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On the history of madder (*Rubia peregrina* L., and *Rubia tinctorum* L.) in pre-modern Iran and the Caucasus

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Abstract: For roughly four thousand years the pulverized roots of both wild (*Rubia peregrina* L.) and cultivated (*Rubia tinctorum* L.) madder have been used in Asia, North Africa and Europe as a red dye. Madder's original, natural habitat extended from Iran to the Mediterranean and madder roots were gathered, processed and used long before the plant was systematically cultivated. Although the red dye derived from madder was put to various uses, the dyeing of fibres for use in textiles and carpets was the primary one, and is first attested c. 2000 BC in Mesopotamian cuneiform sources. In Iran madder's use can be traced from late Antiquity to the modern era, and may have begun as early as the 1st millennium BC. In the 19th century demand for madder in India and Russia was great, spurring large investment in madder cultivation as a cash crop, both in Iran and in the Caucasus. Documents are presented which provide detailed accounts of both madder cultivation and the processing of the roots for the production of dyestuff. The introduction of synthetic dyes in the 1870s largely eradicated the market for madder-based dye in Eurasia and had a profound impact on the carpet industry, in particular.

Keywords: Caucasus; dyes; Iran; madder; *Rubia peregrina* L.; *Rubia tinctorum* L.

1 Introduction

A recent study of colorants used in wall-paintings at Shahdiz, a fortress built in 1107 (on older, pre-Islamic foundations) by the Seljuk ruler Malik Shah on a mountain-top near the southern outskirts of Isfahan,[1] identified the use of a

1 See e.g. Le Strange 1905: 205; Karimian / Ahmadi 2021 suggest the fortress was built on an older Sasanian (3rd–6th cent. AD) foundation.

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madder-based red.[2] Yet although the authors made reference to a small selection of the available literature on the use of madder in antiquity and, historically, in both Iran and Europe, a great deal more material not referred to attests to its use and importance in the Iranian world over the course of almost 3,000 years. Despite the long history of its collection, cultivation and use, madder in Iran has yet to be the subject of an in-depth, longitudinal study stretching from remote antiquity to the modern era.[3] The aim of the present work is to contribute to such a study by examining evidence from Iran as well as areas in the Caucasus which had been, prior to the First and Second Russo-Persian Wars of the early 19th century, Persian territory. This evidence demonstrates the widespread use of red pigment extracted from the roots of both wild and cultivated madder prior to the invention of artificial dyeing agents in the later 19th century. Although a small fraction of the evidence marshalled dating to the 19th century has been discussed in earlier works,[4] the vast majority of the material presented here has never been brought together for the use of scholars interested in textile and dyeing history, ethno- and economic botany or Iranian, Russian and Caucasian agricultural and economic history. This study thus aims to sketch the story of madder in Iran, from a wild natural resource, found growing across the Iranian landscape; to a cultivated cash crop; and finally to a cultivar that ceased to be profitable with the introduction of synthesized red dyes in the 1870s.

2 Madder and its earliest exploitation

Madder is an originally wild perennial (*Rubia peregrina* L.) belonging to the genus Rubia, subfamily Rubiodeae, family Rubiaceae, order Gentianales, the roots of which contain anthraquinones, including the dye components alizarin and purpurin.[5] Its original habitat encompassed southern and southeastern Europe, the Mediterranean basin, Asia Minor, the Caucasus and Iran.[6] Traditionally, wild

2 Holakooei et al. 2020: 6.

3 Murphy 2005 is a popular, journalistic if poetic meditation on Persian carpets with considerable emphasis on madder. It makes no pretence, however, to being a scholarly work. Daniels et al. 2014, while excellent on the analytical side, deals almost exclusively with the presence of madder-based dyes in and on a relatively small number of analyzed objects, and is silent on most of the historical evidence marshalled here.

4 See already Rahimi-Laridjani 1988: 407; Floor 2003; Chenciner 2003: 330–331.

5 Derksen/Van Beek 2002: 629; Melo 2009: 6; Cooksey 2020: 475.

6 As Candolle 1883: 33 noted, 'La garance est certainement spontanée en Italie, en Grèce, en Crimée, dans l'Asie Mineure, en Syrie, en Perse, en Arménie et près de Lenkoran. En avançant de

madder roots were collected in many parts of Iran and the Caucasus before the plant became an important cultivar (*Rubia tinctorum* L.) in the 19th century. Madder is known by a cluster of cognate phytonyms in Iran, including *rūyan/rūnās* (Tehran; Kurdistan);[7] *rūniyās* (Isfahan),[8] and *rōdan(g)* (Hari-rud valley, Khorasan).[9] *R. cordifolia*, on the other hand, was the species commonly used in India, where it was known as *manjit/manjeet*.[10] Unless stated otherwise, references below are exclusively to *R. peregrina* and *R. tinctorum*. While madder roots ground to a fine powder were used principally to manufacture a brilliant red dye for woollen, cotton and silk thread used in carpets,[11] cloth and tapestries,[12] madder was also the source of the deep red pigment known as madder lake (Fr. laque de garance; It. lacca di robbia; Ger. Krapplack) or garanza lake, widely used by both Persian miniaturists[13] and European painters.[14] As Jean Hellot noted in 1750, of all

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l'est à l'ouest dans le midi de l'Europe, la qualité de plante spontanée, originaire, est de plus en plus douteuse .... Evidemment l'habitation naturelle, ancienne et incontestable est l'Asie tempérée occidentale et le sud-est de l'Europe. Il ne paraît pas qu'on ait trouvé la plante au delà de la mer Caspienne ... mais cette région est encore peu connue. L'espèce n'existe dans l'Inde qu'à l'état de plante cultivée, sans aucun nom sanscrit.' Cf. Derksen/Van Beek 2002: 632. Nieto-Galan 2001: 24 betrayed a very Eurocentric bias when he wrote, 'It grew traditionally in the Mediterranean, Levant, Italy, Southern France, Holland and Switzerland.'

7 Hübschmann 1895: 168 considered 'rōnās "Krapp" aus rōyanās' a possible, relatively recent contraction.

8 Hooper 1931: 336–337 = Hooper 1937: 166–167. The name appears as 'ruinass' in 17th and 18th English East India Company documents. See Baladouni/Makepeace 1998: 149, 274. Floyer 1882: 406 noted in Baluchistan, 'I found this word always pronounced "Runask."' Cf. Stack 1882: 238. For the use of Rūynās, madder, as a toponym in the southern Caucasus see Minorsky 1953: 66.

9 Aitchison 1888: 73, who observed madder in the Hari-rud valley and in Khorasan in 1885, noted, 'Native name *Rodang*. A plant extensively cultivated for its roots, which are largely employed in dyeing, and are exported for this purpose.'

10 See the extensive discussion in Watt 1892. For a modern assessment of *R. cordifolia*'s use in the Indian subcontinent see Gulrajani 2001.

11 For analyses of 19th century Persian carpets showing the use of madder as a colorant see Sugiura 1978: 29–31. As Durand 1902: 250, 'the dyes for these carpets are very simple — indigo, madder, and vine leaves being the only things used.' Cf. Sykes 1910: 321 noted, 'Indigo and madder supply the chief of the imperishable dyes.' See the sources collected in Dhamija 1990. With respect to potential technology transfer it is interesting to note that, following the Ottoman conquest of Tabriz in 1514, Persian carpet weavers were deported to Constantinople. See Okumura 2011: 88. This, of course, does not say anything about the specific dyes they were able to access thereafter.

12 For madder's use in Persian tapestry work, see Karabacek 1881: 51.

13 Purinton/Watters 1991: 131.

14 Delaney et al. 2020. There is a vast literature on pigment analysis from ancient Egypt, through the Greco-Roman world and into European wall paintings and works on canvas, attesting to the common use of madder lake. As the sources of the madder imported to manufacture madder lake were many, the focus here will remain on the Iranian evidence. Holland, for example, was 'the

the red dyes, that made from madder was far and away superior to anything else for its color-fastness.[15] Madder's therapeutic and cosmetic uses, while noted here,[16] and its function as a colorant in Persian cuisine,[17] or for identifying livestock,[18] will not be discussed further.

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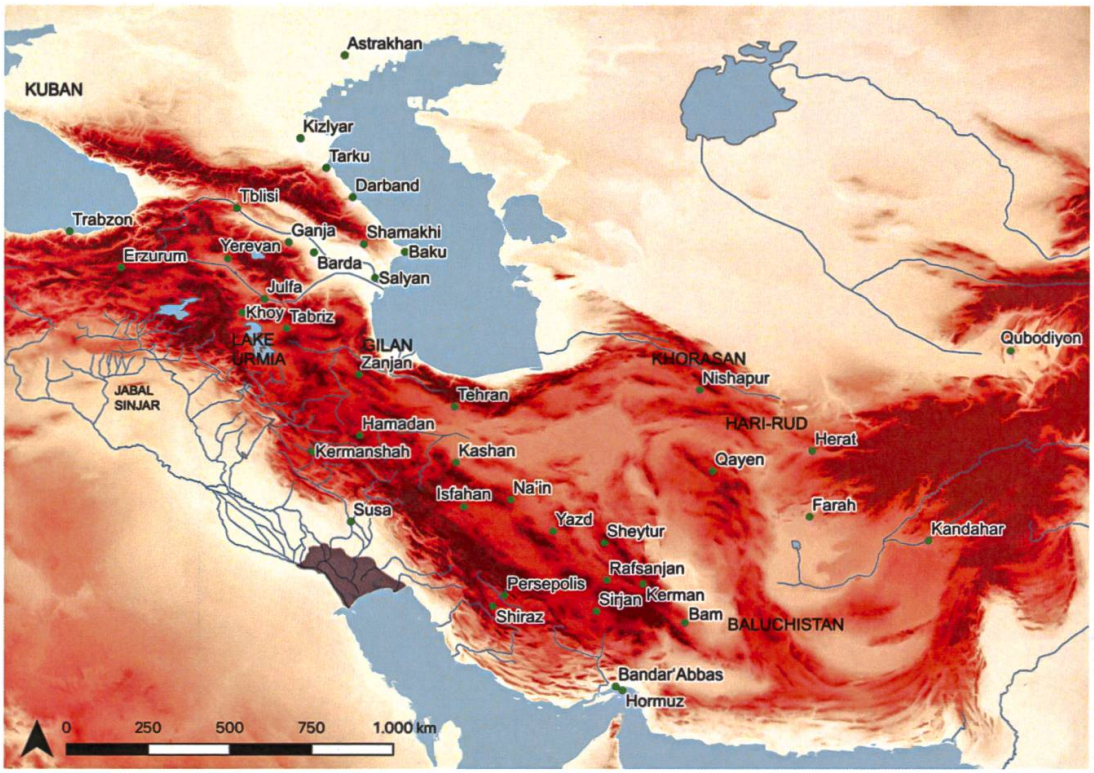
largest and best-known supplier' of madder in Europe before the nineteenth century. See Schott 1992: 5. Cf. Duhamel du Monceau 1757: 75, 'on prétend qu'il y a quelques siècles qu'elle fut transportée des Indes dans la Perse, de ce pays à Venise, & de-là par l'Espagne & la France dans les Provinces-unies. On la cultive actuellement avec beaucoup de succès en Zélande; elle se trouve aussi en Hollande, & particulièrement au pays de Voorn près de la Brille.'

