

The SPIPOLL* project: monitoring plant-visitor interactions in France with citizen science.

* *Photographic survey of flower visitors*



Nicolas Deguines

Assistant professor at University of Poitiers (France),
Lab' *Ecologie et Biologie des Interactions*

Symposium *Solutions to monitor plants, pollinators
and their interactions in a changing world,*

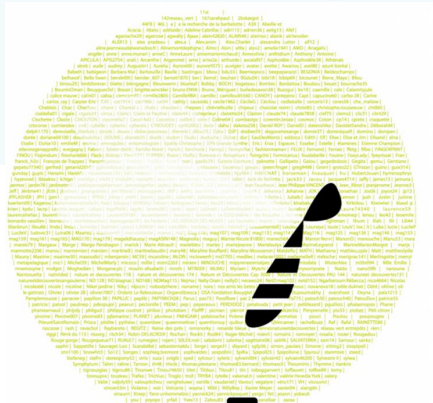
Organizers: *E. Porcher & G. Martin.*

May 23, 2024.



The SPIPOLL* project: monitoring plant-visitor interactions in France with citizen science.

* *Photographic survey of flower visitors*



SPIPOLLIENS

(= Spipoll's participants)



**Mathieu De Flores,
Pascal Dupont, ...**



**Romain Julliard,
Colin Fontaine,
Grégoire Lois, ...**



Nicolas Deguines & many others!

Assistant professor at University of Poitiers (France),
Lab' *Ecologie et Biologie des Interactions*

Symposium *Solutions to monitor plants, pollinators
and their interactions in a changing world,*



Organizers: *E. Porcher & G. Martin.*

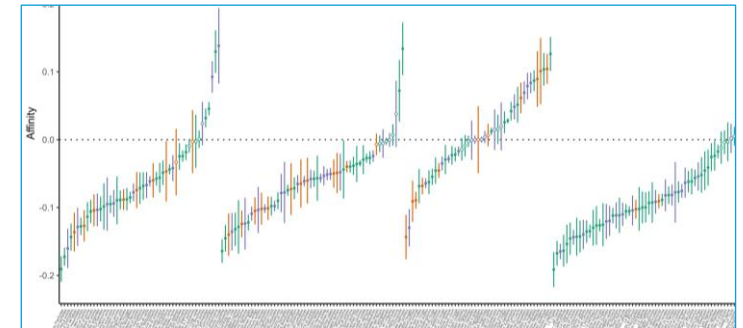
May 23, 2024.

I Objectives of the Spipoll project



**II Data collection
(and pointing out some evolutions since 2010)**

III Main results



IV Scientific perspectives

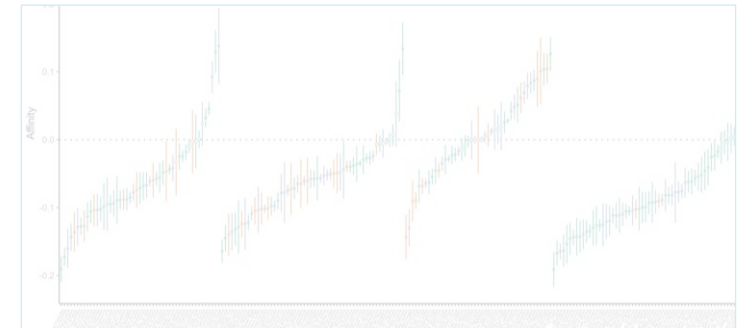


I Objectives of the Spipoll project



**II Data collection
(and pointing out some evolutions since 2010)**

III Main results



IV Scientific perspectives



Are there just honeybees, bumblebees, and solitary bees?

- **Bees** (Hymenoptera, Apoidea)



honey bee



wild bees

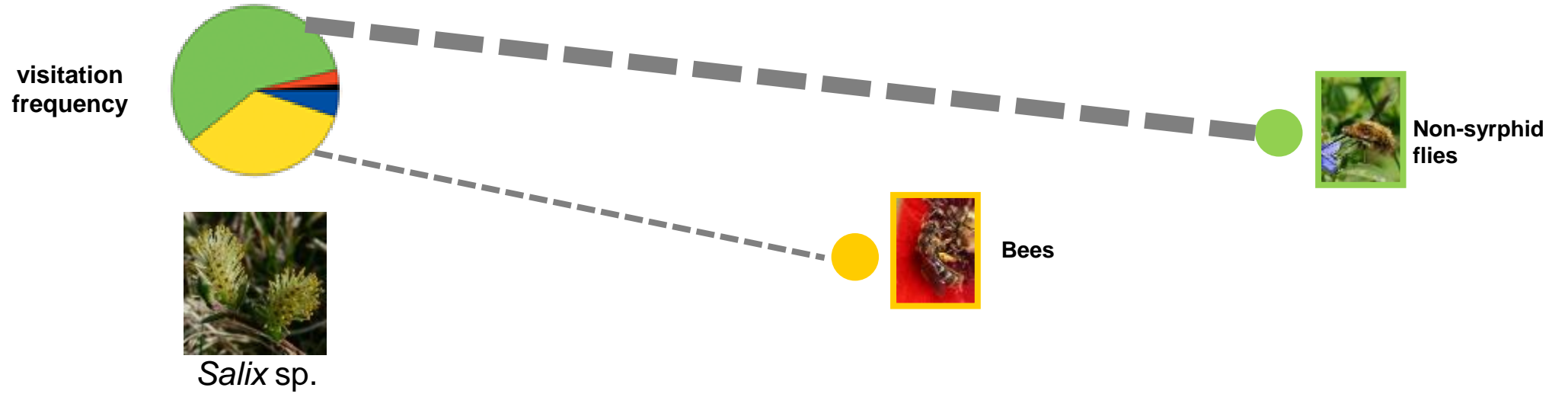
- > 17 000 species
(Michener 2007)
- adults and larval stages feed on pollen and/or nectar



“[...] most pollination ecologists would agree that bees (series Apiformes) are the predominant pollinators for most plants and ecosystems.”

(Winfree *et al.* 2011)

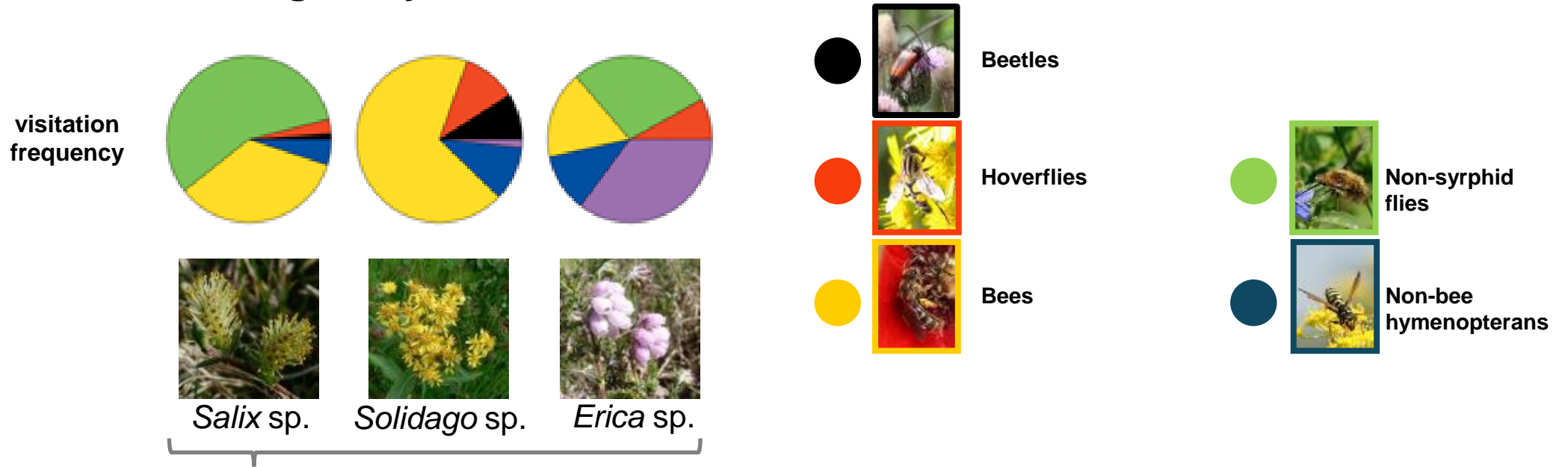
Visitation heterogeneity:



(Dupont & Olesen 2009)

Bees are not the sole pollinators out there...

Visitation heterogeneity:



(Dupont & Olesen 2009)

Each plant:

- high diversity of visitors
- sorting out the pollinators is difficult

Frequency of visits on flowers



Pollination efficiency



All flower visitors are important to consider

(Vazquez 2005)

- **Bees** (Hymenoptera, Apoidea)



- **Flies** (Diptera)



- **Ants, wasps, sawflies, ...**



- **Butterflies & Moths** (Lepidoptera)



- **Beetles** (Coleoptera)



- **Spiders, etc.**

- **Bees** (Hymenoptera, Apoidea)



- **Flies** (Diptera)



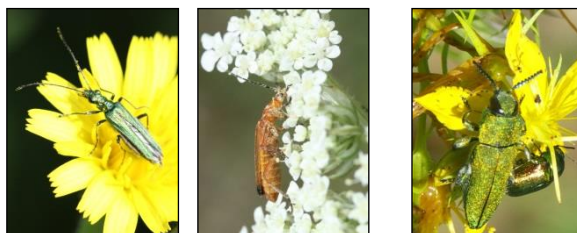
- **Ants, wasps, sawflies, ...**



- **Butterflies & Moths** (Lepidoptera)



- **Beetles** (Coleoptera)



Diverse life traits :

- Food** (pollen, nectar, leaves, preys, hosts...)
- Nesting habits** (cavities, ground, hosts, ...)
- Physiological responses to stresses**
- Flying ability** **Voltinism** **...**

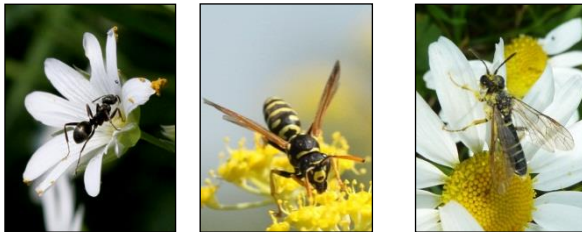
- **Bees** (Hymenoptera, Apoidea)



- **Flies** (Diptera)



- **Ants, wasps, sawflies, ...**



- **Butterflies & Moths** (Lepidoptera)



