Expanding the Vector Control Toolbox is urgently needed and we should vote for it.

William Gorgas, Fred Soper or Israel Kligler pioneers of integrated mosquito control – their legacy is as relevant as 100 years ago.

Norbert Becker, Manuel Lluberas, Peter DeChant, Peter Dambach and Rainer Sauerborn

Kigali
16th of April, 2024
Our RBM-Working group initiated the preparation of an Operational Manual for Larval Source Management in 2012 as an additional tool to the three columns here (in blue) when ever it is feasible to apply.
There is no golden bullet in the fight against malaria - all available tools have to be used - larviciding has to go along with adulticiding whenever it is feasible.

Surprisingly in the World Malaria Report - to my understanding „LSM“ is not mentioned with a single word!

The need for a more integrated control strategy including LSM is underlined in the next slides.
Are the achievements of the RBM Program after the Implementation in the year 2000 enough?

Despite all efforts (excluding LSM) and spending each year almost 3 billion dollars the number of malaria cases didn’t decrease – but increased!

The positive result is that the number of death decreased by 30% the last decades!

What are the main reasons for the failure in the reduction of malaria cases?
What are the challenges of the RBM-Malaria programme?

Pyrethroid Resistance of the vectors

Deltamethrin Resistance in *Anopheles gambiae* s.l. mosquitoes in Africa is tremendously increasing (2005 – 2017)

An. stephensi spreads from 2012-2023 to 7 countries – dramatic increase of malaria cases in Djibouti

Changing vector populations from endophagy (*An. gambiae*) to exophagy (*An. arabiensis*, *An. funestus*)

Shifts to exophagy due to non-uniform exposure to insecticides – selection pressure

„Protection Gap“ when only ITNs and IRS are applied

Gap: 6pm – 10 pm
Risk behavior – working and sleeping in field

Occurrence of new competent vectors: *An. stephensi*

*An. stephensi* spreads from 2012-2023 to 7 countries – dramatic increase of malaria cases in Djibouti
What is the lessons we have to learn?

We have to increase our tool box and should integrate LSM whenever it is feasible and suitable to overcome the mentioned constraints.

In the following slides I give you a few successful examples of the successful implementation of LSM in integrated vector control programs.
Larval Source Management was a core-element in the Malaria and Yellow Fever eradication program in Panama.

First approach of integrated control based on:

1. Drainage
2. Larviciding (oil)
3. Prophylactic quinine
4. Screening
5. Adult killing

By implementing LSM in Panama Gorgas he made the construction of the Panama channel possible – he became a National hero! William C. Gorgas
Larval Source Management was a core-element in the malaria eradication program in Brasil.

Frederick Sober eradicated *An. gambiae* from Northeast Brazil from 1939 – 1940 by Larval Source management with Paris green (arsenic based insecticide) and pyrethrum spraying.
Kligler’s Anti-malaria campaign through LSM resulted in the eradication of malaria 100 years ago in Palestine.

His success to eradicate malaria was based on LSM - making potential breeding sites non-productive for mosquitoes by
- mapping and drainage of the breeding sites,
- using larvivorous fish (*Gambusia* sp.) and
- community participation by educational programs.

Israel Jakob Kligler
a story of success *solely based on LSM* employing formulations of *Bacillus thuringiensis israelensis* and water management in a community-based program to combat floodwater mosquitoes

Members: Communities/Cities/counties: 95
Inhabitants: 3 Million
Control Area: 6,000 km²
Breeding area: 60,000 Hectars
Number of sites: 6,000
Permanent Staff: 60
Temporary staff: 200

Budget: appr. 6.5 Mill. Euro
Average costs: appr. 2.6 €/caput/Year

What are the reasons related to the success of this program!
The break-through was the implementation of LSM based on the use of formulations of *Bacillus thuringiensis israelensis* and water management

Protein toxins of the soil-bacterium *Bacillus thuringiensis israelensis* are extremely selective – kill only larvae of some nematoceren flies as mosquitoes and blackflies. Keeps the biodiversity, Easy to handle – and are not toxic for the user!

