Natural Hazards **6**: 1–10, 1992.

Abnormal Animal Behaviour as a Precursor of the 7 December 1988 Spitak, Armenia, Earthquake

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(Received: 8 September 1989; in final form: 17 September 1991)

Abstract. This paper relates some facts about abnormal animal behaviour prior to several Armenian earthquakes. The catastrophic Spitak, northern Armenia, earthquake of 7 December 1988, $M = 7$, $I_0 = \mathrm{X}$, was preceded by extensive occurrences of abnormal animal behaviour. Proof was established by questioning residents in the area and by distributing specially prepared questionnaires shortly after the event. Approximately 200 reports from 50 sites were examined. The raw data recorded included lists of different types and locations of species that have shown abnormal responses to an impending earthquake, distribution of anomalous occurrences over the area, and precursor times. It is concluded that specially conducted observations of animal behaviour as a possible premonitory phenomenon is both useful and necessary.

Key words. Abnormal animal behaviour, earthquake prediction, premonitory phenomena, Spitak earthquake.

1. Introduction

As in a number of other countries (Evernden, 1977; Rikitake, 1978; Shen Ling-Huang, 1978; Tributsch, 1982), great interest was shown by Soviet investigators in the 1970s in bioprecursors of earthquakes, and primarily in abnormal animal behaviour preceding earthquakes. A review has been published and evidence concerning abnormal animal behaviour prior to earthquakes in the U.S.S.R. from historical times has been analytically examined (Nikonov, 1981; Nikonov and Faidysh, 1982).

Experiments were made under laboratory and field conditions (Krasnogorskaya *et al.*, 1984; Nersesov *et al.*, 1988). However, data available on abnormal animal behaviour before individual events are still inadequate. Speaking of the U.S.S.R., it would be difficult to cite a single example where evidence of this kind has been collected on a broad scale, even after an event.

The Spitak earthquake is different in this respect from previous seismic events in that extensive material has been acquired.

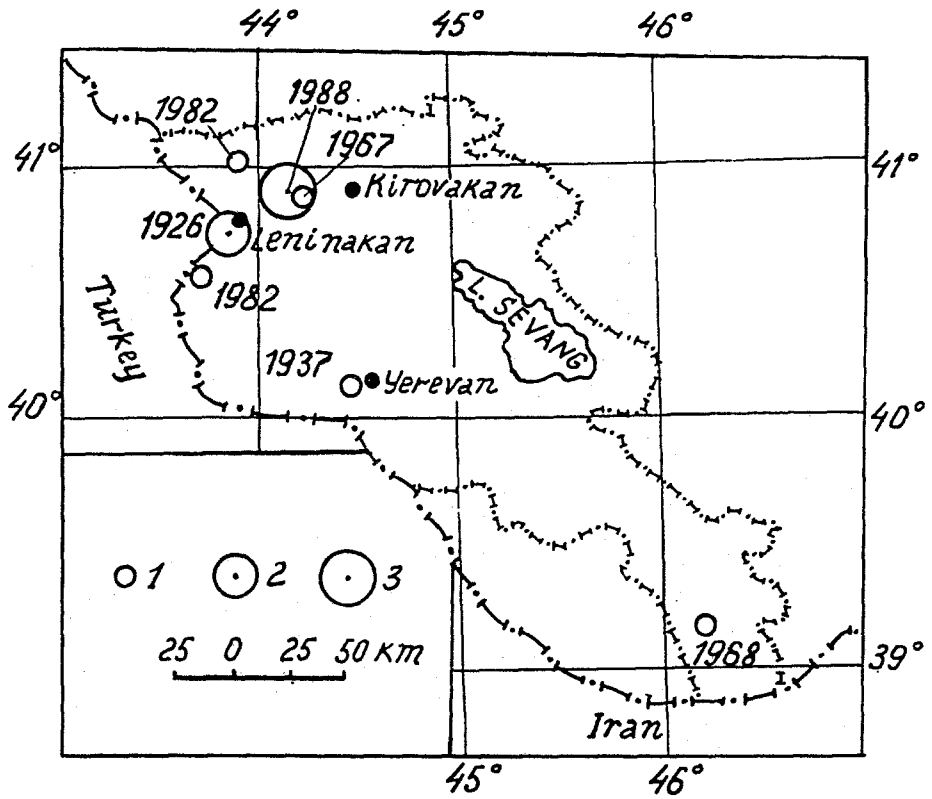

Fig. 1. Epicentres of earthquakes in the Armenian SSR territory which, as far is known, were preceded by abnormal animal behaviour. Earthquake magnitude: 1, 4–5; 2, 5.1–6; 3, 6.1–7.