15 Hellot 1750: 370, 'De tous les rouges, c'est le sien qui est le plus solide, quand il est appliqué sur une laine ou sur une étoffe bien dégraissée, puis préparée par les sels avec lesquels on la fait boüillir pendant deux ou trois heurs; sans quoi ce rouge, si tenace après cette préparation du sujet, ne résisteroit guères plus aux épreuves que les rouges des autres ingrédiens de faux teint.' Cf. Pfister 1928: 242, 'On sait que la matière colorante de cette racine (l'alizarine) se fixe sur la fibre au moyen de sels minéraux; il se forme ainsi des laques très stables dont la couleur varie selong le mordant utilisé: avec l'alun on obtient des rouges vifs, qui correspondent au rouge d'Andrinople; les sels de fer produisent des bruns et même des teintes presque noires, selon l'intensité.' Cf. Pfister 1935: 19, 'Garance—Il s'agit de la matière colorante de *Rubia tinctorum* et *R. peregrina* qui donne, appliquée sur la laine bien dégraissée et mordancée à l'alun et au tartre, le rouge le plus résistant qu'on connaisse.' Cf. Martiniani-Reber 2004: 116.

16 Chardin 1686: 292 noted, 'Pour guérir la Pleuresie, Il faut prendre deux galettes fort-minces de farine ordinaire, les faire bien bouillir dans de l'eau avec de l'alun de roche & avec l'herbe qu'on appelle en François *Garance*, & en Latin *Rubia tinctorum*, & puis les appliquer sur le côté, une devant l'autre derriere, les plus-chaudes qu'on pourra les souffrir. Le reméde se doit réiterer journellement juqu'à la guerison.' Vogt 1832: 652–653 noted the folk belief that madder dye could directly affect bone and help to strengthen and heal it. Cf. Wiesner 1862: 137–138. Parsa 1960: 109 described the setting of a broken limb as follows: 'madder mixed with wax oil (Rovghan-i-mum) and yoke of egg (Zarda tukhm-i-morgh) (some of each) warmed, and placed over the fracture, the fracture is reduced, and at this time a piece of wood is applied to keep the limb straight.' According to Donaldson 1938: 146, 'Leaves of the madder and the indigo plant are pounded together and given to guests to rub on their eyebrows to make them happy during their visit.'

17 Olivier 1807/5: 287, 'On mange quelquefois le pilau avec le yougourt ou avec les sucs de divers fruits, tels que cerises, mûres, grenades. On le colore assez souvent, en tout ou en partie, avec le safran, l'épine-vinette, la garance.'

18 Mann 1906: 190, n. 47, 'Die Krappwurzel hat bekanntlich einen roten Farbstoff, der auch im Orient sehr viel verwendet wird. Rot ist aber dem Kurden die schöne Farbe … "Die Schafe sind fett; sie sehen fast so schön aus, als wenn sie mit Krappfarbe angestrichen wären." Das Anstreichen der Schafe auf dem Rücken mit roter Farbe wird übrigens häufig angewendet, um Begriffsverwechselungen in bezug auf Eigentumsrechte vorzubeugen. Natürlich nimmt man dazu dann möglichst dauerhafte Farben, wie den Krapp.'



The earliest literary evidence of the use of madder as a dyestuff in Mesopotamian cuneiform sources pre-dates its detection as a colorant in excavated textile fragments by over 700 years.[19] Although not Iranian, this evidence is briefly noted here in order to place the Iranian material in a broader context. In 1983 the Dutch Assyriologist Marten Stol identified Sumerian ^{giš}**ú-hàb** = Akkadian *ḫurātu* as madder.[20] The first references to madder's use appear in the archive of a leather-dyeing workshop forming part of the so-called Isin craft archive, dated to c. 2013–1982 BC, where a pair of madder-dyed sandals is noted.[21] Around 1771/0–1764/3 BC Zakira-Hammu, governor of Qattunan, near Jabal Sinjar,[22] wrote to the king of Mari on the Middle Euphrates, Zimri-Lim, to inform him of the capture of people suspected of illegally gathering (presumably

19 For a recent overview of madder and red coloration in ancient Mesopotamia see Thavapalan 2019: 331–338. For a convenient survey of madder in the early Mediterranean and Europe see Cameron 1930.

20 Stol 1983: 534–535. Oppenheim 1967: 242 thought the term was 'most likely not Akkadian … and could therefore belong to a dyeing technology alien to the practices of the Mesopotamian textile industry evidence.'

21 Van de Mieroop 1986: 90. Cf. Landsberger 1967: 169.

22 The location of Qattunan is unknown but Heimpel 1996: 105 suggests it lay 'about halfway between' the confluence of the Euphrates and the Khabur rivers 'and the Radd in the north.'

wild) madder: 'Numheans came … crossed … Latihum in order to dig out madder, and they [stayed] nine days inside the forest. But I did not [know], until someone who had seen them came and spoke to me. I dispatched troop, [and] they conducted them to me. I reproached them about the fact that they … not … and took away their madder. And those, I released them. Forty liters of moist madder … under seal … their guide … I sealed.'[23] Occasionally, incidental references indicate where madder was grown, e.g. in orchards at Nuzi, near modern Kerkuk in northern Iraq, during the mid-2nd millennium BC.[24]

Later, the Assyrian empire appears to have regularized madder deliveries, presumably because madder-based dye was being used on an industrial scale for, among other things, military uniforms or parts thereof.[25] A multi-column, Neo-Assyrian administrative account of wool and madder deliveries, unfortunately damaged in some places, lists quantities of linen in one column, madder in the second, and the names of towns in the western provinces of the empire (Syria, Palestine, Israel) where these commodities originated, in the third. These included many well-known cities such as Carchemish, Megiddo, Sam'al, Amidi, Damascus and Arpad.[26] That some of these deliveries entailed prodigious quantities of madder is shown by the fact that 60 talents of madder is mentioned in one instance. Depending on whether this was the heavy (60.6 kgs) or the light (30.3 kgs) Assyrian talent, the quantity would have amounted to 3,636 or 1,818 kgs.[27] Recipes for dying are known. One involving the use of madder for the production of a red-purple color, occurs in a compilation of recipes from the Neo-Babylonian period, some of which may be copied from earlier sources dating back to the mid-second millennium BC.[28] Madder-based red colorant may have been used on stucco at Uruk, in southern Iraq, but the results of Mass spectrometric and high performance liquid chromatography (HPLC) are not straightforward.[29]

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23 Heimpel 2003: 432. Cf. Vollemaere 2016: 290. Madder was certainly used at Mari at this time. See Thavapalan 2018: 10, n. 35.

24 Abrahami 2014: 295; Thavapalan 2019: 333.

25 Gaspa 2018: 136.

26 Fales/Postgate 1992: 125, no. 116. Cf. Villard 2010: 396; Gaspa 2018: 408.

27 Gaspa 2018: 11.

28 For the text see Finkel et al. 1998: 64–65; Johnson n.d.: 71. My thanks to Prof. Cale Johnson (Berlin) for bringing this reference to my attention.

29 The colorant used was 'rich in pseudopurpurin with no alizarin.' See Daniels et al. 2014: 9. Cf. Simpson et al. 2012: 213 who noted, 'These findings are similar to those from other Eastern ancient madders studied, particularly those from Egypt … but are very different from the chemical compositions recorded in the best studied group of madder pigments, those used in later western European canvas paintings. This may reflect the use of a different plant source, possibly *Rubia peregrina* (wild madder), rather than *Rubia tinctorum* (common madder), but may also be related to different methods of colourant preparation.'

As for Egypt, data on the ancient use of madder as a red colorant, albeit imported,[30] has been accumulating there since the 1930s when the Alsatian chemist Rudolf Pfister (1867–1955) first identified madder pigmentation on textiles in the tomb of Tutankhamun, for which a *terminus ante quem* of 1324 BC can be presumed.[31] It remains the case that no use of madder has been identified in Egypt prior to the 18th Dynasty.[32] Turning to the east, the earliest dated evidence of madder for dyeing in Asia comes from a burial at Yanghai, Turfan in Xinjiang, western China, where wool trouser fragments that include red-dyed fibres were found in a tomb (M157) that has been radiocarbon-dated to 1261–1041 cal. BC (2-sigma).[33] These are, therefore, almost eight hundred years later than the earliest cuneiform evidence from Isin, but less than a century later than the earliest evidence from Egypt.

