



Dynamics of permethrin resistance in a field population of
Anopheles gambiae s.s. in south western Nigeria

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Background

- The use ITNs and IRS are integral component of malaria control
- In spite of the effectiveness, resistance remains a challenge
- Resistance ??
 - > 80% insecticide not public health
 - Historical malaria vector control failure
- Pyrethroid insecticide: class of insecticide approved for treating nets
- Resistance has emerged in *Anopheles gambiae* & *An. funestus*
- Resistance is mainly associated with reduced target site sensitivity / metabolic resistance
- Impact of resistance mechanism on vector control is not fully understood

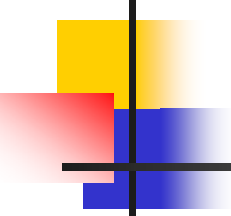
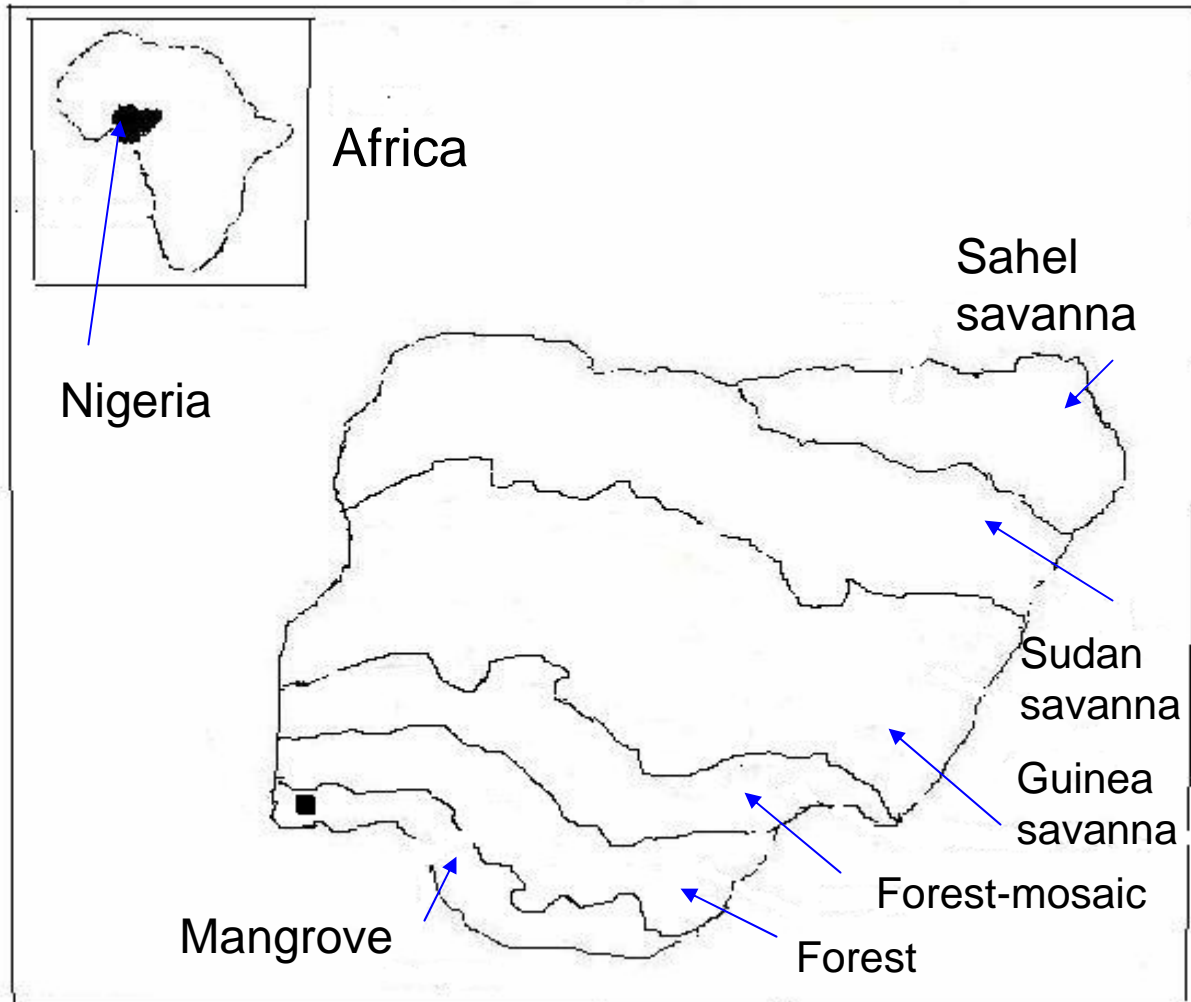
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- In 1999, there was little or no information on the susceptibility status of major malaria vectors to pyrethroid insecticide in Nigeria.
 - We investigated an *An. gambiae* population at Ipokia from January 1999: with the population showing 100% susceptible to permethrin, deltamethrin, lambda-cyhalothrin and DDT
 - By 2001 pyrethroids (permethrin, deltamethrin) and DDT resistance was reported in the mosquito population (Awolola *et. al.* 2002. *Ann. Trop. Med. Parasitol.* **96**:849-852)
 - This presentation highlights changes in the resistance levels from 2001- 2004.



