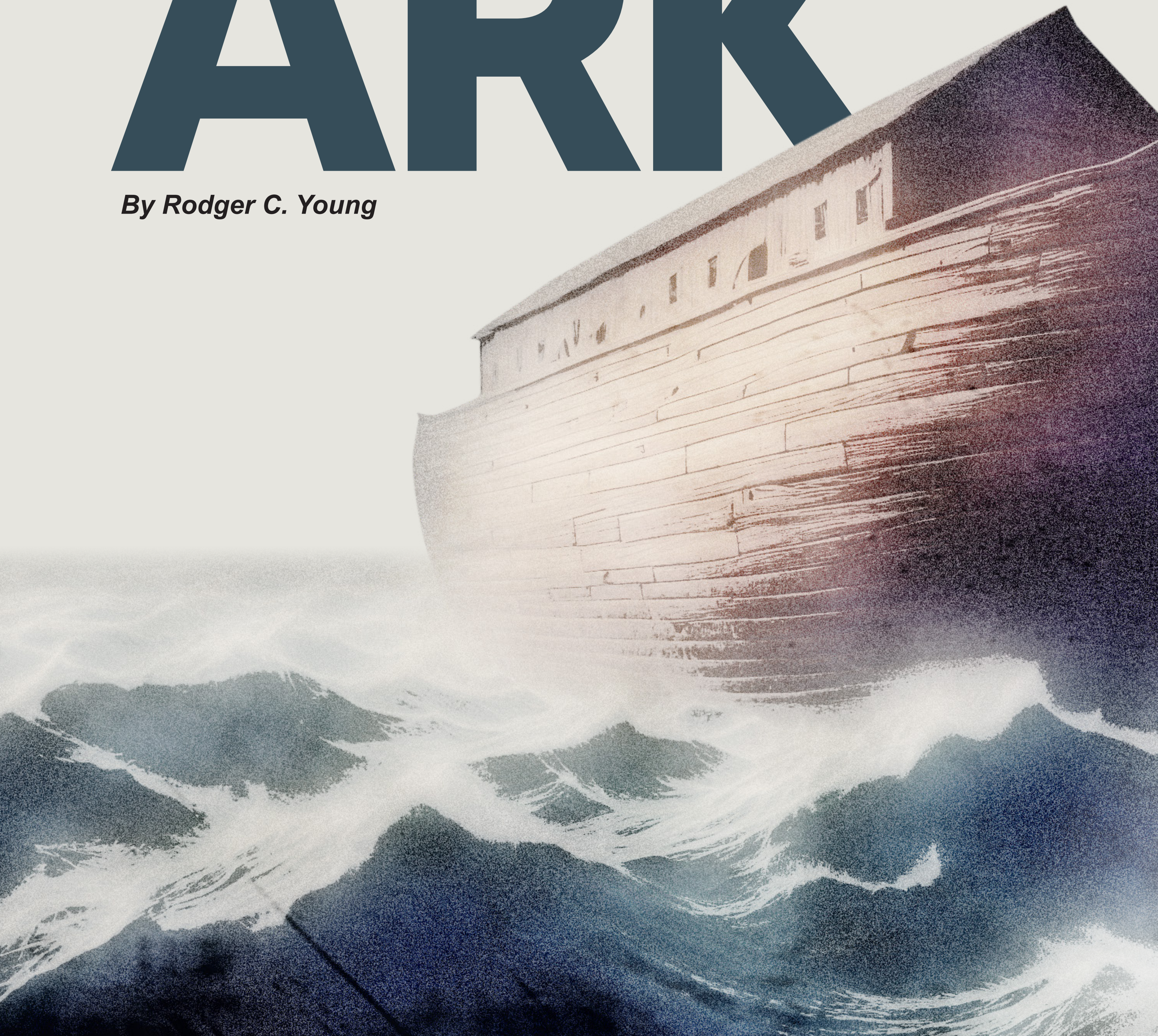
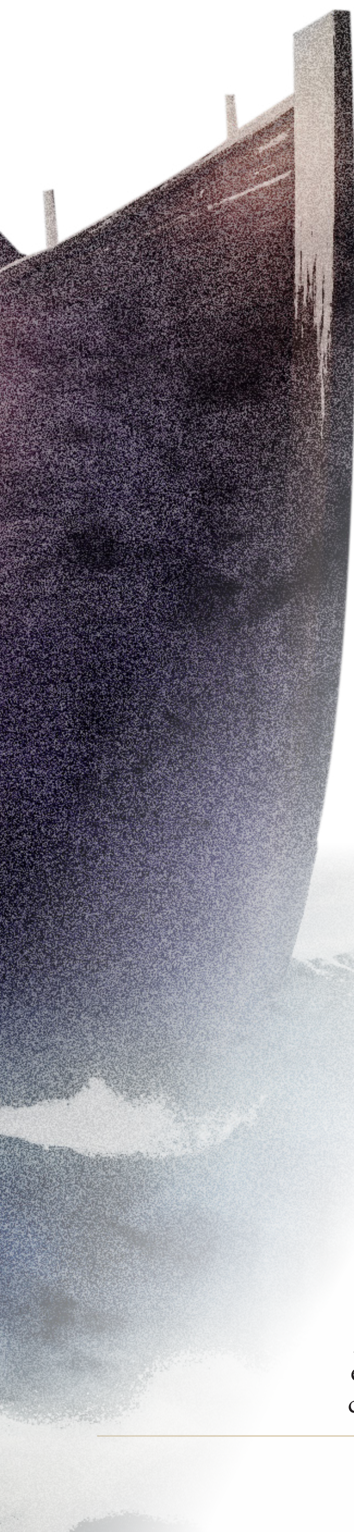
THE NAVIGATION OF NOAH'S ARK

By Rodger C. Young



IN the second week of December 1959, Oxford University dismissed for a six-week Christmas break. This was a time when students were expected to do some studying—at home for the students from the British Isles, but elsewhere for those of us who came from abroad. Airplane travel at that time was expensive, so we Americans took the long break as an occasion to use the relatively cheap, and sometimes free (hitchhiking) travel modes to explore Europe. I chose to spend the time in Norway. Consequently, while still in Oxford I purchased a ticket for passage on a Norwegian passenger ship that was to depart from Newcastle on Britain's east coast, with destination Oslo. Little did I know that I was about to experience the most violent storm for the past two or three decades on the North Atlantic, a region known for the severity of its storms.