3 The Iranian and Caucasian data

In 1907 Vincent Scheil suggested that the Elamite term *ḫarkaman* in a pre-Achaemenid (late Neo-Elamite) administrative text from Susa recording the disbursement of 1 mina 20 shekels of the substance given to Kuddakaka, denoted madder or 'couleur rouge.' This, he pointed out, grew wild on the mountains of Iran,[34] and in fact the text specifies that two garments were died at Hidalu, a locale in the mountains between Susa and Persepolis.[35] Because of the fact that Elamite *ḫarkaman* seems obviously to be a loanword from Akkadian *argamannu*, meaning 'red-purple,'[36] this early attestation has been largely ignored, though Scheil's suggested identification of Elamite *ḫarkaman* with madder has been neither refuted nor embraced. In a recent discussion of dyes and Mesopotamian chemistry, Cale Johnson, however, has noted that a red-purple 'known in Akkadian as *argamannu* "imitation,"' i.e. the dyed material was not produced with 'murex-based purple' dye, but was a facsimile.[37] It would seem plausible to suggest that

30 Loret 1930: 31–32; Aufrère n.d.: 61.

31 For the date of Tutankhamun's death, 1324 BC, see Hornung et al. 2006: 493. My sincere thanks to Dr. Marianne Eaton-Krauß for this reference. For madder on textile fragments in his tomb see e.g. Pfister 1937: 209; Wouters et al. 1990; Reifarth/Völling 2013; Thavapalan 2018: 22.

32 Germer 1992: 71. For instances of madder use in Roman Egypt see Daniels et al. 2014: Table 1.

33 Zhang et al. 2008; Kramell et al. 2014: 222. Cf. Shahid et al. 2019: 58.

34 Scheil 1907: 60.

35 For a full discussion of the various locations proposed see Potts 2005: 173–175.

36 Hinz 1967: 90; Hinz/Koch 1987: 633, s.v. *har-qa-ma-an*.

37 Johnson n.d.: 71. My sincere thanks to Cale Johnson for providing me with a copy of his manuscript discussing this topic in advance of its publication.

the *ḫarkaman* or argamannu at Susa was not a murex-derived dye but one derived from madder roots.

The ancient Chehrabad salt mine, near Zanjan, has yielded the mummified remains of at least eight individuals. Radiocarbon dates on these indicate that three of them died in the middle to late-Achaemenid period (c. 410–350 BC); one in the early Sasanian period (c. 220–390 AD); and the rest in the mid- to late-Sasanian era (c. 430–611 AD).[38] Excavations have also recovered 'hundreds of textile fragments,' yet only in the case of Salt Man #4 could a direct association between an individual and particular textile fragments be established, and in general these lack a 'secure stratigraphic context.'[39] HPLC analysis has shown that some textile fragments from Chehrabad were dyed red with madder.[40] Unfortunately, it is not possible to say whether the textile samples in question date to the Achaemenid or the Sasanian period. With reference to a potential Achaemenid date for some samples, it is, however, interesting to observe that no madder was detected in the fibers of the famous carpet from Pazyryk (near mod. Novosibirsk, Russia). However, felt samples from the same tomb (tomb 5) were found to contain 'alizarin, purpurin, and pseudopurpurin, components that derive from the widely distributed madder plant, *R. tinctorum* L., or one of the other Rubiaceae.'[41]

As for the use of madder during the Sasanian period, this was already well-established by the evidence of Sasanian textiles made using thread died with madder from Egypt and elsewhere.[42] Moreover, the New Persian name for madder is clearly derived from Middle West Iranian (Middle Persian and Parthian) *rōδin* (cf. Khotanese *r(r)ūnai*) which implies knowledge of the plant in the greater Iranian world in late antiquity.[43]

With respect to the early and mediaeval Islamic era, around 920 al-Istakhri mentioned madder growing wild on an island in the Caspian Sea, and noted that people travelled there from the region of Barda in Caucasian Albania (mod.

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38 Vahdati Nasab et al. 2019: Table 1.

39 Hadian et al. 2012: 153.

40 Mouri et al. 2014: Table 2. For a detailed exposition of the analytical techniques used for the detection of madder-based dyes see Daniels et al. 2014.

41 Böhmer/Thompson 1991: 33. The dates of the tomb and the carpet found within it are exceptionally difficult to determine, given that the timbers of which the burial chamber was constructed appear to have been c. 150 years old when put to use; the carpet could have been old by the time it was deposited; and the Chinese silk in the tomb dates to the Warring States era, 480–222 BC, more probably to the third century BC. See e.g. Lerner 1991: 9; Bunker 1991: 21; Hiebert 1992: 120–122.

42 Pfister 1935: 38–40. Pfister 1948: 50 noted that madder was 'utilisée dans la plupart des tissus à l'époque précédant la conquête arabe.'

43 Bailey 1935: 135; Emmerick 1971: 374. Morgenstierne 1933: 36 hypothesized an Old Iranian form **raudana-*.

Republic of Azerbaijan) in order to collect it.[44] Madder at Barda was also mentioned c. 982 in the *Ḥudūd al-'Ālam*.[45] During the 10th and 11th centuries it was exported from Darband (Derbent), in Daghestan further north.[46] According to Yaqut, Nasr-e Xosrow's hometown, Kobadhiyan (mod. Qubodiyon, Tajikistan), was also noted for the export of madder.[47] As noted above, a recent study of pigments employing micro X-ray fluorescence (μ-XRF) and micro Raman spectroscopy (μ-Raman) identified madder-based, red colorant in the wall decoration of the Saljuk fortress of Shahdiz, near Isfahan. Around 1340, during the Ilkhanid period, Ḥamd-allāh Mostawfi mentioned madder production at Khwāf, near Nishapur, in Khorasan.[48] At this time, or slightly earlier, madder seeds from Na'in and Yazd were successfully sown at Tabriz.[49]

Moving on to the Safavid era we have a largely disparate collection of evidence, spanning the length and breadth of the Iranian world. Describing the reign of Shah Isma'il I (r. 1501–1524), the Venetian traveller Josafa Barbaro wrote of Khoy, 'In this city, they also make much crimson dye, by using some red roots, which they dig out of the ground with spades and hoes, and then take to Ormus [Hormuz], and they are employed as red dyes in many parts of India.'[50] The export of madder from Hormuz to India was mentioned at the end of the 16th century by the Portuguese writer Pedro Teixeira.[51] At the beginning of the 17th century Azerbaijan was a noted exporter of madder.[52] In early 1622 William Bell and his three colleagues Henry Darrell, John Purifie and John Benthall wrote from

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44 Mordtmann 1845: 102–103. As Marquart 1903: 2, n. 1, wrote, 'Diese Insel lag … gegenüber die Kurmündung. Sie war gross und es gab auf ihr Röhrichte, Wälder und Wasser. Man führte von da Färberkrapp aus, und es begaben sich dahin aus den Distrikten von Barδa'a Leute die den Krapp suchten … Welche der zahlreichen Inseln von Baku bis Lenkoran gemeint ist, weiss ich nicht zu sagen.' Wild madder roots gathered in cases like this were not necessarily destined only for use by those who gathered them. They also represented a potential cash crop. According to Dionysius of Tel Mahre (fl. 818–845), under severe economic pressure, in 766/7 the Monophysite Christians of Upper Mesopotamia, many of whom were sharecroppers whose land could be easily repossessed, were driven off their land and crossed the frontier into Byzantine territory where they tried to supplement their precarious living by gathering wild madder roots in the area east of Malatya (mod. Turkey). See Cahen 1954: 146; Auzépy 2012: 485.

45 Minorsky 1955: 257, 33a.

46 Minorsky 1958: 127.

47 Tomaschek 1877: 108; Serjeant 1946: 126–127.

48 Barbier de Meynard 1861: 213, n. 3; Le Strange 1919: 152; Serjeant 1946: 120.

49 Rahimi-Laridjani 1988: 414.

50 Stanley 1873: 165–166.

51 Schwarz 1914: 540.

52 D'Avity 1613: 942.

Kohestak (on the mainland south of Minab, near Bandar 'Abbas) to the East India Company factory at Surat that they would 'furnish some "ruhanas" next year.'[53] This appears to have transpired for almost exactly one year later Thomas Barker and John Benthall, based at the English factory at Bandar 'Abbas (Gombroon), wrote to their colleagues at Surat that, 'Some merchants have embarked,' on board the *Blessing* and *Reformation* 'with rūnās and similar commodities.'[54] At the other end of the Persian Gulf the Portuguese purchased madder imported from Persia at Basra, according to António Bocarro's *O Livro das Plantas de Todas as Fortalezas* (1635).[55] Around 1665 the French jeweller Jean-Baptiste Tavernier observed madder, which he called *Ronas*, at Astabad, near Julfa, in what is today Nakhchivan. He was led to believe, presumably by the locals, that this was the only place in the world where the plant grew.[56] On 12 July 1670 Jan Janszoon Struys visited Darband where madder root was readily sold in the market.[57] Jean Chardin mentioned the madder of Isfahan[58] and it was listed in John Fryer's 1698 'Catalogue of Plants growing at *Spahaun*.'[59] In 1717 Pitton de Tournefort reported a large quantity of madder imported from Iran at Erzurum. This he called *boïa*, using its Turkish name.[60] Whereas madder was one of the few commodities bought for export by Dutch East India Company (VOC) merchants and exported from Bandar

53 Foster 1908: 23.

54 Foster 1908: 186.

55 Floor 2006: 514.

56 Tavernier 1676: 47–48, 'L'abondance des eaux rend le terroir excellent, & sur tout il y croist de tres-bon vin. C'est le seul pays du monde qui produit le *Ronas*, dont il se fait un si grand debit en Perse & aux Indes. Le Ronas est une racine qui court dans la terre comme la reglisse [licorice], & qui n'est gueres plus grosse. Elle sert à teindre en rouge, & c'est ce qui donne cette couleur à toutes ces toiles qui viennent de l'Empire du Grand Mogol. Quoy qu'on en tire de terre des morceaux fort longs, on les coupe de la longueur de la main pour en faire des paquets & en mieux remplir des sacs dans quoy on transporte cette marchandise. C'est une chose étonnante de voir arriver à Ormus des Caravanes entieres chargées de ce Ronas pour l'envoyer aux Indes dans les navires qui y retournent. Cette racine donne une forte & prompte teinture, & une barque d'Indiens qui en estoit chargée ayant esté brisée par leur negligence à la rade d'Ormus où j'estois alors, la mer le long du rivage où les sacs flottoyent parut toute rouge durant quelques jours.'

