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## Keynote Forum





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**Rabies control in Mexico, new challenges: skunk species as an example**

**Background:** In Mexico, recently emergent potential reservoirs for rabies virus (RABV) have been identified, such as white-nosed coatis (*Nasua narica*) and the non-previously described as rabies reservoir the skunk *Mephitis macroura*. Since 2000 to 2023, there have been six cases of human rabies transmitted by skunks. The presence of eight species of skunks is described, but the correct identification of these species has been a limitation to associate them with specific antigenic variants (V) and RABV lineages.

**Methods:** A total of positive skunk samples (n=31) were diagnosed in the Rabies Laboratory of the Instituto de Diagnóstico y Referencia Epidemiológicos (InDRE) and antigenic variants detected: V10 (South Baja California skunk), V8 (south central skunk), V1 (northern skunk), and Yucatan Sylvatic (Figure 1). Results: V10 is restricted to the state of SBC, while V1, from the terrestrial cycle, has subsequently settled in wild populations, whereas V8, of bat origin. Yucatan Sylvatic variant has been described in skunks, domestic cats, and dogs. Although skunks have been found to be a species with the potential to successfully maintain and transmit RABV, there is a lack of knowledge about the identity of the reservoir species in the country. The literature describes *Spilogale putorius* as the main RABV reservoir skunk species in Mexico, but the distribution of the species in the territory makes it unlikely. It must be some other species with a wider distribution in the country, as happened in the state of Nuevo Leon, where the main reservoir was believed to be *Mephitis mephitis* but *Mephitis macroura* was recently described.

**Conclusions:** Correct taxonomic/molecular identification of the skunk species will be essential in understanding the dynamics of the RABV in skunk populations and the distribution of variants by region and host. Yucatan sylvatic variant and northern skunk V1 share a canine origin that make them prone to return to dogs, where the disease can easily become enzootic again. Therefore, vaccination campaigns must continue to avoid the reintroduction from skunks to non-vaccinated dogs. The establishment of adequate control measures requires knowledge of the biological features of the emerging reservoir species of RABV in Mexico.



Figure 1. Rabies virus antigenic variants detected in skunks in Mexico from 2000-2022

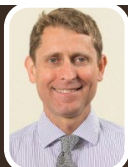
**Recent Publications:**

1. Puebla-Rodríguez, P., Almazán-Marín, C., Garcés-Ayala, F., Rendón-Franco, E., Chávez-López, S., Gómez-Sierra, M., Sandoval-Borja, A, Martínez-Solís, D., Escamilla-Ríos, B., Sauri-González, I., Alonzo-Góngora, A., López-Martínez, I. and Aréchiga-Ceballos, N. Rabies virus in white-nosed coatis (*Nasua narica*) in Mexico: What do we know so far?. *Frontiers in Veterinary Sciences*. 2023.
2. Aréchiga Ceballos N, Puebla Rodríguez P, Aguilar Setién A. The New Face of Human Rabies in Mexico, What's Next After Eradicating Rabies in Dogs. *Vector-Borne and Zoonotic Diseases*. 2022 22(2).69-75. <http://doi.org/10.1089/vbz.2021.0051>
3. Aguilar-Setién A, Aréchiga-Ceballos N, Balsamo Gary A, Behrman Amy J, Frank Hannah K, Fujimoto Gary R, Gilman Duane E, Warner Hudson III T, Jones Shelley M, Ochoa Carrera Luis A, Powell Gregory L, Smith Carrie A, Triantis Van Sickle J, and Vleck Susan E. Biosafety Practices When Working with Bats: A Guide to Field Research Considerations. *Applied Biosafety*. 2022, (27) 3: 169-190. doi: 10.1089/apb.2022.0019.
4. Garcés-Ayala F, Aguilar-Setién Á, Almazán-Marín C, Cuautle-Zavala C, Chávez-López S, Martínez-Solís D, Gómez-Sierra M, Sandoval-Borja A, Escamilla-Ríos B, López-Martínez I, Aréchiga-Ceballos N. Rabies Virus Variants Detected from Cougar (*Puma concolor*) in Mexico 2000–2021. *Pathogens*. 2022, 11(2):265. <https://doi.org/10.3390/pathogens11020265>
5. Jaramillo-Reyna E, Almazán-Marín C, de la O-Cavazos ME, Valdéz-Leal R, Bañuelos-Álvarez AH, Zúñiga-Ramos MA, Melo-Munguía M, Gómez-Sierra M, Sandoval-Borja A, Chávez-López S, Díaz-Quiñonez JA, Aréchiga-Ceballos N. Rabies virus variants identified in Nuevo Leon State, Mexico, from 2008 to 2015. *JAVMA*. 2020, 256 (4). 438-443. doi: 10.2460/javma.256.4.438. PMID: 31999515

