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The *Ourobóros* as an Auroral Phenomenon

ABSTRACT: This article traces the spread and development of the motif of the *ourobóros*, or circular serpent, and proposes that it originated in descriptions of an intense aurora. The earliest artistic examples of the *ourobóros* date to ± 5000 – ± 3000 BCE. The theme proliferated in Egypt and spread to the classical world during the Hellenistic period. In the earliest traditions, emphasis was on the *ourobóros*' associations with the sun god, the creation of the world, the circular ocean, darkness or underworld thought to surround the earth, and a mythical combat. From late antiquity onwards, the *ourobóros* acquired more sophisticated meanings, including a link with the ecliptic band or the zodiac, the lunar nodes, the alchemical process, and eternity. In China, the *ourobóros* largely remained a purely decorative motif, while its most common role in the equatorial regions of America, Africa and Oceania was as a form of the cosmic ocean.

In reviewing hypotheses concerning the origin of the motif, we consider the antiquity of the theme, its near-universality, its geographic link with the outermost boundary of the visible world, and aspects of the dragon's prosopography—such as its precious orb, its filamentation, its twin aspect, and its radiant color scheme. It is proposed that the archetype was inspired by a surge of intense auroral phenomena including a plasma instability type known as a diocotron instability, witnessed by human beings towards the end of the Neolithic period.

SINCE THE BEGINNING OF HISTORY, few characters of world mythology have captured the imagination as much as the dragon. One of the most conspicuous forms assumed by the dragon is the *ourobóros*, the serpent that—as the name says—“devours its tail” (Liddell and Scott 1940:1274).

The present inquiry offers a survey of ouroboros traditions worldwide and from the earliest times onwards, followed by a novel theory to explain its emergence. In the course of this investigation, the narrow definition of the term, which requires the tail to be actually placed in the mouth of the snake, is extended to the concept of enclosing serpents in general.

The earliest known examples of the ouroboros, which are purely artistic, antedate the age of writing and are concentrated in China and the ancient Near East. More than two dozen artifacts incorporating the motif and ranging over a largely continuous period of time have been uncovered in China. The earliest is a terracotta amphora discovered in 1958 at Gāngǔ, Wūshān, Gānsù. This amphora belonged to the Neolithic Yāngsháo culture, which was located along the Yellow River from 5000–3000 BCE (Elisseeff and Bobot 1973:40). This snake-like creature, with its head approaching its tail, is suggestive of “the incipience of the dragon motif, though hind feet are lacking” (Mundkur 1983:75). The motif is also found on a significant number of other objects from China (the earliest from the Neolithic Hóngshān culture), Siberia, and the Crimea (Needham 1980:381). Southwestern Iran is a second early center of iconography, with examples found at Tepe Giyan and Tepe Bouhallan from the first half of the fourth millennium BCE (Mahdihassan 1963:43, fig. 18; Amiet 1966:37; cf. Toscanne 1911:191, fig. 351). The motif also has been discovered on a prehistoric Egyptian ring (Petrie 1914:25 and plate XII). In scattered places around the world, the ouroboros occasionally appears in petroglyphs and on pottery.

The Circular Serpent in Cosmology: Ancient Egypt

According to textbooks and encyclopedias on mythological symbols, the icon of the round snake conveyed the sense of continuity, union, stability, cyclicity, or immortality (e.g., Deonna 1952:163; Lindsay 1970:261; Cooper 1978; Chevalier and Gheerbrant 1996a, 1996b). However, a close inspection of primary source material suggests that the original *Sitz im Leben* of the ouroboros was cosmological:

Cosmic Proportions: The territory encompassed by the coil of the serpent was often understood to be the entire earth, world, or cosmos, vague terms

that originally connoted no more than the simple concept of “all things known or seen.” By encircling the earth, the snake effectively supported and protected it (Chevalier and Gheerbrant 1996b:846).

Solar Connection: The serpent was widely believed either to enclose the sun or, in rare cases, to be the sun (Preisendanz 1935:143, 1940:207).

Cosmogonic Aspect: A number of belief systems directly relate the formation of the ouroboros to the cycle of events understood to represent the creation of the world.

Within the Old World, the oldest historical examples of the ouroboros motif are Egyptian (Preisendanz 1935:143; 1940:194, cf. 208; Needham 1980:375). The earliest textual attestation, which is indicative of the great antiquity of the theme, is a curse in the *Pyramid Texts* (±2300 BCE): “Your tail be on your mouth, O *šnt*-snake!” (689.393). Cosmological symbolism can be inferred from a number of later images on burial objects. Arguably, “the earliest known representation of the *ouroboros*” in funerary art is an episode on the second gilded shrine of King Tutankhamun from the fourteenth century BCE, featuring “a large mummiform figure of the king, his head and feet encircled by two serpents biting their tails. The serpent around the head is called Mehen, the Enveloper” (Piankoff 1955:121, fig. 41; Hornung 1999:78). The two images of Mehen, the encircler, and the snake surrounding the king’s feet supposedly connoted the polarity of heaven and earth (Stricker 1953:7). An image on the funerary papyrus of the Chantress of Amun Henuttawy (1069–747 BCE) features a tail-biting snake. It is placed in the right hand of Gēb, the personification of the earth, over whose body the star-spangled torso of the anthropomorphic sky goddess is extended (British Museum catalog number EA 10018.2; Lanzone 1881:408–10, plate CLIX. 8). Although the exact significance of the ouroboros in this image is elusive, the arrangement leaves little doubt that the Egyptians conceived of it as a prominent phenomenon in the space between heaven and earth—either as a manifestation of the journeying sun or a repetition of the pattern of the enclosing

union of earth and sky (Lindsay 1970:274). In another type of image, the ourobóros surrounds the sun god, Ḥoraḥte, and is supported on the backs of two lions facing away from each other. In some cases, the head of an animal identifiable as the “bull of heaven” corresponds in function to that of a sky-supporting pillar (Piankoff 1949:133–34, plate IV; Stricker 1953:8, 10, 12, cf. fig. 3f, 4a–f; Clark 1959:53).

A cluster of passages both in the *Book of the Dead* and the *Coffin Texts* (± twenty-first to seventeenth centuries BCE) describes the coils of a serpent that surrounded the sun god as pathways of fire. Rē' is “the Coiled One, who makes a circle in a myriad after a myriad (of years) . . . The paths of fire go round about the seat of the Shining Sun, who guards the paths for the great bark of the Coiled One, who makes a circle for myriad after myriad” (*Coffin Texts*:758 [VI. 387], 759–60 [VI. 387–90]; *Book of the Dead* (Papyrus of Nu):131, tr. Allen 1974:107).

In terms of the daily cycle of the sun, the serpent's role is certainly defined as that of the divine antagonist who opposes the sun's rising with clouds and lightning storms (e.g., Stricker 1953:7). A vignette accompanying a spell in the *Book of the Dead* depicts the sun as a cat using a knife to attack the circular serpent that surrounds him at the foot of a tree (*Book of the Dead*:125, tr. Kolpaktchy 1973:214; Lanzzone 1881:plate CIV. 1). Another passage in the same corpus explains that the cat denoted Rē' and the tree denoted the sacred *ished*-tree at Heliopolis (*Book of the Dead*:17, tr. Faulkner 1985:48). A papyrus from 312/311 BCE features Āpep or Āpepi as the ophidian foe of the sun god Rē', who is destroyed by his forced adoption of the circular pose:

O 'APEP, thou foe of Rē', get thee back! . . . thou shalt not come against Rē' in his two heavens when Rē' is in his heavens; he shall triumph over thee, thy tail shall be placed in thy mouth, and thou shalt chew thine own skin, it being cut into upon the altar of the gods, of the Great Ennead which is in Heliopolis.

Hail to thee, O Rē', in the midst of (the coils of) thy *mehen*-serpent; thou art triumphant over 'APEP. (“Bremner-Rhind Papyrus” 1937 and 1938:6.30.15–17, 4.24.11, cf. 22.15, 32.45)

As the embodiment of the lower region of the cosmos, the ourobóros bears an intimate relationship to the darkness of the Dwꜣt, or underworld, through which the sun, emulated by the soul of the deceased king, must travel at night. An image on the alabaster sarcophagus of King

Seti I (±1280 BCE) portrays the boat of the sun god in the first region of the Dwꜣt, described in the *Book of Gates* (as paraphrased by E. A. Wallis Budge) as “a disk containing a beetle; the disk is encircled by a huge serpent in folds, which holds its tail in its mouth.” (1904:vol 1, 180; cf. Hornung 1999:66). The ourobóros is associated with the underworld, which serves as the repository of the temporarily deceased sun god and other disincarnate souls. This association also underlies a number of funerary texts from the sixteenth century BCE onward, including some in which Osiris is depicted within the coil of a serpent that is alternately identified as Wer (the old one or the great one) and as Neḥꜣ Her (fearful face) who was apparently identical with Meḥen (*Book of Caverns*:48, fig. 10, 66–7, fig. 12, 72–74, 129–30, fig. 27; Stricker 1953:10, fig. 3c, fig. 58; cf. Clark 1959:167; Hornung 1999:85–95).

Far from being restricted to the diurnal sunrise, the ourobóros’ activity is most pronounced in its cosmogonic role. In the context of creation, the daily antithesis of the sun and the storm or darkness is reduced to the more fundamental, archetypal struggle between the sun on its first rising and the malevolent forces of the unorganized chaos. The cosmogonic aspect of the circular serpent more specifically manifests as the darkness of the underworld, as the snake was demonstrably conceived as “the thick darkness which enveloped the watery abyss of Nu, and which formed such a serious obstacle to the sun when he was making his way out of the inert mass from which he proceeded to rise the first time” (Budge 1904:vol. 1, 324). As a primordial form of darkness enclosing Rē’, this approximates the prosopography of Sito (son of earth), alias Iru-To (creator of earth), a monstrous serpent that arose “out of the darkness of the Primeval Waters before any definite thing yet existed” (Clark 1959:50, cf. 241; Faulkner 1985:87). The crucial episode in the cycle of creation mythology is preserved in a spell in the *Coffin Texts*, in which the creative deity declares his identity with the coil that surrounded him:

I bent right around myself, I was encircled in my coils,
 one who made a place for himself in the midst of his coils.
 His utterance was what came forth from his own mouth.
 (*Coffin Texts*:321 [IV. 147] translated by Clark 1959:51)

According to translator Raymond Faulkner, the passage here translated as “bent right around myself” is “surely corrupt”¹ (*Coffin Texts*:250, note 16). The comparative evidence reviewed above nonetheless suggests that

the presupposed image is that of the *ourobóros*, producing either single or multiple coils around the solar orb. The texts make it sufficiently clear that this snake was the supreme god of creation (cf. Clark 1959:51; Faulkner 1985:175; Uphill 2003:19).