Fig. 1. Study site





Sample collection: Quarterly From 2001- 2004

- Early Rain (ER): April - June
- Late Rain (LR): July - September
- Early Dry (ED): October - December
- Late Dry (LD): January - March

Methods

Indoor and outdoor adult mosquito collection

Susceptibility test
(WHO kits)

Morphological identification

An. gambiae PCR

M & S
PCR

Kdr
PCR

Larval survey

Laboratory rearing

Susceptibility test

Morphological Id.
PCR:
- Species
- M/S forms
- kdr

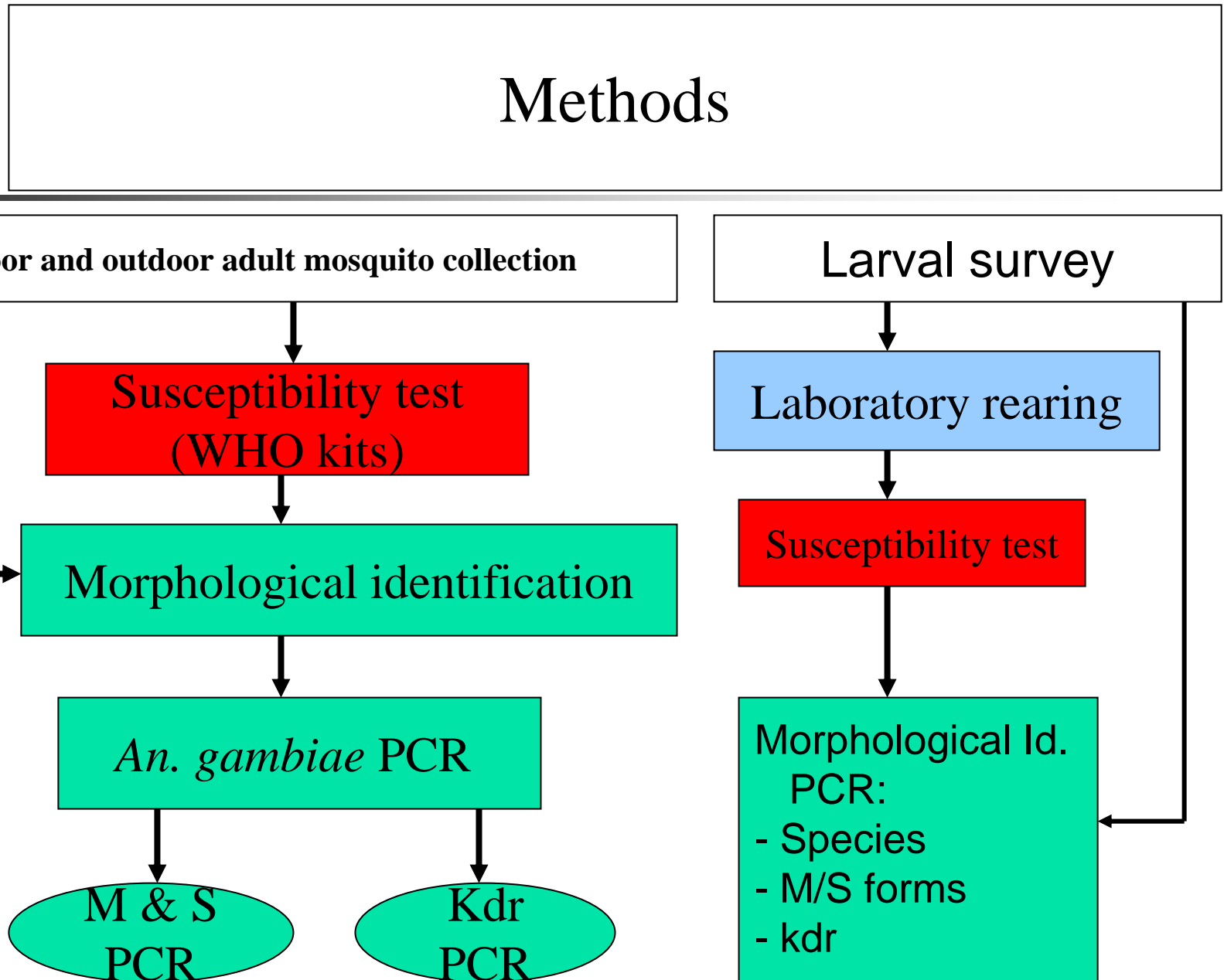


Table 1. Proportion of the molecular M and S forms of *Anopheles gambiae* at Ipokia from 2001-2004

Molecular forms	Proportion (%) of molecular “M” and “S” forms				Total
	2001	2002	2003	2004	
“M” form	301 (37.3)	220 (35.4)	240 (34.0)	244 (34.1)	1005 (35.2)
“S” form	506 (62.7)	402 (64.6)	466 (66.0)	471 (65.9)	1845 (64.8)
Total	807	622	706	715	2850

Adults: M & S form 2001- 2004, $P > 0.05$

Larvae (N = 8520): M & S form 2001- 2004 , $P > 0 .05$

Fig. 2. Proportion of adult the molecular M and S form of *Anopheles gambiae s.s* at different period of the year