The Norwegian ship was pleasant, especially in its smorgasbord meals that featured many varieties of fish and cheese, all prepared very nicely and quite a contrast to the drab meals for which the British are famous or infamous throughout Europe. I particularly took a fondness for gjetost—goat cheese—although all the choices were interesting. But then the storm came, and it was a good thing that not only the tables but also the chairs were fastened to the floor. Soon the sumptuous smorgasbord had few enjoying it, for almost all the passengers, and even some of the Norwegian sailors, became seasick because of the violence of the ship's motion. I did not feel seasick in the slightest, so I figured out various ways to experience what a great storm is like. One such activity was to start up the ladder-like stairs. You wait until the ship starts to fall down from the crest of one of the giant waves. You become very light, and you scoot, almost float, up those stairs for a few seconds until the ship hits the trough at the bottom between two massive waves, at which time you become very heavy and just hang on until the next quasi free fall; then you finish your monkey-like scamper up the steps.



I went to the stern of the ship to watch the up-and-down motion and the waves. When the ship rode over the top, I estimated that it was about 60 feet (18 m) down to the trough between the waves—this included the distance I was raised because the ship's bow was very much pointing downward and its stern was consequently lifted up. The waves then would have been a good 30 feet (9 m) or more in height, which is considered the maximum for ocean storms, except in the case of occasional superwaves. When the stern of the ship fell from the top and sank heavily into the sea, I leaned over the rail and could almost touch the water. All this time the wind was blowing fiercely, and it was raining, then snowing, before we entered Oslo Fjord. At one point I was on the side of the ship when the wind, in its violence, shifted to our starboard side and tore the top off a massive wave, drenching both the side of the ship and me.

During the storm the ship was going very slowly—so slowly that it took an extra day and a half to reach Oslo, a distance of about 600 miles (966 km). One of the sailors explained to me why the ship was moving at such a slow speed. The captain had decided that slowness was necessary if we were to survive this storm. (I later learned that not all ships had survived it.) The important thing, the sailor said, was to keep the ship pointed into the waves. If we turned sideways to them, the force of the waves could cause us to roll over (capsize). Had that happened, you wouldn't be reading this. The slowness of the ship was because the captain was afraid that, as the stern was lifted up when we started down the far side of the wave, the propellor might come out of the water. If the propellor was turning too fast, it might spin off, and then we would no longer be able to prevent turning sideways, and thus capsizing.

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Maybe one reason I went through this storm was so that I could appreciate what "a few, that is, eight persons" (1 Pet 3:20), and the animals on the ark, experienced during the great flood of Noah's day. In what follows, I will apply what I learned from that experience to an explanation of the design principles of Noah's ark. Since I have not seen much literature that deals with the subject of the navigational stability of the ark, at least not to the degree that I think it deserves, I am particularly interested in any feedback on these ideas, some of which I think have never been fully appreciated, and certainly rarely discussed.

How Would You Like Six Degrees of Freedom? Physics Is Fun

If you've taken a basic course in physics, you know that you already have those six degrees of freedom. Also, anyone who has studied the motion of ships, or who has learned about piloting an airplane, is familiar with them. They refer to the motion of an object, and since you're an object, they apply to you. The six degrees are divided into two groups of three. The first group, translational degrees of freedom, refers to your motion in either a (1) forward/backward, (2) left/right, or (3) up/down direction. The second group refers to rotational motion. When an object like an airplane pitches its nose up or down, it is exercising the first kind of rotational motion, called pitch. Pitch rotation may be thought of as rotation about an axis going through the wings of the aircraft. The second kind of rotational motion is called roll. It's the kind of motion that you partake of when you roll over in bed. In that rolling motion you are rotating about an axis that goes from your head to your toes. In the case of an airplane or boat, the roll axis can be thought of as extending from the nose to the tail (bow to stern). The third kind of rotational motion, yaw, may be somewhat less familiar, although it is well known to pilots and to all who are responsible for the navigation of a ship. The yaw degree of freedom is observed when a person in a small boat or canoe paddles on just one side with the intention of turning the bow of the vessel to the left or right.

