

Identifying the Chilazon¹

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The Disappearance of *Techelet*

Techelet, an integral part of the mitzvah of *tzitzit*, was lost to us many centuries ago. The exact time and circumstances of this loss is subject to historical speculation, but it is known that it was available during the time of the *Amoraim* (which closed toward the end of the fifth century of the common era) and was no longer available at the middle of the Gaonic period (the eighth century)².

1. The majority of the research for this article comes from works of Dr. I. Zeiderman, from an article published in "*Techumin*" volume number 9; Dr. Boruch Serman from his as yet unpublished article "*Tekhelet*"; and Dr. Ari Greenspan from a yet unpublished article. Dr. Serman and Rabbi Greenspan, in turn, derived much of their knowledge of *techelet* from Rabbi Eliahu Tevgar, author of the *sefer Kl'il Techelet* and co-founder of Amutat P'til Techelet.

2. The Gemara *Menachot* 42b-43a discusses the usage of *techelet* and the way that it is dyed, "this *techelet*, how do you dye it?" The Gemara 43a recounts that Mar from Moshke brought *techelet* in the years of R. Achai, and that the *techelet* was tested. Rav Achai was of the last of the *Amoraim* and the earliest of the *Rabanan Savrai*, living during the years of Mar b. Rav Ashi and after (circa 500). If so, this is a piece added by the *Rabanan Savrai*. Had the *techelet* become unavailable at the close of the period of the *Rabanan Savrai* (c. 570), there would have been a mention of this following the episode of Rav Achai. (Even if the Rav Achai mentioned here refers to some *Amora* that lived earlier [highly doubtful], yet, there is no mention of

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The best estimate is that the loss of the technology of the *techelet* dyeing process and/or the identity of the *chilazon* (the specific species needed to make *techelet*) is that it was a consequence of the Arab conquest of 639 CE,³ or perhaps the result of the Christian massacres of 628 CE.⁴

The *chilazon* was never available in Bavel (Babylonia), the center of Jewish population during this era, and until that time *techelet* was imported from *Eretz Yisroel*.⁵ Thus, with the

techelet's being unavailable during the years of Ravina and R. Ashi, c. 470 at the close of the Talmud). We may therefore conclude that *techelet* was available until the end of the talmudic era. On the other hand, the *Midrash Tanchuma Parshat Shelach* laments the loss of *techelet*. The estimated date of the final redaction of *Midrash Tanchuma* is about 750 CE.

3. Suggested by Rav Leiner in his introduction to his *sefer*, *Ptil Techelet*, and by Rav Yitzchok Halevi Herzog, *The Royal Purple and Biblical Blue*, Ehud Spanier, Keter Publishing, Jerusalem (1987). "The Arab conquests of Palestine about 639 entailed the total destruction of the purple dyehouses administered by the imperial official. Was this the real cause of the extinction of *techelet*?" (page 112).

Techelet is the subject of Rav Herzog's doctoral thesis first submitted in 1913 and first published in the *The Royal Purple* (1987) from a microfilm of a manuscript.

4. My own theory. The massacre of 628, which was led by Heraclius and inspired by the monks and the Patriarch Modestus, is recorded by Graetz and other historians of the period. Graetz records "he [Heraclius] instituted a persecution of the Jews throughout Palestine and massacred all that failed to conceal themselves in the mountains or escape to Egypt." (*History of the Jews* Vol III, Page 23). It would seem to me that the closure of the dye factories by the Byzantine government would not have, by itself, brought an end to *techelet* manufacture, but the loss of Jewish artisans would have broken the chain of tradition in the knowledge needed for *techelet* manufacture. However, the subsequent closure of the dye manufacture would have been a factor in preventing its renewal in a subsequent generation.

5. This can possibly be inferred from *Menachot* 42b. Abaya asked

destruction of the *yishuv* in *Eretz Yisroel*, came the ultimate disappearance of *techelet*.

Rav Leiner's Attempt of Rediscovery

In 1887 HaGaon HaRav Gershon Henoch Leiner (the Radziner Rebbe) undertook the monumental task of rediscovering the lost *chilazon*.⁶ After proving from the talmudic texts that there is no reason to assume that the *chilazon* became either extinct or irretrievably lost,⁷ he postulated that the *chilazon* is very likely extant in the waters of the Mediterranean Sea, where it was known to exist at one time. With this theory in hand, he undertook a journey to Italy to visit an aquarium where he might study the various species of fish in order to determine, based on the descriptions culled from talmudic literature, the identity of the *chilazon*.

R. Shmuel b. Yehudah, "How do you dye *techelet*?" It is known that R. Shmuel b. Yehudah spent time in *Eretz Yisrael*, and brought back some of his acquired knowledge to Babylonia (See Hyman, *Toldot Tanaim v' Amoraim* p. 1037. "He [R. Shmuel b. Yehudah] was appointed along with his colleagues Ravin and Rav Dimi to travel to *Eretz Yisrael* and bring back teachings from the Masters"). Abaya, therefore, asked him to describe the process, since R. Shmuel b. Yehudah had been there and seen exactly how the *techelet* is dyed. Had the dyeing been prevalent in Babylonia, Abaya could have gone to see how it done himself.

In addition, since the *chilazon* were indigenous to the Mediterranean Sea, it would have been unavailable in Babylonia.

6. Rav Leiner (1839-1891) wrote three *sefarim* on this subject, 1) *S'funei T'munei Chol* (1887), 2) *P'til Techelet* (1888), and 3) *Eyn Ha'techelet* published posthumously (1891). The first *sefer* introduced his arguments regarding the feasibility of discovering the *chilazon*, and was published before his discovery. The second *sefer* was a defense of his identification of the *chilazon* as *Sepia officinalis*. The third was written as a response to his critics.

