The Enigma of Techeilis

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Abstract. Ptil (Association for the Promotion and Distribution of Tekhelet) claim that the evidence for identifying the *Murex trunculus* snail as the source of *techeiles* is decisive. There was great excitement, internationally, when scientists recently analyzed a 2,000-year old piece of fabric from Murba'at. They claimed that the fabric contained the Biblical blue *techeiles*—derived from the Murex. Many find these discoveries by enthusiastic researchers an exciting confluence of Torah and the findings of the scientists. However, there are grave halachic and (להבדיל) scientific problems with these claims. Some of them are treated in this article. A critical evaluation of the scientific claims is warranted.

Ptil quote a number of lines of evidence to justify their claim. (a) They claim that the Talmud indicates that true *techeiles* is indistinguishable from counterfeit *kala ilan*—a blue dye from plant indigo. The Murex dye qualifies as *techeiles* because it is molecularly equivalent to indigo. However, what this actually proves is that the Murex dye is unfit for *techeiles*, given that it is counterfeit *kala ilan* (indigo)—down to the molecular level. The Talmud's reduction test is designed to expose indigoid dyes such as plant indigo or Ptil's Murex dibromoindigo. Ptil samples that we tested, failed the reduction test.

(b) Ptil claim that a (non-extant) passage in Jerusalem Talmud (as quoted by the Raavyah) translates *techeiles* as *porphiron*—the Latin and Greek name for the Murex snail. The claim, frankly, lacks credibility. Raavya does not say what is ascribed to him nor is there any evidence that the word *porphiron*—used in a later part of the passage—means the Murex snail. From the Septuagint and Josephus it is the Biblical *argamon*, not *techeiles* that is identified with *purpura*, the word that is sometimes used for Tyrian purple derived from the Murex.

(c) Ptil claim that extensive marine biological surveys have revealed that the only snails in the Mediterranean which produce stable dyes are those of the Murex family. The problem with this claim is that new species are continually discovered. The Talmud notes that the Chilazon is a rare species appearing once every 70 years. Midrash Tanchuma notes that *techeiles* was concealed, and Arizal writes that "it has been concealed in heaven" for there is no *techeiles* except when the Temple is standing.

There is no evidence that blue dyes were obtained from the Murex in antiquity. The ancients could not have have produced sky blue from the Murex snail with the methods and, materials and tools available to the ancient dyers. It was Tyrian purple that was the famous dye produced from the Murex. The Murba'at fabric was likely dyed with plant indigo mixed with small amounts of Tyrian purple.

There are a number of halachic problems associated with the Murex dye. (d) The Talmud states that one who squeezes the Chilazon while alive is not liable for the Melacha of taking its life. This is because the dye is much better when the Chilazon is alive than dead. The dyer makes every attempt to keep it alive. Thus, he is not liable even though its death is inevitable (פסיק רישא דלא ניחא ליה). The Murex does not fit the Talmud's description. In the case of the Murex, there is no need to take special precautions to keep it alive—the dye is still good for a few hours after its death. The dyer can take a coffee break, still leaving him with plenty of time to extract the dye from the dead Murex. As opposed to the Chilazon, the dyer would be liable for taking the life of the Murex, as the aforementioned leniency for squeezing it live would not apply.

(e) The Talmud states that if one traps and squeezes the Chilazon for its blood, he is liable only for the single Melacha of trapping. However, production of the Murex dye involves cutting a piece of the shell and flesh to extract the dye. This means that there is an additional Melacha of either shearing or taking the life of an animal. Thus the method used in the production of Murex dye is not the process described in the Talmud.

(f) The colourless indoxyl precursor to the Murex dye in its hypobronchial gland of the Murex is not blood, just a mucus (*rir* in Talmudic terminology). However the Talmud describes the Chilazon as having blood (דם). Based on this, the Rishonim ask why extracting the blood from the Chilazon is not the Melacha of taking its life (כִּי הַדָּם הוּא הַנָּפֶשׁ)? This question pre-supposes that the blood of the Chilazon is real, unlike the mucus of the Murex.

(g) The Murex does not satisfy the primary criteria given by the Talmud for the Chilazon, viz. that the colour of the Chilazon's body is like the sea (blue); it comes up rarely, only once in 70 years; and its blood is used for *techeiles* (the Murex dye is not blood but mucus from its probronchial gland). The Talmud also states that the Chilazon's shape is that of a fish. While the Murex might be generally classified as a "fish", it is strange that Chazal do not use the more specific word *shavlul* (snail), rather than "fish" or the more generic term Chilazon. Rabbi Herzog rejected the Murex for just these reasons.

HaGaon HaRav Shlomo Eliyahu Miller points out that normative halacha requires that Tzitzis strings be the same colour as the Tallis (white), except for valid *techeiles* strings. Counterfeit indigo blue strings do not qualify. He also refers us to the Ben Ish Chai who writes that, according to the *kabbalah* of the Arizal, the *sitra achra* (evil forces) takes hold in colours that are similar to the real *techeiles* such as *kala ilan*. Thus, in addition to the various halachic problems, we should not wear the Murex dye which is the counterfeit *kala ilan* (indigo).

Ptil proponents either diminish the importance of these issues and criteria or offer far-fetched explanations. HaGaon HaRav Elyashiv זצ"ל also rejects the Murex. As he notes, the majority of Gedolei Yisroel did not accept previous proposals, which were also later rejected by scientists. How then do we know, he concluded, that the present identification will not be rejected, as were its predecessors? Furthermore, who is great enough in our generation to decide whether to follow Rashi or the Rambam in the preparation of the dye? HaGaon HaRav Ezriel Aeurbach writes that, with respect to past proposals, the vast majority of the "Gaonei Torah and Poskim did not incline after the minority". Likewise, the Gedolei Haposkim of our time reject the current proposals, even to wear the Murex indigo dye out of doubt. He states that this is a serious question which can only be decided by הפוסקים אמתיים.

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The Torah teaches that at least one of the strings of *tzitzis* should be made from *techeiles*. *Techeiles* is traditionally understood to be wool which is dyed blue, while the other strings of the tzitzis are white. The Talmud states that *techeiles* dye was produced from the blood of a sea animal called the *chilazon*. R. Meir used to say, "Why is blue specified from all the other colours? Because blue resembles the colour of the sea, and the sea resembles the colour of the sky, and the sky resembles the colour of the Throne of Glory".[1]

Sometime after the destruction of the second *Bais Hamikdash*, the identity of the *chilazon* was lost. Just as Jews never forgot the Temple, they kept alive the memory of *techeiles* with the hope of one day fulfilling this precious mitzvah.

Ptil Tekhelet recently hosted an international conference to an excited crowd marking 100 years since the doctorateal disseration of Rabbi Yitzchak Halevi Herzog: *The Dyeing of Purple in Ancient Israel.* A highlight of the conference was a presentation by Dr. Na'ama Sukenik from the Israel Antiquities Authority who examined a find from the Murba'at caves in the Judean desert. *Haaretz* reported her find as follows:

> In a rare discovery, scientists have *confirmed* that an almost 2,000-year old piece of fabric found near the Dead Sea contains remnants of the Biblical blue color known as *tekhelet*.[2]

The find was announced internationally.[3] Chareidi magazines also reported the find with great excitement. *Ami Magazine* quotes Prof. Amar from Bar Ilan University (and supervisor of Dr. Sukenik): "This cloth is the second to oldest known verified *techeiles* in history. The fact that it survived over 3,000 years [sic.] is very important. This is the *techeiles* described in Tanach, 100 percent, and to see the Torah come alive

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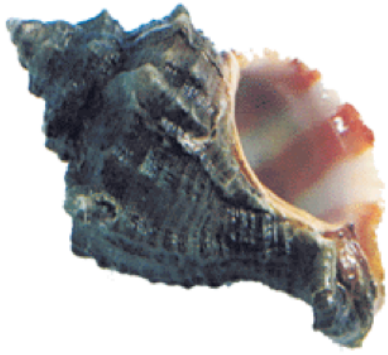
[1] מנחות דף מג ע"ב: תניא, היה ר' מאיר אומר: מה נשתנה תכלת מכל מיני צבעונין? מפני שהתכלת דומה לים וים דומה לרקיע ורקיע לכסא הכבוד, שנאמר: (שמות כ"ד) ותחת רגליו כמעשה לבנת הספיר וכעצם השמים לטהר, וכתיב: (שמות כ"ד) כמראה אבן ספיר דמות כסא.

[2] `http://tekhelet.com/pdf/Press/Haaretz.pdf`, emphasis added. The Israel Antiquities Authority site reported: "A third textile, made of wool, indicating the thread fibers were dyed by exposing them to sunlight or heated after having been dyed, represent another use of the murex snail for achieving a shade of blue, and it is possible that the item in question is an indigo fabric made by means of a technique similar to making the tekhelet (blue) in a tzitzit. The importance of this fabric is extremely significant as there are practically no parallels for it in the archaeological record." (`http://bit.ly/1bTZSJ9`, December 2013.) The Murex snail is implicated, Dr. Sukenik stated at the conference, because HPLC analysis of the fabric found indigo, monobromoindigo and dibromoindigo molecules. In a video presentation at the conference, Dr. Sukenik stated that the colour of the fabric was "blue-greenish" and not from a plant source "which indicate conclusively that the dye came from this species [Murex trunculus]" which was used in the production of *techeiles* (`bit.ly/1ez7ByS`, accessed 7 Feb, 2013).

[3] For the New York Times, see `http://tekhelet.com/pdf/Press/NYTimes.pdf`.



(a) Murex Trunculus snail with exposed hypobronchial gland.

(b) Murba'at fabric dyed blue, according to Dr. Sukenik.[6]

Figure 1: 2000 year old fabric claimed to be dyed blue from Murex Trunculus snail

before our eyes is very exciting. Sadly, to date, we have not discovered any *tzitzis* with *techeiles*".[4] Likerwise, *Mishpacha* reports: "The late-December discovery thrilled scientists and historians, who said the tiny piece of cloth was the first tangible proof that Eretz Yisroel hosted a techeilis producing industry in ancient times".[5]

These are strong words. Scientists have "tangible proof" and have "confirmed" that *techeiles* comes from the murex snail. It seems pleasant to find a confluence between Torah and the findings of the scientists.

But how powerful are the archaeological and scientific proofs? Not very! There are grave halachic and (להבדיל) scientific problems with these claims. Some of them are treated in this article.

2 Production of Tyrian purple in antiquity

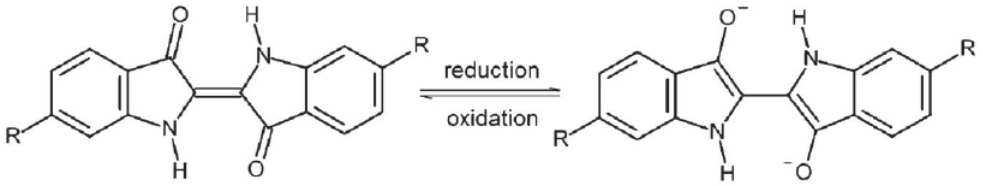
In antiquity, vat dyes were used to obtain a range of colours such as blue (from plant indigo) and purple (from molluscs). Indigo is among the oldest of dyes to be used for textile dyeing and printing. A variety of plants have provided indigo throughout history, but most natural indigo was obtained from those in the genus *Indigofera*.[7]

[4]Nesanel Ganz, Techeilis found?, *Ami Magazine*, January 22, 2014, p23. The Murba'at fabric was not Tzitzis, but some other garment.

[5]Libi Astaire, Techeilis Trek, *Mishpacha*, January 22, 2014, p62.

[6]Left: Murex image from Rabbi Yehuda Rock, *Techumin*, Vol. 16 (reproduced at `tekhelet.com`). Right: Fabric from `antiquities.org.il`.

[7]Species of the genus *Indigofera* are mostly shrubs, though some are small trees or annual or perennial herbs. Most species have flowers in shades of red, but there are a few white- and yellow-flowered



Almost insoluble blue or purple dye	*leuco* forms
Indigo (R = H)	water soluble
Dibromindigo (R = Br)	pale yellow

Figure 2: Scheme of the reduction of indigoids during the vat dyeing process

Tyrian purple was also highly sought, and was derived from molluscs such as the *Murex trunculus*. Indigo blue and the purple dyes come from related indigo-based precursors and were thus produced in similar ways.[8]

For a dye to be useful, it must be colourfast. It should not fade in the sunlight or wash out in soap and water. This means that it must be inert and not bond readily with water or detergents. But if the dye is inert, then it also will not adhere to the fibers of the cloth. The dyer must find a chemical pathway that will allow the dye to enter and adhere to the fabric, and get locked in so that it is colourfast. This was a a much sought-after skill that was developed by the ancient fraternity of dyers.[9]

Murex sea snails are found in relatively shallow waters in rocky shore areas full of seaweed vegetation. These snails are usually partly concealed as they are found burrowed in the sandy seabed with only a small hump from their shell visible. They must be collected live (and kept alive until the pre-dyeing stage is begun) to avoid premature ejection of the purple pigment from the dying animal. The shell is cracked to expose and rupture the hypobranchial gland which is off-white or beige in colour (Fig. 1a). The gland contains the colourless brominated and unbrominated indoxyl precursors in its fluid. As long as the snail is alive, only these colourless precursors exist, and no purple pigment is yet present or produced in the gland.

Tyrian purple from the murex consists mainly of dibromoindigo, and was the only

species (Wikipedia).

[8]Ancient dyes are classified into three main groups: (a) direct dyes (for cotton), (b) mordant dyes and (c) vat dyes (for wool and linen) [4, p367]. Mordant dyes include saffron and kermes. Kermes is a red dye derived from the dried bodies of an insect that lives in the sap of the Kermes oak tree. Kermes binds to fibers via binding agents called mordants such as alum and natron. To dye woolen yarn with kermes, it is boiled in water for a few hours with alum and then left to cool. Vat dyes (indigo and the Tyrian purple) have to be made soluble via chemical reduction which was done in a closed vat as will be explained in the sequel.

[9]See JT, Shabbos, Ch1:halacha 3, and commentary of Pnei Meir.

(a) Dibromindigo as a powder, and its effect on a piece of fabric.

(b) Wool dipped in murex solution from the Hexaplex trunculus, turning blue in the sunlight outside Ptil factory in Israel.

Figure 3: Tyrian purple (Wikipedia commons).

other vat dye known in antiquity other than indigo. The Bromine atoms[10] are responsible for the shift towards purple from the blue of indigo. Tyrian purple and indigo have similar chemical properties and can both be reduced to a *leuco* form [2]. A *leuco* dye is one whose molecules can acquire two forms, one of which is colourless. The procedures for the production of Tyrian purple dye of antiquity are described by Pliny. Koren elaborates the steps as follows [7]:

a) Once the shell has been cracked and the gland exposed or punctured, a piece of snail meat and colourless indoxyl precursors are sliced off (see Fig. 1a). Archaeological digs confirm that the shell was cracked in this way.

b) The dyestuff in the murex gland is composed of two components: (a) the chromogens (colourless indigoid dye precursors), and (b) the dye enzyme purpurase. The purpurase deteriorates in a few hours subsequent to the death of the snail.[11] The piercing of the shell allows the purpurase enzyme (which is naturally present in the gland but physically separated from the precursors) to come in contact with the chromogens (the colourless precursors) to produce indigo and dibromindigo (shown on the left of Fig. 2).

c) Dyes obtained from the murex belong to a class known as vat dyes. In their natural state, such dyes do not dissolve in water thus making it difficult to mix them into a liquid easily absorbed by the fabric. In order to bond with water, they must first undergo a process known as reduction. Once reduced and in solution, the cloth fiber can then be soaked in the dye. The snail meat is a necessary nutrient for the reductive bacteria also present in the snail. The snail meat, with

[10] Symbol Br, a red-brown liquid at room temperature.

[11] Pliny writes: "People strive to catch this shellfish alive, because it discharges this juice with its life".

the developing pigment adhering to it, is placed in a vat.

d) Reduction, in this context, is a process whereby the oxygen in the indigo gains an electron and becomes negatively charged (Fig. 2), allowing it to bond with water. In this reduced state, the molecules are called leuco-indigo ("white-indigo"), as in this form, the dye liquid takes on a pale yellow or green colour. In addition, the negative charge brings the dye molecule closer to the cellulose of the wool, facilitating a stronger bond between the two.

e) How was reduction achieved? In antiquity, the molluskan pigment was naturally reduced in water by the anaerobic[12] bacterium acting as a mild reducing agent over a period of days. Pliny mentions the addition of "salem" (Latin for salt) as the only external auxiliary reagent needed for purple dyeing. This was probably and alkaline salt (such as natron, lime, or limestone), which was necessary for the reductive dissolution of the purple pigment. "In order to maintain anaerobic conditions for the slow bacterial reduction of the indigoid pigments to their soluble leuco form, the dye bath would have needed to be covered throughout the process (except for the brief periods of gently stirring the contents of the dye bath), and hence, no significant photo-debromination of the brominated dyes would have occurred as a result of the action of the sun".[13] In order not to destroy the fermenting action of the bacteria, the dye bath was not boiled, but raised to a moderately hot temperature. Pliny writes that the water in the vat was kept at a uniform and moderate temperature by a pipe brought from a furnace some way off, so that the heat source is not directly in contact with the dye bath [7, p52]. The whole process required extreme care and was thus closely guarded technology. As recently as 1987, researchers Otto Elsner and Ehud Spanier were uncertain as to how the ancient dyers were able to reduce the dye and keep it in a reduced state during complicated and sensitive procedures that lasted many days [12, p161].

f) Once reduced and in solution, wool is dipped into this mixture so that the dye

[12] i.e. without air to prevent oxidation.

[13] The quote is from Koren [7]. He also writes: "In order to reduce the amount of atmospheric oxygen from entering the bath—and thus to prevent the unwanted oxidation of the reduced indigoids—the vat would have also been covered with either a slab of stone or wood. Thus, only a small amount of space would have existed between the top of the liquid and the vat's cover. With the various gases produced from the fermentation process, only a small quantity of air would have been present in the head space above the liquid. This would aid the anaerobic nature of the bacterial action. The lid of the vat would have been opened for very brief periods in order to stir and mix the contents of the liquid very gently so as not to introduce much air into the dye bath, but, except for these very short interludes, the cover would have stayed in place to prevent the entrance of air into the dye liquid. This preventative measure has filtered down through the ages so that already two centuries ago, historic dyeing books directed dyers to fill an indigo vat nearly to the top and to keep it covered."

molecules can throughly penetrate the fibers of the cloth. In order to make the purple dye colourfast and inert so that it is not washed out with water, the dye molecules must be returned to their inert state by a process known as oxidation. The cloth is exposed to air, thereby losing its electrons. The yellow leuco state miraculously changes back to the deep purple of the dibromoindigo dye.

The above steps explain how indigo related Tyrian purple was obtained from the murex as described by writers of antiquity and archaeological finds from those times. Modern chemists, with much hard work, have been able duplicate the ancient methods of vat dyes. "Successful fermentation vats have been produced for all-natural dyeings with molluskan pigments in the United Kingdom, France, and Israel" producing a range of purple colours [7, p51].

3 Blue dye from Murex not known in antiquity

In antiquity, the Murex trunculus was used to produce purple dye, not blue.[14] However, modern researchers seek a marine animal that will produce a blue dye (the traditional colour of *techeiles*). In this they believe that thee have discovered a chemical pathway using the Murex. However, it is unlikely that they are correct.

Step (e) in Section 2 explains how reduction of the murex dye was achieved in antiquity in a vat. Since the molluskan pigment was naturally reduced by the anaerobic bacterium acting as a mild reducing agent, the time necessary for the full reduction of the purple dye was a matter of days.

The dye obtained from the murex consists of a mixture of indigo (blue), monoindigo (purple) and dibromoindigo (red-purple). The modern discovery is that when the brominated molecules are reduced and in their leuco state, irradiation by the ultraviolet rays of the sun break the molecule's bond with bromine. As a result, the purple molecules become free of bromine and on oxidation yield a dye of sky blue indigo.

[14] Dr. Sterman writes: "The other points raised by Dr. Singer regarding the identification of purpura with tekhelet are simply not accurate. Vitruvius [15, Book 7 p.113-129] specifically states that one of the shades that can be obtained from the purpura is blue (lividum)" [11]. Dr. Sterman's claim was repeated by Dr. Menachem Epstein [3]. Dr. Singer responded to both [9, 3]: "There is no historical evidence to support this claim. It is based on a quote from Vitruvius that is taken out of context. Vitruvius doesn't say that the murex was used to dye leaden blue, as claimed, but that depending on the region it produced various shades of purple, black, leaden blue, violet and red. Quite obviously he was not suggesting that murex was used to dye black. He is referring to shades of purple, not different colors. This is how it is cited in modern works [13, p156-158], and also by Rabbi Rabbi Herzog, who further demonstrates that Vitruvius is not even speaking of murex trunculus but of other murex snails" [Herzog1987, p26 and p34].

3.1 Reducing reagent sodium dithionite unknown in antiquity

The modern procedure (used by the Ptil organization) uses a method perfected by the late Prof. Elsner, that transforms much of the red and violet components in the dissolved pigment to the blue indigo dye by (a) first dissolving the pigment with a strongly reactive synthetic chemical reagent called sodium dithionite[15] not available in antiquity—which reduces the solution instantaneously—and then (b) exposing the dye solution to sunlight.[16]

3.2 Vat dyes spoiled by exposure to sunlight

This method was not available to the ancients. In a series of careful experiments with the pigment, Prof. Zvi Koren has shown that—in antiquity—the only way that the pigment could be dissolved by using only the natural materials available at the time was by the very slow bacterial action under anaerobic conditions, which thus required eliminating as much air (oxygen) as possible from entering the dye solution. In order to accomplish this, it was thus necessary to cover the dyeing vessel without exposing the dye solution to the action of the sun, and thus the original red and violet components in the pigment would be essentially unchanged.[17] In response to Dr. Baruch Sterman (co-founder of Ptil), he writes:

> My published scientific experiments with completely all-natural dyeings with the snail pigments clearly show that air must be prevented from entering the dye bath and thus this solution would have needed to be covered at all times, except for the very brief periods of gentle stirring. Their statement that "none of the ancient recipes such as those recorded by Pliny or in the Talmud mention that requirement" is completely irrelevant. The Talmud and Pliny were written as general descriptions, not how-to guides or detailed laboratory manuals for chemistry students. But more importantly, with all due respect to the Talmud or Pliny, I do not need them to tell me that the dye bath that has undergone reduction (the OPPOSITE of oxidation) needs to be covered. It is the SCIENCE of what's possible that tells me that the natural anaerobic reduction process must be performed via the elimination of air. By the way, laboratory and industrial manuals from two centuries ago do detail how to naturally dye with indigo from plants and specifically indicate that the dye bath MUST be covered.

