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Malcolm Nicolson
Centre for the History of Medicine
University of Glasgow
Glasgow, Scotland

Robert P. McIntosh
Department of Biological Sciences
University of Notre Dame
Notre Dame, IN

A History of the Ecological Sciences, Part 6: Arabic Language Science—Origins and Zoological Writings

Arabic Civilization, like the Byzantine, was a synthesis; in this case, primarily of Arabic, Byzantine, and Persian cultures (von Grunebaum 1970). Because Arabic and Persian cultures did not emphasize science, and because Byzantine science barely rose above the mediocre level of Roman science, one might guess that Arabic language science would be no better than Byzantine science. Much of it certainly was not better, but a significant portion of it was. The greatest achievements were in mathematics, astronomy, alchemy, physics, and geography. Almost all surveys of Arabic language science have neglected zoology (Anawati 1970, Huff 1993, 2000, Turner 1995, Rashed 1996, Dallal 1999) and sometimes botany; the notable exceptions are by Nasr (1968, 1976) and Sezgin (1970:357–380). Zoology was disseminated mainly through interesting animal stories, but was also pursued through medicine, veterinary medicine, hunting, and pest control (Bodenheimer 1928:128–167, Petit and Théodoridès 1962:171–180, Pellat et al. 1966). Professor Remke Kruk's studies provide the basis for a new synthesis on the history of Arabic language zoology, which we hope he will someday provide.

Alexander the Great had wanted to conquer Arabia, but died in Babylon before he made the attempt. What was there to conquer? Excepting Yemen in the far south, it consisted of oases, camel caravan trails, and desert—not an environment favorable for the flowering of complex civilization. No one had ever united the tribal Arabs, and around the year 600, there was no awareness that anyone ever would. Yet only a decade before, the charismatic Muhammad of Mecca began retreating into a cave to meditate and listen to a voice telling him to lead his people away from paganism to worship the one god, Allah. Muhammad would be Allah's prophet, and the religion he preached would unite the Arabs in religion and would also provide a means for uniting them politically. Although intolerant of paganism (which much later included Hinduism), Muhammad saw himself as the last of the Hebrew prophets (including Jesus), and therefore he tolerated Judaism and Christianity, even though adherents to those faiths paid more taxes and had fewer rights than Muslims.

The Arabs lacked science in their indigenous traditions, but the cultural, political, and military momentum that Muhammad set in motion continued after his death in 632, and Arabs were willing to learn from those they conquered. Within a century, a vast empire stretched from the Atlantic across North Africa, Syria, Mesopotamia, and Persia to the Indus Valley in India. Arabic was the language of Islamic religion, and it also became the language of most of the conquered lands, excepting mainly Iran and, later (after they became Muslims), the Ottoman Empire, although many Iranians and Turks read Arabic. It was too vast an area to govern for long using medieval communications and transportation, and gradually it separated into various states. Not only the Arabic language, but also commerce and culture, persisted over vast regions after the large empire began to break down.

The Umayyad dynasty established the first Muslim Caliphate at Dam-

ascus in 661. From the start, they were Hellenized and they encouraged scientific studies. However, they lacked the religious fervor of the Abbasids, who overthrew them in 750 and moved their Caliphate to Baghdad. The second Abbasid Caliph brought men of science to Baghdad, the third ordered the collection of Greek treatises, and the fourth established, about 828, a House of Wisdom to sponsor translations from Greek into Arabic, although many of them were first translated into Syriac, then from Syriac into Arabic. Much care went into the translations, but some confusion was inevitable, as when the same Arabic word, qunfudh, was used for hedgehogs and sea urchins (Kruk 1985). Later on, the House of Wisdom inspired other scientific institutions in Cairo, Cordova, and elsewhere in the Islamic civilization (Rosenthal 1975). Arabic language science was studied and advanced over a very much larger territory than were Greek and Roman civilizations. Libraries were valued, and many were created. Acquisition of paper-making techniques from the Chinese during the 700s made this practicable. Institutions of higher learning, called madrasas, also developed, but they focused on religion and Islamic law and lacked courses in science. Some professors taught science in their homes (Huff 1993:74–75). Muslims followed the Byzantine example of supporting hospitals and teaching medicine at them (Savage-Smith 1996:930–936).