57 Writing of his master, Struys noted, 'comme il trafiquoit en garance & autres racines propres à teindre qui ne sont pas rares en ce pays-là, nous étions souvent sur la *Mer Caspienne*.' See Glanius 1681: 218. For W. Glanius, the mysterious translator of Struys' account, see Konwar 2019: 46, n. 25.

58 Chardin 1711: 197.

59 Fryer 1698: 294.

60 Pitton de Tournefort 1717: 111, contracted form of *kök boïa/kökboya*, Turkish for 'madder root.' See Baykara 1998. Cf. Gueudeville 1719: 23 writing about Erzurum, 'On y apporte de Perse la *Garance* ou *Roïa*, qui sert pour les teintures des Cuirs & des Toiles.'

'Abbas prior to 1721, Dutch sources report that it became increasingly difficult to obtain,[61] perhaps because demand for it further north had increased.

The political, economic and social upheavals of the early 18th century undoubtedly contributed to the dearth of sources from this period. Between 1732 and 1746 VOC traders had difficulty obtaining sufficient quantities of madder from Persian or Caucasian sources, and the amount exported ranged from a high of 30,000 lbs (1732) to a low of 5,000 (1745). At Shamakhi in the Caucasus (in mod. Azerbaijan) the Indian traders working for the Dutch could find nobody willing to go to Darband, for fear of being attacked, robbed or even killed by Lezgin raiders.[62] Still, a report from 1757 shows that at least some Persian madder was being sold by VOC merchants at Muscat in Oman.[63] By the mid-18th century Georgia emerged as an important supplier of madder and carvans laden with it travelled from Tblisi to Erzurum and from there to Diyarbakir in eastern Turkey.[64] Similarly, madder was widely cultivated in Kakheti (Georgia) in 1772.[65] Astrakhan, on the Volga in what is today southern Russia, became an important center of dyeing in the last quarter of the 18th century, as well as a gateway to Russia for the importation of madder.[66] Most of the madder preparation and dyeing there was done by Armenians, 'the number of whom on account of the troublesome state of Persia is continually increasing.'[67] Along with a variety of other goods, madder was sourced for the Russian market at Salyan, near the mouth of the Kur River, and Baku (both in mod. Azerbaijan) on the Caspian.[68] The predominance of these northerly sources helps account for the fact that, in his 1750 treatise on drugs, Nicolas Lémery called *Ronas* a root that produced a strong red dye and grew in Armenia and Turcomania on the

61 Floor 2007: 89. My thanks to Willem Floor for bringing this and several more VOC references to my attention.

62 Floor 2009: 236 and Table 5.6.

63 Floor 2007: 213, Table 6.1. The price was 35–40 rupees per 125 lbs.

64 Savary des Brulons 1742: 726.

65 Pallas 1787: 371, 'Krapp ist in Kacheti sehr häufig und wird, wie am Terek, im Frühlinge, ehe das Kraut treibt, zur Hausfärberey und zum Verkauf in Menge gegraben, aber nicht, wie dort in Erdgruben, sondern an der Luft unterm Dach, über den Stuben getrocknet. Ein Litra [pound] frischer Wurzeln galt 1772, ein, und trockne 1 Rbl.[ruble] 40 bis 50 Kop [kopeks].' Cf. Klaproth 1814: 49.

66 Gmelin 1774: 413. Cf. Frey des Landres 1781: 148, 'L'art de teindre en garance est très-connu à Astrakan, & l'on s'y pique d'être aussi versé dans la maniere d'y procéder qu'en Turquie même.' See also the exhaustive account in Pallas 1793 who noted that, 'Die Färberröthe deren man sich in Astrachan bedient, kommt theils über Kizlar zu Lande vom Terek [Tarku], theils zur See und über Derbent, aus dem Persischen Ghilan. An beyden Orten wächst die Pflanze in den Gründen in großer Menge und Vollkommenheit wild und wird auch as dem wilden Rasen gegraben. Die Wurzeln sind gemeiniglich wie ein Federkiel, ja zuweilen eines kleinen Fingers dick und durch den ganzen Mark angenehm bleichroth.'

67 Pallas 1798: 5.

68 Olivier 1807/3: 177.

frontiers of Persia, near the city of Astabac, i.e. which Tavernier called Astabat [Astabad], just across the Aras river and not very far from Old Julfa, and nowhere else.[69] As Pallas noted in 1793, wild madder from Gilan, as well as madder from Tarku [Tarki], reached Astrakhan via Darband. 'In both places the plant grows wild in the fields in great abundance and great perfection,' he wrote, 'and is dug up also in the uncultivated meads. The roots are generally as thick as the barrel of a quill, sometimes as one's finger, and throughought the whole spongy part of an agreeable pale red colour: the bark on the other hand is for the most part very thin, and appears to be of little value.'[70]

Madder, presumably wild,[71] was exploited c. 1804 around Ganja.[72] Just a few years later G.A. Olivier noted that, although wild madder was collected around Kermanshah, Hamadan, Isfahan and Tehran, it was cultivated in virtually all parts of the empire. The best quality came, however, from Farah and Kandahar. Consumption of the root for dye manufacture was considerable, and it formed one of the principal export commodities to India.[73] In 1807 Capt. Hilarion Truilhier, a member of the mission sent by Napoleon to the court of Fath 'Ali Shah, noted that an immense amount of madder was gathered around Yazd, some of which was used locally and some of which was exported to India.[74] The gathering and sale of wild madder roots by nomads was mentioned by J.J. Morier in the account of

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69 Lémery 1760: 646, '*Ronas*, est une racine un peu plus grosse que celle de la Reglisse, & qui, comme elle, s'étend beaucoup dans la terre; elle croît en Arménie ou Turcomanie sur les frontieres de la Perse, proche de la Ville d'Astabac, & non ailleurs. Elle donne une forte teinture rouge à l'eau en peu de tems; on s'en sert au Mogol pour teindre les toiles. On sait un grand commerce de cette racine en Perse & aux Indes elle rend une teinture rouge si prompte & si forte, qu'au rapport de M. Tavernier dans la rélation qu'il a donnée de son voyage de Perse, une barque Indienne qui en étoit chargée ayant été brisée à la rade d'Ormus, la mer parut tout rouge pendant quelques jours le long du rivage, où les sacs de Ronas flottoient.'

70 Pallas 1798: 5.

71 Madder cultivation in the Caucasus was a later innovation. See below.

72 Cazalès 1838: 605, writing, presumably of the situation in 1804 (the date is indicated because of his reference to Tsitsianov's capture of Ganja), noted that the province of Ganja produced cotton, silk, rice and madder. Cf. Herrmann 1835: 508, 'Der Krapp (Doron [Arm. *toron*]) wächst hier allein im Lande, und ist vorzüglicher, als der Cyprische und Karamanische, daher man ihn auch in verschiedene Länder ausführt.'

73 Olivier 1807/3: 188 wrote, 'Nous l'avons trouvée sauvage à Kermanchah, à Amadan, à Téhéran. On la cultive dans presque toutes les provinces de cet Empire. La plus estimée est fournie par Férah et Kandahar. La consommation que l'on en fait dans le pays est trèst-considérable, et c'est un des principaux objets d'exportation pour l'Inde.' Cf. Reichard 1809: 121. For madder growing around Isfahan see Olivier 1807/3: 111. For export to India from Bandar 'Abbas and Bushehr, see Olivier 1807/3: 181. Cf. Dupré 1819: 400–401; Rich 1839: 265; MacGregor 1871: 59, 88, 90; Bishop 1891: 3, n. 1.

74 Truilher 1838: 16.

his 1808–1809 stay in Iran.[75] In 1810 H. Pottinger observed madder cultivation at Nurmanshahr, to the southeast of Bam in Kerman.[76] He also noted that, 'The Kirmānīs chiefly send their shawls, namads,[77] and matchlocks to Khōrasān, Kābal, Balkh, Bokhāra, and the northern provinces, and in return receive assa-fœtida, guns, rhubarb, madder, and other drugs.'[78] The cultivation of madder in Baluchistan at this time was noted by J.M. Kinneir.[79]

Several years late Joseph von Hammer noted that madder was one of the mainstays of the economy of Abarkuh, on the road between Shiraz and Yazd, where it was also cultivated.[80] Madder from Persia was brought regularly to Trabzon, presumably via Erzurum, destined for the markets of Tblisi in Georgia.[81] This suggests that, whereas Georgia had been an exporter of madder in the 18th century, most if not all of which was wild at this time,[82] it was now an importer.[83] Madder was considered one of Persia's chief exports in 1823.[84] Azerbaijan produced madder at this time.[85]

Presumably to satisfy Russian demand and to stimulate the economy, southern Daghestan, which had been under Russian control for most of a century by this time, became an early area of Caucasian madder cultivation[86] In 1826 the French consul Jacques François Gamba wrote that the Russian government would do well to encourage the cultivation of madder in Kakheti (i.e. Georgia), where the soil was suitable for it.[87] In 1839 Dubois de Montpéreux noted that the Russian government had tried to stimulate the creation of madder cultivation in the vicinity

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75 Morier 1812: 231, 'madder roots, which grow wild upon the mountains … are brought down for sale by the *Eelauts* or wandering tribes.'