[15] Also known as sodium hydrosulfite, $Na_2S_2O_4$.

[16] Dr. Sterman oulines the steps as follows: '1. Add Sodium Hydroxide to the dibromoindigo/indigo mixture to increase the PH. 2. Add Sodium Dithionite as a reducing agent 3. Expose to UV to break the bromine bonds 4. Add Amonium Sulfate to lower the PH 5. Add wool and wait a few minutes." Personal communication from Dr. Sterman, October 22, 2000

[17] Zvi C. Koren, "Regarding the Color of Tekhelet", letter to Biblical Archaeological Review, 12/11/2013. Koren explains why in great detail in [7]. Koren's view is that the *techeiles* is the purple dye.

> In the Stermans' response, they state "Koren further implies that there is no way to achieve a sky-blue color from murex dye without modern chemicals." I never said that. What I did indicate was that the ANCIENTS—Jewish or non-Jewish—could not, and would not, produce daylight sky-blue from the snail pigments with the methods, materials and tools available to the ANCIENT dyer. Since the Stermans themselves have obviously not performed all-natural dyeings to produce daylight sky-blue, they cite examples by two others for obtaining bluish shades. Their first example, that Edmonds used a fermentation vat to produce blue-colored wool, is completely misleading. He used a GLASS vessel for his dye bath and exposed the solution to the sun in the photo-debromination process (used by the authors' organization) in order to get a bluish color. Glass is obviously transparent, but in ancient times the Phoenicians and their contemporaries used CLAY vats (the Romans also used metal pots), which are obviously NON-transparent. Thus, light would not—could not—have entered the solution, especially since the solution needed to be covered as I stated above.[18]

3.3 Murba'at fabric a mixture of plant indigo and Tyrian purple?

Earlier we discussed the claim that scientists have confirmed that the almost 2,000-year old piece of fabric found near the Dead Sea contains remnants of the Biblical blue color known as *tekhelet*. We now see one of the reasons that the claim is questionable.

The dyers of antiquity did not have access to the modern reagents used by Ptil to

[18] Zvi C. Koren's Reply to the Stermans' Response, "Continuing the tekhelet debate", BAR 01/02/2014. Koren writes: "The other example that the authors cite is the experiment by Hoffman in which he produced a very light sky-blue wool dyeing. He used the fermentation vat that I had previously detailed, without citing that fact, and then he used Elsner's method of first introducing a woolen sample into the dye bath in order to extract much of the redder—with some blue—component of the pigment. He then placed a SECOND wool sample into the SAME dye bath, which now had less of the red component than before, but also is somewhat diluted with respect to the blue component. Firstly, anyone who is conversant with the Talmud's discussion on this subject would immediately come to the conclusion that to propose that this is what the ancient Hebrews did to perform tekhelet dyeings is nonsense. Halakhically, any textile introduced into the dye bath must be specifically for the sole purpose that the wool must be used for the dyeing of tekhelet from the beginning. To first use a wool sample to get rid of a significant amount of red component—and not to use that sample itself for dyeing it to tekhelet—would make the whole dye bath unfit (not kosher) for any further use! Secondly, this process is also implausible from a logical point of view. To collect many sea snails and process them in lengthy and complicated biochemical procedures, only to be followed by removing (or destroying) an important component from the pigment, in order to produce light blue dyeings, simply does not make any sense." Prof. Koren is probably referring to the following:

רמב"ם יד החזקה (כתב יד תימני) - הלכות ציצית פרק ב : תכלת של ציצית, צריכה צביעה לשמה ; ואם צבעה שלא לשמה, פסולה. והיורה שיש בה הצבע, אם צבע בה מעט צמר לבודקו אם הוא יפה אם לאו, נפסלה היורה כולה. אלא כיצד יעשה, לוקח הצבע מן היורה בכלי קטן, ומניח בו מעט צמר שבודק בו ; ושורף את שבדק, שהרי נצבע לבדיקה. ושופך הצבע שבכלי שבדק בו, שהרי פגמו ופסלו ; וצובע התכלת בשאר הצבע, שלא נפגם : ע"כ. ועיין עולת שלמה למנחות פרק ד דף מב :

reduce the pigment. The only way that the pigment could be dissolved by using only the natural materials available at the time was by the very slow bacterial action under anaerobic conditions in a vat, which thus required eliminating as much air (oxygen) as possible from entering the dye solution. In order to accomplish this, it was thus necessary to cover the dyeing vessel without exposing the dye solution to the action of the sun, and thus the original red and violet components in the pigment would be essentially unchanged.

Furthermore, the scientists assumed that the Murba'at find was from the Murex trunculus because it contained indigo and trace elements of dibromoindigo (the proportion is not stated in their reports). The problem is that, in antiquity, vats were used to dye plant indigo and purple dyes from the murex. Thus, the traces of dibromoindigo in the Murba'at fabric may have come from mixes of these two natural dyes. The blue dye in the fabric would then not derive from the Murex.

In *The Royal Purple and the Biblical Blue* [10, p193 plate-C], we see a range of wool colours obtained by mixing plant or synthetic indigo with dibromoindigo: from sky blue (100% indigo) to a blue purple (50% indigo and 50% dibromoindigo) to pure purple (100% dibromoindigo). Thus the blue in the Murba'at fabric is easily explained as coming from plant indigo vat dyes without the need to posit the modern procedures used by Ptil that were unknown to the ancients.

3.4 Dye from Murex is kala ilan—counterfeit techeiles

The Ptil organziation lists five lines of evidence that, they claim, decisively shows that the the Murex is the *chilazon*. One of the "decisive" proofs is stated as follows: "The Talmud indicates that true tekhelet is indistinguishable from the blue dye of vegetable origin—*kala ilan* (indigo). The dye ultimately derived from trunculus is molecularly equivalent to indigo.[19]

The problem is that the Ptil position is untenable and self-refuting. Obviously, if the Gemara gives chemical tests to distinguish between *techeiles* and *k'la ilan*, they cannot be the same chemical! Ptil and its supporters have attempted to overcome this concern, but the arguments advanced are weak. The chemical test problem, alone, is sufficient to undermine the fundamental Ptil claim and to call into question their attempt to identify the Murex as the *chilazon*.

> In ancient times, there were unscrupulous individuals who would substitute an imitation *techeiles* dye known as *kala ilan* for the real *techeiles*. *Kala ilan* is widely understood to be indigo, traditionally derived from a plant.[20] Indigo was the predominant source of blue dye in ancient times, and was both readily available

[19] `http://tekhelet.com/tekhelet/introduction-to-tekhelet/`, accessed 16 February, 2014.

[20] Aruch on *kala ilan*; Nimukei Yosef Baba Metzia 34a; Herzog ibid, pp.94-96, Responsa Ridbaz v2, 685.

> and relatively inexpensive. This counterfeit *techeiles* was virtually identical to the color of the real *techeiles*. Accordingly, the Rabbis proposed chemical tests that could distinguish between the chemical that made up the authentic *techeiles* and the chemical that made up the counterfeit *techeiles*.[21] These tests are based on subjecting the dyed wool to a fermentation process[22] and ruling it *kala ilan* if the color worsens.[23]

So the Talmud's test would rule out indigo based products such as the Murex dye as a candidate for *techeiles*, and we must search elsewhere for the *chilazon*.

3.5 Talmud's fermentation test detects dibromo/indigo products in vat dyes

Dr. Sterman suggested that it is theoretically possible that some snail meat remaining in the Murex indigo could keep it from failing the Talmud's test.[24]

However, this would mean that the Talmud's test was for incidental properties of the dye like the snail meat rather than than for the detection of its fundamental indigo-like dye properties. Although the Talmud does not provide a complete procedure, the fermentation test is consistent with what one would expect to detect plant or Murex indigo in vat dyes, as explained in detail in earlier sections. In the vat, the indigo based dye was reduced allowing it to bond with water. In the reduced state, the dye liquid takes on a pale yellow or green colour. The test would thus change the colour of plant or Murex based indigo, thus showing that these dyes are the counterfeit.

> Rabbi Herzog, with the aid of renowned dye chemist Dr. A.C. Green, recognized that the Gemara's tests have the aim of chemically reducing indigo. In this state

[21] Menachot 42b-43a.

[22] Herzog ibid. p.102.

[23] Chazal devised two chemical tests to differentiate between the genuine *techeiles* and the forged one. One test determined whether certain specific chemicals were able to make the color fade. The other test determined whether subjecting it to a certain procedure would improve its color or not. If the color faded from the first test and did not improve from the second test, it was clear that it was dyed with the indigo plant and not with genuine techeiles.

[24] Dr. Sterman writes: "I personally have proposed that although there may be no difference molecularly between the two, and therefore according to the methods currently used to dye wool, there is no discernible difference in quality between them, historically, this was not always the case. When dyeing according to natural methods in the ancient world, tekhelet was dyed in a completely different manner than indigo. The former was fermented together with the meat from the snail. Current research by John Edmonds in England has shown that bacteria present in the snail meat plays an active part in the reduction of the dye. On the other hand, indigo was chemically reduced in an entirely different manner. Consequently, it is quite reasonable that the quality and fastness of wool dyed with tekhelet according to the method employed in vat dyeing with snails, would have differed from that of *kala ilan*. This may have been the basis for tests that attempted to distinguish between the two. Nobel Chemist Prof. Roald Hoffman has told me that he finds this proposition to be plausible." [Baruch Sterman. "Response on behalf of the Ptil Tekhelet Foundation", *Journal of Halacha and Contemporary Society*, 2000.]

indigo is yellow, thus the Gemara's stipulation that if the color fades it fails the test and is suspected to be k'la ilan. Since snail indigo and plant indigo are the exact same chemical, murex indigo should also fail this test. Indeed, murex indigo would be expected to fail any chemical test that plant indigo fails, let alone the Gemara's test which is clearly designed to detect indigo.[25]

3.6 Talmud's test is for indigo reduction, not colour fastness

The Talmud initially states that there is no test that can determine if a blue thread is *techeiles* or the the counterfeit indigo. It concludes that there are two complementary tests.

> Menachos 42b. Our Rabbis taught: There is no manner of testing the blue thread; it should therefore be bought only from an expert. ... Is there then no manner of testing the blue thread? But R. Yitzchak the son of R. Yehuda used to test it thus: He used to mix together liquid alum (מגביא גילא),[26] juice of fenugreek (ומיא דשבלילתא),[27] and forty day old urine (ומימי רגלים בן ארבעים יום), and soak [the blue thread] in it overnight until the morning; if the colour faded it is invalid, but if not, it is valid (לא איפרד חזותיה כשרה). Moreover, R. Adda stated the following test before Rava in the name of R. Avira: One should take a piece of hard leavened dough of barley meal and bake it with [the blue thread] inside; if the colour improved it is valid, but if it deteriorated it is invalid; and in order to remember this, think of the phrase 'a false change, a true change!'— So what is the meaning of the statement 'There is no manner of testing the blue thread'? This refers [to the concern that the wool was dyed for the purpose of] testing the pigment.[28]
>
> Mar of Moshkei once obtained in the time of R. Achai some blue thread; on testing it by the test submitted by R. Yitzchak the son of R. Yehuda its colour faded, but on testing it by R. Adda's test its colour improved. He was about to declare it invalid when R. Ahai said to him, This is neither genuine blue nor imitation blue! We must therefore say that one test supplements the other thus: if the test of R. Yitzchak the son of R. Yehuda had been applied and the colour had not faded it is certainly valid, but if its colour had faded we should then test

[25] Mendel Singer, "Author's Reply", *Journal of Contemporary Halacha*, 2000.

[26] Many natural dyes require the use of chemicals called mordants to bind the dye to the textile fibres; *tannin* from oak galls, salt, natural *alum*, vinegar, and ammonia from stale urine were used by early dyers. Many mordants, and some dyes themselves, produce strong odors, and large-scale dyeworks were often isolated in their own districts. (Wikipedia)

[27] Fenugreek (*Trigonella foenum-graecum*) is one of the oldest cultivated medicinal plants. It is an annual herb of the bean family and is widely grown throughout the Middle East and Asia. Fenugreek has traditionally been grown for use as fodder, human food, cloth dye. "Fenugreek yields seeds which, when ground, communicates to stuff a pale yellow of tolerable durability; and the best mordants are found to be alum and muriate of soda, or common salt" [1].

[28] Thus, even if the wool passes the tests, it may not have been made for the sake of the Mitzvah, and thus must be purchased from an expert. Rashi.

> it by R. Adda's test by [baking it in] a hard piece of leavened dough; if its colour improved it is valid, but if it deteriorated it is invalid. A message was sent from there [Palestine] saying, The tests supplement each other.[29]

Many have misunderstood the Talmud's test. The test is not for colour fastness *per se*.[30] It is possible to achieve acceptable colour fastness of the counterfeit indigo dye (*kala ilan*) despite repeated washing. Rather, the Talmud's test appears to be directed at detecting the presence of dibromo/indigo products by reducing them in a vat to their *leuco* state. For example, the first test requires the use of stale urine. "The use of stale urine, which contains ammonia from the decomposition of urea caused by bacterial contamination, can produce moderately alkaline solutions of about pH 8. Stale urine was a popular reagent in Europe in the 18th and 19th centuries for the dyeing of indigo" [7]. Dr. Singer provides comprehensive details and analysis:[31]

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[29] מנחות דף מב ע"ב: ת"ר: תכלת אין לה בדיקה, ואין נקחית אלא מן המומחה תפילין יש להם בדיקה, ואין ניקחין אלא מן המומחה ספרים ומזוזות יש להן בדיקה, וניקחין מכל אדם. ותכלת אין לה בדיקה? והא רב יצחק בריה דרב יהודה בדיק ליה, (סי' בגשם) מייתי מגביא גילא ומיא דשבלילתא ומימי רגלים (מנחות דף מג ע"א) בן ארבעים יום, ותרי לה בגווייהו מאורתא ועד לצפרא, איפרד חזותיה פסולה, לא איפרד חזותיה כשרה ורב אדא קמיה דרבא משמיה דרב עוירא אמר: מייתי חמירא ארכסא דשערי ואפיא לה בגוויה, אישתנאי למעליותא כשרה, לגריעותא פסולה, וסימניך: שינוי שקר, שינוי אמת! מאי אין לה בדיקה נמי דקאמר? אטעימה. מר ממשכי אייתי תכלתא בשני רב אחאי, בדקוה בדרב יצחק בריה דרב יהודה ואיפרד חזותיה, בדרב אדא ואישתנאי למעליותא, סבר למיפסלה, אמר להו רב אחאי: אלא הא לא תכילתא היא ולא קלא אילן היא! אלא שמע מינה שמועתא אהדדי איתמר, היכא דבדקנא בדרב יצחק בריה דרב יהודה לא איפרד חזותיה כשרה, איפרד חזותיה בדקינן לה בדרב אדא בחמירא ארכסא, אישתני למעליותא כשרה, לגריעותא פסולה. שלחו מתם: שמועתא אהדדי איתמר.

[30] When the Talmud (Menachos 42b) describes the dyeing process, it does not mention the reagents alum, fenugreek and stale urine used in the reduction test. It does say certain herbs (סמנין) are used, but there is no evidence that these herbs are the reagents that are used for the reduction of indigo and Tyrian purple. The Talmud states: "Abaye said to Rav Shmuel bar Yehudah: 'That *techeiles*, how do you dye it?' He said to him: We bring blood of the Chilazon and herbs (סמנין) and put them into a vat and boil up the mixture. We then take out a little [of the liquid] into an egg-shell and test [the liquid] with a wad of wool. We then spill out the dye in the egg-shell and burn the [trial sample of dyed] wool."

מנחות דף מב ע"ב: אמר ליה אביי לרב שמואל בר רב יהודה: הא תכילתא היכי צבעיתו להו? אמר ליה: מייתינן דם חלזון וסמנין ורמינן להו ביורה [ומרתחינן ליה], ושקלינא פורתא בביעתא וטעמינן להו באודרא, ושדינן ליה להוא ביעתא וקלינן ליה לאודרא. שמע מינה תלת: שמע מינה טעימה פסולה, ושמע מינה דבעינן צביעה לשמה, ושמע מינה טעימה פסלה. היינו טעימה פסולה היינו צביעה לשמה! אמר רב אשי: מה טעם קאמר, מה טעם טעימה פסולה? משום דבעינן צביעה לשמה. כתנאי: טעימה פסולה, משום שנאמר: (שמות כ"ח) כליל תכלת, דברי ר' חנינא בן גמליאל רבי יוחנן בן דהבאי אומר: אפילו מראה שני שבה כשר, משום שנאמר: (ויקרא י"ד) ושני תולעת.

In the reduction test for counterfeit indigo, the vat is lightly heated. By contrast, when *techeiles* is dyed, the implication is that the herbs are boiled with the blood of the Chilazon and the resulting mixture is the *techeiles* dye (see Tosefos ד"ה וסממנים). The Talmud does not identify these herbs. Rambam (Hilchos Tzitzis 2:2) indicates that one may use any herbs that enable the dye to better penetrate the wool.. However, Rashi (as understood by Tosefos) explains that the herbs are not mixed with the Chilazon blood. First the wool is steeped in a brew of dyes so that the wool will accept the dye, and it is then dyed in pure Chilazon blood.

[31] Mendel Singer, "Understanding the Criteria for the Chilazon", *Journal of Contemporary Halacha*, 2000. Emphasis added.

Fermentation processes were used in the traditional method of dyeing indigo, and causes the blue indigo to change to a yellow solution.[32] Chazal used this knowledge to design tests that indigo would fail. The chemical test proposed by Rav Yitzchak the son of Rav Yehudah describes a fermentation vat typical of what was used in ancient dyeing of indigo. The main ingredient was fermented urine, *mei raglayim*.[33] Though the Gemara's lashon of "ben arba'im yom" could mean the *mei raglayim* had to be 40 days old (thereby sufficiently fermented), or it could mean the *mei raglayim* had to be from someone 40 days old as Rashi notes[34], the *mei raglayim* must be fermented.[35]

The Petil group uses mucus from the murex trunculus snail, and through a process creates indigo, chemically identical to plant indigo. In other words, Petil is saying that real techeilet and imitation techeilet are the same chemical, just made from different sources. **This position is untenable. Obviously, if the Gemara gives chemical tests to distinguish techeilet from *k'la ilan*, they cannot be the same chemical!**

Dr. Allen Kropf, a retired professor of pigment chemistry familiar with the Petil dyeing process, writes in a personal communication, "There should absolutely be no chemical difference between plant and snail indigo. Thus, any chemical test that posits a difference, is not valid, in my opinion". Therefore, the Gemara's chemical tests cannot possibly be testing plant indigo vs. snail indigo. This leaves two possibilities: plant indigo is not *k'la ilan* or snail indigo is not techeilet. Given the wide acceptance of indigo as *k'la ilan*, and the corroboration afforded by the Gemara's tests which are clearly based on detecting indigo, the only conclusion would seem to be that techeilet is not snail indigo.

Nonetheless, Dr. Roald Hoffman, a Nobel-prize winning chemist does reach a different conclusion. Recognizing impossibility of distinguishing plant indigo from snail indigo, he clings to the conclusion that murex indigo is techeilet. He writes

[32] As explained earlier, the chemical reduction of indigo into "indigo white" was done by immersion into a fermentation vat. The first of the two tests in the Gemara describes such a fermentation vat, which should reduce the indigo, thereby fading the blue color and failing the test. Descriptions of fermentation vats can be found in: Edmund Knecht, Christopher Rawson, and Richard Loewenthal, *A Manual of Dyeing, Eighth edition*, (London, 1925), and J.N. Liles, *The Art and Craft of Natural Dyeing*, (Knoxville, 1990).

[33] The ingredients of the test, fermented urine, juice of the fenugreek plant and alum, seem puzzling at first glance. It would not appear to be a convenient test if it involves waiting many days for the mei raglayim to ferment. However, knowing that this is merely describing a typical fermentation vat used for dyeing indigo the matter becomes clear. Techeilet dyeing was probably done at or near the dye houses. Anyone wishing to test techeilet could merely walk over to where indigo was being dyed and put it in a fermentation vat and check it in the morning. The second test uses a hard, leavened dough that has fermented as much as possible (Rabbeinu Gershom, Menachot 43a).

[34] Rashi on Menachot 44a.

[35] Rambam, Hilchot Tzitzit, Ch. 2, Halacha 5; Tosafot on Menachot 43a; Tosafot on Nidah 63a.

of the Gemara's chemical tests, "These tests don't work, because the chemical is the same".[36] Since the Gemara's tests were clearly based on sound scientific knowledge and the tests were actually used ("Rav Yitzchak the son of Rav Yehudah used to test it thus..."[37]), it would seem rather presumptuous to doubt the veracity of the Gemara's tests. It is the scientist's conclusion that murex indigo is techeilet that needs to be re-examined.

Even Dr. Irving Ziderman himself, the chemist whose work led to the creation of the Petil group, acknowledges that murex indigo is guaranteed to fail the Gemara's chemical tests and therefore rejects the theory of murex indigo as genuine techeilet.[38]

The argument that impurities in the snail's meat explains why the Murex would pass the test is untenable for another reason. The Murex snail meat, in fact, enhances chemical reduction, which would make it fail the Talmud's test more easily than plant indigo.[39] HaRav Miller thus writes:

תשובות - תכלת - הרב שלמה אליהו מילר שליט"א.

