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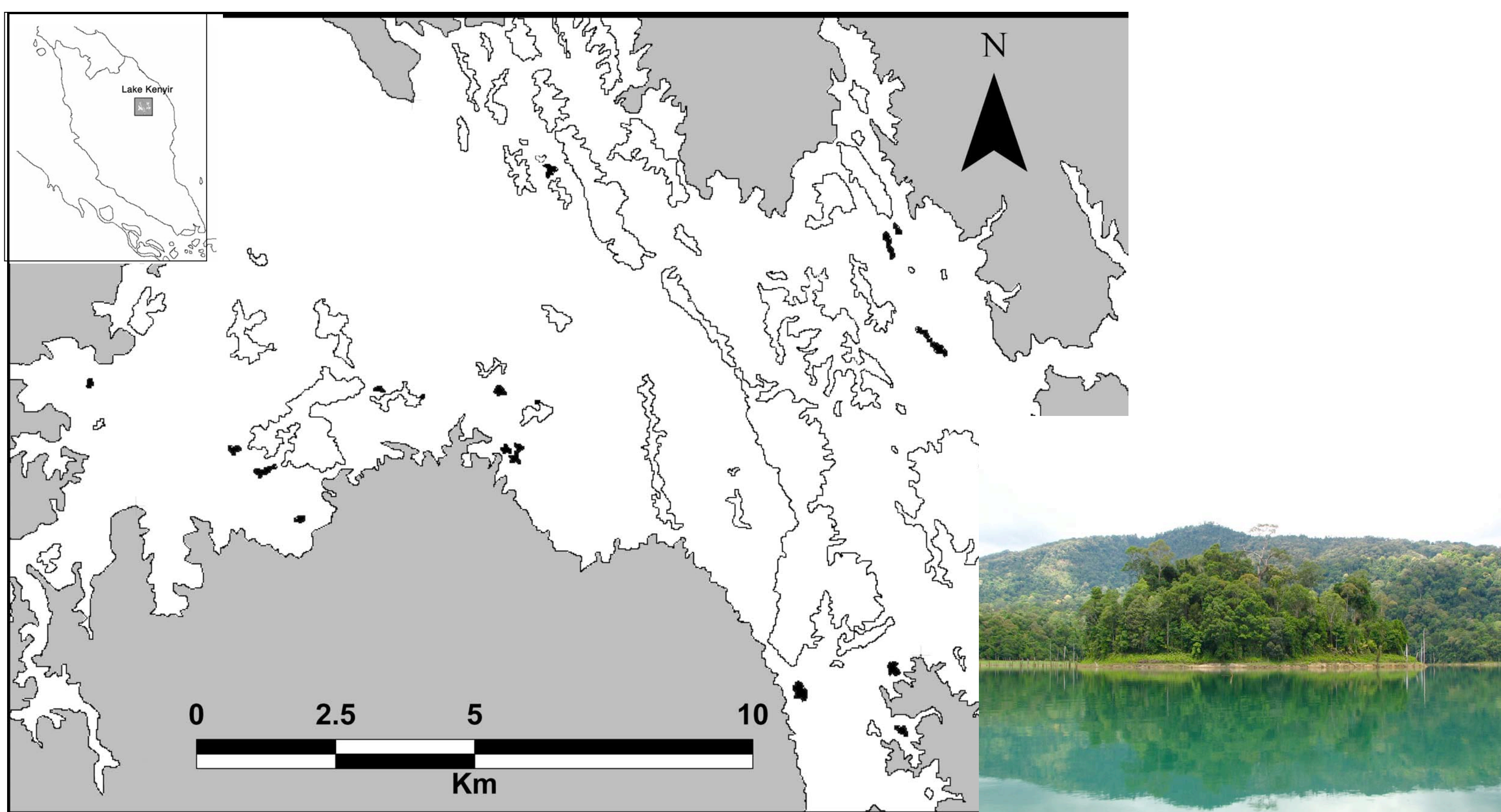
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## Introduction

Resource limitation is one of the central rules in ecology and potentially important for island communities. Theoretically, the most important resource for dung beetles (Coleoptera: Scarabaeidae: Scarabaeinae) is the availability of mammalian dung. Our previous studies, however, suggest that the species distributions of dung beetles on the landbridge islands at Lake Kenyir, Malaysia are likely limited by dispersal. In this study we use experimental approaches to test whether the island communities of dung beetle are limited by food availability or by dispersal.