76 Pottinger 1816: 201; MacGregor 1871: 353.

77 A felted carpet. See e.g. Birdwood 1908: 1071; Laufer 1930: 10.

78 Pottinger 1816: 226; MacGregor 1871: 256.

79 Kinneir 1813: 225.

80 Hammer 1819: 337, 397.

81 Rottiers 1829: 227–228.

82 Gamba 1826/1: 85. For wild madder near Baku in the early nineteenth century see Klaproth 1827: 149. Anonymous 1835: 16 noted madder as one of the wild products of Russian Armenia.

83 Whether this was to supplement local production, in view of Russian demand, is unclear. Describing the economy of Georgia, Gamba 1826/2: 67–68 observed, 'Ils s'occupent de la fabrication des toiles de coton, et se servent, pour les teindre en un très-beau rouge, de la garance sauvage qu'on trouve en abondance dans le pays. On m'en fit voir de très-grosse et de la meilleure qualité; mais quoiqu'elle ne coûte que la peine de l'arracher, on vouloit la vendre humide à 4 roubles argent le poud, ce qui auroit porté le quintal de France à 48 francs.'

84 Gräffer 1823: 27.

85 Gödel 1849: 21.

86 Klaproth 1827: 137.

87 Gamba 1826/2: 68, 'Le gouvernement Russe feroit bien d'encourager la culture de cette plante dans la Kakétie, la nature du sol lui étant très-convenable.'

of Erivan (Yerevan, Armenia).[88] However, according to Alexander Petzholdt, although wild madder was often gathered in the Caucasus, its cultivation on a large scale only began in the 1840s when it was introduced by one Kalb 'Ali Hoseyn, particularly in the Kuban and Darband districts.[89] Oak forests were cut down in order to cultivate madder, which was considered a quick way of achieving great wealth.[90] From there, its cultivation, albeit on a small scale, spread to many other parts of the Caucasus.[91] By the 1860s Ussher noted that, 'We passed near Derbend a number of bullock-carts laden with garance, the root from which the red dye used by the French for the overalls of their soldiers is extracted, which is largely grown in the neighbourhood of the town. The soil and great heat of the climate would seem to answer admirably for its production; we were told that the value of the quantity annually exported amounted to no less a sum than three hundred thousand pounds, and that the supply was on the increase.'[92]

Meanwhile, madder continued to be profitable in Iran itself. *En route* from Bam to Shiraz on 4 February 1850, Keith Abbott 'encountered a caravan of 370 camels on their way from Yezd to Bunder Abassi, laden chiefly with madder-root, cotton, assafœtida, and almonds.'[93] In the 1850s and 1860s madder was cultivated widely in Iran.[94] According to Blau, who visited Iran in the summer of 1857, Tabrizi

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88 Dubois de Montpéreux 1839: 356–357, 'Le gouvernement a fait faire des essais de plantations de garance dans le voisinage de la forteresse, sur une surface de 1,480 toises carrées [1 toise = 3.7986 sq.m.; 1,480 toises = 5,621.9 sq.m.]. Le jardinier qui était chargé de cette plantation, prétendait qu'en 1834 on en retirerait déjà 100 *bathman* [1,000 kgs.] ou 12 quintaux de racines, et que les années suivantes quand la garance serait plus forte, elle donnerait bien les 1,000 bathman ou 120 quintaux, qu'il estimait à 100 francs le quintal.'

89 Petzholdt 1866/1: 212 identified the areas of Kuban and Darband as 'der Hauptsitz des kaukasischen Krapp-Baues.'

90 Petzholdt 1866/1: 218 reported coming to 'die einem Herrn v. Kotzebue gehörigen Ländereien, welche demselben von der Krone geschenkt wurden und auf denen er den vorhandenen Eichenwald in grösstem Maassstabe hatte roden lassen, um auf dem so gewonnenen Neulande ebenfalls Krapp zu bauen. Denn Krapp und immer wieder Krapp bildete das Losungswort Aller in den Kuba'schen wie Derbent'schen Gegenden; im Anbau von Krapp hatte alle Welt das Mittel erblickt, schnell zu Reichthum zu gelangen; und als nun theils in Folge der Ueberproduction, theils in Folge der verminderten Nachfrage der Preis des Krapp ausserordentlich gesunken war, da standen Viele am Rande des Verderbens und wussten sich nicht zu helfen.' In fact, Petzholdt 1866/1: 219 noted that the madder growers of this region, 'in Rücksicht auf sehr wichtige Dinge, wie z. B. Düngung der Krappfelder, die richtige Erntezeit u.s.w. sich in der äussersten Unkenntniss befanden.'

91 Petzholdt 1866/2: 176.

92 Ussher 1865: 201.

93 Abbott 1855: 64; MacGregor 1871: 643.

94 Blau 1858: 84, singled out Tabriz and its hinterland, as well as Yazd, Kashan, Isfahan and, of recent date, the area surrounding Lake Urmia. In 1855 over-production in the latter area (two years

madder was the most highly prized and most expensive. It was normally sold as a root, not in powdered form. Although analyses suggested that Russian madder, recently arrived in the German market, had a higher concentration of pigment than Persian, this was a misleading statistic for the simple reason that much of what was sold as Russian in fact originated at Tabriz and was imported to Russia through Astrakhan, before being sold on as 'Russian madder' in Germany.[95] The Yazd region was also noted for its particularly high yields. Here the grinding and sale of the madder root was the work of Zoroastrians, and Isfahan and Shiraz were the main markets for the product. At Shiraz in 1859 one *man* (5.33 lbs) of ground madder cost 0.13 ducats.[96] In 1865, during the reigns of Napoleon III and Nasr-od Din Shah, a treaty of commerce and friendship between France and Persia stipulated madder among a list of Persian exports that would be admitted into Europe for trade.[97] So lucrative was agro-business in madder that, in his *Jughrafiya-yi Kerman* (1872–1874), Ahmad 'Ali Khan Vaziri-Kirmani wrote, 'Thanks be to God at this time all of the landlords of Kirman's villages became powerful and wealthy—because of the high prices for cotton and madder in India for several years, and shortages of corn in Yazd .... A village that they would once trade for 100 *dīnārs* in cash and a prayer now they won't sell for 3,000 or 4,000 *tūmāns*, especially in Sirjan, Rafsanjan and Arzuyah, whose cotton, madder, and wheat are mostly taken to Bandar 'Abbas and Yazd.'[98] Moreover, despite Russian efforts to stimulate domestic madder production in the Caucasus, madder remained a Persian export to 'the Russian and Turkish markets,' according to an 1871 report.[99] When Stolze and Andreas were in Iran (1874–1881) they found madder cultivated widely, but particularly around Tabriz, along Lake Urmia, and at Kashan, Isfahan and Yazd. Isfahan, Shiraz and Kerman were the principal markets for madder, and export was directed primarily towards Russia, India and the Arabian coast of the

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before Blau's 1857 visit) outstripped demand. Rochechouart 1867: 18 observed madder cultivation around Isfahan. For its cultivation in Mazandaran at this time see Gerstfeldt 1864: 195. Its cultivation at Balfarush (mod. Babol) was noted in Croizier 1873: 39. For madder at Lylan in Azerbaijan see MacGregor 1871: 297.

95 Blau 1858: 84.

96 Polak 1863: 33. Cf. Polak 1865: 151, 'Farbepflanzen werden ebenfalls in Menge gebaut. Die *Rubia tinctoria* (runās, daher wohl die französische Benennung *garance*) findet in vielen Gegenden des Landes einen günstigen Boden und liefert besonders um Yezd reichliche Ernten .... Hauptstapelplätze sind Ispahan und Schiraz. Im Juli 1859 galt in Schiraz das Man (5 1/3 Pfund) gemahlener Krapp 0.13 Dukaten.'

97 Thieury 1866: 43.

98 Gustafson 2014: 57–58.

99 Wheeler 1871: xlii.

Persian Gulf.[100] Similarly, madder 'cultivated with much care' in Baluchistan, was 'exported to Bombay, and some to Khurasan.'[101] Nevertheless, despite considerable exports of madder roots, Schneider estimates that most of what was produced in Iran in the period c. 1850–1900 was consumed by the domestic textile, especially carpet, industry.[102]

4 Techniques of madder cultivation

In addition to being a lucrative cash crop, whether gathered wild or cultivated, one of the great advantages of madder was the fact that it was highly salt-tolerant. In 1867 Rochechouart observed that madder was grown on saline soils because it was thought to rehabilitate, i.e. desalinate, soil that was unsuited to other cultivars.[103] Similarly, at Sheytur, c. 200 kms east-southeast of Yazd, Stack noted, in 1881, that, while the brackish water there 'prohibits the cultivation of poppy. Madder (*runask*) takes its place.'[104] Olmer also observed madder being cultivated in saline soil around Yazd and in Khorasan.[105]

In 1810 Pottinger observed the cultivation of madder in Baluchistan and described it as follows:

> The madder does not become fit to use under three years, and as the culture of it requires some pains, by describing the process, it will afford an idea of the Belooche system of agriculture. The ground being prepared and lined off into small trenches, the seed is put into them and flooded, and, while in that state, the trenches are filled with earth and rich manure. The plants appear in nine or ten days, and in the course of the first summer the stalks increase to three or four feet in height; they are cut down in September and given as fodder to the cattle. After this the ground is repeatedly flooded and manured until spring, when the plants again shoot forth, and such as are intended for seed, are set apart, as this second year is deemed the best for that purpose; the remainder are cut every month or six weeks, which throws all the vegetation into the roots, and adds to their size. Each stalk of those selected for seed,

100 Stolze/Andreas 1885: 17. Statistics on madder export are difficult to assess from this report since 'Farbstoff,' i.e. dye, is sometimes listed without further specification. However, for the year 1863 Stolze and Andreas 1885: 76 recorded the export of 147,880 *man* (of Bandar 'Abbas) of madder [1 *man* of Bandar 'Abbas = 3.864 kg, hence 571,408.32 kgs; see Stolze and Andreas 1885: 33), making it, by weight, the top export commodity from Bandar 'Abbas for the year.

