



# Seasonal variation in ectoparasite load in Malagasy fruit bats

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(C4C student 2022)

# Introduction

- Play important roles in maintain and transmission of the pathogens in host population (Brook et al, 2015, Wilkinson et al 2016)
- Bat ectoparasites are specific
- Limited information available in their ecology : information limited to some older taxonomic works (Theodor 1957,1968a,1968b;Maa1971) and a recent genetic study (Tortosa et al. 2013, Brook et al,2015)

# Research question

What are the main factors influencing the abundance of ectoparasites on Malagasy fruit bats through year ?

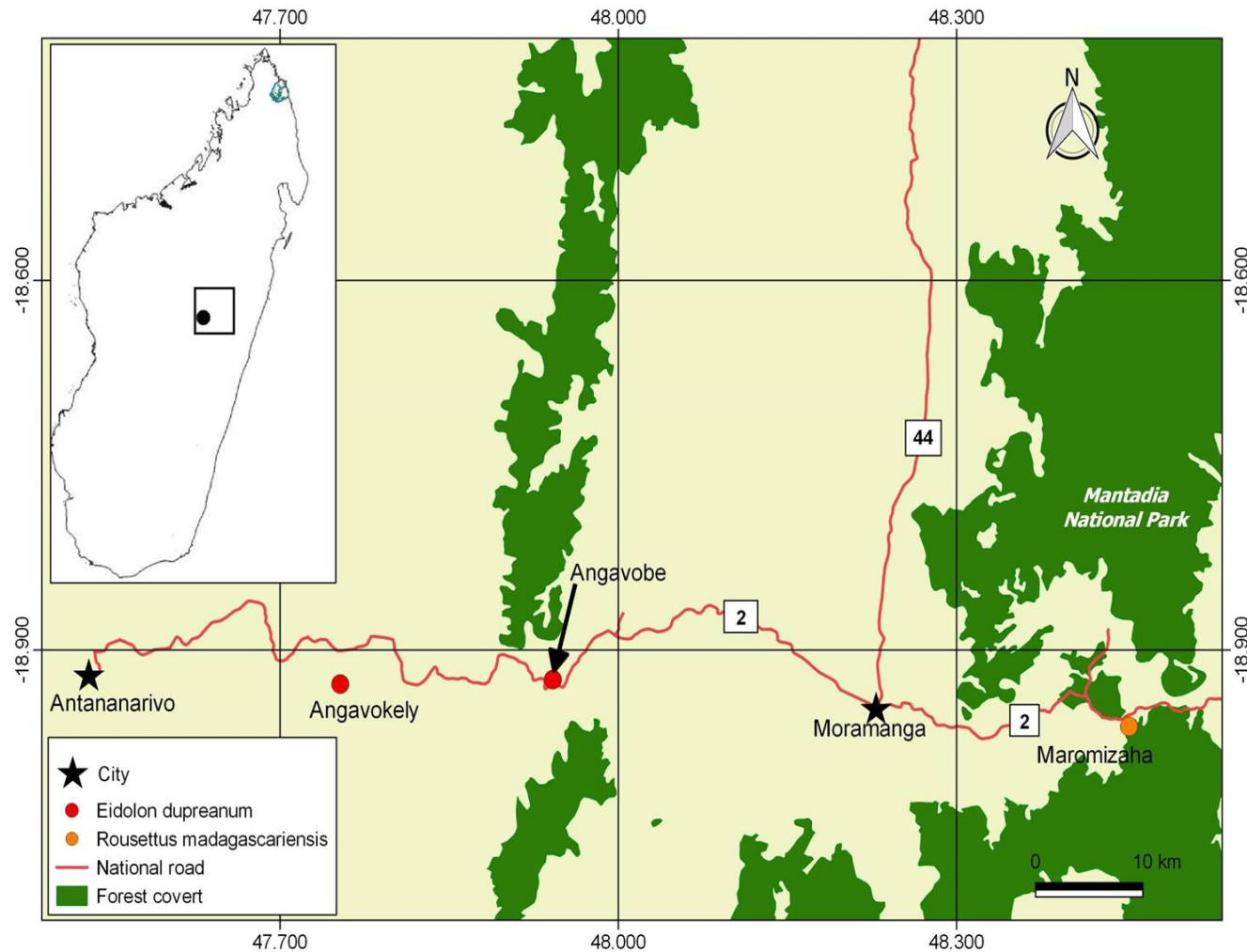
## Specific objectives

- Listing the diversity of ectoparasite hosted by the two cave roosting fruit bat species;
- Determining the pattern of the abundance of three species of bat flies through year
- Determining the main factor influencing the abundance of those ectoparasites

## Hypotheses

- There is a seasonal pattern on the ectoparasite;
- Body mass and forearm have influence on abundance of ectoparasites
- The climate influence the seasonal pattern

# Methodology



A longitudinal study was carried out in 2 districts of Madagascar :  
Manjakandriana and Moramanga

Collection time : 2013-2020

# Methodology

collection_date	bat_sex	bat_age_c	body_length_cm	bat_forearm_mm	bat_tibia_mm	ear_length_mm
Aug 22 2013	male	A	20	130	60	30
Aug 22 2013	male	A	24.5	130	63	27
Aug 22 2013	male	A	24	136	65	27
Aug 22 2013	male	A	23.4	128	60	21
Aug 22 2013	male	A	29	126	62	28
Nov 04 2013	male	A	37	150	77	36
Nov 04 2013	female	L	34.5	153	80	35
Nov 04 2013	female	L	38	147	85	31
Nov 04 2013	female	J	23	91	61	19
Nov 04 2013	male	J	23.5	87	55	22
Nov 06 2013	male	A	33	155	84.3	28.1
Nov 07 2013	female	L	32.5	165	79	25
Nov 07 2013	male	A	32	170	88	22.9
Nov 07 2013	male	J	24.3	98	50	18.8
Nov 08 2013	female	L	28	154	76	24
Nov 08 2013	female	L	31	168	86.4	24
Nov 08 2013	female	J	20	89	45	21

- Traps: mist nets
- Sample collected:
  - Body measurements (forearm, weight)
  - Ectoparasites (in ethanol 70%)



