

True Tekhelet: Identifying *Janthina janthina* as the Hillazon-  
HaTekhelet

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## Abstract

*Tekhelet* dye that was once used in the biblical era for dyeing the curtains of the Tabernacle, the clothes of the High Priest, and the ritual fringes attached to the clothes of Jewish men is derived from the mysterious *hillazon* according to Mishnaic and Talmudic literature. After an effort was made beginning in the late 1800's to identify the modern day creature that represents the *hillazon* and revive *tekhelet* production, Rabbi Herzog wrote a dissertation on the identity of the *hillazon*, the definition of *tekhelet*, and the history of the ancient purple and *tekhelet* dye industry, resting on two potential genera from which the *hillazon* can be identified: *Murex* and *Janthina*. The *Murex trunculus* of the first genus mentioned has been identified as the *hillazon* by dye chemists and the Ptil Tekhelet group, the current producers of *tekhelet*-dyed ritual fringes, despite the *Murex trunculus* failing to match many of the criteria of the *hillazon* mentioned in Talmudic and Rabbinic literature. Due to the success of *Murex trunculus* in dyeing, the *Janthina* genus has almost been forgotten as being proposed by Rabbi Herzog, who was more convinced of *Janthina* being the *hillazon* than the *Murex*. This paper has shown that *Janthina janthina*, the most commonly found species of *Janthina* in the Mediterranean, fits all the criteria describing the *hillazon*. While the *Murex trunculus* has gone through years of dye fastness testing, the *Janthina janthina* has yet to go through such tests. *Janthina janthina* may be the *hillazon*, the producer of true *tekhelet* dye.

## Introduction

At least twice a day Jews recite the three paragraphs of Shema, a prayer derived from Tanakh that is considered by some to be the most important prayer in Judaism. In the third paragraph of Shema, it is said,

*“The Lord said to Moses as follows: Speak to the Israelite people and instruct them to make for themselves fringes on the corners of their garments throughout the ages; let them attach a cord of tekhelet to the fringe at each corner. That shall be your fringe; look at it and recall all the commandments of the Lord and observe them, so that you do not follow your heart and eyes in your lustful urge. Thus you shall be reminded to observe all My commandments and to be holy to your G-d.”<sup>1</sup>*

The Hebrew word תכלת (*tekhelet*) is a specific dye, commonly used on textiles. While in the above mentioned biblical verses *tekhelet* is referred to as a dye used for coloring threads on ציצית or ritual fringes, the word *tekhelet* is mentioned 48 other times throughout Tanakh, ranging from its use as a dye for the curtains of the מִשְׁכַּן or Tabernacle, the clothing of the כהן גדול or High Priest, as well as ציצית for the entire Jewish population. Although there is still a significant debate over what color *tekhelet* is most similar to, Talmudic sources as well as extensive research from Talmudic scholars and *tekhelet* enthusiasts has led to a majority agreement that the dye is a blue-violet color closely resembling the color indigo, which is mentioned in the Talmud as the false *tekhelet*, being derived from the indigo plant *kela ilan*. The Talmud relates that authentic *tekhelet* is indistinguishable from the plant indigo in color, and only through special tests of the dyes fastness can the authenticity of the dye be determined.<sup>2</sup>

Despite the dye being mentioned numerous times throughout Tanakh, not once is the source of *tekhelet* mentioned. The earliest mention of where Tekhelet does derive from is in a Tosefta to a Mishna in Menahot, which states the following.

*“Tekhelet is only proper if it comes from the hillazon, if it not from the hillazon then it is improper...”<sup>3</sup>*

It can be deduced from this line that *tekhelet* must come from a creature called the *hillazon*. This fact is supported by numerous other sources which also remark the *hillazon* as being the true source of *tekhelet* dye. As I will enumerate in further detail later, many different descriptions are given regarding the *hillazon*'s form, its color, where it can be found, its behavior, and its dye secretion. While some of the ascribed character traits are evidently directed towards the *tekhelet* producing creature, other descriptions are vague and cryptic, suggesting that the word *hillazon* was used in antiquity as a broad term for a general

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<sup>1</sup> Numbers 15:37-40.

<sup>2</sup> Babylonian Talmud, Menahot 42b-43a.

<sup>3</sup> Tosefta Menahot. Ch. 9:6. Mechon Mamre. Sefaria.org

classification of creatures. For this reason, it can be assumed in this paper that my use of the word *hillazon* refers to the *tekhelet* producing *hillazon*, occasionally referred to as the *hillazon-hatekhelet* (the *hillazon* which produces *tekhelet*). Sources that make use of the word *hillazon* will be carefully analyzed to determine their significance to the *hillazon-hatekhelet*.

The earliest mention of *tekhelet* in Tanakh is found in Exodus, where G-d tells Moses to command the Israelites to bring gifts to him for use in building and decorating the Tabernacle.<sup>4</sup> While the Talmudist Rabbi Asher ben Yechiel, commonly referred to as the Rosh, wrote that Jews wore *tzitzit* as early as upon receiving the Torah and the commandment to attach *tzitzit* to their clothes at Mount Sinai (the source of their *tekhelet* is unknown),<sup>5</sup> *tekhelet*-dye industries were not built until the Israelites had conquered the land of Israel. Prior to entering the land of Canaan, Moses blessed the tribes of Israel one last time before his death. To the tribe of Zebulun, Moses blessed them saying,

*“And of Zebulun he said: Rejoice, O Zebulun, on your journeys...For they draw from the riches of the sea and the hidden hoards of the sand.”*<sup>6</sup>

While this verse will be discussed in further detail with the aid of Tractate Megillah in the Babylonian Talmud later, the שפוני טמוני חול or hidden hoards of the sand are understood to be the precious *hillazon*. After the conquering of Israel and the assumed establishment of a dye industry, Jews continued to employ *tekhelet* from the precious creature in dyeing *tzitzit* and use in the בית המקדש or Temple in Jerusalem up until conquering nations, exile, and imperial restrictions on the shellfish dye industry limited the rare blue dye’s production. These imperial restrictions were made primarily to limit the availability of *argaman* or purple to those of royalty;<sup>7</sup> however they likely had an effect on the *tekhelet* industry as well, since both the purple and *tekhelet* industries were likely in similar regions. While the exact date when *tekhelet* was lost is heavily debated between scholars, with the earliest point being at the time of the redaction of the Gemara between 550-570 C.E. and the latest being at the end of the Gaonic period in the 8<sup>th</sup> century C.E.,<sup>8</sup> the Midrash Tanhuma compiled in approximately 750 C.E. writes,

*“...but now we only have white, because tekhelet has been hidden.”*<sup>9</sup>

For the next 1000 years, shellfish dyeing was absent from the Mediterranean. It was not until 1858 that French zoologist Henri de Lacaze-Duthiers rediscovered the sacred purple dye

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<sup>4</sup> Exodus 25:4.

<sup>5</sup> Asher ben Yechiel. *She’elot u’Teshuvot haRosh*. Klal 2:9:1. Digitized by Isaac Wolhendler, Vilna, 1881. Sefaria.org.

<sup>6</sup> Deuteronomy 33:18-19.

<sup>7</sup> Herzog, Isaac. *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*. Edited by Ehud Spanier, Keter, 1987, pp. 110-111.

<sup>8</sup> *Ibid*, pp. 112-113.

<sup>9</sup> Midrash Tanhuma. Sh’lach, Siman 15. Edited by Solomon Buber. Townsend 1989 English translated edition. Sefaria.org.

industry which thrived on three species of aquatic snails: *Murex trunculus*, *Murex brandaris*, and *Thais haemastoma*.<sup>10</sup>

Natural sources that produced *tekhelet* and *argaman* were rare in the ancient world. Shellfish in the Mediterranean that could produce such colors with incredible fastness such as the *Murex* genera were discovered by ancient dyers such as the Minoans of Crete in the 17<sup>th</sup> century BCE.<sup>11</sup> While the Minoans may have been one of the earliest civilizations to produce shellfish dye, the Phoenicians championed the *argaman* dye industries. The city of Tyre was known throughout the ancient world for their production of *argaman*, also known as Tyrian purple.<sup>12</sup> Numerous archaeological sites of Tyrian purple dye industries have been discovered along Phoenician coastlines, such as crushed *Murex trunculus* shell accumulations in Sarepta, Sidon, and Tyre. Along with these discoveries, purple shellfish dye industries were also found throughout the Eastern Mediterranean coast, including Syria, Israel, Egypt, Turkey, and Cyprus. While some of the sites dated to the existence of the Roman Empire, some dated as early as LB I (14<sup>th</sup> century BCE).<sup>13</sup> Tel Dor in Israel played a significant role in archaeological support for the *Murex trunculus* as the *hillazon*, as will be discussed later.<sup>14</sup> While *Janthina janthina* dye sites have yet to be discovered in Israel, *Janthina janthina* may have been used in dyeing near Beirut and Tyre as mentioned by Jensen.<sup>15</sup> Despite archaeological evidence supporting a purple dye industry, no archaeological evidence has been found for a *tekhelet* dye industry for *tzitzit* or any textile.

While Lacaze-Duthier's discovery did not lead to much of a revival of the snail dyeing industry, interest in renewal of the shellfish dyeing industry was sparked by Rabbi Gershon Henokh Leiner of Radzyn in 1887. Knowledgeable in Torah, chemistry, languages, and much more,<sup>16</sup> Rabbi Leiner sought to rediscover the elusive *hillazon* and bring back the precious biblical dye through the modern technology of his time. After careful analysis of Jewish sources regarding the *hillazon* and a visit to the Stazione Zoologica in Naples, Italy, Rabbi Leiner determined the *hillazon* to be none other than *Sepia officinalis* or the common cuttlefish, which he publically announced in his pamphlet מאמר שפוני טמוני חול.<sup>17</sup>

Hastily producing large quantities of *tekhelet* dye, the Radzyner Rebbe was met with backlash from other Hasidic and non-Hasidic groups over the failure of *Sepia officinalis* to meet descriptive attributes of the *hillazon* and *tekhelet* in Kabbalah and Gemara, along with reports of the cuttlefish's ink fading from *tzitzit* over time.<sup>18</sup> To settle the *tekhelet* debate, Rabbi Isaac Herzog, who later became the first Chief Rabbi of Ireland and Ashkenazi Chief

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<sup>10</sup> Serman, Baruch. *The Rarest Blue: the Remarkable Story of an Ancient Color Lost to History and Rediscovered*, by Baruch Serman and Judy Taubes Serman, Ptil Tekhelet, 2012, p. 6.

