Radioactivity of snake venom

SIR — A considerable part of the former Soviet Union is contaminated with various radioactive isotopes because of planned release of radioactive waste from nuclear fuel plants, accidents at atomic power stations, surface and underground nuclear explosions, and so on. Information about such contamination was kept secret, so people did not (and often still do not) know that they are living on contaminated territories.

To our knowledge, the collection of snake venom from natural populations is significantly increasing in the former Soviet Union. The only venomous snake that is widespread in the main part of the European zone, the Urals and Siberia, is the viper (*Vipera berus*). Its venom is usually collected using primitive methods and is delivered to foreign consumers through a chain of agents with no state control. But because of the environmental contamination, it is highly likely that the snake venom is contaminated with radioactivity.

There are small amounts of Co^{2+} in *V. berus* venom[1]. The high Ca^{2+} content in venoms of all studied species of snakes[2], and the similarity of Ca^{2+} and Sr^{2+} ions in metabolic reactions, are well known. Reptiles are able efficiently to retain Sr^{2+} from the environment: the accumulation coefficient measured using ^{90}Sr is as high as 150 for reptiles (compared with 20–50 for birds, and about 10 for mammals)[3] with respect to soil. Thus, ^{90}Sr seems to be a likely contaminant of snake venoms.

It is simple to measure ^{137}Cs, ^{90}Sr and ^{60}Co isotopes in venom as it is necessary only to count the radioactivity of dry venom samples. Because venom contains K^+ ions, the natural ^{40}K isotope will contribute to the total radioactivity, but differential quantification of ^{40}K, ^{60}Co, ^{90}Sr and ^{137}Cs isotopes is possible because of their different radiation spectra. Less than 10^{-11} Ci of each isotope can be detected using a routine radioactivity counting procedure. Because the Co^{2+} concentration in *V. berus* venom exceeds 3 μg per g of dry venom, the detection threshold for ^{60}Co in venom corresponds to a specific radioactivity below 10^{-4} Ci mol^{-1}. The concentration of unbound Co^{2+} in the environment is usually small, its concentration in dry venoms being about three orders of magnitude higher than in the waters of snake habitats.

The lack of data on the presence of Sr^{2+} in the venom hinders similar calculation for ^{90}Sr. However, given the high levels of ^{90}Sr contamination mentioned above, this isotope could well be present in venoms. Similarly, ^{137}Cs usually dominates in radioactive outbursts, and is found in almost all organisms living in contaminated areas.

Since migration of *V. berus* individuals is restricted (V. Ragozin, personal communication), the overall contamination of an area can in principle be estimated with a high sensitivity by measuring the radioactivity of snake venom. But financial support for ecological programmes in the former republics of the Soviet Union has decreased due to the general economic crisis, and our research to detect environmental pollution using venom analysis is no exception.

These considerations prompt us to ask people in the West receiving samples of snake venoms to measure their radioactivity and make the results available with appropriate additional information (territory, date of venom collection, and so on). These results will be of great value for people living on contaminated territories and for ecological monitoring. The information could also be important for saving natural *V. berus* populations.

(After this manuscript had been prepared, we learnt that a large (2 kg) consignment of snake venom from Russia was impounded by customs officials because of its high radioactivity.)

Andrey A. Nedospasov
Institute of Molecular Genetics, Russian Academy of Sciences, Moscow 123182, Russia
Alexandr V. Cherkasov
Russian Research Centre, "Kurchatov Institute", Moscow 123182, Russia

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Fluctuating asymmetry measurement

SIR — There is much interest in the use of fluctuating asymmetry as an indicator of selective pressures on an ornamental character[1–4]. In particular, it has been suggested that the degree of symmetry of a character, if it is paired, can indicate male quality as well as its overall length, and if this is so a negative relationship between overall length and degree of fluctuating asymmetry of a character would be seen across individuals. We would like to draw attention to two statistical problems in the measurement of fluctuating asymmetry that could produce some of the results published.

The first point concerns the use of 'relative fluctuating asymmetry'. This index, calculated as the absolute difference in the lengths of paired characters divided by the mean length of the character, is regressed against mean character length. But in the examples above, the same measurement, mean character length, occurs as a component of both the dependent and independent variables, which can lead to spurious correlations[5]. The results of regressions of relative asymmetry against mean character length are meaningless. To give one example, relative asymmetry can lead to significant negative correlations purely from measurement error. Take the hypothetical example of a paired character in which the two elements are always equal in length. A small but consistent measurement error assigned (presence or absence) at random to each of the characters can produce a significant negative relationship between relative fluctuating asymmetry and length even when there is no real difference in length. For purely statistical reasons relative asymmetry should not be used in analysing the relationship between character length and asymmetry. (An assessment of asymmetry can be made from absolute measurements.)

Our second point concerns the use of absolute asymmetry, which we illustrate with data on spur length of the ring-neck pheasant *Phasianus colchicus*. Differences in character length may be due to growth rate, injury or damage, shortening the length of one of a pair of characters. This may bias the results of a regression of absolute asymmetry against character length depending on which measure of character length is used as the independent variable, particularly in the case of injury or damage where the difference in character lengths can be large.

We have data on left and right tarsal spur length of 233 male ring-neck pheasants from five estates in southern England where pheasants were bred in captivity and released to supplement wild stocks for hunting. Data were collected from birds shot during December and January 1990, aged one year or older. We ran regressions of the absolute difference in spur length against two different measures of character length (mean length of the paired character or the length of the longest character), controlling for age in each case. Age is used as a control variable here because absolute asymmetry covaries with age (absolute asymmetry (mm): first-year birds, $n=188$, $x=0.56\pm$ 0.05 (s.e.m.): 2+ year-old birds, $n=45$, $x=1.51 \pm 0.23$; *t*-test $P<0.001$).

When mean spur length was used as the independent variable we found a significant negative relationship (standardized regression coefficient −0.18,