2. Evidence on Abnormal Animal Behaviour before Previous Armenian Earthquakes

In spite of the great number of written records concerning large and catastrophic earthquakes in Armenia, beginning from at least the 8th century (Nikonov, 1989a, 1991), no evidence regarding premonitory animal behaviour has been found.

Abnormal animal behaviour associated with seismic events only became a subject of study during the later part of this century in Armenia, as well as in many other countries and regions. However, such observations were never conducted systematically. For this reason, the available evidence is fragmentary, usually obtained by accident, and far from standardized. Below, we quote some of the more definite observations (Figure 1).

Byus and Gigineishvili (1943) mention a case of unusual dog behaviour before the Leninakan earthquake of 22 October 1926. Three shocks were recorded following at intervals of 30 and 40 min, respectively. In the village of Agin, dogs began to bark before the first shock (I = III–IV) at the epicentral distance 7–20 km, while a few minutes before the second (I = VI) and third shocks (I = VII), they ran from the village into the fields. Dogs in the village of Koshevank (20 km from

the epicenter) began howling, with their noses pointing north, at the start of the last earthquake (I = VI–VII).

Noteworthy and reliable evidence was supplied in 1989 by a resident of Moscow, K. V. Larina. Her observations concern the behaviour of circus animals before the well-known Yerevan earthquake of 7 January 1937 whose epicenter was 20 km southwest of the city of Yerevan, where the intensity was VI. On a performance tour in the city, trained circus horses and dogs began to show signs of unrest. There were at least 10 horses and several dozen dogs, but no other animals. All the horses began neighing, hoofing, and trying to get away from their stalls, so that people were afraid to enter the stables. The dogs began howling in their cages. All this took place before the first shock and on the following day before the second (about three hours before), and continued until the actual shock and during it. Once the shock was over, the animals became quiet, but performances were cancelled as a result of the disturbance.

In January 1989, the author was told by an old resident of the village of Nalband that horses would not go into their stables for about an hour before the Spitak earthquake of 30 January 1967 (I = VI–VII). His dog howled about 10 min before the event, and hens and geese were restive and cackled 5 min before it. This resident of Nalband had not noticed any unusual animal behaviour either before or after that time.

There are reports from the Zangezur region concerning an unusual mass migration of snakes an hour or so before the Zangezur earthquake of 9 June 1968, I = VII–VIII (Nikonov, 1981).

Facts relating to abnormal animal behaviour before several moderate magnitude earthquakes in Armenia in the 1980s were specially collected by the biologist G. O. Ignatosyan. This material was obtained as a result of the questioning of local residents following seismic events (Ignatosyan, 1986). For example, prior to the Gukasyan earthquake of 17 January 1982 in northwestern Armenia, 18 h before the event, pigs were quite unusually restive (bumping into the walls, forcing their way of their sties, refusing to eat, and fighting among themselves). They carried on in this way until the shock occurred, and then quietened down. In contrast to this, sheep were in a state of depression, standing still for a few hours with their heads hung down (at a time when they should not have behaved so). A day or more before the shock, all cats disappeared from the district and only came back after the earthquake. There were changes in the behaviour of other animals too; horses, dogs, hens, geese, and others. Similar phenomena were remarked upon for the Isaakyan earthquake in October of the same year, but no such things ever took place during two other events.

To sum up, as far as we know, abnormal animal behaviour preceded at least six earthquakes, with magnitudes 4–6, intensity IV–V to VIII–IX, during the years 1926–1987 at different sites within the Armenian SSR (see Figure 1). This phenomenon was not properly studied at the time and, as a result, the evidence collected is only fragmentary. It is barely sufficient to establish the fact, that

abnormal animal behaviour did take place in zones of intensity V to VII, at epicentral distances of tens of kilometers, and with precursor times of one day to a few minutes.

When one compares these few retrospective data with similar evidence from other regions, both in this country and abroad (Nikonov, 1981), one readily finds similarities in the animal species involved in the signs of abnormal behaviour, as well as in the distribution over intensity.