<sup>11</sup> Ibid, p. 20.

<sup>12</sup> Ibid, p. 36-37.

<sup>13</sup> Reese, David S., "Shells from Sarepta (Lebanon) and East Mediterranean Purple-Dye Production." *Mediterranean Archaeology and Archaeometry*, vol. 10, no. 1, pp. 113-141. 2008.

<sup>14</sup> Serman, *The Rarest Blue*, p. 48-61.

<sup>15</sup> Jensen, Lloyd B. "Royal Purple of Tyre." *Journal of Near Eastern Studies*, vol. 22, no. 2, p. 105. The University of Chicago Press, 1963.

<sup>16</sup> Kitrossky, Levi. "Do We Know Tekhelet?" *Chidushei Torah*, 2002, [tekhelet.com/kitrossky/tekhelet.htm](http://tekhelet.com/kitrossky/tekhelet.htm).

<sup>17</sup> Serman, *The Rarest Blue*, p. 13-14.

<sup>18</sup> Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, pp. 115.

Rabbi of Israel in the 1920's through the 1950's, wrote a doctoral dissertation on the ancient purple and *tekhelet* snail dye industry in 1913 under the title *Hebrew Porphyrology*. In reviewing Rabbi Leiner's interpretations of Jewish texts surrounding the *hillazon* and *tekhelet*, Rabbi Herzog disagreed with Rabbi Leiner's assumption that every source with the mention of *hillazon* refers to the *hillazon-hatekhelet*.<sup>19</sup> When corresponding with German chemist Paul Friedlander, who had experimented with *Murex brandaris* species, Rabbi Herzog was surprised to find out that Rabbi Leiner's *tekhelet* was actually a synthetic Prussian blue, with *Sepia officinalis*'s ink playing no role in the chemical production of the actual dye. Concluding that the Rabbi had been duped by an Italian chemist, Rabbi Herzog began his own search for the authentic *hillazon*.<sup>20</sup>

While Rabbi Herzog never made a definitive conclusion on the identity of the *hillazon*, his research was invaluable for future *tekhelet* research. He concluded his dissertation with two suggestions of genera under which the *hillazon* could fall: the *Murex* snail and *Janthina* snail genera. Rabbi Herzog's letter to Rabbi Yechiel Michel Tucuzinsky in 1952 regarding the identity of the *hillazon* suggests that Rabbi Herzog believed *Janthina* to be the true candidate, but further research was needed regarding its dye capabilities.<sup>21</sup> Research in the 1960's on the *Murex trunculus* as the *hillazon* led by chemist Sidney Edelstein, followed by marine biologist Ehud Spanier, dye chemist Otto Elsner, and chemist Irving Ziderman's own research in the 1980's led to strong support for the *Murex trunculus* as the *hillazon-hatekhelet*. In 1988 after many years spent attempting to dye wool with the *Murex trunculus*, Rabbi Eliyahu Tavger, a *Murex* enthusiast, succeeded in his efforts.<sup>22</sup> While extensive tests have been performed and heavy research done on the *Murex* snail, Ehud Spanier briefly tested the fastness of a freshly beached *Janthina janthina* snail's ink in Haifa with a cotton fabric, quickly determining the dye to not be fast as the resulting color was brown.<sup>23</sup>

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<sup>19</sup> Ibid, p. 76.

<sup>20</sup> Ibid, p. 117-118.

<sup>21</sup> Tucuzinsky, Yechiel Michel, *Ir HaKodesh V'Hamikdash*, Jerusalem, 1970, vol. 5, ch. 5, p. 55-58.

<sup>22</sup> Sterman, *The Rarest Blue*, p. 205-207.

<sup>23</sup> Mienis, H. K. "A Review of the Family Janthinidae (Mollusca, Gastropoda) in Connection with the Tekhelet Dye." In *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, pp. 201.

## Criteria for Identifying the *Hillazon-Hatekhelet*

As mentioned previously, there are numerous Jewish sources that describe the *hillazon*. It is important to distinguish between criteria which are known to be referring to *hillazon-hatekhelet* (primary criteria) and those criteria that refer to *hillazon* in a general sense (secondary criteria). For the sake of clarity, I have separated the primary and secondary criteria as did Rabbi Herzog in his dissertation and as did Dr. Mendel E. Singer in his article, “Understanding the Criteria for the Chilazon.”<sup>24</sup>

There are 4 primary characteristics ascribed to the *hillazon* in the fourth chapter of Tractate Menahot in the Babylonian Talmud. They are the following:

ת"ר חלזון זהו גופו דומה לים ובריייתו דומה לדג ועולה אחד לשבעים שנה ובדמו צובעין תכלת לפיכך דמיו יקרים<sup>25</sup>

1. “Its body resembles the sea”
2. “Its form is like unto a fish”
3. “It emerges once in seventy years”
4. “with its blood one dyes tekhelet, therefore its blood is expensive”<sup>26</sup>

Unlike the rest of the criteria for the *hillazon* which are mentioned below, the 4 primary criteria from Menahot are without a doubt directly referring to the *hillazon-hatekhelet*, as it is in this chapter of the Gemara that *tekhelet* for the *tzitzit* are also mentioned. Variations of the *baraita* quoted above are seen in other works such as the *Yalkut Shimoni*<sup>27</sup> and the *Baraita d'Tzitzit*.<sup>28</sup> In the *Baraita d'Tzitzit*, characteristic 2 precedes characteristic 1, the *hillazon*'s body is likened to the רקיע or the firmament, and it is said that the creature emerges once every seven years. While Rabbi Herzog dismissed the *Yalkut Shimoni* as being the same translation as the text in the Gemara, he noted the *Baraita d'Tzitzit* variation as being significant.

Before he attempted to determine the creature associated with the *hillazon*, Rabbi Herzog interpreted the characteristics recorded in the Talmud and *Baraita d'Tzitzit* as such. With regard to criterion 1, Rabbi Herzog believed that the color of the *hillazon*'s body or shell was similar to a dark blue or dark violet-blue resembling the color of the Mediterranean or the Israel sky in bright daylight.<sup>29</sup> While Rabbi Herzog concluded that גופו must refer to the body of the creature as opposed to its shell, other scholars have supported that the creature's shell must resemble the color of *tekhelet*. Rabbi Herzog's later correspondence with Rabbi

<sup>24</sup> Singer, Mendel E. “Understanding the Criteria for the Chilazon.” *Journal of Halacha and Contemporary Society*, vol. 40, 2001. Tekhelet.com/library.

<sup>25</sup> Babylonian Talmud, Menahot 44a.

<sup>26</sup> Translation from the William Davidson English Digital Edition, Koren Pub. 2020. Sefaria.org.

<sup>27</sup> Yalkut Shimoni on Torah. Remez 750:13. Sefaria.org.

<sup>28</sup> Tractate Tzitzit Ch. 1:10. Vilna ed. 1883. Sefaria.org.

<sup>29</sup> Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 67.



Tuczinsky suggests that Rabbi Herzog believed both the *hillazon*'s shell and body are the color of *tekhelet*.<sup>30</sup>

Considerably bothered by the vague wording of criterion 2, Rabbi Herzog did not give a conclusive interpretation of the character description, despite analyzing the nature of the word *גדל* or fish in Maimonides' classification, Nachmanides' interpretation, and Aristotle's description and corresponding with French curator of molluscs Dr. L. Germain.<sup>31</sup> Rabbi Leiner understood *ברייתו* to refer to the creature's "form," like Rashi's interpretation in *Shita Mikubetzet*.<sup>32</sup> While more recent *tekhelet* researchers have supported the claim that *ברייתו* simply means that the creature falls under the broad category of being a type of fish,<sup>33</sup> Rabbi Herzog's diligent investigation on criterion 2 leads me to believe he understood *ברייתו* to be a more specific description of the creature.

Rabbi Herzog interpreted criterion 3 as a hyperbole simply meaning that long intervals existed between when the *hillazon* could be caught. He understood this from the disparity between the Talmud's mention of the *hillazon* rising up once every 70 years and the *Baraita d'Tzitzit*'s mention of it being 7 years. Along with Rabbi Leiner's interpretation of the periodic appearance of the *hillazon* only referring to the creature appearing in mass, and that the *hillazon* could be found more often but in small quantities, Rabbi Herzog concluded that the *hillazon* would only appear in large masses in rare instances, but could be found in smaller quantities in the Mediterranean or along the coast.

Lastly with regard to criterion 4, Rabbi Herzog took a literal interpretation of the line, having attributed the expensiveness of *tekhelet* dye to the rare appearance of the *hillazon*. Rabbi Herzog was careful to note that contrary to scholars that suggest the expensive nature lies in the small quantity of dye produced by each *hillazon*, he believed it was the *hillazon*'s rare appearance which made its *tekhelet* dye the price it was worth.<sup>34</sup>

With conclusion of the most significant discussion on the 4 primary criteria for the *hillazon*, I now bring the remaining secondary criteria relating to the creature. Each criterion will be sourced followed by an interpretation and analysis of its relation to the *hillazon-hatekhelet*.

The first secondary characteristic mentioned describes the nature of the *hillazon*, cited in Midrash Rabbah.

<sup>35</sup> שכל זמן שהוא גדל נרתיקו גדל עמו

<sup>36</sup> כשגדל מלבושו גדל עמו

<sup>30</sup> Tuczinsky, *Ir HaKodesh V'Hamikdash*, vol. 5, ch. 5, p. 55-58.

<sup>31</sup> Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 68-69.

<sup>32</sup> Rashi, *Shita Mikubetzet*, Menahot 44a. Otzar HaHochma. Otzar.org. p. 206-208.

<sup>33</sup> Navon, Mois. "The *Hillazon* Baraita." *Threads of Reason*. Ptil Tekhelet, 2013. p. 27.

<sup>34</sup> Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 69.

<sup>35</sup> Midrash Rabbah. Shir HaShirim Rabbah, Parasha 4:11. Sefaria.org.

5. “All the time that [the hillazon] grows, its shell grows with it”
6. “When [the hillazon] grows, its covering grows with it”

At face value, both sections of Midrash Rabbah seem to suggest that the *hillazon* has a shell covering which it remains in for the duration of its life. This would rule out creatures such as crabs, lobsters, and sea slugs who either switch shells, molt, or lack a shell entirely. Sea snails, all having distinct shells, are strongly supported by this secondary characteristic. The cuttlefish, though not having an outer shell, has an inner cuttlebone which grows with the squid and can be considered a shell. While the use of נרתיקו clearly describes a shell, מלבושו may be a synonymous term for an outer growth. It is possible to suggest that the *hillazon* has an additional outer growth covering its shell, however I do not feel this changes the interpretation of this line since Midrash Rabbah appears to not particularly restrict the discussion to the *hillazon-hatekhelet*.