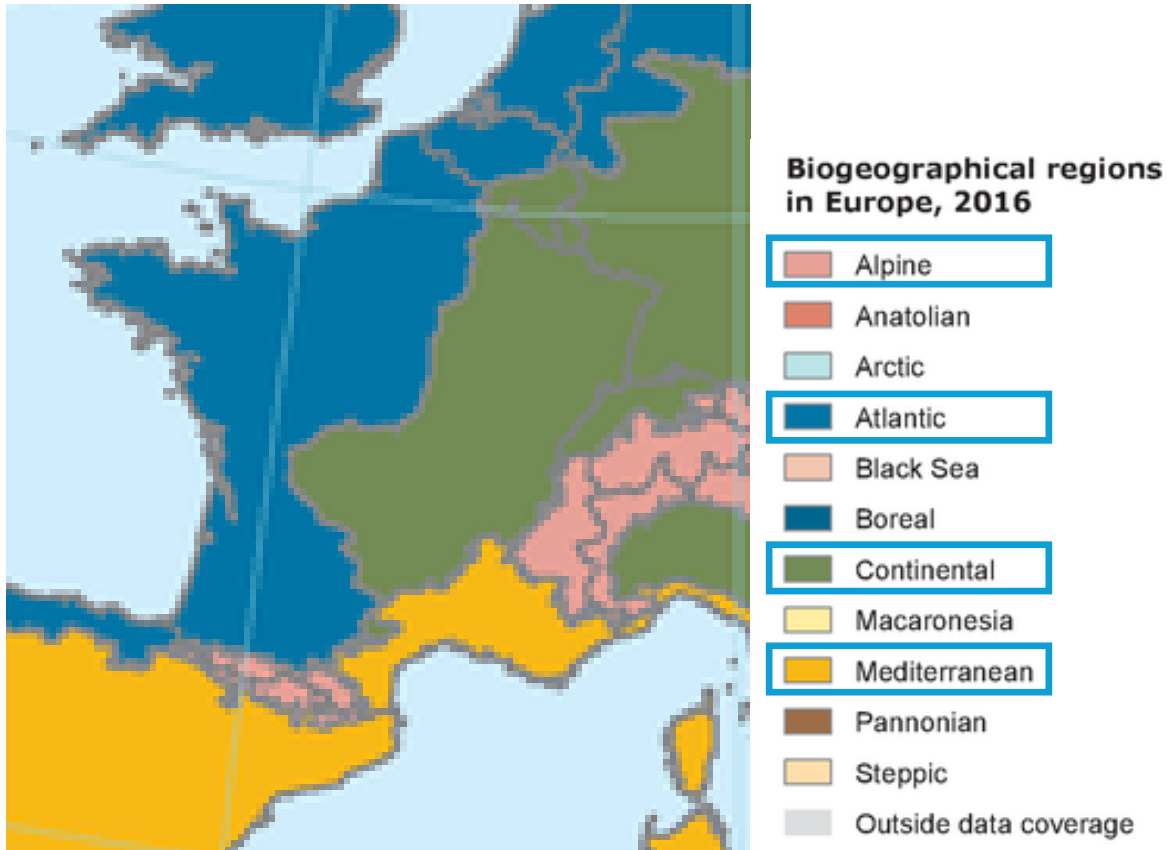
- **Beetles** (Coleoptera)



Diverse life traits...

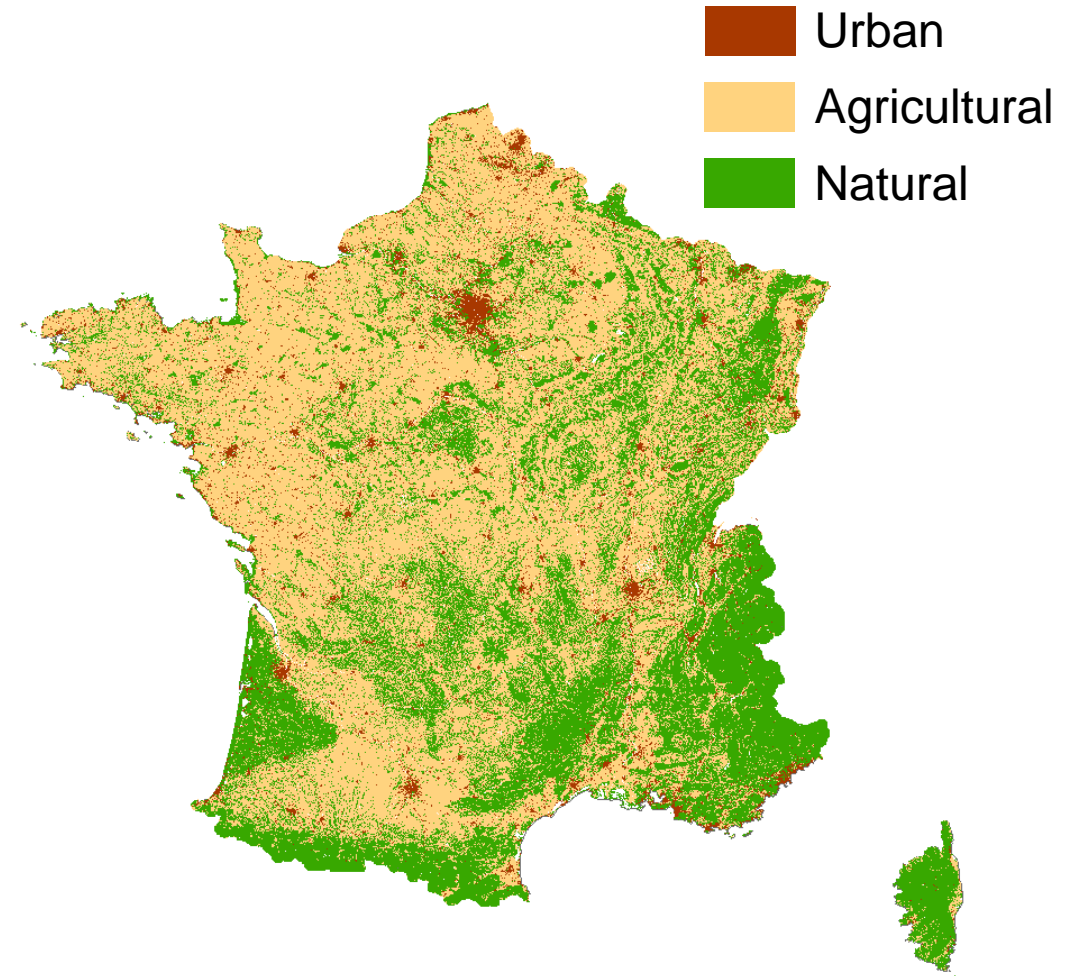
➡ ... driving responses to environmental changes and population trends?

- **Biogeographical regions**

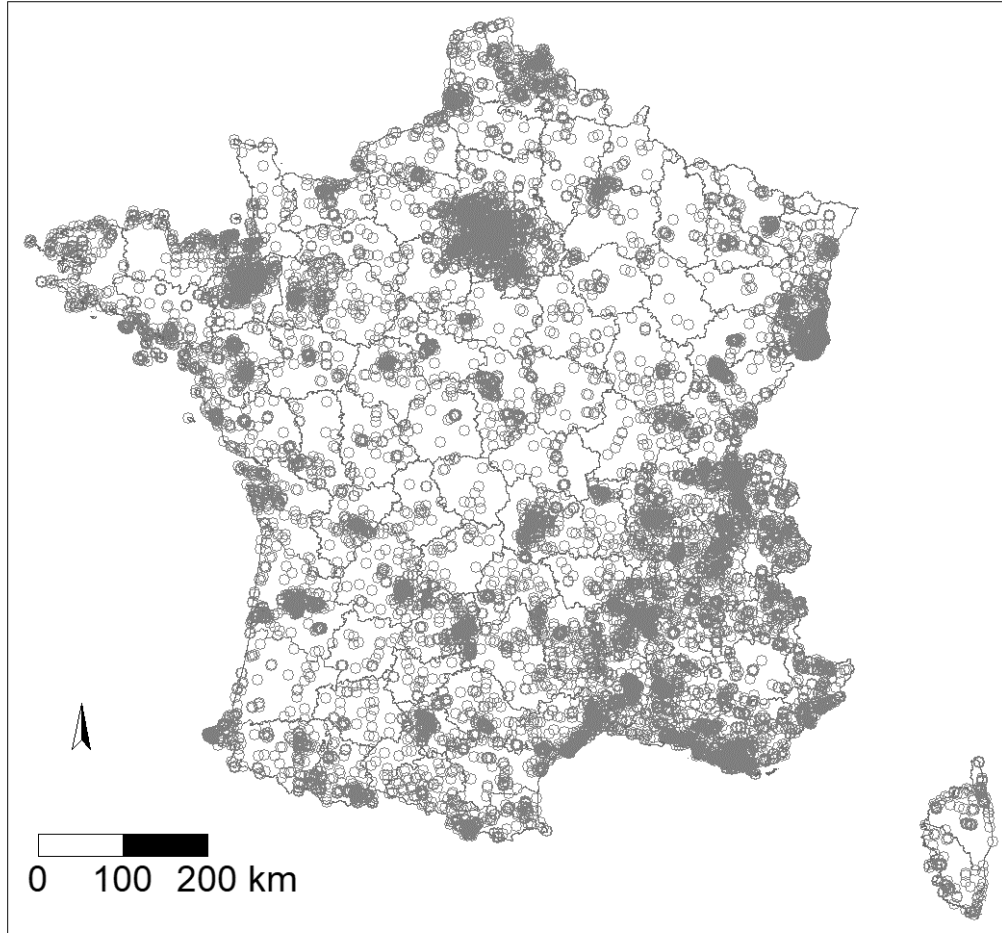


(European Environment Agency)

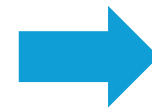
- **Land-uses**



(Corine Land Cover, Bossard et al. 2006)



- ***Broad taxonomic scope***
- ***Interaction with a visited plant***
- ***National scale***
- ***Long-term survey***
- ***Non-lethal observations***



**Done since 2010
thanks to citizen scientists!**



I

Objectives of the Spipoll project

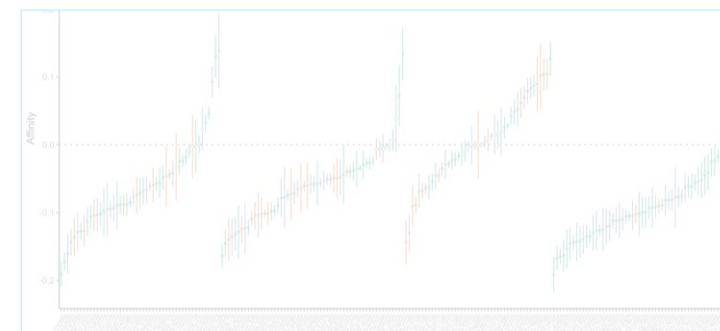


II

Data collection
(and **pointing out some evolutions since 2010**)

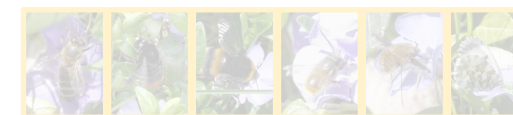
III

Main results



IV

Scientific perspectives



“Citizen science, the involvement of volunteers in research” (Dickinson *et al.* 2010)



1) Choose a location...