7. The subject of his first work, *S'funei Tmunei Chol*.

Despite his great efforts, his formidable erudition, and three treatises that he wrote to support his contention, the Radziner Rebbe's conclusion, that the *chilazon* is the species *Sepia officinalis* (cuttlefish), was met with a great deal of skepticism in his time and years later was conclusively refuted by Rav Yitzchok Isaac Halevi Herzog.⁸ However, his efforts were not all in vain, for in addition to writing the most authoritative work on *techelet* with regard to many facets of this mitzvah, he laid the groundwork for a future generation to seek the *chilazon*.

Recent Attempts at Rediscovery

In recent years, a group of religious scientists who have since formed an association called Amutat Ptil Techelet, took up the task of finding the elusive *chilazon*. They claim that this time the efforts have been met with success.

At the outset, any such claim should be greeted with a healthy dose of skepticism, since even the esteemed Rav Leiner was in error in this very matter and the skepticism that greeted his claim was proven to be quite justified. If so, we must suspect that lesser qualified persons would be at least as likely to come to erroneous conclusions.

However, this should not mean that the claim of the modern discovery should be ignored. Rather, it needs to be examined carefully, and if, after carefully weighing the evidence, it turns out that the claim lacks foundation, it should be rejected. On the other hand, if the evidence in favor of positive identification is overwhelming, then the return of *techelet* should be accepted

8. There can be no doubt that it was Rav Leiner's work that inspired Rav Herzog to devote his doctoral thesis to the subject of *techelet*. No doubt, it was his intention to substantiate his findings, and he was chagrined to discover that the identification of Rav Leiner was erroneous.

by the majority of *shomrei mitzvot*, for this will afford *chovevei mitzvot* an opportunity that has not been available for nearly 1400 years. It should thus be regarded with great excitement and enthusiasm, as a precious and dear element of the mitzvah of *tzitzit* may well have been retrieved.

The Claim

The Ptil Tekhelet Institute claims that a species of snail called by its official Latin name, *Murex trunculus*,⁹ is the *chilazon*. The evidence of this come from a variety of disciplines including history, chemistry, and archeology, intermixed with textual proofs from the Talmud and *Midrash*. An outline of the evidence follows:

1) The Talmud,¹⁰ regarding *tzayadei chilazon* states the following:

..these are the fishers of *chilazon* from Haifa to Sidon.

From this statement we can derive that the natural habitat of *chilazon* was off the shores of what is today northern Israel and southern Lebanon, and what was, in ancient times, Phoenicia.

2) It is documented that the center of the dye industry in the ancient world was Phoenicia.¹¹ The most famous of the

9. *Murex brandaris*, a sister species to *Murex trunculus*, will also fill all the specifications laid out in this monograph. The contention is that the *chilazon* is identified with both of the two murex species since each of these has brominated indigo as natural chemical in its mucus, from which the murex-derived indigo can be extracted.

10. *Shabbat* 27a.

11. Pliny the Elder, *Natural History*, Book IX, pages 40-45, is one of the earliest recorded sources. Aristotle in *De Animalibus Historia* also gives a detailed description of the Phoenician dyeing processes. Also in Strabo, *Geography*; Jones, H.L. Ed.; Loeb Classical Library;

dyes was Tyrian Purple, an extremely expensive dye that was in great demand by the nobility and the extremely wealthy, as it was unique in its beauty and color-fastness.

3) If one opens a *Murex trunculus* snail and squeezes the hypobranchial gland one will obtain a clear mucus.¹² This mucus, if taken out of the shell and exposed to the air, will change from its clear color to yellow, then to green, then to blue and finally to purple.¹³

4) In the late 19th and early 20th century, there were archeological findings of enormous numbers of broken *Murex* shells discovered near the cities of Sidon and Tyre.¹⁴ These were buried in large pits and each broken opposite the hypobranchial gland—a manner consistent with the method needed to extract the dye material found naturally in these snails (and inconsistent with the method employed for its use as a food). The pit near Tyre contained broken shells of *Murex*

Cambridge, 1930 XVI 2,23.

12. *Shabbat* 75a states that the dyer does not want the *chilazon* to die in the process of extracting the "blood" because he wants the dye to remain clear. This indicates rather strongly that the 'blood' or mucus extracted is clear and that it would not remain clear long after the death of the *chilazon*. See also Tosafot *ad. loc.* regarding the "blood" of the *chilazon*, stating that it does not mean the lifeblood but a secretion.

13. J. Wilfrid Jackson, F.G.S "The Geographical Distribution of the Shell-Purple Industry," taken from Volume 60, Part II of *Memoirs and Proceedings of the Manchester Literary and Philosophical Society*, Session 1915-1916.

14. Jackson, *ibid*, writes that archeologist L. Lortet reported (*La Syrie d'aujourd'hui*, Paris 1883 pg. 102) finding in the vicinity of Sidon great banks, a hundred yards long and several yards thick, composed entirely of broken shells of *Murex trunculus*; and in Tyre, H. B. Tristram (*The Land of Israel*, 1882, pg. 48) reports that large quantities of crushed *Murex brandaris* shells were discovered.

brandaris and *Thais haemastoma* (a third type of *Murex* which yields a reddish dye) shells while the pit near Sidon had *Murex trunculus* shells exclusively. Off the coast of Lebanon and Northern Israel these same species can be found even today.

