Reproduction of mimosa and clock anomalies before earthquakes

Are they "*Alice in the Wonderland Syndrome*"?

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Abstract: Some earthquake precursor phenomena told as legends or reported retrospectively for the 1995 Kobe earthquake have been reproduced by laboratory experiments. Mimosa placed on the high voltage sphere of a Van de Graaff electrostatic generator closed its leaves and bowed on charging and air-gap discharging, presumably due to the current induced in its stem. Air-gap discharging caused sudden movements of eels in a nearby plastic aquarium. Eels moved also on applying a pulsed electric field of less than 0.5 V/m, while catfish responded only at around 5 V/m. The higher sensitivity of eels to electric field than that of catfish is consistent with the story in the Ansei Chronicle that a man could not find eels in a river but only catfish in violent movement before the earthquake. Eels might have already hidden themselves in panic. Rapid rotation and stopping of the second hand of a clock, which were observed before the Kobe Earthquake like in the "Alice in the Wonderland", have also been reproduced by exposing clocks to electromagnetic waves generated by air-gap discharging. Reported malfunctioning of home electronic appliances before the earthquake would have been due to some natural electromagnetic disturbance at the epicenter.

Key words: Catfish; clock; earthquake; Kobe; mimosa; precursor.

Introduction. Human anthropology often tells us that there is some truth behind folk tales and taboos. Legends, folklores and proverbs on earthquake precursor phenomena are abundant and have been inherited from generation to generation in Asian countries where frequent earthquakes have caused disasters.[1] There may be some scientific reasons for anecdotes related with earthquakes, though scientists are reluctant to explain these phenomena scientifically to the public.

Reports on precursor phenomena were retrospectively collected from the general public in response to an appeal through the Japanese mass media after the Kobe earthquake that destroyed the city of Kobe and killed 6,427 people on January 17, 1995. It was reported in the book "1519 Statements on Precursors"[2] edited by Wadatsumi that animals became nervous, excited and panicked. Rats and birds evacuated their normal habitats or were, in some cases, seen moving in large numbers as if migrating to avoid the imminent catastrophe. Snakes, tortoises and earthworms emerged from soil in winter. Some fish in ponds floated and either maintained their orientation parallel to each other or moved violently as if panicked. Some died after jumping out of the water. Also some people retrospectively stated that they had headache, felt dizzy and so on before the earthquake. These statements in the book are essentially the same as those found in old folklores and proverbs.[1]

Reports of electrical appliances switching themselves on, second hand of clocks either rapidly rotating or stopping and of radio and television reception being unusually disturbed were added as new precursors to the traditional stories of seismic anomalous animal behaviour (SAAB)[1] and earthquake lightning (EQL) depicted by Terada in 1931.[3] Did the anomalous behavior related with earthquakes begin to shift from animals to electric appliances in the modern city of Kobe ?

Most of these phenomena fall between academic disciplines, i.e. onto the boundary of sciences called "an interdisciplinary field". These phenomena exist also on the boundary between scientific observation and reports in the public or popular mass media, in other words, between scientists and lay citizens. Most scientists have traditionally avoided such a boundary field and regard the statements unreliable as they were based on observations and experiences under unusual psychological conditions of a natural disaster. Some even assert them to be psychogenic

mass hysteria and regard these topics as being out of the scope of science. However, unless someone solves the puzzles related to precursor phenomena scientifically, the public will soon cease to trust science. Most scientists have unfortunately not noticed this public sentiment and confine themselves to problems in their specialized field. The retrospective approach to collect statements from witnesses is a necessary step in documenting these phenomena. They must then be explained scientifically, based on a hypothesis and then reproduced in experiments.

The story of mimosa grass bowing and closing its leaves before an earthquake is well known in Japan.[4),5)] There are also statements that an orchid swung slightly and tree leaves rattled without wind before the Kobe earthquake.[2)]

Another famous story, appearing in the Ansei Chronicle, concerns catfish which are said to "cause" earthquakes in Japan.[1)] A man recalled that he could not find eels in a river but found that catfish exhibited anomalous behavior before the 1846 Ansei earthquake which had a magnitude 7.8. The man's life was saved because he interpreted it as an omen of earthquake. Color woodcuts, innovative at that time, showing a large catfish under the ground causing an earthquake, were circulated; this led to the widespread Japanese legend of the earthquake-creating catfish. One of the pioneering studies involving catfish suggests that seismic electric current might elicit SAAB.[6)] Some aquatic animals have extraordinarily sensitive electro-sensory systems which are used to acquire information for orientation and to communicate with each other.[7)] The electro-sensing organs of animals may be perturbed by electric field prior to an earthquake.[8)]

In this paper, we attempted to reproduce some of these reported precursory phenomena, such as mimosa closing leaves and lettuce dancing, catfish and eel in turmoil and clock malfunctioning before earthquakes.

