

THE TEN PLAGUES OF EGYPT

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I

The ten Plagues of Egypt described in the Bible were central to the liberation of the Jewish people from the oppression of the Egyptians. The succession of disasters demoralised the Egyptians and were seen as a victory for Jewish monotheistic beliefs. In this essay, natural explanations for most of the Plagues are proposed and a chronology of events is provided. Could the mythological explanation of these arguably natural phenomena still have a profound influence on the modern world?

What are plagues?

Biologists define a population as a group of organisms of one species and a community as a group of populations – often a large number – that co-exist in one area. Sometimes, one of the populations expands dramatically in numbers and this has an adverse effect on other populations within the community. Such imbalances may result from immigrations or from conditions especially favourable to the greatly increased population. An example of the effect of immigrations is provided by the introduction of rabbits into Australia. In the absence of natural predators, and aided by their high rate of reproduction, rabbit populations developed such high densities that all manner of controls have been needed to prevent over-grazing of grasslands. An example of especially favourable conditions is provided by years in which aphids, a primary food source of ladybirds, are unusually abundant. For example, during the summer of 1976 it was difficult to drive through some parts of Europe without encountering swarms of ladybirds that required windscreen wipers and washers to be operated at maximum.

Only when huge population increases affect humans, directly or indirectly, are they known as plagues. Plagues are biological but groups of plagues can also be associated with non-living natural events, as occurred in the ten Plagues of Egypt. There appear not to be any single plagues of non-living origin.

Plagues represent threats to the human control of Nature and to human survival, and particularly virulent diseases are often referred to as

‘plagues’. For example the “Black Death” is called the plague (*Yersinia pestis*), and tabloid newspapers in the 80s referred to AIDS as the “Gay Plague”. It is not easy to be rational when faced with a plague and mythical accounts, often focussing on divine retribution and the supernatural, are common.

Attempting to be rational

We all need to have an explanation of events that surprise or frighten us. Sometimes these explanations are rational, sometimes less so, and it is not always easy to know when we are involved with myths and when we are involved with facts. In this section I will discuss how myths arise when a rational explanation is not forthcoming¹. In the main body of the essay I will then attempt to give natural explanations for the ten Plagues of Egypt and identify the context in which the mythology occurred.

So how do myths arise? A good starting point in attempting to answer this question is provided by myths surrounding the cult of John Frum, a cargo cult that developed on the island of Tanna in Vanuatu mid-way through the last century. Cargo cults arise where native peoples have witnessed the import of goods at staging or trading posts, and believe that a god will at some point bring similar goods - “cargo” - for them. On Tanna, the indigenous population had been exposed to the Christian religion and to “cargo”, as an airstrip was built on the island during the Second World War to bring in supplies. All the separate pieces that had been observed were then melded into one: a god called John Frum (described as being dressed in US fatigues including a war helmet) lived in a local volcano and he would bring cargo to the native peoples. To encourage this, clearings were built in the forest to attract the cargo-bearing aircraft and altars (the Christian religious connection) placed in the clearings. These altars didn’t bear the familiar religious symbols of the Catholic Church, but crude models of transport aircraft. Viewed from our sophisticated Western perspective, it is easy to scoff at the ideas of the followers of John Frum but the attempts to rationalise the unknown seem ingenious and were certainly powerful for the followers of the cult. In discussing the ten Plagues and their consequences, it is useful to remember John Frum

¹ There are other possible interpretations of the origin of myths, but it is not the purpose of this article to discuss the topic in detail. I use the OED’s definition of a myth (I.1.a): “A traditional story, typically involving supernatural beings or forces, which embodies and provides an explanation, aetiology, or justification for something such as the early history of a society, a religious belief or ritual, or a natural phenomenon.”

and to remind ourselves of the way that humans attempt to rationalise unfamiliar and awe-inspiring events, and how strongly held the resulting beliefs can be.

