



Native or non-native? That is the question: A complementary discussion to Saint-Paul (2017)

Nativos ou não-nativos? Eis a questão: Discussão complementar à Saint-Paul (2017)

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Resumo Saint-Paul (2017) discutiu o cultivo de espécies nativas na produção aquícola brasileira argumentando que a seleção de espécies para sustentar a demanda nacional já é conclusiva. Porém, as espécies utilizadas, em sua maioria, não são autóctones da bacia hidrográfica onde são cultivadas e, portanto, não devem ser consideradas nativas. Destaca-se ainda, o risco das introduções entre bacias, em um país com dimensões continentais como o Brasil, que abriga várias ecoregiões e “Ramsar sites”. Barreiras naturais são mais relevantes biologicamente que divisões geopolíticas, sendo assim, espécies brasileiras devem ser consideradas não-nativas quando introduzidas em uma bacia ou sub-bacia na qual ela não ocorre naturalmente. Além disso, híbridos não devem ser considerados nativos, pois podem comprometer populações nativas por meio de introgressões genotípicas. Diante disso, o objetivo do presente estudo é discutir o cultivo de espécies introduzidas de outras bacias brasileiras, demonstrando que a aquicultura no Brasil ainda precisa ser aprimorada, visando: *i*) tornar a aquicultura ambientalmente correta, principalmente em relação ao vazamento de resíduos para ambientes naturais; *ii*) regionalizar a produção estimulando o uso de espécies autóctones (e.g. dentro da menor escala biogeográfica possível) através da exploração do mercado local em pequenas e médias escalas; *iii*) evitar o cultivo de híbridos; *iv*) desenvolvimento tecnológico (prevenção de escapes e eutrofização ambiental) e *v*) mudança política e legislativa, adotando o Princípio da Precaução, considerando os efeitos da aquicultura na biodiversidade e nos serviços ecossistêmicos e principalmente levando em conta tratados do qual o Brasil é signatário. Por exemplo, a 10^a Conferência das Partes da Convenção sobre Diversidade Biológica (CBD, Protocolo de Nagoya), onde Brasil e outros 192 países estabeleceram um Plano Estratégico e metas para reduzir a perda de biodiversidade em escala global - o Aichi Metas de Biodiversidade. Reforçamos que o uso de espécies nativas é preferível, porém, estas devem ser escolhidas levando em conta limites biogeográficos (bacias) e não limites geopolíticos. A presente situação da aquicultura no Brasil necessita de mudanças com novas e melhores práticas, do contrário a biodiversidade aquática brasileira poderá ser corrompida pela produção aquícola.

Palavras-chave: aquicultura, impactos, biodiversidade.

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Abstract Saint-Paul (2017) discussed the use of native species in the Brazilian aquaculture, arguing that the selection of species to meet the national demand is concluded. However, many species used in aquaculture are not autochthonous to the basin where they are cultivated, and then should not be considered native. Here we highlight the risks of intra-country introductions in a country with continental dimensions such as Brazil, that shelters a great variety of ecoregions and Ramsar sites. Natural barriers are biologically more relevant than geopolitical divisions, so Brazilian species should be considered as non-native if they are introduced into a basin where they do not occur naturally. Concerning this, we aim to claim the attention to the issue, demonstrating that aquaculture in Brazil still have to be improved, based on sustainable strategies such as: *i*) to make aquaculture more environmentally-friendly, especially by avoiding leaks and pollution (i.e. biotic and abiotic - prevent escapes and eutrophication) to natural ecosystems; *ii*) to regionalize production promoting the use of locally native species (native in the region, basin and/or sub-basin) exploring local markets; *iii*) to avoid hybrids; *iv*) to improve technology in all phases of management; *v*) to improve measures, both mitigating and compensatory, or penalties and liabilities in cases of leakage (e.g. polluter pays principle) and *vi*) a profound change in policies and laws, adopting the Precautionary Principle and considering the effects of aquaculture on biodiversity and ecosystems services, and in particular, with regard to treaties to which it is a signatory. For example, the 10th Conference of the Parties to the Convention on Biological Diversity (CBD, Nagoya Protocol), where Brazil and 192 other countries have established a Strategic Plan and targets to reduce biodiversity loss on a global scale - the Aichi Biodiversity Targets. Besides that, the use of native species is preferred but those species should be selected taken biological and biogeographical frontiers into consideration that will not impact in the ecosystem. The current situation demands a profound behavioral shift towards novel and better practices, or aquaculture will continue to erode the aquatic biodiversity without a positive growth.