Now, from these facts alone, we have no identification whatsoever regarding the *chilazon*. It stands to reason, of course, that these snails must have been used in the dye industry of ancient Phoenicia, since such vast amounts of snail shells broken in a peculiar manner buried in pits can only mean that these snails were used in the dye industry. But the color that results from these snails is purple, not blue. Purple is the color of *argaman*, an important dye in halacha, as this was needed for the *bigdei k'hunah* and other sacred objects. *Techelet* is assumed by tradition and verified through a host of other sources, to be a blue dye, and not purple.

The last piece of the puzzle came to light about 15 years ago when it was discovered that if the dye obtained from *Murex trunculus* is exposed to direct sunlight during the dyeing process, the resultant dye changes from purple to blue.¹⁵

Chemically, after exposure to oxygen the dye of the *Murex trunculus* is dibromoindigo, with a certain amount of indigo intermixed. In the process of making the dye substance water soluble, the dye must be reduced (deoxidized). If, in the reduced state, it is exposed to sunlight, the sun's ultraviolet rays have the power to unbind the bromide atoms from the indigo molecule, leaving the remaining chemical dye, indigo. This indigo is chemically identical to plant-derived indigo, and the dye is therefore the identical color. Plant-derived indigo has

15. The discovery was made in the early 1980's by Otto Elsner and Ehud Spanier while doing research in ancient dyeing techniques. (See *Tekhelet* by Baruch Sterman).

the Hebrew name *k'la ilan*.¹⁶ *K'la ilan* is the false *techelet* mentioned several times in the Talmud, and which is obviously identical in color to *techelet*.

With this, we now have sufficient grounds to identify *Murex trunculus* as a very likely candidate for *chilazon*. 1) It is known that this species was found near Sidon. 2) The remains of a dye factory near Sidon had thousands of *Murex trunculus* shells. 3) This shell produces a dye that can be converted to a blue indigo dye without much difficulty; and 4) This dye is chemically the same as *k'la ilan*, which the Talmud states is the same color as *techelet*.¹⁷

We need also realize that before the 19th century, when Henry Perkins opened the field of synthetic coal-tar dyes, there were very few natural dyes available.¹⁸

That *chilazon* was a shell fish (mollusk) is shown by inferences in the Talmud and Midrash. For one, the Midrash says that the shell (*nartik*) of the *chilazon* grows with it.¹⁹ Second, the Talmud²⁰ says that one who cracks open (*ha'potzeiah*) a *chilazon* violates the Shabbat. The word *potzeiah* from the word *petza*, means to strike with force. When applied to opening a *chilazon*, this word implies cracking something open, as in *p'tziat egozim* (cracking open nuts). If an animal is cracked open, it must have a hard shell to crack, otherwise the term to "cut"

16. The positive identification of *k'la ilan* as indigo comes from the Aruch who states this identification explicitly on the entry *k'la ilan*. Cf. *Radvaz Responsa 2: 685*.

17. *Bava Metziah 61b, Menachot 42b-43a*.

18. *Encyclopedia Britannica*, entry "Dyestuffs and Pigments," mentions 10 to 12 materials that were in use prior to the 19th century. Indigo and the *Murex* dyes were among these.

19. *Psiktah d' Rav Kahana 11:21*.

20. *Shabbat 85a*.

(*lachtoch*) or merely to "open" (*liftoach*) would be employed.

The Talmud also says that "the treasures buried in the sand" (Deuteronomy 33:19) is a reference to *chilazon*.²¹ Snails do burrow into the sands of the shallow waters.

Further support that *chilazon* is a snail (or conch) is that in some Middle Eastern languages, (Farsi and Assyrian²²), the word for snail or conch is *chilazon*.²³ Middle Eastern languages, as Latin languages, often share nouns in common.

A further linguistic proof comes from a statement by the Raaviya²⁴, who quotes a *Yerushalmi* identifying *techelet* with the Greek word *propherin*. *Propherin* is the Greek word for *Murex*.

Chilazon is known to be an uncommon species. This is true of *Murex trunculus* and *Murex brandaris*, for these are found only in some areas off the Mediterranean coast²⁵ and are difficult to obtain in the large quantities needed for dyeing.²⁶

Further, the Talmud tells us that the dye needs to be extracted while the snail is yet alive, or soon after.²⁷ This is in total agreement with the nature of the mucus of the *Murex trunculus* and *Murex brandaris*, since in order for the color changing

21. *Megillah* 6a.

22. A language evolved from Aramaic.

23. From discussion with an Iranian Jew and an Assyrian.

24. *Berachot* §25.

25. In fact, the government of Israel prohibits the catching of *Murex trunculus* off the coast of Israel as it is considered an endangered species.

26. So much so that, in ancient times, the value of wool dyed by the *murex* extract was worth many times its weight in gold. McGovern and Michel, *Acc. Chem Res.* 23, *Royal Purple Dye; The Reconstruction of the Ancient Mediterranean Industry* 152-157 (1990).

27. *Shabbat* 75a.

processes to develop, a specific enzyme, purporase, must be present. This enzyme deteriorates soon after the death of the *Murex* and if the exposure to the air does not occur within a few hours, the mucus will not develop into dibromoindigo.²⁸

Putting this all together, when looking for *chilazon*, we are seeking a mollusk, or more specifically a snail, that was found off the coast of ancient Phoenicia, that was used in the dye industry, that is difficult to obtain, and that can produce a blue dye that is identical in color to indigo and which must be squeezed from the snail while yet alive or immediately after the death of the snail. All these match *Murex* and no other known mollusks.

