**Correlated evolution of wing morphology and echolocation calls in bats**

**Wenyu Zou1, †, Haiying Liang1, †, Pan Wu1, Bo Luo1,2,\*, Daying Zhou1, Wenqing Liu1, Jiashu Wu1, Linjie Fang1, YudieLei1, Jiang Feng2,3,\***

1Key Laboratory of Southwest China Wildlife Resources Conservation of Ministry of Education, China West Normal University, 1# Shida Road, Nanchong 637009, China

2Jilin Provincial Key Laboratory of Animal Resource Conservation and Utilization, Northeast Normal University, 2555 Jingyue Street, Changchun 130117, China

3College of Life Science, Jilin Agricultural University, 2888 Xincheng street, Changchun 130118, China

**†**These authors contributed equally to this work

\*Correspondence: luob041@nenu.edu.cn; fengj@nenu.edu.cn

**Table S1** Original data in this study

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Species | Family | Mass(kg) | Aspect ratio | Wing loading(N/m2) | Relative wing loading | Dura(ms) | FPeak(kHz) | NCall | Context  | Guild  |
| *Neoromicia nana* (*Pipistrellus nanus*) | Vespertilionidae | 0.00421  | 5.80001 | 4.60001 | 28.50551 | 4.002  | 70.002  | NA | Hand release2 | EA3 |
| *Neoromicia capensis* | Vespertilionidae | 0.00631 | 5.70001 | 6.90001 | 37.35331 | 5.104  | 39.404  | 104 | Hand release4 | EA3 |
| *Nycticeinops schlieffeni* | Vespertilionidae | 0.00505 | 6.90005 | 6.70005 | 39.17495 | 3.504 | 42.504  | 24 | Hand release4 | EA6 |
| *Tylonycteris robustula* | Vespertilionidae | 0.00805 | 8.30005  | 13.30005  | 66.48935  | 3.307  | 51.037  | 47  | Combination7 | EA3 |
| *Vespertilio* *murinus* | Vespertilionidae | 0.01155 | 7.00005  | 10.20005  | 45.18245  | 13.278-10  | 25.598-10  | 1558-10 | Free flight8-10 | OA3 |
| *Vespertilio murinus* | Vespertilionidae | 0.01155 | 7.00005  | 10.20005  | 45.18245  | 11.3011  | 26.0011  | NA | Free flight11 | OA3 |
| *Pipistrellus kuhlii* | Vespertilionidae | 0.00475 | 6.30005  | 8.50005  | 50.73515  | 7.648-10 | 38.098-10  | 1428-10  | Free flight8-10 | EA3 |
| *Pipistrellus kuhlii* | Vespertilionidae | 0.00475 | 6.30005  | 8.50005  | 50.73515  | 6.4012  | 39.7012  | 3112 | Combination12 | EA3 |
| *Pipistrellus kuhlii* | Vespertilionidae | 0.00475 | 6.30005  | 8.50005  | 50.73515  | 5.7013  | 41.4013  | 10713 | Combination13 | EA3 |
| *Pipistrellus hesperidus* | Vespertilionidae | 0.00621 | 6.00001  | 6.30001  | 34.28751  | 2.504  | 59.104  | NA | Hand release4 | EA3 |
| *Pipistrellus* *pygmaeus* | Vespertilionidae | 0.00583 | 7.50003  | 8.10003  | 45.07493  | 6.718-10  | 54.988-10  | 1438-10  | Free flight8-10 | EA3 |
| *Pipistrellus* *pygmaeus* | Vespertilionidae | 0.00583 | 7.50003  | 8.10003  | 45.07493  | 5.5013  | 57.7013  | 2713 | Combination13 | EA3 |
| *Pipistrellus pipistrellus* | Vespertilionidae | 0.00525 | 7.50005  | 8.10005  | 46.74565  | 6.868-10  | 46.828-10  | 1538-10  | Free flight8-10 | EA3 |
| *Pipistrellus* *pipistrellus* | Vespertilionidae | 0.00525 | 7.50005  | 8.10005  | 46.74565  | 5.7012  | 48.6012  | 4712 | Combination12 | EA3 |
| *Pipistrellus pipistrellus* | Vespertilionidae | 0.00525 | 7.50005  | 8.10005  | 46.74565  | 5.9013 | 46.9013  | 6113 | Combination13 | EA3 |
| *Nyctalus* *leisleri* | Vespertilionidae | 0.01695 | 7.90005  | 19.30005  | 75.19745  | 10.828-10 | 25.598-10 | 1238-10 | Free flight8-10 | OA14 |
| *Nyctalus leisleri* | Vespertilionidae | 0.01695 | 7.90005  | 19.30005  | 75.19745  | 5.3013 | 30.7013 | 1313 | Combination | OA14 |
| *Nyctalus noctula* | Vespertilionidae | 0.02655 | 7.40005  | 16.10005  | 53.99565  | 14.508-10  | 22.308-10  | 1708-10  | Free flight8-10 | OA3 |
| *Nyctalus noctula* | Vespertilionidae | 0.02655 | 7.40005  | 16.10005  | 53.99565  | 10.9012  | 25.3012  | 2212 | Combination12 | OA3 |
| *Nyctalus noctula* | Vespertilionidae | 0.02655 | 7.40005  | 16.10005  | 53.99565  | 14.8012  | 22.3012  | 2612 | Combination12 | OA3 |
| *Nyctalus noctula* | Vespertilionidae | 0.02655 | 7.40005  | 16.10005  | 53.99565  | 14.7013  | 24.5013  | 4213 | Combination13 | OA3 |
| *Nyctalus noctula* | Vespertilionidae | 0.02655 | 7.40005  | 16.10005  | 53.99565  | 22.1013  | 20.7013  | 4213 | Combination13 | OA3 |
| *Pipistrellus nathusii* | Vespertilionidae | 0.00675 | 7.20005  | 9.80005  | 51.97515  | 7.658-10  | 40.358-10  | 1238-10  | Free flight8-10 | EA3 |
| *Pipistrellus* *nathusii* | Vespertilionidae | 0.00675 | 7.20005  | 9.80005  | 51.97515  | 6.2012  | 40.8012  | 112 | Hand release12 | EA3 |
| *Pipistrellus stenopterus* | Vespertilionidae | 0.015215 | 6.800015  | 17.700015  | 71.443815  | 9.7016  | 37.0016  | 1816 | Hand release16 | EA3 |
| *Pipistrellus stenopterus* | Vespertilionidae | 0.015215 | 6.800015  | 17.700015  | 71.443815  | 13.8016  | 31.0016  | 2016 | Hand release16 | EA3 |
| *Pipistrellus stenopterus* | Vespertilionidae | 0.015215 | 6.800015  | 17.700015  | 71.443815  | 8.3016  | 38.6016  | 616 | Hand release16 | EA3 |
| *Eptesicus nilssoni* | Vespertilionidae | 0.00925 | 6.60005  | 8.10005  | 38.65045  | 13.188-10  | 28.598-10  | 1678-10  | Free flight8-10 | EA14 |
| *Eptesicus nilssoni* | Vespertilionidae | 0.00925 | 6.60005  | 8.10005  | 38.65045  | 6.3017  | 30.5017  | 1217  | Roost emergence17 | EA14 |
| *Eptesicus serotinus* | Vespertilionidae | 0.02235 | 6.50005  | 12.20005  | 43.33815  | 8.388-10  | 30.408-10  | 2258-10  | Free flight8-10 | OA3 |
| *Eptesicus serotinus* | Vespertilionidae | 0.02235 | 6.50005  | 12.20005  | 43.33815  | 6.0012 | 31.7012  | 2412 | Combination12 | OA3 |
| *Eptesicus serotinus* | Vespertilionidae | 0.02235 | 6.50005  | 12.20005  | 43.33815  | 7.3013  | 29.9013  | 1513 | Combination13 | OA3 |
| *Eptesicus furinalis* | Vespertilionidae | 0.007618 | 6.200018  | 7.300018  | 37.123418  | 6.9119  | 39.7719  | 10019  | Combination19 | EA20 |
| *Eptesicus* *brasiliensis* | Vespertilionidae | 0.009515 | 6.332921  | NA | 33.557521  | 3.0022  | 41.1022  | 222 | Hand release22 | EA20 |
| *Eptesicus fuscus* | Vespertilionidae | 0.01595 | 6.40005  | 9.40005  | 37.37685  | 10.6023  | 27.6023  | 83523  | Free flight23 | OA3 |
| *Ia io* | Vespertilionidae | 0.054924 | 6.520024  | 16.190024  | 42.593924  | 2.4025  | 27.6025  | NA | Hand release25 | OA14 |
| *Ia io* | Vespertilionidae | 0.054924 | 6.520024  | 16.190024  | 42.593924  | 3.8025  | 24.8025  | NA | Hand release25 | OA14 |
| *Glauconycteris variegate* (*Chalinolobus variegatus*) | Vespertilionidae | 0.01286  | 6.20006  | 8.60006  | 36.75916  | 5.3026  | 37.5026  | 21126  | Free flight26 | EA6 |
| *Lasionycteris noctivagans* | Vespertilionidae | 0.01065  | 6.60005  | 8.20005  | 37.32325  | 9.4027  | 28.2027  | NA | Free flight27 | EA3 |
| *Plecotus auritus* | Vespertilionidae | 0.00905  | 5.70005  | 7.10005  | 34.12795  | 3.408-10 | 34.48-10 | 2248-10  | Free flight8-10 | NG3 |
| *Plecotus austriacus* | Vespertilionidae | 0.01005 | 6.10005  | 7.90005  | 36.66295  | 3.308-10 | 30.98-10 | 2168-10  | Free flight8-10 | NG3 |
| *Otonycteris hemprichii* | Vespertilionidae | 0.026028  | 6.000028  | 9.590028  | 32.000028  | 5.1929 | 24.4529  | 6829  | Free flight29 | NG14 |
| *Barbastella barbastellus* | Vespertilionidae | 0.01035  | 6.00005  | 9.10005  | 41.81805  | 4.118-10  | 37.858-10  | 558-10  | Free flight8-10 | OA3 |
| *Barbastella barbastellus* | Vespertilionidae | 0.01035  | 6.00005  | 9.10005  | 41.81805  | 3.4013 | 33.2013 | 1013 | Combination13 | OA3 |
| *Barbastella barbastellus* | Vespertilionidae | 0.01035  | 6.00005  | 9.10005  | 41.81805  | 4.3013 | 38.9013 | 1013 | Combination13 | OA3 |
