Malaria control:
Historical lessons & historic opportunities

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8 December 2016

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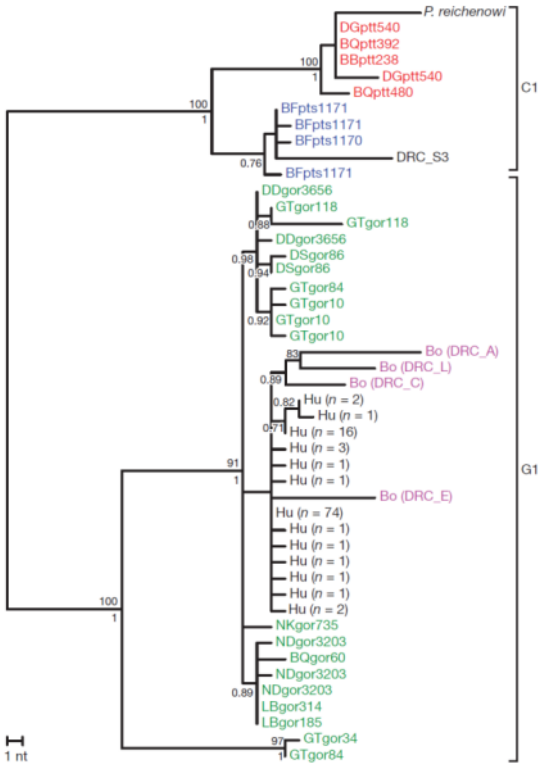
INITIATIVE

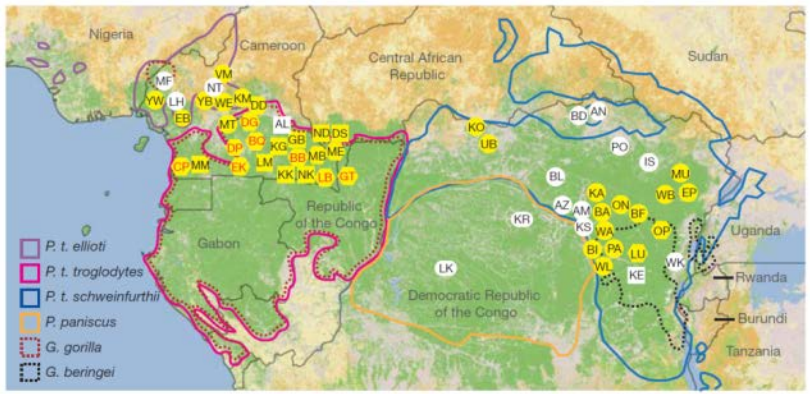
Ancient history

- Parasites in western gorillas found to be nearly identical to *Plasmodium falciparum*



- Related parasites found in 30 million year old mosquitoes

Poinar G, 2005



Liu et al. Nature 2010

Mal'aria

WHAT IS MALARIA?

AND

WHY IS IT MOST INTENSE IN HOT CLIMATES?

CHAPTER I.

GENERAL OBSERVATIONS.

What is Malaria?—General ideas on the subject—Hygienic arrangements based on supposed origin of malaria in vegetable decomposition—Correctness of this theory often doubted, but no other has yet supplanted it—Malarious fevers chief cause of sickness over a large portion of the globe—Till nature and origin of malaria fully understood, little can be done to check its destructive effects—Prevalence of malarious disease in India—Mortality directly resulting from malarious fevers bears but a small proportion to that indirectly caused by them—Malarious diseases and their ill effects well known from a very early period, though their origin is still disputed—Malarious fevers those with which the ancient physicians were best acquainted—Hippocrates does not refer to marsh miasma, though aware of the prevalence of disease in marshy places—Probably knew malaria was not a marsh poison—Other ancient writers on the subject—Avicenna alludes to vegetable decomposition—In more modern times Lancisi a great champion of the theory of "marsh poison."—Ascribed malaria to decomposition of animal as well as vegetable matters—Pringle's observations—Opinions of Lind, Annesley, Fergusson, Williams, McKinnon, Morehead, Bennett, Parkes, Martin, Aitken, Salisbury, and Niemeyer.

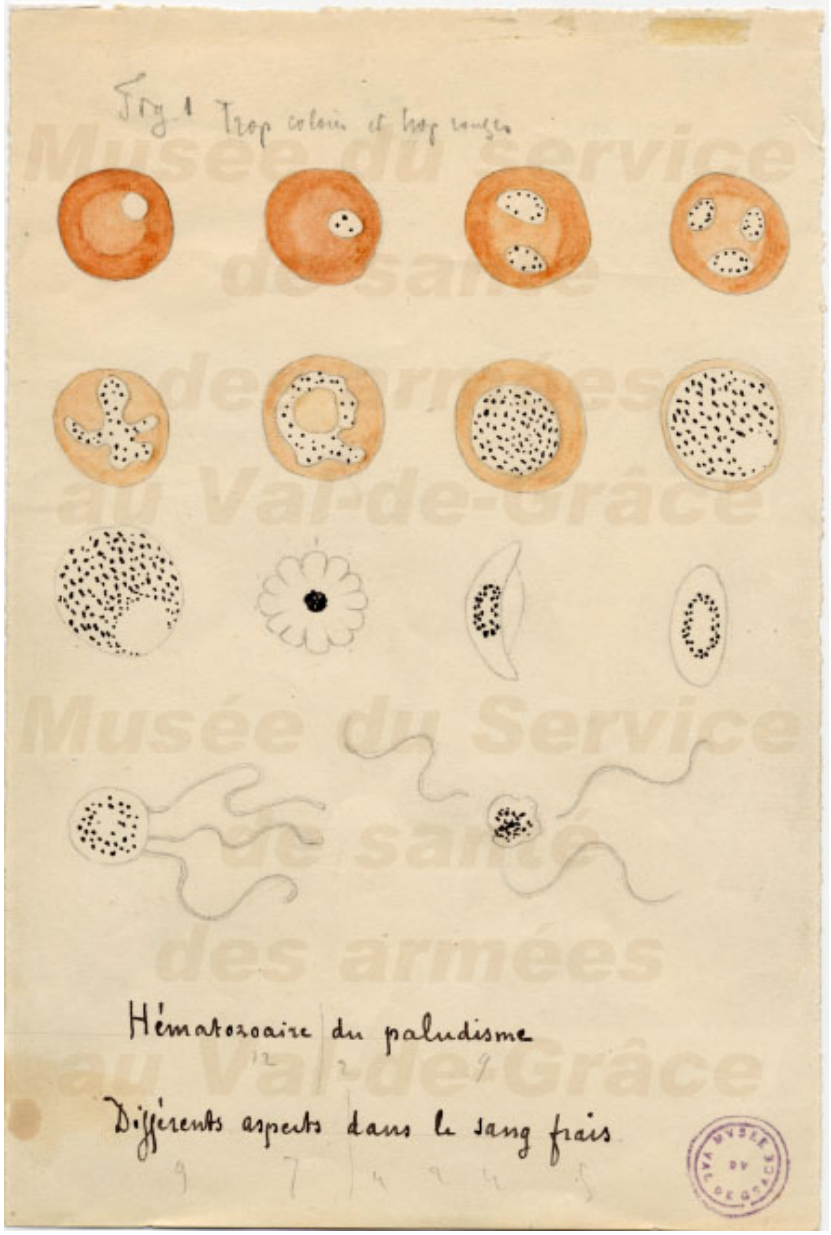
What is Malaria?

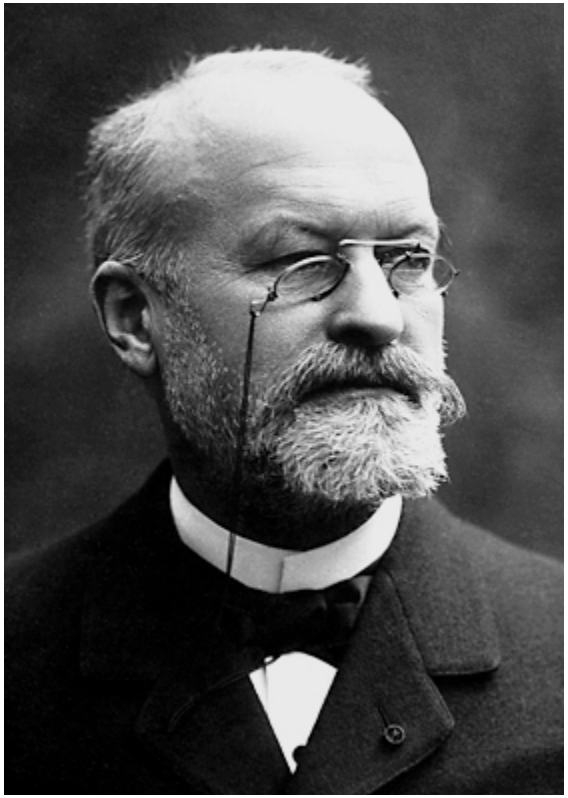
On referring to modern works on Medicine, we find it generally stated, that malaria is a poison given off by organic, especially vegetable matters, in a state of decomposition; and upon this basis are founded the hygienic arrangements of all malarious countries.

Faith in this dogma has many times been shaken, and several authorities have endeavoured to account in other ways for the influence, whatever it be, by which the class of diseases known as malarious fevers is produced; but none of the theories so proposed have stood their ground.

