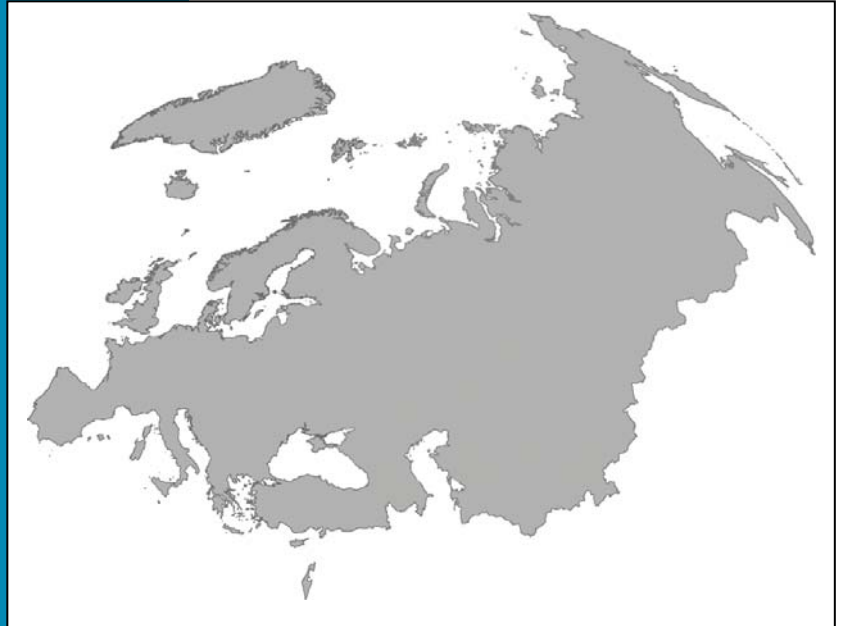




**World Health
Organization**

REGIONAL OFFICE FOR **Europe**



**SURVEILLANCE AND
CONTROL OF INVASIVE
SPECIES OF MOSQUITOES
IN THE WHO EUROPEAN
REGION**

Report of a meeting on the development
of a regional strategy
The Hague, Netherlands, 6–7 June 2012



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ABSTRACT

Recent reports on introductions and invasions of exotic mosquitoes in the World Health Organization (WHO) European Region have raised concern about the potential spread of these species across the region and their implications for public health by causing nuisance and transmission of infectious diseases. The threat is further manifested by the recent emergence or re-emergence of dengue and chikungunya in southern Europe, which justifies immediate action against invasive mosquitoes. However, current surveillance systems to detect invasions are inadequate and human resources are lacking in many countries and areas. The preparedness in the region to respond with appropriate action, in terms of containment or control of invasive mosquitoes, is insufficient and is not supported by legislation. This report recommends areas of work for member states and other partners to address this emerging threat.

Keywords

DENGUE - prevention and control
EPIDEMIOLOGICAL SURVEILLANCE
MALARIA - prevention and control
MOSQUITO CONTROL
PARASITIC DISEASES AND THEIR CONTROL

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Abbreviations

ECDC	European Centre for Disease Prevention and Control
EMCA	European Mosquito Control Association
EU	European Union
IHR	International Health Regulations
IVM	integrated vector management
LLIN	long-lasting insecticidal nets
M&E	monitoring and evaluation
SCRC	Standing Committee of the Regional Committee for Europe
VCNA	vector control needs assessment
VBORNET	network of medical entomologists and public health experts, funded by the ECDC
VWS	Netherlands Ministry of Health, Welfare and Sports
WHO	World Health Organization

1. Background

Recent reports on introductions and invasions of exotic mosquitoes in the World Health Organization (WHO) European Region have raised concern about the potential spread of these species across the region and their implications for public health by causing nuisance and transmission of infectious diseases. A regional partnership among WHO (Regional Office for Europe and the Neglected Tropical Diseases Department at headquarters), the European Mosquito Control Association (EMCA) and the European Centre for Disease Prevention and Control (ECDC), and with the support of the VBORNET network of medical entomologists and public health experts, has been initiated to create greater awareness and understanding about the problem and to assist countries in detecting the problem at an early stage and responding to it promptly.