בס"ד יום ב' לפר' ויחי תשס"ד לפ"ק לכבוד ידידי ר' מנדל זינגר שליט"א:

אודות התכלת החדשה כבר הייתי שם במקום שעושים התכלת ולדעתי כל מש"כ בזה אין שום הוכחה שזהו תכלת, אדרבה יש ב' ראיות גדולות שאינה תכלת. א', דבגמרא ורמב"ם מבואר שיש בדיקה להבחין בין תכלת לקלא אילן, ומה שעושין תכלת החדשה הוא ממש קלא אילן אלא שעושים את זה ממין "מורקס" ומשנים הריר עד שיהא דומה ממש לקלא אילן ואין שום חילוק ביניהם באופן כימי וע"כ א"א להיות שום בדיקה להבחין ביניהם, וכל מה שדחו ראיה ברורה זו אין בו לא טעם ולא ריח.

I visited the place where they produce the new *techeiles*, and in my opinion all that they have written regarding this does not prove that this is [the true] *techeiles*. To the contrary there are two strong proofs that this is not *techeiles*. One, in the Talmud and in the Rambam it is made clear that there is a test to differentiate between *techeiles* and *kala ilan*, however the way the new *techeiles* is produced—it is exactly the same [chemically] as *kala ilan* except for the fact that it originates from the Murex [as opposed to from a plant]. The mucus is changed to be exactly *kala ilan* to the point that there is no difference between them chemically. It follows that there cannot be any test to differentiate between them. Their answers to these questions are not reasonable.

Rav Miller asked Dr. Shabtai Nacson (a Chemical Engineer) to run some tests on the Ptil samples. Dr. Nacson confirmed that the three Ptil samples he tested were, to

[36]Hoffman, Roald. "Blue as the Sea". American Scientist, 78 (July/August 1990):308-9.

[37]Menachot 42b.

[38]I.I. Ziderman, "On the Identification of the Jewish Tekhelet Dye", Gloria Manis [Antwerp] 24(4): 77-80.

[39]"Though 2,000 years ago Pliny obviously never identified the biochemical mechanism or the reducing agent necessary to solubilize the indigoids, in antiquity the reducing agent for such a process must have been the bacteria present in the snail meat. Bacteria found in various plant fermentation vats were successful in the reduction and dissolution of the indigo pigment from plant sources [7]."

a high degree, indigo. Both the Ptil samples and industrial indigo samples lost their colour when bleached, but the industrial indigo was more colourfast than the Ptil dye (see Section B.1).

Dr. Nacson also investigated the Talmud's test as understood by the Rambam. Like other experts, he recognize the procedure as a reduction test. He simulated the test using a reducing agent and found that both the Ptil indigo and industrial indigo failed the simulated test (see Section B.2).

4 Murex fails to match Talmud's description of "issur melacha"

Harav Miller's first concern was that if the Gemara gives chemical tests to distinguish between *techeiles* and *kala ilan*, they are unlikely be the same substance. This makes the blue Murex dye (indistinguishable from indigo) counterfeit *kala ilan*.

HaRav Miller's second concern is the way in which a piece of Murex is cut in preparation for dyeing likely violates a Biblical prohibition of *melacha*[40] in excess of that stated by the Talmud.

4.1 Cutting off a piece of the Murex is either גוזז or נטילת נשמה

Recall that the shell of the Murex is cracked and a piece of the Murex is cut off to expose the hypobronchial gland in order to extract the indoxyl precursors.[41] Modern production is done in the same way (see Fig. 1a) and archaeological digs confirm these procedures were used in antiquity. HaRav Miller writes:

> ב׳ מה שעושין היום שאחר שבירת קצת מן הקליפה הם חותכין קצת מן החי וטוענים שכן מצאו הרבה כזה בחפירות מימים קדמונים, הנה בגמרא מפורש שמלבד איסור צידה ליכא שום איסור בפציעת חלזון ובנטילת הצבע, ובאופן שהם עושים הלא הוא גזיזת דבר מן החי שלכל הדיעות הוי מלאכה מן התורה בשבת כמו הסרת ערלה מן החי, וחייב או משום נטילת נשמה, או משום גוזז לפי״ד הש״מ בכתובות, וא״כ מפורש שמה שהם עושים אין זה באופן שעושים תכלת.
>
> Secondly, the way that they fashion the *techeiles* is that after breaking off the shell [which holds the mucus] they also cut off part of the animal itself, saying that they found it done this way in archaeological digs. In the Talmud it is clear that in the entire process of producing *techeiles* [from trapping the animal up until

[40] One of the 39 categories of calculated labours that violate Shabbos.

[41] Cutting is the normal procedure. If the snails are small, they are crushed whole and added to the vat containing the sliced parts of the bigger snail. "Once the shell has been cracked and the gland exposed or has been punctured, then the snail meat with the developing pigment can be forcibly separated from the shell. The shell is discarded as it will occupy too much space in the vat and the entire snail meat - with the developing pigment adhering to it - is placed in a vat. This snail meat is a necessary nutrient for the reductive bacteria also present in the snail (as described below). With smaller snails, the act of stripping off the snail meat from its shell is more difficult and unnecessary; the simple act of crushing the snail shells insures that the gland has been punctured and that the development of the purple pigment has begun. The crushed smaller snails are added to the vat containing the flesh of the larger snails" [7, p48].

> the forming of the dye] only one [of the 39] biblical prohibition[s of the Sabbath] is transgressed; that is trapping.[42] In the manner that they do it, however, they are cutting off a piece from a live animal. This is a biblical prohibition according to all authorities, just like the removal of the foreskin, either the prohibition of taking a life, or the prohibition of shearing, according to the opinion of the *Shitta Mekubetzes* in tractate *Kesubos*.[43] This is a proof that their method of producing *techeiles* is an incorrect method.[44]

Slicing off a piece off the Murex to access the hypobronchial gland is an act of cutting off a piece from a living animal which is a Biblical *melacha* akin to removing the foreskin (חתיכת קצת מן החי הוי מלאכה דאורייתא או גוזז או נטילת נשמה).

4.2 Shearing according to שיטה מקובצת

According to the ש״מ, doing a Bris Milah on Shabbos is an act of shearing (גוזז) because the Orlah skin is cut.[43] If the baby's eight day falls on Shabbos, the Torah permits this Melacha to be done for the fulfilment of this great Mitzvah.

The Melacha of shearing is only for the removal of appendages like plucking feathers from a bird or shearing wool from sheep. Shearing is the detaching from a human, bird, or animal something which is an appendage to the body (but not an integral part of it). Cutting regular skin or flesh is not shearing.[45] Hence, the Achronim ask how cutting

[42]The Talmud states that if one traps a *chilazon* on *Shabbos* and squeezes out its blood to make *techeiles*, he is only liable for the act of *tzedah* (trapping), not for other *melachos* such as *disha* (threshing) and *netilas neshama* (killing). He is not liable for דישה because the *chilazon* is not גדולי קרקע. He is not liable for נטילת נשמה, even though the death of the *chilazon* is inevitable, because he does not want the chilazon to die (פסיק רישא דלא ניחא ליה).:

שבת דף עה ע"ב הצד צבי וכו'. תנו רבנן: הצד חלזון והפוצעו אינו חייב אלא אחת [משום צידה, אבל אפציעה - ליכא חיוב], רבי יהודה אומר: חייב שתים. שהיה רבי יהודה אומר: פציעה בכלל דישה. אמרו לו: אין פציעה בכלל דישה [שמפרק דמו הימנו כמפרק תבואה מקשין שלה]. אמר רבא: מאי טעמא דרבנן? קסברי: אין דישה אלא לגדולי קרקע.

Tractate Shabbos 75b: "Trapping a deer, etc. Our Rabbis taught: One who traps and squeezes a *chilazon* [to force out its blood] is liable for only one [sin-offering for the *melacha* of trapping]. R. Yehudah said: He is liable to two [sin-offerings, for trapping and squeezing out the blood], for R. Yehudah maintained: squeezing comes under the category of threshing [extracting blood from an animal is similar to extracting grain from its husk (squeezing is a *toladah* of threshing, Ritva). Said they to him: Squeezing does not come under the category of threshing. Rava observed: What is the Rabbis' reason [to rule leniently]? The [Rabbis] said to him: threshing is applicable only to produce from the soil [not to the *chilazon* which is a marine animal]." Note: Menachos 42b explictly states that the chilazon has blood (דם חלזון).

[43]שיטה מקובצת מסכת כתובות דף ה עמוד ב :ועוד הקשו בתוס' דגבי מילה נמי אמרינן בפ' ר' אליעזר דמילה [קלג ב'] האי אומנא דלא מייץ סכנתא היא ומעבירין ליה ופריך פשיטא מדמחללים עליה את השבת מהו דתימא מיפקד פקיד קמ"ל דחבורי מחבר מה צביעה שייכא באותה חבורה ומדאיצטריך קרא למשרי מילה בשבת אין ראיה דלא איצטריך משום הוצאת דם אלא להתיר תלישת בשר דחייב משום תולש כדאמרינן בשבת גבי צפורן שלא פירש דחייב חטאת אם נטלו בכלי ומ"מ קשיא מההיא דפ' ר' אליעזר דמילה דלא שייך צביעה גבי חבורה דמילה. ע"כ.

[44]תשובות - תכלת - הרב שלמה אליהו מילר שליט"א. בס"ד יום ב' לפר' ויחי תשס"ד לפ"ק, לכבוד ידידי ר' מנדל זינגר שליט"א.

[45]Otherwise one would not be able to slice meat on Shabbos as גוזז is liable while the animal is alive

the Orlah can be shearing (גוזז)?

The Chasam Sofer (in tractate Shabbos[46]) suggests that since the Orlah is to be removed from a Jewish body, it is not considered an integral part of the body such as a limb, but as no more than a secondary appendage (דחשוב נטפל לגוף ישראל).[47]

However, the part of the Murex that is cut off for its dye is not an appendage. If so, contra the שיטה מקובצת, there should not be liability for shearing in the case of the Murex?[48]

HaRav Miller answers that, in tractate *Kesuvos*, the Chasam Sofer states that removing the Orlah is also liable due to תולש (removing an entity from its place of growth), which is a sub-category of קוצר (harvesting).[49] If so, then cutting a piece of the Murex

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or dead.

[46] חתם סופר מסכת שבת דף קו עמוד א׃ תני ר׳ אבוה קמי׳ דר׳ יוחנן כל המקלקלין פטורין חוץ מחובל ומבעיר. בירושלמי אמתני׳ דחוץ מן הפתילה שהוא עושה פחם פליגי אי שוחט הוא האב מלאכה וחובל תולדה או בהיפוך, ודאי למ״ד שוחט הוא האב קרוב לשיטת ר״ת דחובל משום נטילת נשמה שמחליש האבר ומה לי קטלי׳ כולה או פלגא. אמנם שיטת רש״י דהוה צובע והקשו תוס׳ פ״ק דכתובות מהאי אומנא דלא מייץ לקמן קל״ג ע״ב והתם מאי צביעה שייך, ולרמב״ם הוא משום מפרק תולדת דש ובעי שיוציא דם כגרוגרת ע״ש. ולפע״ד במילה אית בי׳ נמי משום גוזז כחותך יבלת מבעל חי, ועיין בהרז״ה בסופו דמייתי מדרש רז״ל כבכורה בתאנה בראשיתה שהוא כקציצת העוקץ ע״ש וא״כ ה״ל גוזז.

[47] ווכן עיין במנחת חינוך מוסך השבת מלאכת גוזז אות ה. אבני נזר או״ח סי׳ קל״א אות ד.

[48] Question of Rabbi Zev Knopfler to Harav Miller.

[49] It is normally understood that קוצר is only by גדולי קרקע. However, both the Ramban and Rashba allow for the possibility that this is not necessarily so (see footnotes in MHRK versions).

חידושי הרמב״ן מסכת שבת דף קז עמוד ב׃ הא דאמרי׳ במושיט ידו למעי בהמה ודלדל עובר שבמעיה דחייב משום עוקר דבר מגדולו. קשה לי דהא גוזז ותולש כנף מן העוף כשהן חיין (ע״ד ב׳) לא מחייבינן להו תרתי חדא משום עוקר דבר מגידולו, וכן הנוטל שערו וצפרניו ושפמו (צ״ד ב׳) אין בהן דין עוקר דבר מגדולו דליחייב תרתי אלמא אין משום עוקר דבר מגדולו דהוא תולדה דקוצר אלא בגדולי קרקע, וה״נ משמע בבכורות (כ״ה א׳) גבי תולש צמר מבכור דתולש לאו היינו גוזז וכנגדו בי״ט מותר דלית ביה משום עוקר דבר מגדולו, ועוד דודאי קוצר ודש תרוייהו בחד גוונא גמרי׳ להו ממשכן כי היכי דאמרי רבנן (ע״ה א׳) אין דישה אלא בגדולי קרקע ה״נ אמרי ודאי אין קצירה אלא בגדולי קרקע, ואפי׳ ר׳ יהודה אפשר דמודה בקצירה דהיא ממש מן הקרקע, ותולש מבעלי חיים בכלל גוזז הוא, וי״ל דמדלדל עובר משום נטילת נשמה הוא חייב, והכי קאמר אף על גב דהאי עובר לית ליה בדידיה נשמה כיון דגידולו תלוי בנשמת אמו העוקרו משם נוטל נשמתו ממנו, דלאו מי א״ר ששת בגידולי קרקע כן דמאן דתלש כשותא מהיזמי שיניקתו תלוי בהיזמי כדאמרינן בעירובין בפ׳ בכל מערבין (כ״ח ב׳) דקטלין ליה להיזמתא ויבשה כשותא ומיחייב משום עוקר דבר מגידולו דהוא תולדה דקוצר, ה״נ בבעלי חיים מחייב משום עוקר דבר מגידולו דהוא משום נטילת נשמה דומיא דחובל שהוא משום נטילת נשמה מאבר אחד וסירכא דלישנא נקט וכן נראה הפי׳ הזה מדברי ה״ר משה הספרדי ז״ל בפ׳ אחד עשר מהלכותיו. ומה שאמרו בירושלמי בפ׳ כלל גדול רבנן דקסרין אמרין ההין דצד נונא וכל דבר שהוא מבדילו מחיותו חייב משום קוצר לא אתיא כשיטתא דגמ׳ דילן.

חידושי הרשב״א מסכת שבת דף קז עמוד ב׃ הא דאמרינן במושיט ידו למעי בהמה ודלדל עובר שבמעיה דחייב משום עוקר דבר מגדולו. הקשה הרמב״ן ז״ל דהא תולש כנף מן העוף וכן גוזז כשהן חיין לא מחייבינן תרתי חדא משום עוקר דבר מגדולו וחדא משום תולש או גוזז, וכן הנוטל שערו ושפמו וצפרניו, דאלמא ליכא משום עוקר דבר מגדולו אלא בגדולי קרקע לפי שהוא תולדת קוצר ואין קצירה אלא בגידולי קרקע כמו שאין דישה אלא בגדולי קרקע, והכי נמי משמע בבכורות (כ״ה א׳) גבי תולש צמר מבכור דתולש לאו היינו גוזז וכנגדו ביום טוב מותר דלית ביה משום עוקר דבר מגדולו, ולפיכך פירש הוא ז״ל דדלדל את העובר משום נוטל נשמה הוא חייב והכי קאמר אף על גב דהאי עובר לית ליה בדידיה נשמה כיון דגידולו תלוי בנשמת אמו העוקרו חייב משום נוטל נשמתו ממנו, דלאו מי אמר רב ששת בגדולי קרקע דמאן דתלש כשותא מהיזמי שיניקתו תלויה בהיזמי כדאמרינן בעירובין בפרק בכל מערבין (כ״ח ב׳) דקטלין ליה להיזמתא ויבשה כשותא ומיחייב משום עוקר דבר מגדולו [דהוא תולדה דקוצר הכי נמי בבעלי חיים מיחייב משום עוקר דבר מגדולו] דהוא משום נטילת נשמה דומיא דחובל שהוא משום נטילת נשמה מאבר אחד, וסירכא דלישנא נקט, וכן נראה מדברי הרמב״ם ז״ל בפרק אחד עשר מהלכותיו, ומה שאמרו בירושלמי בפרק כלל גדול רבנן דקסרין אמרין ההיך דצד נונא וכל דבר שהוא מבדילו מחיותו חייב משום קוצר לא אתי כשיטתא דגמ׳ דילן.

is liable for the same reason.

Furthermore, the Shita Mekubetzes can be explained as follows: in the middle of cutting a piece from a live animal, the sliced piece becomes partially detached (אבר המדולדל) and at that point becomes an appendage. If so, in the case of the Murex, there is also liability for גוזז.[50]

4.3 Extracting blood from the chilazon—חובל

The Talmud states that one is not liable for killing the *chilazon* (נטילת נשמה). All methods of killing are forbidden, including shechting, suffocating, drowning etc. Even though the death of the *chilazon* is inevitable, there is no liability because one does not want it to die (מתעסק הוא אצל נטילת נשמה). Not only is there no intention to kill the *chilazon*, rather they try their best to keep it alive to improve the dye.

However, there is another way in which there should be liability for נטילת נשמה. Why is the action of squeezing the *chilazon* for its blood (while alive) not liable for the Melacha of wounding (חובל[51]), as is the case for wounding all other animals?

- Tosefos (in the name of R. Tam) answers the question by saying that for the Chilazon there is no liability because its blood used for the dye is in its own pocket (מיפקד פקיד), when it became disconnected from the creature's circulation system. There is also no liability for the extraction of the rest of the blood which is connected to the circulation system and thus subject to wounding (חבורי מיחבר) because one does not want that blood as he wants to keep the *chilazon* alive (ועל שאר הדם שמחובר חשיב ליה מתעסק).[52]

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[50] שאילות ותשובות תכילת – ר׳ שלמה אליהו מילר שליט״א, ר״ח אדר תשס״ד, לכבוד ידידי הרה״ג ר׳ זאב אריה קנאפלער שליט״א. ... ומה שהעיר מע״כ דליכא חיוב גוזז בנוטל קצת מן החי דאל״כ גם לאחר מיתה יתחייב גוזז בחותך קצת מן המת, וגם במילה גופא מצינו דבבן ח׳ ליכא חיוב מה״ת ואמאי אינו חייב משום גוזז והעיר מדברי כמה אחרונים שרק במילה יש גוזז דחשוב נטפל לגוף ישראל. אולם אף שציין לדברי חת״ס בשבת הלא הי׳ גם לציין לחת״ס בכתובות סוף ה: שכתב דגם יש חיוב תולש בנוטל מן החי א״כ יש לחייב כאן משום תולש. ובעיקר הקושיא ממילת בן ח׳ היה נ״ל לפרש דברי הש״מ דבכל חותך דבר מן החי הלא באמצע החיתוך הוי אבר המדולדל או בשר מדולדל דקי״ל מיתה עושה ניפול ואין שחיטה עושה ניפול וא״כ עכשיו אינו חלק גמור מן החי שהרי מיתה עושה ניפול, וגם אינו נפרד לגמרי שהרי אין שחיטה עושה ניפול א״כ חשיב כדבר הנטפל לחי ושייך בו גוזז, אבל אחר מיתה או בבן ח׳ דלא חשיב חי א״כ לא חשוב כנטפל אלא כחלק מן העיקר שנחתך מקצתו, ורק בחי שהנחתך אין לו חיות גמורה כמו החי בזה שייך תורת גוזז ולא קשה מידי כל הקושיות שהקשו על הש״מ. ואף דבציצין שפרשו רובן ליכא חיוב גוזז מה״ת כמבואר בשבת צ״ד: התם משום דקרובין לינתק וכמו שכתב רש״י שם, אבל בבשר או אבר שפרש רובו נראה דאינה קרובה לינתק ויש חיוב גוזז מה״ת.

[51] שבת דף קלג ע״ב: מוצצין וכו׳. אמר רב פפא: האי אומנא דלא מייץ סכנה הוא, ועברינן ליה. פשיטא, מדקא מחללי עליה שבתא סכנה הוא! מהו דתימא: האי דם מיפקד פקיד, קא משמע לן: חבורי מיחבר. ע״כ. ועיין רש״ לכתובות ה: ד״ה: מיפקד פקיד.
The Mishna states that a surgeon is allowed to draw blood from the wound of Bris Milah on Shabbos. Rav Pappa adds that an expert surgeon who does not do this procedure endangers the baby and is dismissed. What is Rav Pappa adding? One might have thought that the blood of Milah is stored in its own pocket having become disconnected from the rest of the circulatory system (דם מיפקד פקיד), so that drawing it out is not wounding? Rav Pappa therefore informs us that the blood cannot be extracted without causing a wound (חבורי מיחבר), which is the melacha of נטילת נשמה. The extraction of blood is sanctioned in this case because it poses a danger to the baby.

[52] תוספות מסכת כתובות דף ה עמוד ב: דם מיפקד פקיד או חבורי מיחבר -... אבל גבי מילה משמע דאיכא איסורא דאורייתא בהוצאת

- The Ritva quotes the answer of R. Tam, but he also innovates an alternative answer (in the name of the Ramban): there is no liability for merely wounding (partial נטילת נשמה) in entities like the *chilazon* that do not have limbs; the liability is only for taking the whole life of such animals.[53]

4.4 Chilazon dye from real blood—Murex "blood" is mucus

We see from the above answers that Tosefos and the Ritva both take it as a given that the "blood" of the *chilazon* (referenced in the Talmud) is real blood.[54] This is why the Rishonim ask the question: why is the action of squeezing the *chilazon* for its blood (while alive) not liable —as is the case for all animals—because of the Melacha of wounding (חובל)?