3. Abnormal Animal Behaviour before the Spitak Earthquake of 7 December 1988

The main shock of the Spitak earthquake occurred on 7 December 1988 at 11:41:24 local time. It was determined as being located 7 km to the north of the town. Its magnitude was $M = 7(\pm 0.1)$, hypocentral depth was calculated at $h = 8$–13 km, and intensity $I_0 = \text{X}$ (MSK scale). The zone of intensity IX occupied an area of about 45×18 km extending WNW. This zone was dissected by a surface rupture of about 35 km in length with a similar orientation (Nikonov, 1989b).

Evidence of abnormal animal behavior was collected after the event by questioning local residents in the area hit by the earthquake (A. A. Nikonov), sending out special questionnaires (A. A. Nikonov and A. I. Farberov), and publication of a questionnaire in the *Komsomolskaya pravda* newspaper with the responses being specially examined (A. A. Nikonov and V. A. Alekseev).

We do not know for certain whether animals have shown any abnormal behaviour in the area at any other times which were unrelated to earthquakes. This information has not been systematically collected. When questioned, the local residents could merely recall a few isolated cases of abnormal animal behaviour before earthquakes, for example, before the 1967 earthquake in the same area. Judging by the fact that some shepherds mistook dogs howling before the 1988 earthquake as a signal of wolf attack, similar responses seem to have occurred before. Obviously, however, the local population had not observed such evidence of signs of abnormal behaviour of different animals before December 1988. It appears that cases had not been recorded on a similar scale in the area during the lifetime of these generations.

Although observations were made and reported by nonprofessionals and were rarely up to the standards of scientific information, most of the data are accurate. This conclusion rests on the exact and typical details in many reports, the coincidence of facts reported by different persons, even drawing attention to animal behaviour, and discussions with other people before the earthquake (for instance, a resident of Leninakan who was anxious about unusual animal behaviour, had telephoned the local radio station, the police, and the city council, trying to attract attention to this, and to warn about the impending danger, but unfortunately met with derisive remarks), etc. The information reported by breeders of guard dogs is significant.

Uncertain and doubtful cases have not been taken into account. More than 200 reports from over 50 sites were collected. Naturally enough, most came from large cities. No mass questioning and distribution of questionnaires in villages was made. The evidence collected was reliable enough to reflect a number of features in abnormal animal behaviour prior to this earthquake. It should be borne in mind that some reports were concerned with groups or populations of animals rather than with individuals (birds in cages, dogs in villages and frontier posts, fishes in aquariums, cows, horses, and pigs in pens), so that one deals here with thousands of individuals showing abnormal behaviour rather than with a few hundred.

It should be noted, however, that in several cases, some of which involved the epicentral area, the residents did not notice any changes in animal behaviour before the earthquake. Some owners of animals did not notice or did not care to state any abnormalities in animal behaviour before the event.

There is another important fact, namely, that observations of several animals in the same group (mostly guard dogs) did not reveal identical responses from all animals in a group. For instance, speaking about guard dogs, in some sites, out of a total five individuals (standard number) all showed some response, while at other sites, there were responses from 4 or 3 individuals, with the remainder of the dogs remaining quiet.

This fact, which is corroborated by observations at a number of sites along the state border, contradicts the hypothesis of some individuals being excited by others in the same group. On the contrary, one has to admit that a common cause of excitement affected some (but not all) individual animals that were apt to be more sensitive to excitation.

The most frequent and, hence, typical manifestations of behaviour considered to be abnormal, were the following signs for most animals from insects to mammals: increased motor activity, agitation (signs of fear), the urge to leave the usual place of habitation, and a refusal of food. Wild animals were not afraid of man, while domestic animals showed aggressive intentions. Different classes and species of animals naturally showed their own specific responses. For example, dogs most frequently howl or bark violently, horses hoof and struggle out of their stalls, birds flock together and fly away or throw themselves against the wire when caged, fishes dive to lie on the bottom or swim wildly about the aquarium, or even jump out of it, amphibia and reptiles wake up from hibernations (during winter).

Respondents noted that animals were frightened and fled during an earthquake, but it was in a different manner from what had been observed before the earthquake. For example, dogs were barking, but were not howling or growling as they did before the earthquake.

Among the animal species of recorded abnormal behaviour, dogs (36%) and cats (17%) prevail. There are many reports of birds (15%), rats and mice (9%), and an abundance of information on the behaviour of fishes kept in aquariums (15%) (Figure 2).

