NEW OBSERVATIONS REGARDING WARNING SYSTEMS INVOLVING ANIMAL INSTINCTS: A RESOURCE FOR HELPING PREDICT NATURAL DISASTERS

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Abstract

Recent studies have highlighted the potential for utilizing abnormal animal behaviors as valuable precursors for a variety of natural hazards including volcanic activity, tsunamis, and earthquakes. We undertook a survey of literature for determining what kind of abnormal animal behavior was found to be closely linked to natural hazards that then occurred. Dominant patterns found included abnormalities observed in animals' behaviors including toads disappearing, snakes coming out of hibernation, cows moving down a mountain, and videos capturing erratic dogs and birds, all before an earthquake. There were also patterns found with elephants taking high ground before a tsunami, and goats migrating down the slope of a volcano before an eruption. Results of our study clearly show the potential of harnessing erratic and abnormal animal activities as valuable precursor events in advance of natural hazards of a range of magnitudes and intensities. Advances in technology including AI and mass production of relatively inexpensive GPS-enabled micro-tags, infra-red, and satellite monitoring – all could represent the next generation of models that seek to use abnormal animal behavior as early warning systems for a variety of natural hazards.

Introduction & Justification

Scientists are continuing to discover new ways for predicting natural disasters. While it may be possible to close-in on areas of risk, it is nearly impossible to determine exactly where and when such events will occur (David, 2021). There is a fair amount of research on animal behavior that could lead to a successful early warning system. After major natural disasters, there are claims that animals show abnormal behavior in preparation for imminent destruction (Whitehead, 2013). However, an inadequate amount of scientific attention has been paid to the idea of using animals and their erratic and abnormal behaviors for predicting natural disasters. In particular, Chinese scholars have historically led this field of study and consequently their work has sparked a renewed interest among scholars. Animals may possess the sensitivity to filter precursory signals of impending danger, activating a behavioral pattern that can be documented and analyzed (Carayannis, 2008). Such a pattern may be triggered by an innate behavior that animals possess, allowing them to perform certain actions when exposed to specific stimuli (LibreTexts, 2021). This is also known as an internal warning, allowing them to live in targeted areas (Alana, 2019). There are precursory changes such as ground movement, groundwater variations, and electrical or magnetic field changes, making it possible for animals to sense and connect these changes with their sense of impending danger (for example - USGS, 2018). With that, animals can sense changes in the environment around them, giving them enough time to retreat to an area with lesser risk when faced with an imminent eruption, earthquake, or tsunami (Kaine, 2020). Additionally, historical studies on disaster and risk management worldwide have highlighted strong cases for the roles of indigenous knowledge for preparing for and surviving natural disasters (Quilo, 2015). Prior to the advent of modern technology, animals were commonly used by communities for interpreting disasters. Reports have dated the earliest reference of unusual animal activity as far back as in 373 BC (USGS, 2018). Recent research has found a pattern in animal behavior that seems to be consistent with and a continuation of past research. The purpose of this study is to promote awareness within the scientific community regarding the potential of studying behavioral patterns in animals that could lead to development of a successful early warning system.

Methods

Library research was conducted to study different cases of abnormal animal behavior ranging from 373 BC to present day.