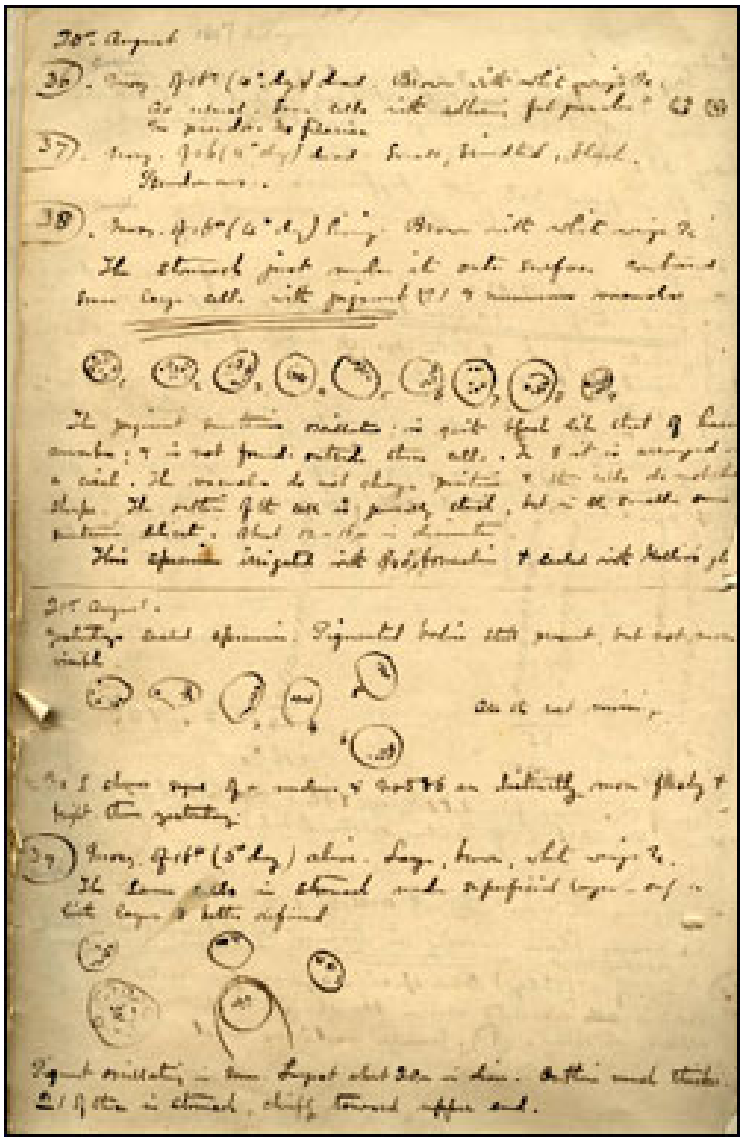
Charles Oldham, 1871

Charles Laveran discovered the malaria parasite in 1880





Ronald Ross discovered mosquitoes transmitted parasites in 1897



- Ross conducted his studies while stationed in India
- Discovered parasites in the stomach tissue of *Anopheles* mosquitoes

"This day relenting God
Hath placed within my hand
A wondrous thing; and God
Be praised. At his command,

Seeking his secret deeds
With tears and toiling breath,
I find thy cunning seeds,
O million-murdering Death.

I know this little thing
A myriad men will save,
O Death, where is thy sting?
Thy victory, O Grave?"

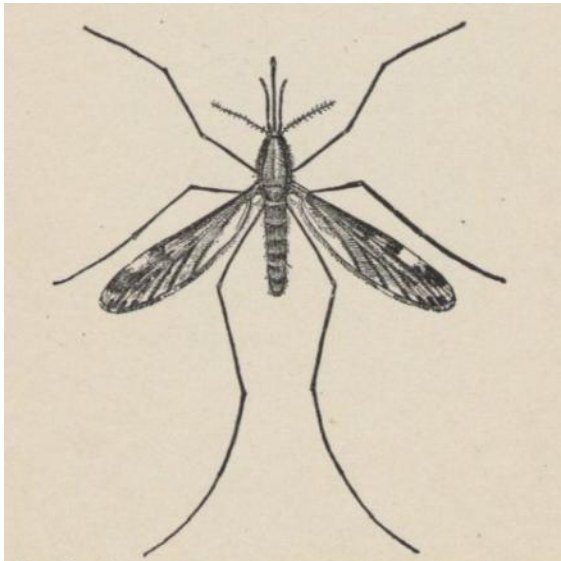


FIG. 8.—ANOPHELES, OR MALARIAL MOSQUITO: FEMALE (Howard)

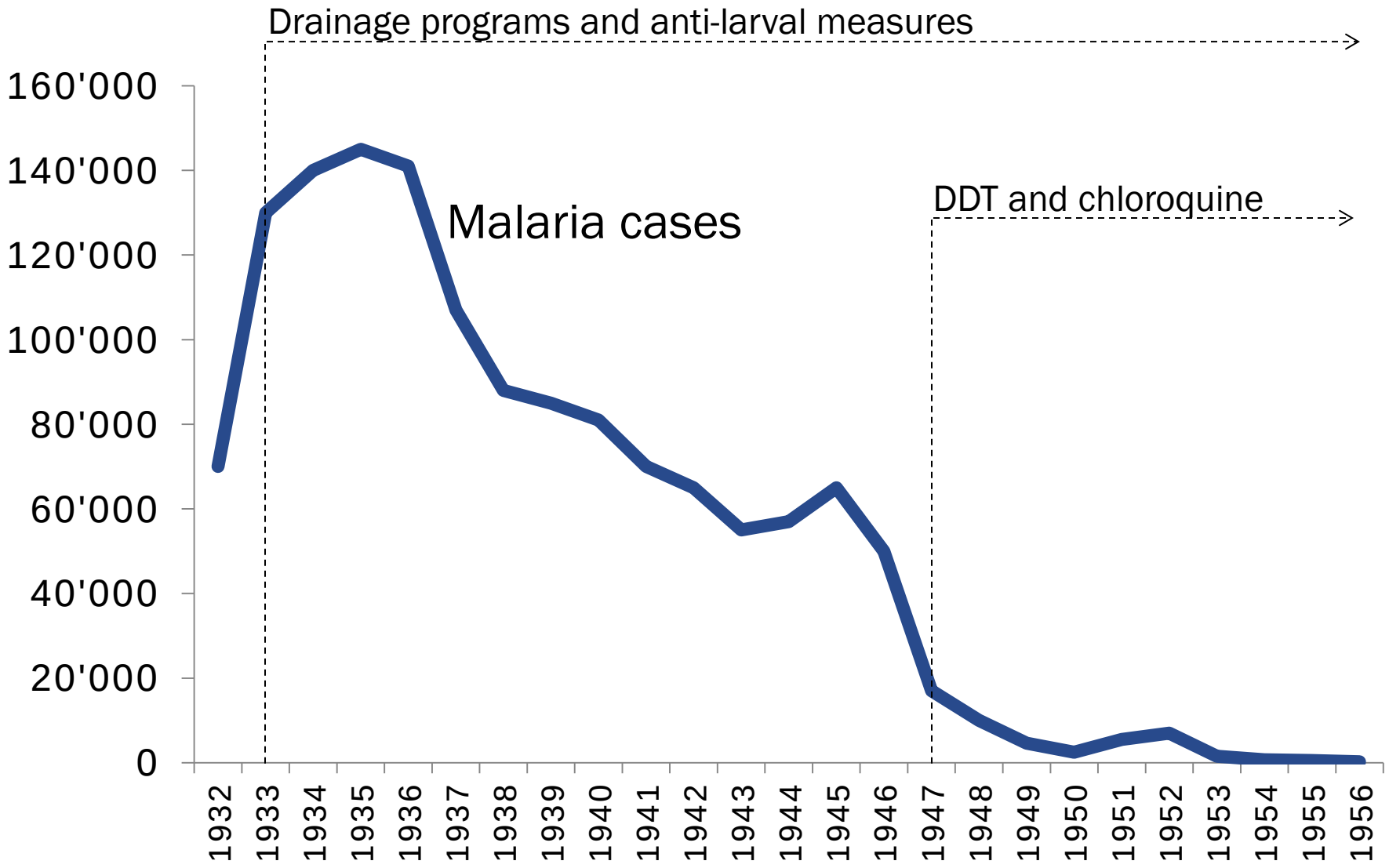
Doty 1912.

Vector control was key to the success of the Panama Canal, 1904

National Library of Medicine

- Col William Gorgas:
  - Drainage, brush cutting, oiling, larviciding
  - Prophylactic quinine
  - Screening, killing adult mosquitoes

In the US, larval control, insecticide spraying, widespread treatment, and development eliminated malaria by 1957



Source: Lisansky, Annals of Int Med 1958

Discovery of DDT's insecticidal properties yielded a potent new weapon

Paul Müller
Nobelprize.org

Patented Sept. 7, 1943 **2,329,074**

UNITED STATES PATENT OFFICE

2,329,074

DEVITALIZING COMPOSITION OF MATTER

Paul Müller, Neu-Allschwil, near Basel, Switzerland, assignor to the firm J. R. Geigy A. G., Basel, Switzerland

No Drawing. Application March 4, 1941, Serial No. 381,763. In Switzerland March 7, 1940

6 Claims. (Cl. 167—22)

For combatting insects of all kind such as flies, stinging flies, moths, beetles, plant-lice and so on, there are mostly used petroleum solutions of pyrethrine or rotenone or aqueous emulsions of such compounds. Nicotine is, in spite of its poisonous character, also used for the protection of plants, but it cannot be used in inhabited rooms.