**Biography**

Nidia Aréchiga-Ceballos holds a degree in Biology from the School of Sciences at the Universidad Nacional Autónoma de México. She completed her Master's degree and PhD. in Biochemical Sciences at the Escuela Nacional de Ciencias Biológicas of the Instituto Politécnico Nacional. She has been a guest researcher at different institutions, including Texas A&M University in College Station, Texas; the Pasteur Institute in Paris, France; and the Division of High-Consequence Pathogens and Pathology, in the Poxvirus and Rabies Branch of the US Centers for Disease Control and Prevention, in Atlanta, Georgia. She completed a post-doc at the Unit for Viral Isolation and Detection of the National Center for Microbiology at the Instituto de Salud Carlos III in Madrid, Spain. In 2012, she won Mexico's national prize for Scientific Journalism and Outreach. She belongs to the Mexican Network of Virology and the Latin American Society for Vector Ecology. She is currently technical support at the Diagnosis and Reference Direction of the Mexican Reference Laboratory InDRE, where formerly she was the Chief of the Rabies Laboratory and coordinated the National Network of Public Health Laboratories for Rabies Diagnosis. Her research is focused on viral diseases in wildlife, particularly in bats and procyonids.

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### Should dogs and cats go vegan?

The environmental impacts of meat-based pet food (e.g., land and water use, fossil fuel consumption, greenhouse gas production, pesticide and fertilizer use, and impacts on biodiversity loss), are globally significant. Given increasing pet ownership globally, 'food' animal use for pet food is rising. However, alternative pet foods based on novel protein sources, such as plants and seaweed, insects, yeast, fungi and laboratory grown meat, are rapidly developing. Vegan pet foods are most developed. These use plant, mineral and synthetic sources to supply necessary nutrients. In 2020 I surveyed 4,060 dog or cat guardians to investigate determinants of pet food purchasing decisions, as well as health, behavioural and other outcomes using different diets. I also surveyed 29 pet food manufacturers to determine whether nutritional soundness and quality control of plant-based pet foods differed from meat-based diets. Results from these and other studies indicate that the healthiest and least hazardous pet foods are nutritionally sound vegan diets. Detailed analysis of feeding behaviour indicates dogs and cats generally find such diets as palatable as conventional diets. And manufacturers of plant-based pet foods appear to adhere to quality control standards at least as good as those used in the creation of conventional diets. The environmental and animal welfare benefits of plant-based and alternative diets are profound. These factors are driving a rapid expansion of this sector.

#### Recent Publications:

1. Knight A, Huang E, Rai N, Brown H (2022). Vegan versus meat-based dog food: Guardian-reported indicators of health. PLoS ONE 17(4): e0265662. <https://doi.org/10.1371/journal.pone.0265662>.
2. Knight A and Satchell L, (2021). Vegan versus meat-based pet foods: owner-reported palatability behaviours and implications for canine and feline welfare. PLoS ONE 16(6): e0253292. <https://doi.org/10.1371/journal.pone.0253292>.
3. Knight A and Light N. (2021). The nutritional soundness of meat-based and plant-based pet foods. Revista Electronica De Veterinaria 22(1), 1 – 21. <http://veterinaria.org/index.php/REDVET/article/view/92>.

#### Biography

Andrew Knight was Founding Director of the University of Winchester Centre for Animal Welfare, and is Adjunct Professor in the School of Environment and Science at Griffith University, Queensland. An experienced cat and dog veterinarian, he's also a UK, European and American Veterinary Specialist in animal welfare. He has around 150 academic and 80 popular publications, and an extensive series of social media videos and several websites (including [www.sustainablepetfood.info](http://www.sustainablepetfood.info)), on vegan companion animal diets, climate change and the livestock sector, invasive animal research, educational animal use, humane clinical and surgical skills training, and other animal welfare issues. He regularly works with animal welfare charities to advocate for animals, and is frequently interviewed by the media. He has received over 20 awards and research grants for this work.

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