Midrash Rabbah uses the shell-like description of the *hillazon* to explain the meaning behind a verse in Deuteronomy which describes the Israelites’ clothing not wearing out,<sup>37</sup> which the Midrash further interprets as that the Israelite’s did not grow out of their clothing. While it is apparent from this that the Midrash is not necessarily directly citing a feature of the *hillazon-hatekhelet*, it is safe to conclude that any creature under the broad classification of *hillazon* must have a shell, which can be extended to the *hillazon-hatekhelet*’s description.

Another characteristic, building off of criterion 3, is described by the biblical exegete Rashi in his commentary on Tractate Megillah of the Babylonian Talmud.

חלזון עולה מן הים<sup>38</sup>

7. “The *hillazon* arises from the sea”

Rashi’s commentary here acts as an aid to a discussion recounted in my introduction, where the tribe of Zebulun was blessed by Moses before entering the land of Israel with the unique role of capturing the *hillazon* and dyeing *tekhelet*. It is evident from here that Rashi’s commentary pertains to the *hillazon-hatekhelet*. Being the case, it can be understood that the *hillazon* must come from the sea, precisely within Zebulun’s territory. Rabbi Herzog’s own interpretation of the Gemara in Menahot as well as his analysis of Pliny, Philo, and Josephus’s writings led him to a similar conclusion, that the *hillazon* must come from the sea, specifically of conchylian origin.<sup>39</sup>

The Rambam dedicated a section of ספר אהבה in the *Mishneh Torah* to the laws regarding *tzitzit*. Within this section, the Rambam describes various traits of the *hillazon*. The Rambam’s description of the *hillazon* is considered as secondary criteria for the sake of this paper since the *hillazon* was lost before his time. Despite never seeing the creature, it should be noted that the Rambam is a credible source for criteria of the *hillazon*, as he also made an

<sup>36</sup> Midrash Rabbah. Devarim Rabbah, Ch. 7:11. Sefaria.org.

<sup>37</sup> Deuteronomy 8:4.

<sup>38</sup> Rashi, Babylonian Talmud, Megillah 6a. על ידי חלזון.

<sup>39</sup> Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 55.

effort to rediscover the creature. Although he undertook the task of reviving the lost *tekhelet*, he ultimately did not succeed.<sup>40</sup>

והוא דג שדומה עינו לעין התכלת ודמו שחור כדיו ובים המלח הוא מצוי<sup>41</sup>

8. “[The *hillazon* is] a fish the color of which resembles that of *tekhelet* and its blood is as black as ink and it is found in the salt-sea”<sup>42</sup>

Similar to criteria 1 and 2, the Rambam describes the *hillazon* as a fish whose body is the color of *tekhelet*. The Rambam adds that the blood of the creature is initially colored black, however upon the addition of certain ingredients and boiling, the dye becomes *tekhelet*, the color of the firmament. Seemingly contradictory to the Rambam’s statement, Rashi comments in Tractate Chullin of the Babylonian Talmud that the *hillazon*’s blood is the color of *tekhelet*.<sup>43</sup> Rabbi Leiner interpreted the two statements as referring to different points in the dyeing of *tekhelet*; the Rambam’s black blood description referring to the original color of the blood secreted from the *hillazon* and Rashi’s *tekhelet* blood referring to the color of the blood after it had been prepared for dyeing.<sup>44</sup>

With regard to the Rambam’s mention of the *hillazon* being found in the salt-sea, both Rabbi Leiner and Rabbi Herzog agreed that this is meant to be understood as a salty sea as opposed to a fresh water source.<sup>45 46</sup> This serves as a valid criterion that the *hillazon* must come from a sea, with the Mediterranean as the prime source of such a creature.

Three mentions of the nature of the *hillazon* are found in separate locations within Tractate Shabbat of the Babylonian Talmud.

ומלדת הארץ השאיר נבזראדן רב טבחים לכורמים וליוגבים... יוגבים אלו צידי חלזון מסולמות של צור ועד חיפה<sup>47</sup>

תנו רבנן הצד חלזון והפוצעו<sup>48</sup>

דכמה דאית ביה נשמה טפי ניחה ליה כי היכי דליציל ציבעיה<sup>49</sup>

<sup>40</sup> Leiner, Gershon Henokh. *Treasures Hidden in the Sand*. Translated by Menachem Kalish and David Herzberg. Transcribed by Reuven Prager. Begedivri. Begedivri.com.

<sup>41</sup> Rambam. *Mishneh Torah*, Fringes Ch. 2:2. Translated by Moses Hyamson, 1949. Sefaria.org.

<sup>42</sup> Translation as given by Rabbi Herzog. Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 75.

<sup>43</sup> Rashi, Babylonian Talmud, Chullin 89a. שהתכלת דומה לים.

<sup>44</sup> Leiner, *Treasures Hidden in the Sand*.

<sup>45</sup> Ibid.

<sup>46</sup> Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 75.

<sup>47</sup> Babylonian Talmud, Shabbat 26a.

<sup>48</sup> Ibid, Shabbat 75a.

<sup>49</sup> Ibid, Shabbat 75a.

9. “But Nebuzaradan the captain of the guard left of the poorest of the land to be vinedressers and husbandmen...the husbandmen are the trappers of the hillazon between the Promontory of Tyre and Haifa”<sup>50</sup>
10. “The Sages taught [in a Tosefta]: One who traps a hillazon and breaks it...”<sup>51</sup>
11. “Here it is different, as the longer [the hillazon] lives, the better [it is] for [the trapper], so that its dye will become purer”<sup>52</sup>

As represented by criterion 9 regarding the *hillazon*, it is apparent that dyers would trap the creature between the city of Tyre in Lebanon and the city of Haifa in Israel. While one could argue that this Gemara is discussing the *hillazon-hatekhelet*, no specific mention is given regarding the *tekhelet* dye. The Gemara makes mention of the *hillazon* simply because it is part of a verse from the book of Jeremiah, the main intention being to continue a discussion on balsam oil. Therefore, I cannot say with certainty that this Gemara is related to the *hillazon-hatekhelet*, for it is possible that Nebuzaradan had left trappers of the *hillazon* species used in the purple dye industry (primarily *Murex*) to provide the equally rare dye. Rashi comments on this Gemara the manner by which dye was extracted from the *hillazon* after collecting them, however this does not have to refer to the *hillazon-hatekhelet* alone and could refer to a general categorization of *hillazon*.

The theory of the mention of the *hillazon* with regards to the purple dye industry can also be applied to criteria 10 and 11, as the Gemara never specifies what the dye from the *hillazon* is used for. Despite this possibility, I believe criteria 10 and 11 to be more valid in reference to the *hillazon-hatekhelet* than criterion 9 since it was of the utmost importance to get the proper dye from the *hillazon-hatekhelet* to fulfill the biblical commandment of *tekhelet* on wool. Specifically for the *hillazon-hatekhelet*, one would be careful when extracting the dye to ensure that only the highest quality *tekhelet* dye was produced.

Regarding criteria 10 and 11, Rabbi Herzog understood the word פּוֹצֵעַ to be derived from the verb פָּצַע or to crush.<sup>53</sup> Therefore *hillazon* dyers would crush the snail to produce its dye, doing so carefully so as not to kill the creature. Interestingly, Rashi interprets פּוֹצֵעַ in criteria 10 to mean squeezing.<sup>54</sup> Rashi is not incorrect in his interpretation, as the word for crushing can be applied to both hard and soft substances. If such was the case, one can argue that disturbing the *hillazon* by squeezing it (but not entirely crushing it and killing the animal) could effectively produce untainted dye. As criteria 11 demonstrates, the *hillazon* is best kept alive to ensure that it produces the highest quality dye. It would seem from the Gemara that the *hillazon*'s dye significantly decreases in quality shortly after the creature is injured or killed since the Gemara suggests that one could easily kill the *hillazon* when extracting its dye, which would reduce the dye's purity.

The next criterion describing the *hillazon*, while not direct, is crucial in understanding the behavior of the creature as well as where it can be found. Mentioned in my introduction, the

<sup>50</sup> Translation from the William Davidson English Digital Edition, Koren Pub. 2020. Sefaria.org.

<sup>51</sup> Ibid.

<sup>52</sup> Ibid.

<sup>53</sup> Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 57.

<sup>54</sup> Rashi, Babylonian Talmud, Shabbat 75a. הפּוֹצֵעַ.

tribe of Zebulun received a blessing from Moses before entering the land of Israel that it should be the source of *tekhelet* for the entire Israelite population. While the verse from Deuteronomy does not mention the *hillazon* directly, Tractate Megillah of the Babylonian Talmud states,

אמר לו כולן צריכין לך ע"י חלזון שנאמר עמים הר יקראו [שם יזבחו זבחי-צדק כי שפע ימים יינקו ושפוני טמוני חול]<sup>55</sup>

12. “[G-d] said to [Zebulun]: all will need you due to the *hillazon*. As it is stated, ‘They shall call the people to the mountain where they shall sacrifice offerings of righteousness; for they shall draw from the riches of the sea and the hidden hoards of the sand.’”<sup>56</sup>

While the Gemara here does not directly mention the *hillazon*’s relation to *tekhelet*, Rashi comments that criterion 12 does refer to the *hillazon-hatekhelet*.<sup>57</sup> Rabbi Leiner specifically understood from this Gemara that the *hillazon* would rise up from the Mediterranean and become buried in the sand, where it could be easily collected and its dye extracted.<sup>58</sup> Based off Rashi’s interpretation of the Gemara, I agree that criterion 12 is a valid criterion of the *hillazon*. The creature appears to specifically amass on the shores in Zebulun’s territory and would become buried in the sand.

Like criterion 12, the following criterion also describes where the *hillazon* is found, being cited in ספרי דברים, an aggadic literature on Deuteronomy.