The *melacha* of slaughtering (שוחט) is the taking of life of any creature, and is Biblically prohibited when done for the benefit derived (e.g. to take fish out of the water to eat it). "Not only is the taking of a complete life considered שוחט, but even to take part of a life is an Issur Min Hatorah of שוחט. This refers to drawing blood from the living body of a human being or animal. The life of the living being is embodied in the blood as the Possuk says: כִּי הַדָּם הוּא הַנָּפֶשׁ—The blood is in the soul of that living creature (Devarim 12:23). Therefore, to remove some of the blood from body is a removal of part of its life and to do so is a Melacha Min Hatorah of שוחט".[55]

By contrast, the colourless indoxyl precursor to the purple dye in the hypobronchial gland of the Murex is not blood.[56] As Rav Perr points out: "The murex mucus is

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דם דאמרינן בפרק ר' אליעזר (שם קלג:) האי אומנא דלא מייץ סכנתא הוא ומעברינן ליה פשיטא מדקא מחללין שבת עליה מהו דתימא דם מיפקד פקיד קמ"ל דחבורי מיחבר ואי הוה משום החלשה ליכא חילול שבת דהויא מלאכה שאין צריכה לגופה דאין צורך להחליש התינוק ונראה לר"ת לפרש דהוצאת דם חשיבה נטילת נשמה כי הדם הוא הנפש וכשנוטל מקצתו נוטל מקצת נשמה וקשה לר"י דאמרי' בפרק כלל גדול (שם עה. ושם) גבי הצד חלזון והפוצעו וליחייב נמי משום נטילת נשמה ומשני מתעסק הוא אצל נטילת נשמה דכל כמה דאית ביה נשמה טפי ניחא ליה כו' ולפי זה אפילו הוא חי גמור הרי יש כאן נטילת נשמה ואומר ר"ת כי דם חלזון שצובעין בו הוא מיפקד פקיד ועל אותו אינו חייב משום נטילת נשמה ועל שאר הדם שמחובר חשיב ליה מתעסק.

[53] חידושי הריטב"א מסכת שבת דף עה עמוד א: מתעסק הוא אצל נטילת נשמה. פירוש שאינו מתכוין להמיתו וכדמפרש ואזיל, וא"ת ותיפוק לי משום חובל, בשלמא למאי דפרש"י ז"ל בפרק שמונה שרצים (לק' ק"ז א') דחובל חייב משום צובע איכא למימר דהכא לא ניחא ליה בציבעא, אבל ההוא טעמא ליתיה דבחובל בשרצים ובאדם מאי ניחא ליה בציבעא, וחובל שהזכירו לגבי בועל את הבתולה פ"ק דכתובות (ה' ב') וחובל דמילה שאמרו (ק"ל א') שהיא דוחה שבת יוכיחו דהא לא ניחא להו בציבעא דדם בתולים ודם מילה, אלא ודאי טעמא דחובל כלשון אחר שפרש"י ז"ל שם דהיינו משום נטילת נשמה במקום שחבל בו כדבעינן לפרושי בדוכתה בס"ד (ק"ז א'), וא"כ הוא הכא נמי הרי חובל, ותירץ ר"ת ז"ל דדם חלזון מיפקד פקיד ואין בו משום חובל וכדאמרינן בכתובות (ה' ב'), ורבינו ז"ל בשם רבו רבינו הגדול ז"ל פירש דשאני חלזון שאינו בעל איברים אלא גוף אטום כחלזונות שבאשפות, ובכי הא ליכא נטילת נשמה אלא כשנוטל כל נשמתו לגמרי.

[54] The Talmud in Menachos 42b refers to דם חלזון. The terminology of מיפקד פקיד and חבורי מיחבר (i.e. wounding) is used in the Talmud with reference to real blood: the blood of Milah and the blood of a Besula.

[55] Rabbi Falk, Slaughtering, Vol. 27, p2.

[56] Research suggests that female snails produce and store tyrindoxyl molecules in the hypobronchial gland (which lies near the reproductive organs) provides the eggs with with biochemical protection against infection [12, p147]. The Murex snail, like all gastropod molluscs, do have blood that is

not blood, neither biologically nor in color. P'til advocates attempt to cope with this problem by writing the word thus, 'blood'. The implication here is that the 'ancients' were imprecise in their use of language. However, there happen to be excellent words used in the Talmud for mucus: *Rir*, *Leicha*, and *Maya* are some of them".[57]

4.5 Murex not Chilazon because its blood is not real (Ramban)

The aforementioned Ramban (quoted by the Ritva[53]) holds that there is no liability for merely wounding animals like the *chilazon* that are undeveloped and do not have limbs; the liability is only for taking the whole life of such animals. Thus, according to the Ramban, there also would be no liability for cutting a piece from the shell of the Murex to access the dye.[58]

The Ramban was forced to innovate this position to answer the question of why squeezing the *chilazon* for its blood is not חובל. This question only arises if the "blood" extracted from the *chilazon* is real—and there really is wounding. So, although the Ramban would not agree that cutting a piece from the Murex is נטילת נשמה, he also would not agree that the Murex is the *chilazon*. If the Murex is the real chilazon then the question that the Ramban was answering does not arise, thus also eliminating the need to innovate that cutting a piece from the snail does not trigger liability.[59]

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often bluish in colour due to the haemocyanin proteins that transport oxygen through the body. They have a simple lung and a heart that pumps the blood into the aorta then into the smaller arteries.

[57] Rabbi Yechiel Yitzchok Perr, Rosh Yeshiva, Yeshiva Derech Ayson, Far Rockaway, NY, Letter to the Editor, Journal of Contemporary Halacha, 2000, .

[58] HaRav Miller had stated that חתיכת קצת מן החי הוי מלאכה דאורייתא או גוזז או נטילת נשמה. Rabbi Zev Knopfler's question to Rav Miller was that according to the Ramban, cutting a piece from the Murex is not נטילת נשמה.

[59] שאילות ותשובות תכילת – ר׳ שלמה אליהו מילר שליט"א, ר"ח אדר תשס"ד, לכבוד ידידי הרה"ג ר' זאב אריה קנאפלער שליט"א. ... אבל להעיר בד"ת מש"כ עמ"ש דחתיכת קצת מן החי הוי מלאכה דאורייתא או גוזז או נטילת נשמה ובגמ' מפורש דליכא שום איסור בעשיית חלזון מלבד בצידה לדידן דקי"ל אין דישה אלא בגידולי קרקע, ומע"כ העיר ע"פ דברי הריטב"א דבחלזון אף שנטילת הדם הוי חובל וכמו כל חבורה לחייב משום נטילת נשמה וכמו שהק' התוס' והתוס' תירצו דדם חלזון שצובעים בו מיפקד פקיד ובריטב"א שהביא מע"כ דבחלזון דאינו בעל איברים ליכא נטילת נשמה במקצתו רק בכולו וא"כ שפיר טוען מע"כ דלפי דברי הריטב"א אין שום טענה דליתחייב משום נטילת נשמה. אולם כידוע תוס' ורוב ראשונים לא תירצו כן ואף לדעת הריטב"א [וכן הביא מהרמב"ן] מ"מ הלא כל ההכרח לחידוש גדול כזה שבעל חי שאינו בעל איברים ליכא חיוב נטילת נשמה רק בכולו ולא במקצתו הוא מכח הקושיא דניחייב פציעת חלזון משום נטילת נשמה מחמת הוצאת הדם כמו כל חבורה, וא"כ מפורש בדבריהם דדם חלזון הוא דם שממנו חי החלזון והוא דם ממש, אבל הריר שב"מורקס" אינו דם כלל ואין בו איסור נטילת נשמה כלל, וא"כ הלא מפורש בראשונים אלו שדם המורקס שהוא רק ריר בעלמא אין זה דם חלזון שבגמרא וא"כ ממנ"פ לפי המפורש בראשונים שיש בזה נטילת נשמה כמו כל דם של בהמה חיה ועוף אין להסתפק כלל ב"מורקס", ואם נתעקש שהראשונים טעו ולא ידעו שאין דם חלזון דם ממש אלא ריר בעלמא ולשון דם הוא לשון מושאל בעלמא כמו דם ענב תשתה חמר, א"כ אין שום מקור להכריח שבבריה קטנה כמו חלזון ליכא חיוב על נטילת נשמה במקצתה וא"כ שפיר יש לחייב מצד נטילת נשמה בנוטל קצת מן החי.

Murex squeezed for blood—not cut (Rashi)

The Talmud does not describe the procedure for obtaining the dye as cutting off a piece of the *chilazon*. The Talmud states that the putative liability for extracting the dye was for squeezing the Chilazon to extract its blood.[60] As Rashi writes, the Talmudic word פוצעו, in this context, means to squeeze the Chilazon with the hand to extract the blood (דוחקו בידיו שיצא דמ). The Murex does not match this description as a piece is sliced off—not squeezed or split in half.[61]

4.6 Murex not subject to Av Melacha of דישה (Rambam)

דש (threshing) is an Av Melacha whose purpose is to extract grain from the chaff. This is the activity that took place in the Mishkan, when seeds were extracted from their encasement for use as agents to bind the dyes to the wool.[62]

The opinion of the Rambam is that מפרק (extracting a liquid from its encasement) such as milking a cow or wounding are liable for דישה. The problem is that cows and wounded animals are not גידולי קרקע? Rabbenu Avraham ben HaRamban answers that גידולי קרקע is only a requirement in the case of the Av Melacha such as extracting grain from the chaff. However, מפרק is only a Toladah of דישה, and in that case there is no requirement of גידולי קרקע.[63]

The Talmud states that extracting the dye from the Chilazon is not liable for דש (threshing) because it does not grow from the ground. According to the Rambam, we are forced to learn that the act (the פעולה) of extracting the dye from the Chilazon, as described in the Talmud, is the Av Melacha (not a Toladah[64]) so that the leniency that the Chilazon is not גידולי קרקע can be applied. The Murex does not fit the Talmud's scenario because the extraction of its dye is akin to the Toladah of מפרק not to the Av.

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[60] שבת דף עה ע"א: הצד צבי וכו'. הצד חלזון והפוצעו [רש"י: דוחקו בידיו שיצא דמו] אינו חייב אלא אחת.

[61] פוצע can also mean to split in half. Rabbi Herzog's understanding was that there is a connotation in "potze'a" of cracking a hard shell. Rav Per writes: "Sad to say, Rabbi Herzog was inexplicably mistaken in this understanding. In both biblical and mishnaic usage, 'potze'a' carries no connotation of a hard object. One of numerous such examples is the Mishnah Ketubot 43b, 'Patza'a Bifaneha', 'he wounded her face'. According to the Radak's Sefer Hasharoshim, Potze'a refers to incising a smooth surface, splitting, cutting, wounding, or causing a fissure. See also Rashi, Shemot 21:25 and Shir Hashirim 5:7. It is the usage of 'splitting', that is found in Shabbat 122b, 'Liftzo'a Egozim', to split, not to crack, nuts. A small experiment demonstrates why the Gemara there speaks of using a kurnos, a blacksmith's hammer, for opening nuts. When a walnut is struck smartly with a light 1/4 lb. hammer along the seam where the halves join, the shell at the contact point is crushed. But when it is merely tapped with a heavy 1 1/4 lb. hammer, it splits in half all the way around. In other places potze'a is used for splitting the limbs from a tree or splitting a stretched string."

[62] רש"י שבת עג. ד"ה האופה.

[63] Others hold that man and animals are regarded as גידולי קרקע because they obtain their nourishment from the ground (עיין רש"י סוכה יא: ד"ה כי חגיגה).

[64] If it is a Toladah, then the Talmud's answer of that it is not גידולי קרקע could not apply, as stated.

Rav Miller writes:

> גם יש להעיר מדברי תשובת ר"א בן הרמב"ם בברכת אברהם ליישב דעת אביו דחובל וחולב חייבים משום תולדות דדש, אף שאין דישה אלא בגדו"ק ומה"ט ליכא חיוב דישה מחלזון כמפורש בגמרא. וביאר דדישה ממש בעינן גדו"ק אבל תולדות דישה אי"צ גדו"ק. וכפי הנראה נטילת הריר מן החלזון אינו דישה ממש, ולכל היותר הוי תולדות דישה אשר אי"צ בהן תנאי גדו"ק לדעת הרמב"ם.
>
> It is also fitting to note the words of Rabbenu Avraham ben HaRambam in his work Bircas Avraham,[65] in answer to a query regarding the opinion of the Rambam. The Rambam states that wounding or milking on the Sabbath is a transgression of the prohibition of *disha*. The Talmud, however, states that *disha* is only applicable to something that grew from the ground. [It is for this reason, states the Talmud, that there is no *disha* to the chilazon.] If so, how could milking or wounding be *disha*? Rabbenu Avraham ben HaRambam replied that with regard to the *av melocho* of disha the Talmud said that there is only *disha* on something that grew from the ground, however with regard to the *toldah* of *disha* one transgresses even by doing *disha* to something that did not grow from the ground. It seems to me that the method which they use to remove the mucus from the murex is at most a *toldah* of *disha*, in which case even though the murex does not grow from the ground it should still be susceptible to the transgression of *disha*. This is in contradiction to the Talmud which exempts the chilazon from *disha* because it does not grow from the ground.[66]

Rabbenu Avraham ben HaRambam writes that מפרק applies when הדם מבליע בבשר ולא בעור or משקה המובלע בזית, i.e. the liquid to be extracted is absorbed in the flesh of the animal or fruit that is encased in skin or peel.[67] The mucus extracted from the Murex appears to be absorbed in the flesh of the probronchial gland which is encased in a shell, and is thus at most the Toladah of מפרק, and not the Av. Thus the Murex does not fit the description in the Talmud that extracting the dye from the Chilazon is an Av Melacha —and not a Toladah.[68]

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[65] שאלה יח.

[66] תשובות - תכלת - הרב שלמה אליהו מילר שליט"א. בס"ד יום ב' לפר' ויחי תשס"ד לפ"ק, לכבוד ידידי ר' מנדל זינגר שליט"א.

[67] See Pesachim 33b, with regards to why juice in a grape does not become *tamei* if the grape becomes *tamei*. One possibility is that משקין מיפקד פקידי, i.e. the juice is considered to be distinct from the flesh of the grape, and contained by the grape skin. Thus, it is not considered to be contaminated by the grape. The Talmud dismisses this possibility quoting Rav Chisda's position as משקין מיבלע בליעי, i.e. the juice is not contained in the fruit but absorbed in its flesh, and is thus reckoned a single entity with it; accordingly, that which contaminates the grape also contaminates the juice (Rashi).

[68] According to the Rambam, the פעולה of extracting the dye from the Chilazon is an Av, and must thus be different than the action of מפרק which is only a Toladah, and thus applicable to an entity whether it is גידולי קרקע or not. So what would extracting blood from the Chilazon look like to be an Av? This is not so clear. Pliny mentions that the normal Murex snails were cracked but the small snails are crushed and added to the vat. That might possibly be closer to the Av Melacha if applied to the Chilazon. See also Chulin 46b מי לא תניא ושאר שקצים ורמשים עד שיצא מהם דם וכי תימא לשמונה

5 Dye better while Chilazon alive— פסיק רישא of the Talmud

The Talmud states that people try not to kill the Chilazon when extracting the dye because the dye is better if extracted while it is alive. Thus, one is not liable for taking the life (נטילת נשמה) of the Chilazon :

> שבת דף עה ע"א : וליחייב נמי משום נטילת נשמה! אמר רבי יוחנן : שפצעו מת. רבא אמר : אפילו תימא שפצעו חי, מתעסק הוא אצל נטילת נשמה [כלומר : לגבי נטילת נשמה הוי מתעסק בדבר אחר, ולא הויא מלאכת מחשבת, שאינו מתכוין שימות]. והא אביי ורבא דאמרי תרווייהו : מודה רבי שמעון בפסיק רישא ולא ימות! שאני הכא, דכמה דאית ביה נשמה טפי ניחא ליה [שדם החי טוב מדם המת, וכיון דכל עצמו מתכוין וטורח לשומרו שלא ימות בידו, אפילו מת אין כאן אלא מתעסק, וכי מודה ר' שמעון במידי דלא איכפת ליה אי מיתרמי, ומיהו איכווני לא מיכוין], כי היכי דליציל ציבעיה [דליציל ציבעיה גרסינן - שתהא מראית, צבעו צלולה].
>
> But let him be liable too for taking life? — Said R. Yochanan: [he is not liable for killing because the Beraisa is discussing a case where] he squeezed [the *chilazon*] after it was already dead. Rava said: You may even explain that he squeezed it whilst still alive [and, nevertheless he is not liable] for taking a life as he is preoccupied with another act [squeezing]. But don't Abaye and Rava both maintain that R. Shimon concedes [that there is liability] where killing is an inevitable consequence[69] of squeezing? Answer: Here it is different, because the longer it stays alive the more he is pleased, in that his dye will be clear.[70]

From this Gemara we learn that there is a significant difference in the dye when extracted while the Chilazon is alive and when it is extracted just moments after its death. Dr. Sterman argues that this is "one of the most powerful proofs supporting the murex as the chilazon":

> This is one of the more powerful proofs supporting the murex as the chilazon. The enzyme required for dye formation quickly decomposes upon the death of the snail, and so the glands that hold the dye precursor must be crushed while the snail is alive or soon after. In experiments, we have seen that as soon as two hours after death, the quality of the dye is severely degraded. Dr. Singer's assertion that 'the Gemara is speaking not of a few hours, but mere moments after death' is totally arbitrary.[71]

שרצים מדמינן לה דתניא נצרר הדם אף על פי שלא יצא and Lechem Mishna to Rambam Hilchos Shabbos 8:9 שמונה שרצים.

[69] literally: 'cut off his head but let him not die'.

[70] Rashi: for the purpose of dyeing, the blood of the *chilazon* live is better than when it is dead. He thus exerts his whole being to prevent his hand from causing the death of the *chilazon*, and he is thus considered considered to be preoccupied (מתעסק) with a different act and does not intend to kill the *chilazon*. R. Shimon concedes liability for the inevitable consequence (פסיק רישא) of killing only if he does not care (דלא איכפת ליה) about the result, not when he is unhappy with the result, as is the case here. Thus he is not liable for נטילת נשמה.

[71] Baruch Sterman, "A response to Dr. Singer's review of murex Trunculus as the source of tekhelet", Journal of Comtemporay Halacha, 2000.

Dr. Sterman's proof is perplexing as it fails to match the Talmud's logic of מתעסק הוא אצל נטילת נשמה. The Talmud asks why there is no liability for taking the life of the Chilazon when it is squeezed? First answer: it is squeezed only after it dies. This could fit the Murex because, as Dr. Sterman avows, the quality of the dye is still good a few hours after the death of the Murex. It is the second answer of the Talmud that is problematic for the Murex.

Second answer: the Chilazon may even be squeezed while alive, and nevertheless there is no liability for taking its life. As Rashi explains, for the purpose of dyeing, the blood of the Chilazon live is better than when it is dead. He thus exerts his whole being to prevent his hand from causing the death of the Chilazon. Therefore, even when it does die, he is regarded as being preoccupied (מתעסק) with a different act, and not intending to kill it. R. Shimon concedes liability for the inevitable consequence (פסיק רישא) of killing only if he does not care (דלא איכפת ליה) about the result. But, in the case of the Chilazon, he is an איכפת ליה, i.e. he is unhappy with the resulting death that spoils the dye. Thus, he is not liable for נטילת נשמה.[72]

5.1 Talmud's logic of פסיק רישא does not apply to Murex

For the Murex, is he an איכפת ליה? Does he care, one way or another, if squeezing the Murex causes its death? No. If the Murex is alive, he need take no special precautions when squeezing it to prevent its death. The dyer can happily take a coffee break after the death of the Murex—the dye will still be good for a few hours, leaving plenty of time to squeeze the dead snail. There is no need for him to exert his whole being to prevent the animal from dying (as required by Rashi for him to be free of liability). He is thus liable for the death of the Murex as an inevitable consequence (פסיק רישא) of squeezing it. Rav Miller writes:

> גם מפו' בגמ' שאופן פציעתו הוא באופן נטילת נשמה, אלא שאינו מכוין לנטילת נשמה והוי מקלקל או פס"ר דלנ"ל לגבי נטילת נשמה, והצבע שעושים הלא גם לדבריהם הלא הוא טוב ומועיל גם שעה או שעתים אחר המיתה, וא"כ גם מזה מוכח שאין תכלת שלהם תכלת של הגמ'.
>
> It is also clear in the Talmud that the process of breaking the shell entails taking the life [of the Murex], however one is not liable for the biblical transgression [of taking a life on the Sabbath] because it is [detrimental to the process of making *techeiles* to kill the Murex and is therefore] *mekalkel* or *psik reisha dlo nicha ley*. They themselves admit that the dye that they make is possible to produce even

[72] Or, according to other Rishonim, he is liable if it is פסיק רישא דלא ניחא ליה. "If the Melacha that will inevitably result from the person's action is of no interest to him (פסיק רישא דלא איכפת ליה), or if it even against his interest (פסיק רישא דלא ניחא ליה), it is not a true Melacha. This is because when the person has no interest whatsoever in the resulting Melacha, it cannot be claimed that he has a subconscious intention to do the Melacha." [Rabbi Pesach Eliyahu Falk, The Laws of Shabbos, Vol. One, p41, Feldheim 2013.] As explained in the next subsection, neither leniency is applicable to the Murex.

> one or two hours after the death of the Murex [and therefore the Murex's death is not detrimental to the process]. This is also a clear proof that their *techeiles* is not the *techeiles* of the Talmud.[73]

5.2 Pliny's description of Murex does not match the Chilazon

Dr. Sterman also writes:

> That assertion [that the Talmud is speaking about the time of death, not hours later] is even more implausible considering that this property is mentioned by both Pliny and Aristotle specifically regarding the murex. Since the murex loses its dye quality a few hours after its death, and those scholars express that fact by saying that the dye must be obtained from live snails, it follows that the Gemara's use of the same terminology would certainly sustain a two hour post mortem limit.[74]

Dr. Sterman claims that Pliny and Aristotle support his contention that the dye deteriorates a few hours after the death of the Murex. This is a mis-reading of Pliny. Pliny writes: "It is a great point to take the fish alive; *for when it dies, it spits out this juice*".[75] As Dr. Singer writes:

> In my article I correctly state, as Rabbi Herzog also does, that Pliny and Aristotle warn that the dye should be extracted from the murex while it is alive because it discharges its dye when it dies.[76] Dr. Sterman cites the first half of their statements, but then ignores the reason they explicitly state and instead supplies his own reason. In fact, these classical sources do not say anything about the dyeing power of the murex diminishing after death, their reason being at odds with the Gemara's explanation regarding the chilazon.