Survivals in Late Antiquity

As an art motif, the *ourobóros* may have spread from Egypt to the Levant. An *ourobóros* decorates the rim of a bowl with a Phoenician inscription from the seventh century BCE that was discovered in 1876 in Praeneste, Italy (Clermont-Ganneau 1878:239, 1880:8, plate III). One also decorates a marble cup from near Sidon, now in Lebanon (Deonna 1952:169). In the visual arts of the classical world, the motif of the round serpent surfaced no earlier than the Roman Imperial age, almost exclusively in esoteric contexts (Deonna 1952:164–65, 170; Needham 1980:377). The syncretistic nature of these appearances indicates an oriental provenance and enabled the snake's magical applications—in the form of spells and amulets—to prevail as the original links with darkness and the underworld began to fade (cf. Bonner 1950:158, 250). Essentially two thematic types can be distinguished. One type, akin to the Hellenistic Egyptian use of 'Āpep, features a victorious deity trampling on the subjugated *ourobóros* (Van Wijngaarden and Stricker 1941:35; Stricker 1943:27 fig. 15; cf. 1944:89; 1953:6, fig. 1; Mundkur 1983:66 fig. 35). Another type features the *ourobóros* protectively surrounding the sun god. Charms with this type of image were often prescribed between the third and fifth centuries CE. For example, a spell from a *Greek Magical Papyrus* advises: "Helios is to be engraved on a heliotrope stone as follows: A thick-bodied snake in the shape of a wreath should be [shown] having its tail in its mouth. Inside [the circle formed by] the snake let there be a sacred scarab" (12.274–76; cf. 1.144–47; 7.586; 12.203–206). In the same tradition, a significant number of Gnostic gems were inscribed with the round snake, typically enfolding the name of the tutelary genius, such as Abraxas, Anubis, Osiris, Horus, Iao, Khnum, Harpocrates or Serapis (Bonner 1950; Chabouillet 1858; cf. Cumont 1898:293; Cook 1914:192; Deonna 1920:128). As borrowings from the southeastern part of the Mediterranean basin, these instances of the *ourobóros* are symbolic in intent and lack a narrative, mythological framework.

In literary format, the Egyptian symbolism of the ourobóros placed its stamp on the colorful legends woven around the biography of Alexander the Great. In the romance traditionally attributed to Alexander's court historian, Callisthenes of Olynthus († 328 BCE), Alexander's *Blitzkrieg* is compared to the serpent's encircling of the "world egg" (*Vita Alexandri Magni* [Armenian version]:1.23–24; cf. *Vita Alexandri Magni* [Syriac version]:1.11) In the Syriac version, the prophecy was subsequently affirmed by the god Ammon himself, who told Alexander in a vision: "Through the serpent thou wilt encircle the whole world like a dragon" (1.30).

The cosmic proportions of the ourobóros and its links with darkness and the infernal region were better preserved in some Gnostic texts. In one, Jesus says: "The outer darkness is a great *dragon* whose tail is in its mouth, and it is outside the *whole* world, and it surrounds the *whole world*." (*Pistis Sophia*:3.126, cf. 3.102, 105–07, 119, 127–28, 4.136). In another Gnostic text, the apostle Thomas encounters a snake who identifies himself as "the offspring of the serpent, . . . I am the son of him who encircles the globe; I am kinsman to him who is outside the ocean, whose tail lies in his mouth" (*The Acts of Thomas*:32; see also Lydus:3.4; Wesselofsky 1885:326–28; Stocks 1910:3, 44; Reitzenstein 1921:78).

The Circular Serpent and the World Ocean

In an archaic cosmological model reflected in many cultures, the ourobóros embodied the cosmic boundary and shared a close association with the equally widespread notion of the circular ocean (Deonna 1920:131). Traditions vary from a mere feeling that the circular snake dwells inside the surrounding water to a direct identification of the two. In some cases, the alternating tides are ascribed to the activity of the creature. Again, the earliest example comes from Egypt. A spell in the *Pyramid Texts* invokes the god Osiris in the following capacity: "you are complete and great in your name of 'Wall of the Bitter Lakes,' you are hale and great in your name of 'Sea'; behold, you are great and round in [your name of] 'Ocean'; behold, you are circular and round as the circle which surrounds the *H3w-nbw*; behold, you are round and great as the *Šn-3-sk*"² (628–29 [366], cf. 847 [454], 1631 [593]). The literal interpretation of Osiris as the personification of a circular ocean is strengthened by the well-known identification of Osiris with life-giving water,³ in particular that of the Nile,⁴ which was itself equated

with the ocean: “For the Egyptians consider Oceanus to be their river Nile, on which also their gods were born” (Diodorus:1.12). As Clark concluded, “There was even a doctrine that Osiris was the whole earth, or the ocean which surrounded the known world. . . . He is in the Red Sea, the Mediterranean and the cosmic ocean which surrounds the world. Such thoughts were not a later development. They belong to one of the earliest hymns that have survived” (1959:117). Late survivals of the Egyptian association of the ouroboros with the sea include “the offspring of the serpent . . . who encircles the globe. . . . who is outside the ocean” encountered by the apostle Thomas (*The Acts of Thomas*:32). Alexander the Great, while airborne, perceived “a large snake coiled in a circle, and inside it a round building like a very small threshing-floor” which represented “the earth; the snake, however, is the sea, which surrounds the earth.” (*Vita Alexandri Magni* (Greek version) 2.41.10–12).⁵

Hints that the ouroboros is a marine creature appear relatively late and somewhat indirectly in Hebrew texts. *Liwyātān* or Leviathan, literally meaning the coiling one, is the most familiar dragon in the Old Testament. Medieval Jewish traditions contend that Leviathan “grips his tail between his teeth and forms a ring around the Ocean” (*Piyyut Weyikkon ‘Olam* 1964:48; cf. Ginzberg 1947:43–46) or that “Behemot and Leviathan are snakes (monsters) on the shore of the ocean, surround the earth like a ring”⁶ (*Vocabularium Aethiopicum*:83). At least three medieval works of art depict Leviathan as “a large fish curled into a ring” (Ameisenowa 1935:421, Fig. 2; Leveen 1944:77; Drewer 1981:153, plates 17b, 18a). These expressions may well reflect much earlier sentiments. For example, *Psalm* 74, 13–14 seems to identify “the coiling serpent” with the sea if *liwyātān* is read as a stylistic parallel to *yām* (the sea) and *hammāyim* (the waters) (Gunkel 1895:59; cf. *Job* 26.12). The link between the serpent and the sea is unambiguous in *Babylonian Talmūd: Baba Batra* (74b), but circularity is not specified in any of these passages. The possibility that Leviathan originally personified the sea is undergirded by the apparent interchangeability of its Ugaritic namesake and predecessor, Lotan, with a dragon called Yamm(u), literally meaning sea (Oldenburg 1969:33, 138; Wakeman 1973:92–93; Fontenrose 1980 [1959]:134; Bonnet 1987:140; West 1997:300–02). Nicholas Wyatt somewhat carelessly implied that Lotan should be “identified mythologically” with “the ocean, the cosmic sea which surrounds the habitable world” (1995:226). A *midraš* (second century CE onwards) hints at the possibility that Leviathan and *yam*

haggādōl (the Ocean) may once have been parallel concepts from a mythological point of view: “The Ocean surrounds the world as a vault surrounds a large pillar. And the world is placed in its circular form on the fins of Leviathan.” (*Midraš ‘Aḥšeret ha-Dibbōrot*:1:63; Wensinck 1916:62; cf. 1918:23).⁷

The watery ourobóros was a common fixture in Viking lore as well. The Icelandic tradition, as laid down in *Prose Edda* (composed by Snorri Sturluson [† 1241 CE]), held that All-father, the supreme deity, received “Iormungand (i.e., the Midgard serpent)” and “threw the serpent into that deep sea which lies round all lands, and this serpent grew so that it lies in the midst of the ocean encircling all lands and bites on its own tail” (*Gylfaginning* in Sturluson:34, cf. 8; *Poetic Edda: Völuspá*:52–56). Because “the Midgard serpent lives still and lies in the encircling sea” (*Gylfaginning* in Sturluson:48), as Snorri opined, professional bards such as Olvir Hnufa, Eystein Valdason, Bragi, and Eilif Gudrunarson could accord *Midgardsormr* such sobriquets as “encircler of all lands,” “steep-way’s [land’s] ring,” “coal-fish of the earth,” “the coal-fish that bounds all lands,” “the ugly ring [serpent] of the side-oared ship’s road [sea],” and “sea-thread” (*Skaldskaparmal* in Sturluson:4, 18).

Strikingly similar ideas are encountered in places far removed from Europe and the Mediterranean world, proliferating in the regions of India, Oceania, Africa, and Latin America, at latitudes between the equator and 30° north. In Vedic mythology, the god Viṣṇu is depicted as being asleep on a cosmic serpent, called Nāga, Śeṣa, or Ananta, at the time of creation. An episode in the *Mahābhārata* (sixth century BCE onwards), describes how Brahmā (alias Prajāpati), in the wake of the churning of the primordial ocean, instructed the serpent to stabilize the wobbly earth by encircling it from below:

This wide earth abounding with mountains and forests, with her oceans and minefields and settlements, which so far has rocked unsteadily, you must now encompass and hold so that she be stable. . . . Then go underneath the earth, thou best of the Snakes. . . . *The Bard said*: Śeṣa consented; the firstborn of the first among the Snakes passed through a chasm in the earth and stayed there. He carries Goddess Earth on his head, encompassing all around the felly of the ocean. . . . the majestic snake Ananta dwells underneath the ground, ubiquitous, holding good Earth up at the bidding of Brahmā. (Vyasa:[5] 32.17–19)

On the island of Nias, off the coast of Sumatra, a prodigious snake is thought to encircle the earth and is held responsible for the tides of the

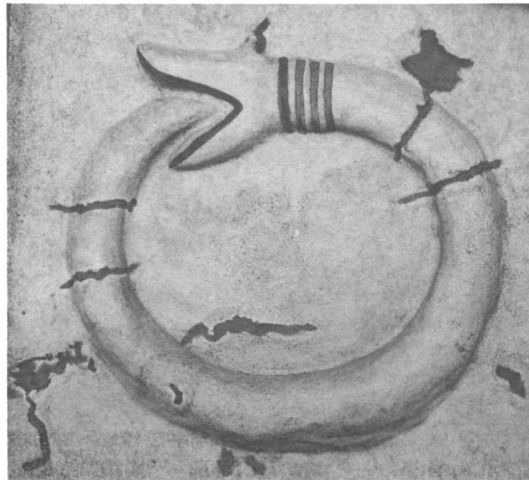


Fig. 1. Bas-relief from the palace of Gezo, representing Dā Ayidohwedo, the god of the rainbow and servant of the thunder (Waterlot 1926:plate IX).

ocean (Modigliani 1890:317–18, 616). And according to the Toba Batak, of Sumatra, the “god of the underworld, of the sea and the lightning” is “Panē na Bolon, the underworld-serpent,” and he “sends the rains, he creates the waves, the thunder and the lightning . . . Moreover, he gives fertility to the fields and bears the middleworld on his head” (Tobing 1956:27, cf. 56, 82, 122; Joustra 1917:331; Winkler 1925:8, 208; 1956:31). On a painting in a Toba house, Panē na Bolon is shown in a head-to-tail position enclosing the middle world (Hasibuan 1985:79, cf. 123).

