this example demonstrates, the *Antidotarium Nicolai* is unconcerned with medical simples and their individual properties; instead, it presents predetermined compound medicines.

Curricular Changes

The most apparent change in the pharmacological curriculum at the University of Paris from c. 1180 to c. 1270 is the switch from teaching medical simples to compound medicines. The increasing complexity of pharmacological theory left no room for doubt that administering compound medicines was superior to prescribing only medical simples. A commentary on the *Antidotarium Nicolai* ascribed to Matthaeus Platearius, a twelfth-century Salernitan physician, presents compound medicines as superior to medical simples in five ways: compound medicines provide greater efficacy, they can treat a combination of illnesses, they can repress the harmful properties of their constituent ingredients, they keep well, and due to the addition of honey or sugar they can taste better than simples. The commentator states (23, 24):

> Great efficacy is a reason [for compounding medicines], since some illnesses are compound and cannot be cured with one medicine alone… Combination of illnesses is a reason, since some illnesses are hot, others cold, yet both can exist together in the human body... [Compounding is needed] in order to repress harmful properties, since some medicines, such as solutive ones, are harmful and sharp, and cannot be taken internally by themselves unless they have previously been mixed with others to repress their sharpness and harmfulness… Compounding is necessary to preserve medicines, since some are naturally humid and quickly decay, so that unless they are mixed with others they cannot be used… Compounding is necessary because of a horrible taste… therefore sweet things must be mixed with them to repress their abominable, horrible taste, such as honey and sugar.

Therefore, it seems unsurprising that the curriculum at the University of Paris would move toward compound medicines over medical simples. This progression toward compound medicines, however, does not mean that the students were necessarily grappling with pharmacological theory. Importantly, the teaching of compound medicines and the disregard for medical simples indicates that the curriculum at the University of Paris was not preparing the medical students to be able to devise their own compound medicines; instead, the students were learning predetermined recipes. This movement away from teaching students the pharmaceutical building blocks may be due to the increasing complexity and unworkability of pharmacological theory—the average university-trained physician would not wish to bother with such complexities. This evidence directly contradicts the idea that university-trained physicians were more concerned with scholastic discourse than prescribing medicines; instead, the evidence suggests that, although university-trained physicians embraced compound medicines, many could have completely ignored the complex, unworkable pharmacological theory.

Additional evidence that university-trained physicians by the end of the thirteenth century no longer cared for medical simples can be seen when one examines and compares the individual ingredients of Macer's *De viribus herbarum* and the *Antidotarium Nicolai* (25). First, the simples described in *De viribus herbarum* are not used often in the *Antidotarium Nicolai*. Second, fewer herbs mentioned in the *Antidotarium Nicolai* would have been available in Paris than herbs mentioned in *De viribus herbarum*, indicating that many of the ingredients in the *Antidotarium Nicolai* would have been substituted for other ingredients. These data indicate that individual simples and their specific properties became less important over the course of the thirteenth century, further implying that the University of Paris was not training its medical students to devise their own recipes but instead to prescribe pre-set remedies.

It is easy to determine which herbs *De viribus herbarum* discusses since each herb receives its own section (26). Determining the ingredients used in the *Antidotarium Nicolai*, however, is more difficult, but digital text analysis of the Latin *Antidotarium Nicolai* provides all ingredients mentioned at least four times in the text (27), and Figure 1 displays the most commonly mentioned ingredients in the *Antidotarium Nicolai*.

The most commonly mentioned ingredient in the Antidotarium Nicolai is water, occurring 119 times in the text. This result is unsurprising since the text instructs the reader to mix many of the ingredients in water. Wine, oil, and syrup were also common solvents, and occur in the text 75, 55, and 31 times, respectively. Aside from honey, which was added to sweeten many remedies, the rest of the most-mentioned ingredients in the Antidotarium Nicolai are plants.