The rationale for the meeting was to address the growing concern of some Member States of the vector-related risk for introducing dengue and chikungunya fever and the continuing spread of *Aedes albopictus* across Europe and to ensure that the countries in need and international organizations (WHO, ECDC, EMCA and others) pledge support in developing a regional strategy for surveillance and control of invasive mosquitoes for the region. The meeting was organized by WHO in collaboration with the Ministry of Health, Welfare and Sports (VWS) of the Netherlands. VWS is gratefully acknowledged for sponsoring and hosting the event.

The two-day meeting brought together a total of 55 experts and policy makers, including representatives from 17 countries from the European Region, regional organizations, and temporary advisors (see Annex 1). Dr Donker was appointed as Chair, Dr Nasci as co-Chair and Dr van den Berg as rapporteur.

2. Meeting objectives

The main aim of the meeting was to outline a regional action plan and to review and advise Member States on approaches for effective surveillance and control of invasive species of mosquitoes in the WHO European Region.

Specific objectives:

- a. To review the global situation and strategy for prevention and control of dengue and chikungunya fever;
- b. To review the spread of invasive species of mosquitoes, including *Aedes albopictus* and the present situation on mosquito-borne arboviral diseases in Europe;
- c. To share experiences on surveillance, containment and control of invasive mosquitoes and identify existing problems and challenges;
- d. To streamline mechanisms for more effective partnership action, including greater advocacy at regional level;
- e. To agree on a strategy and approaches to control the invasive species of mosquitoes and reduce their distribution range in Member countries of the WHO European Region.

3. Outcomes

a. Review of the global situation

The risk of emerging diseases in Europe is directly related to the global disease situation and the volume of international traffic. Past decades have witnessed a global emergence of several vector-borne diseases, most notably dengue. With an increase from 0.5 million cases in the 1990s to 2.2 million cases in 2010 (reported to WHO), dengue has almost surpassed malaria in terms of global spread of infections. The increase in this arboviral disease is due to an upsurge in disease transmission by mosquito vectors but also due to improvements made in reporting. Mortality due to dengue is highest in the WHO South-East Asia Region and the disease is on the rise in the African, Americas and Eastern Mediterranean regions. In 2012, WHO published a Global Strategy for Dengue Prevention and Control (2012–2020), which advocates, inter alia, implementing sustainable vector control, reducing the risk of transmission and improving integrated surveillance (epidemiological and entomological) to ascertain the burden of disease. Chikungunya, a related arboviral disease, has also been expanding its range.

While the number of vector-borne diseases and their incidence in countries of the WHO European Region is much less than that of the tropical, developing countries, there are, nevertheless, a substantial number of such infections in Europe. However the level of awareness about the risk of these diseases is generally low. Tropical infections are constantly introduced into Europe by returning tourists and immigrants, and local transmission of malaria (Greece, 2011–2012), dengue (France and Croatia, 2010) and chikungunya fever (Italy, 2007 and France, 2010) has taken place in recent years. Crucially, this rising pattern has been made possible by the recent invasion of exotic mosquito vectors that are the essential link in the transmission of disease pathogens from one person to another. Of particular concern is *Ae. albopictus*, commonly known as the Asian tiger mosquito, which readily bites humans and is an effective vector of dengue and chikungunya.

The recent re-introduction and transmission of dengue fever with locally-transmitted cases reported in France and Croatia have shown that dengue transmission is possible in different areas of continental Europe where *Ae. albopictus* is present. The outbreak of chikungunya fever in Italy has proven that Europe remains vulnerable to transmission of “tropical” arboviruses and confirmed that *Ae. albopictus* is capable of supporting epidemic-level transmission. The notification of sporadic cases of chikungunya fever in France has shown that favourable conditions for its transmission exist in other areas of Europe with presence of *Ae. albopictus*.

b. Spread of invasive species

Aedes mosquitoes are well known invasive species, able to disperse into new areas and countries. Their invasion in the European Region is a threat to human and animal health and to biodiversity.

