How to conquer the world? Cartographical knowledge in an early colonialist context

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Introduction

It is no coincidence that Edward Said dated the rise of Orientalism towards the end of the 18th century, nor that he prefaced his study of this phenomenon with a quotation from Karl Marx's *Eighteenth Brumaire*: "They cannot represent themselves; they must be represented." (Quante and Schweikard 2016, 130; Bartolovich and Lazarus 2002, 207).

From the very beginnings of European cartography, maps epitomized imperial representations. After Christo-centered world-views, having Jerusalem / Al-Quds in Palestine to its eschatological center, early, less mythological European ecumenical cartographies introduced a new world view that came nearer to geographical figures of the so-called old and so far, only roughly known world. A more rationalized Eurocentrism towards the 15th and 16th centuries took the place of "the holy city" as the world's center.

Early 16th-century maps, representing also parts of the "new world", not rarely projected monstrous imaginations on the territories that were known more or less in outlines of their coastal shapes. Territorial mappings were not rarely permeated with images of horror, among which "cannibals" (anthropophagy) can be traced back to ancient Greek-Roman legends. The anonymous world map, drawn probably in Italy around 1502/06 (Kunstmann II, Bavarian State Library, Munich) is one of the oldest maps showing the "New World" (Bischoff, Lüpkes and Schönlau 2015, 200). Westwards of the Brazilian coastline the map shows a white man roasted over a fire. The stereotype of cannibalism was inscribed as a kind of archetype in European imagination for hundreds of years. Unknown territories were, while being mapped, suffused with fear. Legends of cannibalism continued into the image of Terrae Incognitae up to the new wave of colonial conquest of the first half of the 20th centu-

ry. But, how did the knowledge evolve, which was necessary to draw maps and to sail open seas? More or less precise maps in Europe are only of a recent date.

Till the present day, cartographical world views are under debate, not least when it comes to the necessity to decolonize the understanding of the mapping of the world. A decolonial initiative in England recently demanded the replacement of Eurocentric maps with the *Peters Projection*. Arguing with the historian and cartographer Arno Peters who emphasized "that Mercator maps were giving White Nations a sense of Supremacy over Non-White Nations" (Blake 2018), the initiative demanded the replacement of the use of Eurocentric maps in schools with world maps based on the Peters Projection. Arno Peters has introduced the cartographic projection based on the undistorted size of the continental areas in *Der europa-zentrische Charakter unseres Weltbildes und seine Überwindung* [The Europe-centered Character of our Geographical View of the World and its Correction] (1976).

In *The Darker Side of Western Modernity* Walter Mignolo discusses the "early modern" Dutch geographers, among them Abraham Ortelius whose cartographies were adopted by famous Gerhard Mercator—the Mercator projection is until today the mathematical basis of Eurocentric world maps. He underlines that "the cartographic breakthrough of the 16th century was to displace and replace, on the one hand, the ethnic center with the geo-

metric center, by which coexisting territorialities beyond Western intellectual history were relegated to the past. (It appears as if only Western cartography continued its historical march.)" (Mignolo 2011, 186). In his study *The Idea of Latin America* (2006), Mignolo has already shown that mapping the world corresponded with the colonial matrix of power, going hand in hand "with the triumphal march of European, supposedly universal, history" (26).

In the following I will focus mainly on colonial robberies and adaptions of sciences mainly of Arabic provenience-es, enabling European mapmaking to advance to mathematical geographies of the world, which were nearer to realities. In this context a differentiation between sciences in the North or West and knowledges in the South and the rest of the world is misleading. Enrique Dussel emphasized that discontinuity, in the sense of the rise of new spatial particularities, Europe's self-differentiation from Africa, the Maghreb, the Byzantine Empire and the Middle East was introduced by the crusaders and the European attempts to dominate the Mediterranean. Europe's imagined splitting off from a wider embeddedness in the Mediterranean and its hinterlands went hand in hand with the adoption of Arabic-shaped philosophy (Aristoteles), which reached Paris from Toledo by the end of the 12th century (Dussel 2000, 466). Sciences did not have their offspring in Europe as Eurocentric master narratives make believe, for which astronomical, nau-

tical, geographical, and cartographic sciences will serve as an example outlined in this article.

The fall of the Roman Empire has led to a disappearance of ancient sciences in Europe, and they were reinvented mainly by adopting Arabic sources via Latin translations. In the fields of geography, cartography, and nautical sciences, the early colonial soaking up of all knowledge, useful to conquer by sea and by land, enabled Spanish and Portuguese crusaders to set foot on the coasts and islands of the Americas. Against this background I will, elaborating on the necessary decolonization of the history of science—here especially of so-called European discoveries and related scientific disciplines—introduce a counter-universal approach to the Eurocentric master narrative. While decentering arrogant European self-assertions, claiming that "early-modern" sciences arose out of a mysterious self-creation, my discussion of decisive contributions of Arabic sciences to geography, cartography, and nautical sciences will shed new light on the conditions and necessary premises for the colonial crusaders to sail open seas and find lands to conquer. This also holds true for orientation on the lands that were desired for colonial possession. And, I argue, the colonialist appropriation and adaption of science and knowledge in the South was a continuous process that did not end in what Eurocentric periodization of history calls "modernity".

When "exploring" the Caspian Sea in 1829, Alexander von Humboldt was aware that precise geographical coordinates trace back to Arabic sources from the 11th to the 15th centuries (Quintern 2018, 434) As in the first half of the 18th century Central Asia was among many other territories of the world still unknown lands to Europeans. Alexander von Humboldt had originally planned to participate in the French so-called "expedition" in Egypt in December 1798, which should give rise to European practices of studying and mapping, and thus knowing and colonizing the "other" that Said has so astutely described as Orientalism (1978). Because of diplomatic-political considerations in the context of the acute situation in the Mediterranean as a result of the French military campaign, Humboldt changed his travel plans at a short notice.

The French colonial invasion of Egypt in 1798 was prepared in Paris by a group of orientalist scholars who intensively studied Arabic sources, among which was *al-Khiṭaṭ*, a history and geography of Mamluk Egypt/ Cairo written by al-Maqrīzī (1364-1442). The book *al-Khiṭaṭ* was translated into French and then compiled for the French *Description de l`Égypte* (Brett 2015, 245).. The Description served as a kind of manual for the French conquerors who were unfamiliar with the country along the Nile and depended on such indigenous Arabic written knowledge while invading Egypt. Assimilating Arabic history, topography and geography into their own

early canon of knowledge, the invaders began to represent Arabian knowledge cultures at the same time. In his groundbreaking study *Orientalism* Said deciphered the orientalist and Eurocentric discourse of the 'Orient' as an imagined geography (Said 1979: 49-73). The imperial knowledge system became not only a monologue but claimed for itself authorship of scientific writings and maps.