Presumably, Pliny is saying that the dye must be extracted from the Murex while

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[73] תשובות - תכלת - הרב שלמה אליהו מילר שליט"א. בס"ד יום ב' לפר' ויחי תשס"ד לפ"ק, לכבוד ידידי ר' מנדל זינגר שליט"א.

[74] Baruch Sterman, "A response to Dr. Singer's review of murex Trunculus as the source of tekhelet", Journal of Comtemporay Halacha, 2000.

[75] "The murex does the same; but the purple has that exquisite juice which is so greatly sought after for the purpose of dyeing cloth, situate in the middle of the throat. This secretion consists of a tiny drop contained in a white vein, from which the precious liquid used for dyeing is distilled, being of the tint of a rose somewhat inclining to black. The rest of the body is entirely destitute of this juice. It is a great point to take the fish alive; for when it dies, it spits out this juice. From the larger ones it is extracted after taking off the shell; but the small fish are crushed alive, together with the shells, upon which they eject this secretion." [Pliny the Elder, *Naturalis Historia*, Book 9, Ch. 60.]

[76] Herzog ibid., pp. 74-75; Aristotle, Historia Animalium, Book V, Ch. 15; Pliny the Elder, Naturalis Historia, Book 9, Ch. 60. For a picture of a murex snail discharging its dye upon death, see Nira Karmon, "The Purple Dye Industry in Antiquity" (hebrew), in Chagit Sorek and Etan Ayalon, eds., Colors from Nature: Natural Colors in Ancient Times (Tel Aviv, 1993), p. 85.

alive; if it dies, the dye is discharged and goes lost in the sea. The Talmud is stating something else, viz. that the dye deteriorates immediately on the death of the Chilazon.

6 Colour of Techeiles?

Traditionally, the colour of *techeiles* is blue. It thus comes as a surprise that there are *kisvei yad* (discovered hundreds of years after they were written) that describe *techeiles* as the colour purple coming from the Murex!

The Chavos Yair in Makor Chaim writes that the blood of the Chilazon used to dye *techeiles* is not blue: rather, it is a purple dye that comes from the blood of the fish called *purpura* (i.e. the Murex).[77] Unfortunately, we did not merit to see the Makor Chaim's discussion of how this species fits Chazal, and the Rishonim.[78]

6.1 Techeiles is similar to indigo blue

That the colour of *techeiles* is purple does not seem to be well-supported. As we will see, the colour *argamon* mentioned in the Torah fits better with Tyrian purple from the Murex than *techeiles*.[88]

The traditional understanding is that the colour of *techeiles* is somewhere between green (perhaps turquoise) and blue. Rashi and Ibn Ezra describe *techeiles* as ירוק which would normally mean yellow or green.[79]

According to R. Eliezer in the Mishna, one may recite Shema in the morning from the time that one can distinguish between *techeiles* and *karti*. Rashi writes that *techeiles* is ירוק which is a colour that is close to that of leek (i.e. green).[80]

Based on R. Meir's homily in Menachos (שהתכלת דומה לים), Tosefos[81] explain that ירוק

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[77] מקור חיים יח:ב: דדם חלזון שבו צובעין תכלת אינו בל״א רק צבע שנעשה מדם דג שנקרא הרב פורפר. ע״כ. ועיין כתבי יד: שלטי גבורים ס׳ עט.

[78] Dr. Sterman writes: "The Chavot Ya'ir in his M'kor Chaim states clearly that the chilazon used for dyeing tekhelet is the *purpur*. The Shiltei haGiborim also states explicitly that it is the *purpura*." Dr. Sterman refers us to *Lulaot Hatechelet*, Shlomo Taitelbaum, P'Til Tekhelet, Jerusalem, 2000 page 100 for more information about this work. The logic of the Makor Chaim seems to be that since the colour of *techeiles* is a given—purple—it must come from the purple fish. On the one hand this would support the Ptil position that the Murex is the Chilazon. On the other hand, Ptil should then be producing purple dye—not blue. A possible (but doubtful) source for the Makor Chaim is the Raavya as discussed in Section 6.2.

[79] רש״י על שמות פרק כה פסוק ד (ד) ותכלת - צמר צבוע בדם חלזון וצבעו ירוק (יבמות מנחות מד):

[80] ברכות דף ט ע״ב: מאימתי קורין את שמע בשחרית? משיכיר בין תכלת ללבן. רבי אליעזר אומר: בין תכלת לכרתי. רש״י: תכלת - ירוק הוא, וקרוב לצבע כרתי שקורין פוריי״ש (leek, i.e. green).

[81] תוספות סוכה דף לא/ב: הירוק ככרתי - משמע שמראהו כצבע שקורין ויר״ד בלע״ז וההיא דברכות משמע קצת שדומה לאירנד״א בלע״ז דתנן התם פ״ק (דף ט:) משיכיר בין תכלת לכרתי משמע דמעט משונין זה מזה ובמנחות פ׳ התכלת (דף מג:) אמרינן דתכלת דומה לים וים דומה לרקיע וזהו כעין צבע שקורין אירנד״א בלע״ז אבל בירושלמי משמע שהוא צבע ויר״ד כעין עשבים דאההיא דבין תכלת לכרתי מסיים ליה תכלת דומה לים וים דומה לעשבים ועשבים לרקיע ובפרק אלו טריפות (חולין דף מז:) משמע דירוק דמי לחלמון של ביצה שהוא כעין צבע יאל״ה בלע״ז דאמרינן כגון ביעתא טרפה ופריך אלא ירוקה דכשרה היכי דמי ככרתי וכן משמע בתוספתא דנגעים שדומה לשעוה דתניא ירוק שבירוקים ר׳ אלעזר אומר כשעוה וכחורמל סומכוס אומר ככנף טווס וכחרוץ של דקל וכן משמע בפ׳ ב׳ דנדה (דף יט.)

might also refer to indigo blue (אירנד"א).[82] Rabbi Herzog explains that for practical reasons, the Talmudists divided colour into four classes: (1) שחור black; (2) אדום red; (3) ירוק green, yellow and blue; (4) לבן white (see [10, p92]). Very deep blue shades would in strict halacha be referred to as black. Paler or brighter blue shades would be referred to as ירוק.[83]

The famous statement of R. Meir is that the colour of *techeiles* is similar to the sea (שהתכלת דומה לים).[1] Rabbi Herzog quotes from the British Encyclopedia that "The colour of the ocean far from the land is almost pure blue, and all the variations of tint cowards the green are the result of local disturbances" [10, p90]. He also writes that (a) the greater the transparency, the deeper is the blue and (2) off the Syrian coast the greatest transparency has been reported. Thus, "we at once obtain the result that tekhelet was very much like the deep blue of the Mediterranean along the Palestinian coast".[I]

R. Meir may not be giving a definition of *techeiles* but may merely be explaining its significance. Nevertheless, R. Meir's homily is taken as instructive by the commentaries, and suggestive of sky blue.

The Gaonim translate *techeiles* as sky blue. R. Nachson Gaon, quoting R. Meri's homily, translates *techeiles* by its Arabic name למאסמא, i.e. sky colour [10, p96]. Rav Saadiah Gaon renders *techeiles* by אסמנגון, which is translated as the colour of the bright sky tending to a darker blue.[84] Likewise using R. Meir's homily, Rambam writes that *techeiles* is the deep blue of the clear sky in bright sunshine.[85]

The Talmud records that *techeiles* was indistinguishable from *kala ilan* which is plant indigo according to the Aruch,[86] the authoritative lexicon of the Talmudim and the Midrashim. The colour of indigo is sky blue.[87]

גבי ה' דמים טמאים באשה דתנן הירוק עקביא בן מהללאל מטמא ואמרינן התם מנין לדם נדה שהוא אדום משמע דאין לטמאות באשה אא"כ נוטה למראה אדמומית ובכל הצבעים שזכרתי אין בהן נוטה למראה אדמומית אלא צבע יאל"ה בלע"ז וקרא עמי מוכיח שהוא הנקרא ירוק כדכתיב (תהלים סח) ואברותיה בירקרק חרוץ ובספר המחברת פי' מנחם שהוא זהב הבא מן החוילה ודונש פי' חרוץ זה אבן טובה ופלוגתא דאמוראי היא דאמרינן בבראשית רבה (פ' מ"ג) אקרא דוירק את חניכיו ריש לקיש אמר שהוריקן באבנים טובות ומרגליות כמה דאת אמרת ואברותיה בירקרק חרוץ פי' שלא יהו להוטין אחר הממון ויתעסקו בהצלת נפשות ר' לוי אומר בפרשת שוטרים הוריקן כמה דאת אמרת מי האיש הירא ורך הלבב כלומר מעבירות שבידן ונתביישו במה שהוזקקו לחזור ואמרינן בשילהי ד' נדרים (ד' לב.) וירק את חניכיו רב ושמואל חד אמר שהוריקן בתורה בפרשת שוטרים וחד אמר שהוריקן בזהב פי' קרא דבירקרק חרוץ קדריש וזהב דומה לצבע יאל"ה ומיהו אתרוג עיקרו דומה לשעוה ואותם אתרוגים הבאים לפנינו ירוקים ככרתי כשרים אפילו לר' יהודה כשחוזרים למראה שאר אתרוגים אפילו בתלוש לאחר ששהו בכלי זמן מרובה דודאי גמר פריים:

[82]In אירנד"א, לעזי רשי is translated כחול (= blue). See Aruch.

[83]עיין חולין מג, כבק דלא וכו'.

[84]Torat Chayim to Shemos 25:4.

[85]רמב"ם יד החזקה (כתב יד תימני) - הלכות ציצית פרק ב: (א) תכלת האמורה בתורה בכל מקום, היא הצמר הצבוע כפתוך שבכחול; וזו היא דמות הרקיע, הנראית לעין בטוהרו של רקיע. והתכלת האמורה בציצית, צריך שתהא צביעתה צביעה ידועה, שעומדת ביופייה, ולא תשתנה. וכל שלא נצבע באותה צביעה, פסול לציצית, אף על פי שהוא כעין הרקיע, כגון שצבעו באיסטיס או בשאר המשחירין - הרי זה פסול לציצית. ורחל בת עז, צמרה פסול לציצית:

[86]ערוך - קלא אילן - וממי שתולה קלא אילן בבגדו (ב"מ ס"א) ואומר תכלת הוא פירוש אי"נדקו (א"ב פירוש בל"י מין צבא דומה לתכלת).

[87]In modern terms, indigo is a colour on the visible spectrum—one of the seven colours of the rainbow

Rabbi Herzog points out that the Septuagint renders *techeiles* as *iakinthos* and *argaman* as *porphyra*.[88] It is not so clear how *iakinthos* (hyacinth) differs from the purple of *argaman*, but Josephus compares *iakinthos* to the colour of the sky (i.e. blue).[89]

6.2 Purpura—Raavya/Yerushalmi

Ptil provide a list of proofs that techeilis was derived from the Murex. Their very first proof is from Raavya: "The Jerusalem Talmud (as quoted by Raavya) translates *tekhelet* as *porphiron* (the Latin and Greek name for trunculus-like shells). Pliny and Aristotle describe these shells as the source of the ancient dyes".[122]

It is difficult to see how the Talmud or the Raavya are stating what Ptil ascribe to them. The Raavya is not describing Hilchos Ttizitzis. He quotes a Yerushalmi (a part that is no longer extant) explaining the time for reciting the morning Shema, based on ability to distinguish between a pair of colours: *techeiles* (normally understood as blue) and *karti* (normally understood as green):

> ברכות דף ט ע"ב: משנה. מאימתי קורין את שמע בשחרית? משיכיר בין תכלת ללבן. רבי אליעזר אומר: בין תכלת לכרתי. וקבלתי שיש מין צבא שקורין כרתי ודומה לתכלת. וגרסינן בירושלמי בין תכלת לכרתי בין פורפירין ובין פריפינין, והוא מעיל שקורין בלשון לע"ז פורפירא ויש שדומה לו קצת.
>
> [Mishna: From what time may one recite the Shema in the morning? From the time when one can distinguish] between *techeiles* and white. R. Eliezer states says between *techeiles* and *karti*]. I have heard that there is a colour called *karti* that is similar to *techeiles*, and the text in the Yeushalmi is between between *techeiles* and *karti*, between *porphyrin* and between *parufinen*, which is a coat that is called in Latin *purpura*.

Describing colour perception whether modern or ancient is not an exact science. It is also not straightforward to work out the modern correlates of the colours mentioned in antiquity due to linguistic and cultural shifts. Raavya mentions two pairs—*techeiles*/*karti* (two colours known to be quite similar)—and פריפינין/פורפירין, the latter being a coat called פורפירא.

Of all the words mentioned by the Raavya, it is the latter word פורפירא (a purple coat) that seems to be cognate with the Latin *purpura* (*porphyra* in Greek). In the Lewis and Short Latin dictionary, one meaning of *purpura* is the purple fish. But it might also mean a purple colour or purple cloth or garment. The purple fish might be the Murex, but it might also be the unrelated *bucinum*[III] (shell fish, also used in dyeing purple).[90]

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between blue and violet (Wikipedia).[II]

[88] See Rabbi Herzog's discussion in [10, p78]. From the Septuagint and Josephus we see that it is *argamon* that is identified with *porphyra* (i.e. purple dye, or the purple fish—*Murex trunculus*).

[89] Rabbi Herzog quotes Josephus Book III:7 "Now the vestment of the high priest being made of linen, signified the earth; *the blue denoted the sky*, being like lightning in its pomegranates, and in the noise of the bells resembling thunder" [10, p87].

[90] Lewis and Short, Latin Dictionary, `http://bit.ly/1fOcf7s`, accessed 24 Feb, 2014.

According to Raavya, פריפינין is a purple coat called פורפירא. In the Liddell and Scott Greek-English lexicon, *porfu/reos* is defined as the colour purple, gushing blood, bright red or flushing human complexion, as well as mordant for purple.[91] In the unlikely event that פריפינין means the Murex, it would be qualifying the colour *karti* (the second color of the first pair) not *techeiles*. It is unlikely that *karti* is purple.[80]

What about the first colour פורפירין in the second pair? Ptil claim that this is the Murex. Perhaps they say this so that the reader will identify it with *techeiles*—the first colour of the first pair—on the assumption that the second pair of colours is there to qualify the first pair. Even if all these assumptions are correct, this would make the colour of *techeiles* purple (whereas Ptil are committed to blue)! But, as explained above, the word used in antiquity for the Murex is *purpura*, not פורפירין.

More likely is that Raavya is not using the second pair of colours to qualify the first pair. This second pair can also be used to distinguish the time for Shema.[92] פורפירין might be related to the modern *purpurin*, a red or yellow pigment found in the madder plant, and *porphyrin*—the pigment in red blood cells. Thus, the second pair of colours is the contrast between a reddish-purple garment with one that is purple (פורפירא).

6.3 Techeiles specifically from Chilazon

We must also be careful when dealing with the word *techeiles*. Like *purpura* (which might not be from the Murex), *techeiles* may at times indicate a colour with no specific origin. The Ramban (Shemos 28:2) states that in his time only the King was allowed to wear *techeiles*. In the Ramban's lifetime (Middle Ages) there was no kosher *techeiles*, yet he used the word *techeiles* to discuss contemporary blue dye.

Of course, *techeiles* used for the Mitzvah of Tzitzis must be from the Chilazon: as stated in the Tosefta, *techeiles* is kosher only when specifically taken from the Chilazon.[93] Any other dye such as indigo or woad cannot be used. Based on the Tosefta, Rashi writes that *techeiles* is the wool dyed with the blood of the Chilazon.[94] The Talmud states the Holy One will exact vengeance from he who attaches to his garment threads dyed with cheap *kala ilan* (indigo) and maintains that it is *techeiles*.[95] As Rashi explains, the Torah requires a string of *techeiles* that comes from the expensive dye of the Chilazon; the dye is expensive because the Chilazon only comes out of the water

[91] Henry George Liddell. Robert Scott. A Greek-English Lexicon, revised and augmented throughout by Sir Henry Stuart Jones with the assistance of Roderick McKenzie, Oxford, Clarendon Press. 1940. `http://bit.ly/1eqrhPL`, accessed 24 Feb. 2014. Dr. Singer has *parufaino* as a "a robe with a hem or border of purple".

[92] As suggested by Dr. Singer [8].

[93] תוספתא מסכת מנחות פרק ט׃ (ו) תכלת אין כשרה אלא מן החלזון שלא מן החלזון פסולה.

[94] שמות פרק כה׃ג׃ וּתְכֵלֶת. צֶמֶר צָבוּעַ בְּדַם חֲלָזוֹן, וְצֶבַע יָרוֹק (מנחות מד ע"א;תוספתא מנחות ט׃ו).

[95] בבא מציעא דף סא ע"ב׃ אני הוא שעתיד ליפרע ממי שתולה מעותיו בנכרי ומלוה אותם לישראל ברבית, וממי שטומן משקלותיו במלח, וממי שתולה קלא אילן בבגדו ואומר תכלת הוא.

once in seventy years.[96]

Likewise, the Rambam writes that the *techeiles* Tzitzis strings are kosher only if we use the well-known sky blue dye (וכל שלא נצבע באותה צביעה, פסול לציצית) that comes from the Chilazon (ואחר כך מביאין דם חילזון, והוא דג שדומה עינו לעין הים).[97] The Lechem Mishna points out that only with respect to Tzitzis does the Rambam require specifically the blood of the Chilazon (שצבע זה צריך שיהיה בדם החלזון), and not with respect to the *techeiles* needed for the priestly garments.[98]

7 Primary Criteria for the Chilazon in the Talmud

The primary criteria for identifying the Chilazon is stated in the Talmud in Menachos:

> מנחות דף מד ע"א: ת"ר: חלזון זהו גופו דומה לים, ובריייתו דומה לדג, ועולה אחד לשבעים שנה, ובדמו צובעין תכלת, לפיכך דמיו יקרים. [רש"י: גופו - מראה גופו תבנית דיוקנו. ועולה- מן הארץ. לפיכך- שאינו עולה אלא אחת לע' שנה דמיו יקרין.]
>
> Our Rabbis taught: The Chilazon resembles the sea in its colour, and in shape it resembles a fish; it appears once in seventy years, and with its blood one dyes the *techeiles* thread; and therefore it is so expensive.

Chazal, knowing which species was the Chilazon, chose these statements to describe it. As Dr. Singer points out [8], a candidate species should satisfy these criteria—not just in a minimalist sense—it must be reasonable that Chazal would have chosen these statements to describe it. The primary criteria are thus:

1. The colour of the Chilazon's body is like the sea;
2. Its form is like a fish;
3. It comes up (from the land) once in 70 years; *therefore*, it is expensive.
4. Its blood is used for *techeiles*.

7.1 Murex does not satisfy the primary criteria

It is hard to see how the Murex meets any of these criteria in a clear-cut fashion.

Criterion 1. Dr. Sterman argues that *gufo* ("its body") refers not to the body of the Chilazon, but to algae and other sea-fouling attached to its shell giving the Murex a

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[96] רש"י בבא מציעא דף סא ע"ב: קלא אילן - צבע הדומה לתכלת, ורחמנא אמר (במדבר טו) פתיל תכלת, ותכלת דמיו יקרים, שצבוע בדם חלזון שאינו עולה מן הים אלא אחת לשבעים שנה.ע"כ. ועיין קונטרס תכלת וארגמון ר' מנחם אדלר.

[97] רמב"ם יד החזקה (כתב יד תימני) - הלכות ציצית פרק ב: (א) תכלת האמורה בתורה בכל מקום, היא הצמר הצבוע כפתוך שבכחול; וזו היא דמות הרקיע, הנראית לעין בטוהרו של רקיע. והתכלת האמורה בציצית, צריך שתהא צביעתה צביעה ידועה, שעומדת ביופייה, ולא תשתנה. וכל שלא נצבע באותה צביעה, פסול לציצית, אף על פי שהוא כעין הרקיע, כגון שצבעו באיסטיס או בשאר המשחירין - הרי זה פסול לציצית. ורחל בת עז, צמרה פסול לציצית: (ב) כיצד צובעין תכלת של ציצית, לוקחין הצמר, ושורין אותו בסיד; ואחר כך מכבסין אותו, עד שיהיה נקי; ומרתיחים אותו באהלא וכיוצא בו, כדרך שהצבעין עושין כדי שיקלוט את העין. ואחר כך מביאין דם חילזון, והוא דג שדומה עינו לעין הים, ודמו שחור כדיו, ובים המלח הוא מצוי. ונותנין את הדם ליורה, ונותנין עימו סממנין כמו הקימוניא וכיוצא בה, כדרך שהצבעין עושין; ומרתיחין אותו, ונותנין בו הצמר, עד שייעשה כעין רקיע. וזו היא צורת תכלת של ציצית:

[98] מל"מ ה' כלי המקדש ח:יג.

green colouring.[99]

While admitting that the word *domeh* does not necessarily imply absolute equivalence, the explanation seems forced and based on heaping assumption upon assumption. It is one thing to claim that *gufo* refers to the shell, and not to the snail's body. It is something else to say that "its body" does not mean the snail at all, but sea-fouling covering the shell. Dr. Sterman also has to assume that גופו דומה לים does not mean the sea itself, but the algae that live in the sea-bed. Furthermore, if everything else in the area is covered with algae, why is just this feature of the Chilazon that Chazal found noteworthy?