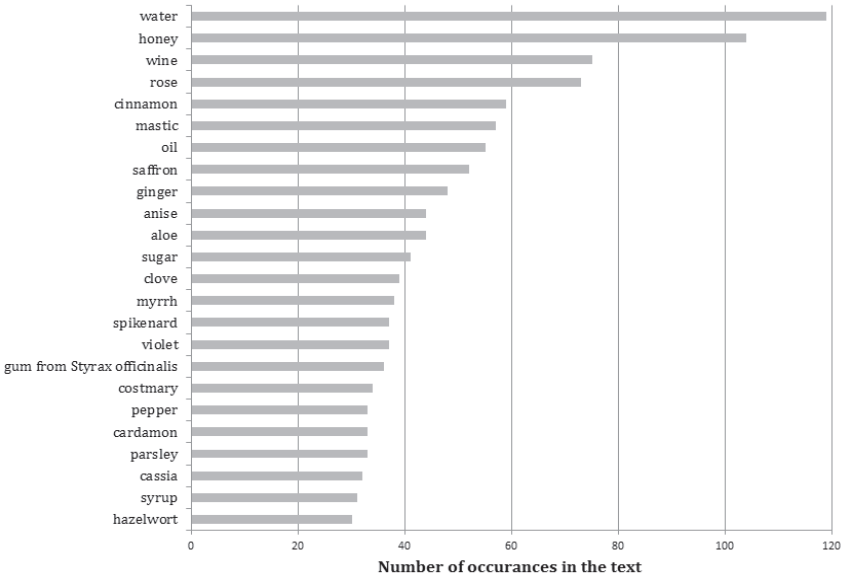

Figure 1. *Occurrences of ingredients in the* Antidotarium Nicolai. *Only those ingredients occurring ≥30 times are listed.*

When comparing the plants in *De viribus herbarum* and the plants in the *Antidotarium Nicolai*, more differences than similarities emerge. Firstly and importantly, *De viribus herbarum* and the *Antidotarium Nicolai* employ different herbs. Of the 76 non-spurious simples in *De viribus herbarum*, 52 simples (68%) occur fewer than 10 times in the *Antidotarium Nicolai*. Indeed, 22 simples (29%) do not appear in the *Antidotarium Nicolai* at all (see Figure 2).

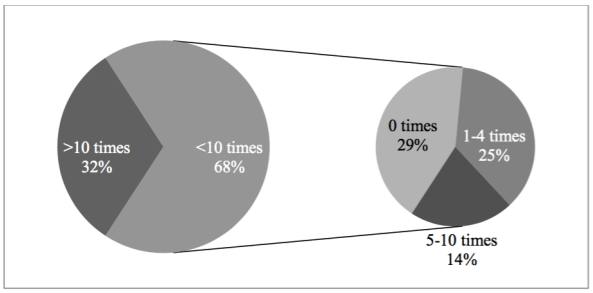

Figure 2. *Occurrences of* De viribus herbarum *simples in the* Antidotarium Nicolai. *The percentages are the proportions of* De viribus herbarum *simples out of 76 total simples.*

Given these data, it is clear that *De viribus herbarum* and the *Antidotarium Nicolai* are exposing the University of Paris medical students to very different medicinal herbs. The variances between these texts extend beyond the mere fact that they expound different herbs, however. Importantly, more herbs from *De viribus herbarum* than from the *Antidotarium Nicolai* would have been able to grow in Paris. When one compares the geographical distributions of the *De viribus herbarum* simples and the herbs mentioned more than 30 times in the *Antidotarium Nicolai*, a distinct trend emerges: the *Antidotarium Nicolai* herbs are from more southerly regions than the *De viribus herbarum* simples (see Figures 3 and 4) (28).

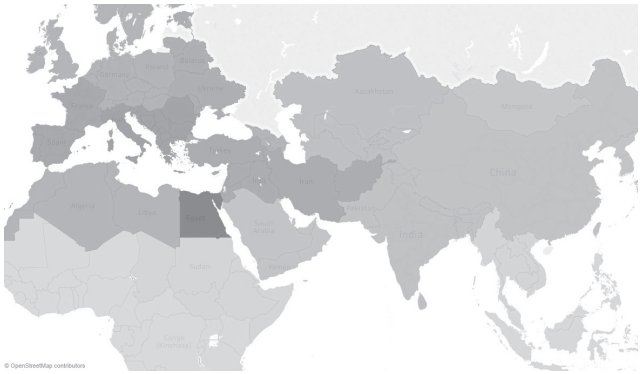

Figure 3. *Geographic distribution of herbs mentioned in* De viribus herbarum. *Produced using Tableau Public version 10.2 (29). A darker shade indicates that more ingredients mentioned in* De viribus herbarum *are present in that region. For reference, 24 ingredients are found in the Democratic Republic of the Congo (light shade), whereas 79 are found in Italy (dark shade).*