אמר ר' יוסי פעם אחת הייתי מהלך מכזיב לצור ומצאתי זקן אחד ושאלתיו בשלום אמרתי לו פרנסתך במה הוא אמר לי מחלזון אמרתי לו ומי מצוי אמר לי השמים מקום בים שמוטל בהרים וסמומיות מכישות אותו ומת ונימק במקומו אמרתי השמים ניכר הוא שגנוז לצדיקים לעולם הבא

13. “Rabbi Yossi said: Once I was walking from Cheziv to Tzor, and, finding an old man and greeting him, I asked him: ‘From what do you earn a living?’ He answered: ‘From *hillazon*.’ I responded: ‘Is it found?’ He replied: ‘By Heaven, there is a place between the mountains (where it is found), and spiders bite it and it dies and is crushed in its place.’ I responded: ‘By Heaven, that must be the one that is secreted for the righteous for the World to Come!’”<sup>59</sup>

Rabbi Herzog mentioned regarding this criterion that the old man must have been referring to the *hillazon-hatekhelet* since Jews of Rabbi Yossi’s time were more interested in *tekhelet* than *argaman*. While Rabbi Yossi was alive when *tekhelet* was still placed on *tzitzit*, he understood that in the Messianic era the *hillazon* will be deposited in mass quantity in this specific location mentioned so that the righteous could clad themselves in it.<sup>60</sup> While I agree

<sup>55</sup> Babylonian Talmud, Megillah 6a.

<sup>56</sup> Translation from the William Davidson English Digital Edition, Koren Pub. 2020. Sefaria.org.

<sup>57</sup> Rashi, Babylonian Talmud, Megillah 6a. על ידי חלזון.

<sup>58</sup> Leiner, *Treasures Hidden in the Sand*.

<sup>59</sup> Sifrei Devarim. Paragraph 354:7. Translation by Rabbi Shraga Silverstein. Sefaria.org.

<sup>60</sup> Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 52.

with Rabbi Herzog that the *hillazon* mentioned in criterion 13 is surely the *hillazon-hatekhelet*, I do not believe this description to be a significant one in aiding the investigation into the identity of the *hillazon*. If one should find this criterion to be significant, I would summarize that the *hillazon* is known to wash up on the sandy shore where animals (lizards according to Rabbi Herzog's version of the text) devour it.

While criteria 12 and 13 have the potential to be relating to the *hillazon-hatekhelet*, criterion 14 falls short on the notion that a sea-snail appearing in the mountains is scientifically unheard of.

עלה להר וראה שהיום אין בו אלא חלזון אחד למחר ירדו גשמים ונתמלא כולו חלזונות<sup>61</sup>

14. "...ascend a mountain and see that today there is only one hillazon there; [then ascend] tomorrow after rain will have fallen and see [the mountain] will be entirely filled with hillazons"<sup>62</sup>

The section of Gemara from Tractate Sanhedrin shown above is part of a larger parable told by Rabbi Ami in response to a heretic challenging him on תחיית המתים or resurrection of the dead. In the parable, Rabbi Ami relates that G-d has the ability to create many creatures from one seemingly through spontaneous generation, using the *hillazon* in the mountains as his example. It is clear that the Gemara's main point is not to give a detailed character description of the *hillazon-hatekhelet*, rather to show G-d's omnipotence. Rabbi Leiner, who included all criteria for the *hillazon* in his ruling on the identity of the *hillazon-hatekhelet*, understood the Gemara to be identifying the creature as a natural burrower which then sticks its head out of the ground, relating it to the hidden hoards of the sand.<sup>63</sup>

What criterion 14 lacks in relation to the *hillazon-hatekhelet*, it gains in relation to the general classification of the *hillazon*. It is most probable that the *hillazon* being referred to are a type of land snail, having an outer shell that fits with the description of the *hillazon* in criteria 5 and 6. This would fit well with the narrative, as land snails are commonly seen after a rain because of their reliance on moisture to survive, ensuring their bodies do not dry out.

The Yad Ramah, seemingly interpreting the *hillazon* mentioned in the Gemara as the *hillazon-hatekhelet*, suggests that the creatures are picked up by a rain cloud (possibly a water spout) and thrown onto the mountains.<sup>64</sup> The Yad Ramah seems to be citing a discussion in Tractate Eruvin surrounding rain cloud formation over the ocean.<sup>65</sup> If this is a

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<sup>61</sup> Babylonian Talmud, Sanhedrin 91a.

<sup>62</sup> Translation from the William Davidson English Digital Edition, Koren Pub. 2020. Sefaria.org.

<sup>63</sup> Leiner, *Treasures Hidden in the Sand*.

<sup>64</sup> Yad Ramah, Yad Ramah on Sanhedrin. Sanhedrin 91a. Warsaw, 1895. Sefaria.org.

<sup>65</sup> Babylonian Talmud, Eruvin 45b.

reasonable characteristic of the *hillazon*, it would contradict criterion 18 in that the creature could not possibly dwell at the bottom of the sea.<sup>66</sup>

Another possibility the Yad Ramah suggests for criterion 14 is that the *hillazon* mentioned in this Gemara regards a species of *hillazon* that procreates from dust and water, called the *hillazon* in Arabic.<sup>67</sup>

The following two criteria discuss the use of the *hillazon*'s shell in treating hemorrhoids as well as the nature of the *hillazon*'s shape and color.

לייתי משקדי חלזוני<sup>68</sup>

הרי בעינו דק תבלול חלזון...<sup>69</sup>

15. "bring from the shells of *hillazon*"

16. "if [there was] in his eye a cataract, a *tevallul*, [or a growth in the shape of] a snail..."<sup>70</sup>

Criterion 15 discusses one bringing the shells of the *hillazon* as a cure for hemorrhoids among a list other medicines. While Rabbi Herzog could not verify whether any molluscs were used in ancient medicine for such treatment, he and I are certain that the Gemara does not pertain to the *hillazon-hatekhelet*.<sup>71</sup>

Criterion 16, like criterion 15, likely does not refer to the *hillazon-hatekhelet*. The Gemara discusses a growth in the eye of an animal prepared to be sacrificed outside the Temple. This growth has the shape of a *hillazon*, although the *hillazon* referred to here is likely a different type of snail. Because the disease was called both *hillazon* and snake, Rabbi Leiner deduced that the *hillazon-hatekhelet* must have fringe-like extensions that resemble a snake and red flesh-like blisters on its organs.<sup>72</sup> Rabbi Herzog was doubtful of this criterion being related to the *hillazon-hatekhelet*, instead attributing the mention to a potential Arabic source.<sup>73</sup>

Another criterion that uses a description of a *hillazon* for an unrelated item is cited in Mishnah Kelim regarding a chain with a lock-piece and its susceptibility to impurity.

או שקשר חלזון ברשה

<sup>66</sup> For a greater description of the Yad Ramah's interpretation of criterion 13, see Kleinman, Doniel Osher. "Techeiles-Is the Murex Trunculus the Chilazon?" Torah Anytime. 2017. Torahanytime.com.

<sup>67</sup> Yad Ramah, Yad Ramah on Sanhedrin. Sanhedrin 91a. Warsaw, 1895. Sefaria.org.

<sup>68</sup> Babylonian Talmud, Avodah Zarah 28b.

<sup>69</sup> Babylonian Talmud, Bekhorot 38a-b.

<sup>70</sup> Translation from the William Davidson English Digital Edition, Koren Pub. 2020. Sefaria.org.

<sup>71</sup> Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 59.

<sup>72</sup> Leiner, *Treasures Hidden in the Sand*.

<sup>73</sup> Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 59.

17. “...if it had a hillazon-[shaped] piece at its end...”<sup>74</sup>

While I would have initially thought that this Mishnah is surely referring to a creature other than the *hillazon-hatekhelet*, the Bartenura and Melechet Shlomo both assert that this passage pertains to the *hillazon-hatekhelet*.<sup>75</sup> The *hillazon* shape in this line is described as being hook-like. Due to the commentary on the Mishnah, along with Rabbi Leiner’s interpretation that the *hillazon-hatekhelet* must have hook-like tentacles, I believe criterion 17 to be a credible criterion of the *hillazon-hatekhelet*.

The last criterion to be analyzed regarding the *hillazon* is from the Raavad’s commentary on *Sefer Yetzirah*, an ancient kabbalistic work.

והמשל בזה כי הנה החלזון אי אפשר לעמוד עליו אם הוא מכלל הדגים או מכלל הצומח כי הוא חי ומתנועע אינו מחליף מקומו כי הוא נעוץ ותקוע בארץ<sup>76</sup>

18. “An exemplification of this is the *hillazon*, for it cannot be determined if it arises from fish or from plants since it live and moves, but does not change its place since it is rooted in the ground”

While the Raavad’s commentary is difficult to decipher and understand, he appears to relate the *hillazon*’s existence like a fish and plant to the 8<sup>th</sup> path of wisdom, the path of completeness. I interpret the Raavad here to be using the *hillazon* as an example of a creature which exemplifies wholeness, having characteristics of plants and fish.<sup>77</sup> It is possible the Raavad did witness the *hillazon-hatekhelet*, although it wouldn’t have been identified with the mitzvah of *tekhelet*. I find it difficult to rely on the Raavad’s description of the *hillazon* because of this, however Rabbi Leiner saw his description as being credited to the *hillazon-hatekhelet*. The Rema MiPano’s interpretation of the Raavad states that the *hillazon* is like a plant that lives attached to the bottom of the sea floor. Once every 70 years, a strong current uproots the *hillazon*, upon which the creature becomes inanimate and washes up on the shore. Using the Rema MiPano’s interpretation, Rabbi Leiner understood the *hillazon* to dwell on the bottom and compared it to the mythical אדני השדה.<sup>78</sup> I don’t believe criterion 18 can be discredited as referring to the *hillazon-hatekhelet*, however there is no strong evidence suggesting that the Raavad’s description is of the *hillazon-hatekhelet* or that the description is meant to be taken literally. Furthermore, if the Raavad is to be understood as referring to the *hillazon-hatekhelet*, the Rema MiPano’s description would conflict with criteria 10 and 11, as proper *tekhelet* cannot be extracted from a dead creature.

In summary, I list the main criteria for defining the *hillazon-hatekhelet*. This will act as an aid in my following discussion of two candidates for the *hillazon*. It should be noted that I

<sup>74</sup> Mishnah Kelim. Ch. 12:1. Mishnah Yomit by Dr. Joshua Kulp. Sefaria.org.

<sup>75</sup> Ibid. See commentary by Bartenura and Melechet Shlomo.

<sup>76</sup> Yosef ben Sholom Ashkenazi, *Raavad on Sefer Yetzirah*, Introduction, The Thirty Two Paths of Wisdom, The Thirty Two Paths Explained verse 8. Warsaw, 1884. Sefaria.org.

<sup>77</sup> For greater detail on the Raavad and Rema MiPano’s commentary regarding criterion 17, see Kleinman, Doniel Osher. “Techeiles-Is the Murex Trunculus the Chilazon?” Torah Anytime. 2017. Torahanytime.com.

