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Genetics and the tiger trail

Genetics is now helping save endangered species, says S.Ananthanarayanan.

Genetics has entered all areas of modern life – bio-engineered food is commonplace, livestock breeding has become more aggressive with genetic intervention, medical science is revolutionized and then in forensic science, DNA fingerprinting, for identification and crime detection, is a daily occurrence.

The ***Wildlife Conservation Society***, New York, has just reported a study published in the journal ***Biological Conservation***, which describes a role that genetic methods can play in helping conserve the endangered Indian tiger. Samrat Mondol, K. Ullas Karanth, N. Samba Kumar, Arjun M. Gopalaswamy, Anish Andheria and Uma Ramakrishnan, all working in the National Centre for Biological Science or the Wildlife Conservation Society and Centre for Wildlife Studies, both in Bangalore, have developed a DNA based tiger identification technique which enables sensitive and error free tracking of tiger populations, to monitor and tailor conservation strategies.

DNA fingerprint

If fingerprints are unique to identify a person, her genetic makeup, as recorded in the million-fold variables of DNA is surely unique over millennia. DNA is a microscopic but giant, thread-like molecule found in the nucleus of cells and whose structure determines how the cell will behave. The DNA thread is a long sequence of units, each of which is a template for the production of one of twenty amino acids, the building blocks of proteins. Sequences of such units specify separate proteins, which then act as communication between cells, the activity of one group of cells setting off the activity of another group, and so on. As there are millions of activities to be monitored in a living thing, the DNA is naturally millions of units long.

The remarkable thing about DNA is that it also has an efficient way to clone or create an image of itself – which happens when a cell has to divide. The DNA first splits into two complementary halves and the cell separates, with one half of the DNA in each part. The half DNA rapidly completes itself from the material of the divided cell and each half becomes a complete cell. In the case of sexual reproduction, as happens with animals, special male and female cells, each with only a half DNA, combine to form the new individual, with a mix of the DNA components of both parents.

It is in this process of the combination of millions of units of DNA of the parents that some variations must occur, and statistically, it is impossible that any two persons have the same final genetic make-up. In broad areas, of course the DNA would be similar, which accounts for racial and family resemblance, but in the details, there are always differences, even in identical twins.

Laboratory methods are now available to identify and map parameters of DNA, rather like a fingerprint expert records the slant and width of whorls and loops in a human fingerprint, to enable comparison. DNA can hence be analysed, often entirely by automation, and compared, using computers, to say in a short time whether a pair of DNA differ or are similar. The ability has become important in crime detection, specifically in saying whether a given person has left her own DNA traces at the site of a crime, or even in demographic research, like tracing the wanderings of the Roman army by polling for Latin DNA features in European populations.

Counting tigers

Keeping count is an important part of managing anything. Science and engineering are centred around exact measurements and economists and governments depend on statistics – of resources, producers, consumers. Idealistic schemes to withdraw customs and excise departments result in loss of more than tax revenue – they block the data about movement and production that these departments collect!

But while collecting data of human activity is routinely implemented, collecting data about wildlife is challenging. To know the population of fish in the sea, to get data about migratory birds, we need to use methods of sampling and statistical analysis. One method of estimating the numbers of fish, for instance is to mark a fixed number of fish and to send them back, to mingle with unmarked fish. When a sample is later snared, the number of marked fish that appear would provide an idea of how many fish there are in all.

While dyes and chemicals have been ways of marking fish, in the case of estimating how many protected whales had been killed, DNA fingerprinting of individual whales, and later watching for their meat to show up in the market was used. With fish and whales, and even with birds, which can be captured, such methods are feasible. But in the case of tiger populations, which the Wildlife Conservation Society has been monitoring these last 15 years in India, it is not practical to trap and stain tigers or to employ most other usual population estimating methods.

Using poop

DNA fingerprinting was used, it is true, by firing sedating darts at tigers and collecting blood or tissue samples, but the method was cumbersome and hence not effective. The Bangalore scientists have now developed a technique of getting the DNA data from tiger droppings. This method is not only 'non-invasive' but is eminently practical and amenable to large scale application by personnel with very simple training.

Once tiger DNA are catalogued, it is at least as effective as those tigers being 'marked' and their movement or their presence, among others not so 'marked', can be tracked by regularly collecting samples of tiger dropping everywhere in the forest.

The 'gold standard' for estimating tiger populations is the 'camera trapping', where individual tigers are photographed and identified by their unique stripe patterns. This is the rough equivalent of actual fingerprinting, but is clearly impractical where the tiger densities are low or the terrain is rugged. The study of estimation by droppings was conducted with collecting 58 samples in the Bandipur forest in Karnataka, and was validated against actual camera trapping estimation. Camera trapping is possible in Bandipur as the populations are in good numbers. The result of the study was that estimations from the DNA data found in droppings was accurate and reliable.

"We see genetic sampling as a valuable additional tool for estimating tiger abundance in places like the Russian Far East, Sunderban mangrove swamps and dense rainforests of Southeast Asia where camera trapping might be impractical due to various environmental and logistical constraints," said noted tiger scientist Dr. Ullas Karanth of the Wildlife Conservation Society.

"This study is a breakthrough in the science of counting tiger numbers, which is a key yardstick for measuring conservation success," he adds. "The technique will allow researchers to establish baseline numbers on tiger populations in places where they have never been able to accurately count them before."

Collecting tiger scat for DNA analysis