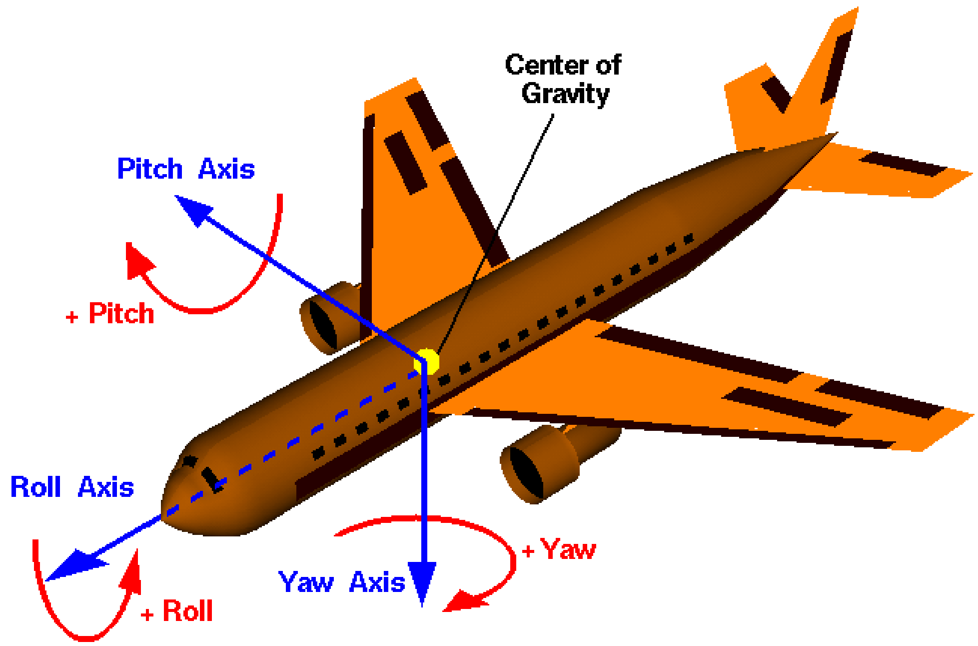
As a side note, the Wright brothers' discovery of how to control yaw in their flying machine is considered their greatest achievement. Yes, they also worked long and hard to get an engine that was powerful enough, and also light enough, to pull the plane through the air. But others were working on this too, since the challenge was so obvious, and everyone knew that advances were continually being made in engine technology. But everyone else was on the wrong track in their approach to managing yaw. Their thinking was dominated by the way that ships control yaw—namely, by means of a rudder. So others who were trying to build flying machines put rudders on their invention, thinking that this was the answer to controlling yaw, and if you can't control yaw, you can't navigate properly. The Wright brothers' breakthrough was when they realized that the way to control yaw is to manipulate the camber of the wings so that the plane's wings initiate a roll, something you've enjoyed every time the plane you were in turned to the right or left and the view through your window became either up to the sky or down to the ground. Once the roll is initiated, the pilot completes the "yaw" (change of direction) maneuver by what is actually a pitch operation. The Wright brothers patented this means of accomplishing yaw, and for many years everyone who built airplanes was required to recognize their patent, even though the roll-pitch combination to accomplish yaw could be initiated by ailerons in the wings rather than the Wrights' method of changing the wings' camber.

In that storm on the North Atlantic, the captain and navigator's control of the roll degree of freedom became all-important. Nothing could be done about the ship's pitch; as long as we were headed into the 30-foot/9-meter (or more) waves, we were going to have the extreme motions up and down that I thought were best observed from the stern—60 feet (18 m) up, down, and then up again in just a few seconds. However, everything possible was being done to control yaw, because, if the ship yawed to the right or left and thus presented its side to the oncoming waves, we would have experienced the second rotational degree of freedom, roll, in a disastrous manner, and that would have been the end of all of us. Yaw was kept under control by the ship's rudder, as long as the ship's motion through the water was fast enough to make the rudder effective.

Control of Yaw and Roll Was Necessary for Noah's Ark

For the inhabitants of the ark, controlling the translational degrees of freedom was of no importance. It mattered little to them whether they were going east or west, north or south, because, once the flood waters covered the earth, there was nowhere to go. Every possible destination was covered by H_2O. (Of course, it would have been inconvenient if they found themselves in the middle of the Atlantic or Pacific when the flood waters subsided.) For the third type of translational motion, the only up/down motion of which the ark was capable was going up and down with the waves.

The ark needed some means of controlling yaw; otherwise the waves would have caused uncontrollable roll during the ark's year-long voyage. And there would have been waves, possibly large ones, because Genesis 8:1 mentions a wind during the time of the flood's abatement. Where there is wind and a large enough expanse of water, there will be waves. Questions of where the water of the



Three rotational degrees of freedom. Credit: Glenn Research Center, NASA, https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/aircraft-rotations/ (Wikimedia Commons, Public Domain).

Ship encountering a moderate storm at sea. Photo from Peter Colón, "God Was in Our Boat," *Israel My Glory*, July/August 2011, https://israelmyglory.org/article/god-was-in-our-boat/.

flood went, though interesting, will not be discussed here. What will be discussed is whether some means of controlling yaw was built into the ark's design. Without such control, the vessel would have turned sideways to the oncoming waves, resulting in a very unstable situation.

The Answers in Genesis designers of the magnificent ark replica in Kentucky recognized this need. Their solution was to assume that yaw could be avoided, or at least controlled, by means of a sail. It could not be a fabric sail, since the eight-person crew of the ark would not have been sufficient to control a sail of the required size. Their website explains:

> A bow-mounted rigid "sail" or *fin* demonstrated a significant steering effect. The optimum design would have the feature as far forward as possible (maximizing the yawing motion arm), relatively high (increasing the wind velocity and away from wave-induced air turbulence), high enough to avoid contact with waves, and as large as possible without compromising stability (wind heeling motion).[1]

Consequently, the Kentucky ark has a wooden sail on its bow.

By firsthand experience, I can say that the wooden sail of the Kentucky ark would not be effective in controlling yaw. It would actually increase the yaw when a sudden change of wind direction occurred, such as was the case with the drenching I experienced when the wind suddenly switched direction and tore off the top of a massive wave many years ago in the North Atlantic. When the wind suddenly switched and came crosswise to Noah's ark, any wooden "sail" would turn the vessel broadside to the waves (assuming it previously was pointed into them). The result would be a tendency to roll, a motion that could be large enough to result in the ship capsizing. A friend of mine who is an experienced yachtsman has gone through large storms on the Atlantic, and he affirms that a wooden sail in a fixed position would be a disaster in a high or even moderate wind.

"What will be discussed is whether some means of controlling yaw was built into the ark's design."

Other than the wooden "sail," the ark replica at the Ark Encounter in Kentucky is excellently designed. Photo by Kaleeb18 (Wikimedia Commons, CC BY-SA 4.0).

The Use of Drogues to Control Yaw, and Therefore Also Roll

For the ark, a rudder could not be used to control yaw because rudders are only effective if the ship is moving at a suitable speed through the water. The ark, having no propulsion system of its own, was driven by the wind and, to a lesser extent, by the movement of water (i.e., waves). Waves can provide some translational movement to objects, but in general anything from foam to supertankers will mostly ride over waves and not travel with them.