Two early writers on animals were from Basra, Iraq. 'Abd al-Malik al-Asma'i (739/740–c.831), wrote works on wild animals, horses, camels, and sheep (Sarton 1927–1931:I, 534–535) and influenced his younger, more famous contemporary, Abu 'Uthman 'Amr ibn Bahr (*c.*776–868/869), who is known to history by an unflattering nickname, al-Jahiz (goggle-eyed). He was a highly esteemed author in the tradition of Aelianus and Timotheos, and had access to an Arabic translation or paraphrase of the Aristotelian *Historia Animalium*, possibly Ibn al-Bitriq's, completed about the year 815 (Kruk 2001*a*). Al-Jahiz's stories of about 350 kinds of animals contain some original observations (Kopf 1952, Lewin 1952, Bodenheimer 1958:194–195, Pellat 1969, Plessner 1973). Bayrakdar's case for al-Jahiz being an evolutionist is unconvincing, but his narrower claim that he "recognized the effect of environmental factors on animal life" (1983:151) seems valid. Apparently, al-Jahiz was the first to discuss food chains, although his details are not always accurate. He claimed that "the lizard is clever in hunting the snake and fox." Perhaps his source was translated into Arabic from a book claiming that the snake and fox are clever in hunting the lizard. He continued (VI, 133: see Asin Palacios 1930:38–39 [in Spanish], and Zirkle 1941:84–85):

> *The mosquitoes go out to look for their food as they know instinctively that blood is the thing which makes them live. As soon as they see the elephant, hippopotamus or any other animal, they know that the skin has been fashioned to serve them as food; and falling on it, they pierce it with their proboscises, certain that their thrusts are piercing deep enough and are capable of reaching down to draw the blood. Flies in their turn, although they feed on many and various things, principally hunt the mosquito. . . . All animals, in short, can not exist without food, neither can the hunting animal escape being hunted in his turn.*

This is the earliest known description of a food chain. Al-Jahiz's animal stories remained immensely popular and influenced later writers.

'Abd al-Latif (1162–1231) was born in Baghdad and became an outstanding physician (Sarton 1927–1931:II, 599–600). He lived in Cairo (1191–1204) and collected information on Nile crocodiles and different kinds of lizards. His accounts of their natural history were based upon both his own observations and previous descriptions. He assumed that crocodile eggs would produce either crocodiles or skinks, depending on whether the hatchlings took to water or to the sand (Provençal 1992). This became part of the traditional folklore.

The only Arabic language rival to al-Jahiz's animal book was one by Muhammad al-Damiri (1341–1405), a professor at Cairo's Al-Azar University. Al-Damiri's *The Life of Animals* is a scholarly encyclopedia that summarizes a vast amount of information (Al-Damiri 1906–1908), although it lacks original observations and includes imaginary beings such as the mount on which the Prophet rode to heaven: it had a human face, horse's mane, and camel's feet (Somogyi 1950, Vernet 1971:549). Clearly, there was an increase in information about animals during almost six centuries separating al-Jahiz and al-Damiri, but there was no one to separate the gold of science from the dross of folklore.

"Books of useful knowledge" often contained chapters or sections on animals. Ibn Qutayba (828–884/889), from Baghdad, was a younger contemporary of al-Jahiz who served as a judge in Dinawar, Iran, before returning home to teach (Huseini 1950, Lecomte 1965, Kunitzsch 1975). Possibly he had access to the same Arabic version of Aristotle's *Historia Animalium* as al-Jahiz used (Bodenheimer and Kopf 1949), and he had access to some unknown Arabic language work on agriculture, perhaps a translation of Kassianos Bassos' *Geoponika* that no longer exists. Ibn Quayba also drew upon Arabic folklore, which could be quite unreliable. His *The Choice of Transmitted Information* has 22 chapters on animals, one on plants, and one on stones. Examples of his folklore are: horses have no spleen, camels no bile, and male ostriches no marrow in their bones (IV.11); giraffes are produced from hybrids between female camels and male hyenas, and males from that mating mate, in turn, with wild cows (IV.12). Some of his information seems based on observation, but often accompanied by hasty generalizations. In a chapter on "Animals hostile to each other," he plausibly reports (IV.13) that there are hostile relations between owls and all other birds, and therefore other birds will attack an owl during the day when its poor eyesight renders it harmless, "but when the night comes, nothing can withstand it." More problematic, how-

ever, is his claim in the same chapter that "Hostility exists between the ass and the crow and between the serpent and the pig; whereas the crow maintains friendly relations with the fox and the latter with the serpent." His unknown authority on agriculture reported that "Between the cabbage and the vine there is enmity; if cabbage be planted in the vicinity of a vine, one of the two will wither and shrivel" (IV.33).

Abu Hayyan al-Tauhidi (d. 1009?), who may have been Iranian, was an intellectual who earned a meager living in Baghdad by copying books. He compiled a book of knowledge meant to entertain and to inspire wonder at the wisdom of creation. Its discussion of animals contains some material not known from other Arabic-language sources, but it also drew heavily from a version of Aristotle's *Historia Animalium* and a version of *Physiologos* (Kopf 1956:398).