2) ... pick a flowering plant species...



© jfcth, 2013, Pailhares

3) ... photograph all insects visiting the flowers



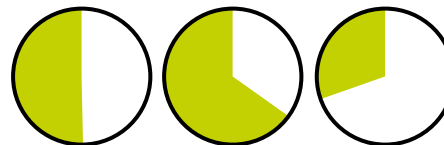
Two sampling effort options

« *Flash* »



20 min exactly

« *Long* »



at least 20 mn, once or more within 3 days



© jfcth - Spipoll

1) Choose a location...



2) ... pick a flowering plant species...



© jfctth, 2013, Pailhares

3) ... photograph all insects visiting the flowers



Two sampling effort options

« *Flash* »



20 min exactly

« *Long* »



at least 20 mn, once or more within 3 days

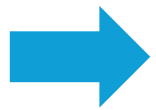
Stopped in 2019 to increase standardized samples



© jfctth - Spipoll



- huge diversity of flower visitors
- difficulty of identification

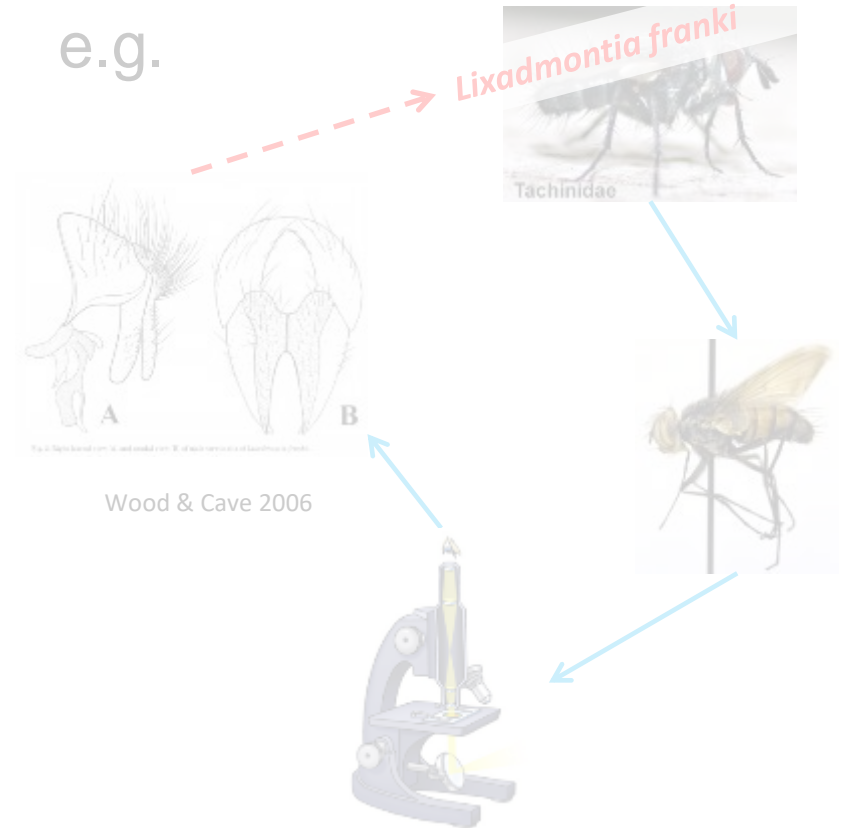


morphospecies =

a group of species differing from all the other groups in any external features that can potentially be seen on pictures.



e.g.



List of Descriptors

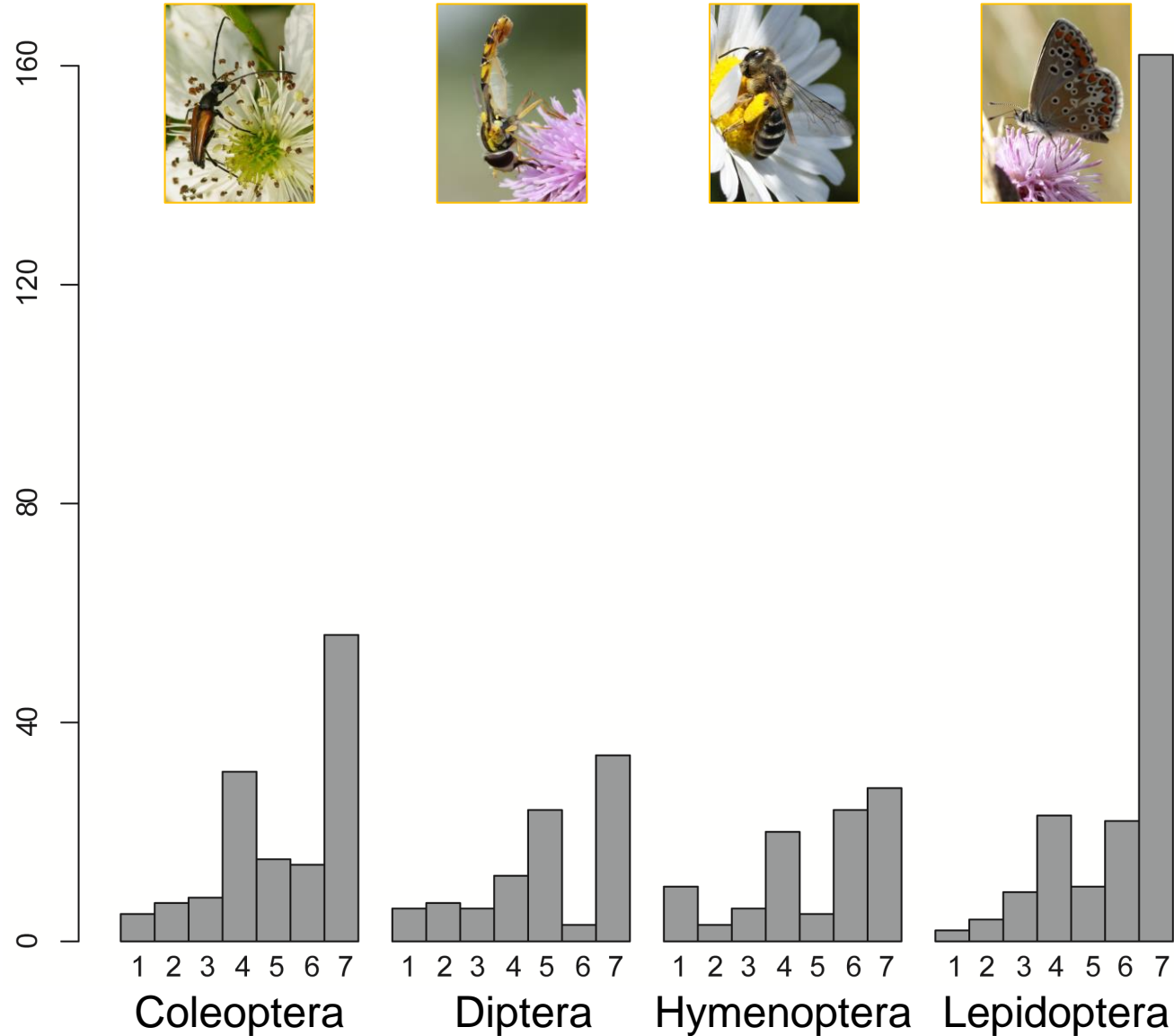
Illustrated modalities for the chosen descriptor

Morphospecies to identify

The screenshot displays the Spipoll identification tool interface. On the left, a sidebar lists descriptors: 'Longueur des antennes', 'Forme des yeux', 'Type de coloration de l'abdomen', 'Type de coloration du thorax', and 'Elargissement et pilosité de la patte postérieure'. The 'Longueur des antennes' descriptor is selected and highlighted with a yellow border. The main area shows three modalities for 'Longueur des antennes': 'Antennes courtes ou', 'Antennes de taille', and 'Antennes longues à'. The 'Antennes de taille' modality is selected, showing a slider at (96) and a grid of six photographs of bees with different antenna lengths. A red box highlights a photograph of a bumblebee on a flower. On the right, a list of 196 remaining taxa is shown, including 'L'Abeille Ceratina noire (Ceratina cucurbitina)', 'L'Abeille coucou Epeoloides (femelle) (Epeoloides coecutiens)', 'L'Abeille mellifère (Apis mellifera)', 'Les Abeilles à abdomen rouge (Sphecodes et autres)', 'Les Abeilles à culottes (Dasypoda)', 'Les Abeilles à thorax roux (Andrena clarkella et autres)', 'Les Abeilles Ceratina bleutées (Ceratina)', and 'Les Abeilles coucou Melecta (Melecta)'. A green button at the bottom right says 'Finish this identification'.

Taxonomic resolution of the visitor morphospecies

Number of defined morphospecies

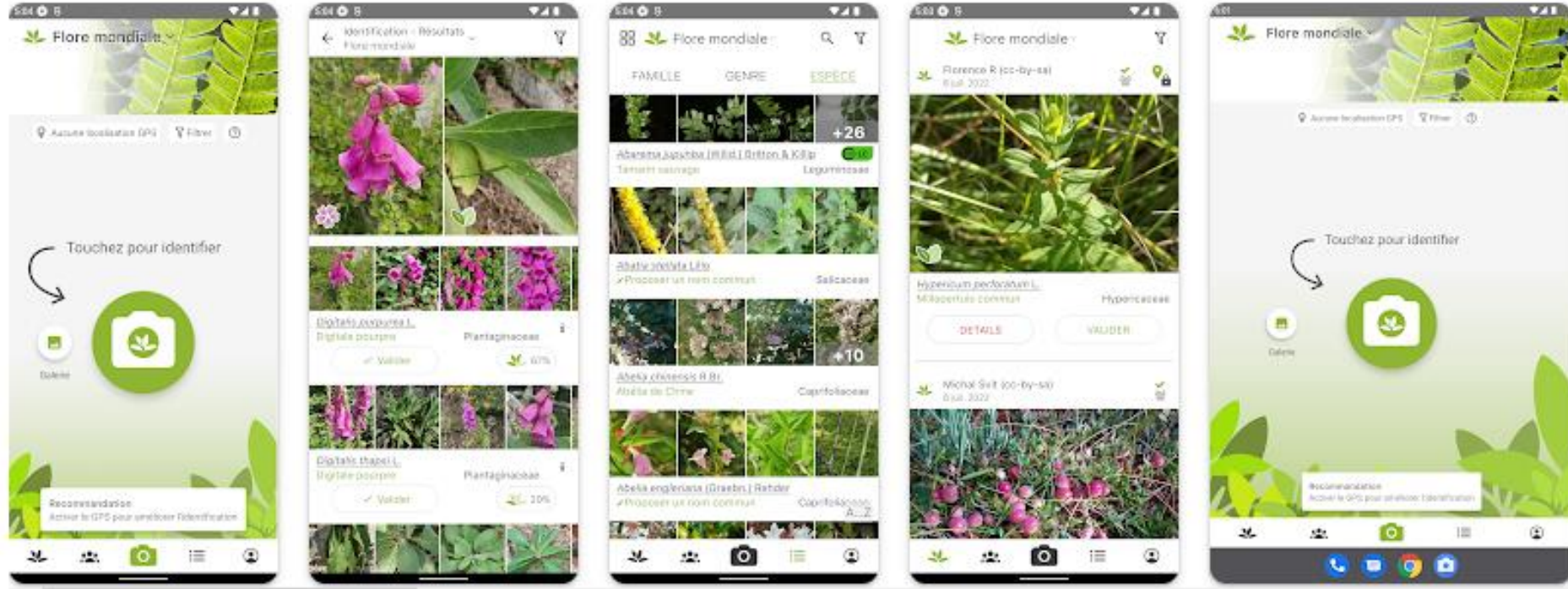


- 1 = (a group of) species from different families
- 2 = a whole family
- 3 = several genera within family
- 4 = species from different genera
- 5 = a genus
- 6 = species from a genus
- 7 = a single species

