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Armenian *karmir*, Sogdian *karmīr* "red", Hebrew *karmīl* and the Armenian scale insect dye in antiquity

Agnes Korn & Georg Warning

For our friend Uwe Bläsing

This paper looks at three terms denoting the colour "red", viz. Armenian *karmir*, the obviously corresponding Sogdian word *karmīr*, and *karmīl* "scarlet" found in the Hebrew Bible. It will first briefly discuss the etymology of these words (summarising an argument made elsewhere) and argue that the words in question are a technical term for a red dye from Armenia produced from scale insects. We will then attempt to show that historical data and chemical analysis of extant historical textiles confirm the Armenian red as the relevant dye.¹

1. Etymologies

1.1 Hebrew *karmīl*

As a starting point, it is worthwhile to consider the status of colour terms in Hebrew (and other premodern cultures) in general. Jacquesson (2012, 68f.) notes: « En français, il y a très peu de choses dont on ne puisse pas dire 'c'est rouge' ou 'c'est noir' - mais en hébreu ancien il y a très peu de choses dont on puisse le dire. En hébreu biblique (...), chaque couleur a un domaine d'application restreint, à certains types d'objets. (...) Il semble qu'elles [= les couleurs] soient souvent comme des textures, des sortes de matière - et l'importance des teintures confirme cette impression. » Essentially, then, colours are not abstract features, but bound to the objects of which they are a quality, rendering colour terms almost material features.

This applies to the shades of an animal's coat, which still nowadays are described much like a quality of the animal (as in English *dun*, German *Falbe* "(horse of) pale colour", *brown bear* as name of a species) as well as to colours of textiles, which may literally refer to the substances with which they are dyed. Thus, Sanskrit *nīla-vant-* (RV+) is actually not "dark, blue", but "rich in indigo, i.e. dyed with large quantities of indigo". In looking for an etymology for the terms under discussion, the question thus is for the dyeing substance it refers to.

¹ Sincere thanks are due to the persons and institutions (specified below) for their permission to publish their photos. We are also very grateful to Johnny Cheung (Leiden) and Erika Korn (Konstanz) for providing copies and references of works not readily available to us. Transcriptions of the Hebrew passages were kindly provided by Annelies Kuyt (Frankfurt a.M.); translations are from *The Holy Bible, containing the Old and New Testaments, Authorized King James Version* (...). Nashville: Broadman & Holman 1979. The underlinings in the passages quoted below are our additions. New Persian is transcribed in the classical pronunciation insofar as literary quotes (and poets' names) are concerned, but in contemporary Farsi pronunciation where the reference is to modern works (including titles of books and articles.) For more details on etymological and philological matters, see Korn (in print).



Fig. 1: Dyeing with indigo, workshop of Dr Ismail Khatri (Gujarat, India).
Photo: Heike Boudalfa

Late Biblical Hebrew *karmīl* occurs only three times. All three attestations are found in the book 2 Chronicles, and refer to the construction of the temple, as in the passage 2 Chron. 3.14:

וַיַּעַשׂ אֶת-הַפָּרֹכֶת הַכֶּלֶת וְאֶרְגָּמָן וְכַרְמִיל וּבֹזָז וַיַּעַל עָלָיו כְּרוּבִים: ✱

► *waya'as et-hapāroket təkēlet wə'argāmān wəkarmīl uvuz waya'al 'ālāw kəruvīm.*

“And he [= Solomon] made the veil [of the temple] of blue, and purple and crimson, and fine linen, and wrought cherubims thereon.”

In the remaining parts of the Old Testament, the series of blue, purple and crimson or scarlet reoccurs repeatedly, but instead of *karmīl* there is the expression *tōla'at šānī* תּוֹלַעַת שָׁנִי, containing the words תּוֹלַעַת / תּוֹלַעַה *tōle'a / tōla'* “worm, maggot” and שָׁנִי *šānī* “crimson, scarlet”.² This expression is reminiscent of French *vermeil* “scarlet”, which is derived from *ver* “worm”. Hebrew *karmīl* is thus likely *a priori* to be not a colour, but a technical term for a dye, made from certain scale insects or cochineals such as the one in Fig. 2.



Fig. 2: *Porphyrophora hamelii* (original length max. 1 cm).
Photo: Paul Starosta

² The series of these three colours always refers to textiles of liturgical importance, used in the temple and for priest's garments (see Brenner 1982, 143-146; Hartley 2010, 185-210; and Clines s.v. for the attestations).

In fact, this has been suggested since long ago; and it has also been generally assumed that Hebrew *karmīl* is a loanword from an Indo-European language and ultimately derives from Proto-Indo-European **k^uřmi-* “worm, maggot” (the protoform of, for instance, Lithuanian *kirmis*, Sanskrit *kṛmi-*, etc.).³ Slavic words for “red” such as Old Church Slavonic *črŭmĭnĭ* show the same line of derivation.

