Mixed-species group formation in response to multiple predators in the South African savannahs

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Abstract

The formation of mixed-species groups (MSGs) (also called heterospecific or polyspecific groups) is often considered an anti-predator strategy used in response to an increased predation risk. Recent studies performed in savanna ecosystems in Africa have demonstrated an increased formation of ungulate MSGs in higher predation risk areas. Nevertheless, these studies only considered one predator species (the lion Panthera leo) in evaluating the response to predation risk. Yet, species evolve in multi-predator systems that require prey to respond to multiple sources of risks. Although the importance of incorporating these multiple predators in studies is recognized, there is still little information on the behavioral strategies, including MSG formation, that prey can use to minimize predation risk from multiple predators. In the present study, we analyzed a large dataset of camera trap data (more than 160,000 observations) from five sites located in savanna biome in South Africa. We studied the likelihood of MSGs formation in response to the presence of different predators (lion, leopard (Panthera pardus), spotted hyena (Crocuta crocuta), and wild dog (Lycaon pictus)). We demonstrated that the probability of forming MSGs increased when (i) the photographic rate of the interacting species increased and (ii) the photographic rate of predators increased. Our results showed that lion and spotted hyena are the predator species most likely to trigger the formation of MSGs for different prey species. These results suggest a "hierarchy of fear" among predators in which both species are the most feared, even for prey species that either predator does not preferentially select. A large number of MSGs formed in the presence of these two predator species included Burchell's zebras (Equus quagga burchellii), in association with species that have complementary modes of predator detection (e.g. wildebeest (Connochaetes taurinus) and giraffe (Giraffa camelopardalis). Our study highlights the importance of incorporating multiple predators into MSG analyses to better understand ecosystem functioning and, community formation.

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Figure 1.

