





Eastern Mediterranean and the Middle East (EMME)





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"Mosquito Surveillance and Control in Spain"



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- Strong relation between first mosquito control programmes and the fight against malaria
- Malaria was en endemic disease in Spain until 1964 (Certificate of Disease Elimination by WHO)
 - <u>Eradication</u>: complete and permanent worldwide reduction to zero new cases of the disease through deliberate efforts. No further control measures are required.
 - <u>Elimination</u>: reduction to zero of new cases in a defined geographical area. Continued measures to prevent reestablishment of disease transmission are required.
- 1980's: Appearance of first Public Mosquito Control Services (wetlands with high abundance of nuisance mosquitoes).
- 1990's: professionalisation of private sector to cover the rest of the territory with the same technical premises and scientific rigor







Urban Mosquito Control (UMC): Valencia





- Mediterranean coastal city
- High extension (>135 km2) that harbor more than 800.000 inhabitants (high fluxes of tourists and immigrants).
- Intrinsic vulnerability factors: suitable urban breeding sites in public areas (68.000 catch basins), relevant macrohabitats with optimal vegetation for adult resting (6 km2 of urban gardens) and favourable climate (hot summers and mild winters; mosquito activity period aprilnovember).





Urban Mosquito Control (UMC): Barcelona



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- Mediterranean coastal city
- Regular urban morphology (relevant for GIS procedures)
- High extension (>100 km2) that harbor more than 1.6 million inhabitants (high fluxes of tourists and immigrants).
- Intrinsic vulnerability factors: suitable urban breeding sites (73.000 catch basins and 320 fountains) and favourable climate (hot summers and mild winters; mosquito activity period aprilnovember).



Methodology: major lines of UMC Programmes





➤ 4 branches of the Programme:

1) Continuous monitoring and control tasks of **Asian tiger mosquito Risk Points (ATMRP):** monthly entomological inspections (every 4-5 weeks) are done in the most suitable areas for *Ae. albopictus* proliferation from April to November.

2) **Quick citizen complaints attention**: this is also a notable source of information about cryptic problems linked to *Ae. albopictus* activity.

3) Employment of the citizen science platform called "**Mosquito Alert**" to improve communication between citizens and public administration regarding the management of mosquito control.

4) Vector monitoring and control in **areas of high** epidemiological risk (arbovirus attendance): entomological surveillance is conducted around imported cases of **DEN**, **ZIKA and CHIK** diagnosed in the city.







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Supervisors/Technical Directors: activities programming and accompaniment of most vulnerable cases (domiciliary inspections associated to imported cases of DEN, ZIKA and CHIK).

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- Entomologists: species identification and samples processing for arbovirus surveillance
- GIS Technicians: map creation and spatial data analysis for each intervention conducted
- Field Technicians: monitoring and control in mosquito activity areas.







Commitment for a biological control programme of mosquitoes

Vectomax FG®: application dosis is 10 grams per catch basin

Vectobac G[®]: application dosis is 2.2 grams per square meter (other bigger water bodies with naturalized fauna like ornamental fountains or ponds)

Device TB2[®] (**Diflubenzuron, IGR:** specifically indicated for high organic charge): application dosis is 1 tablet per catch basin.





Methodology: eventual adulticides

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Very occasional and limited to obvious risk situations for high densities of *Ae. albopictus* females surrounding imported cases of DEN, ZIKA or CHIK (localized applications in adult resting points with deltamethrin)









Arbovirus attendance: the objectives of this branch of the Programme are: a) **risk evaluation** of arbovirus amplification at local scale, b) reduce the probabilities of autochthonous disease transmission by the application of **intensive mosquito control tasks**, and c) analyze the hypothetical **virus circulation** in local vector populations.