More precisely, as established already by Delitzsch (1898, 757f.), the source of *karmīl* must be an Iranian word related to Persian *kirm* “worm” and its derivative *qirmiz* “red”. *karmīl* would then be member of the group of Iranian words that entered Hebrew via Aramaic, and which are comparatively frequent in the book 2 Chronicles.⁴

The Iranian source form, specified as unattested by Delitzsch, might be taken to be present in a word found in the meantime in Sogdian, an Eastern Iranian language from the Middle Iranian period, as Meillet (1912, 247) announced: « Le mot [arménien] *karmir* « rouge », dont le caractère iranien est encore mis en doute par Hübschmann [1897], *Arm. Gramm.*, p. 167, se retrouve maintenant en sogdien sous la forme *krm'yr* ». That this Sogdian word, probably to be read /*karmīr*/ (Gauthiot 1914, 143 etc.), should be the source of Armenian *karmir* has then also be advocated by Olsen (2005, 478) and others.

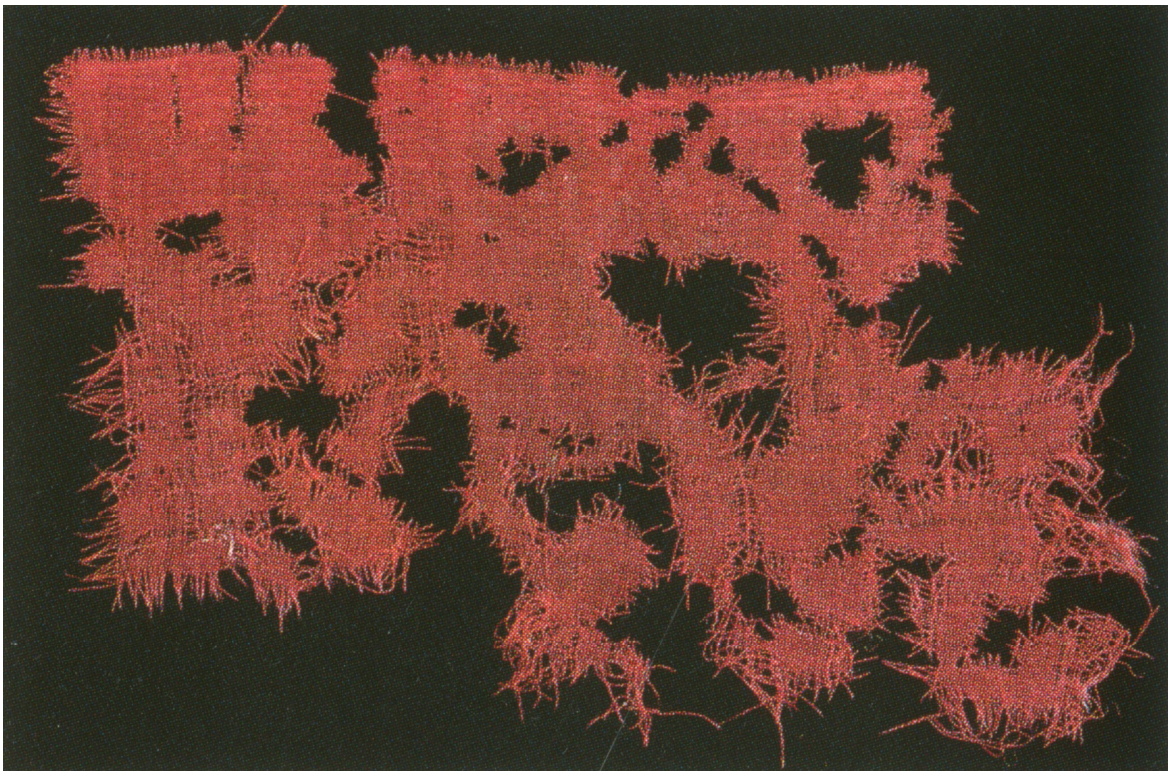


Fig. 3: Cashmere fragment.
Red dye: *Porphyrophora*.

Photo: © Mission archéologique franco-chinoise au Xinjiang

³ Cf. e.g. Mayrhofer (1956, 261).

⁴ We are indebted to Holger Gzella for this information. Cf. Sáenz-Badillos (1993, 115-120); Wagner (1967, 67).

However, there is a considerable geographical distance between Armenian and Sogdian, and also a chronological problem, since the word would need to have migrated early enough from Central Asian Sogdiana into Palestine to feature in the Old Testament. The assumption of Sogdian loanwords in Armenian has also been weakened on linguistic grounds by recent research, which has shown that a Western Iranian language is more likely to be the source.⁵

Obviously, Armenian *karmir* needs to come from an Iranian dialect that shows the required output of PIE **k^hřmi-*. Such a dialect needs to be assumed anyway to account for Iranian loanwords in Armenian such as *marg* “bird”.⁶ Parthian and Persian, the chief sources of Iranian loanwords in Armenian, are excluded because their result of **ř* is *ir* in this context (cf. New Persian *kirm* “worm”). An Iranian language that shows the required output (/kard/ “did”, /barz/ “high”, /varg/ “wolf”) and indeed /karm/ for “worm”, is Zazaki, a contemporary West Iranian language spoken in Eastern Anatolia, overlapping with regions where Armenian was also spoken.