## Data analysis

### Seasonal variation

- ❖ abundance/count of each species or group of ectoparasites

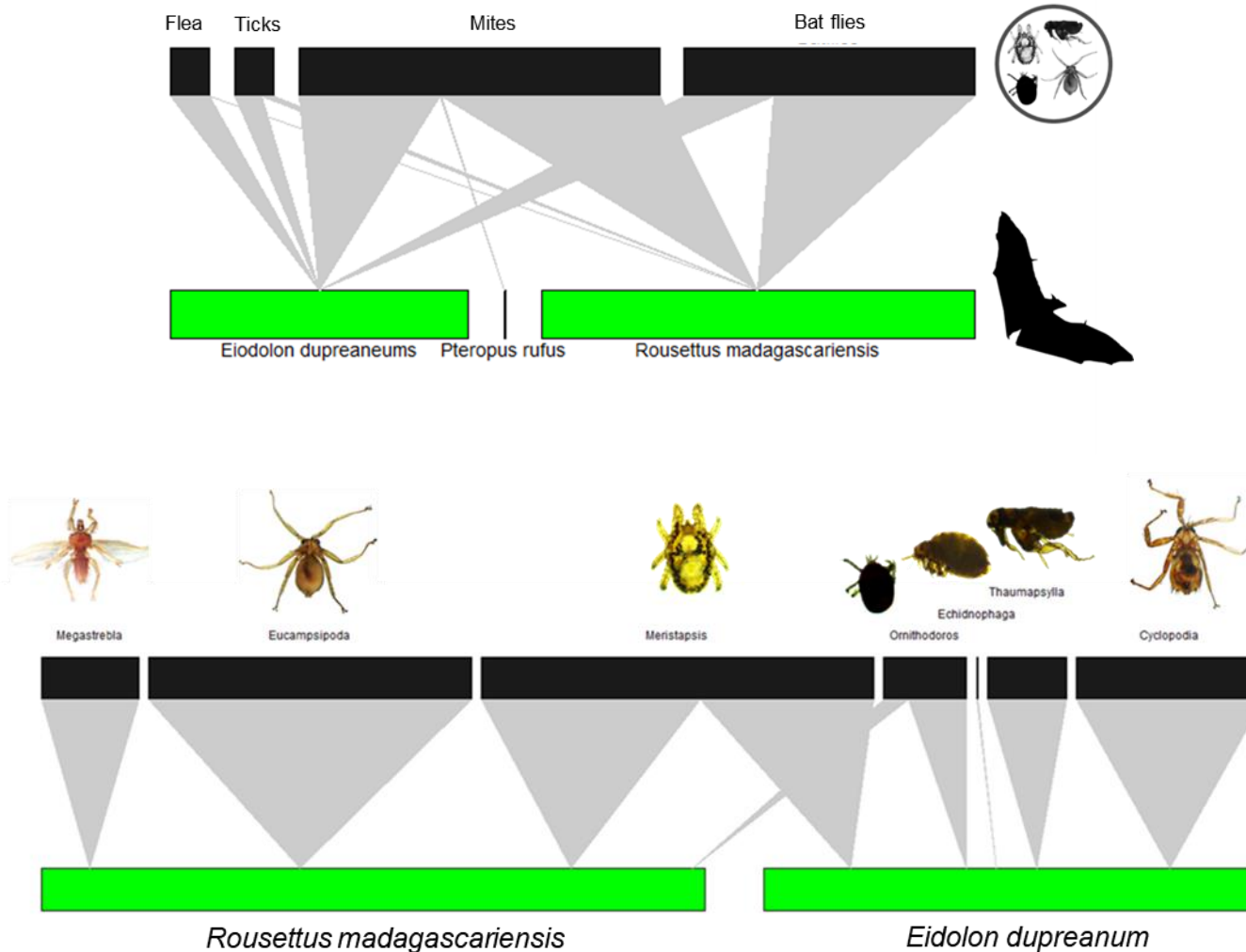
GAM: general additive model

#### Formula:

Count\_of\_ectoparasites\_by\_bat\_species ~ s(day of the year, k=7, bs="cc")+  
s(year, bs="re")+s(forearm, bs="tp", k=7)+s(body mass, bs="tp", k=7)

# Results

## Ectoparasite community in relation to bat community



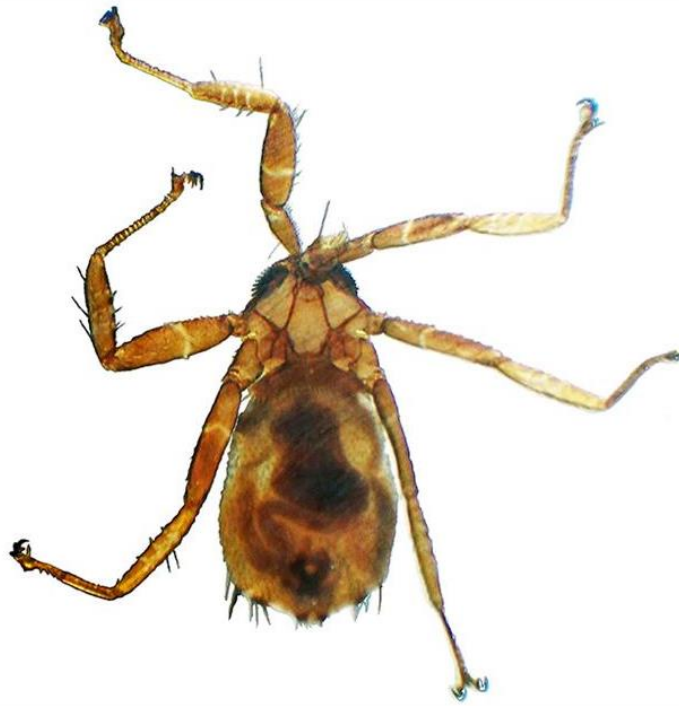
4 groups of ectoparasite found :

- Bat flies
- Flea
- Mites
- Ticks

# Ectoparasites community

Host: *Eidolon dupreanum*

Bat flie (1)



*Cyclopodia dubia*

Fleas (2)



*Echidnophaga* sp



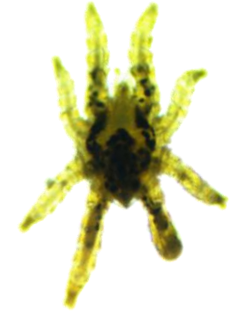
*Thaumapsylla* sp

Tick (1)



*Ornithodoros* sp

Mites (2)



Mite 2  
(*Spinturinix* sp)



*Meristapsis* spp



# Ectoparasites community

Host: *Rousettus madagascariensis*

## Bat flie (2)

*Eucampsipoda madagascariensis* (dorsal view)