Aedes albopictus is currently the most invasive mosquito in the world. This mosquito can adapt to wide-ranging circumstances and is associated with human-made habitats, allowing it to spread in populated, urban areas. Its eggs are transported via

the global trade of goods, particularly used tyres (cars, trucks, heavy vehicles, etc.) and 'lucky bamboo' plants. *Ae. albopictus* is already widespread and abundant in the Mediterranean basin where it is causing biting nuisance and has been implicated as a vector in the local transmission of dengue and chikungunya. Computer modelling based on climatic variables has predicted that the potential distribution of this mosquito extends across most of western and southern Europe, largely due to its ability to overwinter as diapausing eggs. Climate change may expand its potential range further northwards.

Another species, *Aedes aegypti*, known as a highly effective dengue vector, has spread along the Black Sea coast since 2004 and has inadvertently been introduced into Madeira in 2005 and into the Netherlands in 2010. This species could become widely established in southern Europe, where it also occurred before the 1950s.

Other species of container-breeding *Aedes* mosquitoes (*Ae. atropalpus*, *Ae. japonicus*, *Ae. koreicus* and *Ae. triseriatus*) have occasionally been introduced into European countries, some dispersing across countries or able to survive cold winter temperatures, but the status of these species as vectors of disease still needs to be confirmed.

c. Surveillance, containment and control

Surveillance

The prevention and control of invasive mosquitoes hinges on an effective system of surveillance and response. Early detection of mosquitoes introduced into new territories is critical for a timely response to prevent or contain invasion. National authorities should instruct the routine surveillance of those imported goods that are liable to infestation with invasive mosquitoes. Where mosquitoes have become established, continued surveillance is needed to guide decision-making on control action aimed at reducing nuisance or disease risk.

The meeting identified several problems related to surveillance systems in the region. First, the lack of national legislation that mandates surveillance, which is linked to a general lack of political commitment to and awareness of the emerging problem of invasive mosquitoes. Second, the inadequacy of existing capacity for surveillance in most countries, with data collected on an ad hoc basis rather than through routine monitoring. Third, insufficient or lacking funds allocated to establishing or strengthening mosquito surveillance systems in many countries, despite the threat of emerging diseases.

As a way forward, the meeting proposed the harmonization of surveillance systems among countries in the region, with guidance to be provided by WHO and ECDC. In particular, the existing standards and methods on surveillance should become widely available and be adopted in training-of-trainers and operating procedures. Also, a network of reference laboratories should be established, and their capacity enhanced, to support the identification of mosquito samples.

Substantive work has recently been carried out in terms of preparation of standards and guidance and the sharing of information at the regional level. In consultation with WHO, VBORNET and EMCA, the ECDC has developed a guidance document for surveillance procedures and species-specific sampling methods on invasive mosquitoes. The surveillance procedures outlined in the document are tailored to

three scenarios: prior to invasion, with locally established invasion, and with widely established invasion. Where the invasive mosquitoes are implicated in disease transmission, however, additional surveillance procedures will be needed.

For the purpose of information exchange, an online database with regional distribution maps of invasive mosquitoes has been initiated, but the completeness of data is still hampered by the lack of surveillance in many countries and areas. The surveillance data should then be transformed into risk maps and finally be entered into national and international information systems as the basis for response action.

Containment and control

The meeting acknowledged that current surveillance activities need to be better tied to appropriate response action in terms of containment or control of invasive mosquitoes, both at national level and at regional level (i.e. through better coordination between WHO, ECDC and EMCA). In particular, contingency plans should be available for preparedness to contain invasive mosquitoes and to control disease outbreaks in various settings. Guidelines on the control of invasive mosquitoes are being developed jointly by WHO and EMCA.

Containment and control should start at the points of entry. Proper sanitation around seaports and airports, following the successful example of the seaport of Shanghai, China, is a desirable preventive intervention to create inhospitable environments for introduced mosquitoes. This intervention should be supported by surveillance with involvement of port regulatory authorities. Nevertheless, modern international transport of goods is mainly by freight containers, and mosquitoes or their eggs could be present inside freight containers. It was noted that systematic inspection of freight containers is impracticable and, consequently, most containers pass unopened through the ports en route to their destinations. Hence, the main point of entry for introduced mosquitoes is the final destination of individual freight containers, which complicates efforts to prevent invasions. For known sources of invasive mosquitoes, notably imported used tyres and 'lucky bamboo', the systematic inspection and appropriate control at the ports and/or final destinations should be mandated.

