Studies in History and Philosophy of Science xxx (2018) 1–12

Contents lists available at ScienceDirect

Studies in History and Philosophy of Science

journal homepage: www.elsevier.com/locate/shpsa

Can animals predict earthquakes?: Bio-sentinels as seismic sensors in communist China and beyond☆

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ARTICLE INFO

Article history:
Received 15 January 2017
Received in revised form
30 September 2017
Available online xxx

Keywords:
Bio-sentinel
Earthquake
Prediction
Animal behavior
Observation
Seismology

ABSTRACT

This paper examines the international research on abnormal animal behavior prior to earthquakes, with a focus on Chinese seismology during the Cultural Revolution. China experienced a series of powerful earthquakes in the 1960s and 1970s; in response, its scientists developed approaches to earthquake prediction, including the use of bio-sentinels. The paper demonstrates that Chinese seismology did not treat an earthquake simply as a geophysical event, but rather as an amalgam of environmental phenomena, including sensory experiences. Hence, distributive experience and sensory networks of humans and bio-sentinels constituted an important component of studying the environment. This historical case suggests insights into bio-monitoring of the global environment.

1. Introduction

On the morning of March 8, 1966, a powerful earthquake struck Xingtai: a city 220 miles south of Beijing. Houses collapsed on those who were still asleep at the chilly dawn. 8000 people were killed and more than 30,000 were injured. It was the first major earthquake in a populous region of China since the communist revolution in 1949, and the political leadership paid close attention to it.[1] The first batch of scientists already reached the devastated area the next day. Geophysicists, geologists, and other scientific experts began conducting various investigations. In the following weeks, many investigators fanned out doing fieldwork and interviews, with the expressed purpose of collecting witness accounts. In the process, numerous tales of premonitory signs of the earthquake emerged, including unusual animal behavior. On March 23, after another major shock, researchers from the Institute of Biophysics, Chinese Academy of Sciences, arrived in Xingtai to study the phenomenon of abnormal behavior prior to earthquakes. The team combed through more than a dozen communes for information for nearly two months.[2]

In May of that year, China established its first animal observation station for earthquake research in Xingtai. Up to that point, the investigations had been based on gathering recollections after the fact. The research station, by contrast, implemented systematic observation of animal behavior. The station served both as a research and an earthquake prediction facility. Animals were brought over from laboratories in Beijing; Pekinese dogs, monkeys, large white chickens, and white mice turned the station into a small zoo. From 1967 to 1970, scientists were extracted from the Institute of Biophysics, the Institute of Zoology, and the Institute of Animal Sciences to form a task force dedicated to this work. Called the "Earthquake Biology Research Group," the team set up several more observation stations in the Xingtai area and carried out research on an assortment of animals.[3]

As it happened, Xingtai marked the beginning of a series of major earthquakes that caused enormous damage in China during the 1960s and 70s.[4] In response, China fervently pursued earthquake research and defense, with an emphasis on earthquake prediction. By the early 1970s, it had established the most extensive seismological programs in the world and had collected huge quantities of data.[5] In part because of their relative isolation from international scientific communities, and in part because of the

☆ This paper appears in the *SHPS* special issue *Experiencing the Global Environment* (Volume 70, August 2018).

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[1] Fang (1995).

[2] Zhongguo (2008), pp. 42–65, 190–193; Guojia (1986). Hebei (1986) includes hundreds of the collected records of abnormal animal behavior.

[3] Zhongguo (2008), pp. 61–62; For a useful interpretive framework, see Kohler (2002), very different time and place nothwithstanding.

[4] Fan (2012a); Fan (2012b); Shapiro (2001); Schmalzer (2014); Schmalzer (2016).

[5] Dangdai (1993).

https://doi.org/10.1016/j.shpsa.2018.05.009
0039-3681/

political imperatives of self-reliance and mass science, the Chinese developed many distinctive methods of earthquake monitoring and prediction. One such approach was abnormal animal behavior. Indeed, it became the most widely reported feature of Chinese seismology in international media after the supposedly successful prediction of the Haicheng earthquake in 1975. The topic was discussed in *Nature* and reported in the *New York Times*. It also piqued the curiosity of professional seismologists in various countries. In this way, the circulation of ideas, knowledge, and practice regarding the study of animal behavior prior to earthquakes became an intriguing part of the cultural Cold War.[6]

The episode also provides an unusual perspective on experiencing the global environment. Seismic occurrences have long been understood to be a combination of multiple geographical factors, some local and some very general or even global in scale. During the Cold War, seismology became a truly global science in practice. The need and desire to detect underground nuclear tests prompted the expansion of global seismic monitoring, and the ascendancy of plate tectonics in the second half of the 1960s also encouraged a global perspective on seismicity. Thus, seismicity and seismological research could be scaled up or down according to specific phenomena and scientific parameters. Just like seismology; oceanography, climatology, and geomorphology often included the consideration of a multitude of factors on different scales. Environmental globality, therefore, is not a natural whole, but rather the aggregation, translation, and reconfiguration of data, experiences, and concepts of different scales. And one of the important components, though easily forgotten, is sensory experience; an obvious example would be using bio-sentinels to monitor global warming or local changes. Fundamentally, it is not too different from recruiting animals to detect seismic activities.[7]

