

## Brazil: What country is this?

The question in the title of this editorial is the name of a song played by “Legião Urbana,” a famous Brazilian rock band from the 1980s and 1990s. Overall, the song has a very strong political message that seems incredibly up to date and relevant almost 30 y after its release. There are many possible answers to the question evoked by this song: Brazil is the country of music, carnival, warm people, socio-cultural diversity, football (soccer), among many others. In addition, Brazil is a country with marked environment, animal and plant biodiversity, including the incredible, unique Amazon biome. In science, it also happens to be the home, for example, of researchers that worked on the genome sequencing of *Xylella fastidiosa*, the first phytopathogenic bacteria to have its genome sequenced in the world.<sup>1</sup> What about the Temperature Sciences?

Well, while this field still has a long way ahead in Brazil, the choice of “Brazilian research in thermoregulation” as the central topic of a special issue of *Temperature* was certainly not random. Indeed, Brazilian science has exhibited enormous progress over the recent years. In the period between 1998 and 2001, each PhD in the area of Biological Sciences published an average of 1.2 manuscripts in international journals per year, whereas this amount increased by 33% (1.6 manuscripts per PhD per year) in the 2007–2010 period.<sup>2</sup> In particular, Brazilian investigators also have shown increased international participation in the field of Temperature Sciences, as indicated by the results of an advanced search for manuscripts using the word *thermoregulation* as a topic and having at least one author from a Brazilian institution. By using the Thomson Reuters Web of Science database, the search retrieves 4.1 manuscripts per year in the 1990s, whereas this number is almost 7 times higher in the current decade (27.3 manuscripts per year from 2010 until 2015). Similarly, an increasing number of manuscripts published in the present decade is evident when the terms *fever* and *animal production* are searched in association with the term *temperature* in the same database. This quantitative change in scientific output, observed not only in the thermoregulation field, resulted from significant economic improvements that led to higher investments in research, including an increased number of research groups, graduate programs and fellowships for undergraduate and graduate students. Another fact that confirms the ascending insertion of Brazilian scientists in the international community of Temperature Sciences was the organization of the Fourth International Conference on the Physiology and Pharmacology of Temperature Regulation held in Búzios (Rio de Janeiro, Brazil) in 2012, with 21 local principal investigators, graduate and undergraduate students attending the meeting, and with 30% and 15% of the poster presentations and talks made by Brazilians, respectively.

Stimulating scientific collaboration with international research groups has been a strategy adopted by Brazilian funding agencies for a long time and this definitely contributed to the recent achievements made by the Brazilian scientists.<sup>3–6</sup> This stimulus has grown recently with the Science without Borders Program that sent approximately 100 thousand Brazilian students to several universities abroad. An example of the experience provided by this program resulted in the production of an interesting teaching slide<sup>7</sup> and is described in a chronicle published in the special issue.<sup>8</sup> However, this program came with a high cost that corresponded to approximately US\$1.2 billion in 2015 (considering the real-to-dollar conversion on January 1<sup>st</sup>, 2015). In the beginning, it was expected that both public and private organizations would provide financial support to the students, particularly those students from key areas, including science, technology, engineering and math. With the imminent economic crisis, the private companies did not support the program and the financial burden was placed entirely on the Conselho Nacional de Desenvolvimento

Científico e Tecnológico (CNPq), the main Brazilian governmental funding agency. This meant less investment was left for research projects developed by Brazilian investigators. In fact, Brazil currently faces an important economic crisis that may decelerate the recent progress made by Brazilian researchers. Hopefully, it will not!