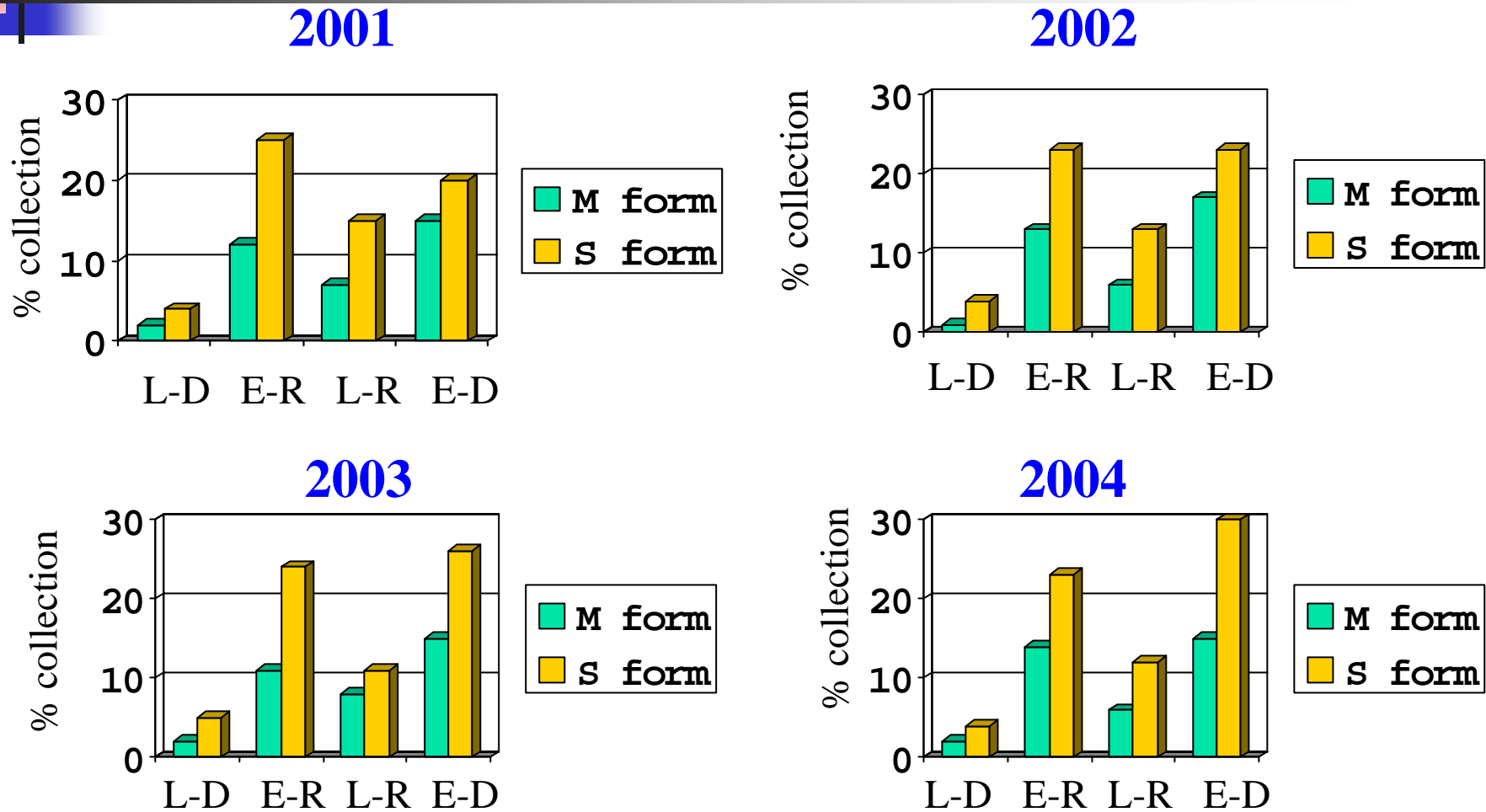




Fig. 3. 24-hours post exposure survival rate of 2-3 day old *Anopheles gambiae* "M" and "S" forms after 1 hr. exposure to 1% permethrin in WHO insecticide test kits