The Fon of Benin depict the cosmos as a calabash, with the upper half corresponding to the sky and the lower half containing the earth with the sea flowing around it. The surrounding sea is equivalent to the primordial serpent Dā Ayidohwedo: “It is often said: *Ayidohwedo daga* (for *do agã*) *da weke*, *Ayidohwedo* turns around the earth like a meridian . . . it is said that *Dā* resides in the ocean (*xu*)”⁸ (Maupoil 1943:63, 73–74; cf. Mercier 1954:220–1; Métraux 1958:320). This motif is abundantly reflected in local art (Herskovits 1938:341 and frontispiece; Burton 1966:298; Merlo and Vidaud 1966). Many similar artifacts include a bas-relief on the palace of King Gezo (figure 1) and a bronze shield that may symbolize the cosmos—like the famous shield of Heracles—and features the ouroborós encircling a square that, in our estimation, may signify the earth (Pitt Rivers 1900:plate 18, catalog #102). A local tradition indicates that this serpent was not

merely an artistic device or a cosmological symbol, but that it was also firmly embedded in the creation mythology cycle:

Now when the task of making the earth was done, the Creator saw that he had put on it too great a weight for it to carry, for there were too many mountains, too many trees, too many large animals. Something had to be done to keep the earth from falling into the sea, and so Aido Hwedo, the male serpent, was asked to coil himself, tail in mouth, and lie below the earth like a carrying pad that men and women use to support burdens which they carry on their heads. But because Aido Hwedo does not like heat, the Creator gave him the sea to live in. (Herskovits 1938:248–49; cf. Mercier 1954:220)

In South America, the Kogi of Colombia maintain that the primordial ocean was “the Great Mother, the origin of all things. Her name was *Gaulčováng*.” In one of her forms, she was “a huge black serpent that encircled the sea” (Reichel-Dolmatoff 1987:83–84). According to the Warao of the Orinoco,

the earth is a disk which floats in the middle of the world sea. Accordingly, the Indians refer to the earth as *hobahi*, “that which is surrounded by water.” Submerged in the ocean and encircling the earth is a serpent whose extreme ends approach each other, *uroboros* [sic] fashion, east of the disk. This sea monster is *hahuba*, “the Snake of Being,” whose body contains the amorphous luminous essence of all life forms on earth and whose breathing regulates the rhythm of the tides. (Wilbert 1981:37–38)

The Shipibo-Conibo, of the Peruvian Amazon, hold strikingly similar ideas. As an informant from Caimito, Laureano Ancon, revealed, “The earth, on which we are situated, is a large disc floating in the great water, *áni páro*. The world snake *Ronín*—half submerged—is nestled around its rim”⁹ (Gebhart-Sayer 1987:25, cf. 51, 72, 86; 1984:10, 13).

Some Other Characteristics of the Circular Serpent

Other recurrent features in the archetypal mythology of the ourobóros are its association with a rounded object, four pillars, the *axis mundi*, the rainbow, and lightning. The ourobóros is sometimes partitioned into black and white sections, has multiple glistening “scales” or “eyes,” and revolves. It also often has a dual nature and a feline aspect. Space permits elaboration on only a few of these.

Rainbow Color

Sources that elaborate on the color pattern of the ouroboros repeatedly specify a variegated rainbow-like spectrum. According to the Huichol people of central Mexico, the ouroboros, whom they called Tāte' Īpou, was "painted red, blue, and yellow" (Lumholtz 1900:39). In Benin, Dā Ayidohwedo was compared to the rainbow as well as the sun (Maupoil 1943:74). "When he appears as the rainbow, the male is the red portion, the female the blue. Black, white, and red are the colors of the garments which *Dā* puts on at different times: night, day, and twilight" (Mercier 1954:221; see also Merlo and Vidaud 1966:301; Métraux 1958:320). As a long-standing emblem of alchemy, the chromatic pattern of the serpent also represented the alchemical process (Jung 1944:399). A medieval alchemical treatise (1478 CE) contains two illustrations of the autophagous serpent with accompanying text. The first illustration of the serpent depicts three windings—green in the center, yellow in the middle, and red at the exterior—while the second one features two concentric rings—green and red—as symbolic of fermentation or putrefaction (Berthelot 1888:22–24, cf. 159, 196; 1885:59; Taylor 1930:112 Fig. 1).

Lightning

In the Judaic tradition two Rabbis stated that, "The reflection of the Leviathan's fins makes the disk of the sun dim by comparison, so that it is said of each of the fins . . . It telleth the sun that it shines weakly" and that: "*The [Leviathan's] underparts, the reflections thereof, [surpass] the sun: where it lieth upon the mire, there is a shining of yellow gold . . . But the place where the Leviathan lies is purer even than yellow gold*" (*Pēsikēta dē-Rab Kahāna*:supplement 2.4; cf. *Babylonian Talmūd: Baba Batra*:74b). In order for the effulgence of the serpent to exceed that of the sun, it must border on the brightness of a lightning flash. Significantly, contemporary beliefs about the ouroboros from the equatorial regions commonly attribute lightning to the circular dragon. To the Toba Batak of Sumatra, Panē na Bolon was "the god of the underworld, of the sea and the lightning . . . As Panē na Bolon, the underworld-serpent, he sends the rains, he creates the waves, the thunder and the lightning . . . he gives fertility to the fields and . . . bears the middleworld on his head" (Tobing 1956:27, cf. 56, 82–83, 122; Joustra 1917:331; Winkler 1925:8,

208; 1956:31). Similarly in Benin Dā Ayidohwedo is intimately connected to the thunderbolt: “Beneath the earth *Ayido Hwedo* is submerged in the waters. . . . he is seen cleaving the waters like a flash of light, his voice is heard and then an altar is raised to him close by” (Mercier 1954:221). Another description from Benin states that the “tail of the celestial serpent is twice the length of the distance between the earth and the sky; that is why there are always two reports when a thunderbolt crashes, the first of the sending of the bolt to earth, and the second of the recoil of the bolt—really the sound made by the tail of Aido Hwedo—as it returns above” (Herskovits 1938:249–50, cf. 108, 163).

Filamentary texture

Both iconographical and textual sources occasionally describe the texture of the ourobóros’ skin as a series of rays, specks, or another, often luminous, repetitive feature. On the base of a Chinese bronze vessel from the Western Zhōu period (1122–1011 BCE), the round body of the snake is decorated with “circumferential stylized rays” (Mundkur 1983:76). These rays may typologically correspond to the feathers of the feathered serpent in the Meso-American tradition, known as Cuculcan to the Maya of Yucatán, Cucumatz to the Quiché Maya of Guatemala, or Quetzalcóatl to the Aztec. Although this is not often reported by scholars, Quetzalcóatl was repeatedly portrayed in circular form on ball rings and in clay reliefs (cf. Seler 1923:150 fig. 120, 153 fig. 123). On the bas-reliefs of royal buildings in Benin, red feathers that indicate both the serpent’s atmospheric nature and its pneumatic composition graced the body of Dā Ayidohwedo (Merlo and Vidaud 1966:316, cf. 307). Luminous dots also studded the skin of a *drákōn* (dragon) whose birth was described in an alchemical poem attributed to an unknown Byzantine scholar, Theophrastus (eighth to tenth century CE), the *De Arte Sacra*:

This dragon, whom they Ouroboros call,
Is white in looks and spotted in his skin,
And has a form and shape most strange to see.
.....
his gleaming skin
And all the bands which girdle him around
Are bright as gold and shine with points of light (7–23; Browne 1920)¹⁰

Rotatory Movement

The enclosing serpent or ocean is in permanent flow (Cooper 1978; Chevalier and Gheerbrant 1996a, 1996b). The Fon regarded the world-encircling snake *Dā Ayidohwedo* as the epitome of movement: “the coils made by *Dā* around the earth are not stationary. *Dā Ayido Hwedo* revolves round the earth. In this way he sets in motion the heavenly bodies” (Mercier 1954:221, cf. 224; Maupoil 1943:74). In addition, the Toba Batak viewed *Panē na Bolon* as “He who completes his revolution in a year, who needs a month to turn round. When he moves, the middleworld is shaking, and when he turns round, it is quaking” (Tobing 1956:56; cf. 82–83, 114, 122–28; Joustra 1917:331; Winkler 1925:9, 1956:26).

The Celestial Aspect of the Circular Serpent

From the sixth century BCE onward, cultures that had adopted a spherical model of the cosmos, such as Greece and India, carried over the notion of the world-surrounding serpent into the new cosmology and portrayed it as the perimeter of the outermost sphere of the material cosmos, universe, or sky, as opposed to the chaotic world that both preceded and surrounded it. Thus, the late Egyptian scholar Horapollo (fifth century CE) ascribed the interpretation of the *ourobóros* as the surrounding “soul of the universe” to the Egyptians in his *Hieroglyphica*:

To show a very powerful king, they draw a serpent represented as the cosmos, with its tail in its mouth and the name of the king written in the middle of the coils, thus intimating that the king rules over the cosmos. And the name of the serpent among the Egyptians is *Meisi*. . . They symbolize the Almighty by the perfect animal, again drawing a complete serpent. Thus among them that which pervades the whole cosmos is Spirit. (1.59, 64, cf. 1.60, 61, 63)¹¹

Correspondingly, on several Gnostic amulets the seven vowels that represent the planets are inscribed in the *ourobóros*, signifying that the latter wrapped itself around the planetary orbits (e.g., Chabouillet 1858?:catalog #2196, #2203, #2205; Bonnet 1950:catalog #135, #139, #172, #191). In the cosmic diagram of the Ophites, the heavenly orbits were “held together by a single circle, which was said to be the soul of the universe and was called *Leviathan*” (Origen:6.25, cf. 6.35; Lewy 1978:354).

In the spherical paradigm of the cosmos, the mundane egg treasured by the dragon could be interpreted as representing the cosmos as a whole.

Thus, the Greek philosopher, Epicurus (± 341 –271 BCE), contended that *pneuma drakontoeidōs* (a dragon-like soul) surrounds the cosmic egg: “Originally the whole was like an egg; but the spirit was then coiled snake-wise round the egg, and bound nature tightly all round like a wreath or girdle” (Epiphanius:1.8.2; cf. Onians 2000 [1951]:250, note 2).

The active consumption by the ourobóros of its own hind parts—which involves contortions that suggest perpetual motion—corresponds to the apparent cyclical revolution of heavenly bodies. The Roman grammarian Macrobius attributed this interpretation of the ourobóros to the Phoenicians, who portrayed the god Janus “in the likeness of a serpent coiled and swallowing its own tail, as a visible image of the universe which feeds on itself and returns to itself again” (1.9.12).¹² As the emblem of the regularity and the cyclicity of stellar movements, the circular snake personified time itself in several cultures (cf. Ficino 1896:5.8.6). The Greek word for time, *chrónos*, was similar to Krónos, the name of the god associated with the planet Saturn since the Hellenistic period. Because Saturn was thought to be the closest body to the fixed stars, it is not surprising that the classical Greeks identified the god Krónos as the personification of time (e.g., Macrobius:1.22.8). Capitalizing on the common mythological theme of Krónos dormant in a cave as well as the familiar Platonic representation of the cosmos as a cave (Plato, *Republic*:7.1–3 [514–18], *Phaedo*: 58–59 [109B–111C]; Porphyry:2, 5 [59], 10), Claudian could thus situate his green ourobóros around *spelunca aevi* (the cave of Time):

Far away, all unknown, beyond the range of mortal minds, scarce to be approached by the gods, is a cavern of immense age, hoary mother of the years, her vast breast at once the cradle and the tomb of time. A serpent surrounds this cave, engulfing everything with slow but all-devouring jaws; never ceases the glint of his green scales. His mouth devours the back-bending tail as with silent movement he traces his own beginning.”¹³ (32–33)

Thus, the circuit completed by the snake corresponds to the annual cycle of the stars. As an image of an ecliptic band, the serpent of time acquires an intimate association with the concept of the year (Preisendanz 1935:143; Needham 1980:376; Chevalier and Gheerbrant 1996b). For example, in the Rabbinical tradition the number of features detected on Leviathan’s body adds up to the number of days in the year: “Some say that Leviathan has as many eyes as the year has days, and radiant scales that obscure the very sun; that he grips his tail between

his teeth and forms a ring around the Ocean" (*Piyyut Weyikkon 'Olam* 1964:48; cf. *Pěšikta dē-Rab Kahāna*:supplement 2.4; *Babylonian Talmūd: Baba Batra*:74b; Ginzberg 1947:127 [45]). Servius states that "according to the Egyptians, the year was indicated before the invention of letters by the image of a dragon biting its own tail, because it returns in itself" (5.85; cf. Anastasius Sinaita:1 [864]; Isidore of Sevilla:5.36.2; Lydus:3.4).¹⁴ According to Horapollo, the Egyptians also compared the snake's scales to the stars (1.2; cf. Olympiodorus of Thebes, *De Arte Sacra* (II. iv. 18), in Berthelot 1885:256, 1888:79–80; Needham 1980:375). The African savant, Martianus Capella, reduced the ouroboros to a mere emblem held in the right hand of the god Saturn and identified with the year: "In his right hand he held a fire-breathing dragon devouring its own tail—a dragon which was believed to teach the number of days in the year by the spelling of its own name" (1.70; cf. Albericus Philosophus of London:1; Remigius of Auxerre:33.8; Vaticanus Mythographus Tertius:1.1, 5–6).¹⁵

Cultures outside of Europe also used the round dragon as an icon of the year. The Toba Batak of Sumatra described Panē na Bolon, named Nai Bala Tongtongan, as "He who completes his revolution in a year, who needs a month to turn round" (Tobing 1956:56, cf. 82). According to one creation story, the monster was implored: "And you, gatipgatip-serpent shall be Pane na Bolon. . . . Change your dwelling-place every three months . . . you shall visit all the eight points of the compass" (Tobing 1956:124, cf. 114, 122; Joustra 1917:331). Furthermore, the serpent's annual movement was carefully synchronized with the cardinal directions (Winkler 1925:9, 1956:26, 29–30; Tobing 1956:126–28; Voorhoeve 1956:40).

