BLOOD, FROGS, AND LICE

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This article analyses the initial three plagues through the eyes of various Torah commentaries and synthesizes scientific explanations within the discussions. The approach, noted by Rav E. Munk [1], is as follows: "In the miracles recorded in the Torah, the supernatural is often interwoven with the natural and the plagues may be defined as miraculously intensified forms of the diseases and other natural occurrences encountered in Egypt." Rav E. Dessler [2] explained that there is no essential difference between the natural and the miraculous. We term an act as a miracle when HaShem causes a novel occurrence, unfamiliar to us. Everyday natural events, those governed by the so-called laws of nature, are also miracles, but their common occurrence and recognizable patterns dilute their significance.

First plague: Blood (real or look-alike)

Instructing what Moshe should inform Pharaoh, the verses read as follows: "So says HaShem, 'Through this shall you know that I am HaShem; behold with the staff that is in my hand I shall strike the waters that are in the River and they shall change to blood. The fish that are in the water shall die and the River shall become foul. Egypt will grow weary of trying to drink water from the River'" (Shemos 7: 17-18). The River referred to in these verses is the Nile River, the key to the economic life of Egypt, an arid country of which 95% is desert. Waters from the Nile River were diverted to streams to irrigate the soil and also to provide a source of freshwater, both for human consumption and for the livestock. The Nile River teemed with various species of fish, readily consumed by the Egyptians. Periodically, the Nile River overflowed, thereby fertilizing the surrounding soils. The retreating waters left many fish trapped within in the grasses and which were easily available for capture. This may explain (Toldos Yitzchak) B'nei Yisrael's complaint when traveling through the desert, "We remember the fish that we ate in Egypt free of charge" (Bamidbar 11:5). Wild game, such as water buffalos, were attracted to the Nile River either were killed for food or were captured and domesticated to plough farm land. The Nile River provided a route of transportation for commerce and people. "And all the world came to Egypt" (Bereshis 41:57). Pharaoh viewed himself as master, or the god, of the Nile River, the life blood of Egypt. The Nile River was the initial target of the plagues.

As mentioned in the Haggadah, each main plague consisted of either four (Rabbi Eliezer) or five (Rabbi Akiva) subcomponents. The first plague consisted of the following events:

a) the Nile River changed to blood or to a blood-like substance;
b) the fish died, leaving the Egyptians without their food staple;
c) the Nile River fouled and emitted an offensive odor;
d) the Egyptians lacked a suitable source of drinking water;
e) and the Egyptians wearied trying to find drinkable water eitherhad to purchase drinkable water from B'nei Yisrael (Rashi) or had to dig for underground water (Ibn Ezra).

Apparently, the Nile River could not maintain such massive numbers of dinoflagellates; their subsequent death followed by their decomposition by aquatic bacteria would lead to the generation of malodorous air pollution.

Interestingly, in the Torah literature there appear to be two distinct interpretations of דם. The most commonly known translation of דם is that of actual human blood (e.g., Targum Onkelos; Maharal; S'forno). Rav Yaakov Culi, in his Me'am Loez, stated that the Nile River turned into blood, with the same taste, smell, and chemical and physical composition of actual blood. The Malbim noted that the Nile River water turned to blood and retained some of the characteristics of human blood, notably, the water was hot (human body temperature is 37°C) and caused the fish to die. The B'chor Shor commented that the Nile River turned to actual human blood, which coagulated (i.e., hemaagglutinated) causing the fish to die.

A lesser known interpretation of דם is that it was a blood-colored water, similar in appearance to, but not actual, blood (Targum Yerushalmi HaShalam; Targum Yonasan). Rav Bachya, as cited by Rav Z. Sorotzkin [3], suggested that water of the Nile River took on the appearance, taste, and smell of blood, but was not actual blood. A

similar explanation was presented by Rav Naftali Zvi (see Haamek Davar; Shemos 7:19) and Rav Avigdor Miller [4]. Quoting Rav Miller, "It was not blood that could be used for transfusions or for fertilizing the land, but the resemblance was close enough to sicken the spectators. A revolting miasma came up from all the streams of Egypt, and the people (who were accustomed to eating and feasting always) lost their appetite, and instead vomited again and again at the sight and odor of the revolting liquid. Normal life in Egypt came to a shocked standstill; and thirst, now the first time in their history, became the chief matter in the land. Everywhere, the infirm and aged lay dead; and the nation groaned in the depths of despair."