Discussion

Animal abnormalities were noticed weeks to minutes before earthquakes, tsunamis, and volcanic eruptions. Total abnormalities show that animal behavioral changes were observed and reported the most, at more than 50% (Figure 1). Abnormal animal behaviors include barking, being panicked, biting, hiding, being erratic, disappearing, etc. (Yamauchi et al., 2014). The closer the animals were to the hypocenter, the earlier abnormal animal behavior was displayed (Figure 6). In 2009, toads near L'Aquila disappeared before an earthquake, during their mating season, and only returned a few days after the aftershocks has abated (Bailey, 2019). These toads were able to sense groundwater changes that occurred before the earthquake. Snakes are also known to exhibit unusual behavior as a response to detecting seismic activity (Kurniawan et al., 2017). Photographs of snakes were captured coming out of hibernation before an earthquake (Figure 8). Also, in 2012, researchers noticed that goats fled from their homes (on the slopes of a volcano), downhill to a nearby town, hours before a volcanic eruption (Figure 9). The goats were able to pick-up warning signs from precursory signals such as seismic activity and gas emissions (Bailey, 2019). Research documented instances of abnormal animal behavior to be consistent with older studies. For example, reports have documented owners who witnessed their dogs barking and whining for no obvious reason prior to an earthquake (Prabhune, 2015). Studying the photograph of the dog (Figure 13) and watching the videos from Turkey and Syria as shown in the results section, it becomes obvious that these animals clearly exhibited abnormal behavioral patterns before the earthquakes. There have been countless reports of animals saving lives such as elephants taking high ground before the 2004 tsunami in Sri Lanka (NOAA, 2013). Villagers were alerted by elephant's behaviors and consequently moved away from the coast in ample time before a tsunami hit the area (Sheldrake, 2005). Additionally, it is contended that hazards such as tsunamis, earthquakes, and volcanic eruptions release infra-sounds that can be detected by animals, this is how the elephants in the case study of Sri Lanka were able to sense the tsunami (Kelley et al., 2013). Natural disasters also cause changes in the ionosphere, which animals are sensitive to and therefore react to (Yao et al., 2012). Animals are known to survive in habitats closer to active volcanoes because they can sense changes before deadly eruptions (Masters, 2020). This is thought to result from the earth's vibrations producing stress from the ground and into the ionosphere in the form of energy that turns into ions, producing serotonin in animals (for example - Bento, 2020). Animals thus are better suited to responding to natural disasters because they can innately detect abnormalities in their environments (Marklay, 2022).

Conclusion

This work confirms that animals have shown a pattern of abnormal behavior before natural disasters throughout time. Research has proven animals to be a reliable predictive resource that could save lives quickly. Animals sense when something is abnormal and their first instinct is to flee to safety (Mott, 2013). While technology is a thriving resource, there are limitations when it comes to predicting natural disasters, short-term forecasting being one of them (Berberichet et al., 2013). Research confirms that abnormalities could be potentially noticed weeks to hours before natural disasters, giving people ample time to take proper precautions. Awareness must be brought to the larger scientific community that animals could be used as an accurate, early warning system.