Figure 4. *Geographic distribution of herbs mentioned in the* Antidotarium Nicolai. *Produced using Tableau Public version 10.2 (29). This map is weighted based on the number of occurrences in the* Antidotarium Nicolai. *For example, rose occurs 73 times in the text and is thus worth 73, while hazelwort occurs only 30 times and therefore is worth 30. The weights for all the ingredients in each region were then summed. Darker shades indicate higher sums. For reference, Kazakhstan has a weighted sum of 345 (light shade), whereas Italy has a weighted sum of 750 (dark shade).*

The southerly shift in ingredients would have directly affected physicians, and physicians-in-training, in Paris. Looking specifically in the region of the University of Paris, 76% of the *De viribus herbarum* simples would have grown in that region. With the change in curriculum to the *Antidotarium Nicolai*, however, the proportion of locally grown herbs dropped to 60%. This drop in local herbs implies that many of the ingredients in the new compound medicines needed to be either imported, an expensive option, or substituted with local herbs. Substitution was probably not uncommon; in the thirteenth century new texts known as *Quid pro quo* began to appear (1). These texts were guides for substituting simples; thus, if a recipe called for "zinziber" or "ginger," a tropical plant which occurs 48 times in the *Antidotarium Nicolai*, a physician or apothecary could check a *Quid pro quo* text for a cheaper, locally available substitute. Indeed, substitution is mentioned explicitly in the apothecaries' oath of 1422 (4).

The change in pharmacological curriculum from *De viribus herbarum* to the *Antidotarium Nicolai*, therefore, meant two major changes in medical students' pharmacological learning. First, medical students c. 1180 learned medical simples while medical students c. 1270 learned compound medicines. Second, medical students c. 1180 would have had access to most of the specific ingredients about which they were learning, while medical students c. 1270 would have had to accept substitutes for almost half of the ingredients in their compound medicines. Both trends indicate that specific medical simples and their distinctive properties were deemphasized at the University of Paris in the thirteenth century.

Conclusion

In "Theory and Practice in Medieval Medicine," Riddle argues that pharmacology became increasingly complex in the Middle Ages, such that by the thirteenth century university-trained physicians were no longer prescribing drugs but were instead composing treatises on the symptoms of their patients. The statutes and curricula of the University of Paris, however, contradict this characterization, at least for the average university-trained physician. The statutes regarding the duties of apothecaries indicate that university-trained physicians were indeed prescribing medicines to their patients, and the medical curricula indicate that students need not have considered the complex theoretical pharmacology being espoused in the treatises of scholarly physicians.

The University of Paris medical curricula provide the crucial evidence that many university-trained physicians disregarded pharmacological theory. While "the authors of the late twelfth-century and thirteenth-century medicine reflect a steady trend toward theory" (1), the medical curricula reflect the exact opposite. The information required for students to construct their own medicines based on pharmacological theory, i.e. the properties of medical simples, ceased being taught at the University of Paris in the thirteenth century, and any theoretical pharmacy that was present in the twelfth-century curriculum was drastically reduced by the thirteenth. For example, *De viribus herbarum*, a required text in the twelfth century, says of garlic: "Experienced physicians place its hot and dry virtues/ In the fourth degree" (11). Such virtues and degrees are characteristic of the theoretical pharmacology which Riddle considers "unworkable." Therefore, knowledge of garlic being hot and dry in the fourth degree would have been required when compounding garlic with other ingredients. Conversely, the required text of the thirteenth century, the *Antidotarium Nicolai*, describes the Great Rest, a compound medicine, as "an opiate that is cold" (21). This later text provides much less theoretical information: the medicine is merely an opiate and cold. The virtues and the degrees of the individual ingredients, and even the degree of the compound medicine, are noticeably absent. Thus, as theoretical pharmacology became more and more complex, the University of Paris reduced medical students' exposure to such complexity.