Now, it is necessary to research the contributions of the Arab world, and the Global South, to a pluri-universal cultural heritage in literature, philosophy, art, music, medicine, humanities and the natural sciences[1]. In order to overcome Eurocentric self-assurances, postcolonial knowledge production needs interdisciplinary efforts, for example regarding the history of so-called discoveries, sciences and values, such as humanism, and, indeed, the history of modernity itself (cf. Dussel 2000). The Renaissance, to which early modernity and humanism are assigned, is a destructive period from a non-Eurocentric, decolonial point of view. The conquest of America, Asia, Africa and Oceania was possible thanks to the adaption of mainly Arabic knowledge, particularly geography and cartography, besides nautical sciences, shipbuilding and other disciplines. After the so-called Crusades from the end of the 10th century onwards, first of Al-Andalus and, less than a hundred years later, of Palestine, it took centuries before a new colonial wave was initiated to cross the open seas towards 'unknown'

worlds. The assimilated Arabic knowledge empowered the Europeans to cross the Atlantic; furthermore, agricultural techniques, for example the plantation of rice, which came with enslaved people from West Africa to the Carolinas and the Mississippi Delta, helped the early settlers to survive in the New World.

In this article, I will focus mainly on geographical and cartographical knowledge and mention only some aspects of agricultural knowledge and techniques that are related to the early colonial plantation system. Sciences and techniques were mainly handed down from Arabic sources after being translated first into Latin and Hebrew, then into upcoming Spanish, Portuguese and Italian. Arabic was the *lingua franca* in Al-Andalus, the Iberian Peninsula, for nearly seven hundred years, especially in science and philosophy.

From Al-Andalus to Abya Yala

When the Spanish *conquistador* Hernán Cortés landed on Mexico's eastern coast of Yucatan in 1519, he came across inhabitants wearing *almaizales, albornoces, and alquizales,* items of clothing with typical Moorish styles ("*en la manera Moriscos*") (Cortés 1985, 31; Cereceda 2012, 98; Gerbi 2010, 98). In his letters to Charles V he described the sacred buildings of the Aztec capital Tenochtitlan as mosques (Cortes 1908, 216). While recalling the sacral architecture of Al-Andalus, Cortés

could not imagine being anywhere else than in Arabic-Islamic lands. When reaching the Mexican coast he still believed to be in Arabic-Islamic lands. Ironically, it were the conquistadores who brought Arabic and Islamic architecture to the so called New World. The Spanish chapel of Cholula is one of the earliest examples of such architectural mixing before 1529. It was built on a sanctuary dedicated to the Mayan-Aztec deity Quetzalcoatl and based on a plan of a mosque that was inspired by the Great Mosque of Cordoba.

Christopher Columbus had already speculated in his diaries about the gracefulness of the Caribbean while often comparing it to the climate, the fauna and flora of Andalusia, which was familiar to him. It is obvious that the Spanish conquerors had only a very rough idea where they were. The early colonial imagination of the geography of the Caribbean Sea and islands was based on spheres and maps, as Columbus noted in his diary on Wednesday, October 24, 1492: "es la ysla de Cipango, de que se cuentan cosas maravillosas, y en las esp[h]eras que yo vi y en las pinturas de mapa mundos es ella en esta comarca." (Pérez and Quintana 1995, 159) ("On the spheres that I saw and on the paintings of world maps it is this region, Cipango is in this region.") (Columbus 2003, 128). Columbus assumed that his trans-Atlantic voyage would lead him to Cathay (China), Cipango (Japan), the Spice Islands (the Moluccas), and India or, more generally, to the 'Indies'. But how and from where might these

spheres and world maps have reached Columbus? Or, to be more precise, how can the geographical, astronomical and cartographical knowledge Columbus was referring to be characterized and historically contextualized?

When Columbus left Granada on May 12, 1492 with a small fleet of three vessels, only three months had passed since the Arab city conceded victory to the conquerors, having been besieged for three years—a strategy the conquistadores would soon enforce on the Aztec capital Tenochtitlan in 1519. A larger number of the Arab inhabitants of Granada fled to the surrounding Alpujarra (*al-bušarāt*) mountains. Archbishop Jiménez de Cisneros commanded, in an *auto-da-fé*, the burning of theological, philosophical and scientific Arabic-Islamic literature—interestingly he left out medical works. This sparked the Arabic uprisings lasting for around 75 years. After Jews were forced to convert to Christianity and become so-called *marranos*, compulsory baptism followed hard on the Muslims who were already 'tamed' by the religious authorities, being called accordingly *mudéjares* (from Arabic *mudaǧǧan* = tamed). From now on they were called Moriscos (Hottinger 1995, 342). The Arabic population had been given the ultimatum in 1502 to either convert or be exiled. While some fled into the nearby mountains, resisting racist persecution, others converted. These crypto-Muslims formed a new social class of 'counterfeited' Christians, who were suspected to secretly follow Islam. In 1526 all Islamic rituals and daily practices, such

as ritual slaughter or the wearing of amulets, were forbidden and racist laws were installed. For example, in case a foster mother of a new born was a so-called New Christian (*Morisca*), it was believed that her milk would make the baby's blood impure (Torres 2006, 174). Up to the fourth grade of the family tree ("*en el quarto grado*"), the 'Holy Inquisition' required 'purity of blood' (Castillo 2005, 735). These racist laws of the purity of blood *(limpieza de sangre*) extended later their scope of validity also to the New World.

Lost knowledge's pathways in early Western Europe

The Inquisition paved the way for a second large wave of deportation of the Moriscos (moors) from Spain in 1609. As a consequence of the expulsion of Moriscos, mainly to North Africa (Maghreb), Islam largely disappeared from Western Europe from 1615 onwards and Muslim communities did not reappear before the 20th century. An affluent crypto-Muslim community might have survived in Grenada until a final inquisitional 'purge' of 1727 (Catlos 2014, 303). Braudel emphasized that erasing Arabic-Islamic knowledge and culture had serious consequences also for the Spaniards. "Who will farm our land, the lords of the 'lugares de moriscos' were no doubt thinking. The expulsion, it was realized in advance, would leave serious wounds" (Braudel 1995, 795). Not least because of the lacking maintenance of

hydraulic irrigation techniques, agricultures in Spain suffered a set-back. To the contrary, the olive cultivation was improved in certain regions of Tunisia to where the Moriscos had been expelled (Glick 1996, 116). "The Moriscos", Américo Castro wrote, "were hard and skillful workers, and it is a commonplace to lament the disaster that their removal brought to agriculture and industry" (Castro 1971, 237).