	Nivel	aparición de casos/brotes	Definición de la situación	Vigilancia, prevención y control)
≹ = =	o	Ninguno o negligible	 Cualquier situación de clima Vectores adultos ausentes o inactivos Sin casos humanos Detección de caso importado 	 Información a los viajeros con destino a zonas endémicas Educación comunitaria Vigilancia humana Encuesta epidemiológica de caso y confirmación microbiológica de caso Vigilancia entomológica
PLAN NACIONAL DE PREPARACIÓN Y RESPUESTA FRENTE A ENFERMEDADES	1	Remota	 Clima favorable a la actividad del vector (habitualmente: primavera, verano y otoño) Presencia de vectores adultos Detección de caso probable importado en fase no virémica o caso en que, habiendo pasado el periodo virémico en España, han transcurrido más de 45 	Respuesta al nivel 0, más: • Medidas preventivas y de control de vectores
TRANSMITIDAS POR VECTORES Parte I: Dengue, Chikungunya y Zika	2	Posible	 ✓ Isolated imported cases (viremic phase after return) ✓ Evidence of vector activity in surroundings 	 Respuesta al nivel 1, más: Determinación del perimetro de intervención Inspección entomológica en el entorno del caso Revisión de actuaciones de control vectorial. Si procede, control adulticida intensificación del control de mosquitos adultos en caso de presencia de virus en las muestras de mosquitos Valoración del control de los vectores en las áreas privadas Revisión y adaptación de la vigilancia virológica Vigilancia activa de posibles casos
Ministerio de Sanidad, Servicios Sociales e igualdad Abril 2016	3	Probable	 Clima favorable a la actividad del vector (habitualmente: primavera, verano y otoño) Presencia de vectores adultos Condiciones ambientales óptimas para incubación extrinseca y supervivencia del vector Detección de 1 caso autóctono probable y/o confirmado 	 Respuesta al nivel 2, más: Difusión de información ciudadana para evitar picaduras (uso de repelentes, protección personal) Alerta de los servicios sanitarios para vigilancia activa (búsqueda de casos en humanos) Revisión y ampliación, si procede, de las medidas de control vectorial, en especial las de control vectorial
	4	Brote	 Clima favorable a la actividad del vector (habitualmente: primavera, verano y otoño) Presencia de vectores adultos Condiciones ambientales óptimas para incubación extrínseca y supervivencia del vector Casos (2 o más) autóctonos probables y/o confirmados en humanos Zona geográfica delimitada 	 Respuesta al nivel 3, más: Difusión de información ciudadana para evitar picaduras (evitar áreas con gran densidad de vectores) Mantenimiento de la vigilancia viral y de casos en humanos Alerta e instauración de vigilancia activa en atención primaria en una zona delimitada según el domicilio de los casos relacionados (búsqueda de casos en humanos) Reforzar las acciones de control vectorial.
	5	Epidemia/Endemia	 Clima favorable a la actividad del vector (habitualmente: primavera, verano y otoño) Presencia de vectores adultos Condiciones ambientales óptimas para incubación extrínseca y supervivencia del vector 	 Respuesta al nivel 4, más: Alerta e instauración de la vigilancia activa en los hospitales y atención primaria en todo el territorio Coordinar la respuesta por el Ministerio de Sanidad, Servicios Sociales e Igualdad.



Methodology: Response actions (level 2)



51359 51362 41566 33616 51349 51345 Parking cerrado (con imbornales Casa abandonada Plantas 16060 52922 4905 4908 acondicionado 16236 11987 47.188 17379 49633 34566 31520 43794 32943 LEYENDA 31221 39961 **IMBORNALES** 15767 ... 19180 33949 ... Con mosquitos y agua Con aqua Con mosq. y sin agua Con agua e insp. lim. Huerto escolar Inspección limitada Sin agua Fuera del ámbito

1. Determination of intervention perimeter; buffer of 150 meters (GIS)

2. Entomological inspection (public and private areas)





3. Review of vector control activities





4. Surveillance of secondary cases





CONTROL DE MOSQUITOS. AYUNTAMIENTO DE VALENCIA MOSQUITO TIGRE. IMBORNALES Y LÍMITE DE INSPECCIÓN (150M) Carrer de Jaca, 7 ^{*} ^{30 m} lokímica laboratorios



laboratorios

Results: Entomological actions (VLC 2016)