| *Antrozous pallidus* | Vespertilionidae | 0.01735  | 6.10005  | 8.10005  | 31.31445  | 5.6319 | 36.4619  | 10019  | Hand release19 | NG30 |
| *Lasiurus borealis* | Vespertilionidae | 0.01675  | 6.70005  | 14.00005  | 54.76425  | 10.5031  | 33.9031  | NA | Free flight31 | EA3 |
| *Lasiurus* *borealis* | Vespertilionidae | 0.01675  | 6.70005  | 14.00005  | 54.76425  | 9.1523  | 36.4523  | 63923  | Free flight23 | EA3 |
| *Lasiurus intermedius* | Vespertilionidae | 0.020218  | 7.700018  | 10.800018  | 39.650618  | 9.8032  | 28.3032  | 2032 | Free flight32 | EA33 |
| *Lasiurus cinereus* | Vespertilionidae | 0.03305 | 8.10005  | 16.50005  | 51.43555  | 8.0034  | 27.8034  | NA | Free flight34 | EA3 |
| *Lasiurus ega* | Vespertilionidae | 0.010718 | 7.600018  | 7.200018  | 32.669218  | 8.7032  | 32.2032  | 3432 | Free flight32 | EA20 |
| *Scotophilus dinganii* | Vespertilionidae | 0.02405 | 7.30005  | 12.40005  | 42.98315  | 4.904  | 33.604  | NA | Hand release4 | EA3 |
| *Scotophilus heathii* | Vespertilionidae | 0.03455 | 8.00005  | 15.00005  | 46.07195  | 2.4035  | 41.2035  | NA | Hand release35 | OA3 |
| *Scotophilus kuhlii* | Vespertilionidae | 0.019936  | 7.000036  | 16.800036  | 61.997536  | 2.9635  | 45.2635  | NA | Hand release35 | EA3 |
| *Myotis ricketti* (*Myotis pilosus*) | Vespertilionidae | 0.017524 | 5.300024  | 8.800024  | 33.890524  | 4.0037  | 45.3037  | 537  | Free flight37 | ET38 |
| *Myotis adversus* | Vespertilionidae | 0.01035 | 6.70005  | 7.90005  | 36.30355  | 4.6836  | 46.2036  | 24336  | Hand release36 | ET3 |
| *Myotis dasycneme* | Vespertilionidae | 0.01145 | 6.80005  | 10.40005  | 46.20275  | 8.9839  | 33.7939  | NA | Free flight39 | ET3 |
| *Myotis muricola* | Vespertilionidae | 0.005024 | 5.880024  | 4.400024  | 25.726824  | 1.9037  | 66.2037  | 437  | Hand release37 | NG40 |
| *Myotis* *nattereri* | Vespertilionidae | 0.00705  | 6.40005  | 6.10005  | 31.88305  | 4.078-10  | 54.398-10  | 1728-10  | Free flight8-10 | NG3 |
| *Myotis* *nattereri* | Vespertilionidae | 0.00705  | 6.40005  | 6.10005  | 31.88305  | 4.7013  | 46.9013  | 1213 | Hand release13 | NG3 |
| *Myotis chinensis* | Vespertilionidae | 0.031824 | 5.460024  | 9.530024  | 30.077024  | 3.6037  | 49.0037  | 837  | Hand release37 | NG41 |
| *Myotis blythii* | Vespertilionidae | 0.021028 | 6.700028  | 10.209328  | 37.000028  | 5.278-10  | 39.858-10  | 1248-10  | Free flight8-10 | NG3 |
| *Myotis blythii* | Vespertilionidae | 0.021028  | 6.700028  | 10.209328  | 37.000028  | 4.3013  | 41.4013  | 4913 | Hand release13 | NG3 |
| *Myotis myotis* | Vespertilionidae | 0.02655  | 6.30005  | 11.20005  | 37.56215  | 5.588-10  | 40.048-10  | 2318-10  | Free flight8-10 | NG3 |
| *Myotis myotis* | Vespertilionidae | 0.02655 | 6.30005  | 11.20005  | 37.56215  | 4.6012  | 39.4012  | 4712 | Hand release12 | NG3 |
| *Myotis myotis* | Vespertilionidae | 0.02655  | 6.30005  | 11.20005  | 37.56215  | 4.6013  | 39.1013  | 4213 | Hand release13 | NG3 |
| *Myotis bechsteinii* | Vespertilionidae | 0.01015  | 6.00005  | 9.00005  | 41.62965  | 4.678-10  | 49.708-10  | 2208-10  | Free flight8-10 | NG14 |
| *Myotis bechsteinii* | Vespertilionidae | 0.01015  | 6.00005  | 9.00005  | 41.62965  | 4.6012  | 44.3012  | 112 | Hand release12 | NG14 |
| *Myotis daubentonii* | Vespertilionidae | 0.00705  | 6.30005  | 7.00005  | 36.58705  | 4.178-10  | 47.918-10  | 2018-10  | Free flight8-10 | ET3 |
| *Myotis daubentonii* | Vespertilionidae | 0.00705  | 6.30005  | 7.00005  | 36.58705  | 4.2012  | 49.3012  | 612 | Hand release12 | ET3 |
| *Myotis emarginatus* | Vespertilionidae | 0.00675  | 5.90005  | 7.10005  | 37.65545  | 3.6013  | 58.0013  | 5213 | Combination13 | NG3 |
| *Myotis tricolor* | Vespertilionidae | 0.01605  | 6.20005  | 8.20005  | 32.53725  | 3.304  | 47.804  | NA | Hand release4 | EA3 |
| *Myotis albescens* | Vespertilionidae | 0.00595 | 6.90005  | 7.50005  | 41.49895  | 2.5042  | 43.0043  | NA | Free flight43 | ET20 |
| *Myotis nigricans* | Vespertilionidae | 0.00425 | 6.50005  | 6.10005  | 37.80085  | 7.2044  | 54.2044  | 37244  | Free flight44 | EA20 |
| *Myotis nigricans* | Vespertilionidae | 0.00425 | 6.50005  | 6.10005  | 37.80085  | 4.3044  | 55.0044  | 43044  | Free flight44 | EA20 |
| *Myotis keaysi* | Vespertilionidae | 0.003818  | 6.400018  | 5.300018  | 33.957418  | 3.3019  | 60.8719  | 10019  | Combination19 | EA45 |
| *Myotis thysanodes* | Vespertilionidae | 0.00845  | 6.10005  | 6.20005  | 30.49515  | 3.7119 | 29.0219  | 10019  | Hand release19 | EA46 |
| *Myotis lucifugus* | Vespertilionidae | 0.00715  | 6.00005  | 7.50005  | 39.01555  | 5.002  | 45.002  | NA | Hand release2 | NG3 |
| *Myotis lucifugus* | Vespertilionidae | 0.00715 | 6.00005  | 7.50005  | 39.01555  | 6.6047  | 45.9047  | 4047 | Hand release47 | NG3 |
| *Myotis leibii* | Vespertilionidae | 0.00655 | 6.10005  | 6.70005  | 35.89475  | 5.002  | 44.002  | NA | Hand release2 | NG46 |
| *Myotis leibii* | Vespertilionidae | 0.00655 | 6.10005  | 6.70005  | 35.89475  | 5.3047  | 48.5047  | 4047 | Hand release47 | NG46 |
| *Myotis californicus* | Vespertilionidae | 0.00425 | 5.60005  | 4.80005  | 29.74495  | 6.002  | 43.002  | NA | Hand release2 | EA48 |
| *Myotis volans* | Vespertilionidae | 0.01045 | 5.80005  | 8.30005  | 38.01905  | 10.002  | 46.002  | NA | Hand release2 | EA3 |
| *Myotis brandtii* | Vespertilionidae | 0.005315 | 6.200015  | 6.500015  | 37.274515  | 3.0649  | 47.9049  | 4249  | Combination49 | EA50 |
| *Myotis mystacinus* | Vespertilionidae | 0.00545 | 6.00005  | 7.10005  | 40.46245  | 3.8012  | 47.7012  | 112 | Hand release12 | EA14 |
| *Myotis* *mystacinus* | Vespertilionidae | 0.00545  | 6.00005  | 7.10005  | 40.46245  | 4.2013  | 47.5013  | 1313 | Hand release13 | EA14 |
| *Murina suilla* | Vespertilionidae | 0.004015  | 5.500015  | 4.900015  | 30.862415  | 2.917  | 101.937  | 347  | Combination7 | NG3 |
| *Murina cyclotis* | Vespertilionidae | 0.006124  | 4.390024  | 5.460024  | 29.877424  | 1.787  | 93.817  | 287  | Combination7 | NG46 |
| *Miniopterus natalensis* | Miniopteridae | 0.01221 | 5.90001  | 7.90001  | 34.31181  | 3.404  | 51.404  | NA | Hand release4 | EA3 |
| *Miniopterus fraterculus* | Miniopteridae | 0.00851  | 5.70001  | 6.40001  | 31.35481  | 3.704  | 62.104  | NA | Hand release4 | EA3 |
| *Miniopterus australis* | Miniopteridae | 0.006751  | 6.790051  | 5.770051  | 30.601751  | 4.427  | 61.467  | 57  | Combination7 | EA3 |
| *Miniopterus schreibersii* | Miniopteridae | 0.013951  | 6.660051  | 9.710051  | 40.378751  | 9.208-10  | 53.278-10  | 1148-10 | Free flight8-10 | EA3 |
| *Miniopterus schreibersii* | Miniopteridae | 0.013951 | 6.660051  | 9.710051  | 40.378751  | 6.7012  | 54.9012  | 6112 | Combination12 | EA3 |
| *Miniopterus schreibersii* | Miniopteridae | 0.013951 | 6.660051  | 9.710051 | 40.378751  | 5.8013  | 54.2013  | 11713 | Combination13 | EA3 |
| *Eumops glaucinus* | Molossidae | 0.037028 | 7.800028  | 16.470028  | 48.900028  | 14.2052  | 17.9052  | 26952  | Free flight52 | OA20 |
| *Nyctinomops laticaudatus* | Vespertilionidae | 0.01303  | 12.70003  | 12.70003  | 54.0041  | 4.8519  | 25.6819  | 5719  | Combination19 | OA20 |
| *Molossus rufus* | Molossidae | 0.02803  | 9.00003  | 23.40003  | 77.0510  | 13.2032  | 29.4032  | 832 | Free flight32 | OA45 |
| *Molossus rufus* | Molossidae | 0.02803  | 9.00003  | 23.40003  | 77.0510  | 13.4032  | 33.0032  | 832 | Free flight32 | OA45 |
| *Molossus molossus* | Molossidae | 0.01625  | 8.70005  | 16.00005  | 63.2250  | 11.3553  | 34.5053  | NA | Free flight53 | OA20 |