The *conquistadores* would soon use slave labor and knowledge coming with enslaved people from West Africa to compensate their losses. The Portuguese had already begun to plant sugar on Madeira by 1420, and extended the plantation system to the Canaries, Azores and Cap Verde Islands in the following decades. Sugar was brought to Al-Andalus and Sicily by Arabs in the 9th century. It is another example of the assimilation of Arabic agricultural knowledge and technique, which the specific terms related to sugar weights bear witness to. For example, the Portuguese *Arroba* (one quarter) is derived from the Arabic *al-ruba*' (Lippmann 1890, 248). In the 16th century sugar mills and refinery introduced an early industrialization into Western Europe based on agricultural products. The knowledge of how to produce spirits, which became essential for later rum production, also goes back to Arabic expertise, as the distilling process was introduced for medical purposes already in the 9th century ((al)cohol = Arabic *(al)-Kuhul*,) (Poppe 1837, 71). The extension of sugar, rice and cotton plantations, based on

Afro-Arabic agricultural knowledge traditions, paved the way for the proto-industrial revolutions in Europe. Later, the shipping of huge quantities of cotton produced by slave labor from the so-called Black Belt in the United States of America (since 1776) to the early European industrial centers, e.g. Lancashire in England, brought the mass production of textiles to a high level. This was important, especially after the Indian hand-woven textile production was destroyed by the British colonizers in the middle of the 19th century (Wolf 2010, 290). The forced south-north transfer of knowledge, science and techniques, which is only touched upon here, needs further and more extensive research in order to help understanding early appropriation of non-Western knowledge and its contribution to colonization, enslavement and Euro-centric industrialization and modernity.

With the forced deportation of a major sector of the Arabic population—a process that began with the conquest of Toledo by the crusaders in 1085 and that lasted for centuries—knowledge was also expelled from the Iberian Peninsula. It seems that the 13th century Alfonso the Tenth, who was born in Toledo in 1221 and later called The Wise (*el sabio*), intended to halt this early brain-drain; he founded a scientific center for translations mainly from Arabic into old Spanish (Castilian) and Latin. Although it seems that he had to hide his endeavors, the Catholic king had a deep respect for Arabic culture and knowledge (Walter 2016, 233). Between 1262 and

1272 Alfonso ordered the compilation of Arabic tables of geographical places, mainly based on the Toledan Tables (astronomical tables written by az-Zarqālī (1029-1087) in Toledo) along with the methods for calculating the degrees of latitudes and longitudes. A multi-confessional team of scholars created an encyclopedia for astronomical studies (*Libros del Saber de Astronomía*), which became significantly important throughout Europe. The tables of coordinates in the encyclopedia are based on three Arabic tables (al-Ma'mūn, al-Battānī and an Al-Andalusian one) (Sezgin 2005, 212). The Ma'mūn astronomers were able to define the inclined ecliptic[2] nearly as precisely as we do nowadays, without having—as Johann Heinrich Moritz von Poppe notes—a telescope at their disposal (Poppe 1837, 456). Following to a certain extent an Arabic-Islamic culture of tolerance, under the reign of Alfonso the Wise sciences did not come to a halt. Later colonial ideology broke with this tradition when sciences became functionalized for imperialistic purposes.

Sciences at colonialist services

In his log-book entry for October 29, 1492, when sailing along the Cuban coast, Columbus compared the beauty of the hills with the Peñas de los Enamorados, which had become familiar to him when marching towards Arabic Malaga, taking part in the campaign of its conquest (Bucher 2006, 101). In his early journeys along the West African Cost at the service of Portuguese crusaders, Co-

lumbus compared his arc measurements with those of Alfraganus (Ibn Kaṭīr al-Farġānī) (Bucher 2006, 84). The astronomer worked in the team of geographers under Caliph al-Maʾmūn in the first half of the 9th century in Baghdad. His book on the history of geography, translated into Latin, enjoyed great popularity among Italian scholars especially. Alfraganus had deep influence on Robert Grosseteste, Ristorro d'Arezzo, Dante Alighieri and Hermann of Reichenau (Hermanus Contractus) (Sezgin 2011, 233). The question is how it was possible that a 9th-century astronomer from Baghdad could have provided Columbus with his astronomical data.

Columbus based his calculations on the determinations of a team of Maʾmūn geographers, among them al-Farġānī (Alfraganus). The Maʾmūn geographical and astronomical research group determined the length of one degree in the meridian as 56 2/3 Arabic miles (Sezgin 2005, 94; Sezgin 2011, 3). The measurements handed down by the Alexandrinian Ptolemy (ca. 100-160 AD) where not precise and comprehensive. Corresponding to 111.31 km along the Equator and multiplied with 360 degrees, this new measurement of the Maʾmūn geographers was nearly as precise as the equatorial circumference measuring 40,075 km (Kohler 2006, 46). The Arabic scientific world did not doubt that the earth was a globe. Columbus was probably also not aware of the difference between Arabic and Italian miles. The Roman-based Italian measurement of one degree in the

meridian was around 80 km (compared to 111 km and 56 2/3 Arabic miles) (Sezgin 2000, 95; Starr 2015, 9). While underestimating the size of the earth by around one third, Columbus might have believed that it is quite easy to reach the Asian coast. This once again proves that precise mathematical and astronomical methods, which are necessary to determine geographical locations and are much more difficult to obtain at sea than on-shore, were more or less unfamiliar to Columbus.