1.2 Persian *qirmiz*

Persian قرمز *qirmiz*, nowadays the usual word for “red”, is surprisingly absent from earlier New Persian (where “red” is *surx*). There is no attestation of *qirmiz* (nor **kirmiz*) in the *Shāhnāme*, and none, for instance, in Omar Khayyām’s *Rubā’iyāt* (where the red wine is described as *lāl* or *arġawān*), nor in the classical Persian texts contained in the TITUS database.⁷ Also, the Persian encyclopaedic dictionary by Dehrodā, who regularly quotes passages from classical poetry for each entry, has no literary example for *qirmiz*.

Hasanī 2010, studying the Persian word *surx* “red”, finds the oldest attestations of *qirmiz* to be verses by Nizāmī (12th century) and by Nāṣir Khusrau (11th century):⁸

همچنین دانم نخواهد ماند برگشت زمان \ موی جعدت عنبری و روی خوبت قرمزی *

► *hamčīnīn dānam nax^wāhad mānd bar gašt-i zamān / mū-yi ja’d-at ‘anbarī va rū-yi xūb-at qirmizī.*

“And I also know that over the course of time your curled hair will not remain amber-scenting nor your good face red (*qirmizī*).”

(Nāṣir Xusrau, *Dīvān*, Qaṣīda 223, line 7)

It may be mentioned in passing that Nizāmī was from Ganja, a town in the Republic of Azerbaijan, some 70 km from the Armenian border of today. It is known as an old centre of carpet production in wool and silk, illustrated here by the Ganja carpet in Fig. 4 (admittedly not ancient, but in the style termed “Old Ganja”). Indeed, one of Nizāmī’s verses containing *qirmiz*, describing a

⁵ Cf. Korn 2013. Note that the absence from West Iranian was the only reason to assume an origin from an East Iranian language for that specific group of loanwords in Armenian (the words in question do not have any specifically East Iranian features).

⁶ A Western Iranian language in addition to Parthian and Persian as source for Iranian items in Armenian needs to be assumed also for other reasons (cf. Korn & Olsen 2012).

⁷ These are: *Viś u Rāmīn* (Gurgānī); *Sindbad-Nāme* (Zahīrī Samarqandī); *Ġazals* (Qabūli).

⁸ Nāṣir Xusrau (1995, 562); it is Qaṣīda no. 253 in other editions. Nāṣir Xusrau was born in Qabodiyon (Khorasan, today Tajikistan).

banquet prepared for Alexander by the Chinese emperor, appears to use *qirmiz* in material-like sense:⁹



Fig. 4: Carpet style *Kedim Ganja* ("Ancient Ganja") from Ganja (Azerbaijan) dated 1895, with dedication in Armenian.¹⁰
Photo: Marco Frangi

⁹ Nizāmī (1956, 410 l. 4). This verse is also the attestation of *qirmizī* quoted in the Tajiki dictionary by Šukurov et al. (1969/II, 691): Нашоти маи қирмизӣ сохтанд / Бисоте ҳам аз қирмиз андохтанд.

¹⁰ For further details see Azadi et al. (2001, 410).

نشاط می قرمزی ساختند / بساطی هم از قرمز انداختند *

► *našāt-i mai qirmizī sāxtand / bisāt-ē ham az qirmiz andāxtand*

“They made the wine’s joy red (*qirmizī*) / [and] also spread out a carpet from red (*qirmiz*) [material].”

(Nizāmī Ganjawi, *Šarafnāma*, episode *Mihmānī-kardan-e xāqān-i Čīn Iskandar-rā*)¹¹

Ancient and also later Arabic dictionaries define *qirmiz* as referring to the Armenian scale insect dye. One of these, the *Aqrab al-mawārid* (ca. 1900), is also the reference given by Dehxodā:¹²

صبغ ارمنى احمر يقال انه من عصارة دود يكون فى آجامهم و يقال انه تصبغ به الثياب فلا يكاد ينصل لونه

šabğun armaniyun aħmaru yuqālu annahu min ‘ašārati dūdin yakūnu fī ājāmihim wa yuqālu annahu tuşbağū bihi at-ṭiyyābu fa-lā yakādu yunḍalu lawnuhu

“A red Armenian dye of which it is said that it is from the juice of a worm living in their swamps, and of which it is said that clothes are dyed with it, and its dye is hardly surpassed.”¹³

Thus, the word must have been borrowed from Persian into Arabic, perhaps already with the meaning of the Armenian red; in Arabic, the initial *k-* was changed into *qāf* to yield *qirmiz*; later on it was borrowed back into Persian.¹⁴ This also implies that Persian cannot be the source of Hebrew *karmīl* (in spite of opinions to the contrary voiced by some authors), and the ultimate source of the word must rather be an Iranian language such as Zazaki.

Also, historical sources say that scarlet dye needed to be imported into Iran,¹⁵ and it is known that textile workshops found it difficult to afford the high prices for the Armenian red dye.¹⁶ It is also known that the Sasanian kings were wearing red coats, and that king Hormisd I sent such a red coat to the Roman emperor Aurelian (270-275),¹⁷ maybe of similar style as the Sasanian caftan in Fig. 5.