| *Molossus molossus* | Molossidae | 0.01625  | 8.70005  | 16.00005  | 63.2250  | 11.5053  | 39.6553  | NA | Free flight53 | OA20 |
| *Mops condylurus* | Molossidae | 0.02831  | 7.40001  | 18.50001  | 60.70041  | 10.004  | 26.704  | NA | Hand release4 | OA3 |
| *Chaerephon* *pumilus* | Molossidae | 0.01131  | 7.40001  | 10.80001  | 48.12081  | 13.6054  | 23.9054  | 6054  | Roost emergence54 | OA3 |
| *Tadarida aegyptiaca* | Molossidae | 0.01604  | 8.12494  | 13.53104  | 53.69054  | 15.5055  | 19.4455  | 12055  | Roost emergence55 | OA3 |
| *Tadarida brasiliensis* | Molossidae | 0.01255  | 8.20005  | 11.50005  | 49.54485  | 11.8456  | 27.0756  | 390156  | Hand release56 | OA45 |
| *Tadarida teniotis* | Molossidae | 0.02503  | 9.80003  | 19.00003  | 64.97113  | 15.068-10  | 12.148-10  | 1158-10  | Free flight8-10 | OA3 |
| *Tadarida* *teniotis* | Molossidae | 0.02503  | 9.80003  | 19.00003  | 64.97113  | 18.4012  | 13.2012  | 1012 | Free flight12 | OA3 |
| *Tadarida teniotis* | Molossidae | 0.02503  | 9.80003  | 19.00003  | 64.97113  | 16.6013  | 13.0013  | 2113 | Free flight13 | OA3 |
| *Tadarida* *fulminans* | Molossidae | 0.03305  | 14.30005  | 20.20005  | 62.96965  | 20.002  | 17.002  | NA | Hand release2 | OA6 |
| *Artibeus lituratus* | Phyllostomidae | 0.05965  | 6.10005  | 17.70005  | 45.3089  | 2.0419  | 61.4419  | 2419  | Hand release19 | NG20 |
| *Artibeus jamaicensis* | Phyllostomidae | 0.04705  | 6.40005  | 16.60005  | 45.9936  | 2.4519  | 57.0419  | 10019  | Hand release19 | NG20 |
| *Phyllops falcatus* | Phyllostomidae | 0.020957  | 6.570057  | 10.880057  | 39.4934  | 4.2058  | 56.2058  | 6458  | Free flight58 | NG57 |
| *Stenoderma rufum* | Phyllostomidae | 0.02235  | 5.90005  | 18.20005  | 64.6519  | 3.1059  | 67.6059  | NA | Hand release59 | NG60, 61  |
| *Platyrrhinus helleri* | Phyllostomidae | 0.013515 | 6.468021  | NA | 43.861821  | 1.3022  | 99.0022  | 522 | Hand release22 | NG20 |
| *Chiroderma villosum* | Phyllostomidae | 0.02295  | 6.40005  | 14.00005  | 49.2941  | 1.4022  | 91.8022  | 422 | Hand release22 | NG20 |
| *Chiroderma trinitatum* | Phyllostomidae | 0.013715 | 6.341021  | NA | 37.455321  | 1.5022  | 96.9022  | 322 | Hand release22 | NG20 |
| *Uroderma bilobatum* | Phyllostomidae | 0.01545  | 6.30005  | 10.10005  | 40.5902 | 1.6022  | 74.7022  | 922 | Hand release22 | NG20 |
| *Sturnira lilium* | Phyllostomidae | 0.01505  | 6.50005  | 12.20005  | 49.4617 | 2.7059  | 73.1059  | NA | Hand release59 | NG62 |
| *Carollia perspicillata* | Phyllostomidae | 0.01915  | 6.10005  | 11.40005  | 42.6419 | 1.8022  | 74.9022  | 1922 | Hand release22 | NG20 |
| *Phyllostomus hastatus* | Phyllostomidae | 0.10705  | 7.60005  | 25.20005  | 53.0771 | 2.7022  | 47.1022  | 322 | Hand release22 | NG20 |
| *Mimon crenulatum* | Phyllostomidae | 0.01485  | 8.30005  | 8.10005  | 32.9865 | 1.5022  | 66.1022 | 322 | Hand release22 | NG20 |
| *Tonatia saurophila* | Phyllostomidae | 0.02296 | 5.905021  | NA | 30.424421  | 1.4022  | 56.5022  | 622 | Hand release22 | NG20 |
| *Macrophyllum macrophyllum* | Phyllostomidae | 0.008963  | 5.500063  | 9.100063  | 43.9871  | 2.3064  | 55.0064  | 2164  | Free flight64 | ET65 |
| *Macrophyllum macrophyllum* | Phyllostomidae | 0.008963  | 5.500063  | 9.100063  | 43.9871  | 3.6064  | 58.0064  | 19564  | Free flight64 | ET65 |
| *Vampyrum spectrum* | Phyllostomidae | 0.15805  | 5.40005  | 18.40005  | 34.0334  | 2.8022  | 79.4022  | 122 | Hand release22 | NG20 |
| *Glossophaga longirostris* | Phyllostomidae | 0.011959  | 6.440059  | 9.340059  | 40.9041  | 1.6059  | 90.8059  | NA | Hand release59 | NG45 |
| *Glossophaga soricina* | Phyllostomidae | 0.01065 | 6.40005  | 10.50005  | 47.7920  | 2.0022  | 94.5022  | 2722 | Hand release22 | NG20 |
| *Monophyllus* *plethodon* | Phyllostomidae | 0.014815  | 6.500015  | 11.500015  | 46.8222  | 1.3059  | 85.6059  | NA | Hand release59 | NG61, 66 |
| *Erophylla bombifrons* | Phyllostomidae | 0.016359  | 6.230059  | 9.570059  | 37.7389  | 4.7059  | 37.9059  | NA | Hand release59 | NG67 |
| *Erophylla sezekorni* | Phyllostomidae | 0.01635  | 6.10005  | 13.10005  | 51.6594  | 2.3031  | 65.3031  | NA | Roost emergence31 | NG46 |
| *Brachyphylla cavernarum* | Phyllostomidae | 0.046215  | 6.400015  | 13.600015  | 37.9060  | 2.6059  | 51.4059  | NA | Hand release59 | NG46 |
| *Choeroniscus minor* | Phyllostomidae | 0.00885  | 6.20005  | 10.40005  | 50.3660  | 1.5022  | 97.9022  | 522 | Hand release22 | NG68 |
| *Desmodus rotundus* | Phyllostomidae | 0.02855  | 6.70005  | 14.00005  | 45.8277  | 2.5419  | 56.8719  | 4119  | Hand release19 | NG20 |
| *Micronycteris megalotis* | Phyllostomidae | 0.00715  | 5.60005  | 7.30005  | 37.9751  | 1.5022  | 98.1022  | 622 | Hand release22 | NG45 |
| *Micronycteris hirsuta* | Phyllostomidae | 0.012415 | 5.388821  | NA | 33.755221  | 1.4022  | 80.8022  | 522 | Hand release22 | NG20 |
| *Micronycteris minuta* | Phyllostomidae | 0.006515 | 5.812021  | NA | 40.766921  | 1.6022  | 61.2022  | 322 | Hand release22 | NG68 |
| *Macrotus waterhousii* | Phyllostomidae | 0.00955  | 9.00005  | 7.30005  | 34.4626  | 1.3031  | 69.2031  | NA | Roost emergence31 | NG69 |
| *Pteronotus macleayii* | Mormoopidae | 0.007170  | 7.100070  | 5.900070  | 30.6922  | 4.0371  | 69.0271  | 17171  | Hand release71 | EA72 |
| *Pteronotus personatus* | Mormoopidae | 0.00803  | 5.80003  | 7.90003  | 39.4936  | 5.7119  | 70.5319  | 10019  | Combination19 | EA20 |
| *Pteronotus davyi* | Mormoopidae | 0.009959  | 6.350059  | 6.330059  | 29.4753  | 4.6059  | 67.0059  | NA | Hand release59 | EA33 |
| *Pteronotus parnellii* | Mormoopidae | 0.019715  | 6.700015  | 6.500015  | 24.0762  | 22.0059  | 61.3059  | NA | Hand release59 | NF3 |
| *Mormoops megalophylla* | Mormoopidae | 0.01705  | 7.10005  | 11.20005  | 43.5521  | 6.8032  | 51.6032  | 1632 | Free flight32 | EA45 |
| *Noctilio leporinus* | Noctilionidae | 0.05905 | 9.00005  | 15.20005  | 39.0408  | 8.4119  | 31.0319  | 5219  | Combination19 | ET3 |
| *Noctilio albiventris* | Noctilionidae | 0.02965  | 7.80005  | 13.90005  | 44.9297  | 10.5073  | 70.0043  | NA | Free flight43 | ET3 |
| *Mystacina tuberculata* | Mystacinidae | 0.01355  | 7.00005  | 12.30005  | 51.6494  | 2.5074  | 49.3074  | 3174  | Combination74 | NG75 |
| *Mystacina tuberculata* | Mystacinidae | 0.01355  | 7.00005  | 12.30005  | 51.6494  | 3.5074  | 45.5074  | 1174  | Combination74 | NG75 |
| *Peropteryx macrotis* | Emballonuridae | 0.006118  | 7.600018  | 5.900018  | 32.2851  | 7.3019  | 41.6119  | 10019  | Free flight19 | OA3 |
| *Peropteryx kappleri* | Emballonuridae | 0.00703  | 9.00003  | 8.50003  | 44.4271  | 9.6076  | 31.6076  | 14076  | Free flight76 | OA3 |
| *Cormura brevirostris* | Emballonuridae | 0.00903  | 7.20003 | 8.20003  | 39.4153  | 8.2076  | 25.2076  | 7676  | Free flight76 | EA20 |
| *Cormura brevirostris* | Emballonuridae | 0.00903  | 7.20003 | 8.20003  | 39.4153  | 8.2076  | 28.1076  | 10576  | Free flight76 | EA20 |
| *Cormura brevirostris* | Emballonuridae | 0.00903  | 7.20003  | 8.20003  | 39.4153  | 8.6076  | 31.4076  | 10276  | Free flight76 | EA20 |
| *Diclidurus albus* | Emballonuridae | 0.02303  | 9.00003  | 12.90003  | 45.3551  | 9.4076  | 23.5076  | 6276  | Free flight76 | OA20 |
| *Diclidurus albus* | Emballonuridae | 0.02303  | 9.00003  | 12.90003  | 45.3551  | 9.6076  | 23.5076  | 3676  | Free flight76 | OA3 |