Experimental. Anomalies related to plants and fish have been duplicated using a Van de Graaff self-charging electrostatic generator (Shimadzu VG250) which produces 250 kV on the high voltage aluminum sphere by frictional electricity. Air-gap discharges were made by moving a grounded wire toward the high voltage sphere to produce electromagnetic noise. Mimosa and lettuce plant were grown in pots from seeds. The pot was placed on the sphere directly. The behavior of the objects were photographed with a video camera.

For another experiment to examine the reaction of fish, two Japanese catfish of the length 60 cm and two eels of the length 50 cm were purchased and kept in glass aquariums having the size of 90 cm×45 cm and water depth of 32 cm. Two aluminum electrodes of the size 40 cm×40 cm were immersed in the aquarium with a separation of 87 cm. A pulsed voltage up to 4 volt was applied using a pulse generator at the pulse width of 1 ms with a repetition rate of one pulse per second. Air-gap discharges of the high voltage sphere were made beside a plastic aquarium in which eels and polyvinyl chloride pipes were kept: under normal conditions eels hid themsleves in the pipes.

Results and discussion. (i) *Folklores on Earthquake Predictors.* (a) Motion of plants. The mimosa in a pot on the sphere of a Van de Graaff electrostatic generator straightened up and closed its leaves when a high voltage was applied as shown in Fig. 1 (a) and (b). When the sphere was discharged by grounding and then charged up, the plant bowed and stood up again as if to dance. Electrostatically induced electric current through the stem is considered to have flown by the appearance of the charges on the sphere. The contraction movement of cells in mimosa was thoroughly investigated in electrophysiology.[9)]

Leaves of a lettuce plant in a pot danced up and down when the high voltage sphere was made on and off by touching with a grounded rod. When a branch of azalea with leaves was placed on the sphere, the separation distances between nearby leaves increase and return to the original position just as electrode foils in a classical gold-leaves-electroscope open and close as the sphere was charged and discharged. From these results, it may be hypothesized that the appearance of an intense pulsed charge density on the ground in the epicenter area before the earthquake caused the reported rattling of leaves before the earthquake.[2)]

(b) Behavior of catfish and eels. Electrostatic discharges were made beside a plastic aquarium containing living fish, using the Van de Graaff generator. Eels, in a polyvinyl chloride pipe placed in the plastic aquarium, were shocked and rapidly came out of the pipe when air-gap discharges were made between the high voltage sphere and a grounded rod. The output of digital storage oscilloscope (DSO) having peak voltage of about 50 V/m and pulse width of less than 0.1 μ, was detected during discharges between the parallel plate electrodes in another nearby aquarium.[10)] Apparently eels are responding to the EM waves generated by the air-gap discharges.

Similar experiments were made in the Izu-Atagawa Banana Alligator Garden where crocodiles closed their eyes when the air-gap discharges were made at about 1 m

(a) (b)

Fig. 1. Photographs of mimosa grass on the high voltage sphere of a Van de Graaff frictional electrostatic generator, (a) before and (b) after the application of a high voltage of 250 kV to the sphere. A folklore of mimosa leaves closing its leaves and bowing as an earthquake precursor phenomenon was produced experimentally.

(a) (b)