Keywords: Aquaculture, Impacts, Biodiversity.

Saint-Paul (2017) in a recent paper discussed the Brazilian aquaculture production, arguing that native species are “*boosting the development of aquaculture in the country*”. In a broad sense an ideal strategy for a sustainable aquaculture production must include more and more “*native*” species, exploring the local market and suited with local ecosystems. However, we disagree that the “*selection to meet the national demand has been concluded*” (Saint-Paul 2017). First, it is necessary to brighten what is really considered a native species, mainly in a megadiverse country with continental dimensions such as Brazil (Frehse, Braga, Nocera & Vitule, 2016; Pelicice et al., 2017). Brazil possesses 12% of the planet's reserve of available freshwater, and more than two million hectares of marshlands, reservoirs and estuaries suitable for aquaculture, as well as 25,000 rivers across the country (Saint-Paul, 2017). However, the author ignores intra-country invasions and the complexity of Brazil's hydrography, which includes all major river systems of the region, different biomes, ecoregions, hotspots and Ramsar sites (Pelicice et al. 2017). This biogeographical complexity in turn is reflected in a rich fish biodiversity (i.e. Brazil holds >3,300 freshwater fish species or 60% of the Neotropical fish fauna; Froese & Pauly, 2016), largely because the huge vicariousness that provides high dissimilarity of fish assemblages between and even intra-basins (Rosa & Lima, 2008; Abilhoa, Braga, Bornatowsky & Vitule, 2011). This diversity of fish fauna in Brazil includes complex taxonomic, phylogenetic and functional dimensions (e.g. Lévêque, Oberdorff, Paugy, Stiassny & Tedesco, 2008; Toussaint, Charpin, Brosse & Villéger, 2016; Vitule et al., 2017), playing a wide range of ecosystem functions and services, such as nutrient cycling, grazing, seed dispersal and professional and recreational fishing that benefit different sectors of human society in large scale (Pelicice et al., 2017). Because of these complex dimensions, the production of ‘*native*’ species is difficult to define and operate in broad scales, and especially considering that intra-country introductions (species of fish introduced outside their native basin) are common (Vitule, Freire & Simberloff, 2009; Vitule, Bornatowski, Freire, & Abilhoa, 2014). Many intra-country introductions along the country has been causing impacts such as declines in the diversity of native communities, competition with native fishes, and biotic homogenization of fish assemblages (e.g. Latini & Petrere, 2004; Alves, Magalhães & Brito, 2007; Vitule, Freire & Simberloff, 2009; Daga et al. 2015; Pelicice et al. 2017). This type of introductions are dangerous primarily because geopolitical divisions do not reflect relevant biogeographical or ecological boundaries (Abel et al., 2008), moreover, basins may be functionally distinct even if geographically close (Vitule, Skóra & Abilhoa, 2011; Skóra, Abilhoa, Padiál, & Vitule, 2015; Rodrigues-Filho et al., 2016). In addition, any analysis related to production of native and non-native species, using broad sense definitions, i.e. large taxonomic groups, hybrids and data from FAO database, are biased. Taxonomic groups should be identified at species level, per ecoregion and/or endemic basin, otherwise, many different species may be accounted as one (e.g., *Pseudoplatystoma* spp., *Brycon* spp., *Cichla* spp., *Prochilodus* spp.), and consequently, considered as a native species in basins where they do not occur naturally. Due to the biological and political realities of Brazil decisions about which species should be selected for future aquaculture development are not a simple task. So, definitively the selection to meet the national demand is far from being concluded.