| *Diclidurus albus* | Emballonuridae | 0.02303  | 9.00003  | 12.90003  | 45.3551  | 9.7076  | 25.8076  | 3476  | Free flight76 | OA3 |
| *Cyttarops alecto* | Emballonuridae | 0.00653  | 5.80003  | 6.10003  | 32.6803  | 9.8076  | 35.9076  | 12376  | Free flight76 | EA20 |
| *Saccopteryx bilineata* | Emballonuridae | 0.00755  | 6.10005  | 5.90005  | 30.1366  | 8.8032  | 46.8032  | 2532 | Free flight32 | EA20 |
| *Saccopteryx bilineata* | Emballonuridae | 0.00755  | 6.10005  | 5.90005  | 30.1366  | 9.2032  | 44.5032  | 2532 | Free flight32 | EA20 |
| *Centronycteris centralis* | Emballonuridae | 0.00553  | 5.80003  | 5.40003  | 30.5866  | 5.9076  | 41.3076  | 15676  | Free flight76 | EA20 |
| *Rhynchonycteris naso* | Emballonuridae | 0.00395  | 6.50005  | 4.30005  | 27.3128  | 4.3819  | 95.7919  | 10019  | Free flight19 | EA62 |
| *Emballonura monticola* | Emballonuridae | 0.00535  | 7.70005  | 5.80005  | 33.2604  | 5.427  | 51.247  | 177  | Combination7 | EA3 |
| *Taphozous mauritianus* | Emballonuridae | 0.03404  | 7.21674  | 15.42744  | 47.6157  | 7.404  | 25.904  | NA  | Hand release4 | OA3 |
| *Taphozous melanopogon* | Emballonuridae | 0.03915  | 10.00005  | 25.90005  | 76.3005  | 6.027  | 29.717  | 337  | Combination7 | OA3 |
| *Saccolaimus saccolaimus* | Emballonuridae | 0.046436  | 8.600036  | 18.400036  | 51.1997  | 12.2036  | 22.6036  | 19836  | Hand release36 | OA3 |
| *Nycteris tragata* | Nycteridae | 0.016536  | 4.700036  | 7.700036  | 30.2415  | 2.877 | 97.647  | 167  | Combination7 | NG3 |
| *Nycteris macrotis* | Nycteridae | 0.01155  | 5.20005  | 7.10005  | 31.4505  | 1.204  | 76.704  | NA | Hand release4 | NG77 |
| *Nycteris thebaica* | Nycteridae | 0.01105 | 5.50005  | 6.30005  | 28.3233  | 1.3529  | 70.1829  | 1329  | Free flight29 | NG3 |
| *Rhinolophus* *hildebrandti* | Rhinolophidae | 0.02435  | 6.80005  | 9.80005  | 33.8301  | 45.2078  | 42.1078  | 1278  | Hand release78 | NF61, 79 |
| *Rhinolophus hildebrandti* | Rhinolophidae | 0.02435  | 6.80005  | 9.80005  | 33.8301  | 57.7078 | 42.8078  | 2478  | Hand release78 | NF61, 79 |
| *Rhinolophus* *hildebrandti* | Rhinolophidae | 0.02435  | 6.80005  | 9.80005  | 33.8301  | 46.908  | 42.2078  | 1978  | Free flight78  | NF61, 79 |
| *Rhinolophus ferrumequinum* | Rhinolophidae | 0.02265  | 6.10005  | 12.20005  | 43.1455  | 45.008-10  | 82.408-10  | 538-10  | Free flight8-10 | NF3, 80 |
| *Rhinolophus ferrumequinum* | Rhinolophidae | 0.02265  | 6.10005  | 12.20005  | 43.1455  | 49.4049  | 82.3049  | 2149 | Combination49 | NF3, 80 |
| *Rhinolophus ferrumequinum* | Rhinolophidae | 0.02265  | 6.10005  | 12.20005  | 43.1455  | 53.8012 | 78.7012 | 2812 | Combination12 | NF3, 80 |
| *Rhinolophus ferrumequinum* | Rhinolophidae | 0.02265  | 6.10005  | 12.20005  | 43.1455  | 50.5013 | 81.3013 | 6313 | Combination13 | NF3, 80 |
| *Rhinolophus euryale* | Rhinolophidae | 0.01095 | 6.20005  | 8.10005  | 36.5267  | 53.8012  | 104.8012 | 3812 | Combination12 | NF81 |
| *Rhinolophus euryale* | Rhinolophidae | 0.01095  | 6.20005  | 8.10005  | 36.5267  | 40.6013  | 102.4013 | 4513 | Combination13 | NF81 |
| *Rhinolophus mehelyi* | Rhinolophidae | 0.01582 | 6.6882 | 9.2582 | 37.5017  | 35.9012  | 109.5012  | 1612 | Combination12 | NF81 |
| *Rhinolophus landeri* | Rhinolophidae | 0.00905  | 6.10005  | 6.70005  | 32.2052  | 43.1078  | 109.0078  | 878  | Hand release78 | NF61, 77 |
| *Rhinolophus hipposideros* | Rhinolophidae | 0.00685  | 5.70005  | 7.10005  | 37.4700  | 43.6013  | 111.1013  | 3413 | Combination13 | NF3, 80 |
| *Rhinolophus hipposideros* | Rhinolophidae | 0.00685  | 5.70005  | 7.10005  | 37.4700  | 45.7049  | 109.0049  | 2449 | Combination49 | NF3, 80 |
| *Rhinolophus luctus* | Rhinolophidae | 0.033915  | 5.600015  | 9.100015  | 28.1142  | 69.9036  | 42.6036  | 2836  | Hand release36 | NF3 |
| *Rhinolophus trifoliatus* | Rhinolophidae | 0.012336  | 4.500036  | 6.300036  | 27.2661  | 44.5036  | 53.1036  | 4036  | Hand release36 | NF3 |
| *Rhinolophus macrotis* | Rhinolophidae | 0.005224  | 5.020024  | 4.800024  | 27.7011  | 30.4037  | 66.4037  | 1137  | Hand release37 | NF61, 83 |
| *Rhinolophus pusillus* | Rhinolophidae | 0.004324  | 5.090024  | 4.680024  | 28.7747  | 31.6037  | 105.0037  | 1037  | Combination37 | NF3 |
| *Rhinolophus lepidus* | Rhinolophidae | 0.006536  | 5.000036  | 6.200036  | 33.2502  | 25.2335  | 102.3135  | NA | Hand release35 | NF3 |
| *Rhinolophus lepidus* | Rhinolophidae | 0.006536  | 5.000036  | 6.200036  | 33.2502  | 28.3036 | 97.8036 | 24036  | Hand release36 | NF3 |
| *Rhinolophus sinicus* | Rhinolophidae | 0.011924  | 5.320024  | 8.440024  | 36.9626  | 33.8037  | 76.8037  | 737  | Hand release37 | NF61, 84 |
| *Rhinolophus stheno* | Rhinolophidae | 0.007915  | 6.000015  | 6.400015  | 32.1293  | 30.5037  | 91.1037  | 637  | Hand release37 | NF3 |
| *Rhinolophus affinis* | Rhinolophidae | 0.013924  | 5.140024  | 7.200024  | 29.9410  | 43.2037  | 71.1037  | 1837  | Combination37 | NF61, 85 |
| *Rhinolophus pearsonii* | Rhinolophidae | 0.015724  | 4.990024  | 7.290024  | 29.1095  | 41.5037  | 53.0037  | 1837  | Combination37 | NF61, 86 |
| *Hipposideros speoris* | Hipposideridae | 0.01105 | 6.50005  | 8.90005  | 40.0123  | 6.9987  | 130.4987  | NA | Combination 87 | NF3 |
| *Hipposideros pomona* | Hipposideridae | 0.006724  | 4.800024  | 5.440024  | 28.8515  | 7.0037  | 125.1037  | 737  | Combination37 | NF61, 88 |
| *Hipposideros caffer* | Hipposideridae | 0.00935  | 6.30005  | 6.60005  | 31.3797  | 8.0089  | 145.4089  | NA | Free flight89 | NF3 |
| *Hipposideros ruber* | Hipposideridae | 0.010115  | 6.600015  | 8.000015  | 36.9919  | 8.0675  | 131.9675  | 2275 | Free flight75 | NF61, 75 |
| *Hipposideros armiger* | Hipposideridae | 0.062124  | 5.570024  | 12.210024  | 30.8303  | 11.1037  | 65.0037  | 2937  | Combination37 | NF61, 90 |
| *Hipposideros larvatus* | Hipposideridae | 0.018824  | 5.300024  | 8.880024  | 33.3915  | 7.8037  | 86.5037  | 3237  | Combination37 | NF61, 90 |
| *Aselliscus stoliczkanus* | Hipposideridae | 0.005824  | 5.650024  | 4.900024  | 27.2675  | 4.7037  | 127.5037  | 537  | Combination37 | NF61, 90 |
| *Asellia tridens* | Hipposideridae | 0.011915  | 7.000015  | 9.000015  | 39.3820  | 10.3091 | 117.9091 | 1591 | Free flight91 | NF61, 75 |
| *Asellia tridens* | Hipposideridae | 0.011915 | 7.000015  | 9.000015  | 39.3820  | 7.9729 | 116.6029  | 5629 | Free flight29 | NF61, 75 |
| *Hipposideros* *commersoni* | Hipposideridae | 0.08905  | 7.70005  | 15.70005  | 35.1615  | 12.002  | 61.002  | NA | Hand release2 | NF46, 61 |
| *Triaenops persicus* | Rhinonycteridae | 0.01095  | 7.40005  | 9.20005  | 41.4871  | 8.5078  | 83.0078  | 1178  | Hand release78 | NF6 |
| *Rhinopoma microphyllum* | Rhinopomatidae | 0.03205  | 8.00005  | 20.50005  | 64.5635  | 8.3729  | 29.4229  | 11629  | Free flight29 | OA92 |
| *Rhinopoma hardwickii* | Rhinopomatidae | 0.01635  | 6.90005  | 14.00005  | 55.2085  | 8.5729  | 33.9929  | 25729  | Free flight29 | OA92 |
| *Craseonycteris thonglongyai* | Craseonycteridae | 0.00195  | 7.10005  | 5.20005  | 41.9754  | 3.5093  | 73.2093  | NA | Free flight93 | NG92 |
| *Cardioderma cor* | Megadermatidae | 0.030028  | 5.2028  | 9.633528  | 31.000028  | 1.3495  | 49.1395  | 35495  | Combination95 | NG92 |
| *Megaderma lyra* | Megadermatidae | 0.044624  | 5.240024  | 11.710024  | 33.0167 | 2.6037  | 42.5037  | 837  | Hand release37 | NG92 |
| *Megaderma spasma* | Megadermatidae | 0.027028  | 5.0028  | 9.901228  | 33.000028  | 2.0635  | 55.9035  | 535  | Hand release35 | NG92 |