101 Stack 1882: 238.

102 Schneider 1990: 281.

103 Rochechouart 1867: 159 wrote, 'On cultive généralement la garance dans des terrains salés, parce qu'on prétend que cette plante est un amendement excellent et rend le terrain propre à toutes les autres cultures.

104 Stack 1882: 238.

105 Olmer 1908: 74.

> produces one flower on the very top of it. In the pod, which succeeds, are two seeds; this, when ripe, is plucked off and laid apart, the stems are then taken away, as in the first year, and similar precautions adopted to enrich the soil. In the third summer the stalks are pruned as in the two preceding, and in September the roots are dug up; they are quite straight, without any ramifications whatever, and usually from three to five feet long, but very thin; these roots are immediately cut into small pieces and dried, in which state they are sold.[106]

In 1864–1865 Alexander Petzholdt carefully studied madder cultivation in the Kuban and Darband regions of the Caucasus. He noted that the ground was primarily tilled using an immense plough drawn by 12–16 oxen in the Kuban region, while around Darband it was done by hand with a spade.[107] This was less a reflection of the different soil characteristics of each region, than it was of the fact that madder cultivation around Kuban was an enterprise of large landowners who had trouble finding enough labor to till their extensive fields by hand, whereas madder cultivation around Darband was the domain of small landowners, and tilling was often done by landless laborers and/or sharecroppers. One result of the different régime followed in each region was that, around Kuban, the crop was 'harvested,' i.e. the roots were dug up and the field completely emptied, only once every four to five years, whereas around Darband, the harvest took place every three years, when only the roots spreading to the sides of the plant,[108] but not the principal root, were removed, which permitted the individual plants to produce for 15–20 or even more years. Petzholdt saw 15–22 year-old madder fields, which the owner hoped to continue harvesting for another 20 years. Because of the fact that planting and harvesting occurred in the spring and autumn, Petzholdt was unable to observe the entire life-cycle of the madder plant, and relied on an 1863 study, published in Russian, for much of his information.

One factor in choosing which fields to sow with madder was ease of irrigability, which weighed heavily in its favor. Additionally, a preference for previously uncultivated land was clear, e.g. forest land cleared for the purpose, even though this often resulted in environmental degradation and later regret at having cleared such land, particularly as there was otherwise no shortage of arable land in these regions which, particularly when manured, would have been just as productive. Particularly in the Kuban region, madder cultivation was a get-rich-quick scheme, whereby the potentially negative consequences for the land were simply ignored. Work in the madder fields was particularly sought by the Lezgins, who descended from their mountain homes in the autumn and remained until the spring. They were considered the best madder workers.

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106 Pottinger 1816: 324–325.

107 Petzholdt 1867/2: 176–177.

108 According to Petzholdt 1867/2: 178 this procedure was known by the Tatar term *kalam*.

When land was prepared for cultivation, madder was either immediately sown or, in some cases, a summer fruit such as watermelons, the profit from which was often sufficient to repay the initial investment costs. This was particularly true in the case of small holdings, whereas in the larger land holdings, madder was usually sown immediately. Fieldwork began in the autumn with the ploughing up or turning of the soil. When done by hand, beds, 3.5–5 ft wide, separated by 2 ft wide furrows for irrigation, were prepared. Digging by hand usually went to a depth of c. 18–20 in., equal to the length of the blade of a *kisgiri* (spade). Ploughing was done to a depth of c. 10–11 in.[109] In cases where the soil ploughed, seed was sown broadcast after the first snowfall. The advantage of this was that the black seeds were easily visible against the white of the snow, which helped insure a more even distribution across the field. In the spring, as soon as the soil began to dry out, it was also easier to dig the young sprouts into the soil, using a *zakan* (brush harrow),[110] before they were damaged by the dry winds. An initial weeding by hand took place in April, and a second in August, although this was often ignored.[111] Towards the end of the first year the young plants were covered with c. 5 in. of earth, generally dug out of the furrows between the beds, sometimes causing these to be up to two feet deep, which was unnecessary for purposes of irrigation.[112] It was thought that this helped in the production of alzarine, the colorant in madder, in the roots.

Apart from irrigation, the work needed during the second year was principally weeding, generally in April or May, and again in August, if workers were available. As in the first year, the young plants were covered in the autumn with a layer of soil, up to 7 in. thick. If the weeding in the first and second years had been done properly, it was required only in the spring of the third year. By this time the growth of the madder was such that it overtook that of the weeds. Although madder bloomed and produced seed already in the second year, the yield was to limited at that time to warrant harvesting, and this was done instead at the end of the summer of the third year in order to acquire seed for further sowing. This was done by cutting the part of the plant above ground with a sickel, and letting the stalks and leaves remain on the

109 Petzholdt 1867/2: 182, n. *, noted that these measurements were based on both oral and written information. In digging for root samples, for the purpose of chemical analysis, however, Petzholdt wrote that these were never so deep, and were much closer to the surface of a field.

110 For drawings of a *zakan* see Petzholdt 1867/2: 136, Fig. 12.

111 As a curiosity Petzholdt 1867/2: 182, n. *, observed that the weeding of madder fields was often done carelessly or not at all, due to the absence of the Lezgin workers or because of the costs involved, whereas on one occasion near Darband he found workers harvesting lentils by hand that had self-propagated in and amongst the madder. These grew in such quantity, one fieldworker told him, that they were worth harvesting.

112 Petzholdt 1867/2: 183.

ground for several days to dry out, after which the seeds were obtained by threshing with a threshing-sledge (*kewri*). The plants were again covered with soil in the autumn. Besides irrigation and gathering seeds in late summer, nothing further happened during the fourth year. By this time the plants were ready to be harvested, but economic factors made it advisable to wait until the spring of the fifth year. These included the need to wait until warmer weather in order to prepare the market-ready roots, without the need for specially constructed drying rooms, whereas, on the other hand, the harvesting of the madder became more expensive since the Lezgin workers were no longer available in the spring. Many madder farmers, however, preferred to harvest only in the sixth year in which case, with the exception of a single irrigation, nothing further occurred, not even a further covering of the plants during the autumn. While this practice resulted in a larger harvest of roots, it is not clear that it led to a commensurate increase in alzarine. Such late-harvested madder was called *koramit/karamit* from the Tatar term *kora*, meaning 'quiet,' since the plants had lain largely undisturbed during the preceding year.[113]

The actual harvesting of the madder roots was always done by hand, with a spade, standing on the bed and working backwards. The workers involved in this were called *belgi*. As they loosened the soil, young boys advanced down the bed. Using a curved stick they broke up the clods of earth, freed the roots and threw them onto a woollen *palas*. If only the side roots were meant to be harvested, leaving the principal root intact, great care was required, such that only selected workers were involved. After their removal from the ground, the roots were dried in an unusual fashion. For this purpose long, narrow trenches (*tondir*) were dug, c. 20 ft long, 1.5–2 ft wide and 6–7 ft deep. The walls of these trenches were strengthened with a layer of mud but if they seemed at risk of collapsing, they were reinforced with mudbrick. In both cases, they were strengthened by setting a fire in the bottom of the trench, after which the fresh madder roots, that had been sprinkled with water to keep them wet, were piled in, up to three feet deep and again drenched with water and covered with a felt blanket so as to retain the moisture. After 10–12 h the roots would have shrunk by 1/3 and were then removed using iron pitchforks and placed on a level place, like a threshing floor, and spread out in a 4–5 in. thick mass. This was turned frequently and in two or three days was completely dry and ready for packing and shipment.[114] In this way the roots lost c. 70% of their weight when freshly dug out of the ground, and were already dark red inside, whereas they had previously looked

113 Petzholdt 1867/2: 164, n. **.

114 Cf. Pallas 1798: 5, who wrote, 'At Terek the fresh gathered roots are placed above each other in a stove, or in a pit dug in viscous earth which has been strongly heated. Earth is then thrown over the madder, and it must sweat until the stove or pit becomes cold; when the roots, the second or third day, are taken from it, and either spread out or hung up to dry. The same process is usual also in Persia.'

yellow. After this the empty trenches were again heated and filled with fresh madder roots, such that two rounds of the process could be completed within 24 h.[115] The dried roots were put into large hemp sacks (*charall*) capable of holding 252–324 lbs (7–9 *pood*) each,[116] taken to market and there sold.

With respect to overall yields, the cultivators near Kuban and Darband c. 1865 reckoned with a madder root yield of 3,600 lbs. (100 *pood*) per hectare every four years.[117] Their counterparts in France, on the other hand, averaged about twice this over three years. The factors considered most influential with respect to yield by Petzholdt were the careful preparation of the earth; fertilization (manuring); and weeding in the first and second years. Irrigation, on the other hand, was considered less important. In the case of large-scale cultivation using plough teams in the Kuban region, this was often found insufficient to satisfactorily reach appropriate depths for seed maturation and to break up the soil for proper aeration. Failure to fertilize and weed adequately were also factors tending to lower yields.[118]

5 Milling the madder roots

The milling process and equipment has only rarely been described.[119] According to Polak, the work was performed at Yazd largely by Zoroastrian

115 This is broadly similar to the procedure at Astrakhan documented in Pallas 1793: 112, 'Am Terek werden die frischgesammelten Wurzeln von dem Volk in einem Brühofen, oder einer Grube welche man in zählaimigtem Erdreich ausgräbt und stark heizt, auf einander gepackt und der Ofen dick mit Erde überschüttet; auf diese Art muß die Röthe so lange schwitzen, bis der Ofen erkaltet, da man denn die Wurzeln (den zweyten, ja dritten Tag) herausnimmt und zum Abtrocknen auseinander breitet oder aufhängt. Eben dieses Verfahren soll auch in Persien üblich seyn.'