Both the first mentioned agents show the disadvantage of smelling disagreeably in spite of the admixture of strong perfuming agent, when they are used in form of petroleum solutions. In aqueous emulsions they are however stable only for a short time, as their activity already strongly decreases after a short time.

All experiments for inventing artificial substances acting very rapidly and positively, but being nearly or completely odorless and having no irritating effect upon human beings have given until now no essential result. Thus for example the use of halogenated nitriles, especially of trichloracetonitrile, is limited to uninhabited buildings or to closed receptacles, as these halogenated compounds, even when extremely diluted, irritate very strongly the mucous eye-membrane.

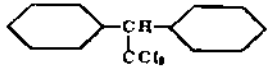
Therefore, it is very surprising that the condensation products of 1 molecule of chloral or bromal with 2 molecules of compounds with replaceable hydrogen from the aliphatic, araliphatic and benzene series, show, beside the sure killing effect on insects, only a very weak and not at all a disagreeable odor and do not exert even in finely dispersed form any irritating effect on the mucous membranes of the eyes, nose or throat.

The preparation of the claimed compounds is known in many cases, and where this is not so it will be described in detail in some of the following examples.

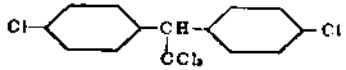
The following examples illustrate the present invention. The parts are by weight, unless otherwise stated.

Example 1

By treating, while strongly stirring, a mixture of 2 molecules of benzene or chlorobenzene with 1 molecule of chloral or chloralhydrate with an excess of concentrated sulfuric acid (of 100 per cent strength) heating takes place after same time, which first increases up to about 60° C. and then slowly decreases again. Stirring is continued until the reaction mass has cooled down to room temperature and contains solid particles. Then it is poured into much water whereby the raw condensation product separates out in a solid form. It is well washed out and, after being recrystallised from alcohol, it is obtained in form of white, fine crystals which show a weakly fruit-odor. The formulae of these compounds are the following ones:



and

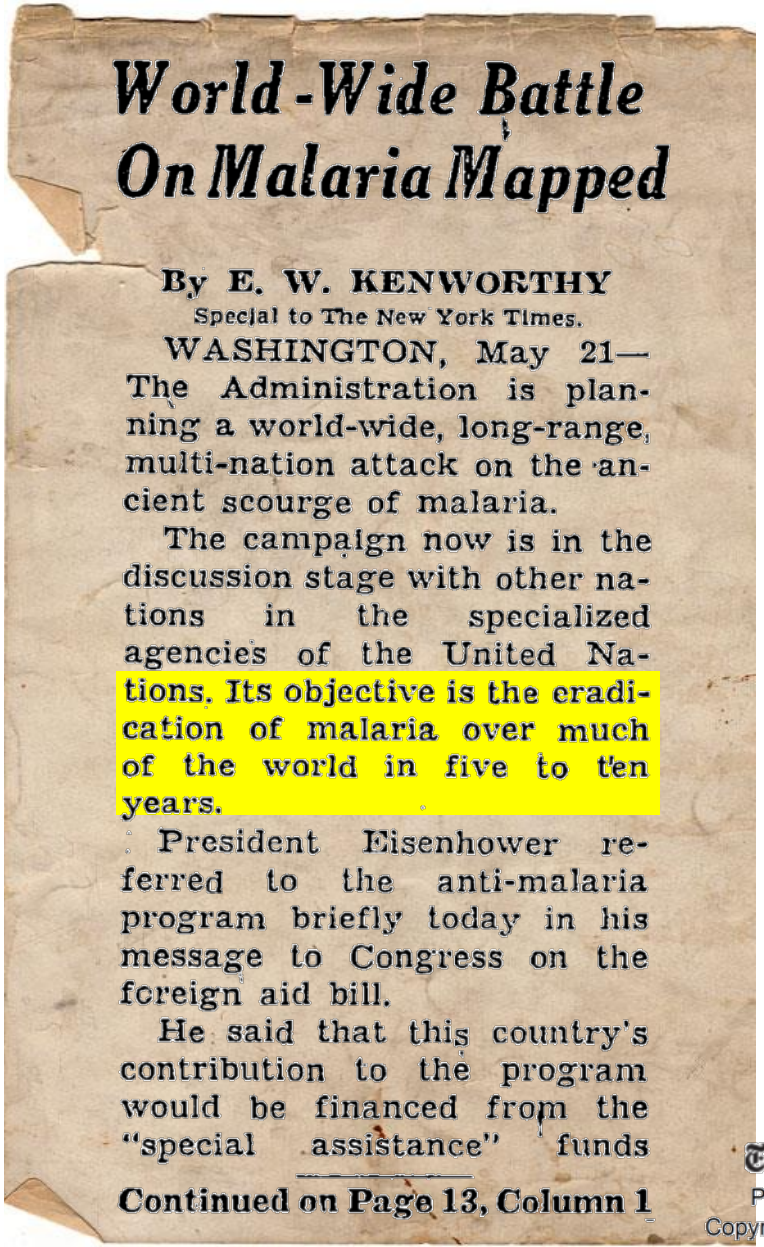


The first compound melts at 64° C., the second one at 103–105° C. (about the preparation see also O. Fischer, B. 7, 1191). These two diphenyl-

Indoor residual spraying with DDT

Indoor Spraying in Italy, 1945
Source: National Museum of Health and Medicine

The Global Malaria Eradication Program, 1955-1969



World-Wide Battle On Malaria Mapped

By E. W. KENWORTHY
Special to The New York Times.

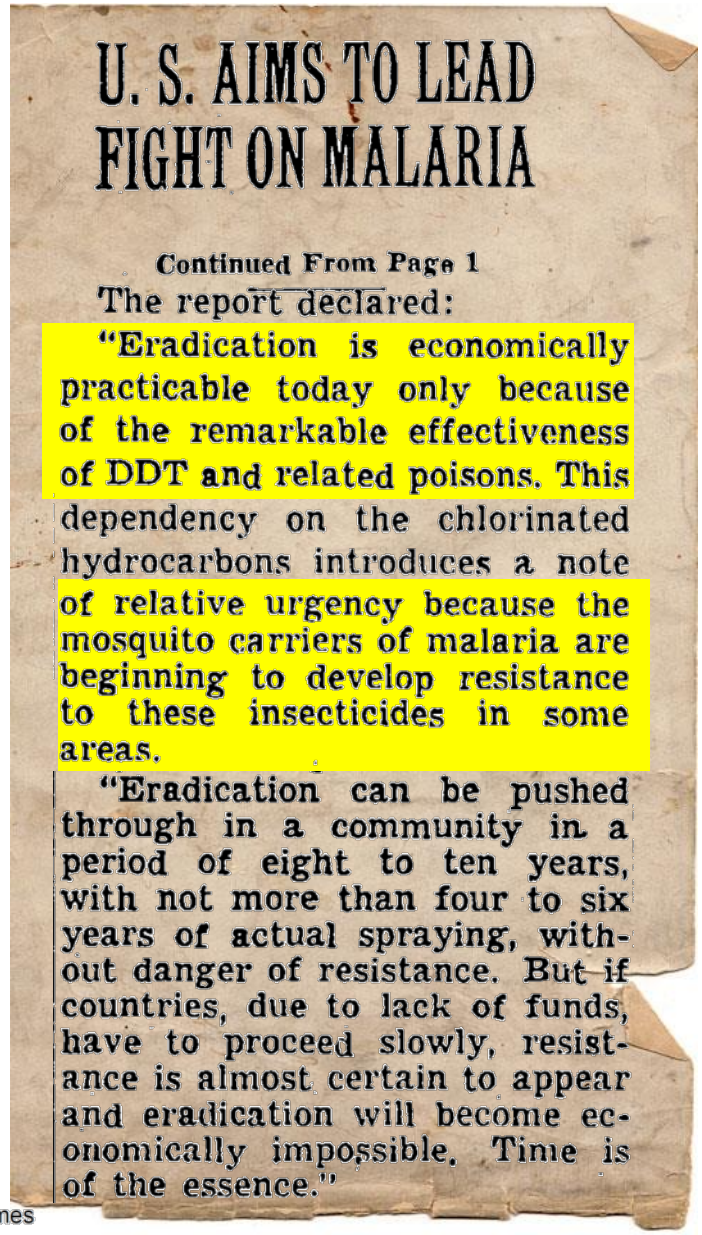
WASHINGTON, May 21—The Administration is planning a world-wide, long-range, multi-nation attack on the ancient scourge of malaria.

The campaign now is in the discussion stage with other nations in the specialized agencies of the United Nations. Its objective is the eradication of malaria over much of the world in five to ten years.

President Eisenhower referred to the anti-malaria program briefly today in his message to Congress on the foreign aid bill.

