

Over the past four decades, the emergence and consolidation of global supply chains has become a widely studied managerial reality. The reference model is that of an interdependent worldwide network, in which the exchange of goods has never been easier and less costly. But are we aware that global supply chains are also the source of the spread of the Asian tiger mosquito, with ever-increasing health risks for populations? Gilles Paché sheds light on this dark side of globalisation, which we urgently need to take fully into account.



GLOBAL AND LOCAL **SUPPLY CHAINS:** SERVING THE SPATIAL SPREAD OF THE **ASIAN TIGER MOSQUITO**

by Gilles Paché

The positive influence of global supply chains on the expansion of international trade can no longer be questioned, including huge poverty reduction. According to the World Bank, the relationship between international trade and poverty reduction is indisputable: from 1990 to 2017, developing countries increased their share of world exports from 16 per cent to 30 per cent and, at the same time, the rate of extreme poverty dropped from 36 per cent to 9 per cent¹. On their side, for four decades now, thanks to increasingly efficient routing techniques, Western consumers have been able to access commodities and goods that travel thousands of kilometres from their place of production to their place of consumption, at reasonable prices. As I mentioned previously in an article published

by *The European Business Review*, the COVID-19 pandemic highlighted the immediate dramatic effects of global supply chain disruptions on the world economy, multiplying recurrent shortages in supply systems, and I suggested that regionalisation of supply systems could be a possible way out². In short, even if globalisation is sometimes criticised from a social viewpoint, particularly regarding working conditions in certain poor countries, it is a true economic reality, and the performance of global supply chains is an essential part of it.

However, this globalisation associated with the triumph of neoliberalism is far from stopping at the exchange of commodities, goods, and people. The corridors implemented to ensure rapid, reliable transportation, for

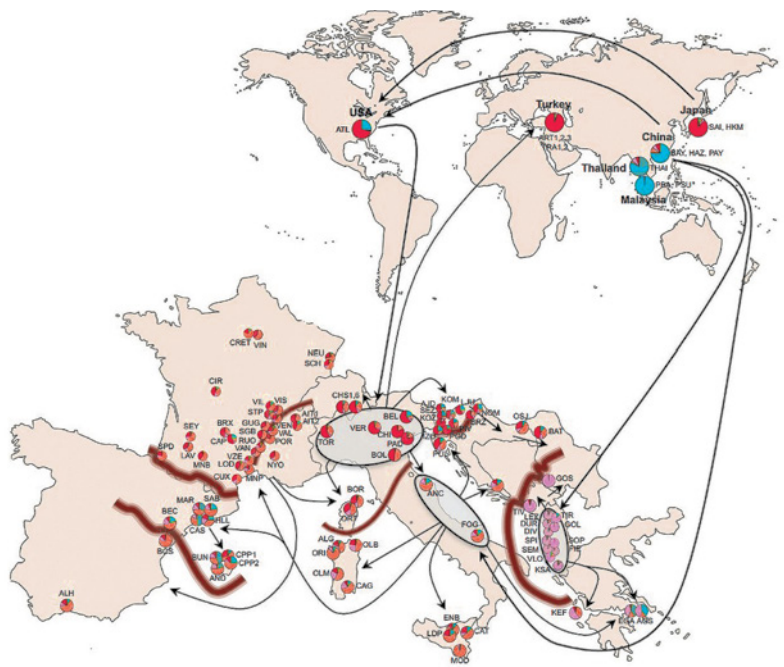


AN INVASIVE INSECT THAT TRAVELS EASILY

The Asian tiger mosquito, which originated in the forests of Southeast Asia, colonised the countries bordering the Indian Ocean before spreading worldwide from the 1980s onwards. (Today, only Antarctica remains untouched.)

Figure 1, proposed by Stéphanie Sherpa and colleagues, shows the main colonisation routes taken by the Asian tiger mosquito⁵. This expansion is linked to biological characteristics. Its eggs are resistant to desiccation, which increases their lifespan and enables them to survive for several weeks. In addition, the species is capable of diapause, i.e., the insect's development stops in response to unfavourable environmental variations. This enables the eggs to survive the winter in temperate zones. The biological characteristics explain why the Asian tiger mosquito adapts to a variety of environments, particularly urban ones, taking advantage of a multitude of containers in which to lay its eggs. An opportunistic anthropophile, the Asian tiger mosquito bites humans and can carry viruses such as dengue, chikungunya and Zika.