Two scholars from Qazwin, Iran, who wrote on science are named al-Qazwini for their home town; they may or may not be related. Zakariya al-Qazwini (c.1203–1283) went to Damascus for an education and then served as a jurist in Iraq (Ahmad 1975). The first of his two works, *Wonders of the Creation*, is on cosmography. Drawing upon both Greek and Arabic-language sources, this work showed vast knowledge, but little originality or critical thinking. He discussed, for example, not only plants and animals, but also angels, without making clear that knowledge of the former comes from observations, whereas knowledge of the latter comes from religious writings. (Some of his accounts were translated into German by E. Wiedemann [1916], and extracts from that were translated into English by Bodenheimer [1958:216].) His other work, on geography, was entitled *Wonders of the Lands* in the first version (1262) and *Monuments of the Lands and Histories of the Peoples* in the second version (1275). It is a dictionary of towns and countries that gave some indication of latitude and longitude, and also discussed the influence of locations on the people, plants, and animals. Hamdullah al-Qazwini (b. 1281/1282) was a financial officer for Abu Sa'id, the Mongol Il-Khan. He wrote three works: a universal history, a rhymed Persian history, and *Hearts' Delight*, a science encyclopedia, of which two parts are available in English: geography (discussed in Part 7) and zoology (Stephenson 1928). He divided animals into domesticated (a sampler is in Nasr 1968:118–125) and wild. The most important section of each discussion contained the "properties" of a species—what each part could be used for, according to folklore.

Hunting was a sport for many upper-class Muslim men, and there are manuals on falconry and other kinds of hunting, written by an Arab, Moamin, an Iranian, Ghatrif, and others (Tjerneld 1945, Viré 1960), and a memoir by a Syrian hunter, Usamah (1095–1188), who observed or participated in hunting by both falconry and other means (Hitti 1929). However, these writings added little to natural history beyond what was known from other sources. Arabic language authors also wrote on horse medicine (Viré 1965, Karasszon 1988:116–129).

Several aspects of zoology were widely discussed in Arabic-language medical literature. The common assumption that Islamic civilization forbade dissection of human cadavers or even animals is incorrect (Savage-Smith 1995), although there were few significant discoveries made during such investigations. There are several indications that Arabic-language medical authors enriched the understanding of parasites, gained when the medical encyclopedia by Paul of Aegina (died after 642) had been translated into Arabic (Théodoridès 1957, 1966:136–137, Hoeppli 1959, Part I). Al-Razi (c.854–925) was a leading medical author (Pines 1975) who discovered that a skin disease previously ascribed to an injured nerve was actually due to parasitic Guinea worms (Stewart 1950, 350), although the source of the worm was unclear. Generally, physicians followed the Greco-Byzantine tradition in accepting the spontaneous generation of parasites (Kruk 1990, 1999*a, b*). Two leading medical authors, Ibn Sina (Latinized as Avicenna, 980–1037) and Ibn Rushd (Latinized as Averroës, 1126–1198; Arnaldez and Iskandar 1975), wrote commentaries on Aristotelian zoological works, and a section of Ibn Sina's *Shifa* on animals was translated into Latin during the early 1200s by Michael Scot. As a medical reference, Ibn Sina's *Canon of Medicine* was second in importance only to Al-Razi's *Comprehensive Book of Medicine* (Anawati and Iskandar 1978). The *Canon*'s chapter on intestinal worms (which Ibn Sina believed arose from fermentation) was translated into English by Khalil (1922), who also discussed the identification of four kinds of worms described. Ibn Zuhr (c.1091–1162) was a physician from Seville, Spain, whose two important medical texts indicate some progress in knowledge of parasites. For example, he described the itch mite (Théodoridès 1955, Hamarneh 1976).

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Frank N. Egerton
Department of History
University of Wisconsin-Parkside
Kenosha WI 53141
E-mail: frank.egerton@uwp.edu

The Ecosystemic Life Hypothesis III: The Hypothesis and its Implications

In the first article in this series (Fiscus 2001), I introduced the ecosystemic life hypothesis as a potential solution to conceptual roadblocks that I encountered when trying to define ecological health. In the second article (Fiscus 2002), I presented four concepts that, when connected together, suggest life and ecosystem are inextricably linked. In this final article, I present the ecosystemic life hypothesis proper and discuss its far-reaching implications.

The ecosystemic life hypothesis melds the ideas of coupled transformers (Lotka 1925), ecological origin of life (Odum 1970), ascendancy (Ulanowicz 1997), closure to efficient cause (Rosen 1991), and others mentioned in the previous two articles into four propositions. I preface the hypothesis using additional concepts of emergence, phase transition, and bifurcation, but do not define these here; for these I follow the work of Holland (1995), Kauffman (1993), and Prigogine (1996), respectively.

Preface concepts

A) Life is an *emergent property* of physical and chemical dynamics. Thus it requires physical and chemical dynamics, but is also *independent* of those dynamics to a degree described within the concept of emergence.

B) The original emergence of life from nonliving dynamics was a *bifurcation* into two alternate system states. This bifurcation was also a *phase transition* in which dynamics began qualitatively new behavior.

The hypothesis:

1) The bifurcation at the origin of life resulted in *two functional pro-*