Brazil is a continental country (total area of 8,514,887 km<sup>2</sup>) with a considerable north-to-south extension and with 92% of its area located in the tropical zone of the Earth. In addition, Brazil has 6 different biomes, namely the Amazon, Cerrado, Caatinga, Pantanal, Atlantic Forest and Pampa biomes. Within these, there is the unique Amazon biome that covers approximately 49% of the Brazilian territory and has the greatest biodiversity of the world.<sup>9</sup>

This mostly warm-to-hot weather often imposes a significant and sometimes dangerous thermoregulatory stress on athletes,<sup>10</sup> soldiers<sup>11</sup> and agricultural workers,<sup>12,13</sup> among others. Regarding the thermoregulatory stress on athletes, Brazil hosted the Fédération Internationale de Football Association (FIFA) World Cup in 2014, when the environmental stress was classified as high according to relative humidity and wet-bulb globe temperature (WBGT) data in 25% of the matches (16 out of 64). Under these stressful conditions, top-level football players altered their physical exercise pattern, including reduced distance run at high intensity and improved rate of successful passes.<sup>14</sup> In addition to this major football event, Brazil will host the Olympics and Paralympics in 2016. As discussed by Veneroso and colleagues,<sup>15</sup> while temperatures in Rio de Janeiro are not likely to be very high during the upcoming Olympics (August mean temperature was 22°C in the last 3 years), it is still advisable that football athletes who will compete in northern cities (e.g. Manaus and Salvador) acclimatize to higher temperatures for 2 to 3 weeks prior to the matches.

Aside from the sport sciences context, the thermal diversity of the environment is a challenge for many other animal species too, and, thus, it is important to further understand how these species exchange heat with their surroundings.<sup>16,17</sup> Indeed, no doubt that the thermal stress related to animal production and reproduction has also contributed to the development of the Temperature Sciences in Brazil. For example, the environmental challenge often deserves particular attention and, therefore, it becomes an important research field in the context of cattle-raising,<sup>18</sup> as most of the cattle raised in this country came from different parts of the planet.

The Brazilian diversity can also be noticed when looking at the topics of the manuscripts published in this special issue, with papers focusing on behavioral thermoregulation,<sup>19</sup> brown adipose tissue thermogenesis,<sup>20</sup> circadian rhythms of body temperature,<sup>21</sup> heat acclimation,<sup>22</sup> exercise thermoregulation,<sup>23</sup> mediators of thermoregulatory manifestations induced by systemic inflammation,<sup>24,25</sup> motion sickness-induced hypothermia,<sup>26</sup> and temperature and Alzheimer disease.<sup>27</sup>

As in several countries, thermoregulation is not an established section inside the field of Physiology in Brazil. For instance, thermoregulation is not a topic that is studied separately in the Human Physiology disciplines in any of the Brazilian Universities. In general, the contents regarding thermoregulation are discussed briefly in lectures about metabolism or the cardiovascular system. Although this fact may indicate an attempt to teach Physiology in an integrated manner, it may also indicate that thermoregulation is not an established subject that is taken into account during the organization of such disciplines. Moreover, there is no specific section for thermoregulation during poster presentations in the annual meetings of the Brazilian Physiological Society. However, it is very interesting to note that the most important award given to young investigators in Brazil was named after Alvaro Ozório de Almeida, a pioneer thermal physiologist who developed relevant research projects related to the metabolic rate of subjects living in tropical countries.<sup>28</sup>

Brazilian scientists are motivated to produce research of the highest standards, publish in the most prestigious peer reviewed journals of their field, and participate fully with the international community. Furthermore, Brazilians believe in qualitative initiatives such as the development of an academic journal aimed at gathering the scientific research in the field of temperature sciences<sup>29</sup> and that has a very consolidated editorial board.<sup>30</sup> The initial plan was to publish 5 or 6 manuscripts in the special issue on Temperature Sciences in Brazil, but, fortunately, we have finished the issue with a total of 20 items. These interesting

numbers indicate that Brazilian researchers approved of the initiative of *Temperature* and selected this journal as an important source to disseminate their science.


Having said that, we invite the readers to enjoy the special issue in the *Temperature* journal. We are very enthusiastic with the final content and hope that it will highlight the quality of the research conducted in Brazil in the field of Temperature Sciences. We also hope that this issue will contribute to further improvements to the Brazilian research groups, including more opportunities of collaborative projects with international groups. And answering the question again... Brazil is also the home of established and emerging groups that produce relevant knowledge in the Temperature Sciences!

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