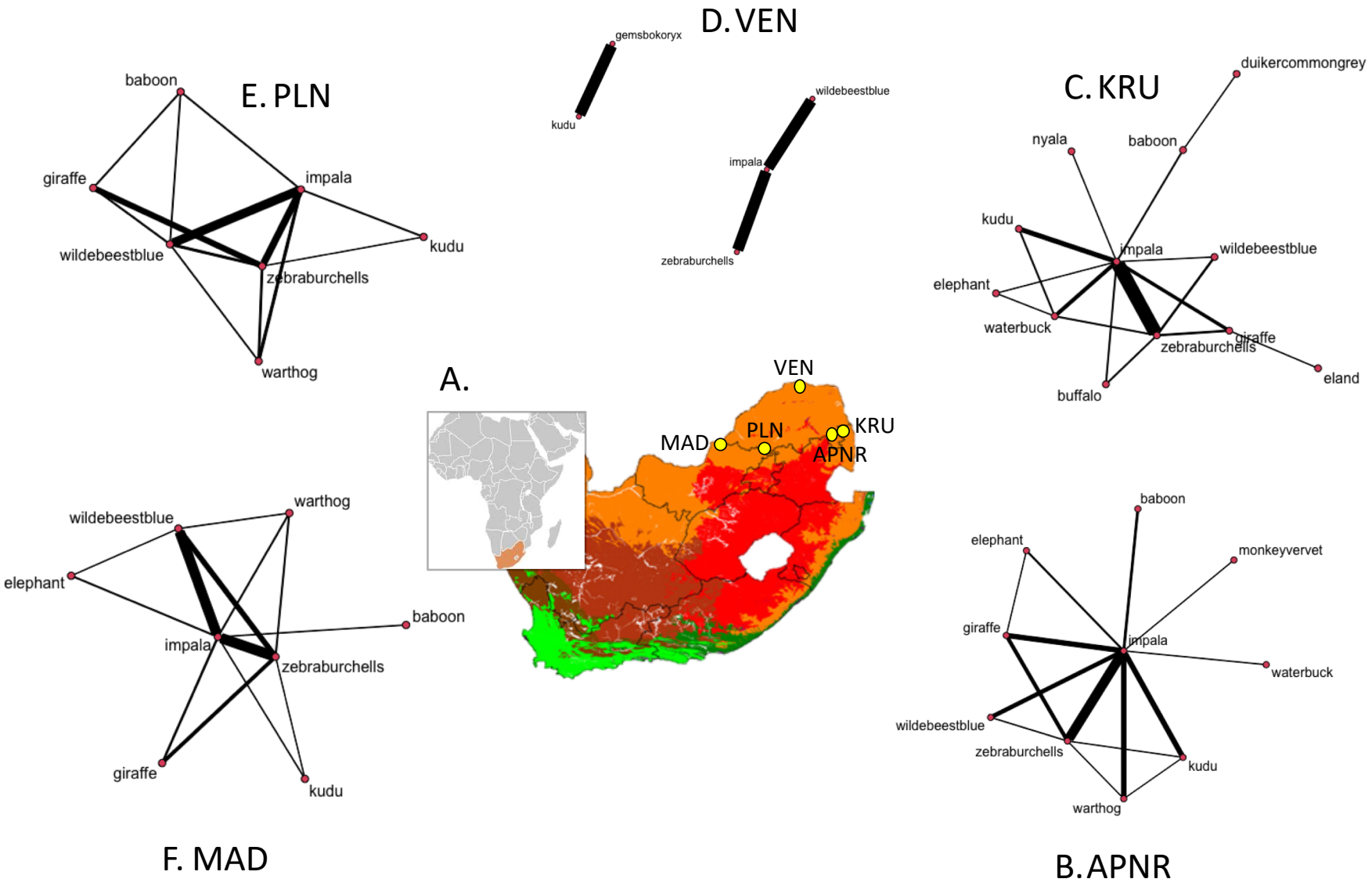

D. VEN
gemsbokoryx
kudu
wildebeestblue
impala
zebraburchells
E. PLN
baboon
giraffe
impala
kudu
wildebeestblue
zebraburchells
warthog
C. KRU
duikercommongrey
nyala
baboon
kudu
impala
wildebeestblue
elephant
waterbuck
giraffe
zebraburchells
eland
buffalo
A.
VEN
MAD
PLN
KRU
APNR
wildebeestblue
warthog
elephant
baboon
impala
zebraburchells
giraffe
kudu
baboon
elephant
monkeyvervet
giraffe
impala
waterbuck
wildebeestblue
zebraburchells
kudu
warthog
F. MAD
B. APNR

Figure 2.