<sup>78</sup> Leiner, Gershon Henokh. *Ptil Tekhelet*. Ch. 8:56. B’nei Brak, 1999. Sefaria.org.



have chosen to use lettering to relate each criterion that does apply to the *hillazon* to potential candidates instead of numbering, so as not to cause confusion with the previous analysis of the criteria that do and do not pertain to the *hillazon-hatekhelet*.

- a) The creature's body (and or shell) must be similar to the color of the sea (the color *tekhelet*). (see criterion 1)
- b) The creature must have the form of a fish, or at least resemble one. (see criterion 2)
- c) The creature is rare, but will wash onto the shores in masses once in a great length of time.(see criterion 3)
- d) The blood or ink of the creature is used to dye *tekhelet* (with the possibility that the blood itself is considered *tekhelet*). (see criteria 4 and 8)
- e) The creature must come from the sea (salt-water). (see criterion 7)
- f) The creature must have a hard outer shell which is or may be crushed to extract the *tekhelet* dye. (see criteria 5, 6, and 10)
- g) The *tekhelet* secreted by the creature is in its purest form when the creature is alive, as death taints it. (see criterion 11)
- h) The creature can be found buried in the sand. (see criterion 12)
- i) The creature is known to wash up along Israel's coast in the ancient territory of Zebulun. (see criterion 12)
- j) When the creature washes up on the shore, scavenging animals feed on it. (see criterion 13)
- k) The creature has tentacle-like hooks. (see criterion 17)

## Reservations on the *Murex trunculus* as the *Hillazon-Hatekhelet*

Shown by archaeological evidence in Crete, the Mediterranean sea-snail *Murex trunculus* was used in the purple-dye industry as early as 1750 B.C.E.<sup>79</sup> Archaeological dye sites along Israel's coast in the 1860's led Rabbi Herzog to suggest the *Murex trunculus* as a snail employed in the manufacture of *tekhelet* dye, although no evidence of *tekhelet*-dyed wool was found.<sup>80</sup> A more recent discovery of *Murex trunculus* being used in dye pits in *Tel Dor*, Israel have strengthened the *Murex* theory, however no evidence pointing to the industry being linked to producing *tekhelet* was found at this site either.<sup>81</sup> While extensive research was done by Rabbi Herzog in hopes of identifying the *Murex* as the *hillazon* that would produce *tekhelet*, Rabbi Herzog did not feel the *Murex* met all the criteria he had amassed from his research.

One reservation Rabbi Herzog had on the *Murex trunculus* was that it would produce a blue-violet color instead of the indigo-blue *tekhelet* he had described in his thesis. While researching ancient dyeing techniques in the 1980's, dye chemist Otto Elsner discovered that upon exposure to light, the blue-violet color secreted by the *Murex* would convert to an indigo blue, the color associated with the fake *tekhelet* described in the Babylonian Talmud derived from the *kela ilan*, or indigo plant.<sup>82 83</sup> With marine biologist Ehud Spanier's assistance, the biology and biochemical nature of *Murex*'s dye was discovered.

In the hypobranchial gland of the *Murex trunculus*, the precursors to the indigo dye exist as a clear liquid substance called indole with an additional bromine, sulfur, and potassium atom, defined as the dye precursor. Oxidation, exposure to sunlight, and the presence of the enzyme Purpurase results in the conversion of this dye precursor to dibromoindigo (commonly known as Tyrian purple), which can then be reduced along with sunlight to form indigo. The Purpurase enzyme found in the *Murex* quickly decomposes upon the snail's death, so the shell near the hypobranchial gland must be quickly crushed and the dye extracted to ensure the utmost purity.<sup>84</sup>

Although the *Murex* has been shown to produce a dye of the exact same chemical nature as false *tekhelet*, I do not consider this proof that the *Murex* is the *hillazon*. I mention later regarding the *janthina* snail that no evidence exists to suggest that *tekhelet* must be the exact same chemical as indigo. The requirement, as based off the Talmud's discussion on false *tekhelet*, is that *tekhelet* be indistinguishable from indigo to the naked eye. Instead of examining the *Murex*'s dye as an assessment for its identification as the *hillazon*, I evaluate it based on the criteria I have set forth above.

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<sup>79</sup> Baruch Serman, "The Science of *Tekhelet*," in *Tekhelet: Renaissance of a Mitzvah* (New York: YU Press, 1996), p. 64.

<sup>80</sup> Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 24.

<sup>81</sup> Serman, *The Rarest Blue*, p. 53-54.

<sup>82</sup> Serman, *Tekhelet: Renaissance of a Mitzvah*, p. 76. It should be noted that it was known prior to Elsner's discovery that *Murex trunculus* produced indigo dye, yet chemists realized the dye was not pure indigo, since it had a purplish hue.

<sup>83</sup> Babylonian Talmud, Menahot 40a.

<sup>84</sup> Serman, *Tekhelet: Renaissance of a Mitzvah*, p. 76-77.

Beginning with criterion a), the *Murex trunculus* immediately fails to match the description of the *hillazon*'s body or shell being the color of the sea. The *Murex* has a white shell with red-orange bands, though it is commonly covered in green or brown algae. The snail's flesh is white, thereby also failing to meet this criterion. Rabbi Herzog was reluctant to identify the *Murex* as the *hillazon* because of this reason.<sup>85</sup> Rabbi Mois Navon, a member of Ptil Tekhelet which produces *Murex*-based *tekhelet* dye, asserts in his book *Threads of Reason* that the הַגֵּן refers to the shell of the *hillazon* and that the mention of its color resembling the sea is simply to describe that the creature is camouflaged by the ocean. He supports *Murex* with this claim, stating that the *Murex* is well hidden on the sea floor by numerous plants.<sup>86</sup> I respectfully disagree with Rabbi Navon on this matter, as Rabbi Herzog had already determined the הַגֵּן to be the body of the creature (as opposed to the shell) and the Aramaic word for shell existed at the time of the writing of the Babylonian Talmud. As for the color of the shell, it is unlikely that the color or nature of the seafloor was well-known at the time of writing the Talmud, let alone before then. Furthermore, I doubt the rabbis would have given such a vague description of the *hillazon*'s color if it could be so easily misinterpreted. Surely the color of the *hillazon* must be of blue in nature, as representative of G-d's throne of glory.

With regard to criterion b) which discusses the *hillazon*'s form being that of a fish, *Murex* proponents have suggested that ברייתו refer to the creature's form, thus suggesting that the snail's shell has a fusiform shape which can resemble a fish.<sup>87</sup> Rabbi Navon has interpreted the criterion differently, suggesting that the *hillazon* is simply a creature that dwells in the sea.<sup>88</sup> While no direct evidence exists to support a precise interpretation of the line, I believe that Rabbi Herzog understood the line in the literal sense, that the *hillazon* is a certain type of fish, appears like a fish, or even acts like one. Despite the *Murex*'s fusiform shape, its behavior does not resemble that of a fish and therefore it does not satisfy criterion b).

Criterion c) which discusses the *hillazon* appearing once every 70 years, thereby making its *tekhelet* dye expensive is disputed between *Murex* supporters and opponents. The *hillazon* is said to appear only rarely along the shore, yet *Murex trunculus* snails dwell on the rocky bottom along Israel's coastline year round. As shown by Spanier in his paper on the archaeological evidence of the purple dye industry in Israel, *Murex* snails are easily caught using a baited basket.<sup>89</sup> Rabbi Navon writes that criterion c) is meant to be viewed as a hyperbole (similar to Rabbi Herzog) and the rare appearance of the *hillazon* only refers to mass strandings on the shore. Otherwise, Navon argues, the *hillazon* should have been easily caught by dyers as evident by Nebuzaradan's ruling as I mentioned in criterion 8.<sup>90</sup> I respectfully disagree with Rabbi Navon's assertion here as well, for as I had mentioned

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<sup>85</sup> Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*. Appendix B: The Dyeing of Purple in Ancient Israel, p. 141.

<sup>86</sup> Navon, Mois. "The Hillazon Baraita." *Threads of Reason*. Ptil Tekhelet, 2013. p. 26-27.

<sup>87</sup> Spanier, Ehud. "Muricid Snails and the Ancient Dye Industries." *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*. 1987. p. 180.

<sup>88</sup> Navon, *Threads of Reason*, p. 27.

<sup>89</sup> Spanier, Ehud and Karmon, Nira. "Archaeological Evidence of the Purple Dye Industry from Israel." *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*. 1987. p. 148.

<sup>90</sup> Navon, *Threads of Reason*, p. 27-28.

regarding criterion 8, it is not conclusive that the *hillazon* mentioned there is referring to the *hillazon-hatekhelet*. Furthermore, no evidence exist for *Murex trunculus* mass strandings globally. In the case that *Murex* snails should wash up with other molluscs (possibly due to an algae bloom or a large storm), they are likely dead or near death and therefore their ink would be useless in producing *tekhelet* dye.

As mentioned previously, only through a chemical oxidation-reduction does *Murex* ink become the color of indigo, the presumed color of *tekhelet*. In accordance with criterion d) which states that the blood or ink of the *hillazon* is used to dye *tekhelet*, the *hillazon*'s blood or ink would seemingly have to already exist as the color of *tekhelet*. *Murex* fails this criterion since its ink is clear when it is a precursor in the hypobranchial gland.<sup>91</sup> Rabbi Navon suggests that criterion d) acts as an explanation for *tekhelet*'s hefty price since the *Murex* is only capable of producing a small amount of dye, with approximately 250,000 snails needed to produce one ounce of pure *tekhelet*.<sup>92 93</sup> While Rabbi Navon's interpretation is reasonable, Rabbi Herzog, as I mentioned earlier, warned against such interpretation. Rabbi Herzog was certain that the expensive nature of *tekhelet* was due to the rarity of the *hillazon* as opposed to the quantity of dye the creature would produce.<sup>94</sup>

Little evidence is needed to show that *Murex* satisfies criterion e) which states that the *hillazon* must come from the sea. The snail is found all over the Mediterranean.