The distribution of these observations over the area is more or less uniform

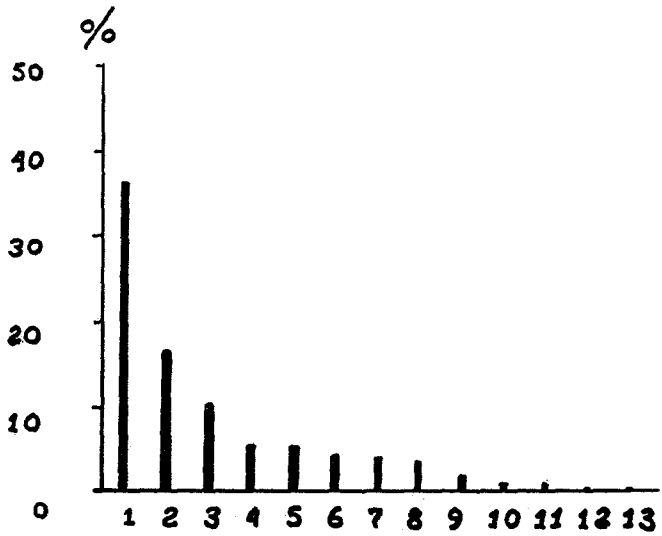

Fig. 2. Species of animals whose abnormal behaviour was recorded prior to the Spitak earthquake of 7 December 1988 (%, from all reports registered by the author). 1, dogs; 2, cats; 3, birds; 4, fishes; 5, rats; 6, mice; 7, cows; 8, horses; 9, pigs; 10, snakes; 11, insects; 12, tortoises; 13, worms.

(Figure 3). Most of the sites where the information was collected are situated in a wide strip along the Pambak River and in a north-south band to the west near the state border. This is due to the location of places of residence and data acquisition. About 30% of the reports came from the epicentral area (within 30 km of the epicenter). One can infer from the data that a stable character of the signals (positive reports of abnormal animal behaviour) is noted within about 100 km – to the southeast of Yerevan, Razdan, and Sevan, and to the north as far as the village of Akhalkalaki and Tbilisi.

Some isolated reports came from as far as 180 km away (Kirovabad) and even as far as 220 km (Ordzhonikidze). There are reports of abnormal behaviour of birds and rodents coming from North Caucacus and even from as far as the Don River (that is, 500–800 km), but the association of these phenomena with future earthquakes cannot be considered as reliably established. Thus, the premonitory abnormal behaviour of a variety of different animals was recorded, not only in the epicentral zone and zones of high intensity, but also where the intensity of shaking was VI or less, possibly even in such places where people did not notice the earthquake effects.

Unusual animal behaviour was recorded 2–3 days prior to the event at about 15 sites. The site furthest from the epicenter is situated 180 km from it. The largest precursor time of all was noted in the future epicentral zone itself where dogs began howling about one month (?) before the earthquake. This phenomenon was noted a week before the event at some sites in the epicentral zone (Figure 4). A few days and hours before the event, in an area within a radius of a few tens of kilometers from the future epicenter, manifestations of abnormal animal behaviour