¹¹ Wilberforce Clarke translates (Nizāmī 1881, 651): “Exhibited the joyousness of the crimson wine; / Cast also a carpet of crimson silk.” while Bürgel’s German prose translation has “The red wine, which was drunk on red carpets, raised the spirits” (Nizāmī 1991, 296). The Persian text edition comments “They spread out a red (*qirmizī*) carpet and tablecloth in the gathering place and, as they served red wine on the red carpet, they started to celebrate the red wine (all with *surx*)” (Nizāmī 1956, 410).

¹² Dehxodā (XXXVIII, 230 s.v. قرمز). Cf. also the quotes in Lane (VII, 2519), and note that the dictionary of classical Persian by Steingass (1891, 966) qualifies *qirmiz* as coming from Arabic.

¹³ The print edition has *tuşyağū* “made” (one additional dot) for the semantically more fitting *tuşbağū* ‘dyed’ that figures in the online version (<http://www.loghatnaameh.org/dehkhodaworddetail-b3e3d7b1273048f0ae52be830cd0ae1b-fa.html>).

¹⁴ In Turkic, the words for “red” mirror the influence of Persian: *qirmızı* is “red” in those Turkic languages closer to Persian influence (Turkish, Azeri) while others (Kazakh, Kirgiz, Tatar, Uzbek) use the inherited word *qızıl*.

¹⁵ Born (1936, 223), referring to Pfister.

¹⁶ Cf. Kurdian (1941, 106).

¹⁷ Born (1936, 223); Pfister (1935, 35).



Fig. 5: Cashmere caftan (6th/7th c.) found in Antinoë (Egypt).
Red dye: *Porphyrophora hamelii*.
Photo: © Lyon, MTMAD - Pierre Verrier

1.3 Textual evidence

Indeed, classical sources and Armenian historical texts (as well as testimonies from later times)¹⁸ combine to show that the red dye produced in Armenia was famous for its quality already in antiquity. The clearest description is in the *Geography* (short version, chapter V, xv) attributed to Anania Širakac'i (610-685):

✻ Եւ ունի Արարատ լեռինս, և դաշտս՝ և զամ պարարտութի (...) Եւ
որդն սիգաբերեալ յարմատոյ, առ ՚ի զարդ կարմրութե՛ն գունոյ.

¹⁸ For which see Kurdian 1941; Donkin (1977, 849-853); and Cardon (2014, 627f.).

► *Ew owni Ararat lerins, ew dašts, ew zamenayn parartowt'iwn (...). Ew ordn sizabereal yarmatoy, ar' i zard karmrowt'ean gownoy.*
 « La province d'Ararat a des montagnes , des plaines avec toute sorte de productions (...) : on y trouve aussi un ver qui naît de la racine d'une plante et qui fournit la couleur rouge ».¹⁹

Even earlier is the pharmaceutical work *Materia medica* by Dioskurides (1st century AD), who says about the scale insect dye (IV: 48):

✱ ἀρίστη δέ ἐστὶν ἡ Γαλατικὴ καὶ Ἀρμενιακὴ, ἔπειτα ἡ Ἀσιανὴ καὶ Κιλίκιος, ἐσχάτη δὲ πασῶν ἡ Σπάνη.

"The best is from Galatia and Armenia, then that from Asia and that from Cilicia, and last of all that from Spain."²⁰

2. Textiles and cochineals

2.1 Scale insects used for dyeing²¹

The next step for the present argument is to demonstrate that the evidence of etymological reasoning and of textual resources has a counterpart in reality, i.e. that an Armenian dye was used widely enough to render the assumption plausible that it is referred to by Hebrew *karmīl*: the Armenian scale insect is by far not the only species from which cochineal dyes have been produced. The best known type is the Mexican scale insect, *Dactylopius coccus* (Fig. 6), which was widely used before synthetic colours were invented, but it can not play a role here because it came from Latin America too late to be of relevance.



Fig. 6: *Dactylopius coccus* on cactus.
 Photo: Ana Roquero

¹⁹ My transcription; edition and translation Saint-Martin (1819, 367, who notes p. 390: « Il s'agit ici d'une sorte de cochenille. »).

²⁰ Edition Wellmann (II, 205); translation Osbaldeston & Wood (2000, 588f.).

²¹ For details, cf. Cardon (2014, 585-642; 2007, 607-666) and Łagowska & Golan 2011.

The Indian scale insect, *Kerria lacca* (Fig. 7), forms encrustations on branches; one breaks the twigs with the encrustation into pieces and puts them into water to use the dye. This substance is called *lākṣā*- in the Sanskrit literature and described much like a mineral, probably because the crusts are not seen as being composed of individual insects. The word *kṛmi*-“worm”, on the other hand, is not used for the scale insect. Assumptions that Armenian *karmir*, or Persian *qirmiz*, might be of Indian origin, are thus rather unlikely.²²



Fig. 7: *Kerria lacca* crust on twig.
Photo: Barbara Bigler

Then, there is the Mediterranean scale insect *Kermes vermilio* (Fig. 8), which predominantly lives on Mediterranean oak trees. In the passage quoted in Section 1.3 above, Dioskurides refers to this species, obviously assuming that the regions he mentions all use the same cochineal. However, *Kermes* was not seen as an insect in antiquity, but rather perceived as a kind of fruit or berry of the tree (indeed the females are immobile).