From a direct interpretation of criteria f) and g) which discuss crushing the shell of the *hillazon* without killing the creature to ensure purity of the *tekhelet* dye, it would seem that *Murex* clearly fulfills these criteria. The snail has a hard shell that must be crushed to extract its dye. The Purpurase enzyme degrades after the snail has died, tainting subsequently extracted dye. Furthermore Rabbi Herzog and Rabbi Navon agree that the word פוצע is used to describe crushing with a tool, however Rashi interprets it to mean squeezing.<sup>95</sup> While I agree that a tool was likely used to crush the *hillazon* in dyeing facilities similar to that of *Murex trunculus* in the purple dye industry, I find it difficult to say that one could easily (if not mistakenly) crush a *Murex* shell by hand. The Gemara mentioned in criteria 9 and 10 suggests that one could accidentally crush the *hillazon*'s shell, killing the creature and rendering its dye unfit for *tekhelet* dyeing. This is not the case by the *Murex*, as the shell is quite hard and cannot be crushed without a tool. With regards to Rashi's interpretation that one squeeze the creature, this could be understood as irritating the *hillazon* in such a way that it produces dye, however I am unaware of the *Murex* secreting dye upon irritation. With regard to criterion g), Ptil Tekhelet maintains that the *Murex* loses its dyeing power several hours after the snail's death.<sup>96</sup> This does not fit well with the criterion since the Gemara

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<sup>91</sup> Sterman, *Tekhelet: Renaissance of a Mitzvah*, p. 76-77.

<sup>92</sup> Navon, *Threads of Reason*, p. 28-29.

<sup>93</sup> Sterman, *The Rarest Blue*, p. 222.

<sup>94</sup> Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 69.

<sup>95</sup> Navon, Mois. "HaPotzo – Extracting the Dye of *Murex trunculus*." *Threads of Reason*. Ptil Tekhelet, 2013. p. 34-35.

<sup>96</sup> Singer, Mendel E. "Understanding the Criteria for the Chilazon." *Journal of Halacha and Contemporary Society*, vol. 40, 2001.

seems to indicate that the dye becomes worthless only moments after the *hillazon* is killed, otherwise there would be little concern of killing the creature prematurely.

Criteria h), i), and j) describe the *hillazon* being found buried in the sand along Israel's coast and being fed upon by scavenging animals. Since these criteria are similar in discussion, they are simultaneously analyzed with respect to the *Murex*. As mentioned regarding criterion c), I am unaware of the *Murex* washing up on Israel's coastline or any shoreline. If such is the case, the *Murex* would fail to meet the requirements for h), i), and j). One could suggest that the *Murex* must only live along the shores of Zebulun, however this would contradict criterion c), since something that exists along the shoreline year-round cannot be rare in appearance. One can suggest that an environmental change to the region (such as overfishing) may have led to *Murex* being commonly found along Israel's coast, however evidence of the purple dye industry would suggest that the *Murex* existed as a sustainable population along Israel's coast at the same time that *tekhelet* dye was being produced.

Little is to be said regarding criterion k). While the *Murex* evidently has no hook-like tentacles on its body, one may suggest that it is the snail's shell which has such protrusions. I do not feel that this is strong evidence to support the *Murex* since their shells vary in shape and form, with some lacking the protrusions entirely.

Although not one of the criteria I consider being relevant to the *hillazon-hatekhelet* discussion, it should be noted that the *Murex* does seem to match criterion 18, despite the vague description and interpretation of this criterion. Almost like a plant, the *Murex* dwells on the seafloor but moves like an animal. If the *Murex* becomes detached from the seafloor and washes onto the shore, it dies. My reservation regarding criterion 18 and the *Murex* is what occurs after the animal becomes washed up. For if the animal dies after becoming detached from the ground, how could one procure *tekhelet* from it if it is already dead? While I do not believe criterion 18 is relating to the *hillazon-hatekhelet*, the *Murex* should still be noted for seemingly matching this criterion if one should argue that criterion 18 is relevant to the *hillazon-hatekhelet* debate.

While the *Murex trunculus* has been shown to fit only a few of the criteria of the *hillazon*, support for the snail exists in archaeological evidence. In an excavation of Masada in the 1950's, a small piece of cloth dyed with *Murex trunculus* was found dating to Herodian times.<sup>97</sup> While this has been used by Ptil Tekhelet as evidence that the *Murex trunculus* must be the *hillazon*, I find difficulty in readily agreeing with them since the cloth was clearly not used for *tzitzit*, rather most likely for a royal garment. Evidence of 3 *Murex*-dyed woolen materials (although not *tzitzit*) were found at wadi Murabba'at in an excavation of Bar Kochba caves in the 1950's.<sup>98</sup> While the find serves as evidence that the *Murex trunculus* was used as a shellfish dye (as also shown by remains of dye-industries), it does not prove that the *Murex* produces authentic *tekhelet*, nor does it prove that *Murex* dye was used for

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<sup>97</sup> Sterman, *The Rarest Blue*, p. 76-79.

<sup>98</sup> Sukenik, Naama. "Chemical Analysis of Murex-Dyed Textiles from Wadi Murabba'at, Israel." *Journal of Archaeological Science: Reports*, vol. 3, 2015, pp. 565-570., doi:10.1016/j.jasrep.2015.08.003.

*tzitzit*. The limited textile evidence supports *Murex*'s capacity to act as a dye, yet no evidence has been found for *tekhelet*-dyed *tzitzit*.

## Proposal to Reinvestigate *Janthina janthina* as the *Hillazon-Hatekhelet*

After discussing his own reservations on the *Murex trunculus* in his presentation to the Belfast Natural History and Philosophical Society in 1919, Rabbi Herzog suggested one last candidate for the still lost *hillazon*. This was the *Janthina* genus; a genus of pelagic snails which were rare and not understood. While in his presentation he cited the two most likely candidates, *Janthina pallida* and *Janthina prolongata* (also referred to as *Janthina globosa*), his 1913 thesis also included the *Helix janthina*, today known as the *Janthina janthina*.

Upon publication of Rabbi Herzog's thesis in 1987, marine biologist Ehud Spanier reviewed the genus *Janthina* as a potential candidate for the *hillazon*, determining *Janthina janthina* and *Janthina prolongata* to be the two most viable species from the genus due to their recorded presence along Israel's coast.<sup>99</sup> After failing to stain cotton fabric with the dye from a freshly beached *Janthina janthina* snail in Haifa, Israel, Spanier abandoned Rabbi Herzog's suggested snail in favor of the *Murex trunculus*.<sup>100 101</sup>

In 2002, Dr. Shaul Kaplan, a marine biologist working at Israel's Oceanographic and Limnological research center published a paper on his efforts to dye wool with *Janthina janthina*.<sup>102</sup> Not attracting much attention and failing to produce a dye that wouldn't fade after 2 weeks, Dr. Kaplan seemingly abandoned his research in 2014, one year after a *tekhelet* conference was held in Jerusalem.<sup>103</sup> Despite abandoning his work, Kaplan succeeded where no one else could, having done more research on *Janthina* than anyone else since 1987. While I enumerate how *Janthina janthina* fits the numerous criteria of the *hillazon* mentioned earlier, I supplement my own research with Dr. Kaplan's firsthand account of the rare snail species.

Upon a quick glance at *Janthina janthina*, one can instantly tell that it satisfies criterion a), that of the *hillazon* having a body that is the color of the sea. The snail's body and shell are the same color as the dye it secretes, a modified astaxanthin-protein complex sourced from the *janthina*'s prey *Veella veella*.<sup>104</sup> Shells from the snail may range in color from violet to sky-blue with a countershading that allows the snail to remain camouflaged from on top and beneath it when drifting in the sea. This characteristic of countershading is common among fish, supporting *janthina*'s fulfillment of criterion b) as well.

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<sup>99</sup> Mienis, Henk K. and Spanier, Ehud. "A Review of the Family Janthinidae (Mollusca, Gastropoda) in connection with the *Tekhelet* Dye." *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*. 1987. p. 202.

<sup>100</sup> Ibid, p. 201.

<sup>101</sup> Sterman writes that in a personal correspondence with Otto Elsner, *Janthina janthina* was not shown to be fast either (See footnote). Sterman, *Tekhelet: Renaissance of a Mitzvah*, p. 76.

<sup>102</sup> Kaplan, Shaul. "גילוי התכלת" *Or Torah* 417, 2002. [Tekhelet.com/library](http://Tekhelet.com/library).

<sup>103</sup> ניר, דיאנה בחור. "חלזון של משיח". *כלכליסט*, 16 Jan. 2014, [www.calcalist.co.il/local/articles/0,7340,L-3621850,00.html](http://www.calcalist.co.il/local/articles/0,7340,L-3621850,00.html).

<sup>104</sup> While discussed later, I have attached a paper here showing the chemical nature of *Janthina janthina*'s dye. Barnard, W., and D. De Waal. "Raman Investigation of Pigmentary Molecules in the Molluscan Biogenic Matrix." *Journal of Raman Spectroscopy*, vol. 37, no. 1-3, 2006, pp. 342–352., doi:10.1002/jrs.1461.

While Rabbi Herzog had difficulty interpreting criterion b), Dr. Kaplan provides a novel suggestion about the *hillazon*'s resemblance to a small silver-scaled fish. As a pelagic snail, the *janthina* survives by building a bubble raft from its own mucus. The bubble raft acts as a flotation device which the snail clings to as it drifts. If the *janthina* becomes partially detached from its raft, it quickly creates new bubbles with its propodium (anterior part of the foot) by extending its foot towards the surface, rapidly folding its foot to encase an air bubble, and coating the air bubble in mucus secreted from the propodium. This entire sequence is performed in roughly 10 seconds and can be performed up to 10 times in rapid succession before pausing. If the *janthina* snail becomes completely detached from its raft, it sinks and dies as it cannot construct a new bubble raft without access to the water's surface.<sup>105</sup>

The *janthina*'s bubble raft can extend up to 13 cm in length and 2 cm in width.<sup>106</sup> As Dr. Kaplan notes while searching for the creature by boat in the Mediterranean,

*"Janthina's bubble rafts look very much like a small fish with many scales, to the extent that if you find one with its shell buried in the sand and its bubble raft sticking out - one who doesn't recognize it can think that it is a small fish."*<sup>107</sup>

Seeing the creature on the beach in Florida myself, I can attest to Dr. Kaplan's claim that *janthina*'s bubble raft can be mistaken for a small shiny fish from a distance or to one who does not know about the snail. All the more so I can imagine that one seeing the creature drifting in the waves out at sea, where it is even more difficult to discern *janthina*'s distinct features, would likely describe it as a fish before closer examination.

Where the *Murex trunculus* fails, *Janthina janthina* excels. The *Janthina janthina* has been shown to be exclusively rare in appearance in nature, fitting the description given by criterion c) that the *hillazon* arises in mass once every 70 years. Dr. Kaplan makes note regarding his own efforts at collecting the elusive snail,

*"A diligent search [for the janthina] by boat with nets in the heart of the sea may result in two, three, or even a dozen snails. However once in a while [janthina] may amass on land in tons."*<sup>108</sup>

While I have observed small quantities of *janthina* stranded on the beaches of Boca Raton, Florida along with *Physalia physalis*, mass strandings of the *Janthina* genus have been recorded globally, including a recent mass stranding in the Mediterranean off the coast

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<sup>105</sup> Lalli, Carol M. and Gilmer, Ronald W. "The Janthinid Snails: Raft Builders." Ch. 2, p. 11. *Pelagic Snails: The Biology of Holoplanktonic Gastropod Mollusks*. Stanford University Press, 1989.