The change in the medical curriculum in the thirteenth century also exposed medical students to fewer locally grown herbs, instead exposing the students to herbs exotic to the region that thus had to be imported, the expensive option, or substituted with local herbs. The appearance of *Quid pro quo* texts in the thirteenth century indicates that prescribers and patients often opted for substitution. The willing substitution of medical simples and the overall deemphasis of readily available, locally grown simples provides further evidence that physicians were not trained in the properties of simples and the process of compounding original medicines while studying at the University of Paris. The average university-trained physician, therefore, was not constructing his own compound medicines and thus was not using complex pharmacological theory when treating patients.

Riddle writes that the "general medical practitioner," i.e., those not trained in scholastic medicine, "assimilated little of the frequently unworkable theory" (1). The evidence from the University of Paris demonstrates that many university-trained physicians assimilated little of the unworkable theory as well. Despite the increasing complexity of pharmacological theory found in *consilia* and other scholastic works in the Middle Ages, the University of Paris reduced the pharmacological theory it taught to its medical students. Instead, by c. 1270 the students learned readily administrable compound medicines which needed little to no pharmacological theory to use.

References and Notes

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7. This statute was translated by Thorndike, Ref. 3, pp 81-82). The original Latin is available in *CUP*, Vol. I, no. 453, Ref. 3.
8. This statute's description of "texts heard" refers to the structure of a medieval university lecture in which the master would read a portion of the text and then provide commentary. Students acquired their own copies of the texts by copying them from exemplars held in libraries. See chapters 5 and 7 of C. O'Boyle, *The Art of Medicine: Medical Teaching at the University of Paris, 1250-1400*, Brill, Leiden, 1998, for more information on lecture structure and the availability of texts in the medical school at the University of Paris.
9. C. O'Boyle, Ref. 8.
10. F. Wallis, Ed., Ref. 6.
11. *De viribus herbarum* was translated in full by B. P. Flood, Jr., in his dissertation (B. P. Flood, Jr., Macer Floridus: A Medieval Herbalism. Ph.D. Dissertation, University of Colorado, 1968, pp 109-110 and 157-158). The original Latin is available in Macer Floridus, *De Viribus Herbarum*. L. Choulant. Ed., Leopoldi Vossii, Leipzig, 1832, pp 34-35 and 59-60, https://archive.org/details/deviribusherbaru00mace/ (accessed Mar. 27, 2019).
12. Some manuscripts of *De viribus herbarum* include twenty more spurious ingredients. The ingredients are considered spurious because they were not part of the original poem but added later. Of these spurious ingredients, twelve are plants; five are animal products, e.g., cheese and spider webs; two are minerals, i.e., sulfur and alum; and the last is vinegar (Flood, Ref. 11).
13. For example, "The vapor of the cooked herb [absinth] clears out obstructed ears." Translated by Flood (Ref. 11, p 102).
14. For example, "When boiled it [garlic] aids a cough and soothes shortness of breath." Translated by Flood (Ref. 11, p 111).
15. For example, "When it is ground up and applied with honey, it [leek] aids sores." Translated by Flood (Ref. 11, p 139).
16. For example, "If you mix nard with it [absinth], such as comes from Gaul,/ And you grind the mixture and mix it with mead,/ You will especially purge the menses by such a drink." Translated by Flood (Ref. 11, p 101).
17. B. P. Flood, Jr., "The Medieval Herbal Tradition of Macer Floridus," *Pharm. Hist.*, **1976**, *18*, 62-66.