Along with the snake's association with the cyclicity of space and time, the snake is also often described in dictionaries as a symbol of physical and temporal unity, embracing such abstract concepts as union, eternity, immortality and infinity (e.g., Howey 1955:2; Mahdihassan 1963:23; Lindsay 1970:261). These associations had already begun to crystallize towards the end of ancient Egyptian history. As can be gleaned from Horapollo, the Egyptians interpreted the ouroboros not only as an image of the cosmos, but also as Eternity (1.1).¹⁶ The symbolism of the circular snake that unified the concepts of beginning and end continued to flourish in late antiquity and afterwards, particularly in the alchemical tradition (texts given in Berthelot 1885:59 note 1, 61; 1888:79–80, 132, 134, 196).

Toward an Explanation of the Circular Serpent

Scholars have tended to report the ancient interpretations of the ourobóros in an uncritical manner, content to argue that the image of the ourobóros arose as a spontaneous expression of a snake, the visible horizon, the rainbow, the ocean, the outermost sphere of the cosmos, the celestial equator, the ecliptic band, time or the year personified, the lunar nodes, immortality, perpetuity, or cyclicity. Needless to say, the ourobóros did represent all of these meanings to various peoples over time and space, but whether such associations account for the *origin* of the icon is a different question. In their quest for a more tangible prototype in the natural world, symbologists have often failed to raise a number of unsettling questions.

Those who prefer a naturalist outlook point out that the flexible body of a snake is “as eminently appropriate for purely decorative purposes as for esoteric ones,” while ecdysis, the process by which snakes periodically shed their skins, could have reinforced the ourobóros’ association with rejuvenation (Mundkur 1983:76).¹⁷ However, the shedding of the skin is not an annual event, but rather occurs four to eight times a year, thus weakening the symbolic link between the ourobóros and the year. Another zoological question is whether any species of snakes has been known to consume its own rear parts. In a casual remark, the early apologist of the Christian church, Epiphanius of Salamis († 403 CE), noted that the snakes interred by the Egyptians below their temples would naturally be induced to autophagous behavior (Epiphanius:1.22.2.2–4, repeated in 1.30.26.5–7). While this may be evidence of a genuine burial rite and the Egyptians may have embraced such explanations of the ourobóros, one should bear in mind that such evidence does not necessarily stand up in the cold light of day. As one zoologist points out, “It is doubtful . . . that any serpent can or has ever been known to attempt to bite or swallow its own tail” (Mundkur 1983:75). As it happens, a case is on record of a female captive python committing suicide at the threat of death by beginning to devour her own tail. However, although such incidents may happen, Christian Merlo and Pierre Vidaud rightly point out that the despair of suicide is a far cry from the sovereign majesty of the mythical ourobóros (1966:307, 309). Recognizing the problem, Joseph Needham more boldly propagated that “ourobóros actually lives—in the shape of the South African armadillo lizard, which when disturbed holds the tip of its tail in its mouth in order to protect its belly by its spring scales. Not

impossible therefore is it that the ancients had a living pattern before them, rather than having to form one entirely out of their imaginations" (1980:385). But needless to say, *Cordylus cataphractus* is not a snake, is not known outside South Africa in places where the mythology of the ouroboros prevails, and is just as incapable of illuminating the nature of the mythical ouroboros' properties as actual snakes. The snake's extreme spine flexibility, its recurrent shedding of the skin, and its highly anomalous behavior of ingesting its own tail all fail to explain the cosmic proportions of the mythical serpent, its identification with the circular ocean, its connection with lightning, the rainbow, and the sun, its ball-shaped treasure, and its role in myths of creation.

The undeniable celestial dimension to the mythology of the ouroboros is given more attention in a number of alternative explanations. Prompted by the identification of Dã Ayidohwedo with the rainbow, Merlo and Vidaud argue that the image of the round serpent may simply have originated as a thought experiment to complete the rainbow's arc below the horizon (1966:312–13). Although this explanation may seem ingenious at first blush, it does not fit well with additional aspects of the ouroboros, such as serving as the cosmic ocean that encloses the disc of the earth, producing lightning and earthquakes, or performing a rotatory movement in the sky.

The roundness of the horizon appears obvious to many observers and therefore could have led to the notion of the circular ocean. In the early twentieth century, Arent Jan Wensinck argued that the idea of a circular ocean was quite natural: "The primitive eye starts from what it observes: the seashore presents the unlimited sight of the ocean; this means that the ends of the earth are surrounded by the ocean" (1918:21). A number of modern scholars argue along similar lines (e.g., Ellis Davidson 1975:175; Brown 1995:110; Onians 2000 [1951]:249). Yet for all the confidence expressed in such observations, the circularity of the horizon is less obvious than these writers suggest. Although the impression of roundness may certainly present itself to people familiar with relatively flat and open geographic environments, observers might as easily imagine the expanse of land or sea they see as extending indefinitely in all directions, particularly in cultural contexts that have not yet embraced a spherical model of the cosmos. Furthermore, why would forest-dwellers such as the Warao or the Shipibo-Conibo, who have never conceived of the idea of a spherical earth, envision a round horizon? At best the apparent rotundity of the horizon may

have confirmed the cosmological beliefs of ancient societies, while early guesses about the distribution of water may have influenced the notion of a flowing world ocean. Even if it were granted that the horizon and, by extension, the oceans, are circular, the choice of a snake to represent the imagined perimeter of the world remains anomalous and puzzling. The natural appearance of the ocean is not quite as clearly endowed with such a “serpent-like motion” as some anthropologists have claimed (contra Lumholtz 1900:81), but does this mean that the choice of a serpent for its symbol was just a flight of fancy? Where do the specific colors and the feather-like filamentation associated with this creature come from? Finally, the natural condition of the equator or the ecliptic also does not clarify the specific cosmogonic and cosmological context within which the themes of the circular snake and ocean are so firmly embedded: why was the ourobóros thought to have formed from the breath-like *prima materia* of the abyss? And why was it conceived as the animated source of life on earth? These questions remain unanswered even if the ourobóros is merely a metaphor for the horizon, the ecliptic, or the rainbow.

The Circular Serpent as an Auroral Phenomenon

A priori, the appearance of the ourobóros on very early works of art, including pottery and petroglyphs, strongly suggests a prototype that did not come in the form of sophisticated astronomical speculation, but rather presented itself as natural, immediate, spontaneous, and relevant. In addition, the practically universal distribution of the motif requires, if not an innate psychological cause along the lines of Jung’s as yet unproven collective unconscious, then a highly visible and conspicuous cause in the sky, one impressive enough to survive for millennia as a pervasive theme. As traditional images of astronomical content typically portray the *entire* object as it appears to the eye, one would expect a celestial prototype of the ourobóros to have looked like a complete ring—unlike the rainbow or the ecliptic band, which require a sufficient level of astronomical sophistication to be extrapolated to a circle. The *aurorae*, also known as the northern and southern lights, are promising candidates for an interpretation along these lines.

Aurorae are *plasmas* or partially ionized gases that glow when the ionosphere of the earth experiences an increased influx of charged particles from space, notably from the solar wind (Alfvén 1981:1).



Fig. 2. Auroral ring seen over Toemmeraas, Norway, on October 6, 2002 at 22:50. © Trygve Lindersen.

Electrons and ions flow into the earth's lower ionosphere along so-called *Birkeland currents*, which are circular or oval electrical currents that follow the magnetic field lines that surround the polar cusps (the openings at the magnetic north and south poles of the earth where the aurorae are at their brightest and most powerful). These sheets of electrical currents form the rapidly waving curtains of light seen in the most familiar form of auroral display (Peratt et al 2007:797). Hannes Alfvén was the first to analyse the formation of such auroral curtains as what is now called a *diocotron instability* (Peratt 1992:29). While dancing curtains and cavorting flames are among the most familiar forms of the aurora, ring-shaped formations are also known. Examples of annular aurorae observed near the magnetic north pole are the glowing green circles seen over Toemmeraas, Norway, in the aftermath of a solar storm on October 6, 2002 (figure 2), and those observed in Alaska over the Knik River on an October evening in an unknown year (Bryson, Hall, and Pederson 2006). Because these rings visually resemble the mythical ouroboros, we propose that auroral bands, of the diocotron instability type, are capable of explaining many of the appearances and symbolic meanings of the ouroboros.

In both medieval Europe and China, auroral formations with a circular morphology have been described in terms of walls and boundaries, reminiscent of the ouroboros' role as delimiter of the world (Dall'Olmo 1980:13; *Sòng Shì, Tàizōng Jì*, 5, in Xu et al 2000:200). Sources from the same areas have also applied words for dragon to observed aurorae (Dall'Olmo 1980:13–14; Kim Busik, *Samguk Sagi*, 16, in Xu et al 2000:191; *Shānhǎi Jīng*, in Xu et al 2000:183–84). The intense lightning-like luminosity assigned to the ouroboros in some sources could be explained by

the bright synchrotron light emitted by an auroral diocotron instability.¹⁸ The luminescence of aurorae has repeatedly provoked their comparison to nocturnal suns (*Hàn Shū, Xiàowǔdì Běnfā*, 6, in Xu et al 2000:189), an interpretation which offers a way to understand the ancient Egyptian sun god's representation as a coiling serpent. The respective rainbow-like colors attributed to the ourobóros fall within the spectrum of colors observed in aurorae, which typically shifts from red to green (Peratt 2003:1193; Peratt et al 2007:797). The filamentary character of intensely glowing plasmas, as often observed in rayed aurorae, resembles the rays and scales decking the serpent's skin in ancient art and traditions. Exceptionally active aurorae have occasionally seemed to touch the horizon (Corliss 1982:16, 21)—an observation that facilitates the ourobóros' link to the horizon as the meeting place of sky and earth or water. Furthermore, the repeated description of the ourobóros as the supreme representation of movement and as the vivifying soul of the cosmos resonates with the surprisingly life-like properties of the glowing plasma seen in the aurorae.