Data are taken from published literature. Dura: call duration. FPeak: peak frequency. Guild: foraging guild. NCall: number of echolocation calls analyzed. NA: not available. OA: open-space aerial forager. EA: edge-space aerial forager. ET: edge-space trawling forager. NG: narrow-space gleaning forager. NF: narrow-space flutter-detecting forager. Superscript numbers indicate the source of the references (see below).

References:

1 Schoeman, M. C., and Waddington, K. J. (2011). Do deterministic processes influence the phenotypic patterns of animalivorous bat ensembles at urban rivers? *Afr*. *Zool*. 46, 288-301. doi: 10.1080/15627020.2011.11407502

2 Fenton, M. B., and Bell, G. P. (1981). Recognition of species of insectivorous bats by their echolocation calls. *J*. *Mammal*. 62, 233-243. doi: 10.2307/1380701

3 Jung, K., and Threlfall, C. G. (2018). Trait-dependent tolerance of bats to urbanization: a global meta-analysis. *P*. *Roy*. *Soc*. *B* 285: 20181222. doi: 10.1098/rspb.2018.1222

4 Schoeman, M. C., and Jacobs, D. S. (2008). The relative influence of competition and prey defenses on the phenotypic structure of insectivorous bat ensembles in southern Africa. *PLOS* *One* 3: e3715. doi: 10.1371/journal.pone.0003715

5 Norberg, U. M., and Rayner, J. M. (1987). Ecological morphology and flight in bats (Mammalia; Chiroptera): wing adaptations, flight performance, foraging strategy and echolocation. *Philos*. *T*. *R*. *Soc*. *Lond*. *B* 316, 335-427. doi: 10.1098/rstb.1987.0030

6 Monadjem, A., Taylor, P. J., Cotterill, F., Schoeman, M. C. (2010). *Bats of Central and Southern Africa: A Biogeographic and Taxonomic Synthesis*. Johannesburg: Wits University Press.

7 Hughes, A. C., Satasook, C., Bates, P. J., Soisook, P., Sritongchuay, T., and Jones, G., et al. (2011). Using echolocation calls to identify Thai bat species: Vespertilionidae, Emballonuridae, Nycteridae and Megadermatidae. *Acta*. *Chiropterol*. 13, 447-455. doi: 10.3161/150811011X624938

8 Barataud, M. (2015). *Acoustic Ecology of European Bats: Species Identification, Study of Their Habitats and Foraging Behaviour*. Paris: Biotope.

9 Barataud, M. (2017). “Update of the 3rd edition (2015) of Acoustic ecology of European bats http://ecologieacoustique.fr/?page\_id=1713 consulted on the 10/2003/2018,” Retrieved from: http://ecologieacoustique.fr/?page\_id=1713.

10 Roemer, C., Coulon, A., Disca, T., and Bas, Y. (2019). Bat sonar and wing morphology predict species vertical niche. *J*. *Acoust*. *Soc*. *Am*. 145, 3242-3251. doi: 10.1121/1.5102166

11 Schaub, A., and Schnitzler, H. U. (2007). Echolocation behavior of the bat *Vespertilio murinus* reveals the border between the habitat types “edge” and “open space”. *Behav*. *Ecol*. *Sociobiol*. 61, 513-523. doi: 10.1007/s00265-006-0279-9

12 Papadatou, E., Butlin, R. K., and Altringham, J. D. (2008). Identification of bat species in Greece from their echolocation calls. *Acta*. *Chiropterol*. 10, 127-143. doi: 10.3161/150811008X331153

13 Russo, D., and Jones, G. (2002). Identification of twenty-two bat species (Mammalia: Chiroptera) from Italy by analysis of time-expanded recordings of echolocation calls. *J*. *Zool*. 258, 91-103. doi: 10.1017/S0952836902001231

14 Dietz, C., Helversen, O. Von., Nill, D., Lina, P. H., and Hutson, A. M. (2009). *Bats of Britain, Europe and Northwest Africa*. London: A & C Black.