Fig. 8: *Kermes vermilio* on mediterranean oak.
Photo: Dominique Cardon

²² For more discussion of the Indic scale insect, see Korn (in print, 3.1).

The European scale insects, *Porphyrophora*, comprise several species. The ones potentially relevant here are the Armenian one, *Porphyrophora hamelii* (Fig. 2), and the European one, *Porphyrophora polonica* (Fig. 9).



Fig. 9: *Porphyrophora polonica* on grass root.
Photo: Dominique Cardon

2.2 Chemical analysis

In a series of articles and books from the 1930s, Rodolphe Pfister published and examined a number of textile specimens from regions in contact with the Iranian cultural sphere, which in a number of instances show Iranian motifs or Iranian style. The red colorants of these pieces include, besides madder (*Rubia tinctorum*), a scale insect dye other than *Kermes*.²³ One such piece is the tapestry fragment (Fig. 10), about which Pfister says: « Quant au style, nous trouvons de nombreux souvenirs sassanides », and applies this also to details of the weaving technique.²⁴ The textiles Pfister analysed were found in Egypt (dating from the 3rd-7th c. AD), and in Dura-Europos (Fig. 13) and Palmyra in Syria (2nd-3rd c. AD), on the border between the Roman and the Iranian empires.²⁵

²³ This particularly applies to textiles from Antinoë (Egypt), about which Pfister (1935, 46) says that they « correspondaient toujours à une origine persane » (similarly 1934, 83 n. 21). Pfister (1928, 242) also notes that cochineal dyes start to appear in Egypt as part of the Iranian influence.

²⁴ Pfister (1936, 82). See also Pfister (1932a, 134-139) for some Oriental stylistic features of this group of textiles.

²⁵ Pfister (1935, 36f.). Pfister (1934, 85): « Palmyre étant alors le principal intermédiaire pour le commerce partho-romain et plus généralement pour les échanges d'Orient à Occident, Doura a profité de cette situation en devenant ville caravanière. »



Fig. 10: Tapestry fragment found in Egypt (Antinoë).
Red dye: *Porphyrophora*.
Photo: Pfister (1936, 80a)

Pfister identifies the red of this tapestry as well as a number of other

textiles²⁶ as being dyed with a *Porphyrophora* scale insect. He suggests that it is *Porphyrophora polonica*, and proceeds to develop an argument how this species might have ended up in Iranian lands, and in fact in Syria and Egypt. This logic sounds somewhat far-fetched, and suggests a closer look at the method²⁷ by which Pfister arrives at his conclusion.

To determine the dyestuffs used, Pfister produced test samples of white wool dyed with various substances; his scale insect dyes were “Lac dye” (*Kerria lacca*), “Kermes” (*Kermes vermilio*) and “Cochineal” (*Dactylopius coccus*). He then compared the chemical reactions of these against each other, and to threads taken from historical textiles. His method was to extract the colorants with various acids etc. and then to treat the solutions with further substances. At each stage, he looked at the colour obtained.²⁸ Pfister finds that the three scale insect dyes react differently in his experiments (particularly when the extraction is done by chlorhydric acid),²⁹ and there is evidence for all of them in one or the other historical textile sample. Now, the question was what is present in the samples showing reactions similar to that of the Mexican scale insect (rather than to the other scale insect dyes or to madder or other red dyes derived from plants), since this insect did not exist in Europe and Asia in antiquity. Not knowing at first which scale insect

²⁶ These are the following items:

Pfister 1932 (textiles from Antinoë in the Louvre): Pl. 13 bottom left, Pl. 14 bottom left, Pl. 14 top (= Pfister 1932a, Pl. XLI), all described as having their red by indigo over madder (*Rubia tinctorum*), but recognised as *Porphyrophora* in 1936, 9 n. 1);

Pfister 1934 (no photos): woollen trousers (apparently several pieces, details not given) “dyed with a cochineal colorant that is similar, but not identical to Kermes”, thus from a hitherto unknown cochineal reacting similar to the Mexican scale insect (p. 83);

Pfister 1935 (no photos): two monochrome items from Antinoë (Musée Guimet, p. 39), one monochrome item from Dura-Europos (Louvre, p. 43); several pieces from Palmyra of which the weft is dyed with scale insect (p. 44, in some cases combined with purple);

Pfister 1936: E1 Pl. XXXI (= Fig. 10), E2 Pl. XXXII (Musée de Cluny), description of both p. 81f. (apparently found in Egypt, as Pfister p. 83 says that their details suggest “non-Egyptian origin”); p. 9 n. 1 mentions the items from the Louvre published in 1932 and one additional item (unpublished?);

Pfister 1934a / 1937 / 1940 (textiles from Palmyra): 1934a: T1, T18, T19, S15 (doubtful), L1, L7, L21; 1937: L 60, L 61 (with black-and-white photo), L31, L52, L53, L62; another part of L62 is 1940, 26 recognised as cochineal with lac-dye, which is also the red dye of four items in 1940 (L 121 with black-and-white photo; L 124 with colour photo; L 123); 1937, 12 also mentions a wollen medaillon in a Gothenburg museum and 1940, 69 three items dyed with “Polish cochineal” from Xinjiang (cf. n. 34) in the Victoria and Albert Museum London (Ch. 00230, STEIN 1921/II, 982 with photos in vol. IV; Ch 0028, Ch 00248);

1940 p. 7: Palmyra items in TP III items spätestens 1. Jh. AD

Pfister / Bellinger 1945 (textiles from Dura-Europos): nos. 7, 33-2 (no photos), 132 (black and white photo), 133 (Fig. 13).