But, one may argue, even granting all this, we still do not have positive identification for *chilazon*. One might suggest that the true *chilazon* is a yet-undiscovered mollusk and that *Murex*, although it can produce a blue indigo dye, is *possul* for

28. Dr. Boruch Sterman, *Tekhelet*. In correspondence to me, Dr. Sterman stated that he asked eminent biochemists and they confirmed that if left in the body of the *Murex*, the enzyme purporase (needed for the production of the indigo molecule) could not survive very long after the death of the *Murex*. According to Joel Yisraeli, professor of Microbiology, this deterioration would take place in a matter of minute. He explains, "Inside a cell there are proteins whose job it is to eat up and decompose other proteins. In order for the cell to function, the protein eaters must be suppressed (by other proteins, of course). As soon as you turn off the suppressors, the eaters go to work and chomp away at a very fast rate. Whenever I cut into a cell, if I haven't chemically found some way to suppress the eaters, then everything is gone within minutes." It should also be noted that both Aristotle and Pliny reported the same phenomena with regard to *Murex* and noted that the dyers seek to remove the dye from the *Murex* while the snail is still alive. However, actual experimentation to determine the rapidity of deterioration has not been done to the time of the writing of this article. It is hoped that this will be done in the not-distant future.

techelet nonetheless, since this is the wrong mollusk. After all, it is possible (even if highly improbable) that two different mollusks have the same chemical in the mucus and share all the other characteristics stated above.²⁹

Rav Herzog, in his thesis, argues quite forcefully that this is a fallacious argument, for the following reason:³⁰ Surely, the *chachmei ha'mishna* were well aware of the dyes produced just north of them in Phoenicia. Now, if the dye produced by the *Murex* is indeed *not* valid, then, just as the Mishna admonished against the use of *k'la ilan*, the Mishna would have admonished to avoid the use of the "*possul*" mollusk and would have described the differences between the two species³¹ (as the

29. Rav Tevgar in his *sefer, K'kil Tekhelet*, argues quite forcefully that this suggestion is untenable, since all mollusks in the Mediterranean have been discovered. This is known because marine biologists have continually searched and continue to search the Mediterranean Sea for new species of all types, and no new species of mollusks have been discovered for many decades (other than on rare occasion those which have migrated from the Atlantic due to storms or other rare events). The only new discoveries in recent decades have been micro-organisms scarcely visible to the human eye. The likelihood that there is a yet-undiscovered mollusk indigenous to the Mediterranean that is the true *chilazon*, must be dismissed as more than remote.

Rav Tevgar argues further that the word *chilazon* implies merely that *techelet* must be produced from a snail, not any specific snail, and if in fact there are two different snails that can produce *techelet*, then either would be valid for *techelet*!

30. *The Royal Purple*, page 74.

31. Understandably, the concern for the use of *k'la ilan* as a substitute for *techelet* would be a far greater concern, since plant indigo is inexpensive and *murex* is presumably as expensive as our hypothetical *chilazon*; there would therefore be no profit motive to substitute the real *chilazon* with *murex*. Nonetheless, it stands to reason that if there were two different species both capable of producing an indigo dye and both sharing so many similarities, that the Talmud would have

Talmud took the trouble to identify the differences between the *arava* and the *zafzafa*.³² Needless to say, there is no such Mishna or *Braitha* that does so. The absence of such a dictum is a strong indication that there was indeed only one known mollusk that was used for the blue dye and if so, this was *Murex*.

Rejection of Sepia as *Chilazon*

As mentioned earlier, the Radziner Rebbe, Rav Gershon Henoch Leiner, identified the *chilazon* as the common cuttlefish, *Sepia officinalis*. He amassed impressive evidence to prove this, and in fact, many were convinced by the weight of his evidence and the strength of his conviction.³³

Rav Yitchok Herzog, who studied Rav Leiner's *sefer* with great interest, subjected his argument to rigorous analysis. He obtained some samples of the Radziner *techelet* and sent them to three different laboratories in three different countries, for chemical analysis. The results astonished him. It turned out that all three laboratories came to the same conclusion — the dye claimed to be *techelet* was in fact a well-known synthetic dye known to the world as "Prussian Blue", first synthesized in 1704.³⁴ He then sent a letter to the Radziner's son (Rav Gershon Henoch had passed away in 1891) asking for the exact process by which the *techelet* was made. He received a reply

been concerned that an error would be made by those involved in producing the dye in thinking that there is no halachic difference between them and would have warned about this possible error.

32. *Sukkah* 34a.

33. The Marsham, (the Bezhana Rav, HoRav Sholom Mordechai Schwadron) and Rav Itzel Ponevizer, both universally recognized *gedolei ha'dor*, wore these *Sepia*-dyed *techelet*. (Heard from Rav Dovid Kohn.)

34. The chemical formula for Prussian Blue is $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3 + 12\text{K}^+$.

from one of the manufacturers as to the exact method. Rav Herzog's further investigation into the process led him to understand that the *sepia* ink had little to do with the final product, and that it was the chemicals added to the mixture that were, in fact, the basis for the resultant dye. The *sepia* ink is not a necessary ingredient for the dye produced by this process. Any organic compound will do, and in fact the original Prussian Blue was manufactured using ox blood as one of the ingredients.

Rav Herzog, recognizing the greatness and integrity of the Radziner Rebbe, suggested that Rav Leiner must have enlisted the help of a chemist in order to find the method to change the black ink to blue. The chemist did his best by introducing the chemicals needed to synthesize Prussian Blue.³⁵ Rav Leiner assumed that since the added chemicals had no intrinsic color (they were either clear or white) that the blue color is inherent in the black ink. The chemicals added only removed the impurities from the *sepia* ink and what was left behind was a pigment extracted from the *sepia* itself. He was therefore convinced that the Prussian Blue dye that emerged from the squid ink is the *techelet* that he sought for so long.