So, how do we know what went on at the time of the ten Plagues of Egypt? Our record comes from Judaeo-Christian religious writings, and the sources given below are from the King James' Bible. This is a written account recorded following generations of verbal transmission, with the inevitable distortions that result. We all know that telling stories over and over again results in changes and this also applies to recording and translation, with variations induced by the thinking and scholarship of the time. In taking this line, I am not arguing that the biological and physical events described did not take place – I think it very likely that they did – rather that they have been embellished, ordered, and described through the lens of religious mythology.

The biblical account therefore needs to be set in its political, social and geographical context. It appears that events took place in Egypt (although I have been told by one Jewish scholar that this might not be the case) and involved Jewish people who were oppressed and working for the ruling Egyptians. As well as this inequality of political power, there was a clash between the belief systems of the two peoples – the Jews being monotheistic, with an all-powerful, supernatural God and the Egyptians being polytheistic and animalistic. We have much less information about the geographical and climatic context, but I will suggest below that dramatic climatic effects probably had an important role to play.

II

The Ten Plagues of Egypt

In this section, each plague is described using a quotation from the King James' Bible², and I follow each with a natural explanation (where possible). In giving explanations, I concentrate solely on the plagues themselves, not on the more dubitable conversations between individuals and deities described in the biblical account.

1. Rivers turned to blood, fish killed

Exodus 7: 17-21

17. Thus saith the Lord, In this thou shalt know that I am the Lord: behold, I will smite with the rod that is in mine hand

² <http://quod.lib.umich.edu/k/kjv/>

upon the waters which are in the river, and they shall be turned to blood.

18. And the fish that is in the river shall die, and the river shall stink; and the Egyptians shall lothe to drink of the water of the river.

19. And the Lord spake unto Moses, Say unto Aaron, Take thy rod, and stretch out thine hand upon the waters of Egypt, upon their streams, upon their rivers, and upon their ponds, and upon all their pools of water, that they may become blood; and that there may be blood throughout all the land of Egypt, both in vessels of wood, and in vessels of stone.

20. And Moses and Aaron did so, as the Lord commanded; and he lifted up the rod, and smote the waters that were in the river, in the sight of Pharaoh, and in the sight of his servants; and all the waters that were in the river were turned to blood.

21. And the fish that was in the river died; and the river stank, and the Egyptians could not drink of the water of the river; and there was blood throughout all the land of Egypt.

Some rivers carry high sediment loads and, where soils and underlying rocks are red, the water has the same red colour as a result. Indeed, there are several “Red Rivers” in the World that have been so named for this reason. If there was abnormally heavy rainfall on soils that had been baked by a drought, the result would be a flood which then subsided. This could lead to sediment-rich water from red tributaries being fed into larger rivers^{3,4,5} and remaining in adjacent flood pools. The ancient Egyptians identified the “Black Lands” (those with fertile, alluvial soils washed from upstream, organic-rich deposits) surrounding the Nile from the “Red Lands” of adjacent regions (characterised by desert soils that were brightly coloured)⁶. The influx of red soils from the Red Lands is probably being described here.

So what about the fish kills and the stink? Fish are dependent on their gills for gas exchange, and these delicate structures are protected by a covering of mucus secreted from cells over the gill surface. In response to clogging by sediments, excess mucus is produced to reduce the abrasive effect. However, unless times of high sediment load are brief, the excess mucus prevents respiration and can lead to kills on a dramatic scale, with dead fish becoming all too visible at the water surface. As we know, dead fish decompose and then certainly stink. Add to this the decomposition of any other organic matter trapped within the sediments and there will be

³ <http://dannysdesktop.themesunlimited.com/Files/nasa/ColumbiaRedRiver.jpg>

⁴ http://www.waterencyclopedia.com/images/wsci_04_img0504.jpg

⁵ http://sherpaguides.com/georgia/chattahoochee/chattahoochee_in_peril/sediment.jpg

⁶ <http://www.ancientegypt.co.uk/geography/home.html>

an abundance of foul-smelling reduced gasses emanating from pools and the margins of streams and rivers.