We find many traces of Arabic heritage all over Central Europe, thus also in the cultural fields, e.g. in the wood-carved figures of 1480, the Morisco dancers, by the Bavarian artist Edmund Grasser. The original figures remained in the old town hall of Munich till the early 1930s. The travel of knowledge and culture as a consequence of the conquest (called Reconquista) of the mainly Arabic-Islamic Iberian Peninsula (al-Andalus) has not yet been sufficiently researched. Arabic lands, with the most western Al-Andalus (Maġrib al-Aqsa), were centers of flourishing science, culture and daily life from the 9th till the 13th century. This holds true also for the cross-cultural and multi-confessional Sicily under Arabic influence. Sicily was first under Abbasīd then under Fātimid rule (9th and 10th century). The Norman King Roger the Second (1095–1154) and the Emperor Frederic the Second (1198–1250) followed a societal model of tolerance and learning. Not only sugar cane, dates, citrus fruits, cotton and olives were cultivated by

Arabs in southern Italy (Schlicht 2000, 44). In contrast to the long tradition of crusade-conquest of Al-Andalus, the Normans in Sicily incorporated Arabic-Islamic culture and daily life. As a consequence, also sciences, philosophy, medicine and architecture, based on a culture of tolerance, were not declining in southern Italy.

Again, this chapter is not able to discuss the general impact of Arabic science and culture on European developments in further detail, nor to excavate the historical context of early colonialism in more depth. However, any postcolonial and critical history of the conquest of Abya Yala needs to be aware of these continuities, here the overlapping of the so-called *Reconquista* with the conquest of the so-called 'New World.' From a Native American perspective Jack Forbes has studied possible pre-colonial interconnections between the Americas and Africa, among them early seafaring across the Atlantic (Forbes 1993, 10). Against the background of the historical inter-connectivity and continuities between the general impact of Arabic science and culture on European developments, the so-called Reconquista and the conquest of the so-called 'New World', it becomes obvious that the Spanish and Portuguese conquerors in the 'New World' followed the same warfare strategies that were used earlier, be it the strategy of besieging cities or massacring the encountered people. When Hernán Cortés viewed the important trade city Cholula for the first time, he was overwhelmed by its beauty. He also

adored the city's architecture, believing that all the impressive buildings were mosques. Texoco was another city where he assumed large buildings to be mosques. The rumors about the Alpujarra Mountains around Granada, where the Arabic rebels around Grenada 'eat their enemies', were projected onto the indigenous people of the area, now in the central Mexican highlands (Beck 2013, 178). Whether or not Cortés might have assumed that the population of Cholula was Islamic, there were no moral scruples against killing 'non-believers' in the 'New World', e.g. the Cholula Massacre in late October, 1519 (Sahagún 1905; Del Castillo 1844; Levy 2008, 68; Thomas 1993, 258). Cortés estimated the number of dead as 3,000 in two hours, while De Tapia puts the number of victims as high as 20,000 (Cortés 2001, 466). This was a kind of massacre-based warfare hitherto unknown to the people of Abya Yala. It seems that especially the brutal warfare of the *conquistadores* made Spanish settler colonialism possible. This holds true also for the Maya and Aztecs, with more centralized states. But some people, like the Cuna (Panama) and the Mapuche (Chile and Argentina), put up effective resistance against the conquerors and were never subordinated by the Spanish crusaders. As the Spanish and Portuguese conquerors had come upon Arab-Islamic shaped lands whenever they left their familiar environment, be it in North or West Africa, they were probably caught in an imagined geography when reaching worlds new to them. Another reason for this might have been the maps that they used.

Mapping the world

The 15th century marks the emergence of a newer cartographic worldview in Western Europe. With the introduction of the Ptolemaic worldview into Latin Europe, the visualization of the world became an incontestable authority. Main characteristics of the Ptolemaic world maps—even if many historians agree that Ptolemy did not draw maps himself in the middle of the 2nd century (Sezgin 2011, 170-173; Dilke 1987, 177-178; Brotton 2012, 20)—are the representation of the Indian Ocean as an inner lake (often also the Atlantic was shown as a lake, or the ecumene surrounded by a *terra incognita*), the depiction of the Caspian Sea in a melon shape and the over-extension of the Mediterranean Sea to around 60 degrees. Even Ptolemy provided around 8,000 coordinates of the known world, latitudes further south of the Equator (Meroë) are lacking (Sezgin 2005, 34-36). The largest parts of Africa were unknown to Ptolemy. If we compare several Ptolemaic maps from the 15th century with, for example, the world map of Gerhard Mercator (*Universalis Tabula iuxta Ptolemeum*, 1578), we become aware of Mercator's more precise version of the course of the Nile, even though many inaccuracies remain, for example the melon shape of the Caspian Sea. Cartographical knowledge did not develop in linear and progressive fashion. The knowledge about certain geographical shapes and figures seems to have been lost for

centuries, when we compare the more accurate shape of the north-south aligned Caspian Sea in the world map of al-Idrīsī of 1154 with Gerhard Mercator's melon shape (1578).

For a long time there existed the mistaken belief—represented on dozens of printed Ptolemaic Maps from the 15th century onwards—that the Indian Ocean is a lake and Africa and the Indian Sub-continent are connected by a land-bridge. It seems that this mistaken belief is to be blamed not only on cartographical misinterpretation but on sheer ignorance. The Europeans at this time did not have the faintest idea of the cartographical figures of the Indian Ocean, the Pacific, the Islands, and the coastal lines etc. Alexander Humboldt emphasized that it was Arabic cartography of the 12th century that mapped for the first time the triangular shape of Africa, showing the possibility of circumnavigating Africa (Quintern 2018, 343). From the 8th to the 16th century the Indian Ocean was mainly an Arabic-African-Persian-Indian-Chinese sea. It was connected by long-distance trading and communicating routes, be it the Silk Road from China via Central Asia to the Mediterranean, the Incense Road from Yemen via the Arabian Peninsula to Antioch and Gaza in Palestine and the African trading roads, which connected East and West Africa via the trans-Sahara routes in the North and from the East-African port cities via the Central African water streets (e.g. along the River Congo) to the Atlantic. When Carl Peters con-

quered Tanzania in the 1880s, his self-perception, while speaking about his conquest, still followed the ideology of the crusaders (Wehler 1976, 338). After the Maji Maji uprisings were brutally crushed, Peters became the commissioner of so-called German East Africa, and thus began one of the darkest chapters in German colonial history. Carl Peters' colonialist vision also included the annexation of the area of the Nile headwaters (Perras 2004, 133).