## Methods

**Study site:** Lake Kenyir, northeast of Peninsular Malaysia, a ca 36,900 ha hydroelectric reservoir created in 1986.



**Dung supplementation:** We selected 16 small islands (< 4 ha) which had already been repeatedly surveyed using human dung baited live pitfall traps between Jun 2008 and Apr 2009 to establish baseline data. Between Apr 2009 and Oct 2009 we dispersed 10 kg of cattle dung onto eight of the islands every 10-15 days and these islands along with eight control islands were surveyed monthly to monitor the dung beetle communities over time.

**Statistical analysis:** The temporal trends of the dung beetle counts were examined by a generalized additive mixed effects model (GAMM). We then generated the means over 50-day periods to smooth out the fluctuations and tested the effect of dung supplementation using generalized linear mixed effects models (GLMMs).

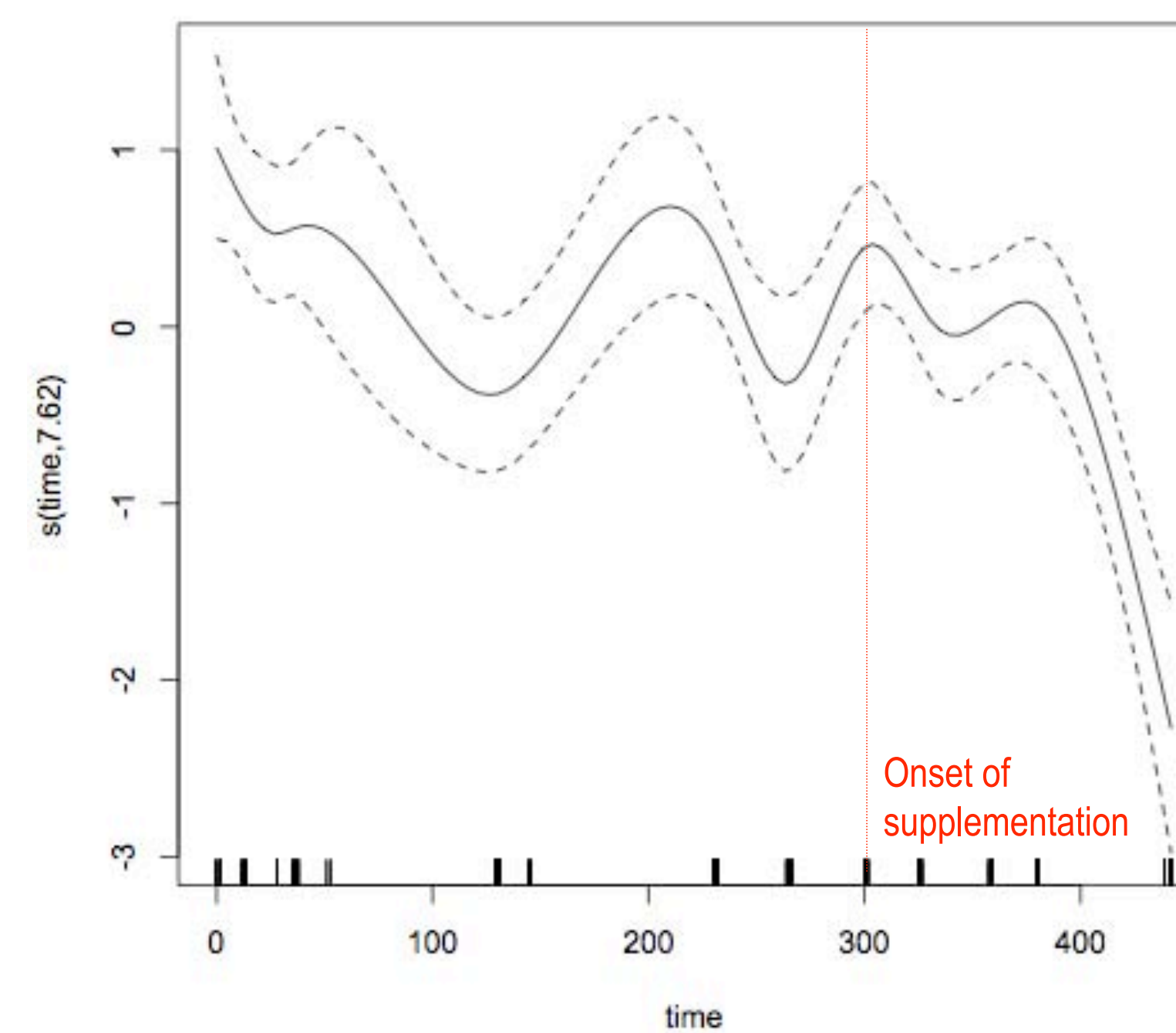
### Dung beetle reintroduction:

Between 14 and 20 May 2010, a common species *Paragymnopleurus maurus* was reintroduced to Island 1 (504 indiv.) and Island 2 (293 indiv.), where the species were not previously found. Surveys were conducted immediately after the release and subsequently on 7-8 Jun and 3-4 Jul to monitor these populations.

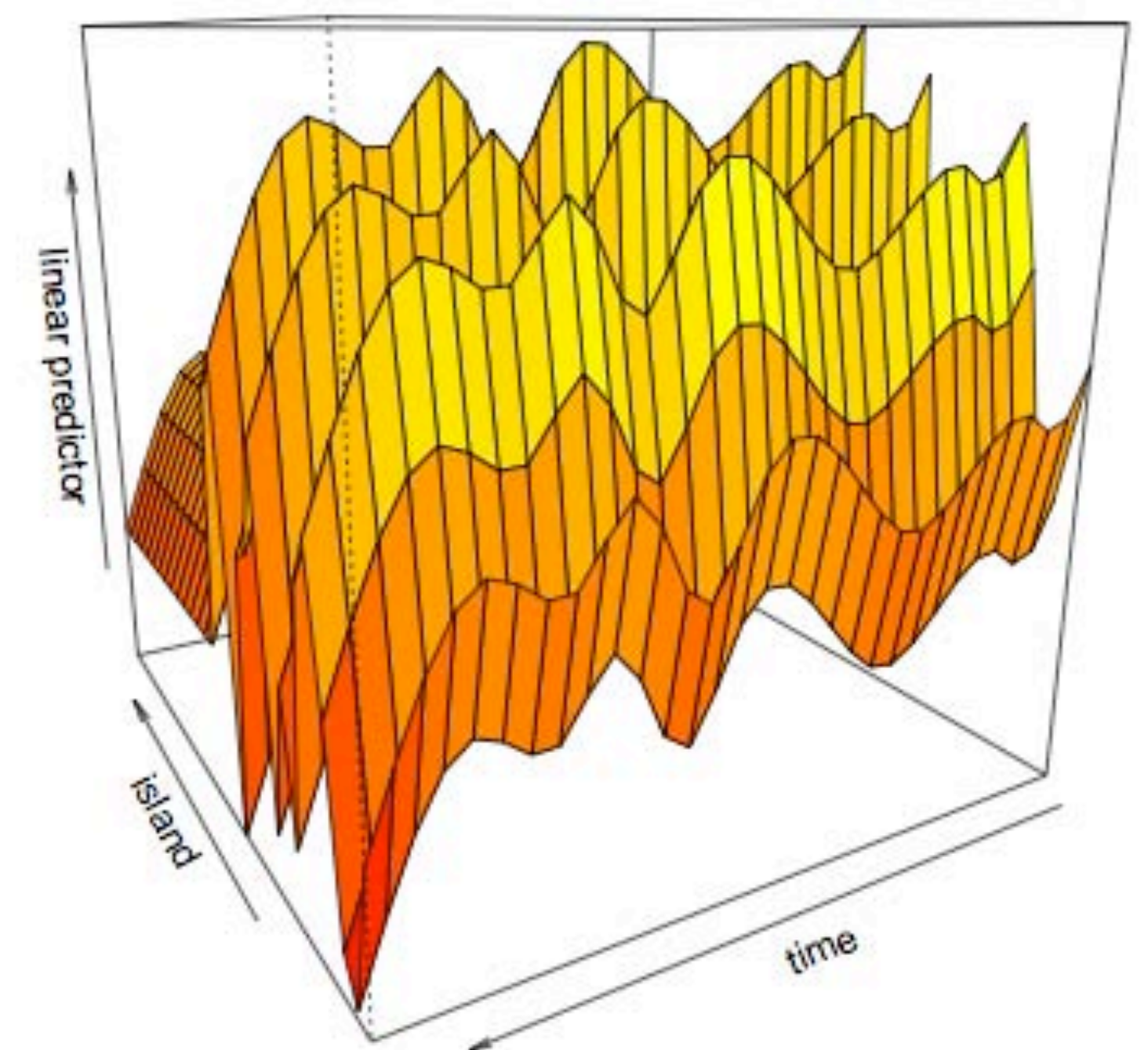


*Paragymnopleurus maurus*

## Results



**Fig. 1.** Smoother function of dung beetle abundance time series. Period of fluctuation is approximately 100 days.

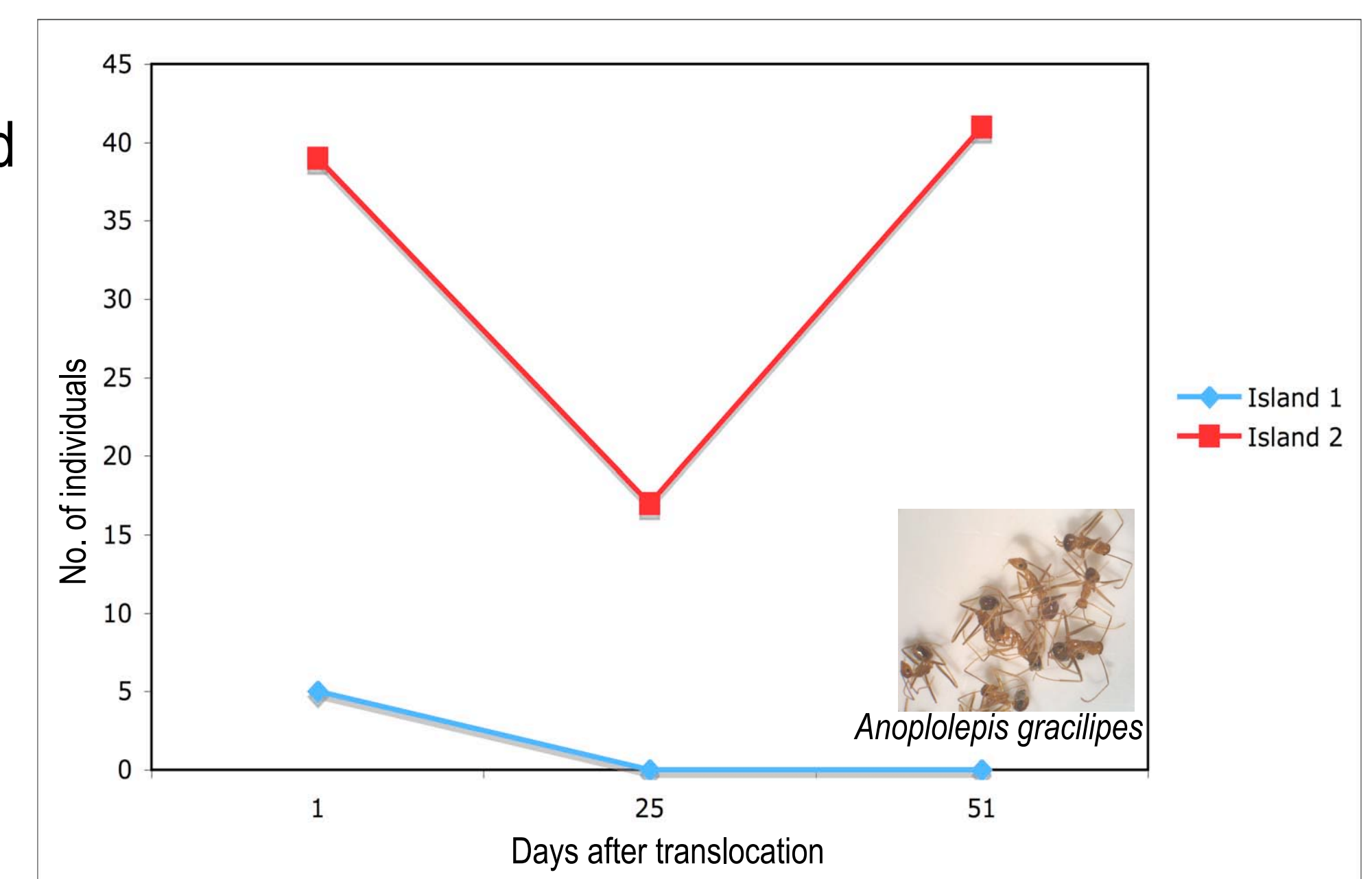


**Fig. 2.** 3D graph showing temporal fluctuations of dung beetle abundance synchronized among 16 islands.

**Table 1.** Ranking of GLMMs testing the effects of time period, dung supplementation and their interaction on dung beetle abundances on 16 islands. Dung supplementation did not affect the populations significantly during the period of observation.

Model description	K	LL	AIC <sub>c</sub>	ΔAIC <sub>c</sub>	wAIC <sub>c</sub>	%DE