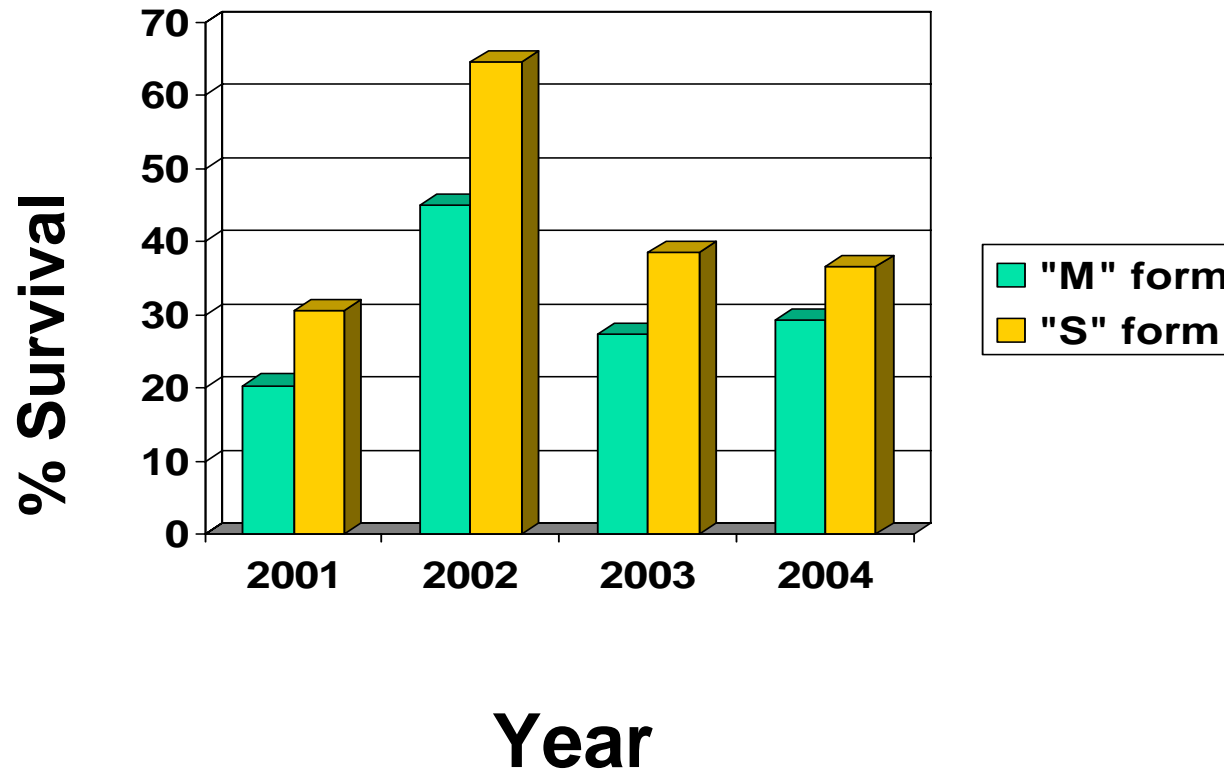




Fig. 4. 24-hours post exposure survival rate of 2-3 day old *Anopheles gambiae* "M" and "S" forms after 1 hr. exposure