Granted that there may have existed world maps during the life time of Ptolemy in the 2nd century, we have to ask whether there had been any development of cartographical knowledge from then until the 16th century. The 19th-century myth of the Renaissance connotes the rebirth of a flourishing, mainly Greek-inspired, scientific era in Antiquity. But, when studying the sources of many of the works translated into Latin, be it in mathematics, optics, medicine or philosophy, an Arabic template comes to light. Interestingly, the adaptation and incorporation of cartographic knowledge took a longer time, compared to other scientific disciplines. Recent studies by Fuat Sezgin revealed that Maximus Planudes plausibly adapted Arabic-Islamic expertise, mainly coordinates and specific geographical figures and shapes, into his own scholarship. The Byzantine monk established a team of geographers and cartographers in Constantinople at the end of the 13th century. Planudes, also copyist of Ptolemy's Geography of the 2nd century, described mainly methods for projecting and drawing maps beside the coordinate tables—and mentioned the

Fig. 1 Gerhard Mercator, Universalis Tabula iuxta Ptolemeum. World Map in the Ptolemaic Tradition, probably Cologne, 1578, copperplate engraving.

existence of 26 maps at the end of the manuscript of Ptolemy's Geography.

The late 13th-century Mappa Mundi or so-called T-O-maps—named after orbis (orbis terrarum) with the letter T depicting the waters inside the circle of an O (orb), the circle for the lands—are far less realistic than the Ptolemaic maps. They reveal more about mythologies and eschatology than the geography of the known world. Beside the English Hereford T-O map, the world map of Ebstorf is one of the best studied samples. The body of Jesus frames and carries the world at the same time. The world is displayed with the East at the top ('East-up'), with the paradise in the East also at the top, Jerusalem is shown at the center. Faceless human-like beings, monsters, cannibals and wild animals and sceneries of violence are displayed on the Asian-African periphery, which suggests that the unknown caused anxiety.

With Brunetto Latini's *Livres dou Trésor* in 1310, an astonishingly new cartographical worldview emerges, nearly parallel to the apocalyptic visualizations. It shows a 'South-up' world map, surrounded by a dark ocean, the circumnavigation of Africa, the course of the Nile etc. Early Latin-European world maps, because of their characteristical shape called T-O-Maps, were oriented Eastwards (e.g. *Mappa Mundi*)—we still find this in the term ORIENTation—and put Jerusalem into the center (the world map of Ebstorf serves as one example). In contrast, Arabic maps were —directed towards the South and did not contain an identifiable center (for example the maps of Latini and Idrīsī depicted below).

Also, the Brunetto Latini World Map uses the typical Arabic South orientation, possibly because the Florentine diplomat Latini, who was a teacher of Dante, had been on a mission in 1260 to the Castilian ruler Alphonso the Wise, where he probably came into contact with Arabic cartographic knowledge

Both maps can be traced back to an Arabic cartographic tradition which flourished in Baghdad from the early 9th century onwards, after the translations of Ptolemaic works, Indian astronomical tables, Middle Persian texts etc. had been reworked and enhanced. Arabic-Islamic map making was often based on mathematical-astronomical methods (trigonometry); drawing precise maps without it is therefore virtually impossible. The world map of al-Idrīsī of 1154, designed for Roger II, King of Sicily, is a good example, handing down older precise cartographical knowledge, for example the course of the Nile probably based on the Ma'mūn geographers and a new, more realistic, form of the Caspian Sea. Al-Idrīsī's map clearly shows the circumnavigability of Africa, and the Indian Ocean as an open sea.

The Venetian Marino Sanuto (ca.1260–1338) represented a world map in his handbook *Liber Secretorum Fidelium Crucis Super Terrae Sanctae*, written around 1321, in order to facilitate the conquest of Palestine. It is based in large parts on the world map of al-Idrīsī, especially when it comes to the geography of Africa. Also mistakes of al-Idrīsī, for example the inaccuracies depicting the Atlas Mountains as a continuous mountain range, were reproduced. This is an early example for the appropriating and colonialist usage of cartographical knowledge.

Fig. 2 Ebstorfer World Map, ca. 1300, T-O-Design, probably elaborated at the monastery of Ebstorf, Northern Germany. The original map was destroyed during Second World War bombings but a reproduction from a facsimile survived. In clear contrast to the so-called Ptolemaic maps, the European Mappae Mundi (World Maps) were far from rational approaches.Accessed October 8, 2016. https://commons.wikimedia.org/wiki/File:Ebstorfer-stich2.jpg

It should be taken into account that the so called old world's long-distance sea trading centers from the 8th to the 16th century, before the Portuguese crusaders appeared, were located mainly along the Arabian-African and Indian and Chinese coasts of the Indian Ocean, as Janet Abu-Lughod has shown in her ground-breaking study *Before European Hegemony* (Abu-Lughod 1991). Joseph Needham demonstrated that Arabic-Chinese trade relations were soon extended to the coast of East Africa when Arabs began to establish trading posts in Somalia, Sofala, Zanzibar and Madagascar in the 8th and 9th centuries (Needham 2007, 494). In the 9th century the historian and geographer al-Yaqʿūbī (d. 897 or after 905) described in his Kitāb al-buldān (Book of the countries) the long-distance sea trade from China to Morocco at the Atlantic coast.

The report from the last quarter of the 9th century tells us that boats built in Ubulla on the Tigris regularly anchored next to the Baḥlūl mosque in the North African port of Māssa (south of Agadir) on the Atlantic coast and transported goods to China (Sezgin 2005, 565). The famous Tang Annals, edited in 945 AD, mentioned approximately 2,000 Arab and Persian merchants trading in Canton. Precise geographical, cartographical and nautical knowledge was required in order to circumnavigate the southern tip of Africa.We do not have an Arabic monograph on the compass at our disposal, but know from a later treatise by al-Ašraf from Yemen written in (1291 AD) that navigators were aware of the phenomenon of magnetic variation, which they took into account when plotting their courses.