Male

Female

*Megastrebla wenzeli* (Dorsal view)

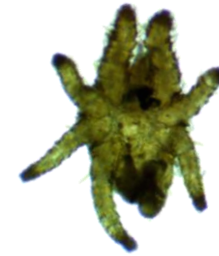


## Tick (1)



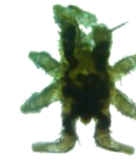
*Ornithodoros* sp

## Mites (3)

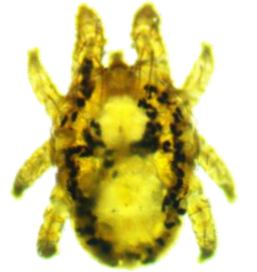


Mite 6

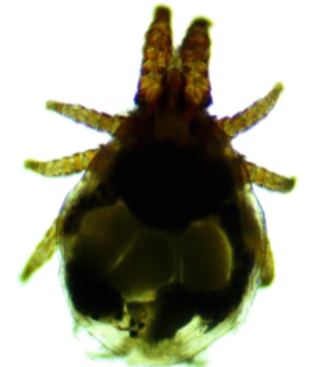
(*Spinturnix* spp.)



Mite 5



*Meristapsis* spp.



Mite 7  
(*Acystopus* sp??)

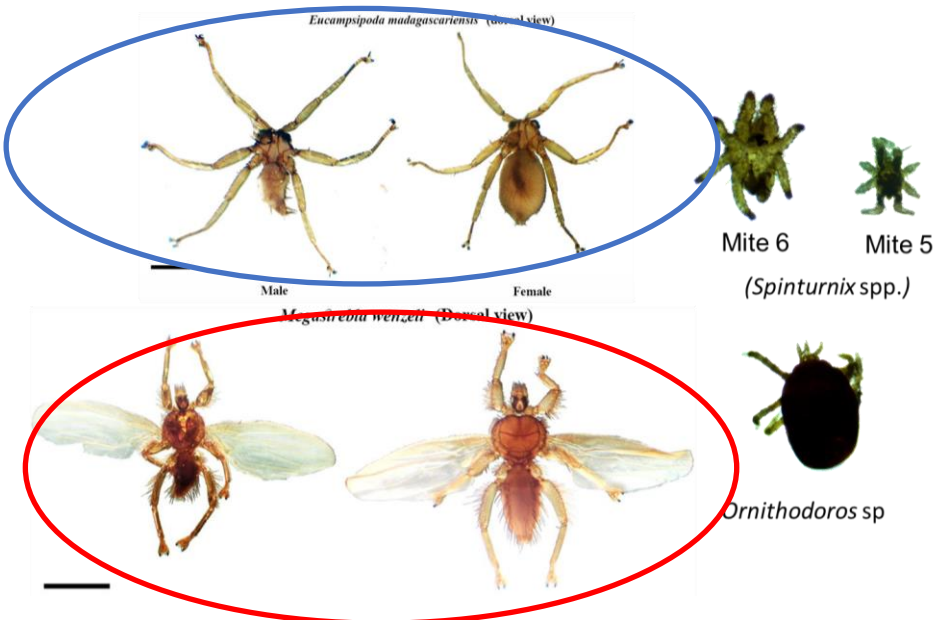
# Study populations



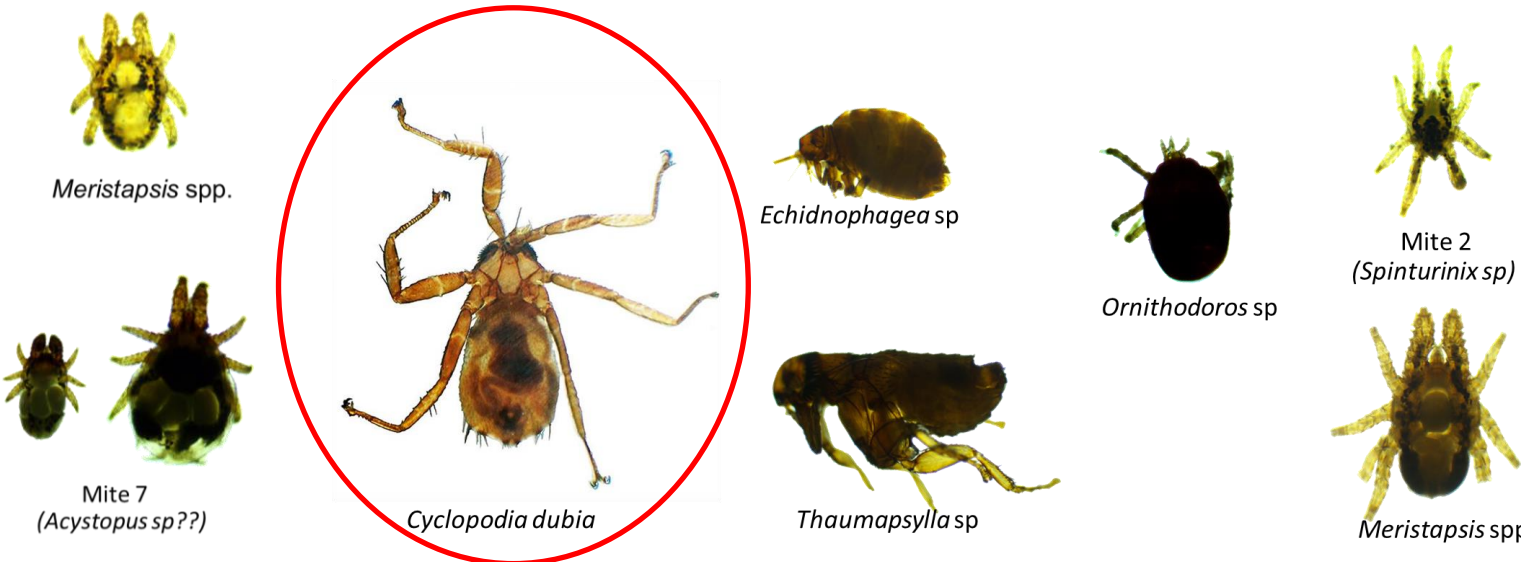
Host



Host: *Rousettus madagascariensis*



Host: *Eidolon dupreanum*

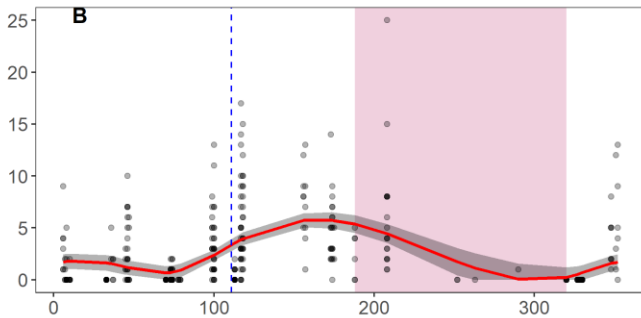
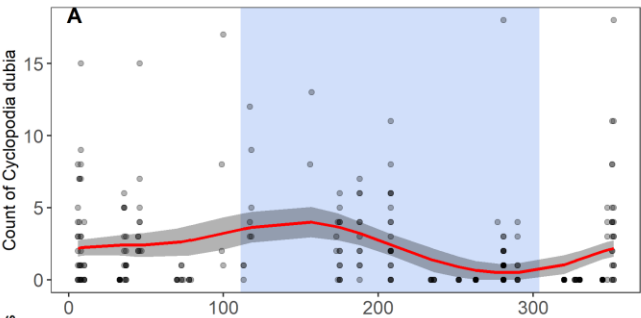