Contemporary aurorae are sporadic and usually last for a maximum of several hours. The most intense and largest auroral displays occur during a solar storm, when the incoming flux increases dramatically (Peratt et al 2007:797). Yet even these last no longer than a few days. How might the fleeting, intermittent character of auroral outbursts be reconciled with the semi-permanent stability of the ourobóros as expressed in its identification with the boundary of the visible world? Moreover, the feeble aurorae observed today are most often seen at circumpolar latitudes, far removed geographically from the temperate and equatorial zones connected to the mythology of the ourobóros. One answer to these challenges is the possibility that a dramatically enhanced solar wind provoked a severe geomagnetic storm. Although aurorae are generally a mild, benign, and relatively short-lived phenomenon, an intense solar storm or some other extreme disturbance of the geomagnetic field would provoke an excessive auroral outburst, producing more enduring formations visible in areas much closer to the equator. The earliest example of such a low-latitude aurora in modern science is the first recognized space weather event, which may also have been "the largest solar energetic particle event in the past several hundred years" (Townsend et al 2006:226). On September 2, 1859, a day after English amateur astronomer Richard Carrington observed a white-light solar flare that indicated a massive magnetic explosion on

the sun, “skies all over planet Earth erupted in red, green, and purple auroras. . . . Indeed, stunning auroras pulsated even at near tropical latitudes over Cuba, the Bahamas, Jamaica, El Salvador, and Hawaii” (Bell and Phillips 2008; cf. Cliver and Svalgaard 2004:417). Between 1859 and 1958, six well-documented aurorae were observed “within 30° of the geomagnetic equator,” five of which “had well-documented reports of equatorward extensions that exceeded the 20° (Honolulu) low latitude extreme of the September 1859 storm” (Cliver and Svalgaard 2004:417–18; see further Corliss 1982:21).

How would an extremely enhanced influx of charged particles from the solar wind affect the appearance of the aurora? In recent decades, plasma physicists have made considerable progress modeling auroral behavior under laboratory conditions. These physicists have found that rare high-energy disturbances of the geomagnetic field produce intense aurorae, which develop complex forms technically known as “plasma instabilities.”¹⁹ Simulations indicate that, under conditions even more extreme than the Carrington event of 1859, the aurora would take the form of a glowing high-energy current tube connecting the magnetic poles of the earth to the poles of the sky like the electrodes in an electrochemical cell, such as a battery (Peratt et al 2007:800–01). The findings presented below draw primarily on a computer simulation called a Particle-in-Cell (PIC) simulation, running for months, which was conducted first at Lawrence Livermore National Laboratory in California, and later at Los Alamos National Laboratory in New Mexico. This simulation used IBM Roadrunner, which is currently the world’s fastest computer. The initial conditions and boundary conditions delimiting this experiment were specified in 2000 for the simplest Birkeland current configuration possible—a single, solid Birkeland current running along an electric field and a magnetic field. The number of electrons and ions modeled in the simulation was initially set at 8,000 at Stanford University in 1976. This number was increased to 32,000 at Livermore National Laboratory in 1979 and has expanded ever since at Los Alamos National Laboratory, always in step with dramatic improvements in computer power. The increased number of particles enables observation at a higher resolution, similar to the use of a larger and a better lens in a telescope. The only initial parameters for the experiment were the undifferentiated plasma formed of this original sea of millions of electrons and ions, the vertical magnetic field required for Birkeland’s currents to run

through (to which this plasma was subjected), and Maxwell's equations, which are a standard set of physical laws that describe the inter-relationship between electric fields, magnetic fields, electric charge, and electric current. Harold Webster has shown that these forces are the "laboratory analogs of the polar aurora" (Peratt 1992:74). Their combined operation alone would eventually yield an enormous radiant column that would achieve a semi-permanent mode. The plasma tube would have pinched into two conspicuous egg-shaped plasmoids, situated at 306,000 and 266,000 km above the surface of the earth (Peratt et al 2007:802). Eventually, the current flow would terminate and the column would dissipate, scattering pieces of glowing debris into space.²⁰

The mythological accounts of the ouroborós can be correlated with a particular phase in the developmental course of such an intense auroral outburst. In this phase the sheath surrounding the discharge column visible above the pole would thin out, filament, and produce vortices or rather "discrete vortex-like current bundles," formed of auroral currents weaker than a giga-Ampère comparable to the sheets or curtains observed in auroral apparitions today (Peratt et al 2007:798). This model indicates that the initial number of bright plasma filaments formed would have been 112 or 56 (Peratt 2003:1207). As the surrounding plasma sheath flows around the upper plasmoid, it thins and gives rise to a diocotron instability around its equator, with a width not exceeding perhaps a fifth of the diameter of this plasmoid. Laboratory photographs capturing cross-sectional views of the beam confirm that the corresponding segment of the plasma tube at this stage may have looked remarkably similar to a rotating circular snake devouring its own tail (figure 3),²¹ suggesting that a diocotron instability produced in an intense aurora may have served as the ultimate inspiration for the mythical ouroborós. In these photographs, the object rotates, so that the head appears to be chasing the tail. In mythological terms, moreover, each of the plasmoids enclosed within the ring may correspond to the world, the egg, or the underworld or nocturnal sun confined by the circular serpent.

If such a high-energy density aurora has occurred, the complete encapsulation of the earth within the same surrounding plasmasphere that produced the diocotron instability higher in the atmosphere may have given human observers at that time the impression that they were inhabiting some sort of underworld enclosed by the many radiating streamers that flowed forth from beneath the ouroborós. In ancient

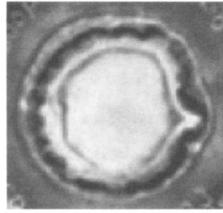


Fig. 3. A high-current diocotron instability, rotating counterclockwise. Courtesy A. L. Peratt.

cosmologies the center of the earth was typically occupied by a cosmic pillar symbolized as a giant tree or mountain, which also appeared to form the earth's highest part. Therefore, this hypothetical scenario explains how the erstwhile formation of a ring-shaped aurora in the polar sky may have spawned the near-universal belief that it encompassed the earth or the world: the serpent believed to surround the earth was really wrapped around the lower strata of the cosmic mountain seen above the center of the earth.

At present, the earliest recorded aurorae are “a multi-colored light” listed in Chinese annals for the last year of king Zhāo of Zhōu, around 950 BCE (*Zhúshū Jìnián* or *Bamboo Annals*; *Gǔjīn Tùshūwù Jìchéng*, 102; *Tàipíng Yùlǎn*, 874, all in Xu et al 2000:188) and an unusual “red glow” in the night sky mentioned on a Babylonian clay tablet dated to 567 BCE. The latter observation “occurred at a time when the geomagnetic (dipole) latitude of Babylon was about 41° N compared with the present value of 27.5° N; suggesting a higher auroral incidence at Babylon in 567 BC than at present” (Stephenson et al 2004:615).²² If our analysis is correct, the mythology and iconography of the ouroboros can be seen as a recollection of an aurora that was experienced much earlier, long before the rise of an appropriate astronomical terminology such as the one employed by the Babylonians or the Chinese. This hypothetical event would have transpired on a more extreme scale than the modest aurorae observed today, involving a diocotron instability phase known both from laboratory experiments and occasional ephemeral recrudescences seen in contemporary aurorae. This mother of all aurorae, inscribed in the annals of creation myths around the world, is conjectured to have occurred towards the end of the Neolithic period. While scientists have not yet fully modeled the earth's magnetic field for this early time, it is noteworthy that the scientific evidence for increased auroral activity in the ancient Near East during the sixth century BCE facilitates the

proliferation of the ouroboros theme at equatorial latitudes in Central America, Africa, and Oceania.²³

This highly speculative theory raises more questions than it answers. Ultimately, the validity of the auroral explanation of the archetype of the ouroboros hinges on the feasibility of the plasma-physical model. Until specialists in auroral physics are in a position to replicate or to rule out the formation of a ring shaped diocotron instability in the aurora similar to the one apparent in our own experiments, the proposed explanation of the ouroboros motif will remain controversial. Nonetheless, even at this early stage we feel that the apparent ubiquity, antiquity, and cosmological significance of the ouroboros are better explained by our theory, rooted in natural history and auroral physics, than by any explanation offered before. The awe instilled by the monster, which casts its shadow still today, reflects the awesome spectacle even of contemporary tranquil aurorae. An interdisciplinary study with an open mind towards the turbulent events of the past would throw a clearer light on the dragon's fuzzy past.

Encouragingly, the present intellectual climate is conducive to such lines of inquiry. Within the history of ideas, the hypothesis that the worldwide motif of the tail-biting dragon was originally based on observations of an extreme type of aurora fits into recently revived scholarly interests in transient natural phenomena as the ultimate inspiration for widespread mythical themes. In our view, this hypothesis better explains such widespread motifs than the introspective and structuralist psychosociological models preferred during most of the twentieth century and championed by thinkers such as Sigmund Freud, Carl Jung, Joseph Campbell, Émile Durkheim, Georges Dumézil, and Claude Lévi-Strauss. On a par with the nascent field of geomythology, the exploitation of cutting-edge scientific knowledge of atmospheric and astronomical events such as aurorae, mega-lightning, and the passage of comets is a modern continuation of the nineteenth-century nature school of mythology, which looked to the ordinary properties of the sun, moon, and vegetal life, as the inspirational source of prominent mythical themes (e.g., Masse 1995; 1998; Barber and Barber 2006; Bobrowsky and Rickman 2007; Piccardi and Masse 2007). Yet unlike the old school, the modern interdisciplinary approach places no emphasis on elaborate metaphors and the linguistic aspects of mythical names. This approach concentrates on short-lived, dramatic events—such as tsunamis, volcanic eruptions, aurorae, lightning, or meteor showers—instead of less

awe-inspiring spectacles such as the sunrise or the lunar cycle. Further exploration of the inspiration for shared motifs benefits from the immensely improved state of research taking place in geophysics, plasma physics, climatology, and related scientific disciplines.

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Notes

1. The term “corrupt” is commonly used in the discipline of philology and means that the original text has been distorted in the version we have before us today.

2. While “Ḥꜣw-nbw” may have referred to Phoenicia specifically (Bikai 1989:135), Clark (1959:117) rendered it as “the Outermost Lands” and “the Šn-‘3-sk” as “the Surrounding Ocean.”

3. For examples of the well-known identification of Osiris with life-giving water, see *Pyramid Texts*: 589 (357), 848 (455), 868 (460), 1291 (536), 1631 (539), 2007 (676), 2111 (690); *Book of the Dead: Introductory Hymn to Osiris*; Hippolytus:5.1.7 (150); Erman 1911:933–34; and Breasted 1959:20.

4. For examples of the identification of Osiris with the Nile, see Plutarch:32 (363D), 33 (364A–B), 36 (365B), 38 (366A); Budge 1904:vol. 2, 122–23; Boylan 1999:17; and Kurth 2004:7.

5. Translation provided by the authors.

6. Translation provided by the authors.

7. That Leviathan supports the earth, lying in—but perhaps not being identical with—the waters below it, is also found in other sources, including *Apocalypse of Abraham* (Codex Sylvester):21; Hirschman 1976:11; *Pirqē de-Rabbi'Elī 'ezer*; *Midraš Kōnen*:26; *Seder Rabbā di-Bērēšit*:9; *Bərāitā di Ma'aseh Bērēšit* (MS. Paris, Bibliothèque Nationale; cf. *Sēpher Razi'el*:fol. 35a–36b), 185–92 in Séd 1965:58–59, cf. 1964:293.