AJUNTAMENT DE VALÈNCIA

LOCATOR MAP

Cases	Virus / origin country	Date	Entomological findings	Control measures	Observations	NORTH SECTION
Case 1*	DEN / Ecuador	Feb	Cx. pipiens (L, A) Catch basins analysed: 132 (2% positive).	Larvicides	Notification outside the theoretically favourable period for vector activity (March- November)	
Case 2	ZIKA / Bolivia	Apr	<i>Cx. pipiens</i> (L, A) and <i>Cs. longiareolata</i> (L, A). Catch basins analysed: 206 (5% positive).	Larvicides and removing breeding sites	Additional risk area: school (patient was a student who went to school during viremic period).	As
Case 3	ZIKA / Bolivia	May	 <i>Cx. pipiens</i> (L, A) and <i>Cs. longiareolata</i> (L, A). Catch basins analysed: 71 (7% positive). 	Larvicides	None particular situation to remark	LEGEND Residential Arbovirus Risk Area Other Arbovirus Risk Area
Case 4	DEN / Tahiland	Jul	Catch basins analysed: 157 (26% positive).	Larvicides	None particular situation to remark	Asian Tiger Mosquito Risk Points Asian Tiger Mosquito Activity Points Asian Tiger Mosquito Activity Points Valencia Municipal Limits
Case 5	ZIKA / Colombia	Aug	<i>Cx. pipiens</i> (L, A) and <i>Cs. longiareolata</i> (L, A). Catch basins analysed: 101 (18% positive).	Larvicides	None particular situation to remark	✓ 7 imported cases (2 CHIK; 6 cases from L attended inside the vi
Case 6	CHIK / Bolivia	Sep	<i>Cx. pipiens</i> (L, A) and <i>Cs. longiareolata</i> (L, A). Catch basins analysed: 264 (3% positive).	Larvicides	Additional risk areas: 2 hospitals (patient was in the urgencies units of both hospitals during viremic period).	 ✓ 11 arbovirus risk are ✓ 1 010 establishesi
Case 7*	ZIKA / Mexico	Oct	<i>Cx. pipiens</i> (A) and <i>Ae.</i> <i>albopictus</i> (A**). Catch basins analysed: 111	Larvides and adulticides (local spraying in catch	Additional risk area: hospital (patient was a sanitary professional who was working in the bognital during virgonia	 1.042 catch basins p (7% mosquito activity)
			(5% positive).	Dasilisj	neriod)	 All cases with entomotion

Table. Data associated to the 7 confirmed cases of DEN, ZIKA and CHIK diagnosed in Valencia during 2016. * Cases environmentally attended inside the viremic period. ** Two females of Ae. albopictus were collected resting in the patient building (in outside conditions) coinciding with the viremic period.



DARWIN

- DEN, 4 ZIKA and 1 atin America; 2 cases remic period)
- eas (mobility)
- prospected & treated
- ological surveillance in private areas (1 positive for Ae. albopictus)





Results: Entomological actions (BCN 2015-16)



Analysis of virus presence in *Ae. albopictus* females collected

2015: 26 samples of 8 cases. <u>All negative</u>.

2016: 11 samples of 7 cases. <u>All negative</u>.







Conclusions



Once DEN, ZIKA or CHIK imported cases are diagnosed, the establishment of quick response protocols based on entomological surveillance and control is mandatory to evaluate the risk of arbovirus transmission and also to minimize the local disease amplification. At this point, <u>inspections on private</u> <u>areas</u> (patient domiciles) are very appropriate.