<sup>106</sup> *Ibid*, p. 11.

<sup>107</sup> Kaplan, "גילוי התכלת", p. 12.

<sup>108</sup> *Ibid*, p. 3.



of Italy in 2017<sup>109</sup> as well as one in Key West, Florida in 1897 described by American malacologist Charles Torrey Simpson,

*“Before I reached it I noticed that as far as the eye could see, it was a mass of the most intense glowing violet color, and on coming up to it was astonished to find that this color came from untold millions of Janthina, which had been washed up in the night, for when I had left the beach the evening before at dusk, not one was to be seen. To say that they lined the shore gives no idea of the real truth. Everywhere, from below low water to highest tide mark they were piled up, in most places, over shoe-top deep, and in the hollows of rocks one could have waded in among them up to his knees.”*<sup>110</sup>

Through Rabbi Herzog’s interpretation of 70 years (or 7 years) referring to extended periods of absence of the snail, *Janthina janthina* strongly fits the characterization ascribed in criterion c). While no mass strandings have been recorded along Israel’s coastline to my knowledge, Spanier writes in his review of the genus that a sample of *Janthina janthina* shells was taken from a grave strewn with the shells in a Muslim cemetery in Jaffa in 1937. *Janthina prolongata* and *Janthina janthina* have been recorded off Israel’s coast in the Mediterranean, however Spanier suggests that this number may have been far greater in the past, but has since been reduced due to increased pollution in the sea.<sup>111</sup> A personal secondhand account by my father describes him witnessing more than a dozen washed up *Janthina janthina* scattered over a mile of beach between Atlit and Haifa in 1996.

Criterion d) which describes the *hillazon*’s blood being used to dye *tekhelet* presents a challenge for *janthina*’s identification as the *hillazon*. While Rabbi Herzog was convinced that *tekhelet* was a well-lit sky-blue, Ptil Tekhelet asserts that *tekhelet* is identical to the false *tekhelet* produced by the *kela ilan*: indigo. The *Murex trunculus*’s dye is a derivative of indigo dibromoindigo, which is easily converted to indigo through a chemical process, According to Sterman, dyed wool from the *Murex* and dyed cotton from the *kela ilan* look the same to the naked eye, however only through chemical testing can they be distinguished, hence the statement in the Babylonian Talmud that only G-d can tell the difference between real and fake *tekhelet*.<sup>112</sup>

While I do not intend to discuss the full-extent of the discussion on *tekhelet*’s color and the nature by which it is bound to wool, Sterman asserts that a trace of dibromoindigo will always exist in *Murex* indigo, no matter how pure the dye.<sup>113</sup> By Ptil Tekhelet’s criteria then,

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<sup>109</sup> F. Betti, G. Bavestrello, M. Bo, M. Coppari, F. Enrichetti, M. Manuele & R. Cattaneo-Vietti (2017) Exceptional strandings of the purple snail *Janthinapallida* Thompson, 1840 (Gastropoda: Epitoniidae) and first record of an alien goose barnacle along the Ligurian coast (western Mediterranean Sea), *The European Zoological Journal*, 84:1, 488-495, DOI: 10.1080/24750263.2017.1379562

<sup>110</sup> Simpson, C. T. *The Nautilus*, 10 (12), 133-134 (1897). Found in Mienis, Henk K. and Spanier, Ehud. “A Review of the Family Janthinidae (Mollusca, Gastropoda) in connection with the *Tekhelet* Dye.” *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*. 1987. p. 200.

<sup>111</sup> Mienis, “A Review of the Family Janthinidae (Mollusca, Gastropoda) in connection with the *Tekhelet* Dye.” *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 202.

<sup>112</sup> Sterman, *The Rarest Blue*, p. 152.

<sup>113</sup> *Ibid.*

*tekhelet* clearly does not have the same chemical structure as pure indigo. Thus the criterion that the *hillazon*'s dye be blue like indigo relies on a visual observation rather than spectroscopy. *Janthina janthina*'s dye is an entirely different chemical from indigo, yet its color appears the same as indigo to the naked eye. As Dr. Kaplan mentioned in an interview,

*"[Janthina] creates a glowing, more beautiful blue than the Murex, yet it fades after two weeks."*<sup>114</sup>

It can surely be supported then that if a proper method for dyeing *janthina* that could have been performed in ancient times is discovered, *janthina* surely matches the description of criterion d). With regards to *janthina*'s blood, Dr. Kaplan states that it is as black as ink when initially extracted and amassed, fitting the Rambam's criterion that the *hillazon*'s blood is as black as ink. The same could not be said for the *Murex* since its blood is clear when first extracted from the snail, only becoming dibromoindigo (dark violet-blue) when exposed to oxygen.

Like the *Murex*, little is to be said regarding criterion e) and *janthina*, as the snail is only known to dwell in seas.

As with many of the criterion mentioned *janthina* differs considerably from the *Murex*, so too *janthina* differs regarding its shell. While the *Murex* has a hard shell that is similar to many seafloor-dwelling molluscs, *janthina* has a fragile and light shell that can easily be crushed by one's hand. The thin shell wall composed of calcium carbonate with traces of calcite and aragonite allows *janthina* to float.<sup>115</sup> This would seem to align well with criterion f) which discusses crushing the *hillazon*'s shell, as with the Gemara there one could easily crush and kill the *janthina* snail when attempting to extract its dye. This would explain the Gemara's mention of criterion g), that one must take extra caution when extracting the *hillazon*'s dye so as not to crush it. Dr. Kaplan further verified criterion g) with the following;

*"If the [janthina] is dead, [its] ink is next to useless. [Dr. Kaplan] has tried repeatedly to dye wool with various preparations made from dead snails with no success. The dye itself cannot be used if frozen, dried, alcohol extracted or expressed from dead snails. Such preparations yield only the weakest fugitive colors if any at all. One must have live snails to produce a satisfactory color."*<sup>116</sup>

The Gemara's understanding of criterion g), that the snail's death instantly degrades its dye, is supported by Dr. Kaplan's statement above. Only the dye from a living creature is

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<sup>114</sup> דיאנה בחור, ניר. "חלזון של משיח". כלכליסט, 16 Jan. 2014, [www.calcalist.co.il/local/articles/0,7340,L-3621850,00.html](http://www.calcalist.co.il/local/articles/0,7340,L-3621850,00.html).

<sup>115</sup> Lalli and Gilmer, *Pelagic Snails*, p. 11.

<sup>116</sup> Kaplan, "גילוי התכלת", p. 25.

suitable, and Dr. Kaplan was careful to extract the *janthina* dye by simply irritating the snail, causing it to release copious amounts of pure violet dye (in some cases blue).<sup>117</sup>

When discussing criterion b), I noted that Dr. Kaplan mentioned *janthina* being buried in the sand, therefore satisfying criterion h). While I have not witnessed a mass stranding, I have witnessed *janthina* on the surface of the sand and buried amongst seaweed. I imagine that if merely covered with sand (not being completely buried), one could find the *janthina* snails upon sifting through the sand. With some shells having a sapphire or deep violet color, one could easily think he has found a treasure buried in the sand, a שפוני טמוני חול. Furthermore I would like to propose that should one find such a snail buried with its violet-blue shell contrasted by the tan sand, he would instantly be reminded of the color of the sea, the sky, and G-d's throne of glory, as described in Tractate Menahot of the Babylonian Talmud.<sup>118</sup>

No mass strandings of *janthina* along Israel's coast have been recorded, however as I mentioned previously regarding criterion c), a gravesite in Jaffa may suggest that mass strandings did occur at one time. Spanier records in his review that *Janthina janthina* and *janthina prolongata* can be found drifting off of Israel's coast after western storms. While *Janthina janthina* is the more common species and can be found along Israel's whole coast, *Janthina prolongata* is less common and only found in a few restricted locations.<sup>119</sup>

Since *janthina* are a global tropical species, they are likely infrequently washed into the Mediterranean from the Atlantic Ocean through the Strait of Gibraltar rather than having a persistent endemic population in the Mediterranean. While I am unaware of anything inherent to the *prolongata* species that would cause it to have more restrictive strandings than other species of *Janthina*, a peninsula or prominence along a coastline could serve as a concentrating mechanism for drifting species when they're drifting along with shore winds.

Evidence of *janthina*'s use in the marine snail dye industry (or at least attempts) was found near Beirut and in the middens of Tyre.<sup>120</sup> While some may argue that this would invalidate the interpretation of Zebulun's tribe being the only one having access to the *hillazon*, I believe it more valid to interpret the Gemara as saying that the snail is known to wash up on Zebulun's coast more frequently than in other locations. As evident by Spanier in his review and Dr. Kaplan's research, *janthina* has been found washed up in small quantities along Israel's northern coast presumably in what was once Zebulun's territory, fitting well with criterion i).

I believe both the *Murex trunculus* and *Janthina janthina* fit criterion j)'s description. The Sifrei's description of scavengers feeding on the *hillazon* when stranded suggests that the

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<sup>117</sup> For cases of blue dye being excreted from *Janthina*, see Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 72.

<sup>118</sup> Babylonian Talmud, Menahot 43b.

<sup>119</sup> Mienis, Henk K. and Spanier, Ehud. "A Review of the Family Janthinidae (Mollusca, Gastropoda) in connection with the Tekhelet Dye." *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 202.

<sup>120</sup> Jensen, Lloyd B. "Royal Purple of Tyre." *Journal of Near Eastern Studies*, vol. 22, no. 2, p. 105. The University of Chicago Press, 1963.

creature is immobile when not in the water. This is true for both *Murex* and *Janthina*, though *Janthina* more so, as it is only capable of drifting. Dr. Kaplan notes that he has found fragments of *Janthina* shells along Israel's coast with the snail eaten from it. Due to the shell's fragile nature, any bird or small lizard can break it open and devour the animal inside without difficulty.<sup>121</sup>

A peculiar feature of the *Janthina Janthina* snail is its tentacles. Likely used as a sensory organ since the creature lacks visible eyes, the pair of tentacles extends from the head of the creature, fitting the description given by Rabbi Leiner in שפוני טמוני חול. Rabbi Leiner wrote that the Arukh, a Jewish lexicographer, drew the *hillazon* with tentacles extending from its head.<sup>122</sup> Surely this description seems to fit *Janthina*, thereby satisfying criterion k).