It is obvious, however, that the secretion of the *chilazon* that makes *techelet* must be the basic dye itself, not an inconsequential ingredient that can be supplied by any organic source.

Although this in itself is more than enough to discredit the Radziner Rebbe's theory, there are quite a number of other discrepancies that make this identification highly questionable.

35. The chemicals added to the mixture are iron, potash, ammonium chloride, muratic acid, sulfuric acid, and tartaric acid. The only element to which the organic compound (be it *sepia* ink or any other organic substance) contributes is nitrogen.

For one, cuttlefish are quite common and were, in fact, a source of common ink at one time.³⁶ The Talmud indicates that *techelet* was very expensive, so much so that even the few threads for *tzitzit* amounted to an expense.³⁷ This does not square with cuttlefish ink.

Second, the Talmud says that “the treasures buried in the sands” refers to the *chilazon*.³⁸ Cuttlefish cannot exist in sand.

Third, the cuttlefish does not have an external shell³⁹, and it appears from the Talmud that the *chilazon* has a hard shell which needs to be cracked in order to obtain the dye.

Last, the *techelet* is known to be a very permanent dye, while the Prussian Blue will wash out with soap. (The Radziner Rebbe addresses these issues, of course, but gives answers that are quite forced.)

Rav Herzog’s Thesis

As we noted earlier, Rav Herzog’s doctoral thesis was on the subject of *techelet*. After refuting the claim of the Radziner Rebbe, he investigated other possibilities and set forth as a final point, his own hypothesis. In his thesis he came close to suggesting that *Murex trunculus* was indeed the *chilazon*. However, due to four difficulties in this identification, he was forced to reject *Murex trunculus*. The greatest of the objections is that the dye of *trunculus* is purple, not blue. The second

36. *Encyclopedia Britannica*, entry “Cuttlefish.”

37. *Menachot* 43b. This is further adduced by the concern for counterfeit *techelet* of indigo, mentioned earlier.

38. *Megillah* 6a.

39. Though it does have an internal shell, called the cuttlebone, one does not need to break this bone in order to get the ink out of the ink sac.

objection is that the dye is not especially permanent. The third objection is based on a statement of the Talmud that “the body of the *chilazon* is like the sea.”⁴⁰ Rav Herzog understood this to mean that the color of the *chilazon* is like the color of the sea (blue). *Murex trunculus* shells are not blue but rather a light brown color. The final objection is that it does not appear “once in seventy years” as the Talmud says is the nature of *chilazon*.⁴¹

The first two objections have, with new knowledge, been adequately answered. As noted earlier, the *trunculus* dye is indeed purple, but if the dye is subjected to sunlight it will turn blue in the dyeing process. The second objection, that it is not especially fast, is simply not so. Rav Herzog was ill informed as to the fastness of the dye by someone who did not study the dye sufficiently.⁴² In fact, if properly prepared with the correct reduction agents, (chemicals used to treat wool to absorb the dye) the dye is extraordinarily fast. In a recent test, a thread of *techelet* was bathed for three days in strong bleach solution without the slightest effect.⁴³ The third objection has been answered by viewing the snail in habitat. The snail in the water will take on a blue-green color due to the sea-fouling organisms. The snail that Rav Herzog had in hand was evidently cleaned of its fouling and therefore did not have the appearance of the sea.

The last of the objections remains, for we do not know of

40. *Menachot* 44a.

41. *Ibid.*

42. It is very likely that the dye was tested in cotton, which does not absorb the indigo very well.

43. Verified by personal experimentation. The dyed wool was soaked in a strong bleach solution. Pure bleach will dissolve the wool itself.

any comet-like appearance of *Murex trunculus* or *Murex brandaris*. However, several suggestions have been made to explain what the Talmud might have meant by this. In any case, the Rambam, in identifying *techelet* did not mention this as one of the identifying features of the *chilazon*, and the Radziner Rebbe, in identifying *sepia*, gave an interpretation that would fit the *Murex* equally well.

It is clear that one did not need to wait seventy years to get the *chilazon*, for an industry existed upon its basis, and it is obvious that no industry can exist where the supplies become available only once in seventy years. Rather, it seems that the Talmud is saying that only rarely *chilazon* come up ashore and become available in abundance.

Some speculative answers as to why this may be include, perhaps this could be due to reproductive patterns that we are not yet aware of, or perhaps the Talmud was referring to a rare storm or other such rare occurrence that would cause the *chilazon* to come ashore in large numbers.

Rav Herzog concluded his thesis without an identification of the *chilazon*, but left open a suggestion that it might be a snail called *janthina*, which has a violet colored shell. He suggested that perhaps the mucus of this snail may have the properties needed to create a blue dye. In addition to the blue color of the shell, one other feature is striking with regard to the *janthina*. This species often live in large groups that are attached to one another. In rare occasions, they are known to wash ashore by the millions. This could easily be what the Gemara means by the description of "once in seventy years", meaning, as we would say, "once in a lifetime". Rav Herzog noted that the Talmud does not state, when giving the reason for the enormous expense of *techelet*, that the amount of snails

needed is immense,⁴⁴ but that the occurrence of the species is rare.