Besides the introduction of mosquitoes, the introduction of human cases (of dengue or other vector-borne arboviral disease) requires further attention, but a legal framework to monitor the importation of cases is still lacking. Better surveillance, appropriate and timely information of travellers and target groups, and real-time mapping of imported cases need to be addressed. Impediments to the screening of suspected cases include the lack of awareness of arboviral diseases among local physicians, lack of good-quality and reliable rapid diagnostic tests and lack of expertise to interpret the results of confirmatory tests.

Mosquito control measures must be safe to humans and non-target organisms, and application techniques appropriate for each specific setting. Preventive measures such as import restrictions on infested goods or habitat management should be strengthened. Biocide products, to be applied by certified spray operators, are a main tool used in the containment and control of invasive mosquitoes at the larval or adult stage, whereby it is noted that biocides targeting adult mosquitoes must be restricted for use in high-risk situations only. A common problem encountered in countries in the region is that biocide products are not readily available for their intended use. A major obstacle is the cost and procedure of registering mosquito control products in each country, especially in smaller markets. Moreover, a recent policy decision taken

by countries of the European Union (EU) has resulted in complicated and costly registration procedures for biocides to be used for mosquito control.

Considering the urgency of the problem of invasive mosquitoes, the meeting stressed that the **registration** of biocide products for mosquito control should become **coordinated and harmonized** across the European Region. This would increase efficiency and reduce cost for distributors and end-users. To expedite the registration process, the EU and/or individual countries should be encouraged to adopt the existing recommendations and specifications of the WHO Pesticide Evaluation Scheme on vector control biocides and application equipment as a basis for their registration.

Strategies for the containment and control of invasive mosquitoes are still being developed. The biological limitations of invasive mosquitoes suggest that two main strategies would apply: (1) In areas with optimal environmental conditions, containment may be feasible soon after introduction, but once populations have established, “management” to reduce biting nuisance and transmission risk would be the objective. An example is the establishment and local abundance of *Ae. albopictus* in the Mediterranean region, a problem which has proven difficult to contain. (2) In areas with suboptimal environmental conditions, detection of imported mosquitoes and elimination of introduced mosquitoes should be the objective. This should involve the prioritization of high-risk areas or routes of entry, as currently practiced in Germany, to make most efficient use of resources.

Examples from the United States suggest, however, that containment of invasive mosquitoes may not be easy to achieve or sustain, even under suboptimal environmental conditions for the mosquitoes. Also, previous experiences with the control of established *Aedes* populations through community participation and removal of mosquito breeding sites have not yielded positive results. Hence, new and innovative methods and strategies of containment and control, as well as new measures to prevent introduction (e.g. through import restrictions), are urgently needed.

d. Advocacy and partnership

Advocacy

Immediate action against invasive mosquitoes is justified by the threat of emerging mosquito-borne diseases in the region, as evidenced by recent outbreaks of dengue and chikungunya in southern Europe. However, a lack of awareness and political commitment to avert the problem of invasive mosquitoes has been noted at country and regional levels. Part of the problem is a shortage of technical expertise, resulting in poor surveillance, inadequate preparedness for mosquito control and a weak evidence base on the effectiveness of control interventions. Hence, the meeting recognized the need for advocacy at all levels.

Countries should raise the issue of invasive mosquitoes on the policy agenda aiming to promote legislation and coordination. It was suggested that the strategy for advocacy should point to existing cross-border initiatives (e.g. avian influenza, climate change, one health, migrant health). Because each cross-border initiative requires a preparedness plan, it should be explored to incorporate vector control for prevention of disease crises. The meeting specifically stressed that the registration of

biocides for mosquito control requires urgent advocacy at EU level and that a group of experts (e.g. EMCA members), or several front states, should take up this task, supported by available data.

Also, advocacy by WHO and Member States is needed to add specific capacities (e.g. for surveillance and control of invasive mosquitoes) to the core capacity requirements of the International Health Regulations (IHR). Specifically, the meeting recommended that countries should have capacity and legislation in place to inspect and control the introduction of invasive mosquitoes with used car tyres and 'lucky bamboo'. This could, for example, include preventive measures taken in the country of origin, or a shift in responsibility and accountability to the implicated companies. Legislation should support the access of premises for inspection, sample collection to detect the presence of exotic mosquitoes, and the application of control measures in order to eliminate introduced mosquitoes.