~ period	4	-180.85	370.1	0	0.455	20.1
~ period + supplementation + period : supplementation	6	-178.95	370.8	0.65	0.329	21.0
~ period + supplementation	5	-180.5	371.6	1.49	0.216	20.3
~ supplementation	4	-218.85	446	75.93	0	3.4
~ 1	3	-226.45	459.1	89.01	0	0

**Fig. 3** No. of *P. maurus* detected after reintroduction. While detected number on Island 2 remained similar after 51 days, the populations on Island 1 crashed immediately after reintroduction. The invasive ant *Anoplolepis gracilipes* was found in hyper abundance on Island 1 as compared to Island 2.



## Discussion & Conclusions

- Dung beetle communities on small islands at Lake Kenyir are not food limited.
- Results from the ongoing *P. maurus* reintroduction experiment suggest that dung beetle communities on small islands are likely to be dispersal limited. In other words if dung beetles are able to arrive on such islands recolonization is possible.
- The hyper abundance of the invasive ant *A. gracilipes* may pose a serious threat to the survival of dung beetles on small isolated islands.

In conclusion, dispersal limitation and stochastic processes, not food limitation, are the major drivers of the distribution of dung beetles on small islands in Lake Kenyir. More long term studies on such unique systems are needed to shed light on the mechanisms through which biotic communities are being impacted by forest fragmentation.

**Acknowledgments:** We thank Mr. Johannes Huijbregts from the National Museum of Natural History Naturalis, Leiden, the Netherlands for his great help in species identification. This study was supported by the National University of Singapore (Grant no. R-154-000-331-112).

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