- **630 morphospecies defined**
- **46% of species *stricto sensu***
- ***Genus* known for 70%**

Taxonomic resolution

Semi-automatic plant identification with Pl@ntnet (since 2019)



© jfcth - Spipoll



(next talk by Alexis Joly & Pierre Bonnet)



© sagittaire06 - Spipoll

- *Black and yellow sawflies* is proposed by the participant.
- Participants can comment / emit *doubt*.
- Entomologists of the OPIE **validate** each identification



Alexis Borges, Bruno Didier, Pascal Dupont, Mathieu de Flores, Serge Gadoum, Hervé Guyot, Samuel Jolivet, Pierre Zagatti.



© sagittaire06 - Spipoll

- *Black and yellow sawflies* is proposed by the participant.
- Participants can comment ~~/ emit doubt.~~ **validate**
- Entomologists of the OPIE **validate** each identification

Time(of experts)-consuming (> 600 000 pictures)

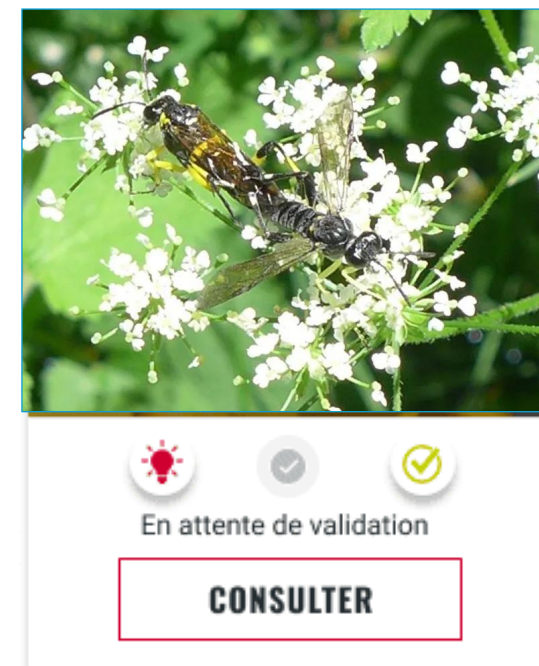
+

Gains of entomological skills

Deguines *et al.* 2018

+

Will to allow new ways of participating



> 95% of pictures are validated (by 3 peers)



© jfcth - Spipoll



Interactions of identified plant & visitors

+

GPS coordinates

+

sampling effort

+

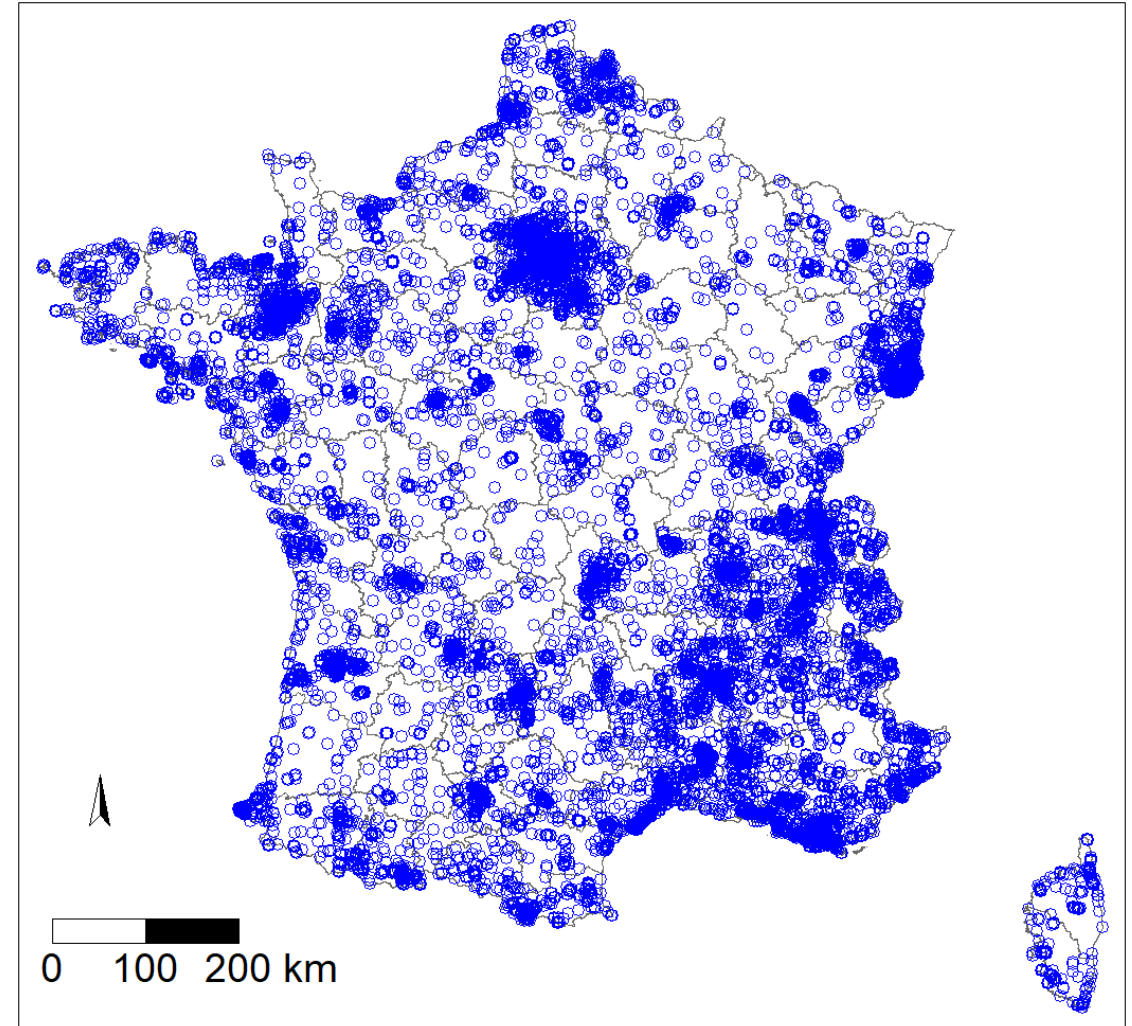
date/time + weather conditions

= a « **collection** »

Sept. 2023 :
73 807 collections



SPIPOLL



I

Objectives of the Spipoll project

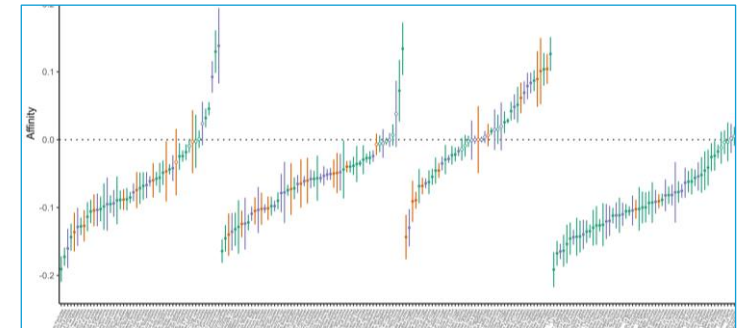


II

Data collection
(and **pointing out some evolutions since 2010**)

III

Main results



IV

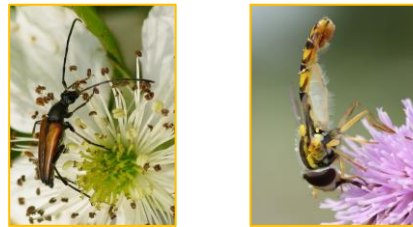
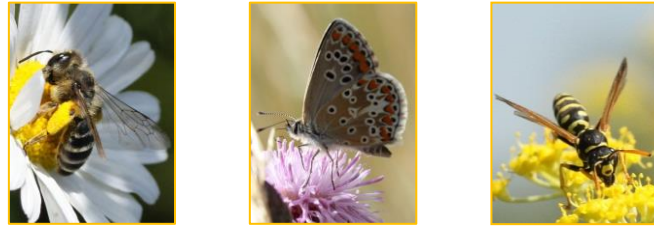
Scientific perspectives



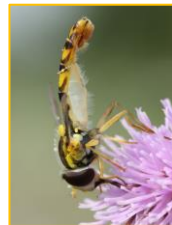
Responses of flower-visitors to land-use changes (mainly urbanisation)



Consequences of participation for volunteers



Responses of flower-visitors to land-use changes (mainly urbanisation)



Consequences of participation for volunteers

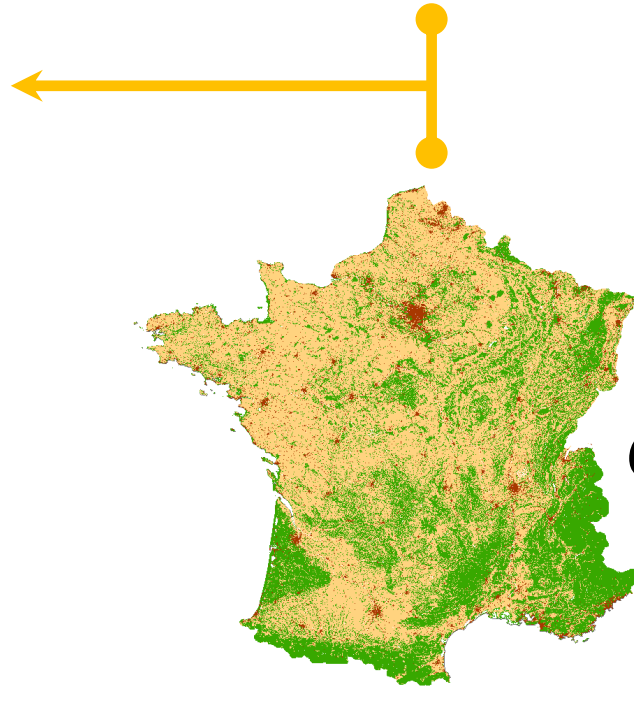
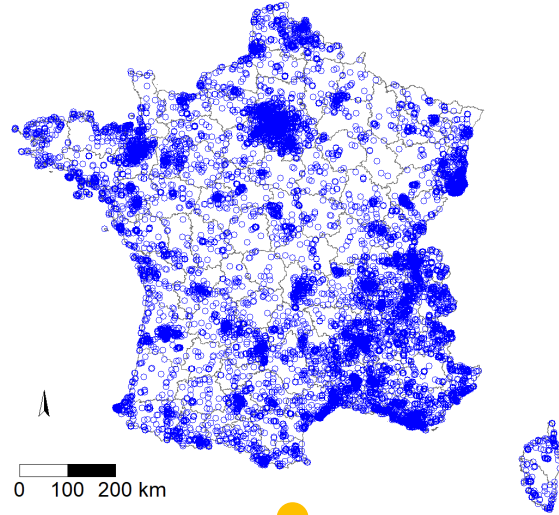