FIGURE 1 Colonisation routes taken by the Asian tiger mosquito



Source: Stéphanie Sherpa and colleagues

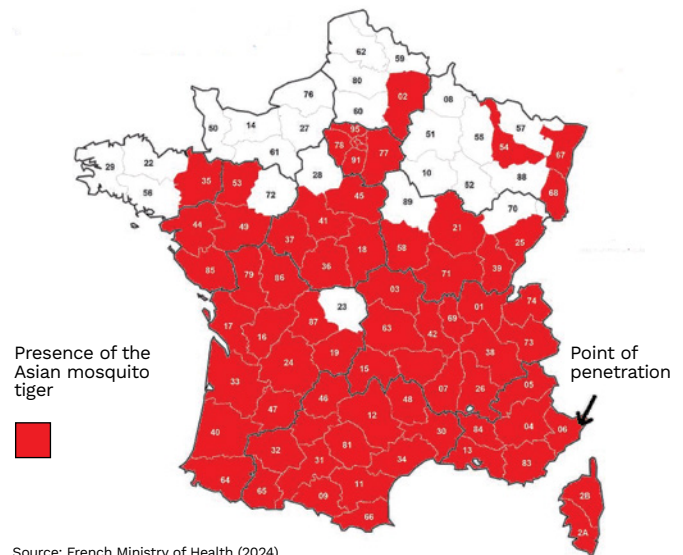
example with shipping lines crossing the oceans, are also an effective support for the transportation of a wide range of animal species. History recalls that the terrible plague epidemic that, in 1720, ravaged Marseille, in the south of France, causing 50,000 deaths – half the city's population – was due to a ship bringing back cloth from the Levant (Palestine, Lebanon, Syria, and Asia Minor) ... but also infected rats, as Jacques Colin brilliantly recalls³. Although the situation is not comparable, global supply chains are once again at the service of an invasive insect, the Asian tiger mosquito (or *Aedes albopictus*), which represents a significant threat to the health of populations. “What's the most dangerous creature on earth? Without question the answer is: the mosquito. Mosquitoes and the diseases they spread have been responsible for killing more people than all the wars in history”⁴. While the spatial spread of the Asian tiger mosquito is partly linked to the biology of the species, international trade is clearly an aggravating factor.

Chronologically speaking, the first Asian tiger mosquitoes were identified in Albania in 1979, then in the United States, more precisely in Houston, Texas, in 1985. In both cases, they disembarked from cargo ships from Asia. The first cases in Western Europe were reported in Italy in the 1990s, followed by France in the early 2000s. The spread of the phenomenon has kept pace with the explosion in international trade. As the eggs are highly resistant to drought and cold, the larvae can develop in the smallest puddles, while the adult Asian tiger mosquito travels easily in shipping containers. Once it has reached its destination, it continues its journey, taking advantage of both individual and collective means of land transportation (car interiors, trucks, trains, etc.). In infested areas, Asian tiger mosquitoes, in search of a blood meal, enter the means of transportation, then emerge during stops and, if they find favourable breeding grounds nearby, they proliferate in a previously unscathed area. This is probably how the Asian tiger mosquito arrived in southern France from Italy, before conquering the country.

The French case is very interesting in order to give an idea of the influence of local supply chains on the spread of the Asian tiger mosquito. The species first became established in 2004 in Menton, near the Principality of Monaco. While the situation appeared to be under control until 2010, everything changed from that point onwards. Indeed, from 2010 to 2020, the number of French regions colonised grew exponentially, as dengue cases multiplied. By the early 2020s, health authorities were recognising that the deterioration of the situation was unavoidable, due to the increase in the continuous exchange of goods and people. In the knowledge that the Asian tiger mosquito is resistant to insecticides, it was publicly acknowledged that the whole of France would be affected soon, with a foreseeable extension to the whole of Europe. The location map provided by the French Ministry of Health confirms the validity of this dire prognosis by early 2023, with viral diseases becoming a major public health problem (see **figure 2**). This should come as no surprise since, as early as the late 1990s, Donald Kennedy and Marjorie Lucks noted that the conversion of compartmentalised national

Like a wink of history, the Asian tiger mosquito has seized upon the hub-and-spokes model to conquer new territories. This is why many analysts conclude that international trade is largely responsible for its rapid spread.

FIGURE 2 Establishment of the Asian tiger mosquito in France at the beginning of January 2023



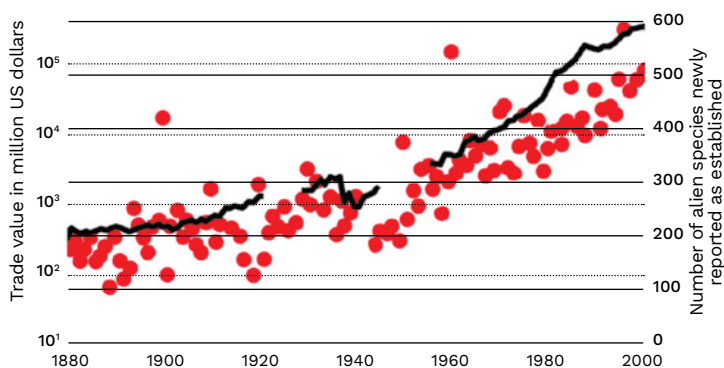
Source: French Ministry of Health (2024)

economies into an interdependent worldwide network was clearly a facilitating factor in the proliferation of the Asian tiger mosquito⁶.