2. Frogs

Exodus 8:2-14

2. *And if thou refuse to let them go, behold, I will smite all thy borders with frogs:*
3. *And the river shall bring forth frogs abundantly, which shall go up and come into thine house, and into thy bedchamber, and upon thy bed, and into the house of thy servants, and upon thy people, and into thine ovens, and into thy kneading troughs:*
4. *And the frogs shall come up both on thee, and upon thy people, and upon all thy servants.*
5. *And the Lord spake unto Moses, Say unto Aaron, Stretch forth thine hand with thy rod over the streams, over the rivers, and over the ponds, and cause frogs to come up upon the land of Egypt.*
6. *And Aaron stretched out his hand over the waters of Egypt; and the frogs came up, and covered the land of Egypt.*
7. *And the magicians did so with their enchantments, and brought up frogs upon the land of Egypt.*
8. *Then Pharaoh called for Moses and Aaron, and said, Intreat the Lord, that he may take away the frogs from me, and from my people; and I will let the people go, that they may do sacrifice unto the Lord.*
9. *And Moses said unto Pharaoh, Glory over me: when shall I intreat for thee, and for thy servants, and for thy people, to destroy the frogs from thee and thy houses, that they may remain in the river only?*
10. *And he said, To morrow. And he said, Be it according to thy word: that thou mayest know that there is none like unto the Lord our God.*
11. *And the frogs shall depart from thee, and from thy houses, and from thy servants, and from thy people; they shall remain in the river only.*
12. *And Moses and Aaron went out from Pharaoh: and Moses cried unto the Lord because of the frogs which he had brought against Pharaoh.*
13. *And the Lord did according to the word of Moses; and the frogs died out of the houses, out of the villages, and out of the fields.*
14. *And they gathered them together upon heaps: and the land stank.*

Anyone living near a village pond will know that frogs migrate to breed. It is common to see special road signs warning of frogs crossing and there is ample evidence that many do not make it. As I have a garden pond I have observed such migrations for myself and have even found frogs in my front porch, seemingly trying to make their way to the garden through the house. The drive to find water in which to breed is a powerful one.

Pools on the flood plains of rivers are excellent breeding sites for frogs and it is common to see migrations to such water bodies from dry-weather refuges. It is then that frogs become very visible, after having remained hidden from view for much of the year. Once through the tadpole stage, young frogs become air-breathing and usually leave their birthplace to seek food and shelter among leaves and under stones. Just as with the migration of adults, there will be a high mortality and frogs that are not eaten by predators or scavengers begin to decompose. Together with other rotting detritus left behind after floods, a stink is likely to result.

There is another less commonplace explanation for the observation described in the biblical text. When water bodies dry, spadefoot toads bury themselves in sandy deposits which remain moist during dry periods. Some may surround themselves with a cocoon made from mucus and skin cells which forms a near impervious barrier to water loss and, with a reduction in metabolism, means they can survive long dry spells. When rains and flooding return, the toads emerge from deep within sediments, or from their cocoons, to continue adult life, seeking breeding sites if the rains are seasonal. In a year of sudden rains, an unusually dramatic emergence of spadefoot toads may have been sufficient to promote myths of spontaneous generation (water + sediment = animals) and their appearance would certainly have stirred the thoughts of all observers. Spadefoot toads lack the warty skin associated with the common toad, so they more closely resemble frogs. They are found currently in the Eastern Mediterranean, but may have had a quite different distribution at the time of the ten Plagues.

3. Lice

Exodus 8:16-17

15. *And the Lord said unto Moses, Say unto Aaron, Stretch out thy rod, and smite the dust of the land, that it may become lice throughout all the land of Egypt.*
16. *And they did so; for Aaron stretched out his hand with his rod, and smote the dust of the earth, and it became lice in man, and in beast; all the dust of the land became lice throughout all the land of Egypt.*

There is not much information here. The description implies that conditions were dry as the land was dusty, but we don't know the time period between the strike from Aaron's rod and the appearance of "lice" (which is probably a term for many kinds of invertebrates). The problem of translating events from sparse and potentially inaccurate description is familiar to exegesisists, but we can suggest

interpretations given certain assumptions. We know that many soil-dwelling insects have life cycles that result in mass emergences when conditions are good for the immature stages. This is likely after rainfall when otherwise near-desert conditions are transformed into a meadow of vegetation and flowering plants. Visitors to countries with hot, dry climates for much of the year are familiar with this transformation and with the abundance of insects that can suddenly result during the wet season. It is possible that given such weather conditions, a mass emergence of this type was so dramatic as to appear almost instantaneous.