Nonetheless, Dr. Sterman writes that modern research has shown that *janthina* could not have been the *chilazon*, for, among other reasons, although it does secrete a blue liquid, it does not produce a dye that can be used to color cloth, for this fluid turns brown after a few minutes and, in addition, is water soluble. Chemists have not found a way to use the secretion as a viable fabric dye.⁴⁵ Moreover, this species lives by floating on the water, and will drown underwater. It cannot, therefore, live in the sand, and the scriptural description of *sefunei t'munei chol* cannot describe the *janthina*.

The Color of Techelet

While the color of *techelet* is thought to be blue by virtually all, one of the modern scholars who has done pioneering work in this field, Dr. I. Zeiderman, (in an article published in *Techumin* volume 9) has suggested that it is not so. In that same article, he marshals much evidence to prove that *Murex trunculus* is indeed the *chilazon*, but argues that the color of *techelet* is not blue but rather purple with a bluish shade (*segol hanota l'kchol*).

To this, he presents the following argument:

The Talmud asks how one can distinguish between *k'la ilan* and *techelet*.⁴⁶ The Gemara then gives a method of chemical

44. It does take about 30 *murex trunculus* to extract enough dye for the four threads needed to make one pair of *tzitzit*.

45. H.K Mienis and E. Spanier, "A Review of the Family Janthinidae in Connection with the Tekhelet Dye," *The Royal Purple*, p. 197. Confirmed with correspondence between Dr. Sterman and the late Dr. Otto Elsner.

46. *Menachot* 42b-43a.

testing. The threads are soaked in a series of chemicals. If the color does not fade, then it is *techelet*. If it does, then it should be subjected to another series of chemicals. If the color becomes bright again, it is *techelet*. If it remains faded, it is *k'la ilan*.

Now, if the dye obtained from *trunculus* is indeed indigo, then it would seem that it would be impossible for there to be any difference at all between the two. Any chemical that will fade one will fade the other, and similarly. Equally, any chemical that will not fade one will not fade the other.

However, if the color of *techelet* is purple, then we can understand that the artificial *techelet* is made from a combination of the indigo dye with a red dye. It is the red dye that will be affected by the chemicals stated in the *gemorra*, and that is why the pure *techelet* will stay fast while the ersatz *techelet* will fade.

R. Yehudah Rok of Yeshivat Har Etzion, in disagreement with Dr. Zeiderman, brings much evidence that the color of *techelet* is indeed a pure blue. Among his proofs is the fact that Rambam states that the color of *techelet* is the color of the sky, and that the Gemara says the color is like that of the sea. Neither the sky nor the sea are purple or any shade of purple.⁴⁷ Further proof may be adduced from the fact that it has been translated as "blue wool" by tradition, a point raised by Rabbi Leiner in his work against those who have claimed in his time that *techelet* was green or black. The Greek translations, made yet when *techelet* was extant, also translate *techelet* as "*iakinthos*", which, when transliterated into modern language is "hyacinth"

47. Zeiderman suggests that immediately after sundown the sky is indeed a shade of purple due to the mixture of the red rays of the sun and the blue sky. Even if so, this does not explain the match with the color of the sea, and with regard to the sky's color seems to be quite forced. The Rambam states clearly the color of the sky while the sun shines. (*L'ein ha'shemesh*).

which is known to be a blue colored flower.⁴⁸

R' Yehuda Rok, acknowledging that Dr. Zeiderman does have a point, contends, correctly, I believe, that the direct evidence in favor of blue *techelet* far outweighs the indirect evidence he advances to identify *techelet* as purple.

Possible answers to solve the riddle of the chemical testing cited by the *gemorra* may lay in variant methods used for dyeing with indigo rather than in the dye itself.⁴⁹ It is also possible that although the dye chemical of both the *Murex trunculus*

48. Hyacinths come in a variety of colors; however this is a relatively recent phenomena as botanists have cultivated and created many new types of hyacinths. However, even today, most of the hyacinths are blue. *Encyclopedia Britannica* states, (entry "Hyacinth"), "Most species have...fragrant flowers that usually are blue but may be pink, white, or other colours in cultivated varieties." We may be sure that if someone wanted to describe a color by the familiar flower, the hyacinth, in ancient times, it was blue that was meant, even if there was, even at that time, variants in the color of the flower. By analogy, if one were to describe a particular color as "the color of the rose" everyone would understand that a deep red color was meant, despite the fact that there are pink, white and yellow roses available in the flower shops.

49. In correspondence to me Dr. Sterman wrote the following: "Though we are not one hundred percent certain, it would appear that snail *tekhelet* and indigo were reduced in different ways. *Tekhelet*, since it comes from a snail, may have been reduced chemically using lead and tin pots with the sulfuric reducing agent found in the glands of the snails. (This seems to be what Pliny describes.) Indigo, on the other hand, comes from a plant and has no proteins or sulfur compounds. Up till a few tens of years ago in America, and still in some African countries, indigo was reduced by fermentation, using bran, madder and sugars to cultivate the bacteria necessary to reduce the dye. These differences may have had something to do either with the way that the dye adhered to the wool, or perhaps to some extraneous chemicals found in the dyed wool (maybe in the snail *techelet*, or just as possibly in the plant indigo.)

extract and the indigo plant are identical, nonetheless, the impurities that are inherent in both the animal and vegetable materials may have some effect upon the take of the dye into the fabric.

Other Objections

One of the major points raised by Rav Leiner in support of his theory is that the Rambam states⁵⁰ that the color of the secretion of the *chilazon* is black like ink.⁵¹ This identifies quite well with *sepia* and not at all with *Murex trunculus*. On the other hand, however, Rashi and Tosafot⁵² both seem to state that the color of the *chilazon* extract was blue, not black,⁵³ a

50. *Hilchot Tzitzit* 2:1.