# Seasonal variation of the ectoparasites abundance

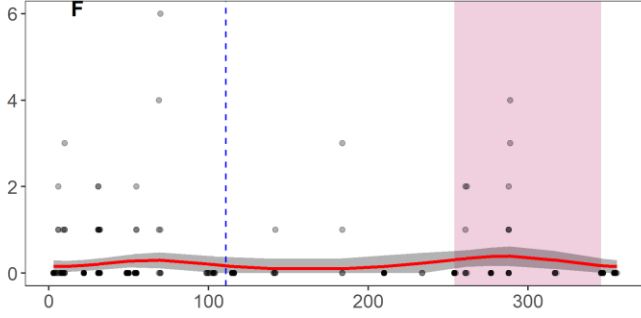
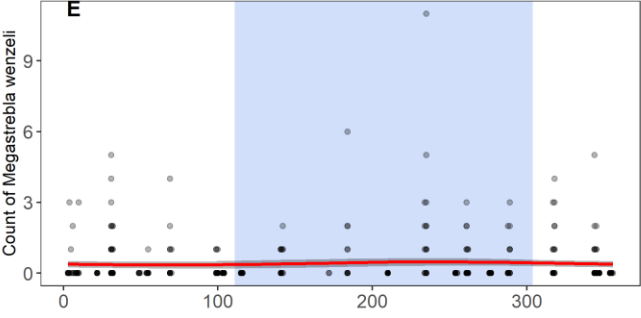
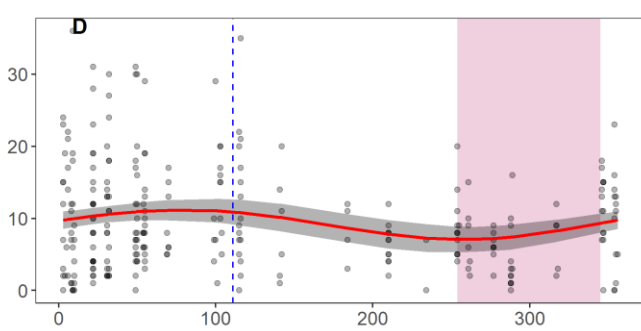
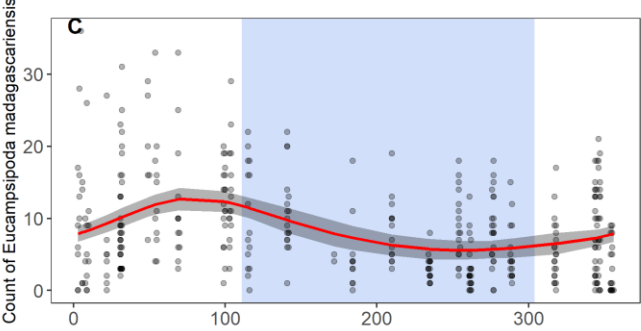
Male

Female

*Eidolon  
dupreanum*



*Rousettus  
madagascariensis*



Variation of the abundance of bat flies (Nycteribiidae & Megastreblidae) hosting by *Eidolon dupreanum* (A & B) and *Rousettus madagascariensis* (C, D, E, F) through the year

Blue shade : dry season  
Pink shade: gestation period  
Dast line : start of dry season (Andrianiana & Andry et al, 2022)

Basic spline= “cc”

Knot number= 7

Y= field count of the ectoparasite

Fixed effect= day of the year (1-365 days)