4. Beasts or flies

Exodus 8:20-24

20. And the Lord said unto Moses, Rise up early in the morning, and stand before Pharaoh; lo, he cometh forth to the water; and say unto him, Thus saith the Lord, Let my people go, that they may serve me.

21. Else, if thou wilt not let my people go, behold, I will send swarms of flies upon thee, and upon thy servants, and upon thy people, and into thy houses: and the houses of the Egyptians shall be full of swarms of flies, and also the ground whereon they are.

22. And I will sever in that day the land of Goshen, in which my people dwell, that no swarms of flies shall be there; to the end thou mayest know that I am the Lord in the midst of the earth.

23. And I will put a division between my people and thy people: to morrow shall this sign be.

24. And the Lord did so; and there came a grievous swarm of flies into the house of Pharaoh, and into his servants' houses, and into all the land of Egypt: the land was corrupted by reason of the swarm of flies.

This is an excellent description of the mass swarming of dancing midges (not the biting variety, but those sometimes referred to as gnats). In locations near, or over, water (see verse 20 above) such swarms can be spectacular. In northern Iceland, Myvatn (midge lake) is so named because of the huge swarms of midges that emerge periodically⁷. When these swarms are particularly dense, livestock are brought into shelter to avoid excessive inhalation of flies and subsequent asphyxia. It is the male flies which swarm and they do so to attract female flies. Swarms are formed over any tall object, which is why they appear over our heads when we stay still, but the most spectacular swarms are commonly called “smoking chimneys” because the mass of flies, all moving, resemble smoke. Once the female flies are fertilised they look for water

bodies in which to lay their eggs, one reason for the association of swarms with water.

Emergence of midges from the water is similarly spectacular, and the newly-emerged adults coat buildings, cars, washing and anything else they land upon. Slow sand filters used by the water industry to clean drinking water are an ideal habitat for developing midges, and the larvae are beneficial in the filtration process. However, their numbers are enormous, and householders living near the filter beds sometimes complain of the numbers of flies that enter their homes and generally make life disagreeable. Filters are drained from time to time and their sand surface cleaned, only for them to become colonised by egg-laying females immediately on being re-filled.

The land of Goshen (verse 22) is considered to be in the north east of ancient Egypt, within the Nile delta. It is possible that the conditions in this region were less suitable for colonisation by midges, due to a lack of standing water bodies, saline waters, excessive plant growth over the surface of sediments, effective drainage, or evaporation. In other locations where sandy sediments had become flooded we have the ideal conditions for dancing midges, similar to those seen in modern sand filters.

5. Pestilence

Exodus 9:3-7

3. Behold, the hand of the Lord is upon thy cattle which is in the field, upon the horses, upon the asses, upon the camels, upon the oxen, and upon the sheep: there shall be a very grievous murrain.

4. And the Lord shall sever between the cattle of Israel and the cattle of Egypt: and there shall nothing die of all that is the children's of Israel.

5. And the Lord appointed a set time, saying, To morrow the Lord shall do this thing in the land.

6. And the Lord did that thing on the morrow, and all the cattle of Egypt died: but of the cattle of the children of Israel died not one.

7. And Pharaoh sent, and, behold, there was not one of the cattle of the Israelites dead. And the heart of Pharaoh was hardened, and he did not let the people go.

