

Understanding the Criteria for the Chilazon

Mendel E. Singer, Ph.D.

This article originally appeared in the Rabbi Jacob Joseph School sponsored journal, the Journal of Halacha and Contemporary Society, Vol. 40, Sukkot 2001. Reprinted with permission.

BIO: Assistant Professor, School of Medicine, Case Western Reserve University, Cleveland, Ohio.

BACKGROUND

The Torah commands us to wear a thread of blue, techeilet, in each corner of our tzitzit.[1] While tzitzit serve as a visual reminder to do the mitzvot, the blue thread reminds us of Hashem: "Techeilet resembles [the color of] the sea, and the sea the sky, and the sky the throne of glory".[2] The Gemara informs us that the techeilet dye comes from a bodily fluid (lit: blood)[3] of the chilazon.[4] At some point it became forgotten which species is the chilazon. Exactly when techeilet ceased to exist is unknown. Though some have suggested this happened sometime between 500-700 C.E.[5], there is evidence that techeilet continued to be dyed in some places for another several hundred years.[6]

In the 1880's, Rabbi Gershon Henoch Leiner, the Radzyner Rebbe zt"l, set out to identify the chilazon species. Although widely known for his talmudic expertise (e.g. Sefer Sedrei Taharot), he had studied biology, chemistry and engineering, and practiced medicine as well.[7] Guided by the simanim (signs) provided by the Talmud and the Rishonim, he traveled across Europe, studying at the famed aquarium of Naples. He decided that the long lost chilazon is sepia officinalis (the common cuttlefish), believed by some to be the opinion of Rambam.[8] He wrote three books on techeilet, comprising nearly 500 pages. In the words of one of his present day dissenters, "These books still stand as the definitive works on the subject, and form the halachic foundation of any discussion of the topic".[9] Even today Radzyn produces techeilet from the cuttlefish.

Rabbi Dr. Yitzchak Herzog z"l, a brilliant talmudist, Jewish historian and the Chief Rabbi of Eretz Israel from 1936-1959, was fluent in numerous languages and techeilet was the subject of much of his doctoral dissertation. Rabbi Herzog rejected the Radzyner Rebbe's position, and concluded that the chilazon was a member of the Janthina species.[10] However, the dye produced by the Janthina turned brown, and was not permanent. It appears that Rabbi Herzog did not pursue this matter further, and no techeilet was ever produced from the Janthina.

In recent years there has been a movement in favor of the murex trunculus snail as the chilazon. Fueled by the work of Dr. Irving Ziderman, an academic scientist at the Israel Fiber Institute, followers of this theory formed an organization, Petil Tekhelet Foundation. Based largely on archeological and scientific evidence, they have been active in publishing, lecturing and electronic dissemination.[11] Their work has, for the most part, gone without critical appraisal.

This article will attempt to elucidate the criteria for identification of the chilazon, clarify what is required to meet these criteria, and then evaluate the theory that murex trunculus was the chilazon. The criteria will be presented in 4 categories. The first section will discuss the primary criteria, based on statements brought by the Gemara for the purpose of describing the chilazon. This is followed by an analysis of the Gemara's chemical tests for techeilet. Secondary criteria will deal with those characteristics of the chilazon which can be deduced from statements made for other purposes. Lastly, there is a section for other evidence which might be brought to lend further credence to, or discredit a claim.

PRIMARY CRITERIA

The strongest criteria for identifying the chilazon comes from the Gemara Menachot, where the subject of techeilet is discussed extensively.[12] There, the Talmud cites several sources in order to describe the chilazon. These statements are of the utmost importance because they were cited for the sole purpose of describing the chilazon. Chazal, knowing which species was the chilazon, chose these statements to describe it. As such, in order for a candidate species to satisfy these criteria, it is not sufficient to meet these criteria in a minimalist sense. It must be reasonable that Chazal would have chosen these statements to describe it. In evaluating whether a particular species is the chilazon, a strong case must be made for all of the primary criteria. The primary criteria for the chilazon come from the following statements: "Chilazon zehu gufo domeh l'yam, ubriato domeh l'dag, v'oleh echad l'shiv'im shanah u'bdamo tzov'in techeilet, l'fichach damav yekarim".[13] This establishes four primary criteria for the chilazon:

- 1. the color of its body is like the sea**
- 2. its form is like a fish**
- 3. it comes up once in 70 years, its "blood" is used for techeilet, therefore**
- 4. it is expensive.**