He said that this country's contribution to the program would be financed from the "special assistance" funds

Continued on Page 13, Column 1



U. S. AIMS TO LEAD FIGHT ON MALARIA

Continued From Page 1

The report declared:

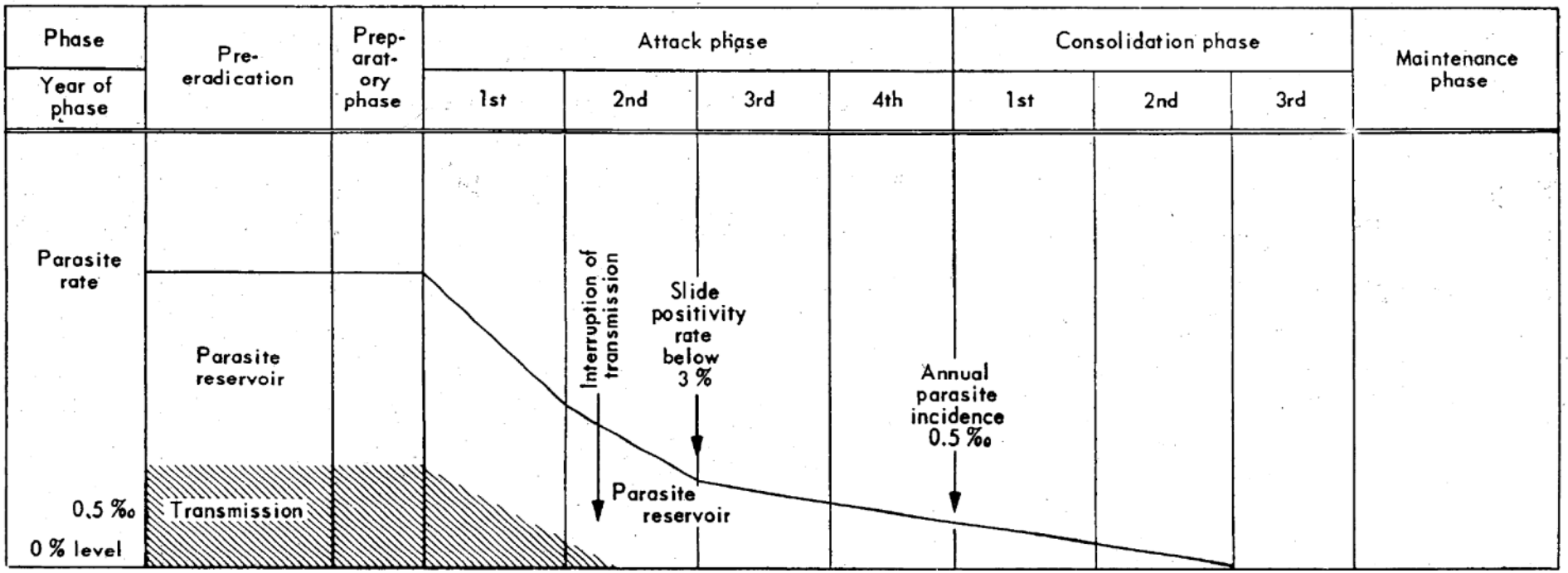
"Eradication is economically practicable today only because of the remarkable effectiveness of DDT and related poisons. This dependency on the chlorinated hydrocarbons introduces a note of relative urgency because the mosquito carriers of malaria are beginning to develop resistance to these insecticides in some areas.

"Eradication can be pushed through in a community in a period of eight to ten years, with not more than four to six years of actual spraying, without danger of resistance. But if countries, due to lack of funds, have to proceed slowly, resistance is almost certain to appear and eradication will become economically impossible. Time is of the essence."