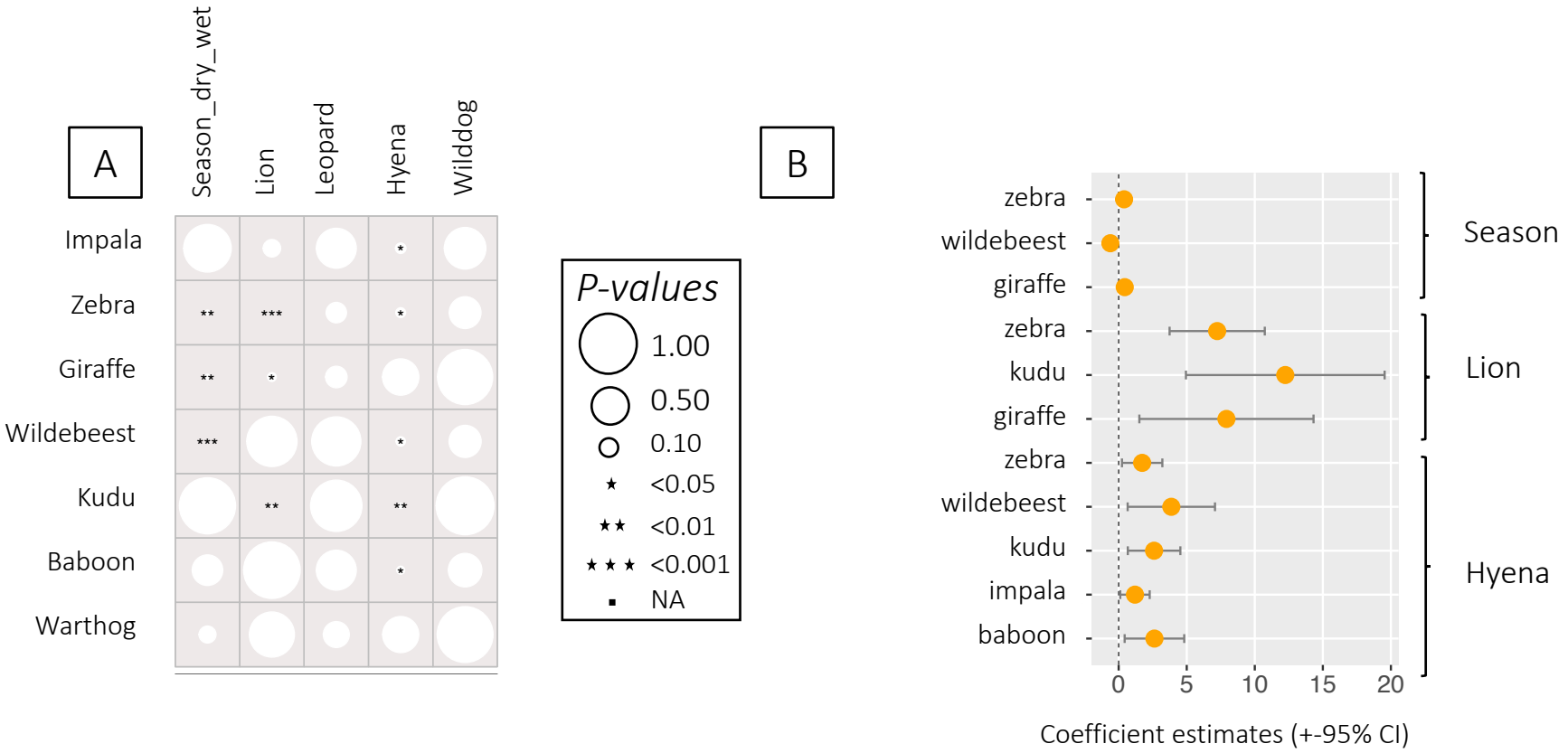

A
Season_dry_wet
Lion
Leopard
Hyena
Wilddog
Impala
Zebra
Giraffe
Wildebeest
Kudu
Baboon
Warthog
P-values
1.00
0.50
0.10
<0.05
<0.01
<0.001
NA
B
zebra
wildebeest
giraffe
zebra
kudu
giraffe
zebra
wildebeest
kudu
impala
baboon
Season
Lion
Hyena
0
5
10
15
20
Coefficient estimates (+-95% CI)

Figure 3.