8. Translation provided by the authors.

9. Translation provided by the authors.

10. The Greek for “white in looks and spotted in his skin” is *leukēn mēn ópsin kai katástiktōn dorān*, for “gleaming skin” *tēs doras chrōan*, and for “points of light” *stigmās pháous*. As it represents the alchemical *opus*, the serpent is subsequently transformed into silver and then into gold.

11. Horapollo may have been referring to the *mnh*, the royal cartouche that was customarily written around the names of kings. Scholars have long regarded this cartouche as a derivative of the ourobóros (Stricker 1953:14).

12. The cups at Palestrina and from Sidon corroborate the claim of Phoenician affinity with the ourobóros (Bourdais 1895:151).

13. The Mithraic image of the snake wound about Mithra's cave can hardly be divorced from this theme.

14. Translation provided by the authors.

15. The Latin for “a fire-breathing dragon devouring its own tail” is *flammiuomus draco caudae suae ultima devorans*.

16. Horapollo's distinction between the ourobóros representing the cosmos and the one embodying eternity is not rigid (Cumont 1898:293; Nilsson 1950:481, note 5).

17. This explanation for the choice of the snake, particularly the ourobóros, as a symbol of life and immortality has been propagated by ancient and modern authors alike. Compare Horapollo:1.2; Preisendanz 1940:194; Mahdihassan 1963:20; Sanchuniathon in Baumgarten 1981:245–46, 255.

18. Synchrotron radiation refers to electromagnetic emissions generated by circular or spiral motion of electrons along a magnetic field, as in Birkeland currents. For further explanation see Peratt 1992:197–98.

19. The relevant physics and a brief overview of the history of research are discussed in Peratt 1992, cf. 2003, and Peratt et al 2007.

20. As argued in Peratt 2003 and Peratt et al 2007, a large segment of archaic petroglyphs with geometric or abstract designs often tentatively interpreted as solar symbols correspond to aspects of such an intense aurora, taking into account geographic factors such as latitude and field-of-view.

21. The images reproduced here are discussed in Peratt 1992:31, 84–85. Peratt and Snell (1985) follow the mechanism underlying these experiments to very high currents in intense beam experiments.

22. For the evolving orientation of the global geomagnetic field over the past 3,000 years, see Constable et al 2000.

23. As the Scandinavian version of the ouroboros is embedded in the framework of Germanic mythology, it is likely that it only arrived in northern Europe during the first millennium BCE, as the Indo-European ancestors of the people that spoke the Proto-Germanic language settled there from their original homelands in the steppes of Ukraine, north of the Black Sea (coming there from their earlier homeland, the Armenian highlands south of the Caucasus mountains) (Gamkrelidze and Ivanov 1995).

References Cited

The Acts of Thomas

1993 In *The Apocryphal New Testament: A Collection of Apocryphal Christian Literature in an English Translation*, trans. James Keith Elliott, 439–512. Oxford: Clarendon Press.

Albericus Philosophus of London

1742 *De Deorum Imaginibus*. In *Auctores Mythographi Latini*, ed. Augustinus van Staveren, 896–938. Leiden: Samuel Luchtmans.

Alfvén, Hannes

1981 *Cosmic Plasma*. Dordrecht, The Netherlands: D. Reidel.

Allen, Thomas George

1974 *The Book of the Dead or Going Forth by Day: Ideas of the Ancient Egyptians Concerning the Hereafter as Expressed in their Own Terms*. Studies in Ancient Oriental Civilization, 37. Chicago: The University of Chicago Press.

Ameisenowa, Zofia

1935 “Das messianische Gastmahl der Gerechten in einer hebräischen Bibel aus dem XIII. Jahrhundert; Ein Beitrag zur eschatologischen Ikonographie bei den Juden.” *Monatsschrift für Geschichte und Wissenschaft des Judentums*, 79/43:409–22.

Amiet, Pierre

1966 *Elam*. Auvers-sur-Oise, France: Archée.

Anastasius Sinaita

1865 *Anagogicarum Contemplationum in Hexaemeron*. In *S. P. N. Anastasii Cognomento Sinaitæ Patriarchæ Antiocheni, Opera Omnia*, 89:1, ed. Jacques-Paul Migne, 851–1077. *Patrologiæ Cursus Completus . . .*, series Græca Prior. Paris: Petit-Montrouge.

The Apocalypse of Abraham

1984 Trans. Anne Pennington. In *The Apocryphal Old Testament*, ed. Hedley Frederick Davis Sparks, 363–91. Oxford: Clarendon Press.

Babylonian Talmūd: Baba Batra

1935 *Baba Bathra Translated into English with Notes, Glossary and Indices*, trans. Maurice Simon. London: Soncino Press.

Barber, Elizabeth W., and Paul T. Barber

2006 *When They Severed Earth from Sky: How the Human Mind Shapes Myth*. Princeton: Princeton University Press.

Baumgarten, Albert I., trans.

1981 *The Phoenician History of Philo of Byblos: A Commentary*. *Études préliminaires aux religions orientales dans l'Empire Romain*, 89. Leiden: E. J. Brill.

- Bell, Trudy E., and Tony Phillips
 2008 "A Super Solar Flare." Retrieved from http://science.nasa.gov/headlines/y2008/06may_carringtonflare.htm (accessed May 6, 2008).
- Berthelot, Marcellin, ed.
 1885 *Les origines de l'alchimie*. Paris: Georges Steinheil.
 1888 *Collection des anciens alchimistes Grecs*. Paris: Georges Steinheil.
- Bikai, Patricia
 1989 "The Phoenicians." In *The Crisis Years: The 12th Century B. C.: From Beyond the Danube to the Tigris*, ed. William A. Ward and Martha Sharp Joukowsky, 132–41. Dubuque, Iowa: Kendall/Hunt.
- Bobrowsky, Peter T., and Hans Rickman, ed.
 2007 *Comet/Asteroid Impacts and Human Society: An Interdisciplinary Approach*. New York: Springer.
- Bonner, Campbell
 1950 *Studies in Magical Amulets Chiefly Graeco-Egyptian*. Ann Arbor: The University of Michigan Press.
- Bonnet, Corinne
 1987 "Typhon et Baal Saphon." In *Studia Phoenicia V: Phoenicia and the East Mediterranean in the First Millennium B. C. E.*, ed. Edward Lipiński, 101–44. *Orientalia Lovaniensia Analecta*, 22. Leuven: Peeters.
- Book of Caverns*
 1945 In *The Tomb of Ramesses VI: Texts*, trans. Alexandre Piankoff, ed. Natacha Rambova. Bollingen Series, 40.1. New York: Pantheon Books.
- Bourdais, P.
 1895 "Dates sur la sphère céleste des Chaldéo-Assyriens." *Journal Asiatique ou recueil de mémoires d'extraits et de notices relatifs à l'histoire, à la philosophie, aux langues et à la littérature des peuples orientaux* 9/5:142–52.
- Boylan, Patrick
 1999 [1922] *Thoth: The Hermes of Egypt: A Study of Some Aspects of Theological Thought in Ancient Egypt*. Oxford: Oxford University Press.
- Breasted, James Henry
 1959 *Development of Religion and Thought in Ancient Egypt*. New York: Harper and Brothers.
- "Bremner-Rhind Papyrus"
 1937 "The Bremner-Rhind Papyrus—III," trans. Raymond O. Faulkner. *The Journal of Egyptian Archaeology* 23:166–85.
 1938 "The Bremner-Rhind Papyrus—IV," trans. Raymond O. Faulkner. *The Journal of Egyptian Archaeology* 24:41–53.
- Brown, John Pairman
 1995 *Israel and Hellas*. Beihefte zur Zeitschrift für die alttestamentliche Wissenschaft, 231. Berlin: Walter de Gruyter.
- Browne, C. A., trans.
 1920 "The Poem of the Philosopher Theophrastos upon the Sacred Art: A Metrical Translation with Comments upon the History of Alchemy." *The Scientific Monthly* 11/September 1920:193–214.

- Bryson, George, Calvin Hall, and Daryl Pederson
 2006 "Sky Lights: a New Book Explores the Glorious Glow—and Lure—of Aurora Borealis." Excerpted from *Northern Lights: The Science, Myth, and Wonder of Aurora Borealis*, photographs by Calvin Hall and Daryl Pederson, essay by George Bryson (Seattle: Sasquatch Books, 2001). *The Seattle Times: Pacific Northwest Magazine*, January 6, 2002. Retrieved from <http://seattletimes.nwsourc.com/pacificnw/2002/0106/cover.html>.
- Budge, E. A. Wallis
 1904 *The Gods of the Egyptians or Studies in Egyptian Mythology*, 1–2. London: Methuen and Co.
- Burton, Sir Richard
 1966 *A Mission to Gelele King of Dahome*. London: Routledge and Kegan Paul.
- Chabouillet, Pierre-Marie-Anatole
 1858? *Catalogue général et raisonné des camées et pierres gravées de la Bibliothèque Impériale*. Paris: Claye and Rollin.
- Chevalier, Jean, and Alain Gheerbrant, ed.
 1996a "Ouroboros." In *A Dictionary of Symbols*, trans. John Buchanan-Brown, 728. London: Penguin.
 1996b "Serpent." In *A Dictionary of Symbols*, trans. John Buchanan-Brown, 846. London: Penguin.
- Clark, Rundle T.
 1959 *Myth and Symbol in Ancient Egypt*. London: Thames and Hudson.
- Claudian
 1956 *De Consulatu Stilichonis*. In *Claudian*. Loeb Classical Library, 136. London: William Heinemann.
- Clermont-Ganneau, Charles
 1878 "La coupe Phénicienne de Palestrina et l'une des sources de l'art et de la mythologie Helléniques; Notes d'archéologie orientale." *Journal Asiatique ou recueil de mémoires d'extraits et de notices relatifs à l'histoire, à la philosophie, aux langues et à la littérature des peuples orientaux* 7/11:232–70, 444–44.
 1880 *L'imagerie Phénicienne et la mythologie iconologique chez les Grecs: Ire partie: La coupe Phénicienne de Palestrina*. Études d'archéologie orientale. Paris: Ernest Leroux.
- Cliver, Edward W., and Leif Svalgaard
 2004 "The 1859 Solar-Terrestrial Disturbance and the Current Limits of Extreme Space Weather Activity." *Solar Physics* 224:407–22
- Coffin Texts*
 2004 [1973–78] *The Ancient Egyptian Coffin Texts: Spells 1–1185 and Indexes*, trans. Raymond O. Faulkner. Oxford: Aris and Phillips.
- Constable, Catherine G., Catherine L. Johnson, and Steven P. Lund
 2000 "Global Geomagnetic Field Models for the Past 3000 Years: Transient or Permanent Flux Lobes?" *Philosophical Transactions of the Royal Society of London, Series A* 358:991–1008.
- Cook, Arthur Bernard
 1914 *Zeus: A Study in Ancient Religion*, 1. Cambridge: Cambridge University Press.