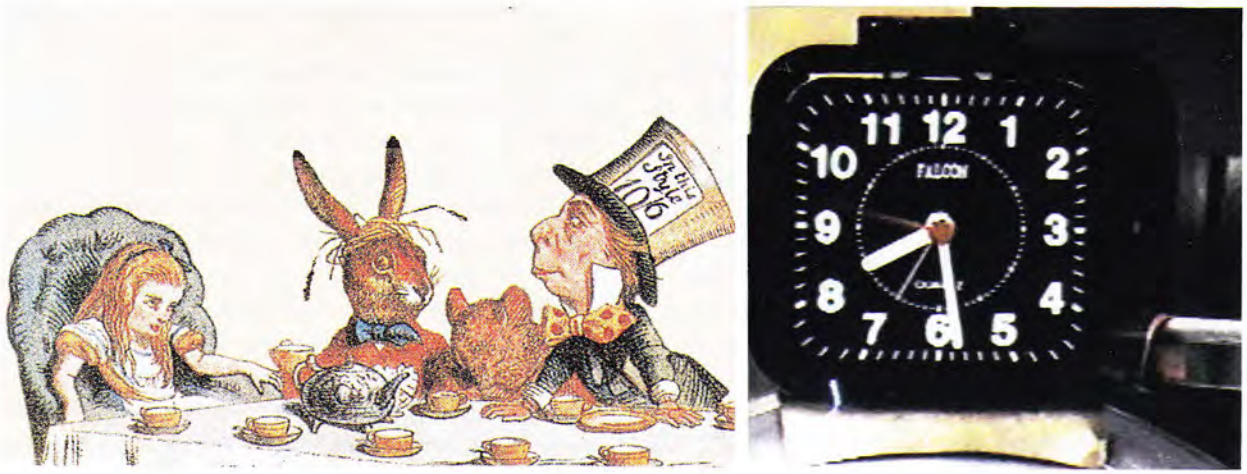

Fig. 2. (a) An illustration of the Mad Tea Party by J. Danniel in Chapter 7 of "Alice's Adventure in Wonderland and Through Looking Glass" by Lewis Carroll. (b) The retrospective statement of a rapidly rotating second hand of a clock observed a day before the Kobe earthquake, which might be considered as psychogenic perception anomaly induced by drugs, was reproduced by the streamer discharge between the clock plastic case and the high voltage sphere of a Van de Graaff electrostatic generator. The plastic case is charged positively by collecting air ions and the insulation is breakdown by air-gap discharges. The eight times higher speed than normal suggests that three flip-flops in the digital IC circuit were shunted.

away from their face. When similar discharge experiments were done with catfish, no changes were observed.

The responses of catfish and eels to switching DC electric field on and off were studied. The critical field intensity required to produce a response from catfish at 5 V/m was much more than 0.2 V/m for eels. Eels were as sensitive as crocodiles and sea lions, both responded to 0.5 V/m. Crocodiles showed anomalous behavior at the Izu-Atagawa Banana Alligator Garden before the Izu volcanic eruptions in 1987 and sea lions at the Kobe-Oji Zoo before the Kobe earthquake.[11] Eels swarming to the beach at Niigata were reported before the earthquake at Niigata in 1933.[1]

The alignment behavior of fish and silkworms led to the idea that SAAB are behavioral field-avoidance responses when animals are exposed to seismic electric-pulse stimuli.[11] An applied pulse field of 5~10 V/m (0.1~0.2 A/m^2) with the pulse width of ms, which was estimated from our electromagnetic model of a fault,[8] caused fish to align themselves perpendicular to the field direction. This was because the body has a higher resistivity perpendicular to the body-length direction than parallel to it and so the body current is minimized when they align perpendicular to the field direction.[10]

The Ansei story indicates that, since eels have a higher sensitivity to electric signals than catfish, they must have escaped or hidden well before the earthquake leaving the catfish behind. Eels might indeed be very sensitive to seismic electric precursors considering their response during our discharge experiments. Pulsed electric field or electric field of EM waves would be responsible for electro-physiological responses (excitement, panic, etc.). The hypothesis of charged aerosols[12] as a cause of SAAB of underwater animals seems questionable. The induced current in the synapse of the nervous system would be due to a seismic pulsed electric field, i. e., to a wave packet consisting of EM waves at different frequencies. The pulsed field of F=5 V/m, 400 V/m in air, will correspond to the power, S of EM waves of about 400 W/m^2 (40 mW/cm^2) using the relation of $F=(SZ)^{1/2}=19.4\ S^{1/2}$, where Z is the impedance. Electric pulses during an interval of μs must have paralyzed catfish before the earthquake.[13]

We were observing natural background electric field using parallel electrodes in an aquarium placed on the campus of our university.[10] Natural noise field of 2 V/m of an unknown origin surprised eels in nearby aquarium and hamsters in a nearby cage on 19:04, Nov. 14, 1996. Two earthquake of the magnitude, M=2.2 and 1.9 occurred in the southern Kyoto about 30 km away from the campus on 12:23, Nov. 17. The earthquake of M=3.8 on 0:51, Nov. 17 at Niijima was 345 km away: the relation of $S \propto M_0^{1/2}/R^2$, where M_0 is the earthquake moment, R, the distance, and the intensity decay in the conductive earth[10] indicate that this field intensity is less than those of the former two nearby earthquakes. The correlation of the pulsed electromagnetic noises with these earthquakes is not clear without identifying the source location of electric pulses.