The New York Times
Published: May 22, 1957

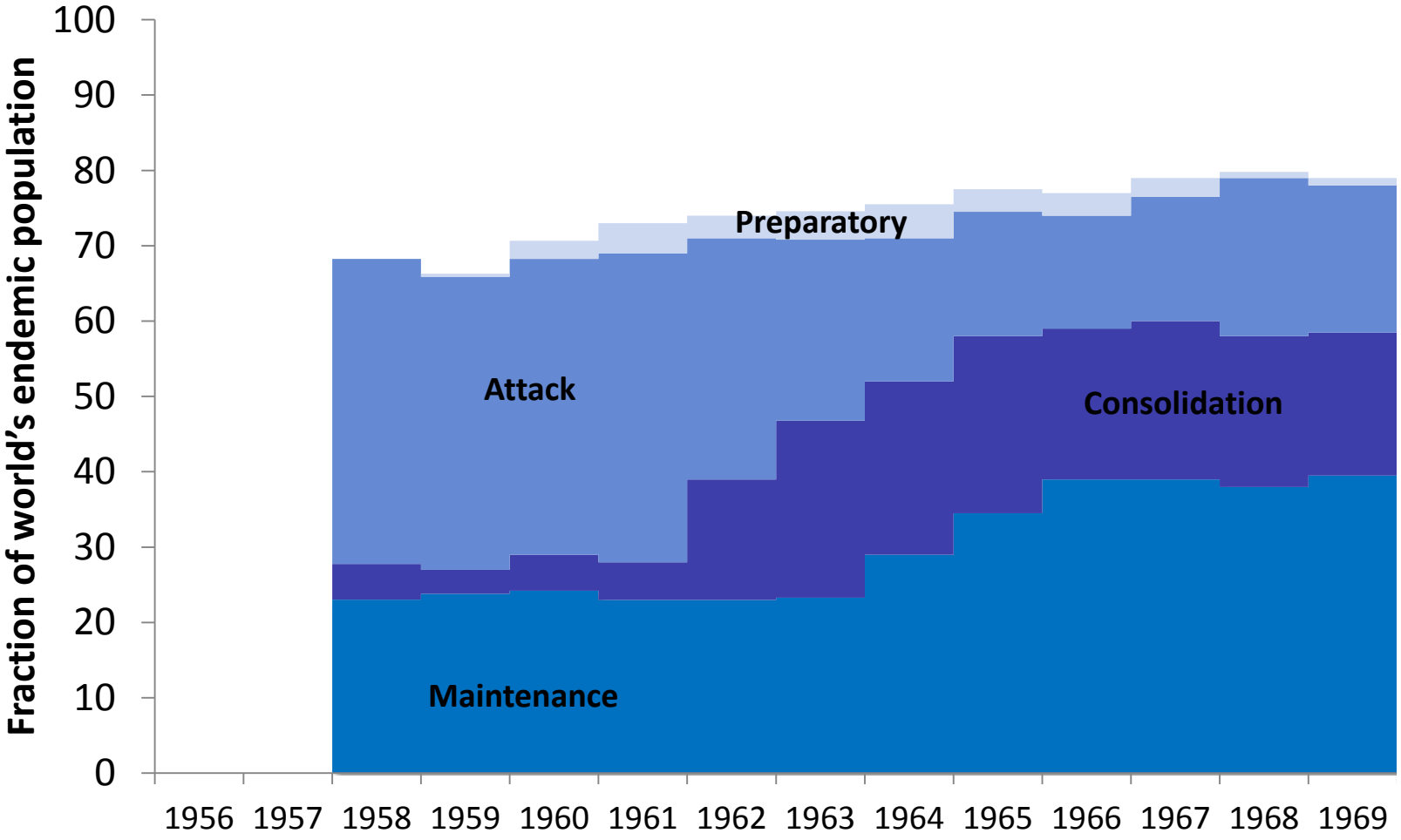
Phases of the eradication program

(a) Expected trend of malaria situation during an eradication programme



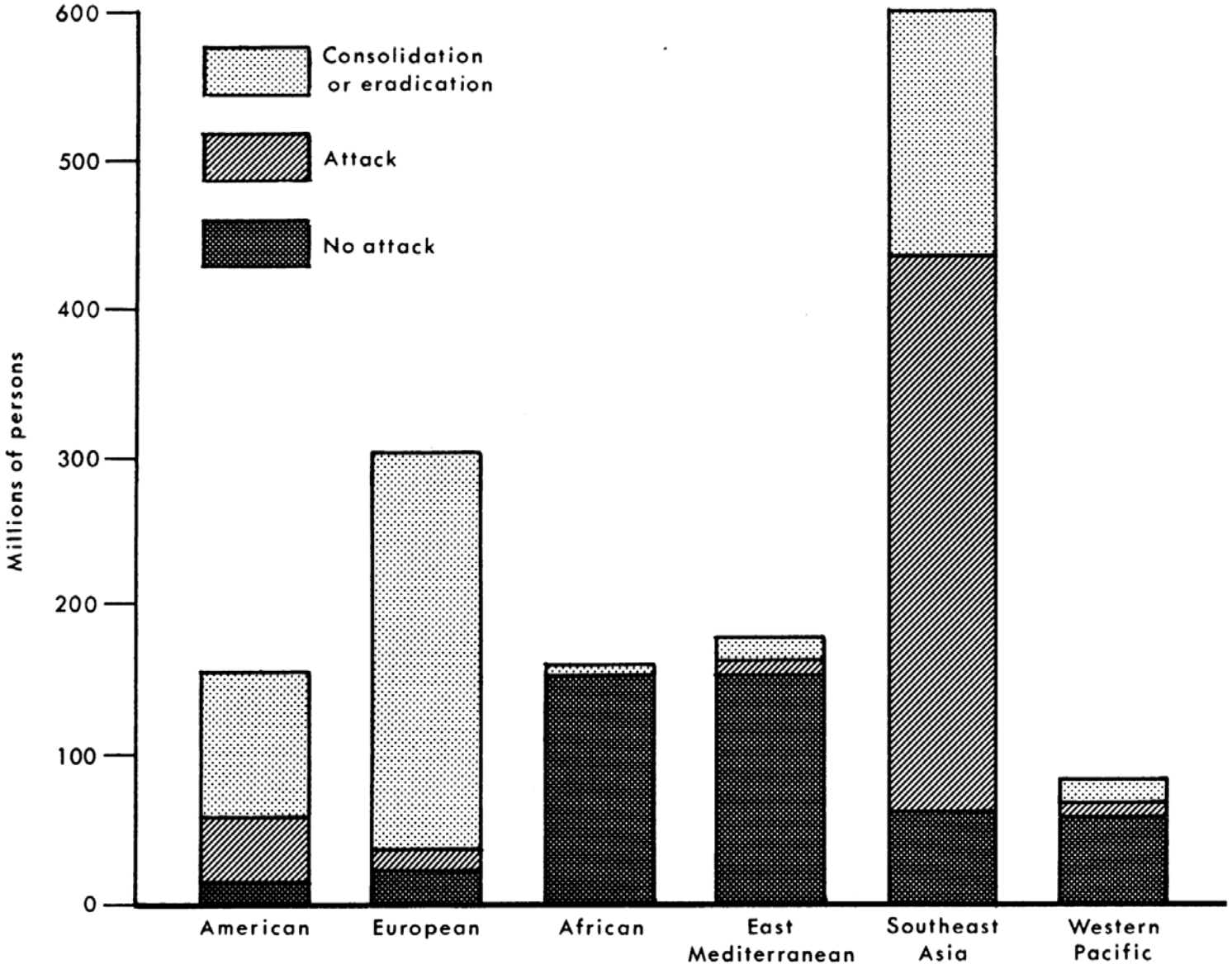
Source: Gockel 1961

Global populations covered by programs over time



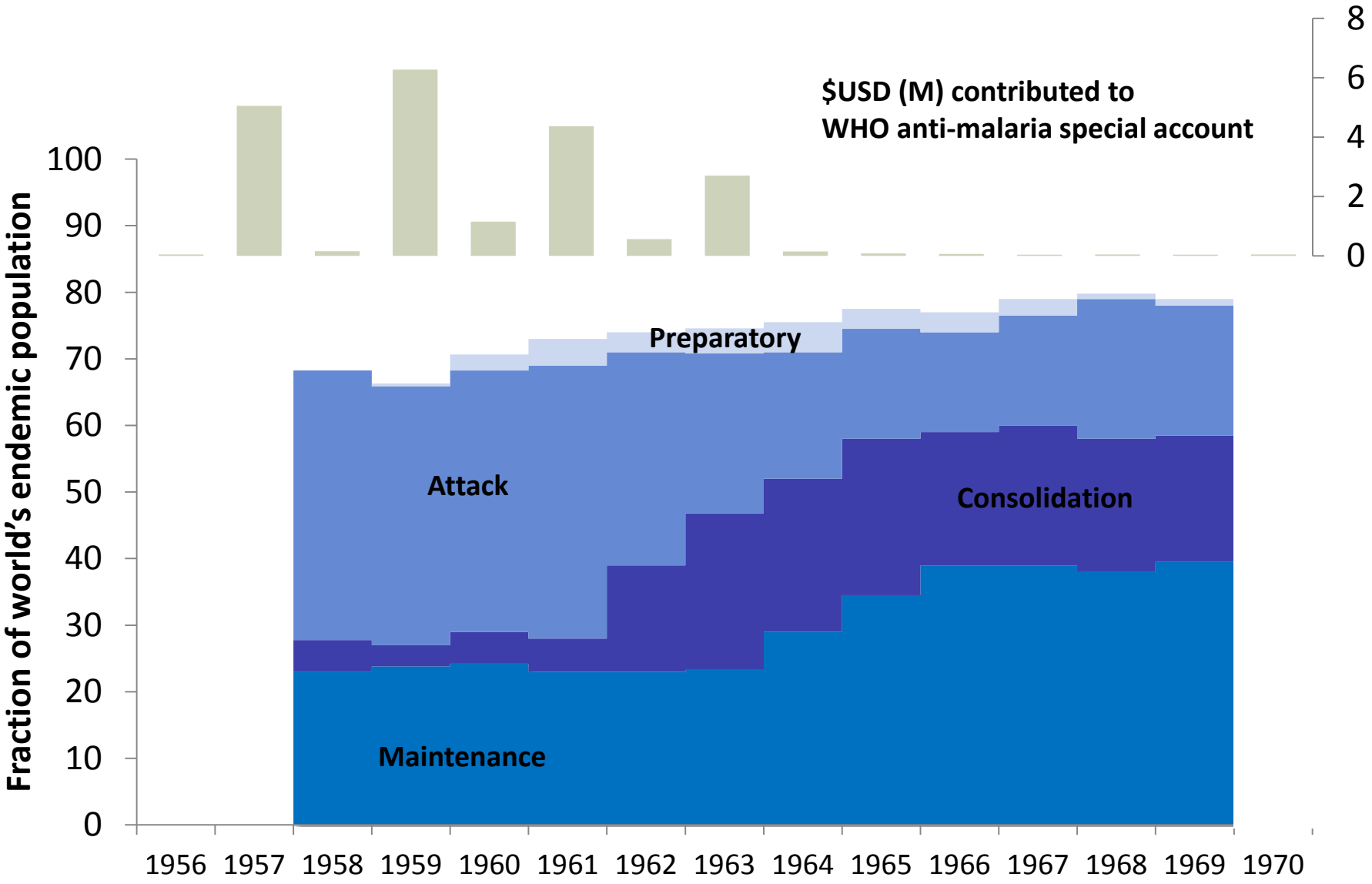
Sources: Najera 1968, Najera 1999, and Scholtens et al. Int J Epi 1972 **1**:1

Global eradication left out Africa



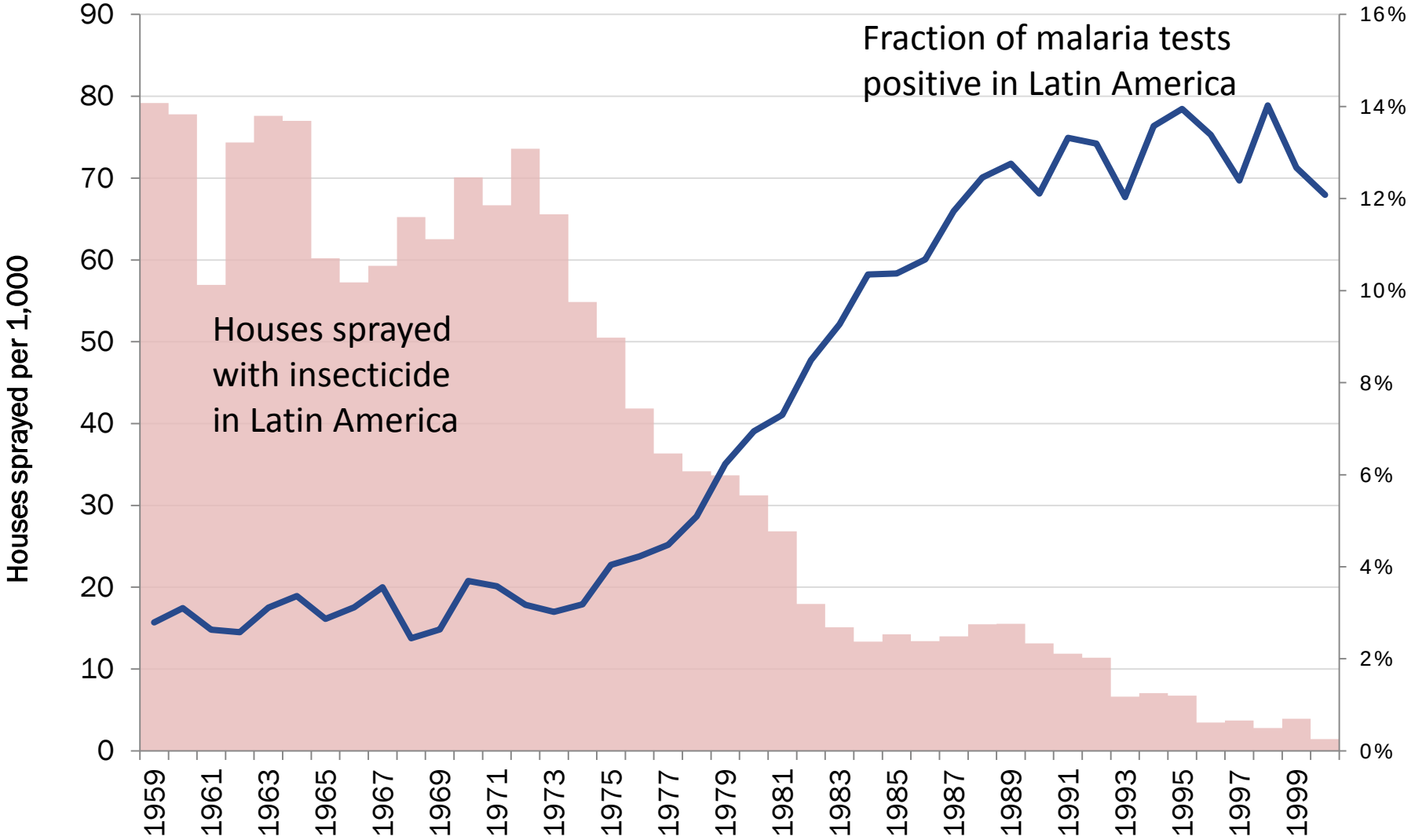
Source: G. Macdonald, Public Health Reports, 1965