15 Jones, K. E., Purvis, A., and Gittleman, J. L. (2003). Biological correlates of extinction risk in bats. *Am*. *Nat*. 161, 601-614. doi: 10.1086/368289

16 Kingston, T., Jones, G., Akbar, Z., and Kunz, T. H. (2003). Alternation of echolocation calls in 5 species of aerial-feeding insectivorous bats from Malaysia. *J*. *Mammal*. 84, 205-215. doi: 10.1644/1545-1542(2003)084<0205:AOECIS>2.0.CO;2

17 Fukui, D., Agetsuma, N., and Hill, D. A. (2004). Acoustic identification of eight species of bat (Mammalia: Chiroptera) inhabiting forests of southern Hokkaido, Japan: potential for conservation monitoring. *Zool*. *Sci*. 21, 947-955. doi: 10.2108/zsj.21.947

18 Rydell, J., Arita, H., Santos, M., and Granados, J. (2002). Acoustic identification of insectivorous bats (order Chiroptera) of Yucatan, Mexico. *J*. *Zool*. 257, 27-36. doi: 10.1017/S0952836902000626

19 Zamora-Gutierrez, V., Lopez-Gonzalez, C., Macswiney Gonzalez, M. C., Fenton, B., Jones, G., and Kalko, E. K., et al. (2016). Acoustic identification of Mexican bats based on taxonomic and ecological constraints on call design. *Methods Ecol*. *Evol*. 7, 1082-1091. doi: 10.1111/2041-210X.12556

20 Kalko, E. K., Estrada Villegas, S., Schmidt, M., Wegmann, M., Meyer, C. F. (2008). Flying high—assessing the use of the aerosphere by bats. *Integr*. *Comp*. *Biol*. 48, 60-73. doi: 10.1093/icb/icn030

21 Marinello, M., and Bernard, E. (2014). Wing morphology of Neotropical bats: a quantitative and qualitative analysis with implications for habitat use. *Can*. *J*. *Zool*. 92, 141-147. doi: 10.1139/cjz-2013-0127

22 Pio, D. V., Clarke, F. M., Mackie, I., and Racey, P. A. (2010). Echolocation calls of the bats of Trinidad, West Indies: is guild membership reflected in echolocation signal design? *Acta*. *Chiropterol*. 12, 217-229. doi: 10.3161/150811010X504716

23 Obrist, M. K. (1995). Flexible bat echolocation: the influence of individual, habitat and conspecifics on sonar signal design. *Behav*. *Ecol*. *Sociobiol*. 36, 207-219. doi: 10.1007/BF00177798

24 Furey, N. M., and Racey, P. A. (2016). Can wing morphology inform conservation priorities for Southeast Asian cave bats? *Biotropica* 48, 545-556. doi: 10.1111/btp.12322

25 Thabah, A., Li, G., Wang, Y., Liang, B., Hu, K., and Zhang, S., et al. (2007). Diet, echolocation calls, and phylogenetic affinities of the great evening bat (*Ia io*; Vespertilionidae): another carnivorous bat. *J*. *Mammal*. 88, 728-735. doi: 10.1644/06-MAMM-A-167R1.1

26 Obrist, M., and Fenton, M. B. (1989). Roosting and echolocation behavior of the African bat, *Chalinolobus variegatus*. *J*. *Mammal*. 70, 828-833. doi: 10.2307/1381721

27 Barclay, R. M. (1986). The echolocation calls of hoary (*Lasiurus cinereus*) and silver-haired (*Lasionycteris noctivagans*) bats as adaptations for long-versus short-range foraging strategies and the consequences for prey selection. *Can*. *J*. *Zool*. 64, 2700-2705. doi: 10.1139/z86-394

28 Norberg, U. M., and Fenton, M. B. (1988). Carnivorous bats? *Biol*. *J*. *Linn*. *Soc*. 33, 383-394. doi: 10.1111/j.1095-8312.1988.tb00451.x

29 Hackett, T. D., Holderied, M. W., and Korine, C. (2017). Echolocation call description of 15 species of Middle-Eastern desert dwelling insectivorous bats. *Bioacoustics* 26, 217-235. doi: 10.1080/09524622.2016.1247386

30 Bell, G. (1982). Behavioral and ecological aspects of gleaning by a desert insectivorous bat *Antrozous pallidus* (Chiroptera: Vespertilionidae). *Behav*. *Ecol*. *Sociobiol*. 10, 217-223. doi: 10.1007/BF00299688

31 Murray, K. L., Fraser, E., Davy, C., Fleming, T.H., and Fenton, M.B. (2009). Characterization of the echolocation calls of bats from Exuma, Bahamas. *Acta*. *Chiropterol*. 11, 415-424. doi: 10.3161/150811009X485639

32 Macswiney, G. M. C., Clarke, F. M., and Racey, P. A. (2008). What you see is not what you get: the role of ultrasonic detectors in increasing inventory completeness in Neotropical bat assemblages. *J*. *Appl*. *Ecol*. 45, 1364-1371. doi: 10.1111/j.1365-2664.2008.01531.x

33 Williams-Guillén, K., and Perfecto, I. (2011). Ensemble composition and activity levels of insectivorous bats in response to management intensification in coffee agroforestry systems. *PLOS One* 6: e16502. doi: 10.1371/journal.pone.0016502

34 Belwood, J. J., and Fullard, J. H. (1984). Echolocation and foraging behaviour in the Hawaiian hoary bat, *Lasiurus cinereus* semotus. *Can*. *J*. *Zool*. 62, 2113-2120. doi: 10.1139/z84-306

35 Wordley, C. F., Foui, E. K., Mudappa, D., Sankaran, M., and Altringham, J. D. (2014). Acoustic identification of bats in the southern Western Ghats, India. *Acta*. *Chiropterol*. 16, 213-222. doi: 10.3161/150811014X683408

36 Pottie, S. A., Lane, D. J., Kingston, T., and Lee, B. P. H. (2005). The microchiropteran bat fauna of Singapore. *Acta*. *Chiropterol*. 7, 237-247. doi: 10.3161/150811005775162632

37 Furey, N. M., Mackie, I. J., and Racey, P. A. (2009). The role of ultrasonic bat detectors in improving inventory and monitoring surveys in Vietnamese karst bat assemblages. *Curr*. *Zool*. 55, 327-341. doi: 10.1093/czoolo/55.5.327

38 Ma, J., Jones, G., Zhang, S. Y., Shen, J., Metzner, W., and Zhang, L., et al. (2003). Dietary analysis confirms that Rickett's big-footed bat (*Myotis ricketti*) is a piscivore. *J*. *Zool*. 261, 245-248. doi: 10.1017/S095283690300414X

39 Verboom, B., Boonman, A. M., and Limpens, H. J. (1999). Acoustic perception of landscape elements by the pond bat (*Myotis dasycneme*). *J*. *Zool*. 248, 59-66. doi: 10.1111/j.1469-7998.1999.tb01022.x

40 Mckenzie, N., Gunnell, A., Yani, M., and Williams, M. (1995). Correspondence between plight morphology and foraging ecology in some palaeotropical bats. *Aust*. *J*. *Zool*. 43, 241-257. doi: 10.1071/ZO9950241

41 Ma, J., Liang, B., Zhang, S., and Metzner, W. (2008). Dietary composition and echolocation call design of three sympatric insectivorous bat species from China. *Ecol*. *Res*. 23, 113-119. doi: 10.1007/s11284-007-0344-5

42 Braun, J. K., Layman, Q. D., and Mares, M. A. (2009). *Myotis albescens* (Chiroptera: Vespertilionidae). *Mammalian Species* 846, 1-9. doi: 10.1644/846.1

43 Surlykke, A., and Kalko, E. K. (2008). Echolocating bats cry out loud to detect their prey. *PLOS One* 3: e2036. doi: 10.1371/journal.pone.0002036

44 Siemers, B. M., Kalko, E. K., and Schnitzler, H. U. (20010. Echolocation behavior and signal plasticity in the Neotropical bat *Myotis nigricans* (Schinz, 1821) (Vespertilionidae): a convergent case with European species of Pipistrellus? *Behav*. *Ecol*. *Sociobiol*. 50, 317-328. doi: 10.1007/s002650100379

45 Castillo-Figueroa, D. (2020). Ecological morphology of neotropical bat wing structures. *Zool*. *Stud*. 59: e60. doi: 10.6620/ZS.2020.59-60

46 Myers, P., Espinosa, R., Parr, C. S., Jones, T., Hammond, G. S., and Dewey, T. A. (2018). *The Animal Diversity Web*. Available online at: https://animaldiversity.org.