Whether the water of the Nile River turned to actual blood or to a blood look-alike may impact on what caused the fish to die and why the waters were befouled. As suggested by Rav Sorotzkin [3], if the Nile River turned to actual blood, the befouling of the Nile River may be due to bacterial decomposition of the blood. Subsequently, unable to live in blood and in an aquatic ecosystem made anaerobic by excessive bacterial metabolic activities, the fish died. Bacterial decomposition of the fish added to the malodorous emissions from the Nile River.

On the phrase, "For they could not drink from the waters of the River (Shemos 7:24), Rav Munk [1] wrote that although blood is drinkable, the Egyptians could not endure seven days without drinking actual water. Do people really drink blood? Apparently, yes; the phrase "human hematophagy" describes the habit of certain societies to drink blood and to use animal blood in food items. The African Masai drink a liquid composed of a mixture of cow milk and cow blood and many communities throughout the world consume blood sausage. Ritual hematophagy, as seen in the consumption of human blood, is also known. The Scythians, a nomadic Russian people, drank the blood of the first enemy killed in battle [5].

Rav C. Rabinowitz (Daas Sofrim) suggested that the very thirsty Egyptians, in the hope that the waters only appeared red but were not actually blood, drank from the Nile River. They were incorrect and the drinking of the blood only intensified their thirst. Rav Dovid Cohen (Simchas Yavetz, Haggadah of Pesach) noted that in the Torah it specifically mentioned that the Egyptians were not able to drink from the Nile River as it was polluted with dead and decaying fish, not because it was blood. Implying, apparently, people could drink This last point is also stated by Rav Yaakov Tzevi Mecklenburg (see Munk [6]). "In the worst emergency, the people could have drunk blood. If blood were not considered a drink by the Torah, its consumption would not have been forbidden on pain of death. This is why the Torah mentioned not only the fact that the water would turn to blood, but that the fish of the river would all die. Once the river would be full of blood plus rotting carcasses of dead fish, even the option of drinking the blood would not exist."

If not changed to actual blood, what factors came into play to cause the waters to appear blood-like in color and in overall appearance? Rav Munk [1] mentioned the possibility of aquatic vegetation causing the Nile River to turn a pale red in color. Secular scientists have offered a variety of possibilities, including the deposition of red meteorite dust from a passing comet, deposition of volcanic ash, the intrusion of red silt, and the contamination of the Nile River by red-pigmented flagellated protozoa, zooplankton, dinoflagellates, microfungi, and cyanobacteria [7, 8]. This last hypothesis, sudden overgrowth of an aquatic microbial species, may have the most merit. Although little publicized because of its potential negative impact on tourism, Florida often experiences red tides caused by a bloom (population explosion) of the red-colored dinoflagellate, Karenia brevis. This specific alga produces many neurotoxins (termed, brevetoxins), some of which become airborne and when a red tide coincides with an onshore breeze, hospitals in Florida prepare for an influx of patients. Brevetoxins constrict pulmonary (lung) bronchioles and, thus, are extremely harmful to asthmatics and others with breathing problems [9]. Other red-pigmented dinoflagellates, including species of *Gymnodinium* and *Gonyaulax*, also are involved in such blooms and also produce various neurotoxins. Such toxins are harmful to fish and other aquatic vertebrates [10]. Apparently, the Nile River could not maintain such massive numbers of dinoflagellates; their subsequent death followed by their decomposition by aquatic bacteria would lead to the generation of malodorous air pollution. As noted, each main plague had several subcomponents that added to the misery of the Egyptians; emissions of aquatic and airborne toxins generated by red-pigmented dinoflagellates would be a deleterious subcomponent of the plague, דם.

It really does not matter whether the Nile River was transformed into actual blood or into a blood look-alike. The Nile River was the pride of Egypt and was worshipped as a god. The Egyptians would prostrate themselves first thing in the morning to the Nile River, the god who provided them with a livelihood [3]. This so-called god was now transformed into a stinking cesspool! Rav Miller [4] cited the following passages from the *Admonitions of Ipuwer,* an ancient Egyptian papyrus manuscript, which apparently referred to the first plague: "The river is blood …. Blood is everywhere…. Men shrink from tasting …. That is our water…. What shall we do? Everything is in ruination..."