UMC: conclusions and future objectives

- Improve networks of communication among medical and vector control units, because entomological inspections inside the viremic phase are still lower than desirable (communication of suspected/probable cases instead confirmed ones).
- The analysis of virus circulation in local vector populations is essential for risk assessment (quick examination to adapt and dimension properly the vector control activities to execute).
 - DENV presence in Ae. albopictus females associated to domiciliary conditions in an imported case declared in the MAB: evidence of virus circulation (unpublished data)

Intrinsic incubation (viremia phase) DEN: 1-8 days ZIKA: 3-5 days CHIK: 1-10 days

Extrinsic incubation DEN: 10 days ZIKA: 15 days CHIK: 10 days

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Wetlands Mosquito Control (WMC) Programmes



The effort on mosquito prevention (larviciding) goes unnoticed



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WMC Programmes affected by rainfall and temperatures evolution, but also other more complex issues related to <u>hydrology</u> (changes in water dynamics) and <u>biodiversity</u> impact (legislation)

distance

Breeding



Wetlands Mosquito Control (WMC) Programmes



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RED DE PARQUES NACIONALES

NATURA 2000 Ramsar

- management of wetlands for people respectful enjoyment and an asons (reduce zoonoses transmission rates): improving environmental quality o wetlands.
- Selective tools with minimum impact (Bti)
- No to immobilism on wetlands management / Yes to rational, respectful and technified management of wetlands









"Flood water" mosquitoes

Ochlerotatus caspius Ochlerotatus detritus (winter peak)



Main "permanent water" mosquitoes

Culex pipiens Culex modestus Culiseta longiareolata Culiseta annulata Culiseta subochrea





Culex theileri Culex laticinctus Culiseta litorea Uranotaenia unguiculata Coquillettidia richiardii Coquillettidia buxtoni



"Tree hole" & "artificial container" mosquitoes (rare)

Only nuisance mosquitoes are treated and controled





Aedes albopictus Ochlerotatus echinus Ochlerotatus geniculatus Anopheles plumbeus







WMC Programmes: working methodology

sample



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collection. Good training of technicians potential breeding geolocated.

of

sites are Weekly larval monitoring during the period of maximum activity (aprilbiweekly october) and during the rest of the year (november-march).

All



CDC Sentinel 5. Traps biweekly to monitor mosquito populations

2. Evaluation of larval density, percentages of different development stages, precheck

species identification and

3. Daily re-evaluation of field data collected in lab conditions.

4. Mosquito control tasks by terrestrial, aerial or pedestrian methods.



WMC Programmes: Bti treatments



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Becker (EMCA, 2015)

Bti: Efficacy and specificity

Different Sensitivities of nematoceran flies for BTI

Family	Dosage	Mortality	Sensibility	
Culicidae	0,2 ppm	100%	x	104
Simuliidae	0,4 ppm	100%	2x	X
Psychodidae	1 ppm	100%	5x	-
Chironomidae	1,8 ppm	90%	>10x	Canada
Dixidae	2 ppm	100%	10x	~
Chaoboridae	180 ppm	no effect	0	*B
Sciaridae	3 ppm	90%	15x	-
Tipulidae	30 ppm	50%	>100	0
Ceratopogonidae	180ppm	no effect	0 (EMCA 201	5)

Sensitivity to *Bti* in chironomidae and culicidae larvae (data from acute toxicity tests in laboratory conditions)

Famille	Taxon	CL ₅₀ (UTI)
Chironomidae	Chironomus salinarius	16118
	Chironomus spp.	12200
	Chironominae other	10359
	Crycotopus	10359
	Dicrotendipes	10359
	Orthocladius	9000
	Orthocladiinae other	31500
	Psectrotanypus	6215
	Smittia	54000
	Tanypodinae other	7143
Culicidae	Culicidae all	37





WMC Programmes: Bti treatments



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Legislation



MINISTERIO DE SANIDAD, SERVICIOS SOCIALES E IGUALDAD SECRETARIA GENERAL DE SANIDAD Y CONSUMO

DIRECCIÓN GENERAL DE SALUD PÚBLICA, CALIDAD E INNOVACIÓN

SUBDIRECCIÓN GENERAL DE SANIDAD AMBIENTAL Y SALUD LABORAL



We should prepare an <u>Aerial Applications Plan</u> for each wetland yearly specifying which concrete biotopes are requested to be treated

Nº Registro / Autorización: ES/MR(NA)-2016-18-00388

VECTOBAC 12 AS

3. El titular de la autorización cumplirá, los requisitos especiales establecidos en el cuadro siguiente. De no ser así, el producto biocida no podrá mantenerse en el mercado.

