NOTE ON THE EFFECTS PRODUCED BY EARTHQUAKES UPON THE LOWER ANIMALS.

By John Milne.

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From the description of all great earthquakes we learn that dogs, horses, cattle, and other domestic animals, at the time of these disturbances, have shared the consternation of their masters.

Even with comparatively small disturbances the lower animals often exhibit signs of uneasiness. In a description of the London earthquake of 1749, it is said that roach were observed to leap in a canal, whilst fish in general seemed to be in great confusion and much afrighted. (*Gentleman's Magazine*, No. XXIII., p. 220.) Now and then it has been observed that after an earthquake fish have risen to the surface of the water either dead or dying.

In the Tokio earthquake of 1880 a gentleman observed that a cat which was in his bed room exhibited strong feelings of distress, running backwards and forwards before the door, which was closed, evidently wishing to escape. The foxes outside barked and the horses kicked down some of the boards which confined them in their stable. Records like these, which might be multiplied, show that at the time of an earthquake the lower animals are sensible to the fact that something unusual is taking place, from which they are evidently desirous to escape.

The most interesting observations are those when animals have shown signs of agitation before an earthquake. My

friend, Mr. James Bissett, of Yokohama, writes me that *30 seconds* before the first shock on the 15th of last January, one of his ponies suddenly got up on its feet and pranced about in the stall, evidently terrified at the coming shake. A similar observation was made about a pony in Tokyo.

A few seconds before an earthquake, I have often had the opportunity of confirming the fact that pheasants scream. The frogs, which by their croaking disturb the stillness of the summer nights, I am assured by several observers, suddenly cease their vociferation before an earthquake. The Japanese assert that moles show their agitation by burrowing.

Hamilton states that geese are painfully aware of a coming shock by quitting the water, or by their cackling. Geese, swine, and dogs are said to show clearer signs than other animals of an approaching earthquake. After the Calabrian earthquake it is said that the neighing of a horse, the braying of an ass, or the cackle of a goose, was sufficient to cause the inhabitants to fly from their houses in the expectation of a shock. Many birds, before an earthquake, are stated to show uneasiness, hiding their heads beneath their wings and behaving in an unusual manner.

At the time of the Calabrian shock little fish like sand eels (cirricelli), which are usually buried in the sand, came to the top and were caught in multitudes. (See *Report of British Association*, 1850, p. 68.)

It is stated by H. D. Warner,* in an article entitled "The City of Earthquakes" (*Atlantic Monthly*, March, 1883), that the natives in Caraccas possess oracular quadrupeds such as dogs, cats, and jerboas, which anticipate coming dangers by their restlessness. Before the earthquake of 1812, at Caraccas, a stallion broke out from its stable and escaped to the highlands, which was regarded as the result of the prescience of a coming catastrophe. Before the Chilian earthquakes of 1822

* Some of Mr. Warners' statements have been severely criticized in the pages of *Nature*.

and 1835 immense flocks of sea birds flew inland, as if they had been alarmed by the commencement of some sub-oceanic disturbance, and before the last shock it is related that all the dogs escaped from the City of Talcahuano.

That the lower animals show signs of alarm at the time of a severe shaking is an observation hardly requiring explanation. If, on the contrary, it had been observed that they did not exhibit feelings of uneasiness an explanation might be necessary. The observations which do require an explanation are those where animals have shown a strange behaviour a short time *before* an earthquake, which so far as I can learn is usually 10 or 30 seconds in advance of the actual shaking.

The only explanation which I can offer for this phenomenon is that such animals are sensitive to small tremors which precede nearly all large earthquakes. Diagrams of earthquake motion showing these preliminary tremors, which have an amplitude of less than $\frac{1}{10}$ of a millimeter and are performed at the rate of six per second, have been published in the Transactions of this Society. If we were living on a hard, rocky formation the amplitude of these movements might be less and their frequency increased. If we are standing up, or down-stairs, or out of doors, we do not feel them, but if we are upstairs, sitting down, and all is quiet, they may occasionally be recognized. I have felt them, taken out my watch and noted the time 10 or 15 seconds before the actual earthquake came. On one occasion two of my friends, seated in an upstairs room, noticed them, while I myself, standing, endeavoured to detect them but failed. The problem before us may therefore be explained upon the assumption that certain of the lower animals are sensitive to small motions which we pass by unnoticed.

The alarm of intelligent animals like dogs and horses may be the result of their own experience, which has taught them that small tremors are premonitory of movements more alarming.

With pheasants, frogs, and geese, which latter animals have exhibited sensitiveness to anything unusual since the time they saved the Capitol, the alarm may be due solely to the tremors.

Cases where animals have exhibited strange behaviour several hours or days before an earthquake are probably accidental occurrences. In volcanic districts it has sometimes happened that before an earthquake certain gases have emanated from the earth, and where this has occurred the smaller animals have not only been alarmed but sometimes killed.

Occurrences like these are, however, extremely rare. Rossi mentions an instance where quantities of fish were killed by a gas eruption in the Tiber. On the morning of April 6th, 1874, at Follonica, the streets and roads were covered with dead rats and mice, in fact it seemed as if it had rained rats. The only explanation for the phenomena was that these animals had been destroyed by emanations of carbon diodide.

Discussion.

In the discussion which followed, Dr. C. G. Knott suggested as a reason why we do not feel slight tremors when standing, is that the points of contact with the earth are limited to our feet, and even these are more or less isolated by our boots, &c. Dr. Harrel gave an instance of a pony now in Tokio, showing symptoms of alarm at the time of a shaking. Professor Sekiya, who had kept pheasants to study their behaviour at the time of an earthquake, said that they had not yielded any definite results, inasmuch as they often screamed when there was no earthquake. Dr. Divers referred to a cockatoo in his possession which invariably screeched at the time of an earthquake.