USED TYRES: THE PERFECT CULPRIT

Logistics management researchers and practitioners will be familiar with figures 1 and 2. As with many goods manufactured in Asia and consumed in Europe and North America, two supply chains are interlinked: a *global* supply chain and a *local* supply chain. The global supply chain is based on radial axes several thousand kilometres long, while the local supply chain delivers commodities and goods to recipients over short distances, usually a few tens or hundreds of kilometres. The hub-and-spokes model, or “platforming” model, formalised by the creator of FedEx in the mid-1960s⁷, is the most complete formalisation of the global / local articulation. It is thanks to it – or because of it – that the global spread of *Made in China* has become the norm over the years. Like a wink of history, the Asian tiger mosquito has seized upon the hub-and-spokes model to conquer new territories. This is why many analysts

FIGURE 3 The correlation between globalisation and the proliferation of invasive species over the centuries



Source: Stéphanie Sherpa

conclude that international trade is largely responsible for its rapid spread. More generally, **figure 3** by Stéphanie Sherpa highlights the strong correlation between globalisation movement and the proliferation of invasive species⁸.

However, in the stream of millions of commodities and goods in circulation between continents, an ideal culprit has been singled out for attention, including in numerous academic works. This is the long-distance transportation of Asian tiger mosquito larvae in used tyres. More specifically, this trade concerns truck, construction vehicle and aircraft tyres, which are retreaded for new use, in reference to a recycling policy that is now very dynamic. Thanks to technological innovations in polymer waste, used tyres are now seen as an important source of valuable raw materials, generating a highly lucrative market⁹. Imports of

used tyres are particularly active between Asia, the United States, and Europe, representing global sales of US\$5.45 billion in 2023, with a forecast of US\$6.41 billion by 2028. Modelling by Sandra Oliveira and colleagues confirms that the Asian tiger mosquito's spatial spread is set to explode between now and 2035¹⁰. Several open-air used tyre storage centres in Asia have been found to be infested with the mosquito, and cargo contamination has spread internationally during sea container transportation.

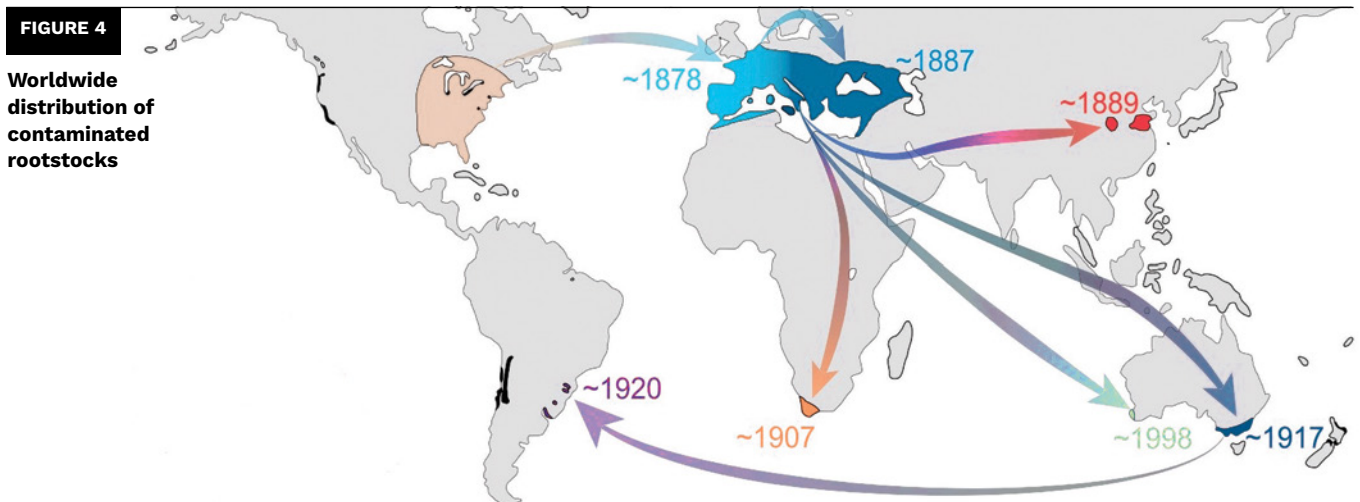
This is not a new problem, writes Martin Enserink; in fact, it was identified long ago in a famous study which clearly demonstrated that the Asian tiger mosquito arrived in Texas at the same time as waterlogged used tyres from Asia¹¹. Once water has entered a tyre, it is virtually impossible to get it out, providing a “cosy nest” for the Asian tiger mosquito to proliferate undisturbed, even during a long journey. Over the last few decades, this activity has generated transcontinental flows of several hundred million tons of used tyres, which gives an idea of the volume of larvae and Asian tiger mosquitoes involved. Finally, it is possible to speak of a perverse effect of the recycling policy, a key component of the circular economy. On the one hand, the reuse of tyres saves scarce resources in terms of additives (silica, resin, sulphur, etc.), and on the other, it is at the origin of the proliferation of an invasive species whose eradication will absorb resources to avoid a dramatic health crisis. In any case, only cross-border political action will provide satisfactory answers to the problem¹².