Second plague: Frogs

"Hashem said to Moshe, 'Say to Aharon, stretch out your hand with your staff over the rivers, over the canals, and over the reservoirs, and raise up the frogs over the land of Egypt'"(Shemos 8:1). Apparently, only the fish, not the frogs, died when the Nile River and its tributaries were changed to blood or to a blood-like substance. Why? Fish absorb dissolved oxygen through their gills and, perhaps, their death may be related to the lack of suitable quantities of dissolved oxygen in the Nile River. Bacterial decomposition of the dead fish would have depleted the waters of their dissolved oxygen. Frogs are amphibians and are not confined to an aquatic system and, if the

surrounding vegetation remained moist, they could have survived as terrestrial denizens for the week of the plague. Or, frogs have lungs and even if they remained in the anaerobic water of the Nile River, they could come to the water surface and breathe air. In addition to pulmonary (lung) respiration, frogs have two other modes of gaseous respiration, allowing for gas exchange both in water and on land. The moist skin of frogs is supplied with capillary blood vessels, allowing for cutaneous gas exchange when in water or on land. Gas exchange also occurs across the moist surfaces of the mouth and pharynx [11]. Breathing through their lungs, most important when metabolic activity is increased, probably came into play when the frogs left the Nile River to infest Egypt. As noted, "The River shall swarm with frogs and they shall ascend and come into your palace and your bedroom and your bed and into the houses of your servants and of your people, and into your ovens and into your kneading bowls. And into you and you people and all your servants will the frogs ascend" (Shemos 7:28-29.).

When noting the dialogue Moshe should have with Pharaoh, HaShem stated, "But if you (i.e., Pharaoh) refuse to send out, behold I will strike all of your territory with frogs" (Shemos 7:27). Rav Miller [4] suggested that the phrase "all of your territory" implied that not only aquatic frogs but various species of terrestrial frogs and land toads infested Egypt. In particular, he made note of the giant toad, *Bufo marinus,* which consumes birds and small mammals and has poisonous cutaneous glands that secrete a deadly toxin when someone inadvertently stepped upon. Another usually large amphibian is the West African frog, *Conraua goliath,* more than 30 cm long from the tip of nose to anus and with a weight of 3.3 kg (or, about 7½ pounds). This giant frog devours animals, such as rats and ducks [12] and may also have been involved in the plague.

The plague of frogs commences with the following, "Aharon stretched out his hand over the waters of Egypt and the frog (צפרדע) infestation ascended and covered the land of Egypt (Shemos 8:2). In this verse the word "frog" is in the singular and Rashi cited a Midrash contending that one frog initially emerged from the Nile River. When the Egyptians struck the frog, it fragmented into many frogs. On a surface view, this appears to describe cloning, through which differentiated adult cells become embryonic or totipotent to develop into copies of the original organism. Interestingly, prior to the cloning the lamb Dolly, the initial successful cloning experiments, developed in the 1950s by Robert Briggs and Thomas King, were with frogs (*Rana pipens*) [13]. With this in mind, and probably pushing a scientific explanation to its extreme, striking the initial frog may have caused shedding of its differentiated epidermal somatic cells, which became totipotent or zygote-like cells, undergoing mitotic divisions to generate multicellular frogs.

In addition to causing physical discomfort to the Egyptians, the frogs and toads employed psychological warfare. As part of their reproduction and mating behavior, male frogs and toads croak and call vociferously to attract females (Hickman *et al*., 2005). The Egyptians believed that the frogs were the reincarnation of the Hebrew babies cast into in the Nile River; "Pharaoh commanded his entire people, saying, 'Every son that will be born - into the River shall you throw him'" (Shemos 1:22). The Egyptians imagined that the frogs emerging from the Nile River, with their incessant croaking, were the reincarnated bodies of the dead babies crying out that their blood to be avenged [4].

Eventually, Pharaoh pleaded with Moshe to eliminate the plague of frogs. "HaShem carried out the word of Moshe and the frogs died - from the houses, from the courtyards, and from the fields. They piled them up into heaps and heaps and the land stank" (Shemos 8:9-10). Thus, the pollution of the atmosphere initiated through the rotting fish in the Nile River from the first plague now continued throughout the land as the frogs slowly decomposed in the hot Egyptian climate.

Although this will not be discussed, it is interesting to note that some commentaries, such as the Rav Bachya, the Ramban (*see* Munk [1]),and the S'forno (Shemos 8:3), interpreted צפרדע as the crocodile. The Haamek Davar (Shemos 7:28) suggested that צפרדע referred both to frogs and crocodiles, with frogs infesting all of Egypt and crocodiles infesting Pharaoh's palace. For an in-depth analysis on the identity of צפרדע as the crocodile, the reader is directed to an article by Dr. S. Sperber, Department of Talmud, Bar-Ilan University [14]

