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Letter to the Editor

Misleading guidance for decision making on tsetse eradication: Response to Shaw et al. (2013)

The paper entitled "Estimating the costs of tsetse control options: An example for Uganda" (Shaw et al., 2013) presents full cost estimates for eliminating or continuously controlling riverine tsetse species *Glossina fuscipes fuscipes* Newstead (*palpalis* group) in Uganda in order to facilitate decision-making and financial planning. Four tsetse control techniques were compared: "(i) artificial baits (insecticide-treated traps/targets or ITT), (ii) insecticide-treated cattle (ITC), (iii) aerial spraying using the sequential aerosol technique (SAT) and (iv) the addition of the sterile insect technique (SIT) to the insecticide-based methods (i–iii)".

While the economic approach as such might be sound to generate a basis for estimating the cost of tsetse control campaigns, the assessment is based on a disputed model (Vale and Torr, 2005) that assumes that the above insecticide-based methods alone can succeed in eradicating riverine tsetse populations. The limitations of this model are both mathematical (appropriate criteria for using and publishing agent-based models were not respected) and ecological (important characteristics of riverine tsetse populations were neglected) (Peck and Bouyer, 2012). The model was apparently developed based on experimental field data of the *morsitans* (savannah) group of tsetse fly species (*Glossina morsitans morsitans* Westwood and *Glossina pallidipes* Austen) that have fundamental different ecological characteristics as compared to riverine species such as a two-dimensional distribution pattern, a much higher sensitivity to landscape fragmentation and a lower opportunistic feeding behaviour (Van den Bossche et al., 2010).

Moreover, no matter what is suggested by a mathematical model, the authors should have carefully studied the real ecological situation in Uganda, should have provided an assessment of the population dynamics of *G. f. fuscipes* in the target area and should have substantiated their parameters with appropriate references. A review of past control efforts indicates there are no examples of successful operational eradication campaigns against riverine tsetse fly populations except those that included an SIT component (see summary in Table 1).

One of the main reasons for failure has often been the use of a single control tactic in a localized area, rather than integrating several control tactics in an area-wide approach. Evidence for a successful eradication effort using solely ITT could only be found against a *G. morsitans centralis* (savannah fly) population in Zambia (Bart et al., 1993). No eradication has ever been achieved using only ITC in any tsetse group. This is not really surprising as after a control trial in Burkina Faso, Bauer et al. (1999) reported that "*Glossina tachinoides* persisted in a small habitat outside the ZAP (Zone Agro-Pastorale), with catches varying from 0.2 to 2.1 flies per trap per day, the majority of the surviving flies feeding on reptiles, as can be seen from the blood-meal analyses". The same problem was reported with *Glossina austeni*, which is probably closer to the riverine than to the savannah group considering its behaviour and ecology. After a failed major eradication campaign that was mainly based on ITC, a follow-up effort that included the SIT as part of an area-wide integrated pest management (AW-IPM) campaign succeeded to eradicate this species from Unguja Island (Vreysen et al., 2000). In West Africa, several SAT trials, or even application of residual insecticides by air, resulted in important reductions of the riverine target population density – but never in eradication (Vloedt van der et al., 1980; Baldry et al., 1981).

Even assuming a 3-year treatment intervals between SAT campaigns to maintain suppression as done by Shaw et al. (2013) appears unreasonably optimistic as evidence suggests that a suppressed tsetse population takes little more than one year to recover after an SAT effort (Turner and Brightwell, 1986). This frequency could even foster the generation of secondary problem scenarios, i.e. reduced cattle immunity against trypanosomes and thus breaking the endemic cycle which could result in important epidemic outbreaks (Desquesnes et al., 2009; Van Den Bossche and Delespaux, 2011).

The use of ITT at 7 km^{-2} failed to eradicate *G. f. fuscipes* even when used in a 32 km^2 isolated section of an island (Table 1 – Okoth et al., 1991), which is almost double the target density used in Shaw et al. (2013) paper to calculate eradication costs. Moreover, the authors suggest that an "improved target design has the potential to increase field cost-effectiveness (as measured by tsetse killed per m^2 of cloth) by a factor of 10". It must be noted however that the price of the cloth (around € 3 for a 1 m^2 target) is not the

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Table 1
Impact of past tsetse control campaigns. The risk of false negative concerns only the cases when eradication was reported but flies were still present as the population had dropped below detectable level with the traps used; it is based on the probability of not detecting surviving flies (Barclay and Hargrove, 2005). This probability is provided in brackets in the corresponding colon. The risk of false positive concerns only the cases when eradication was achieved but not reported as rapid reinvasion occurred: it was documented qualitatively considering the data reported by the authors. A detailed explanation of the risk of false positives and negatives is provided in the supplementary file, section A. When eradication was not reported, the observed reduction rates are provided in brackets.