Deguines *et al.* 2018, Torres *et al.* 2022, Bedessem *et al.* 2023



Land-use affinity

- Urban
- Agricultural
- Natural



Corine Land Cover

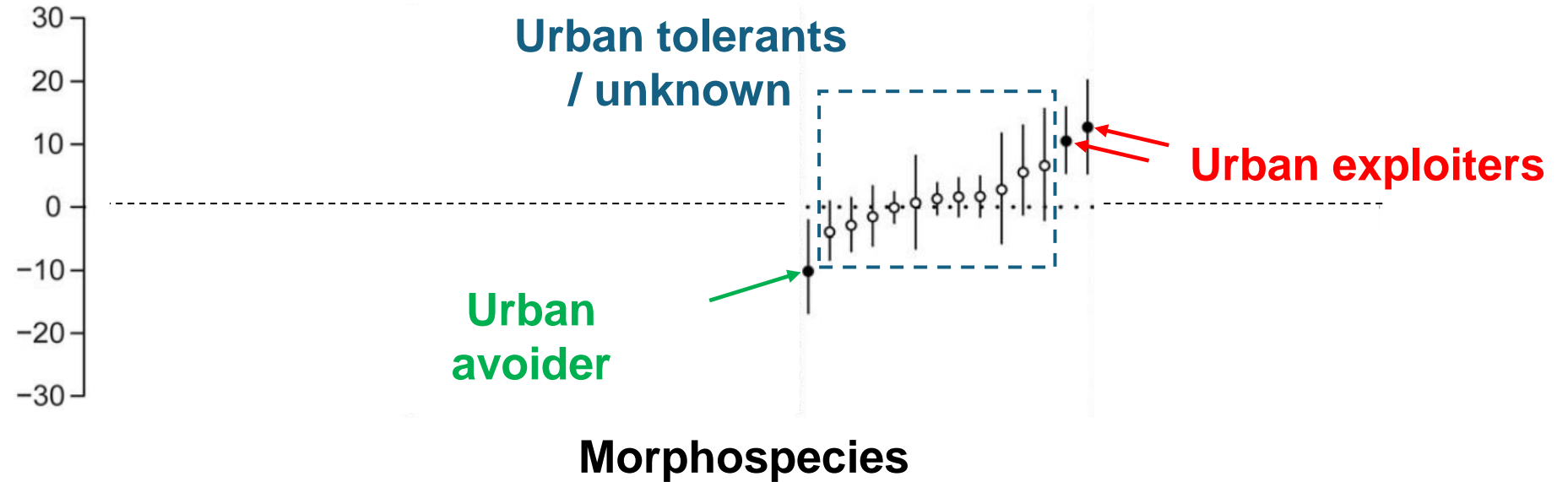
- In which land-use are found wild flower visitors?
- Are cities refuges?

Variables but overall negative responses to urbanization



Hymenoptera

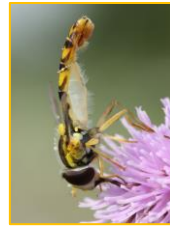
Urban land-use affinity



Variables but overall negative responses to urbanization



Coleoptera



Diptera

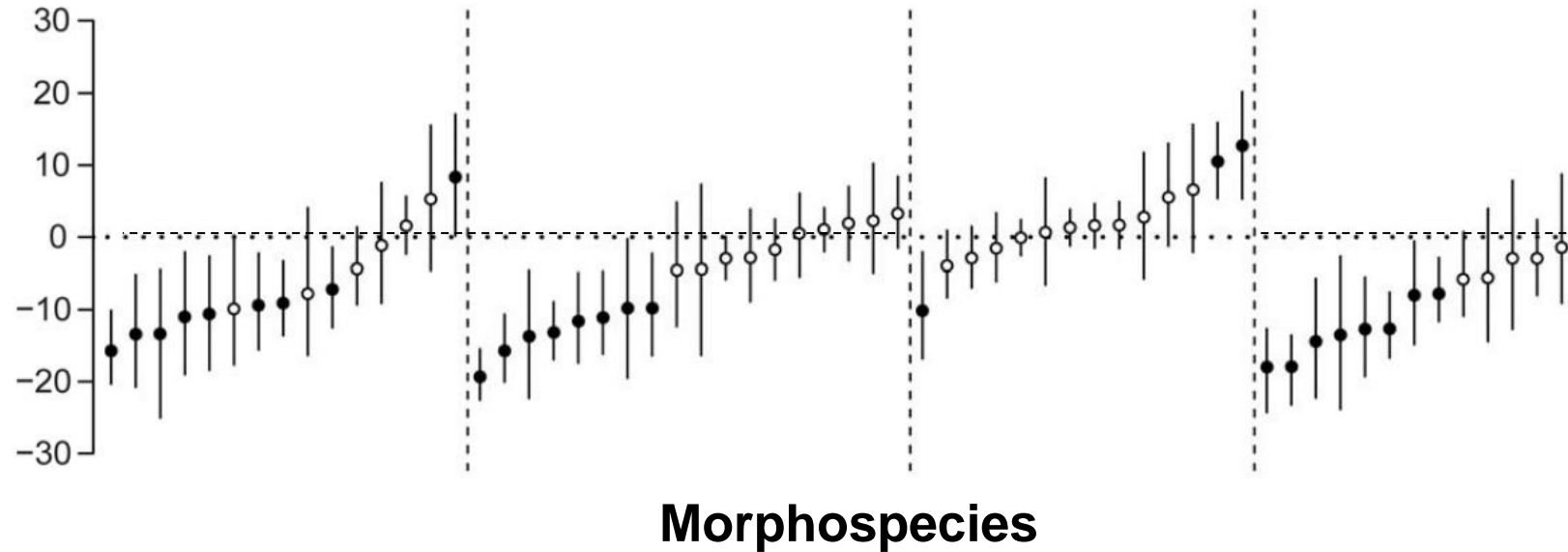


Hymenoptera



Lepidoptera

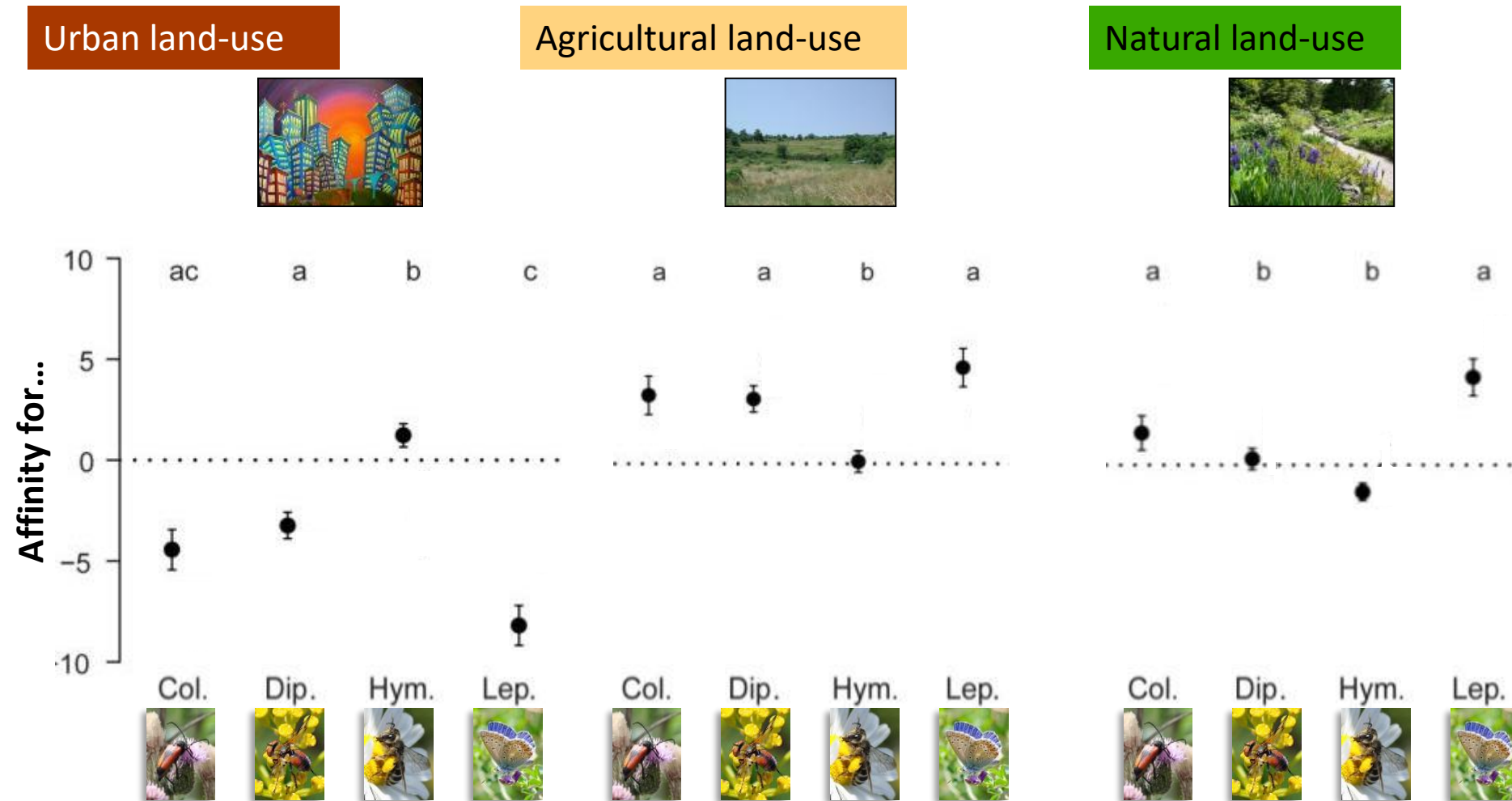
Urban land-use affinity



➔ 42% of urban avoiders (2010 data ; 60 morphospecies analyzed)