Murrains are diseases of livestock that result from transmission of an infectious agent, often by another organism as vector. If there was an abundance of biting insects, as well as the non-biting varieties, it is evident that transmission of disease between cattle and other livestock would occur rapidly. Mosquitoes are very likely to have been vectors and, as we know, they breed in water and, after flooding or seasonal rains, are found in their millions. Go to the boreal

⁷ <http://www.hi.is/~arnie/swarms.htm>

forest after snow melt, or to parts of tropical countries where there is an abundance of small pools and you will get some indication of their numbers and the capacity of the female flies to take blood meals. It is in taking blood meals that flies transmit disease organisms from one host to the next. To prevent coagulation of blood, a little saliva is pumped out by the fly into the capillary from which the blood meal is being taken. Infected saliva then allows ready transmission of the disease to the blood flowing to the rest of the host's body.

6. Boils

Exodus 9:8-10

8. *And the Lord said unto Moses and unto Aaron, Take to you handfuls of ashes of the furnace, and let Moses sprinkle it toward the heaven in the sight of Pharaoh.*
9. *And it shall become small dust in all the land of Egypt, and shall be a boil breaking forth with blains upon man, and upon beast, throughout all the land of Egypt.*
10. *And they took ashes of the furnace, and stood before Pharaoh; and Moses sprinkled it up toward heaven; and it became a boil breaking forth with blains upon man, and upon beast.*

Blains are swellings or blisters on the skin, and boils are similar but often contain pus as a sign of infection. The general description of blains is of a raised area which is often reddened and has, near its centre, an obvious small depression or pore. This could equally well be a description of the effects of insect bites and especially those of blackflies (two-winged flies, not garden aphids). Adult female blackflies⁸, like female mosquitoes, require a blood meal to provide nutrients essential for the development of eggs. The method of biting in blackflies is different, however. Instead of the needle-like mouthparts of mosquitoes, female blackflies have cutting mouthparts that make a small wound from which blood can be sucked, salivary secretion again being used to prevent coagulation. There is often a reaction to these bites and this may result in infection if they are scratched in response to persistent itching. Bites often have local reddening caused by haematomas and scratching causes swelling⁹.

Like mosquitoes, blackflies also breed in water but their larvae are dependent on running water to feed so these are insects of streams and rivers. They are able to exploit even large, torrential rivers and one species of blackfly that lives in high latitude

rivers has a life cycle that coincides with the time of maximum discharge from melting snow and ice. This species is found as hundreds of millions of flying adults along the river and the very small flies look a little like smuts *en masse*. Indeed, smut is a term used for blackflies in parts of Northern America where smut fishing (emulating individual emerging flies) is a method of catching trout. Could these be the "ashes of the furnace"?

7. Fiery hail

Exodus 9:18-32

18. *Behold, to morrow about this time I will cause it to rain a very grievous hail, such as hath not been in Egypt since the foundation thereof even until now.*
19. *Send therefore now, and gather thy cattle, and all that thou hast in the field; for upon every man and beast which shall be found in the field, and shall not be brought home, the hail shall come down upon them, and they shall die.*
20. *He that feared the word of the Lord among the servants of Pharaoh made his servants and his cattle flee into the houses:*
21. *And he that regarded not the word of the Lord left his servants and his cattle in the field.*
22. *And the Lord said unto Moses, Stretch forth thine hand toward heaven, that there may be hail in all the land of Egypt, upon man, and upon beast, and upon every herb of the field, throughout the land of Egypt.*
23. *And Moses stretched forth his rod toward heaven: and the Lord sent thunder and hail, and the fire ran along upon the ground; and the Lord rained hail upon the land of Egypt.*
24. *So there was hail, and fire mingled with the hail, very grievous, such as there was none like it in all the land of Egypt since it became a nation.*
25. *And the hail smote throughout all the land of Egypt all that was in the field, both man and beast; and the hail smote every herb of the field, and brake every tree of the field.*
26. *Only in the land of Goshen, where the children of Israel were, was there no hail.*
27. *And Pharaoh sent, and called for Moses and Aaron, and said unto them, I have sinned this time: the Lord is righteous, and I and my people are wicked.*
28. *Intreat the Lord (for it is enough) that there be no more mighty thunderings and hail; and I will let you go, and ye shall stay no longer.*
29. *And Moses said unto him, As soon as I am gone out of the city, I will spread abroad my hands unto the Lord; and the thunder shall cease, neither shall there be any more hail; that thou mayest know how that the earth is the Lord's.*
30. *But as for thee and thy servants, I know that ye will not yet fear the Lord God.*
31. *And the flax and the barley was smitten: for the barley was in the ear, and the flax was balled.*
32. *But the wheat and rie were not smitten: for they were not grown up.*