It is not quite clear whether any of the pieces published in Pfister 1928 (textiles from Antinoë, with black-and-white photos) contain the scale insect dye in question (and if any are identical to some he republished later).

²⁷ Description see Pfister (1935, 25-31, 33-35, 46f.).

²⁸ For details, cf. Pfister (1935, 24f.), who says that some tricky cases were checked with black light (a certain type of UV light, wave length 375nm) which produces fluorescence in some substances, but does not specify which ones.

²⁹ Pfister (1935, 33f.). Previously Pfister had thought (following other authors) that the Mediterranean insect would react similarly to the Mexican scale insect (Pfister 1928, 229) and thus assumed that Kermes is present in the specimens that he then found to contain two different cochineal dyes (cf. Pfister 1935, 46).

could be involved here, Pfister preliminarily called it “Persian cochineal” (thus in 1934a), until he got hold of the Polish scale insect and announced that the reactions obtained are like those of the Mexican scale insect: « Nous avons finalement trouvé le colorant du Vieux-Monde qui donne des réactions identiques avec celles de la cochenille [mexicaine], c’est *Margarodes polonicus* [= *Porphyrophora polonica*], coccidé vivant à la naissance des racines de certaines plantes des steppes » (Pfister 1935, 35).

Indeed, Pfister’s observation is right insofar as the similarity of the Mexican and the *Porphyrophora* reds is concerned: « des travaux plus récents sur le rouge d’insectes (...) ont montré que la similitude de composition et la variabilité des proportions des composants, tant majoritaires que mineurs, sont telles chez les *Dactylopius* et *Porphyrophora* spp., que la distinction entre espèces et leur identification dans un textile ancien sont particulièrement complexes et qu’elles nécessitent le recours à de nouvelles méthodes d’extraction et d’analyses » (Cardon 2014, 626).

We thus argue that Pfister’s method of merely looking at colours obtained in his experiments (rather than carrying out a chromatography) is insufficient to determine which *Porphyrophora* species is present in the textiles in question. Also, he obviously did not think of the Armenian scale insect, nor did he have some at hand to compare his results to.

Contemporary methods qualified as necessary by Cardon to determine the exact species include chromatography by HPLC (high performance [formerly: high pressure] liquid chromatography). The liquid to be analysed is pressed through a tube (with a solvent such as acetonitrile or a mixture of methanol/water) that contains an adsorbent material (such as synthetic resin or calcium carbonate), with which the components of the solution will interact in different ways, producing differing speeds for the components on their way through the tube. The components thus pass a certain fixed point of the tube at different moments, where one sends light of an appropriate wave length through the tube (often UV light) to measure the percentage of light that is absorbed by the solution; one can also determine the start, maximum and end of their passage at the fixed point. Solvent, adsorbent material and wave length of light need to be chosen depending on the substances one wishes to analyse. The chromatogram then shows the light absorption rate in relation to the time within which the solution passes the tube (cf. Fig. 11). The characteristic time points of the various components can then be identified with the behaviour of the pure substances which one submits to the same analysis. The chromatogram also allows to calculate the quantity of the various components in the solution (by integrating the area below the curve).

Studies employing the method just outlined include the one by Wouters & Verhecken 1989. In order to submit dyed textiles to chromatography, one extracts and dissolves the colorant and separates it from the mordant, for instance by a liquid containing an acid, to yield a solution which is then analysed. Wouters & Verhecken first produced test samples of dyed wool with various scale insects to determine their dyeing substances. These turn

out to be acids such as carminic acid, kermesic acid, etc. It emerges that the various species of scale insects contain substances which are closely related chemically, but in very different quantities.³⁰ Wouters & Verhecken then proceeded to compare the results to those of historical textiles.³¹