Rambam clearly states that the colour of the Chilazon fish itself resembles the blue of the sea (והוא דג שדומה עינו לעין הים[97]), which is also the simple meaning of the description in the Talmud.[100] Dr. Sterman also has to assume that "resembles the sea" means green here, and blue just a few lines earlier in the Talmud, dealing with the same subject, where it refers to the colour of *techeiles* (i.e. sky blue as advertised by Ptil).

Dr. Sterman suggests *gufo* cannot mean the soft body since it would be impractical to describe the colour of the body which can only be viewed by the careful breaking of the shell and extraction of the soft body. This presupposes that the Chilazon is completely enclosed by a hard exterior shell.

Criterion 2: Its form is like a fish (dag). It is reasonable to say that the Murex snail might be classified as a *dag*, a term that might apply to all sea creatures. But it is not certain that the Chilazon is a snail. Ptil assumes that *nartik* or *malvush* of the Midrashim means a shell. Rav Perr writes: "Despite the fact that we lack an adequate explanation for these words, there is only the one opinion, that of Rabbi Binyomin Mosufa, that *nartik* means a shell. All the other Rishonim and Acharonim refer to the chilazon as a fish, ignoring the word *nartik*. No doubt this is because there is a perfectly good word for snail in the Mishnah Shabbat 77b, *shavlul*. This is also used in an Aramaic form in the Gemara Menachot 42b, *shavlulita*. The contention that the Sages of the Talmud held the Chilazon in their hands, and did not use the word snail for it, but chose to call it a fish, is completely untenable."[101]

Criterion 3: Comes up once in seventy years; therefore it is expensive. Dr. Sterman admits that there is no characteristic of the Murex trunculus that would meet this criterion. He speculates that the replenishing of the snail population suggests a steady pattern of increase in the population and not an unusual abundance [11], but this does

[99] "Moreover, the general description would most naturally be that of the chilazon *in situ*—covered in its characteristic sea-fouling (and not after it has been assiduously polished). The murex Trunculus snail has a *greenish* color when it is alive in the ocean, and anyone who has seen it underwater is struck by its camouflage and resemblance to the sea" [11].

[100] וכו פירוש רבינו גרשם, גופו דומה לים - מראה גופו, ובריייתו - צורתו.

[101] However, see also Section 7.3

not help to explain how the Murex satisfies the Talmud's criterion. Rabbi Herzog cites a 7 year cycle for his candidate species [10, p73]. Rashi comments that it comes up from the earth (not the sea) once in seventy years.[102] It is because of its rare appearance that it is expensive (ועולה- מן הארץ. לפיכך- שאינו עולה אלא אחת לע' שנה דמיו יקרין). Thus, during the times of Chazal, *techeiles* was expensive due to the Chilazon's rare appearance. That is why there were many counterfeiters who would colour Tzitzis with a dye extracted from an indigo plant which looked similar to the colour of *techeiles* and would falsely market it as such. The Murex, clearly, does not satisfy the third criterion.

Also, the Beis HaLevi (quoted in the forward to Ein Hatecheles page 13) rejected the Radzyner's *techeiles* based on a penetrating question. He asked, how is it possible that the mesora could have been lost, that this commonly available squid is in fact the fabulous Chilazon? And since it is common, the Beis HaLevi continued, then there is a mesora that the squid is not the Chilazon! Thus, as pointed out by Rabbi Perr: "Tyrean dye faces even more severe objections, since it was massively produced throughout the Middle East, and continued to be produced in Constantinople until May 29, 1453. Beside the omission from the Talmud, there is not one hint by Rashi, the Rambam, or any other Rishon, that Tyrean purple manufactured in the sunlight was actually the much sought-after techelet. The proposition that the sages of the Talmud and the Rishonim were ignorant of facts on a subject of deep concern to them, facts that were commonly known in the world around them, is a proposition that is impossible to accept."

Criterion 4: its blood is used for techeiles. As discussed in Section 4.4, the Rishonim (in the context of חובל) explain that the we are talking about the life blood of the Chilazon (כִּי הַדָּם הוּא הַנָּפֶשׁ). The colourless indoxyl precursor to the purple dye in the hypobronchial gland of the Murex is not blood. The Murex snail, like all gastropod molluscs, do have blood that is often bluish in colour due to the haemocyanin proteins that transport oxygen through the body. They have a simple lung and a heart that pumps the blood into the aorta then into the smaller arteries. As Rav Perr points out: there happen to be excellent words used in the Talmud for Murex mucus, *Rir*, *Leicha*, and *Maya* are some of them.[57]

7.2 The importance of the Talmud's primary criteria

Dr. Sterman makes the startling assertion that we can essentially ignore the descriptions brought by Chazal in Menachos (44a) because many Rishonim do not cite these criteria or omit one of them.[103] But as Dr. Singer writes, there is only one *sugya* in the entire

[102] See also Rashi to Shabbos 74a, Baba Metzia 61a, Sanhedrin 91a, Chulin 89a.

[103] Dr. Sterman writes: "Dr. Singer makes a sweeping statement at the beginning of his article that cannot go unchallenged. He states that "the strongest criteria for identifying the chilazon come from the Gemara Menachot" and specifically from the braita found in Menachot 44a. This assertion

Talmud that deals explicitly with the details of *techeiles*. "Nowhere else in the Talmud do Chazal cite statements for the primary purpose of describing the Chilazon. How can these statements of Chazal not be important? Dr. Sterman has said that the writings of the Radzyner Rebbe and Rabbi Herzog must form the foundation of any *halachic* discussion of techeilet. These criteria are the heart of Rabbi Herzog's criteria, essential to the Radzyner Rebbe's criteria, and have been considered of unquestioned importance even in most, if not all prior writings by supporters of the murex trunculus theory. How can Dr. Sterman now claim they are not essential?"[104]

Rabbi Herzog did not reject the Murex trunculus only because of the difficulties of using it to produce blue dye. Rabbi Herzog writes: "The inquirer equipped with a knowledge of the experiments of Lacaze-Duthiers, of the discoveries of Wilde, deSaulcy, and Gaillardot and of the conclusions arrived at by Dr. Dedekind will go to the Talmud only for a confirmation of the identification of the tekhelet-species with Murex trunculus. *But there is a surprise in store for him*".[105] What is the surprise? Rabbi Herzog introduces the Talmudic signs for the Chilazon in Menachos, and after a long discussion of the signs, concludes that Murex fails to meet them. Rabbi Herzog writes that the Murex trunculus fails to meet the criterion that its body is the colour of the sea, it does not come up once in 70 years, and it is doubtful that its shape can be described as that of a fish [10, p70].

Rashi quotes the criteria in Menachos in multiple places. It would be presumptuous to assume that those who omit one (e.g. "rises once in seventy years"), did so because they felt it could be ignored.[102] For example, Rambam does not explicitly mention the "rises once in seventy years" criterion. However, Rambam writes that the punishment for not wearing white strings is greater than for not wearing the *techeiles* strings of Tzitzis because white is available and *techeiles* is not available in all places and at all

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is very difficult to reconcile with the fact that most rishonim, in their discussion of the topic, do not quote this braita. ... Clearly the rishonim did take the criteria of the braita at face value. They treat these statements as general descriptive identifiers and not as distinct and essential of the chilazon" [11].

[104] "And the sage of blessed memory gave us signs regarding this Chilazon in Tractate Menachos 44. Our Rabbis taught: The Chilazon resembles the sea in its colour and in shape resembles a fish etc. And it seems clear that our Sages gave us clear signs regarding the Chilazon for in their wisdom they saw that because of our exiles and the great expense in attaining it that it was almost certain that we would forget which is the correct Chilazon. Therefore they drew a clear picture for us and gave us all the sure signs of its identification so we would know how to search for it with G-d's help. You should know that Rambam (may his memory be a blessing) in Mishnah Torah copied this Braisa—and it is a known thing that Rambam does not bring in Aggadic material unless it has relevance to the law. So we must certainly say that it is a law that we can depend on the reliability of these signs that this is the Chilazon whose blood is kosher fit for dyeing the Techelet". [Radzyner, *Sefunei Temunei Chol*]

[105] [10, p65], emphasis added.

times.[106] Rabbi Adler suggests that the Rambam is here hinting to the ועולה אחד לשבעים שנה criterion. The halachic force of the criterion is that the punishment for not wearing *techeiles* is not as great due to its scarcity. The Murex may not be ubiquitous in space, but it has been around in many places and at all times.

7.3 Secondary Criteria: does Chilazon have a shell?

Ptil assumes that the Chilazon has a hard shell that grows with it. This criterion is not mentioned among the primary criteria detailed in Menachos (discussed in previous sub-section). The Midrash Shir HaShirim says about the Chilazon, that its *nartiko* grows with it[107], where *nartiko* is taken to be a shell.[108]

Rashi quotes the Midrash, but translates חלזון as חֹמֶט.[109] For the land animals in Vayikra that create impurity, Rashi translates חֹמֶט into the Old French *limace*, meaning either a snail or a slug.[110] Thus, "chilazon" is also a general term for all snails whether land snails or sea snails. It is possible that the chilazon of Midrash Shir Hashirim might be talking about land snails that have a shell. The Talmud in Menachos (listing primary criteria for the Chilazon of *techeiles*) does not list a shell as a requirement; thus, it is possible that this specific species of Chilazon that dwells in the sea does not have a shell.

The Aruch also divides "chilazon" into different categories. In the third entry, he quotes the Talmud tractate Sanhedrin 91a "go up to the mountains, where you will see but one snail, while by to-morrow the rain has descended and it is covered with snails",[111] obviously talking about land snails on the mountains that come out after the rain. In entry four, he brings the criteria of the Talmud in Menachos for the Chilazon of *techeiles*, and he also quotes tractate Shabbos 26a about trapping the Chilazon. Rabbi

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[106] רמב"ם יד החזקה (כתב יד תימני) - הלכות ציצית פרק ב׃ (ט) קשה עונש מי שאינו מניח לבן, יותר מעונש שלא הניח תכלת, לפי שהלבן, מצוי לכול; והתכלת, אינה מצויה לכול - לפי שאינה מצויה בכל מקום ולא בכל זמן, מפני הצבע שאמרנו׃

[107] שיר השירים רבה (4:11) - שמלתך לא בלתה מעליך כו' ולא היו גדלים? אמר ליה צא ולמד מן החלזון שכל זמן שהוא גדל נרתיקו גדל עמו.

[108] As Dr. Singer reports, this would rule out hermit crabs, for example, since they do not grow shells but rather move into shells they find. This would also rule out species like the lobster that when outgrowing their shell, discard it and grow another. It would not rule out cuttlefish which do not have an external shell like a snail, but do have have an internal cartilage shell. Elsewhere, the Midrash Devarim Rabbah 7:11 says "when it grows, its *malvush* grows with it" [Midrash Devarim Rabbah 7:11].

[109] רש"י דברים פרק ח׃ד שִׂמְלָתְךָ לֹא בָלְתָה. עֲנָנֵי כָבוֹד הָיוּ שָׂפִים בְּכָסוּתָם וּמְגַהֲצִים אוֹתָם כְּמִין כֵּלִים מְגֻהָצִים, וְאַף קְטַנֵּיהֶם כְּמוֹ שֶׁהָיוּ גְּדֵלִים, הָיָה גָּדֵל לְבוּשָׁן עִמָּהֶם, כִּלְבוּשׁ הַזֶּה שֶׁל חֹמֶט שֶׁגָּדֵל עִמּוֹ (שהש"ר ד׃יא)׃ לֹא בָצַקָה. לֹא נָפְחָה כְּבָצֵק, כְּדֶרֶךְ הוֹלְכֵי יָחֵף שֶׁרַגְלֵיהֶם נְפוּחוֹת׃

[110] Rashi to Vayikra 11:30, see ArtScroll notes on O.F. Rashi to Chagiga 11a describes the *chomet* as *limace* that grows a shell. Slugs do not have a shell.

[111] סנהדרין דף צא ע"א׃ שמא תאמר לזמן מרובה עלה להר וראה שהיום אין בו אלא חלזון אחד, למחר ירדו גשמים ונתמלא כולו חלזונות.

Adler suggests that the Melacha of trapping is applied only to the sea Chilazon (used for *techeiles*) not to the land snail. There is then no proof that the sea Chilazon has a shell. The Rishonim do not quote the *nartik* as a criterion for the Chilazon.[112] He also suggests that the correct role of secondary criteria in the Midrashim is as an aid to understanding the explicitly specified primary criteria for the Chilazon. Further investigation is warranted.

8 Halacha—Murex indigo does not satisfy ממין הכנף

Normative halacha mandates that, unless genuine *techeiles* is used, Tzitzis should be placed only on garments of the same colour. For example, if the garment is red, one places two strings of red and two of *techeiles*. If the Tallis is white then white strings. Thus, a question arises: if a string dyed blue with the Murex indigo is not authentic *techeiles*, can it be placed on a white Tallis?

A *braisa* in the Talmud states that only a thread of its own kind (colour) satisfies the Tzitzis requirement (אין פוטר בה אלא מינה).[113] As Rashi states, a red garment requires red Tzitzis.[114] Rashi (and Raavad) are understood to be saying that you need the same colour ממין הכנף as a דאורייתא. But Tosafos says that its because זה קלי ואנוהו which would be מדרבנן.[118]

The Tur[115] quotes in the name of Rashi and the Rambam that the Tzitzis must be the same colour as the garment.[116] The Shulchan Aruch states that those who are careful with halacha conduct themselves according to this position.[117]

The Rema writes that Ashkenzaim are accustomed to wear only white Tzitzis what-

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[112] Dr. Kohut in his Musaf Aruch states that the chilazon of entry four also has a shell that grows with it. Rabbi Adler correctly states that there is no evidence for this.

[113] תלמוד בבלי מסכת מנחות דף מא/ב: מיתיבי טלית אין פוטר בה אלא מינה

[114] רש"י מנחות דף מא/ב: מיתיבי טלית אין פוטרין בה לשם לבן אלא מינה - אם אדומה היא יטיל בה שני חוטין אדומים ושני חוטין תכלת וכן שאר גוונים:

[115] טור אורח חיים הלכות ציצית סימן ט: וכתב הרמב"ם שצריך לעשות הציצית מצבע הטלית אם הוא אדום יעשה הציצית אדום ואם הוא ירוק יעשה הציצית ירוק וכן פי' רש"י ור"י פירש שא"צ וכתב בספר המצות קטן ומיהו נכון ליזהר שלא לעשות ציצית של פשתן בשל משי אף על פי שהגאונים ור"ת אסרו לעשות אפי' ציצית של פשתן בטלית של פשתן רבינו שלמה ורב אלפס התירו ולזה הסכים אדוני אבי הרא"ש זצ"ל:

[116] רמב"ם יד החזקה - הלכות ציצית פרק ב: (ח) טלית שהיא כולה אדומה או ירוקה או משאר צבעונין עושה חוטי לבן שלה כעין צבעה אם ירוקה ירוקין אם אדומה אדומין היתה כולה תכלת עושה לבן שלה משאר צבעונין חוץ מן השחור מפני שהוא נראה כתכלת וכורך על הכל חוט אחד תכלת כדרך שעושין בשאר ציציות שאינן צבועין. [השגת הראב"ד - טלית שהיא כולה אדומה כו' עד שאינן צבועין כתב הראב"ד ז"ל ראיתי מי שהקשה עליו ועל זאת הברייתא שהקפידה על הצבע שיהא הציצית מצבע הטלית כדי שיהא ממין הכנף והוקשה עליו מה שאמר רבא בריש התכלת מידי ציבעא גרים להיותו מין כנף ולאו קושיא היא דהתם לענין אקדומי תכלת ללבן קא פריך דאין ראוי שיקדים תכלת ללבן בשביל הצבע אע"פ שהטלית כולו תכלת אלא ודאי מצוה להקדים לבן לתכלת אע"פ שהיא מינה והתורה אמרה על ציצית הכנף פתיל תכלת לעולם התכלת יבא על ציצית הכנף כלומר שיהא התכלת אחרון בו ומ"מ צריך שיהא בו ממין צבע הטלית כדי שיהיה בו ממין הכנף עכ"ל]:

[117] שולחן ערוך סי' ט' סעי' ה' - ויש אומרים שצריך לעשות הצצית מצבע הטלית והמדקדקין נוהגין כן. [רמב"ם פ"ב מהל' צצית ה"ח - טלית שהוא כולו אדומה או ירוקה או משאר צבעונין עושה חוטי לבן שלה כעין צבעה אם ירוקה ירוקין אם אדומה אדומין.] רמ"א סי' ט' סעי' ה' - והאשכנזים אין נוהגין לעשות הציציות אלא לבנים אף בבגדים צבועים ואין לשנות (תרומת הדשן סי' מ"ו)

ever the colour of the garment.[116] However, the Bach writes that the simple understanding of the Talmud is like Rashi (and the Rambam as quoted by the Mechaber) making the matching colours a Biblical requirement, which is why there is a widespread custom is to wear a Tallis that is white with white strings.[118] Even Tosefos would agree that it is מצוה מן המובחר to wear strings the same type and colour as the garment.[119]

It is possible to argue that the two non-*techeiles* "white" strings should be the same colour as the garment, but the two strings that replace the *techeiles* strings might not have to satisfy ממין הכנף, and thus could be any colour.[120] However, the Shulchan Aruch and its commentaries to not make this distinction.

HaGaon HaRav Yosef Shalom Elyashiv zt"l quotes the Shulchan Aruch as a reason to reject the Murex indigo dye. As the Poskim write from a verse in Daniel—both the Tallis and the Tizitzis should be white (לְבוּשֵׁהּ כִּתְלַג חִוָּר).[121] Rav Miller likewise writes: "There is a halachic reason that the string should be the same colour of the garment, except for white Tzitzis on other colours (Rema). It is for this reason that we wear a white Tzitzis garment i.e. since all our strings are white."

9 Conclusion

9.1 Ptil Claims Problematic

The Ptil website lists five lines of evidence that they claim proves that the the Murex is the Chilazon:

> The evidence for identifying the Murex trunculus as the source of tekhelet is *decisive*, and goes beyond merely fitting the general descriptions of the Chilazon as found in the Talmud.[122]

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[118] ב"ח אורח חיים סימן ט ג: וכתב הרמב"ם שצריך לעשות הציצית מצבע הטלית וכולי. הכי משמע פשטא דסוגיא בפרק התכלת (מא ב) דקאמרינן טלית אין פוטר בה אלא מינה וכמו שפירש רש"י אם אדומה יטיל בה שתי חוטין אדומים ושתי חוטין תכלת אלא דקשיא מהא דאמרינן בריש פרק התכלת מידי ציבעא גרים ובמרדכי הלכות קטנות (סי' תתקמח) תירץ דבשאר מיני בגדים דוקא כיון דלרבא דרשינן הכנף מין כנף כדתנא דבי רבי ישמעאל השתא כיון דמדאורייתא אינו פוטר אלא במינן צריך שיהא ממש מינן דאף הצבע צריך שיהא כצבע הטלית ולא אמרו בגמרא מידי ציבעא גרים אלא בבגדי צמר ופשתים דתכלת פוטר בהן דכיון דכתיב הכנף מין כנף וכתיב פתיל תכלת אלמא תכלת לאו מין כנף הוא ועוד תירץ דמדאורייתא ודאי לאו ציבעא גרים אלא מדרבנן משום זה אלי ואנוהו בעינן שיהו צבועין בצבע הטלית ונראה דמה שנהגו כל ישראל בטלית של צמר לבן הוא כדי לאפוקי נפשין מפלוגתא דרבוותא ולכן יש להזהר שלא לעשות לו טלית קטן מתחת למדיו מבגדי צבעונין או יעשה גם הציצית מצבע הטלית דאף ר"י לא אמר אלא שאינו צריך אבל אם צבען מצבע הטלית הוה מצוה מן המובחר ועוד דפשטא דתלמודא משמע כפירוש רש"י והרמב"ם ושארי ליה מאריה להסמ"ג שכתב אפירוש רש"י דלא דק גם לא כמו שכתב הרב בהגהת שלחן ערוך (ס"ה) דהאשכנזים עושין ציציות לבנים אף בבגדים צבועים ואין לשנות עכ"ד דלפענ"ד שינוי זה הגון הוא אלא מיהו בצינעא מתחת למדיו דלא ליתי לאינצויי כיון דלא נהגו לצבען ועיין בתרומת הדשן סוף סימן מ"ו:

[119] וכו כתוב בט"ז ומ"א. מגן אברהם סימן ט ס"ק ו: ו (פמ"ג) (מחה"ש) מצבע הטלית - וכתב ב"ח ולכן יש לעשות הטלית לבן, ובסי' כ"ד כתב משום ודכתיב לְבוּשֵׁהּ כִּתְלַג חִוָּר (דניאל פרק ז:ט).

[120] עייו מלבים בס' ארה"ח הובא בקונטרס תכלת וארגמון ר' מנחם אדלר.

[121] מבתב בענין חלזון וארגמון, יוסף שלו אלישיב זצ"ל, י"ט אייר תשנ"ב, הובא בקונטרס תכלת וארגמון, ר' מנחם אדלר, תשנ"ט.

[122] `http://tekhelet.com/tekhelet/introduction-to-tekhelet/`, accessed 16 February, 2014. Emphasis added.

Although Ptil claims that the evidence is *decisive*, the opposite seems more likely. Let's review the claims:

(*a*) **Ptil Claim** "The Jerusalem Talmud (as quoted by the Raavyah) translates *tekhelet* as *porphiron* (the Latin and Greek name for trunculus-like shells). Pliny and Aristotle describe these shells as the source of the ancient dyes".[122]

Problem The claim, frankly, lacks credibility. Where is the evidence that *porphiron* means the Murex snail? Raavya quotes a (non extant) passage from the Talmud Yerushalmi—a passage that is not describing the Chilazon. Rather, the passage describes the time for Krias Shma in the morning when one can distinguish between closely related colours such as *techeiles* (blue) and *karti* (green). Raavya also mentions another pair of closely related colours *porphiron* (possibly a reddish-purple garment) and *parufinen*, a purple coat that Raavya says is called *purpura*. Even the word *purpura* has no necessary identification as being from the Murex, as the purple colour might come from a different species such as the shell-fish *Buccinum*. The word might not even refer to the source from which it comes, and may just mean the colour purple. Purple dye was also made by mixing plant indigo blue and red from madder or kermes. This was the common man's purple. From the Septuagint and Josephus it is the Biblical *argamon*, not *techeiles*, that is identified with *purpura*.[89] See Section 6.2.