Third plague: Lice infestation

HaShem said to Moshe, "say to Aharon, 'Stretch out your staff and strike the dust of the land; it shall become lice ( ) throughout the land of Egypt. So they did; Aharon stretched out his hand with his staff and struck the dust of the land, and the lice (כנם) infestation was upon man and beast; all the dust of the land became lice (כנם) throughout the land of Egypt (Shemos 8:12-13). Note the differential spellings of "lice" in these two sentences. The initial term, כנם, is thought to refer to the white parasitic body lice that attach to, sting, and penetrate the bodies of humans and animals (Or HaChayim). Rav Miller suggested a connection between the first and third plague. When the Nile River changed to blood or to a blood-like liquid, the Egyptians stopped from bathing and laundering their garments, thereby initiating a hygienic scenario to promote lice infestation of their scalp and body. The latter term, , written in the plural, refers to at least 14 varieties (Rav M. Alshich) of species of jumping, black lice that originated from the Egyptian soil (Or HaChayim). The Ramban suggested that these were actually a new creation, "for it is not in the nature of dust to turn into lice." Whereas the white body lice produced visible eggs ("nits'), the jumping, black species (Tosfot citing Rav Joseph of Orleans, Shabbos 12a) produced microscopic eggs [15] and thus were believed to have arisen by spontaneous generation (Rashi explaining the opinion of Beis Hillel, Shabbos 12a). Rav Miller [4] postulated that כנם included numerous parasitic species of lice,

fleas, ticks, and mites and suggested that this plague caused more than a mere excessive itching of the skin. He noted a host of pathologies, ranging from sores, rash, fever, and general debilitation to nervous complications, meningitis, and encephalitis, cardiac anomalies, and arthritic symptoms.

Ticks, mites, fleas, and lice are classified within the phylum Arthropoda, with mites and ticks in the Class Arachnida and fleas and lice in the Class Insecta. Ticks are larger than mites and carry a greater variety of infectious microbes than any other arthropods. Lice and fleas are types of wingless insects that are parasitic throughout their lifecycle (Hicksman *et al*., 2003). There are several arthropod-borne diseases, through which a specific flea, louse, tick, or mite transfer an infectious microbe from an animal, the primary reservoir, to a human being. The following are some diseases that Rav Miller may have included under the category of כנם. For example, the disease, ehrlichiosis (causative bacterial agent: *Ehrlichia chaffeenis*) is transmitted from white-tailed deer and dogs to humans by the Lone Star tick (*Amblyomma americanum*). Once inside the human body, the bacteria infect white blood cells (the monocytes) causing a non-specific febrile illness. The disease, epidemic (louse-borne) typhus, caused by the bacterium, *Rickettsia prowazekii,* is transmitted from human to human by the body louse, *Pediculus humanus* corporis. These rickettsia spread in the infected person to cause inflammation of the blood vessels, leading to abrupt headache, fever, and muscle ache. More familiar is Lyme disease, caused by the bacteria of the genus, *Borrelia*. The tick, *Ixodes scapularis,* transmits the bacteria from infected deer to humans. The initial symptoms of Lyme disease include malaise, fatigue, headache, fever, and chills, which, if untreated, progresses to neurological abnormalities, heart inflammation, and arthritis. Finally, infected persons may develop symptoms resembling Alzheimer's disease and multiple sclerosis. Other arthropod-borne diseases include plague (causative bacterial agent: *Yersinia pestis*), Q fever (causative bacterial agent: *Coxiella burnetii*), and Rocky Mountain spotted fever (causative bacterial agent: *Rickettsia ricketsii*) [10].

Whereas the above-noted diseases are caused by bacteria transmitted through lice and ticks, arthropods also may transmit disease-causing protozoa and viruses from infected animals to humans. For example, the group of human diseases, termed leishmaniasis, are caused by protozoa, with their reservoirs being dogs and rodents, and transmitted through female sand flies. The viral infection, tick-borne encephalitis, is transmitted through bites from infected ticks, *Ixodes ricinus,* and is manifested as meningitis, encephalitis, and meningoencephalitis [10]. Apparently, these are the types of arthropod-borne diseases suggested by Rav Miller [4] to have occurred through the third plague.

SUMMARY

In the first three plagues HaShem initiated an attack on Egypt, using components of nature as the invading army. In addition to adversely affecting the Egyptians, physically, psychologically, and economically, HaShem attacked all components of the Egyptian biosphere: the aquatic ecosystems–the waters of the Nile River changed to blood or to a blood-like substance; the atmosphere–the air became polluted with malodors emanating from rotting fish and frogs; and the terrestrial ecosystems–the soils became infested with lice, ticks, and mites. ■

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