Water management to modify the breeding sites to be not productive for mosquitoes and encouraging of the major larval predators – the FISH.
Prerequisites for a successful LSM programme in an integrated strategy

Political will!

Functioning Infrastructure on a community-base!

Clear responsibilities

Training of staff in biology of vectors, handling of insecticides and operation

Precise Mapping

Mapping and numbering of the breeding sites for quick communication.
We have suitable Formulations and Application techniques to our disposal for...

**Ground Application**
- Knap sack sprayers
- 500g Vectobac WG in 10 Liter of water/ha
- BTI- corn cob granule
- 5-10 kg/ha

**Aerial Application**
- Helicopters and drones allow precise wide-scale application when abundant floodings occur.

Knap sack sprayers
500g Vectobac WG in 10 Liter of water/ha

BTI- corn cob granule
5-10 kg/ha

VECTOBAC GRANULATE

Helicopters and drones allow precise wide-scale application when abundant floodings occur.
Summary of the LSM-activities with Bti in the Upper Rhine Valley the last 40 years

Consumption of Bti from 1981-2020 > 5000 tons

Granules: 5.086 tons
Powder/Fluid concentrates: 86 tons

Treated areas from 1981-2020 > 420.000 hectares

Total area: 423.998 Hectars
Helicopter applications: 274.668 hectares
Ground application: 149.330 hectares
Result of all LSM activities: >95 % Reduction of the floodwater mosquitoes

Employing CO$_2$-baited EVS-traps in regular intervals for quality control.

The Public appreciates the results with great enthusiasm – increase of life quality!
Remarkable Side-effects of LSM with Bti

Conservation of the biodiversity

No resistance after 40 years!
Bridging from the Upper Rhine to the Sahel zone in Burkina Faso

The EMIRA Project
(ecological malaria reduction in Africa by LSM)

A cooperative programme between the Health Department in Nouna, Province of Kossi, Burkina Faso, the University of Heidelberg and the German Mosquito Control Programme (KABS)

Financed by the Foundation of Manfred Lautenschläger (appr. 400.000 Euros)

The Provinz Kossi has ca. 230.000 inhabitants; Capital city „Nouna“: 25.000 inhabitants.
Altogether 84 villages (red) were treated with Bti and 43 villages (black) served as control.
Building the infrastructure
In the Preparation phase (2013) for the Intervention phase (2014-2015)

Mapping of the breeding sites and assessment of the optimum dosage of Vectobac WG (2013)

For each village maps are prepared (GPS-codes) for quick and precise intervention.


In each cluster 4 villages and in each 3 houses have been monitored by CDC traps bi-weekly

Epidemiological Data collected from the Health Center in Nouna
Assessment of the optimal dosage and Capacity building

- Assessment of the optimal dosage (2013)

  Tested product: Vectobac WDG (3000 ITU/mg

  Result: 300 g/ha each 10 days.

- Capacity building and development of the community-infrastructure

  Selection of spray personal (each village 1 spray team with each two people) = 160 people

  Quality control: 20 controllers check the accuracy of the treatments
Sensitization of the villagers

Governmental application, close cooperation of all relevant authorities (ministries, health departments, institutions was important
Training of the 180 field workers

Training in the health center in Nouna

Project manager is: Dr Issouf Traore and Dr Peter Dambach
Application in Nouna is as successful as in the Upper Rhine Valley with an appropriate infrastructure on both sides.
Counts of Anopheles females per night per trap

Reduction of the vector population by >70% in the intervention zone.
Cost-analysis studies for LSM with Bti

Germany: 1.50 Euros/person/year

Kenya: 1.11 US$/person/year

Burkina-Faso: 1 Euros/person/year
Some additional proofs of the efficiency of LSM in the fight of Malaria

Some other successful IVM programs including LSM:


Conclusion and recommendation

LSM should be considered as the 4th column beside LLINs, IRS and effective diagnosis and medical treatment of malaria cases whenever it is feasible and applicable.

RBM programme should provide a certain amount (at least ca. 10 %) of the available money for LSM, our WG should select projects feasible to reach our goals.
THANK YOU for your ATTENTION!