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## Threads of Reason

*A Collection of Essays on Tekhelet*

by Rabbi Mois Navon

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### ***About the Book***

This collection of essays is the result of research spanning more than a decade, motivated by nothing more than the desire to reach a clear understanding of the issues surrounding the rediscovery of *tebbelet* through the *Murex trunculus*. Is it possible to renew a biblical commandment without a *mesorah* (tradition)? Must religious objects, like *tzitzit*, be made from kosher substances? Does one violate the *melakhah* (Shabbat labor) of trapping when obtaining a snail on Shabbat? Bringing together biology and halakhah, chemistry and *aggadah*, archeology and theology – and applying careful consideration and logical reason – these essays seek to address the numerous questions that arise in the endeavor to revive this unique commandment. And as *tebbelet* is a commandment that has been forgotten for over 1300 years, each essay is colored with the marvel of a lost biblical commandment returned anew to the Jewish people. This collection of essays, then, can be seen as a group of threads – threads of reason – spun into a cord strong enough to bind a new generation in the fulfillment of an ancient commandment.

## Chemical Testability

Our Rabbis taught [in a *baraita*]: There is no manner of testing *tekehelet* [to determine if it is made from the *hillaẓon* or from *kela ilan*<sup>1</sup> – Rashi] ... But [the Amora] R. Yitzhak bar R. Yehudah used to test it thus: he used to mix liquid alum, fenugreek juice, and urine of a forty-day-old child<sup>2</sup> and soak the blue thread overnight until morning; if the color faded – it is invalid, if it did not fade (*lo ipareid bazutei*) – it is valid (*kasher*). R. Adda stated ... one should take a piece of hard leavened dough of barley meal and bake it with [the blue thread] inside; if the color improved – it is valid, but if it deteriorated – it is invalid ... [And] the statement, “There is no manner of testing *tekehelet*” refers to the test sample.

Menahot 42b-43a

Though the rabbis of the *baraita* (Tannaim) state that there is no manner of testing to determine if the *tekehelet* dye is of snail origin (i.e., *hillaẓon*) or of plant origin (i.e., *kela ilan*), the rabbis of the Gemara (Amoraim) do provide chemical methods of testing. The Gemara itself attempts to reconcile the contradiction by stating that the import of the *baraita* is that there is no manner of testing if the wool was dyed intentionally for *tzitzit* – i.e., whether the dye lot was from the test sample or from the intended dye run. That is, though there is a chemical method of testing between plant and snail source dyes, there is no means of testing if the snail source dye was made with the proper intent.

This conclusion, that there is a way to distinguish the dye source, implies that there is a clear chemical difference between the indigo dye obtained from the plant versus that obtained from the *hillaẓon*. Now, given that the blue dye produced by

the *Murex trunculus* is molecularly identical to that produced by the plant (*kela ilan*),<sup>3</sup> this would seem to signal the death knell for the *Murex trunculus* as the *hillazon*. For if there is a test to distinguish between the plant dye and the *hillazon* dye, and the *Murex* dye is equivalent to the plant dye, then the test will invalidate the *Murex* dye just as readily as it does the plant dye.

Curiously, when the test specified by the Gemara was carried out on samples of *Murex trunculus* dye, they did not fade – *lo ipareid hazutei – kasher*.<sup>4</sup> As an important aside, the Gemara (Men. 43a) continues to discuss the nature of the tests and explains that the first test is a stand-alone test to validate a sample, such that only if the sample *fails* the first test is the second test then used to double-check the first.<sup>5</sup> Since the *Murex trunculus* dyed sample did not fade in the first test, it was unequivocally validated.

So now we have a question – not on the *Murex* dye but on the Gemara’s test. For today, any indigo blue, be it from the *Murex trunculus* or the *kela ilan* plant, will hold up to the test. A number of solutions are offered:

- At the time of the Tannaim, who authored the *baraita* stating that “there is no test,” the two dyes were indeed identical and no test could distinguish between the *hillazon* dye and the plant dye. However, at the time of the Amoraim, who suggested the tests, the plant source was actually different than the genuine *kela ilan* from Tannaitic times; the Amoraim simply referred to it as “*kela ilan*” since it was the current alternate source of blue dye. It was this “other” *kela ilan* that was distinguishable from the snail dye via chemical testing.<sup>6</sup>
- The chemicals that accompany the indigo molecule from the snail differ from those that accompany the plant indigo, and due to this difference the snail dye is more fast to wool than the plant dye.<sup>7</sup> Now, though today all indigo dyeing is performed with chemicals that allow for the dye to stay very fast in the wool regardless of the source, in ancient times, it is conjectured, differing dye sources employed differing chemical processes.
- Along these lines, it is proposed that the differing chemical environments were due to the differing dye sources themselves. That is, the dye manufacturing process in the time of the Gemara was such that they added the actual snail during the reduction process, something that wasn’t done in plant-based dyeing and could have affected the fastness of the dye.<sup>8</sup>

Now, the first proposal can be safely discounted, for it is a matter of historical record that the only blue dye known to the ancient world was indigo – be it from plant or snail.<sup>9</sup> Accordingly, any plant being used to dye blue would be producing indigo and thus have the same reaction to the Talmudic test. The other two proposals, while not entirely solving the problem, do point in the direction of a fourth solution which supplies a socio-economic justification along with its description of the chemical processes to provide a rather convincing explanation that distinguishes plant-based indigo from snail-based indigo.