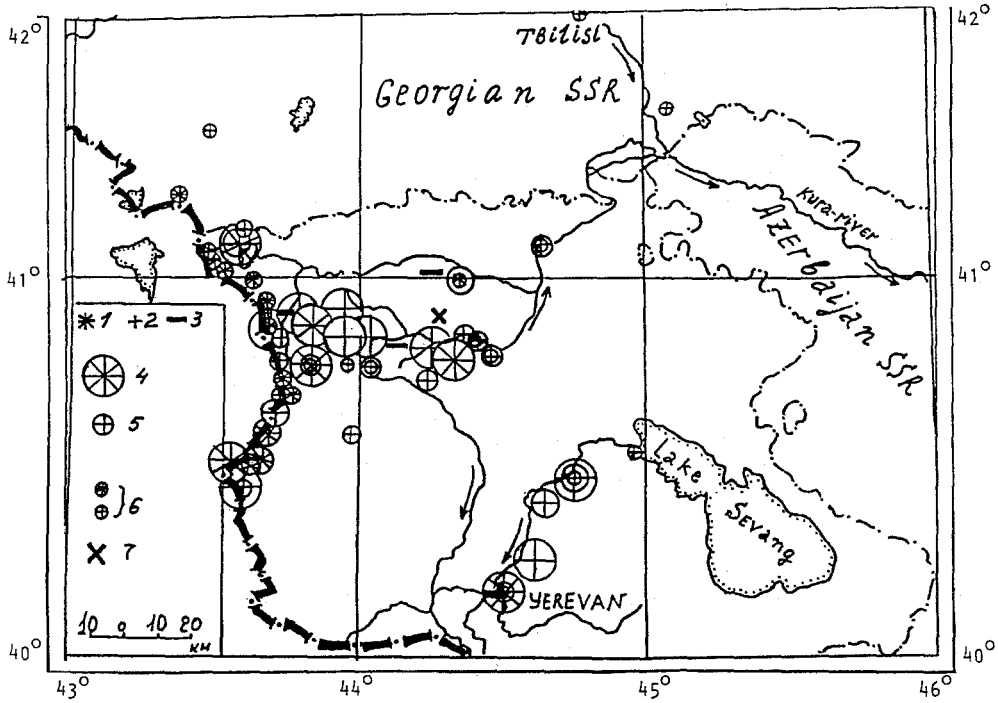

Fig. 3. Sites of recorded abnormal animal behaviour prior to the Spitak earthquake of 7 December 1988. 1–3 – number of reports at a site: 1, many; 2, several; 3, none. 4–6 – earliest recorded precursor time (hours): 4, 72–24; 5, 24–12; 6, 1.5–0.1. 7 – epicenter location.

became obvious and occurred on a mass scale. The same took place an hour or so before the earthquake. Exactly as previously in other cases, the number of anomalous signs for the Spitak earthquake, the number of individuals showing them, and the degree of response increased as the event approached. A few minutes before the shock, it could have been forecasted by any observer of animal behaviour, or even in fact, by any resident of northern Armenia with a knowledge of biological precursors (some indeed guessed correctly and admitted to the possibility of an earthquake).

There is a significant fact reported by A.Garibyan, a resident of Leninakan. His cat and dog were extremely restive beginning from the evening of 6 December. He went out to walk his dog at 7.30 in the morning of 7 December (more than 4 h before the earthquake). At that moment, his cat bolted out of the house and, paying no attention to the rats rushing about on the lawn, climbed a tree.

His dog refused to return home, and had to be dragged back, wildly resisting and biting its master.

At 9.45, it began frantically howling and barking, so that its master realised that something was very wrong here and so telephoned the city Police Department.