Modern sea anchor (drogue). Photo by Ed Dunens (Wikimedia Commons, CC BY 2.0).

There is, however, a way to control a ship's yaw known to mariners. It is by means of a drogue, also called a sea anchor. In modern ships and yachts, sea anchors usually look like a small parachute. Just as the familiar aerial parachute provides resistance to the natural movement of the parachutist (downward), a drogue/sea anchor is designed to offer resistance to the natural movement of a yacht or ship being driven by the wind or waves. For that purpose, it is important that the drogue be connected (to something sturdy!) on the bow of the ship. Since the force of the wind or waves will cause the vessel to move through the water, the drogue, by its drag or resistance, will then keep the bow pointed into the oncoming wind and waves. This minimizes the yaw and thus avoids, hopefully, any catastrophic roll. A modern skipper has expressed appreciation for the effectiveness of such a drogue in keeping his craft pointed into the waves:

> After deployment [of a sea anchor] my yawl [a two-masted sailing boat] lay bow-to the wind and waves with very little yawing. With 400 feet of rode there was absolutely no shock loading. My boat rode like a duck, up and over each wave, always nose to the wind. Altogether a very pleasant, safe, and secure feeling.[2]

This is what was needed for Noah's ark: Its bow needed to maintain its position pointed into the wind and waves, hopefully to provide "a very pleasant, safe, and secure feeling" for all aboard.

Ancient drogues did not resemble the modern parachute-type drogue. Instead, they were heavy pieces of rock through which a hole had been bored in order to hold a rope that would be attached to the bow of the ship. The drogue was not lowered into the water until its use became essential, which normally would only be in the emergency of being unable, by normal sailing methods, to keep the prow pointed into the oncoming waves. Such drogues have been found on the seafloor of the Mediterranean and are on display in various museums of the region.

Surprising Development: The Ark's Drogues Have Been Found

In eastern Turkey, close to the Iranian border, there are numerous large rocks protruding out of or lying on the ground, with holes drilled in the top. This area, in ancient times, was called Ararat (Urartu in ancient Assyrian inscriptions; Armenia from the fourth century BC until the early 20th century AD). Some of these distinctive rocks have been moved to an old Armenian cemetery for use as grave markers. The rocks resemble the anchor stones that were used on ships in classical times. However, the drogues found in the Ararat region are far larger than anything found in the Mediterranean. Exact measurements of the Ararat drogues are unavailable, but to give a rough idea of their size, we shall use 7 feet (2.1 m) in height, 4 feet (1.2 m) in width, and 1 foot (0.3 m) in thickness as a conjectured average.[3] According to Andrew Jones, who has photographed the drogues in situ, 26 such objects have been found in the area about 30 miles (48 km) west of the traditional Mount Ararat.[4] The Turkish name for this dormant volcano is Agri Dagh; the name Mount Ararat has been applied to the mountain only in fairly recent times, and the Bible says that the ark came to rest "on the mountains of Ararat" (Gen 8:4), not on any mountain called "Ararat."

The stones/drogues are composed of basalt. We can estimate their weight. Given the rough dimensions just estimated, the volume of the postulated average stone can be approximately determined as $7' \times 4' \times 1' = 28$ cubic feet (0.79 m^3). The density of basalt is around 180 pounds per cubic foot (ca. 2,900 kg/m^3). The weight of the presumed average drogue would therefore be approximately 5,040 pounds (2,286 kg), or 2.52 tons. The aggregate weight of 26 such anchor stones would be about 65.5 tons. In the water, they would "weigh" less according to the amount of water displaced; the roughly estimated 728 cubic feet (20.6 m^3) of water displaced by the 26 drogues would weigh about 45,427 pounds (20,605 kg), or 22.7 tons (the density of water being around 62.4 lb./ft.^{3}). This would reduce the effective weight of the 26 drogues in the water from 65.5 tons to about 42.8 tons.

But, assuming for the present that these are the actual drogues used by Noah's ark, why are there so many of them? The following discussion will explore the possibility that they could have been used for purposes other than keeping the bow of the ship pointed into the waves (the usual function of drogues, both ancient and modern). Specifically, they could have served as ballast external to the ship, and also as counterweights to reduce the up-and-down motion of the ship (pitch).

Buoyancy and Ballast

Is there any explanation of why such a massive amount of weight—estimated above at roughly 65.5 tons—would be used in the drogue stones of Noah's ark? There appear to be two reasons: (1) the necessity of using more than one drogue to control the ship's direction, due to the immense size of the ark, and (2) the need to counteract the ark's buoyancy. Buoyancy is the upward force that a liquid applies to any object immersed in, or partially immersed in, the liquid. Calculation of the buoyancy force is straightforward: It is the weight of the liquid displaced by the object in the liquid.

What was the buoyancy of the ark? Interestingly, the ark's dimensions, as given in Genesis 6:15, are in the same ratio of length/width/height as a modern oceangoing vessel of approximately the same size. This fact in itself should give pause to skeptics who maintain that the flood story is entirely myth. The biblical description of the ark contrasts with the later, corrupted versions of the flood story, in which the shape and dimensions of the vessel that survived the flood, if given, are always nautically impossible.

Ancient drogues found in the Mediterranean. Photo by José M. Ciordia (Wikimedia Commons, CC BY-SA 4.0).

As indicated, in order to calculate the buoyant force acting on the ark, it is necessary to estimate the volume of water the ark displaced when fully afloat. In doing such a calculation, we shall use the dimensions of the ark as calculated by the engineers associated with the Ark Encounter museum in Kentucky. These designers wisely used the length of the ancient Egyptian (and also early Mesopotamian) cubit, 20.6 inches (52.3 cm), instead of the later cubit of 18 inches (45.7 cm). Examples of this earlier, longer cubit are found in museums in Egypt and at archaeological sites in Mesopotamia. With the ark's dimensions at 300 × 50 × 30 cubits, using the more ancient cubit results in a length of 515 feet (157 m), a width of 86 feet (26 m), and a height, from keel to top of the main deck, of 51.5 feet (15.7 m). Another sensible choice by the designers of the Kentucky ark was to assume that the bow would be shaped like the bow of any modern large oceangoing vessel—that is, it would be narrowed down to a rather sharp shape in order to reduce the stress of impact with an oncoming wave, in contrast to the stronger and more sudden force that a square bow would present to the waves.