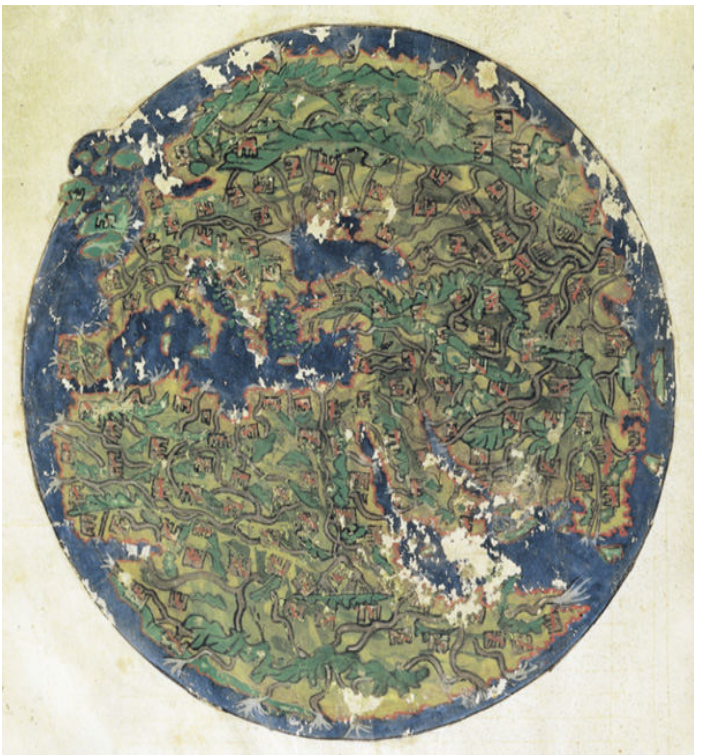

Fig. 3 World Map in Brunetto Latini's Livres dou Trésor (Treasure-house of knowledge), an encyclopedia, which included a universal history and ethics beside sections on geography. Only one surviving manuscript, dating back to 1310, includes the "World Map." Digital reproduction © Institute for Arabic-Islamic History of Science, Frankfurt a.M.

Fig. 4 Copy of the World Map of al-Idrīsī designed for Roger II, King of Sicily, in 1154. The world map is included in a manuscript, dated to late 13th / early 14th century, which is now preserved at Bibliothèque Nationale de France, MS. Arab 2221, fol. 3v-4r. Accessed October 8, 2016. https://gallica.bnf.fr/ark:/12148/btv1b6000547t/f14.image.

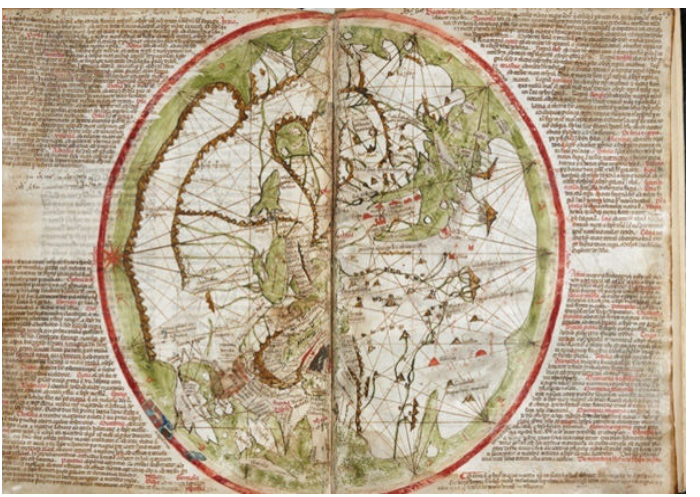

Fig. 5 'Liber secretorum fidelium crucis' by Marino Sanudo with maps by Pietro Vesconte, created ca. 1321. British Library, Public Domain, Add.MS 27376* Accessed July 15, 2018. https://www.bl.uk/collection-items/liber-secretorum-fidelium-crucis-by-marino-sanudo.

He mentioned that in the Indian Ocean the compass needle does not point exactly in the direction of the polar star, but only approximately (bi-t-taqrīb) (Sezgin 2010, 233; Sezgin 2000, 237). Most probably the compass, beside other nautical instruments, reached Mediterranean seafarers from these seafarers on the Indian Ocean.

When the Portuguese under Henry the Seafarer conquered the Moroccan Atlantic port city Ceuta in 1415, they were surprised to find Chinese porcelain and Arabic maps. From 1422 to 1434 the Portuguese tried over twenty times to sail beyond Cape Bojador ('The Cape of Fear'), which is south of Morocco, finally succeeding with Gil Eanes in 1434. When the Portuguese entered what is now Senegal for the first time in 1444, they believed they were close to the Nile, flowing into the western sea (Baker 1967, 65), probably as the map of al-Idrīsī shows a Western arm of the Nile flowing into the Western-African Atlantic. These Portuguese sea 'journeys' went hand in hand with hunting for Africans to enslave, whom the Portuguese described as 'Moors.'

It is typical for the creation of Eurocentric legends and master narratives that Henry, the Portuguese pretender to the throne, who never or not more than once went out to sea, is mythologized as 'Henry the Seafarer' (Bucher 2006, 78). In 1483 Columbus sailed along the West African Coast to Elmina (Arabic al-mīnā'= port) in Ghana, thereby always having land in sight. Cristobal and Bar-

tholoméo Colon both lived in Lisbon since 1480, where the younger brother worked as a sea cartographer. It is well known that the Italian Paolo dal Pozzo Toscanelli (1397–1482) sent a map to Portugal, which showed Atlantic Asia towards the West. The map, which did not survive, had reached probably the nautical school in Lisbon. It cannot be ruled out that it was this map that Columbus and his son mentioned when sailing in the Caribbean. A report on another map, the Map of Fra Mauro from 1459, is astonishing. The Venetian monk probably accessed cartographic information necessary to draw the map through Niccolò de Conti (d. 1469), a traveler who left Venice for Damascus, where he started to learn Arabic. De Conti then travelled via Baghdad, Basra, Persia to India, Sumatra, Java and Vietnam, before returning to Venice in 1444 via Aden, Jeddah and Cairo. One report among around 3,000 legends on the map tells of an Indian junk (*zoncho de India*). While crossing the Sea of India towards the Ilse of Men and Women and driven by a storm beyond the Cape of Diab, it went "through the Green Isles, out into the Sea of Darkness towards the Algarve in the west. For forty days they found nothing but sky and water." (Sezgin 2011, 116)

Fuat Sezgin analyzed the legend about the Fra Mauro map in the context of a possible pre-Columbian 'discovery' of America, collecting all possible historic testimonies, which sustain the hypothesis of a journey to America by Muslim seafarers (Sezgin 2013). The Fra Mauro

Map shows the shape of Africa quite precisely at a time when the Portuguese had not yet reached the tip of Africa. Without expanding the debate on a pre-Columbian 'discovery' of America, the extensive studies by Fuat Sezgin enable a deep insight not least into mathematical, astronomical, and nautical backgrounds, an essential key to grasp maps.