47 Mukhida, M., Orprecio, J., and Fenton, M. B. (2004). Echolocation calls of *Myotis lucifugus* and *M. leibii* (Vespertilionidae) flying inside a room and outside. *Acta*. *Chiropterol*. 6, 91-97. doi: 10.3161/1508110042176635

48 Simpson, M. R. (1993). *Myotis californicus*. *Mammalian species* 428, 1-4. doi: 10.2307/3504100

49 Vaughan, N., Jones, G., and Harris, S. (1997). Identification of British bat species by multivariate analysis of echolocation call parameters. *Bioacoustics* 7, 189-207. doi: 10.1080/09524622.1997.9753331

50 Müller, J., Brandl, R., Buchner, J., Pretzsch, H., Seifert, S., and Strätz, C., et al. (2013). From ground to above canopy—Bat activity in mature forests is driven by vegetation density and height. *Forest*. *Ecol*. *Manag*. 306, 179-184. doi: 10.1016/j.foreco.2013.06.043

51 Rhodes, M. P. (2002). Assessment of sources of variance and patterns of overlap in microchiropteran wing morphology in southeast Queensland, Australia. *Can*. *J*. *Zool*. 80, 450-460. doi: 10.1139/z02-029

52 Mora, E. C., and Torres, L. (2008). Echolocation in the large molossid bats *Eumops glaucinus* and *Nyctinomops macrotis*. *Zool*. *Sci*. 25, 6-13. doi: 10.2108/zsj.25.6

53 Mora, E. C., Macías, S., Vater, M., Coro, F., and Kössl, M. (2004). Specializations for aerial hawking in the echolocation system of *Molossus molossus* (Molossidae, Chiroptera). *J*. *Comp*. *Physiol*. *A* 190, 561-574. doi: 10.1007/s00359-004-0519-2

54 Fenton, M., Jacobs, D., Richardson, E., Taylor, P., and White, W. (2004). Individual signatures in the frequency-modulated sweep calls of African large-eared, free-tailed bats *Otomops martiensseni* (Chiroptera: Molossidae). *J*. *Zool*. 262, 11-19. doi: 10.1017/S095283690300431X

55 Deshpande, K., and Kelkar, N. (2015). Acoustic identification of *Otomops wroughtoni* and other free-tailed bat species (Chiroptera: Molossidae) from India. *Acta*. *Chiropterol*. 17, 419-428. doi: 10.3161/15081109ACC2015.17.2.018

56 Gillam, E. H., and Mccracken, G. F. (2007). Variability in the echolocation of *Tadarida brasiliensis*: effects of geography and local acoustic environment. *Anim*. *Behav*. 74, 277-286. doi: 10.1016/j.anbehav.2006.12.006

57 Tavares, V. D. C., and Mancina, C. A. (2008). *Phyllops falcatus* (Chiroptera: Phyllostomidae). *Mammalian Species* 811, 1-7. doi: 10.1644/811.1

58 Macías, S., Mora, E. C., Koch, C., and Helversen, O. Von. (2005). Echolocation behaviour of *Phyllops falcatus* (Chiroptera: Phyllostomidae): unusual frequency range of the first harmonic. *Acta*. *Chiropterol*. 7, 275-283. doi: 10.3161/150811005775162597

59 Jennings, N. V., Parsons, S., Barlow, K. E. and Gannon, M. R. (2004). Echolocation calls and wing morphology of bats from the West Indies. *Acta*. *Chiropterol*. **6**, 75-90. doi: 10.3161/1508110042176644

60 Genoways, H. H., and Baker, R. J. (1972). *Stenoderma rufum*. *Mammalian Species* 18, 1-4. doi: 10.2307/3503991

61 Denzinger, A., and Schnitzler, H. U. (2013). Bat guilds, a concept to classify the highly diverse foraging and echolocation behaviors of microchiropteran bats. *Front*. *Physiol*. 4: 164. doi: 10.3389/fphys.2013.00164

62 Kalko, E. K., and Handley, C. O. (2001). Neotropical bats in the canopy: diversity, community structure, and implications for conservation. *Plant Ecol*. 153, 319-333. doi: 10.1023/A:1017590007861

63 Weinbeer, M., Meyer, C. F., and Kalko, E. K. (2006). Activity pattern of the trawling phyllostomid bat, *Macrophyllum macrophyllu*m, in Panamá. *Biotropica* 38, 69-76. doi: 10.1111/j.1744-7429.2006.00101.x

64 Brinkløv, S., Kalko, E. K., and Surlykke, A. (2010). Dynamic adjustment of biosonar intensity to habitat clutter in the bat *Macrophyllum macrophyllum* (Phyllostomidae). *Behav*. *Ecol*. *Sociobiol*. 64, 1867-1874. doi: 10.1007/s00265-010-0998-9

65 Campbell, S. (2011). “Ecological specialisation and conservation of Australia’s large-footed myotis: a review of trawling bat behaviour,” In *The Biology and Conservation of Australasian Bats*, eds B. Law, P. Eby, L. Lumsden, D. Lunney. Mosman: Royal. Zoological. Society. Of. NSW. 72-85.

66 Homan, J. A., and Jones, J. K. (1975). *Monophyllus plethodon*. *Mammalian Species* 58, 1-2. doi: 10.2307/0.58.1

67 Soto-Centeno, J. A., Phillips, D. L., Kurta, A., and Hobson, K. A. (2014). Food resource partitioning in syntopic nectarivorous bats on Puerto Rico. *J*. *Trop*. *Ecol*. 30, 359-369. doi: 10.1017/S0266467414000145

68 Sampaio, E. M., Kalko, E. K., Bernard, E., Rodríguez-Herrera, B., and Handley, C. O. (2003). A biodiversity assessment of bats (Chiroptera) in a tropical lowland rainforest of Central Amazonia, including methodological and conservation considerations. *Stud*. *Neotrop*. *Fauna*. *E* 38, 17-31. doi: 10.1076/snfe.38.1.17.14035

69 Sánchez, Ó., and Wilson, D. E. (2016). Food items of *Macrotus waterhousii* (Chiroptera: Phyllostomidae) in central Mexico. *Therya* 7, 161-177. doi: 10.12933/therya-16-355

70 Emrich, M. A., Clare, E. L., Symondson, W. O., Koenig, S. E., and Fenton, M. B. (2014). Resource partitioning by insectivorous bats in J amaica. *Mol*. *Ecol*. 23, 3648-3656. doi: 10.1111/mec.12504

71 Macías, S., Mora, E. C., and García, A. (2006). Acoustic identification of mormoopid bats: a survey during the evening exodus. *J*. *Mammal*. 87, 324-330. doi: 10.1644/05-MAMM-A-124R1.1

72 Mancina, C. A. (2005). *Pteronotus macleayii*. *Mammalian Species* 778, 1-3. doi: 10.1644/778.1

73 Kalko, E. K., Schnitzler, H. U., Kaipf, I., and Grinnell, A. D. (1998). Echolocation and foraging behavior of the lesser bulldog bat, *Noctilio albiventris*: preadaptations for piscivory? *Behav*. *Ecol*. *Sociobiol*. 42, 305-319. doi: 10.1007/s002650050443

74 Jones, G., Webb, P. I., Sedgeley, J. A., and O'donnell, C. F. (2003). Mysterious *Mystacina*: how the New Zealand short-tailed bat (*Mystacina tuberculata*) locates insect prey. *J*. *Exp*. *Biol*. 206, 4209-4216. doi: 10.1242/jeb.00678

75 Jones, G., Morton, M., Hughes, P., and Budden, R. (1993). Echolocation, flight morphology and foraging strategies of some West African hipposiderid bats. *J*. *Zool*. 230, 385-400. doi: 10.1111/j.1469-7998.1993.tb02691.x

76 Jung, K., Kalko, E. V., Von Helversen, O. (2007). Echolocation calls in Central American emballonurid bats: signal design and call frequency alternation. *J*. *Zool*. 272, 125-137. doi: 10.1111/j.1469-7998.2006.00250.x

77 Fenton, M. B., and Fullard, J. H. (1979). The influence of moth hearing on bat echolocation strategies. *J*. *Comp*. *Physiol*. 132, 77-86. doi: 10.1007/BF00617734

78 Taylor, P., Geiselman, C., Kabochi, P., Agwanda, B., and Turner, S. (2005). Intraspecific variation in the calls of some African bats (Order Chiroptera). *Durban*. *Mus*. *Novit*. 30, 24-37.

79 Fenton, M. B., and Rautenbach, I. (1986). A comparison of the roosting and foraging behaviour of three species of African insectivorous bats (Rhinolophidae, Vespertilionidae, and Molossidae). *Can*. *J*. *Zool*. 64, 2860-2867. doi: 10.1139/z86-412

80 Jones, G., and Rayner, J. (1989). Foraging behavior and echolocation of wild horseshoe bats *Rhinolophus ferrumequinum* and *R. hipposideros* (Chiroptera, Rhinolophidae). *Behav*. *Ecol*. *Sociobiol*. 25, 183-191. doi: 10.1007/BF00302917

81 Voigt, C. C., Dekker, J., Fritze, M., Gazaryan, S., Hölker, F., and Jones, G., et al. (2021). The impact of light pollution on bats varies according to foraging guild and habitat context. *BioScience* 71, 1103-1109. doi: 10.1093/biosci/biab087

82 Salsamendi, E., Aihartza, J., Goiti, U., Almenar, D., and Garin, I. (2005). Echolocation calls and morphology in the Mehelyi’s (*Rhinolophus mehelyi*) and Mediterranean (*R. euryale*) horseshoe bats: implications for resource partitioning. *Hystrix* 16, 149-158. doi: 10.4404/hystrix-16.2-4353

83 Shi, L. M., Feng, J., Liu, Y., Ye, G. X., and Zhu, X. (2009). Is food resource partitioning responsible for deviation of echolocation call frequencies from allometry in *Rhinolophus macrotis*? *Acta*. *Theriol*. 54, 371-382. doi: 10.4098/j.at.0001-7051.099.2008

84 Li, Y., Wang, J., Metzner, W., Luo, B., Jiang, T. L., and Yang, S., et al. (2014). Behavioral responses to echolocation calls from sympatric heterospecific bats: implications for interspecific competition. *Behav*. *Ecol*. *Sociobiol*. 68, 657-667. doi: 10.1007/s00265-013-1680-9

85 Phommexay, P., Satasook, C., Bates, P., Pearch, M., and Bumrungsri, S. (2011). The impact of rubber plantations on the diversity and activity of understorey insectivorous bats in southern Thailand. *Biodivers*. *Conserv*. 20, 1441-1456. doi: 10.1007/s10531-011-0036-x

86 Zhou, J., Xie, J. H., Dai, Q., Zeng, Y. J., Liu, J. X., Zhang, W. G., et al. (2002). Feeding behavioral strategy of *Rhinolophus pearsoni* in summer. *Zool*. *Res*. 23, 120-128.