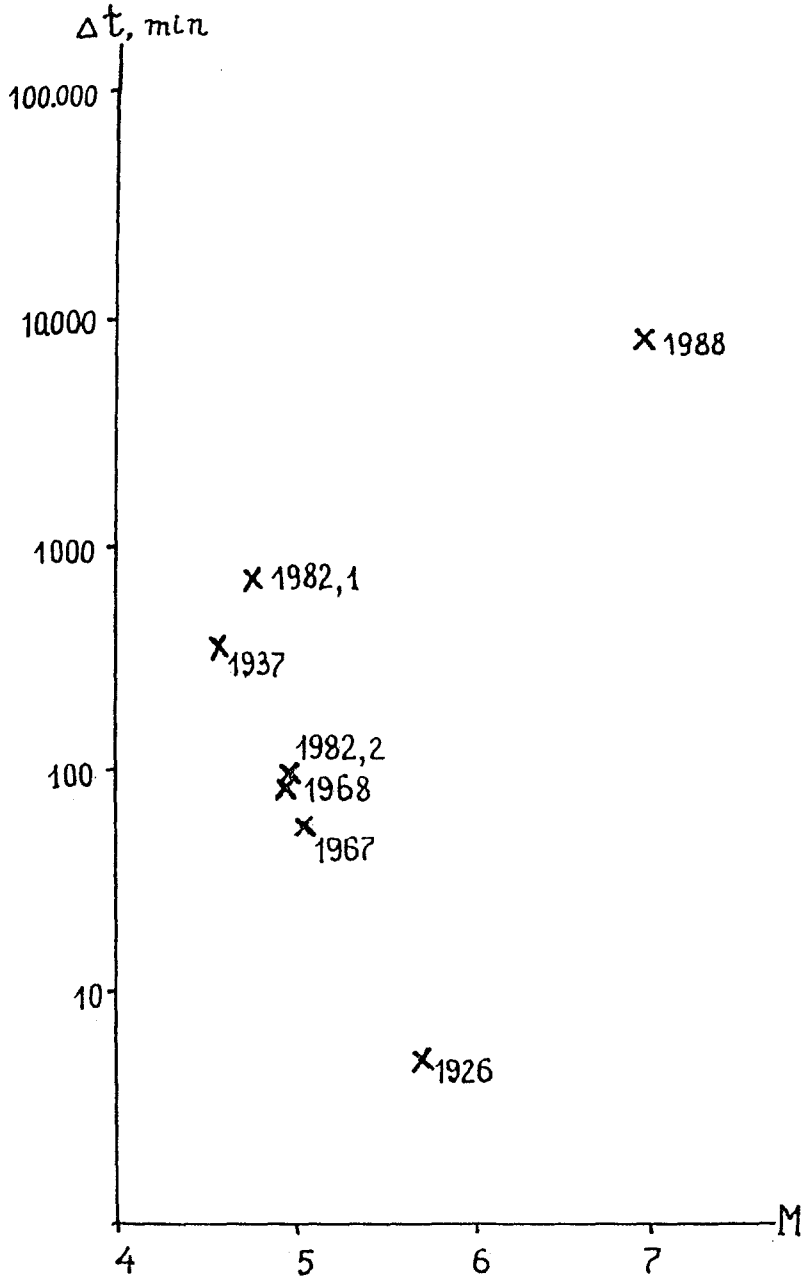

Fig. 4. Earthquake magnitude (M) versus earliest recorded precursor time based on abnormal animal behaviour (Δt, min) within the Armenian SSR territory.

After that, he telephoned the City Council and then the local radio station. Each time, he received a negative response.

At 10 h (1 h 40 min before the earthquake), Garibyan approached his neighbours and suggested that they should all leave their houses and discuss the situation outside, all the more so because there was a dog next door that was very restless.

They were still in the yard when the earthquake struck, so they were able to escape the worst of the quake and retreat to a nearby vacant lot.

We deliberately omit the problems of possible causes of abnormal animal behaviour before earthquakes, because this has been treated elsewhere (Evernden, 1977; Rikitake, 1978; Nikonov, 1981; Nikonov, Faidysh, 1982; Tributsch, 1982; Krasnogorskaya *et al.*, 1984). Regarding the 1988 Spitak earthquake, it should only be remarked that preseismic abnormal animal behaviour does not correlate with foreshocks, because there was a quiescence with just two foreshocks occurring the day before the event, with hydrometeorological conditions, nor with the gas emanations. There is also the important fact that response was shown by different animals which lived on the ground, underground, in the air, and in water. No information is available on abnormal animal behaviour before the two foreshocks of the Spitak earthquake of intensity IV or V during the day before the main event. On the other hand, local residents had repeatedly noticed abnormal behaviour in cats at the epicentral zone before aftershocks of intensities IV, V, and VI.

4. Conclusion

Even the evidence of abnormal animal behavior before the Spitak earthquake (and previous ones) which we have collected (certainly incomplete), can be regarded as sufficient to make a definite conclusion. The conclusion is as follows: abnormal animal behaviour before the Spitak earthquake was so obvious and occurred on so large a scale that it would have been impossible to miss the precursors of the impending event had the population been told about the precursor or had the specialists turned their attention to the extensive region of western Trans-Caucasus. That conclusion is strengthened by the fact that other prognostic signs were recorded in the future epicentral area. These signs included changes in the water table of boreholes (unusual for that season), the bursting water pipes in Spitak, and two perceptible foreshocks in the area a day before the main event.

It is important to emphasize that all the evidence relating to abnormal animal behaviour before the Spitak earthquake, is no different from that mentioned for other earthquakes in other seismic regions (Evernden, 1977; Rikitake, 1978; Shen Ling-Huang, 1978; Nikonov, 1981). This not only concerns signs of unusual behaviour in different animal species themselves, but also their distribution in time and space, as well as the fact that some animals showed no response at all. This is more proof that we are dealing with a phenomenon that has not been properly studied concerning its causal connections, but is, nevertheless, quite real.

The following conclusion suggests itself: the deliberate and able monitoring of

abnormal animal behaviour in all seismic regions, in particular within areas where a long-term prediction of future events has been made, can and ought to become a real element of the earthquake prediction system.

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