Although a lot of buoyancy might seem like a good thing—and it is for small crafts like canoes or rowboats—too much buoyancy is destabilizing for a large oceangoing vessel. Therefore oceangoing ships, both ancient and modern, used some form of weight (ballast) in the bottom of the ship to overcome excessive buoyancy, although for something like an oil tanker, the oil itself can provide the needed ballast weight. An example of stones used as ballast has been found in the remains of a shipwreck in the Mediterranean that is dated to about 1100 BC.[5]

The ark, then, would have had a problem with buoyancy, and especially since it was made of the mysterious "gopher" wood. This suggests that something must have been done to overcome the excessive buoyancy that would make the ship unstable. We can get a fairly accurate estimate of the magnitude of the buoyant force on the ark based on the reasonable shape of the ark replica in Kentucky, including the narrowing of the front part of the ship in order to better meet the oncoming waves. We shall also assume that the draft of the ship was one-half the height of the main deck—that is, 15 cubits (26 feet [7.9 m]). When the calculation is done using these figures, the ark must have displaced approximately 1,111,000 cubic feet (31,460 m^3) of water, which would give an upward force (buoyancy) of 69 million pounds, or 34,500 tons. This upward force must be counterbalanced if the ark was to attain the estimated 26 feet (7.9 m) of draft needed to give it stability. Since it seems unlikely that the ark plus its contents could have provided all this vast weight (the interior could not be densely packed as in a modern oil tanker), it is reasonable to assume that some sort of ballast was required to achieve the estimated optimum draft. This provides a possible explanation of the postulated aggregate total of 65.5 tons of drogue stones that have been found in the Ararat region: Some of these drogue stones were used not just to keep the ark pointed into the waves, but as a form of ballast, external to the ship. This, of course, would be impracticable for any ship that was trying to move through the water by sail power or oar power. The ark, however, was unique among all ancient ships in that it wasn't designed to go anywhere; the main design purpose of the ark was just to stay afloat, and to minimize the effect of the waves on the comfort of its human and animal passengers.

Largest of the drogue stones discovered in eastern Turkey. Some of them, like this one, bear engraved crosses from different centuries of the Christian era, suggesting that they may have been regarded as objects with religious significance. Photo courtesy of Andrew Jones of NoahsArkScans.com.

How the drogue/ballast stones accomplished this will be addressed in a later section. The estimated 65.5 tons from the 26 drogue stones would be part of the required weight necessary to counteract to a suitable degree the buoyancy problem of the ark. It is assumed here that these weights would all have been attached to the front of the ark, while ordinary ballast (stones or slag) would have been used inside the ship in the stern. Some researchers have proposed that the drogues found in the Ararat region could have been attached to the sides, or even to the keel, of the ark, but such arrangements would defeat the essential requirement of keeping the bow pointed into the oncoming waves. Consequently, my thesis is that all were attached to the general area of the bow using ropes of various lengths, requiring a very strong structure at the bow to support weights of this magnitude. Also, there was no need for any mechanism to lower the drogues into the water, as will be explained momentarily.

Attempts to Explain Away These Remarkable Stones

If these man-crafted rough objects in eastern Turkey are not anchor stones, then what else could they be? Any alternate theory would need to explain the hole in the top. One imaginative explainer-away says that the holes were for sighting; aligning two such stones would allow the viewer to sight onto some distant object (what object?) à la Stonehenge.[6] In order to further discredit the idea that these could be the ark's drogue anchors, it is stated that there is no basalt in Mesopotamia, where Noah is presumed to have lived before the flood.[7] But nothing in the book of Genesis indicates that Noah and his family lived in Mesopotamia, and the long lifespans, and assumed comparably long periods of fertility, of the prediluvian patriarchs and their wives imply that Adam's descendants numbered in the millions if not billions before the flood, which would require expansion far beyond the original area of settlement east of Eden (Gen 3:24).

An equally improbable explanation is that the stones were only grave markers, as mentioned. It is only natural that many would find these objects as ready-made grave markers, but this does not explain why most of them are not found at a grave site, while there would have been a natural tendency to relocate them to the Armenian cemetery for just such a use. Others have objected that the stones are of much too late a date to be associated with the ark, since Christian crosses, in the Roman and also the Byzantine style, have been found on some of them. But this just testifies to the universal human tendency to add graffiti to any open flat surface, and the drogue anchors that are still in the ground or only recently excavated are without graffiti. Also, the styles of the crosses indicate different time periods, separated by centuries, in which the Christian graffiti were made; they are of no more use in dating the drogues than is the presence of a bullet mark on one of them.

There is really no other satisfactory explanation for what these objects are if they are not drogue anchors for a massive boat. Yet they are found at altitudes ranging between 6,000 and 7,000 feet (1,829 and 2,134 m), about 170 miles (274 km) from the nearest large body of water (the Black Sea), and about 750 miles (1,207 km) from the Mediterranean. For those who do not allow physical and scientific evidence of any type to contradict their a priori anti-Bible prejudice, it must be concluded that there is some reason other than logical, rational thinking that motivates their unwillingness to accept the results of archaeological and scientific data that support the Bible's account of a great, and universal, flood.