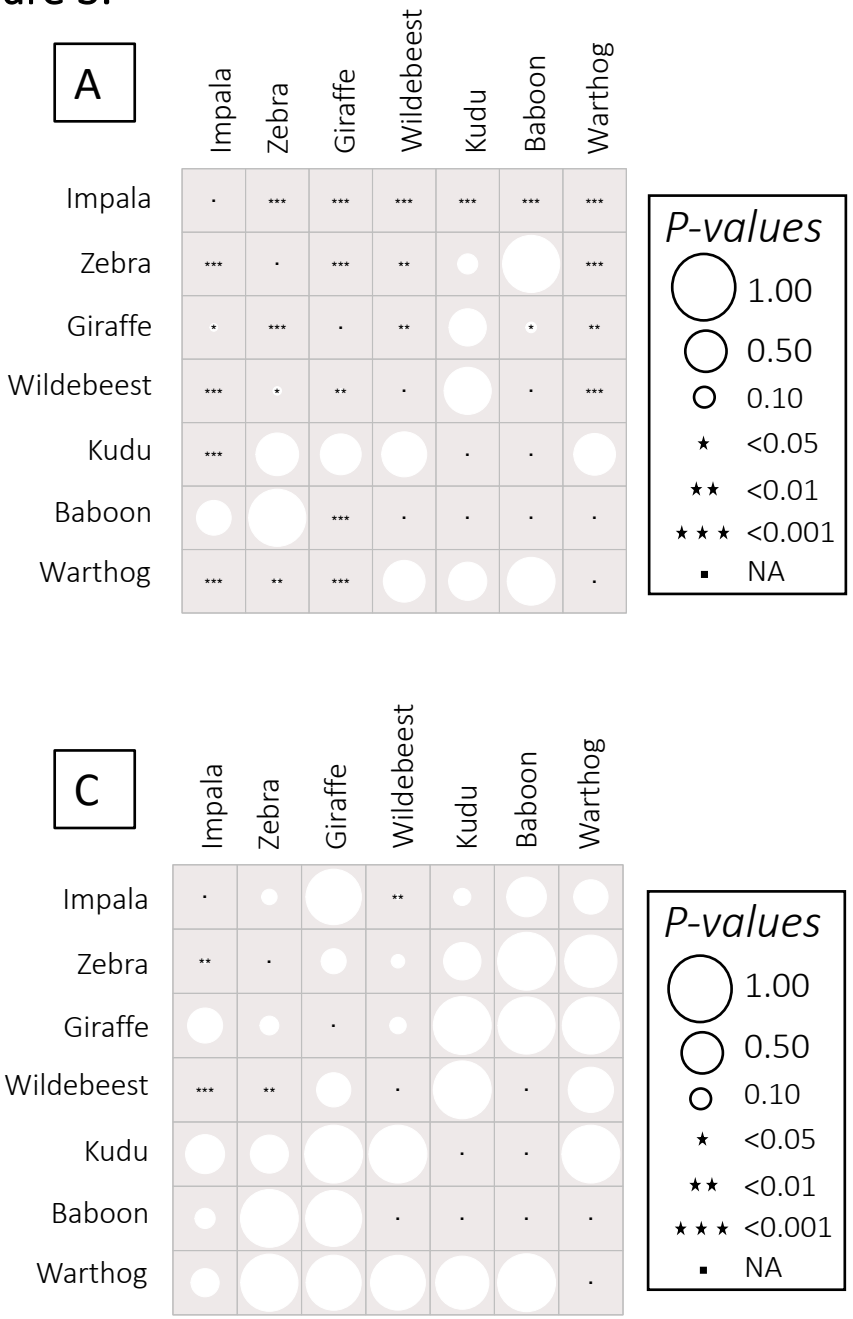
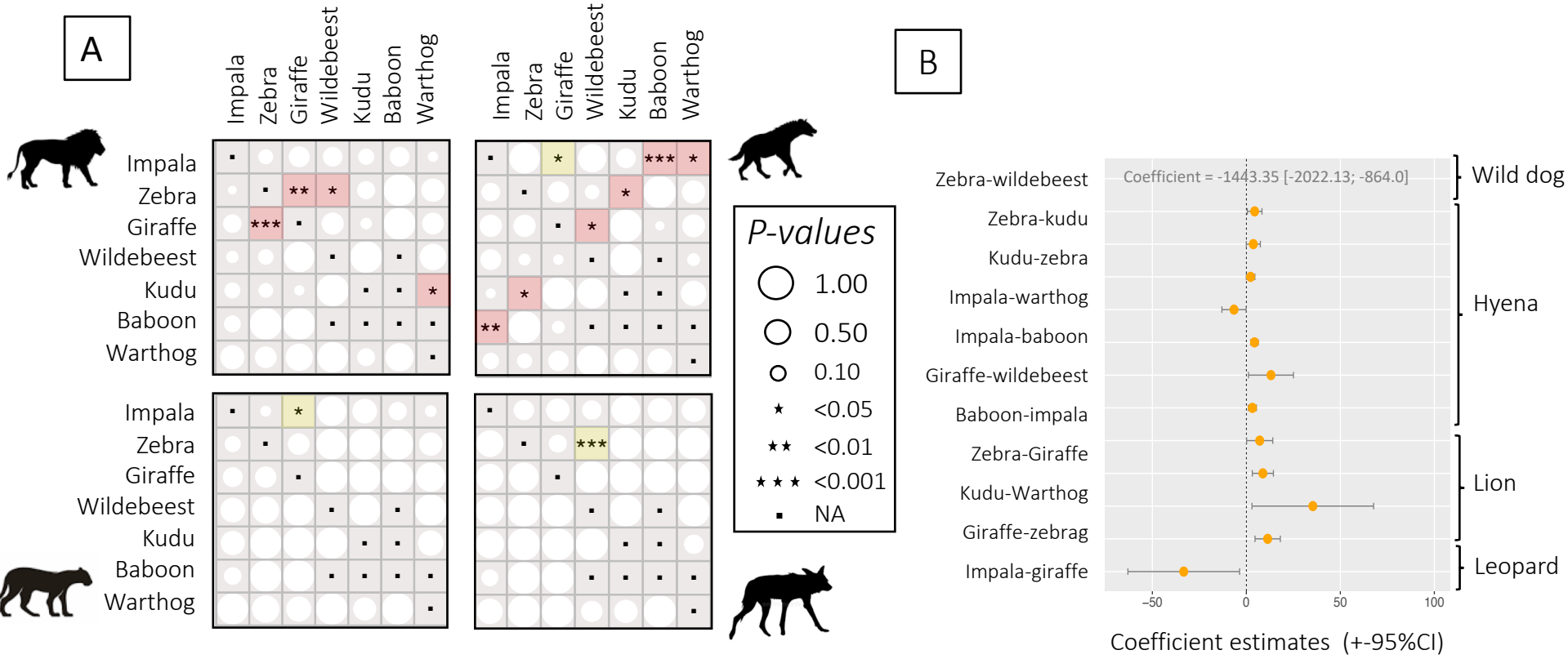