87 Pavey, C. R., Grunwald, J. E., and Neuweiler, G. (2001). Foraging habitat and echolocation behaviour of Schneider's leafnosed bat, *Hipposideros speoris*, in a vegetation mosaic in Sri Lanka. *Behav*. *Ecol*. *Sociobiol*. 50, 209-218. doi: 10.1007/s002650100363

88 Wordley, C. F., Sankaran, M., Mudappa, D., and Altringham, J. D. (2018). Heard but not seen: Comparing bat assemblages and study methods in a mosaic landscape in the Western Ghats of India. *Ecol*. *Evol*. 8, 3883-3894. doi: 10.1002/ece3.3942

89 Fenton, M. B. (1986). *Hipposideros caffer* (Chiroptera: Hipposideridae) in Zimbabwe: morphology and echolocation calls. *J*. *Zool*. 210, 347-353. doi: 10.1111/j.1469-7998.1986.tb03638.x

90 Zhou. (2001). *Spatial Niches and Intespecific Relationships among Seven Bat Species in Guizhou Province*. Guiyang: Guizhou Normal University (in Chinese).

91 Benda, P., Faizolâhi, K., Andreas, M., Obuch, J., Reiter, A. and Ševčík, M., et al. 2012. Bats (Mammalia: Chiroptera) of the Eastern Mediterranean and Middle East. Part 10. Bat fauna of Iran. *Acta*. *Soc*. *Zool*. *Bohem*. 76, 163-582.

92 Ratcliffe, J. M., Fenton, M. B., and Shettleworth, S. J. (2006). Behavioral flexibility positively correlated with relative brain volume in predatory bats. *Brain*. *Behav*. *Evol*. 67, 165-176. doi: 10.1159/000090980

93 Surlykke, A., Miller, L. A., Møhl, B., Andersen, B. B., Christensen-Dalsgaard, J., and Jørgensen, M. B., et al. (1993). Echolocation in two very small bats from Thailand *Craseonycteris thonglongyai* and *Myotis siligorensis*. *Behav*. *Ecol*. *Sociobiol*. 33, 1-12. doi: 10.1007/BF00164341

94 Hill, J. E., and Smith, S. E. (1981). *Craseonycteris thonglongyai*. *Mammalian species* 160, 1-4. doi: 10.2307/3503984

95 Smarsh, G. C., and Smotherman, M. (2015). Intra-and interspecific variability of echolocation pulse acoustics in the African megadermatid bats. *Acta*. *Chiropterol*. 17, 429-443. doi: 10.3161/15081109ACC2015.17.2.019

96 Bernard, E., and Fenton, M.B. (2003) Bat mobility and roosts in a fragmented landscape in central Amazonia, Brazil. *Biotropica*, 35, 262-277. [doi](https://doi):10.1111/j.1744-7429.2003.tb00285.x

**Table S2.** Relationship between wing morphology and size-corrected echolocation call parameters

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Bats  | Parameter | Predictors  | Model | AICc | *R2* | Estimate  | *P* |
| All bats studied(*N* = 152) | Size-corrected call duration (SCCD) | Relative wing loading  | BM | -4.00 | 0.79 | -0.32 | 0.056 |
| OU | 162.20 | 0.076 | -0.17 | 0.58 |
| **λ** | **-18.70** | **0.81** | **0.11** | **0.57** |
| OLS | 162.30 | 0.075 | -0.17 | 0.58 |
| Aspect ratio | BM | -2.00 | 0.79 | 0.20 | 0.54 |
| OU | 161.20 | 0.078 | 0.36 | 0.39 |
| **λ** | **-20.10** | **0.81** | **0.26** | **0.38** |
| OLS | 161.30 | 0.078 | 0.36 | 0.39 |
| Size-corrected peak frequency (SCPF) | Relative wing loading  | BM | -156.60 | 0.73 | 0.35 | 0.0005 |
| OU | -50.60 | 0.11 | -0.62 | < 0.0001 |
| **λ** | **-184.10** | **0.73** | **-0.24** | **0.037** |
| OLS | -50.90 | 0.11 | -0.62 | < 0.0001 |
| Aspect ratio | BM | -152.90 | 0.74 | -0.53 | 0.0079 |
| OU | -69.50 | 0.21 | -1.20 | < 0.0001 |
| **λ** | **-201.40** | **0.75** | **-0.56** | **0.0008** |
| OLS | -69.50 | 0.21 | -1.19 | < 0.0001 |
| Bats excluding narrow-space flutter-detecting foragers(*N* = 126)  | Size-corrected call duration (SCCD) | Relative wing loading  | BM | -12.00 | 0.62 | -0.19 | 0.27 |
| OU | 51.00 | 0.18 | 0.82 | < 0.0001 |
| **λ** | **-36.50** | **0.68** | **0.48** | **0.014** |
| OLS | 50.90 | 0.18 | 0.82 | < 0.0001 |
| Aspect ratio | BM | -13.20 | 0.62 | 0.35 | 0.30 |
| OU | 32.30 | 0.29 | 1.75 | < 0.0001 |
| **λ** | **-37.40** | **0.66** | **0.65** | **0.032** |
| OLS | 32.50 | 0.29 | 1.75 | < 0.0001 |
| Size-corrected peak frequency (SCPF) | Relative wing loading  | BM | -130.90 | 0.66 | 0.36 | 0.0007 |
| OU | -63.40 | 0.10 | -0.41 | 0.0067 |
| **λ** | **-164.80** | **0.69** | **-0.23** | **0.047** |
| OLS | -63.50 | 0.11 | -0.41 | 0.0062 |
| Aspect ratio | BM | -129.00 | 0.68 | -0.61 | 0.0047 |
| OU | -86.30 | 0.25 | -1.08 | < 0.0001 |
| **λ** | **-180.60** | **0.72** | **-0.69** | **0.0001** |
| OLS | -86.30 | 0.25 | -1.08 | < 0.0001 |

SCCD and SCPF refer to the residuals extracted from the best-fitting phylogenetic generalized least square (PGLS) regressions of log10 body mass on log10 call duration and log10 peak frequency, respectively. RWL: relative wing loading. AR: aspect ratio. BM: Brownian motion model. OU: Ornstein-Uhlenbeck model. λ: lambda model. OLS: ordinary least square regression. AICc: Akaike’s information criterion corrected for a small sample size. The best-fitting models are shown in bold.

**Table S3.** Relationship between wing morphology and echolocation call parameters after weighting for sample size

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Number of bat species  | Parameter | Predictors  | Model | AICc | *R2* | Estimate  | *P* |
| 117 | Call duration | Relative wing loading  | BM | 102.20 | 0.83 | 1.17 | < 0.0001 |
| OU | 165.70 | 0.15 | 1.06 | 0.0002 |
| **λ** | **97.80** | **0.82** | **1.19** | **< 0.0001** |
| OLS | 165.70 | 0.035 | 1.06 | 0.0002 |
| Aspect ratio | BM | 110.20 | 0.81 | 1.21 | 0.0008 |
| OU | 166.90 | 0.084 | 1.36 | 0.0006 |
| **λ** | **105.40** | **0.80** | **1.27** | **0.0003** |
| OLS | 166.90 | 0.037 | 1.36 | 0.0006 |
| Peak frequency  | Relative wing loading  | BM | 10.40 | 0.64 | -0.77 | < 0.0001 |
| OU | 34.20 | 0.15 | -1.07 | < 0.0001 |
| **λ** | **8.40** | **0.60** | **-0.87** | **< 0.0001** |
| OLS | 34.20 | 0.20 | -1.07 | < 0.0001 |
| Aspect ratio | **BM** | **-4.30** | **0.65** | **-1.33** | **< 0.0001** |
| OU | 17.60 | 0.30 | -1.69 | < 0.0001 |
| λ | -3.90 | 0.63 | -1.34 | < 0.0001 |
| OLS | 7.30 | 0.31 | -1.69 | < 0.0001 |

BM: Brownian motion model. OU: Ornstein-Uhlenbeck model. λ: lambda model. OLS: ordinary least square

regression. AICc: Akaike’s information criterion corrected for a small sample size. The best-fitting models are

shown in bold.