18. J. M. Riddle, "The Latin Alphabetical Dioscorides Manuscript Group," in *Quid Pro Quo: Studies in the History of Drugs*, Variorum, Hampshire, UK, 1992, IV1-IV6.
19. J. M. Riddle, "Pseudo-Dioscorides' *Ex Herbis Feminis* and Early Medieval Medical Botany," *J. Hist. Biol.*, **1981**, *14*, 43-81.
20. F. E. Glaze, "Speaking in Tongues: Medical Wisdom and Glossing Practices in and around Salerno, c. 1040-1200," in A. Van Arsdall and T. Graham, Eds., *Herbs and Healers from the Ancient Mediterranean through the Medieval West*, Ashgate, Burlington, VT, 2012, 63-106.
21. N. Everett and M. Gabra, "The Pharmacology of Medieval Sedatives: The 'Great Rest' of the *Antidotarium Nicolai*," *J. Ethnopharmacol.*, **2014**, *155*, 443-449, doi:10.1016/j.jep.2014.05.048. The quoted recipe was translated by Everett and Gabra (p 444). The original Latin is available in W. S. van den Berg, Ed., *Eene Middelnederlandsche Vertaling van Het Antidotarium Nicolaï (Ms. 15624-15641, Kon. Bibl. Te Brussel) Med Den Latijnschen Tekst Der Eerste Gedrukte Uitgave van Het Antidotarium Nicolaï*, Brill, Leiden, 1917, p 131, https://www.dbnl.org/tekst/_ant004wsva01_01/index.php (accessed Mar. 27, 2019).
22. Preparation involved more than just mixing the ingredients. As described for the great rest, preparation could include boiling, crushing, and straining as well as grinding, dissolving, and cooking.
23. M. McVaugh, "Matthaeus Platearius (d. 1161): The Rationalization of Pharmacy," in E. Grant, Ed., *A Source Book in Medieval Science*, Harvard University Press, Cambridge, MA, 1974. The quoted commentary was translated by McVaugh (p 787).
24. Solutive refers to "a treatment which dissolves and disperses corrupt humors" (Wallis, Ref. 6, p 550).
25. The texts of Dioscorides, i.e., *Ex herbis feminis* and the Latin Alphabetical Dioscorides, were excluded from this analysis because the names of the herbs in these texts are presented in Greek transliterated into Latin letters; the corresponding Latin names are seldom given. Conversely, Macer's *De viribus herbarum* and the *Antidotarium Nicolai* use the Latin names for herbs. For example, the Modern English "plantain" is called "plantago" in *De viribus herbarum* but called "arnoglossa" in *Ex herbis feminis*. Because the analysis involves comparing the herbs present in each text by their Latin names, the Greek-named herbs in the Dioscorides texts could not be included.
26. Flood's translation of *De viribus herbarum* was used for the analysis (Ref. 11).
27. Text analysis was performed using Voyant Tools (S. Sinclair and G. Rockwell, *Voyant Tools*, 2016, http://voyant-tools.org/). The Latin version of the *Antidotarium Nicolai* used was the 1917 edition (Ref. 21).
28. In order to determine the geographic distributions of the herbs, *World Economic Plants: A Standard Reference* was used (J. H. Wiersema and B. León, *World Economic Plants: A Standard Reference*, CRC Press, Boca Raton, FL, 1999). Two caveats must be mentioned about the use of this source. The first caveat is that this is a source of modern plant distributions; plant distributions during the twelfth and thirteenth centuries may have been different from modern distributions due to climactic differences.

    The second caveat is that, since *World Economic Plants* lists plants according to their Linnaean *Genus species* names, each Latin plant name needed to be translated twice: once into Modern English and again into a *Genus species* designation. For example, the plant called "artemisia" in Latin is "mugwort" in Modern English (translation 1). According to the Common Name Index of *World Economic Plants*, "mugwort" corresponds to the species *Artemisia vulgaris* (translation 2). These translations, though necessary for the geographic analysis, could have introduced error by wrongly associating certain Latin names with specific genera or species.

    All Modern English translations of the *De viribus herbarum* herbs are based on Flood's translation of the poem (see Flood, Ref. 11). Modern English translations of the ingredients in the *Antidotarium Nicolai* are from Lewis and Short (C. T. Lewis and C. Short, *A Latin Dictionary*, Clarendon Press, Oxford, 1879, http://www.perseus.tufts.edu/hopper/text?doc=Perseus%3atext%3a1999.04.0059 (accessed Mar. 27, 2019)). All Linnaean *Genus species* designations of Modern English common plants names are based on the Common Name Index of *World Economic Plants*.
29. Due to the constraints of the software, modern country boundaries needed to be used in Figures 3 and 4; plant distributions certainly do not adhere to political boundaries, and these boundaries do not reflect the boundaries of the Middle Ages. Nevertheless, the maps allow the visualization of broad distributions. Russia was excluded from the map due to its being in multiple climactic regions.

About the Author

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