⁸ <http://www.icp.ucl.ac.be/~opperd/parasites/images/simulium2.jpg>

⁹ <http://www.blackfly.org.uk/images/bfbites3.jpg>

Under some conditions, dramatic storms produce very large hailstones¹⁰ and these can be very destructive, damaging houses and also causing a risk of injury to anyone venturing out. If the hailstones were created within a large storm system it is likely that there would be much lightning and perhaps “ball lightning”¹¹. There is some conjecture as to whether ball lightning exists, but there are many reports of very bright discharges that are tennis ball-sized and seem to float near the surface or run along the ground, which could correspond to “fiery” hail. What is clear is that this storm, with its accompanying hailstones, severely damaged crops over a very large area, flattening them so they could not be harvested. This was especially devastating as both the barley and the flax were ripening and, as any farmer knows, losing a crop at this late stage is heartbreaking. Later-developing grasses like wheat and rye were less affected.

8. Locusts

Exodus 10:3-15

3. *And Moses and Aaron came in unto Pharaoh, and said unto him, Thus saith the Lord God of the Hebrews, How long wilt thou refuse to humble thyself before me? Let my people go, that they may serve me.*

4. *Else, if thou refuse to let my people go, behold, to morrow will I bring the locusts into thy coast:*

5. *And they shall cover the face of the earth, that one cannot be able to see the earth: and they shall eat the residue of that which is escaped, which remaineth unto you from the hail, and shall eat every tree which groweth for you out of the field:*

6. *And they shall fill thy houses, and the houses of all thy servants, and the houses of all the Egyptians; which neither thy fathers, nor thy fathers' fathers have seen, since the day that they were upon the earth unto this day. And he turned himself, and went out from Pharaoh.*

7. *And Pharaoh's servants said unto him, How long shall this man be a snare unto us? let the men go, that they may serve the Lord their God: knowest thou not yet that Egypt is destroyed?*

8. *And Moses and Aaron were brought again unto Pharaoh: and he said unto them, Go, serve the Lord your God: but who are they that shall go?*

9. *And Moses said, We will go with our young and with our old, with our sons and with our daughters, with our flocks and with our herds will we go; for we must hold a feast unto the Lord.*

10. *And he said unto them, Let the Lord be so with you, as I will let you go, and your little ones: look to it; for evil is before*

you.

11. *Not so: go now ye that are men, and serve the Lord; for that ye did desire. And they were driven out from Pharaoh's presence.*

12. *And the Lord said unto Moses, Stretch out thine hand over the land of Egypt for the locusts, that they may come up upon the land of Egypt, and eat every herb of the land, even all that the hail hath left.*

13. *And Moses stretched forth his rod over the land of Egypt, and the Lord brought an east wind upon the land all that day, and all that night; and when it was morning, the east wind brought the locusts.*

14. *And the locusts went up over all the land of Egypt, and rested in all the coasts of Egypt: very grievous were they; before them there were no such locusts as they, neither after them shall be such.*

15. *For they covered the face of the whole earth, so that the land was darkened; and they did eat every herb of the land, and all the fruit of the trees which the hail had left: and there remained not any green thing in the trees, or in the herbs of the field, through all the land of Egypt.*

Desert locusts undergo a phase change from a solitary form to a gregarious form when forced together into large groups¹². The solitary form is cryptic (i.e. camouflaged) and lives like a grasshopper, with immature stages getting larger with successive moults and the last larval moult producing the winged adult able to disperse locally. When population density is very high, or food limited, a physiological control mechanism causes the locusts to become brighter in colour and to form dense bands of hoppers that move across the land devouring any available vegetation. Adults emerge to form swarms that disperse even more widely to find food¹³ and these attack crops should they encounter them. The result is devastation of any crop plants and severe competition for any grazing animals.