(*b*) **Claim** "The Talmud indicates that true tekhelet is indistinguishable from the blue dye of vegetable origin—*kala ilan* (indigo). The dye ultimately derived from trunculus is molecularly equivalent to indigo".[122]

Problem. What it actually proves is that the Murex dye is unfit for *techeiles*, given that it *is* counterfeit *kala ilan* (indigo)—down to the molecular level. The Talmud's reduction test is designed to expose fake plant indigo or dibromoindigo (Murex) dyes. Ptil samples that we tested, failed the reduction test. See Section 3.5.

(*c*) **Claim** "Extensive marine biological surveys have revealed that the only snails in the Mediterranean which produce stable dyes are those of the Murex family. The dye obtained from trunculus is very stable and steadfast, which accords with the Rabbinical description of tekhelet".[122]

Problem Given that new species are continually discovered, it is strange to claim that scientists have definitively eliminated all candidates other than the Murex.[123] The Talmud already mentions that the Chilazon is a rare

[123]Google for "new species" to see the point. Japanese scientists discovered a new species of baleen whale in the South China Sea in 2003 [16]. "Can you imagine? An animal of more than 10 meters was unknown to us in the 21st century", said one of the scientists, Tadusu Yamada, of Tokyo's National Science Museum, and senior author of the study. Time Magazine

species[124], and at the time of the compilation of the Midrash Tanchuma (compiled 750 CE) *techeiles* was already concealed.[125] Rabbi Yehoshua of Kutna writes in the name of the Arizal that "it has been concealed in heaven" for there is no *techeiles* except when the Temple is standing.

(*d*) **Claim** "Archeologists in Tyre and elsewhere uncovered mounds of Murex shells dating from the Biblical period which were broken in the exact spot necessary to obtain the dyestuff. Chemical analysis of blue stains on vats from 1200 BCE reveals patterns consistent with those of modern day trunculus".[122]

Problem Yes, the Murex was used in antiquity to produce famed Tyrian purple. This is possibly the Biblical dye *argamon*. The Septuagint and Josephus translate *argamon* as *purpura*.[89]

(*e*) **Claim** "When listing the precious commodities used in building the Mishkan (tabernacle), the Torah consistently includes tekhelet along with gold, silver, and other familiar materials, recognized by all for their worth. Yechezkel speaks of the tekhelet from Tyre and the "Isles of Elisha", and the Megillah tells us that in Persia, Mordechai wears royal clothes made of tekhelet. Surely, the Torah is referring to that same valuable dye commonly used by royalty throughout the rest of the ancient world".[122]

Problem There is no evidence that blue dyes were obtained from the Murex in antiquity (see Section 3). The ancients could not have have produced sky blue from the Murex snail with the methods and, materials and tools

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reports ten new interesting species of animals discovered in 2013, `http://science.time.com/2013/12/04/science-and-space/slide/top-10-new-species/`, accessed 2 March 2014. To give another example, a new snail species, with a beautifully translucent shell, was recently discovered more than 3,000 feet underground in a Croatian cave, `http://www.huffingtonpost.com/2013/09/16/transparent-snail_n_3936796.html`, accessed 2 March, 2014. "A giant fluorescent pink slug and a cannibal snail have been discovered in a remote part of Australia. The pink slug grows up to 20 centimetres long, while the carnivore snail preys on its vegetarian relatives. Both bizarre creatures live around Mount Kaputar near Narrabri in New South Wales—around 323 miles northwest of Sydney", `http://www.dailymail.co.uk/sciencetech/article-2332545/The-bizarre-blood-slugs-cannibal-snails-remote-mountain-region-Australia.html`, report is dated 29 May 2013. There has been a notable increase in the number of exotic species of fish and molluscs in the Mediterranean. "Since the publication of the CIESM Atlases, there has been a notable increase in the number of exotic species in the Mediterranean, in all three taxa [(Fishes, Decapods, and Molluscs], but especially in molluscs. This dramatic increase may be attributed to the significant augmentation of collection activity, both by scientists and by amateur naturalists. In addition, most molluscs have hard shells which remain after their death, thus allowing detection of abortive colonization attempts; this is not possible concerning other taxa" [5]. A species is a newcomer to the Mediterranean Sea if it has not appeared before the before the 1950s for the crustaceans. These species often invade the Mediterranean from elsewhere.

[124] See Section 7.

[125] מדרש תנחומא פר' שלח - ועכשיו אין לנו תכלת תכלת נגנז.

available to the ancient dyers. It was Tyrian purple that was the famous dye produced from the Murex. The Ramban talks about royalty of his time wearing "techeilis". Given that there was no kosher *techeiles* available in his time, Ramban uses this word colloquially to refer to any quality blue dye such as from plant indigo, well-known in antiquity.

9.2 Halachic problems with the Murex dye

There are dicussions in the Talmud about the indentity and nature of the Chilazon that rule our the possibility that it is the murex. Here is a summary of some of the issues dicussed in this article:

- The Talmud states that one who squeezes the Chilazon while alive is not liable for the Melacha of taking its life. This is because the dye is much better when the Chilazon is alive than dead. The dyer makes every attempt to keep it alive. Thus, he is not liable even though its death is inevitable (פסיק רישא דלא ניחא ליה). In the case of the Murex, there is no need to take special precautions to keep it alive—the dye is still good for a few hours after its death. The dyer can take a coffee break, still leaving him with plenty of time to extract the dye from the dead Murex. Thus, the aforementioned leniency for squeezing the live Murex does not apply and he would be liable for causing its death. See Section 5.

- The Talmud states that if one traps and squeezes the Chilazon for its blood, he is liable only for the single Melacha of trapping. However, production of the Murex dye involves cutting a piece of the shell and flesh to extract the dye. This means that there is an additional Melacha of either shearing or taking the life of an animal. Thus the Murex cannot be the Chilazon described in the Talmud. See Section 4.1.

- The colourless indoxyl precursor to the Murex dye in its hypobronchial gland is not blood, just a mucus (*rir* in Talmudic terminology). However the Talmud describes the Chilazon as having blood (דם). Based on this, the Rishonim ask why extracting the blood from the Chilazon is not the Melacha of taking its life (כִּי הַדָּם הוּא הַנָּפֶשׁ)? This question pre-supposes that the blood of the Chilazon is real. This means that the mucus from the Murex is not the required blood of the Chilazon. See Section 4.4.

- The extraction of mucus from the Murex is akin to מפרק —a Toladah of threshing (דש), rather than the Av. This Toladah involves extracting a liquid from its encasement such as milking a cow, extracting blood (wounding) and extracting juice from a fruit. The Av applies only to plant material, whereas the Toladah

applies to plant material and non-plant material, according to the Rambam as explained by his son. Thus, the Talmud's statement that squeezing the Chilazon for its blood is liable for threshing must be referring to a different animal than the Murex. This is because the Talmud is describing the case of an Av Melacha—where the leniency that the Chilazon is not plant material applies. See Section 4.6.

- The Murex does not satisfy the primary criteria given by the Talmud for the Chilazon, viz. that the colour of the Chilazon's body is like the sea (blue); it comes up rarely, only once in 70 years; and its blood is used for *techeiles* (the Murex dye is not blood but mucus from its probronchial gland). The Talmud also states that the Chilazon's shape is that of a fish. While the Murex might be generally classified as a "fish", it is strange that Chazal do not use the clearer word *shavlul* (snail), if the Murex snail is indeed the Chilazon. See Section 7.

9.3 A מצוה דאוריתא can be decided only by גדולי הפוסקים אמתיים

Rav Elyashiv, applies the Bais Ha-Levi with respect to the contemporary use of the Murex snail. The Bais Ha-Levi stated that we require a *mesorah*.[126] After much scientific investigation the Radziner Rebbe zt"l publicized his cuttlefish theory. Rav Elyashiv notes that the Gedolei Yisroel of his generation did not agree with him. Later scientists came and rejected the theory. Now scientists confidently claim that the Murex is the Chilazon. How then do we know, he concluded, that the present identification will not be rejected, as were its predecessors?[121]

As we have seen in this article, the claims made by Ptil for the Murex dye are highly doubtful both for halachic and (להבדיל) scientific reasons. Furthermore, halacha mandates that, unless genuine *techeiles* is used, Tzitzis should be placed only on garments of the same colour. For example, if the garment is red, one places two strings of red and two of *techeiles*. If the Tallis is white then white strings. As the Poskim state, it is thus halachicly questionable whether string with the Murex dye (chemically equivalent to *kala ilan*) can be placed on a white Tallis.

[126] "Since the tradition about identifying Techelet ended, since for many generations we have not known what the Chilazon of our sages refers to, then even if we succeeded in restoring this information through technical, scientific proofs and clear phenomena, that information still could not enter our tradition, and it is impossible for us to pass legal rulings based on this information without a halachic tradition." (Rav Y.D. Soloveichik, in Nefesh Ha-Rav, pp. 52-53). "Ha-Gaon Ha-Rav Yosef Shalom Elyashiv likewise quoted the Beit Ha-Levi regarding the contemporary use of the murex snail, and he further noted that the Radziner Rebbe's identification did not achieve acceptance, nor did that of Ha-Gaon Ha-Rav Yitzchak Isaac Ha-Levi Herzog. How then do we know, he concluded, that the present identification will not be rejected, as were its predecessors?" (Kovetz Teshuvot 2:1). `http://www.ravaviner.com/2013/08/placing-techelet-in-ones-tzitzit.html`, accessed 27 Feb. 2014.

Ha-Gaon Ha-Rav Ezriel Auerbach writes that, with respect to past proposals, the vast majority of the "Gaonei Torah and Poskim did not incline after the minority". He writes that the Gedolei Haposkim of our time reject the current proposals, even to wear the Murex indigo dye out of doubt. He states that this is a serious question which can only be decided by הפוסקים אמתיים.[121]

We long to restore this precious Mitzvah of *techeiles*. But, notes Rav Elyashiv, there is a disagreement Rashi and the Rambam whether chemicals can be added to obtain the required colour for the dye.[30] Who is able to weigh the proper method of preparation in our times?[127]

Rav Miller refers us to Ben Ish Chai who writes that, according to the *kabbalah* of the Arizal, the *sitra achra* (evil forces) takes hold in colours that are similar to the real *techeiles* such as *kala ilan*.[132] Thus, in addition to the halachic problems, we should not wear the Murex dye which is the counterfeit indigo.

Rav Elyashiv quotes Rav Yehoshua Kutna that it has been established for over 1000 years that *techeiles* was concealed as explained in the Midrash. And the Arizal stated that *techeiles* is for those times when there is a Bais Hamikdash.[128] "We hope for the salvation of Hashem Who will send a Righteous Teacher so that we can fulfill the Mitzvos of the Torah with precision. Yosef Shalom Elyashiv" זצ״ל.[121]

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[127] Rabbi Chaim Twerski claims: "However, this objection cannot be said with regard to the Murex trunculus, as it is indeed blue before any chemicals are added, and the chemicals that are added to enable the dyeing process do not affect the outcome of the dye itself" [14]. I am not sure this is correct. The mucus from the murex is colourless and becomes purple when mixed with the enzyme purpurase from the snail. Ptil add agents such as soduim dithonite to reduce the mucus which is an essential step to make it soluble. While in the reduced state, the blue colour is obtained with the help of sunlight that removes the Bromine atoms. How is this procedure consistent with Rashi?

ועיין שו"ת ישועות מלכו חלק אורח חיים סימן ג: משא"כ עתה לפ"ד האר"י ז"ל אין חיוב בתכלת ומסייעי להו הא דגנזוהו בימי האמוראים והרי גם בתקנתא דרבנן אמרינן גזירה עבידא דבטלה ותקנתא דרבנן מקמי' גזירה לא מבטלינן, א"ו כדעת האר"י ז"ל דהאידנא אינו נוהג מצות תכלת, איברא שאם הי' בנמצא תכלת בבירור והי' ידוע לנו כיצד צובעין ודאי הי' ראוי לאחוז במצוה זו אלא שאין לנו בירור גמור שזה הוא תכלת גם מלאכת הצביעה לא נתברר לנו בבירור גמור כי במנחות דף מ"ב ע"ב בתוס' ד"ה וסממנים מבואר כי לדעת רש"י היורה שנותנים לתוכה דם חלזון לצבוע לא היו רשאין לערב סממנים אחרים כ"א דם חלזון לבד, ומה שמבואר בש"ס דמייתינן דם חלזון וסממנים זה הוא שהצמר נותנים לכתחילה עם סממנים כדי שתהא נקי' ותקבל הצבע אבל היורה שנותנים לתוכה הדם חלזון לא הי' רשאין לתת לתוכה שום דבר רק דם חלזון וצמר, אבל דעת הרמב"ם ז"ל בפ"ב מה' ציצית אינו כן אלא כפשט לשון הש"ס דביורה שנותנין החלזון נותנים הסממנים ג"כ ומי יכריע בזה"ז, גם פשט לשון הספרי וגם לשון רש"י במנחות דף מ"ב משמע שאין זה חלזון המוכשר לתכלת, ודברי הרב שיחי' אינו אלא השערה בעלמא ע"כ א"א לסמוך ולסייע את מלאכתו, ולא אוכל לכתוב את אשר עם לבבי בענין התכלת יען כי גם זאת אינו אלא השערה בלבד לכן לא בעה"ח בענין זה:

[128] שו"ת ישועות מלכו חלק אורח חיים סימן א: לכן ודאי שאין לנו להחמיר ולחוש לצבוע חוט מדם דג ידוע אחר שכבר הוחזק אצל ישראל זה יותר מאלף שנה שנגנז התכלת ופשט לשון הספרי ומדרשו של האר"י ז"ל מסכים לזה, אמם /אמנם/ לבוא בקטטות ומריבות אין לנו אחר שהציצית של לבן כשרים גם כשהם צבועים כדמשמע מהא דמנחות דף מ' דקאמר ל"י אלא קלא אילן, ומהא דר"פ תכלת מידי צבעא גרים, ומצד לא תתגודדו אין לחוש יותר משאר דברים, והתירוצים שנאמרו שם יש לתרצם גם בזה, ולא רציתי להאריך במכתב כי לא ניתן לכתב בכתב, יתענג מעכ"ת ויחוג את חג המצות בחדוה ודיצות כנפשו ונפש נאמן באהבתו ישראל יהושיע חופ"ק קוטנא. שו"ת ישועות מלכו חלק אורח חיים סימן א: ואתא שפיר מדרשו של האר"י ז"ל, דאין תכלת אלא בזמן בהמ"ק

9.4 Science as the handmaiden of Torah

There was great excitement at the Ptil conference celebrating the centennial of Rabbi Herzog's ground-breaking doctorate on *techeiles*.[129] Many are delighted by the discoveries of enthusiastic scientists involving a happy confluence of Torah and the findings of the scientists. What is lacking is a critical evaluation of scientific claims and the role of science in Torah. In a letter written late in his life to R. Yonasan ha-Kohen of Lunel, the recognized rabbinic leader of Jewry of Provence, Rambam expresses his commitment to the primacy of Torah learning. All other disciplines are mere handmaidens to Torah:

> She [the Torah] is my loving hind, the bride of my youth, whose love has ravished me (enraptured me continuously) since I was a young man (Prov. 5:19). Many strange and foreign women have nevertheless become rival wives to her: Moabites, Edomites, Sidomtes, Hittites. The Lord, may He be blessed, knows that I took these other women in the first instance only in order to serve as perfumers, cooks, and bakers for her (my true bride)[130], and to show the peoples and the princes her beauty for she is exceedingly fair to behold (Esther I: II). Still, her conjugal rights were diminished (i.e., the attention paid to her suffered) because my heart was divided into many parts through its concern for all the other branches of wisdom. And yet, how hard I have worked, day and night, for these past ten years, in order to compile this composition [i.e., the *Mishneh Torah*].[131]

Commenting on this passage, Prof. Twersky observes: "The emphasis upon the ancillary role of philosophy, its teleological and axiological subservience to Torah, is particularly significant, for there was no apparent need for apologetics in this context—the Provencal scholars were enthusiastic about Maimonides' philosophical activities

[129] This year marks the 100th anniversary of Rabbi Yitzchak Halevi Herzog's foundational doctorate, *The Dyeing of Purple in Ancient Israel*. The Ptil website states: "This work inaugurated the era of modern research into the lost biblical blue dye and laid the foundations for all subsequent work in the field. To celebrate this event, Ptil Tekhelet, together with Yad Harav Herzog and Yeshiva University, will be hosting an international conference with leading personalities presenting their thoughts on the re-establishment of the beautiful mitzvah of Tekhelet. Hundreds of thousands of Jews around the world are wearing Tekhelet strings on their tzitzit for the first time in 1300 years, and that is certainly something to celebrate". The conference was held on December 30th, 2013 at the Begin Heritage Center in Jerusalem.

[130] "And Samuel told all the words of the Lord to the people who asked him for a king. And he said, This will be the customary practice of the king who shall reign over you; He will take your sons, and appoint them for himself, for his chariots, and to be his horsemen; and some shall run before his chariots. ... And he will take your daughters to be perfumers, and to be cooks, and to be bakers" (וְאֶת־בְּנוֹתֵיכֶם יִקַּח לְרַקָּחוֹת וּלְטַבָּחוֹת וּלְאֹפוֹת). [Shmuel I:8:13]

[131] J. Blau, Teshuvos ha-Rambam, vol. 3 (Jerusalem 1961), p57. The translation is given in Twersky, *Introduction to the Code*, p40. His quoted comment is on p38.

and were requesting the last part of the *Moreh* and negotiating for its Hebrew translation." Rambam clearly states the principle that the other disciplines assume their true importance only in relationship to Torah learning. They add an important auxiliary dimension to that learning, but only when they are brought into the context of the teachings of the Torah.

Thus, it is not the scientific data (real or imaginary) that drives our understanding of Torah. Our study of the mitzva of *techeiles* must start with an in depth examination of the Torah sources. In our study, the scientific data has been a handmaiden that has supported the traditional understanding of the mitzva of *techeiles*.

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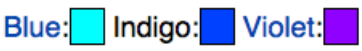
Notes

[I] "If someone were to ask you what is the color of the ocean, chances are that you would answer that is was blue. For most of the world's oceans, your answer would be correct. Pure water is perfectly clear, of course – but if there is a lot of water, and the water is very deep so that there are no reflections off the sea floor, the water appears as a very dark navy blue. The reason the ocean is blue is due to the absorption and scattering of light. The blue wavelengths of light are scattered, similar to the scattering of blue light in the sky but absorption is a much larger factor than scattering for the clear ocean water. In water, absorption is strong in the red and weak in the blue, thus red light is absorbed quickly in the ocean leaving blue. Almost all sunlight that enters the ocean is absorbed, except very close to the coast. The red, yellow, and green wavelengths of sunlight are absorbed by water molecules in the ocean. When sunlight hits the ocean, some of the light is reflected back directly but most of it penetrates the ocean surface and interacts with the water molecules that it encounters. The red, orange, yellow, and green wavelengths of light are absorbed so that the remaining light we see is composed of the shorter wavelength blues and violets. ... The most important light-absorbing substance in the oceans is chlorophyll, which phytoplankton use to produce carbon by photosynthesis. Due to this green pigment - chlorophyll - phytoplankton preferentially absorb the red and blue portions of the light spectrum (for photosynthesis) and reflect green light. So, the ocean over regions with high concentrations of phytoplankton will appear as certain shades, from blue-green to green, depending upon the type and density of the phytoplankton population there. The basic principle behind the remote sensing of ocean color from space is this: the more phytoplankton in the water, the greener it is—the less phytoplankton, the bluer it is." `http://science.nasa.gov/earth-science/oceanography/living-ocean/ocean-color/`, accessed 25 Feb. 2014

[II] Wikipedia: Dye from plant indigo  Colour scale: 

[III] "The Buccinum is found on rocks near the shore; the Purpura or Murex inhabits deeper water, and has been hence called *pelagia*; it has been dredged in twenty-five fathoms. The Buccinum derives its name from the form of the shell, which has a wide opening like that of a trumpet, and appears, used for this purpose, in the hands of marine deities in ancient art. The Buccinum of Pliny is probably the *Buccinum lapillus*, or *Purpura lapillus* of modern naturalists; his *Purpura pelagia* their *Murex trunculus*. The Murex has the same general form as the Buccinum; but the shell is more rough and spinous, and the word was used of anything stony and pointed. The structure and habits of the Murex,

its long tongue armed with silicious teeth, by which it pierces the shells of other conchylia and feeds on their flesh, correspond exactly with the description of the *Porphyra* by Aristotle in his History of Animals[6, p239]. “The Buccinum being smaller [than the Murex], the sac was not extended, but the body crushed with the shell, and both thrown together” [6, p241]. “In order to produce the the Tyrian purple, the Buccinum was added last; the dye of the Murex being necessary to render the colours fast, while the Buccinum enlivened by its tint of red the dark hue of the Murex” [6, p242].

A HaGaon HaRav Shlomo Eliyahu Miller, Shlita, Techeilis

מכתב עד תכילת – ר׳ שלמה אליהו מילר שליט״א : בס״ד יום ב׳ לפר׳ ויחי תשס״ד לפ״ק : לכבוד ידידי ר׳ מנדל זינגר שליט״א

אודות התכלת החדשה כבר הייתי שם במקום שעושים התכלת ולדעתי כל מש״כ בזה אין שום הוכחה שזהו תכלת, אדרבה יש ב׳ ראיות גדולות שאינה תכלת. א׳, דבגמרא ורמב״ם מבואר שיש בדיקה להבחין בין תכלת לקלא אילן, ומה שעושין תכלת החדשה הוא ממש קלא אילן אלא שעושים את זה ממין ״מורקס״ ומשנים הריר עד שיהא דומה ממש לקלא אילן ואין שום חילוק ביניהם באופן כימי וע״כ א״א להיות שום בדיקה להבחין ביניהם, וכל מה שדחו ראיה ברורה זו אין בו לא טעם ולא ריח.