Partial effect= year of collection

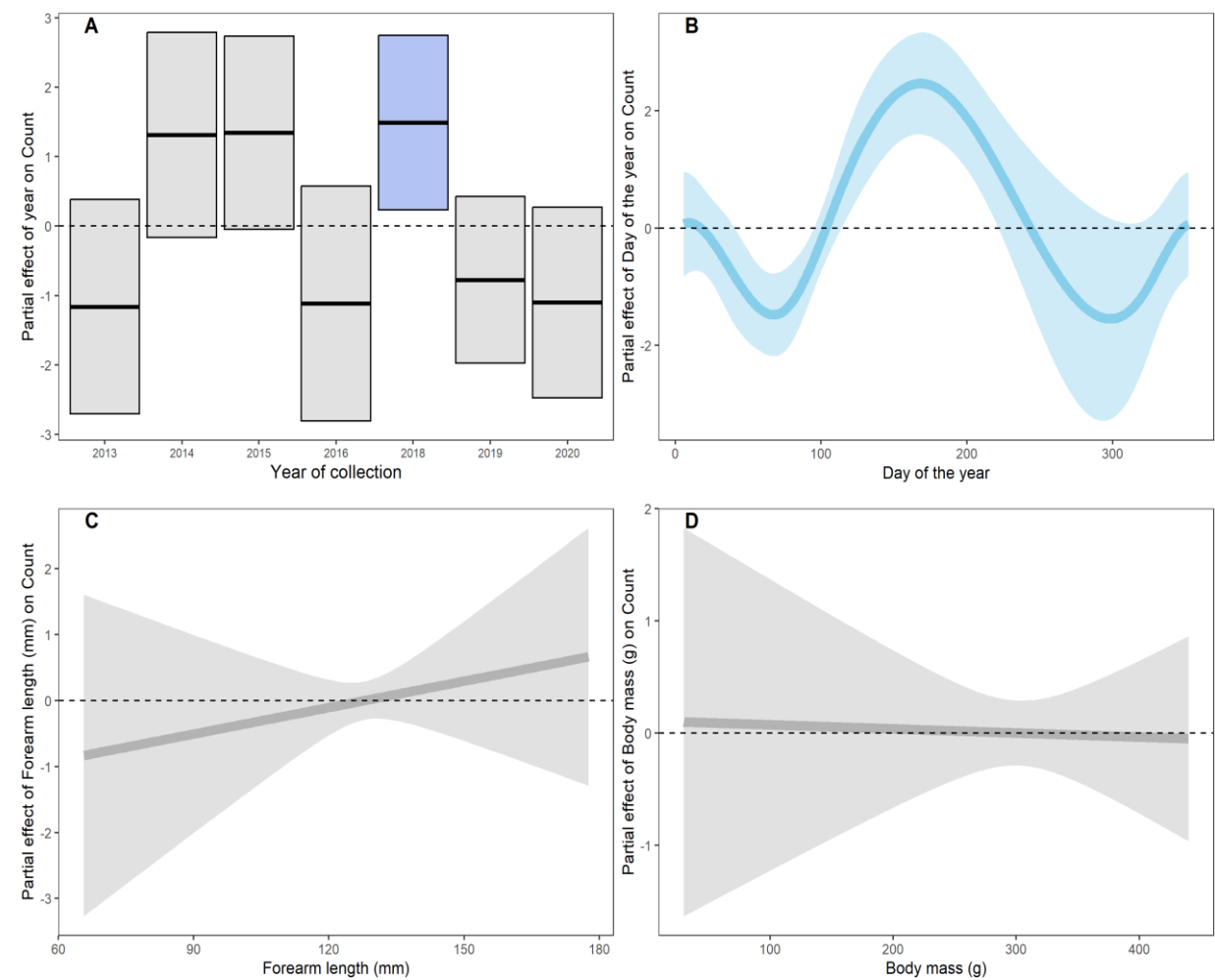
# Partial effects

*Cyclopodia dubia* (host female)



Partial effect of the year, bat forearm length, weight, on the ectoparasite count

Model1=gam ( count~s(day of the year,bs=cc,k=7)+s(year,bs=re)+s(weight,k=7,bs="tp")+s(forearm,k=7,bs="tp",data)



Approximate significance of smooth terms:

	edf	Ref.df	F	p-value	
s(yday)	3.667	5	37.243	1.75e-05	***
s(year)	4.968	6	5.513	1.90e-06	***
s(bat_forearm_mm)	1.000	1	0.427	0.514	
s(bat_weight_g)	1.000	1	0.513	0.474	

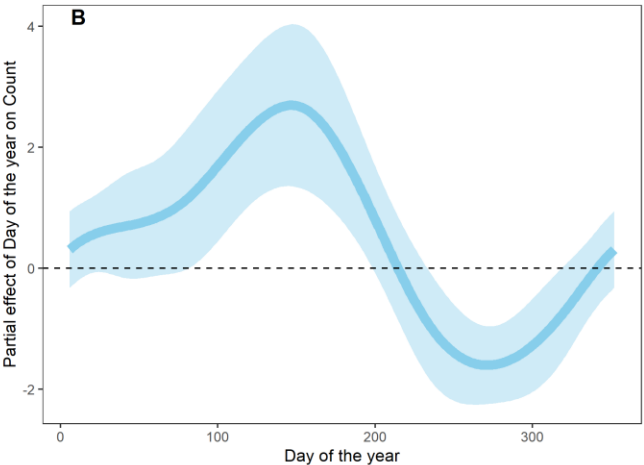
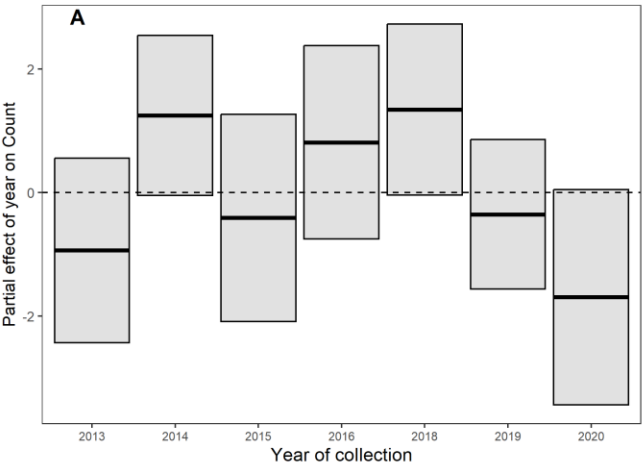
# Partial effects

*Cyclopodia dubia* (host male)



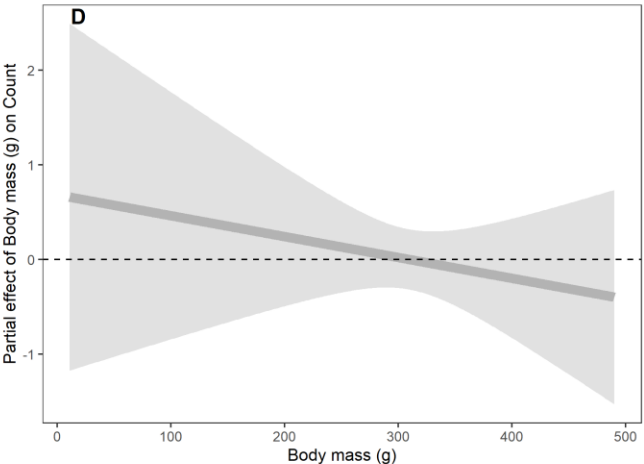
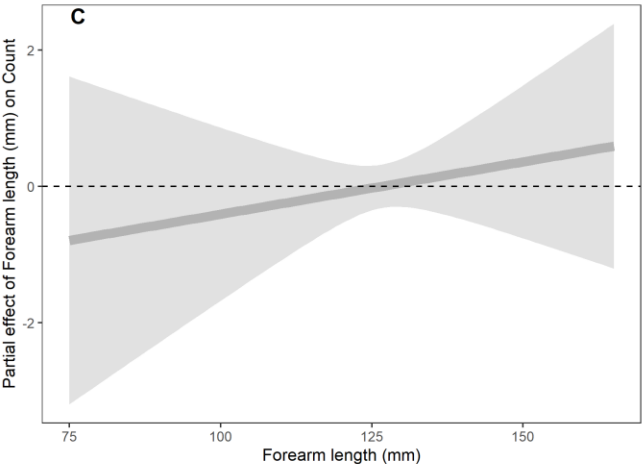
Partial effect of the year, bat forearm length, weight, on the ectoparasite count

```
Model1=gam ( count~s(day of the year,bs=cc,k=7)+s(year,bs=re)+s(weight,k=7,bs="tp")+s(forearm,k=7,bs="tp",data)
```