In an article entitled, “Identifying Tekhelet: New findings,” Dr. Roy Hoffman from the Institute of Chemistry at the Hebrew University of Jerusalem writes that the difference detected by the Talmudic test is due to the difference in the chemical processing of the two different dye sources.<sup>10</sup> He surmises that due to the great expense involved in procuring the necessary chemicals to create a proper reduction vat, this process was reserved exclusively for the snail dye and not the plant dye. The plant dye could be done cheaply by simply grinding the indigo leaves and preparing a high concentration suspension in water. The resulting dyed wool would look identical to that from the snail-based dye; however, it would not be bonded well in the wool.

Prof. Hoffman explains that the urine test mentioned in the Gemara describes the process for reducing the dye.<sup>11</sup> If the dye was properly reduced when first dyed in the wool (as was the case for the snail-based dye), the reduction will merely cause the dye to reduce again, such that when the wool is removed from the vat, the dye will oxidize back into the wool as it had in the original dyeing – and thus there will be no notable fading. However, if the dye was never properly reduced, it will not have bonded well with the wool in the first place and thus, upon being reduced in the test vat, it will not re-bond with the wool upon removal from the vat. This, then, explains the fading noted by the Gemara in the case of *kele ilan*.

In conclusion, this explanation neatly resolves the long standing enigma regarding the Gemara’s chemical test for true *tekhelet*. But regardless of whether or not one accepts the explanation, it should be clear that the proposed chemical test does not throw into question the validity of *Murex trunculus tekhelet* – for it clearly passes the test of remaining fast to the wool. In the words of the Gemara: “*lo ipareid bazutei – kasher.*”

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- <sup>1</sup> *Kela ilan* is the plant source for indigo (see Arukh, s.v., *kela ilan*; Radvaz Responsa 2:685); it was the primary source for the blue dye of the ancient world, coming from, most ubiquitously, the *Indigofera tinctoria* plant (see R. Menachem Burstein, *Ha-Tekhelet* [Jerusalem: Sifriyati, 1988], p. 75).
- <sup>2</sup> “Alternatively, urine that has sat for forty days” (Rashi, ad loc.).
- <sup>3</sup> Otto Elsner and Ehud Spanier, “The Past, Present and Future of *Tekhelet*,” in *The Royal Purple and The Biblical Blue* (Jerusalem: Keter, 1987), p. 175.
- <sup>4</sup> The test was performed in the Ptil Tekhelet factory by Joel Guberman who noted that, while every effort was made to perform the test according to the Gemara, the Gemara provided only a list of ingredients but not their quantities.
- <sup>5</sup> “... one test supplements the other thus: if the test of R. Yitzhak bar R. Yehudah had been applied and the color had not faded it is certainly valid, but if its color had faded we should then test it according to R. Adda’s test by [baking it in] a hard piece of leavened dough; if its color improved it is valid, but if it deteriorated it is invalid. A message was sent from there [Israel] saying: the tests supplement each other.” (Men. 43a).
- <sup>6</sup> R. Yehuda Rock, “Renewal of Tekhelet and Issues on Tzitzit and Tekhelet,” *Techumin*, 16, sec. III, pp. 16-17, (online expanded version: <http://tekhelet.com/pdf/rak.pdf>).
- <sup>7</sup> *Ibid.*
- <sup>8</sup> Baruch Serman offered this explanation in a personal conversation with me, adding that Nobel Chemist Roald Hoffman had acknowledged its viability.
- <sup>9</sup> Personal correspondence with Prof. Zvi Koren, Edelstein Center for the Analysis of Ancient Artifacts at Shenkar College in Ramat Gan. Similarly, dyer Y. Safri explained to me that vat dyeing was used only for indigo – either plant- or snail-based.
- <sup>10</sup> *The BaDaD Journal* 27 (2012), <http://tekhelet.com/pdf/naturaldyepaper3.pdf>.
- <sup>11</sup> Similarly R. Herzog, in a lecture to the Belfast Natural History and Philosophical Society in 1919, presented a letter from Professor Green, Professor of Tinctorial Chemistry at the University of Leeds, who explained, “It would seem clear from the quotation given [i.e., Men. 42-43], that the tests prescribed have the object of ascertaining whether the dye is easily reduced” (“Hebrew Porphyrology” in *The Royal Purple and The Biblical Blue* [Jerusalem: Keter, 1987], Appendix B, p. 143).