116 The *pood* at this time was 36 lbs. See e.g. Fitzpatrick/Hakala 2016: 50.

117 According to Radde 1874: 67, the yield sometimes reached 120–130 *pood*, or 4,320–5,680 lbs. The costs involved over five years per hectare were c. 400 Rbl. Silver, while the harvest was sold for 6 Rbl./*pood*, or c. 600 Rbl., yielding a profit of 200 Rbl. at 40 Rbl./year.

118 For questions of price and the influence e.g. of the American Civil War and European madder exports on Kuban and Darband madder production, see Petzholdt 1867/2: 188–190; Radde 1874: 67. Alongside rice, cotton and silk, madder was one of the main cultivars of the region, both for domestic consumption and export. See Stumm 1875: 178. Compare this with Rochechouart 1867: 158–159 who wrote, 'Le 20 mars, on prépare la terre, puis on plante les tronçons de racine et l'on fume avec des cendres. Après ces opérations, on herse fortement et fréquemment, puis on arrose aussi souvent que possible. La troisième année, le 20 mars, on commence à arracher, en prenant du bord, les morceaux que l'on veut replanter .... La garance perd 3/4 en séchant: elle se vend sèche 2 fr. 25 c. les 6 kilos, quelquefois un peu plus; il arrive qu'un hectare bien aménagé donne jusqu'à 5 kalvars, 15 quintaux dans les trois ans.'

119 Even Wulff 1966: 190, whose treatment of madder is surprisingly brief, made no mention of the process.

laborers.[120] In 1793 the great Prussian scholar Peter Simon Pallas (1741–1811) published a detailed description which has generally been overlooked. Here follows an English translation published in 1798[121] of Pallas' original German text:

> This madder is ground at Astracan, for the use of the dyers, in horse-mills kept by the common people, and constructed in the following manner: In the middle of the mill, which is built on a level spot of ground, a circular place is walled round with bricks to the height of four spans, the inner face of which is made to slope gently from the circumference towards the centre, and a groove goes round the inside of this brick-work to receive the mill stone. The whole surface of the brick-work is covered with plane smooth boards, and in the middle of it stands a perpendicular spindle, which at the top is inserted into a cross beam, and at the bottom rests in a socket. The spindle is turned by means of an oblique beam passing through it, to the shorter end of which is fastened a mill-stone moveable like a wheel round its axis, and a horse is yoked to the other end, which reaches beyond the brick-work. The madder, which has been well dried in the sun, must be first coarsely broken in the groove under the mill-stone, and afterwards ground until it become a very fine powder.[122]

6 Dying

Although one writer on Persian carpets declared that 'scarcely any details of the traditional dye process are on record,'[123] a full description exists by Pallas, from 1793, which was translated into English and published in the first volume of the

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120 Polak 1865: 151, 'Mit dem Mahlen der Pflanze sowie mit dem nicht unbeträchtlichen Handel und Export beschäftigen sich die Gebern.'

121 Pallas 1798: 5–6.

122 Pallas 1798: 5–6. Cf. Pallas 1793: 113, 'Diese Röthe wird in Astrachan, zum Färbergebrauch auf besondern Roßmühlen zermalmt, die von gemeinen Leuten gehalten werden, und folgendergestalt eingerichtet sind. In der Mitte der Mühlenkammer, welche auf platter Erde angelegt ist, wird von Ziegeln ein vier Spannen hoher, zirkelrunder Platz aufgemauert, dessen Oberfläche gegen den Mittelpunkt zu ganz gemächlich abschüssig oder vertieft, und mit einer zirkelförmig um den Mittelpunkt laufenden Rinne, für den Mühlstein versehen ist. Die ganze Oberfläche dieses Gemäuers ist mit glatt gehobelten Bretern getäfelt. Mitten auf dem Gemäuer seht ein senkrechter Spindelbaum, der oben in einem Querbalken, unten aber in einer Hülfe, auf dem Gemäuer seinen Umlauf hat, und durch welchen ein Querbalken geht, an dessen kürzern Ende ein Mühlstein, wie ein Rad und seine Achse beweglich, fest ist; an dem andern Ende, welches über das Gemäuer hinausreicht, wird das Pferd angespannt. Die Röthe welche an der Sonne wohlgetrocknet und grob gebrochen in die Rinne unter den Mühlstein gebracht wird, muß unter demselben so lange zermalmt werden, bis sie ganz zu einem feinen Staube wird. Die Müller, welche davon ihre Nahrung haben, bekommen für verzig Pfund sein gemahlene Röthe einen halben Rubel Mühlengeld.'

123 Spooner 1986: 206.

Philosophical Magazine in 1798.[124] Importantly it includes details on the mordant used, as well as the addition of ground wild sumac leaves (*Rhus cotinus* or *Cotinus coggyria*). Because it has been generally ignored, the section on dyeing is quoted here *in extenso*.

> The dye-stuffs necessary for dyeing red, besides the two already mentioned [madder and sumach], are gall-nuts, alum, an indigenous bad kind of soda, called *kalakar*, which is burnt in the wilds of Kislar [Kizlyar] and Astracan, from the salsuginous or soda plants, that grow there in abundance, and lastly fish-oil. The latter is boiled in the fisheries on the lower part of the Volga, and on the Caspian sea, from the entrails of the sturgeon and other large fish, but chiefly from those of the *perca lucioperca*, the shad [pike-perch], and other kinds little esteemed in those parts. The proof of its being proper dyeing is, that when mixed with a lixivium of soda [lye] it must immediately assume a milky appearance. Should that not be the case, it cannot be used by the dyers. The soda is burnt partly at Kislar by Armenians, and partly in the wilds of Astracan by the Calmucks. The latter, because it is very impure, sells at Astracan for only fifteen copeks per pood, but the former is worth more than thirty.
>
> The cotton to be dyed red is first washed exceedingly clean in running water, and, when the weather is clear, hung up on poles to dry. If it does not dry before the evening, it is taken into the house, on account of the saline dews so remarkable in the country around Astracan, and again exposed to the air next morning. When it is thoroughly dry it is laid in a tub, and fish-oil is poured over it till it is entirely covered. In this state it must stand all night, but in the morning it is hung up on poles, and left there the whole day; and this process is repeated for a week, so that the cotton lies seven night in oil, and is exposed seven days to the atmosphere, that it may imbibe the oil and free itself from all air. This process is repeated seven successive times, in order that the cotton may fully imbibe the oil, and free itself from all air.
>
> After this preparation a mordant is made of three materials, which must give the grounds of the red colour. The pulverized leaves of sumach are first boiled in copper kettles; and, when their colouring matter has been sufficiently extracted some powdered galls are added, with which the colour must be again boiled; and by these means it acquires a dark dirty colour. After it has been sufficiently boiled the fire is taken from under the kettle, and alum put into the still hot liquor, where it is soon dissolved. The proportion of these three ingredients I cannot determine with sufficient accuracy, because the dyers make use of different quantities at pleasure. The powder of the sumach leaves is measured into the kettle with ladles; the water is poured in according to a gauge, on which marks are made to show how high the water must stand in the kettle to soak six, eight, ten, &c. puds of cotton yarn. The galls and alum are added in the quantity of five pounds to each pud of cotton. In a word, the whole mordant must be sufficiently yellow, strong, and of an astringent taste.
>
> As soon as the alum is dissolved, no time must be lost in order that the mordant may be suffered to cool. The yarn is then put into hollow blocks of wood shaped like a mortar, into each of which such a quantity of the mordant has been poured as may be sufficient to moisten

124 It was largely plagiarized by John Galt in 1812 without any acknowledgement of Pallas' authorship. See Galt 1812: 419–420.

the yarn without any of it being left. As soon as the workman throws the mordant into the mortar, he puts a quantity of the yarn into it, and presses it down with his hand till it becomes uniformly moistened, and the whole cotton yarn has struck. By this it acquires only a pale yellow colour, which however is durable. It is then hung up on poles in the sun to dry; again washed in the stream; and afterwards dried once more.

By the yellow dye of the sumac leaves, the madder dye becomes brighter and more agreeable; but the galls damp the superfluous yellow, and together with the alum prepare the yarn for its colour. Some dyers however omit the use of these leaves altogether, and prepare their mordant from galls and alum only, by first boiling the galls in due proportion with the requisite quantity of water, then dissolving the alum with boiling water in a separate vessel, afterwards pouring both liquors together into a tub, and suffering the cotton to remain in them an hour, or an hour and a half; after which it is dried gradually, then washed, and again dried once more. By this process the yarn acquires a dirty reddish colour.

The next part of the process is to prepare the madder dye. The madder, ground to a fine powder, is spread out in large troughs, and into each trough is poured a large cup full of sheep's blood, which is the kind that can be procured with the greatest facility by the dyers. The madder must be strongly mixed in it by means of the hand, and then stand some hours in order to be thoroughly soaked by it. The liquor then assumes a dark red appearance, and the madder in boiling yields more dye.