Approximate significance of smooth terms:

	edf	Ref.df	F	p-value	
s(yday)	4.250	5	71.626	8.63e-07	***
s(year)	5.083	6	8.844	< 2e-16	***
s(bat_forearm_mm)	1.000	1	0.454	0.501	
s(bat_weight_g)	1.000	1	0.013	0.910	
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# Partial effects

*Eucampsipoda madagascariensis* (host female)

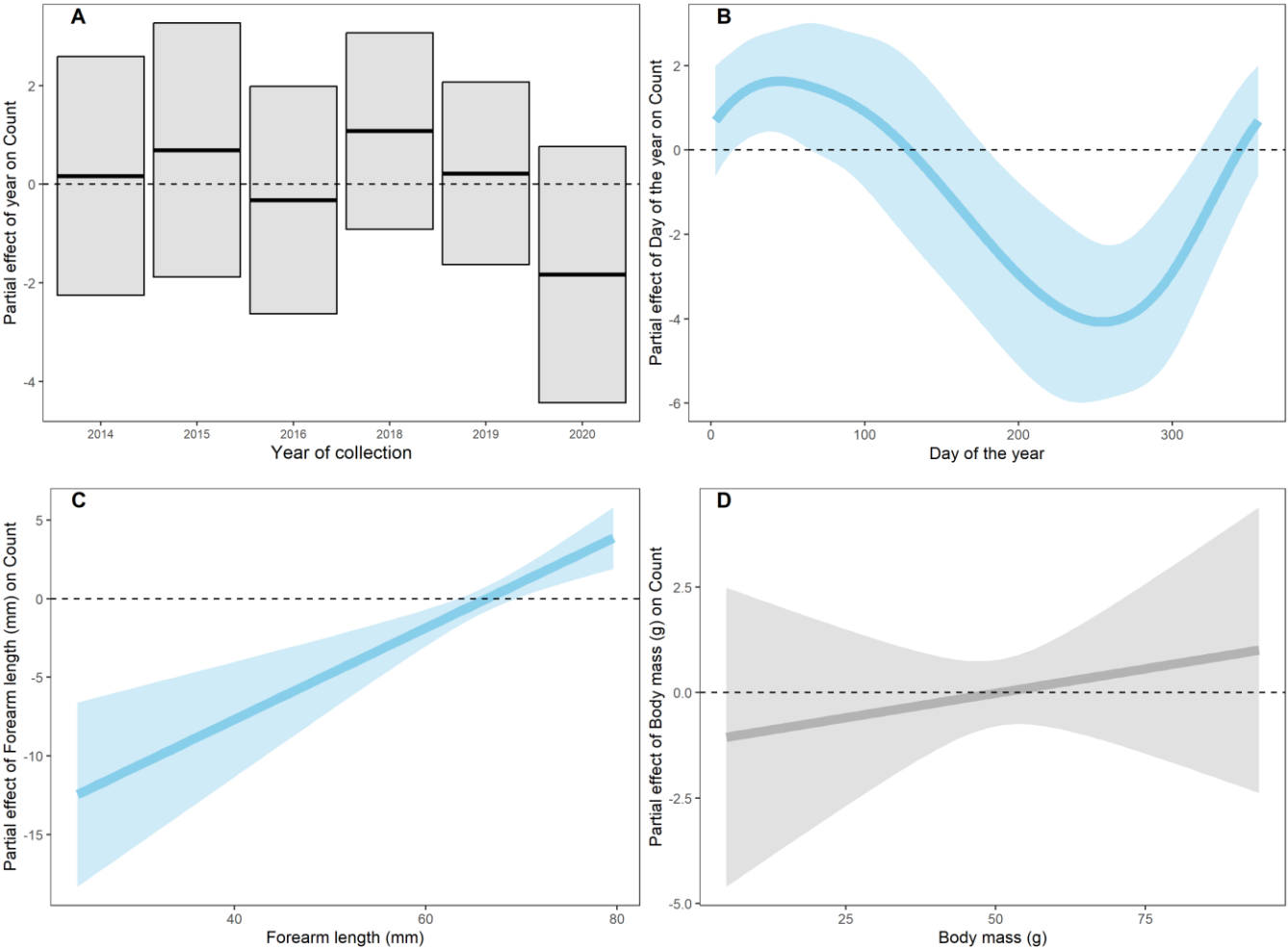


Partial effect of the year, bat forearm length, weight, on the ectoparasite count

Model1=gam ( count~s(day of the year,bs=cc,k=7)+s(year,bs=re)+s(weight,k=7,bs="tp")+s(forearm,k=7,bs="tp",data)

Approximate significance of smooth terms:

	edf	Ref.df	F	p-value	
s(yday)	2.502	5	6.756	2.96e-05	***
s(year)	2.935	5	0.819	0.209	
s(bat_forearm_mm)	1.000	1	17.698	3.64e-05	***
s(bat_weight_g)	1.000	1	0.359	0.549	