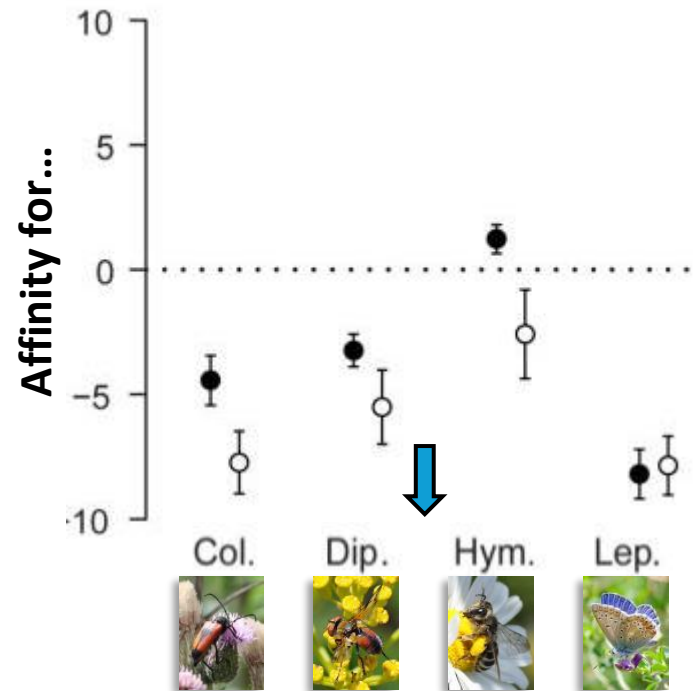
➔ 72% (2010-2022 ; 235)

Constraining land-use preferences among orders



Constraining land-use preferences between common vs. infrequent taxa

Urban land-use



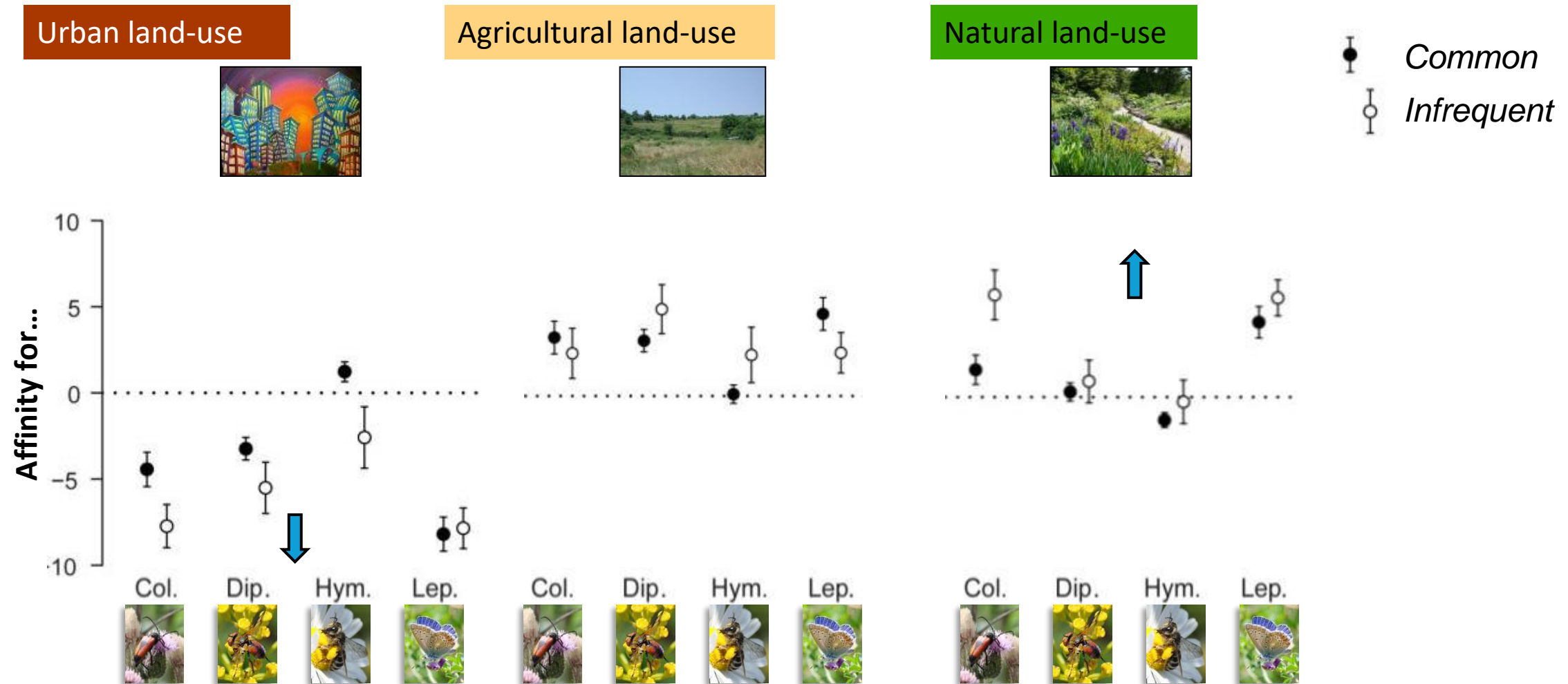
observed in **more than 2%** of collections made in **at least one** land-use type

Common
morphospecies

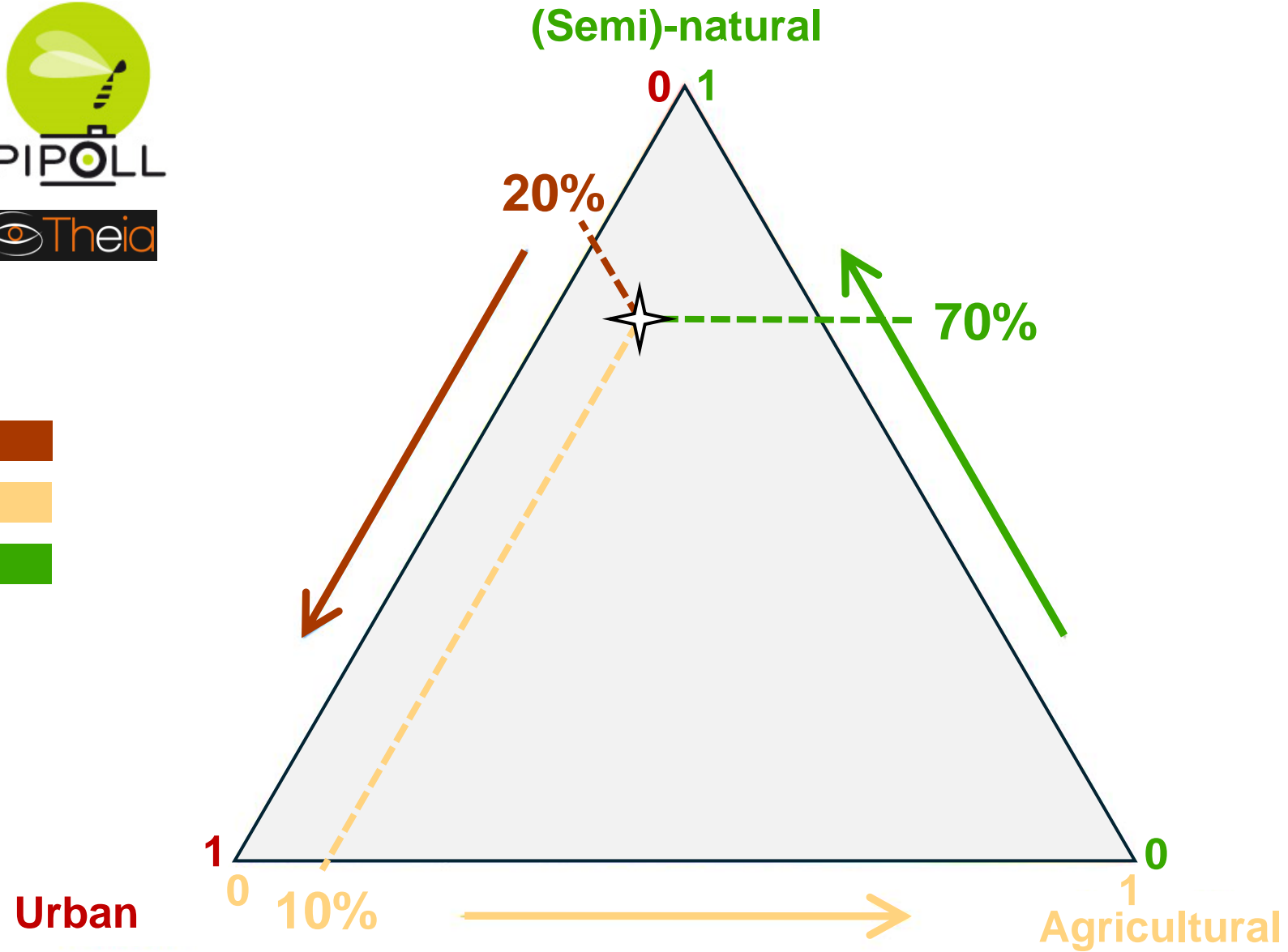
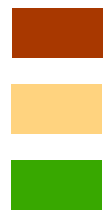
Infrequent