Results

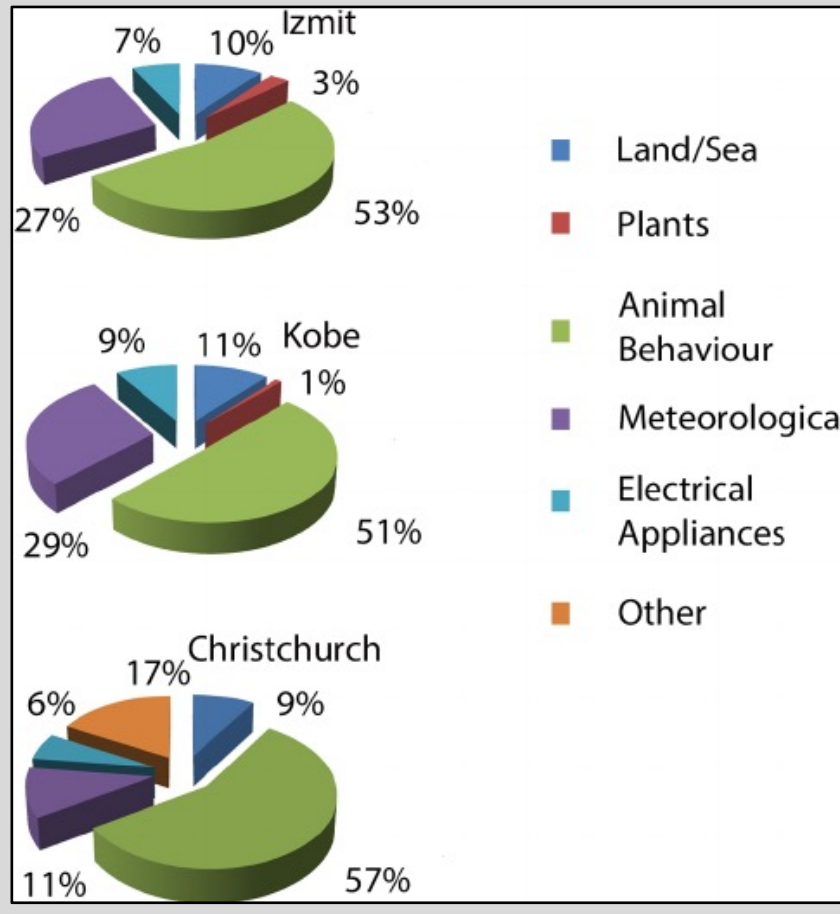### Abnormalities Studied

Figure 1.
A chart of multiple unusual phenomena reported through letters, fax, and e- mails by citizens before **1)** the Izmit Earthquake in 1999 and, **2)** the Kobe earthquake in 1995 (Ulusoy and Ikeya, 2008) and, **3)** the Christchurch earthquake in 2010. Animal behavior was reported more than 50% of the total abnormalities. (From Whitehead, 2013).

Figure 2.
Biological anomalies including animal behavior showing the most abnormalities out of all included categories. (From Fidani et al., 2014).

Table 1. Types of observations with respect to the distance from L'Aquila.

Type of observational	< 20 km (#)	> 20 km (#)	Total (#)
Earthquake lights	237	12	249
Radio-telecommunications	68	16	84
Unusual sounds	55	14	69
Unusual fluid emissions	144	18	162
Soil deformation	25	5	30
Unusual meteorology	140	26	166
Biological anomalies	467	84	551
All	1,136	175	1,311

Specific Animal Reports

Figure 3.
Reports showing that about 60% of abnormal animal behavior is observed before natural disasters. (From Fidani et al., 2014).

Figure 4.
Abnormal animal behavior types reported days to weeks prior to the earthquakes. (Yada et al., 2021).

Figure 5.
Reports of cows' abnormal behavior prior to earthquakes. (From Fidani et al., 2014).

Animal Warning Time Compared to Distance and Days

Figure 6.
Plot showing abnormal animal activities prior to eight earthquake events with magnitudes greater than 4. Each point represents the warning time prior to the earthquakes. The closer in distance to the hypocenter, the greater the warning time. (From Wikelski et al., 2020).

Figure 7.
As the magnitude of the L'Aquila earthquake increased, the appearance of toads decreased. (From Grant et al., 2011).