The campaign was financed by the USA + domestic contributions



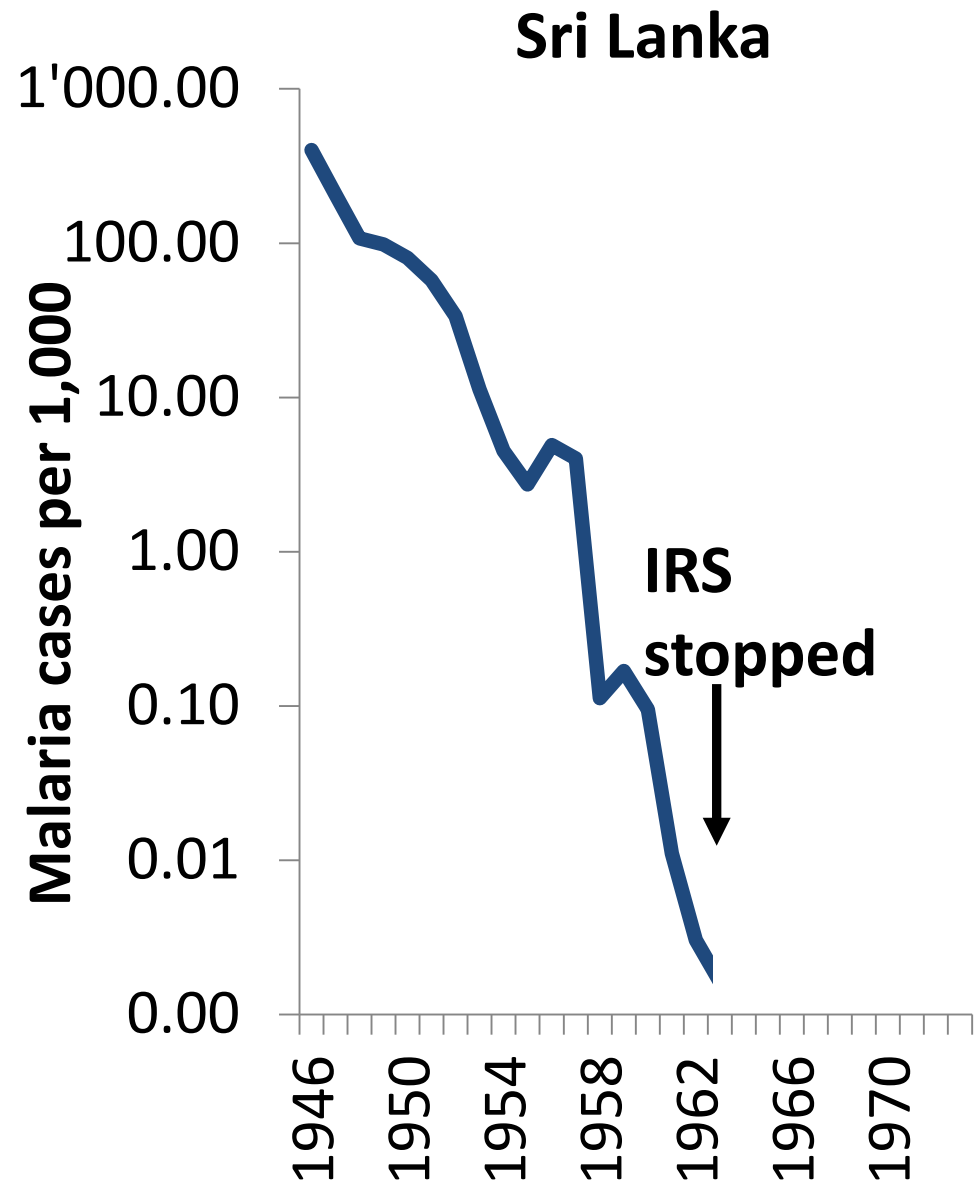
Sources: Najera 1968, Najera 1999, and Scholtens et al. Int J Epi 1972 **1**:1