As Rabbi Herzog points out, the first requirement uses the lashon gufo, meaning body or flesh.[14] It does not refer to the shell, which is usually rendered nartik or klipah. The lashon here, gufo domeh l'yam, is similar to the statement just a few lines earlier in the Gemara, techeilet domeh l'yam, where it is understood that the color of techeilet is similar to the color of the sea. There the comparison is extended to the sky and the sapphire, indicating that techeilet is blue.[15] If, just a few lines apart, dealing with the same subject, we find the same expression, domeh l'yam, it is reasonable to conclude that the meaning is the same in both cases. If techeilet and the body of the chilazon are both domeh l'yam, then the color of techeilet and the color of the body of the chilazon must be similar, i.e. both blue. This is supported by the lashon of the braita of tzitzit, which states "gufo domeh l'rekiah".[16]

The body of the murex does not resemble the sea. The Petil group argues that the shell of the murex trunculus is sometimes covered with a sea fouling. The color of these organisms will vary from place to place, but is sometimes blue or green.[17] This argument fails on three counts.

First, the requirement is for the body, not the shell. Second, the color of the sea fouling is only sometimes blue. Since it is usually not blue, the Gemara certainly would not choose to describe it as blue. Third, it is implausible that Chazal would choose to identify the murex trunculus by giving a description of the sea fouling, which is neither a part of the creature nor distinctive, since it covers everything else in the area, as well.[18] Some have tried to argue that the Hebrew word yam can also mean seabed. However, only the shell is colored like the seabed, not the body. Considering that yam almost always means sea, and is used as such in regards to the color of techeilet in many places, it is hard to believe it could be used to mean seabed here. In fact, the requirement that the color of the body of the chilazon be like the yam is just a few lines after the Gemara's statement that techeilet is the color of the yam, which everyone, including the murex supporters, agrees means sea.

As for criterion 2, the statement in the Gemara is "briato domeh l'dag". Briato means "its form", as explained by Rashi and Rabbeinu Gershom.[19] Murex trunculus in no way resembles a fish. Supporters of the murex trunculus theory suggest briato could mean "its creation", since murex spawn like fish. Aside from relying on an interpretation of briato that is contrary to the classical mefarshim, there is another difficulty. Since most mollusks spawn, it is unlikely that Chazal would have chosen this characteristic to distinguish the chilazon from other species.

Regarding criterion 3, the requirement of once in 70 years, the Radzyner Rebbe says this means that there are times when the chilazon is abundant.[20] Likewise, Rabbi Herzog, citing also the braita of tzitzit that says the chilazon comes up every 7 years, is of the opinion that there should be some cycle, though not necessarily 7 or 70 years.[21]

Murex trunculus has no known cycle or times of unusual abundance. Petil followers have tried to argue that the Hebrew sheva shanim in the braita could also mean seven-fold, and Pliny the Elder mentions an optimal seven-month cycle for harvesting murex snails.[22] This not only ignores the Gemara's expression of 70 years, but also assumes that seven-fold means seven one-month periods.

They do not suggest a reason why the base unit should be one month. Clearly the intention of the Gemara and the braita is that it is unusual for there to be an abundance, and every seven months is hardly unusual or noteworthy.

Purple dye from all species of murex, including trunculus, was exceedingly expensive. This was because each snail possessed so little dye that it took about 8,000 snails to make one gram of dye! [23] In criterion 4, Rashi explains that the techeilet dye was expensive because of the chilazon's rare appearance, and not because of the minute dye quantity. [24] This follows from the language of the Gemara where the statement that the dye is expensive is introduced with the word lefichach, "therefore", and the preceding statement was about the once in 70 year appearance of the chilazon. Rabbi Herzog indicates that this requirement implies that the quantity of dye in the chilazon was not very small, which is inconsistent with murex trunculus. [25]

Chemical Tests

In ancient times, there were unscrupulous individuals who would substitute an imitation techeilet dye known as k'la ilan, for the real techeilet. K'la ilan is widely understood to be indigo, traditionally derived from a plant. [26] Indigo was the predominant source of blue dye in ancient times, and was both readily available and relatively inexpensive. This counterfeit techeilet was virtually identical to the color of the real techeilet. Accordingly, the Rabbis proposed chemical tests that could distinguish between the chemical that made up the authentic techeilet and the chemical that made up the counterfeit techeilet. [27] These tests are based on subjecting the dyed wool to a fermentation process [28] and ruling it k'la ilan if the color worsens. Fermentation processes were used in the traditional method of dyeing indigo, and causes the blue indigo to change to a yellow solution. [29] 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. [30] 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 [31], the mei raglayim must be fermented. [32]

Mei raglayim of babies under 6 weeks old consists mostly of water, making it a poor choice for fermentation. Thus, the Gemara's use of "ben arba'im yom" could reasonably be understood either way. Regardless, it is clear that the Gemara's chemical tests were based on the chemical properties of indigo and were designed so that indigo would fail the test.