observed in **less than 2%** of the collections made **in each** land-use type

Constraining land-use preferences between common vs. infrequent taxa



Characterizing preferences in the triple land-use gradient

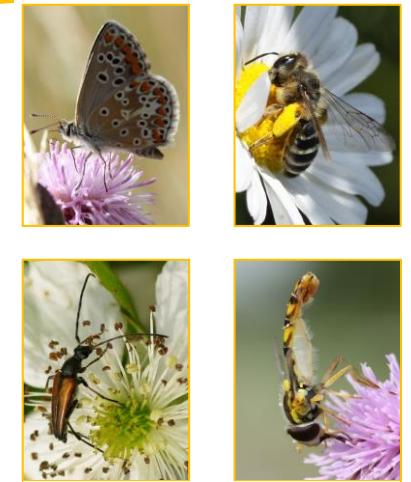


Characterizing preferences in the triple land-use gradient

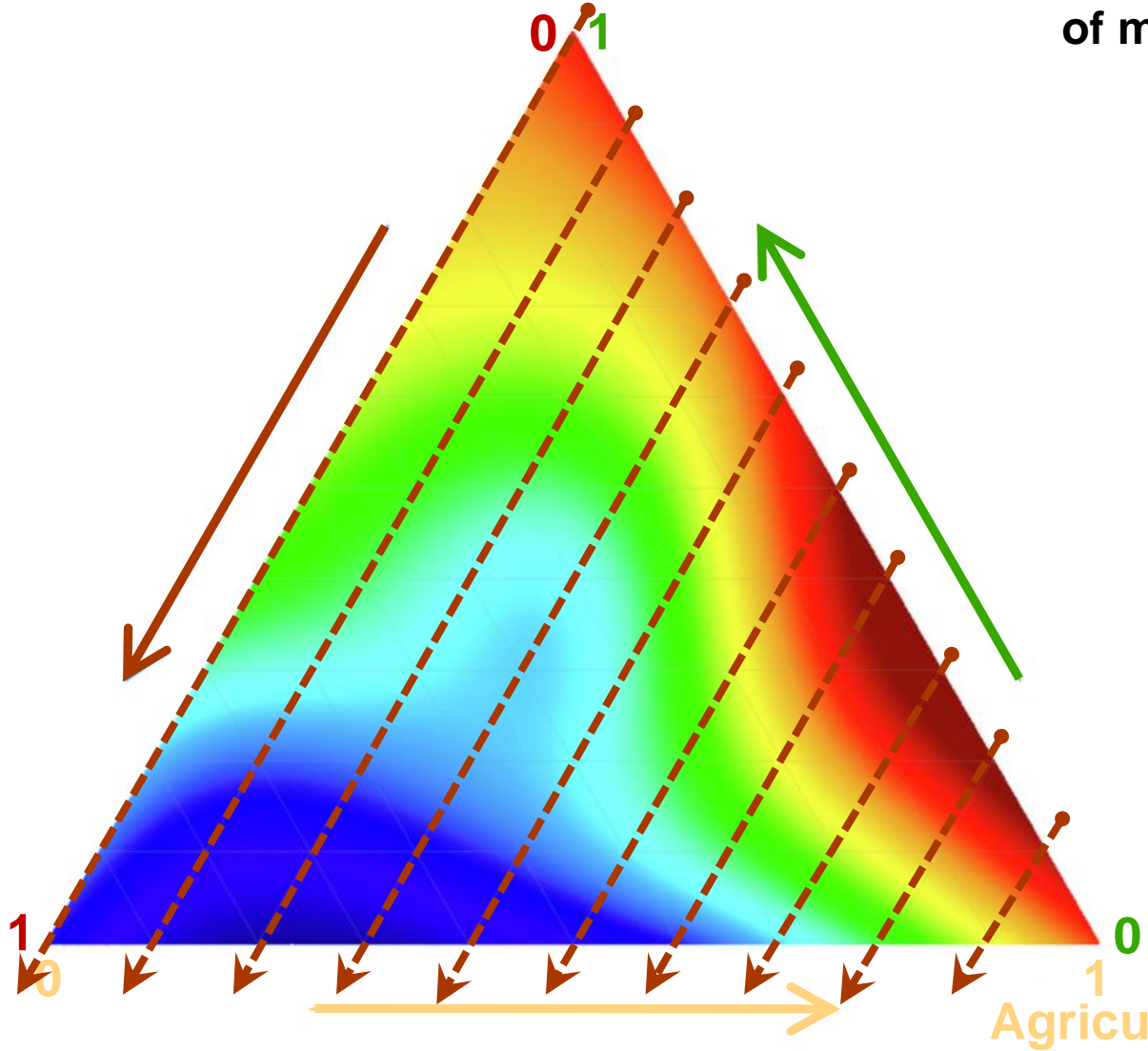
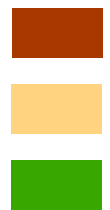


(Semi)-natural

Predicted number of morphospecies (in 20 min)



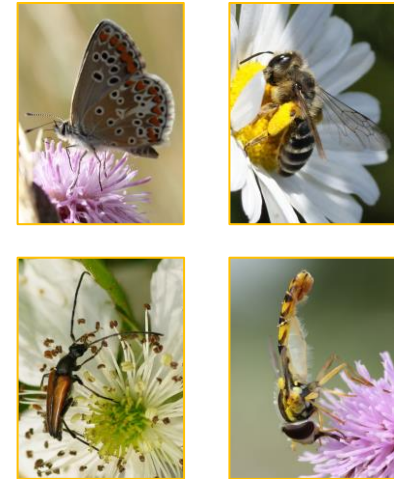
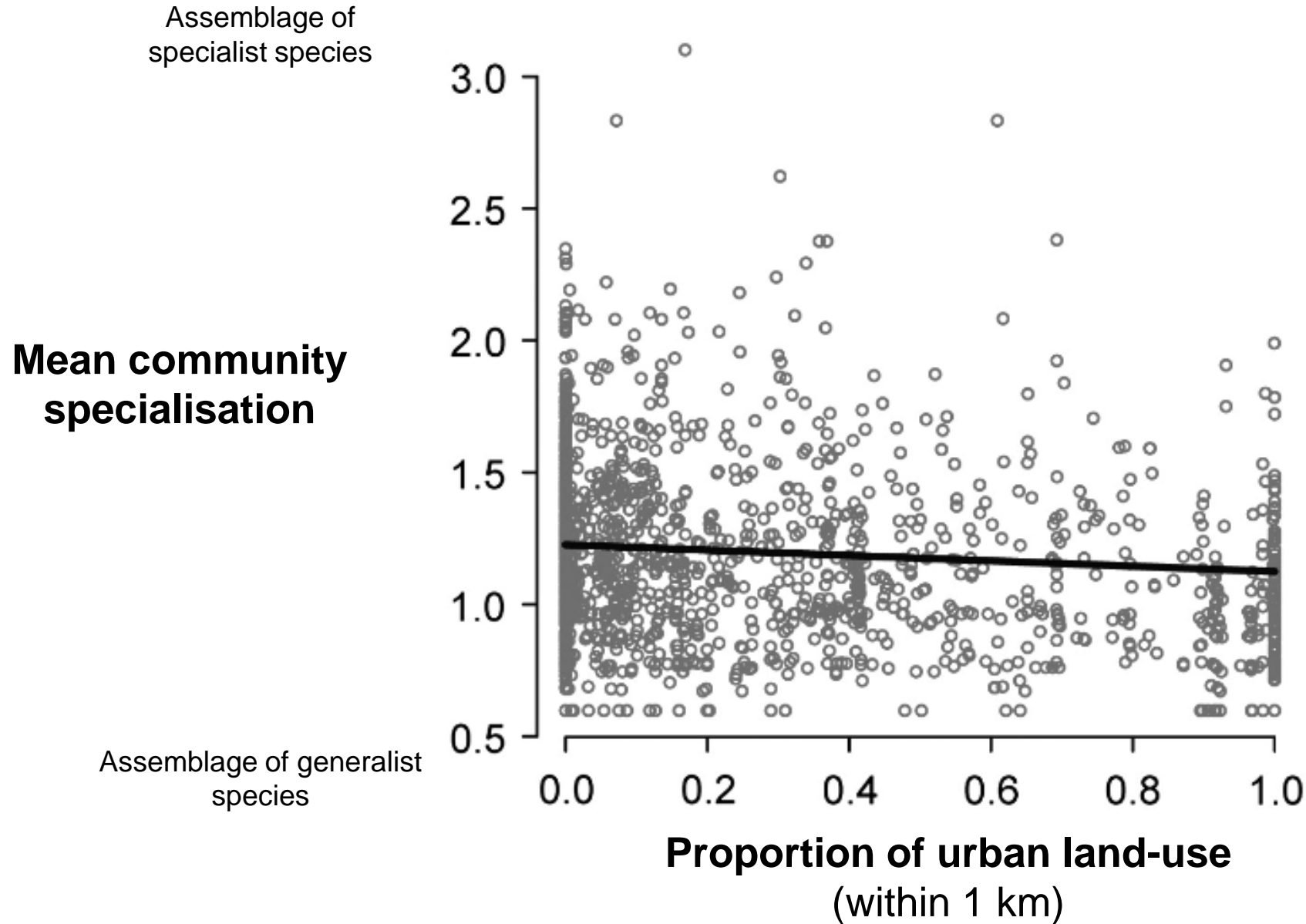
Total richness decreases with urbanization



Urban

Agricultural

Urban avoiders are floral resources specialists



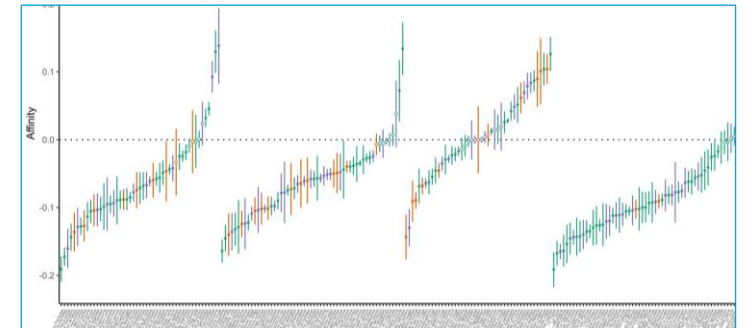
I

Objectives of the Spipoll project



II

Data collection
(and pointing out some evolutions since 2010)



III

Main results

IV

Scientific perspectives



Annual pesticide sales
(at ca. few city scale)

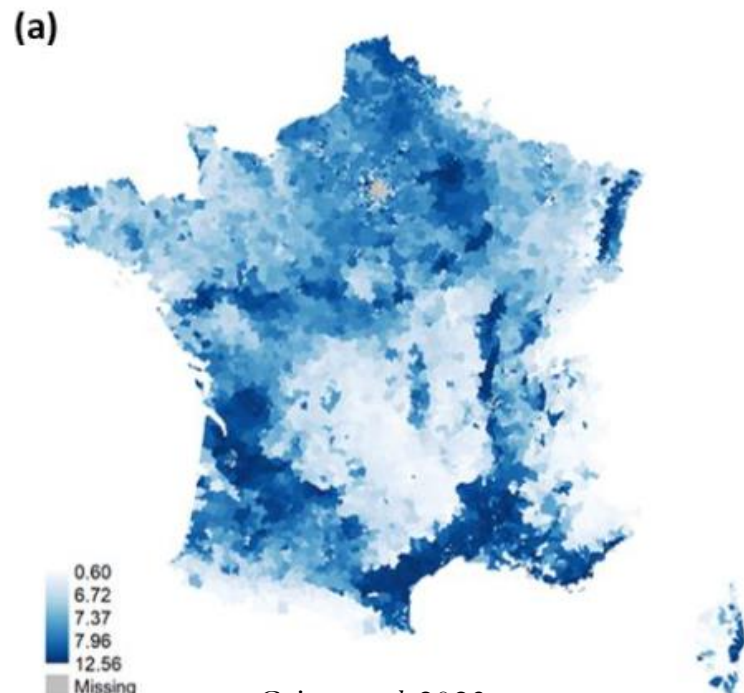


Toxicity to honeybee,
half-life, metabolites.