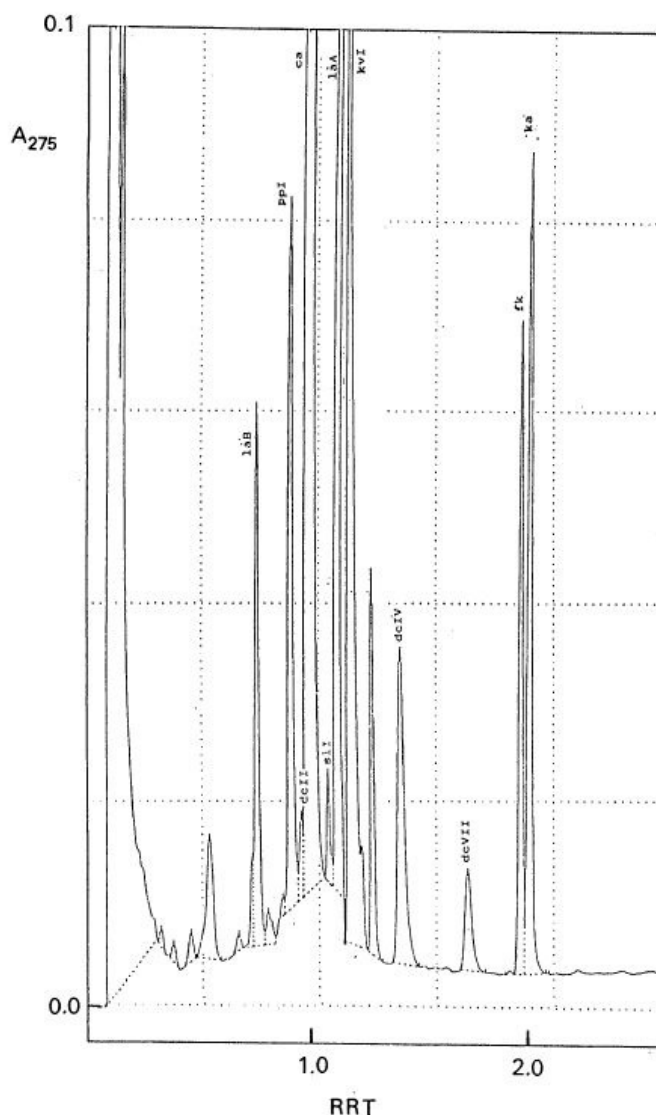


Figure 1 A combined display of high performance liquid chromatograms of scale insect dyes. The identification of each product in an unknown sample results from its retention time relative to that of carminic acid (RRT) and from UV-VIS spectral analysis [14]. The analytical wavelength was 275nm.

³⁰ As the test samples also showed, these quantities also depend on the mordant employed (as on the details of the extraction of the colorant from the insect and the dyeing process).

³¹ The procedure of producing test samples of wool dyed with various substances and comparing their behaviour to threads taken from historical textiles, and to extract the dye by an acid and analyse the solution is not unlike Pfister's approach, but the methods of analysis are quite different. Analysing solutions obtained from dyed wool (rather than analysing the dyes themselves) intends to produce conditions close to those of the historical textiles. It needs to be kept in mind that the mordants have an important effect on how the dyes will attach to the fibres (thence quite differing colours depending on the mordant employed).

Fig. 11: Graph by Wouters & Verhecken (1989, 190) showing an analysis by chromatography of a combination of scale insect dyes; the acids are measured in relation to carminic acid (whose “relative retention time” is set as the reference point 1.0)

Fig. 12 presents the concluding table by Wouters & Verhecken 1989 summarising their analysis (adapted for the present purposes, and with the results for the Armenian scale insect *Porphyrophora hamelii* highlighted). It shows the relative quantities of selected dyeing acids in test samples and in historical textiles from various regions and centuries. Clearly the main difference is that between *Dactylopius* and *Porphyrophora* on the one hand and *Kermes* and *Kerria lacca* on the other. But within the first group, the chemical composition of *Dactylopius* is by far closer to *Porphyrophora hamelii* than to *Porphyrophora polonica*.

dyeing acids → ↓ scale insects	laccaic acid B	“dc II” ³²	carminic acid	laccaic acid A	flavokermesic acid (+) kermesic acid
<i>Dactylopius coccus</i> (Fig. 6)	0	1.4-3.8	94-98	0	0.4-2.2
<i>Porphyrophora hamelii</i> (Fig. 1)	0	0.1-1.2	95-99	0	1.0-4.2
<i>Porphyrophora polonica</i> (Fig. 9)	0	+	62-88	0	12-38
<i>Kermes vermilio</i> (Fig. 8)	0	0	0	0	0-25; 75-100
<i>Kerria lacca</i> (Fig. 7)	0-20	0	0	71-96	3.6-9.0

Fig. 12: Composition of dyeing acids in various scale insects (adapted from Wouters & Verhecken 1989, 198³³)

As mentioned above, Pfister found the results for *Porphyrophora polonica* “identical” to those of *Dactylopius coccus*. Since the composition of the dyeing substances of *Porphyrophora hamelii* is much closer to *Dactylopius coccus* than that of *Porphyrophora polonica* (cf. the numbers in bold in Fig. 12), this suggests two possibilities: Either Pfister’s method would yield the same results for *Porphyrophora hamelii* and *Porphyrophora polonica*, which would mean that the method is not fine-grained enough to permit a decision between the two species, or else Pfister’s observation is mistaken (the results are actually not “identical”), and *Porphyrophora hamelii* would have behaved more similar to *Dactylopius* had Pfister had the opportunity to carry out experiments with this species. We thus argue that Pfister’s approach is not sufficient to permit a decision in favour of *Porphyrophora polonica*. It seems at least as likely (and historically much more so) that the textiles in

³² “d[actylopius] c[occus] II” is a yellow dyeing substance which is present in several scale insect dyes (Wouters & Verhecken 1989, 191). In the meantime, it has been recognised as a glucoside of flavokermesic acid (Cardon 2014, 696). The chemical structures of flavokermesic and kermesic acid are very similar (cf. Fig. 4 in Cardon 2014, 695).