To address the general public, it was pointed out that communication strategies are needed to increase awareness about invasive mosquitoes and to prepare communities for public health interventions, which include vector control. Also, it was suggested that communities should be encouraged or educated to take part in the surveillance and control of invasive mosquitoes. For example, vigilance by the public can alert authorities on the appearance of exotic mosquitoes in new locations. Where mosquitoes have become established, the public could participate in mosquito control (e.g. by using novel mosquito trapping methods, sanitation, or source reduction); however, strategies for community mobilization need to be further developed and their effectiveness evaluated.

Advocacy is also needed to strengthen the evidence base on invasive mosquitoes. The meeting identified several research priorities to be addressed by countries and regional partners: the adaptation or acclimatization mechanisms of invasive mosquitoes (e.g. diapauses, cold hardiness, competition) should be studied; the vector competence of invasive mosquito species for disease pathogens needs to be determined; vectorial capacity (a measure of efficiency of transmission) of established mosquito species should be measured; new methods for surveillance and control of invasive mosquitoes urgently need to be developed; the susceptibility of invasive mosquitoes to the available biocides should be systematically monitored; preventive strategies of insecticide resistance management should be developed; and the efficacy of control methods and strategies should be subjected to critical evaluation.

Regarding the shortage of technical expertise, the meeting proposed that countries first carry out a needs assessment and prioritize requirements for training and infrastructure development, for example, by using the vector control needs assessment (VCNA) protocol as developed by WHO.

Partnership

Mosquito invasion is clearly a cross-boundary problem, requiring functional partnerships between neighbouring countries and at regional level to ensure harmonization of surveillance and response action, particularly at the points of entry and in high-risk zones (e.g. routes of introduction). Partnership could lead to cross-border agreements between neighbouring countries on the inspection of imports, following the example of Georgia and Azerbaijan. At EU level, surveillance should include internal routes of introduction between Member States.

At regional level, the meeting acknowledged the importance of technical assistance on vector surveillance and control to be given by organizations (e.g. WHO, ECDC, EMCA) and regional projects (e.g. Mediterranean Research Initiative, VBORNET). This assistance should encompass: guidance and training to countries on how to develop capacity for vector surveillance and control; facilitation of cross-border agreements between countries; coordination of activities at regional level; helping to design risk reduction strategies; strengthening the network of reference laboratories; and providing support for monitoring and evaluation. Moreover, the regional information platform with its guidance documents and central database on invasive mosquitoes and disease cases should be enhanced and its use among scientists and policy workers encouraged.

Partnership is also needed within each country. Since mosquitoes can exploit a range of environments, effective coordination among the implicated sectors (e.g. public health, municipalities, agriculture and private sector) is central to a national surveillance and control programme. Intersectoral collaboration has started in Greece in response to the increasing problem with malaria. Where responsibilities are decentralized according to sector or area, functional coordination at national level is important (e.g. to allocate extra funds in emergency situations).

e. Development of a strategy

The meeting identified the Annual Meeting of the WHO Regional Committee for Europe, in September 2013, as an opportunity for leading countries and experts to raise the problem of invasive mosquitoes on the regional agenda. Subsequently this issue should be brought forward to the Standing Committee of the Regional Committee (SCRC) in December 2012. The meeting suggested the formation of a drafting group to outline a regional strategy on invasive mosquitoes for the European Region. Also, a Regional Action Plan should be developed, which would describe the emerging problem, outline possible solutions and evidence-based measures, and define players and capacity requirements. The aim is that the strategy and action plan can be adopted (with a resolution) by the Regional Committee for Europe in 2013, which is necessary to achieve broad political commitment across the region.

Following the development of a Regional Strategy and Action Plan on invasive mosquitoes, individual countries should be encouraged and supported to develop their own strategy and action plan, adapted to the local context.