to 4% DDT in WHO insecticide test kits

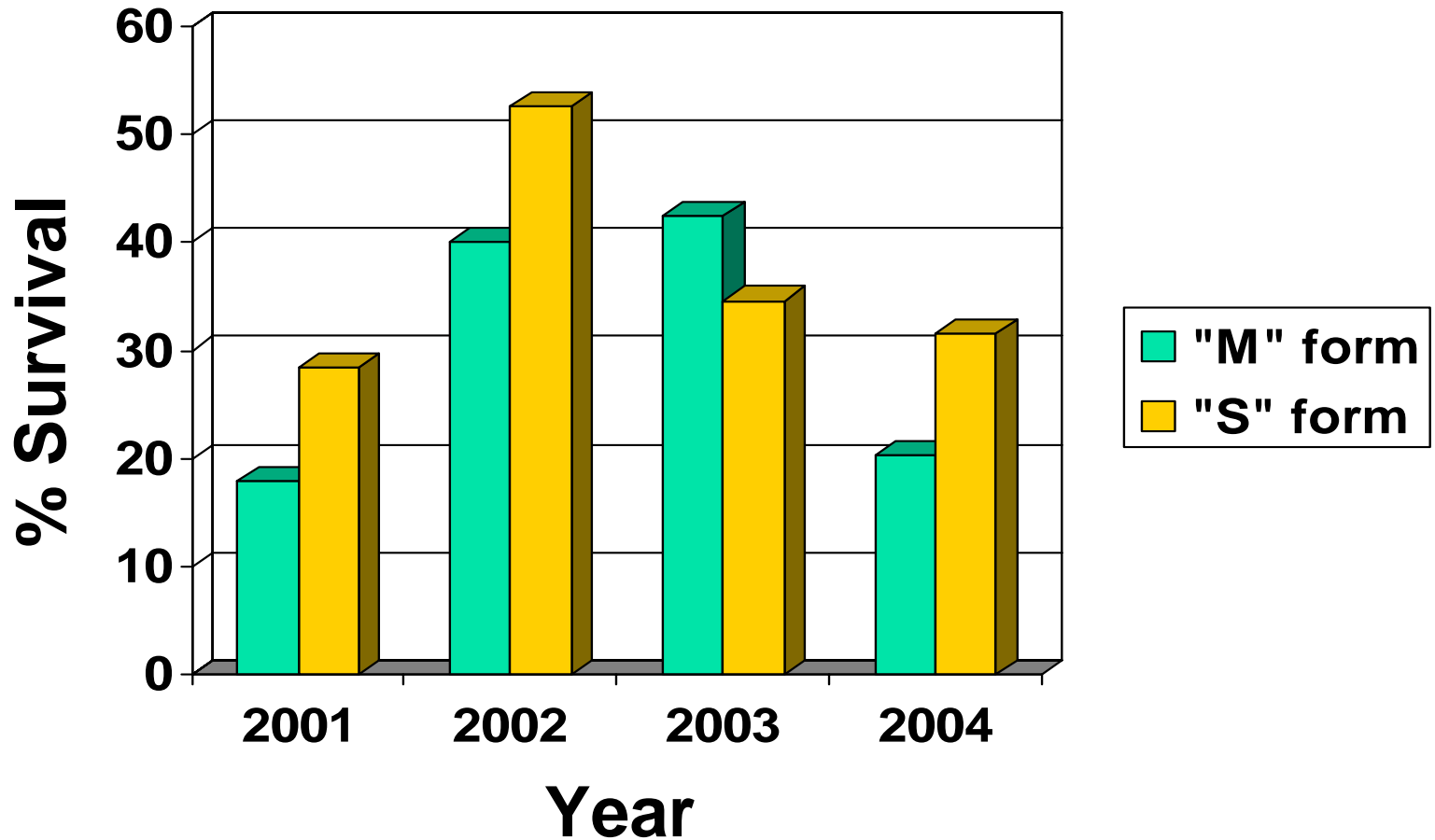
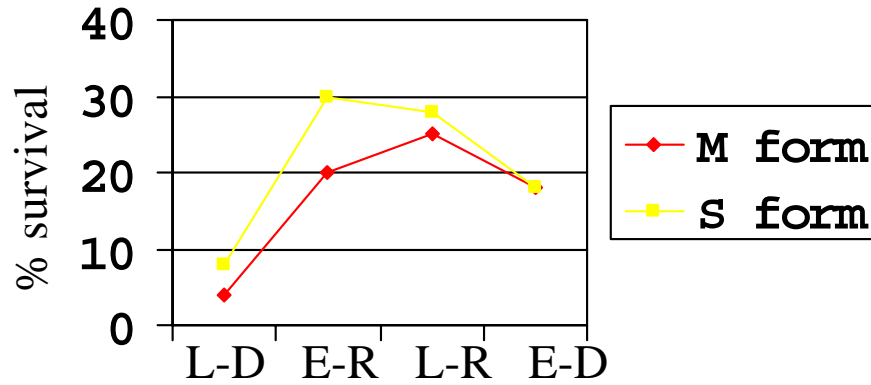
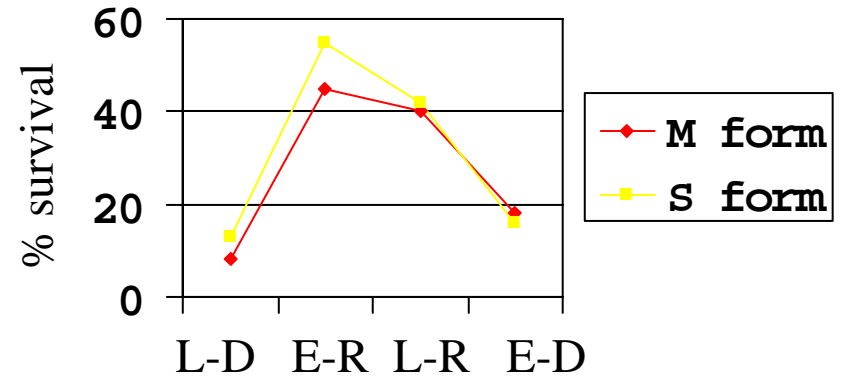