Use of Drogues to Protect the Ark at the Beginning of the Flood

Consider another aspect of the drogues. They were never taken aboard the ark. When the ark was under construction, they would have been laid out in front of the ark, on the ground, with ropes of different lengths attached to them. When the rain began, the ark faced an immediate danger: As soon as the water became deep enough to float the vessel, it would begin to drift. Unless the ark was built on the top of a hill (unlikely, although see the Altaic folklore below), when this drift began there would be objects nearby, possibly hills, buildings, or trees. Initially, some of these objects would still be protruding above the water, and there would be many others in the area that were not yet submerged as deep as the assumed 26-foot (7.9-m) draft of the vessel. If the wooden hull struck any of these when the ark first started to drift, there would be disaster. It was therefore necessary that the vessel be constrained by conventional anchors until the water covered all the surrounding territory, including its trees and rocky protrusions, to a depth of at least 26 feet (7.9 m). The several drogues attached to the front of the ship would have accomplished this by acting like conventional anchors when the floodwaters first began to rise. The last drogue to lift off the earth's surface, thus ceasing to act as a conventional seafloor anchor and starting to act like a true sea anchor, may have had a rope a few hundred feet long.

Unlike conventional drogues, whether ancient or modern, the ark's drogues seemingly had four purposes: (1) to act as seafloor anchors at the start of the flood, to keep the ark from drifting into nearby objects; (2) then to act as sea anchors (drogues proper) to keep the ship's prow pointed into the waves; (3) to serve as ballast for the front part of the ship, thereby freeing up space in the front of the ship that would otherwise be occupied by regular ballast material such as boulders; (4) to moderate the ark's pitch (see next section).

I find this a wonderful example of ingenuity in design. Notice also that, once the drogues were attached with ropes to some sturdy structure at the prow of the ark before the flood, there would be no need to service them in any way until it came time to loose them from the ark as the floodwaters receded and the drogues began to drag on the earth's surface. Such freeing from the drogues would have been accomplished by the ship's crew by means of a sharp saw or axe—a very simple task. The drogues with the longest ropes would have been cut off first, and then the others successively as they dragged on the bottom.

For those willing to separate the wheat from the chaff in ancient testimonies, as opposed to those who regard everything in the worldwide accounts of the flood as entirely legendary fiction, there is a somewhat distorted remembrance of these drogue anchors, and their attached ropes, in the story of the flood given by the Altaic people of central Asia:

> Up to the time when the flood (*jaik*) hid all the earth, Tengys (Sea) was lord over the earth. During his rule there lived a man called **Nama**, a good man, whom Ülgen commanded to build an ark (*kerep*). Nama, who had three sons, Sozun-uul, Sar-uul, and Balyks, was already failing of sight and therefore left the building of the ark to his sons. When the ark, which was built on a mountain, was completed, Nama told his sons to **hang from its corners and walls eight cables of eighty fathoms each**. . . . After this had been done, Nama entered the ark, taking with him his family and the various animals and birds which, threatened by the rising waters, gathered around him. Seven days later **the cables attached to the earth gave way and the ark drifted free**.[8]

Surprise Benefit: The Drogues Would Moderate Pitch

There are three reasons why seagoing ships have a sharp prow. The first is efficiency. Streamlining enables vehicles (cars, planes, ships) to move through water or air faster and with less expenditure of energy. The second reason is safety. The ship is less likely to be damaged by the force of the waves or any extreme pitching if the prow can slice into the waves, reducing the pitch and the shock of the waves. The third reason is comfort of the passengers and crew. A sharp prow, as it slices into the wave, will allow the ship to travel through the wave with less raising of its front and subsequent lowering, the "pitch" discussed at the beginning of this article. The greater the pitch, the more strain not only on the structural members of the ship but also on the people inside.

The first consideration, efficiency, was not a design principle for the ark. No fuel was being expended, and there was no hurry to go anywhere. The ark was unlike most ships built before or since in that it was not designed to convey people or things from one place to another. It was only designed to stay afloat, and its ultimate destination was not under the control of its crew.

The second and third principles regarding the ship's prow, however, were very much designed into the ark. Here the sharp prow and the drogue anchors played a significant role. As explained, the sharp prow would naturally reduce the pitch, but the drogue anchors also served this purpose: An oncoming wave, in order to elevate the front of the ship, would have to also raise up all the drogue anchors, which were situated at depths in the water determined by their rope lengths. These anchors offered three types of resistance to the upward motion of the prow: their weight, their inertia, and the liquid or viscous friction with the water.

The ark was thus eminently designed for safety and for the comfort of its human and animal passengers. Horses and cows, and presumably other large animals, can panic if they are on a ship when the ocean gets rough. Therefore it was important to reduce the ship's pitch motion as much as possible. As estimated earlier, if there were 26 drogue anchors, each averaging about 2.52 tons, that means there were approximately 65.5 tons of deadweight that must have been overcome to raise the bow, just in the drogue anchors alone. Although the effective weight of the anchors in use both as drogues and as ballast for the front part of the ship would be less because of their immersion in water, it was not only their weight but also their inertia that counteracted the lifting force of the waves, and their inertia was not reduced by their being immersed in water. Also, they offered viscous friction equal to many more tons of force in a direction against the uplift presented when meeting a wave. While the drogues served this double purpose—navigational direction and ballast—it was not necessary that they all be fastened to the exact frontal point of the bow. They could be spread a little bit along the side of the (presumably somewhat pointed) bow and still serve both functions. They would not be spread uniformly along the sides of the ship and even to the stern; that would result in drogue forces working in all directions and not just the one essential direction—namely, into the oncoming waves.

This was a tremendous force that was exerted in opposition to the force from waves to raise the prow. But what happened as the ship passed over the crest and began to travel down the back part of the wave? Here the pitch was downward, and according to the presumption made above that the drogues were only attached to the bow of the ark, there would not have been comparable drogues on the stern to prevent it from rising and hence hinder the bow's downward motion.