Now having discussed *Janthina Janthina*'s suitability with all the criteria that have been likely attributed to the *hillazon-hatekhelet*, I would like to lastly mention *Janthina*'s relation to criterion 14. While I am most certain that this Gemara is not referring to the *hillazon-hatekhelet*, the possibility allows me to introduce *Janthina Janthina* as matching this criterion as well. While the *Murex* dwells at the bottom of the sea and is unlikely to be thrown onto a mountain in a storm, *Janthina* are light and dwell at the surface. This lends the possibility that a water spout could draw up the snails from the water and throw them onto coastal mountains. I do not support this possibility in its full extent, rather just merely suggest it. In additional support, the *Janthina Janthina*'s dextrally-coiled shell is the same shape as the shells of many land-snail species, further suggesting that one could associate an appearance of a *Janthina* on the beach with a snail in the mountains.

While *Janthina Janthina* clearly fits many of the criteria for the *hillazon*, no archaeological evidence has been found of the snail being used in ancient dyeing of textiles. One may suggest that the lack of evidence disproves the *Janthina* theory presented by Rabbi Herzog, however I will address this as directly as possible as I did regarding the archaeological evidence for *Murex* dyeing in ancient Israel. For one, *Janthina* shells are extremely delicate and can easily break even upon holding them in one's hand. Therefore, I find it unlikely that remnants of the shell would remain intact throughout years of burial and eventual excavation. Furthermore, *Janthina* shell remains (if any were present) may have been overlooked, as many current excavations regarding the shellfish dye industry have laid focus on the *Murex trunculus* as the *hillazon*.<sup>123</sup> As these excavations have shown, shellfish-dye based textiles in Israel have been exceedingly rare, with only 3 remains being found so far. It is possible that clothes containing *Janthina* dye (specifically *tzitzit*) did not survive years of deterioration.

As a second point, I would like to suggest that the *tekhelet* dye industry may have not been as prominent as the *argaman* industry. While many *Murex* snails are required to produce an ounce of dye, a single *Janthina* snail can produce the equivalent. The likelihood of finding middens stocked with *Janthina* shells is even less so if so few snails were required

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<sup>121</sup> Kaplan, "גילוי התכלת", p. 3.

<sup>122</sup> Leiner, *Treasures Hidden in the Sand*.

<sup>123</sup> Sukenik, Naama. "Chemical Analysis of Murex-Dyed Textiles from Wadi Murabba'at, Israel." *Journal of Archaeological Science: Reports*, vol. 3, 2015, pp. 565–570., doi:10.1016/j.jasrep.2015.08.003.

to provide *tekhelet* dye for a very specific niche. Furthermore, assuming criterion c) regarding the *hillazon*'s infrequent and rare mass stranding to be true, *Janthina* shells would only be present in mass in middens at very specific points in time, with possible generational gaps in between each appearance. This combined with the fragility of the shell makes it even less likely that archaeologists would find evidence of *Janthina* dyeing, even if they were fervently searching for it.

If archaeological evidence of *Janthina* dyeing was found in Israel, this would further support its proposal as the *hillazon*, however it would not solidify it. Even if *tzitzit* dyed with *Janthina* based dye were found, I would also not say that this is an absolute proof of the *hillazon*, as who is to say that the color is in fact *tekhelet* and that the dye is derived from the proper creature, the *hillazon*? I believe that it is crucial to follow the biblical and rabbinic criteria for the *hillazon* brought forth in providing support for identifying *Janthina* as the true *hillazon*, and ultimately it should be through *mesorah* (tradition), as discussed by Rabbi Moshe Tendler<sup>124</sup> and Rabbi Mois Navon<sup>125</sup>, that the *hillazon*'s identity is determined.

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<sup>124</sup> Tendler, Moshe D., "Identifying *Tekhelet*: Masoret and Yedi'ah," in *Tekhelet: Renaissance of a Mitzvah* (New York: YU Press, 1996), p. 39-50.

<sup>125</sup> Navon, Mois. "On History, *Mesorah*, and *Nignaz*." *Threads of Reason*. Ptil Tekhelet, 2013. p. 18-24.

## Conclusion

The *Murex trunculus* has received significant attention in its ability to properly bind to and dye wool. The same treatment has not been given to *Janthina janthina*, mostly due to the rare nature of the creature and the little knowledge on how to properly domesticate it for research purposes. In this vein, Dr. Kaplan has done more research on *janthina*'s dyeing capabilities than any other researcher, despite being alone in his research and a marine biologist as opposed to an esteemed chemist.

While I could not find an exact mention of Dr. Kaplan's dyeing methods with *janthina*, his 2002 paper suggests that he extracted the dye from living *janthina* snails grown in his lab in Jaffa by "milking them," irritating the snails to produce violet dye from their hypobranchial gland without killing them. This secretion can amount to an ounce for a single snail, as opposed to the requirement of many *Murex* snails to reach an equal quantity.<sup>126</sup> This aligns well with Rabbi Herzog's view that *tekhelet*'s expensiveness is not attributed to the small quantity produced by each *hillazon*, but rather the *hillazon*'s rarity. Once the dye was collected, Dr. Kaplan is assumed to have followed the Rambam's interpretation of the ancient dyeing method described in his Mishneh Torah.<sup>127</sup> The violet dye extract from the *janthina* was heated along with קמורליא or קמוניא, which is translated as potash<sup>128</sup> or chamomile.<sup>129</sup> This process, according to Dr. Kaplan, would convert the violet color to a brilliant blue: *tekhelet*.

Despite *janthina*'s incredible staining power,<sup>130</sup> Dr. Kaplan's *tekhelet* faded from the wool after 2 weeks. I propose further investigation on *janthina* dye's fastness. From firsthand accounts as well both Spanier and Dr. Kaplan's writings, it is known that *janthina* produces a strong dye which can stain one's hands and clothes. The dye is an astaxanthin-protein complex derived from *janthina*'s main source of food *Verella verella*. Interestingly, astaxanthin by itself is a carotenoid pigment, having a deep red hue, the same pigment that gives wild salmon its color. When bound in *verella*, it becomes a blue carotenoprotein with a spectrum between violet and blue depending on temperature and salinity. The absorbance of this blue carotenoprotein which is also found in *janthina* is practically identical to the *Murex* and indigo absorption spectrums, lying roughly between 600-620 nm.<sup>131</sup> The fact that the blue color can remain stable for long periods is attested to in *janthina* shell collections. Perhaps one day we will find the method that allows it to persist as it does in the living snails on the high seas. Until then it is interesting to note that the world's leading supplier of the astaxanthin molecule is in Israel. Algatech, located in Kibbutz Ketura in the Arabah near Eilat, harvests astaxanthin from a microalgae that they grow in large outdoor bioreactors. As

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<sup>126</sup> Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 72.

<sup>127</sup> Rambam. *Mishneh Torah*, Fringes Ch. 2:2. Translated by Moses Hyamson, 1949. Sefaria.org.

<sup>128</sup> Ibid.

<sup>129</sup> Rambam. *Mishneh Torah*, Tzitzit Ch. 2:2. Translated by Eliyahu Touger, 2019. Chabad.org.

<sup>130</sup> ניר, דיאנה בחור, "חלזון של משיח". כלכליסט, 16 Jan. 2014, [www.calcalist.co.il/local/articles/0,7340,L-3621850,00.html](http://www.calcalist.co.il/local/articles/0,7340,L-3621850,00.html).

<sup>131</sup> Herring, Peter J. "Stability of the Blue Pigment of *Verella* and *Porpita*." *Comparative Biochemistry and Physiology*, vol. 39B, p. 1039-1043. Pergamon Press. 1971.

a powerful antioxidant that can pass through the blood-brain barrier, astaxanthin is sold as a medical supplement rather than a pigment.

Hopefully through this work which has enumerated the many criteria *Janthina janthina* fulfills with regard to the *hillazon-hatekhelet* one will be stimulated to study its dyeing capabilities (perhaps using pure astaxanthin for starters). Despite the research by Dr. Spanier and Dr. Kaplan that has been done with the *Janthina janthina* snail thus far, it is only a fraction of the amount of testing done on the *Murex trunculus*. I firmly believe *Janthina janthina* and its dyeing capabilities deserve more careful examination with regard to the *hillazon* and *tekhelet* debate. As I quote from Dr. Ehud Spanier and Rabbi Herzog,

*“The biology and chemistry of [Janthina janthina] has to be studied more intensively”<sup>132</sup> as it is “deserving of serious evaluation.”<sup>133</sup>*

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<sup>132</sup> Mienis, Henk K. and Spanier, Ehud. “A Review of the Family Janthinidae (Mollusca, Gastropoda) in connection with the Tekhelet Dye.” *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*, p. 204.

<sup>133</sup> Herzog, *The Royal Purple and the Biblical Blue: Argaman and Tekhelet*. Appendix B: The Dyeing of Purple in Ancient Israel, p. 142.

## Appendix



**Figure 1.** *Janthina janthina* snails discovered on the beach in Boca Raton, Florida. Though presumed dead, one was still attached to its bubble raft. Both shells were approximately 20 mm in diameter. (Malkiel, Yosef. “*Janthina janthina* snails with Bubble Raft.” 2020. Boca Raton, Florida)





**Figure 2.** A presumed dead *Janthina janthina* washed onto the sandy shore along with seaweed. Note the clear bubble raft still attached to the snail. The שפוני תמוני חול! (Malkiel, Yosef. “*Janthina janthina* snail stranded on Beach surrounded by Seaweed.” 2020. Boca Raton, Florida)



**Figure 3.** A presumed dead *Janthina janthina* with a portion of its body visible in its shell. Note the purple color of its body, the same color as its shell and the same color as the sea. One of its two hook-shaped tentacles is also visible. (Malkiel, Yosef. “*Janthina janthina* body and tentacles.” 2020. Boca Raton, Florida)



**Figure 4.** An aerial view of a disturbed *Janthina janthina* secreting a violet dye. (Malkiel, Yosef. "Disturbed *Janthina janthina* Secreting Violet Dye." 2019. Boca Raton, Florida)



**Figure 5.** *Janthina janthina* attached to their natural prey *Velella velella*. Note that both the deep blue color of *Velella velella* and the violet color of *Janthina janthina* are derived from the same pigment: astaxanthin. (Malkiel, Yosef. “*Janthina janthina* feeding on *Velella velella*.” 2020. Boca Raton, Florida)