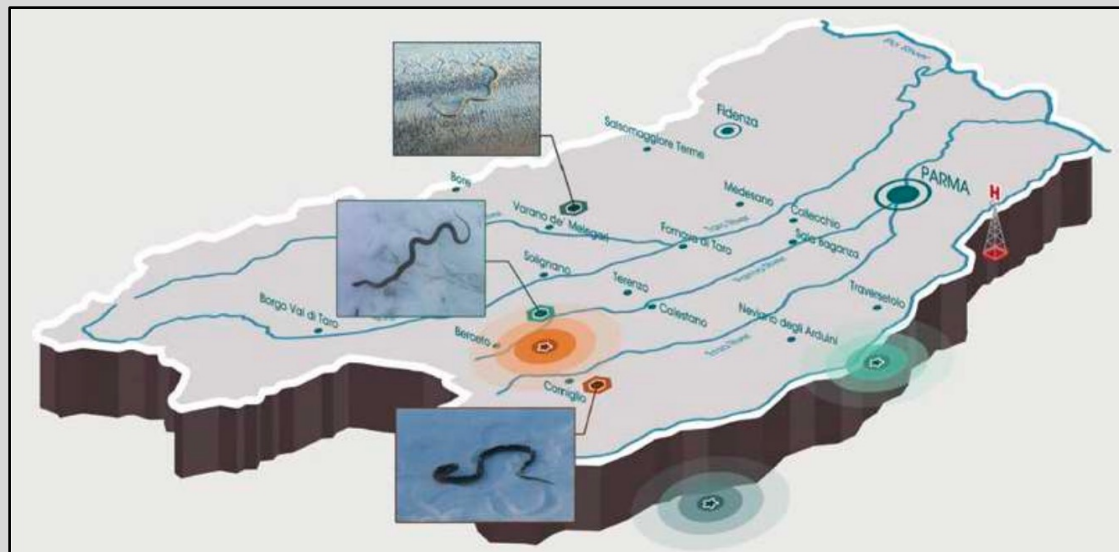### Cameras and GPS Loggers

Figure 8.
Photographs documenting reptiles coming out of hibernation in seismic areas of North-Western Apennines in Italy. (From Straser, 2013).