It has to be emphasized at this point that the capacity to sail the Indian Ocean seems to be a key for the decryption of a possible crossing of the Atlantic before Columbus. Furthermore, the colonial conquest of Africa, Asia and America is to be studied transcontinentally and comparatively. Not rarely do we find a personal union when it comes to central figures, e.g. Pedro Álvares Cabral, the famous 'discoverer' of Brazil, who was the successor of Vasco da Gama. After 'discovering' Brazil in spring 1500, Cabral already defeated an Arabic-Islamic fleet near Calicut (Planhol 2000, 394). Fuat Sezgin has shown that Brazil was most probably known to Afro-Arabic seafarers long before the continent was known to Europeans (Billig 2017, 260-262). Other early cross-Atlantic contacts were the undisputable Newfoundland journeys by the Vikings via Greenland and the reverse crossings of the Atlantic by Native Americans—researched by Jack Forbes in his prominent study *Africans and Native Americans* (Forbes 1993).

Fig. 6 Fra Mauro World Map, 1459 or 1460, 2.4 by 2.4 meters, Museo Correr, Venice, Italy.
The original map is orientated southwards (here northwards). Public Domain. Accessed October 8, 2016. http://upload.wikimedia.org/wikipedia/commons/9/95/Fra_Mauro_World_Map,_c.1450.jpg.

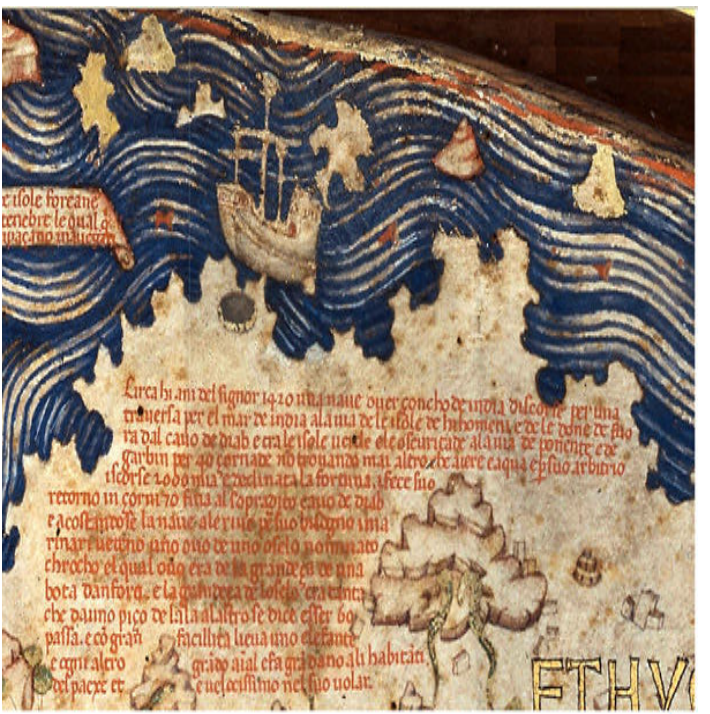

Fig. 7 Legend on the Fra Mauro World Map telling the route of the Indian junk (zoncho de India).

While the Native people of the Pacific were very experienced in orienting themselves with the help of the Southern Cross, the course of birds and cloud formations, for example, the Portuguese and Spanish crusaders did not have sufficient experience, nor fundamental knowledge to precisely apply astronomical nautical instruments. Still, in the 15th century the Portuguese believed that the world did not extend beyond Cape Bojador. Columbus imagined the world in a pear shape; his latitude 'measurements' of Cuba deviated by 21 degrees (42 degrees compared to actual 21 degrees) (Sezgin 2005, 142).

In short: the knowledge of the *conquistadores* is to be seen primarily in the fields of ruthless warfare, while their astronomical, cartographic and nautical knowledge clearly had Arabic-Islamic sources. When the Portuguese finally circumnavigated the southern tip of Africa at the turn of the 16th century under Bartolomeu Diaz and Vasco da Gama, they were piloted by Arab navigators (Sezgin 2005, 37). From da Gama's diaries we learn about the usage of graduated sea maps and advanced nautical techniques used by the Arab navigators, who might thus have unintentionally paved the way for early colonialism in India. The Portuguese term for a navigator who masters to sail on the open Indian Ocean was 'Malemo' from Arabic 'Mu'alim' (teacher) (Agius 2009, 130). Such experienced pilots were often also taken hostage and forced to sail with the Portuguese, thus enabling European colonialism (Da Gama 2006, 63). A historical account of events in the year of 1415 illuminates contrast-

ing developments along the African coasts. While on the African East coast Chinese ships arrived with presents, e.g. porcelain, before returning with gifts, among them a giraffe, the Portuguese conquered the Arabic port city of Ceuta on the Western coast at the end of the trans-Saharan trade route. They also looted Arabic charts, portolan maps and nautical instruments, which probably enabled them to sail further south (Salentiny 1977, 33). After hard negotiations with Spain, the Portuguese succeeded in the treaty of Tordesillas (1494) to claim Brazil for domination, raising the question whether or not they might have known about lands along the coast of Southern America much earlier.

Conclusion

In the context of a much-needed decolonization of the history of science and technology, it is preferable to discuss the beginnings of a more systematized colonialism in relation to the early prerequisites, such as the appropriation of non-European knowledge, which enabled Europeans to reach as far as the shores of the Americas and the Indian Ocean. The history of astronomy, geography, cartography, and nautical sciences, beside shipbuilding and other fields of knowledge, are to be challenged by decolonial studies from a Global South perspective. Regarding especially the modernization of colonialism in the long 15th century—compared to preceding crusading movements—it is obvious that the appropriation and integration of Arabic science and

techniques took around five centuries. The waves of Arabic knowledge that reached Europe introduced what in Eurocentric historical thought is often called 'the Renaissance' (ital. *rinascimento*). But did the travel of Arabic knowledge stop in South-Western Europe? Or, was it taken along the transatlantic colonization of Aby Yala to the other side of the ocean? Walter Mignolo discusses the impact of the Latinization on Indigenous science and knowledge, with the example of Amerindian medicinal, botanic knowledge transmitted orally into Nahuatl, which then had been written down and visualized with botanic drawings by European missionaries (Mignolo 1998, 57).