2. Bio-sentinels: tremors, critters, and senses

Using animals to keep an eye on the surroundings was nothing new. Humans have relied on guard dogs for more than ten thousand years. The superior senses of sight, hearing, and smell of dogs and their vigilance made them excellent sentinels for their human partners. From the late 19th century on for almost one hundred years, miners took canaries with them into the coalmines as detectors of harmful gases, especially carbon monoxide. More recently, scientists have suggested that cats and other pets may serve as sentinel animals in detecting environmental hazards. Finally, there is also environmental research that employs sentinel species, such as oysters, to monitor metal contamination or ecological stress in bay areas.[8]

There are at least two meanings of sentinel animals in these examples. In one, we are talking about certain individuals stand on watch for threats to their group, such as the sentinels in a clan of meerkats. In the other, we are talking about humans employing certain species – called sentinels or indicator species – in attempts to biomonitor the environment. Both meanings are relevant to understanding the Chinese program of earthquake monitoring and prediction, and both are about sensory perception and responses. Also, both highlight the interconnections between part and whole – for example, between individuals and the social group or the ecology in which they belong. Bio-agents in a sensory network play the role of monitoring the environment and detecting signs of potential danger. In fact, the military tone of the term, bio-sentinel, actually captures something about Chinese seismology at the time, which was carried out in the spirit of war and national defense.

The national program of earthquake monitoring and prediction relied heavily on extensive networks of sensory observation that comprised of humans, animals, and simple instruments. Tens of thousands of human participants put their sight, hearing, taste, and smell to good use, looking out for anomalous signs in their surrounding environments. The monitoring networks depended on layers of sensory perception and cognition: humans observed signs of abnormal animal behavior which were in turn reactions of the animals to certain seismic signals that escaped human senses. Together, these different agents formed a sensory network of distributive perception and experience.[9]

Different seismological communities harbored different attitudes toward these kinds of directly observable phenomena. Seismologists in the United States, for example, tended to be skeptical of sensory phenomena reported by eye-witnesses prior to or during an earthquake – e.g., earthquake light, earthquake sound, smell, and other macro-phenomena of sensory experience.[10] They reckoned that most of these occurrences were either incidental phenomena or the results of sensory confusion. When people saw light and heard sound, they were probably witnessing the effects of snapped electric powerlines, shattered building structures, etc. rather than actual seismic events. Or perhaps they were disoriented by sensations caused by sudden physical motion or psychological agitation. Such sensory experiences were unreliable and could not serve as building blocks of science. In fact, many would insist that even if these phenomena did exist, they were epiphenomena of limited interest to seismology.

Chinese seismologists, on the other hand, took these phenomena seriously. The immediate reason was that they were eager to discover methods of earthquake prediction and were willing to consider all possibilities. Anything that might help them make advances in earthquake prediction was worth a try. Moreover, the ethos of science during the Cultural Revolution urged them to value reports, observations, and anecdotes collected from the people. Presumably, too, the sheer weight of numbers – there were so many of them! – convinced Chinese seismologists of the reality of such phenomena. They tended to treat these sensory-based phenomena as facts and included them in the innumerable books on earthquake prediction in the 1960s and 70s. Indeed, some Chinese seismologists claimed that they had personally encountered these phenomena. A young seismologist encountered earthquake light – an eerie scene of floating balls of light – prior to the 1975 Haicheng earthquake.[11] I'm not trying to solve the puzzle here. What matters is that at the time, many Chinese seismologists considered sensory experiences of various kinds a proper topic for serious scientific investigation.

The field data collected in the wake of the Xingtai earthquake seemed to support the phenomenon of abnormal animal behavior. Most cases appeared one or two days, or even a few hours or minutes, before the earthquake – which indicated a possible connection between seismic activity and animal behavior. The animals were, not surprisingly, mostly domestic animals, such as cats, dogs, pigs, and chickens. These animals were in close proximity with humans; if they behaved in an unusual way, people noticed it. Within the zone of intensity VIII, 30.4% of the 3021 chickens investigated had exhibited unusual behavior prior to the

[6] "Earthquake Prediction Raises Issues." (1975); "Quake Prediction Called Valuable," (1975); "Animals Are Tested on Quake Forecasts," (1977); "Forecast Earthquake," (1975); "The Chinese Dimension." (1975); "Still a Lot to Learn from the Chinese." (1976).

[7] Barth (2003).

[8] E.g. Wikelski and Tertitski (2016); Warmworth and Cekercioglu (2011); Reif (2011); Moore (2008).

[9] Fan (2012a); Coen (2013).

[10] Valencius (2013), ch. 4.

[11] Xu (1976); Huang and Deng (1978).

Please cite this article in press as: Fan, F., Can animals predict earthquakes?: Bio-sentinels as seismic sensors in communist China and beyond, Studies in History and Philosophy of Science (2018), https://doi.org/10.1016/j.shpsa.2018.05.009