Devastating resurgence followed cessation of the global program

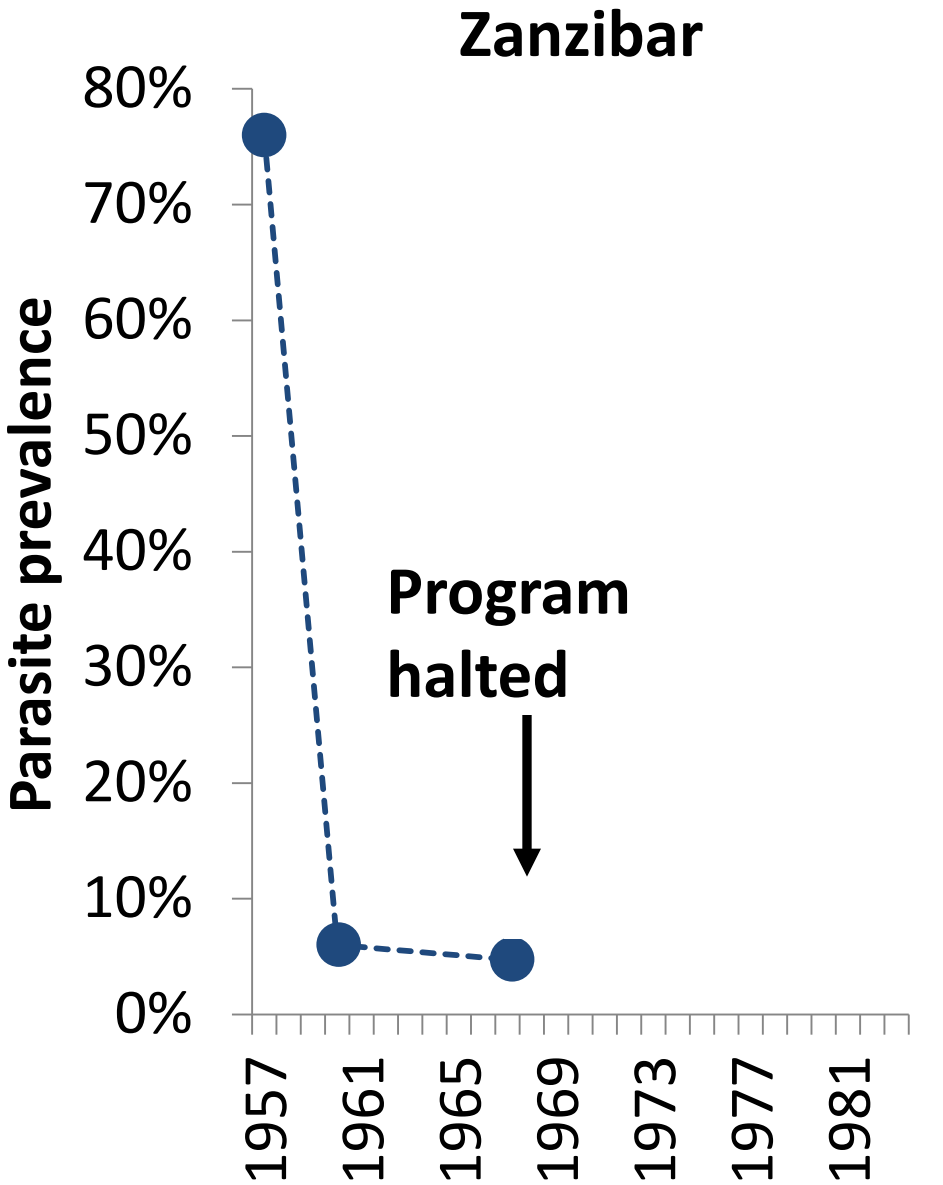


Source: Cohen et al. Malaria Journal 2012

Devastating resurgence followed cessation of the global program

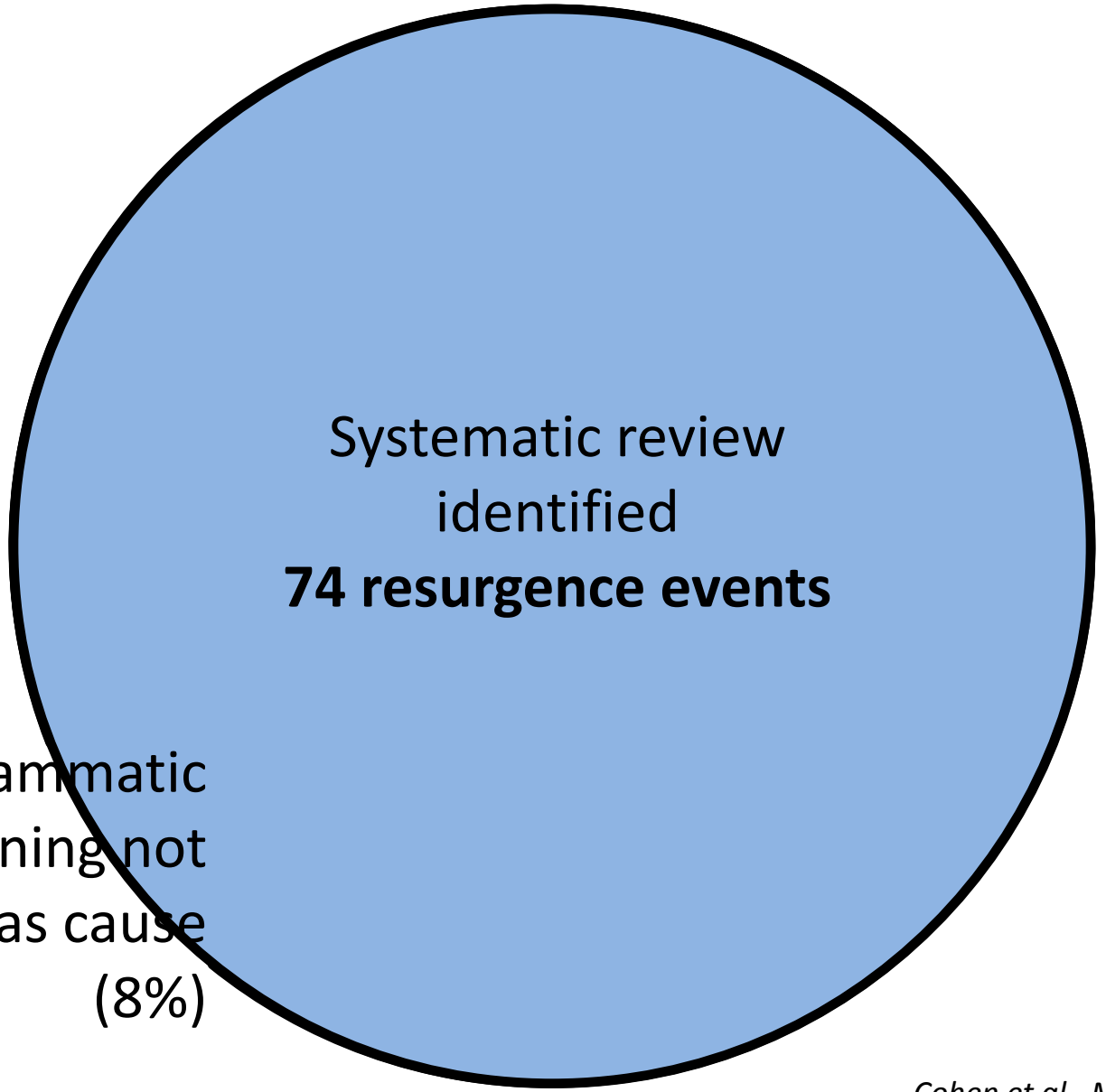


Kondrashin & WHO SEARO, 1987



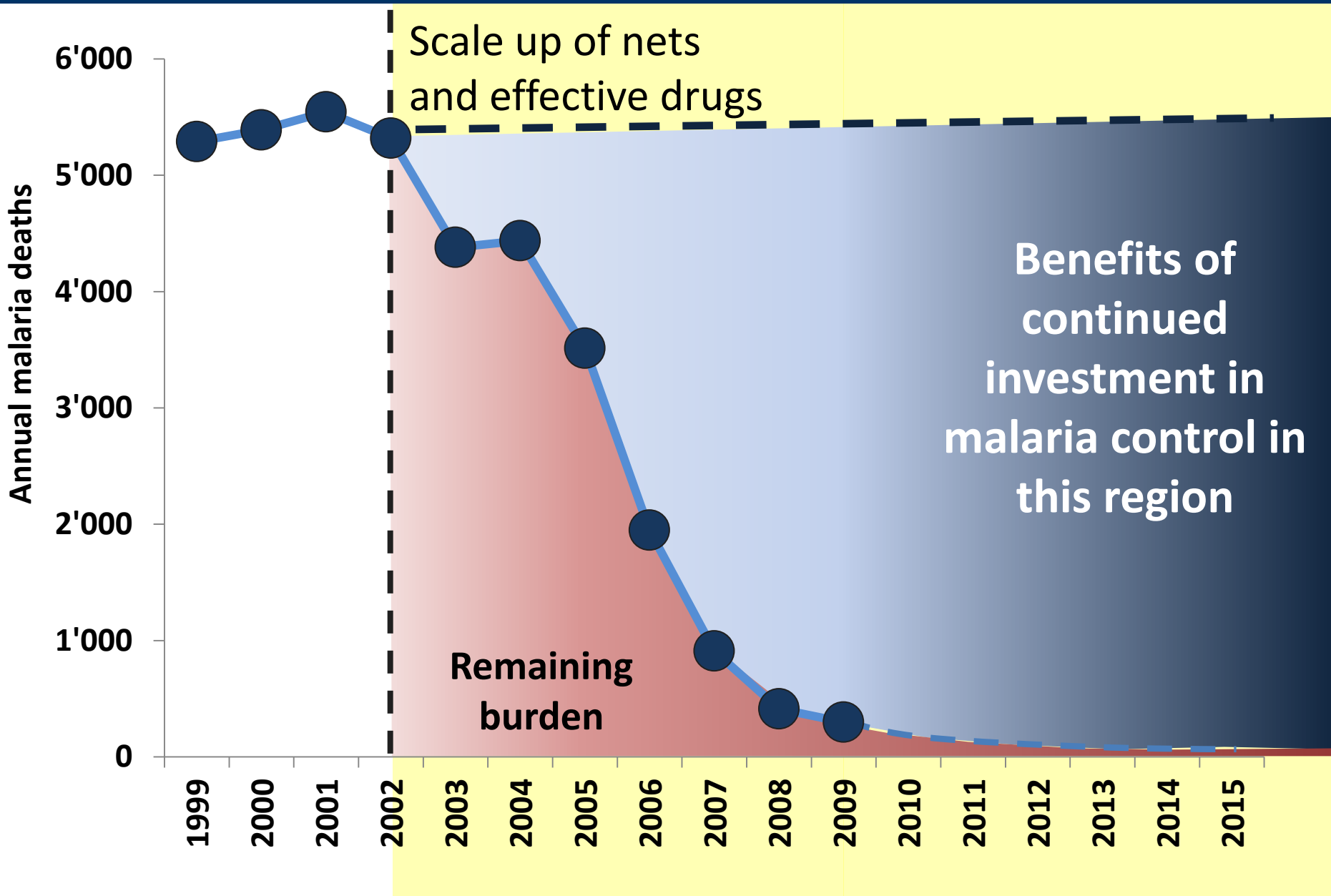
Smith et al. Science 2011

Review demonstrates the frequency of resurgence in malaria's history

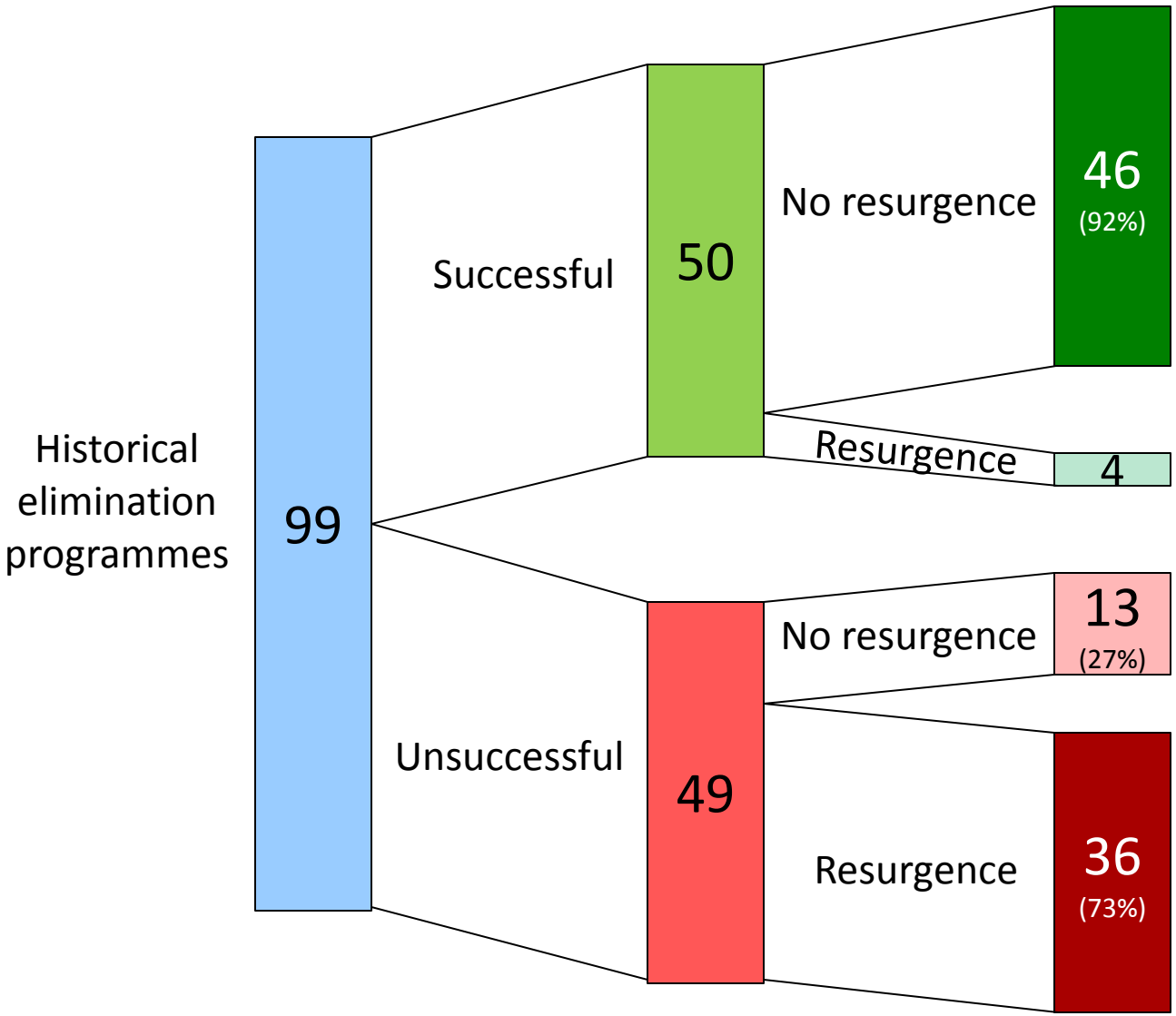


Cohen et al., Mal J 2012

Investment decisions must be based on malaria potential, not burden



How can we consolidate and maintain recent successes?