Method	Country	Area	Duration	Target species	Eradication obtained	False positive	False negative	Reference
ITT 11/km river	Ivory Coast	79 km river	2 months	*G. palpalis gambiensis*	No (98%)	No (barrier)		Laveissiere and Couret (1981)
				G. tachinoides	No (99.8%)	No (barrier)		Laveissiere and Couret (1981)
ITT 4/km^2	Zambia	3000 km^2	4 years	*G. morsitans centralis*	Yes		No[a]	Bart et al. (1993)
ITT 3–5/km^2	Zimbabwe	600 km^2	4 years	*G. morsitans morsitans*	No (99.99%)	No (central area)		Vale et al. (1988)
				G. pallidipes	No (99.99%)	No (central area)		Vale et al. (1988)
ITT 7/km^2	Uganda	32 km^2	4 months	*G. fuscipes fuscipes*	No (97.3%)	No (barrier)		Okoth et al. (1991)
ITT 5/km river	Ethiopia	150 km^2	1 year	*G. fuscipes fuscipes*	No (74%)	No (barrier)		Leak et al. (1996)
				G. pallidipes	No (92%)	No (barrier)		Leak et al. (1996)
ITT 4/km river	Nigeria	1500 km^2	>14 months	*G. tachinoides*	No (>90%)	No (barrier)		Takken et al. (1986)
ITC 10–20/km^2	Ethiopia	200 km^2	3 years	*G. fuscipes fuscipes*	No (no reduction)			Leak (1995)
				G. pallidipes	No (84%)	No (insufficient reduction)		Leak (1995)
				G. morsitans submorsitans	No (83%)	No (insufficient reduction)		Leak (1995)
SAT 5 cycles	Botswana	16,000 km^2	2 years	*G. morsitans centralis*	Yes		No ($p < 0.001$)	Kgori et al. (2006)
SAT 4 cycles	Ghana	6745 km^2	1 month	*G. tachinoides*	No (98%)[b]	No (central area)		Adam et al. (2013)
				G. palpalis gambiensis	No (98%)[b]	No (central area)		Adam et al. (2013)
SAT 9 cycles	Kenya	300 km^2	5 months	*G. pallidipes*	No (90–99.9%) [c]	No (central area)		Turner and Brightwell (1986)
ITT 60/km^2 + netting of pig pens 20/km^2 + ground spraying	Guinea	<20 km^2	17 months	*G. palpalis gambiensis*	No (100%)[d]	No (isolated island)		Kagbadouno et al. (2011)
ITC 6–18/km^2 + ITT 4/km^2	Burkina Faso	400 km^2	3 years	*G. tachinoides*	No (91.8%)	Yes (no barrier)		Bauer et al. (1999)
				G. morsitans submorsitans	No (98.4%)	Yes (no barrier)		Bauer et al. (1999)
ITC 9–28/km^2 + ITT 45–70/km^2	Unguja	1650 km^2	5 years + 18 months	*G. austeni*	No (80% fem, 98% males)	No (Island)		Höreth-Böntgen (1992) and Vreysen et al. (1999)
ITC 2.5/km^2 + ITT 1/km^2	Ghana	18,000 km^2	1 year	*G. tachinoides*	No (≈96%)	No (barriers)		Adam et al. (2013)
				G. palpalis gambiensis	No (≈96%)	No (barriers)		Adam et al. (2013)
(ITC 9–28/km^2 + ITT 45–70/km^2) + SIT	Unguja	1650 km^2	(6.5) + 3.5 years	*G. austeni*	Yes		No[e]	Vreysen et al. (2000)
I TT 2.4/km^2 + SIT	Burkina Faso	3000 km^2	3 years	*G. tachinoides*	Yes		Yes ($p = 0.43$)[f]	Cuisance et al. (1984) and Politzar and Cuisance (1984)
				G. palpalis gambiensis	Yes		Yes ($p = 0.56$)[f]	Cuisance et al. (1984) and Politzar and Cuisance (1984)
ITT 4/km river + SIT	Nigeria	1500 km^2	+3 years	*G. tachinoides*	Yes		No ($p < 0.001$)[g]	Takken et al. (1986)

[a] Monitoring using stationary traps, screen fly rounds, electric net fitted on a motorcycle during one year in one block, two years in the second.
[b] 22% of the adult females dissected after each cycle were survivors so that the number of cycles was limited to 4.
[c] Over 99.9% in main habitats and about 90% in conifer plantation.
[d] No fly was captured in July 2010 (low efficiency of the traps used) but then tsetse were captured with sticky traps in 2011–2012.
[e] 399leg-panel traps deployed in 55 fixed monitoring sites during 1.5 years.
[f] Considering the number of trapping events with 41 biconical traps set every month during 48 h until July 1985 (trap efficiency of 1.2% (±1.3%) and 0.9% (±0.9%)/km^2 per day for *G. t.* and *G. p. g.*, respectively).
[g] 384 sentinel traps were set permanently and collected every 24–48 h.

sole cost factor to be considered as the deployment cost (labour, vehicle, fuel, etc.) represents an additional € 5–7 per unit. Since a smaller target kills a smaller number of flies than a target of a larger size, a higher density of these smaller targets per unit of surface area is required to obtain the same tsetse mortality rate, which obviously will result in higher deployment costs (see additional file, section B for more details).

The treatment costs of ITC as calculated by Shaw et al. (2013) are based on the SOS campaign against *G. f. fuscipes* in Uganda where 9–22 heads of cattle/km^2 were treated every 3 months. Although the prevalence of *Trypanosoma brucei* s.l. was reduced initially, the tsetse suppression efforts, failed to further reduce disease transmission; on the contrary, the prevalence increased again to the pre-control level within nine months (Morton, 2010; Selby, 2010). The intensity of treatment and its frequency were thus inadequate to have any meaningful level of tsetse suppression. A simple model (see supplementary file, section C) integrating the feeding behaviour of *G. f. fuscipes* in Uganda (Waiswa et al., 2006) and the knock down rates associated to restricted application of insecticides against riverine species (Bouyer et al., 2007) shows that given the treatment frequencies used in the SOS programme, the estimated daily mortality rate imposed to this species was indeed too low to induce any suppression, not even speaking of eradication.

In conclusion, the above examples clearly indicate that Shaw et al. (2013) have based their economic analysis on various assumptions originating from a dodgy model and that are contrary to what has been experienced in the field against riverine tsetse in general and *G. f. fuscipes* in particular. This paper is thus misleading and provides wrong advice to governments and tsetse control operators.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.prevetmed.2013.05.017.

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