Figure 9.
Goats that live on the slope of Mt. Etna were tracked using GPS loggers. The movement pattern shows that the goats migrated down towards the town of Randazzo prior to the volcanic eruption. (From Maier, E., Google Earth, 2012 GeoEye, 2012 Tele Atlas).
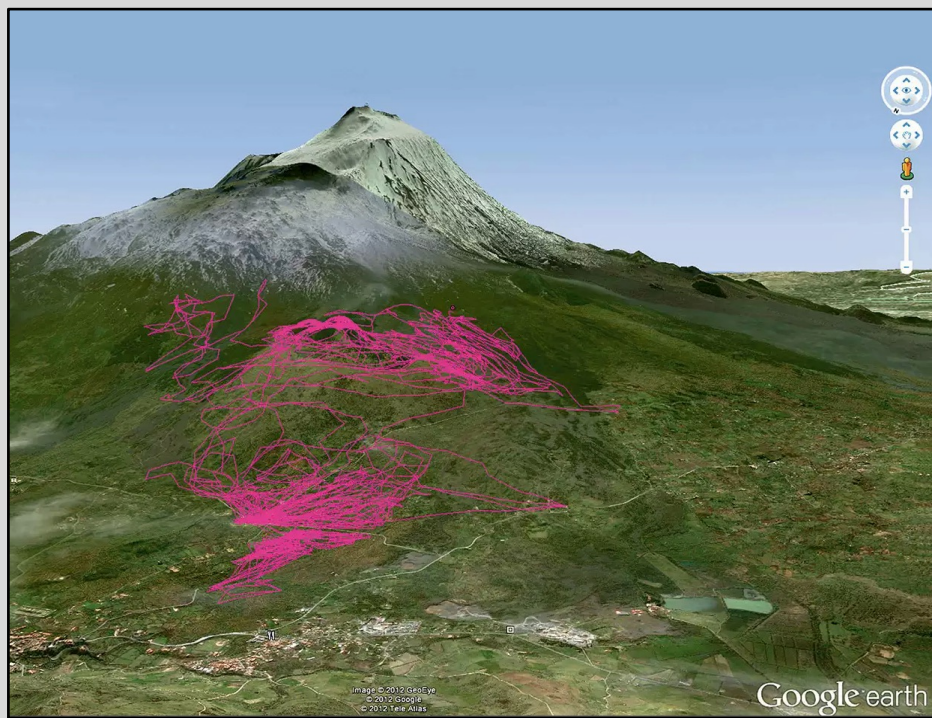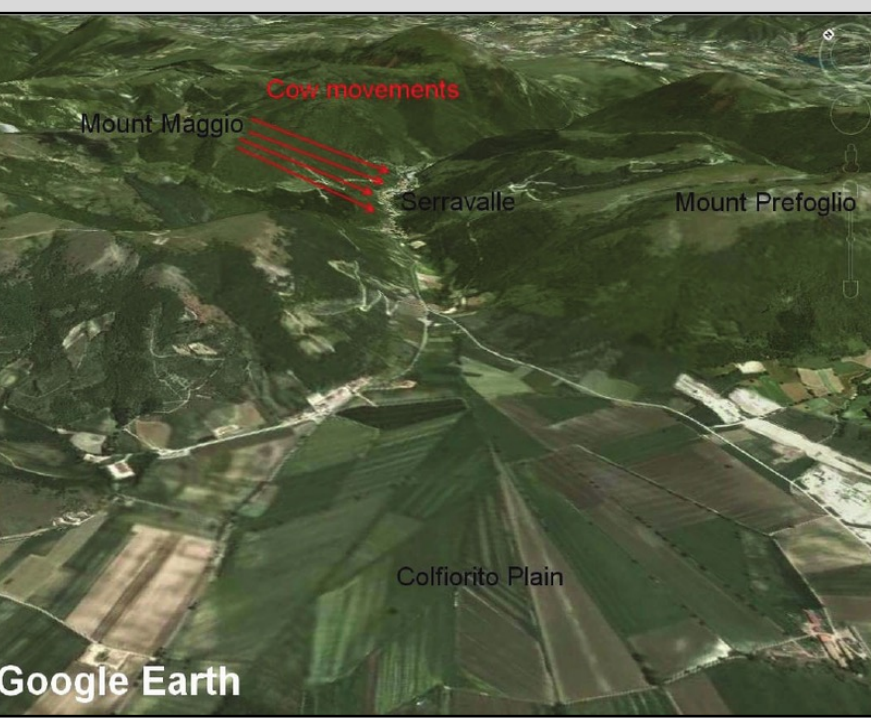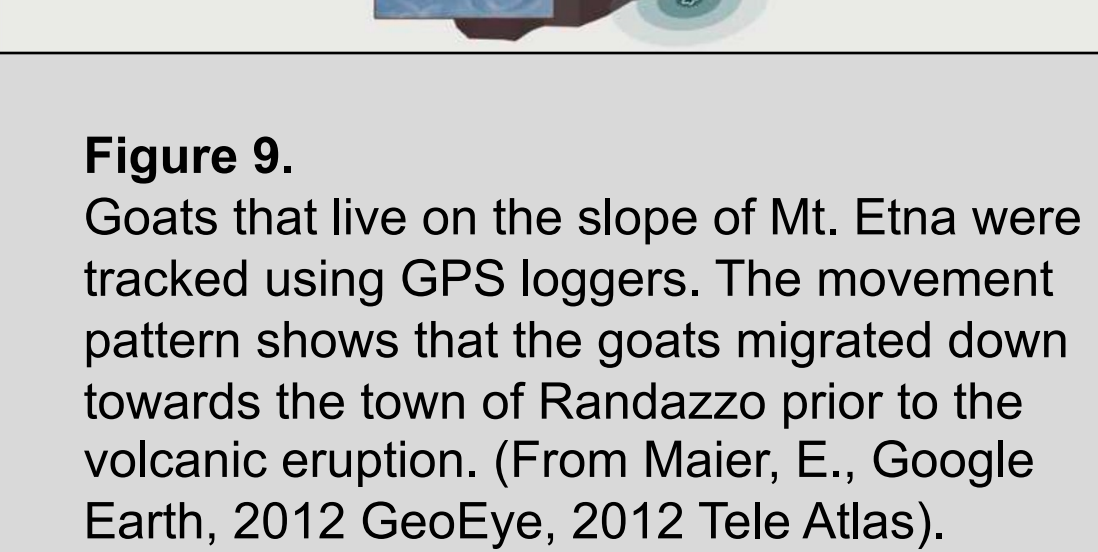
Figure 10.
Red arrows indicating cow movement down Mount Maggio, two days prior to the earthquake. Villagers reported the herd of cow migrating down near the village of Serravalle del Chienti. (From Fidani et al., 2014).