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.[33] 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 the impossibility of distinguishing plant indigo from snail indigo, he clings to the conclusion that murex indigo is techeilet. He writes of the Gemara's chemical tests,

"These tests don't work, because the chemical is the same".[34] 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..."[35]), 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.[36] Petil writings have suggested that the chemical tests might be designed to detect impurities that might be found in plant indigo, but are not found in snail indigo.

This logic demonstrates a lack of understanding of the nature of the chemical tests. It is clear from the above discussion that the Gemara's tests are based on the chemical nature of indigo, and not any remaining impurities. Thus, the murex-indigo used by Petil for techeilet will fail the Gemara's tests, rendering it invalid. However, a distinction must be made between evaluating whether a species is the chilazon and assessing whether a particular dye is techeilet. Even though murex indigo cannot be genuine techeilet, this does not by itself preclude the possibility that murex trunculus is the chilazon. There may be an as of yet undiscovered, alternative process that creates a different blue dye (i.e. not indigo) from the murex trunculus. Therefore, it is still necessary to evaluate whether murex trunculus meets the criteria for the chilazon.

An interesting side-note: the process used by Petil to make indigo from murex trunculus would also work for the other species famous for their use in ancient purple dyeing, murex brandaris and purpura (thais) haemastoma.[37] Indeed, none of the arguments presented in Petil writings appear to uniquely identify murex trunculus.

Secondary Criteria

There are other sources from which additional information about the chilazon can be deduced. These criteria can lend valuable support to a theory postulating a particular species as the chilazon. However, care should be taken in determining the weight placed on these criteria. These criteria were not brought for the purpose of identifying the chilazon, as was the case with the primary criteria discussed above. As such, it may be that a particular statement should not be understood literally or exactly. Unlike the primary criteria, meeting secondary criteria should only involve a plausible explanation, and does not have to bring out the uniqueness of the chilazon, and may be difficult to understand without already being familiar with the species. There is also the complication that it is not always clear when the Gemara's use of the word chilazon is speaking specifically of the chilazon shel techeilet. In some of these cases the classical mefarshim clarify this, in other cases it remains ambiguous.

Shell grows with it: The Midrash says about the chilazon, "its shell (nartiko) grows with it". [38] 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. Elsewhere, the Midrash Rabbah says "when it grows, its malvush grows with it". [39] Malvush, garment, would appear to be some form of growth on the exterior of the chilazon. The term malvush, garment, seems to imply that it is not merely attached, but covers the body of the chilazon, or surrounds it. Murex trunculus has a shell of its own, but doesn't seem to have anything else that could be termed a malvush. It may be that the Midrash is using malvush as a synonym for shell. This would make sense in the context of the Midrash, which discusses the issue of whether the Jews in the desert outgrew their clothes. The chilazon is brought as an example to suggest that the clothes grew with the wearer. Referring to the shell as malvush, garment, would be consistent with the context. Based on this understanding of malvush, murex trunculus would appear to meet this criterion.

Hard shell: The Gemara discusses the case of someone who extracts the dye from the chilazon on Shabbat. [40] The verb used by the Gemara in describing the action of the person extracting the dye is potzea. Potzea is usually understood to mean to crush or crack open. [41] This would imply that the chilazon has a hard shell, though this could be an external or an internal shell. Rashi says that the person squeezes (docheik) the chilazon in his hand to get out the blood (dye secretion). From Rashi's comment we can only infer that squeezing the chilazon can make the dye come out. Rashi's use of the word "squeeze" is difficult to understand since it seems to imply a soft substance, not a hard shell.

This difficulty in understanding Rashi might be resolved if the chilazon, while being held in the hand, has a shell on one side, and flesh on the other. Thus, the person squeezes the fleshy side of the chilazon, and in the process may crack open, or crush, the hard shell on the other side.

Murex trunculus has a hard, external shell that is cracked in order to get the dye out. The shell almost completely encloses the body. This would be consistent with the usual understanding of potzea, but not with Rashi's docheik.