Fig. 5. Susceptibility level of the molecular M and S form of *Anopheles gambiae s.s* in 1% permethrin at different period of the year

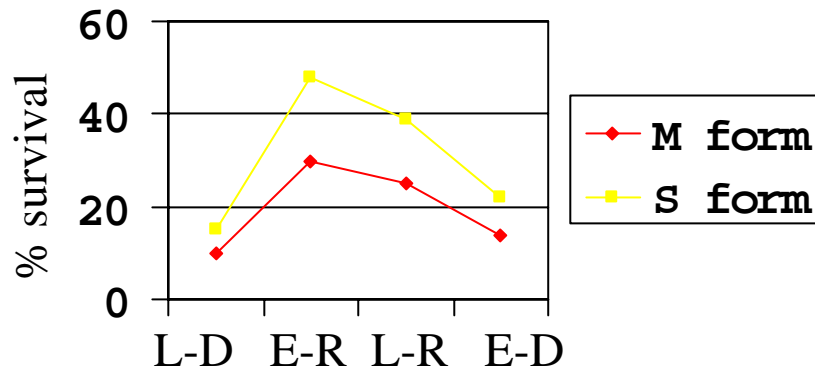
2001



2002



2003



2004

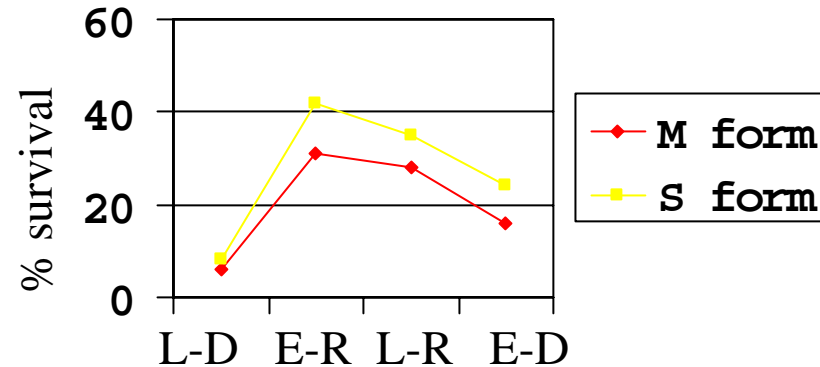
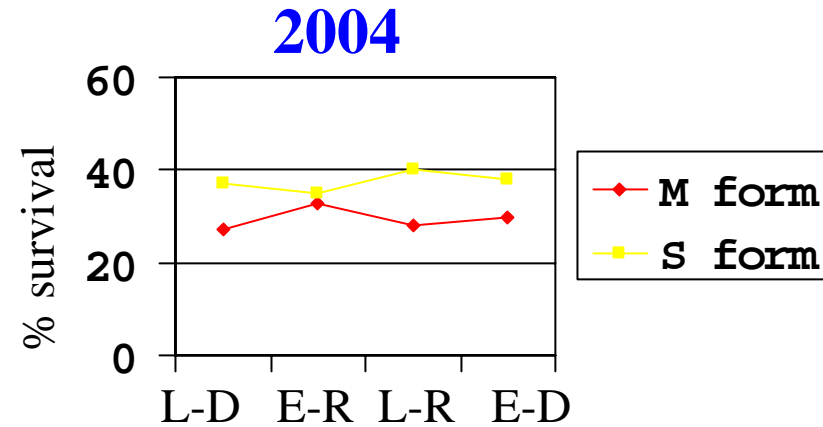
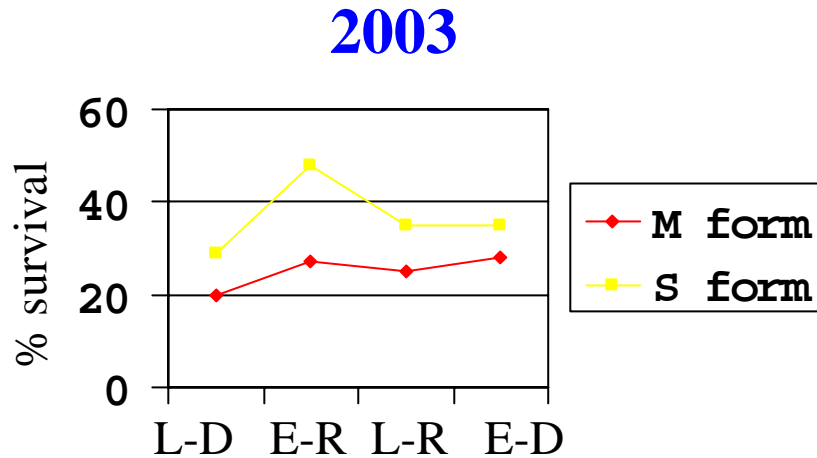
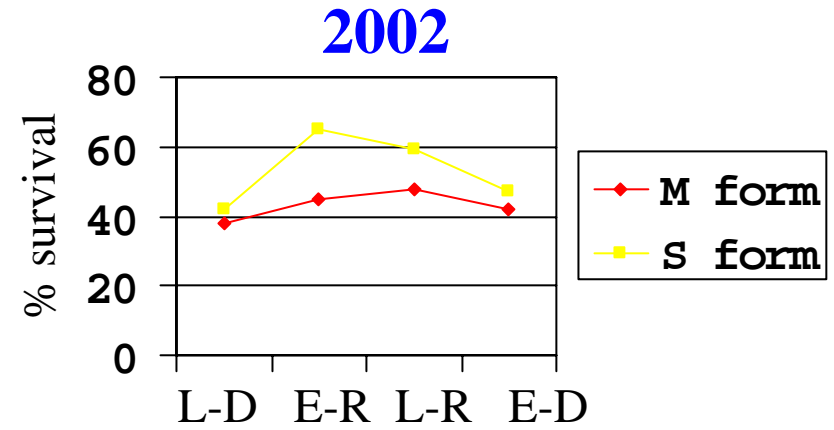
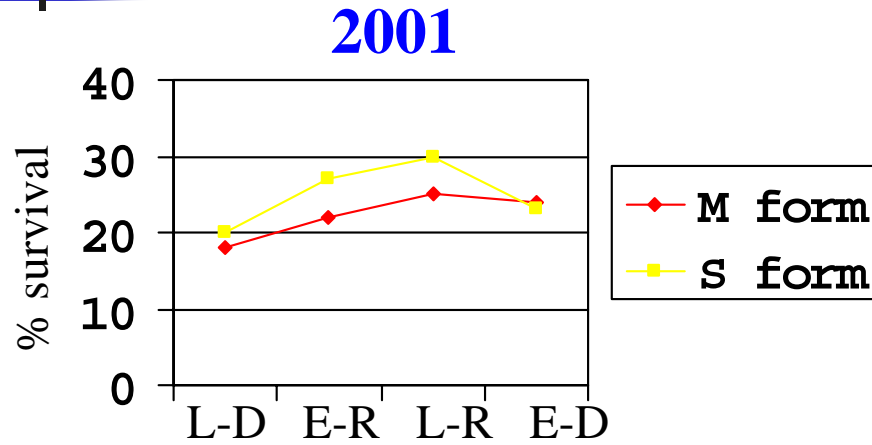


Fig. 6. Susceptibility level of 2-3 days old *Anopheles gambiae* s.s in 1% permethrin at different period of the year