(ii) *Rapidly moving clock—"Alice in Wonderland syndrome"*? A citizen of Ashiya city, 25 km away from the epicenter, telephoned one of the authors and told about a mysterious precursor phenomenon which occurred a day before the Kobe Earthquake and requested that it should be explained to her scientifically. The hands of her quartz clock stopped moving and slightly moved in opposite direction just like a scene in a science fiction movie. There were reports of stopped quartz clocks in Beijing at a distance of 160 km from the epicenter, eight hours before the Great Tangshang Earthquake that killed 240,000 people in 1976.[5] The similar story is found in the precursor statements edited by Wadatsumi.[2] The second hand began to rotate quickly a day before the earthquake. One graduate student also confessed that she had seen the same but had not told people. The clocks continued to work normally after the earthquake.

The story sounds like a psychogenic perception anomaly of time in the "*Alice in Wonderland Syndrome*". The Hatter said to Alice at A Mad Tea Party in Chapter 7 of the book, *Alice's Adventure in the Wonderland*,[14] "*Now, if you only kept on good terms with him (Time), he'd do almost anything you liked with the clock...: you'd only have to whisper a hint to Time, and round goes the clock in a twinkling! Half-past one, time for dinner!*"

The clock at the speed eight times faster than normal and alarm sounds were produced by discharges between the clock and the high voltage sphere of a Van de Graaff generator. This suggests that three flip-flops in the digital IC circuit were shunted, leading to eight times more pulses to the pulsed motor and so faster movement.

Our experimental results showed that an exposure to EM waves from an antenna at the emitting power of 10 W in a frequency range from 120 to 130 MHz caused failures of a clock and a video camera taking picture of the clock. Other anomalies of electric appliances, natural switching of radio, TV and air conditioners were also reproduced by EM noises produced by air-gap discharges using the Van de Graaff generator. The phenomena ahead of earthquakes may be elucidated in terms of errors caused by electronic noise leading to digital code errors and

natural switching by shunting circuits due to discharges.

A large electrostatic charge density and intense electromagnetic fields must have caused electronic discharges leading to generation of these precursors. The seismic electric field (SES) of the Greek VAN method[15] would be ascribed to the field of electromagnetic waves at ultra low frequency (ULF).[10] Seismic EM waves can propagate over long distances through earth-wave-guides.[16]

Summary. While this paper has described electromagnetic experiments that succeeded in reproducing some of reported earthquake precursors, we make no claim for earthquake prediction by the observation of these phenomena. However, there may be a link between these widely reported phenomena and the occurrence of earthquakes. If so, these modern precursor phenomena that can be experienced in our daily life will provide a valuable warning and might save lives of ordinary citizens in earthquake-prone areas. These simple experiments on precursor phenomena using a Van de Graaff electrostatic generator available at a high school science room may be demonstrated to pupils, teachers, students and to the general public to illustrate the phenomena scientifically.

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References

1) Musya, K. (1995) Earthquake Catfish. Akashi Publisher (in Japanese).
2) Wadatsumi, K. (1995) 1591 Statements on Precursors. Tokyo Publisher, Tokyo (in Japanese).
3) Terada, T. (1931) Bull. Earthquake Res. Inst., Tokyo Univ. **9**, 225–255.
4) Daigo, M. (1985) Proverb Dictionary for Disaster Prevention. Tokyo-do Publisher, Tokyo (in Japanese).
5) Dai, H. (1996) Big Earthquake Can Be Predicted. Green Arrow, Tokyo (in Japanese).
6) Abe, N. (1934) Sci. Rep. Tohoku Imp. Univ. Biol. **9**, 87–96.
7) Bastian, J. (1994) Physics Today **47**, 30–36.
8) Ikeya, M., Takaki, S., and Takashimizu, D. (1996) J. Phys. Soc. Japan **65**, 710–712.
9) Toriyama, H., and Jaffe, M. J. (1972) Plant Physiol. **49**, 72–81.
10) Ikeya, M., Takaki, S., Matsumoto, H., Tani, A., and Komatsu, T. (1997) J. Circuit, Systems and Computers **7**, 135–146.
11) Ikeya, M. (1996) Kagaku **66**, 408–418 (in Japanese).
12) Tributsch, H. (1985) Wenn Die Schlangenn Erwachen (translated by M. Watanabe). Asahi Newspaper Co. Tokyo (in Japanese).
13) Ikeya, M. (1998) Why Do Animals Behave Anomalously? —Birth of Electromagnetic Seismology. NHK Press, Tokyo (in Japanese).
14) Carroll, L. (1962) Alice's Adventures in Wonderland and Through Looking Glass, Penguin Books, London.
15) Uyeda, S. (1996) In A Critical Review of VAN (ed. Lighthill, J.). World Scientific, Singapore, pp. 3–49.
16) Ikeya, M., Kinoshita, Y., Matsumoto, H., Takaki, S., and Yamanaka, C. (1997) Jpn. J. Appl. Phys. **36**, L1558–L1561.