A
Impala
Zebra
Giraffe
Wildebeest
Kudu
Baboon
Warthog
P-values
1.00
0.50
0.10
<0.05
<0.01
<0.001
NA
B
zebra_wildebeest
zebra_warthog
zebra_impala
zebra_giraffe
wildebeest_zebra
wildebeest_warthog
wildebeest_impala
wildebeest_giraffe
warthog_zebraburchells
warthog_impala
warthog_giraffe
kudu_impala
impala_zebrab
impala_wildebeest
impala_warthog
impala_kudu
impala_giraffe
impala_baboon
giraffe_zebra
giraffe_wildebeest
giraffe_warthog
giraffe_impala
giraffe_baboon
baboon_giraffe
0
5
10
15
Coefficient estimates (+-95% CI)
C
Impala
Zebra
Giraffe
Wildebeest
Kudu
Baboon
Warthog
P-values
1.00
0.50
0.10
<0.05
<0.01
<0.001
NA
D
zebra-impala
wildebeest-zebra
wildebeest-impala
impala-wildebeest
−1
0
Coefficient estimates (+-95% CI)

Figure 4.


A
Impala
Zebra
Giraffe
Wildebeest
Kudu
Baboon
Warthog
P-values
1.00
0.50
0.10
<0.05
<0.01
<0.001
NA
B
Zebra-wildebeest
Zebra-kudu
Kudu-zebra
Impala-warthog
Impala-baboon
Giraffe-wildebeest
Baboon-impala
Zebra-Giraffe
Kudu-Warthog
Giraffe-zebrag
Impala-giraffe
Coefficient = -1443.35 [-2022.13; -864.0]
Wild dog
Hyena
Lion
Leopard
−50
0
50
100
Coefficient estimates (+-95%CI)