Dye is better while chilazon is alive: We learn in the Gemara that people try not to kill the chilazon when extracting the dye because the dye is better if extracted while the chilazon is alive.[42] 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. Petil followers argue that the murex secretion (mucus) loses its dyeing power a few hours after the snail's death. This doesn't help since the Gemara is speaking not of a few hours, but mere moments after death. Another problem is Pliny's statement that the murex discharges its dye upon death.[43] If so, the reason not to kill the murex when removing the gland containing the dye is because otherwise the precious few drops of dye will be lost!

Hidden in the sand: The Gemara in Megilah states that the verse in Devarim 33:19, "sefunei temunei chol" ("hidden treasures of the sand"), refers to the chilazon shel techeilet.[44] It is not clear how restrictive this criterion is. It might only mean that the chilazon is considered to be a creature of the sand and that it is hidden. In this case, it would seem to be sufficient to be hidden by its own shell, and that it would not be necessary to bury itself in the sand. On the other hand, it might mean that it is hidden because it is buried in the sand. This is the understanding of the Radzyner Rebbe, citing the Sefer HaKaneh (Hilchot Tzitzit) as stating that the chilazon buries itself in sand with its head sticking out.[45] The murex trunculus lives on the sand, and simply by virtue of hiding its body in its shell could be considered hidden. There are times when it buries itself in the seabed, which might satisfy the general requirement of burying itself in the sand. Given that this is a secondary criterion, murex trunculus would seem to reasonably meet this criterion, though not in the manner described by the Sefer HaKaneh.

Color of the blood: Rambam states that the "blood" of the chilazon shel techeilet is black like ink".[46] Rashi states that the appearance of the "blood" of the chilazon shel techeilet is like the color of techeilet.[47] The Radzyner Rebbe reconciles the apparent contradiction between Rashi and Rambam by explaining that when Rashi says maris damo, "appearance of its blood", he is referring to the "blood" after it is prepared for dyeing, while Rambam refers to the original color of the "blood".[48] Supporters of the murex theory follow the lead of Rabbi Herzog who, unable to find a source to support Rambam's statement, speculated that Rambam was basing this on an erroneous statement of Aristotle, and dismissed this statement of Rambam.[49] However, it is not clear that the Petil group's techeilet meets the description of Rashi, either. The murex secretion is essentially clear. Left in the sun it turns purple-blue. When it is placed in a chemical solution it turns yellow. It is then exposed to ultraviolet radiation, after which the wool threads are dipped in the solution. The wool turns blue when it is removed from the solution and exposed to the air.

Thus, the murex trunculus dye is never blue as a liquid, only turning blue after it is already on the garment. This might be reconciled by saying that when Rashi refers to the appearance of the blood of the chilazon, he means the dye as it appears on the tzitzit after the dyeing is completed. As a secondary criterion, this would seem to be an acceptable explanation of Rashi, although there is still the problem of dismissing the Rambam on a matter of science.

Treatment for hemorrhoids: The Gemara also tells us that the chilazon was used to treat hemorrhoids.[50] Rabbi Herzog states that modern pharmaceuticals knows nothing of the use of a mollusk to treat hemorrhoids.[51] Rabbi Herzog's comments are a bit puzzling. Given that this treatment was from the times of the Gemara, it would be likely that mention of this would be found now only in non-traditional medical sources, what might be deemed today to be "alternative medicine". Additionally, the Radzyner Rebbe had already written that cuttlefish ink has been used as a treatment for hemorrhoids since ancient times.[52] Indeed, it is still sold today for this purpose.[53] As for murex trunculus, in ancient times it was considered to be bad for the bowels.[54]

Tentacles bent like hooks: The Mishnah describes a chain hanging on the wall, with something called a chilazon attached to the head of the chain.[55] The mefarshim say it was called this because it was shaped like the chilazon shel techeilet[56], and Tiferes Yisroel explicitly states that this was an iron hook attached at the end which was used to hang the chain on a wall. The Radzyner Rebbe understands this to mean the chilazon has long tentacles that are bent like hooks.[57] No part of a murex snail would fit this description.

Snake-like extensions: The Gemara speaks of red flesh-like warts, forming a snake-like shape in the eye.[58] This disease is called both snake and chilazon. The Radzyner Rebbe states that the chilazon must have snake-like limbs or extensions, and have red warts.[59] This description does not fit murex trunculus.