4. Conclusions and recommendations

a. Conclusions

The threat of emerging mosquito-borne diseases in the WHO European Region, as manifested by the recent emergence or re-emergence of dengue and chikungunya in southern Europe, justifies immediate action against invasive mosquitoes. However, current surveillance systems to detect invasions are inadequate and human resources are lacking in many countries and areas. Moreover, the preparedness in the region to respond with appropriate action, in terms of containment or control of invasive mosquitoes, is insufficient and is unsupported by legislation, for example, regarding putative sources such as used car tyres and 'lucky bamboo' plants. The

availability of biocides for containment and control of invasive mosquitoes is constrained by obstacles in registration at national and EU levels, while the evidence-base on the effectiveness of biocides and other control methods needs to be augmented.

b. Recommendations

Member States

1. Generate awareness and political commitment regarding the problem of invasive mosquitoes.
2. Adopt the existing standards for surveillance, risk assessment and control of invasive mosquitoes in training-of-trainers and operating procedures.
3. Enact the systematic inspection and appropriate control of exotic mosquitoes in imported goods, particularly used tyres and 'lucky bamboo'.
4. Carry out a vector control needs assessment (VCNA) to identify national requirements for training and infrastructure development.
5. Implement communication strategies to raise public awareness about invasive mosquitoes.
6. Member States are requested to develop or revise appropriate national policies to enable effective control of invasive species and to advocate or lobby the EU for necessary amendments and harmonization of their legislations.

WHO, ECDC and EMCA

7. Advocate the harmonization of procedures for registration of mosquito control biocides across the region and promote the availability of necessary mosquito control biocides in the region and at EU level; specifically, advocate that recommendations and specifications of the WHO Pesticide Evaluation Scheme are adopted as a basis for registration.
8. Inform the WHO Regional Committee for Europe about the agenda item on invasive mosquitoes for its meeting in September 2012, and the SCRC for its meeting in December 2012; and draft a Regional Strategy and Action Plan on invasive mosquitoes to be presented to the Committee in 2013.
9. Provide technical assistance to countries, in particular on surveillance (both epidemiological and entomological), risk assessment, control, and contingency plans for disease outbreaks.
10. Enhance coordination between countries and institutions across the region with regard to key activities on invasive mosquitoes.
11. Establish a network of reference laboratories in support of the identification of mosquito samples.
12. Promote research on invasive mosquitoes, most importantly on methods and strategies for containment and control.

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Annex 2. Programme of work

FINAL AGENDA

Wednesday, 6 June 2012

- 09:00–09:40 **Opening of the meeting and welcome remarks**
Dr Marianne Donker, Director, Public Health,
Ministry of Health, Welfare and Sport
- 09:40–09:50 **Appointment of chairperson and rapporteur**
Objectives of the meeting and introduction of meeting procedure,
working arrangements and housekeeping matters
- 09:50–10:10 **Global situation and strategy for the prevention and control of**
Dengue
Dr Raman Velayudhan, WHO/headquarters
- 10:10–10:20 **Regional situation and challenges: mosquito borne arboviral**
diseases in Europe
Dr Mikhail Ejev, WHO/Europe
- 10:20–10:30 **Plenary Discussion**
- 11:00–11:20 **Review of invasive species in Europe: distribution and threat to**
public health
Dr Francis Schaffner
- 11:20–11:40 **Surveillance of vectors of arboviral infections in the WHO European**
Region
Dr Wim Van Bortel and Dr Hervé Zeller, ECDC
- 11:40–12:00 **Containment and control of invasive species of mosquitoes in the**
WHO European Region
Dr Asghar Talbalaghi and Dr Norbert Becker, EMCA
- 12:00–12:30 **Plenary Discussion**
- 14:00–15:00 **Country experiences and policy challenges**
Croatia, France, Netherlands, United States
- Plenary Discussion**
- 15:30–17:30 **Group work**
- Group 1: Surveillance approaches and mechanisms for invasive**
species of mosquitoes
- Group 2: Containment and control of invasive species of mosquitoes**

Group 3: Regional strategy for surveillance and control of invasive species of mosquitoes in the WHO European Region

Thursday, 7 June 2012

09:00–12:30 **Group work continued**

14:00–15:30 **Group work presentations**

15:30–16:00 **Plenary Discussion**

16:30–17:00 **Finalization of a regional strategy**

17:00–17:30 **Closing remarks**

Dr Guénaël Rodier, Director, DCE, WHO/Europe

Dr Marianne Donker, Director, Public Health, Ministry of VWS

Mr Paul Huijts, Director General, Public Health, Ministry of VWS

The WHO Regional Office for Europe

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