Unofficial translation of Letter from Rav Shlomo Eliyahu Miller, Shlita, on *techeiles*. 2nd day, Parshas Vayechi, 5764. To my dear friend, R' Mendel Singer, Shlita.

I visited the place where they produce the new *techeiles*, and in my opinion all that they have written regarding this does not prove that this is [the true] *techeiles*. To the contrary there are two strong proofs that this is not *techeiles*. One, in the Talmud and in the Rambam it is made clear that there is a test to differentiate between *techeiles* and *kala ilan*, however the way the new *techeiles* is produced—it is exactly the same [chemically] as *kala ilan* except for the fact that it originates from the Murex [as opposed to from a plant]. The mucus is changed to be exactly *kala ilan* to the point that there is no difference between them chemically. It follows that there cannot be any test to differentiate between them. Their answers to these questions are not reasonable.

ב׳, מה שעושין היום שאחר שבירת קצת מן הקליפה הם חותכין קצת מן החי וטוענים שכן מצאו הרבה כזה בחפירות מימים קדמונים, הנה בגמרא מפורש שמלבד איסור צידה ליכא שום איסור בפציעת חלזון ובנטילת הצבע, ובאופן שהם עושים הלא הוא גזיזת דבר מן החי שלכל הדיעות הוי מלאכה מן התורה בשבת כמו הסרת ערלה מן החי, וחייב או משום נטילת נשמה, או משום גוזז לפי״ד הש״מ בכתובות, וא״כ מפורש שמה שהם עושים אין זה באופן שעושים תכלת.

Secondly, the way that they fashion the *techeiles* is that after breaking off the shell [which holds the mucus] they also cut off part of the animal itself, saying that they found it done this way in archaeological digs. In the Talmud it is clear that in the entire process of producing *techeiles* [from trapping the animal up until the forming of the dye] only one [of the 39] biblical prohibition[s of the Sabbath] is transgressed; that is trapping.[42] In the manner that they do it, however, they are cutting off a piece from a live animal. This is a biblical prohibition according to all authorities, just like the removal of the foreskin, either the prohibition of taking a life, or the prohibition of shearing, according to the opinion of the *Shitta Mekubetzes* in tractate *Kesubos*.[43] This is a proof that their method of producing *techeiles* is an incorrect method.[44]

גם מפו׳ בגמ׳ שאופן פציעתו הוא באופן נטילת נשמה, אלא שאינו מכוין לנטילת נשמה והוי מקלקל או פס״ר דלנ״ל לגבי נטילת נשמה, והצבע שעושים הלא גם לדבריהם הלא הוא טוב ומועיל גם שעה או שעתים אחר המיתה, וא״כ גם מזה מוכח שאין תכלת שלהם תכלת של הגמ׳.

It is also clear in the Talmud that the process of breaking the shell entails taking the life [of the Murex], however one is not liable for the biblical transgression [of

taking a life on the Sabbath] because it is [detrimental to the process of making *techeiles* to kill the Murex and is therefore] *mekalkel* or *psik reisha dlo nicha ley*. They themselves admit that the dye that they make is possible to produce even one or two hours after the death of the Murex [and therefore the Murex's death is not detrimental to the process]. This is also a clear proof that their *techeiles* is not the *techeiles* of the Talmud.[73]

גם יש להעיר מדברי תשובת ר"א בן הרמב"ם בברכת אברהם ליישב דעת אביו דחובל וחולב חייבים משום תולדות דדש, אף שאין דישה אלא בגדו"ק ומה"ט ליכא חיוב דישה מחלזון כמפורש בגמרא. וביאר דדישה ממש בעינן גדו"ק אבל תולדות דישה אי"צ גדו"ק. וכפי הנראה נטילת הריר מן החלזון אינו דישה ממש, ולכל היותר הוי תולדות דישה אשר אי"צ בהן תנאי גדו"ק לדעת הרמב"ם.

It is also fitting to note the words of Rabbenu Avraham ben HaRambam in his work Bircas Avraham,[65] in answer to a query regarding the opinion of the Rambam. The Rambam states that wounding or milking on the Sabbath is a transgression of the prohibition of *disha*. The Talmud, however, states that *disha* is only applicable to something that grew from the ground. [It is for this reason, states the Talmud, that there is no *disha* to the chilazon.] If so, how could milking or wounding be *disha*? Rabbenu Avraham ben HaRambam replied that with regard to the *av melocho* of disha the Talmud said that there is only *disha* on something that grew from the ground, however with regard to the *toldah* of *disha* one transgresses even by doing *disha* to something that did not grow from the ground. It seems to me that the method which they use to remove the mucus from the murex is at most a *toldah* of *disha*, in which case even though the murex does not grow from the ground it should still be susceptible to the transgression of *disha*. This is in contradiction to the Talmud which exempts the chilazon from *disha* because it does not grow from the ground.[66]

והנה יש מחלוקת הראשונים כמה חוטין בעינן לתכלת, א' משמונה או ב' משמונה [דהיינו א' מד' חוטין שבציצית], או ד' חוטין מח' [דהיינו ב' חוטין שלמים תכלת וב' חוטין לבן]. והנה לדעת הרמב"ם דבעינן פתיל א', עי' אור שמח ריש הלכות ציצית שכתב בדעת הרמב"ם דחוט א' חציו תכלת וחציו לבן דלצובעו כולו תכלת א"א דפתיל א' ולא שנים. ונ' כוונתו דלהרמב"ם דפתיל הכוונה א' א"כ הוי בל תוסיף כשצובע ב' חוטין [מן הח' חוטין דהיינו חוט שלם], וא"כ אם התכלת כשרה ועושים יותר מחוט א' לדעת הרמב"ם אסור והוי בל תוסיף, אבל בזה שכתבנו שהתכלת פסולה הרווחנו שלא עברו על בל תוסיף לדעת הרמב"ם.

There is a disagreement among the Rishonim as to how many of the tzitzis strings were dyed with tcheiles, some say one [of eight], some say two [of eight, i.e. one full string out of the four full strings], and some say four [of eight i.e. two full strings]. The opinion of the Rambam is that only one [of eight] string[s] is dyed with tcheiles. It seems to me that the intention of the Ohr Sameyach at the beginning of Hilchos Tziztis is that one who dyes more than one string with tcheiles would transgress Bal Tosif according to the Rambam. If then, this tcheiles is really the true tcheiles and one would use it on more than one string one would be transgressing Bal Tosif according to the Rambam. However according to what we have earlier proven that this is not the real tcheiles we have gained that those

who do wear it [on more than one string] have not transgressed Bal Tosif according to the Rambam.

גם ראיתי שאחד מן המחזיקים בתכלת החדשה דחה דברי הגר"ח ז"ל שאמר דמצד סד"א לחומרא ליכא חיוב לעשות מעשה שהוא ספק מצוה. והיה סבור שסברות הגר"ח שבכל ספק מצוה ליכא חיוב סד"א לחומרא, ודחה דבריו מדברי הר"ן דגם בבהש"מ מחויב ליטל לולב ואתרוג אף דלא הוי אלא ספק מצוה. ולא הבין כלל סברת הגר"ח ואינו ענין כלל לדברי הר"ן. והי' לו לזכור הגמ' גברא רבה אמר מלתא אין מזניחין אותו. סברת הגר"ח הוא במצוה שמחויב בתורת ודאי, ויש לפניו אופן לקיימו מספק, ואחר שיקיים מספק עדיין נשאר מחויב בדבר מדין סד"א לחומרא, א"כ ליכא חיוב מה"ת לעשות דבר שאף אחר עשייתו נשאר החיוב לעשות מוטל עליו. ואינו דומה כלל לדברי הר"ן דבבהש"מ יש חיוב מספק וע"י עשייתו הוא פוטר עצמו מן החיוב ולא נשאר שום חיוב עליו. וא"כ אף אם היה ספק השקול אם זהו תכלת, לדברי הגר"ח ליכא חיוב מצד סד"א לחומרא להטילו בבגדו.

I have seen that one of the supporters of the new tcheiles has [wrongly] disproved the words of the Grach zal who stated that even though there is a halacha that with regard to a d'oraisa we are stringent [i.e. if one is in doubt whether something is forbidden one must be stringent], nevertheless one does not have to do something which is a safaik mitzvah [i.e. if it is in doubt as to whether you will be doing a mitzvah by doing a certain action you are not obligated to do it]. Now, this person thought that if so one never has to do a mitzvah which is in doubt. Therefore he sought to disprove this from the Ran who states that one must still fulfill the mitzvah of lulav even if it is already bein hashmashos . This person has not understood the reasoning of the Grach, which has nothing to do with the Ran. He should have remembered the words of the Talmud that when a great man says something we do not reject him [see Chullin 7b]. The reasoning of the Grach is that when one is surely obligated in a mitzvah and has a opportunity to fulfill it in a way that is a safeik [if he has fulfilled the mitzvah] he is not obligated to take up that opportunity since anyway he will have to fulfill it again in a definite manner. This is different from the Ran's case where after he has done the mitzvah of lulav bein hashmashos he will definitely be exempt from lulav, hence he must do the mitzvah even though he is in doubt.

ובעיקר סברת הגר"ח נראה דתלוי בפלוגתא דרמב"ם ורשב"א אי סד"א מה"ת לחומרא או מדרבנן לחומרא, דלדעת הרשב"א דמה"ת לחומרא א"כ אם יטיל ספק תכלת בבגדו עדיין נשאר חיוב מצוה עליו מד"ת מדין סד"א לחומרא, וכיון דלא יפטר מחיוב ע"י הטלת ספק תכלת ליכא חיוב עליו להטיל בבגדו ספק תכלת. אולם לדעת הרמב"ם דסד"א מה"ת לקולא, א"כ י"ל ע"י הטלת ספק תכלת נפטר מחיובו מה"ת ושפיר י"ל דחייב מה"ת להטיל ספק תכלת בבגדו לפטור חיוב תכלת שעליו. וידוע תשובת הר"ן לענין להתיר נדר בביהש"מ של יום חלות הנדר דתלוי בפלוגתא הנ"ל דלדעת הרשב"א דסד"א מה"ת לחומרא כבר חל הנדר ויכול להתירו מה"ת, משא"כ לדעת הרמב"ם דמה"ת סד"א לקולא. א"כ בביהש"מ עדיין מותר מה"ת וא"כ לא חל עדיין הנדר וא"א לו להתירו עדיין. אולם למש"כ החו"ד בסימן ק"י דהרמב"ם לא ס"ל דסד"א מה"ת לקולא רק בספק איסור, דמה"ת דוקא ודאי אסור, אבל לענין קיום מצות מחויב לקיים באופן ודאי וספק קיום מצוה גם לרמב"ם אינו פוטר חיובו. וא"כ אף לדעת הרמב"ם אם יטיל ספק תכלת עדיין נשאר בחיובו מה"ת, וא"ש סברת הגר"ח דליכא חיוב לעשות דבר שאף אחר עשייתו נשאר החיוב עליו, ואף שיש ראיות מכמה פוסקים דלא ס"ל כסברת הגר"ח, וגם האדמו"ר מראדזין ז"ל כבר דן על סברא זו, מ"מ עיקר הסברא סברא ישרה וא"א לדחותו בקל.

With regard to the Grach it seems that his logic depends on the argument between the Rambam and the Rashba. The Rashba holds that this that one must be stringent with regard to a doraisa is in itself a halacha that is doraisa. The Rambam, however, is of the opinion that it is only midrabanan that we must be stringent. Now, according to the Rashba after wearing safeik tcheiles one would have to search for definite tcheiles midoraisa, therefore one can reason that one would not have to wear safeik tcheiles. However, according to the Rambam, midoraisa after wearing safeik tcheiles one is exempt from searching for definite tcheiles, hence one would be obligated to wear safeik tcheiles. It is known the words of the Ran in his Responsa (ch. 51) regarding the nullification of oaths . The Ran says that according to the Rambam during twilight the oath has not yet taken place and cannot be nullified, however according to the Rashba the oath has taken place [because midoraisa one must be stringent] and therefore may be nullified even bein hashmashos.

The Chavos Daas (Shulchan Aruch, Yoreh Deah, ch. 110) states that even the Rambam who holds that when in doubt regarding a negative prohibition one need not be stringent midoraisa, agrees that with regard to a doubt whether one has fulfilled a positive command one must be stringent midoraisa. If so, even the Rambam agrees that one who has worn only doubtful tcheiles must wear definite tcheiles to ensure that he has fulfilled the mitzvah. It follows that the logic of the Grach would be applicable even according to the opinion of the Rambam. Even though there are proofs from many Poskim that they argue on the Grach, and the Radziner Rebbe zt"l asked on the Grach, still it is a sound piece of logic and it is not easy to push it off.

ומה שטוענים שמצאו מיני המורקס בחפירות, יתכן מאד שהיה צבע ארגמן אשר עד לפני כ"ד שנה לא ידעו שיש אופן לשנות הצבע ולעשותו קלא אילן ממש, א"כ י"ל בימים קדמונים לא ידעו מזה אלא שעשו מזה צבע אחר. ובפרט שכבר כתבתי שלפי הראיות שהביאו גם בימים קדמונים היו עושים באופן שהם עושים, וא"כ הוי מלאכה דאורייתא כמו הסרת ערלה מן החי. ועיין בן איש חי בספרו בן יהוידע על ב"מ דף ס"א שכתב ע"פ קבלה מדברי האר"י ז"ל דגוון קלא אילן יש לסט"א אחיזה [ורק בתכלת כשרה אין לו אחיזה], וע"ש שהאריך בזה, א"כ לדעתי שזהו קלא אילן יש קפידא על פי קבלה בדוקא שלא להשתמש בגוון זו שיש בו אחיזה לסט"א. מלבד הטעם ע"פ הלכה שאינו בגוון דכנף, דאם אינו תכלת בעינן לכתחילה שיהיו הציצית כגוון הכנף אין עושים רק ציצית לבנים וכמ"ש הרמ"א סימן ט' ס"ה אף בשאר גוונים של בגד ומה"ט מדקדקים לעשות טלית רק גוון לבן כיון דאין עושין ציצית רק לבנים.

With regard to what they say that have found the Murex in archeological digs, it is extremely possible that it was used to dye argaman (purple). Even up to 24 years ago they did not know that it is possible to use the murex for Techeiles and thought that it could only be used for purple. If so, it could be that in those times also it was used for argaman. This is especially so after they have pointed out that the way it is cracked open in the digs violates a biblical prohibition of the Sabbath like the removal of the foreskin and we have already proven that this is not the way they produced tcheiles. See the Ben Ish Chai in "Ben Yehoyada"

on Baba Metzia 61 who writes that according to the kabbalah of the Arizal the sitra achra (lit. other side i.e. evil forces) have a hold on the colour of kala ilan unless used in real Techeiles.[132] If so, we should not wear the new tcheiles since it is kala Ilan and thereby give power to the Sitra Achra. This is besides for the halachic reason that the string should be the same colour of the garment, except for white tzitzis on other colours (see Rama ch.9 num.5). It is for this reason that we wear a white tzitzis garment i.e. since all our strings are white.

והנה בעיקר מה שדוחקים המדעים בזה מפני שלא ידוע שום מין אחר וע"כ צריך להיות המורקס, אבל אין זה כלום לכל יודע דבר דתמיד מוצאים דברים שלא ידעו מתחילה, ובפרט חלזון שכבר אמרו עליו שאינו מנמצא עכשיו.

Now, this that the scientists have said that they do not know of any other species that could be tcheiles and therefore it must be the murex, this is not true to anyone who knows anything because they are always finding new things that they have not known about. This is for sure so with regard to the tcheiles of which it is said that it is not available nowadays.

סוף דבר לדעתי יש קפידא בדוקא שלא להשתמש במין תכלת החדשה הבאה מן ה"מורקס".

ידידו, שלמה אליהו מילר

After all is said, it is my opinion that one should not use the new tcheiles made from the murex.

In friendship, Shlomo Eliyahu Miller

B Chemical testing of Murex samples

Dr. Shabtai Nacson has a Ph.D in Chemical Engineering. He was asked by Rav Miller to investigate the Ptil dyes. Dr. Sterman kindly provided him with three samples to test.

B.1 Murex dye chemically equivalent to indigo

From: Sabatino Nacson
Sent: Thursday, March 22, 2001 1:50 AM

[132] ספר בניהו בן יהוידע על בבא מציעא דף סא/ב: אני הוא שהבחנתי במצרים, בין טיפה של בכור, לטיפה שאינה של בכור: שם וממי שתולה קלא אילן בבגדו ואמר תכלת היא. מקשים מאי רבותא דהאי רמאות במצוה זו של ציצית, משאר רמאות שעושין במצוות אחרים, כגון אינו רוצה להפסיד שכר כתיבת פרשיות של תפילין, אלא מניח חתיכת נייר בבתים, ואומר מזוזה היא, ומביא חוטין לבן מן השוק ומניח בבגדו ואומר ציצית הוא, וכן כיוצא בזה. ונ"ל בס"ד, על פי מ"ש רבינו האר"י ז"ל בשער מאמרי רשב"י דהסטרא אחרא יש לה אחיזה יותר בגוון שהוא כמראה תכלת, אבל התכלת עצמו שהוא מדם הלזון שאנחנו מניחין בציצית הוא קדושה גדולה, ולכן לא היה נוהג אלא בזמן בית המקדש, כי הלבן והתכלת הם רומזים לבחינה עליונה ע"ש, ולכן הגוון שדומה למראה התכלת נקרא קלא אילן, כי קלא גימטריא ס"מ. והנה ידוע שהסטרא אחרא מתאוה להתדמות לקדושה, כדרך הקוף שטבעו להתדמות לאדם, וכן הוא מנהג הסטרא אחרא, על כן כיון שזה עושה מרמה במצוה זו להביא קלא אילן, שהוא חלק הסטרא אחרא (דפלור) [דפלוני], במקום תכלת שהוא קדושה, גורם שתכנס הסטרא אחרא במקום הקודש, ויתקיים מה שנאמר [משלי ל' כ"ג] ושפחה כי תירש גברתה, כי זה נותן כח לסטרא אחרא להתלבש במלבושי כבוד חס ושלום, ולכן עונו גדול יותר משאר מרמות שעושים בשאר מצוות, מפני שזה הרמאות בקלא אילן, שהוא חלק פלוני ששם נאחז, כי לכן קלא הוא מספר ס"מ, ולכן נפרע ממנו על זאת יותר משאר רמאות דשאר מצות. ובזה מדויק המאמר באומרו שתולה קלא אילן בבגדו ואמר תכלת הוא, הכונה בשביל שאמר תכלת הוא, נמצא קרא שם תכלת שהוא בקדושה על קלא אילן שהוא סטרא אחרא, והרי זה כקורא את הכלב בשם המלך:

To: joel@tekhelet.com [Joel Guberman]
Subject: Re: FW: Sample of Tekhelet

Hi Joel:

I ran the three Tekhelet samples on the GC-IMS system and got the same results that I had few months ago. The results definitely indicate that the major component of the samples is indigo when compared to commercial purchased sample of indigo from Sigma/Aldrich with a minimum purity of 95%.

Both the retention time and reduced mobility or equivalent mass of the protonated ion are identical to indigo and definitely confirm that the extracted Tekhelet samples that you sent me are indeed indigo.

...

The wet chemistry test showed that all Tekhelet samples were affected by the bleaching agent (NaOCl) [Sodium hypochlorite] and changed from blue to white-yellow ppt. Whereas, genuine indigo did not react, since it is already oxidized.

The results are puzzling. Reducing agent(s) acted on all samples equally including indigo from Aldrich Chemicals. The bleaching test is a bit alarming since it says that a dyed fabric will loose its blue color if bleached. In fact, I tried it on dyed wool that you sent and indeed it changed color.

Let me know your comments or where to continue from this point. I could spend more time doing tests and evaluation but the GC-IMS experiment is pretty conclusive at this point.

Looking forward to your reply and Baruch's input.
Best regards,
Dr. Shabtai Nacson

B.2 Murex dye reduced by simulation of Talmud's test

Sent: Friday, January 05, 2001 10:30 AM
From: Dr. Shabtai Nacson

I finally figured out the Rambam's test procedure. It consists of two separate tests, one involving the use of aged urine, straw and slime from a snail and the other test is baking the dyed wool thread impeded in a barely dough.

I found out that the first test was commonly used in the past for reducing the dye using strong reducing bacteria from the aged urine with other additives to enhance growth of these reducing bacteria. Today, most processes use sodium hydrosulphite [Sodium dithionite] to reduce the dye from a blue colored solution to a yellow-green solution at 50 deg. C. The wool is then added to the pot and allowed to mix well before removal for drying. During the drying process, the dye gets oxidized by the oxygen in the air and turns to blue and stays blue in the oxidized form.

The Rambam is saying that using a reducing agent (in this situation reducing

bacteria), the tekhelet should not be significantly affected and if it is slightly faded, then the second test with baking with barely dough should restore that fading and not enhance it.

Aging urine for forty days and mixing with straw and slime is not the best thing you want to do. Rather I used the reducing agent on both indigo and tekhelet sample and found that both dyes were immediately affected and turned to yellow-green colour. This is also the procedure used by the people dying the tzitzit as described earlier.

If the tekhelet was easily reduced, then it failed the Rambam identification test! What am I missing? It is seems to be too *pashut*? Both the indigo and [Ptil] tekhelet were reduced and became yellow-green. On exposure to oxygen, they regain their blue colour.

The only intriguing difference is that indigo was not easily oxidized and the tekhelet was immediately oxidized and lost its colour to yellow liquid with a white precipitate.