51. It should be noted that we do not know the source for the Rambam, a point that led Rav Leiner to speculate that the Rambam had himself discovered the *sepia* and obtained *techelet* from it – for otherwise how would he have known that the "blood" of the *chilazon* is black. There is no known *midrash* or any other source that indicates that the color of the "blood" of the *chilazon* is black? One can only speculate that the Rambam took this information from a secular source (as he did in a few other cases with regard to factual matters as he states himself at the end of *Hilchot Kidush Hachodesh*, which was taken from Ptolemaic astronomy), and that this source was, perhaps, itself either corrupted or faulty. In fact, Aristotle does say that "in the northern part they give a black dye and in the southern parts red." Vitruvius, an Aristotelian scholar, says that Aristotle was referring to the color of the dye, not the shell of the mollusk. (Aristotle, *Di Animalibus Historia*, p. 175). Rav Herzog makes the same speculation, page 77.

52. *Menachot* 42b. See also *Eyn Hatechelet* section 22 for a discussion concerning the Rashi and Tosafot.

53. Where the *Braitha* tells us, "One brings the "blood" of the *chilazon* and chemicals," Rashi states that it is the manner of dyers to soak the wool in *tzarif* to enable the wool to absorb the dye. Now, if Rashi would agree to the Rambam that the "blood" of the *chilazon* is

point conceded by Rav Leiner in his *sefer, Eyn Hatechelet*.⁵⁴

Another objection can be deduced from a notable statement of Rabbenu Bachya with regard to why silk was not used in the construction of the *mishkan*.⁵⁵ He answers that silk, since it is derived from a worm, which is an impure species, would not be fitting for the *mishkan*. He then asks that if so, why is *tola'at shani* used to make the red wool? He answers that the color does not come from the worm itself, but from a shell in which the worm is contained. Evidently, Rabbenu Bachya would

black, there would be no need to explain the need of the chemicals brought with the "blood" of the *chilazon* to be for the sake of the wool, as it is needed for the dye color itself! Tosafot, *ad. loc.*, ask how the use of chemicals is allowed in the *chilazon* blood. Wouldn't the chemicals be an additive to a pure substance, and therefore render the dye *possul*? Tosafot answer, "perhaps the *techelet* is by its definition a mixture of these chemicals." Now, if the "blood" of the *chilazon* is black, then the question of Tosafot doesn't begin to make sense. Of course chemicals are needed, for without the chemicals the *chilazon* "blood" produces the wrong color!

In fact, in order to dye with the *murex*, as with any vat dyeing process, chemicals do need to be added to the dye itself. Dyes are, by nature, insoluble in water, for a colorant that is soluble in water would not be much good as a dye, as it would wash out of the cloth when soaked in water. This leads to a problem. How do you get the dye into the fabric? In order to soak or cook the dye into the fabric, you do need to dissolve the dye in water. A dye cannot be both water soluble and insoluble at the same time! The solution to this problem is to alter the chemical make-up of the dye temporarily by reducing the dye (that is, to introduce a base chemical that will remove the oxygen from the chemical compound that is the dye, and change it into a different chemical temporarily). This new chemical will be water soluble. The fabric is soaked in the reduced solution (which, in this case, will have a green color) until the fabric has well absorbed the dye. When the fabric is then removed from the water, the oxygen from the air will combine with the reduced dye and it will revert back to its original chemical makeup, turning back to the blue indigo. The transformation is immediate and complete.

have to assume that the *chilazon* is also a type of a kosher species, for otherwise how could it be valid for the use of dyeing the priestly vestments and the *mishkan* itself?⁵⁶ However, Rashi says explicitly that the *chilazon* is a type of *tola'at* (worm).⁵⁷ It does not seem possible to reconcile Rashi's opinion with that of Rabbenu Bachya. In matters of fact, such as whether or not *chilazon* is a kosher species, both cannot be correct.

Another objection that can be raised is that the Talmud states that "the body of the *chilazon* is like the sea and its creation is like a fish."⁵⁸ How does this statement square with *Murex trunculus*?

The first half of that statement has been discussed earlier, that the color of the shell, in the water, is indeed like the color of the sea. The second part of the statement was taken by Rav Leiner to mean that the nature of the species is similar to that of a fish, a fact that can easily be regarded as consistent with *Sepia officinalis*; but in which way could this be true with regard to *Murex trunculus*? Perhaps the "creation" means its coming into being, i.e. its method of birth. *Murex trunculus*, like fish, are spawned from eggs.

Other Halachic Considerations

When the Radziner Rebbe took his findings to the *gedolei Yisrael* of his time, he met with some measure of resistance. Among the most significant responses were those of the Kutna Rav (Rav Yisrael Yehoshua Trunk, known as Reb Yehoshua

54. He says that we can ignore both Rashi and Tosafot. Since both did not have the *chilazon* they were unable to do anything but guess at the color of the dye, and blue would be a logical assumption. The Rambam, who says that it is black, must have had a better source for his information

Kutna, author of *Yeshuot Malko*) and the Brisker Rav, Rav Yosef Ber Soloveitchik (author of *Bet Halevi*).

The Kutna Rav's rejection was based on the fact that the dye was made with added chemicals, and he quoted Rashi and Tosafot as inferring that the color of the extract of the *chilazon* itself was the dye color.

As we have seen, the Kutna Rav's argument was exactly on target. His suspicion, that the chemicals added were the main coloring agent and that the *sepia* was therefore not the *chilazon* was the very same objection that Rabbi Herzog raised and substantiated. 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.