³³ “All figures represent relative abundances, calculated from integration at 275nm” (Wouters & Verhecken, *ibid.*).

question are dyed with the Armenian red.

Historical textiles which were submitted to chemical analysis that has shown their red dye to be the Armenian scale insect *Porphyrophora hamelii* include the Sasanian caftan mentioned above (Fig. 5). As this caftan was found in Antinoë in Egypt, it seems highly likely that other textiles from the same excavation (such as Fig. 10) contain the same *Porphyrophora* species, and the same logic would extend to *Porphyrophora* dyes of Iranian style from other parts, such as the pieces from Dura-Europos (among these Fig. 13) and Palmyra.

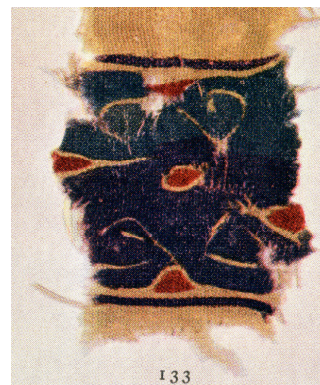


Fig. 13: Woollen fragment from Dura Europos.
Red dye: *Porphyrophora*.
Photo: Pfister (1945, Pl. I)

One might then suggest that further historical textiles from the Iranian sphere which have been shown to be dyed with a *Porphyrophora* might likewise contain *Porphyrophora hamelii*. This applies to the cashmere fragment from Xinjiang (Fig. 3), and at this point we are reminded of the Sogdian word *karmīr* and of the fact that the Sogdians were traders along the Silk Road, and very much present in what is now Xinjiang, and red pieces of cloth are among the commodities mentioned in Sogdian texts.³⁴

Other historical textiles submitted to HPLC yielding *Porphyrophora hamelii* as red dye include a pair of a bishop's knitted silk gloves from France (15th/16th c.) and a hat offered by King Henry VIII to the town of Waterford, Ireland (16th c.),³⁵ demonstrating how appreciated the Armenian red proved throughout centuries and cultural spheres.

If, then, the Armenian red was so widely spread that it found its way in Iranian textile remains preserved in Syria and Egypt, it seems quite probable that *karmīl* in the Ancient Testament, which since Delitzsch 1898 has been assumed to be of Iranian origin, refers to exactly this red dye.

3. Conclusion

As mentioned in Section 1.1, *karmīl* in the book 2 Chronicles replaces *tōla'at šānī* used in the other books of the Old Testament. The Chronicle books

³⁴ In fact, Pfister (1934, 88) mentions textiles found by Sir Aurel Stein in Xinjiang which seem to be of "Syro-Iranian character", and Pfister (1940, 69) describes some of Stein's pieces from the Thousand Buddha Caves as dyed with "Polish cochineal" (cf. n. 26).

³⁵ Photos in Cardon (2014, 627, 629).

retell events described in older sources, with characteristic adaptations. The description of the building of the temple in 2 Chronicles 2-5, within which the only three attestations of *karmīl* are found, re-describes the construction of the Temple found in 1 Kings 6-7, but adds a curtain (while no textiles are mentioned in 1 Kings). The term “veil” as well as the actual formulation clearly is a reference to “the design and construction of the tabernacle” (Williamson 1982:209) made by Moses in the desert (Exodus 25-27). Particularly parallel to the passage quoted in Section 1.1 is Ex. 26:31:

וְעָשִׂיתָ פָּרֹכֶת תְּכֵלֶת וְאַרְגָּמָן וְתוֹלַעַת שָׁנִי וְשֵׁשׁ מְשֻׁזָּר מְעֻשָׂה הַשָּׁב יַעֲשֶׂה אֹתָהּ כְּרֻבִים
 ▶ *we‘asīta pāroket təkēlet wə‘argāmān wətōla‘at šānī wəšēš mošzār ma‘asēh ḥošēv ya‘aseh ‘otah kəruvīm*
 “And thou shalt make a veil of blue, and purple, and scarlet, and fine twined linen of cunning work: with cherubims shall it be made.”

One might wonder whether perhaps the motivation for the substitution of *karmīl* for *tōla‘at šānī* in the quasi-quote lies in a substitution of scale insect dyes in this period. The commonly used *tōla‘at šānī* is likely to refer to *Kermes*, which was in use in Antiquity and into modern times all around the Mediterranean.³⁶ In 2 Chronicles, reflecting Aramaic influence, and Iranian via Aramaic, it seems possible in view of the discussion above that the reference of *karmīl* is to the Armenian dye.³⁷

If so, this would imply that the term for the colour, or rather for the dye, came with the colorant it referred to, just as so many commodities of trade have brought their names with them. This would confirm the statement quoted at the beginning that Hebrew colour terms, and in fact probably any ancient colour terms, are a feature of the object they come with, underlining once again the importance of studying etymology together with the realities that the speakers employed the words for.

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³⁶ According to Cardon (2014, 595), the *Kermes* species referred to by *tōla‘at šānī* is *Kermes echinatus*, which is not identical, but very similar, to *Kermes vermilio*.

³⁷ Cf. Singer (1954, 246): “The best variety [of cochineal red] is said in the Old Testament to have come from the mountains—that is, the Armenian region.”

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