The swarms of gregarious phase locusts described above were clearly large scale and the factors that promoted these swarms must have been severe.

9. Darkness

Exodus 10:19-23

19. *And the Lord turned a mighty strong west wind, which took away the locusts, and cast them into the Red Sea; there remained not one locust in all the coasts of Egypt.*

20. *But the Lord hardened Pharaoh's heart, so that he would*

¹⁰ <http://www.spc.noaa.gov/faq/tornado/hailjim.htm>

¹¹ <http://www.abc.net.au/science/news/stories/s520317.htm>

¹² <http://users.ox.ac.uk/~ipe/phase.html>

¹³ http://news.bbc.co.uk/1/shared/spl/hi/picture_gallery/04/africa_desert_locusts/html/1.stm

not let the children of Israel go.

21. And the Lord said unto Moses, Stretch out thine hand toward heaven, that there may be darkness over the land of Egypt, even darkness which may be felt.

22. And Moses stretched forth his hand toward heaven; and there was a thick darkness in all the land of Egypt three days:

23. They saw not one another, neither rose any from his place for three days: but all the children of Israel had light in their dwellings.

The winds were very strong, so this indicates that large air masses were involved in the development of a major storm. We've all seen the dramatic darkening of the sky produced by a dense cover of storm clouds but whether this explains three days of darkness is debatable. Perhaps they were mythical days not days as we know them?

10. Death of the firstborn

Exodus 11:4-7

4. And Moses said, Thus saith the Lord, About midnight will I go out into the midst of Egypt:

5. And all the firstborn in the land of Egypt shall die, from the firstborn of Pharaoh that sitteth upon his throne, even unto the firstborn of the maidservant that is behind the mill; and all the firstborn of beasts.

6. And there shall be a great cry throughout all the land of Egypt, such as there was none like it, nor shall be like it any more.

7. But against any of the children of Israel shall not a dog move his tongue, against man or beast: that ye may know how that the Lord doth put a difference between the Egyptians and Israel.

I can offer no explanation for this plague. Perhaps it relates to some infectious disease, but why the effect on the first born?

III

Chronology of the ten Plagues in relation to natural events

Given a possible natural explanation for most of the plagues, we can piece together a chronology of events that corresponds to the order of description in the biblical text.

After a long period of drought there was a dramatic change in weather. Heavy rains resulted in flooding and the run-off of sediment-rich water from desert soils. As the sediment was red, there was a dramatic colour change in the river. Some tributary streams also produced obvious plumes of red

sediment in the main river and these resembled pools of blood. The extent of the suspended sediment was such that fish kills ensued after clogging of the gills by excessive mucus production. Many of the same processes occurred in adjacent lakes and ponds until the sediment in these isolated water bodies settled. All over the area, dead fish and other organic matter decomposed and the resultant smell was very obvious.

Once the flood waters began to recede, leaving ponds and lakes on the flood plain, an abundance of frogs migrated to the water to breed, or were released from deep within sandy sediments. Frogs migrating to, and from, breeding sites then died, leaving a conspicuous quantity of decomposing bodies.

Adult insects began to emerge from the soil in areas where there was little standing water and these mated and began to lay eggs in large numbers. The rapidly growing vegetation formed a ready source of food for their larvae and the result was a series of obvious population explosions among successful insect species. Many aquatic insects colonised newly flooded regions or hatched from eggs that had remained dormant. Amongst these insects were some, like dancing midges, that have short life cycles, with masses of adults emerging within three weeks of the eggs hatching to produce larvae. After dispersing to the surrounding area in their millions, the midges sought out flowering plants that had grown from seeds stored in the freshly watered soils. These provided plant sugars to fuel flight and males formed dense mating swarms.

Many aquatic insects with biting adults also began to emerge, having fed on organic detritus that was washed into pools and streams. Larvae of mosquitoes and blackflies are largely suspension feeders, adapted to capture tiny particles from the water column. These particles were abundant after the flood and included algal cells, bacteria and dead organic matter. After emergence (mosquitoes from still water and blackflies from running water, including the large river) the female flies sought blood meals and these were taken from wild and domestic animals, and from humans. Inevitably, parasites were transmitted by these vectors and this resulted in diseases of livestock and also many painful bites, some of which became infected and very obviously swollen.