The *Bet Halevi's* objection is a more complicated one. In fact, exactly what he said is also a matter of disagreement, and quite unverifiable, since there is no written record. His letter to the Radziner was not printed verbatim in the Radziner's third *sefer*, but was paraphrased. Rav Yosef Ber Soloveitchik had a somewhat different version regarding the objection of his great-grandfather.⁵⁹

According to the Radziner Rebbe, the objection of the Brisker Rav was as follows. In order to accept that *Sepia officinalis* is the *chilazon*, we will have to explain why it was not available during the 13 centuries that it was not used. For if it was available, then the very fact that it was not used during this entire time is ample proof that *sepia* is in fact not the *chilazon*.

59. See *Nefesh Harav* by HaRav Hershel Schachter. It is quite possible, of course, that he had two objections, and only the stronger objection was communicated in writing to Rav Leiner, while the second was communicated orally to his son and remained a family tradition.

The Radziner countered that he did indeed explain that the science of making a blue dye out of the black ink was indeed lost, and that it was only after much effort that he rediscovered the process. In addition, the identification of the fish itself would have been lost over the period of time, since the loss of one element (the process) would have eventually resulted in the loss of the second (the identification of the species).

It would appear that the Brisker Rav was not satisfied with this answer, for the *sepia* is a common sea animal and was available in many places in the world where Jews lived. Evidently, it did not seem reasonable to him that the *sepia* would be so unavailable that the science of making the dye would ever have been lost.

This objection does not apply to *Murex trunculus*, which is an uncommon species. Had a generation elapsed without Jews in northern Israel, as did happen in the sixth century of the Common Era, then the identification of this species would have been forgotten to all the sages who lived in Babylonia and other countries of the Diaspora.

According to Rav Yosef Ber Soloveitchik, the objection was much more basic. The reason he did not accept *sepia* was simply because we no longer have a *mesorah* (tradition) with regard to the identity of *chilazon*, and without a *mesorah*, we cannot know that we have identified the *chilazon*.

The Radziner did not counter this objection because it was not presented to him. However, one might argue on his behalf that one does not need absolute certainty in halacha with regard to the establishment of a factual matter, but rather all that is ever needed is a reasonable basis. Indeed, the principle of *rov* (that we follow the majority) or *chazaka* (that we follow the *status quo*), the two most used instruments of halacha in matters of *issur* and *heter*, are prime examples of where the halacha instructs us to follow reasonable assumptions even though there

is no certainty of fact.

The halachic basis for identifying *chilazon* is simple — the evidence has created an *umdana d'muchach*, a relative certainty that exceeds the power of *rov*. *Rov* is not a sufficient basis, for example, to decide a monetary issue against a defendant (*muchzak*) yet an *umdana d'muchach* can be sufficient evidence according to some opinions.⁶⁰ If so, in matters of *mitzvot* or even matters of *issur*, where *rov* is sufficient to determine a matter of fact, all the more so may one rely upon an *umdana d'muchach*.

Moreover, although it must be acknowledged that *mesorah* is a very strong force in halacha, by no means does a *mesorah* create a certainty of fact. For example, what could be a greater matter of *mesorah* than the method of making *t'fillin*? Only *soferim* are involved and each *sofer* was trained by an older *sofer*. Yet, although the order of the *parshiot* in a set of *t'fillin* must be correct for the *t'fillin* to be valid, there is a lack of absolute certainty as to what is the correct order, with no fewer than four differing opinions.⁶¹ If the halacha would demand absolute certainty in the essential elements of a mitzvah, then we would not wear *t'fillin* today because there is an area of disagreement as to the correct order of the *parshiot*. But we do wear *t'fillin*. Evidently, the framework of halacha allows for the possibility

60. See statement of Shmuel, *Bava Batra* 93a. It should be noted that a reverse *s'vara* is stated there according to Rav; however in matters of jurisprudence, the halacha follows Shmuel.

61. There is a dispute between Rabbenu Tam and Rashi whether the order is *Kadesh, V'haya ki Yeviacha, Shma, V'haya im Shamo*, or *Kadesh, V'haya ki Yeviacha, V'haya im Shamo, Shma*. In addition, there is the opinion of the *Shimusha Rabba* that the order is right to left from the standpoint of the one who wears the *t'fillin* rather than (as assumed in practice and based on our text of the Talmud) from the standpoint of the reader (facing the one who wears the *t'fillin*.) This makes, therefore two possibilities for each of the two orders.

of error, and instructs us to follow the most reasonable likelihood, be it based *on rov, chazaka, umdana*, or any method of determination of fact accepted within the halachic framework.

Conclusion

The argument for identifying *chilazon* as *Murex trunculus* has much merit. However, it cannot be said this identification can be 100% absolute, both with regard to the species or even with regard to the color. Nonetheless, the element of certainty would seem to surpass the threshold needed for identification *l'halacha*. Moreover, there is no *issur* in wearing a blue colored thread in the *tzitzit*, even if it turns out that this is not *techelet*, a point made poignantly by the Radziner Rebbe, in his *sefer, Ptil Techelet*.⁶²

As with anything that is not definite, this matter is likely to be controversial for a long time to come. If I may offer my own humble opinion it would seem that this identification ought to be accepted by many, if not the majority of *poskim*. But it will likely take much time for this to happen, for halacha is by its very nature conservative, and in general, a consensus is reached only after much debate and deliberation.

62. As Rav Leiner states in *Eyn Hatechelet* and in *Ptil Techelet*, the curse meted out for those who use *k'la ilan* in their *tzitzit* and claim that they are wearing *techelet*, is meant for those who are intent upon deception, not those who are making a sincere attempt of fulfilling the mitzvah.