REMEMBER GLOBAL WARMING

The Asian tiger mosquito is not the only invasive species resulting from globalisation whose effects have been dramatic for many manufacturing activities. For example, the emerald ash borer, native to China and Russia, an extremely devastating insect that uses the same international trade routes as the Asian tiger mosquito, is spreading very quickly in North America, having first been detected in 2002 in Ontario and Michigan. Infested ash trees die within two or three years. Unfortunately, ash is an essential component in the manufacture of tool handles, guitars, and office furniture. Another historical example is the contamination of European vines by mildew. American vines were massively imported into France circa 1878 to combat phylloxera. However, they proved incapable of resisting certain fungi present in France, which were the source of mildew. In the late 19th and early 20th centuries, modern vineyards around the world took France as their model. The country exported rootstocks resistant to phylloxera but carrying destructive fungi. **Figure 4** by Michael Fontaine and colleagues shows how international trade contributed to the spread of downy mildew, the effects of which would be dramatic for the wine industry¹³.


As far as the Asian tiger mosquito is concerned, if international used-tyre logistics appears to be the main culprit, we need to add an aggravating circumstance at the start of the 21st century: global warming. Climate change is accelerating the spread of the insect and is directly linked to global supply chains. For example, the carbon footprint of maritime transportation is mainly made up of bunker emissions (a petroleum residue obtained after refining gasoline or diesel)¹⁴. Considered a heavy fuel oil that is difficult to burn, its combustion releases carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), the main gases responsible for global warming. The resulting rise in temperatures encourages the Asian tiger mosquito to colonise new territories, in a biological process known to entomologists. In the early 2010s, research by Ilia Rochlin and colleagues suggested that 50 per cent of the planet could be affected¹⁵, and it is to be feared that the situation has since worsened. The Asian tiger mosquito is a cold-blooded organism, unable to regulate its internal temperature. As a result, the warmer the weather, the more it will be able to develop in higher latitudes and multiply its areas of colonisation, including in Northern Europe. If people in the United Kingdom think that mosquitoes are only an African or Mediterranean problem, they are sadly mistaken!



Source: Michael Fontaine and colleagues

Another biological process aggravates the situation in the context of global warming. When the Asian tiger mosquito sucks blood from a sick person, the virus is not digested in its stomach, but is released in the saliva of the mosquito, which bites every 5 to 7 days. From a health perspective, the situation can have serious implications, as the multiplication of the virus in the Asian tiger mosquito depends directly on temperature; the warmer it is, the more the process is accelerated¹⁶. Thus, while it takes around 10 days for the dengue virus to reach the salivary glands when the temperature is around 25° C, this time frame is reduced to 7 days above 30° C. The consequence is potentially dramatic: as the climate warms, the number of Asian tiger mosquitoes will increase, and more Asian tiger mosquitoes will be infectious if they bite sick people. As we can see, by combining the interactions between living systems and technical systems, the case of the Asian tiger mosquito underlines the fact that global supply chains are not always at the origin of a better world. Who could doubt it?

It would therefore be a mistake to believe that the COVID-19 pandemic was a unique case of total paralysis of international trade due to a virus that travelled easily. On the contrary, it is highly likely that new health crises will occur in the future, impacting all global supply chains, as production and physical distribution systems are now irrevocably interconnected on a worldwide scale. Under these conditions, one geographical area will automatically suffer a disruption in supplies from another geographical area if the latter is hit by a virus as violent as SARS-CoV-2, paralyzing its local supply chains. From this viewpoint, the case of the Asian tiger mosquito should serve as a lesson, as it highlights the logistical networks that generate the greatest vulnerability. Clearly, it is hard to imagine going back to a past based on protectionist policies that compartmentalise

geographical zones from one another. As a result, it is particularly urgent to consider how best to protect “gateways” – in other words, the hubs at the interface between global and local supply chains. To return to the example given at the beginning of this article, this is what the port authorities were unwilling or unable to do in Marseille during the meteoric spread of the plague in 1720. 

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