OTHER EVIDENCE

Aside from establishing criteria to identify the chilazon, it may be possible to find evidence to corroborate an opinion regarding the identity of the chilazon. The following paragraphs discuss this type of evidence in the context of the murex trunculus theory.

Archeological evidence: There can be little doubt that murex trunculus was used in ancient dyeing. It has long been accepted that murex trunculus was used for dyeing purple in ancient times.[60] There is significant archeological evidence to support this. However, all of the evidence suggests it was used for purple dyeing. There is absolutely no evidence to suggest that murex trunculus was used to dye blue. In fact, as Dr. Ziderman himself points out, it would be absurd to think that non-Jews would use murex to make indigo blue when they could make the same thing easier and cheaper using plants, as was done all over the world.[61] One might argue that murex-indigo was used to make techeilet, while the identical but inexpensive plant indigo was used for all other blue dyeing. However, piles of murex trunculus shells have been found at many ancient dyeing sites, not just in the vicinity of the Jews.

Certainly at those other sites they would only have used murex trunculus for purple. The notion that murex trunculus was used for making indigo is both illogical and groundless. Let us examine the archeological evidence.

Mounds of murex trunculus shells (as well as two related species, murex brandaris and purpura haemastoma) have been found at ancient dye sites in many locations. These shells were cracked in the exact spot to get the dye. This is solid proof that murex trunculus was used in ancient dyeing, but does not imply it was used for dyeing blue. A 13th century B.C.E. potsherd from Sarepta has a stripe of dye that is believed to be from the murex trunculus - it is a purple stripe, with no detectable blue (indigo) content.[62] A vat from a dig at Tel Shikmona has purple murex dye on it, not blue as previously described in a brochure from the Petil Tekhelet Foundation (from the picture it is obviously purple, but the text erroneously said blue). Pliny speaks in great depth about dyeing with murex; different shades of purple, red and violet, but not blue.

Petil followers point out that at one site the shells of murex brandaris and purpura haemastoma were together, but the murex trunculus shells were in a different area. They leap to the conclusion that murex trunculus must have been used for dyeing blue. They are ignoring Pliny (among others), who states that the famed Tyrian purple shade was produced by double-dyeing with murex brandaris and purpura haemastoma.[63]

Thus, it was logical that those two species were found together, and apart from murex trunculus. How does that suggest murex trunculus was used for dyeing blue? In fact, it is hard to see how chemical analysis of archeological finds could ever support the idea that murex trunculus was used for dyeing blue. If the chemical is purely indigo, the natural assumption would be that the source was plant indigo, which was used around the world. If indigo was found with traces of purple, it might be suggestive of murex trunculus dye. Murex trunculus dye is naturally a mix of purple and blue, and has to be irradiated to induce a photochemical reaction from which blue dye results. If this process were not completed, the dye would be mostly blue with traces of purple.

However, *murex trunculus* produces dyes with varying mixtures of indigo and purple (brominated indigo). Some batches of dye may turn out to be almost all indigo, and other batches might turn out to be all purple. Thus, even when the intention is to use the natural purple-blue of *murex trunculus*, a particular batch could turn out to be almost pure indigo.

Also, mixing of dyes was common. A mix of blue and purple might be the product of *murex trunculus*, or it might be the mixture of plant indigo with purple dye from other *murex* species. Not only is there no archeological support for the notion that *murex trunculus* was used to dye blue, it may be that it is not even possible for archeological evidence to accomplish this through chemical analysis alone!

It has been suggested that the image of a *murex* shell on a Bar Kochba coin is "apparently irrefutable evidence" that *murex trunculus* was the source of *techeilet*. [64] Why else would a non-kosher species appear unless it was used for a mitzvah? *Murex* dyeing was a major industry, with some regions employing half their population in *murex* fishing. [65]

Moreover, the *murex* was a status symbol, associated with wealth and royalty. Bar Kochba was not original: *murex* images showed up on coins from many places, both before and after Bar Kochba's time. [66] It would appear that Bar Kochba used the *murex* image either for the same reason as others did (i.e. status symbol, commercial importance), or, perhaps, to give his government the appearance of more legitimacy by following the lead of other governments that printed coins with *murex* images.

Linguistic Proofs: Petil followers offer some linguistic arguments in attempting to support their position. The word *chilazon* is a general term for snail, not only in modern Hebrew but in some other languages as well. Aside from not pointing specifically to *murex trunculus*, it is not clear which species *chilazon* referred to at the time of the Gemara. It may have been a general term for mollusk. Did it only include gastropods, or could it have included cephalopods such as octopus and squid? This is unclear.