After a period of warm, drier weather there was another period of severe storms. A change in the movement of large air masses promoted the development of huge thunder clouds that darkened the sky. Very heavy rain turned to hail during its descent through the clouds and some of the hailstones were large enough to cause injury. The storm lasted for many hours and the effect on crops

was devastating. Having grown well with the ample irrigation provided by the first series of storms, many crops were now ripe and the battering by hail and winds meant that much was lost. It was not only crops that were affected, all vegetation was beaten down and started to decompose.

During the good growing season locusts were among the terrestrial insects that multiplied. They were in the solitary form but the destruction of vegetation in the second series of storms meant that food for the insects became depleted. The result was a phase change to produce the gregarious form and large swarms of hoppers moved across the land eating remaining vegetation as they went. Once adults were produced these formed aerial swarms that were able to travel over long distances and were very obvious to anyone in the area.

The north-eastern parts of Egypt (the land of Goshen, where many Jewish people lived) was less affected by these events than the main Nile Valley. The impact of the plagues was considerable here and the main victims were the Egyptians. None of the events was unnatural, and they formed a logical sequence, but their extent was highly unusual.

How the ten Plagues were interpreted at the time

The interpretation of the ten Plagues must have been influenced by contemporary mythologies. We have the record made by the Jewish people, but do not know how Egyptians interpreted these events. In the biblical text, the ten Plagues are written up as an example of the power of the Jewish God but the catastrophic events must have had a demoralising effect on the Egyptians, and the loss of crops and animals would have made life very difficult for all humans in the region. Indeed, the polytheistic Egyptians were observers of nature and we know that some organisms and natural events were given supernatural status in their religion. In this context, a series of plagues of such magnitude may have led to a feeling of persecution or punishment by their deities, and perhaps it is not surprising that the oppressed minority was then released.

What can we learn from the ten Plagues of Egypt?

The key question that arises is: did the ten Plagues of Egypt take place? I have suggested that the majority of them could certainly have occurred given the descriptions in the biblical record, and that they follow a logical chronology. The mythologising of these events by theists has had huge consequences - the plagues were used to provide evidence of the superiority of one belief system over another. Indeed,

if the theistic explanation is the correct one, it can be argued that this was a victory of monotheism (Jewish beliefs) over polytheism/animalism (Egyptian beliefs). However, perhaps that is to be expected when the record is in the religious writings of the Jewish faith.

The victory of Jewish monotheism also became the victory of Christian monotheism as the origins of both religious groups are shared. Islam then developed from the same roots in the first Millennium and it, too, is strongly monotheistic. It was Islam that resulted in the final overthrow of widespread polytheism in Egypt although it is worth noting that the beliefs of some Mediterranean polytheistic religions were recorded by Islamic scholars. Much of our knowledge of these religions and their myths comes from their writings. For example, what would we know of Greek mythology if Christian and Moorish cultures had not met in Spain during the Middle Ages? Without access to ancient writings translated into Arabic, the re-translations by Christian religious scholars of the time would not have occurred.

Although I have put forward natural explanations of the events, I am not arguing that this is evidence against a supernatural power. If the ten Plagues of Egypt were planned, and delivered, by a god, the catalogue of disturbance is most impressive and the cumulative effect very powerful. The problem comes in promoting one religion (complete with its mythologies) as being right and therefore superior. The Jewish people in ancient Egypt achieved freedom through their fundamentalism but at what cost? Disputes between religious factions continue to dominate and harm, just as they have done throughout history. Even some atheists seem to be joining the fundamentalist camp, asserting that there is no supernatural deity, as such an entity doesn't fit with their evolutionary "mythologies". Perhaps the ten Plagues teach us that many explanations are possible for one series of events, and warn against allowing belief in the truth of one explanation to inspire fundamentalism?

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