The high standard of Arabic systematization of medicine was one of the reasons why the notorious Ximenes, head of the inquisition, abstained from burning Arabic medicinal books following the conquest of Grenada, the last remaining Arabic city on the Iberian Peninsula in 1492. Not least Ibn Sīnā (Avicenna) had systemized and broadened medical knowledge, based on ancient Galenic, Dioscuridian, Rufus and other sources. The Perso-Arabic Ibn Sīnā became the Latinized Avicenna. His 11th century's Canon of Medicine was one of the most important teaching books for medicine up to early 20th century. In *Islamic Science and the Making of the European Renaissance* (2007), George Saliba has discussed the Arabic revision of Greek, specifically astronomic, science. Also, science does not have a religion, a long-term and universal approach to the history of science verifies that

the travel of knowledge flows—embedded into social, cultural and religious milieu—through time and space[4]. But, knowledge is not pure knowledge. In the context of colonialism, science is far from being embedded into a constructive and peaceful travel and exchange of knowledge between peoples, cultures, and continents, but instead immersed in a colonial power matrix that has produced a certain hierarchized epistemological ordering system. Decolonial research will have to go to the bottom of sciences, analyzing the ethical and wider milieu in which knowledge is embedded.

After the completion of the so called "Reconquista", on the periphery of the Spanish Empire new knowledge began to take shape, be it in Italian Florence or Bologna. The adaption of mainly Arabic scientific sources into the early European knowledge canon needs to be included into the debates regarding any 'rethinking of humanism'. Hans Belting has shown exemplarily with the history of the discovery of mathematical laws and their application in optics, which enabled the construction of the central perspective in early modern painting, that this know-how traces back mainly to Arabic expertise. Leonardo Da Vinci, who based his knowledge in this regard foremost on the Latin translation of the book of optics (Kitāb al-Manāzir), written by Ibn al-Haitham (d. 1040) in Cairo, is just one example. Da Vinci was also inspired by this insight to experiment with the *camera obscura* (Belting 2012, 142). Furthermore, the historical layers of a new understanding of the human

body, health, medicine and pharmaceutics will have to be taken into consideration, as much as the spreading of Averroism to the universities of Padua or Bologna in the 16th century. Averroism is a philosophical school based on the Arabic-Islamic tradition of Ibn Rushd (d. 1198), emancipating philosophy and the autonomy of the idea of 'human beingness' from theological narrowness. The rejection of the philosophy of Averroes (Ibn Rushd) at the University of Paris from mid-13th century onwards had initiated a long lasting animosity towards humanistic thought and sciences. The Bishop of Paris had decreed in 1270 that it is wrong "to assume that human beings know", i.e. that human beings strive for knowledge. On the contrary, sciences, philosophy, literature and culture were flourishing when embedded into humanistic world views. The preeminent culture of tolerance, be it in Bagdad, Cairo or Cordoba, was a precondition for any unfolding of sciences. To sail the open sea, be it the Indian Ocean, the Pacific or the Atlantic, required first and foremost geographic positioning, which in turn necessitates profound knowledge of fix-star astronomy together with special skills to operate and orchestrate different navigational instruments (compass, hourglasses or the Kamāl)

Late 15th-century European *conquistadores* assimilated Arabic astronomy, nautical ciences and cartography, before being able to reach the shores, where they hoped to find the long-desired treasures. The European colonisers first had to appropriate knowledge, before being capable of looting the Global South.

A critical re-reading of the so-called European Renaissance requires the study of the historic fundaments, written sources and philosophical meta-dimensions on which science and technology were based at the turn from the 15th to the 16th century, in order to decolonize the history of science. Arabic astronomical and cartographical knowledge was able to offer geographical orientation far beyond the early mythological and apocalyptic visions in European maps. When Columbus crossed the Atlantic, the more ethical foundation of knowledge, sciences, navigation and seafaring was thrown overboard, and knowledge was transformed for colonialist purposes. In order to achieve a more ethical foundation of history of science and knowledge, the task of postcolonial and decolonial scholarship is to re-evaluate the history of science, disentangle Eurocentric appropriations of non-European sciences, and assign non-European sciences their appropriate achievements and role in the development of science proper.

Notes

1. Here pluri-universal means plurality in unity. Human Beingness shares only one globe which is not separable into many worlds. This holds also true for the one universe even though there might be many. Contrary to hegemonic Eurocentric narratives, dominating the understanding of history since the globalization of colonialist-enlightened master narratives over a long time

even beyond Europe, universalism, which I take as a theoretical basis (Quintern 2020 [1996]), has Asia and Africa as point of departure for the long east-south-north travel of science into Europe. In this context Enrique Dussel differentiated imperial from what he calls "Muslim" universalism, emphasizing that Muslim "universality" reached from the Atlantic to the Pacific. "Latin Europe was a secondary, peripheral culture and up to this point had never been the 'center' of history" (Dussel 2000:466).

2. The inclined ecliptic is the ca. 23.4° inclination of the axis of the earth to its orbital plane, resulting in greater heat and more hours of daylight in one hemisphere. The inclined ecliptic is responsible for the cyclic change of seasons over the course of a year.

3. I have seen so far three different translations of the legend. The original Old Italian legend has to be proven again. "Circa hi ani del Signor 1420 una nave over çoncho de india discorse per una traversa per el mar de india a la via de le isole de hi homeni e de le done de fuora dal cavo de diab e tra le isole verde e le oscuritade a la via de ponente e de garbin per 40 çornade, non trovando mai altro che aiere e aqua, e per suo arbitrio iscorse 2000 mia e declinata la fortuna i fece suo retorno in çorni 70 fina al sopradito cavo de diab. E acostandose la nave a le rive per suo bisogno, i marinari vedeno uno ovo de uno oselo nominato chrocho, el qual ovo era de la grandeça de una bota d'anfora, e la grandeça de l'oselo era tanta che da uno piço de l'ala a l'altro se dice esser 60 passa, e con gran facillità lieva uno elefante e ogni altro grando animal e fa gran dano a li habitanti del paexe et è velocissimo nel suo volar." Transcriptions of the map's texts by Piero Falchetta. Accessed October 8, 2016. http://ge-

oweb.venezia.sbn.it/cms/images/stories/Testi_HSL/FM_iscr.pdf

4. For example, one of my future projects will research Indigenous medical knowledge in the South of today's Costa Rica and the North of Panama, comparing it with "old world" knowledge brought by the conquistadores. Sometimes we find specific endemic medical plants parallel to imported ones from the "old world", e.g. mint from the same family. Also, the healing knowledge differs and corresponds.

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