Feachem Lancet 2010

Cohen Mal J 2012

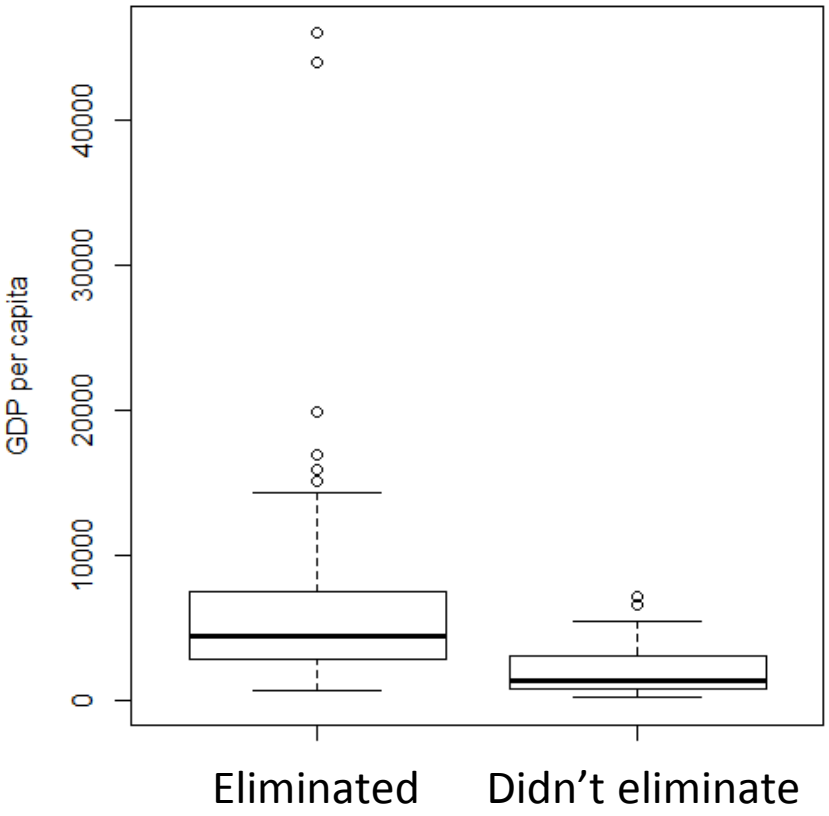
A sticky situation: the unexpected stability of malaria elimination

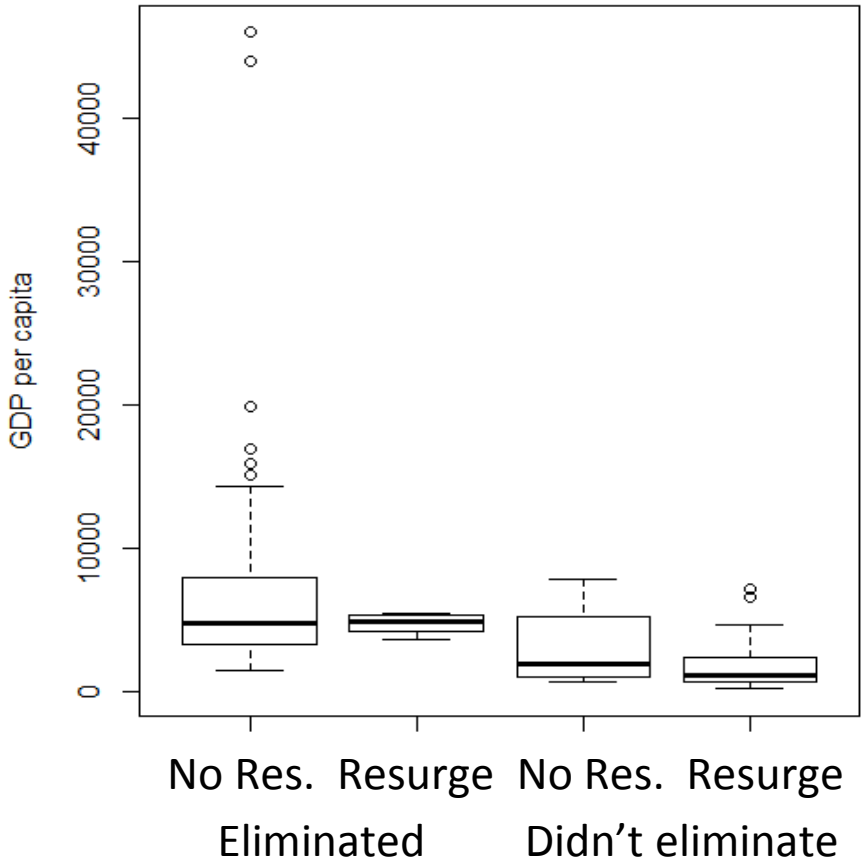
David L. Smith[1,2,3,4,5], Justin M. Cohen[6], Christinah Chiyaka[3], Geoffrey Johnston[1,2,3], Peter W. Gething[7], Roly Gosling[8], Caroline O. Buckee[9], Ramanan Laxminarayan[4], Simon I. Hay[5,7] and Andrew J. Tatem[5,10]

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B

rstb.royalsocietypublishing.org

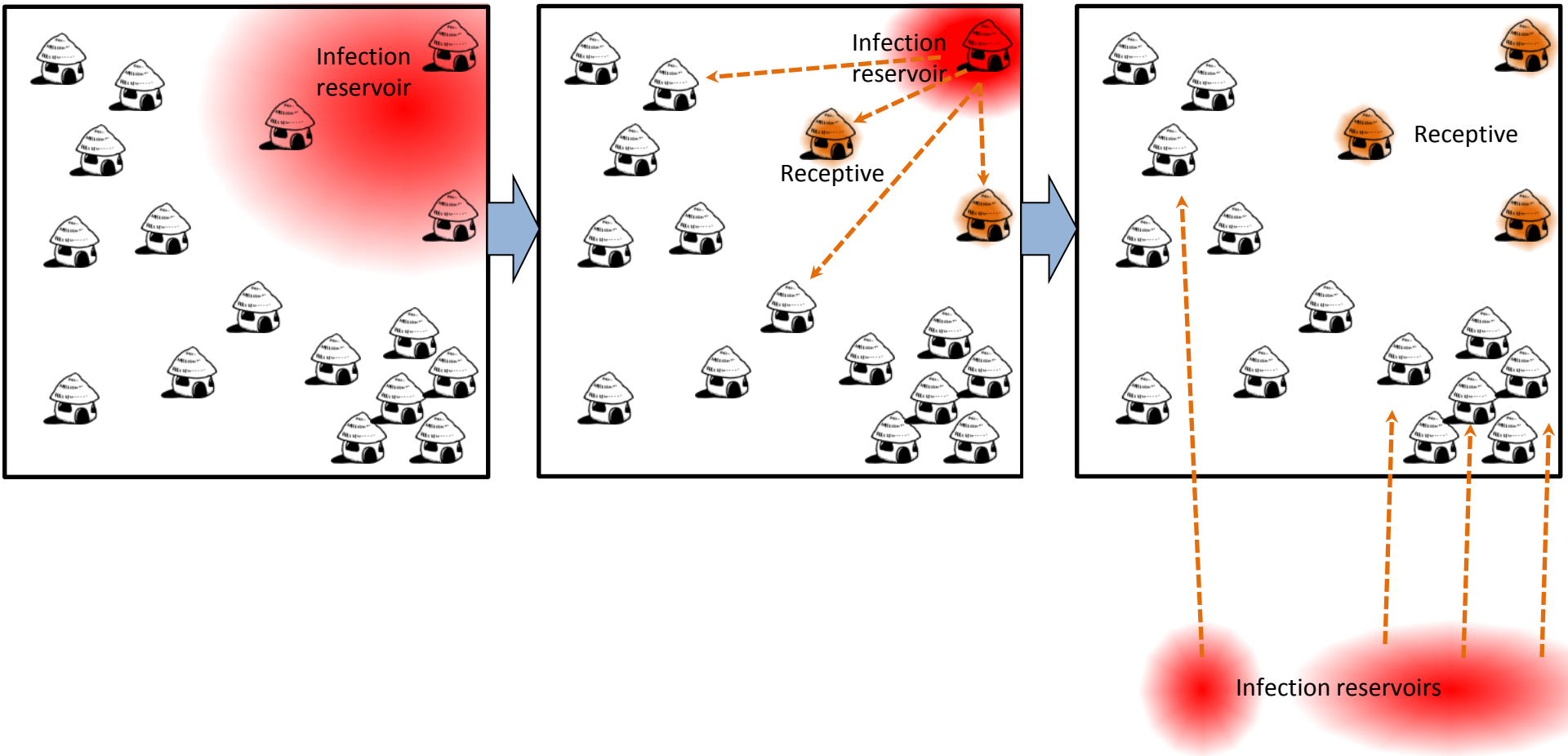
Are successful eliminators just stronger programs?





Smith, Cohen, et al., Phil Trans Roy Soc B 2013

Importation from elsewhere is different from having internal reservoir



Second chances