HIMR

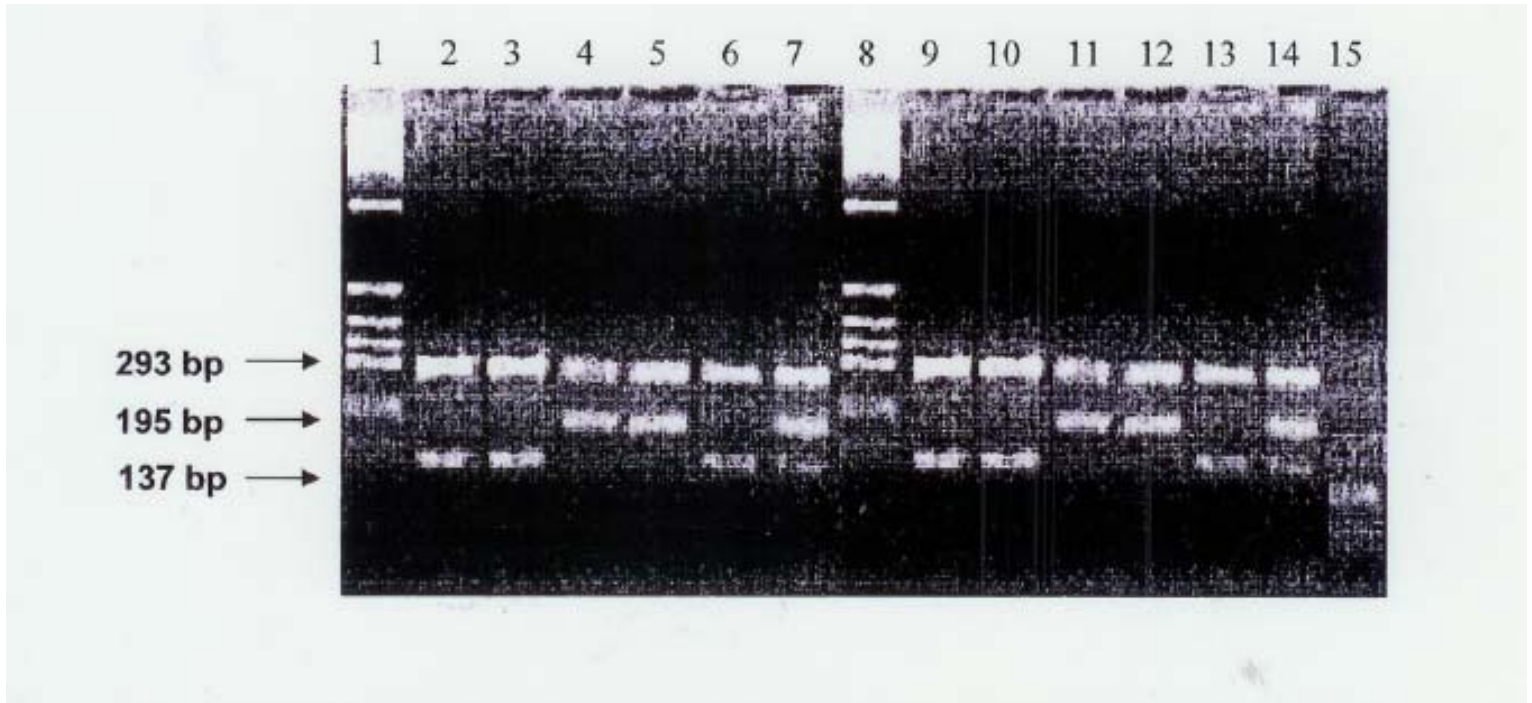
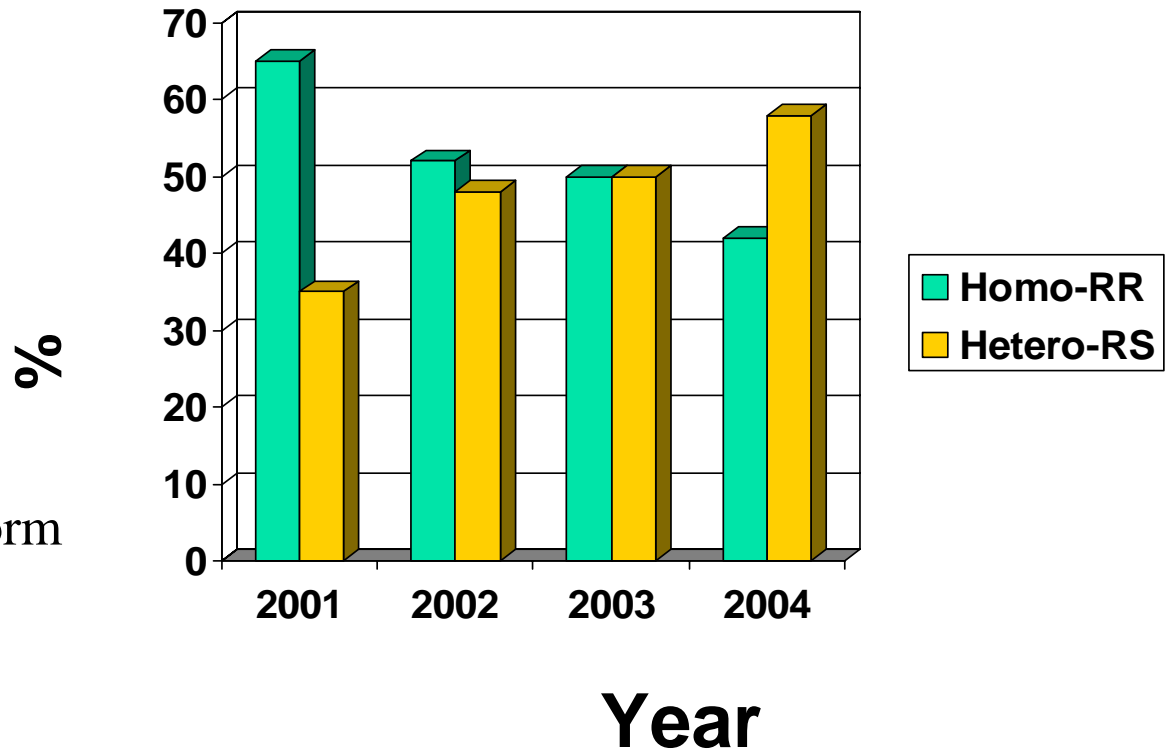


