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Deer and global warming

FJ Pérez-Barbería considers methane emissions by wild ruminants

Red deer are one of the 250 worldwide ungulate species. Ungulates are the link between producers and consumers in the trophic chain; key taxa in the evolution and development of humans, (i) as a hunting resource and promoters of human brain evolution through fabrication of hunting arms and clothing; (ii) as source of protein, milk, fibre, and work tools during the Neolithic revolution and in the present; (iii) as facilitators of human gene flow as a means of long distance transport; (iv) more recently their role as landscape and biodiversity engineers has been recognised, due to their impact on vegetation through grazing and browsing and on soils through nutrients mobilization, trampling and drainage; and (v) as promoters of rural economy through hunting ecotourism. But these species, specially ruminants, are also important actors in climate change through their emision of methane (CH^4), a key component of greenhouse gases and global warming.

Methane is a potent greenhouse gas[1] because of its higher global-warming potential (ca. 21 times) and shorter atmospheric lifespan (1/5–1/20) than

carbon dioxide, which makes methane reduction strategies an effective short term means of slowing global warming.[2] Methane emissions by human activities have more than doubled since the 1700s, and they contribute to global warming. One of the sources of CH^4 is produced by incomplete oxidation of feed in the gut of ruminants.[3] Domestic ruminants produce most of thae emissions from animal sources (85 Tg/yr) and it has been suggested that about one third of methane emissions worldwide come from ruminants' enteric fermentation,[1] but emissions by wild ruminants have been poorly estimated. Methane emissions by ruminants might play a significant role in global warming. For example, it has been suggested that about 13,400 years ago, herbivore megafauna released 9.6 Tg yr-1 of methane to the atmosphere, and the massive extinction event of America's megafauna 11,500 years ago could have been responsible for 12.5 to 100% of the overall methane decline recorded at that period,[4] although this has been questioned by Brook and Severinghaus.[5]

With the aim of assessing the contribution of wild rumimants to global methane emissions Dr. Pérez-Barbería[6] modeled the relationship between CH^4 and body mass in ruminants using 503 published experiments and new data from sheep and red deer in respirometry chambers, and the effects of different sources of variation, such as type of diet, content of fibre in the feed, daily intake and differences between species and between the techniques used to measure methane emissions in each experiment. He also used these models to produce global estimates of CH^4 emissions from wild ruminants (Figure 1, below). The study was published in the journal Science of the Total Environment.

To accomplish these aims he created a database on methane emissions from ruminants and pseudo-ruminants fed pure or mixed diets that only contained herbage, and no supplements as dietary components, by a comprehensive literature review. There were records of methane emissions for eight species: sheep, *Ovis aries*; cattle, *Bos taurus*; llama, *Lama glama*; alpaca, *Vicugna pacos*; red deer, *Cervus elaphus*; goat, *Capra aegagrus*; water buffalo, *Bubalus bubalis*; yak, *Bos grunniens*.

To estimate CH^4 global emissions he created a comprehensive database of the population sizes, body mass, estimated intake, and feed digestibility of 195 species by sex of wild ruminants across the world.

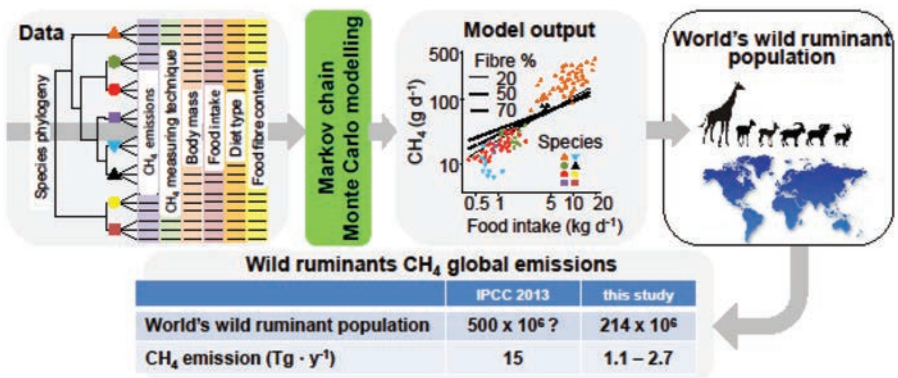

Figure 1.

Graphical summary of the methodology used to estimate global emissions by wild ruminants. Published in *Science of the Total Environment*.[6]


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As a pragmatic compromise he estimated methane emissions in wild ruminants assuming all individuals at adult body mass and maintenance food intake in the wild. The study fitted a number of regression models on methane emissions. The simplest model only included body mass against methane emission while successive models incorporated the other sources of variation described above. The models were fitted using complex statistics based on Markov chain Monte Carlo techniques.

The study found that the simplest model produced a linear relationship between body mass and methane emissions. This means that per unit of body mass, as body mass increases methane emission increases at a constant rate. This would suggest that methane production might be mainly a factor of gut capacity, as wet gut contents scale linearly with body mass.[7] However, when models incorporated the variation due to animal species, type of diet and technique of measuring methane, the relationship could be either linear or similar to the relationship between body mass and metabolic requirements.

Another interesting finding was that models which included feed intake and dietary fibre indicated that (i) although both increase CH^4, dietary fibre depresses CH^4 as the levels of intake increases, and (ii) there was significant positive effect of body mass in methane emissions, which suggested that larger ruminants produce greater amounts of methane emissions than smaller ruminants per unit of feed intake and for diets with similar content of fibre.

In relation to differences between species and after taking into account body mass, cattle produce more CH^4 per unit of feed intake than red deer, sheep or goats, and there are no significant differences between CH^4 emissions produced by red deer and sheep. It remains unclear how some species can produce more methane than others after controlling for their body mass and what and how much they eat, but it could be possible that the gut of some species provides a more favorable environment for methanogens (i.e. methane bacteria producers), mainly Archae.

When the parameters of the statistical models were applied to the estimated world population of wild ruminants, the average estimates of methane global emissions were between 1.1 – 2.7 Tg/yr. Surprisingly, these estimates were smaller than the 15 Tg per year figure presented in the reports of the Intergovernmental Panel on Climate Change (IPCC) (1 Chapter 6, Table 6.8). The study tried to find out the causes of such a big difference and the author found some problems in the data provided by the ICPP. Ruminant world population used in the IPCC report was bigger (500 million) that the population estimated in Pérez-Barbería[6] (average = 214 million, range = 210 – 219) and it remains obscure how 500 million were estimated. Not taking into account species variability in the IPCC report was another issue, the use of methane output from cattle, a high methane producer, as representative methane output of wild ruminants, might also contribute to higher global emissions.

The study concludes that inventories on methane emissions by wild ungulates should take into account the effects of diet, feed intake and animal species variability, but the main limitation researchers face in calculating accurate global CH^4 emissions from wild ungulates is a lack of reliable information on their population sizes. Despite these difficulties, when estimating CH^4 emissions at global scale, the models presented by Pérez-Barbería[6] are invaluable in assessing methane emissions from ruminant species fed herbage diets, accounting for species, body mass and dietary fibre, when their population sizes are known, which is possible for many deer populations. These models can be very useful in red deer management to assess the methane emissions by local populations.

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