Total hazard
ratio

Cocktail index



Cairo *et al.* 2023

Results soon!
(models are running
for ca. 20-40 species)

- **14 years of data (2010-2024)**
- **over 660 000 plant-visitor interaction records**
- **over 4 000 participants**

- **.... but challenges remain:**
 - ❖ only a small core of long-term participants (3.7% participate more than 5 yrs)
 - ❖ high turnover in participants (85% participate only one year)

- **Feasibility/precision needs to be assessed.**

Received: 11 July 2019 | Revised: 13 December 2019 | Accepted: 20 December 2019

DOI: 10.1002/ece3.6060

ORIGINAL RESEARCH

Ecology and Evolution WILEY

Influence of taxonomic resolution on mutualistic network properties

Estelle Renaud | Emmanuelle Baudry | Carmen Bessa-Gomes

- 41 plant-pollinator networks...
- downgraded at various lower taxonomic resolution.

“the relative values of all indices are strongly conserved at different taxonomic resolutions”

Renaud *et al.* 2020

TABLE 1 Commonly used network indices


Index	Matrix ^a	Nature of the index, per network	Representation
Nestedness			
NODF	B	Extent to which interactions of less-connected species form subsets of the interactions of more-connected species	
BR	B		
SR	B		
WNODF	W		
Connectance			
	B	Proportion of realized interactions among all possible ones	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>High</p> </div> <div style="text-align: center;"> <p>Low</p> </div> </div>
Modularity			
	W	Extent to which interactions between pollinators and plants are organized into delimited modules	
Robustness			
	B	Speed at which plant taxa disappear as pollinator taxa disappear	
Normalized degree			
	B	Connectance of each taxa (this is the only index calculated per taxa and not per network)	
Motif frequency			
	B	Frequency of each of the 17 kinds of motifs that can link up to 5 taxa between them	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>1</p> <p>1</p> </div> <div style="text-align: center;"> <p>3</p> <p>5</p> </div> <div style="text-align: center;"> <p>6</p> <p>13 13</p> </div> <div style="text-align: center;"> <p>15</p> <p>40 40 39</p> </div> </div>

Received: 11 July 2019 | Revised: 13 December 2019 | Accepted: 20 December 2019
DOI: 10.1002/ece3.6060

ORIGINAL RESEARCH

Ecology and Evolution Open Access WILEY

Influence of taxonomic resolution on mutualistic network properties

Estelle Renaud  | Emmanuelle Baudry | Carmen Bessa-Gomes

- 41 plant-pollinator networks...
- downgraded at various lower taxonomic resolution.

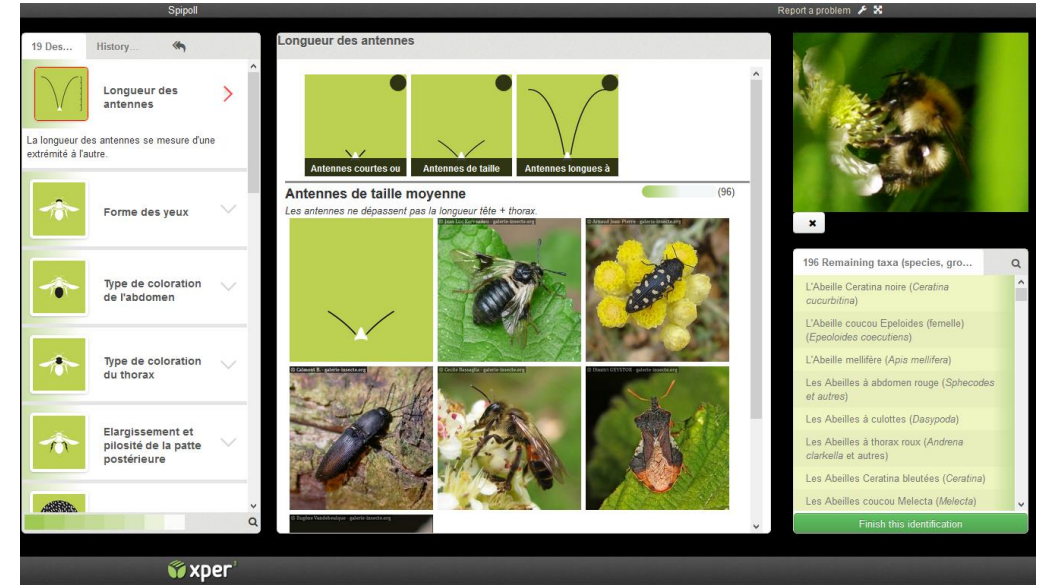
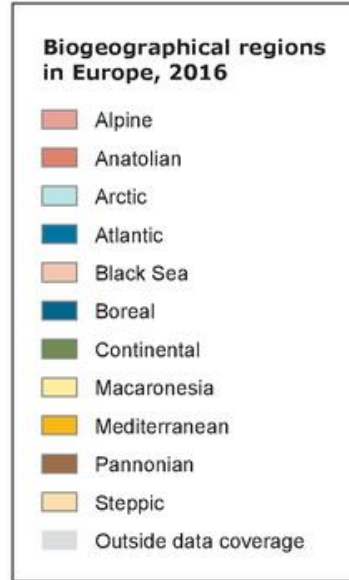
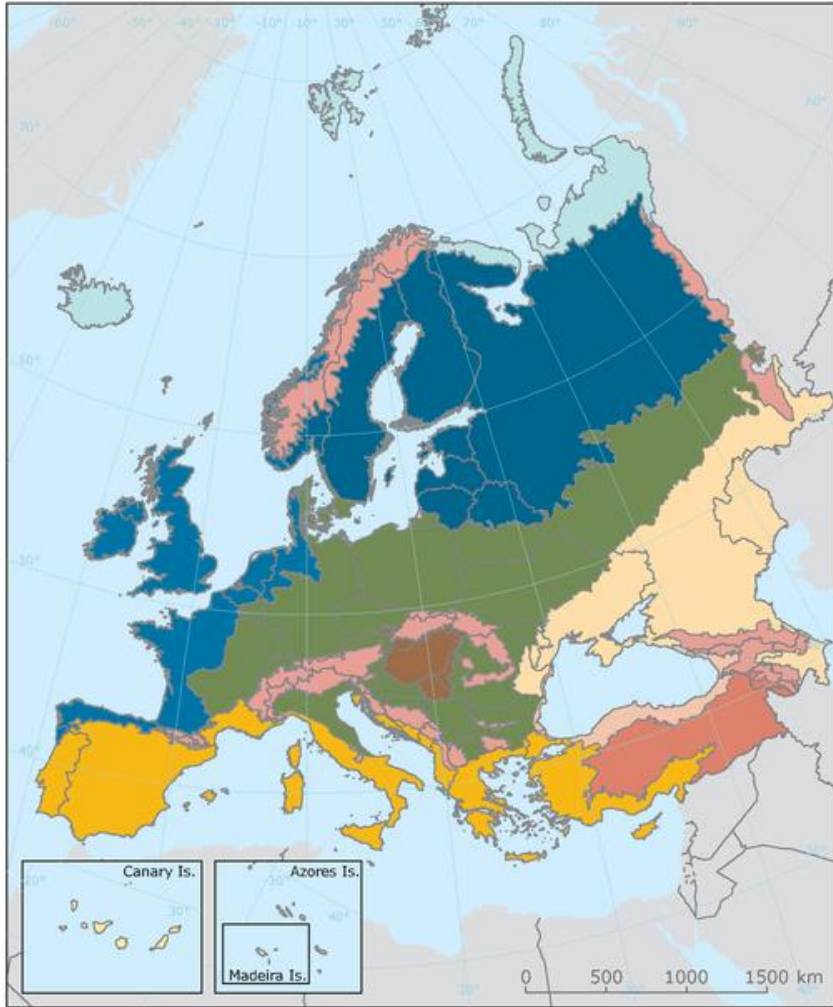
“the relative values of all indices are strongly conserved at different taxonomic resolutions”

Renaud *et al.* 2020



© jfcth, 2013, Pailhares

Building plant-visitor networks
(at Spipoll taxonomic resolution)
&
assessing changes along environmental gradients?
(ecosystem functioning stability, ...)



- **France shares with Europe four widely distributed biogeographical regions.**

- **Yet, given species changes, ID tool updates required prior expansion.**

Thank you for your attention.

Thanks to participants

Thanks to all who contributed to the Spipoll

174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000

SPIPOLLIENS

Suivi Photographique des Insectes Pollinisateurs



References

- Bedessem, B., Torres, A. C., Fontaine, C. and Deguines, N. 2022. Science learning in biodiversity citizen science: Inputs from the analysis of online social interactions within a contributory project for pollinators' monitoring. - *Biological Conservation* 276: 109807.
- Bossard, M., Heymann, Y., Lenco, M. and Steenmans, C. 2006. CORINE Land Cover.
- Cairo, M., Monnet, A., Robin, S., Porcher, E. and Fontaine, C. 2023. Identifying pesticide mixtures at country-wide scale. - *PCI Ecotox Env Chem* in press.
- Deguines, N., Julliard, R., de Flores, M. and Fontaine, C. 2012. The whereabouts of flower visitors: contrasting land-use preferences revealed by a country-wide survey based on citizen science. - *PLoS ONE* 7: e45822.
- Deguines, N., Julliard, R., de Flores, M. and Fontaine, C. 2016. Functional homogenization of flower visitor communities with urbanization. - *Ecology and Evolution* 6: 1967–1976.
- Deguines, N., de Flores, M., Lois, G., Julliard, R. and Fontaine, C. 2018. Fostering close encounters of the entomological kind. - *Frontiers in Ecology and the Environment* 16: 202–203.
- Desaegher, J., Chiron, F. and Bessa-Gomes, C. 2023. Nationwide study of the triple landscape gradient across natural, agricultural and urban areas for the richness of flower-visiting insects. - *Biological Conservation* 288: 110355.
- Dupont, Y. L. and Olesen, J. M. 2009. Ecological modules and roles of species in heathland plant-insect flower visitor networks. - *Journal of Animal Ecology* 78: 346–353.
- Goujon, P. 2010. Système d'Identification Interactive MultiMédia. Université Pierre et Marie Curie, Service BioMedia. Available: <http://abiris.snv.jussieu.fr/identificationTest/applet/presentation.html>. Accessed 27 August 2012.
- Michener, C. D. 2007. *The Bees of the World*. - The Johns Hopkins University Press.
- Renaud, E., Baudry, E. and Bessa-Gomes, C. 2020. Influence of taxonomic resolution on mutualistic network properties. - *Ecology and Evolution* 10: 3248–3259.
- Torres, A.-C., Bedessem, B., Deguines, N. and Fontaine, C. 2022. Online data sharing with virtual social interactions favor scientific and educational successes in a biodiversity citizen science project. - *Journal of Responsible Innovation*: 1–19.
- Winfree, R., Bartomeus, I. and Cariveau, D. P. 2011. Native Pollinators in Anthropogenic Habitats. - *Annual Review of Ecology, Evolution, and Systematics* 42: 1–22.