Petil writings also mention the Septuagint's Greek translation of *techeilet* as *porphyros* (word used for purple or *murex*). Rabbi Herzog raises this issue and dismisses it rather handily. [67] He points out that everywhere else (including that same chapter) the Septuagint uses *iakinthos* for *techeilet* and *porphyra* for *argaman*, and shows how the Hebrew text they must have been given could not have matched our Masoretic tradition, and that the translation was probably given for *argaman*, not *techeilet*.

Some have suggested that Raavya (Berachot 9b Siman 25) equates *techeilet* with *porphyrin*, the Greek word for *murex*, though they do not supply a full explanation of this statement by Raavya and do not mention that in both Greek and Latin the word for *murex* and the word for purple are the same. Let us examine the passage in question.

Raavya quotes a Yerushalmi (a part that is no longer extant) explaining the time for reciting the morning shema: "[from the time when one can distinguish] between techeilet and karti, between porphyrin and parufinen, which is a coat that is called in Latin purpura". A logical explanation of this missing Yerushalmi is that the second comparison between porphyrin and parufinen is a color distinction that would be as hard to tell apart in the dark as blue (techeilet) and green (karti).

Porphyrin is from the Greek word meaning purple. Parufinen, from the Raavya's description, appears to be from the Greek parufaino, meaning "a robe with a hem or border of purple", [68] which is consistent with the hagahot where this color is equated with argaman. Thus, between porphyrin and parufinen might mean to distinguish between the purple border of a robe and the rest of the garment.

Petil suggests that this Yerushalmi is equating murex with techeilet. Obviously they cannot mean that techeilet is the murex, but rather the source of techeilet is the murex. However, this logic would render the Yerushalmi as "between techeilet and karti, between a murex snail and a purple coat". Aside from sounding bizarre, it is difficult to see how a purple coat could be the source of karti. Karti is usually understood to be green, like a leek. [69] There is a minority view that karti is not green, but a different color close to techeilet. [70] However, even if you rely on this view, which is based on a citation from Aruch which is no longer extant, to explain a Yerushalmi that is no longer extant, the wording still doesn't work. Additionally, this would require equating karti with argaman, which does not fit with any opinion. There does not appear to be a way to interpret Raavya's statement as equating murex with techeilet.

Proof by Omission: There is a simple logic that argues against murex trunculus as chilazon. At the times of the Gemara, purple dyeing with murex snails was pervasive throughout the region. This may explain why the Gemara does not mention the source of the argaman (red-purple) dye - everyone knew! Murex snails were famous: Murex dye sold for more than its weight in gold, its shell appeared on many governments' coins, royal edicts were issued to monopolize use of the dye, and Pliny wrote about the murex dyeing process. There was even a well-known term for the murex that was the same in Greek and Latin (porphyra, purpura).

If this species was the source of techeilet, why didn't the Gemara tell us this? Why didn't the Gemara say that the chilazon was from the family of purple-giving snails? Wouldn't this have been simpler and clearer than the signs provided by the Gemara? [71] It is implausible that the Gemara would choose to ignore a well known classification term, opting instead to describe the chilazon through a set of characteristics from which someone might be able to determine the correct species.

SUMMARY

The identity of the chilazon was lost for many centuries. Without a tradition as to the correct species, and without a sample of ancient techeilet, it might not be possible to identify the chilazon with certainty.[72] However, there are minimum requirements that can be expected to be met in order to seriously entertain the possibility of a particular species being the chilazon. Chazal, knowing the identity of the chilazon, chose several distinguishing characteristics to describe it.

For a species to be considered as the chilazon, these criteria would have to be clearly met in such a way that it would have been reasonable for Chazal to have chosen these statements to describe this species. The Gemara also provides chemical tests to distinguish between genuine techeilet and k'la ilan, imitation techeilet. Any techeilet that would clearly fail this test could be rejected with certainty. It would also be reasonable to expect the species under consideration to fit most of the characteristics of the chilazon that can be deduced from sources outside of the sugya of techeilet.

Murex trunculus does not meet any of the primary criteria. Arguments brought in favor of the murex trunculus depend on new interpretations of the Gemara that contradict the classical mefarshim and even the precise language of the Gemara. Even with these explanations, it could not be reasonably stated that Chazal would have chosen these statements to describe the murex trunculus.