The risk of negative impacts of intra-country introductions has already been evidenced in Brazil with the introduction of the Cichlidae ‘*tucunaré*’ (*Cichla* spp.) in the Doce River and Paraná river basins, (Latini & Petrere, 2004; Pelicice & Agostinho, 2009; Britton & Orsi, 2012), the ‘*corvina*’ (*Plagioscyon squamosissimus*) (Agostinho & Gomes, 2002) and the ‘*dourado*’ (*Salminus brasiliensis*) in the Paraná River basin (Gubiani, Frana, Maciel & Baumgartner, 2010; Ribeiro et al., 2017). Even introductions of ‘*Pirarucu*’ or ‘*Paiche*’ (*Arapaima gigas*) from Brazil to adjacent basins of other countries have caused impacts (Macnaughton et al., 2015), emphasizing that geopolitical division cannot be used to define the species status (i.e. native or non-native). Also, the co-introduction of parasites associated with aquaculture species can cause serious ecological, economic and social impacts (e.g. Torchin, Lafferty, Dobson, McKezie & Kuris, 2003; Vitule, Freire & Simberloff, 2009). To make the matter worst, aquaculture production is not the only vector of intra-country introductions in Brazil. Sport-fishing is another major vector stimulated by sport fishermen and stakeholder's, however all species released by anglers have been, one way or another, produced and sold by the productive sector via aquaculture in the last instance, e.g. sport fish and baits (Vitule, Freire & Simberloff, 2009; Gubiani, Frana, Maciel & Baumgartner, 2010; Britton & Orsi, 2012; Pelicice, Vitule, Lima-Junior, Orsi & Agostinho, 2014).

The use of hybrids is another relevant threat of the Brazilian aquaculture production. These specimens represent a serious risk to the native community and should not be considered as native species (Elton, 1958, Rhymer & Simberloff, 1996). Rather, they should be recognized as a threat to their native parents and congeners, due to predation and competition (Lockwood, Hoopes & Marchetti, 2007) due to interbreed with native species, which cause loss of genetic resource, and consequently compromises native populations

(Alves, Varela, Moro & Kirchnick, 2014; Hashimoto, Senhorini, Foresti, & Porto-Foresti, 2012; Vaini, Grisolia, Prado & Porto-Foresti, 2014; Lima, Oliveira, Giacomini & Lima-Junior, 2016). More importantly is the fact that these arguments cited above may have synergistic effects with poor practices of management and the low technology used in Brazilian aquaculture, regarding environmental care, such as high rates of escapes from cages and ponds (Azevedo-Santos, Rigolin-Sá & Pelicice, 2011; Magalhães & Jacobi, 2017), and anthropogenic alteration of the natural habitat such as, construction of dams (Agostinho, Pelicice & Gomes, 2008) and pollution (Freire et al. 2016). Finally, we recognize and cheer the effort of Saint-Paul (2017) to bring the use of native species in the aquaculture production in Brazil to discussion, however for us to assert that native species are boosting the Brazilian aquaculture, major improves in the activity are still necessary, based on environmental and sustainable strategies such as: *i*) to make aquaculture more environmentally-friendly, especially by avoiding leaks and pollution (i.e. biotic and abiotic - prevent escapes and eutrophication) to natural ecosystems; *ii*) to regionalize production promoting the use of 'real' locally native species (native in the region, basin and/or sub-basin) exploring local markets; *iii*) to avoid hybrids; *iv*) to improve technology in all phases of management; *v*) to improve measures, both mitigating and compensatory, or penalties and liabilities in cases of leakage (e.g. polluter pays principle) and *vi*) a profound change in policies and laws, adopting the Precautionary Principle and considering the effects of aquaculture on biodiversity and ecosystem services, in particular, with regard to treaties to which it is a signatory. For example, the 10th Conference of the Parties to the Convention on Biological Diversity (CBD, Nagoya Protocol), where Brazil and 192 other countries have established a Strategic Plan and targets to reduce biodiversity loss on a global scale - the Aichi Biodiversity Targets www.cbd.int.

The current *modus operandi* of aquaculture development in Brazil has introduced several intra-country non-native species (e.g. extralimital), and released pollutants into aquatic systems with many underexplored negative impacts (e.g. trophic cascades, eutrophication, pollution, genetic erosion, diseases, habitat destruction and biotic homogenization), especially in long term, which is incompatible with the persistence of biodiversity and ecosystem services. In our view, there is no simple solution to correct or minimize these effects, especially only by means of the use of 'native' species in a broad sense. The current situation demands a profound behavioral shift towards novel and better practices, or aquaculture will continue to erode the aquatic biodiversity without a positive growth.

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