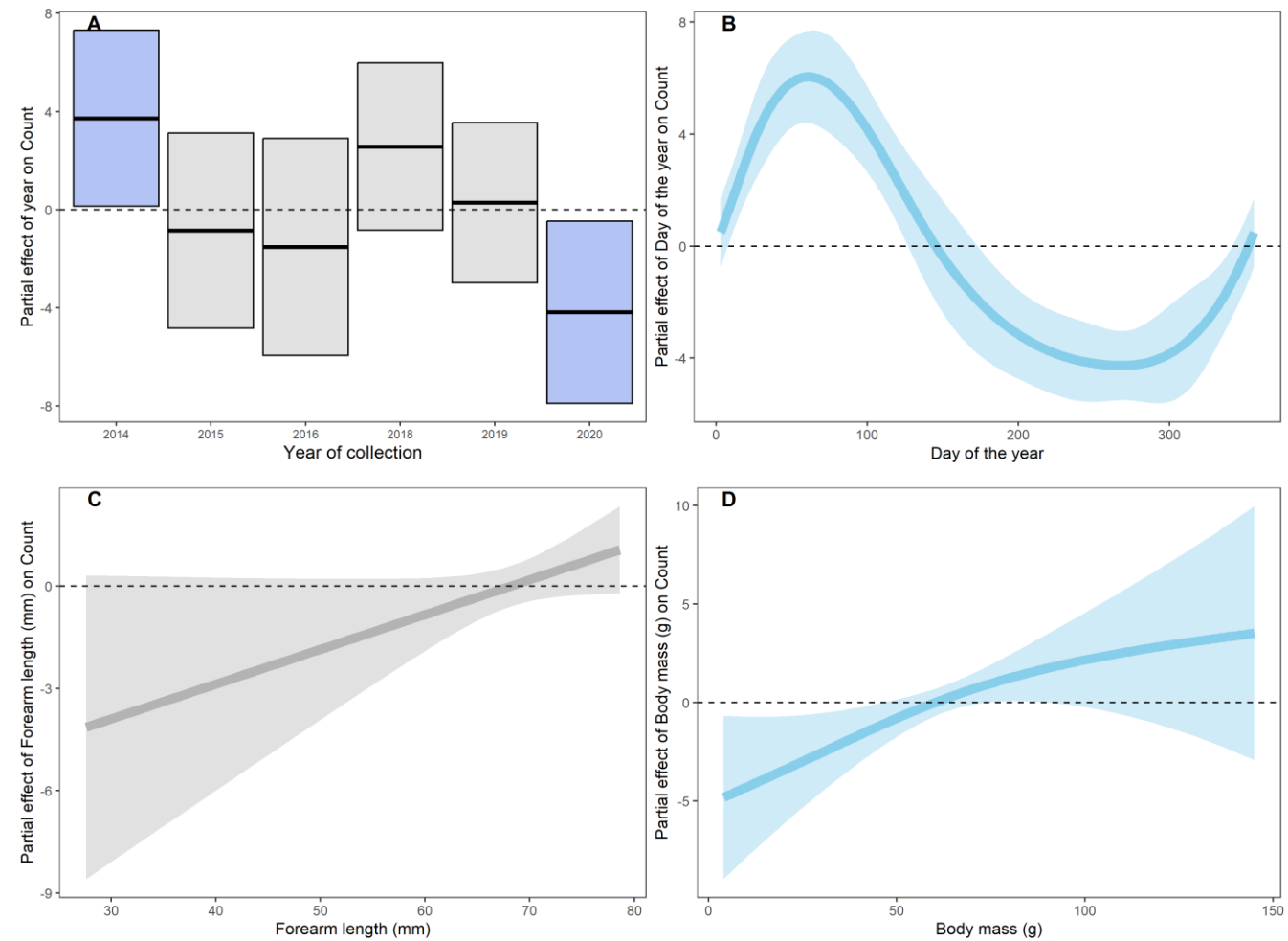
# Partial effects

*Eucampsipoda madagascariensis* (host male)



Partial effect of the year, bat forearm length, weight, on the ectoparasite count

Model1=gam ( count~s(day of the year,bs=cc,k=7)+s(year,bs=re)+s(weight,k=7,bs="tp")+s(forearm,k=7,bs="tp"),data)



Approximate significance of smooth terms:

	edf	Ref.df	F	p-value	
s(yday)	4.050	5.000	116.540	< 2e-16	***
s(year)	4.477	5.000	6.445	2.16e-06	***
s(bat_forearm_mm)	1.000	1.000	3.379	0.0669	.
s(bat_weight_g)	1.567	1.982	3.368	0.0371	*

# Partial effects

*Megastrebla wenzeli* (host female)