Drogue anchors on the stern were not needed. As soon as the prow started to sink down the backside of the wave, the tension on the ropes leading to the drogue anchors diminished. Because of the friction of these large stones in the water, they would not drop in the depths as fast as the prow as it seesawed downward. Any downward acceleration would automatically reduce the tension on the ropes. In the extreme case of free fall, the prow would not experience any downward pull at all from its drogues. The tension on the hawsers would relax as many tons of weight were momentarily released from them. The prow, freed to some extent from the full force of the heavy weights, would experience the tremendous upward thrust of the ship's buoyancy, and this buoyancy would counteract the downward plunge of the bow. For a large wave, the difference in the effective buoyancy would be large, and for a small wave the force would be small. The inertial and viscosity effects of the drogues would therefore be large when the ark's motion was large, and smaller when the ark's motion when coming down from a wave was smaller. In both cases the smoothing-out effect of the drogues would match, to some extent, the amount of counter-effect needed to minimize the ship's pitch. Because all their downward force was exerted on the prow of the ship, the drogues had the advantage of leverage when acting against the tendency of a wave to lift that end. Because of this leverage, their weight was more effective in counteracting upward motion than if the same weight were distributed throughout the ship as part of its ballast.

What has been described is a damping system in which corrective forces were applied to reduce the seesawing of the ship as it encountered rough seas. These forces were applied automatically and instantaneously. Their effect was to smooth the ride. I would conjecture that the pitching motion of the ark was probably much smoother than what any modern ship of comparable size would experience going through similar seas. Even when modern sailing ships use light drogues, these drogues are used mostly to limit yaw, not pitch. The smoothness of the ark's voyage was important in the planning; comfort and safety were paramount design features of the ark and its system of drogue anchors. The drogue anchors therefore provided for managing the direction and motion of the ship with no demands on the time or strength of the crew.

The Drogue Anchors Were Multipurpose

It is considered a mark of engineering excellence when one part of a structure or apparatus can serve more than one purpose, especially if it does so without compromise to any of the functions it fulfills. It is even more remarkable when this can be done with a simple system that requires little maintenance and has few moving parts, reducing the likelihood of failure. The ark's drogues had all of this. They are not as pretty as modern parachute-type drogues, but prettiness was not a requirement. As crude as they might look to the modern person who puts so much emphasis on appearance, the drogues used on the ark represent a more brilliant engineering accomplishment than their modern counterparts that indeed control yaw but do little to manage pitch. If the purposes of the drogues in the ark's design were as postulated in the present discussion, then one can conclude that the design was brilliant, completely new and creative, and eminently successful.

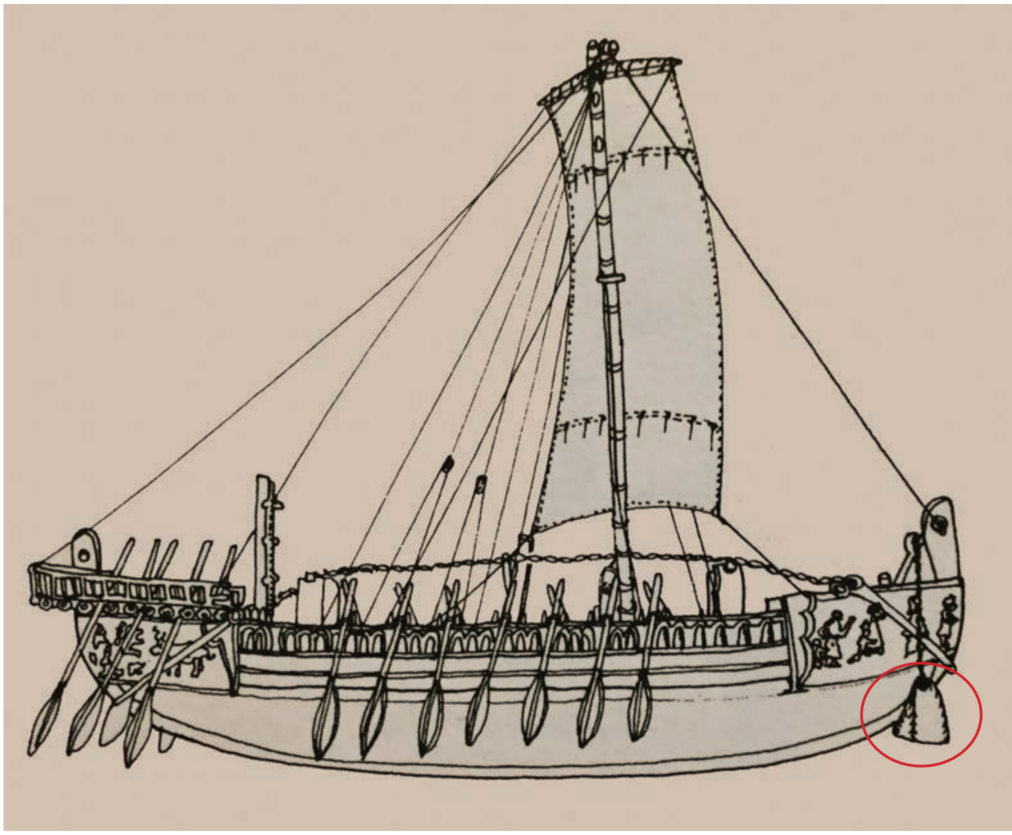


Illustration of how a stone drogue was attached to the prow of ancient ships, to be released into the water only when neither sail nor oars could keep the ship pointed into the oncoming waves. Drawing reproduced from Enzo Angelucci and Attilio Cucari, *Ships* (Mondadori, 1975), 21. Red oval added.

Apparently, what happened was that as the waters were receding, the lowest drogue anchor began scraping on the bottom. Noah's family then cut its hawser to release it. As they drifted a little further, the second-lowest anchor began to drag, and it was released. By comparing the elevations where the drogues exist now (except those displaced to the cemetery), it might be possible to roughly determine the lengths of their various ropes.

A Scientific Test

Another avenue of research should be undertaken in this study of the Ararat drogues. Geologists derive much of their information about the Ice Age or Ice Ages from the study of erratic boulders.