After this process water is made hot in large kettles, fixed in brick-work; and as soon as it is warm the prepared red dye is put into it, in the proportion of a pound to every pound of cotton. The dye is then suffered to boil strongly; and, when it is enough, which may be tried on cotton threads, the fire is removed from under the kettle, and the prepared cotton is deposited near it. The dyer places himself on the edge of the brick-work that encloses the kettle; dips the cotton yarn, piece by piece, into the dye; turns it round, backwards and forwards; presses it a little with his hands; and lays each piece, one after the other, in pails standing ready for the purpose. As soon as all the cotton has received the first tint, it is hung up to dry: as the red, however, is still too dull, the yarn which has been already dyed once, and become dry, is put once more into the dying-kettle, and must be left there to seethe for 3 h over a strong fire, by which it acquires that beautiful dark red colour which is so much esteemed in the Turkey yarn. The yarn is now taken from the dye with sticks; the superfluous dye which adheres to it is shaken off; the hanks are put in order, and hung up, one after another, to dry. When it is thoroughly dry, it is washed in the pure stream and again dried. The only fault of the Astracan dyers is, that the colour is sometimes brighter and sometimes darker, probably because they do not pay sufficient attention to the proportions, or because the madder is not always of the same goodness.

In the last place, the abovementioned soda (*kalakar*) is dissolved with boiling water in tubs destined for that purpose, and it is usual here to allow twenty pounds of soda to forty pounds of cotton, or half the weight. Large earthen jars, which are made in Persia of very strong clay, a yard and a half in height, almost five spans wide in the belly, and ending in a neck of a span and a half in diamter, enclosed by means of cement in brick-work over a fire-place, in such a manner that the necks only appear, are filled with the dyed cotton yarn. The lye of dissolved soda, which is blackish and very sharp, is then poured over it till the jars be filled; and some clean rags are pressed into their mouths, that the uppermost skains of yarn may not lie

uncovered. A fire is then made in the fire-place below, and continued for 24 h; and in the mean time the steam which arises from the jars is seen collected among the rags in red drops. By this boiling the dye is still more heightened, and is made to strike completely; every thing superfluous is removed, and all the fat matter which still adheres to the yarn is washed out: nothing more is then necessary for completing the dye of the yarn but to rinse it well several times in running water, and then to dirty it.[125]

7 The end of an industry

Serious investigation by European chemists of madder to identify and isolate the coloring agents, alizarine and purpurine, began in earnest in 1823 when the applied chemist Fréderic Kuhlmann (1803–1881), founder of Établissements Kuhlmann, in Lille, published the first of several papers on the chemistry of madder.[126] Three years later the Société industrielle de Mulhouse offered a cash prize 'for the best analytical investigation of madder.'[127] This was won by the French chemists Jean-Jacques Colin (1784–1865) and Pierre-Jean Robiquet (1780–1840) who were successful in isolating the active colorant in powdered madder root.[128] Efforts to create artificial alizarine culminated, in December, 1868, in the granting of a patent for 'a product closely allied in many of its properties to the coloring matter of madder.'[129] It was not long before artificial dye, replacing that produced from ground madder roots, began to infiltrate Iran and the Caucasus. Although the 1870 exhibition in St. Petersburg of manufactured goods from the Caucasus displayed madder dyestuff from Darband, Kuban and the area around Tblisi, areas which were predicted at that date to have a bright future,[130] Radde and Koenig noted, two and a half decades later, that, in

125 Pallas 1798: 6–10.

126 Kuhlmann 1823. Cf. Kuhlmann 1827, 1828. For Kuhlmann's career and influence see e.g. Thépot 1985; Wisniak 2017.

127 Travis 1994: 8.

128 Colin/Robiquet 1826 and 1827.

129 Christie 1870.

130 Matthäi 1872: 233–234, 'Der Kaukasische *Krapp* ist seiner intensiven Färbung und seines reichen Gehaltes an Farbestoff wegen berühmt; die vorzüglichste Sorte desselben ist unter dem Namen "Marena" bekannt und bildet einen sehr bedeutenden Handelsartikel, indem diese Marena nach Russland (grösstentheils Moskau) und von hier aus selbst in's Ausland verkauft wird. Ein Theil dieses kaukasischen Krapps wird allerdings auch in den russischen Fabriken verarbeitet, und ist es namentlich die grosse Farbewaarenfabrik von P. Maljutin Söhne (Moskauer Gouvernement), welche grosse Quantitäten dieser kaukasischen Marena verarbeitet. Die berühmteste Marena wird in der Nähe von Derbent (Dagestan'sches Gebiet), dann auch im Gouvernement Tiflis und in der Umgegend von Kuba (Bakuer Gouvernement) gewonnen. Besonders die letztere wird

the Caucasus, the introduction of inferior artificial dyes around 1870 marked the beginning of the end of the once lucrative madder industry, causing financial ruin there and in the Crimea.[131] So alarming was the situation that a law was passed in Russia in 1876 aimed at 'the protection of the cultivators of the Russian madder (marena), who for the last twenty years have been extensively engaged in its culture in the province of Daghestan' by prohibiting 'the importation of artificial alizarine into the Russian Empire.'[132] By 1881 domestic madder cultivation around Darband was seriously struggling,[133] and in 1889 Abercromby noted that, 'year by year the price has kept falling from fifty roubles a *pud* to one rouble twenty kopeks, so that now it scarcely repays cultivation.'[134] The situation was comparable further south. C.J. Wills, who was in Iran from 1866 to 1881, wrote that, 'The Persians dislike dyes that are not fast, as the aniline, and prefer the old ones, such as madder and indigo'[135] and a law was passed in 1900 banning the import of aniline dyes, although this simply resulted in smuggling.[136] Despite the fact that, as Rice wrote in 1916, 'The punishment for using

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ihrer intensiven Färbung wegen berühmt und geschätzt. Es unterliegt keinem Zweifel, dass sowohl die kaukasische Tabak- als Krappcultur einer grossen Zukunft entgegengehen, da Klima wie Bodenverhältnisse beiden landwirthschaftlichen Culturzweigen ausserordentlich zusagen. Freilich bedingen auch beide einen grossen Aufwand an menschlichen Arbeitskräften, welche sich jedoch reichlich durch die hohen Verkaufspreise sowohl des Krapps als des Tabaks bezahlt machen.'

131 Radde/Koenig 1895: 26–27 wrote, 'Seit 25 Jahren ist der Kultur von *Rubia tinctoria*, die ehedem so lukrativ war, durch die unechten Anilinfarben der Todesstoß versetzt worden. Große Kapitalien gingen damals in Südfrankreich (Avignon), in der Krim, im Kubaschen und Lenkoranschen Gebiete und auch hier zu Grunde. Einen farbenfesten Ersatz für das Krapprot hat man auf chemischem Wege noch nicht gefunden.'

132 Anonymous 1877: 490. The article added, 'A few years ago the value of the crop was estimated to have an annual value of three millions of rubles, but it has now greatly fallen off.'

133 Koechlin-Schwartz 1881: 148, describing the part of Darband closest to the Caspian, 'c'est sur le versant de ces coteaux que se récoltait, il y a peu d'années encore, la plus belle garance du monde. Malheureusement la fabrication des couleurs d'aniline a tué la garance et ruiné ceux qui la cultivaient. Il y a en ce moment sur ces collines de la garance sur pied pour des centaines de mille roubles; on ne la coupe plus, puisqu'on ne saurait à qui et où la vendre. C'est une culture perdue.' Cf. Albrecht 1906: 178, 'Während Derbent im Altertum als bedeutende Handelsstadt, in der der Handel mit Seidenstoffen und Krapp die Käufer anzog, und als starke Festung erwähnt wird, hat es diese Bedeutung heute verloren. Die Krappwurzel wird nicht mehr angebaut.'

134 Abercromby 1889: 210.

135 Wills 1891: 191.

136 Zugmayer 1905: 155–156, 'Durch vermischen des Krapp mit anderen Farbstoffen können über hundert namentlich unterschiedene Abstufungen von Rot hergestellt werden, und man kann ziemlich sicher sagen, dass alles Rot, das auf orientalischen Teppichen vorkommt, hauptsächlich aus Krapp besteht. Auszunehmen sind davon die Anilinfarben, die sich mitunter auch finden; doch ist der Unterschied auch für den grössten Teppichlaien augenfällig, wenn man einen

aniline dyes is said to be amputation of the right hand,'[137] there was clearly no going back, and the profound changes wrought in both the agricultural and textile manufacturing spheres by the introduction of artificial dyes were irreversible. Still, according to Hooper, who wrote in the 1930s, madder was not entirely driven out of the market, for he reported that it was 'grown extensively in Anar-dara,[138] Koin [Qayen], and Yezd, whence the root is exported in quantity to Herat. From Herat it is re-exported to Afghanistan, Turkestan, and India .... It is sold in two forms: one with the cylindrical, red roots in lengths of 1 or 2 in.; and the other with the crushed root made into balls ready for the dyer.'[139]

8 Conclusion

The bright red dyestuff extracted from the roots of both wild and cultivated madder has a long history of use in the Iranian world, *senso latu*. Although the evidence of madder's from Iran and the Caucasus is not as early as that found in cuneiform and Egyptian sources, it is possible that madder was already known to the Elamites of the mid-1st millennium BC. Certainly by late antiquity it was employed in dyeing fibres for the textiles produced in Sasanian workshops, and it continued to be used until the late 19th century when artificial, aniline dyes ruined the market for madder. As a wild natural resource, madder was collected by both sedentary and nomadic groups in many parts of Iran, and madder cultivation, a lucrative business due to both domestic demand and foreign markets, principally Russia and India, stimulated investment in the sector. A plant that was integral to Iran's famous carpet-weaving industry, madder deserves greater recognition by all scholars with an interest in the history of Iranian and Caucasian arts, crafts, technology and natural resources.

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anilingefärbten Teppich neben einen echten legt: der brutal grelle Ton der Anilinfarbe kann sich nicht entfernt mit der vornehm diskreten, satt gedämpften Pflanzenfarbe messen .... Die Einfuhr von Anilinfarben wird durch ein sehr vernünftiges Gesetz vom Jahr 1900 verboten, aber durch Schmuggel gelangen sie doch often genug ins Land.'

137 Rice 1916: 44.

138 Town in Baluchistan. See Hooper 1931: 337.

139 Hooper 1937: 167.

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