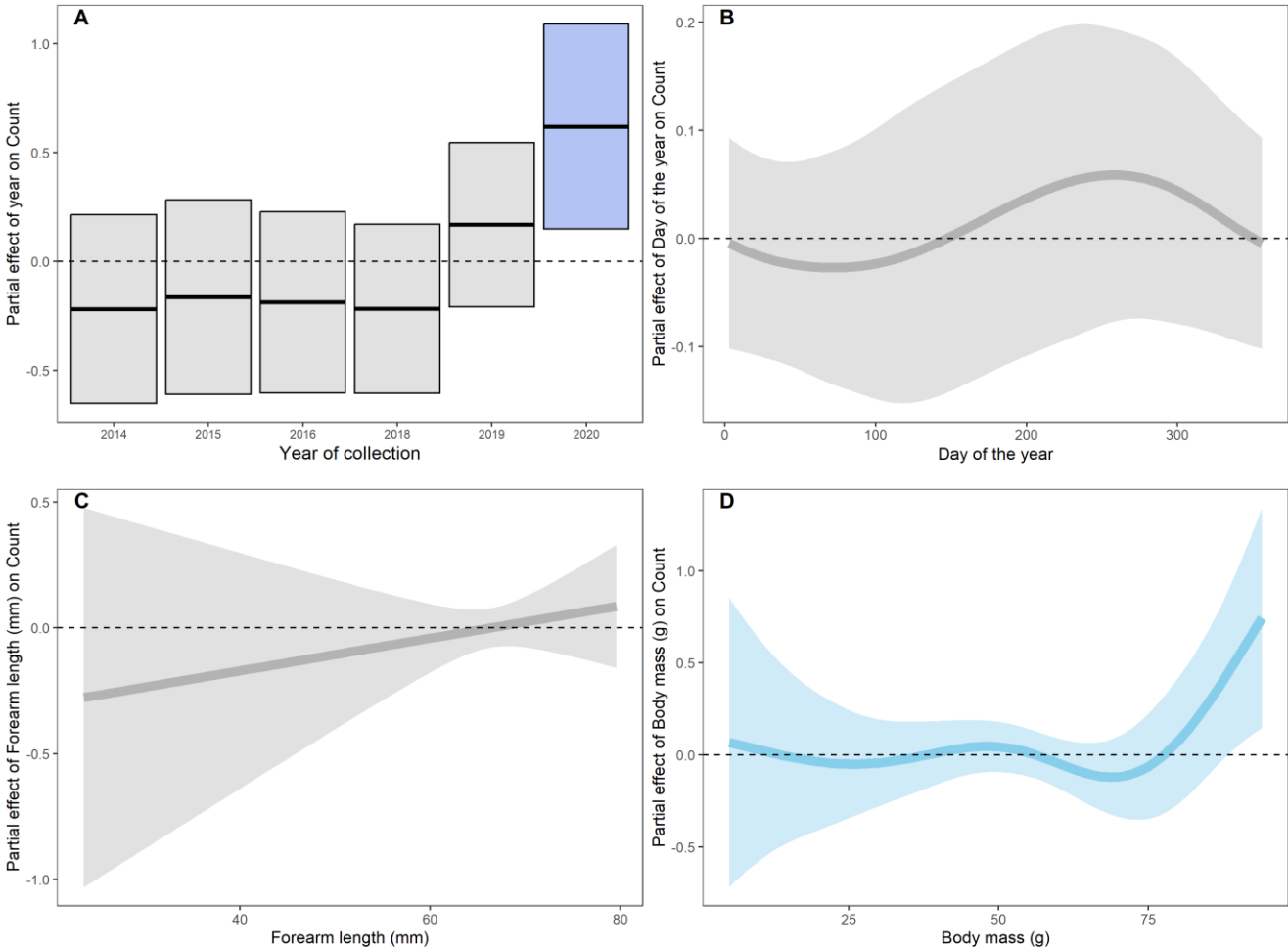


Partial effect of the year, bat forearm length, weight, on the ectoparasite count

Model1=gam ( count~s(day of the year,bs=cc,k=7)+s(year,bs=re)+s(weight,k=7,bs="tp")+s( forearm,k=7,bs="tp"),data)

Approximate significance of smooth terms:

	edf	Ref.df	F	p-value
s(yday)	0.7587	5.000	0.367	0.279
s(year)	4.5156	5.000	6.531	2.06e-06 ***
s(bat_forearm_mm)	1.0000	1.000	0.524	0.470
s(bat_weight_g)	4.0359	4.828	2.033	0.098 .





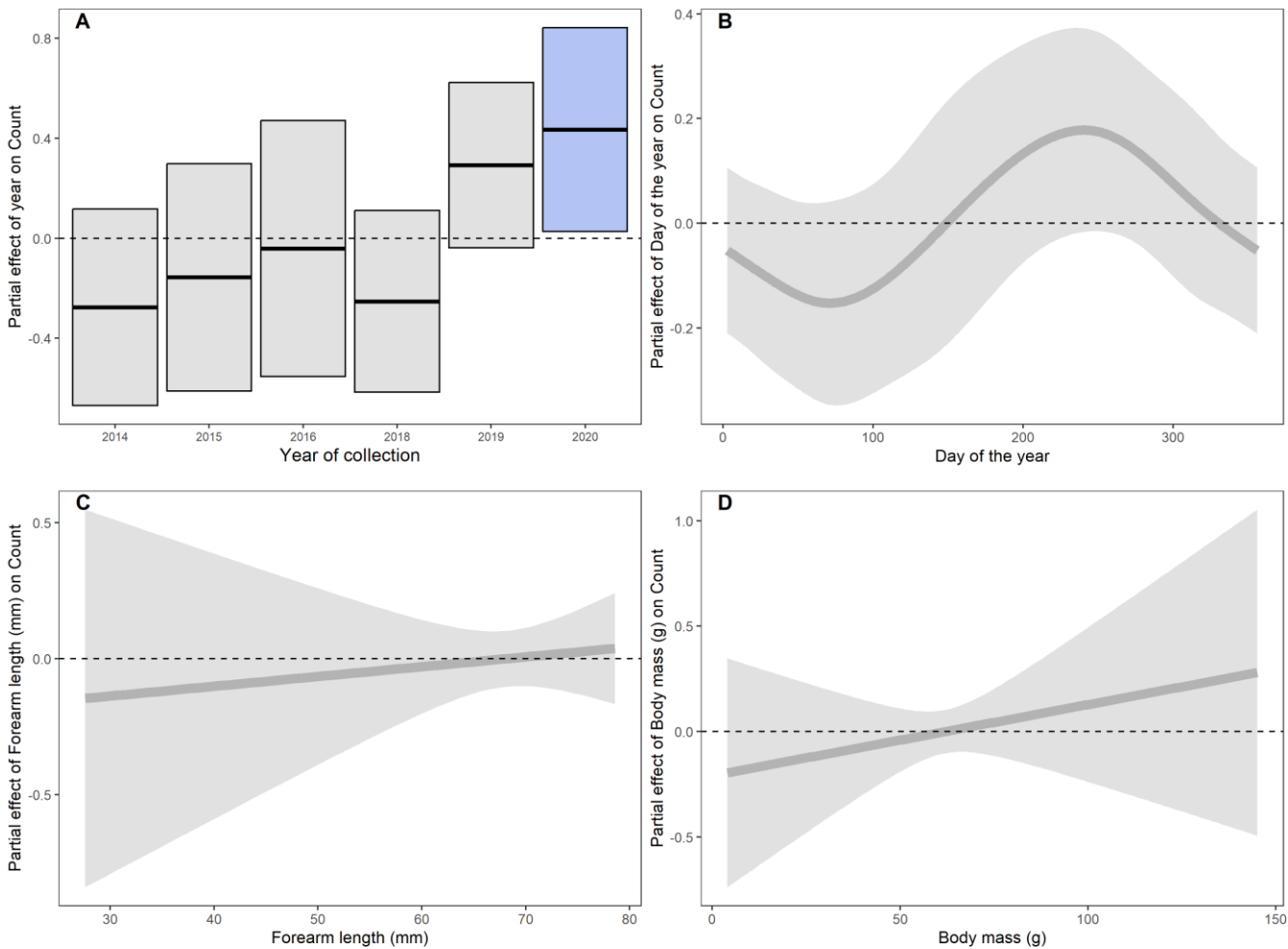
# Partial effects

*Megastrebla wenzeli* (host male)



Partial effect of the year, bat forearm length, weight, on the ectoparasite count

Model1=gam ( count~s(day of the year,bs=cc,k=7)+s(year,bs=re)+s(weight,k=7,bs="tp")+s( forearm,k=7,bs="tp"),data)



Approximate significance of smooth terms:

	edf	Ref.df	F	p-value
s(yday)	1.752	5	1.696	0.0455 *
s(year)	3.700	5	5.342	3.65e-06 ***
s(bat_forearm_mm)	1.000	1	0.174	0.6768
s(bat_weight_g)	1.000	1	0.514	0.4739

## Next step

- Phylogeny of Bat flies
- Add climate as predictor variable

A dramatic sky with blue and white clouds, silhouetted birds in flight, and a large tree in the bottom left corner.

Thank for your  
attention