These are stones that were carried by glaciers, or sometimes by icebergs, far from their place of origin. By determining the mineral and chemical composition of the boulder, and comparing with outcroppings of that rock type perhaps several hundred miles away, it is possible to determine where the boulder came from and how far the glacier moved before depositing it.

The rough-hewn drogue stones of the Ararat region are composed of basalt. Basalt varies in its chemical composition in various parts of the earth, and although the exact place of origin of a given piece of basalt cannot be determined, its general locus can be ascertained through chemical analysis—whether it came from the Mid-Atlantic Ridge, the Columbia Gorge formation, or some other general area known to geologists who are qualified in this kind of analysis. Thus the basalt of the Columbia Gorge area in western North America, which is usually quite black, differs from the basalt of southern California, which is of a light gray hue.

Interestingly, a chemical analysis of a chip taken from one of the Ararat drogue stones has already been done, and the sample's chemical composition is given in a journal article.[9] Although the article's abstract claims that "anchor stones at Kazan (Arzap) are derived from local andesite and not from Mesopotamia," there is no comparison in the following text with the chemistry of andesite/basalt in the surrounding region. It is totally inconsistent when a scientific article makes a claim in its abstract that is not supported in the article's text. Neither is there any evidence, biblical or otherwise, that the ark was built in Mesopotamia. Since the cited article fails to provide this essential evidence, the crucial comparison with the andesite/basalt of the Ararat region remains to be done. Specifically, comparison should be done with the basalt from eruptions of the nearby dormant volcanoes, the largest of which, Agri Dagh (Mount Ararat), last erupted in AD 1850. To be thorough, the chemical composition of basalt from eruptions in earlier times (lower strata) in the Ararat region should also be examined to take into account the possibility that the chemical composition of the underlying magma may have changed over the preceding centuries and millennia. If the chemical composition of the drogues cannot be matched with that of any of the basalt layers in the Ararat region, that would be scientific verification that the drogues were brought to the area from another geological region. If this is indeed the result of the scientific analysis, then it will be interesting to see what alternatives are produced by those whose a priori presuppositions rule out the historicity of the biblical account of the flood. How would such skepticism explain how and why someone would drag large basaltic objects in the form of sea anchors—sea anchors much too large for any conventional ship—to a place high in the mountains and far distant from any sea? Would those who claim to be scientific in their thinking be willing to accept the results of this scientific experiment? And, for those of us who believe in the historicity of a worldwide flood, a chemical analysis of the drogue stones might reveal the general area where Noah and his family lived while building the ark. There is no reason to think that the ark mysteriously, after drifting for a year, ended up in the exact same place where it was constructed.

"How would such skepticism explain how and why someone would drag large basaltic objects in the form of sea anchors—sea anchors much too large for any conventional ship—to a place high in the mountains and far distant from any sea?"

Endnotes

1. Tim Lovett, "How Could the Ark Avoid Being Capsized?," Answers in Genesis, January 5, 2025, https://answersingenesis.org/noahs-ark/how-could-ark-avoid-being-capsized/.

2. Testimonial quoted in Darrell Nicholson, "Sea Anchors & Drogues," Practical Sailor, updated March 11, 2020, https://www.practical-sailor.com/sails-rigging-deckgear/sea-anchors-drogues/. The author of this interesting web page on drogues introduces the topic with the statement, "Sea anchors are as old as seafaring."

3. My appreciation to Andrew Jones of NoahsArkScans.com, who, at my request, took measurements of the aboveground portion of the largest stone found. His measurements were 210 cm, height; 150 cm, width; and 32 cm, thickness—or 6.9 × 4.9 × 1.05 feet (email message to author, April 29, 2026). The buried portion of the stone would thus make it more than 7 feet tall. Given the necessary imprecision because no one has published exact measurements of these stones, we will use, as a rough estimate, the dimensions of 7 feet (2.1 m) tall, 4 feet (1.2 m) wide, and 1 foot (0.3 m) thick—somewhat smaller than the largest stone—for the size of the conjectured average stone. Jones's research is in a different area than what is covered in the present article, and his helpfulness in providing measurements does not necessarily imply his agreement with the conclusions presented herein.

4. Steven Law, "The Hunt for Noah's Ark: Durupinar," pt. 1, Patterns of Evidence, April 10, 2026, https://www.patternsofevidence.com/2026/04/10/the-hunt-for-noahs-ark-durupinar-part-1/.

5. Rossella Tercatin, "In First, Three Shipwrecks from Biblical Times Uncovered off the Coast of Israel," *Times of Israel*, October 8, 2025, https://www.timesofisrael.com/in-first-three-shipwrecks-from-biblical-times-uncovered-off-the-coast-of-israel/.

6. Anne Habermehl, "Decoding a World Navel 'Visual Language' Through Ideational Cognitive Archaeology: Further Comments," *Answers Research Journal* 17 (2024): 354.

7. Lorence Gene Collins and David Franklin Fasold, "Bogus 'Noah's Ark' from Turkey Exposed as a Common Geologic Structure," *Journal of Geoscience Education* 44, no. 4 (1996): 441.

8. *The Mythology of All Races*, ed. Louis Herbert Gray and John Arnott MacCulloch, vol. 4, *Finno-Urgic, Siberian*, by Uno Holmberg (Marshall Jones, 1927), 364, https://archive.org/details/in.ernet.dli.2015.283531; emphasis added. The Altaic myth continues with various incidents that are clearly fabulous, such as when Nama/Noah became very old, his wife urged him to kill all the people and animals that were then inhabiting the earth, upon which Nama killed his wife instead (Holmberg, 365). In one detail, however, the Altaic legend shares a theme that was quite memorable, and hence common among remembrances of the flood taken from various parts of the world: the sending out of birds after the ark came to rest to determine if the ground was habitable.

9. Collins and Fasold, "Bogus 'Noah's Ark,'" 441, table 1.