- Cooper, Jean C., ed.
1978 "Ouroboros." In *An Illustrated Encyclopaedia of Traditional Symbols*, 124. London: Thames and Hudson.
- Corliss, William R.
1982 *Lightning, Auroras, Nocturnal Lights, and Related Luminous Phenomena: A Catalog of Geophysical Anomalies*. Glen Arm, Md.: The Sourcebook Project.
- Cumont, Franz
1898 "Masque de Jupiter sur un aigle éployé, bronze du Musée de Bruxelles." In *Festschrift für Otto Benndorf zu seinem 60. Geburtstage*, ed. Karl Masner, 291–95. Vienna: Alfred Hölder.
- Dall'Olmo, Umberto
1980 "Latin Terminology Relating to Aurorae, Comets, Meteors and Novae." *Journal for the History of Astronomy* 11:10–27.
- Deonna, Waldemar
1920 "Le Trésor des Fins d'Annecy." *Revue Archéologique* 50/11:112–206
1952 "Ouroboros." *Artibus Asiae* 15/1/2:163–70.
- Diodorus Siculus
1946 *Diodorus of Sicily*, 1, trans. Charles Henry Oldfather. Loeb Classical Library, 279. London: William Heinemann.
- Drewer, Lois L.
1981 "Leviathan, Behemoth and Ziz: A Christian Adaptation." *Journal of the Warburg and Courtauld Institutes* 44:148–56.
- Elisseeff, Vadime, and Marie-Thérèse Bobot
1973 *Trésors d'art chinois récentes découvertes archéologiques de la République Populaire de Chine*. Paris: Petit Palais.
- Ellis Davidson, Hilda R.
1975 "Scandinavian Cosmology." In *Ancient Cosmologies*, ed. Carmen Blacker and Michael Loewe, 172–97. London: Allen and Unwin.
- Epiphanius
1987 *The Panarion of Epiphanius of Salamis: Book I (Sects 1–46)*, trans. Frank Williams. Nag Hammadi Studies, 35. Leiden, The Netherlands: E. J. Brill.
- Erman, Adolf
1911 "Ein Denkmal memphitischer Theologie." *Sitzungsberichte der königlich preussischen Akademie der Wissenschaften* 43:916–50.
- Faulkner, Raymond O., trans.
1985 *The Ancient Egyptian Book of the Dead*. New York: MacMillan Publishing Company and London: British Museum Publications.
- Ficino, Marsilio
1896 *Plotini Enneades cum Marsilii Ficini Interpretatione Castigata*, ed. Fridericus Creuzer and Georg Henricus Moser. Paris: Firmin-Didot.
- Fontenrose, Joseph
1980 [1959] *Python; A Study of Delphic Myth and its Origins*. Berkeley and Los Angeles: University of California Press.
- Gamkrelidze, Thomas V., and Vjacheslav V. Ivanov
1995 *Indo-European and the Indo-Europeans: A Reconstruction and Historical Analysis of a Proto-Language and a Proto-Culture*, 1–2. Trends in Linguistics; Studies and Monographs, 80. Berlin: Mouton de Gruyter.

Gebhart-Sayer, Angelika

1984 *The Cosmos Encoiled: Indian Art of the Peruvian Amazon*. New York: Center for Inter-American Relations.

1987 *Die Spitze des Bewusstseins: Untersuchungen zu Weltbild und Kunst der Shipibo-Conibo*. Münchner Beiträge zur Amerikanistik, 21. Hohenschäftlarn, Germany: Klaus Renner Verlag.

Ginzberg, Louis

1947 *The Legends of the Jews*, 5. Philadelphia: The Jewish Publication Society of America.

Greek Magical Papyrus

1992[1986] *The Greek Magical Papyri in Translation: Including the Demotic Spells*, trans. Hans Dieter Betz. Chicago: University of Chicago Press.

Gunkel, Hermann

1895 *Schöpfung und Chaos in Urzeit und Endzeit; eine religionsgeschichtliche Untersuchung über Gen 1 und Ap Joh 12*. Göttingen: Vandenhoeck and Ruprecht.

Hasibuan, Jamaludin S.

1985 *Art et Culture Batak*. Jakarta: P.T. Jayakarta Agung Offset.

Herskovits, Melville J.

1938 *Dahomey: An Ancient West African Kingdom*. New York City: J. J. Augustin.

Hippolytus

1921 *Philosophumena or the Refutation of All Heresies Formerly Attributed to Origen, but now to Hippolytus, Bishop and Martyr, who Flourished about 220 A. D.*, 1–2, trans. Francis Legge. London: Society for Promoting Christian Knowledge.

Hirschman, Jack, trans.

1976 "Baraita on the Work of Creation." In *The Secret Garden: An Anthology in the Kabbala*, ed. David Meltzer, 3–20. Barrytown, New York: Station Hill Openings.

Horapollo

1993[1978] *The Hieroglyphics of Horapollo*, trans. George Boas. Bollingen Series, 23. Princeton: Princeton University Press.

Hornung, Erik

1999 *The Ancient Egyptian Books of the Afterlife*. Ithaca: Cornell University Press.

Howey, M. Oldfield

1955 *The Encircled Serpent: A Study of Serpent Symbolism in All Countries and Ages*. New York: Arthur Richmond.

Isidore of Sevilla

2006 *Etymologies*, trans. Stephen A. Barney, et al. Cambridge: Cambridge University Press.

Joustra, M.

1917 "Verschillende Verbodsbepalingen, Eertijds bij de Heidensche Bataks der Tobasche Landen van Kracht: Uit het Tobaasch Vertaald." *Bijdragen tot de Taal-, Land- en Volkenkunde van Nederlandsch-Indië* 73:311–43.

Jung, Carl Gustav

1944 *Psychologie und Alchemie*. Zürich: Rascher Verlag.

Kolpaktchy, Gregoire, trans.

1973 *Livre des morts des anciens Égyptiens*. Paris: Omnium Littéraire.

Kurth, Dieter

- 2004 *The Temple of Edfu: A Guide by an Ancient Egyptian Priest*. Cairo: The American University in Cairo Press.

Lanzone, Ridolfo V.

- 1881 *Dizionario di Mitologia Egizia*, 1. Torino: Fratelli Doyen.

Leveen, Jacob

- 1944 *The Hebrew Bible in Art*. The Schweich Lectures of the British Academy. London: Oxford University Press.

Lewy, Hans, ed.

- 1978 *Chaldaean Oracles and Theurgy; Mysticism Magic and Platonism in the Later Roman Empire*. Paris: Études Augustiniennes.

Liddell, Henry George, and Robert Scott, eds.

- 1940 "Ὀὐροβόρος." In *A Greek-English Lexicon*. Oxford: Clarendon Press.

Lindsay, Jack

- 1970 *The Origins of Alchemy in Graeco-Roman Egypt*. London: Frederick Muller.

Lumholtz, Carl

- 1900 *Symbolism of the Huichol Indians*. Memoirs of the American Museum of Natural History, 3; Anthropology, 2. New York: American Museum of Natural History.

Lydus, John

- 1898 *Ioannis Laurentii Lydi Liber de Mensibus*, ed. Ricardus Wuensch. Leipzig: B.G. Teubner.

Macrobius

- 1969 *Macrobius: The Saturnalia*, trans. Percival Vaughan Davies. New York: Columbia University Press.

Mahdihassan, S.

- 1963 "The Significance of Ouroboros in Alchemy and in Primitive Symbolism." *Iqbal* 1963:18–47.

Martianus Capella

- 1977 *The Marriage of Philology and Mercury: Martianus Capella and the Seven Liberal Arts*, trans. William Harris Stahl and Richard Johnson. New York: Columbia University Press.

Masse, W. Bruce

- 1995 "The Celestial Basis of Civilization." *Vistas in Astronomy* 39/4:463–477.
 1998 "Earth, Air, Fire, and Water: The Archaeology of Bronze Age Cosmic Catastrophes." In *Natural Catastrophes during Bronze Age Civilisations; Archaeological, Geological, Astronomical and Cultural Perspectives*, ed. Benny J. Peiser, Trevor Palmer and E. Bailey, 53–92. BAR International Series, 728. Oxford: Archaeopress.

Maupoil, Bernard

- 1943 *La géomancie à l'ancienne côte des esclaves*. Travaux et mémoires de l'Institut d'Ethnologie, 42. Paris: Institut d'Ethnologie.

Mercier, Paul

- 1954 "The Fon of Dahomey." In *African Worlds; Studies in the Cosmological Ideas and Social Values of African Peoples*, ed. Daryll Forde, 210–34. Oxford: Oxford University Press.

- Merlo, Christian, and Pierre Vidaud
 1966 "Le symbole dahoméen du serpent queue-en-gueule." *Objets et Mondes; La Revue du Musée de l'Homme* 6/1:301–28.
- Métraux, Alfred
 1958 *Le vaudou haïtien*. Bibliothèque des Sciences Humaines. Paris: Gallimard.
- Midraš 'Aseret ha-Dibbəröt*
 1938 In *Bet ha-Midrash: Sammlung kleiner Midraschim und vermischter Abhandlungen aus der ältern jüdischen Literatur*, vol. 1, ed. Adolph Jellinek, 62–90. Jerusalem: Bamberger and Wahrmann.
- Midraš Kōnen*
 1938 In *Bet ha-Midrash; Sammlung kleiner Midraschim und vermischter Abhandlungen aus der ältern jüdischen Literatur*, vol. 2, ed. Adolph Jellinek, 23–39. Jerusalem: Bamberger and Wahrmann.
- Modigliani, Elio
 1890 *Un Viaggio a Nias*. Milano: Fratelli Treves.
- Mundkur, Balaji
 1983 *The Cult of the Serpent: An Interdisciplinary Survey of its Manifestations and Origins*. Albany: State University of New York Press.
- Needham, Joseph
 1980 *Science and Civilisation in China*, vol. 5. Cambridge: Cambridge University Press.
- Nilsson, Martin P.
 1950 *Geschichte der griechischen Religion: II: Die Hellenistische und römische Zeit*. Handbuch der Altertumswissenschaft, 5.2.2. München: C.H. Beck.
- Oldenburg, Ulf
 1969 *The Conflict between El and Ba'al in Canaanite Religion*. Dissertationes ad Historiam Religionum Pertinentes, 3. Leiden, The Netherlands: E. J. Brill.
- Onians, Richard B.
 2000 [1951] *The Origins of European Thought about the Body, the Mind, the Soul, the World, Time, and Fate: New Interpretations of Greek, Roman and Kindred Evidence also of Some Basic Jewish and Christian Beliefs*. Cambridge: Cambridge University Press.
- Origen
 1965 *Contra Celsum*. Trans. Henry Chadwick. Cambridge: Cambridge University Press.
- Peratt, Anthony L.
 1992 *Physics of the Plasma Universe*. New York: Springer Verlag.
 2003 "Characteristics for the Occurrence of a High-Current, Z-Pinch Aurora as Recorded in Antiquity." *IEEE Transactions on Plasma Science* 31/6:1192–1214.
- Peratt, Anthony L., John McGovern, Alfred H. Qōyawayma, Marinus A. van der Sluijs, and Matthew G. Peratt
 2007 "Characteristics for the Occurrence of a High-Current Z-Pinch Aurora as Recorded in Antiquity Part II: Directionality and Source." *IEEE Transactions on Plasma Science* 35/4:778–807.

Peratt, Anthony L., and Charles M. Snell

- 1985 "Microwave Generation from Filamentation and Vortex Formation within Magnetically Confined Electron Beams." *Physical Review Letters* 54:1167–70.

Pēsikta dē-Rab Kahāna

- 1975 Trans. William Gershon Braude and Israel Kapstein. The Littman Library of Jewish Civilization. London: Routledge and Kegan Paul.

Petrie, W. M. Flinders

- 1914 *Amulets Illustrated by the Egyptian Collection in University College, London*. London: Constable and Company.

Piankoff, Alexandre

- 1949 "Les deux papyrus 'mythologiques' de Her-Ouben au Musée du Caire." *Annales du Service des Antiquités de l'Égypte* 49:129–44.
 1955 *The Shrines of Tut-Ankh-Amon*, ed. Natacha Rambova. Bollingen Series, 40.2. New York: Pantheon Books.