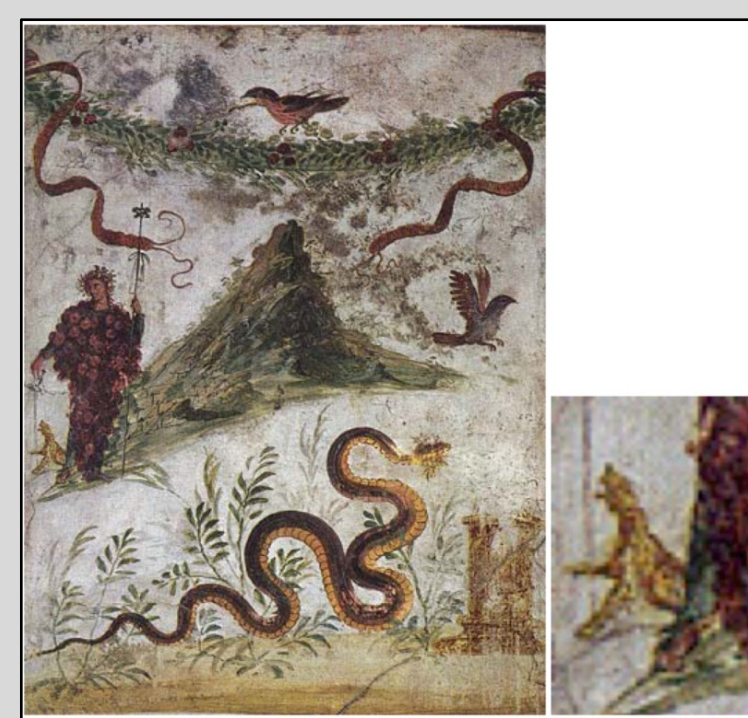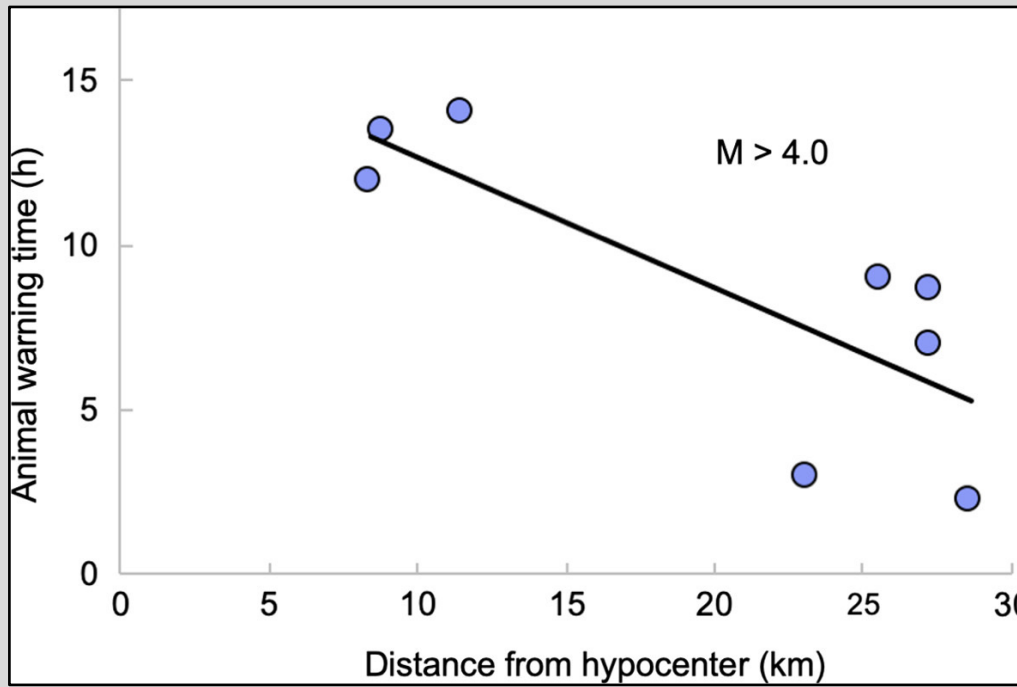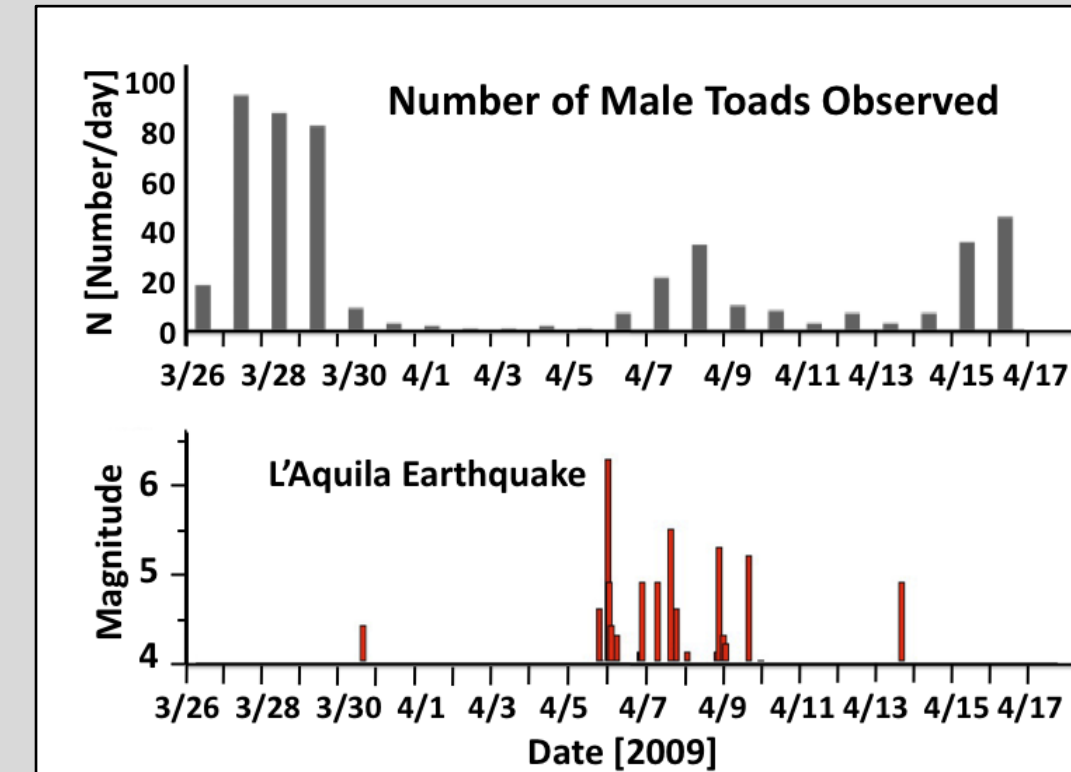### Earlier Observations Relating to Today's Findings