Fig. 7. Detection of the *kdr* gene in a wild population of *Anopheles gambiae* “S” form. Lane 1 & 8: mwm, lane 2: 2,3,9,10 & 13: susceptible, lane 4,5,11&12: homozygous resistant, lane 7&14: heterozygous resistant, lane 15: negative control



Fig. 8. Allelic frequency of the *kdr* gene in a wild population of *Anopheles gambiae* “S” form from 2001-2004



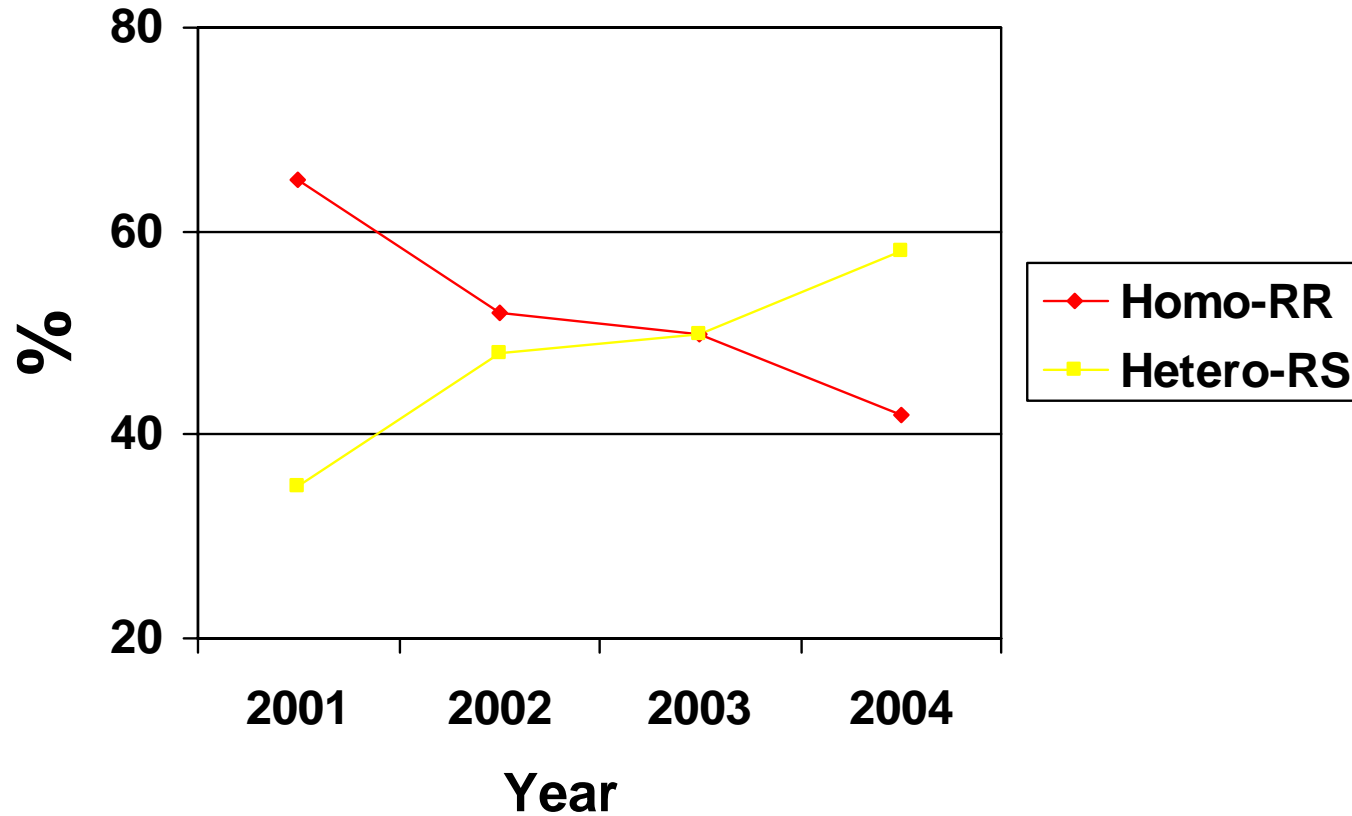
- Resistant level of S form with *kdr* frequencies:

Permethrin: $r = 0.74$

DDT: $r = 0.68$



Fig. 9. Allelic frequency of the *kdr* gene in a wild population of *Anopheles gambiae* “S” form at different period of the year





Summary

- No significant increased in resistance level from 2001-2004
- Kdr found only in the molecular S form, the M form possibly has a different resistant mechanism (metabolic??)
- How long will this resistance gene last in the population (fitness cost)?
- Absence of the kdr resistant gene in the M form supports the theory of a possible reproductive isolation in this sympatric taxa



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