Piccardi, Luigi, and W. Bruce Masse, eds.

- 2007 *Myth and Geology*. Geological Society Special Publication, 273. London: Geological Society.

Pirqē de-Rabbi 'Eli' ezer

- 1971 [1916] *Pirqē de Rabbi Eliezer (the Chapters of Rabbi Eliezer the Great) According to the Text of the Manuscript Belonging to Abraham Epstein of Vienna*, trans. Gerald Friedlander, N.Y.: Sepher-Hermon Press.

Pistis Sophia

- 1978 Ed. Carl Schmidt and trans. Violet MacDermot. Nag Hammadi Studies, 9; The Coptic Gnostic Library. Leiden, The Netherlands: E. J. Brill.

Pitt Rivers, Augustus

- 1900 *Antique Works of Art from Benin*. London: Harrison and Sons.

Pīyyuṭ Weyikkon 'Olam

- 1964 *Pīyyuṭ Weyikkon 'Olam*, apud *Maḥzor* of the Romans. In *Hebrew Myths: The Book of Genesis*, Robert Graves and Raphael Patai, 48. London: Cassell.

Plato

- 1943 *Phaedo*, trans. Harold North Fowler. Loeb Classical Library, 36. London: William Heinemann.
 1946 *The Republic*, trans. Paul Shorey. Loeb Classical Library, 276. London: William Heinemann.

Plutarch

- 1936 *Moralia: De Iside et Osiride*, vol. 5, trans. Frank Cole Babbitt. Loeb Classical Library, 306. London: William Heinemann.

Poetic Edda

- 1996 Trans. Carolyne Larrington. The World's Classics. Oxford: Oxford University Press.

Porphyry

- 1983 *On the Cave of the Nymphs*, trans. Robert Lambertson. Barrytown, New York: Station Hill Press.

Preisendanz, Karl

- 1935 "Ein altes Ewigkeitssymbol als Signet und Druckermarken." *Gutenberg-Jahrbuch* 1935:143–49.

- 1940 "Aus der Geschichte des Uroboros." In *Brauch und Sinnbild; Eugen Fehrl zum 60: geburtstag gewidmet von seinen Schülern und Freunden*, ed. Ferdinand Herrmann and Wolfgang Treutlein, 194–209. Karlsruhe, Germany: Südwestdeutsche Druck- und Verlagsgesellschaft.
- Pyramid Texts*
- 1969 *The Ancient Egyptian Pyramid Texts*, trans. Raymond O. Faulkner. Oxford: Oxford University Press.
- Reichel-Dolmatoff, Gerardo
- 1987 "The Great Mother and the Kogi Universe: A Concise Overview." *Journal of Latin American Lore* 13/1:73–113.
- Reitzenstein, Richard
- 1921 *Das iranische Erlösungsmysterium: Religionsgeschichtliche Untersuchungen*. Bonn: A. Marcus and E. E. Weber.
- Remigius of Auxerre
- 1962 *Remigii Autissiodorensis Commentum in Martianum Capellam, Libri I–II*, ed. Cora E. Lutz. Leiden, The Netherlands: E. J. Brill.
- Séd, Nicolas
- 1964 "Une cosmologie juive du haut moyen age: La Béraytā di Ma'aseh Bērēšit." *Revue des Études Juives: Historia Judaica* 4/3 (123):259–305.
- Séd, Nicolas, trans.
- 1965 "Une cosmologie juive du haut moyen age: La Béraytā di Ma'aseh Bērēšit; Le texte, les manuscrits et les diagrammes." *Revue des Études Juives: Historia Judaica*, 4/4 (124):23–123.
- Seder Rabbā di-Bērēšit*
- 1967 In *Batei Midrashot: Twety [sic] Five Midrashim Published for the First Time from Manuscripts Discovered in the Genizoth of Jerusalem and Egypt*, ed. Rabbi Shlomo Aharon Wertheimer, 27–28. Jerusalem: Ktab Wasepher.
- Seler, Eduard
- 1923 *Gesammelte Abhandlungen zur Amerikanischen Sprach- und Alterthumskunde*, 4. Berlin: Behrend and Co.
- Servius
- 1923 *In Vergilii Aeneidis Commentarius*. In *Servii Grammatici qui Feruntur In Vergilii Carmina Commentarii*, 1, ed. Georgius Thilo and Hermannus Hagen. Leipzig: B. G. Teubner.
- Stephenson, F. Richard, David M. Willis, and Thomas J. Hallinan
- 2004 "The Earliest Datable Observation of the Aurora Borealis." *Astronomy and Geophysics* 45/6:615–17.
- Stocks, Hermann
- 1910 "Ein Alexanderbrief in den Acta Cyriaci et Julittae." *Zeitschrift für Kirchengeschichte* 31/1:1–47.
- Stricker, Bruno Hugo
- 1943 "Magische Gemmen." *Oudheidkundige Mededeelingen uit het Rijksmuseum van Oudheden te Leiden: Nieuwe Reeks* 24:25–30.
- 1944 "Aanteekeningen op Egyptische Litteratuur- en Godsdienstgeschiedenis." *Oudheidkundige Mededeelingen uit het Rijksmuseum van Oudheden te Leiden: Nieuwe Reeks* 25:52–90.

- 1953 *De Grote Zeeslang*. Mededelingen en Verhandelingen van het Vooraziatisch-Egyptisch Genootschap Ex Oriente Lux, 10. Leiden, The Netherlands: E. J. Brill.
- Sturluson, Snorri
1987 *Snorri Sturluson: Edda*, trans. Anthony Faulkes. Everyman's Library. London: Dent.
- Taylor, F. Sherwood
1930 "A Survey of Greek Alchemy." *The Journal of Hellenic Studies*, 50:109–39.
- Theophrastus
1963 "De Arte Sacra." In *Physici et Medici Graeci Minores*, vol. 2, ed. Iulius Ludwig Ideler, 328–35. Amsterdam: Adolf M. Hakkert.
- Tobing, Philip Lumban
1956 *The Structure of the Toba-Batak Belief in the High God*. Amsterdam: Jacob van Campen.
- Toscagne, Paul
1911 "Études sur le serpent: figure et symbole dans l'antiquité élamite." In *Mémoires de la Délégation en Perse*, 12.4, 153–228. Paris: n.p.
- Townsend, Lawrence W., et al
2006 "The Carrington Event: Possible Doses to Crews in Space from a Comparable Event." *Advances in Space Research*, 38:226–31.
- Uphill, Eric P.
2003 "The Ancient Egyptian View of World History." In "Never Had the Like Occurred": *Egypt's View of Its Past*, ed. John Tait, 15–29. London: University College of London Press.
- Van Wijngaarden, Willem D., and Bruno Hugo Stricker
1941 "Magische Stèles." *Oudheidkundige Mededeelingen uit het Rijksmuseum van Oudheden te Leiden: Nieuwe Reeks* 22:6–36.
- Vaticanus Mythographus Tertius
1834 *De Diis Gentium et Illorum Allegoriis*. In *Scriptores Rerum Mythicarum Latini Tres Romae Nuper Reperti ad Fidem Codicum MSS. Guelferbytanorum Gottingensis, Gothani et Parisiensis*, 1, ed. Georgius Henricus Bode, 152–56. Celle, Germany: E. H. C. Schulze.
- Vita Alexandri Magni* (Armenian version)
1969 *The Romance of Alexander the Great by Pseudo-Callisthenes: Translated from the Armenian Version*, trans. Albert Mugrdich Wolohojian. Records of Civilization Sources and Studies, 82. New York: Columbia University Press.
- Vita Alexandri Magni* (Greek Version)
1974 *Vita Alexandri Magni*, (Greek manuscript L), trans. H. van Thiel, *Leben und Taten Alexanders von Makedonien: der Griechische Alexanderroman nach der Handschrift L*. Texte zur Forschung, 13; Darmstadt: Wissenschaftliche Buchgesellschaft.
- Vita Alexandri Magni* (Syriac version)
1979 [1889] *The History of Alexander the Great Being the Syriac Version, Edited from Five Manuscripts of the Pseudo-Callisthenes with an English Translation*, trans. E. A. Wallis Budge. Amsterdam: APA Philo Press.

Vocabularium Aethiopicum

- 1892 *Das Buch Henoch aus dem Aethiopischen in die ursprünglich hebräische Abfassungssprache zurückübersetzt, mit einer Einleitung und Noten versehen*, trans. L. Goldschmidt. Berlin: Richard Heinrich.

Voorhoeve, Petrus

- 1956 "Nachschrift," postscript for "Pane na Bolon, ein Kriegsorakel der Toba-Batak auf Sumatra" by Johannes Winkler. *Bijdragen tot de Taal-, Land- en Volkenkunde* 112:37–40.

Vyasa

- 1973 "Mahābhārata," 1, (Astika Parva). In *The Mahābhārata: I: The Book of the Beginning*, trans. J.A.B. van Buitenen. Chicago: The University of Chicago Press.

Wakeman, Mary K.

- 1973 *God's Battle with the Monster: A Study in Biblical Imagery*. Leiden, The Netherlands: E. J. Brill.

Waterlot, Em. G., ed.

- 1926 *Les bas-reliefs des bâtiments royaux d'abomey (Dahomey)*. Travaux et mémoires de l'institut d'ethnologie, 1. Paris: Institut d'Ethnologie.

Wensinck, Arent Jan

- 1916 *The Ideas of the Western Semites Concerning the Navel of the Earth*. Verhandelingen der Koninklijke Akademie van Wetenschappen: Letterkunde, 17.1. Amsterdam: J. Müller.
- 1918 *The Ocean in the Literature of the Western Semites*. Verhandelingen der Koninklijke Akademie van Wetenschappen te Amsterdam: Letterkunde, Nieuwe Reeks, 19.2. Amsterdam: Johannes Müller.

Wesselofsky, Alexander N.

- 1885 "Der Drache zu Babylon." *Archiv für Slavische Philologie* 8/1:326–30.

West, Martin L.

- 1997 *The East Face of Helicon: West Asiatic Elements in Greek Poetry and Myth*. Oxford: Clarendon Press.

Wilbert, Johannes

- 1981 "Warao Cosmology and Yekuana Roundhouse Symbolism." *Journal of Latin American Lore* 7/1:37–72.

Winkler, Johannes

- 1925 *Die Toba-Batak auf Sumatra in gesunden und kranken Tagen: Ein Beitrag zur Kenntnis des animistischen Heidentums*. Stuttgart: Chr. Belser A. G.
- 1956 "Pane na Bolon, ein Kriegsorakel der Toba-Batak auf Sumatra." *Bijdragen tot de Taal-, Land- en Volkenkunde* 112:25–37.

Wyatt, Nicholas

- 1995 "The Significance of ŠPN in West Semitic Thought: A Contribution to the History of a Mythological Motif." In *Ugarit; ein ostmediterranes Kulturzentrum im alten Orient; Ergebnisse und Perspektiven der Forschung*, ed. M. Dietrich and O. Loretz. Abhandlungen zur Literatur Alt-Syrien-Palästinas und Mesopotamiens, 7, 213–37. Münster: Ugarit-Verlag.

Xu, Zhentao, David W. Pankenier, and Yaotiao Jiang

2000 *East Asian Archaeoastronomy: Historical Records of Astronomical Observations of China, Japan and Korea*. Earth Space Institute Book Series, 5. Amsterdam: Overseas Publishers Association, Gordon and Breach Science Publishers.

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