	· · · · · · · · · · · · · · · · · · ·
	REQUISITOS ESPECIALES
1.	La aplicación aérea del producto requiere una autorización específica del órgano competente de la Comunidad Autónoma correspondiente.
2.	La utilización del producto en Espacios Naturales Protegidos, Red Natura 2000 o Áreas protegidas por instrumentos internacionales, o cuando la aplicación pueda dañar a la fauna silvestre, deberá contar con una autorización administrativa específica del órgano competente de la Comunidad Autónoma correspondiente.
3.	El tratamiento deberá ser objeto de supervisión por parte del/los Departamento(s) competente(s) en la materia (desde el prisma de protección de la salud de los hombre, animales y plantas) de la Comunidad Autónoma correspondiente. Por ello, debería comunicarse debidamente los datos relativos a la fecha, lugar exacto, duración de tratamiento y empresa aplicadora.
4.	Se harán controles frecuentes de la calidad del agua.

"The aerial application of the product requires a <u>specific authorization</u> from the competent agency of the corresponding Autonomous Region."

"The use of the product (Bti) in Natural Protected Areas, Natura 2000 Network or other zones protected by diferent international instruments, or when the application may harm wildlife, must have a <u>specific</u> <u>administrative authorization</u> from the competent agency of the corresponding Autonomous Region."



We should apply yearly for permission regarding to Bti treatment and deliver a report with main results of each mosquito control campaign





Aerial Applications Plan





Plan de Aplicaciones Aéreas contra Mosquitos en el Término Municipal de Cabanes

- <u>Map of the treatment areas</u> (buffer of 50 meters to inhabited areas, as risk mitigation measure).
- Justification that <u>terrestrial treatments are non-viable or not</u> <u>enough efficient</u> to reduce the mosquitoes incidence (big extension of floods, inaccessibility to some breeding sites,...).
- The area requested to be treated with Bti by aerial applications should be <u>bigger than 0.5 hectares</u>.
- Only helicopters are permitted, not other aircrafts (planes). Drones under study.
- Helicopters should have a Global Positioning Systems (GPS) with real-time differential correction service (DGPS) to record the data of the treatments performed (doses and flight routes). This information should be stored during 3 years after the treatment and can be solicited by public agencies at any time.







-61068

-41068

-36068

-26068





Conclusions







- ✓ A detailed <u>knowledge of mosquito species</u> (taxonomy, behaviour and phenology) and the <u>hydrological</u> <u>dynamics of wetlands</u> are mandatory to implement integrated and efficient surveillance and control programmes in these complex ecosystems.
- ✓ Fortunately we have <u>selective tools</u> (basically *Bacillus thuringiensis israeliensis*) to work in these protected enclaves maximizing the environmental respect. So <u>we need to involve the environmental agencies</u> in our respectul mosquito control programmes in order to continue analyzing carefuly and seriously which is the real impact of our activity in the wetlands (we can always improve our actions but we can not just stop and not intervene in this issue of <u>major interest for Public Health</u>).
- ✓ 2 potential risks: (1) the <u>accumulation of spores and toxins in the environment</u>, and possible proliferation of Bti a long time after spraying, which may have an impact on the whole ecosystem functioning, (2) the evolution of <u>resistance to Bti</u> in mosquitoes, rendering the treatment inefficient. It is therefore necessary to <u>develop monitoring tools to follow the fate of spores and toxins in the environment and the evolution of</u> <u>resistance in target mosquito populations</u> (Després *et al.*, 2011).
- ✓ Definitively <u>aerial treatments are absolutely necesary</u> to cover properly some big flooding areas that show high incidence of mosquitoes. Nowadays drones are also promising complements that should be properly legislated to help us in the fight against mosquitoes in wetlands.



Native and Non-Native Vector Management in the Eastern Mediterranean and the Middle East (EMME)

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Thanks for your attention!

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