The techeilet dye produced by the Petil Tekhelet Foundation must fail the chemical tests provided by the Gemara since it is the exact same chemical as k'la ilan. Additionally, the Gemara's tests were designed to make indigo fail the test, and Petil's techeilet is indigo. Thus, murex-derived indigo as techeilet is an utterly untenable position. This is acknowledged even by the chemist whose work led to the Petil group's formation.

Murex trunculus meets few of the secondary criteria, and archeological evidence provides no support whatsoever for the proposition that murex trunculus was used in the ancient dyeing of blue in general, let alone techeilet in particular.

Since murex snails were famous for their purple dyeing and there was a well-known term for murex, it would seem rather odd that the Gemara chose not to use this term, instead providing descriptive statements that have failed to provide a consensus opinion for many centuries.

In summary, the case for murex trunculus as the chilazon has little merit. Indeed, the evidence against murex trunculus as the chilazon is overwhelming.

FOOTNOTES:

1 Bamidbar 15:38.

2 Menachot 43b.

3 Hebrew: dam. The chilazon has two "bloods", one that is the life blood, and another that is stored in its own sac. This other "blood" is the source of the techeilet dye (Rabbeinu Tam, Tosafot, Shabbat 75a)

4 Menachot 44a, Masechet Ketanot Masechet Tzitzit Ch. 1 Halacha 10, Tosefta Menachot 9:16.

5 Rabbi Isaac Herzog, "Hebrew Porphyrology", in Ehud Spanier, ed., The Royal Purple and the Biblical Blue: Argaman and Tekhelet (Jerusalem, 1987), p.112. Baruch Serman, "The Science of Tekhelet", in Rabbi Alfred Cohen, ed., Tekhelet: The Renaissance of a Mitzvah (New York, 1996), p.70.

6 The Radzyner Rebbe bases this on the fact that gaonim did not write about halachot that were no longer applicable, and two of the gaonim wrote about the laws of tzitzit based on techeilet (Rav Natronei Gaon, Rav Shmuel bar Chofni). He also notes that Rambam explained in a responsum the practical application of the laws of techeilet, implying they were wearing techeilet in Luniel. (Rabbi Gershon Leiner, Sefunei

Temunei Chol. Published in Sifrei HaTecheilet Radzyn (Bnei Brak, 1999), pp. 5-6. A nearly complete English translation of this sefer can be found at <http://www.begedivri.com/techeilet/Sefunei.htm>)

7 Chapter on Rabbi Gershon Leiner in Frenkel, Rabbi Isser, Yechidei Segulah (Tel Aviv, 1967).

8 Ludwig Lewysohn, Zoologie des Talmuds. (Frankfurt, 1858), pp. 283-285.

9 Stermann ibid. p. 73.

10 Herzog ibid.

11 The Petil Tekhelet Foundation maintains an excellent online library on their web site, <http://www.techeilet.co.il> . This library was the source for many of the pro-murex arguments cited here. Their great efforts at publicizing the neglected mitzvah of techeilet is inspiring.

12 Menachot 41-44.

13 Menachot 44a.

14 Herzog ibid., p. 70.

15 Although Rashi states that techeilet is green (Shemot 25:4), it should be pointed out that there were few color designations in the Gemara, and that green represented a color classification that includes blue (Herzog ibid. p.92). Indeed, elsewhere Rashi states the color of techeilet resembles the darkened sky at dusk (Bamidbar 15:41).

16 Masechtot Ketanot Masechet Tzitzit Ch. 1 Halacha 10

17 Serman ibid. p.69.

18 Serman ibid. p.69.

19 Rashi, Shita Mikubetzet and Rabbeinu Gershom, Menachot 44a; Herzog ibid. p.65.

20 Leiner ibid. p.4.

21 Herzog ibid. pp. 69,73.

22 R.J. Forbes, Studies in Ancient Technology Vol 4, 2nd edition (Leiden, 1964), p.120.

23 P. Friedlander, "Über den Farbstoff des antiken Purpurs aus murex brandaris", Berichte der Deutschen Chemischen

Gesellschaft. 42(1909):765-770.

24 Rashi on Menachot 44a.

25 Herzog ibid. p. 70.

26 Aruch on k'la ilan; Nimukei Yosef Baba Metzia 34a; Herzog ibid, pp.94-96, Responsa Ridbaz v2, 685.

27 Menachot 42b-43a.

28 Herzog ibid. p.102.

29 Indigo, to be able to penetrate wool, must first be converted (oxygen removed) into its chemically reduced form, known as "indigo white" (which is really more of a yellow, or yellow-green). After wool is dipped into "indigo white", it is removed from the solution and turns blue upon exposure to the oxygen in the air. 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).