Figure 11.
Historical painting of Bacchus and excited animals near the volcano Vesuvius, depicting that the animals were anticipating a natural disaster. (From Tributsch, 2013).

Figure 12.
A flyer distributed to the people of China, showing and explaining abnormalities in animal behavior prior to earthquakes. (From Tributsch, 2013).

Figure 13.
Photographs of an erratic dog and fleeing rats. This abnormal behavior was shown prior to a M=7.2 earthquake in 1976. (From Tributsch, 2013).

Videos of Animals Behaviors Before Earthquake in Turkey & Syria

A M=7.8 earthquake hit southern Turkey and northern Syria on February 6, 2023 (Issa, 2023).

- **Link to birds behaving erratically the night before the Turkey earthquake:**

1. (Lillian, 2023)
https://twitter.com/lilian37458552/status/1622699575415898112?ref_src=twsrc%5Etfw%7Ctwcamp%5Etweetembed%7Ctwterm%5E1622699575415898112%7Ctwgr%5Eaa685a3f41042d9a586fed991242816b13418dfb%7Ctwcon%5Es1_&ref_url=https%3A%2F%2Fenglish.alarabiya.net%2Ffeatures%2F2023%2F02%2F07%2FCan-animals-actually-predict-earthquakes-

2. (Reddit, 2023)
https://www.reddit.com/r/AnimalsBeingGeniuses/comments/10vi6wr/birds_acting_weird_just_before_the_earthquake_in/

- **Link to dog howling before the Turkey earthquake :**

3. (Stray Beautiful, 2023)
https://www.tiktok.com/@straybeautiful/video/7197057446169546030

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