30 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).

31 Rashi on Menachot 44a.

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

33 The Petil writings and web site boast (bold print) of how their techeilet is chemically equivalent to indigo.

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

35 Menachot 42b.

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

37 P.E. McGovern, "Ehud Spanier: The Royal Purple and the Biblical Blue (Argaman and Tekhelet): The Study of Chief Rabbi Dr. Isaac Herzog on the Dye Industries in Ancient Israel and Recent Scientific Contributions", Isis 81:308 (September 1990):563.

38 Midrash Shir HaShirim Rabbah 4:11.

39 Midrash Devarim Rabbah 7:11.

40 Shabbat 75a.

41 Leiner, ibid. p.27. Herzog ibid. p.57.

42 Shabbat 75a and Rashi ad loc.

43 Aristotle, Historia Animalium, Book V, Ch. 15; Pliny the Elder,

Naturalis Historia, Book 9, Ch. 60.

44 Megilah 6a and Rashi ad loc. See also Midrash Bamidbar Rabbah 13:16.

45 Leiner, ibid. p.29.

46 Rambam, Hilchot Tzitzit, Ch.2, Halacha 2.

47 Chulin 89a, Rashi.

48 Leiner ibid. pp. 28-9.

49 Herzog ibid. p.77.

50 Avodah Zarah 28b.

51 Herzog ibid. p.59.

52 Rabbi Gershon Leiner, Ein HaTecheilet in Sifrei Techeilet Radzyn, pp.292-3. That this was known in the times of the Gemara can be confirmed in three 1st century texts: Pliny the Elder, ibid.Book 32:1; Celsus, De Medicina, Book 2:29; Dioscorides, De Materia Medica, Book 2:23.

53 Sepia, cuttlefish ink, is sold in tablet form as a treatment for hemorrhoids. One such store is Vitamin USA of Findlay, OH (www.vitaminusa.com/pharmacy/03-06960-67713.html).

54 Celsus ibid. Book 2:30.

55 Keilim, ch. 12, Mishnah 1.

56 Idem, Rav Ovadiah MiBartenura, Melechesh Shlomo.

57 Leiner, Sefunei Temunei Chol p.27.

58 Bechorot 38a-b.

59 Leiner ibid. p.27.

60 P.E. McGovern, and R.H. Michel, "Royal Purple Dye: Tracing Chemical Origins of the Industry"., Analytic Chemistry 57(1985):1514A-1522A.

61 Ziderman ibid.

62 McGovern ibid.

63 Pliny ibid. Book 9, ch. 62.

64 Rabbi Norman Lamm, "New Discoveries and the Halakhah on Tekhelet"
in Rabbi Alfred Cohen, ed., *Tekhelet: The Renaissance of a Mitzvah* (New
York, 1996), p.23.

65 Franco Brunello, *The Art of Dyeing in the History of Mankind*,
translated by Bernard Hickey (Venice, 1973), pp. 91-92.

**66 Found on Corinthian and Tyrian coins (Brunello, *ibid.*, p.92;
Serman *ibid.*, p.64). Also found on a coin from Taras (Taranto), minted
hundreds of years before Bar Kochba (Brunello *ibid.* p.105) - see coin
at <http://www.geocities.com/~dougsmi/feac50tar.html>.**

67 Herzog *ibid.* p.78.

68 Liddell-Scott-Jones *Lexicon of Classical Greek*,
<http://www.perseus.tufts.edu>.

69 See, for example, Targum Onkelos Bamidbar 11:5, Sukkah Ch. 3 Mishnah 6.

70 Rabbeinu Yonah on Berachot 9b.

71 Herzog *ibid.* p.60.

72 The archeologist Yigael Yadin believed he found techeilet from the Bar Kochba era (circa 135). The unspun, purple wool that he found was subjected to chemical analysis and found to be made of indigo and kermes, a common red dye made from an insect. This combination was a common, inexpensive substitute for the expensive murex purple. It is puzzling why Dr. Yadin thought this was techeilet. The wool was just beginning to be spun. It was not attached to a garment. No white threads were intermingled. Despite Dr. Yadin's imaginative drawings of how this wool was actually partially completed tzitzit, any connection between this wool and tzitzit is pure speculation. See Yigael Yadin, Bar-Kochba: The rediscovery of the legendary hero of the Second Jewish Revolt against Rome.(New York, 1971).